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Steven Dahl
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Re: **Hydrologic Assessment**
Proposed surface mine expansion
Skagit County Parcel P44865

Dear Mr. Dahl:

This report was conducted to assess the potential impacts to groundwater and surface water resources from the proposed expansion of the existing surface gravel mine onto the Skagit County Parcel P44865. The pre-application meeting with the Skagit County Planning and Development Services indicated that a report characterizing the area's groundwater is a required element of the Mining Special Use Permit.

Based on our assessment of the subject property and vicinity and the water resources in the vicinity, it is our opinion that the gravel mine expansion will not have an appreciable impact on groundwater or surface water resources.

This assessment included a field inspection of the subject property, review of available geologic mapping and lidar (light detection and ranging) imagery of the site and vicinity, review of Department of Ecology records documenting existing domestic water use in the vicinity, and review of previously prepared reports on the existing mine on the adjoining property to the north and a landfill on a property to the east.

Geology

The Geologic Map of the Sauk River 30- by 60-minute Quadrangle, Washington (Tabor and others, 2002) indicates that the subject property is underlain by Vashon recessional outwash (Figure 1).

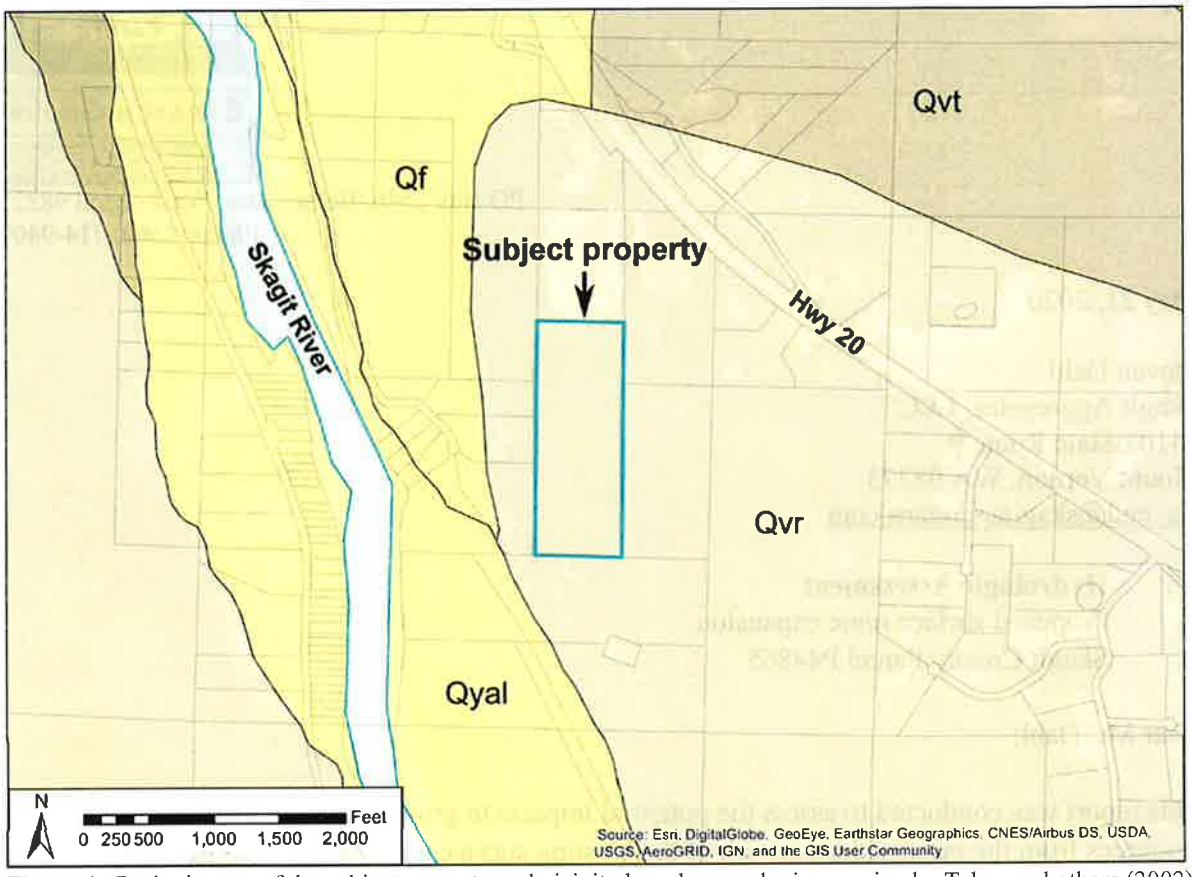

Figure 1. Geologic map of the subject property and vicinity based on geologic mapping by Tabor and others (2002). Qvr = Vashon recessional outwash, Qvt = Vashon till, Qf = Quaternary alluvial fan, Qyal = Quaternary younger alluvium.

Vashon recessional outwash consists of well-sorted and stratified sand and gravel deposits with minor silts and clays. The unit is typically parallel bedded but can also be locally cross-bedded. Recessional outwash was deposited in and along meltwater streams emanating from the receding glacial ice in the later stages of the last major glacial period, the Vashon Stade of the Fraser Glaciation approximately 14,000 to 12,000 years ago. Vashon recessional outwash was not overridden by glacial ice so tends to be less dense and compact than other glacial units.

Our site observations and lidar interpretation are generally consistent with the above-described mapping. The subject property is located on top of an outwash surface that has since been incised through by the Skagit River located to the west leaving the outwash surface as an elevated terrace. Hand-dug test pits on the site and observations of exposures in the existing gravel mine revealed medium dense sand and gravel with rounded pebbles and cobbles consistent with Vashon recessional outwash (Figure 2). Areas of slightly siltier soils were observed in the bottom of the topographic depressions (kettles) on the southern portion of the property. The observed recessional outwash deposits are well drained with no pooled water areas or evidence of surface water observed anywhere on the subject property.

Figure 2. Photograph of outwash in existing gravel mine on adjacent property to the north.

Four monitoring wells constructed on the adjacent property to the east, the Sauk Landfill, provide insight into geologic conditions at greater depth (Hong West & Associates, 1990 and Ecological Land Services, 2002). Well logs indicate that clean sand and gravel deposits extend to approximately 65 feet below the ground surface (bgs) on the east side of the property to approximately 140 feet bgs on the west side of the property (approximately 400 feet elevation above mean sea level (asl)). Two layers of siltier material were encountered at approximately 400 and 360 feet asl. The upper siltier layer was discontinuous and therefore not considered a perching layer. The lower silt layer was only approximately 2.5 feet thick but was more continuous and was deemed capable of acting as a confining layer for the underlying aquifer. An approximately 10- to 15-foot thick layer of silty gravel underlies the silt layer, which itself is underlain by strata of silt and clay to approximately 200 feet asl. A gravel deposit lies beneath the silt and clay unit to an unknown depth.

Soil Survey

The NRCS Web Soil Survey indicates that two dominant soil types are present on the property with one minor constituent. *Winston gravelly silt loam, 0 - 8% slopes* makes up approximately

66% of the subject property and is described as forming on outwash terraces overlain by volcanic ash and loess. The unit is well drained with moderately high to high hydraulic conductivity. Soil is generally 20 to 40 inches deep before encountering a restrictive layer. *Barneston gravelly ashy loam, 8 to 30% slopes* makes up approximately 33% of the subject property and is described as forming on the crest and sides of glacial features with parent materials consisting of ash and loess over glacial outwash. The unit is somewhat excessively drained with moderately high to high hydraulic conductivity. Soil is generally more than 80 inches thick before encountering a restrictive layer.

Topography

The topography of the site and vicinity is represented on Figure 3, a lidar bare earth image of the site and vicinity.

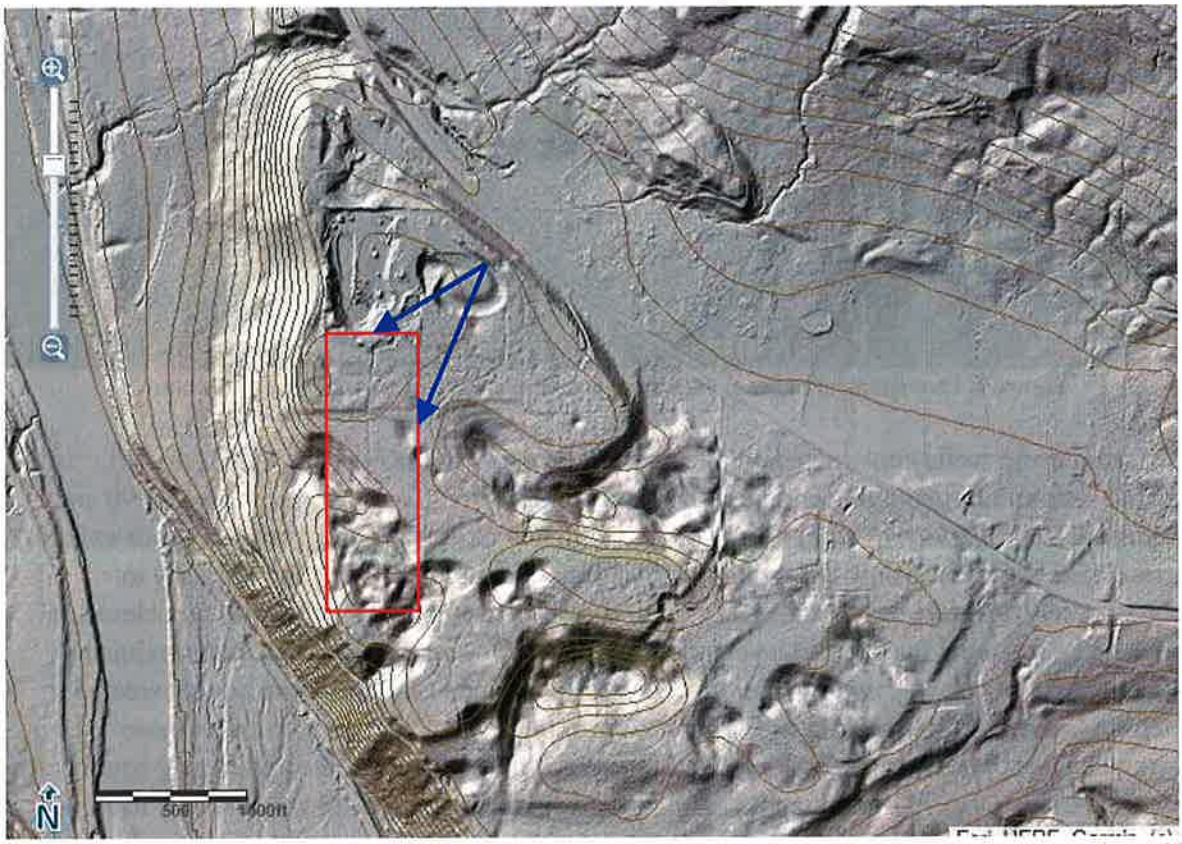

Figure 3. Lidar bare image of proposed expansion property and vicinity from Skagit iMap. Contour intervals are 20 feet. Blue arrows show range of groundwater flow directions of upper semi confined aquifer based on water levels at adjoining landfill site.

Topography on the northern portion of the subject property is relatively level, due to the property's position on top of a large glacial outwash terrace. Elevations on the terrace range from approximately 565 feet asl to 540 feet asl with a gentle slope to the southwest.

The southern portion of the property consists of several irregular topographic depressions. The morphology of the depressions is consistent with the features being kettles formed by buried or partially buried blocks of ice that then melted leaving forming depressions. The base elevation of these depressions range from approximately 510 feet to 431 feet asl. Gentle to moderate slopes descend from the level terrace or ridgelines between kettles to the kettle bottoms.

Streams and Wetlands

The subject property is located within the Skagit River drainage basin of the Upper Skagit Water Resource Inventory Area (WRIA) 4 (Wasington State Department of Natural Resources, 2020). DNR mapping does not identify any watercourses as being present on the subject property. DNR and U.S. Fish & Wildlife (USFWS) mapping also does not identify any wetlands as being present on the subject property (Wasington State Department of Natural Resources, 2020; U.S. Fish & Wildlife Service, 2020). The nearest mapped wetland is adjacent to the Skagit River approximately 500 feet to the southwest and down gradient of the subject property. The mapping is consistent with our own observations.

The nearest mapped watercourse is an old flood overflow channel approximately 500 feet southwest of the southwest corner of the site and approximately 250 in elevation below. Unnamed, fish-bearing streams are located approximately 4,000 feet southeast and 1,900 feet north and northwest of the subject property. The Skagit River is located approximately 1,100 feet west of the subject property at its nearest point.

Our observations are consistent with the above-described mapping. No evidence of surface water or wetlands or concentrations of hydrophilic vegetation were observed on the property.

Hydrology and Groundwater Flow

Groundwater wells were installed to assess the aquifers underlying the Sauk Landfill property immediately to the east of the subject property by Hong West & Associates (HWA, 1990). HWA identified two aquifers beneath the area: 1) A semi-confined aquifer is within an approximately a 10- to 15-foot thick silty outwash gravel unit capped by a thin (~2 ft) but apparently continuous silt layer, and 2) A deeper confined aquifer beneath a 150-foot thick silt and clay cap. HWA found that Sauk Landfill site is underlain by glacio-fluvial deposits. Well-graded sand and gravel deposits are present from the surface to depths ranging from approximately 30 feet below ground surface (bgs) on the north side of the landfill to about 90 feet bgs on the southeast side of the landfill. This unit is underlain by poorly graded (well sorted) sand that varies from about 140 feet thick on the western site margin to about 65 feet thick on the eastern site margin. A thin (1 to 15 feet thick) silt unit underlies the sand layer. The silt unit is subsequently underlain by an approximately 10- to 20-foot thick silty gravel unit that hosts the uppermost aquifer. The overlying silt layer appears to act as a semi-confining layer for the uppermost aquifer. All four on-site monitoring wells are screened within this semi-confined aquifer. Beneath the silty gravel

unit is a clayey silt to silty clay unit. Nearby domestic well logs indicate this unit is about 150 feet thick. Domestic well logs indicate a gravel deposit of unknown thickness underlies the clayey silt unit. This gravel deposit is host to a deep confined aquifer(s) that is the principal water supply for domestic wells in the area.

Potentiometric surfaces calculated for the semi-confined aquifer fluctuate between approximately 360 and 390 feet above mean sea level (asl) (Skagit County Public Works, 2018). Water level measurements from this aquifer indicate that groundwater flow direction varies from south to west (see Figure 3) and is generally towards the Skagit River. A review of drinking water wells indicates that domestic drinking water wells do not tap this aquifer for local drinking water.

Potentiometric surfaces calculated for the deeper aquifer are between approximately 200 and 210 feet asl indicating the confined nature of this deeper aquifer in that it has a higher potentiometric surface than the semiconfined aquifer above it. Water level data reviewed by Hong West & Associates (1990) indicate that groundwater flow in this deeper confined aquifer is to the southwest, toward the Skagit River.

Based on the inferred flow directions, both of the above described aquifers are believed to by hydrologically connected to the Skagit River and water from the aquifers is in continuity with the Skagit River and discharge water to the river.

Measurements of outwash material from the shallow unconfined aquifer on the adjacent Sauk Landfill provide estimates of hydraulic gradient (0.007 ft/ft), hydraulic conductivity (1.4 ft/day), porosity (25%), and groundwater flow velocity (0.04 ft/day) (Skagit County Public Works, 2018).

Proposed mining activities on the subject property are planned to result in the excavation of approximately the upper 70 feet of sand and gravel material, reaching a maximum depth of approximately 450 feet asl (Ecological Land Services, 2002). Therefore, the maximum depth of mining activities will be a minimum of 60 feet above the measured upper limit of the upper aquifer underlying the subject property. Since planned planed maximum depth of excavation is well above the local upper aquifer, mine excavation will not alter groundwater flow direction.

Geologic materials in the mine at the end of excavation are still expected to be highly porous and permeable sand and gravel material. Surface runoff and infiltration characteristics will not be altered appreciably from present conditions as all areas around the perimeter of the mine will remain highly permeable as most areas at the base of the final mine excavation. We observed no evidence of springs or seepage on the slopes below the proposed mine expansion area to the west or on slopes within the mine area kettles. We do not anticipate that groundwater or surface water will be encountered by mining activities.

Water Quality

Groundwater monitoring from the adjacent landfill property has indicated that landfill decomposition and leachate are not significantly impacting local groundwater quality (Ecological Land Services, 2002; Skagit County, 2018). The pH values are slightly below state groundwater quality standards, but pH values in the groundwater upgradient of the landfill has been observed to have similar pH values. Other than pH, groundwater beneath the landfill has met applicable groundwater quality standards since at least 2012.

The mine will not impact surface waters. Groundwater will not be impacted by the mine activity as long as no hazardous or organic rich materials are used as back fill material in the mine and best practices are followed for mine operations to prevent fuel releases.

Conclusions & Recommendations

Based on our review of existing subsurface and surficial geologic and hydrologic data for the subject property and vicinity, it is our opinion that the surface gravel mine expansion will not impact groundwater quality, quantity, or distribution as long as the proposed mine plans are followed. Any fueling and equipment management should follow best practices. Back fill of soils in the mine excavation will not alter water quantity or quality as long as no hazardous materials or organic wastes are utilized as back fill soils.

Long-term groundwater monitoring immediately adjacent to the subject property indicates that groundwater will remain at least 60 feet below the base of planned mining activities. Domestic water wells in the vicinity tap a deeper confined aquifer capped with approximately 150 feet of silt and clay. Therefore, domestic water supplies will not be impacted by planned mining activities.

The high expected infiltration capacity of site soils currently exposed and at the planned base of mining activities is expected to result in full infiltration of all precipitation not taken up by evaporation and transpiration and is unlikely to result in the formation of new surface water courses on or off the subject property.

Stratum Group appreciates the opportunity to be of service to you. Should you have any questions regarding this assessment please contact our office at (360) 714-9409.

Sincerely yours,

Stratum Group

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