3.3 WATER RESOURCES - GROUNDWATER

This section of the DEIS describes the existing groundwater conditions on the site and in the site vicinity (including the Sequalitchew Creek watershed). Potential impacts associated with the EIS Alternatives are evaluated and mitigation measures identified. This section is based on the *Earth and Water Resources Report* (May 2023), *Stormwater Management Report* (February 2021)*, Groundwater Model Update* (June 2017), and *South Parcel Monitoring Plan* (November 2017) all prepared by Aspect Consulting and peer reviewed by Mott MacDonald (see **Appendices B**, **D**, **E**, and **F**).

3.3.1 Affected Environment

Groundwater Hydrology

Groundwater occurs in five primary hydrogeologic units at or near the surface in the site area, which are described in **Table 3.3-1** and depicted in generalized cross section **Figure 2-3** in **Chapter 2**. From top to bottom, these include the Steilacoom Gravel, the Upper Confining Unit, the Vashon Outwash, the Olympia Beds, and the Sea Level Aquifer. The Steilacoom Gravel (Qvs) is coarse-grained and primarily composed of extremely permeable gravel; the Upper Confining Unit is a thin (five to 10 foot thick) silty zone and is not uniformly present across the site area; the Vashon Outwash (Qgog/Qva) is composed of sand and gravel; the Olympia Beds (Qob) are composed of fine-grained silts and clays deposited during an interglacial period; and the Sea Level Aquifer (Qpog) is composed of pre-Olympia sand and gravel glacial drift deposits.

These hydrologic units reflect the glacial history of the Puget Lowland. The oldest geologic deposits of the Sea Level Gravel (Qpog) are the result of earlier (pre-Vashon) glacial advance and retreat. The Olympia Beds (Qob) were deposited above the Qpog sediments during the interglacial period preceding the most recent Vashon glaciation and include fine-grained deposits of low permeability. After the OlympiaBeds (Qob) were deposited, the advancing Vashon-era continental glacier carved a valley through the Qob and partially into the underlying Sea Level Aquifer (Qpog), depositing Vashon Outwash sediments within the valley. As the Vashon glacier melted and receded, a lobe of ice blocked the northward drainage of the Puyallup valley, creating a lake. The Steilacoom Gravel (Qvs) is interpreted to have formed when a series of ice dam bursts released the glacially impounded water, which transported coarse-grained sediments into a broad outwash plain in the Sequalitchew Creek area. These flood deposits filled in low areas, created thick deltas, and flowed over the then-existing coastal bluffs within the Olympia Beds and into the glacial valley. The contact between the new Qvs sediment deposits and the former steep bluffs is referred to as the “Olympia Beds Truncation”.

Table 3.3-1
SUMMARY OF HYDROSTRATIGRAPHIC UNITS AND CALIBRATED PARAMETER VALUES

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.

Source: Aspect Consulting, 2022.

The Steilacoom Gravel (Qvs) and the Vashon Outwash (Qgog) form the uppermost shallow groundwater aquifer underlying the site area (herein referred to as the Vashon Aquifer), which is unconfined. The Upper Confining Unit present within the Vashon Aquifer behaves neither as an aquifer nor a competent aquitard (which is a geologic stratum that restricts but does not prevent movement of water); it nonetheless somewhat separates the uppermost Qvs portion of the Vashon Aquifer from the lower Qgog/Qva portion, and in cross section (**Chapter 2**, **Figure 2-3** and **Figure 3.3-1,** is represented by the dashed line that underlies the Steilacoom Gravel (Qvs) and separates it from the Vashon Outwash (Qgog/Qva). The Qvs is a subunit of the more regionally extensive Vashon Recessional Outwash (Qgog) geologic unit, both of which are shown in **Figure 3.3-1**.

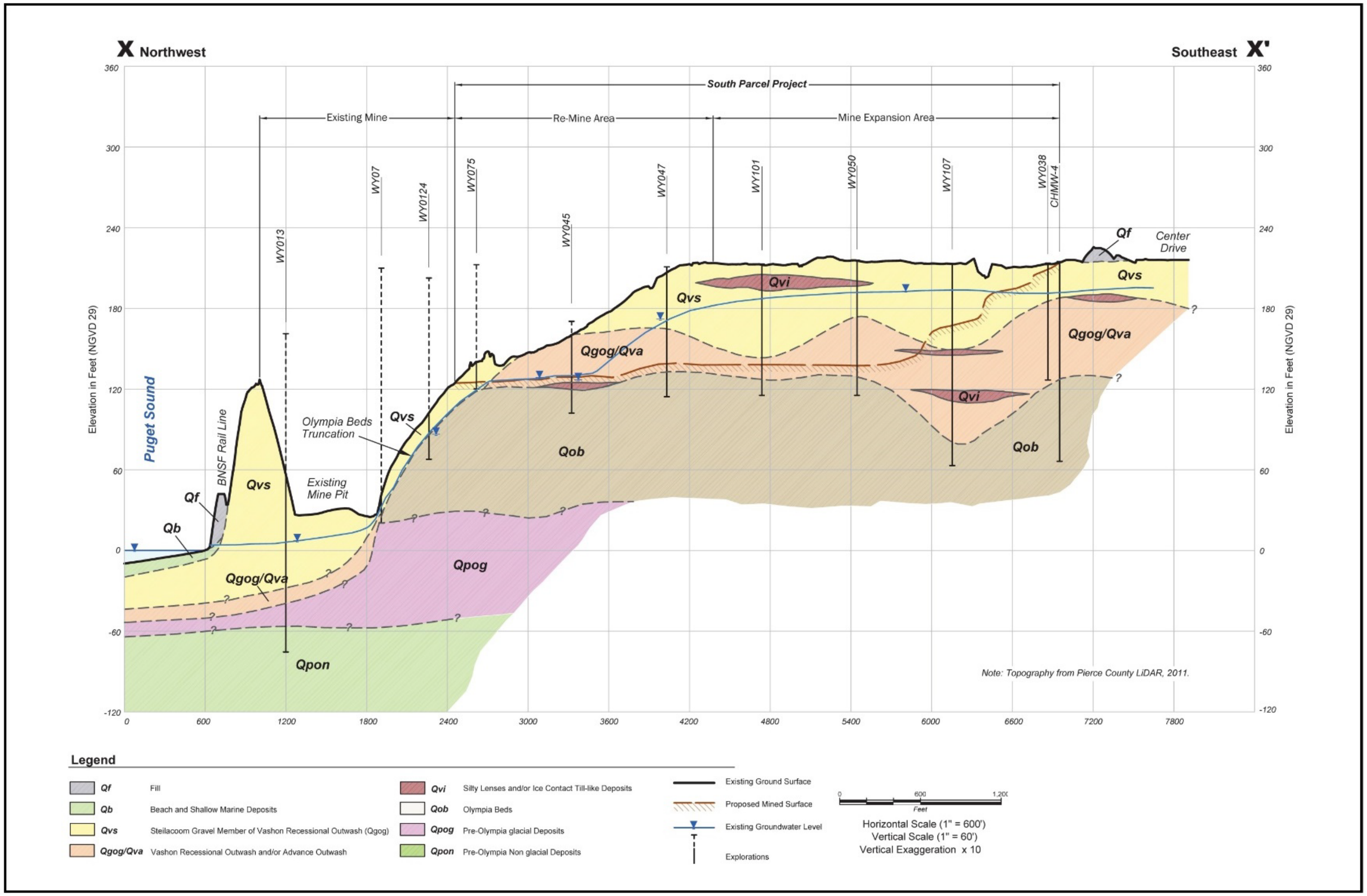
The Vashon Aquifer is separated from the Sea Level Aquifer by the Olympia Beds (Qob), which behaves as an aquitard and is approximately 40 to 80 feet thick in the site area. The Sea Level Aquifer is a highly productive regional aquifer that is generally confined, (i.e. its water is pressurized due to aquitard layers that overlie and underlie the aquifer) except in areas west of the Olympia Bed Truncation, with the approximate location of the truncation shown in **Figure 3.3-2**.

Surface soils overlie the major surficial geologic units. Over most of the site area surficial soils do not appreciably alter the hydrology; however, in wetland areas peaty soils are present and underlain by silty ice-contact deposits, as depicted in **Chapter 2**, **Figure 2-3** and **Figure 3.3-3**. The presence of finer-grained materials beneath the primary wetland complex in the area (e.g., Bell, McKay, Hamer, East Edmond, and West Edmond marshes) affects the relationship between wetland waters and groundwater. Where peaty soils occur, the amount and rate of surface water that can flow into (or out of) the Vashon Aquifer is limited due to their low permeability. In areas where historical activities removed peat and/or fine-grained marsh soils from the wetlands (such as near roadways, the former railway grade that separates East and West Edmond marsh, and channelized areas of Edmond Marsh where former fish hatchery activities removed peat to improve fish passage) surface water and groundwater have a greater degree of hydraulic connection, and therefore the local wetland response to aquifer drawdown is greater (aquifer drawdown is the decrease in groundwater level that occurs due to dewatering).

Groundwater Flow and Water Levels

Groundwater flow occurs primarily in the Vashon Aquifer and Sea Level Aquifer. Surface water features may also reflect aquifer water levels and/or interact with shallow groundwater as locations of groundwater recharge or discharge; therefore, local surface water relationships with groundwater are also discussed in this sub-section.

Pioneer Aggregates South Parcel Project
Draft EIS

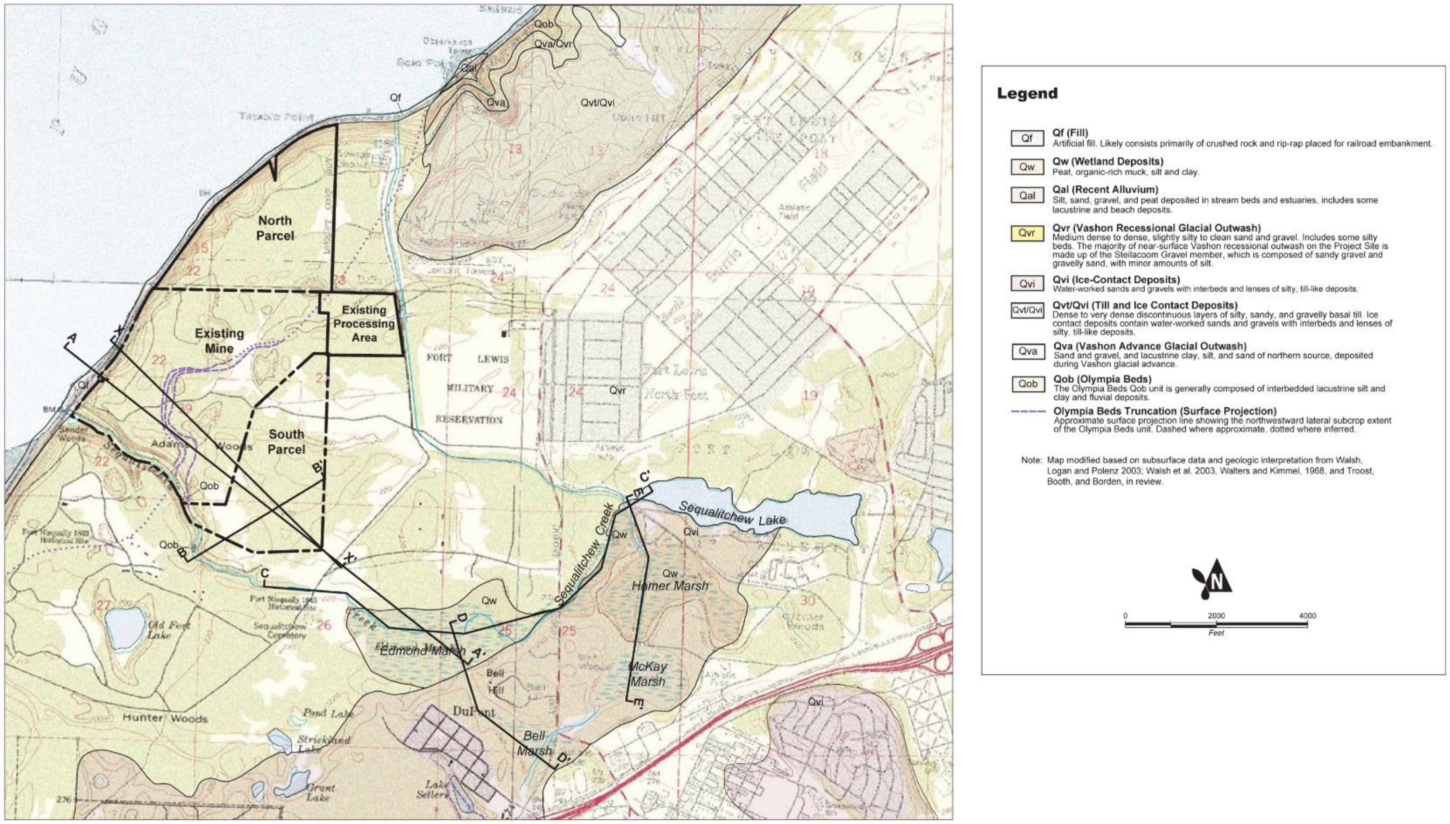


Source: Aspect, 2022.

EA Engineering, Science, and Technology, Inc., PBC

Figure 3.3-1

Generalized Geologic Cross Section

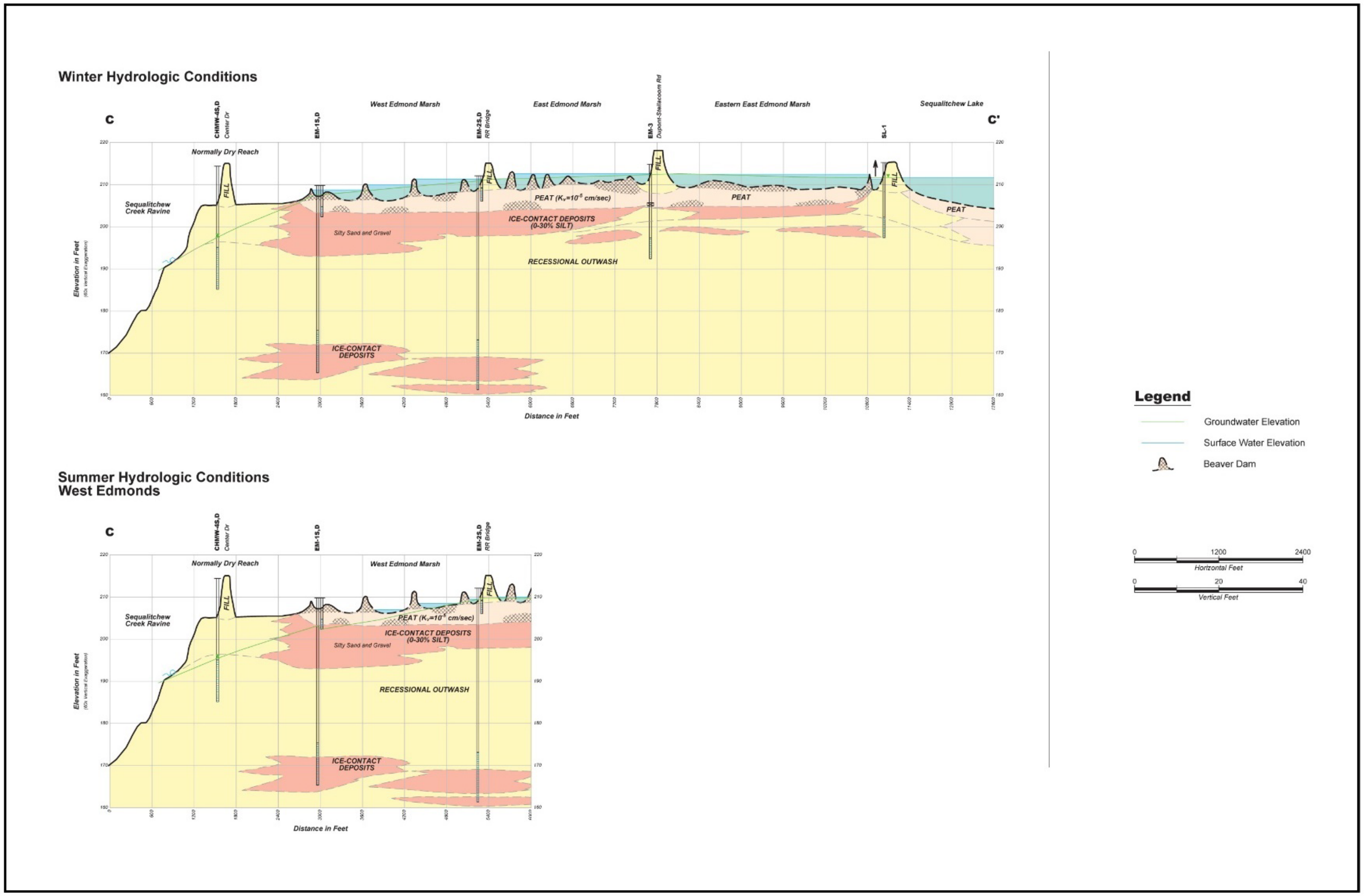


Source: Aspect, 2022.

EA Engineering, Science, and Technology, Inc., PBC

Figure 3.3-2
Regional Geologic Map

Pioneer Aggregates South Parcel Project
Draft EIS



Source: Aspect, 2022.

EA Engineering, Science, and Technology, Inc., PBC

Figure 3.3-3

Edmond Marsh Cross Section

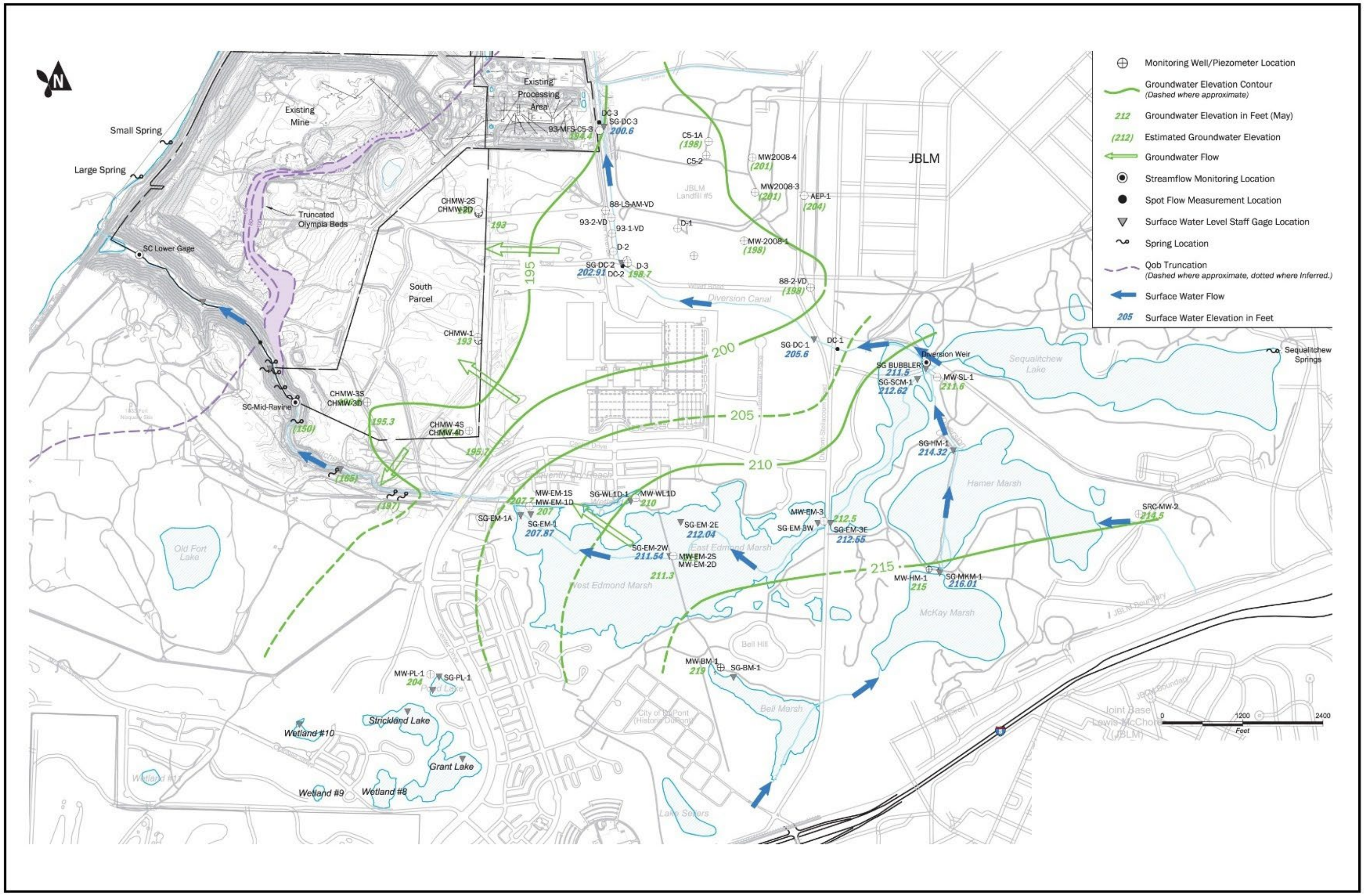
Vashon Aquifer water level monitoring as well as lake and wetland stage monitoring has occurred near the site on a monthly basis since 2003. **Figure 3.3-4** presents observed Vashon Aquifer water levels elevations and surface water elevations from May 2010, which represents approximate average annual conditions. Vashon Aquifer water levels east of the Olympia Bed Truncation are significantly higher (ranging from approximately 190 to 215 feet) than water levels to the west, where groundwater elevations in the merged Vashon-Sea Level Aquifer are approximately 15 feet). As depicted in **Figure 3.3-1**, the water table drops steeply across the truncation and has an elevation close to sea level in the merged Vashon-Sea Level Aquifer.

Vashon Aquifer water level elevations presented in **Figure 3.3-4** indicate that groundwater flow is generally to the northwest. Local variations however occur, with local groundwater flow paths to the southwest near the upper Sequalitchew Creek ravine where groundwater discharge occurs and adds flow to the creek. The JBLM Diversion Canal about a mile to the northeast has some stretches where it gains flow due to groundwater discharge and some reaches where it loses surface water to groundwater.

Seasonal water level fluctuation is variable in the Vashon Aquifer, with groundwater levels varying by two to three feet near Edmond Marsh and by greater than 10 feet at monitoring well CHMW-3S on the South Parcel near the Sequalitchew Creek ravine. Seasonal water level variations are lower near large surface water features that potentially recharge groundwater (such Edmond Marsh) and higher near perennial groundwater discharge locations (such as at the Olympia Beds truncation and the Sequalitchew Creek ravine above the truncation). Groundwater levels are typically highest in early or mid-spring and lowest in fall.

Because the Sea Level Aquifer is separated from the Vashon Aquifer in most of site area by the low-permeability Olympia Beds, where the Olympia Beds are present the vertical flow of groundwater between the Vashon Aquifer and the Sea Level Aquifer is significantly impeded. Because of this, water levels in the Sea Level Aquifer east of the truncation do not require as much monitoring or characterization in as much local detail as the Vashon Aquifer. In the Sea Level Aquifer groundwater flow is generally to the northwest towards Puget Sound based on regional mapping by the USGS.

Water level elevations measured in kettle depression lakes and wetlands can be representative of aquifer water levels if they do not receive significant surface water inflows and/or if fine-grained sediments do not separate the surface water body from the underlying aquifer. However, because these lakes and wetlands are surface water features and future changes in their water levels will not notably impact flow into or out of the Vashon Aquifer, these features and changes in their surface water level elevations are discussed in Section 3.4, **Surface Water**. These surface water features include Old Fort Lake, Pond Lake, Strickland Lake, Grant Lake, Wetlands #8, #9, #10 and #11, Wetland 1-D, and the onsite Kettle Wetland.



Source: Aspect, 2022.

EA Engineering, Science, and Technology, Inc., PBC

Figure 3.3-4

Surface Water System

Aquifer recharge typically occurs if precipitation infiltrates past the root zone in the subsurface. This direct precipitation-based recharge occurs through soils throughout the site area. Groundwater recharge can also occur if the water level elevation of a surface water body is higher than the water level in the aquifer beneath it. The rate of recharge entering groundwater from a surface water body is proportional to the permeability of the sediments (i.e., their ability to transmit water) connecting the two water bodies and the difference in water level elevation between them. The rate of groundwater discharge to a surface water body is controlled by the same relationship but occurs when the groundwater elevation is higher than the surface water elevation. Groundwater recharge and discharge relationships between surface water and the underlying aquifer can vary with seasonal changes in water levels. Areas or features where groundwater recharge or discharge occurs are discussed below.

Lakes

Sequalitchew Lake, the headwater of Sequalitchew Creek, is fed by Sequalitchew Springs (which serve as JBLM's primary water supply) at the eastern end of the lake. Spring discharge not consumed by JBLM flows into Sequalitchew Lake. Sequalitchew Lake has a surface water outlet to Sequalitchew Creek at its western end, which currently flows into the Diversion Canal due to beaver dam blockages. Water levels at Sequalitchew Lake are currently controlled by a weir at its outlet. Sequalitchew Lake water levels likely represent the approximate average groundwater elevation in its vicinity; however, due to its surface water inflows and controlled outlet elevation, lake water levels do not solely reflect aquifer water levels. Additional detail is provided in Section 3.4, **Surface Water**.

As previously mentioned, kettle lake and wetland features that do not have surface water inflows or outflows (and therefore do not cause significant aquifer recharge or discharge) are discussed in Section 3.4, **Surface Water**.

Wetlands

Bell, McKay, Hamer, East Edmond, and West Edmond marshes comprise the large wetland complex southeast of the site. Groundwater-surface water interactions in these wetlands are complex and vary both seasonally and by location. Wetland water level elevations are typically higher than local groundwater elevations and provide net aquifer recharge. However, due to surface water inflows and diversions, beaver activity, seasonality, and the sloping water table, variations in the groundwater/surface water relationship can potentially occur in each wetland and can affect the amount of groundwater recharge/discharge that occurs there. Groundwater recharge and discharge can jointly occur if a wetland overlays a sloping water table, with groundwater discharge occurring on the upgradient side of the wetland and recharge occurring on its downgradient side.

Bell Marsh has the highest elevation of these marshes and receives surface water inflow from JBLM stormwater runoff. It has a surface water outflow to McKay Marsh, and likely supports some shallow groundwater recharge and groundwater flow to the north to Edmond Marsh (which has a water level elevation typically 6 to 7 feet lower). McKay Marsh receives surface water inflow from Bell Marsh; its primary outflow is surface water flow to Hamer Marsh, though based on surface water elevations some shallow groundwater recharge is likely and may flow west-northwest parallel to a small chain of wetlands toward Edmonds Marsh. Hamer Marsh receives surface water inflow from McKay Marsh and JBLM stormwater. Its primary surface water outflow is to the Diversion Canal and to East Edmond Marsh when its water level elevation exceeds 214 feet (which is the invert elevation of a connecting culvert). Shallow groundwater recharge and subsurface flow west to East Edmond Marsh also likely occurs. Hamer Marsh has been characterized as having greater connection to and receiving more discharge from groundwater than Bell or McKay marshes based on water level monitoring data; however, some seasonal groundwater discharge into Bell and McKay marshes is likely. For current conditions, groundwater modeling for this EIS (introduced in the Groundwater Modeling sub-section below) estimates average annual aquifer recharge from Bell, McKay, and Hamer Marshes combined to be 0.9 cfs.

East Edmond Marsh is separated from the outlet of Sequalitchew Lake and the Diversion Canal by a large beaver dam, which maintains higher water levels within the marsh relative to Sequalitchew Lake. Inflows to East Edmond Marsh (including its areas both east and west of DuPont-Steilacoom Road) are primarily via shallow groundwater flow from the north or east from Bell, McKay, and Hamer Marshes, the culvert previously mentioned from Hamer Marsh, and inflow from a small stormwater system draining a portion of Center Drive runoff on the north side of the marsh. It currently has surface water outflow to the Diversion Canal (via overtopping the beaver dam) and surface water outflow to West Edmond Marsh (via a culvert beneath the railway grade west of DuPont-Steilacoom Road, which separates East and West Edmond Marsh, though it is frequently blocked due to beaver activity). Subsurface outflows include flow to West Edmond Marsh through the railroad grade sediments, or downward into the Vashon Aquifer. Greater downward flow into the Vashon Aquifer likely occurs on the north side of the marsh since the regional water table is lower there (as shown in **Figure 3.3-4**). For current conditions, groundwater modeling (further discussed in the Groundwater Modeling sub-section) estimates average annual aquifer recharge from East Edmond Marsh to be 3.3 cfs.

Surface water levels in West Edmond Marsh are controlled by multiple beaver dams, as shown in **Figure 3.3-3**. The most consequential beaver dam is the westernmost dam, which controls the western extent of the marsh in the wet season. Outflow from this dam to Sequalitchew Creek generally occurs only in winter months, and typically infiltrates to groundwater due to the absence of low-permeability wetland soils (this portion of Sequalitchew Creek immediately east of Center Drive is referred to as the “dry reach” and surface flow rarely extends from the marsh outlet to downstream reaches of Sequalitchew Creek). Subsurface inflows to West Edmond Marsh primarily include groundwater inflow from upgradient (including from Bell Marsh), subsurface inflow from East Edmond Marsh, and possibly shallow subsurface inflow flow from several stormwater infiltration ponds located on the marsh’s periphery.

Seasonal surface water level variations are greater in the western portion of West Edmond Marsh compared to elsewhere in the marsh complex, and generally range from four to five feet. During most summers the westernmost portion of the marsh typically goes dry, as shown in cross section **Figure 3.3-3**. The western two-thirds of West Edmond Marsh typically have "perched" conditions between May and October, meaning the water table is below the marsh bottom elevation. Because surface water and groundwater are seasonally disconnected in this area, decreases in aquifer water levels during summer months would not cause local surface water levels to decrease. However, for the majority of the marsh complex surface water and groundwater levels are similar and hydraulically connected to one another, and therefore aquifer drawdown generally will cause surface water elevations to decrease. These locations are farther from the Site and the decreases in groundwater levels diminish with distance from the mine.

For current conditions, groundwater modeling (discussed in the Groundwater Modeling sub-section) estimates average annual aquifer recharge from West Edmond Marsh to be 0.1 cfs, with the total marsh-complex recharge rate (which includes Bell, McKay, Hamer, East Edmond, and West Edmond marshes) estimated to average approximately 5.3 cfs.

Streams

Vashon Aquifer discharge to Sequalitchew Creek currently occurs in the upper portions of the ravine west of Center Drive, primarily through spring and seep discharges east of the Olympia Beds truncation. Spring-fed discharge along the walls and near Sequalitchew Creek within the ravine provide year-round baseflow to Sequalitchew Creek. Average annual baseflows measured at the mid-ravine monitoring location (**Figure 3.3-4**) are 1.6 cfs, with baseflows ranging from 0.5 cfs in the summer to 2.5 cfs in winter.

Groundwater discharge to the Diversion Canal occurs between the Diversion Weir and SG-DC-1 (**Figure 3.3-4**). Groundwater recharge to the Vashon Aquifer from Diversion Canal stream loss occurs downstream of SG-DC-1.

Groundwater recharge to the combined Vashon-Sea Level Aquifer from Lower Sequalitchew Creek also occurs near where the creek discharges to Puget Sound. These areas where stream loss is interpreted to occur are based on water level data. The associated recharge quantities have not been quantified but are likely small relative to other sources of recharge/inflows to the combined Vashon-Sea Level Aquifer and are not key to understanding the effects of the Proposed Action.

Springs

As discussed above, spring discharge from the Vashon Aquifer occurs at Sequalitchew Springs at the east end of Sequalitchew Lake which has reported discharge rates of up to 9,000 gpm (or roughly 20 cfs), and generally provides more water than JBLM consumes. Excess spring water not used for water supply flows into Sequalitchew Lake, though during dry summers, periods can occur where Sequalitchew Spring discharge is fully consumed by JBLM, causing there to be no surface water flow from Sequalitchew Lake to the Diversion Canal.

Vashon Aquifer discharge also occurs at numerous unnamed seeps and springs within the Sequalitchew Creek ravine, as discussed above. The average annual discharge rate for combined springs in the Sequalitchew Creek ravine is approximately 1.6 cfs with flows ranging from 0.5 cfs in the summer to 2.5 cfs in winter.

Spring discharge to Puget Sound from the comingled Vashon-Sea Level Aquifer occurs at intertidal and subtitle seeps and springs. The largest of these springs (Large Spring, shown in **Figure 3.3-4**) has observed discharge rates ranging from 9.1 to 18 cfs. It is estimated that approximately 15 to 23% of the freshwater discharge at the intertidal springs comes from the Vashon Aquifer, while the remainder comes from the Sea Level Aquifer. The total average groundwater discharge rate to Puget Sound from the project area is estimated to be 131.5 cfs.

Groundwater Quality

Groundwater quality sampling from select wells within the mine and completed in the Steilacoom Gravel occurred in 2005, and were tested for pH, specific conductance, and nitrate as nitrogen. No water quality standards were exceeded.

Fort Lewis Landfill 5 is a closed landfill and former Superfund Site located northeast of the South Parcel (see **Figure 3.3-4**, labeled JBLM Landfill 5) and historically has had groundwater quality exceedances for select volatile organic compounds, manganese, and iron. Landfill 5 was removed from the federal National Priorities List of contaminated sites in 1995 because site cleanup was completed, and all cleanup goals were achieved. The most recent groundwater quality data reviewed from the site is from 2010, and both iron and manganese concentrations were found in exceedance of secondary drinking water standards (for aesthetics rather than health concerns) at wells upgradient and downgradient of the landfill. Elevated iron and manganese concentrations are reported to be regional phenomenon and have been observed at other wells in the area. Landfill 5 is upgradient of the northern part of the South Parcel, and therefore groundwater with elevated iron or manganese concentrations may flow beneath the site under existing conditions within the Vashon Aquifer.

Saltwater intrusion can occur in the comingled Vashon-Sea Level aquifer due to its close proximity and hydraulic connection to Puget Sound. Pumping wells, which commonly cause saltwater intrusion, are not reported to exist in the comingled aquifer west of the site; therefore, only tidally induced mixing between saltwater and freshwater in the immediate vicinity of the intertidal zone currently occurs. Depending on tidal stage and season, the saltwater component of discharge at Large Spring is estimated to range between 36 and 99 %.

The site is also in the Tacoma Smelter Plume area but has soil arsenic concentrations of less than 200 mg/kg. Ecology has determined this soil concentration level as unlikely to pose a threat to groundwater quality.

Water Supply Wells and Springs

The City of DuPont has three water supply wells at its Bell Hill wellfield (located approximately one mile southeast of the South Parcel), with Wells 1 and 3 completed in the Sea Level Aquifer and Well 2 completed in a deeper confined aquifer beneath the Sea Level Aquifer. The City's Hoffman Hill wellfield has two wells located over a mile southwest of the South Parcel which are also completed in the Sea Level Aquifer. The City also has a pending water right application to develop a wellfield sourced from the Sea Level Aquifer in the vicinity of Pond and Grant Lakes near Center Drive. The City's existing and proposed water supply wells produce water either hydraulically upgradient of (Bell Hill and the Pond Lake area) or cross-gradient (Hoffman Hill) to the South Parcel and are completed in confined aquifers which are hydraulically isolated from the Vashon Aquifer.

Prior well inventories in 1991 and 2006 for private residential water supply wells in the site area did not identify any within the Vashon Aquifer in close proximity of the site, nor in the comingled Vashon-Sea Level Aquifer near the active mine site.

As previously mentioned, Sequalitchew Springs provides most of JBLM's water supply.

3.3.2 Impacts of the Alternatives

This sub-section identifies and analyzes the potential for impacts to surface and groundwater resources on and in the vicinity of the site under the EIS Alternatives.

As described in **Chapter 2** of this DEIS, the 2011 Settlement Agreement states that permits for the Pioneer Aggregates South Parcel Project (Proposed Action) shall not be effective until permits for the Sequalitchew Creek Restoration Plan (Restoration Plan)[1], as a separate but related action. The Restoration Plan seeks to restore and enhance streamflow and ecological functions from Sequalitchew Lake through Edmond Marsh into Sequalitchew Creek ravine by sequentially restoring diverted flows back to the creek, improving the sustainability of flows through the system, and restoring aquatic habitat.

Consistent with the 2011 Settlement Agreement, this DEIS assumes that mining and reclamation activities under the Proposed Action would not proceed until permits and funding are in place to implement the Restoration Plan. It is assumed that projects associated with the Restoration Plan would be mitigation for certain environmental impacts identified in this DEIS, and that permits for the restoration Plan would be a condition of any City of DuPont approval of the Proposed Action. However, because the Restoration Plan is considered a separate project that would be subject to separate environmental review and could be funded and implemented independent of the Proposed Action, the general discussion in the Environmental Impacts sub-section of Groundwater only addresses the impacts of the proposed mining/reclamation and does not include implementation of the Restoration Plan. This is intended to help the reader understand the impacts of the proposed

[1] *The Sequalitchew Creek Restoration Plan is sponsored and developed by CalPortland, the Environmental Caucus and the South Puget Sound Salmon Enhancement Group (SPSSEG).*

mining/reclamation, and the need for the Restoration Plan with the proposed project. Proposed mining/reclamation in combination with the Restoration Plan is specifically discussed below in the Cumulative Impacts sub-section.

ALTERNATIVE 1 – PROPOSED ACTION

This sub-section describes impacts to groundwater quality and quantity that could occur due to the proposed mine expansion. The primary project impact to groundwater would be decreased Vashon Aquifer water levels due to dewatering activities needed for mining. Ultimately, the gravel deposits which the Vashon Aquifer is comprised of would be removed from the Re-Mine Area and part of the South Parcel. Drawdown of the Vashon Aquifer is anticipated to affect groundwater and surface water features (streams and wetlands) within a one to two-mile radius from the proposed mine site. The extracted groundwater would be conveyed to a constructed wetland system and ultimately infiltration galleries located at the bottom of the current mine, where the Vashon Aquifer and the Sea Level Aquifer are comingled and permeable Steilacoom Gravels are present. Because local surface waters are closely related to groundwater, changes in the groundwater-surface water relationship at nearby surface water features is also discussed.

As previously described in **Chapter 2**, a dewatering plan to accomplish the Proposed Action has been developed and is comprised of four steps (see **Section 2.5** for details). Briefly, these steps include:

- **Step 1:** 10 “Step 1” dewatering wells shown in **Figure 2-4** would be pumped for 60 days to confirm groundwater model predictions and to adjust the dewatering plan (with respect to well spacing, design, and pumping rate) as necessary prior to additional dewatering. This step will be fully reversible since no gravel will be extracted during this step.
- **Step 2:** The 24 Step 1 and Step 2 dewatering wells shown in **Figure 2-4** would be pumped for approximately six months, serving as a larger scale pumping test to confirm groundwater model predictions and to dewater gravels in preparation of mining. This step will be fully reversible since gravel will not be extracted. For Steps 1 and 2, if model predictions significantly differ from the observed hydraulic response, model refinements and/or adjustments to the subsequent dewatering and mining activity plans would be made.
- **Step 3:** This step represents the active dewatering and mining phase of the Proposed Action. Pumping from an estimated 66 dewatering wells (shown as the Step 1, 2, and 3 wells in **Figure 2-4**) may concurrently occur during the step as mining progresses southward toward Sequalitchew Creek. This step is expected to last between five and eight years, is when active gravel mining would occur, and its duration will be dependent on market conditions and successful achievement of groundwater drawdown thresholds. Potential impacts on aquifer water levels are expected to build slowly over time as wells are added and mining progresses southward. Water level monitoring data would be compared to model predictions, and if more drawdown occurs than predicted, adaptive actions with respect to dewatering and/or mining

would be required to ensure that target drawdown levels are not exceeded. Step 3 could be partially reversible (depending on the extent of gravel extraction that occurs prior to a hypothetical mining moratorium or market downturn).

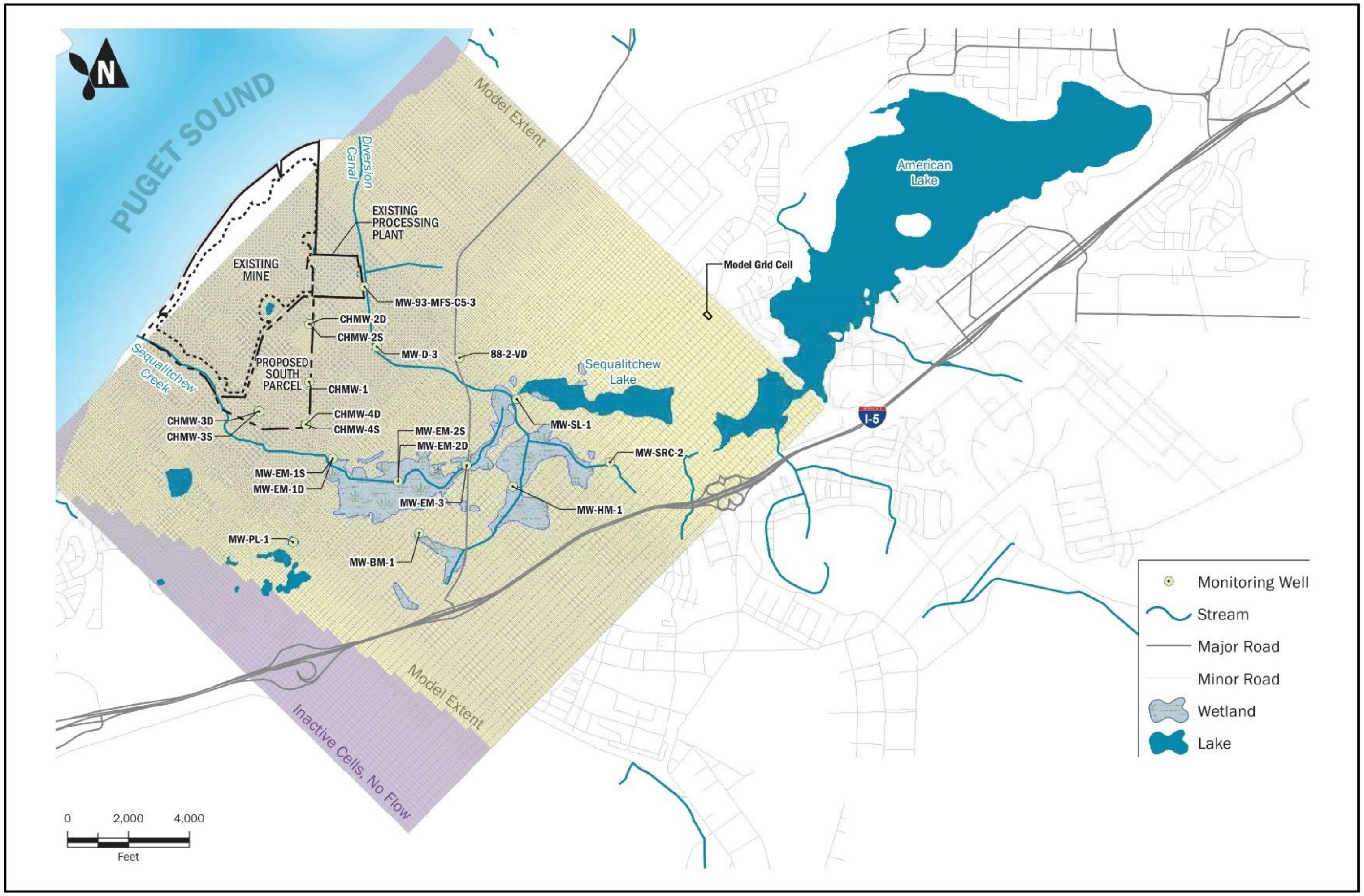
- **Step 4:** This step represents the planned condition for the South Parcel following the completion of active dewatering and would continue in perpetuity. A passive dewatering trough would be constructed at the toe of the eastern mine slope to collect groundwater, and would replace the dewatering wells. Collected groundwater would be conveyed to the mitigation wetland and infiltration facilities at the western margin of the Existing Mine. Gravel mining at locations west of the trough will continue in early phases of Step 4 (following completion of the trough) until all sand and gravel planned for mining has been extracted. Step 4 would be irreversible.

For the following discussion, it is assumed that the Proposed Action would proceed to completion, and therefore Step 3 would be irreversible.

Groundwater Modeling

To estimate likely extraction well pumping rates and groundwater drawdown due to dewatering, a 3-dimensional groundwater flow model of the project area was developed for this EIS. The groundwater model refined and updated previous site groundwater models developed in 2003, 2004, and 2009 to incorporate recent hydrogeologic data and interpretations and was calibrated to recent water level monitoring data. The groundwater model is a set of equations that are inter-related in a way that enables simulation of groundwater levels and flows for the area surrounding the gravel mine (see **Figure 3.3-5** and **Appendix E** for detail). Five different model scenarios were generated:

- An "existing conditions" model was developed to simulate groundwater levels as they currently exist. The existing conditions scenario simulates monthly water levels from 2004 to 2015, using observed surface water body elevations and calculated recharge rates as inputs for each monthly timestep (see **Appendix E** for further detail).
- A "Step 1 future conditions" scenario modified the "existing conditions" scenario by including active pumping from the 10 Step-1 dewatering wells shown in **Figure 2-4** for each monthly timestep. Monthly pumping rates were adjusted to maintain groundwater levels at target elevations that would allow mining to occur.
- A "Step 2 future conditions" model scenario modified the "existing conditions" scenario by including active pumping from the 24 Step-1 and Step-2 dewatering wells (**Figure 2-4**) for each monthly timestep. Monthly pumping rates were adjusted to maintain groundwater levels at target elevations that would allow mining to occur.
- A "Step 3 future conditions" model scenario modified the "existing conditions" scenario by including active pumping from all 66 dewatering wells for Steps 1, 2, and 3 (**Figure 2-4**) for each monthly timestep. Monthly pumping rates were adjusted to maintain



Source: Aspect, 2022.

EA Engineering, Science, and Technology, Inc., PBC

Figure 3.3-5

Existing Monitoring Well Network

groundwater levels at target elevations that would allow mining to occur. The Step 3 model scenario assumes all dewatering wells will actively pump at the same time, while in actuality Step 3 dewatering is planned to occur over five to eight years, with dewatering progressively extending southward as mining activities incrementally extend southward. It is possible that not all Step 3 dewatering wells will pump at the same time as simulated (if possible CalPortland plans to construct a passive dewatering trough in the north part of the site as mining extends southward), however, to evaluate the maximum potential effects of Step 3 pumping, all dewatering wells are simulated as active.

- A "Step 4 future conditions" model scenario modified the "existing conditions" scenario by including a passive dewatering trough to capture groundwater that will emanate from seeps at the base of the finished-grade eastern mine slope of the South Parcel.

The difference between groundwater levels and flows simulated by the different model scenarios are the best available information on groundwater impacts from the proposed dewatering plan. Those impacts are discussed in the sub-sections below. Although all groundwater models are simplified approximations of reality, the model generated in this case is the most comprehensive model developed to date for this area, and therefore the best existing tool for the impacts analysis.

Since groundwater and surface water are generally connected, the model represents these connections quantitatively. Surface water features where groundwater discharge consistently occurs (including Sequalitchew Springs and Sequalitchew Creek and its neighboring seeps in the ravine above the Olympia Beds) are simulated as "drain" cells in the model. Bell, McKay, Hamer, East Edmond, and West Edmond marshes are simulated using "river" cells that allow both groundwater recharge and discharge to occur across low-permeability wetland soils (to reflect the hydraulic connection that exists between surface water and groundwater in the marsh complex). Wetland soil properties were assigned based on field data and through model calibration, and areas where wetland soils have likely been disturbed were simulated with higher permeability than wetland soils that have not been disturbed. Drain cells are also included in marsh areas to simulate surface water outflow from the marshes during the wet season.

Potential aquifer recharge sources not simulated in the model include the Diversion Canal and Sequalitchew Lake.

The groundwater modeling approach and methodology used for the EIS is consistent with industry standard hydrogeologic practices, and reasonably simulates a complex hydrogeologic system. Because all hydrogeologic models are simplifications of reality, their predictions are subject to uncertainty (in a similar manner to how weather forecasts are subject to uncertainty). Identified areas where greater model uncertainty may exist for the site model are described in **Appendix E** and can be summarized as follows:

- Based on the model assumptions discussed above, the predicted amount of aquifer drawdown due to dewatering could be overestimated. This potential bias is considered “conservative” with respect to drawdown because if bias is present, the model most likely will over predict aquifer drawdown.
- The groundwater model was calibrated to Vashon Aquifer water level data alone; therefore, more uncertainty exists for model predictions of Vashon Aquifer discharge to surface water such as in the Sequalitchew Creek ravine.
- Sufficient aquifer water level data from the Sea Level Aquifer were not available for model calibration; therefore, greater uncertainty exists with respect to water level predictions for the Sea Level Aquifer compared to the Vashon Aquifer. However, dewatering activities are not proposed in the Sea Level Aquifer and the Olympia Beds provide relative isolation from the changes in water level in the Vashon Aquifer.

Wetland Water Balance Modeling

The site groundwater model is capable of estimating changes in groundwater level and discharge to springs and Sequalitchew Creek in the upper ravine due to dewatering activities since it simulates the primary physical processes and parameters affecting them. However, the groundwater model cannot predict changes in marsh-complex water levels because surface water inflows to the marshes are not directly simulated in the groundwater model, and monthly marsh surface water levels are input values to the groundwater model. A water balance model was developed for this EIS to predict changes in wetland water levels and flows. The wetland water balance model is discussed briefly here because a groundwater component is simulated by it.

The wetland water balance model first simulated the “existing” condition based on historical water level data and simulation results were improved through model calibration. Changes in groundwater levels (as simulated by the groundwater model) for each dewatering step were then input into the water balance model, and it was used to predict changes in wetland water levels and flows emanating from the wetlands due to changes in the underlying groundwater level. The water balance model was also used to estimate likely effects on the wetlands if the Proposed Action and the Sequalitchew Creek Restoration Plan occur (see the Cumulative Impacts sub-section for details).

The water balance model divided the marsh complex into 1) an upper area consisting of Bell, Hamer, and McKay marshes; 2) a central area comprised of the East Edmond Marsh area; and 3) West Edmond Marsh. Water inflows into each of these areas consisted of precipitation directly on the wetlands, surface water inflows, and groundwater discharge. Outflows consisted of evapotranspiration from open water and vegetation, surface water outflows, and groundwater recharge. Time steps were monthly. Changes in wetland water elevation were calculated by assessing the change in water storage within each wetland group (total water in minus total water out) and spreading that change in volume over the area of the wetland. A qualitative calibration process was performed where existing condition simulated water levels were compared to historically observed wetland water levels.

The groundwater component simulated in the water balance model is significantly simplified compared to the groundwater model; each wetland has a single soil permeability value assigned, a uniform monthly groundwater elevation beneath each wetland is assigned, and a uniform aquifer permeability adjacent to each wetland is assigned. Additionally, groundwater levels beneath each wetland do not change in response to predicted recharge or discharge flow to/from the wetland. Nonetheless, because significant changes to the hydrology of the wetland complex will occur as part of the Sequalitchew Creek Restoration Plan and their likely impacts on the underlying aquifer system are difficult to quantify, output from the wetland water balance model was used in the EIS to make interpretations regarding the likely aquifer system response to changes in surface water elevations and flows caused by the Restoration Plan. It should be noted that groundwater elevation predictions from the groundwater model were used as input for the wetland water balance model; no wetland water balance model outputs were incorporated into the groundwater model.

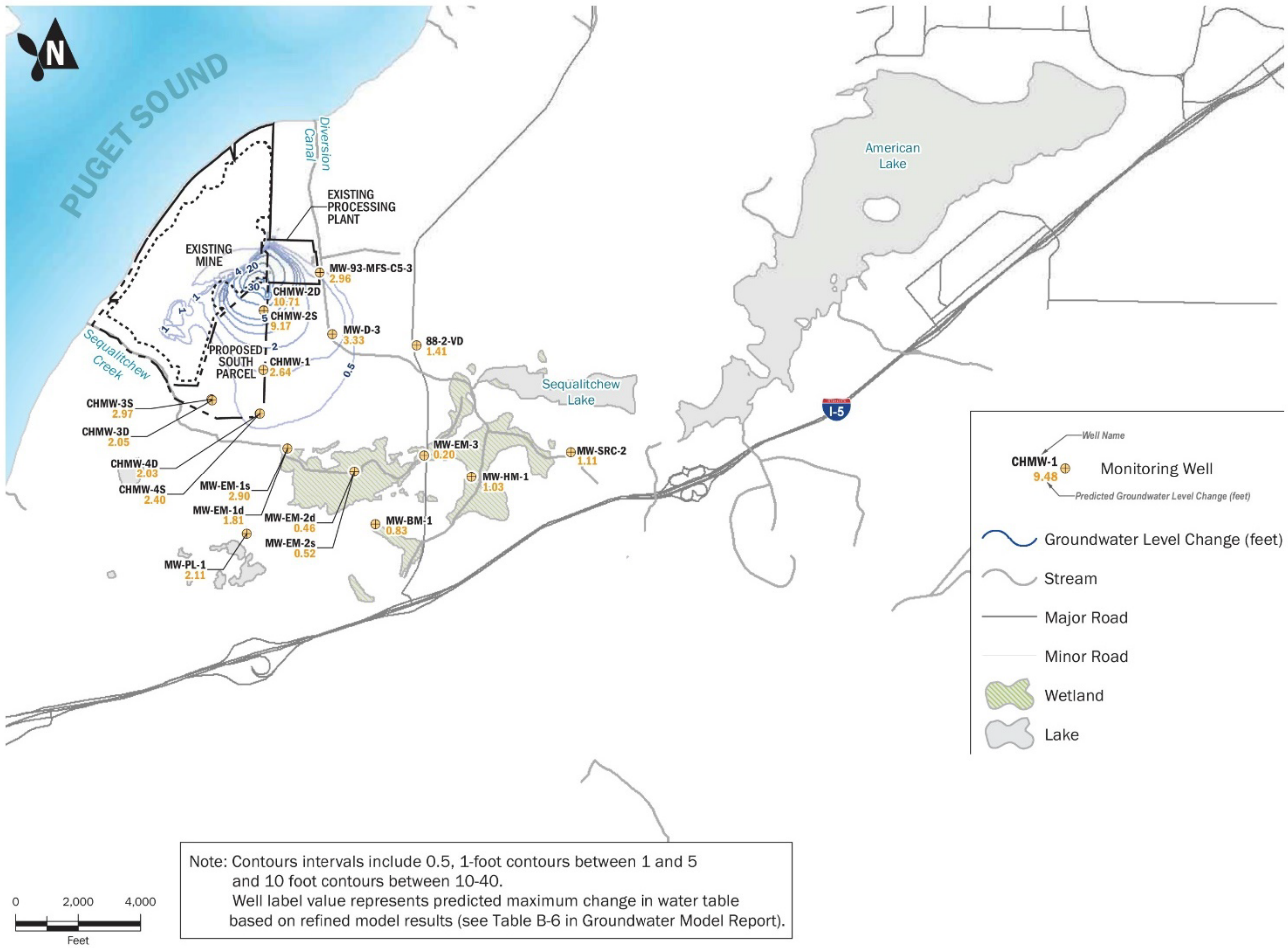
Groundwater Flow and Water Levels

Water levels in the Vashon Aquifer are expected to decline significantly at the project site due to the Proposed Action. Aquifer drawdown is projected to generally decrease with increasing distance from the dewatering area, as discussed in this subsection. As discussed in the Surface Water sub-section, aquifer drawdown would cause surface water level elevations to decrease.

Three types of predicted water levels (and drawdown) based on groundwater model results were calculated and applied in the following ways:

- “Raw” predicted water levels are water levels predicted by the calibrated model, with no additional corrections. Model predicted changes in groundwater recharge and discharge were calculated using “raw” water levels.
- “Refined” predicted water levels are based on “raw” predicted water levels but have been statistically corrected to be more accurate based on field measurements at existing wells. “Refined” water levels are effectively best estimate predictions of expected future water levels near the site, but could only be calculated at site-area monitoring wells where real-world water level measurements exist.
- “Performance threshold” predicted water levels are calculated using “refined” water levels but incorporate additional corrections for model uncertainty relating to seasonal and annual climate variations. “Performance threshold” values represent “worst case scenario” predicted water levels and drawdown. Defined through statistical testing (a 95% lower confidence interval), “performance threshold” water levels are expected to have less than a 5% chance of being exceeded due to random chance.

Raw maximum predicted drawdown contours for each dewatering step are shown in **Figures 3.3-6** through **3.3-9**. Maximum performance threshold predicted drawdown values are listed next to each well in **Figures 3.3-6** to **3.3-9**. The performance threshold maximum drawdown



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).

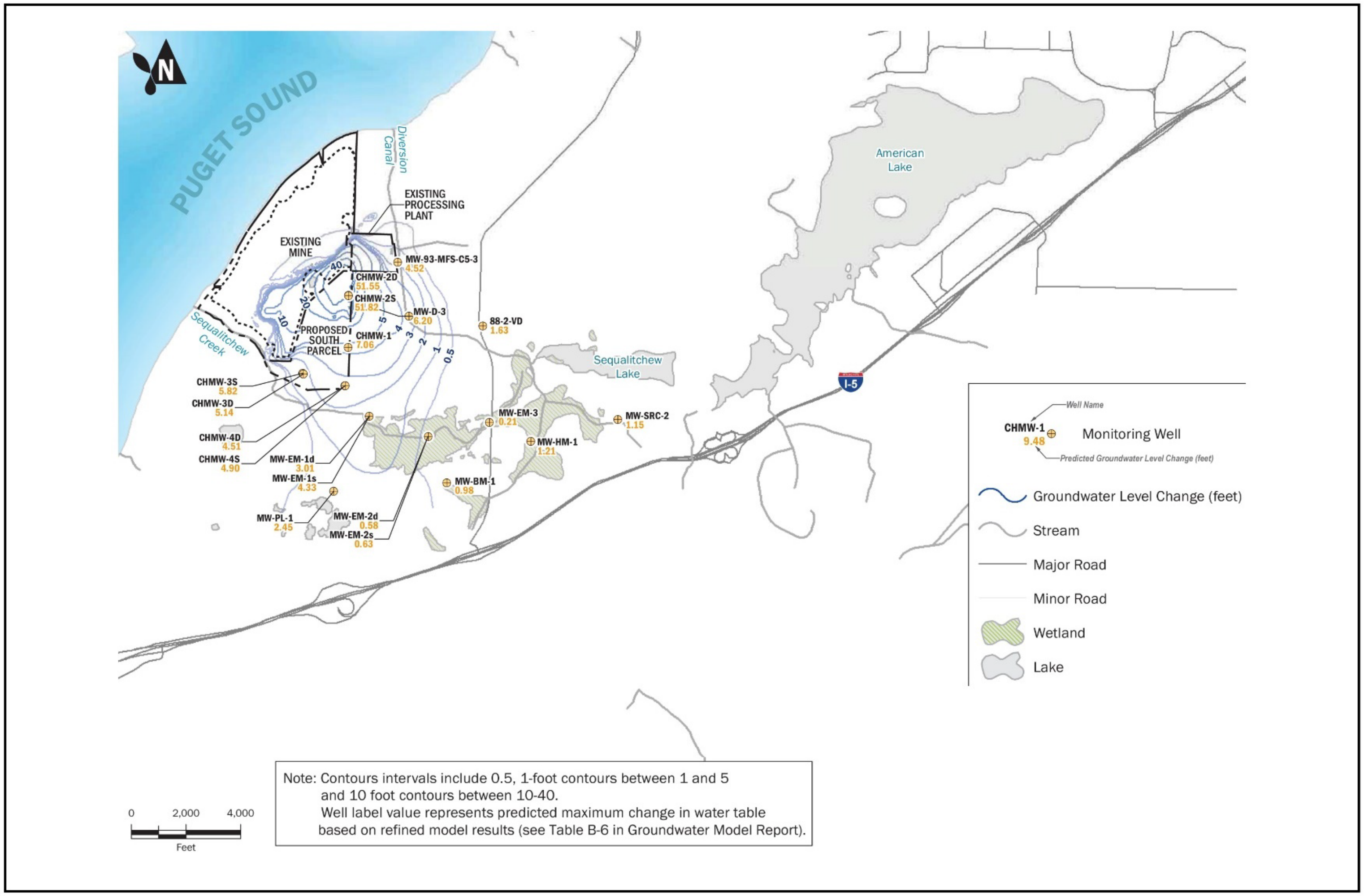
Source: Aspect, 2022.

EA Engineering, Science, and Technology, Inc., PBC

Figure 3.3-6

Maximum Model Calculated Groundwater Level Changes: Step 1

Pioneer Aggregates South Parcel Project
Draft EIS



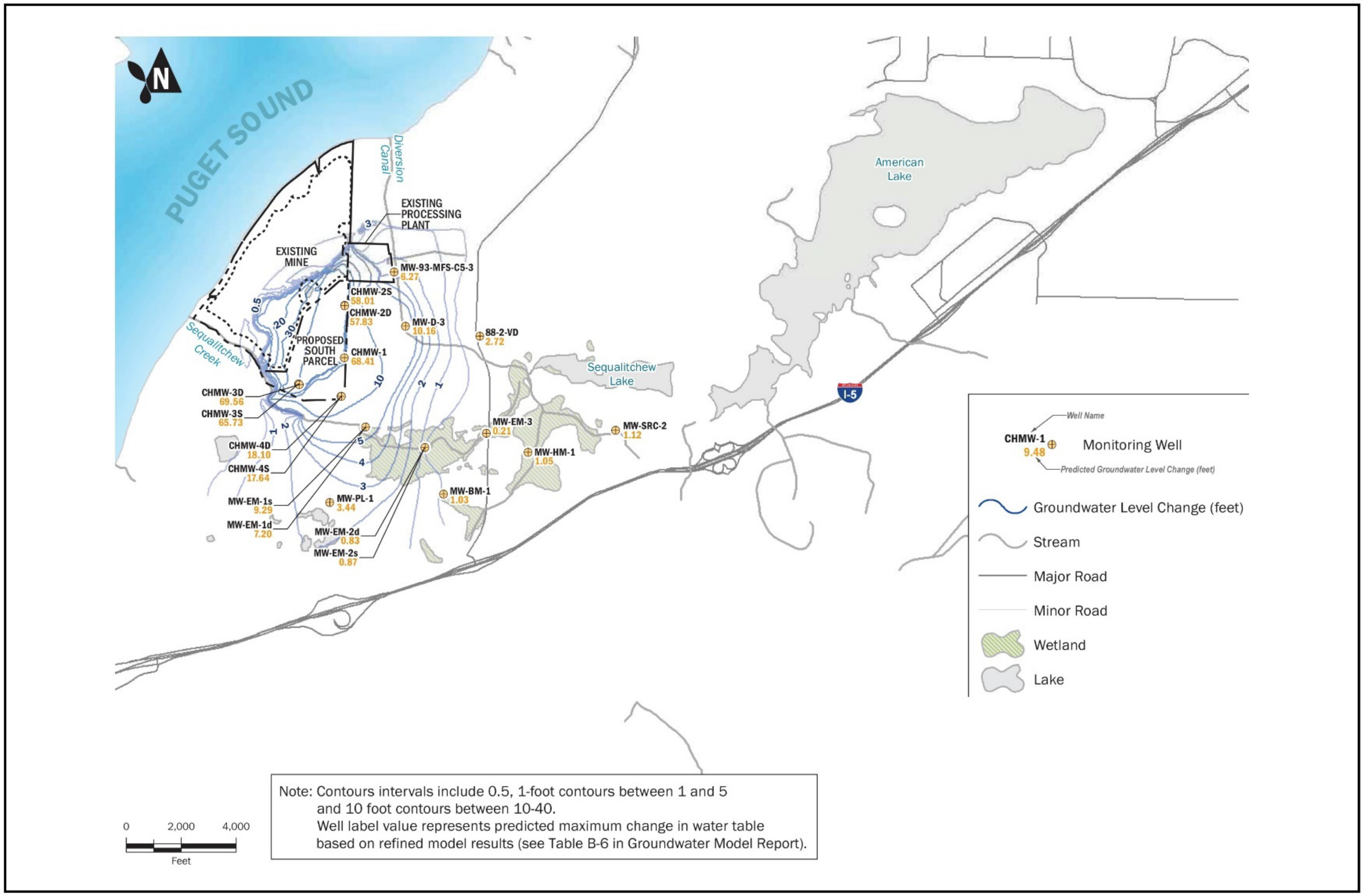
Source: Aspect, 2022.

EA Engineering, Science, and Technology, Inc., PBC

Figure 3.3-7

Maximum Model Calculated Groundwater Level Changes: Step 2

Pioneer Aggregates South Parcel Project
Draft EIS

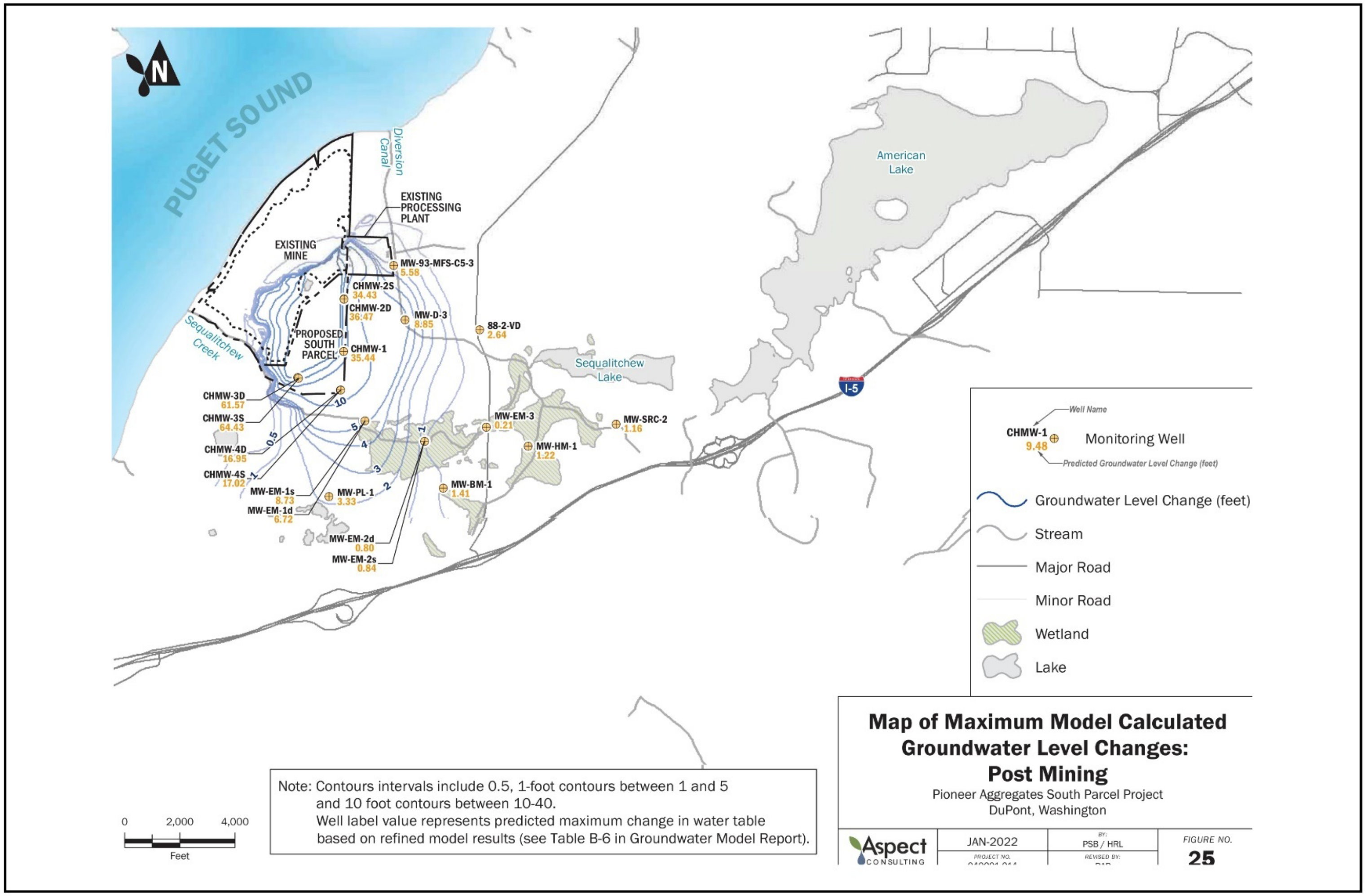


Source: Aspect, 2022.

EA Engineering, Science, and Technology, Inc., PBC

Figure 3.3-8

Maximum Model Calculated Groundwater Level Changes: Step 3



Source: Aspect, 2022.

EA Engineering, Science, and Technology, Inc., PBC

Figure 3.3-9

Maximum Model Calculated Groundwater Level Changes: Post Mining values are greater than the contoured (raw maximum predicted) drawdown values because model and seasonal predictive uncertainties are added to them.

- Maximum predicted raw and performance threshold drawdown values at the South Parcel and the wetland complex are discussed below for each dewatering step below:
- Step 1 (10 dewatering wells pumping for 60 days in the northeast corner of the South Parcel): The performance threshold maximum predicted drawdown at a site monitoring well is 10.71 feet at CHMW-2D (approximately 450 feet south of the southernmost Step 1 dewatering well), while in the wetland complex area it is 2.90 feet at MW-EM-1S (located at the west end of West Edmond Marsh). Up to 30 feet of raw drawdown is predicted to occur in the vicinity of the active dewatering wells (**Figure 3.3-6**), while less than 0.5 feet of raw drawdown is predicted to occur beneath the wetland complex and Sequalitchew Creek. Because Step 1 will only last for 60 days, it is possible that measurable aquifer drawdown at more distant features (such as the marsh complex) may not occur if Step 1 commences during the wet season when the wetlands are “full” and provide ample recharge to the water table.
- Step 2 (24 dewatering wells pumping for six months in the northeast and east-central portions of the South Parcel): : The performance threshold maximum predicted drawdown is 51.82 feet at CHMW-2S, while in the wetland complex area it is 4.33 feet at MW-EM-1S (at the west end of West Edmond Marsh). A raw maximum predicted drawdown of over 40 feet is predicted for a broad area in the mine vicinity near the active dewatering wells (**Figure 3.3-7**), while less than 0.5 to almost 2 feet of raw drawdown is predicted to occur beneath the wetland complex and Sequalitchew Creek. Similar to Step 1, because Step 2 will only last for six months, aquifer drawdown near the wetlands may be difficult to observe if Step 2 occurs primarily during the wet season when aquifer recharge is higher.
- Step 3 (up to 66 dewatering wells pumping for five to eight years in the eastern and southern sections of the South Parcel): The performance threshold maximum predicted drawdown is 69.56 feet at CHMW-3D (**Figure 3.3-8**) and is up to 9.29 feet beneath the western edge of the marsh complex (at MW-EM-1S). Maximum performance threshold drawdowns farther east in the marsh complex range are approximately one foot or less. Raw maximum predicted drawdown values of greater than 40 feet are predicted across much of the South Parcel, while beneath West Edmond Marsh the raw maximum predicted drawdown ranges from approximately 6 feet to 0.5 feet (and decreases to the east). Between 5 and 10 feet of raw maximum drawdown is predicted beneath Sequalitchew Creek in the upper ravine, while less than 0.5 feet is generally predicted beneath East Edmond, Bell, Hamer, and McKay marshes.
- Step 4 involves passive dewatering via a trough located in the eastern and southern sections of the South Parcel and will be active in perpetuity. The performance threshold maximum predicted drawdown is 64.43 feet at CHMW-3S (**Figure 3.3-9**) and is up to 8.73 feet beneath West Edmond Marsh (at MW-EM-1S). Maximum performance threshold drawdowns farther east in the marsh complex are approximately one foot or less. Relative to Step 3, onsite drawdown will be less with the passive groundwater collection system. Less drawdown is predicted from passive dewatering relative to active dewatering because the excavated mine slope and trough can more efficiently

maintain groundwater elevations at levels beneath the proposed mine floor than pumping wells.

With the Proposed Action, the general groundwater flow direction in the Vashon Aquifer is expected to remain to the northwest. However, in the immediate vicinity of the project site, local groundwater flow paths are expected to change and flow toward the dewatering wells (or the groundwater collection trough in Step 4) rather than flowing toward their existing natural discharge points (i.e., the Olympia Beds Truncation or seeps in the Sequalitchew Creek ravine). Changes in local flow direction would likely be greatest during Steps 1 and 2 and during earlier phases of Step 3 (when dewatering would be focused in the northern part of the South Parcel). During later phases of Step 3 and in Step 4 local groundwater flow paths would be similar to current conditions, though local flow paths that currently discharge from the north to the Sequalitchew Creek ravine may be reversed and instead terminate at a dewatering well or seeps that drain to the Step 4 groundwater collection trough.

Predicted water level changes in the Sea Level Aquifer are expected to be negligible beneath the Olympia Beds because it is hydraulically isolated from the Vashon Aquifer by the Olympia Beds. Therefore, no notable change in its northwest groundwater flow direction is expected.

West of the Olympia Beds Truncation where the combined Vashon and Sea-Level Aquifer exists, groundwater flow would generally remain to the west/northwest toward Puget Sound, though localized groundwater paths near the planned infiltration facility at the far west end of the mine could change due to groundwater mounding beneath it. Because the mine dewatering system intercepts groundwater from the Vashon Aquifer that would otherwise enter the comingled aquifer (via downward groundwater flow at the Olympia Beds truncation), the total volume of water entering the comingled Vashon and Sea Level aquifer should not significantly change during Steps 1 and 2. Groundwater levels would likely be higher near the planned infiltration facilities due the more concentrated and higher rate of infiltration expected to occur at those facilities relative to the existing area where groundwater from the Vashon Aquifer enters and provides recharge to the comingled Vashon-Sea Level Aquifer. During Steps 3 and 4 slightly more water is likely to be infiltrated in the comingled aquifer than currently flows into it from the Vashon Aquifer since some groundwater that naturally discharges to Sequalitchew Creek in the upper ravine (above the Olympia Beds) is expected to be captured by the dewatering system and conveyed to the infiltration facilities.

Though the general direction of groundwater flow is not expected to appreciably change following completion of the Proposed Action, lower groundwater levels in the Vashon Aquifer near the site are expected to result in less groundwater discharge to surface water bodies and more aquifer recharge due to surface water losses. Expected changes in groundwater recharge/discharge relationships and aquifer water levels near these features due to the Proposed Action are discussed below.

Lakes

Because slightly lower aquifer water levels are predicted near Sequalitchew Lake (less than 0.5 feet of raw aquifer drawdown is predicted for all dewatering steps, while performance threshold maximum drawdown values near Sequalitchew Lake range from 0.21 to 2.72 feet in Step 3), more recharge may occur in its vicinity since the lake typically receives surface water inflows from Sequalitchew Springs.

As mentioned previously, expected changes in surface water levels at kettle lake and wetland features where surface water inflow/outflow does not occur (and therefore groundwater recharge/discharge is not expected) are discussed in the Surface Water sub-section.

Wetlands

Lower aquifer water levels beneath the wetland complex are predicted to cause more surface water inflow to the Vashon Aquifer within the wetlands. Relative to existing conditions, the groundwater model predicts that aquifer recharge from the combined wetland complex would increase by the following average amounts during dewatering:

- Step 1: similar to existing conditions/no significant change
- Step 2: 0.2 cfs greater than existing conditions
- Step 3: 0.6 cfs greater than existing conditions
- Step 4: 0.5 cfs greater than existing conditions

Greater surface water inflow from the wetlands to the aquifer would cause aquifer water levels beneath them to be somewhat buffered and experience less drawdown than would occur in their absence. However, increased groundwater recharge from the wetlands would cause wetland water levels to decrease, as discussed in Section 3.4, **Surface Water**. A brief discussion of predicted changes in aquifer water levels beneath the wetland complex follows.

Bell, McKay, and Hamer Marshes are relatively far from the South Parcel, and less than 0.5 feet of raw aquifer drawdown is predicted beneath all three marshes during all dewatering steps. Performance threshold maximum aquifer drawdown values of approximately one foot are predicted at each marsh for each dewatering step (with a predicted range across all dewatering steps of between 0.83 and 1.41 feet as shown in **Figures 3.3-6** to **3.3-9**). Predicted changes in marsh water level due to aquifer drawdown are discussed in Section 3.4, **Surface Water**, and are less than predicted changes in aquifer water levels primarily because of surface water inflows and the presence of low-permeability marsh sediments (which limit the rate of surface water flow into aquifer).

Beneath East Edmond Marsh, less than 0.5 feet of raw aquifer drawdown is predicted for Step 1, up to 0.5 feet for Step 2, and up to one foot of drawdown for Steps 3 and 4. Performance threshold maximum drawdown during all dewatering steps ranges from 0.20 to 0.87 feet. Smaller decreases in marsh water levels are predicted relative to groundwater levels, as discussed in Section 3.4, **Surface Water**. Though closer to the project site than Bell, McKay, and Hamer Marshes, lower model uncertainty with respect to aquifer water level predictions exists at East Edmond Marsh, causing it to have lower performance threshold drawdown values than Bell, McKay, or Hamer Marshes.

West Edmond Marsh is the closest large wetland to the site and has more raw drawdown predicted than the other wetlands. As previously discussed, during Steps 1 and 2, raw maximum drawdown of 2 feet or less is predicted beneath the wetland, while performance threshold maximum drawdown values of up to 4.33 feet are predicted. During Steps 3 and 4 between approximately 1 and 5 feet of maximum raw drawdown is predicted (depending on location, as shown in **Figures 3.3-8** and **3.3-9**). In Steps 3 and 4, performance threshold maximum drawdown values of up to 9.29 feet of drawdown are predicted at the west end of the marsh (MW-EM-1S), and while only 0.87 feet is predicted at its east end (MW-EM-2S). Higher predicted drawdown values at the west end of West Edmond Marsh are likely due to it being closer to site dewatering features, and because only seasonal hydraulic connection exists between surface water and groundwater (due to the fine-grained marsh sediments which cause surface water to be seasonally disconnected or "perched" above groundwater). Existing summer conditions in the western portion of West Edmond Marsh would result in surface water being either perched above the water table or dry (see **Figure 3.3-3**). Where perched conditions exist aquifer drawdown would not cause surface water inflow (i.e., recharge) to the aquifer to increase, and in the absence of buffering surface water inflows, more aquifer drawdown would occur. With lower aquifer water levels, more surface water in West Edmond Marsh would be seasonally perched and disconnected from groundwater. The effects of increased aquifer drawdown on surface water level elevations and wetland function are discussed in Section 3.4, **Surface Water**, and in Section 3.6, **Plants and Animals**.

Streams

The groundwater model predicts significant reductions in Sequalitchew Creek baseflow through the ravine due to decreases in aquifer water level caused by the Proposed Action. In dewatering Steps 1 and 2, spring and seep discharge within the ravine are not predicted to significantly change because the dewatering steps are relatively short (months in duration) and the pumping wells are relatively far from Sequalitchew Creek (approximately 3000 feet or more, as shown in **Figure 2-4**). In Step 3, groundwater discharge to the ravine is predicted to decrease by 83% on average, with the greatest decreases occurring in the dry season. During Step 4, discharge to the ravine is predicted to be on average 79% less than existing conditions, and similarly the greatest decreases are predicted in the dry season. In Step 4, the average annual baseflow (which is fed by groundwater discharge at seeps and springs) of Sequalitchew Creek is projected to be reduced from approximately 1.6 cfs to approximately 0.34 cfs. Step 4 is predicted to have slightly less impact on Sequalitchew Creek baseflows than Step 3 because the passive dewatering trough will induce slightly less aquifer drawdown than the active dewatering wells.

Groundwater recharge from Lower Sequalitchew Creek where it overlays the combined Vashon-Sea Level Aquifer has not been quantified but is expected to decrease with decreasing upstream baseflows in Sequalitchew Creek. The reduction in recharge from Lower Sequalitchew Creek is likely insignificant relative to other inflows and recharge sources to the combined Vashon-Sea Level Aquifer

Aquifer recharge from and discharge to the Diversion Canal also is not quantified. The reach of the Diversion Canal downstream of Sequalitchew Lake and upstream of DC-1 currently receives groundwater discharge. Under the Proposed Action, aquifer drawdown may cause less discharge to the canal in that reach. If so, more water would be retained by the aquifer in that area, which would potentially reduce aquifer drawdown in that vicinity.

Springs

Predicted changes in spring discharge for the Sequalitchew Creek ravine are discussed in the Streams sub-section above.

No change in Sequalitchew Springs discharge to Sequalitchew Lake is expected due to the Proposed Action since aquifer drawdown is not predicted to occur there.

Changes in discharge at the Large Spring and other springs adjacent to Puget Sound which receive water from the comingled Vashon-Sea Level Aquifer have been estimated using the groundwater model at approximately a 2% increase due to the Proposed Action. Since dewatering is expected to capture groundwater that would normally discharge to Sequalitchew Creek, slightly more water would be infiltrated into the Vashon-Sea Level Aquifer than currently discharges to it from the Vashon Aquifer. This additional water entering the aquifer may slightly increase local groundwater elevations and spring discharge rates.

Puget Sound

Marine discharge to Puget Sound from the comingled Vashon-Sea Level Aquifer is not likely to change significantly and may slightly increase (predicted to be less than 2%) since mine dewatering is predicted to capture some Sequalitchew Creek base flow, which would then be infiltrated in the comingled aquifer (as discussed above in the Springs sub-section). However, the total volume of water discharging to Puget Sound in the project area (both groundwater and surface water) should not significantly change.

Groundwater Quality

Groundwater quality beneath and in the area of the South Parcel would largely be unaffected by the Proposed Action. Mining permits require best management practices for groundwater and stormwater pollution prevention, defined spill control and cleanup procedures, and operations management to minimize the use of potential pollutants within the mine. The consistent presence of heavy machinery onsite would enable a rapid spill cleanup response, where contaminated soils can quickly be excavated into and removed by a dump truck.

Groundwater with elevated iron and manganese concentrations flowing beneath Fort Lewis Landfill 5 would continue to flow toward the project site and the Olympia Beds Truncation, though dewatering potentially would cause more to flow toward the dewatering features rather than the Olympia Beds Truncation. The ultimate destination of groundwater captured through dewatering or groundwater flowing over the Olympia Beds Truncation would be the same (the comingled Vashon-Sea Level Aquifer), however.

Greater surface water inflows from the wetlands could affect groundwater temperature and water quality in the immediate vicinity of the wetlands, but because aquifer mixing and dilution would occur, notable changes in groundwater quality at the dewatering site are not expected.

Significant saltwater intrusion impacts are not expected due to the Proposed Action, though less flow in Sequalitchew Creek could result in a slight landward shift of the saltwater-freshwater interface near its mouth. Slight increases in recharge to the comingled Vashon-Sea Level aquifer could cause intertidal springs west of the existing mine to have a slightly greater freshwater component.

Drinking water supplies near the South Parcel (Sequalitchew Springs, DuPont's Bell Hill and Hoffman Hill wellfields) are not expected to be impacted by the Proposed Action since they are either significantly upgradient of the project site (Sequalitchew Springs) or completed in deeper aquifers that are separated from the Vashon Aquifer by confining units.

Water Supply Wells and Water Supply Springs

The proposed project would not directly disturb the Olympia Beds or the deeper aquifers, and therefore indirect impacts on deep-aquifer water levels are expected to be minimal. Model results indicate that the change in water level in the Sea Level Aquifer at the edge of the model boundary in the direction of the City wellfield is less than 0.1 feet. Thus, existing and proposed City wellfields are not expected to be impacted by the Proposed Action.

Aquifer drawdown is not predicted to occur at Sequalitchew Springs, and therefore no effects on JBLM's water supply springs are expected.

No water supply wells are known to exist in the site area which tap the Vashon Aquifer, and therefore none would be impacted by the Proposed Action.

CUMULATIVE IMPACTS WITH PROPOSED ACTION AND SEQUALITCHEW CREEK RESTORATION PLAN

Introduction

As indicated in **Chapter 2** of this EIS, the 2011 Settlement Agreement states that permits for the Pioneer Aggregates South Parcel Project shall not be effective until permits for the Sequalitchew Creek Restoration Plan are in place, as a separate but related action. The Sequalitchew Creek Restoration Plan seeks to restore and enhance streamflow and ecological functions from Sequalitchew Lake through Edmond Marsh into Sequalitchew Creek ravine. Restoration of Sequalitchew Creek seeks to address almost two centuries of human manipulation. The principal goals of the Restoration Plan are to restore flows in Sequalitchew Creek, portions of which are now dry. This goal will be achieved by implementing a series of actions in a coordinated and adaptively managed project. The Restoration Plan is intended to sequentially restore diverted flows back to the 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.

The Restoration Plan is composed of multiple elements and phasing; its general objectives are to achieve year-round surface water flow in Sequalitchew Creek from Sequalitchew Lake to Puget Sound, minimize surface water flow to the Diversion Canal, and improve habitat conditions for native salmonid populations in the Sequalitchew Creek watershed.

Cumulative Impacts

Expected cumulative impacts to the groundwater system with the Proposed Action and Restoration Plan include:

- Lower surface water levels in East Edmond Marsh are predicted to cause the marsh to become a groundwater discharge feature because its planned surface water elevation will be lower than the underlying groundwater elevation. Beneath West Edmond Marsh groundwater recharge is projected to increase due to the increased surface water flow through it. Surface water levels are not expected to significantly change at Bell, McKay, and Hamer Marshes with the restoration plan, and therefore significant changes in their groundwater recharge/discharge relationships are not expected.
- Greater surface water flows through West Edmond Marsh and the Sequalitchew Creek "dry reach" is likely to increase groundwater recharge in its vicinity. Increased recharge in this area potentially will cause spring discharge in the upper Sequalitchew Creek ravine to increase, particularly if concentrated recharge occurs in the western portion of the "dry reach". However, if substantial streamflow losses in the current "dry reach" section of Sequalitchew Creek occur, a possible action identified in the restoration plan is adding a liner of low permeability materials to the creek bed in this vicinity. If this does occur, less groundwater recharge would occur in the "dry reach" area.
- Streamflow loss from Lower Sequalitchew Creek to the combined Vashon-Sea Level Aquifer should increase (as well as nearby aquifer water levels) due to the higher surface water flows through Sequalitchew Creek.
- During dry summers (when Sequalitchew Springs discharge to Sequalitchew Lake is fully consumed by JBLM), no surface water outflow from Sequalitchew Lake to East Edmond Marsh and Sequalitchew Creek will occur. These infrequent dry periods are predicted to last for several weeks to months, and during these periods the hydraulic system would shift closer to the condition simulated by the groundwater model with no Restoration Plan actions. However, because surface water level elevations in East and West Edmond marshes would be lower due to beaver dam removal, the aquifer would likely receive less recharge from the wetlands. Therefore, during drought periods greater aquifer drawdown could develop beneath Edmond Marsh and/or less groundwater discharge may occur in the Upper Sequalitchew Creek ravine with the Restoration Plan.
- Intertidal spring water quality and discharge rates from the combined Vashon-Sea Level Aquifer are not expected to change with the Proposed Action and the Restoration Plan.
- Recharge near the Diversion Canal (if any) would likely decrease since the Restoration Plan aims to minimize surface water flows in the Diversion Canal. Monitoring data and

the groundwater model calibration effort suggest that the Diversion Canal is not a significant source of recharge to the aquifer.

ALTERNATIVE 2 – NO ACTION

The No Action Alternative includes two scenarios: Scenario A – Continuation of Existing Site Conditions; and Scenario B – Site Development under Existing Zoning.

Scenario A

Under No Action Alternative Scenario A, the surface and groundwater conditions would remain as under existing conditions.

Scenario B

If the site were to be developed consistent with existing zoning, clearing and grading associated with construction would increase potential for erosion impacts to surface and groundwater resources; with adherence to applicable regulations during construction, significant impacts to these resources are not anticipated. The increase in impervious surfaces on the site with development consistent with existing zoning would increase stormwater runoff; with adherence to applicable regulations related to stormwater quantity and quality, significant impacts are not anticipated.

As indicated above, development of the site consistent with existing zoning includes the potential for the Sequalitchew Creek Restoration Plan to be implemented without the Proposed Action. However, there are no other known substantial funding sources other than CalPortland.

3.3.3 Mitigation Measures

Proposed Mitigation Measures

The following mitigation measures have been included in the Proposed Action to reduce surface water and groundwater impacts.

- Groundwater and surface water level monitoring for features in the site area that could potentially be affected would be implemented (see **Appendix F** for details). Monitoring data would be reviewed throughout the active dewatering period and used in support of the Proposed Action mitigation measures bulleted below. City review of monitoring data should include retention of a qualified hydrogeologist to provide qualified review of both data and projected impacts.
    - Steps 1 and 2 of the aquifer pumping tests would be completely reversible and would allow for confirmation testing of groundwater model predictions. If observed impacts differ significantly from predicted impacts, updates to the

groundwater model would be pursued to improve its predictive accuracy for subsequent dewatering steps and/or adjustments to the dewatering and mining activity plans would be made.

- The dewatering plan would be phased so that dewatering would start at locations farthest from Sequalitchew Creek and the wetland complex, and gradually would proceed closer to the waterbodies only if observed aquifer water levels do not exceed performance threshold values.

- If performance threshold water levels are exceeded, adaptive management responses (such as adjusting the dewatering operations and/or the boundaries and depth of mining so that performance threshold exceedances do not occur) would be required before additional mining could occur.

- Since dewatering Step 3 would be irreversible, increased monitoring vigilance at different phases of Step 3 as dewatering and mining progress southward could be warranted to ensure that performance threshold water levels are not exceeded.

- Erosion and sediment controls and stormwater treatment, which are intended to protect groundwater quality and the long-term performance of the proposed infiltration facilities, would be implemented (see **Appendix D** and Section 3.1, **Earth**, for details).

Other Possible Contingency Mitigation Measures

- As an element of the approval conditions for the Proposed Action, the City of DuPont could require a Monitoring and Response Plan. The Monitoring and Response Plan could include, among other things, definition of monitoring methodology, establishment of performance thresholds, and identification of contingency response measures to the considered for implementation if monitoring indicates exceedance of a performance threshold. The Monitoring and Response Plan could incorporate elements of the adaptive management processes proposed to be established for the Proposed Action and the Sequalitchew Creek Restoration Plan.

- The Sequalitchew Creek Restoration Plan is a separate but related action that is intended to be implemented in parallel with the Proposed Action. The mine and the stream restoration project each have their own adaptive management process tailored to achieving the goals and objectives of each specific project. The interaction between the two adaptive management processes could include: 1) project schedules that encourage restoration in advance of the potential impacts from mining; 2) development of performance thresholds for mining that support restoration and 3) coordinated monitoring and open sharing of information. The City, as the permitting authority for both projects would have a key role in assuring consistency between the two adaptive management plans. The adaptive management process included in the

Monitoring Plan (see **Appendix F**) includes, but is not limited to, the following potential mitigation actions if the impacts of dewatering on groundwater levels are greater than anticipated including: Installing additional monitoring locations; modifying the dewatering system or approach; revising the mining plan; and providing additional mitigation to impacted surface waters.

- The Sequalitchew Creek Restoration Plan's adaptive management process similarly identifies examples of potential response actions to be implemented if restored flows do not meet the plans objectives that include, but are not limited to: removing beaver obstructions; installing additional beaver exclusion devices; escalating beaver management; installing additional flow paths through the former railroad grade that divides Edmond Marsh; sealing the losing reach; creating connections to Bell and/or McKay marshes; and expediting later elements of the Restoration Plan.

Other groundwater contingency mitigation measures that could be implemented as part of the adaptive management process include:

- Groundwater captured from the mine could be conveyed to the Sequalitchew Creek ravine (either by open channel or micro-tunneling). This approach could provide mitigation for decreased seep discharge within the ravine if the conveyance outfall (or confluence) is located in the vicinity where groundwater discharge currently occurs. However, this mitigation measure could require revisiting conflicting provisions in the 2011 Settlement Agreement and would not augment streamflow between Sequalitchew Lake and the ravine.

- Groundwater captured from the mine could be pumped into Edmond Marsh rather than into the Sequalitchew Creek ravine. Benefits of this mitigation approach would be that cool groundwater (which has a low summer water temperature relative to surface water) would enter the marsh and could enhance Sequalitchew Creek surface water flow and fish habitat. A potential drawback of this mitigation action is that groundwater discharge/infiltration to the comingled Vashon-Sea Level Aquifer would substantially decrease. In addition, it likely would over-mitigate expected dewatering impacts to Sequalitchew Creek if active year-round (as opposed to only during certain dry or low-flow conditions).

- Water could be actively conveyed to Edmond Marsh during dry periods, while during all other periods captured groundwater from the South Parcel could be conveyed to the lower mine area for infiltration (as is planned in the Proposed Action). This could serve as a contingent measure for consideration and/or further study to supplement Sequalitchew Creek flows during dry periods when no outflow from Sequalitchew Lake occurs or if the Restoration Plan provides less environmental benefit than currently expected.

3.3.4 Significant Unavoidable Adverse Impacts

Under the Proposed Action with the Sequalitchew Creek Restoration Plan, unavoidable adverse impacts to the surface water system of the Sequalitchew Creek watershed would likely include:

- The Vashon Aquifer water table would significantly decrease in the vicinity of the South Parcel. Groundwater levels beneath Edmond Marsh, the closest marsh to the site, are predicted to decrease by up to 0.87 feet near its center (at MW-EM-2S) and remain up to 0.84 feet lower following completion of the Proposed Action. At the west end of the marsh (MW-EM-1S), long-term groundwater level declines of up to 8.73 feet could occur.

- Groundwater discharge in the Sequalitchew Creek ravine is expected to significantly decrease (by an annual average of up to 83%) during the Proposed Action and is expected to provide on average 79% less baseflow to Sequalitchew Creek following the Proposed Action. Greater percentage decreases in baseflow are expected during the dry season. Impacts to baseflow quantity could be mitigated by the Sequalitchew Creek Restoration Plan, except during periods when surface water outflow from Sequalitchew Lake does not occur.

- The intent of the proposed mitigation measures described in Sub-section 3.3.3, is to reduce these unavoidable adverse impacts to a non-significant status. If implementation of the proposed mitigation measures fails to mitigate these unavoidable adverse impacts, the City will consider implementing other possible contingency mitigation measures listed in Sub-section 3.3.3 as part of the adaptive management process.