Appendix B

Soils, Geology, Groundwater, and Geologic Hazards Report
Associated Earth Sciences, Inc.

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Soils, Geology, Groundwater and Geologic Hazards Report
for the Draft Environmental Impact Statement

EARTH AND GROUNDWATER

SNOQUALMIE MILL SITE

Snoqualmie, Washington

Prepared for

SNOQUALMIE MILL VENTURES, LLC

Project No. 20120126H012
March 10, 2020

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SOILS, GEOLOGY, GROUNDWATER AND GEOLOGIC HAZARDS REPORT FOR THE DRAFT ENVIRONMENTAL IMPACT STATEMENT

EARTH AND GROUNDWATER

SNOQUALMIE MILL SITE

Snoqualmie, Washington

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EARTH AND GROUNDWATER EXECUTIVE SUMMARY

This Technical Report has been prepared in support of the Draft Environmental Impact Statement (EIS) for the Snoqualmie Mill Site (Mill site) Planned Commercial/Industrial (PCI) Plan. The project site is located in the city of Snoqualmie, Washington (Figure 1). It is bounded by the City limits on the north, Borst Lake (Mill Pond) on the south, SE Mill Pond Road on the west, and the "hillside" area owned by King County along 396th Drive SE on the east. The site is located within Sections 29, 30, and 32 of Township 24, Range 8 East. Other nearby features and uses include the Snoqualmie River on the west, the City's sanitary sewer treatment plant, the City's North Well Field public water supply, and an existing gravel mining operation to the north. The Borst Lake/Mill Pond is not owned by the applicant and is not part of the Proposed Action.

EARTH AND GROUNDWATER

This section of the EIS presents the probable significant earth- and groundwater-related impacts from development of the Mill site, focusing specifically on Planning Area 1. Associated Earth Sciences, Inc. (AESI) has previously completed multiple subsurface studies both on- and offsite. Previous reports completed by AESI for the Mill site include a geotechnical engineering report (AESI, 2012) and an environmental site assessment current conditions report (AESI, 2015a) documenting existing conditions at the site. AESI has completed many geologic and groundwater studies for other nearby projects since the mid-1980's. Subsurface information from these studies include exploration pits, exploration borings, groundwater level data from groundwater monitoring wells in different aquifers, and surface water monitoring data from the Snoqualmie River, Tokul Creek, and the Mill Pond. Aquifer tests were also completed in many of the wells.

Our study included the review of available geologic literature, analysis of previously completed exploration pits, exploration borings, and groundwater wells, visual geologic reconnaissance of the site, review of Light Detection and Ranging (LIDAR) imagery of the region, and evaluation of nearby water well logs. Additional subsurface exploration completed specifically for the current project included advancing one exploration boring and two cone penetrometer tests (CPTs).

Affected Environment

The project site lies within the Puget Sound Lowland, which is a broad topographic and structural basin extending generally north-south between the Cascade Range on the east to the Olympic Mountains on the west. The project site was part of several previous geologic studies including AESI (2010, 2012, 2015a), Turney et al. (1995), Booth (1990), Frizzell et al. (1984), Tabor et al. (1993), and Dragovich et al. (2009b).

Geology

The geology surrounding the site is complex with a wide range of geologic units exposed in close proximity to the site. Geology in the vicinity of the site is shown on Figure 6 and geologic cross-sections are shown on Figures 7 through 10. Based on the referenced geologic mapping and AESI's previous work, two erosional valleys incised into Tertiary-age bedrock have been identified in the area. The ancient Snoqualmie River established a course through a bedrock valley in the immediate vicinity of the site (Figure 11). One of these paleovalleys is located under the present-day Lake Alice Plateau, south and west of the current Snoqualmie River and west of the Mill site (Figure 11).

The bedrock valleys have been filled by a series of younger, Quaternary-age sediments. These sediments accumulated as a result of alternating glacial and non-glacial deposition. Ice advanced southward from British Columbia into the Puget Lowland multiple times within the last 2 million years. The ice was part of the widespread Cordilleran continental ice sheet that covered much of northwestern North America and periodically extended down into the Puget Sound as a broad, tongue of ice commonly referred to as the Puget Lobe. In addition to the erosion and scouring of the Lowland, the Puget Lobe deposited a variety of glacial sediments, including outwash sand and gravel from meltwater streams, proglacial lacustrine (lake) silts and clays, deltaic sediments deposited in ice-dammed lakes, and glacial till deposited at the base and along the margins of the active glacial ice. Mountain glaciers also extended down the major river valleys such as the Snoqualmie, scouring the landscape and depositing sediments. During interglacial periods, erosion and deposition occurred primarily through the action of river systems flowing to the northwest, most notably the Snoqualmie River in the vicinity of the project. Non-glacial sediments were deposited in a wide variety of environments and include fluvial sands and gravels, lacustrine silt/clay, and peat.

During the retreat of the Vashon-age ice, a proglacial lake formed in the ancient Snoqualmie River valley. Meltwater from the receding ice sheet created a prograding delta system at Tokul Creek. This resulted in vast quantities of Vashon-age recessional sand and gravel deposited in what has been referred to in the geologic literature as the Tokul Creek Delta. This delta is located just north of the Mill site and is the source material for the Snoqualmie Sand and Gravel Pit. The delta forms a relatively level bench near elevation 550 feet and covers approximately 1.5 square miles. This thick deltaic sequence prevented the Snoqualmie River from re-establishing its pre-ice course, resulting in the development of post-glacial Lake Snoqualmie in the vicinity of the Mill site and deposition of lacustrine silts and clays. The outlet for Lake Snoqualmie was diverted by the delta to the location of the present-day Snoqualmie Falls.

Hydrogeology

Surface water features in the vicinity of the site include on-site wetlands, on-site streams, the Mill Pond south of the site, and the Snoqualmie River west-southwest of the site. The Snoqualmie River Shallow Aquifer is present beneath the site and is formed within near-surface Snoqualmie River deposits. A deeper aquifer (Tokul Creek Delta Aquifer) is formed within sand

and gravel deposits of the Tokul Creek Delta. Throughout most of the site, the Snoqualmie River Shallow Aquifer is hydraulically separated from the Tokul Creek Delta Aquifer by a thick deposit of recent (Holocene) lacustrine silt and clay.

In general, a groundwater divide is present in the central portion of the Mill site. In the south and western portions of the site, groundwater flows towards the Snoqualmie River and the Mill Pond. In the northern portion of the site, groundwater flows to the north toward the Tokul Creek Delta. The gradient in the shallow aquifer steepens to the north of the site as it merges with the Tokul Creek Delta Aquifer. Ultimately, the groundwater in the Tokul Creek Delta Aquifer flows to the north and discharges at a spring zone along Tokul Creek, north of the project (Figure 12).

<u>Soils</u>

Soils on the site formed primarily over post-glacially deposited alluvial sediments; however, much of the Mill site has been significantly modified through grading and filling during and subsequent to the operation of the mill, disturbing the natural soil profile. The soils that are present onsite have not had sufficient time to develop the deep weathering profiles present in soils of many unglaciated terrains. Instead, they exhibit a direct relationship to the underlying parent material, local climate, and vegetation. The vast majority of soils present onsite consist of Arents and Nooksack silt loam (Figure 5), which formed over a mixture of volcanic ash and other deposits or alluvium on floodplains and river terraces, respectively. Barneston gravelly ashy coarse sandy loam formed in areas over glacial outwash and is present primarily near the northeastern corner of the site, where the topography slopes up to the Tokul Creek Delta north of the site.

<u>Geologic Hazards</u>

Erosion, landslide, steep slope, seismic, channel migration, and flood hazard areas and critical aquifer recharge areas (CARAs) are regulated under the *Snoqualmie Municipal Code* (SMC) Chapter 19.12 - “Critical Areas.” Based on published critical areas maps produced by the City of Snoqualmie, King County, and our observations of regional and local topographic and geologic conditions, as documented in this report, these types of geologic hazards all exist to a variable extent in areas of the project site

Landslide/Steep Slope Hazards

The landslide/steep slope hazard risks on the property have been subdivided into two hazard zones based on local geotechnical engineering and geologic hazard standards. These hazard zones are illustrated on Figure 15 and are described below.

> <u>*Landslide/Steep Slope Hazard Zone 1*</u>: Landslide/Steep Slope Hazard Zone 1 encompasses the vast majority of the site and is considered to possess a low landslide hazard risk due to low slope gradients.

Landslide/Steep Slope Hazard Zone 2: Landslide/Steep Slope Hazard Zone 2 is generally localized to the eastern margin of the site. Portions of the slopes in this area appear to meet the definition of steep slope hazards – slopes with inclinations greater than 40 percent over a vertical height of at least 10 feet. Portions of these slopes also appear to meet criterion #1 for landslide hazards. Zone 2 is considered to possess a low to moderate risk of landslides if disturbed by improper grading/clearing or uncontrolled drainage. In their existing conditions these areas do not show evidence of slide activity.

Erosion Hazards

Erosion Hazard Areas are defined under SMC Section 19.12.100. Erosion Hazards are limited to the slopes at 15 percent or greater on the eastern margin of the site, mapped as Barneston Series soils on the *USDA Soil Conservation Service, King County Soils Survey*. This area is shown on Figure 14. A discussion of on-site soils is presented under “Soils,” Section 1.2.1.

Based on the sediment characteristics and slope gradients, two zones with differing degrees of potential erosion hazards are shown on Figure 14 and are discussed further below.

Erosion Hazard Zone 1: Erosion Hazard Zone 1 includes the majority of the Mill site, which is relatively flat. Because of the low slope gradient, this area is considered to possess a low erosion hazard risk. These areas are underlain by Arents and Nooksack Series soils at slopes of 0 to 2 percent.

Erosion Hazard Zone 2: Erosion Hazard Zone 2 is considered to possess a slight to moderate risk of erosion. This area is located on the northeastern margin of the Mill site. These areas are underlain by Barneston Series soils at slopes of 15 percent or greater.

Seismic Hazards

Seismic hazards (including surficial ground rupture, seismic-induced landslides, liquefaction, lateral spreading, and ground motion) were also analyzed for the Mill site. No evidence of surface faults or associated ground rupture was observed at the Mill site; however, strands of the Rattle Snake Mountain Fault Zone (RMF) and the Snoqualmie Valley Fault may be present beneath the site based on regional geologic mapping. While these faults are potentially active, they do not displace Holocene sediments, suggesting that they have not been active within the last 10,000 years. There is no other evidence that either of these faults are currently active (Dragovich et al., 2009a,b). The risk of fault rupture is considered to be low at the site.

Most of the site is underlain by loose existing fill, overbank deposits, river channel deposits, and lacustrine sediments, some of which are saturated. These materials are potentially at risk of liquefaction and lateral spreading during a design-level seismic event, shown as Seismic Hazard Zone 2 on Figure 18.

Flood Hazards

Flood hazard areas are regulated under SMC Section 15.12 and 19.12.150. Most of the Mill site is within the 100-year floodplain Zone AE shown on the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) of the area, below the base flood elevation (BFE). Zones AE are areas that have a 1 percent probability of flooding every year (100-year floodplain) and where predicted flood water elevations above mean sea level have been established. Properties in Zone AE are considered to be at high risk of flooding under the National Flood Insurance Program (NFIP). The southwestern portion of Planning Area 1 is within the delineated floodway. The floodway is defined as the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than a designated height. The 100-year floodplain and floodway are both shown on Figure 19.

Proposed development within the floodway and 100-year floodplain is regulated by the City of Snoqualmie's Flood Hazard Regulations (SMC 15.12) and federal FEMA regulations. Site development will require compliance with general standards in the SMC, including requirements for final grades after construction, the protection of site utilities from adverse impacts due to flooding, and the demonstration that the proposed development will not increase the flood levels during the occurrence of the base flood discharge.

Channel Migration Hazards

Per the SMC, Channel Migration Zones (CMZs) along the Snoqualmie River are categorized into Potential Hazard Areas, Moderate Hazard Areas, and Severe Hazard Areas. Based on the maps in the referenced report and shown on Figure 14, a section along the southwestern edges of Planning Area 1 and Planning Area 3 are within the Moderate Hazard Area. The majority of Planning Area 1 and the western portion of Planning Area 3 are within mapped Potential Hazard Areas (Figure 14). Development is not limited in potential hazard areas; however, only certain development or activities are allowed in severe and moderate CMZs. Based on current site planning, new structures are not currently planned within either the Severe or Moderate Hazard Areas except for the realignment of SE Mill Pond Road. Structures are planned within the mapped Potential Hazard Area.

Critical Aquifer Recharge Areas (CARAs)

Review of the map *King County Critical Aquifer Recharge Areas* dated March 1, 2012 (shown on Figure 20) indicates that the area immediately surrounding the Mill site to the north, and portions of the site on the west and northwest parts of the property are classified as a Category 1 CARA. The areas mapped as Category 1 CARA appear to generally correspond to the mapped 10-year time-of-travel (TOT) wellhead protection areas (WPAs) for groundwater production wells. The area immediately south of the Mill site, including the Mill Pond, and portions of the site on the southeast and southwest parts of the property are classified as a

Category 2 CARA. The majority of the Mill site, however, is not classified. Many of the WPAs shown on the above-referenced King County map appear to be delineated using a calculated fixed radius (CFR) technique, which can lead to misleading WPAs in complex hydrogeologic settings, such as those underlying the Mill site and vicinity.

AESI developed numerical groundwater flow models, using MODFLOW, to evaluate the groundwater capture zones for both the North Well Field (NWF) and South Well Field (SWF) (AESI, 1994, 1995c, 1996), north and south of the Mill site. The capture zones delineated by the MODFLOW modeling incorporate a conceptual hydrogeologic model developed by AESI through analysis of subsurface conditions observed in explorations completed on- and offsite, review of conditions reported on Ecology well logs, water level monitoring, and detailed hydrogeologic mapping. The MODFLOW model indicates that the TOT zones for the well field are highly elliptical (AESI, 1994, 1995c, 1996).

The wells for the NWF withdraw groundwater from the Deep Aquifer, which is separated from shallower aquifers by multiple low-permeability aquitards and receives limited recharge from shallower aquifers near the well field. Particle tracking plots, which illustrate flowpaths generated by the MODFLOW computer model, support this interpretation. Most of the water discharging from the well field comes directly from upgradient sources in the Deep Aquifer, originating a few miles upvalley (southeast) of the 10-year TOT boundary. Modeling suggests only about 5 to 10 percent of the water at the well field would originate in the Tokul Creek Delta Aquifer, Snoqualmie River Shallow Aquifer, or surface water sources within the 10-year TOT zone (AESI, 1996). The vast majority of recharge from the Mill site will bypass the deeper aquifer system within the 10-year TOT zone, discharging directly into the Snoqualmie River to the west or into the Tokul Creek Delta Aquifer to the north and emerge at the spring zone along Tokul Creek, ultimately flowing to the Snoqualmie River downgradient of the falls.

Impacts and Mitigations

This section describes our evaluation of probable environmental impacts relative to geologic hazards, surface water, and groundwater resources that could occur as a result of proposed development of the Mill site without mitigation. Our analysis of probable significant impacts associated with geologic hazards includes the following: erosion hazards including stream/river erosion (channel migration), landslide hazards, seismic hazards, flood hazards, and critical aquifer recharge areas (CARAs). Our analysis of CARAs is limited to groundwater quantity impacts. Geotechnical development impacts are also discussed.

<u>Geologic Hazard Impacts and Mitigations</u>

Potential impacts from geologic hazards at the site include potential landslide/steep slope, erosion, seismic, flood, and channel migration hazards.

Landslide and Steep Slope Hazards

The existing landslide and steep slope hazards onsite could be adversely impacted from three primary activities during development. These include clearing, grading (earthwork), and stormwater management.

Clearing could increase the existing landslide hazard potential by removing vegetation which would normally intercept some of the rainfall, resulting in higher runoff volumes. Grading (earthwork) activities could increase the existing landslide hazard potential. Fill material placed on or adjacent to a steep slope will increase the driving forces acting in the subsurface, which would increase the risk of slope failures. Surface drainage patterns are typically altered by grading. If the new drainage pattern results in an increase in either surface or subsurface water flow on or near a slope, landslides could occur.

Non-structural fills could fail due to inadequate compactive effort, use of organic soils, improper site preparation, oversteepened slopes, or other factors. Cut slopes could also fail if they are oversteepened, toe support is removed, or drainage is improperly directed.

Since most of the steep slope areas are located just offsite, potential landslide and steep slope hazards under the No Action Alternative would remain substantially unchanged from either the Proposed Action or Alternative 1.

With proper design and installation of the temporary and permanent stormwater management systems; establishment of minimum building and vegetation clearing setbacks onsite; and, review and approval of proposed development plans by a geotechnical engineer prior to construction, no significant landslide hazard impacts are expected.

Erosion Hazards

The most significant increase in erosion hazard potential onsite will be during construction. Clearing and grading activities during construction will increase erosion potential onsite through the removal of vegetation and by exposing soil directly to precipitation and runoff. Exposed soil will be subject to erosion and sediment transport. Nearby surface water features that could be adversely impacted by increased sedimentation include on-site wetlands and streams, the Mill Pond, and the Snoqualmie River. Post-construction (developed) conditions impacts should be similar to existing conditions, since exposed surfaces would be covered with structures, roadways, or new plantings.

The stormwater management plan for the Mill site proposes to discharge to the Snoqualmie River. Stormwater runoff from the western side of the site will be conveyed through storm pipes to a broad surface swale that will be constructed along a portion of the new SE Mill Pond Road. The stormwater will be conveyed as surface water flow through the swale to the Ordinary High Water Mark (OHWM) elevation of the river. Stormwater runoff from the eastern side of the site will be conveyed to the river through the existing system of on- and off-site wetlands.

Potential adverse impacts include erosion along the swale or along the system of wetlands and streams if significant flows are routed to these features or if the base or side slopes are not properly protected with vegetation or constructed of stable material.

Erosion hazard impacts would be mitigated with the provision of landscaping and impervious coverage of soils, the implementation of a temporary erosion and sediment control (TESC) plan during construction per City of Snoqualmie standards. It is our opinion that with the proper implementation of the TESC plans and by field-adjusting appropriate mitigation elements (best management practices [BMPs]) during construction, the potential adverse impacts from erosion hazards on the project may be mitigated.

Seismic Hazards

Due to the lack of evidence of surface faults in the vicinity of the Tehaleh EBPC site, the potential for surface rupture impacting the site is low, and no mitigation is necessary in relation to surface rupture.

The risk of seismically induced landslides onsite is low due to the general lack of steep slopes onsite, and the slopes just east of the site consist of glacially consolidated sediments that are typically resistant to landslide activity. These slopes are along the eastern boundary of Planning Areas 2 and 3, which are analyzed at a programmatic level in the EIS; and therefore, planned development in this area is very preliminary. Later in the design process, once a development concept has been formulated, the geotechnical engineer for the project should review the site plans to determine whether a quantitative assessment of slope stability on the eastern part of the site is warranted.

The subject site is underlain by alluvial sediments that are potentially susceptible to liquefaction during an earthquake. Liquefiable sediments were identified at depths continuing from 25 to 70 feet below ground surface, and the liquefaction-induced settlement calculated for the site ranges from about 2 to 8 inches over this depth range. We anticipate that any future structures onsite will be supported on deep foundation systems or use ground improvement techniques to mitigate the risk of settlement and the risk of liquefaction-related damage to the new structures.

Lateral spreading is a hazard on sites where liquefaction-prone material is located near exposed slopes. In the case of the Mill site, this includes areas near the banks of the Snoqualmie River. The liquefied soil layers and non-liquefiable overburden may spread horizontally toward the water due to the reduction of soil strength and lack of confinement on the water side. The potential lateral displacement in Planning Area 1 was calculated at a distance of 100 to 150 feet from the Snoqualmie River. Our analysis indicates that the magnitude of lateral spreading could be on the order of 1 to 2 feet towards the shoreline for a design seismic event. Additional analyses will be necessary when development plans are formalized and more subsurface information is available. Potential mitigation options include: 1) relocation of the new road alignment and roundabout near the Snoqualmie River, 2) installation of structural elements along the roadway edge such as a continuous, large-diameter drilled shaft wall, or 3) use of ground improvement methods such as stone columns or deep soil mixing to strengthen weak native soils presumed to exist adjacent to the river. In the event that the SE Mill Pond Road is damaged, the existing haul road will provide a secondary route onto and off of the site. We anticipate that risks of damage to the new structures resulting from lateral spreading will be mitigated by use of deep foundation systems or ground improvement techniques.

Structural design for the project under all of the Alternatives should follow 2015 *International Building Code* (IBC) standards. The 2015 IBC defines Site Classification by reference to Table 20.3.-1 of the *American Society of Civil Engineers* Publication ASCE 7, the current version of which is ASCE 7-16. In our opinion, the subsurface conditions at the site are consistent with a Site Classification of “E” or “F” as defined in the referenced documents depending upon local site conditions. Sites that are classified as Site Class “F” require a site-specific evaluation of ground motion. There is an unavoidable adverse impact related to a large seismic event causing some non-structural damage to buildings onsite.

Flood Hazards

Potential adverse impacts from flood hazards could be created by proposed site development due to filling portions of the site within the floodplain of the Snoqualmie River, including raising various site areas, roads, and building pads above the delineated BFE.

Compliance with flood hazard regulations, as defined in the SMC Sections 15.12 and 19.12.150, requires an analysis demonstrating that the proposed development will not increase flood levels during the occurrence of the base flood discharge. Watershed Science and Engineering (WSE) prepared a “No Net Rise Hydraulic Analysis” for the Mill site (WSE, 2018). The WSE report is described under Section 1.4 “Proposed Mitigations.” Based on the hydraulic modeling by WSE, the proposed grading plan and compensating storage will provide suitable mitigation for flood hazard impacts related to a potential rise in the BFE. There is an unavoidable potential adverse impact related to very large flood events (greater than 100-year) that could inundate the proposed development.

Channel Migration Hazards

A section along the southwestern edges of Planning Area 1 and Planning Area 3 are within the Moderate Channel Migration Hazard Area. The majority of Planning Area 1 and the western portion of Planning Area 3 are within a mapped Potential Hazard Area, which represents a lower level of channel migration hazard than the moderate or severe CMZs. Structures, roadways, or other facilities built within the severe or moderate CMZs may be susceptible to damage due to the gradual channel erosion and migration of the Snoqualmie River. Project planning should incorporate appropriate channel migration protection standards where possible to limit potential impacts to the roadway. There is an unavoidable potential adverse impact to proposed site structures due to the long-term erosion and channel migration of the Snoqualmie River.

Surface Water and Groundwater Impacts and Mitigations

Surface Water

The site lies entirely within the Snoqualmie River Basin and currently drains to the Snoqualmie River. The entire site (with the exception of some small areas of the site above the BFE) as well as all downstream areas lie within the 100-year floodplain of the river. The strategy for stormwater management for development of the Mill site is primarily flood control and compliance with flood hazard regulations. During typical rainfall events, stormwater management will include collection, treatment, and direct discharge to the Snoqualmie River and collection, treatment, and discharge to on-site and off-site wetlands to maintain wetland and stream hydrology. The Snoqualmie River is designated as a Direct Discharge Receiving Water Body by the 2016 *King County Surface Water Design Manual* (KCSWDM) and the 2012/2014 Washington State Department of Ecology *Stormwater Management Manual for Western Washington* (Ecology Manual), thus the site is exempt from flow control requirements.

In summary, the Stormwater Management Plan for the Mill site will include: 1) direct discharge to the Snoqualmie River, 2) maintenance of existing sub-basin hydrology to on-site and off-site wetlands, 3) runoff treatment of pollutant-generating impervious surfaces (PGIS), and 4) flood control and compliance with flood hazard regulations. Discharge to on- and off-site wetlands and streams consistent with existing conditions is a key component of the proposed stormwater management for the Mill site with the intent to maintain existing hydrology on- and offsite, and prevent significant adverse impacts to nearby surface waters.

Groundwater

Development has the potential to change the amount of surface water and groundwater recharge. Clearing vegetation and replacing it with suburban landscaping (such as lawns) reduces evapotranspiration, increasing the amount of water available for groundwater recharge and runoff. Depending upon how stormwater is managed, the increase in groundwater recharge may be counteracted by an increase in impervious surfaces (building and pavement areas), and other factors. On-site stormwater management will include collection, treatment, and direct discharge to the Snoqualmie River and collection, treatment, and discharge to on-site and off-site wetlands to maintain wetland hydrology. The intent of the proposed plan is to maintain discharge to on-site and off-site wetlands and streams consistent with existing conditions; therefore, groundwater recharge post-development is also expected to be similar to existing conditions, and no adverse impacts are anticipated.

Critical Aquifer Recharge Areas (CARAs)

The analysis of potential impacts to CARAs is limited to a consideration of potential groundwater quantity (recharge) impacts and does not take into account potential sources of contamination. Probable water quality impacts are not addressed in this technical report. As described above, groundwater recharge post-development is expected to be similar to existing conditions, and therefore no adverse impacts to CARAs are anticipated with respect to water quantity.

<u>Geotechnical Impacts and Mitigations</u>

The Mill site will require mass grading in some areas to achieve desired roadway, parking, and building pad elevations. Preliminary engineering estimates indicate that between 300,000 to 350,000 cubic yards (cy) of displacement (fill) could occur, and an equal volume of compensating storage will be created to ensure no increase in flooding. Cut and fill quantities are assumed to be similar for the Proposed Action and Alternative 1.

Potential geotechnical impacts could include various construction-related elements, such as: 1) site preparation, 2) structural fill placement, and 3) foundations. Examples of potential adverse impacts could include sloughing of temporary or permanent cut slopes if oversteepened, failure of fill soils due to improper placement and compaction, or excessive foundation settlement if the loose, soft native sediments underlying the site are not mitigated. However, since geotechnical oversight is an integral part of the project design and construction, no adverse impacts are considered likely. “Geotechnical Mitigations” are presented in Section 1.4.3 of this report.

In summary, the following are geotechnical design elements that should be considered in the future development planning process to mitigate settlement and risks from liquefaction and lateral spreading:

- The site development plan should be done in a way that does not increase loads on weak subsurface materials, if possible.

- Final site ground surface elevations should be kept at or below existing site grades, if possible. Mitigations that could be used to reduce the potential for settlement beneath newly filled areas could include removal and replacement of the old fill, preloading of the old fill, or support of structures upon deep foundations or other ground improvement methods.

- New structures, including buildings, substantial retaining walls, and similar structures with significant foundation loads, will require deep foundations or possibly deep ground improvement approaches. Floor slabs will also need to be supported on deep foundations or areas of deep ground improvement.

- New paving will require remedial preparation of the existing fill. Remedial preparation is likely to include placement of a geogrid or geotextile material in conjunction with a layer of sand and gravel or crushed rock fill. The purpose of this layer is to make the expected settlement of the paving more uniform. Settlement of paved surfaces will occur, and will require periodic maintenance that is more frequent and more extensive than is typical for sites that are not underlain by weak subsurface materials.

- New buried utilities, particularly those that are sensitive to grade changes such as gravity sewers, should be supported on a layer of new structural fill similar to that which will be used below paving. The incorporation of a layer of new fill below planned utilities will reduce but not eliminate the risk of future differential settlement and associated repairs.

Significant Unavoidable Adverse Impacts

Development of the Mill site will result in potential earth- and groundwater-related impacts associated with construction (site clearing and grading, installation of utilities/infrastructure), geologic hazards, groundwater, and surface water. With the implementation of the mitigation measures related to these hazards, as discussed in detail in this report, no significant unavoidable adverse earth- or groundwater-related impacts would be anticipated, except for potential adverse impacts related to long-term erosion of the Snoqualmie River, very large flood events, and very large seismic events.

1.1 EARTH AND GROUNDWATER

1.1.1 Introduction and Project Description

The Proposed Action is approval of a Planned Commercial/Industrial (PCI) Plan for the Snoqualmie Mill site (Mill site). The project site is located in the city of Snoqualmie, Washington (Figure 1). It is bounded by the City limits on the north, Borst Lake (Mill Pond) on the south, SE Mill Pond Road on the west, and the "hillside" area owned by King County along 396th Drive SE on the east. The site is located within Sections 29, 30, and 32 of Township 24, Range 8 East. Other nearby features and uses include the Snoqualmie River on the west, the City's sanitary sewer treatment plant, the City's North Well Field public water supply, and an existing gravel mining operation to the north. The Borst Lake/Mill Pond is not owned by the applicant and is not part of the Proposed Action.

The 261-acre Mill site was annexed to the City in 2012; however, a 15-acre area in the northeastern portion of the site (Planning Area 2) remains within unincorporated King County. Annexation of this area would occur before any specific development is proposed on this portion of the Mill site. This area is included in the PCI Plan, however, and most of it is proposed to remain undeveloped.

<u>Proposed Action</u>

The applicant is seeking approval of a PCI Plan and a development agreement for the Mill site. The proposed development agreement will help guide subsequent planning and development of the overall site.

The Draft Environmental Impact Statement (EIS) addresses development of the Mill site in several phases over an approximate 15-year period. Buildout would include a total of approximately 1.83 million gross square feet leasable area (1.879 building footprint) of light industrial/manufacturing, warehouse, office, retail, and residential uses. When fully developed, the site could generate an estimated 3,350 jobs. A majority of the overall site (157 acres, 60 percent) would remain undeveloped and be maintained for open space, landscaping, wetlands and streams, wildlife habitat, and flood storage.

The site has been divided into three distinct areas for purposes of planning and permitting. The PCI Plan application provides detailed information for Planning Area 1, an approximate 102-acre area in the northwestern portion of the site proposed as the first phase of development. Planning Area 1 is proposed to be comprised of a combination of warehouse/manufacturing, light industrial, second-story residential, and destination retail uses. This area is identified as the "Village." The Village center will be aligned along an east-west pedestrian-oriented corridor and main private drive known as Mill Street. This will be the primary gateway for the entire developed Mill site.

More conceptual information is provided for Planning Areas 2 and 3, and site planning is currently at a programmatic level. These areas would be developed after Planning Area 1.

Planning Area 2 is approximately 56 acres in size and is located in the northeastern portion of the Mill site. It is anticipated that Planning Area 2 would consist of warehouse and manufacturing uses. Large-scale industrial spaces/warehouses for a variety of light industrial uses with associated parking are envisioned in this northern planning area. The large blocks of industrial warehouse construction will accommodate light industrial production spaces, assuming homogeneous buildings spaced equally apart and docking areas between. The finished floor (FF) of the warehouses are assumed to be at or above the base flood elevation (BFE), while the docking and parking areas are assumed to be approximately 4 feet lower in elevation.

Planning Area 3, the Office/Campus District, is approximately 104 acres in size. It includes significant areas of the open space in the center and southeast portions of the site. It has the potential to be developed as a corporate or institutional campus, possibly by a single large user.

A lot line adjustment application has also been submitted to modify the boundaries, but not the number, of existing lots. Applications for building permits and other required development approvals will be submitted during or following the approval process for the PCI Plan.

Primary access to the site would be from SR 202 and SE Mill Pond Road. As shown on Figure 2, existing SE Mill Pond Road would be realigned and moved farther to the north to cross Planning Area 3 in a general east-west direction and at the main western entrance into the site, SE Mill Pond Road would be moved slightly to the northeast to accommodate a new roundabout. Segments of the realigned road would be developed in conjunction with individual planning areas. The new road would be a public road built to City standards. Most of the existing SE Mill Pond Road would be abandoned as the new road segments are completed, portions of which could be converted to a recreational trail.

1.1.2 Project Alternatives

Three alternatives have been developed based on State Environmental Policy Act (SEPA) requirements and the applicant's stated project objectives: No Action Alternative, PCI Plan Application Alternative, and Alternative 1. The purpose of an alternative in an EIS is to provide a comparison to the proposal and to explore opportunities for impact mitigation. While the alternative articulates a theoretically possible development scenario, it is not a plan that is necessarily proposed or desired by the applicant.

1. No Action Alternative

SEPA requires that an EIS contain a No Action Alternative. For the Mill site, "no action" means that the Proposed Action, the PCI Plan (Alternative 2 below), would not go forward and the City would not act on the proposal. Since City policies and regulations require approval of a PCI Plan as a pre-requisite for redevelopment, no redevelopment would occur. Existing on-site uses, including the Dirtfish Rally School and other uses identified in Section 2.2.1, would continue indefinitely, as permitted by the Pre-Annexation Agreement. While redevelopment is likely at some point in the future, it is not assumed in the near term or in the context of the current proposal. The No Action Alternative in the EIS primarily serves as a baseline against which the proposal and other alternatives can be measured.

2. PCI Plan Alternative

This alternative would be substantially similar to the submitted PCI application, with the exception of the outdoor performance space. The outdoor performance space would be eliminated in this alternative at the request of the applicant. This alternative is described under "Proposed Action" above. Table 1.1-1 below provides approximate land use totals for each of the planning areas for the proposed development (PCI Plan Alternative).

TABLE 1.1-1
SNOQUALMIE MILL DEVELOPMENT PLAN
PCI PLAN ALTERNATIVE
(Gross Leasable Area/Gross Acres[1])

	Planning Areas			
Land Use	**1**	**2**	**3**	**Site Totals[1]**
Warehouse/Manufacturing	280,000	400,000		680,000
Light Industrial	120,000			120,000
Retail/Restaurant[2]	70,000		25,000	95,000
Residential (Mixed-Use)[3]	134,000			134,000
Office/Campus	--	--	800,000	800,000
Total	604,000	400,000	825,000	1,829,000
Building Footprint/Gross Area	13 acres	9 acres	19 acres	40 acres
Open Space[4]	65 acres	28 acres	64 acres	157 acres
Roads/Other Impervious[5]	24 acres	19 acres	21 acres	65 acres
Total Area	101 acres	56 acres[6]	104 acres	261 acres

[1] Numbers rounded.
[2] Includes restaurant uses (approximately 15,000 square feet), tasting rooms, specialty retail, and indoor event center space (10,000 square feet).
[3] Assumes 160 residential units located on the second floor through fourth or fifth floors of mixed-use buildings in Planning Area 1. Units would be rental, market rate, in a mix of one- and two-bedroom apartments.
[4] Total open space includes wetlands, streams and their associated buffers; constructed wetlands; landscaped areas; undeveloped land used for compensatory flood storage, habitat and passive open space; active open spaces including public plazas and lawn areas, small outdoor spaces adjacent to individual buildings (26 acres); and the portion of Planning Area 1 subject to a conservation easement (32 acres of proposed Lot 5).
[5] Includes roads, sidewalks, parking areas, etc.
[6] Approximately 15 acres in the northern portion of Planning Area 2 is currently located within unincorporated King County. This area would be annexed to the City prior to development; most of the area would be retained as open space.

3. Alternative 1

An alternative redevelopment program is shown in Table 1.1-2 below. The alternative includes 1.85 million square feet, which is generally comparable to the proposal (Table 1.1-1), but with a different land-use mix and emphasis. Open space and building/impervious site coverage would be comparable to the proposed PCI Plan – 60 percent and 40 percent, respectively. Building layout in Planning Area 1 would also be comparable to the proposed PCI Plan. Holding development amount and site coverage constant is intended to help focus on the environmental effects of changing land uses.

Land use would be predominantly warehouse; combined with manufacturing and light industrial use, these land-use categories would comprise 80 percent of total development, compared to 45 percent for the PCI Plan. Compared to the Proposed Action, retail and office uses would be reduced, and a smaller indoor event space would be developed. Residential uses would be less than the PCI Plan. Compared to the proposed PCI Plan, total development in Planning Area 1 would be less and development in Planning Area 3 would be somewhat greater.

Alternative 1 (Alternative 1) includes an outdoor performance space in Planning Area 3. It assumes approximately 3.7 acres of landscaped open space with a constructed stage, with capacity for approximately 5,000. Planning Area 3 is not expected to develop until the latter stages of site development.

Alternative 1 could generate approximately 42 percent fewer jobs compared to the PCI Plan (1,550 compared to approximately 3,350 jobs for the proposal) which is a result of the lower employment associated with warehouse and industrial uses compared to office uses. In terms of environmental consequences, fewer jobs would also result in reduced impacts to many elements of the environment, including traffic, water consumption, public services and facilities, and utilities.

TABLE 1.1-2
ALTERNATIVE 1
(Gross Square Feet)

	Planning Areas			
Land Use	**1**	**2**	**3**	**Site Totals(1)**
Warehouse/Mfg	291,000	390,000	715,000	1,396,000
Lt. Industrial	96,000			96,000
Retail/Restaurant	82,000	0	0	82,000
Office	0	0	156,000	156,700
Residential(2)	104,000	0	0	104,000

Land Use	Planning Areas			Site Totals(1)
	1	2	3	
Outdoor Performance Space(3)	0	0	2,000 (stage)	2,000
Event Center	15,000	0	0	15,000
Totals	588,000	390,000	873,000	1,851,700

(1) Numbers rounded.
(2) Assumes 120 market rate rental units in a mix of one- and two-bedroom units, averaging 835 square feet.
(3) Assumes a 3.7-acre landscaped/grass open space area with a permanent stage (2,000 square feet), and a capacity for approximately 5,000. An average of two concerts per week are assumed to occur primarily on weekend evenings from June through September.

1.1.3 Existing Development

Current Site Uses and Facilities

In 2003, the mill was closed and demolition of existing buildings and site cleanup activities began. Several original industrial buildings remain, however, and some are currently used for storage. The old brick Powerhouse, which housed a steam-powered generator, and an associated 211-foot-tall brick stack still exists onsite and is designated as a King County Landmark. Remnants and foundations from numerous buildings are still present, generally on the eastern portion of the site. The hillside (42 acres) contiguous to the site on the east was acquired by King County Parks in 2015 and is planned to become part of the Snoqualmie Valley Trail. This area is not part of the Mill site and is not included in the PCI application.

There are several current uses of the site that will continue in the near term but will be displaced by planned development over time. Ultimate Rally LLC (aka Dirtfish Rally School) has been leasing land for operating a driving instruction school on a portion of the site since 2006. The Dirtfish Rally School uses the site’s network of paved and unpaved roads, primarily in the central portion of the site. Associated facilities provide space for storage of equipment and parts, maintenance of vehicles, and an office/classroom building located on the eastern hillside. The site’s road system will be modified or displaced over time, and activities curtailed, as phased development occurs.

Other current activities include storage of wood recycling materials, production and storage of topsoil for local construction projects, a bee hive operation, temporary construction staging, and truck storage.

Borst Lake (aka the Mill Pond) is a separate property located south of the Mill site. The pond was excavated and used by Weyerhaeuser for log sorting. The lake is not owned or controlled by the applicant and is not part of the Snoqualmie Mill PCI Plan.

1.1.4 Purpose and Scope

The purpose of this study was to document existing conditions of the Mill site property and immediate surrounding vicinity in terms of soil, geology, groundwater, and geologic hazards, and to evaluate the environmental impacts of the Proposed Action. The information obtained for the characterization of existing conditions was used to identify potential impacts to the affected environments.

Our study included the review of available geologic literature, analysis of previously completed exploration pits, exploration borings, and groundwater wells, visual geologic reconnaissance of the site, review of Light Detection and Ranging (LIDAR) imagery of the region, and evaluation of nearby water well logs. Additional subsurface exploration completed specifically for the current project included advancing one exploration boring and two cone penetrometer tests (CPTs). With this data, the type, thickness, distribution, and physical properties of the subsurface sediments and groundwater conditions were evaluated.

Figure 2 shows proposed Mill site land-use diagrams for the Proposed Action. The locations of monitoring wells and area water wells are shown on Figure 3. Other explorations completed in the vicinity of the subject property are shown on Figure 4.

Exploration boring, exploration pit, and CPT logs completed onsite are included in Appendix A, Off-site boring and well logs are included in Appendix B, laboratory testing results are included in Appendix C, and water level monitoring data is included in Appendix D. Slope stability modeling results are included in Appendix E. Summary tables containing ground surface elevation, depth, and other information are included in relevant appendices. This report summarizes our findings, opinions, and conclusions.

1.1.5 Literature Review

Associated Earth Sciences, Inc. (AESI) has completed many geologic and groundwater studies at the Mill site and for other nearby projects since the mid-1980's. Subsurface information from these studies include exploration pits, exploration borings, groundwater level data from groundwater monitoring wells in different aquifers, and surface water monitoring data from the Snoqualmie River, Tokul Creek, and the Mill Pond. Aquifer tests were also completed in many of the wells. The following section summarizes the information reviewed for the preparation of this technical report, organized by project.

- Mill Site

AESI previously completed a geotechnical engineering report (AESI, 2012) and an environmental site assessment current conditions report (AESI, 2015a) documenting existing conditions at the site. Work completed on the Mill site included excavation of 32 exploration pits and advancing 2 exploration borings completed as wells (MW-1 and MW-2). MW-2 was installed as a combination monitoring and dust suppression supply well for the on-site rally school, extending to a depth of 232 feet.

- Tokul Creek Water Rights

AESI completed a hydrogeologic evaluation (AESI, 2010) in support of the temporary (5-year) donation of the Weyerhaeuser's Tokul Creek water right (SWC 180(A)) to the Washington State Trust Rights Program. The 2010 report provides documentation necessary to identify the extent to which the water right was exercised during the 5 years prior to the donation. The study included extensive surface water and groundwater monitoring to characterize hydrogeology at the site and the relation between water levels in the shallow aquifer, deeper aquifers, the Mill Pond, and the Snoqualmie River in relation to the diversion of water from Tokul Creek.

- Snoqualmie Sand and Gravel (previously Milwaukee Pit) - North of the Mill Site

Between 1986 and 1991, 16 exploration borings (EB and SS&G) were drilled for previous studies by AESI at the Snoqualmie Sand and Gravel Pit. Monitoring wells were installed in three of the borings (SS&G#3, EB-B4W, and EB-C1W), and production wells were installed in two of the borings (SS&G#1 and SS&G#2). Studies completed at the Snoqualmie Sand and Gravel Pit are described briefly below.

  - 1986 sand and gravel evaluation for the Milwaukee Pit (AESI, 1986), which included drilling of two exploration borings (EB-1 and EB-2, later re-named well SS&G#1), laboratory testing, and pump tests.

  - Several studies (AESI, 1991, 1993a, 1993c) completed for the expansion of the Snoqualmie Sand and Gravel Pit, which included completion of multiple exploration borings and groundwater wells, refractive seismic analyses, and the pump testing of wells in both the Deep Aquifer (well SS&G#2) and Tokul Creek Delta Aquifer (well SS&G#3).

  - 2001 study (AESI, 2001) to assess the impacts of the proposed bedrock mining at the Snoqualmie Sand and Gravel Pit, using information in the exploration pits, borings, and wells completed for the previous studies described above.

- Snoqualmie Shallow Aquifer Analysis

AESI completed an analysis of the shallow Snoqualmie River Aquifer (AESI, 1993b) for the Snoqualmie Falls Hydroelectric Project. The purpose was to study the impacts of changes to the Snoqualmie River stage on the groundwater levels in the adjacent floodplain and terraces due to the Snoqualmie Falls Hydroelectric Project. The study included the installation of many shallow groundwater monitoring wells around Snoqualmie, two of which (EB-3 and EB-4) were installed on the Mill site. An extensive database of periodic shallow groundwater level monitoring extended from 1992 to 2003 for most of the wells. AESI currently monitors EB-4 at the Mill site.

- Snoqualmie North Well Field

Various studies (AESI, 1990, 1993d, 1994, 1996) were completed by AESI in support of the Snoqualmie Ridge North Well Field (NWF), subsequently transferred to the City of Snoqualmie, located just north of the Mill site. The work included the installation and pump testing of various water supply wells (including TW-6, TW-7, and TW-8). A groundwater flow model was developed to delineate a wellhead protection area for the NWF and estimate potential impacts to both deep and shallow aquifers and surface water due to pumping at the NWF. The extensive aquifer testing and flow modeling was required to obtain water rights from the Washington State Department of Ecology, and source approval from the Department of Health.

- Snoqualmie South Well Field

Studies were completed by AESI and others (AESI, 1995c; GeoEngineers, 1995; Gray & Osborne, Inc., 2005) at the Snoqualmie South Well Field (SWF), south of the Mill site. Work included installation of deep water supply wells, aquifer testing, and development of a groundwater flow model to delineate a wellhead protection area for the SWF and evaluate impacts to deep and shallow aquifers and surface water due to pumping at the SWF.

- Snoqualmie Waste Water Treatment Plant

AESI completed a hydrogeology and water quality evaluation for the proposed Snoqualmie Waste Water Treatment Plant (WWTP) project (AESI, 1995a) just northwest of the site. Work included installation of monitoring wells and analysis of groundwater samples to evaluate impacts to groundwater quality for the proposed expansion of the WWTP. AESI also completed a geotechnical engineering report for the WWTP (AESI, 1989), which included completion of exploration pits and borings on the WWTP site.

- Mount Si High School

AESI completed geotechnical engineering reports for the Mount Si High School, south of the Mill site, and immediately adjacent to the SWF (AESI, 2004b, 2015b, 2017). Our work included completion of exploration borings and cone penetrometer tests (CPTs) at the site as well as development of a stone column ground improvement system for support of building foundations. Pacific Groundwater Group completed studies (Pacific Groundwater Group, 2009, 2010) to evaluate the feasibility of a groundwater heat-pump system at Mount Si High School. The work included completing a groundwater flow model for the Deep Aquifer and installation of three deep wells for the heat-pump system. Aquifer testing was also completed on the wells.

1.2 AFFECTED ENVIRONMENT

Subsurface conditions at the Snoqualmie Mill site (Mill site) were inferred from AESI's extensive previous hydrogeologic and geotechnical studies as described under Section 1.1.5, including on-site and off-site explorations by AESI and others. Available subsurface exploration completed for this study was augmented by data obtained from other nearby projects, including the Snoqualmie Waste Water Treatment Plant (WWTP), Snoqualmie Sand and Gravel Mine (SSG), Snoqualmie Shallow Aquifer study (SSA), Snoqualmie North Well Field (NWF), Snoqualmie South Well Field (SWF), and others. AESI previously completed a geotechnical report (AESI, 2012) and environmental site assessment (AESI, 2015a) for the Mill site.

We also inferred subsurface conditions from our visual reconnaissance of the site and surrounding areas, and from our review of applicable geologic literature, LIDAR maps, and other pertinent documents.

1.2.1 Soils

Soils on the site formed primarily over post-glacially deposited alluvial sediments; and therefore, have not had sufficient time to develop the deep weathering profiles present in soils of many unglaciated terrains. Instead, they exhibit a direct relationship to the underlying parent material, local climate, and vegetation.

The soil types identified on the site are extrapolated from the United States Department of Agriculture (USDA) Soil Conservation Service (SCS), subsequently identified as the Natural Resources Conservation Service (NRCS), and the geologic information obtained from the exploration pits. In general, four major soil types were identified on the Mill site, and two minor soil units were also mapped by the SCS onsite. An additional unit, the Tokul Series located immediately offsite to the east, is described due to proximity and topographic (upslope) position. These units include:

- Arents
- Barneston Series
- Nooksack Series
- Edgewick silt loam
- Tokul Series
- Seattle Muck

The locations of these soils are graphically illustrated on Figure 5 and are described in detail below. The extent of the soils shown on the figure are based on mapping by the SCS. Based on extensive subsurface exploration, SCS-mapped soil extents were edited to more closely match site-specific conditions. Topographic gradients which typically subdivide each soil series into subunits have been combined on the map to simplify presentation.

Arents

Arents soils are mapped over the majority of the central, eastern, and southeastern areas of the site. These soils are described by the SCS as moderately deep to very deep, moderately well drained to somewhat excessively drained soils formed in a mixture of volcanic ash and a variety of other deposits. They occur over various types of environments at slopes ranging from 0 to 8 percent. No single profile is representative of these soils, and they are typically disturbed, having been used for mill yards, sorting yards, mills, dams, or old towns. Permeability in the Arents soils is considered to be moderate or moderately rapid. Runoff is slow, and the hazard of water erosion is slight.

Barneston Series

The Barneston gravelly coarse sandy loam is composed of excessively drained soils that typically form over glacial outwash. These soils are characterized by dark grayish brown gravelly coarse sandy loam 9 inches thick. The subsoil is dark yellowish brown very gravelly sandy loam 5 inches thick. The upper 7 inches of the substratum is dark brown extremely gravelly sand. The lower part to a depth of 60 inches is dark yellowish brown extremely gravelly sand.

The Barneston Series soils were mapped by the SCS at the northeastern corner of the site along the southern edge of the Tokul Delta, adjacent to the Snoqualmie Sand and Gravel Mine. Due to its high permeability, surface runoff within the Barneston Series soils is considered slow, and erosion hazards are considered low to moderate on gentle slopes as surface water has more of a tendency to percolate downward.

Edgewick Silt Loam

The Edgewick silt loam is mapped by the SCS in a very small area at the far southeastern corner of the site. This unit is composed of well drained soils on river terraces. These soils are characterized by an 8-inch-thick surface layer of dark brown silt loam. The subsoil is olive brown silt loam 12 inches thick. The upper 13 inches of the substratum is olive brown fine sandy loam. The next 13 inches is olive brown loamy sand. The lower part to a depth of 60 inches is dark grayish brown very gravelly sand. Permeability in the Edgewick silt loam is considered to be moderate. This soil is subject to occasional, brief periods of seasonal flooding. Channeling and deposition are common along streambanks.

Nooksack Series

The Nooksack silt loam is mapped on the western and northwestern areas of the site. This soil series consists of moderately well drained soils formed in alluvium on floodplains and river terraces. Typically, these soils are characterized by a very dark grayish brown silt loam 11 inches thick. The subsoil is dark grayish brown silt loam 18 inches thick. The substratum to a depth of 60 inches is dark grayish brown and grayish brown silt loam. Surface runoff is generally very slow, and erosion hazard is generally low due to the very low slope gradient (typically 0 to 2 percent).

Seattle Muck

The Seattle Muck is mapped by the SCS in a very small area just west of Wetland 10 at the north end of the Mill site. The Seattle Muck very deep, very poorly drained soil is in depressions in river valleys. Typically, the surface layer is dark brown muck 8 inches thick. The underlying material to a depth of 60 inches is dark brown and black, stratified highly organic soil. Permeability is moderate in this soil. Runoff is very slow, and there is little to no hazard of erosion.

Tokul Series

The Tokul gravelly loam is a moderately deep, moderately well drained, nearly level to very steep soil in areas underlain by glacially derived deposits. These soils are mapped on the slopes just east of the Mill site. These soils are characterized by brown and grayish brown, gravelly loam up to about 60 inches in depth developed over a substratum of dense glacial till.

Permeability in the Tokul Series is considered to be moderate in the surface layer and subsoil, becoming very slow to nil in the underlying till. Runoff is slow. Sheet and concentrated flow erosion hazards are considered to be low for slopes under about 20 percent and moderate to high for slopes over about 20 percent.

1.2.2 Regional Geologic Setting

The project site lies within the Puget Sound Lowland, which is a broad topographic and structural basin extending generally north-south between the Cascade Range on the east to the Olympic Mountains on the west. The project site was part of several previous geologic studies including AESI (2010, 2012, 2015a), Turney et al. (1995), Booth (1990), Frizzell et al. (1984), Tabor et al. (1993), and Dragovich et al. (2009b).

The geology in the vicinity is complex with a wide range of geologic units exposed in close proximity to the site. Geology in the vicinity of the site is shown on Figure 6 and geologic cross-sections are shown on Figures 7 through 10. Based on the referenced geologic mapping and AESI's previous work in the area, two erosional valleys incised into Tertiary-age bedrock have been identified in the area. The ancient Snoqualmie River established a course through a bedrock valley in the immediate vicinity of the site (Figure 11). One of these paleovalleys is located under the present-day Lake Alice Plateau, south and west of the current Snoqualmie River and west of the Mill site (Figure 11).

The bedrock valleys have been filled by a series of younger, Quaternary-age sediments. These sediments accumulated as a result of alternating glacial and non-glacial deposition. Ice advanced southward from British Columbia into the Puget Lowland multiple times within the last 2 million years. The ice was part of the widespread Cordilleran continental ice sheet that covered much of northwestern North America and periodically extended down into the Puget Sound as a broad, tongue of ice commonly referred to as the Puget Lobe. In addition to the erosion and scouring of the Lowland, the Puget Lobe deposited a variety of glacial sediments, including outwash sand and gravel from meltwater streams, proglacial lacustrine silts and clays, deltaic sediments deposited in ice-dammed lakes, and glacial till deposited at the base and along the margins of the active glacial ice. Mountain glaciers also extended down the major river valleys such as the Snoqualmie, scouring the landscape and depositing sediments. During interglacial periods, erosion and deposition occurred primarily through the action of river systems flowing to the northwest, most notably the Snoqualmie River in the vicinity of the project. Non-glacial sediments were deposited in a wide variety of environments and include fluvial sands and gravels, lacustrine silt/clay, and peat.

During the retreat of the Vashon-age ice, a proglacial lake formed in the ancient Snoqualmie River valley. Meltwater from the receding ice sheet created a prograding delta system at Tokul Creek. This resulted in vast quantities of Vashon-age recessional sand and gravel deposited in what has been referred to in the geologic literature as the Tokul Creek Delta. This delta is located just north of the Mill site and is the source material for the Snoqualmie Sand and Gravel Pit. The delta forms a relatively level bench near elevation 550 feet and covers approximately 1.5 square miles. This thick deltaic sequence prevented the Snoqualmie River from re-establishing its pre-ice course, resulting in the development of post-glacial Lake Snoqualmie in the vicinity of the Mill site, resulting in the deposition of lacustrine silts and clays. The outlet for Lake Snoqualmie was diverted by the delta to the location of the present-day Snoqualmie Falls.

1.2.3 Site Geology/Stratigraphy

The primary geologic units interpreted to be present at the site or in the vicinity of the site include the following:

1. Tertiary Bedrock;
2. Olympia and pre-Olympia-age undifferentiated deposits;
3. Vashon Stade deposits - advance outwash, lodgement till, and recessional deposits (including the Tokul Creek Delta); and
4. Holocene (Recent) deposits

A map showing surficial geology in the project vicinity is presented on Figure 6. AESI’s interpretation of the subsurface conditions are shown on Cross-Sections A-A’ and B-B’ (Figures 7 through 10). Both cross-sections are subdivided into two separate figures covering the span of each section. The information presented on these cross-sections is a combination of geologic mapping, subsurface data obtained from our explorations for this project, explorations that we completed for previous projects in the vicinity, and explorations completed by others.

These cross-sections are discussed further in subsequent parts of this report in context with specific geologic units and groundwater conditions.

Many explorations have been completed by AESI on the Mill site and other projects in the vicinity since the late 1980’s. In order to differentiate between AESI explorations at different sites with the same name, suffixes have been added to exploration names in this report as needed. These include the following: “MS” for the Mill site, “WWTP” for the expansion of the Snoqualmie WWTP (northwest of the site), “SSG” for Snoqualmie Sand and Gravel (north of the site), “NWF” for the Snoqualmie Ridge North Well Field (north of the site), “SWF” for the South Well Field (south of the site), and “SSA” for the Snoqualmie Shallow Aquifer analysis (both on- and offsite).

The following section presents more detailed subsurface information organized from the oldest (deepest) to youngest (shallowest) sediment/bedrock types encountered in the explorations completed for the project.

Bedrock

Surface exposures of bedrock in the vicinity of the site can be observed at Snoqualmie Falls to the northwest, along Tokul Creek to the north and northeast. Bedrock in the area has been mapped by Tabor et al. (1993), Frizzell et al. (1984), and Dragovich et al. (2009b) as primarily volcanic in origin. Volcanic rocks exposed north and northeast of the Mill site in the Tokul Creek valley are late-Eocene in age (47 to 36 million years ago [Ma]) and have been interpreted to be volcanic rocks of Mount Persis (Tabor et al., 1993). These rocks are described as porphyritic andesite flows, andesite to dacite breccia, dacite to rhyolite tuff, and minor interbedded lithic sandstone, tuffaceous siltstone, and conglomerate, and rare basalt. These Eocene rocks unconformably overlie older Cretaceous to Jurassic-age (with dated ages ranging from about 96 to 147 Ma) western mélange belt metasedimentary rocks, consisting of metamorphosed sandstone, tuff, conglomerate, and argillite, which are exposed northeast and east of the site.

Younger Miocene-age (dated to about 18 to 23 Ma) volcanic rocks are exposed at the surface north and northwest of the site, particularly at Snoqualmie Falls and along the lower section of Tokul Creek. These Miocene rocks consist of andesite to trachyandesite flows and lithic tuff breccia with minor lahars and rare vitric tuff. They form a bedrock topographic high near Snoqualmie Falls, which has been interpreted to represent an ancient Miocene volcanic center. The Miocene rocks are faulted against the older Eocene volcanic rocks along the Snoqualmie Valley Fault, which is mapped to lie along the eastern edge of the site (Dragovich et al., 2009b). The Snoqualmie River flows over the relatively resistant Miocene bedrock forming Snoqualmie Falls, situated approximately 2,300 feet west-northwest of the Mill site.

Bedrock was encountered in explorations completed for the Snoqualmie Sand and Gravel Pit (AESI, 1993a, 2001) just north of the Mill site, including borings EB-A1 through EB-A3 (Figure 4) at various elevations (ranging from about 460 feet to 604 feet). North of the project site, the upper surface of the bedrock was encountered during drilling of the wells for the NWF (TW-5 through TW-8) at elevations ranging from about minus 190 feet to minus 120 feet (AESI, 1994). Just northwest of the Mill site, bedrock was encountered during drilling at the City of Snoqualmie WWTP at an elevation of about 358 feet in OBW-2 (AESI, 1995a). Bedrock was not encountered in any of the explorations completed on the Mill site. Where observed, all bedrock extended below the termination depth of the explorations.

The variations in relief of the top of the bedrock corresponds with erosional bedrock valleys of the ancestral Snoqualmie River (Figure 11). Evidence for the valley include subsurface exploration, seismic reflection profiles (Liberty, 2009), and gravity analysis near the site and west of the site at Snoqualmie Ridge (AESI, 1987, 1988a, and 1995b).

Pre-Olympia Deposits

Pre-Olympia undifferentiated deposits, consisting of laminated to massive silt, clay, sand, gravel, and clayey diamicton, have been documented in limited areas surrounding the site. These sediments have been mapped from discontinuous surface exposures in areas to the west and east of the city of Snoqualmie (Dragovich et al., 2009b). Current evidence suggests that these sediments have a limited distribution. The pre-Olympia-age deposits include both glacial and non-glacial sediments. The exact age of these sediments are unknown; however, because of their stratigraphic position beneath Olympia-age deposits (see below) in areas, they are considered to be greater than 60,000 years. These sediments are generally dense since they have been glacially consolidated.

In addition to the limited surface exposures, pre-Olympia glacial sediments have been documented within test wells drilled by AESI at the NWF (Figure 7) and on the Lake Alice Plateau for the Snoqualmie Ridge project (AESI, 1987, 1995b) within the western, ancestral Snoqualmie River paleovalley, west of the site (Figure 11).

Pre-Olympia to Olympia-age (described below) sediments were also encountered in wells TW-5, TW-6, TW-7, and TW-8 completed for the NWF just north of the Mill site (AESI, 1994, 2004a) within the eastern, ancestral Snoqualmie River paleovalley (Figure 11). At the locations of TW-5, TW-6, TW-7, and TW-8 the pre-Olympia/Olympia deposits directly overlie bedrock.

Olympia/Pre-Olympia Non-Glacial

Surface exposures of Olympia to pre-Olympia-age sediments have been mapped extensively to the west of Snoqualmie (Dragovich et al., 2009b). Olympia-age sediments accumulated in non-glacial alluvial/fluvial environments prior to the Fraser Glaciation. The upper boundary of the Olympia sediments varies significantly in age since it represents the top of a southward migrating facies boundary at the limit of direct influence of the advancing Cordilleran ice sheet. Measured ages for Olympia-age deposits range from about 15,000 to 60,000 years ago (Troost, 2016). They were deposited in a wide variety of non-glacial environments and range from lacustrine silts and clays, fluvial sand and gravel, and occasional organics. These sediments are generally dense since they have been glacially consolidated.

Olympia/pre-Olympia sediments have been observed in various borings, wells, and exploration pits completed by AESI for other off-site, nearby projects. Based on well log data at the NWF (TW-5, TW-6, TW-7, and TW-8) and SWF (well nos. 1, 1-R, and 2), Olympia or pre-Olympia deposits directly overlie bedrock within the paleovalley in the vicinity of the Mill site.

Pre-Vashon non-glacial deposits that are likely to be Olympia in age were encountered in explorations EB-A7 and EB-A8 at the Snoqualmie Sand and Gravel Pit, just north of the Mill site. The upper surface to this material ranged from approximately elevation 497 feet in EB-A7 to elevation 265 feet in EB-A8. The non-glacial deposits were observed to extend below the termination depth of the explorations. The non-glacial deposits varied in composition but generally consisted of highly oxidized, sandy gravelly silt, equigranular fine sand and organic-laden silt with localized sand and gravel lenses, and silty fine sand to sandy silt.

The one deep subsurface exploration (MW-1) at the Mill site indicates that older overbank and river channel deposits related to the Snoqualmie River directly underlie the lacustrine deposits. These older deposits were interpreted to be pre-Vashon and may be Olympia in age. These deposits consisted of fine sand with silt and clay (overbank) and gravel and fine to coarse sand (channel). These deposits were about 30 feet thick where encountered in boring MW-1 and at a depth of about 200 feet (elevation of about 220 feet).

Radiocarbon dating has been performed on selected samples from various wells completed by AESI at the Mill site and vicinity since the 1990's. Samples from pre-Vashon sediments were tested from wells TW-8 at the NWF and City of Snoqualmie well no. 2 at the SWF. The results of radiocarbon dating are summarized in Table 1.2-1. The oldest age date that can be reliably measured using radiocarbon dating techniques varies somewhat based upon the method and sample preservation history but is generally up to 50,000 years. The reported dates from the samples in Table 1.2-1 were all older than maximum age limit, which in this case ranged from about 40,000 to 42,000 years ago. Therefore, these non-glacial sediments may either represent older Olympia-age deposits (Olympia-age deposits range from approximately 15,000 to 60,000 years ago), or they may represent older pre-Olympia non-glacial sediments.

TABLE 1.2-1
RADIOCARBON DATING SUMMARY
OLYMPIA - PRE-OLYMPIA DATES

Project	Exploration	Sample Depth (feet)	Sample Elevation (feet)	Material Tested	Calibrated BP ^{14}C Age
South Well Field	City Well #2	474	-52	Wood	> 41940
North Well Field	TW-8	245	260	Wood	> 41240
North Well Field	TW-8	395	110	Wood	> 40380

Dates are reported as radiocarbon years before present (BP), where present is defined as 1950 AD by convention.
Conventional dates were calibrated using OxCal 4.3 using the calibration curve IntCal 13.
Radiocarbon dating performed by Beta Analytic, Inc.

Vashon Stade Deposits

The Vashon sediments described below were deposited during the Vashon Stade of the Fraser Glaciation. The Fraser Glaciation began about 25,000 years ago with the expansion of alpine glaciers, which coalesced to form the Puget Lobe that gradually advanced southward, eventually reaching the north Washington border about 18,000 years ago and reaching the Seattle area by about 17,000 years ago (Haugerud et al., 2017). Its maximum extent south of Olympia occurred approximately 16,000 years ago, after which the ice stagnated and retreated rapidly to the north (Troost, 2016).

The Fraser Glaciation was the last major continental glaciation of the region. Much of the existing geomorphology around the project area was created by processes related to the Vashon-age glacier, and these units dominate the near-surface geology in the upland areas surrounding the site.

Vashon Advance

During the advance of the Vashon ice sheet, an ice-dammed lake formed in the ancient Snoqualmie River valley. A high-energy river flowing southward from the ice sheet deposited a delta in the proglacial lake downstream of the glacier. Deltaic sediments of advance gravelly sand and sandy gravel overlain by fine to medium sand and cobbley sandy gravel represent deltaic foreset beds and topset beds (AESI, 1987). This unit was observed primarily by AESI west of the Mill site in explorations completed for the Snoqualmie Ridge development (AESI, 2003). Foreset bedding was well exposed in a gravel pit located in the vicinity of Snoqualmie Ridge as well as in excavation completed during development of the site. The thickness of this unit is expected to approach 150 feet along the northern flank of the Lake Alice Plateau. Non-deltaic Vashon advance sediments were also deposited by meltwater streams and on the margins of the delta complex (AESI, 1987). Vashon advance silt and clay was deposited in a low-energy environment, and may represent lacustrine sediments of the proglacial lake that formed in the Snoqualmie River valley.

Vashon advance deposits are exposed at the ground surface on the northern slopes of the Lake Alice Plateau west of the Mill site and on upland slopes surrounding the Mill site. Surface exposures of the advance lacustrine sediments are mapped in various areas surrounding the site, generally underlying the coarser-grained advance outwash or deltaic deposits. In the immediate vicinity of the site, Vashon advance outwash deposits overlying advance lacustrine deposits are mapped on the slopes along the eastern margin of the Mill site (Dragovich et al., 2009b).

Vashon advance deposits were observed in limited explorations in the immediate vicinity of the Mill site. For example, advance outwash was encountered in OBW-1 completed for the Snoqualmie WWTP (AESI, 1995a) just north of the Mill site at a depth of about 20 feet overlying bedrock and underlying Vashon lodgement till. Vashon advance sediments were not observed in any of the explorations completed onsite. MW-1 completed in the southeastern area of the site encountered recent (Holocene) river channel and lacustrine deposits directly overlying older Snoqualmie River alluvium, interpreted as pre-Fraser (possibly Olympia) in age, with no intervening Vashon-age deposits.

Vashon Lodgement Till

Vashon lodgement till consists of an unsorted mixture of silt, sand, gravel, cobbles, and occasional boulders deposited at the base of the Vashon-age ice sheet. As a result, the till has been consolidated into a very dense condition by the massive weight of glacial ice. Vashon lodgement till deposits are extensive and mapped across much of the upland surrounding the Mill site. They are one of the predominate surficial deposits throughout the topographically higher upland areas that surround the Mill site, which is characterized by elongate, generally northwest-southeast-trending hills and swales that parallel the flow direction of the Vashon-age ice sheet.

Vashon lodgement till was not encountered in any explorations completed at the site except for EP-1000 completed at the site’s northeastern corner near the toe of the eastern slopes. This pit encountered medium dense to dense silty fine to medium sand with gravel underlying the existing fill that was interpreted to be lodgement till. The till extended to the full depth explored of about 7 feet at this location. The till is expected to be absent underneath the majority of the site.

Vashon till was encountered in limited areas directly overlying the bedrock just north of the Mill site in explorations completed for the Snoqualmie Sand and Gravel Pit and just northeast of the site at the Snoqualmie WWTP project. Lodgement till is exposed at the surface on the slopes just east of the site, overlying Vashon advance outwash (Dragovich et al., 2009b).

Due to the large amount of fine-grained sediment and relative high density, unweathered Vashon till generally has a very low permeability and is considered a barrier to groundwater flow.

Tokul Creek Delta

As the Vashon ice sheet receded following the ice maximum, a proglacial lake again formed in the ancient Snoqualmie River valley. Meltwater from the receding ice sheet created a prograding delta system at Tokul Creek. This resulted in vast quantities of Vashon-age recessional sand and gravel deposited in what has been referred to in the geologic literature as the Tokul Creek Delta. This delta is located just north of the Mill site and is the source material for the Snoqualmie Sand and Gravel Pit. Exploration borings completed at the sand and gravel pit indicate that the delta deposits are up to about 280 feet in this area (AESI, 1986, 1988b, 1993a, 2001). The delta forms a relatively level bench near elevation 550 feet and covers approximately 1.5 square miles.

The recessional rivers eroded older sediments and in most areas the Tokul Creek Delta deposits directly overlie older pre-Vashon deposits. The delta onlaps bedrock under some areas of the Snoqualmie Sand and Gravel Pit to the north of the Mill site and just east of Snoqualmie Falls, northwest of the Mill site (Figure 9).

The thick deltaic sequence prevented the Snoqualmie River from re-establishing its pre-ice course, resulting in the development of post-glacial Lake Snoqualmie in the vicinity of the Mill site. The outlet for Lake Snoqualmie was diverted by the delta to the location of the present-day Snoqualmie Falls. Medium dense sand, interpreted to be deposits of the Tokul Creek Delta, was encountered at a depth of approximately 55 feet in both EB-1 and CPT-1 completed near the northeast corner of the Mill site (Figure 4) underlying lacustrine sediments that were deposited in post-glacial Lake Snoqualmie. In general, this deltaic sand is expected to be present at depth underneath the northern portion of the site. The deltaic deposits are interpreted to pinch out to the south (Figure 7).

Recent (Holocene) Deposits

As described previously, the thick Tokul Creek deltaic sequence prevented the Snoqualmie River from re-establishing its pre-ice course, resulting in a lake within the valley. Recent, also termed Holocene-age (<10,000 years old), lacustrine silts and clays were subsequently deposited within this lake. Once the lake filled with sediment, a fluvial environment established the modern-day Snoqualmie River. Recent Snoqualmie River channel deposits, generally consisting of gravelly sand, and overbank floodplain silts and clays were deposited on the fine-grained lacustrine sediments. The recent Snoqualmie River deposits are limited to the modern Snoqualmie River valley and underlie the Mill site at shallow depths, directly underlying recent fill material.

The units encountered in the exploration borings and exploration pits onsite are consistent with sediments deposited in channel and overbank environments of a meandering river system. The present-day meandering Snoqualmie River channel occupies a small part of its alluvial plain, and lies within a meander belt which consists of a complex of active channels, abandoned channels, and near-channel environments. Through time, the meander belt shifts its position on the alluvial plain forming a complex pattern of juxtaposed environments resulting in abrupt changes in grain size vertically and laterally throughout the system. The near-surface deposits may range from channel deposited sands and gravels, overbank silts, and/or lacustrine silt/clays within relatively short distances both laterally and vertically.

Recent alluvium is present beneath the entire site, except for the limited sloping areas near the project boundary on the northeastern and eastern margins of the site. The vast majority of the site lies within the floodplain of the Snoqualmie River and is underlain by Holocene alluvium at relatively shallow depths just below the existing fill. The depositional environment of the near-surface deposits (just below the fill) range from river channel, overbank deposits, and lacustrine sediments. Figure 6 shows AESI's interpretation of the extent of these depositional environments of the native material just below the existing fill onsite. The river channel deposits are limited to a relatively small area on the eastern portion of the site and are interpreted to be the result of deposition by a smaller stream that had crossed the Mill site prior to development of the original Mill site. The existing stream (S-1) enters the north end of the site and is diverted into a system of conveyance swales just after entering the site. The stream is routed to the northwest corner of the site, and ultimately discharges to the Snoqualmie River.

Recent sediments were encountered to depths ranging from about 55 to 60 feet near the northwest corner of the site (at the locations of EB-1 and CPT-1), where they overlie sand interpreted to represent deposits of the Tokul Creek Delta. The recent alluvium is interpreted to be substantially thicker to the south and east, farther from the delta. CPT-2 on the eastern side of Planning Area 1 encountered alluvium to the full depth explored of 80 feet.

Based on deeper explorations completed onsite, the near-surface fluvial and floodplain deposits overlie a thick section of lacustrine silts and clays deposited in post-glacial Lake Snoqualmie. MW-1 completed near the south end of the site encountered lacustrine sediments between approximately 40 and 200 feet in depth. Older Snoqualmie River deposits interpreted to represent pre-Fraser non-glacial fluvial sediments were encountered beneath the lacustrine sediments. Deep borings completed for other projects in the vicinity of the site also encountered lacustrine deposits. For example, the City of Snoqualmie well no. 2 at the SWF, located approximately 4,000 feet south of the site just south of the Snoqualmie River, encountered recent lacustrine deposits to a depth of about 290 feet overlying pre-Fraser sediments. The lacustrine deposits form a significant hydraulic barrier to vertical ground water flow beneath the Mill site.

Radiocarbon dating was performed on selected samples from various wells completed by AESI at the Mill site and vicinity since the 1990's. Samples from Holocene sediments were tested from MW-1 completed onsite, City of Snoqualmie well no. 2 at the SWF, EB-1 from the Kimball Creek Pump Station, and EB-2 from Mount Si High School. The results of radiocarbon dating are summarized in Table 1.2-2. The ages generally range from 8840 years before present (BP) at an elevation of 227 feet to 3210 years BP at an elevation of 392 feet. The trend of younger dates at shallower elevations reflects the gradual sedimentation and filling of post-glacial Lake Snoqualmie over time.

TABLE 1.2-2
RADIOCARBON DATING SUMMARY
RECENT DEPOSITS

Project	Exploration	Sample Depth (feet)	Sample Elevation (feet)	Material Tested	Calibrated BP ^{14}C Age
South Well Field	City Well #2	95	327	Charred Material	6530 (±140)
Mill Site	MW-1	37.5	383	Wood	6310 (±40)
Mill Site	MW-1	194	227	Wood	8840 (±150)
Kimball Creek Pump Station	EB-1	25	392	Wood	3210 (±200)
Mount Si High School	EB-2	45	375	Organic Sediment	6820 (±80)
Mount Si High School	EB-2	45	375	Plant Material	6720 (±70)
Mount Si High School	EB-2	65	355	Plant Material	6720 (±70)

Dates are reported as radiocarbon years before present (BP), where "*present*" is defined as 1950 AD by convention.
Conventional dates were calibrated using OxCal 4.3 using the calibration curve IntCal 13.
Radiocarbon dating performed by Beta Analytic, Inc.

<u>Existing Fill</u>

Fill material was placed across the property at various times in the past to accommodate mill operations. Existing fill was encountered in all of the explorations completed at the site. Several exploration pits were terminated in existing fill without encountering the underlying native sediments, and therefore the full depth of fill at those locations was not measured. In general, the fill is thinner (3 to 4 feet) in the east beneath the primary Mill site area and thickens to the west (9 to 16 feet) toward the Snoqualmie River.

The existing fill was of variable composition, generally characterized by loose to medium dense sand with gravel, silt, cobbles, and boulders. Woody debris, including logs, dimensional lumber, and sawdust, was also frequently observed over wide areas and in substantial thicknesses.

Other materials encountered in the existing fill included buried intact asphalt-cement-paved surfaces, crushed rock, metal and wood stave pipes, ash, geotextile fabric, steel, asphalt rubble, and other similar materials.

There is a large pile of wood debris over 20 feet in height in the north-central portion of Planning Area 3. Exploration pit EP-1005 was completed approximately in the center of the log pile. The existing wood waste and other fill extended to the full depth of the exploration pit, approximately 15 feet.

1.2.4 Hydrogeology

This section of the report provides information on surface water and groundwater resources. The hydrogeology study for the property included a review of existing literature and an extensive array of groundwater wells to acquire information on the regional groundwater regime. This data was used in conjunction with the subsurface explorations and visual field reconnaissance. Copies of the water wells logs are presented in Appendices A and B. The locations of these wells are shown on Figure 3.

Surface water features in the vicinity of the site include on-site wetlands, on-site streams, the Mill Pond south of the site, and the Snoqualmie River west-southwest of the site. A shallow aquifer is present beneath the site, formed within near-surface Snoqualmie River deposits. A deeper aquifer is formed within sand and gravel deposits of the Tokul Creek Delta, which are exposed north of the site. Throughout most of the site, the shallow aquifer is hydraulically separated from the Tokul Creek Delta Aquifer by a thick deposit of recent (Holocene) lacustrine silt and clay.

In general, a groundwater divide is present in the central portion of the Mill site. In the south and western portions of the site, groundwater flows towards the Snoqualmie River and the Mill Pond. In the northern portion of the site, groundwater flows to the north toward the Tokul Creek Delta. The gradient in the shallow aquifer steepens to the north of the site as it merges with the Tokul Creek Delta Aquifer. Ultimately, the groundwater in the Tokul Creek Delta flows to the north and discharges at a spring zone along Tokul Creek, north of the project (Figure 12).

AESI initiated surface water level monitoring at the Mill site from July 2008 to October 2011 to document: 1) water level fluctuations in the Mill Pond due to the Tokul Creek diversion, and 2) the degree of hydraulic connection between groundwater within the Snoqualmie River Shallow Aquifer and surface water within the Mill Pond and the Snoqualmie River. Monitoring stations were established in two wells (EB-1 and EB-4), at a staff gauge in the Snoqualmie River, and a staff gauge in the Mill Pond near the fire flow pump station. In addition, historic data for wells EB-1 and EB-4 and the Mill Pond staff gauge is available from a study of the Snoqualmie River Shallow Aquifer completed as part of Puget Sound Energy's Snoqualmie Falls Hydroelectric Project (AESI, 1993b). As part of the current EIS process for the site, water level monitoring was reinitiated at the Mill Pond, Snoqualmie River, EB-4, and MW-2 onsite and is currently ongoing. Off-site water level data from various aquifers is also available from different projects near the Mill site, including the NWF, the SWF, SSG, and the Snoqualmie WWTP. Hydrographs of the current and historic water level data are included in Appendix D. Monitoring stations are shown on Figure 3. Data from this surface water and groundwater level monitoring is described further in following sections, where relevant.

The following sections provide detailed information about surface and groundwater onsite and in the vicinity.

Surface Water

The distribution of surface water features on the site is limited to various wetlands, multiple surface water drainage ditches, and six streams. The wetlands, on-site streams, and drainage ditches are described in detail in technical reports prepared for the site by Raedeke Associates, Inc. (Raedeke, 2012) and Cedarock Consultants, Inc. (Cedarock, 2012). In addition to on-site wetlands and streams, significant surface water near the site includes the Mill Pond just south of the site, Tokul Creek north of the site, and the Snoqualmie River located west and south of the site. These different surface water features are described further below.

Snoqualmie River

In the vicinity of the Mill site, the Snoqualmie River flows approximately to the north-northwest just west-southwest of the site. The river flows over the relatively resistant bedrock forming Snoqualmie Falls approximately 2,300 feet west-northwest of the site. The Snoqualmie River watershed upstream of Snoqualmie Falls drains an area of about 375 square miles. Principal tributaries include the North, Middle, and South Forks of the Snoqualmie River. The confluence of the tributaries is in the vicinity of North Bend, about 2 miles southeast of the city of Snoqualmie. The average discharge for the Snoqualmie River just downstream of the falls from 1959 to present was about 2,700 cubic feet per second (cfs) (U.S. Geological Survey [USGS], 2018). Precipitation in the watershed ranges from over 180 inches per year in the Cascades to approximately 60 inches at Snoqualmie (Washington State Department of Ecology [Ecology], 1995).

A water level monitoring station located in the Snoqualmie River upstream of Snoqualmie Falls and downstream of the Mill Pond has been monitored to record Snoqualmie River water levels, for comparison with groundwater levels in the Snoqualmie River Shallow Aquifer, and surface water levels in the Mill Pond. Monitoring stations are shown on Figure 3. Monitoring data are summarized in Appendix D.

Tokul Creek

Tokul Creek flows generally from the northeast to the southwest, flowing into the Snoqualmie River just over ½ mile downstream from Snoqualmie Falls. The creek is located over 5,000 feet north of the site, where is flows through a steep-walled ravine that is incised with an overall height up to about 350 feet through the Tokul Creek Delta deposits (described previously in this report). According to the WRIA 7 *Salmonid Habitat Limiting Factors Analysis* (Washington State Conservation Commission, 2002), the Tokul Creek watershed drains an estimated 21,704 acres.

Surface water flow in Tokul Creek was monitored to determine groundwater inflow from the Tokul Creek Delta Aquifer (described separately later in this report). Two flow stations, one at the southeast Tokul Road bridge (Upper Station, SG-3) and one just downstream of the SR 202 bridge (Lower Station, SG-4) were monitored in 2008, 2009, and 2010, during the months of July (2008 only), August, September (2008 and 2009), and October. The monitoring stations are shown on Figure 3. The difference in flow between the Upper and Lower Stations represents groundwater discharge into Tokul Creek from the Tokul Creek Delta Aquifer. Based on the monitoring results, aquifer flow (spring discharge) from the Tokul Creek Delta Aquifer ranges from about 3½ to 8 cfs. Total flow at the lower monitoring station ranged from about 18 to 40 cfs, with an average measured flow of about 28 cfs.

Tokul Creek has a limited hydraulic connection to aquifer systems below the Tokul Creek Delta Aquifer in the vicinity of Snoqualmie. AESI's hydrogeologic report for the Snoqualmie Ridge NWF (AESI, 1994), quantified instream flow impacts to Tokul Creek due to pumping from a deeper pre-Vashon aquifer (described separately later in this report). The results of groundwater modeling calculated instream flow impacts of approximately 50 to 55 gallons per minute (gpm) for the average annual water right amount of 425 gpm from the NWF. Ecology used 55 gpm and 88.3 acre-feet per year (afy) as the estimated impact to surface water. To mitigate potential impacts to instream flow, 0.122 cfs and 88.3 afy was transferred from Weyerhaeuser's Surface Water Certificate (SWC) 180 to the State Trust Water Right (TWR) Program for instream flows.

The Mill site operated starting in the mid-1920's through 2003, and up until 1991 obtained all of its water supply from Tokul Creek. The original surface water right certificate was issued to the Snoqualmie Falls Lumber Company, predecessor to Weyerhaeuser, with a priority date of November 27, 1926. The instantaneous quantity was originally 15 cfs, but was reduced after donation of the "Record B" portion to the TWR Program on July 27, 1995 as mitigation for new groundwater appropriation by the City of Snoqualmie to supply the Snoqualmie Ridge development, as described above.

A diversion was installed on Tokul Creek, directing surface water (by gravity flow) to an adjacent storage pond. The point of diversion was located in the NE ¼ NW ¼ of Section 20, Township 24 North, Range 8 East. The maximum rate of withdrawal from Tokul Creek was measured to be 2.08 cfs (corresponding to an annual quantity of 863.8 afy) in February 2006 (AESI, 2010). An electrical pump lifted water from the diversion pond to two elevated storage tanks that supplied the mill operations. The water was pumped through a WWTP and then to two 250,000-gallon storage tanks. These tanks remained full throughout the year to supply industrial water uses and the mill's fire protection system. When full, the tanks overflowed into a drainage system consisting of pipes and surface flow which conveyed water through the Mill site to the Mill Pond.

The Tokul Creek diversion is no longer active. An application to enter the water right into the TWR Program was submitted to Ecology on January 3, 2011. The water was put into trust as a temporary donation of 863.8 acre-feet of water per year to assist in providing instream flows in Tokul Creek, the Snoqualmie River, and the Snohomish River. The water right is now owned by the Snoqualmie Valley Watershed Improvement District (SVWID). The SVWID and the Snoqualmie Valley Preservation Alliance (SVPA) have recently developed a Water Bank to facilitate the seasonal exchange and use of water rights located within the SVWID for irrigation purposes in the Snoqualmie River valley downstream of Snoqualmie Falls (AESI, 2018).

Mill Pond

The Mill Pond/Borst Lake is a circular pond, located just south of the site and is not part of the current Mill site owned by Snoqualmie Mill Ventures, LLC (SMV) or included in the proposed PCI Plan. It was excavated and enlarged to facilitate mill activities, and was primarily used to sort logs when the mill was in operation. The water surface of the pond was maintained artificially high while the Tokul Creek diversion was active (described above). The water level in the Mill Pond was historically controlled by a weir (with the bottom of the V-notch set an elevation of 411.24 feet) located in an overflow channel along the south shore of the pond adjacent to the Snoqualmie River. Overflow water from the pond would flow through the weir, through a box culvert underneath SE Mill Pond Road, and ultimately discharge to the Snoqualmie River. At the time of the writing of this report, a gap has eroded through the berm southeast of the weir, lowering the pond level several feet below the level of the weir. Water currently flows through this gap in the berm, along the roadside ditch northeast of SE Mill Pond Road, and through the culvert underneath the road. During major flood events, the Snoqualmie River will flood and backflow to the culvert and weir area.

An extensive description of AESI's interpretation of the combined surface water and groundwater level monitoring from 2008 to 2011 is provided in AESI's 2010 Trust Water Right Temporary Donation Report for Tokul Creek (AESI, 2010). In summary, from July 2008 to September 2009, the Tokul Creek diversion pumps operated on a limited basis to allow the Mill Pond to drain to a more "natural" level. The water level data shows that the Mill Pond level was directly influenced by the Tokul Creek diversion and in general showed no direct response to the Snoqualmie River, except under extreme flood events.

Well EB-4 (SSA) is completed onsite in the Snoqualmie River Shallow Aquifer. Monitoring data from the 1990's illustrate that the historic water elevations are very similar to EB-4 water elevations monitored July 2008 through November 2010. During the 1993 to 1995 time-period, the Mill Pond was kept full to support Mill site activities. From July 2008 to September 2009, the diversion was shut down to allow the Mill Pond to drain to a lower level. With the Tokul Creek diversion shut down, the water levels in the Mill Pond declined and then stabilized at about 408.5 feet in late 2008. Flooding during subsequent winter storms caused erosion of the weir and berm, creating a new outlet at a lower elevation for the Mill Pond. In response, water levels in the Mill Pond fell, with a minimum recorded level of approximately 406 feet in the summer of 2009. Comparison of the historic and current data shows that the Snoqualmie Shallow Aquifer level (monitored at EB-4) remains similar, and the drop of the Mill Pond water level in late 2008 is directly attributable to removing the inflow from the Tokul Creek diversion. Although some component of flow in the shallow aquifer on the southern end of the site likely discharges to the Mill Pond, the quantity of discharge into the pond from the Snoqualmie River Shallow Aquifer cannot maintain the Mill Pond water level at the higher historic levels.

Differing water level elevations and response timing trends between the Mill Pond and shallow aquifer suggest the hydraulic connection between the shallow aquifer and the Mill Pond is somewhat limited. For example, on Figure D-1 in Appendix D, location "C" highlights a time of water level rise in well EB-4 as the regional Snoqualmie River Shallow Aquifer is recharged by October 2008 rains. This rise does not occur in the Mill Pond surface water level. Mill Pond water levels remain flat to very slightly declining, unaffected by the rise in water level in the Snoqualmie River Shallow Aquifer. This difference in water level trend demonstrates the Snoqualmie River Shallow Aquifer does not maintain surface water levels in the Mill Pond above about elevation 406 feet in the summer and elevation 409 feet in the winter (AESI, 2010).

Streams

Six streams (S-1 through S-6) have been identified in the immediate vicinity of the site (Raedeke, 2012 and Cedarock, 2012). S-1 and S-2 flow through the site. S-3 through S-6 flow down the slopes just east of the site. Fifteen other watercourses on the site are classified as drainage ditches based on location, physical characteristics, and the absence of a natural surface water source (Cedarock, 2012). Surface water features, including streams and wetlands, are shown on Figure 12.

S-1 flows down the eastern slopes and enters the site at the northeast corner, confined within a relatively steep-walled ravine. Upon discharging to the valley floor, the stream flows west through Wetland 10, and passes through a culvert underneath the Snoqualmie Sand and Gravel haul road into a deep roadside ditch that follows the haul road south and then west, situated between the haul road and Wetland 11. S-1 flows offsite along the western project boundary where it continues to flow west offsite another 800 feet before discharging directly to the Snoqualmie River. The supply of water for S-1 onsite is primarily streamflow entering the site at the northeast. Depending upon seasonal conditions, Wetlands 8 and 9 and other ditches on the north end of the site may contribute flow to stream S-1. Observations made by Cedarock in July 2012 (Cedarock, 2012) indicate that all the flow at the time was sourced from off-site stream inflow at the northeast corner, as other potentially contributing wetlands and ditches were dry. Flow within S-1 at that time was estimated to be approximately 0.5 cfs.

S-2 is located in the south-central portion of the site and generally flows north to south, discharging to the Mill Pond through a culvert under the levee at the north end of the pond. The supply of water for S-2 is a combination of surface runoff, nearby roadside/drainage ditches, and shallow groundwater seepage. Surveyed water levels in S-2 in May and June 2012 ranged from about 408 to 410 feet, and surveyed water levels on March 6, 2018 ranged from about 411 to 413 feet. The corresponding water levels in EB-4 (located northwest of S-2) and MW-2 (located northeast of S-2) were higher, suggesting groundwater seepage contributes flow to S-2 and is likely to be the primary source of flow in the summer. In August 2012, the flow through S-2 was estimated to be approximately 30 gpm (Cedarock, 2012).

Streams S-3 through S-6 are all located on the slopes east of the site. These streams eventually discharge into the onsite storm/sewer system. Cedarock (2012) indicates that these are all perennial streams, while Raedeke (2012) indicates that some of them may be seasonal in nature. AESI observed S-4, S-5, and S-6 on March 28, 2018 from 396th Drive SE. At this time, all three streams were flowing through culverts underneath the road and continued down the slope. The streams continued upslope of the road, and the source of water was not determined. The regional geologic map shows Vashon advance outwash overlying Vashon advance lacustrine just upslope of the roadway. The observed surface flow may be due to groundwater seepage emanating from the Vashon advance outwash, where it overlies the low-permeability lacustrine sediments. The surface water flow may also be due to seasonal interflow seepage from the adjacent till-mantled uplands.

Wetlands

Twenty-six wetlands have been delineated across the site (Raedeke, 2012, 2015). Surface water features at the site, including wetlands, are shown on Figure 3. Generally, the wetlands onsite can be categorized into two distinct types: 1) a seepage wetland, which receives water from groundwater seepage that is sourced, at least in part, outside of its topographic basin, and 2) a basin wetland, which receives water from within its topographic basin through surface runoff or interflow (shallow groundwater flow, unrelated to the Snoqualmie River Shallow Aquifer).

Water levels in the on-site wetlands were surveyed in May and June 2012 and on March 6, 2018 by Goldsmith Engineering (Goldsmith). These surface water levels were compared to groundwater levels in the on-site groundwater monitoring wells that are screened in the shallow aquifer (EB-4 and MW-2) in order to evaluate which wetlands may be supported by groundwater seepage. Those wetlands where the surface water level is lower than the groundwater level in the shallow aquifer are likely to be supported, at least in part, by groundwater seepage. Surface water levels are summarized in Table 1.2-3. The groundwater elevations from EB-4 and MW-2 from the closest date to the wetland survey are shown on Table 1.2-3 for reference. The August 2012 groundwater levels were measured two to three months after the wetland survey. Based on the period of record from EB-4 at the site, the groundwater levels in August of a given year are approximately 1 to 2 feet lower than the shallow aquifer levels in May and June; therefore, for the purpose of comparison to wetland levels, it should be noted that groundwater levels in EB-4 and MW-2 were likely to be 1 to 2 feet higher in May/June 2012 than the water levels measured in August 2012.

TABLE 1.2-3
WATER LEVEL ELEVATIONS
WETLANDS

Wetland/Well	2012 Elevation (feet)	2018 Elevation (feet)
EB-4	415.91 (8/15/12)	417.4 (3/6/18)
MW-2	412.99 (8/14/12)	414.56 (3/28/18)
	May/June 2012	**March 6, 2018**
Wetland 8	415.9-416.9	417.8
Wetland 9	418.5	417.2
Wetland 10	416-417	-
Wetland 11	413.9	-
Wetland 12	408.0-413.3	411.6-413.9
Wetland 13	411.4-413.3	413.4
Wetland 14	413.1-415.2	413.1
Wetland 15	413.5-413.7	413.7
Wetland 19	417.2-418.3	-
Wetlands 20, 21, 22	418.9-419.4	-
Wetland 24	415.3-416.7	415.8
Wetland 25	417.9-418.4	-
Wetland 26	420.8-421.4	-
Wetland 27	421.3-421.7	-
Wetland 28	420.6-422.0	-
Wetland 29	417.5	-

The delineated wetlands can be categorized by their source of hydrology, as follows:

1. <u>Wetlands 12, 13, 14, and 15</u>: These wetlands are limited to the areas surrounding the deep drainage ditches that cross the site and, based on the water level data appear to be supported by groundwater seepage from the Snoqualmie River Shallow Aquifer. Wetland 12 is much larger than Wetlands 13, 14, and 15 and extends throughout much

of the central and western portions of the site (Figure 3) within a drainage ditch. Wetland 12 runs along the south side of the haul road, along the north side of Planning Area 1, and extends to the south through the central portion of the site. At the south end of the site, Wetland 12 contains stream S-2, which discharges into the Mill Pond through a culvert under the levee. Wetlands 13, 14, and 15 are relatively smaller and located just east of and flow into Wetland 12.

2. Wetland 1 through Wetland 7: Except for a small portion of Wetland 7, these wetlands are located offsite on the slopes just east of the site. Streams S-3, S-4, S-5, and S-6 flow down these eastern slopes as well and contribute to the hydrology of Wetlands 1, 2, and 4. As described above, AESI observed S-4, S-5, and S-6 in March 2018 from 396th Drive SE, and all three streams were flowing through culverts underneath the road and continued down the slope toward the site. The streams continued upslope of the road. The source of hydrology for the wetlands and related streams has not been determined but appears to be groundwater seepage (Raedeke, 2012). The regional geologic map (Dragovich et al., 2009b) shows Vashon advance outwash overlying Vashon advance lacustrine just upslope of the roadway. The observed surface water may be due to groundwater seepage emanating from the Vashon advance outwash, where it overlies the low-permeability lacustrine sediments. The surface water flow may also be due to seasonal interflow seepage from the adjacent till-mantled uplands. Wetlands 1, 2, 4, 5, and 6 flow into the existing stream channels or drainage ditches that ultimately discharge into the existing stormwater system for the Mill site. On-site observations by Raedeke (2012) indicate that Wetland 3 infiltrates offsite on the slope downgradient of the wetland. The southern, downgradient end of Wetland 7 crosses the far southeastern corner of the site and discharges to the Mill Pond.

3. Wetlands 8, 9, 19, and 24: It is not clear from the available data weather these wetlands are supported by groundwater seepage. The surveyed water elevations are similar to the measured levels in EB-4 and MW-2 onsite. Several other lines of evidence suggest that these wetlands may not be supported by groundwater. For example, Wetland 19 is located within a topographic low that extends beyond the wetland to the north at lower elevations. If Wetland 19 was groundwater-supported, the wetland would likely fill the full extent of the topographic low. Observations of Wetlands 8 and 9 in July 2012 (Cedarock, 2012) suggest that these two wetlands go dry in the summer.

4. Wetlands 10 and 11: The hydrology of Wetlands 10 and 11 is primarily supported by stream S-1, which flows through them. S-1 enters the site at the northeast corner, flowing down the slopes northeast of the site. The surveyed water level in Wetland 11 within the roadside ditch north of the haul road is several feet below the water level in EB-4, such that groundwater seepage may partially contribute to the hydrology of Wetland 11 in this area.

5. Wetlands 20, 21, 22, 25, 26, 27, 28, and 29: These wetlands are generally above the elevation of the Snoqualmie River shallow groundwater and do not appear to be groundwater-supported. These wetlands are located in the southwest area of the site.

Groundwater

Water that exists in the pore spaces of sediments is part of the hydrologic cycle. In the natural state, the hydrologic cycle begins with infiltration of precipitation (recharge) and ends with discharge to springs, streams, wetlands, and/or wells. Under natural conditions, groundwater recharge and discharge may shift with climatic cycles but remain in overall balance. Groundwater will flow under saturated conditions, preferentially through materials with greater porosity and permeability, such as clean gravels and sands. Where geologic conditions limit discharge, groundwater accumulates in such permeable zones, which are termed *aquifers*.

Ecology's well records were reviewed for wells in the vicinity of the Mill site. The locations of these wells are shown on Figure 3 and their logs are presented in Appendix B. Most well logs on file with Ecology are prepared by non-geologists, and standardized geologic descriptions commonly are not used. The interpretations from these well data are considered a rough approximation, and provide a general overview of regional conditions.

Groundwater level monitoring has been conducted in wells on and near the site in different aquifers. Groundwater level data obtained from the groundwater monitoring program by AESI are presented in Appendix D.

The groundwater system in the vicinity of the project site has been subdivided into five "aquifers." These include: 1) Bedrock "aquifer(s)," 2) Deep Aquifer, 3) Pre-Fraser Aquifer, 4) Tokul Creek Delta Aquifer, and 5) Snoqualmie River Shallow Aquifer.

Bedrock "Aquifer(s)"

Bedrock was not encountered in any of the wells completed on the Mill site. No seepages were observed from exposures of bedrock observed by AESI at Snoqualmie Sand and Gravel (AESI, 1993a, 2001). North of the site at the NWF, wells TW-5, TW-6, TW-7, and TW-8 were drilled into bedrock, but were completed in an overlying aquifer since no significant amounts of water were found in the bedrock. Several of the reviewed Ecology logs indicate a relatively discontinuous occurrence of groundwater in bedrock (locations 1, 2, 17, 34, 41, 42, 64, and 66) that appears to be perched at relatively high elevations. These domestic wells are primarily located on upland areas northeast of the Mill site.

Flow to wells is interpreted to originate primarily in fracture zones within the rock mass since intergranular porosity and permeability are interpreted to be very low. Although the volcanic rock in the vicinity of the site is capable of supplying limited quantities of water to wells, the bulk hydraulic conductivity of the rock mass is low, and the units typically behave as a barrier to groundwater flow. The term bedrock "aquifer" is used in this report since a few wells do produce from the rock mass; however, within the context of the overall hydrogeologic setting in Snoqualmie surrounding the site, rocks are considered aquitards or aquicludes relative to the highly transmissive aquifer intervals in the Pleistocene/Holocene deposits. This characterization of groundwater in bedrock is consistent with previous studies within East King County (Turney et al., 1995).

Flow through fractured rock is highly anisotropic (preferential orientation), controlled by discontinuities in the rock mass. Discontinuities include fractures (joints), faults, bedding planes, and other geological discontinuities. Groundwater preferentially flows through open fractures and other permeable discontinuities. Typically, most of the flow is through only a small percentage of the total fracture set. Groundwater storage in a rock mass with low primary porosity and permeability is relatively limited with a low capacity to transmit groundwater.

Groundwater recharge is interpreted to be primarily from: 1) direct precipitation where bedrock is exposed at the ground surface, 2) leakage from streams, wetlands, or lakes in direct contact with bedrock, and 3) leakage through overlying geologic materials into bedrock. Discharge from the bedrock occurs: 1) where saturated fractures daylight at the ground surface, 2) into adjacent geologic units, and 3) to production wells.

Deep Aquifer

The Deep Aquifer is developed in Olympia or pre-Olympia-age fluvial sands and gravels. Wells TW-5, TW-6, TW-7, and TW-8 at the NWF, SS&G#1 and SS&G#2 at the SSG north of the site, and City well nos. 1, 1-R, and 2 at the SWF were screened in this aquifer. The Deep Aquifer has a lenticular map pattern since it represents an ancient Snoqualmie River system confined within a narrow bedrock valley. The Deep Aquifer extends upvalley (southeast) from the site to the Grouse Ridge/Middle Fork Embankment area east of Tanner (AESI, 1996). The downvalley extent of the aquifer is uncertain; however, discharge from this aquifer occurs downstream of Snoqualmie Falls. The width of the Deep Aquifer is about 2,000 feet in the vicinity of the NWF, just north of the Mill site. Based on a seismic reflection study south of the Mill site (Liberty, 2009), the width of the Deep Aquifer may be wider (over 3,000 feet) in the vicinity of the SWF.

The Deep Aquifer is separated from overlying aquifers by a discontinuous aquitard that consists of approximately 50 to 100 feet of fine-grained pre-Olympia/Olympia deposits (AESI, 1994, 1995c). The Deep Aquifer does not have a direct connection with the waters of surface streams due to the presence of intervening aquifers and aquitards totaling several hundred feet in thickness.

Pump tests have been conducted on various wells in the Deep Aquifer, including TW-6 and TW-7 (AESI, 1993d, 1994), TW-8 (AESI, 2004a) at the NWF and well nos. 1 and 2 (GeoEngineers, 1995) and well no. 1-R (Gray & Osborne, Inc., 2005) at the SWF, and three deep wells for the groundwater heat-pump system at Mount Si High School, just south of the SWF (Pacific

Groundwater Group, 2009, 2010). Only test data from two wells (IW1 and EW1) are included in the Pacific Groundwater Group reports. IW2 was installed later in 2012. In general, these pump tests show that the Deep Aquifer behaves as a semi-confined leaky aquifer. The fine-grained confining layer overlying the Deep Aquifer is apparently discontinuous, allowing for some limited hydraulic connectivity with overlying aquifers. During a combined pump test of TW-6 and TW-7 at the NWF (AESI, 1994), four observation wells (EB-C1W, SS&G#3, and OBW-1 [NWF] and OBW-2 [NWF]) completed in the Tokul Creek Delta Aquifer (described further below) each exhibited minor drawdown as a result of the 8-day pump test. Drawdown was 0.1 to 0.2 feet in EB-C1W, approximately 1.2 feet in SS&G#3, and very small to negligible (less than 0.1 feet) in OBW-1 and OBW-2. These results indicate that the confining layers (aquitards) in the vicinity of the NWF (OBW-1 and OBW-2) effectively limit the hydraulic connection between the Deep Aquifer and shallower aquifers, while the observed drawdown over 2,000 feet northwest (EB-C1W) and over 2,000 feet east (SS&G#3) of the NWF indicate greater aquifer interconnection, implying significant stratigraphic variability across the study area. Drawdown in observation wells completed in the Deep Aquifer were much larger – a drawdown up to 4.5 feet was observed in well no. 1 (SWF) about 1.5 miles south of the NWF, and a drawdown of up to 55 feet was observed at TW-5 at the NWF. Drawdown in TW-5 stabilized after approximately 4,000 minutes of pumping, supporting the interpretation of leaky aquifer conditions.

Aquifer testing at the SWF (GeoEngineers, 1995) included a 7-day dual well (well no. 1 and well no. 2) pump test. During the test, about 2 feet of drawdown was observed in TW-6 and TW-7 at the NWF. In contrast, shallow observation wells completed in the immediate vicinity of the pumping wells at the SWF did not respond to pumping from the Deep Aquifer interval, indicating a limited hydraulic connection between the Deep Aquifer and shallower aquifers in the vicinity of the SWF.

Aquifer testing at Mount Si High School included step testing of well IW1 up to a rate of 295 gpm for 350 minutes and a constant-rate test of EW1 (Pacific Groundwater Group, 2010). During the step test water levels were monitored in IW1 and EW1 at Mount Si High School and City well no. 1-R at the SWF. During the step test a drawdown of 0.6 feet was measured at well no. 1-R at the SWF. Both EW1 and well no. 1-R were monitored during the constant-rate test. About 4 feet of drawdown was measured in well no. 1-R during the constant-rate test. IW2 was installed in 2012 after the referenced Pacific Groundwater Group report. AESI analyzed the pump test data reported on the Ecology well log for IW2 by using correlations between specific capacity and transmissivity (see Figure 100 in Theis et al., 1963). Using this method, the calculated transmissivity for IW2 is about 13,500 square feet per day (ft^2/day), which is relatively similar to the transmissivity of 18,700 ft^2/day for the constant-rate pump test of EW1 calculated by Pacific Groundwater Group (2010).

Based on water level measurements at SS&G#1, SS&G#2, TW-5, TW-6, and TW-7, and a ground water modeling evaluation performed for the NWF (AESI, 1994), groundwater in the Deep Aquifer flows toward the northwest with a hydraulic gradient of about 1.5 percent. Recharge to the Deep Aquifer occurs from limited vertical leakage through the overlying aquitard and primarily from throughflow of groundwater coming downvalley from the southeast. Particle tracking plots, generated from groundwater flow models completed for both the NWF (AESI, 1994) and the SWF (AESI, 1995c), support this interpretation. Based on the models, most of the water discharging at the NWF and SWF comes directly from upgradient sources in the Deep Aquifer, originating a few miles upvalley (southeast) of the delineated 10-year time-of-travel (TOT) boundary. The modelling suggests only about 5 to 10 percent of the water discharging at the well fields would originate within the 10-year TOT zone. Therefore, recharge from shallower aquifers in the vicinity of the well fields account for no more than about 10 percent of the water pumped at the NWF and SWF (AESI, 1995c, 2007).

Several aquifer characteristics have been determined from various pump tests performed on the Deep Aquifer. These include the coefficient of transmissivity (T), the storage coefficient (S), horizontal hydraulic conductivity of the aquifer (K), and the vertical hydraulic conductivity of the overlying aquitard (K'). Average values for these parameters are presented in Table 1.2-4. Detailed descriptions of pump test methods, analyses, and results are presented in previous studies conducted by AESI (AESI, 1990, 1994, 1995c, 2004a), GeoEngineers (1995), Gray & Osborne, Inc. (2005), and Pacific Groundwater Group (2010).

TABLE 1.2-4
DEEP AQUIFER PARAMETERS FROM PUMP TESTS
AT THE NORTH WELL FIELD, SOUTH WELL FIELD, AND MOUNT SI HIGH SCHOOL

Pumping Well ID	T(1) (ft^2/day)(2)	S(3)	K(4) (ft/day)(5)	K'(6) (ft/day)(5)
TW-7 (NWF)	1,400	2×10^{-4}	28	6.3×10^{-3}
TW-6 (NWF)	2,020	8×10^{-4}	31	0.4×10^{-3}
TW-8 (NWF)	3,000 - 3,500	1×10^{-4}	45 - 55	-
Well No. 1-R	2,000-3,000	-	-	-
Well No. 2	7,000	6×10^{-4}	130	-
IW1	5,700	2.5×10^{-3}	-	-
EW1	18,700	4×10^{-4}	-	-
IW2	13,500	-	-	-

(1) T -= coefficient of transmissivity
(2) ft^2/day = square feet per day
(3) S = storage coefficient
(4) K = horizontal hydraulic conductivity of the aquifer
(5) ft/day = feet per day
(6) K' = vertical hydraulic conductivity of the overlying aquitard

Aquifer transmissivity in the Deep Aquifer generally appears to increase upvalley from the site. Pump tests indicated transmissivity exceeds 20,000 ft^2/day east of Tanner (Golder Associates, 1996).

Pre-Fraser Aquifer

The Pre-Fraser Aquifer is developed in Olympia-age non-glacial or other undifferentiated pre-Fraser deposits underlying the site. Well MW-1 completed on the Mill site is screened in fluvial sand and gravel at a depth of 220 to 230 feet, interpreted to be ancient Snoqualmie River deposits, possibly Olympia-age. No other groundwater wells are set in this aquifer; however, it was also identified in wells completed at the NWF during completion of wells in the Deep Aquifer and Tokul Creek Delta Aquifer (see below), where it consisted primarily of silty fine sand.

The thickness of the Pre-Fraser Aquifer at the NWF ranges from about 60 feet to over 120 feet. At the NWF, the Pre-Fraser Aquifer is separated from the underlying Deep Aquifer by 50 to 100 feet of low-permeability sediments. This aquitard is discontinuous and may not be present southeast of the NWF in the vicinity of the Mill site, where in some areas the Pre-Fraser Aquifer is interpreted to have a more direct hydraulic connection with the underlying Deep Aquifer (AESI, 1994, 1995c, 2001). Limited information is available on the flow direction of this aquifer as MW-1 is the only well in the vicinity producing from this interval. However, the groundwater flow direction is expected to be similar to the underlying Deep Aquifer. The aquifer is interpreted to extend both upvalley (south) and downvalley (north) from the subject site, but like the Deep Aquifer, its width would be limited by the narrow bedrock valley of the ancient Snoqualmie River.

The leaky confined aquifer behavior determined from pump tests in the Deep Aquifer suggests that the Pre-Fraser Aquifer acts as a “source zone” providing some water to the Deep Aquifer by leakage through the semi-confining layer.

Tokul Creek Delta Aquifer

The Tokul Creek Delta Aquifer is interpreted to be developed in the Vashon recessional delta deposits north of the Mill site and beneath the northern portion of the Mill site underlying the recent lacustrine deposits. Several wells north of the site are completed within this aquifer, including EB-C1W, OWB-1 (NWF), OBW-2 (NWF), MW-3 (SSG), and SS&G#3. Water level measurements in these wells indicate that groundwater in the Tokul Creek Delta Aquifer flows toward the west to northwest with a hydraulic gradient of approximately 3 percent. The Snoqualmie Sand and Gravel Pit wells did not extend to the bottom of this aquifer; however, where this aquifer was penetrated at the NWF, the Tokul Creek Delta Aquifer is separated from the underlying aquifers by a thick sequence of fine-grained, undifferentiated pre-Fraser sediments. Aquifer pump tests at the NWF suggest some limited hydraulic connection between the Tokul Creek Delta Aquifer and deeper aquifers (AESI, 1994).

North of the Mill site at the NWF, the aquifer has been documented to be about 140 feet thick. EB-1 completed near the northwest corner of the Mill site encountered Tokul Creek Delta deposits at a depth of approximately 55 feet and was saturated below a depth of about 65 feet, but EB-1 did not fully penetrate the aquifer. The extent of the Tokul Creek Delta Aquifer is limited by the distribution of the recessional deltaic deposits. This unconfined aquifer is bounded by bedrock to the north and west and is interpreted to pinch out beneath the northern portion of the Mill site (Figure 7).

Recharge to the Tokul Creek Delta Aquifer is primarily from direct precipitation, with some additional recharge from the adjacent Snoqualmie River Shallow Aquifer (see below). Based on data presented by the USGS (Turney et al., 1995), the Tokul Creek Delta Aquifer in the site vicinity is recharged at a rate of about 40 inches per year from direct precipitation. Recharge amounts from the Snoqualmie River Aquifer have not been quantified at this time. The Tokul Creek Delta Aquifer discharges at Tokul Creek in the vicinity of SR 202. Based on summertime stream gauging data (AESI, 1994), the aquifer discharges at a rate of about 3½ to 8 cfs. This measured flow includes discharge into the creek from both the north and south. According to data presented by Turney et al. (1995), groundwater on the northwest side of Tokul Creek also flows toward Tokul Creek. This suggests that Tokul Creek serves as a hydraulic barrier between the site and areas located northwest of Tokul Creek.

Groundwater contours within the Snoqualmie River Shallow Aquifer and the Tokul Creek Delta Aquifer are shown on Figure 13. The average groundwater elevation north of the site at SS&G#3 is about 320 to 340 feet, with a seasonal range of 10 to 20 feet since 1994 (Appendix D). In the vicinity of OBW-1 and OBW-2 at the NWF, average groundwater elevations of about 300 to 320 feet have been documented. Downgradient in EB-C1W, the average groundwater elevation of the Tokul Creek Delta has been documented at about 260 feet. Measurements in August 1999 indicated that EB-B4W is a dry well, and the water table for the aquifer is lower than elevation 285 feet at this location. At the WWTP wells northwest of the Mill site, groundwater levels at OBW-2A, OBW-3, and OBW-5 indicate a localized easterly to northeasterly hydraulic gradient that appears to be influenced by the Snoqualmie River Shallow Aquifer (see below). These groundwater levels and flow directions are consistent with those presented by Turney et al. (1995).

Limited pump test information indicates that transmissivity (T) and hydraulic conductivity (K) are highly variable in the Tokul Creek Delta Aquifer (AESI, 1996). As shown in Table 1.2-5, relatively low values of T and K were determined from a low-rate aquifer test performed on SS&G#3. However, high values of T and K were calculated from an aquifer test at the NWF. This broad range in T and K values reflects significant differences in the nature of the aquifer media at the two tested localities. The aquifer media at the Snoqualmie Sand and Gravel site consisted of fine sand deposited in a low-energy pro-delta environment. In contrast, the aquifer media in the tested interval at the NWF consisted of clean sandy gravels and cobbles deposited at the mouth of the recessional meltwater stream.

TABLE 1.2-5
TOKUL CREEK DELTA AQUIFER PARAMETERS

	$T^{(1)}$	$K^{(2)}$
Snoqualmie Sand and Gravel Pit	220 $ft^2/day^{(3)}$	3.6 $ft/day^{(4)}$
NWF	24,000 $ft^2/day^{(3)}$	200 $ft/day^{(4)}$

(1) T = coefficient of transmissivity
(2) K = horizontal hydraulic conductivity of the aquifer
(3) ft^2/day = square feet per day
(4) ft/day = feet per day

Snoqualmie River Shallow Aquifer

The Snoqualmie River Shallow Aquifer is located within the present-day Snoqualmie River valley, including the Mill site. The Snoqualmie River Shallow Aquifer generally consists of fine to medium sand with gravel, deposited in channel and near-channel environments of a meandering river system. The aquifer is shallow, typically less than 50 feet, and is discontinuous in map pattern (AESI, 1993b), primarily contained within the coarse-grained river channel deposits.

Most of the groundwater in this aquifer discharges towards the Snoqualmie River. However, a groundwater divide is present in the central portion of the Mill site where a portion of this aquifer discharges by subsurface flow into the Tokul Creek Delta Aquifer to the north. A steep hydraulic gradient has been identified at the interface between these two aquifers. Water levels drop approximately 200 feet in a distance of about 1¼ miles, from an average elevation of 400 feet in the Snoqualmie River Shallow Aquifer, near the City of Snoqualmie, to approximately 200 feet where the Tokul Creek Delta Aquifer discharges at Tokul Creek. Recharge to the Snoqualmie River Shallow Aquifer occurs from upvalley aquifer sources and direct precipitation within the valley.

At the south end of the Mill site, the shallow aquifer is interpreted to discharge to some extent into the Mill Pond; however, the hydraulic connection appears to be somewhat limited based on water level monitoring data (as described under the “Mill Pond” section above).

In general, Snoqualmie River Shallow Aquifer groundwater levels rise during periods of recharge (rainfall). Groundwater levels also rise when discharge is slowed or reversed by a rise in the level of the Snoqualmie River. When the Snoqualmie River rises, a temporary backflow occurs from the river into its banks. This phenomenon is known as bank storage. Groundwater elevations are controlled by the relationship between recharge and discharge, including bank storage, and by the material properties of the soils through which the groundwater moves.

Hydraulic testing has been performed on eight observation wells completed in the Snoqualmie River Shallow Aquifer within and near the City of Snoqualmie (AESI, 1993b). Maximum hydraulic conductivity values and the range of storage coefficients calculated from falling-head slug tests are summarized in Table 1.2-6.

TABLE 1.2-6
SNOQUALMIE RIVER SHALLOW AQUIFER PARAMETERS

K(1)	S(2)
70 ft/day(3)	1×10^{-5} to 7×10^{-4}

(1) K = horizontal hydraulic conductivity of the aquifer
(2) S = storage coefficient
(3) ft/day = feet per day

The slug test results indicated that the Snoqualmie River Shallow Aquifer behaves as a confined system. However, in similar hydrogeologic settings, delayed yield behavior has been observed from pump tests. Groundwater modeling suggests that the aquifer can behave either as a confined or unconfined system depending on seasonal water levels (AESI, 1996).

Interflow Network

Interflow is the shallowest of all groundwater types and forms within a soil that is more permeable than the geologic parent material from which it was derived. Rainfall will generally soak into the ground through relatively permeable surficial soil until it encounters less-permeable sediments (such as very low-permeability, unweathered Vashon lodgement till), which act as a barrier to further downward movement. Interflow zones do not develop in the soils of coarse-grained surficial sediments such as the Vashon recessional delta deposits. An interflow network is interpreted to develop where lodgement till is present at relatively shallow depths, typically throughout till-mantled uplands east of the Mill site. Water within the interflow network flows downslope closely following the existing topography. Interflow seepage may be the source of water for the streams flowing downslope just east of the site (as described above under "Streams").

The interflow network is seasonal and is generally not active during prolonged periods of dry weather. Water in this zone may be randomly distributed within the soil horizon, and the interflow zone is generally not capable of supporting production wells. Therefore, the interflow zone is not considered an aquifer.

Water Quality

Water quality samples of surface water were taken at three locations onsite on December 18, 2017 from streams S-1 and S-2. The sample locations are shown on Figure 12. The samples were measured in the field by AESI for temperature, pH, turbidity, dissolved oxygen, and conductivity. Samples were submitted to Analytical Resources, Inc. (ARI) in Tukwila, Washington and tested for biochemical oxygen demand (BOD), total alkalinity, fecal coliforms, total suspended solids, total ammonia-nitrogen, nitrate plus nitrite-nitrogen, total phosphorus, ortho phosphate, total petroleum hydrocarbons, oil and grease, dissolved copper, dissolved lead, dissolved zinc, calcium, magnesium, and hardness. Testing results are summarized below in Table 1.2-7 and attached in Appendix C.

TABLE 1.2-7
WATER QUALITY RESULTS

	S-1 Inlet	**S-1 Discharge**	**S-2 Discharge**
Temperature (°C)(1)	6.74	5.81	7.25
Specific Conductance (µS/cm^3)(2)	74	84	117
Conductivity (µS/cm)(3)	49	44	77
DO(4) Saturation (%)(5)	92.5	26.6	60.6
DO(4) (mg/L)(6)	11.31	3.32	7.32
pH	6.62	5.94	6.01
Turbidity (NTU)(7)	14.2	14.2	1362*
BOD(8) (mg/L)(6)	2.0	1.6	2.8
Fecal Coliforms (CFU/100 ml)(9)	135	5	160
TSS(10) (mg/L)(6)	10.1	4.7	502
Total Ammonia-Nitrogen (mg/L)(6)	ND(15)	0.045	0.161
Nitrate + Nitrate-Nitrogen (mg/L)(6)	0.258	0.044	0.054
Total Phosphorus (mg/L)(6)	0.0580	0.460	0.374
Ortho Phosphate (mg/L)(6)	0.0140	0.0130	0.0100
HEM(11) Oil & Grease (mg/L)(6)	ND(15)	ND(15)	ND(15)
SGT-HEM(12) NP(13) Oil & Grease (mg/L)(6)	ND(15)	ND(15)	ND(15)
HEM(11) Polar Oil & Grease (mg/L)(6)	ND(15)	ND(15)	ND(15)
Diesel Range Organics (C12-C24) (mg/L)(6)	ND(15)	0.567	ND(15)

	S-1 Inlet	S-1 Discharge	S-2 Discharge
Motor Oil Range Organics (C24-C38) (mg/L)[6]	ND[15]	3.29	ND[15]
Dissolved Lead (µg/L)[14]	0.161	0.108	0.227
Dissolved Copper (µg/L)[14]	1.54	1.42	3.05
Dissolved Zinc (µg/L)[14]	2.15	5.90	9.30
Hardness (mg/L)[6]	27.8	33.5	125
Calcium (mg/L)[6]	6.21	7.86	23.5
Magnesium (mg/L)[6]	2.98	3.38	16.2
Total Alkalinity (mg/L)[6]	24.8	34.9	60.8

(1) °C = degrees Celsius
(2) µS/cm³ = microsiemens per cubic centimeter
(3) µS/cm = microsiemens per centimeter
(4) DO = Dissolved Oxygen
(5) % = percent
(6) mg/L = milligrams per liter
(7) NTU = Nephelometric Turbidity Units
(8) BOD = Biochemical Oxygen Demand
(9) CFU/100 ml = Colony Forming Unit per 100 milliliters
(10) TSS = Total Suspended Solids
(11) HEM = Hexane Extractable Material
(12) SGT-HEM = Silica Gel Treated-Hexane Extractable Material
(13) NP = Non Polar
(14) µg/L = micrograms per liter
(15) ND = Non Detect

Monitoring Program

AESI has an extensive database of groundwater and surface water levels collected from various wells and surface water monitoring locations over the past 30 years. Monitoring locations include groundwater wells on the Mill site, the NWF, the SWF, Snoqualmie Sand and Gravel, the Snoqualmie WWTP, and various wells in Snoqualmie screened in the Snoqualmie River Shallow Aquifer, and others. Surface water stations that have periodically been monitored include the Mill Pond, Tokul Creek, and the Snoqualmie River.

Current monitoring stations related to the Mill site include two wells (MW-1 and EB-4) located at the Mill site, and staff gauges in the Snoqualmie River and at the Mill Pond near the fire flow pump station. Continuously reading pressure transducer/data logger equipment was installed in the wells and in staff gauges. Manual water levels are typically measured monthly and data logger equipment is downloaded during site visits.

AESI maintains historical water level information for the majority of the wells and staff gauge locations shown on Figure 3, many of which were installed in the early to middle 1990's. Relevant AESI groundwater and surface water level hydrographs are attached in Appendix D.

1.2.5 Geologic Hazards

Erosion, landslide, steep slope, seismic, channel migration, and flood hazard areas and critical aquifer recharge areas (CARAs) are regulated under the *Snoqualmie Municipal Code* (SMC) Chapter 19.12 - "Critical Areas." Based on published critical areas maps produced by the City of Snoqualmie, King County, and our observations of regional and local topographic and geologic conditions, as documented in this report, these types of geologic hazards all exist to a variable extent in areas of the project site. A discussion of these critical areas as they relate to the Mill site is presented in the following sections.

<u>Erosion Hazard Areas (SMC 19.12.100)</u>

Erosion Hazard Areas are defined under SMC Section 19.12.100 as follows: *those areas of the city containing soils which, according to the USDA Soil Conservation Service, King County Soils Survey, dated 1973, and any subsequent revisions or additions thereto, and the USDA Soil Conservation Service, Soils Survey for Snoqualmie Pass Area, Parts of King and Pierce Counties, WA, dated December 1992, may experience severe to very severe erosion hazard, and which occur on slopes of 15 percent or greater.*

Erosion Hazards are limited to the slopes at 15 percent or greater on the northeastern margin of the site, mapped as Barneston Series soils on the above-referenced Soil Survey. This area is shown on Figure 14. A discussion of on-site soils is presented under "Soils," Section 1.2.1.

Erosion Processes

In order to evaluate potential erosion impacts (and subsequently provide mitigation) as a result of the proposed development, it is important to understand where and how erosion occurs. The sediment begins motion by a process called *gross erosion*, which can be subdivided into *sheet erosion* and *channel erosion*.

Sheet erosion is caused by shallow "sheets" of water flowing over the cleared land surface and transporting soil particles which have been detached by raindrops. The shallow surface flow rarely moves as a uniform sheet for more than a few feet before concentrating in surface irregularities and resulting in rill erosion. Additional sediment is thus picked up and transported. This erosion process is continuous over several storm or normal rainfall events. If the rills become more than a few inches deep, then the erosive regime changes to gully erosion where concentrated water flow can transport large quantities of sediment during a single storm event. In the Puget Sound region this usually occurs on slopes greater than 20 percent.

Different soil types and geologic parent materials can have widely differing susceptibilities toward each separate erosive regime. As an example, the lodgement till typically develops a soil horizon (Tokul Soil Series) that is significantly less dense than the geologic parent material; however, it contains about the same percentages of fines. This soil is susceptible to sheet erosion or channel erosion (concentrated flow) due to its lower density. The geologic parent material is significantly less susceptible to channel erosion for a given storm event due to its high density and cohesive nature. Conversely, the glacial outwash deposits develop a soil horizon (Barneston Series soils) that is much less susceptible to sheet erosion, primarily due to its high permeability preventing the development of sheet flow during normal rainfall events. However, the parent material (mostly sand and gravel) is highly susceptible to erosion under concentrated (channel) flow regimes, even on relatively gentle slopes.

In addition, slope gradients and vegetation also play an important role in determining erosional impacts. In general, steeper slopes have a higher susceptibility to erosion as surface water has the capability of achieving higher velocities and, hence, has more energy available to erode and transport sediments. Vegetation, on the other hand, has a tendency to reduce the potential development of concentrated flows by dispersing rainfall, impeding surface water flow, and reducing surface water velocities.

Based on the sediment characteristics and slope gradients, two zones with differing degrees of potential erosion hazards are shown on Figure 14 and are discussed further below.

Erosion Hazard Zone 1

Erosion Hazard Zone 1 includes the majority of the Mill site, which is relatively flat. Because of the low slope gradient, this area is considered to possess a low erosion hazard risk. These areas are underlain by Arents and Nooksack Series soils at slopes of 0 to 2 percent.

Erosion Hazard Zone 2

Erosion Hazard Zone 2 is considered to possess a slight to moderate risk of erosion. This area is located on the northeastern margin of the Mill site. These areas are underlain by Barneston Series soils at slopes of 15 percent or greater.

Landslide Hazard Areas (SMC 19.12.110) & Steep Slope Hazard Areas (SMC 19.12.120)

The SMC defines Landslide Hazard Areas as *"those areas of the city subject to a risk of landslide, including the following areas:*

1. *Any area with slopes greater than 15 percent and impermeable soils (typically silt and clay) frequently interbedded with granular soils (predominantly sand and gravel) and springs or groundwater seepage;*

2. *Any area that includes areas with significant visible evidence of groundwater seepage, and which also includes existing landslide deposits regardless of slope;*

3. *Any area which has shown movement during the Holocene epoch (from 10,000 years ago to present) or which is underlain by mass wastage debris of that epoch as determined by a geologist;*

4. *Any area potentially unstable as a result of rapid stream incision or stream bank erosion;*

5. *Any area located on an alluvial fan, presently or potentially subject to inundation by debris flow or deposition of stream-transported sediments."*

The SMC separately defines Steep Slope Hazards as "*those areas of the city where the ground rises at an inclination of 40 percent or more within a vertical elevation change of at least 10 feet*".

The attached "Landslide & Steep Slope Hazards" map (Figure 15) illustrates Landslide/Steep Slope Hazard Areas identified at the site.

Landslide/Steep Slope Hazard Zones

The landslide/steep slope hazard risks on the property have been subdivided into two hazard zones based on local geotechnical engineering and geologic hazard standards. These hazard zones are illustrated on Figure 15 and are described below.

<u>Landslide/Steep Slope Hazard Zone 1</u>

Landslide/Steep Slope Hazard Zone 1 encompasses the vast majority of the site and is considered to possess a low landslide hazard risk due to low slope gradients.

<u>Landslide/Steep Slope Hazard Zone 2</u>

Landslide/Steep Slope Hazard Zone 2 is generally localized to the eastern margin of the site. Portions of the slopes in this area appear to meet the definition of steep slope hazards – slopes with inclinations greater than 40 percent over a vertical height of at least 10 feet. Portions of these slopes also appear to meet criterion #1 for landslide hazards.

The large wood waste pile located in Planning Area 3, just east of the eastern edge of Planning Area 1, contains slopes that are 40 percent or greater. These slopes meet the steep slope hazard definition in the City code even though they are not naturally occurring.

Zone 2 is considered to possess a low to moderate risk of landslides if disturbed by improper grading/clearing or uncontrolled drainage. In their existing conditions these areas do not show evidence of slide activity.

Seismic Hazard Areas (SMC 19.12.130)

Regional seismicity is discussed in the following sections, followed by a description of potential seismic hazards, including ground rupture, ground motion response, liquefaction, and seismically induced landslides.

Stresses that cause earthquakes in western Washington are mainly due to the interaction of tectonic plates that meet off the coast of Washington State, referred to as the Cascadia Subduction Zone (CSZ). The Juan de Fuca oceanic plate, which forms the floor of the northeastern Pacific Ocean, moves northeastward with respect to the North American continental plate at an average rate of about 1.3 inches per year (Miller et al., 2001). Differences in density of the two plates cause the denser oceanic Juan de Fuca plate to sink or subduct beneath the less dense North American continental plate. This subduction zone defines the fault boundary between the Juan de Fuca plate and the North American plate that overrides and overlies it. The Juan de Fuca plate underlies the North American plate at a depth of about 15 to 20 miles beneath much of the Puget Lowland. Tectonic processes active in the CSZ region include accretion, subduction, deep earthquakes, and active volcanism of the Cascades.

Local Seismicity

The Mill site is located in an area of low to moderate historical seismicity. Table 1.2-8 summarizes historical and recorded seismic events greater than magnitude (M) 3.0 in the vicinity (less than 20 miles) of the site as obtained from the University of Washington's Pacific Northwest Seismic Network (PNSN). Figure 16 shows the locations and magnitudes for all events M ≥ 2. A significant number of seismic events of M < 2 have been recorded in the site vicinity that are not presented here. An M 4.2 earthquake, which occurred on December 30, 1978 and was located about 4 miles north-northwest of the site boundary, is the largest and nearest seismic event recorded in the site vicinity since the installation of the Pacific Northwest Seismic Network in 1970.

TABLE 1.2-8
HISTORICAL SEISMICITY IN THE VICINITY
OF THE MILL SITE (M>3.0)

Date	Latitude (°N)	Longitude (°W)	Depth (mi)[1]	Magnitude
9/4/1970	47.6167	-121.803	9.2	3.2
6/9/1973	47.5987	-121.812	3.3	3.3
12/30/1978	47.595	-121.844	11	4.2
2/1/1979	47.5307	-121.908	4.2	3.5
10/4/1983	47.4603	-121.838	13.1	3
12/29/1990	47.4738	-121.812	10.3	3.5
4/19/1992	47.461	-122.054	14	3.1
1/21/1996	47.4507	-121.788	12.7	3.3
2/14/2001	47.5182	-121.897	3.9	3.1
9/12/2015	47.5178	-121.75	11.7	3.9
10/22/2016	47.5378	-121.917	15	3

Source: Pacific Northwest Seismic Network.
[1]mi - miles

Earthquake Types

Three types of earthquakes occur in the Pacific Northwest that affect western Washington: 1) deep intraplate earthquakes that occur within the subducting Juan de Fuca plate, 2) shallow to deep interplate earthquakes that occur at the boundary between the subducting Juan de Fuca plate and the overriding North American plate, and 3) shallow crustal earthquakes that occur within the North American plate.

The Juan de Fuca plate must bend as it subducts beneath the North American plate causing deep intraplate earthquakes within the Juan de Fuca plate. There is evidence that six such earthquakes have occurred in the Puget Sound region with estimated magnitudes greater than 6.0 since 1870 (Cascadia Region Earthquake Workgroup, 2008). Three such historical earthquake events in Washington State include the 1949 Olympia earthquake (M 6.8), the 1965 Seattle-Tacoma earthquake (M 6.5), and the 2001 Nisqually earthquake (M 6.8). These and several other historical earthquakes in Washington State had deep epicenters at depths of about 20 to 30 miles or more below the Puget Lowland. These depths imply that the epicenters were located within the Juan de Fuca plate underlying the CSZ (Lidke et al., 2003). An earthquake recurrence interval for this type of earthquake can be estimated at approximately 20 to 25 years, given the historic record referenced above.

Shallow to deep interplate (or subduction zone) ruptures occur between the Juan de Fuca plate and the North American plate. The last known great earthquake in the northwest was in 1700. Records provided by buried soil layers, tree ring and radiocarbon dating of dead trees, and deep-sea deposits indicate that this subduction earthquake occurred with a magnitude of approximately 8.9 (Adams, 1996; Atwater, 1987, 1996; Atwater et al., 1991; and Yamaguchi, 1997). A documented tsunami occurred in Japan that has been correlated to this earthquake (Satake et al., 1996). Geological evidence indicates that great earthquakes (> M 8.0) may have occurred sporadically at least seven times in the last 3,500 years, suggesting a return time of about 500 years (Atwater et al., 2003, 2005), while seafloor core evidence indicates that there have been forty-one subduction zone earthquakes on the CSZ in the past 10,000 years, suggesting a general average earthquake recurrence interval of approximately 240 years (Goldfinger et al., 2012).

The third type of event is a shallow, crustal earthquake occurring within the North American plate. Although no evidence of surface faults or associated ground rupture was observed at the Mill site, there are several active crustal faults in western Washington that may pose significant, though very infrequent, seismic hazards in the Puget Sound region. The most notable of these near the site, the Seattle and Rattlesnake Mountain Fault Zones, are described below.

Surficial Fault Zones

Two primary components contribute to the active deformation of western Washington – 1) southwest-northeast contraction driven by locking of the Cascadia subduction zone, and 2) the clockwise rotation of Washington and western Oregon around a pole of rotation centered around the junction of Washington, Oregon, and Idaho (McCaffrey et al., 2013). This compression and rotation causes the north-south shortening of the crust in western Washington, which is estimated to range from 3 to 5 millimeters (mm) per year (Mazzotti et al., 2002; McCaffrey et al., 2013). Crustal faulting within the Puget Lowland shows a pattern of deformation that generally consists of reverse faults (thrust faults) to accommodate this north-south shortening linked by strike-slip transfer (horizontal motion) zones. The various fault zones mapped throughout the Puget Lowland are manifestations of this shortening, including the Seattle Fault Zone (SFZ), Tacoma Fault Zone (TFZ), South Whidbey Island Fault Zone (SWIF), and in the vicinity of the Mill site, the Rattlesnake Mountain Fault Zone (RMF) which is interpreted to be an extension of the SWIF (Dragovich et al., 2009b). This complex of faults is shown on Figure 17.

The SFZ is a south-dipping thrust fault system. The SFZ ranges from 2.5 to 4 miles wide and is approximately 50 miles long extending through Seattle and connects on its western edge to the Saddle Mountain Fault near the Olympic Mountains and connects on its eastern edge to the RMF, forming a transpressional (combined compression and horizontal translation) zone that facilitates the north-south shortening of the crust (Anderson et al., 2017). The SFZ generally marks the northern edge of an area of uplifted crustal bedrock (the Seattle uplift) and the southern edge of a basin infilled with younger glacial and non-glacial sediments (Seattle basin).

The connection between the SFZ and the RMF is located near Fall City, approximately 3 to 4 miles northwest of the Mill site. The RMF consists of a band of faults showing both vertical and horizontal components of motion and essentially marks the eastern, lateral edge of the Seattle uplift. Recent geologic mapping (Dragovich et al., 2009a,b) has identified strands of the RMF and other faults in the vicinity of the Mill site. The closest of these faults to the project are the Snoqualmie Valley Fault and RMF-8 (a strand of the RMF), both of which are mapped to cross the site and are shown on Figure 18. The Snoqualmie Valley Fault trends north-south through the eastern margin of the site, and the RMF-8 trends northwest-southeast through the central portion of the site. While both of these faults are potentially active, they do not displace Holocene sediments, suggesting that they have not been active within the last 10,000 years. There is no other evidence that either of these faults is currently active (Dragovich et al., 2009a,b).

There is indirect evidence that the main strand of the RMF zone (RMF-1) may be active locally in the North Bend Quadrangle (Dragovich et al, 2009a), where deformed Quaternary sediments have been observed southwest of North Bend and southeast of Rattlesnake Lake. RMF-1 is inferred to be present about 1 mile west of the Mill site (Dragovich et al., 2009b) and directly west of Snoqualmie Falls (Figure 18). It has been speculated that RMF-1 has caused disturbance of Quaternary sediments in the vicinity of the falls (Dragovich et al, 2009b); however, direct evidence of the deformation or displacement of Quaternary sediments is currently very limited. The recurrence interval of the RMF is not currently known.

Seismic Hazards

Seismic Hazards in the SMC are defined as "*those areas of the city subject to severe risk of earthquake damage as a result of seismically induced landslides, earth adjustments, settlement or soil liquefaction.*" The potential for each of these hazards to adversely impact the proposed project is discussed below. Seismic Hazards are shown on Figure 18.

1. <u>Earthquake Induced Landslide Hazard Areas</u>: Earthquake vibration may cause unstable material to fail by influencing existing planes of weakness within bedrock (such as bedding planes or fault planes) or within unconsolidated material (such as existing landslides). The USGS documented many earthquake-induced landslides throughout the Puget Lowland that occurred due to shaking from the 2001 Nisqually event, and several researchers have correlated previous mass movements in Lake Washington to an earthquake on the Seattle Fault about 1,100 years ago (Jacoby et al., 1992; Karlin and Abella, 1992, 1996).

   It is our opinion that the risk of damage to the proposed structures by seismically induced landsliding is low over the majority of the site due to the lack of steep slopes. However, the risk would be higher in those areas where slopes exceed 40 percent. These include areas mapped as Landslide Hazard Zone 2 on Figure 15. The site includes slopes along the east edge of the parcel that appear to be underlain at shallow depths by glacially consolidated sediments that tend to be resistant to slope failures during a seismic event. Development on or near the east slopes of the parcel may warrant a quantitative assessment of slope stability during a seismic event, though the risks of such slope failures are likely to be low. There is no evidence of landslide activity either onsite or on the slopes offsite along the eastern project boundary. Landslide Hazards are discussed in more detail under "Landslide Hazard Areas (SMC 19.12.110) & Steep Slope Hazard Areas (SMC 19.12.120)."

The existing wood waste pile is large and has tall and relatively steep side slopes. If the existing wood waste pile is to remain as it currently exists, and new development is planned nearby, consideration of slope stability during a seismic event may need to be considered. However, we understand the wood waste pile will be removed, prior to development in the area.

2. Liquefaction Hazard Areas: The term *liquefaction* refers to a dramatic loss of shear strength occurring in a subsurface soil deposit when subjected to shaking, as during an earthquake. The seismically-induced loss of soil strength can result in failure of the ground surface and can be expressed as landslides or lateral spreads, surface cracks and settlement, and/or sand boils. Seismically-induced liquefaction typically occurs in loose, saturated, non-cohesive sandy and silty soils commonly associated with recent river, lake, and beach sedimentation. In addition, seismically induced liquefaction can be associated with areas of loose, saturated fill.

   The low-lying areas of the site contains existing fill, overbank deposits, river channel deposits, and lacustrine sediments, some of which are saturated. These materials are potentially at risk of liquefaction during a design-level seismic event, shown as Seismic Hazard Zone 2 on Figure 18.

   The eastern and northeastern slopes along the eastern margin of the site are underlain by glacially consolidated material that is not expected to be susceptible to seismically-induced liquefaction.

3. Lateral Spreading: Due to the low strength of the existing fill and lacustrine sediments, the lower-lying parts of the site could be susceptible to failure by lateral spreading during a seismic event, even on relatively gently inclined slopes. This area includes Seismic Hazard Zone 2 on Figure 18.

4. Fault Rupture Hazard Areas: Ground rupture occurs as offsets of the ground surface and is limited to the immediate area of the fault. As described previously, a strand of the RMF (RMF-8) and the Snoqualmie Valley Fault may cross through the Mill site, based on recent geologic maps. There is no evidence that these are active faults. Holocene-age sediments do not appear to be disturbed beneath the site, suggesting that, if these faults exist, they have not been active for the last 10,000 years. No evidence of surface faults or associated ground ruptures were observed on the Mill site. The main strand of the RMF (RMF-1) is located approximately 0.75 miles west of the Mill site and is the

nearest known fault to the project that may be active. Studies of the RMF Zone indicate that RMF-1 may be an active fault capable of generating surface ruptures, although the recurrence interval of movements along the fault is unknown. It is our opinion, based on existing geologic data, that the risk of surface rupture impacting the Mill site is low.

Ground Motion

Ground motion from an earthquake results from shear, pressure, and surface waves propagating through the earth's crust from the earthquake's hypocenter. The ground motion caused by these waves is the seismic shaking felt during an earthquake. The intensity of the shaking felt at a given location during and immediately after an earthquake, is a result of several variables including: 1) the magnitude of the earthquake, 2) distance from the earthquake, 3) depth of the earthquake, 4) the type of rocks and unconsolidated sediments underlying a given site, and 5) attenuation of the seismic energy between the earthquake and a given site.

The Nisqually 2001 earthquake provided opportunities for direct observation of ground motion during a large regional earthquake. The University of Washington's PNSN created a "shake map" of peak acceleration and velocity from wave forms collected from the earthquake. Peak acceleration is the maximum acceleration experienced by a particle at the earth's surface during the course of the earthquake motion. The event was located between Olympia and Tacoma at a depth of 32.6 miles. Based on PNSN data the Mill site experienced moderate to strong shaking.

The Mill site is underlain by relatively soft, saturated sediments that may amplify the ground motion. Based on the relative density of the subsurface soils obtained from standard penetration test (SPT) data to a depth of 100 feet in EB-1 onsite and seismic shear wave velocity data obtained from CPT-1 and CPT-2 onsite, the site soils are consistent with Site Class "E" or possibly Site Class "F", since the site is underlain by liquefiable soils, in accordance with the 2015 *International Building Code* (IBC) and *American Society of Civil Engineers* Publication ASCE 7-16 *Minimum Design Load and Associated Criteria for Buildings and Other Structures*. Site Class "E" applies to sites underlain by soft silts and clays. Site Class "F" applies to sites underlain by soft or loose soils that are also liquefiable and requires completion of a site-specific seismic response analysis.

Flood Hazard Areas (SMC 15.12 and SMC 19.12.150)

Flood hazard areas are regulated under SMC Section 15.12 and 19.12.150. Most of the Mill site is within the 100-year floodplain Zone AE shown on the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) of the area, below the base flood elevation (BFE). Zones AE are areas that have a 1 percent probability of flooding every year (100-year floodplain) and where predicted flood water elevations above mean sea level have been established. Properties in Zone AE are considered to be at high risk of flooding under the National Flood Insurance Program (NFIP). The southwestern portion of Planning Area 1 is within the delineated floodway. The floodway is defined as the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than a designated height. The 100-year floodplain and floodway are both shown on Figure 19.

Proposed development within the floodway and 100-year floodplain is regulated by the City of Snoqualmie's Flood Hazard Regulations (SMC 15.12) and federal FEMA regulations. Site development will require compliance with general standards in the SMC, including requirements for final grades after construction, the protection of site utilities from adverse impacts due to flooding, and the demonstration that the proposed development will not increase the flood levels during the occurrence of the base flood discharge. Compliance with these standards is described in the "Snoqualmie Mill Planned Commercial-Industrial Plan – Master Drainage Plan, Preliminary Draft," dated April 6, 2018 and prepared by Goldsmith (DEIS Appendix X).

Channel Migration Zones (SMC 19.12.140)

Channel Migration Zones (CMZs) are regulated under SMC Section 19.12.140 and are defined as "*the area along a river within which the channel(s) can be reasonably predicted to migrate over time as a result of natural and normally occurring hydrological and related processes when considered with the characteristics of the river and its surroundings as delineated on the Snoqualmie River Channel Migration Area Map, contained in Channel Migration in the Three Forks Area of the Snoqualmie River*" (King County Department of Natural Resources, Surface Water Management Division, Seattle, WA, 1996).

The referenced report delineates CMZs along the Snoqualmie River in the vicinity of the site, categorizing areas into Potential Hazard Areas, Moderate Hazard Areas, and Severe Hazard Areas. Based on the maps in the referenced report and shown on Figure 14, a section along the southwestern edges of Planning Area 1 and Planning Area 3 are within the Moderate Hazard Area. The majority of Planning Area 1 and the western portion of Planning Area 3 are within mapped Potential Hazard Areas (Figure 14).

Development is not limited in potential hazard areas; however, only certain development or activities are allowed in severe and moderate CMZs. Per SMC 19.12.140(C), only the "*following activities are allowed within the severe and moderate channel migration zone:*

1. *Trails and boardwalks;*
2. *Forest practices;*
3. *Ongoing agriculture;*

4. *Bridges, utilities and transportation structures when no other feasible alternative exists;*

5. *Development with a primary purpose of protecting or restoring ecological functions."*

Based on current site planning, new structures are not currently planned within either the Severe or Moderate Hazard Areas except for the realignment of SE Mill Pond Road. Structures are planned within the mapped Potential Hazard Area.

<u>Critical Aquifer Recharge Areas (SMC 19.12.200)</u>

Title 19.12.200 of the SMC presents the definitions of CARA as follows:

1. *"Category I critical aquifer recharge areas include those areas mapped by King County and are determined to be highly susceptible to groundwater contamination and that are located within a sole source aquifer or a wellhead protection area.*

2. *Category II critical aquifer recharge areas include those areas mapped by King County and determined to:*

    a. *Have a medium susceptibility to ground water contamination and are located in a sole source aquifer or a wellhead protection area; or*

    b. *Are highly susceptible to ground water contamination and are not located in a sole source aquifer or wellhead protection area.*

3. *Category III critical aquifer recharge areas include those areas mapped by King County and determined to have a low susceptibility to groundwater contamination."*

Review of the map *King County Critical Aquifer Recharge Areas* dated March 1, 2012 (shown on Figure 20) indicates that the area immediately surrounding the Snoqualmie Mill site to the north, and portions of the site on the west and northwest parts of the property are classified as a Category 1 CARA. The areas mapped as Category 1 CARA appear to generally correspond to the mapped 10-year TOT wellhead protection areas (WPAs) for groundwater production wells. The area immediately south of the Mill site, including the Mill Pond, and portions of the site on the southeast and southwest parts of the property are classified as a Category 2 CARA. The majority of the Mill site, however, is not classified.

As identified in the SMC Title 19.12.200(C), certain uses or activities are prohibited in a Category 1 CARA. According to SMC Title 19.12.200(F), certain activities and uses not prohibited require a hydrogeologic assessment to be completed prior to approval of that activity or use. Storage tanks constructed in a CARA need to comply with containment and corrosion protection requirements and other uses such as agriculture, sewage disposal, golf courses, and vehicle repair need to implement best management practices with respect to their operations.

Many of the WPAs shown on the above-referenced King County map consist of a circular WPA centered around the groundwater source, including the WPA delineated for the NWF just north of the Mill site. These circular WPAs appear to have been delineated using a calculated fixed radius (CFR) technique. The CFR is a simple two-dimensional analysis, assumes that the initial hydraulic gradient is horizontal (i.e., that there is no ambient groundwater flow), and does not take into account complex hydrogeologic conditions, such as aquifer heterogeneities, varied aquifer geometry, bedrock boundaries, and a sloping hydraulic gradient, all of which are present in the vicinity of the Mill site. As a result, delineated WPAs obtained via the CFR method for the NWF may be misleading.

AESI developed numerical groundwater flow models, using MODFLOW, to evaluate the groundwater capture zones for both the NWF and SWF (AESI, 1994, 1995c, 1996), north and south of the Mill site. The capture zones delineated by the MODFLOW modeling incorporate a conceptual hydrogeologic model developed by AESI through analysis of subsurface conditions observed in explorations completed on- and offsite, review of conditions reported on Ecology well logs, water level monitoring, and detailed hydrogeologic mapping. The resulting capture zone calculated by the three-dimensional MODFLOW model takes into account existing conditions and represents a more realistic estimate of the TOT zones to the production wells at the NWF and SWF.

The MODFLOW model indicates that the TOT zones for the well field are highly elliptical (AESI, 1994, 1995c, 1996). For example, at the NWF the 10-year TOT zone extends just over 2 miles south of the well field, through the Mill site and Mill Pond, but only a few hundred feet to the north. The calculated capture zone is relative narrow, generally in the range of 3,000 feet (AESI, 1996). The overall shape is controlled by the hydrogeologic setting and reflects the combination of a narrow bedrock bounded aquifer with a steep hydraulic gradient.

The wells for the NWF withdraw groundwater from the Deep Aquifer, which is separated from shallower aquifers by multiple low-permeability aquitards and receives limited recharge from shallower aquifers near the well field. As described previously under "Deep Aquifer," particle tracking plots, which illustrate flowpaths generated by the MODFLOW computer model, support this interpretation. Most of the water discharging from the well field comes directly from upgradient sources in the Deep Aquifer, originating a few miles upvalley (southeast) of the 10-year TOT boundary. Modeling suggests only about 5 to 10 percent of the water at the well field would originate in the Tokul Creek Delta Aquifer, Snoqualmie River Shallow Aquifer, or surface water sources within the 10-year TOT zone (AESI, 1996). The vast majority of recharge from the Mill site will bypass the deeper aquifer system within the 10-year TOT zone, discharging directly into the Snoqualmie River to the west or into the Tokul Creek Delta Aquifer to the north and emerge at the spring zone along Tokul Creek, ultimately flowing to the Snoqualmie River downgradient of the falls.

1.3 POTENTIAL IMPACTS

The following sections of this report describe our evaluation of probable significant environmental impacts relative to geologic hazards, surface water, and groundwater resources that might result from development of the Snoqualmie Mill site (Mill site), without mitigation. Our analysis of probable significant impacts associated with geologic hazards includes the following: erosion hazards including stream/river erosion (channel migration), landslide hazards, seismic hazards, flood hazards, and critical aquifer recharge areas (CARAs). Our analysis of CARAs is limited to groundwater quantity impacts. Geotechnical development impacts are also discussed.

The potential impacts presented in the following sections are discussed in reference to the Proposed Action. Any differences in the potential impacts in relation to the No Action Alternative or Alternative 1 are presented at the end of each section.

<u>Proposed Stormwater Management</u>

Stormwater management for the Mill site (aside from flood regulations) is regulated by the 2016 *King County Surface Water Design Manual* (KCSWDM) and the 2012/2014 Washington State Department of Ecology *Stormwater Management Manual for Western Washington* (Ecology Manual). In addition, development at the site will be required to comply with the Floodplain Management Regulations of the National Flood Insurance Program (NFIP), administered by the Federal Emergency Management Agency (FEMA).

As described in the "Snoqualmie Mill Planned Commercial-Industrial Plan – Master Drainage Plan, Preliminary Draft," dated April 6, 2018 and prepared by Goldsmith Engineers [Goldsmith], the site lies entirely within the Snoqualmie River Basin and currently drains to the Snoqualmie River from one Threshold Discharge Area. As defined by the KCSWDM, a Threshold Discharge Area is an on-site area draining to a single natural discharge location, or multiple natural discharge locations that combine within one-quarter-mile downstream. Drainage leaves the site at three locations; directly to the river via overland flow, through the Mill Pond via on-site ditches (the Mill Pond drains through a culvert under SE Mill Pond Road to the Snoqualmie River), and the Northeast portion of the site that drains to the river via a large off-site wetland complex lying north of the property. The entire site (with the exception of some small areas of the site above the base flood elevation [BFE]) as well as all downstream areas lie within the 100-year floodplain of the river.

The strategy for stormwater management for development of the Mill site is primarily flood control and compliance with flood hazard regulations. During typical rainfall events, stormwater management will include collection, treatment and direct discharge to the Snoqualmie River and collection, treatment and discharge to on-site and off-site wetlands to maintain wetland and stream hydrology. The Snoqualmie River is designated as a Direct Discharge Receiving Water Body by the KCSWDM and the Ecology Manual, thus the site is exempt from flow control requirements. Proposed developed discharge to on-site and off-site wetlands will be evaluated for consistency with existing conditions by the wetland biologist. This applies to all wetlands and drainages between the site and the Snoqualmie River.

Therefore, the Stormwater Management Plan for the Mill site can be described in four primary components:

1. Direct Discharge to the Snoqualmie River

2. Maintenance of Existing Sub-Basin Hydrology to On-Site and Off-Site Wetlands

3. Runoff Treatment of Pollutant Generating Impervious Surfaces (PGIS)

4. Flood Control and Compliance with Flood Hazard Regulations

1.3.1 Hydrogeologic Impacts

<u>Surface Water Impacts</u>

Under both the Proposed Action and Alternative 1, stormwater runoff will be collected, treated for water quality, and then conveyed to surface water discharge locations – to the Snoqualmie River directly or through on-site wetlands and streams (and the Mill Pond) before ultimately discharging to the Snoqualmie River. Stormwater routed to on-site wetlands will first receive enhanced water quality treatment by passing through stormwater wetlands.

Snoqualmie River

The Mill site qualifies for Direct Discharge Flow Control Exemption per the KCSWDM since it is considered a Major Receiving Water by the manual and meets the other requirements in KCSWDM Section 1.2.3.1, which in part includes the requirements that the flowpath from the project site to the point-of-discharge be no longer than one-quarter mile and the direct discharge will not divert flows from or increase flow to an existing wetland or stream sufficient to cause a significant adverse impact. Discharge to on- and off-site wetlands and streams consistent with existing conditions is a key component of the proposed stormwater management for the Mill site with the intent to maintain existing hydrology on- and offsite, and prevent significant adverse impacts.

The average discharge for the Snoqualmie River just downstream of the falls from 1959 to present was about 2,700 cubic feet per second (cfs) (U.S. Geological Survey [USGS], 2018). The quantity of proposed discharge of on-site stormwater runoff to the Snoqualmie River will be insignificant compared to existing instream flow. No potential adverse impacts to the Snoqualmie River have been identified.

Potential impacts to the Snoqualmie River for Alternative 1 would remain substantially unchanged from the Proposed Action. Under the No Action Alternative, there would be no direct discharge of stormwater runoff to the Snoqualmie River.

Tokul Creek

The Tokul Creek Delta Aquifer discharges into Tokul Creek north of the site. As described in Section 1.2.4, based on the flow monitoring results in the creek, aquifer flow (spring discharge) from the Tokul Creek Delta Aquifer ranges from about 3½ to 8 cfs. The Snoqualmie River Shallow Aquifer underneath the northern portion of the site flows to the north and ultimately merges with the Tokul Creek Delta Aquifer north of the site. Reduced or increased recharge onsite could therefore impact the overall quantity of water flowing in the shallow aquifer to the north and impact flows in Tokul Creek.

Potential impacts to the Tokul Creek Delta Aquifer and Snoqualmie River Shallow Aquifer are discussed below under "Groundwater Impacts." In general, groundwater recharge under developed conditions is expected to be similar to recharge under existing conditions, such that no adverse impacts to groundwater quantity are anticipated, and therefore, no adverse impacts to the Tokul Creek spring discharge are anticipated.

Potential impacts to the Tokul Creek for Alternative 1 would remain substantially unchanged from the Proposed Action. Under the No Action Alternative, discharge into Tokul Creek from the Tokul Creek Delta Aquifer would be unchanged.

Mill Pond

Most of the surface water runoff generated on the Mill site is collected by the linear Wetland 12 system, which extends to the south end of the site where it discharges directly to the Mill Pond. There are also limited areas where surface water runoff directly discharges to the Mill Pond; however, there is no development proposed in these areas, except at the southeastern corner of the site.

The Tokul Creek diversion to the Mill Pond (described under Section 1.2.4) was ceased in 2011. The current level of the Mill Pond is controlled primarily by the outlet elevation with some variation due to stormwater runoff directed to the pond from the Mill site and occasional flooding of the Snoqualmie River. The current outlet of the pond is through a breach in the berm just southeast of the control weir, which was reconstructed in 2009 after a previous breach in the berm. Based on ongoing monitoring, the water level in the Mill Pond is maintained at an elevation of about 409 feet with minor variation. This variation appears to be primarily due the discharge of stormwater into the pond from the Mill site, instead of an expression of shallow groundwater fluctuations. As described under Section 1.2.4, differing water level elevations and response timing trends between the Mill Pond and shallow aquifer suggest the hydraulic connection between the shallow aquifer and the Mill Pond is somewhat limited. The observed water level fluctuations in the Mill Pond are consistent with discharge into the pond from stormwater runoff.

Potential impacts to the Mill Pond due to development could include: 1) an increase/decrease in total volume of surface water runoff that is conveyed to the pond, and 2) an increase in peak discharge to the pond during storms. Large uncontrolled discharge to the pond could cause the water levels to fluctuate to a greater degree than existing conditions and potentially increase discharge flows from the Mill Pond, which could cause additional erosion of an existing breach in the Mill Pond berm.

The stormwater management plan for the site includes maintaining discharge to the on-site wetlands and streams consistent with existing conditions, and thus discharge to the Mill Pond is also expected to be similar to existing conditions. Therefore, no adverse impacts relative to surface water quantity at the Mill Pond are anticipated.

Potential impacts to the Mill Pond for Alternative 1 would remain substantially unchanged from the Proposed Action. Under the No Action Alternative, surface water flows to the Mill Pond would continue similar to existing conditions with similar water level fluctuations observed on the recent hydrographs.

Streams

Six streams (S-1 through S-6) have been identified in the immediate vicinity of the site (Raedeke Associates, Inc. [Raedeke], 2012 and Cedarock Consultants, Inc. [Cedarock], 2012). S-1 and S-2 flow through the site and could potentially be impacted by site development. S-3 through S-6 flow down the slopes just east of the site.

Stream S-1 flows down the eastern slopes and enters the site at the northeast corner. After entering the site, the stream flows west through Wetland 10 and then through a deep roadside ditch that follows the Snoqualmie Sand and Gravel haul road south and then west. The supply of water for S-1 onsite is primarily streamflow entering the site at the northeast corner; however, S-1 does receive additional flow from on-site stormwater runoff at the northeast area of the site, including seasonal flow from Wetlands 8 and 9. The northeast area of the site is within Planning Area 3, which is being analyzed on a programmatic level in the EIS. Conceptually, under developed conditions stormwater runoff in Planning Area 3 will be routed to existing wetland conveyance systems and then to the Snoqualmie River.

S-2 is located in the south-central portion of the site and generally flows north to south, discharging to the Mill Pond. The supply of water for S-2 is a combination of surface runoff, nearby roadside/drainage ditches, and shallow groundwater seepage. Under the Proposed Action, a portion of the stormwater runoff from the site will be routed to S-2 and then to the river through the Mill Pond.

Both of these streams have the potential to be affected by the proposed project. Potential impacts could include: 1) an increase/decrease in total volume of surface water runoff and 2) an increase in peak discharge during storms. However, the stormwater management plan for the site includes maintaining discharge to the on-site wetlands and streams consistent with existing conditions; therefore, no adverse impacts to the on- and off-site streams are anticipated.

Potential impacts to the streams for Alternative 1 would remain substantially unchanged from the Proposed Action. Under the No Action Alternative, surface water flows to the streams would continue similar to existing conditions.

Wetlands

The preliminary draft Master Drainage Plan by Goldsmith (2018) delineated several sub-basins at the site. The majority of the Mill site is tributary to and drains through the extensive Wetland 12 system. Approximately 149 acres (57 percent) of the site (most of the central, west, and eastern areas) flows to Wetland 12 (or to Wetland 28 then to Wetland 12) and eventually to the Mill Pond. Approximately 31 acres (12 percent) at the northeast corner of the Mill site drains to Wetland 9 and then flows to a large wetland complex at the north end of the site, which includes Wetland 11, and eventually discharges to the Snoqualmie River. The only areas onsite that do not directly flow to the on-site wetlands are relatively small areas along the southern edge of the site that flow to the Mill Pond and along the western edge of the site that flow to the Snoqualmie River.

A portion of stormwater runoff generated onsite will be routed to the Wetland 12 system in the central area of the site and the Wetland 9 system at the northeastern corner of the site. The proposed development could alter the amount of flow routed to the wetlands, which could in turn impact their existing, natural seasonal fluctuation in water level.

As described in the preliminary Master Drainage Plan (Goldsmith, 2018), development in Planning Area 1 could potentially impact three wetland sub-basins, including the two Wetland 12 sub-basins (WL 12 W and WL 12 NW) on the western side of the site and the Wetland 28 sub-basin (which ultimately flows to Wetland 12). These sub-basins are shown on Figure 6-1 in the Master Drainage Plan (Goldsmith, 2018). The conversion of pervious surfaces to impervious surfaces due to development in Planning Area 1 based on the Planned Commercial/Industrial (PCI) Plan was analyzed in the Master Drainage Plan (Goldsmith, 2018). The total Effective Impervious Area (EIA) for the three sub-basins under existing conditions is 9.95 acres, and the total EIA under developed conditions is 33.28 acres. This increase in total EIA has the potential to increase the quantity of stormwater runoff flowing to the wetlands in Planning Area 1, depending upon the stormwater management plan for the site.

Development in Planning Areas 2 and 3 is still conceptual at this time, and the PCI Plan does not provide details for proposed development in these areas; therefore, an analysis similar to

Planning Area 1 above is not possible. However, the PCI Plan does define a maximum level of buildout as part of the PCI approval, indicating that the total EIA in Planning Area 2 and Planning Area 3 will be approximately 78 acres, which is a reduction of about 30 percent from existing conditions. This reduction in EIA has the potential to increase recharge to the shallow aquifer and subsequently increase seepage into on-site groundwater-supported wetlands. Planning Areas 2 and 3 are still at a programmatic level, such that it is not possible at this time to define the configuration of the wetland sub-basins under developed conditions.

It is the intent of the stormwater management plan for the site to maintain flows to existing on- and off-site wetlands similar to existing conditions, such that adverse impacts are not anticipated. Many of the on-site wetlands are supported primarily by shallow groundwater (as described in Section 1.2.4, "Hydrogeology"), such that they are not susceptible to minor changes in discharge from stormwater runoff. Stormwater runoff routed to the wetlands quickly flows through the on-site system of interconnected wetlands and drainage ditches before discharging offsite.

Potential impacts to the wetlands in Alternative 1 would remain substantially unchanged from the Proposed Action. Under the No Action Alternative, surface water flows to the wetlands would continue similar to existing conditions.

Groundwater Impacts

Under the proposed stormwater management plan for the site, stormwater runoff will be collected and directed to the Snoqualmie River. The stormwater runoff will be either discharged directly to the Snoqualmie River or discharged to existing on-site wetlands, which indirectly convey water to the Snoqualmie River through the Mill Pond. Proposed stormwater control at the Mill site under the Proposed Action is described in detail in Goldsmith's preliminary Master Drainage Plan (2018).

In general, potential impacts to groundwater recharge due to site development could include –

1. Gain or loss of groundwater recharge resulting from conversion of undeveloped land (or redevelopment of existing developed areas) into the various proposed industrial, commercial, and residential uses;

2. Impacts to underlying aquifers and downgradient usage as a result of a change in recharge; and

3. Impacts to surface water features as a result of a change in recharge.

Development has the potential to change the amount of surface water and groundwater recharge. Clearing vegetation and replacing it with suburban landscaping (such as lawns) reduces evapotranspiration, increasing the amount of water available for groundwater recharge and runoff. Depending upon how stormwater is managed, the increase in groundwater recharge may be counteracted by an increase in impervious surfaces (building and pavement areas), and other factors. The primary factors that would increase the amount of groundwater recharge are: 1) infiltration of stormwater runoff, 2) infiltration of imported water such as that used for irrigation, and 3) conversion of existing forestland to cleared, pervious surfaces (lawns, shrubbery, etc.). The primary factors that would decrease the amount of groundwater recharge are: 1) addition of impervious surfaces, and 2) diverting stormwater runoff to off-site locations.

The stormwater management plan for the site is described above under "Proposed Stormwater Management." In general, on-site stormwater management will include collection, treatment and direct discharge to the Snoqualmie River and collection, treatment and discharge to on-site and off-site wetlands to maintain wetland hydrology. The intent of the proposed plan is to maintain discharge to on-site and off-site wetlands and streams consistent with existing conditions; therefore, groundwater recharge post-development is also expected to be similar to existing conditions.

AESI has conducted ongoing groundwater level monitoring at the Snoqualmie Ridge development since 1996, located about 1.5 miles west of the Mill site. Similar to the Mill site, the stormwater management approach for the initial phase of buildout at Snoqualmie Ridge included collection, treatment, and direct discharge to the Snoqualmie River. The groundwater level data from Snoqualmie Ridge provides a long-term record of the trend of aquifer levels both prior and subsequent to extensive development in the area and provides an analog for comparison to assess potential impacts to groundwater levels due to development at the Mill site. Groundwater monitoring well MW-1, located in the Snoqualmie Ridge development, is screened in the Lake Alice Aquifer, which is an unconfined aquifer developed within Vashon advance fluvial and deltaic sand and gravel deposits. The Vashon advance outwash is overlain by relatively low-permeability Vashon lodgement till, which mantles the Lake Alice Plateau where the Snoqualmie Ridge development is situated. No evidence of development-related reductions in the Lake Alice Aquifer levels have been noted in the 22-year period of record obtained from MW-1 since monitoring began in 1996. This data is consistent with other long-term groundwater level monitoring data that AESI has collected at other sites throughout the Puget Sound and indicates that no adverse groundwater quantity impacts are expected due to development at the Mill site.

Bedrock "Aquifer(s)"

Probable significant adverse impacts to the bedrock aquifer could occur if development of the Mill site resulted in a significant reduction in recharge. However, as described above, groundwater recharge is anticipated to be similar to existing conditions. Therefore, no probable significant adverse impacts to the bedrock aquifer, or yields to neighboring wells completed in the bedrock aquifer, have been identified.

Potential impacts to the bedrock aquifer for Alternative 1 would remain substantially unchanged from the Proposed Action. Under the No Action Alternative, no significant reduction in recharge to the bedrock aquifer would be expected. Individual water supply wells could potentially be constructed and withdraw groundwater from the bedrock aquifer. However, daily demands would likely be small and no probable significant impacts are anticipated.

Deep Aquifer

The Deep Aquifer is developed in Olympia or pre-Olympia-age fluvial sands and gravels. It represents an ancient Snoqualmie River system confined within a narrow bedrock valley. Its presence is limited by the ancient bedrock valley, extending upvalley (southeast) from the Mill site towards North Bend and downvalley (northwest) downstream of Snoqualmie Falls.

The Deep Aquifer exhibits leaky confined aquifer behavior and is separated from surface water sources and aquifers by multiple aquitards with combined thicknesses of about 300 feet. The Deep Aquifer does not have a direct connection with the waters of surface streams due to the presence of intervening aquifers and aquitards totaling several hundred feet in thickness.

Recharge to the Deep Aquifer occurs from limited vertical leakage through the overlying aquitards and is primarily from throughflow of groundwater coming downvalley from the southeast. As described in detail under "Affected Environment," groundwater flow models indicate that most of the water discharging at the North Well Field (NWF) and South Well Field (SWF) comes directly from upgradient sources in the Deep Aquifer, originating a few miles upvalley (southeast) of the Mill site. The modeling suggests that recharge from shallower aquifers in the vicinity of the Mill site account for no more than about 10 percent of the water pumped at the NWF and SWF (AESI, 1995c, 2007).

Because of the limited recharge from overlying aquifers in the vicinity of the Mill site (as described above) and since no significant reduction in recharge to overlying aquifers is expected, no significant reduction in recharge to the Deep Aquifer is anticipated. Therefore, no probable significant impacts to the Deep Aquifer have been identified from the Proposed Action.

Potential impacts to the Deep Aquifer for Alternative 1 would remain substantially unchanged from the Proposed Action. Under the No Action Alternative, no significant reduction in recharge to the Deep Aquifer would be expected. Individual water supply wells could potentially be constructed and withdraw groundwater from the Deep Aquifer. However, daily demands would likely be small and no probable significant impacts are anticipated.

Pre-Fraser Aquifer

The Pre-Fraser Aquifer is developed in Olympia-age non-glacial or other undifferentiated pre-Fraser deposits underlying the site. The thickness of the Pre-Fraser Aquifer near the

Mill site ranges from about 60 feet to over 120 feet, based on borings at the NWF. The Pre-Fraser Aquifer encountered in onsite well MW-1 is separated from the underlying Deep Aquifer by 50 to 100 feet of low-permeability sediments. This aquitard is discontinuous and may not be present southeast of the NWF in the vicinity of the Mill site, where in some areas the Pre-Fraser Aquifer is interpreted to have a more direct hydraulic connection with the underlying Deep Aquifer (AESI, 1994, 1995c, 2001). The Pre-Fraser Aquifer is separated from overlying aquifers and surface water due to the presence of about 200 feet of low-permeability, Holocene-age lacustrine silt and clay underlying the Mill site. Recharge to the Pre-Fraser Aquifer occurs from limited vertical leakage through the overlying aquitard and throughflow from upgradient sources.

Since no significant reduction in recharge to overlying aquifers is expected, no significant reduction in recharge to the Pre-Fraser Aquifer, is anticipated, and therefore, no probable significant impacts to the Pre-Fraser Aquifer have been identified from the Proposed Action.

Potential impacts to the Pre-Fraser Aquifer for Alternative 1 would remain substantially unchanged from the Proposed Action. Under the No Action Alternative, no significant reduction in recharge to the Pre-Fraser Aquifer would be expected.

Tokul Creek Delta Aquifer

The Tokul Creek Delta Aquifer is interpreted to be developed in the Vashon recessional delta deposits north of the Mill site and beneath the northern portion of the Mill site underlying the recent lacustrine deposits. Recharge to the Tokul Creek Delta Aquifer is from direct precipitation where the delta is exposed at the ground surface north of the Mill site, which will not be impacted by on-site development. Additional recharge occurs from the Snoqualmie River Shallow Aquifer, which flows to the north below the north end of the Mill site and eventually merges with the Tokul Creek Delta Aquifer. Since the stormwater management plan will be designed to maintain hydrology to the on-site wetlands and other surface water features, recharge to the Snoqualmie River Shallow Aquifer will not be significantly impacted, and therefore, recharge to the Tokul Creek Delta from the shallow aquifer will not be significantly impacted due to site development.

Potential impacts to the Tokul Creek Delta Aquifer for Alternative 1 would remain substantially unchanged from the Proposed Action. Under the No Action Alternative, no significant reduction in recharge to the Tokul Creek Delta Aquifer would be expected.

Snoqualmie River Shallow Aquifer

The Snoqualmie River Shallow Aquifer is located within the present-day Snoqualmie River valley, including the Mill site. The Snoqualmie River Shallow Aquifer generally consists of fine to medium sand with gravel deposited in channel and near-channel environments of a meandering river system. Recharge to the Snoqualmie River Shallow Aquifer occurs from upvalley aquifer sources and direct precipitation within the valley, including on the Mill site.

Development in general could potentially reduce recharge to the Snoqualmie River Shallow Aquifer underlying the site if stormwater runoff was conveyed directly into off-site streams or the Snoqualmie River, which would quickly transport the water downstream away from the site. However, as described previously, since the stormwater management plan will be designed to maintain hydrology to the on-site wetlands and other surface water features, recharge to the Snoqualmie River Shallow Aquifer will not be significantly impacted by development onsite.

Potential impacts to the Snoqualmie River Shallow Aquifer for Alternative 1 would remain substantially unchanged from the Proposed Action. Under the No Action Alternative, no significant reduction in recharge to the Snoqualmie River Shallow Aquifer would be expected.

Interflow

As described under "Groundwater" in Section 1.2.4 an interflow network is present at shallow depths in areas underlain by lodgement till, including the slopes just east of the Mill site. Since development on these slopes is not part of the Proposed Action or Alternative 1, we do not anticipate adverse impacts to shallow interflow.

1.3.2 Geologic Hazard Impacts

<u>Erosion Hazard Impacts</u>

The most significant increase in erosion hazard potential onsite will be during construction. Clearing and grading activities during construction will increase erosion potential onsite through the removal of vegetation and by exposing soil directly to precipitation and runoff. Exposed soil will be subject to erosion and sediment transport. Nearby surface water features that could be adversely impacted by increased sedimentation include on-site wetlands and streams, the Mill Pond, and the Snoqualmie River. Post-construction (developed) conditions impacts should be similar to existing conditions, since exposed surfaces would be covered with structures, roadways, or new plantings.

The stormwater management plan for the Mill site proposes to discharge to the Snoqualmie River. Stormwater runoff from the western side of the site will be conveyed through storm pipes to a broad surface swale that will be constructed along a portion of the new SE Mill Pond Road. The stormwater will be conveyed as surface water flow through the swale to the Ordinary High Water Mark (OHWM) elevation of the river. Stormwater runoff from the eastern side of the site will be conveyed to the river through the existing system of on- and off-site wetlands.

Potential adverse impacts include erosion along the swale or along the system of wetlands and streams if significant flows are routed to these features or if the base or side slopes are not properly protected with vegetation or constructed of stable material.

Potential erosion hazards for Alternative 1 would remain substantially unchanged from the Proposed Action. Under the No Action Alternative, there would be no potential erosion hazards related to the surface swale since there would no direct discharge to the river.

Landslide and Steep Slope Hazard Impacts

The existing landslide and steep slope hazards onsite could be adversely impacted from three primary activities during development. These include clearing, grading (earthwork), and stormwater management.

Clearing could increase the existing landslide hazard potential by removing vegetation which would normally intercept some of the rainfall, resulting in higher runoff volumes. Grading (earthwork) activities could increase the existing landslide hazard potential. Fill material placed on or adjacent to a steep slope will increase the driving forces acting in the subsurface, which would increase the risk of slope failures. Surface drainage patterns are typically altered by grading. If the new drainage pattern results in an increase in either surface or subsurface water flow on or near a slope, landslides could occur.

Non-structural fills could fail due to inadequate compactive effort, use of organic soils, improper site preparation, oversteepened slopes, or other factors. Cut slopes could also fail if they are oversteepened, toe support is removed, or drainage is improperly directed.

Potential landslide and steep slope hazards for Alternative 1 would remain substantially unchanged from the Proposed Action. Since most of the steep slope areas are located just offsite, potential landslide and steep slope hazards under the No Action Alternative would remain substantially unchanged from either the Proposed Action or Alternative 1, with the exception of the wood waste pile in Planning Area 3 which would remain in-place under the No Action Alternative. Under the Proposed Action and Alternative 1 the wood waste pile would eventually be removed to allow development in Planning Area 3.

Seismic Hazard Impacts

Liquefaction

The subject site is underlain by alluvial sediments that are potentially susceptible to liquefaction during an earthquake. To assess the liquefaction risk, we performed a liquefaction analysis for this site in accordance with guidelines published in Seed & Idriss, 1982; Seed et al., 1985; and Kramer, 1996. Our liquefaction analysis was completed with the aid of LiquefyPro computer software Version 5.8h (2009) by CivilTech Corporation. This program accepts input for cone penetrometer test (CPT) data, groundwater levels, soil unit weight, and the depth and grain-size distribution of the sediments of concern to calculate seismically induced settlement. The liquefaction analysis was conducted based on the subsurface conditions encountered in the CPTs advanced at the site.

Based on liquefaction analysis utilizing soil data from CPT-01, CPT-02a, and groundwater data from boring EB-1, the subsurface conditions encountered at the site are predicted to experience liquefaction during a design-level seismic event. Liquefiable sediments were identified at depths continuing from 25 to 70 feet below ground surface, and the liquefaction-induced settlement calculated for the site ranges from about 2 to 8 inches over this depth range.

Lateral Spreading

Lateral spreading is a hazard on sites where liquefaction-prone material is located near exposed slopes. In the case of the Mill site, this includes areas near the banks of the Snoqualmie River. The liquefied soil layers and non-liquefiable overburden may spread horizontally toward the water due to the reduction of soil strength and lack of confinement on the water side. We performed a preliminary lateral spread analysis based on methods presented by Youd et al. (2002). The potential lateral displacement in Planning Area 1 was calculated at a distance of 100 to 150 feet from the Snoqualmie River. Our analysis indicates that the magnitude of lateral spread could be on the order of 1 to 2 feet towards the shoreline for a design seismic event. Additional analyses will be necessary when development plans are formalized and more subsurface information is available.

Earthquake-Induced Landslide Hazards

The site includes slopes near the east edge of the parcel underlain at shallow depths by glacially consolidated sediments, based on geologic mapping (Dragovich et al., 2009b), that tend to be resistant to slope failures during a seismic event. These slopes are offsite; however, landslide activity on the slopes could impact site development near the toe of the slope. Development near the east slopes may warrant a quantitative assessment of slope stability during a seismic event, though the risks of such slope failures are interpreted to be low due to the very dense nature of the glacially consolidated sediments. These slopes are along the eastern boundary of Planning Areas 2 and 3, which are analyzed at a programmatic level in the EIS; and therefore, planned development in this area is very preliminary. Later in the design process, once a development concept has been formulated, the geotechnical engineer for the project should review the site plans to determine whether a quantitative assessment of slope stability on the eastern part of the site is warranted.

The existing wood waste pile at the north end of Planning Area 3 is large and has tall and relatively steep side slopes. At this time, development in Planning Area 1 is not planned in close proximity to the wood waste pile. We understand that the wood waste pile will be removed during the development in Planning Area 3; therefore, no adverse impacts are anticipated in relation to the wood waste pile.

Future development along the bank of the Snoqualmie River and shoreline of the Mill Pond could be at-risk from landslide activity along the river bank or shoreline during a strong seismic event. Very limited subsurface information is available in these two areas and bathymetry of both water bodies is limited. Development in Planning Area 1 would be accessed using SE Mill Pond Road which parallels the northern river bank and could be impacted by earthquake-induced landslide activity.

SE Mill Pond Road

During development of Planning Area 1, the portion of the road immediately adjacent to the site entry will be moved slightly to the northeast to accommodate the construction of a new roundabout. Southeast of the proposed western site entry, SE Mill Pond Road will remain in its existing location along the banks of the river. Eventually, during development of Planning Areas 2 and 3, this southeastern portion of SE Mill Pond Road will be realigned farther to the north in a general east-west direction, as shown on Figure 2. As described above, the existing alignment of SE Mill Pond Road is susceptible to damage due to earthquake-induced landslide activity where it lies adjacent to the banks of the Snoqualmie River or the Mill Pond.

Surface Ground Rupture

Ground rupture occurs as offsets of the ground surface and is limited to the immediate area of the fault. As described previously, a strand of the Rattlesnake Mountain Fault Zone (RMF) (RMF-8) and the Snoqualmie Valley Fault may cross through the Mill site, based on recent geologic mapping (Dragovich et al., 2009b). There is no evidence that these are active faults in the vicinity of the Mill site. Movement along these hypothesized faults do not appear to disturb Holocene-age sediments, suggesting that, if they exist, they have not been active for the last 10,000 years. No evidence of surface faults or associated ground ruptures was observed on the Mill site. The nearest known fault to the project site that may be active is the main strand of the RMF (RMF-1), which is located approximately 1 mile west of the Mill site based on regional mapping (Dragovich, 2009b). Studies of the RMF Zone indicate that RMF-1 may be an active fault capable of generating surface ruptures, although the recurrence interval of movements along the fault is unknown. It is our opinion, based on existing geologic data, that the risk of surface rupture impacting the Mill site is low.

Ground Motion

Structural design for the project under all of the alternatives should follow *International Building Code* (IBC) standards. As of the writing of this report, the currently adopted version of the IBC by the City of Snoqualmie is the 2015 edition. The 2015 IBC defines Site Classification by reference to Table 20.3.-1 of the *American Society of Civil Engineers* Publication ASCE 7, the current version of which is ASCE 7-16. In our opinion, the subsurface conditions at the site are consistent with a Site Classification of “E” or “F” as defined in the referenced documents depending upon local site conditions.

Seismic Hazard Impacts - Alternatives

Potential seismic hazards for Alternative 1 would remain substantially unchanged from the Proposed Action. Under the No Action Alternative the existing historic Mill site structures would remain, which are susceptible liquefaction, lateral spreading, and ground motion hazards. Under the No Action Alternative, the wood waste pile would likely remain, which is potentially susceptible to earthquake-induced landslide activity under current conditions.

<u>Flood Hazard Impacts</u>

As stated in the “Affected Environment” section of this report, most of the Mill site is within the 100-year floodplain shown on the FEMA Flood Insurance Rate Map of Snoqualmie, below the BFE. Potential adverse impacts from flood hazards could be created by proposed site development due to filling portions of the site within the floodplain of the Snoqualmie River, including raising various site areas, roads, and building pads above the delineated BFE.

Compliance with flood hazard regulations, as defined in the *Snoqualmie Municipal Code* (SMC) Sections 15.12 and 19.12.150, requires an analysis demonstrating that the proposed development will not increase flood levels during the occurrence of the base flood discharge. Watershed Science and Engineering (WSE) prepared a “No Net Rise Hydraulic Analysis” for the Mill site (WSE, 2018). The WSE report is described under Section 1.4 “Proposed Mitigations.”

Potential flood hazards for Alternative 1 would remain substantially unchanged from the Proposed Action. Under the No Action Alternative there would be no site grading within the floodplain; therefore, flood hazards would remain unchanged from existing conditions.

<u>Channel Migration Impacts</u>

As described in “Affected Environment” and shown on Figure 14, a section along the southwestern edges of Planning Area 1 and Planning Area 3 are within the Moderate Channel Migration Hazard Area. The majority of Planning Area 1 and the western portion of Planning Area 3 are within a mapped Potential Hazard Area, which represents a lower level of channel migration hazard than the moderate or severe channel migration zones (CMZs). Structures, roadways, or other facilities built within the severe or moderate CMZs may be susceptible to damage due the gradual channel erosion and migration of the Snoqualmie River.

Potential channel migration hazards for Alternative 1 would remain substantially unchanged from the Proposed Action. Under the No Action Alternative there would be no structures built near the Snoqualmie River, so the risk from channel migration would be lower.

Critical Aquifer Recharge Areas (CARA)

This discussion of CARAs is limited to a consideration of potential groundwater quantity (recharge) impacts and does not take into account potential sources of contamination. Probable water quality impacts are not addressed in this technical report. As described under "Affected Environment," portions of the site lie within a delineated Category II CARA, but much of the site has not been classified on the published King County maps. Potential groundwater quantity impact due to site development could include –

1. Gain or loss of groundwater recharge resulting from conversion of undeveloped land (or redevelopment of existing developed areas) into various proposed industrial, commercial, and residential uses; and

2. Impacts to underlying aquifers and downgradient usage as a result of change in recharge.

Potential adverse impacts to aquifers underlying the site are described in detail in their respective sections under "Groundwater" in Section 1.2.4. Potential impacts to CARAs for Alternative 1 would remain substantially unchanged from the Proposed Action. Potential impacts to CARAs under the No Action Alternative would remain similar to the Proposed Action since groundwater recharge under developed conditions will be similar to existing conditions.

1.3.3 Geotechnical Impacts

The Mill site will require mass grading in some areas to achieve desired roadway, parking, and building pad elevations. Preliminary engineering estimates indicate that between 300,000-350,000 cubic yards (cy) of displacement (fill) could occur, and an equal volume of compensating storage will be created to ensure no increase in flooding. Cut and fill quantities are assumed to be similar for the Proposed Action and Alternative 1.

Potential geotechnical impacts could include various construction-related elements, such as: 1) site preparation, 2) structural fill placement, and 3) foundations. Examples of potential adverse impacts could include sloughing of temporary or permanent cut slopes if oversteepened, failure of fill soils due to improper placement and compaction, or excessive foundation settlement if the loose, soft native sediments underlying the site are not mitigated. However, since geotechnical oversight is an integral part of the project design and construction, no adverse impacts are considered likely. "Geotechnical Mitigations" are presented in Section 1.4.3 of this report.

1.4 PROPOSED MITIGATIONS

The following sections discuss recommended mitigations for potential adverse impacts to earth, groundwater, and geologic hazards at the Snoqualmie Mill site (Mill site). Geologic hazards considered include erosion, landslide, seismic, flood, and channel migration hazards and critical aquifer recharge areas (CARAs). A summary of the hazards, potential impacts, and mitigation measures discussed in this report are presented in Tables 1.4-1 and 1.4-2. Proposed mitigation measures, if necessary, are described for each of the identified geologic hazards. The recommended mitigations described in this section apply to both the Proposed Action and Alternative 1, since the proposed development between these alternatives is substantially similar with respect to potential earth and groundwater-related impacts. Under the No Action Alternative, existing site uses would continue indefinitely with no significant additional impacts; therefore, the mitigations described in the following sections would not apply.

1.4.1 Hydrogeologic Mitigations

TABLE 1.4-1
GROUNDWATER
SUMMARY OF IMPACTS AND MITIGATIONS

Hazard	Unmitigated Probable Significant Impacts	Proposed Mitigation Measures Designed into the Proposal	Unavoidable Impacts
Groundwater			
Interflow	• No anticipated on-site interflow.	• None.	• None.
Aquifers	• Change in recharge if all runoff is collected and directly discharged to the Snoqualmie River.	• Stormwater concept will maintain existing flows to on- and off-site streams and wetlands.	• None.
Surface Water			
Streams	• Volume of discharge to streams could be increased due to increased impervious area.	• Discharge of stormwater runoff to streams will be designed to be similar to existing conditions. Additional runoff will be directed to the Snoqualmie River.	• None.
Snoqualmie River	• None. Volume of discharge to the river will be insignificant relative to existing instream flows.	• None.	• None.

Hazard	Unmitigated Probable Significant Impacts	Proposed Mitigation Measures Designed into the Proposal	Unavoidable Impacts
Tokul Creek	• Spring flow from the Tokul Creek Delta Aquifer will not be impacted.	• None.	• None.
Mill Pond	• Reduced flow to the Mill Pond if all site stormwater is discharged directly to river.	• Maintain surface runoff discharges from the site to the wetlands and streams that flow to the Mill Pond.	• None.
Wetlands	• Reduced flow to wetlands if all site stormwater is discharged to river.	• Maintain surface runoff discharges from the site to the wetlands, consistent with existing conditions.	• None.

<u>Surface Water</u>

Under the No Action Alternative, there would be no direct discharge to the Snoqualmie River and discharge to other existing surface water features on- and offsite would remain unchanged; therefore, no mitigation would be required. The mitigations described below apply to both the Proposed Action and Alternative 1.

Snoqualmie River

The Mill site will discharge stormwater runoff directly to the Snoqualmie River. The quantity of discharge will be insignificant relative to the instream flows in the Snoqualmie River. No adverse impacts are anticipated, and no mitigation measures are required.

Tokul Creek

As described under Section 1.3.1, groundwater recharge at the site is not anticipated to be significantly impacted due to site development; and therefore, water levels in the Snoqualmie River Shallow Aquifer and Tokul Creek Delta Aquifer downgradient of the site will also not be significantly impacted.

Since significant impacts to the Tokul Creek Delta Aquifer are not anticipated, spring discharge into Tokul Creek from this aquifer will not be adversely impacted, and no mitigation measures are required.

Mill Pond, Wetlands, and Streams

The stormwater management plan is designed to maintain runoff and hydrology to the on-site wetlands and streams, such that the discharge into the Mill Pond under developed conditions should be similar to existing conditions. No adverse impacts to the Mill Pond, wetlands, and streams are anticipated, and no additional mitigation measures are required.

Groundwater Mitigations

No probable adverse impacts to aquifers were identified in Section 1.3.1, "Hydrogeologic Impacts," and no mitigation measures are required.

1.4.2 Geologic Hazard Mitigations

TABLE 1.4-2
GEOLOGIC HAZARDS
SUMMARY OF IMPACTS AND MITIGATIONS UNDER THE PROPOSED ACTION

Hazard	Probable Significant Impacts	Proposed Mitigation Measures Designed into the Proposal	Unavoidable Impacts
Erosion Hazards	Erosion Zone: Zone 1: Low Zone 2: Slight to Moderate	• Cover exposed soils of areas not actively worked within 48 hours. • Establish and implement erosion and sedimentation control plan utilizing applicable best management practices (BMPs) from the applicable *King County Surface Water Design Manual* (KCSWDM) pertaining to wet season requirements, subject to approval by the Washington State Department of Ecology, for any earthwork construction during the wet season, defined as October 1 to April 30. • Establishment of post-development landscaping. • Direct stormwater into stormwater facilities. • Control runoff and reduce velocities (rock dams, revegetate). • Trap sediments (silt fences, ponds). • Inspections by Certified Erosion and Sediment Control Lead (CESCL) onsite during construction.	• Some short-term soil loss during construction. Stabilized developed conditions similar to pre-developed condition.

Hazard	Probable Significant Impacts	Proposed Mitigation Measures Designed into the Proposal	Unavoidable Impacts
Landslide and Steep Slope Hazards	Zone 1: Low Zone 2: Low to Moderate	• Control cut and fill slope gradients. • Remove log/debris pile prior to development in Planning Area 3. • Site-specific analysis of impacts related to slopes just east of site prior to development in Planning Areas 2 and 3.	• None. No unavoidable impacts due to eastern slopes are anticipated due to the dense nature of the glacially consolidated sediments that comprise the slope.
Seismic Hazards			
Surficial Ground Rupture	• Low	• None recommended. No known active fault.	• None.
Earthquake-Induced Landslide	• Low for majority of site.	• Control cut and fill slope gradients. • Remove log/debris pile prior to development in Planning Area 3.	• None.
SE Mill Pond Road	• Risk of landslide activity along banks adjacent to the Snoqualmie River and Mill Pond.	• Ground improvement techniques along realigned portions of SE Mill Pond Road, such as the installation of stone columns or deep soil mixing. • Existing haul road will provide access onto and off of the site from the east, connecting to 396th Drive SE.	• Existing, unmitigated segments of SE Mill Pond Road adjacent to the Snoqualmie River and Mill Pond are potentially subject to landslide activity during a large seismic event.

Hazard	Probable Significant Impacts	Proposed Mitigation Measures Designed into the Proposal	Unavoidable Impacts
Liquefaction	• High potential risk for alluvium underlying majority of site.	• Support structures on deep foundation systems or using ground improvement techniques.	• Unmitigated segments of SE Mill Pond Road adjacent to the Snoqualmie River and Mill Pond are potentially subject to lateral spread during a large seismic event.
Ground Motion	• Potential risk of structural damage.	• Construct per *International Building Code* standards for the appropriate site class - Site Class "E" or "F" based on site conditions. • Site-specific geotechnical analysis will be required for Site Class "F".	• Non-structural damage anticipated for some large seismic events.
Channel Migration	• Higher risk for moderate to severe channel migration zones.	• Locate structures outside of moderate to severe channel migration zones. • Implement appropriate channel migration protection standards where possible to limit potential impacts to SE Mill Pond Road.	• Risk of erosion over the long term along the banks of the Snoqualmie River.
Flood Hazards	• Possible rise in base flood elevation (BFE) due to new development in floodplain.	• Excavate compensating storage for areas with raised grades. • Zero-rise floodway analysis.	• Risk of large flood inundating proposed developed areas.
Critical Aquifer Recharge Areas	• No significant impact to aquifer recharge.	• None.	• None.

Erosion Hazard Mitigation

The on-site soils are considered susceptible to erosion when exposed to surface water, particularly in a sloping environment. Proper control of surface water runoff will be important in alleviating potential erosion hazards. To mitigate and reduce erosion hazard potential on the site, project planning and construction should follow City of Snoqualmie standards of practice with respect to temporary erosion and sedimentation control (TESC) and management of erosion hazards. Specific best management practices (BMPs) to be implemented during construction will be outlined in the geotechnical engineering reports and the TESC plans for each project element.

The recommendations in the "Erosion Hazard Mitigation" section of this report are consistent with current City of Snoqualmie and the Washington State Department of Ecology (Ecology) standards and are considered industry standard practices. The following mitigations apply under all Alternatives. The recommended erosion control BMPs to be used at the site should include, but not be limited to:

- A TESC plan should be established for the project during the design phase and submitted to the City for approval. The geotechnical engineer should review the grading, erosion, and drainage plans prior to final plan design. An erosion control inspector should be onsite during construction to monitor the performance of proposed mitigation measures, and propose changes as needed.

- Construction activity should be scheduled or phased as much as possible to reduce the amount of earthwork activity that is performed during the winter months. Prior to the wet season, any exposed subgrades should be hydroseeded, covered with plastic sheeting, or otherwise protected. Seeding should take place prior to September so that the grass will be established prior to the wet season.

- TESC measures should be installed prior to any site activity or disturbance.

- Filter fences are temporary structures utilized to trap sediment transported from sheet erosion while allowing some conveyance of water through the filter fabric. Filter fences are not designed for concentrated flows, but are most effective in retaining sediment transported from sheet flow in relatively small catchment areas. Filter fences should be used as a perimeter sediment interception measure, as warranted, adjacent to wetlands, stream and river corridors, open space areas, and other sensitive areas located in or adjacent to construction zones to reduce the risk of sediment transport into these features.

- Source control measures are practices that are used to reduce erosion risks before they occur. These measures typically involve cover practices and drainage control. During the wetter months of the year, or when large storm events are predicted during the summer months, work areas should be stabilized, so the site can receive the rainfall without excessive erosion or sediment transport. The required measures will depend on the time of year and the duration that the area will be left un-worked. During the winter months, areas that are to be left un-worked should be covered with straw or plastic. During the summer months, stabilization may consist of seal-rolling the subgrade. The stabilization should include establishing temporary stormwater conveyance to route runoff to the approved discharge location.

- Surface runoff and discharge should be controlled during and following development. Uncontrolled discharge may promote erosion and sediment transport. Under no circumstances should concentrated discharges be allowed to flow over the top of steep slopes.

- Soils that are to be reused around the site should be stored in such a manner as to reduce erosion from the stockpile. Protective measures may include, but are not limited to, covering with plastic sheeting, the use of low stockpiles in flat areas, and the use of silt fences around pile perimeters.

- All temporary or permanent devices used to collect surface runoff should be directed into tightlined systems or constructed ditch systems that discharge into approved stormwater control facilities, such as detention ponds or dispersion facilities. Permanent water quality ponds or detention ponds may be used as temporary sediment ponds. The permanent detention facilities must be cleaned of all accumulated sediment after the completion of construction activities.

- After construction is complete, disturbed areas should be revegetated as soon as possible. If it is outside of the growing season, the disturbed areas should be covered with mulch or plastic sheeting, as recommended in the erosion control plan.

It is our opinion that with the proper implementation of the TESC plans and by field-adjusting appropriate mitigation elements (BMPs) during construction, the potential adverse impacts from erosion hazards on the project may be mitigated.

Landslide and Steep Slope Hazard Mitigation

It is our opinion that construction of the Mill site will not increase the existing landslide hazard risks, provided the recommendations presented in this report are properly followed. To reduce the potential landslide risks as a result of development, the following mitigation measures should be implemented. The following mitigations apply under all Alternatives.

- Except for the northeastern corner of the site and the wood/debris pile in Planning Area 3, the Mill site is relatively flat, and landslide/steep slope mitigation is not necessary.

- No fill, topsoil, or other debris should be placed on steep slopes. Uncontrolled material placed on steep sloping ground is susceptible to movement. Any fill planned for slopes steeper than 5H:1V (Horizontal:Vertical) elsewhere on the property should be benched into the slope and placed as structural fill. Compaction values and drainage recommendations for structural fill can be provided by the geotechnical engineer once specific grading plans have been determined as part of development applications.

- The wood waste/debris pile at the north end of Planning Area 3 should be removed prior to development in this area.

- To reduce the risk of increasing slope stability hazards as a result of construction, it is recommended that all permanent cut slopes in the natural sediments be graded to a maximum 3H:1V. Cut slopes in fill soils should be no steeper than 3H:1V unless approved by the geotechnical engineer. Where steeper gradients are required, an approved erosion protection structure or retaining structure should be utilized. It should be noted that rockeries are not considered retaining structures but erosion protection devices. Rockeries should not be used in association with unstable soil or non-reinforced, fill soils.

- No surface water should be directed toward or over steep slopes. Stormwater may be tightlined down steep slopes provided the alignment, discharge location, and design are approved by the geotechnical engineer. Currently, such activities are not contemplated.

- Site-specific studies should be completed to analyze potential impacts related to the slopes just east of the site, prior to development in Planning Areas 2 and 3. These slopes are generally underlain by very dense glacially consolidated sediments that are typically resistant to landslide activity; therefore, adverse impacts are not anticipated.

Seismic Hazard Mitigation

Earthquake Induced Landslide Hazards

The off-site slopes near the east edge of the parcel appear to be underlain at shallow depths by glacially consolidated sediments that tend to be resistant to slope failures during a seismic event. In general, we do not anticipate any mitigation will be required; however, depending upon the nature of the planned development near the toe of the steep slopes, a quantitative assessment of slope stability may be warranted. Once a development concept has been formulated, the geotechnical engineer for the project should review the site plans to determine if slope stability modeling is recommended.

No mitigation is required for potential landslide hazards related to the wood waste pile since we understand that it will be removed during the development of Planning Area 3.

SE Mill Pond Road

Future development along the bank of the Snoqualmie River (including the existing SE Mill Pond Road) and shoreline of the Mill Pond, could be at-risk from landslides during a strong seismic event. Limited subsurface information is available in the immediate vicinity of these two surface water features adjacent to the site. Additional subsurface exploration and stability analyses should be completed in the future in this area by the municipal agency responsible for the roadway during the design process. Similarly, subsurface explorations and stability analyses should be completed for future development along the shoreline of the Mill Pond. At both locations, bathymetric surveys should be completed to determine the geometry of the underwater portion of the river bank and lake shoreline.

During development of Planning Area 1, the portion of the road immediately adjacent to the site entry will be moved slightly to the northeast to accommodate the construction of a new roundabout. Later during development of Planning Areas 2 and 3, the portion of SE Mill Pond Road southeast of the site entry will be realigned farther to the north in a general east-west direction, as shown on Figure 2. These realigned areas of the road can be mitigated during their construction. Preliminary slope stability analyses indicate that the risk of river bank failure along the Snoqualmie River can be mitigated as described in the following section.

Slope Stability Analysis

We completed a preliminary static and seismic slope stability analysis for the bank along the Snoqualmie River adjacent to the current SE Mill Pond Road where a future road realignment and roundabout for the Phase 1 development is planned. We interpreted subsurface conditions using the nearest subsurface explorations to the road and river, bathymetry information for the Snoqualmie River completed for a previous study in the vicinity of the site, and river level information from as-built plans for the existing bridge that crosses the Snoqualmie River downstream of the site.

Slope stability analyses were conducted using the computer program Slope/W, Version 2016, by Geoslope International Ltd. The program used Spencer's method for evaluating a rotational failure. Input parameters for the analysis included slope geometry, geology, and groundwater conditions, soil strength parameters, and dynamic (i.e., seismic) conditions. For evaluation of slope stability under dynamic conditions, a peak horizontal ground acceleration (PGA) of 0.26g was used in our analysis. This seismic coefficient is equal to 0.5 times the PGA determined from USGS website https://earthquake.usgs.gov/designmaps/beta/us/. Soil strength parameters used for our analysis were assumed based on laboratory testing of samples obtained from boring EB-1 (2018), typical published values, and our prior experience.

The stability of a slope can be expressed in terms of its factor of safety. The factor of safety is the ratio between the forces that resist sliding to the forces that drive sliding. For example, a factor of safety of 1.0 would indicate a slope where the driving forces and the resisting forces are exactly equal. Increasing factor of safety values greater than 1.0 indicate increased stability. Factors of safety below 1.0 indicate conditions where driving forces exceed resisting forces and slope failure is imminent. Factors of safety of 1.5 and 1.1 are typically considered to be the minimum acceptable values for slope stability under static and seismic conditions, respectively. The slope stability analyses indicate that the minimum factor of safety for the static condition is greater than 1.5, but for seismic conditions the factor of safety is below 1.0. The results of our slope stability analyses are included in Appendix E.

In our opinion, possible mitigation options for consideration to address seismic stability could include the following:

1. Relocation of the new road alignment and roundabout with a setback sufficient that a slope failure will not impact the road. Our stability analysis indicates that a setback of about 70 feet would be necessary from the top of the existing river bank. Review of current plans appears to show the roadway alignment from 80 to 100 feet from the river bank.

2. Installation of structural elements along the roadway edge such as a continuous, large-diameter drilled shaft wall (secant pile wall) to constrain the roadway prism from being undermined by a slope failure. With this option the river bank would be allowed to experience failure during a strong earthquake, but the ground behind the continuous wall would remain in place so that the roadway could remain in service.

3. Use of ground improvement methods such as stone columns or deep soil mixing to strengthen weak native soils presumed to exist beneath the river bank and area adjacent area near the top of the bank. Our analysis indicates that stone columns or deep soil mixing would be needed to depths of about 70 feet below existing roadway elevation and need to extend about 30 feet back from the top of the river bank.

Secondary Site Access

Initially only the areas of roadway immediately adjacent to the western site entry will be realigned during development of Planning Area 1. Other portions of the SE Mill Pond Road adjacent to the Snoqualmie River or Mill Pond will remain in their existing, unmitigated condition and could be impacted by landslides due to a seismic event. In the event that the SE Mill Pond Road is damaged, the existing haul road will provide a secondary route onto and off of the site. The haul road runs east-west along the northern border of Planning Area 1, continues east through Planning Area 2, and then climbs the eastern slope up to 396th Drive SE. The slopes just east of the site are underlain by geologic units that have been glacially consolidated to a very dense condition; therefore, they are much less susceptible to earthquake-induced landslide activity.

Surface Ground Rupture

In general, the risk of surface ground rupture is low at the site. No known active faults are present beneath the site; mitigation measures are not currently required.

Liquefaction

The site contains existing fill, overbank deposits, river channel deposits, and lacustrine sediments, some of which are saturated. Our analysis indicates that these materials are at risk of liquefaction during a design-level seismic event and settlement of liquefaction is estimated to range from 2 to 8 inches. Because we anticipate that any future structures onsite will be supported on deep foundation systems or use ground improvement techniques to mitigate settlement risks, we anticipate that risks of liquefaction-related damage to the new structures will also be mitigated.

Lateral Spreading

Due to the low strength of the existing fill and lacustrine sediments, the lower-lying parts of the site could be susceptible to failure by lateral spreading during a seismic event, even on relatively gently inclined slopes. Our preliminary analysis suggests that structures in Planning Area 1 located near the northern bank of the Snoqualmie River could experience horizontal displacement due to lateral spreading on the order of 1 to 2 feet. Because we anticipate that any future structures onsite will be supported on deep foundation systems or use ground improvement techniques to mitigate settlement risks, we anticipate that risks of damage to the new structures resulting from lateral spreading will also be mitigated.

Ground Motion

Structural design for the project under all of the Alternatives should follow 2015 *International Building Code* (IBC) standards. The 2015 IBC defines Site Classification by reference to Table 20.3.-1 of the *American Society of Civil Engineers* Publication ASCE 7, the current version of which is ASCE 7-16. In our opinion, the subsurface conditions at the site are consistent with a Site Classification of “E” or “F” as defined in the referenced documents depending upon local site conditions. Sites that are classified as Site Class “F” require a site-specific evaluation of ground motion.

There is an unavoidable adverse impact related to a large seismic event causing some non-structural damage to buildings onsite.

Flood Hazard Mitigation

Mitigating flood hazards at the site will involve compliance with applicable flood hazard regulations developed by the City and Federal Emergency Management Agency (FEMA). The Proposed Action and Alternative 1 will involve raising site grades for various site areas, roads, and building pads above the mapped base flood elevation (BFE). In order to mitigate potential adverse impacts that would raise the BFE, grades will be lowered in other areas to create compensating flood storage. Compensating flood storage is assumed to be available between BFE and the seasonal high groundwater level in the shallow aquifer. Based on groundwater level monitoring at the site, the seasonal high groundwater level in the Snoqualmie River Shallow Aquifer is about 418 feet elevation at the location of EB-4.

A hydraulic model was developed by Watershed Science and Engineering (WSE) in order to verify that the proposed site grading and compensating storage will not result in an increase in flood levels during the occurrence of the base flood discharge (WSE, 2018). The model was used to simulate surface water elevations from a 100-year flood event under both pre-development and post-development conditions. No rise in the floodwater surface elevation was predicted for the proposed grading conditions model as compared to the existing conditions model.

The hydraulic model was also used to assess potential impacts downstream of the site (WSE, 2018). The downstream model extended from upstream of the confluence of the South Fork Snoqualmie River at its upstream end to approximately NE 124th Street in Duvall at its downstream end. The results indicate that there will be no increase in downstream flooding. The model predicted that the proposed grading conditions at the Mill site will lower the water surface elevations by approximately 0.01 feet at three of the five locations considered.

Based on the hydraulic modeling, the proposed grading plan and compensating storage will provide suitable mitigation for flood hazard impacts related to a potential rise in the BFE. There is an unavoidable potential adverse impact related to very large flood events (greater than 100-year) that could inundate the proposed development.

Channel Migration

Potential adverse impacts due to channel migration will be mitigated by following the development standards described in *Snoqualmie Municipal Code* (SMC) 19.12.140, which regulates channel migration and associated erosion hazard zones. Except for SE Mill Pond Road, no structures will be built within the mapped moderate or severe channel migration zones (CMZs) as required by the SMC. The proposed relocation of the SE Mill Pond Road at the entrance onto the site is located within a moderate CMZ. Per SMC 19.12.140(C), transportation structures (such as roads) are allowed in moderate and severe CMZs when no other feasible alternative exists. Project planning should incorporate appropriate channel migration protection standards where possible to limit potential impacts to the roadway. There is an unavoidable potential adverse impact to proposed site structures due to the long-term erosion and channel migration of the Snoqualmie River.

Critical Aquifer Recharge Areas (CARAs)

Potential impacts and recommended mitigation measures related to CARAs in this technical report are limited to a consideration of groundwater quantity. As described under "Groundwater Impacts," on-site recharge will be maintained near existing levels. Since groundwater recharge under developed conditions is expected to be similar to existing conditions, no potential adverse impacts to groundwater quantity have been identified and no mitigation is required.

1.4.3 Geotechnical Mitigations

Introduction

The exploration and analysis completed for the Mill site indicates, from a geotechnical standpoint, the site is suitable for the proposed development provided the mitigation recommendations contained herein are properly followed. As with any large-scale project, detailed geotechnical review must be performed throughout the design phase and construction process to verify that geotechnical issues/considerations have been adequately understood and the recommendations properly implemented. Site-specific geotechnical engineering recommendations must be provided as development plans and construction methods are determined. The geotechnical recommendations presented in this section are preliminary and subject to revision as project designs evolve.

The majority of the site is underlain by existing fill that is of variable composition but typically contains substantial wood waste. The existing fill is underlain by low-strength overbank and lacustrine sediments. These subsurface conditions pose geotechnical challenges to construction at the site. The existing fill, overbank, and lacustrine sediments are prone to consolidation under foundation loads, and are therefore not suitable to support conventional shallow foundations. Liquefaction that may occur in subsurface materials during a seismic event may also present a risk of settlement to future site improvements. Lateral spreading that may occur during a seismic event may create unacceptable horizontal and vertical displacements in locations of future structures near the shorelines of the Snoqualmie River and the Mill Pond.

The following are geotechnical design elements that should be considered in the future development planning process to mitigate settlement and risks from liquefaction and lateral spreading:

- The site development plan should be done in a way that does not increase loads on weak subsurface materials, if possible.

- Final site ground surface elevations should be kept at or below existing site grades, if possible. If final grades must be raised substantially, the weight of the new fill is likely to induce settlement in weak subsurface soils and to result in the risk of long-term settlement of the new fill along with any new structures, buried utilities, and paving in the areas that are founded directly on new fill. Mitigations that could be used to reduce the potential for settlement beneath newly filled areas could include removal and replacement of the old fill, preloading of the old fill, or support of structures upon deep foundations or other ground improvement methods.

- New structures, including buildings, substantial retaining walls, and similar structures with significant foundation loads, will require deep foundations or possibly deep ground improvement approaches. The site conditions will pose challenges to these foundation support approaches.

- New floor slabs will also need to be supported on deep foundations or areas of deep ground improvement.

- New paving will require remedial preparation of the existing fill. Remedial preparation is likely to include placement of a geogrid or geotextile material in conjunction with a layer of sand and gravel or crushed rock fill. The purpose of this layer is to make the expected settlement of the paving more uniform. Settlement of paved surfaces will occur, and will require periodic maintenance that is more frequent and more extensive than is typical for sites that are not underlain by weak subsurface materials.

- New buried utilities, particularly those that are sensitive to grade changes such as gravity sewers, should be supported on a layer of new structural fill similar to that which will be used below paving. The incorporation of a layer of new fill below planned utilities will reduce but not eliminate the risk of future differential settlement and associated repairs.

The geotechnical mitigation recommendations provided herein are consistent with the "Updated Subsurface Exploration, Geologic Hazards, and Preliminary Geotechnical Engineering Report" by AESI (2012).

<u>Site Preparation</u>

Existing buildings, foundations, buried utilities, vegetation, topsoil, and any other deleterious materials should be removed where they are located below planned construction areas. Where existing wells are not compatible with future site development plans, they should be decommissioned in accordance with *Washington Administrative Code* (WAC) Section 173-160 by a Washington State licensed well driller. All disturbed soils resulting from demolition activities should be removed to expose underlying undisturbed native sediments and replaced with structural fill, as needed. All excavations below final grade made for demolition activities should be backfilled, as needed, with structural fill. Erosion and surface water control should be established around the clearing limits to satisfy local requirements.

Once demolition has been completed, existing fill should be addressed. Addressing existing fill may employ various strategies depending on the nature of the project that is proposed. For building pads where foundation and floor loads will be supported on deep foundation or ground improvement systems, most of the existing fill will likely be left in place, and a construction working surface would be constructed. Paving areas would likely be prepared by removing and reworking or replacing 2 feet of existing fill. Buried utility areas would likely be prepared by excavating 2 feet of the existing fill below the planned pipe bedding elevation and replacing the overexcavated material with new structural fill.

Site Drainage and Surface Water Control: The site is subject to flooding by the Snoqualmie River. Flood risks and potential regulatory requirements related to development in potentially flood-prone areas should be reviewed. The site should be graded to prevent water from ponding in construction areas and/or flowing into excavations. Exposed grades should be crowned, sloped, and smooth-drum rolled at the end of each day to facilitate drainage. Accumulated water must be removed from subgrades and work areas immediately prior to performing further work in the area.

Groundwater Control: The Snoqualmie River Shallow Aquifer seasonal high groundwater elevation has been measured to be about 418 feet. Groundwater is expected to be encountered less than 5 to 10 feet below ground surface across most of the site and is likely to be encountered in excavations completed during construction. If significant groundwater is encountered, dewatering in advance of excavation and/or shoring may be required for deep excavations.

Subgrade Protection and Compaction: To the extent that it is possible, the existing gravel surfacing should be used for construction staging. If building construction will proceed during the winter, a working surface of sand and gravel, crushed rock, or quarry spalls should be used to protect the building pad and any other exposed soils, particularly in areas supporting concentrated equipment traffic. Subgrade conditions are expected to be soft and silty, and a geotextile separation fabric such as Mirafi 500X, should be used between the subgrade and the new fill. For building pads where floor slabs and foundation construction will be completed in the winter, a similar working surface should be used. Construction of working surfaces from advancing fill pads could be used to avoid directly exposing the subgrade soils to vehicular traffic.

Following demolition, site stripping, and planned excavation, the stripped subgrade within the building and pavement areas should be proof-rolled with a fully loaded dump truck to identify any soft or yielding areas. Any soft/loose, yielding, or organic soils should be removed to a stable subgrade, if possible. The subgrade should then be scarified, adjusted in moisture content, and recompacted to the required density. All soft or yielding soils should be overexcavated to the satisfaction of the geotechnical engineer and replaced with structural fill, as needed or treated with an admixture such as cement. If the subgrade sediments are soft and cannot be recompacted to a firm and unyielding condition, a section of crushed rock underlain by engineering/stabilization fabric (such as Mirafi 500X or equivalent) may be required to provide a stable base. We recommend at least 2 feet of crushed rock be placed over the fabric; however, due to the variable nature of the on-site sediments, this thickness may need to be adjusted in the field depending upon performance.

Most of the on-site soils, contain a high percentage of fine-grained material which makes them moisture-sensitive and subject to disturbance when wet. The contractor must use care during site preparation and excavation operations so that the underlying soils are not softened. If disturbance occurs, the softened soils should be removed and the area brought to grade with structural fill. Consideration should be given to protecting access and staging areas with an appropriate section of crushed rock.

If crushed rock is used for the access and staging areas, it should be underlain by engineering separation/stabilization fabric, such as Mirafi 500X, to reduce the potential of fine-grained materials pumping up through the rock and turning the area to mud. We generally recommend that at least 2 feet of crushed rock be placed over the fabric; however, due to the variable nature of the near-surface soils and differences in wheel loads, this thickness may have to be adjusted by the contractor in the field.

Temporary and Permanent Slopes: Stable temporary slopes should be the responsibility of the contractor and should be determined during construction. For estimating purposes, however, temporary, unsupported cut slopes in unsaturated existing fill and native sediments can be made at a maximum slope of 1.5H:1V. Below the shallow groundwater level, excavations will need to be shored, dewatering may be required, and/or cut slopes will need to be significantly flatter than 1.5H:1V. Permanent cut slope angles must be determined once the project design is available. As is typical with earthwork operations, some sloughing and raveling may occur and cut slopes may have to be adjusted in the field. In addition, WISHA/OSHA regulations should be followed at all times.

Structural Fill

Structural fill will be necessary to establish desired grades in some areas onsite. All references to structural fill in this report assume that proper attention will be given to subgrade preparation, fill type, placement, and compaction of materials, as discussed in this section. Percent compaction in other applications, such as wall backfill, could be different than the values reported in this section and must be evaluated by the geotechnical engineer, as appropriate. The compaction specifications identified for specific applications should be used as described.

Subgrade Preparation: After overexcavation/stripping has been performed to the satisfaction of the geotechnical engineer/engineering geologist, the upper 12 inches of exposed ground should be recompacted to a firm and unyielding condition, as determined by the geotechnical representative. The condition of all subgrades should be verified by a geotechnical representative before fill placement begins. If the subgrade contains too much moisture, adequate recompaction could be difficult or impossible to obtain, and should probably not be attempted. As described in "*Subgrade Protection and Compaction,*" soft areas may need to be underlain by a section of crushed rock underlain by engineering/stabilization fabric to provide a stable base. After compaction of the exposed ground is tested and approved, or a free-draining rock course is laid, structural fill could be placed to attain desired grades.

Soil Moisture Considerations: The suitability of soils used for structural fill depends primarily on their grain-size distribution and moisture content when they are placed. Soils in which the amount of fine-grained material (smaller than the No. 200 sieve) is greater than approximately 5 percent (by weight as measured on the minus No. 4 sieve size) should be considered moisture-sensitive. Generally, these materials cannot be consistently compacted to a specified structural fill density when the moisture content is more than 2 percentage points above or below optimum. Use of moisture-sensitive soil in structural fills should be limited to favorable dry weather conditions. Much of the on-site soils contained significant amounts of silt and are considered moisture-sensitive.

Structural Fill Materials and Placement: Structural fill is defined as non-organic soil, acceptable to the geotechnical engineer, placed in horizontal loose lifts with a maximum thickness of 12 inches. Each lift should be compacted by mechanical methods to at least 95 percent of the maximum density, using the modified Proctor test (*American Society for Testing and Materials* [ASTM] D-1557) as the reference standard. Proposed fill soils must be evaluated by the geotechnical engineer prior to their use in fills. This would require that a Proctor test be performed on a sample of the proposed fill material in advance of its placement onsite to determine its field compaction standard.

The existing fill soils present onsite were highly variable, ranging from quarry spall and granular fill to materials that contained significant amounts of organic material, demolition waste and silt and are considered highly moisture-sensitive. In our opinion, these soils are not suitable for reuse as structural fill. Non-organic on-site soils free of demolition waste and other deleterious materials may be reused in structural fill applications if moisture conditions can be achieved that allow compaction to a firm and unyielding condition and to the specified minimum density for the application where they are used. If fill is placed during wet weather or if proper compaction cannot be obtained, a select import material consisting of a clean, free-draining gravel and/or sand should be used. Free-draining fill consists of non-organic soil with the amount of fine-grained material limited to 5 percent by weight when measured on the minus No. 4 sieve fraction with at least 25 percent retained on the No. 4 sieve. Organic-rich soils are not suitable as structural fill under any circumstances. Soils used for structural fill should not contain any organic matter, debris, environmental contaminants, or individual particles greater than about 6 inches in diameter.

The geotechnical engineer's representative must observe the stripped subgrade and be present during placement of structural fill to monitor the work and perform a representative number of in-place density tests. In this way, the adequacy of the earthwork could be evaluated as filling progresses and any problem areas may be corrected at that time.

Foundations

Due to the presence of deep, soft native soils and potential for the loose to medium dense granular layers to liquefy during a strong seismic event, foundation and floor slab loads for new structures should be supported either by deep foundation systems or a deep ground improvement system. Since a consistently dense layer of subsurface materials does not exist within accessible depths for foundation piles or common ground improvement techniques, foundation elements with substantial end-bearing capacity appear unlikely. Deep foundation elements that rely on friction along the pile shaft, or ground improvement techniques such as stone columns or compacted aggregate piers that are completed above remaining underlying weak sediments should be considered, depending on structural support requirements and location-specific subsurface conditions. Existing fill soils were observed to contain wood waste, logs, rock fills, and metal debris, which will make it difficult to install deep foundations or to use ground improvement tools using driven or drilled methods. It may be necessary to remove obstacles to foundation construction or to relocate deep foundation elements to avoid obstacles. The existing fill soils are expected to include wood waste and rock fills, which can allow cement grout to escape during construction of deep foundation elements. This may limit the available deep foundation approaches that could be considered and may make it more difficult to install deep foundation systems that are selected.

Spread footings may be used for building support when founded directly on existing fill and native soils that have been mitigated using ground improvement techniques, such as stone columns. No footing should be founded in or above loose, organic, or existing uncontrolled fill soils. Allowable foundation soil bearing pressures can be determined once detailed project plans are available.

It should be noted that the area bounded by lines extending downward at 1H:1V from any footing must not intersect another footing or intersect a filled area that has not been compacted to at least 95 percent of ASTM D-1557. In addition, a 1.5H:1V line extending down from any footing must not daylight because sloughing or raveling could eventually undermine the footing. Thus, footings should not be placed near the edge of steps or cuts in the bearing soils.

Disturbed soil not removed from footing excavations prior to footing placement could result in increased settlements. All footing areas should be inspected by the geotechnical engineer prior to placing concrete to verify that the design bearing capacity of the soils has been attained and that construction conforms with the geotechnical recommendations. Perimeter footing drains should be provided as recommended by the geotechnical engineer.

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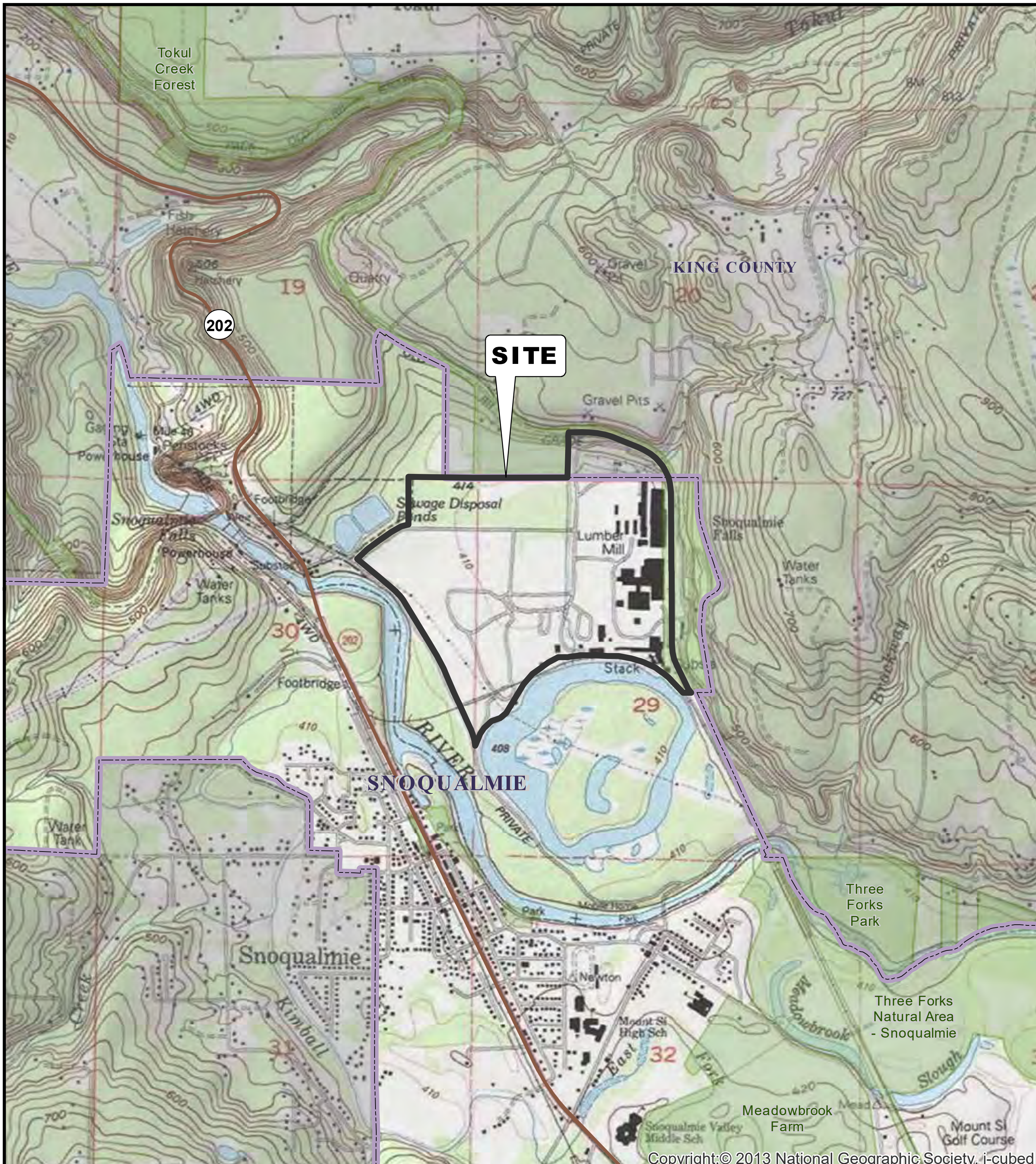

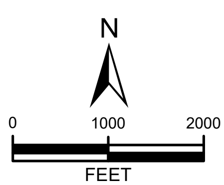

DATA SOURCES / REFERENCES:
USGS: 7.5' SERIES TOPOGRAPHIC MAPS, ESRI/I-CUBED/NGS 2013
KING CO: STREETS, PARCELS, CITY LIMITS 1/18

LOCATIONS AND DISTANCES SHOWN ARE APPROXIMATE

NOTE: BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION

associated earth sciences incorporated

VICINITY MAP

SNOQUALMIE MILL SITE
SNOQUALMIE, WASHINGTON

PROJ NO.	DATE:	FIGURE:
120126H012	4/18	1

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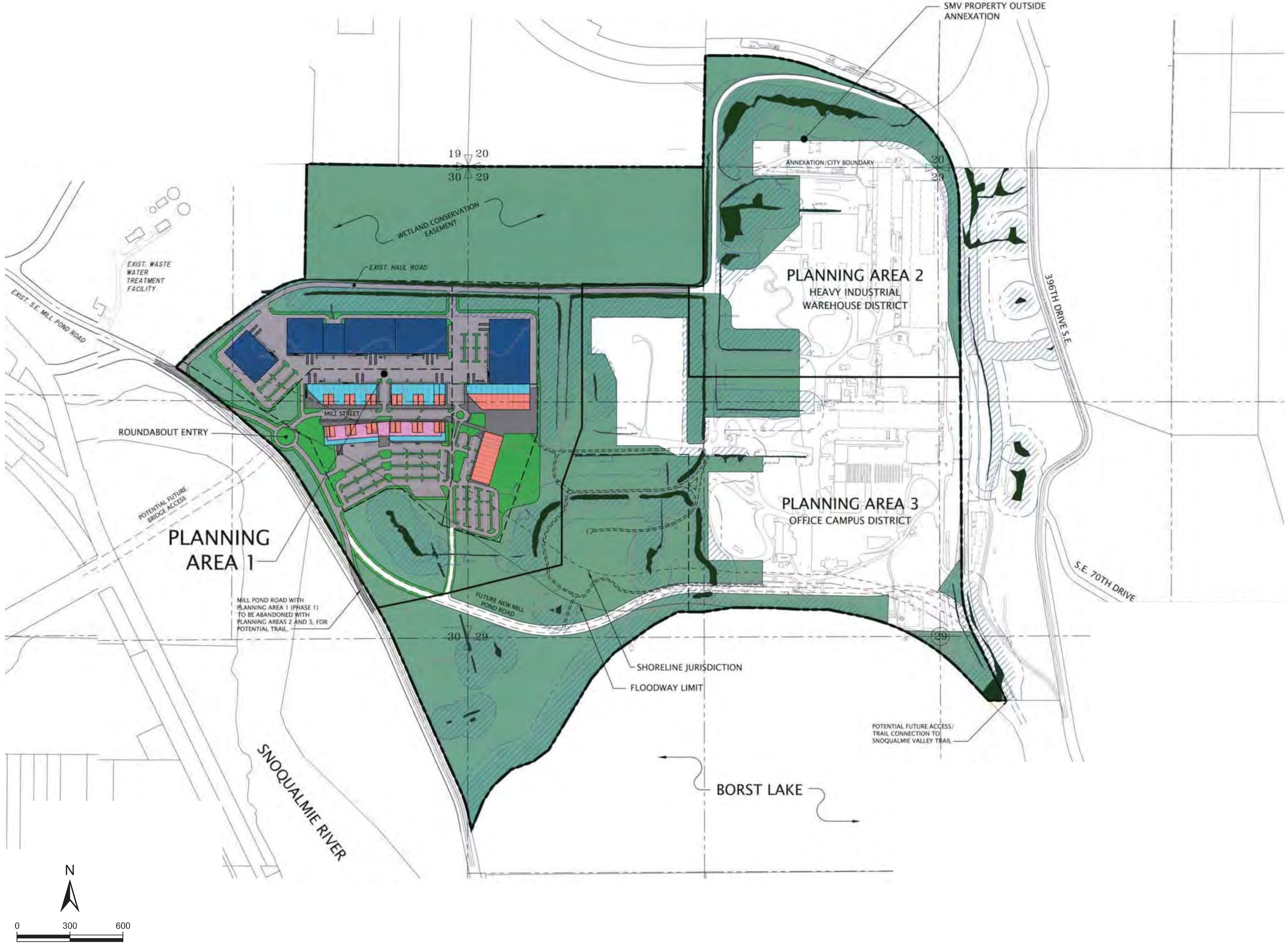

LEGEND:

- RETAIL
- HEAVY INDUSTRIAL
- LIGHT INDUSTRIAL
- RESIDENTIAL
- ROADS / PARKING
- PEDESTRIAN HARDSCAPE / SIDEWALK
- LANDSCAPE AREAS (GREENS, COMMONS, PUBLIC ASSEMBLY AREAS, TRAILS, GENERAL LANDSCAPE AREAS)
- OPEN SPACE: NATURAL AREAS (SENSITIVE AREAS, STORMWATER MANAGEMENT, FLOODPLAIN MANAGEMENT GRADED REVEGETATED BUFFERS)
- WETLAND / STREAM
- EXISTING CONDITIONS FUNCTIONAL BUFFER
- PROPERTY BOUNDARY
- PLANNING AREA BOUNDARY
- LLA PARCEL BOUNDARY
- PROPOSED TRAIL SYSTEM
- EXISTING BUILDINGS

CONTOUR INTERVAL = N/A

NOTE: LOCATION AND DISTANCES SHOWN ARE APPROXIMATE.

NOTES:
1. BASE MAP REFERENCE: GOLDSMITH, SNOQUALMIE MILL, OVERALL SITE PLAN, SHEET SP-1, 3/22/17 AND GOLDSMITH, SNOQUALMIE MILL, SITE PLAN-PLANNING AREA 1, SHEET SP-1, 6/8/18

associated earth sciences incorporated

SITE PLAN

SNOQUALMIE MILL SITE
SNOQUALMIE, WASHINGTON

PROJ NO.	DATE:	FIGURE:
120126H012	3/18	2

LEGEND:

- WATER SUPPLY WELL, AESI LABEL FOR WELL REPORT
- MONITORING WELL, AESI LABEL FOR WELL LOG

AESI PROJECT NAME

- MILL SITE
- TOKUL WATER RIGHTS
- SOUTH WELL FIELD
- NORTH WELL FIELD
- WASTEWATER TREATMENT PLANT
- SNOQUALMIE CASINO SEWER
- SHALLOW AQUIFER
- SAND AND GRAVEL / BEDROCK MINING
- CROSS SECTION
- CITY BOUNDARY
- CONTOUR 100 FT
- CONTOUR 20 FT

NOTE: MUCH OF MILL SITE IS AT ELEVATION 415 - 425'
NO WELL REPORTS AVAILABLE FOR 61 - 66

DATA SOURCES / REFERENCES:
PSLC 2016 KING CO., DELIVERY 4 FLOWN
3/26/16 - 8/27/16, GRID CELL SIZE IS 3'. CONTOURS FROM LIDAR
PSLC: CEDAR RIVER WATERSHED 2014
DELIVERY2 = CEDAR RIVER/LAKE, JULY 2014.
WA STATE PLANE NORTH (FIPS 4601), NAD83(HARN)
NAVD88 GEOID03 (GEOID03), US SURVEY FEET
LIDAR PROJECTS MOSAICED USING BLEND IN OVERLAP
KING CO: PARCELS, STREETS, HYDRO 1/18
LOCATIONS AND DISTANCES SHOWN ARE APPROXIMATE

BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION

associated earth sciences incorporated

WELL LOCATIONS

SNOQUALMIE MILL SITE
SNOQUALMIE, WASHINGTON

PROJ NO.	DATE:	FIGURE:
120126H012	4/18	3

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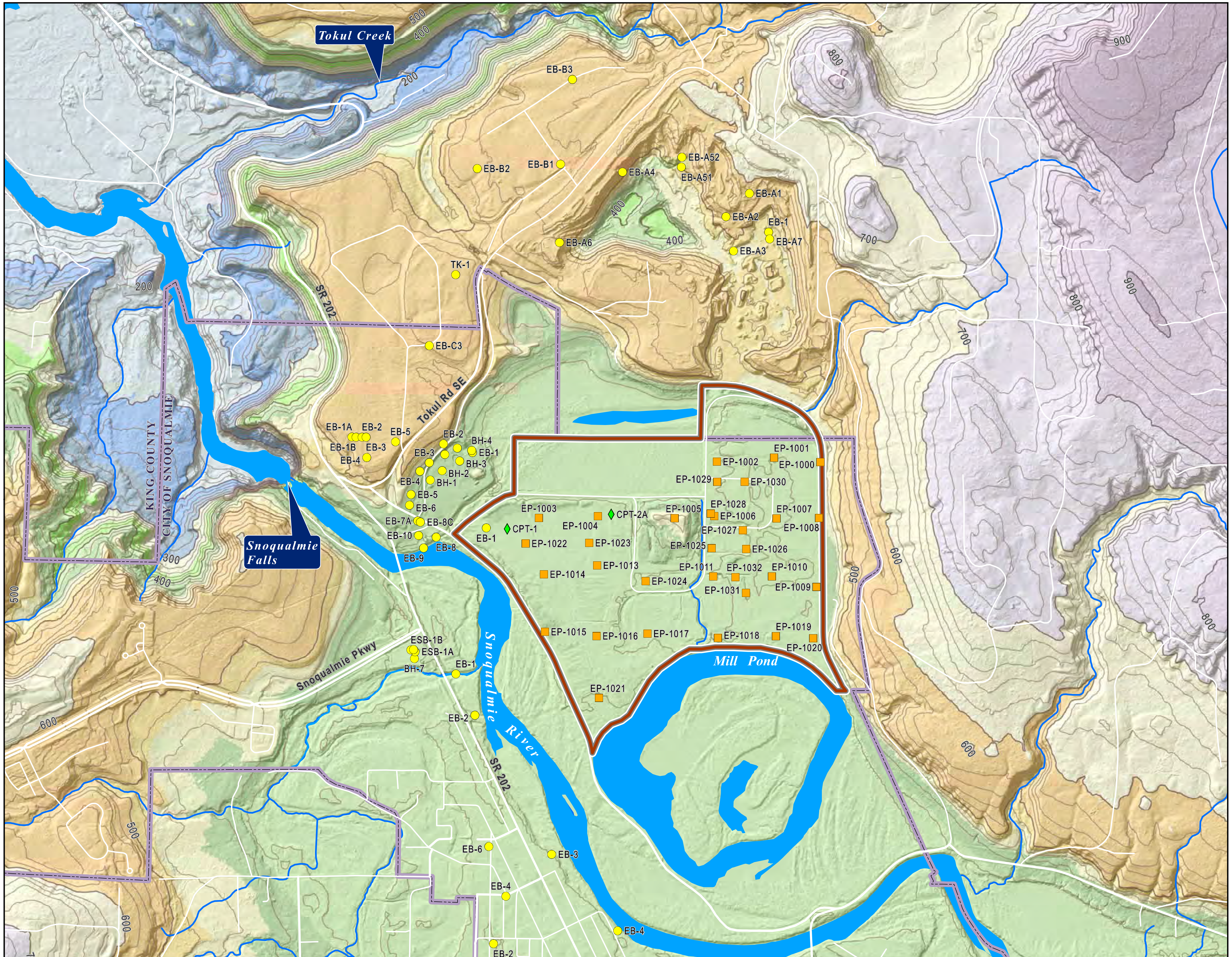

LEGEND:

- SITE
- EXPLORATION BORING
- CONE PENETROMETER
- EXPLORATION PIT
- CITY BOUNDARY
- CONTOUR 100 FT
- CONTOUR 20 FT

DATA SOURCES / REFERENCES:
PSLC 2016 KING CO.
DELIVERY 4 FLOWN 3/26/16 - 8/27/16
GRID CELL SIZE IS 3'.
WA STATE PLANE NORTH (FIPS 4601), NAD83(HARN)
NAVD88 GEOID03 (GEOID03), US SURVEY FEET
KING CO: PARCELS, STREETS, HYDRO 1/18

LOCATIONS AND DISTANCES SHOWN ARE APPROXIMATE

N

0 600 1200
FEET

BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION

associated earth sciences incorporated

EXPLORATION PITS AND BORINGS

SNOQUALMIE MILL SITE
SNOQUALMIE, WASHINGTON

PROJ NO.	DATE:	FIGURE:
120126H012	4/18	4

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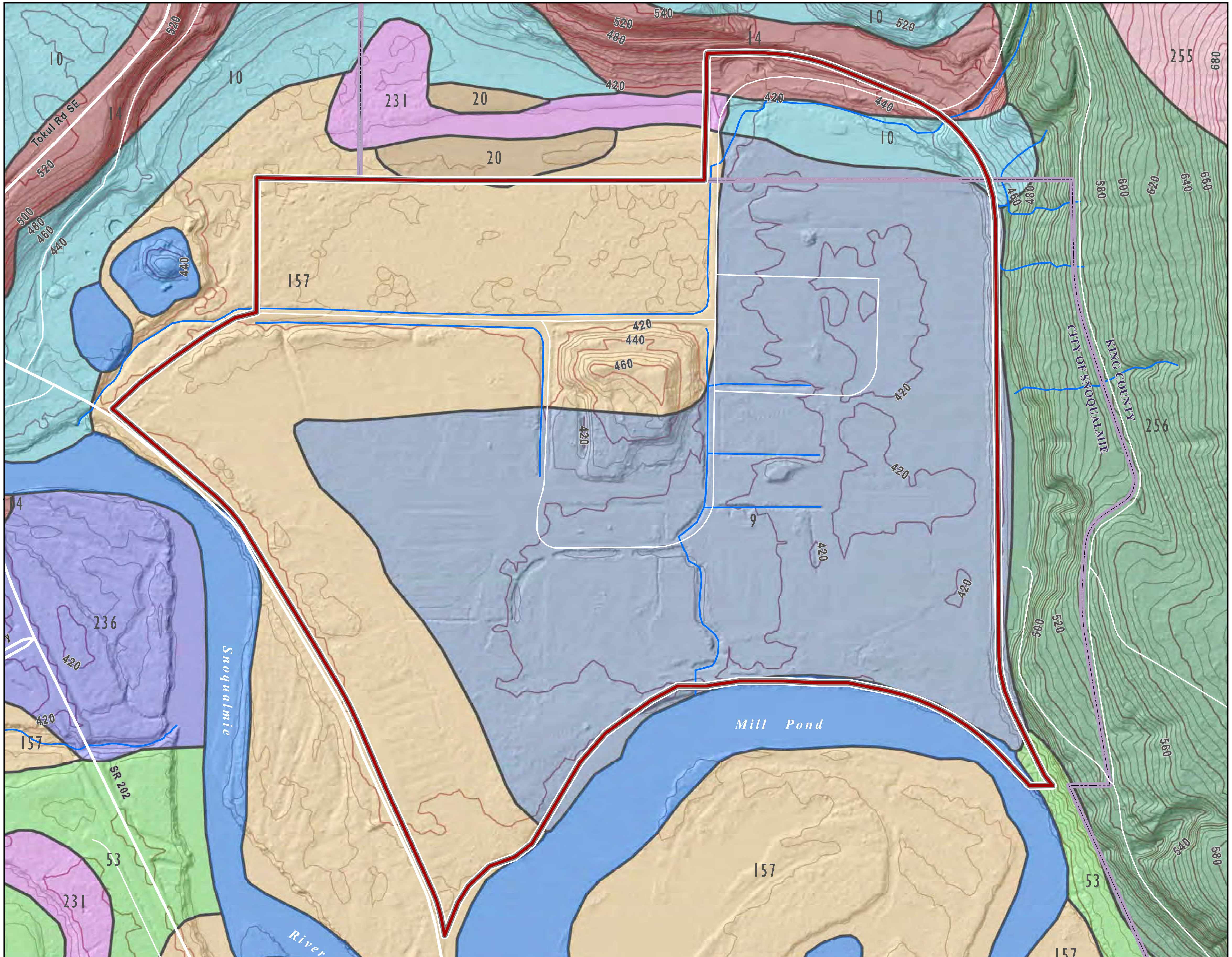

LEGEND:

- SITE
- 9 - Arents, 0-8% slope
- 10 - Barneston gravelly ashy coarse sandy loam, 0-8% slope
- 14 - 10 - Barneston gravelly ashy coarse sandy loam, 8-30% slope
- 20 - Belfast silt loam, 0-2% slope
- 53 - Edgewick silt loam, 0-3% slope
- 157 - Nooksack silt loam, 0-2% slope
- 231 - Seattle muck, 0-1% slope
- 236 - Si silt loam, 0 - 2% slope
- 255 - Tokul gravelly medial loam, 8-15% slope
- 256 - Tokul gravelly medial loam, 15-30% slope
- CITY BOUNDARY
- CONTOUR 20 FT
- CONTOUR 5 FT

DATA SOURCES / REFERENCES:
PSLC 2016 KING CO., DELIVERY 4 FLOWN 3/26/16 - 8/27/16,
CEDAR RIVER WATERSHED 2014, DELIVERY2 JULY 2014.
WA STATE PLANE NORTH (FIPS 4601), NAD83(HARN)
NAVD88 GEOID03 (GEOID03), US SURVEY FEET, GRID CELL SIZE IS 3'.
LIDAR PROJECTS MOSAICED USING BLEND IN OVERLAP
CONTOURS FROM LIDAR
KING CO: STREETS, 1/18
NRCS SOILS

LOCATIONS AND DISTANCES SHOWN ARE APPROXIMATE

N
0 250 500
FEET

BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION

associated earth sciences incorporated

SOILS

SNOQUALMIE MILL SITE
SNOQUALMIE, WASHINGTON

PROJ NO.	DATE:	FIGURE:
120126H012	4/18	5

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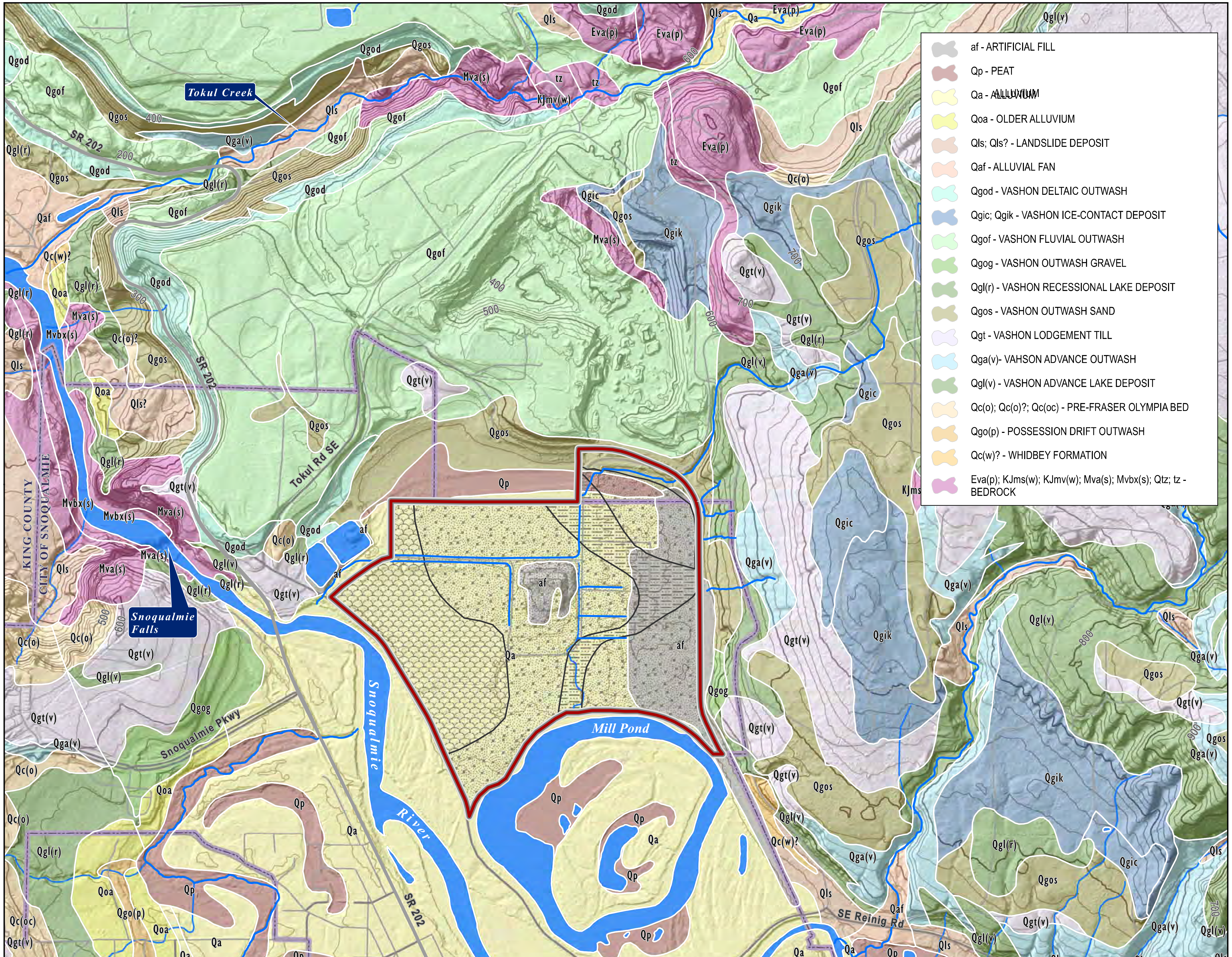

LEGEND:

- SITE
- GEOLOGY UNITS UNDER FILL ONSITE
- RIVER CHANNEL
- LACUSTRINE
- OVERBANK
- CITY BOUNDARY
- CONTOUR 100 FT
- CONTOUR 20 FT

NOTE:
MAPPING OF GEOLOGY UNITS UNDERLYING THE EXISTING ONSITE FILL IS BASED ON AESI EXPLORATION PITS.

DATA SOURCES / REFERENCES:
PSLC 2016 KING CO., DELIVERY 4 FLOWN 3/26/16 - 8/27/16, GRID CELL SIZE IS 3'.
PSLC: CEDAR RIVER WATERSHED 2014
DELIVERY2 = CEDAR RIVER/LAKE, JULY 2014.
WA STATE PLANE NORTH (FIPS 4601), NAD83(HARN)
NAVD88 GEOID03 (GEOID03), US SURVEY FEET
LIDAR PROJECTS MOSAICED USING BLEND IN OVERLAP
CONTOURS FROM LIDAR
KING CO: PARCELS, STREETS, HYDRO 1/18
WADNR: GEOLOGY, 24K 11/17, SNOQUALMIE 7.5 MINUTE QUAD, GM-75, 7/09

LOCATIONS AND DISTANCES SHOWN ARE APPROXIMATE

N

0 600 1200
FEET

BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION

associated earth sciences incorporated

GEOLOGY

SNOQUALMIE MILL SITE
SNOQUALMIE, WASHINGTON

PROJ NO.	DATE:	FIGURE:
120126H012	4/18	6

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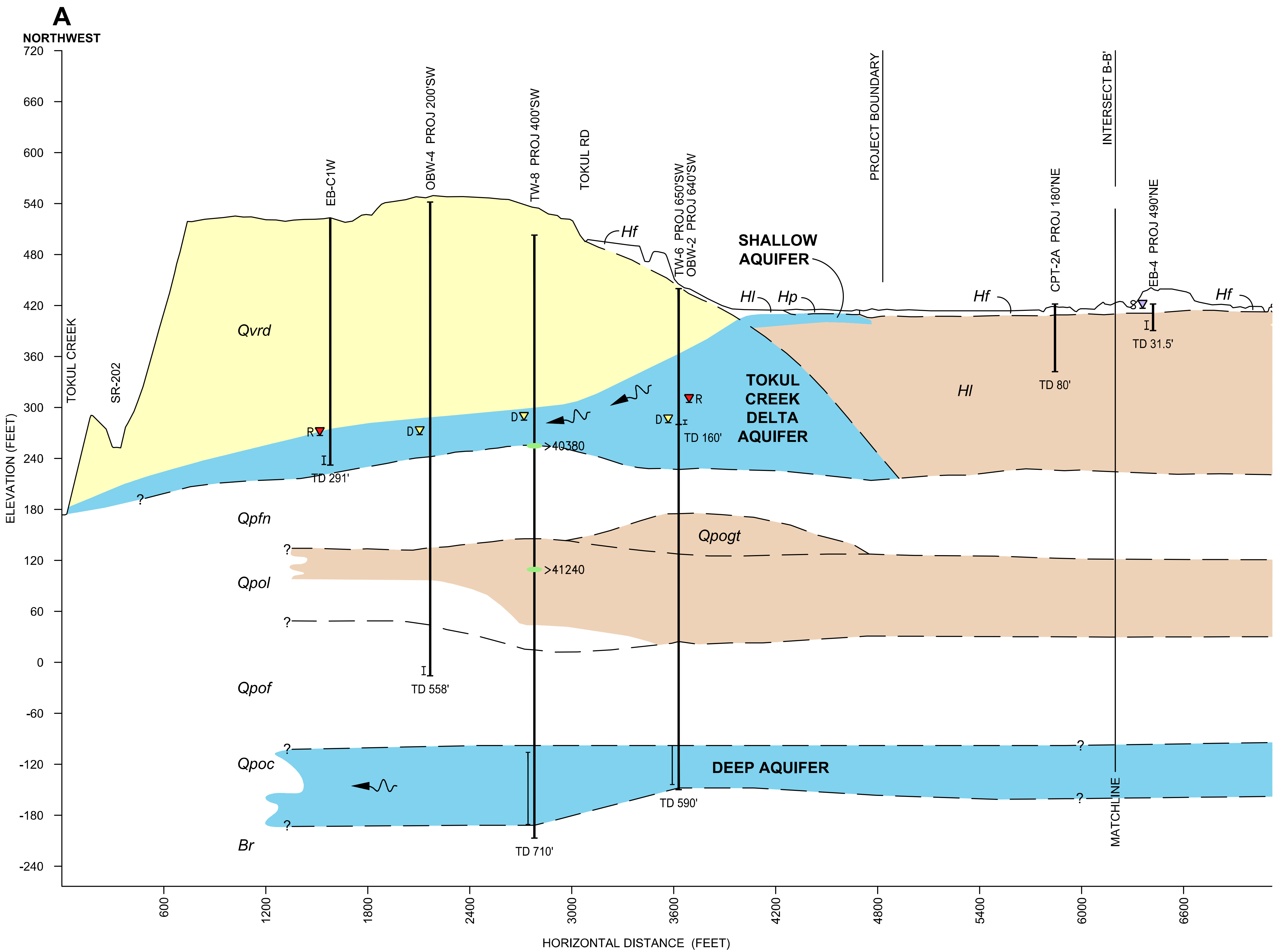


LEGEND:

Hf	HOLOCENE FILL
Hp	HOLOCENE PEAT
Ha	HOLOCENE ALLUVIUM
Hl	HOLOCENE LACUSTRINE
Qvrd	VASHON RECESSIONAL OUTWASH DELTA - COARSE GRAINED
Qvr	VASHON RECESSIONAL OUTWASH UNDIFFERENTIATED
Qvt	VASHON LODGEMENT TILL
Qva	VASHON ADVANCE OUTWASH
Qvlc	VASHON ADVANCE LACUSTRINE
Qpfn	PRE-FRASER NONGLACIAL UNDIFFERENTIATED
Qpogt	PRE-OLYMPIA GLACIAL TILL
Qpol	PRE-OLYMPIA LACUSTRINE
Qpof	PRE-OLYMPIA FLUVIAL FINE GRAINED
Qpoc	PRE-OLYMPIA FLUVIAL COARSE GRAINED
Qpou	PRE-OLYMPIA UNDIFFERENTIATED
Br	BEDROCK
	COARSE GRAINED
	LOW PERMEABILITY - FLOW BARRIER
	EXPLORATION / WELL
	SCREENED INTERVAL
	AQUIFER:
S	SHALLOW
R	TOKUL CREEK DELTA
PF	PRE-FRASER
D	DEEP
	GROUNDWATER FLOW DIRECTION
TD	TOTAL DEPTH OF BORING
	GEOLOGIC CONTACT
	^{14}C CAL BP

VERTICAL EXAGGERATION = 5X

NOTE: LOCATION AND DISTANCES SHOWN ARE APPROXIMATE

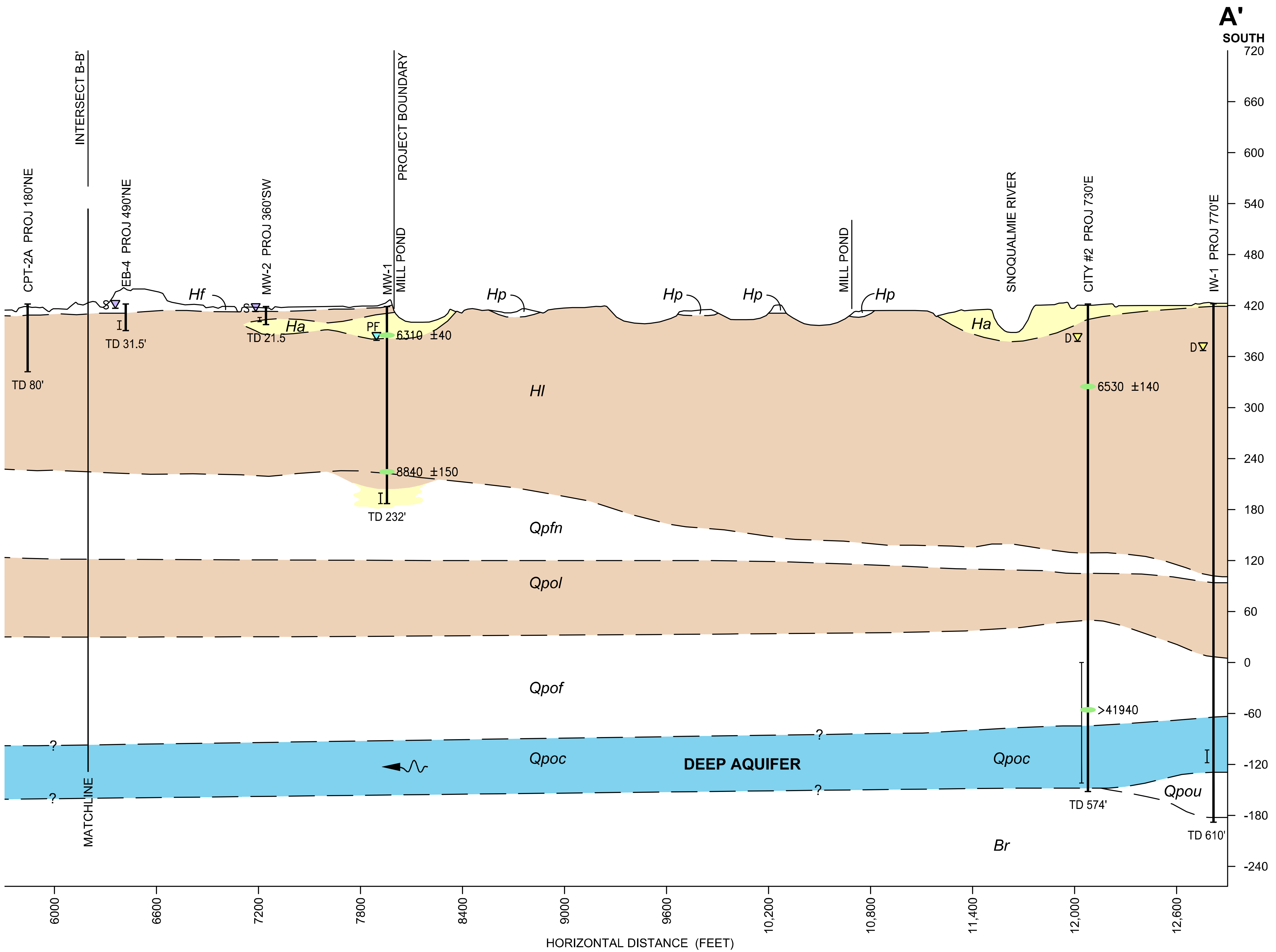
NOTES:
1. THE SUBSURFACE CONDITIONS PRESENTED IN THIS GEOLOGIC CROSS-SECTION ARE BASED ON AN INTERPRETATION OF CONDITIONS ENCOUNTERED IN WIDELY SPACED EXPLORATIONS COMPLETED AT THE SUBJECT SITE AND RELEVANT SITE INFORMATION DEVELOPED AND PROVIDED BY OTHERS. THE SUBSURFACE INTERPRETATIONS PRESENTED IN THIS GEOLOGIC CROSS-SECTION SHOULD NOT BE CONSTRUED AS A WARRANTY OF ACTUAL SUBSURFACE CONDITIONS AT THE SITE. OUR EXPERIENCE HAS SHOWN THAT SOIL AND GROUNDWATER CONDITIONS CAN VARY SIGNIFICANTLY OVER SMALL DISTANCES.

BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION

associated earth sciences incorporated

HYDROGEOLOGIC CROSS-SECTION A - A' NORTHWEST
EIS SNOQUALMIE MILL SITE
SNOQUALMIE, WASHINGTON

PROJ NO.	DATE:	FIGURE:
120126H012	5/18	7



LEGEND:

Hf	HOLOCENE FILL
Hp	HOLOCENE PEAT
Ha	HOLOCENE ALLUVIUM
Hl	HOLOCENE LACUSTRINE
Qvrd	VASHON RECESSIONAL OUTWASH DELTA - COARSE GRAINED
Qvr	VASHON RECESSIONAL OUTWASH UNDIFFERENTIATED
Qvt	VASHON LODGEMENT TILL
Qva	VASHON ADVANCE OUTWASH
Qvlc	VASHON ADVANCE LACUSTRINE
Qpfn	PRE-FRASER NONGLACIAL UNDIFFERENTIATED
Qpogt	PRE-OLYMPIA GLACIAL TILL
Qpol	PRE-OLYMPIA LACUSTRINE
Qpof	PRE-OLYMPIA FLUVIAL FINE GRAINED
Qpoc	PRE-OLYMPIA FLUVIAL COARSE GRAINED
Qpou	PRE-OLYMPIA UNDIFFERENTIATED
Br	BEDROCK
	COARSE GRAINED
	LOW PERMEABILITY - FLOW BARRIER
	EXPLORATION / WELL
	SCREENED INTERVAL
	AQUIFER:
S	SHALLOW
R	TOKUL CREEK DELTA
PF	PRE-FRASER
D	DEEP
	GROUNDWATER FLOW DIRECTION
TD	TOTAL DEPTH OF BORING
	GEOLOGIC CONTACT
	^{14}C CAL BP

VERTICAL EXAGGERATION = 5X

NOTE: LOCATION AND DISTANCES SHOWN ARE APPROXIMATE

NOTES:
1. THE SUBSURFACE CONDITIONS PRESENTED IN THIS GEOLOGIC CROSS-SECTION ARE BASED ON AN INTERPRETATION OF CONDITIONS ENCOUNTERED IN WIDELY SPACED EXPLORATIONS COMPLETED AT THE SUBJECT SITE AND RELEVANT SITE INFORMATION DEVELOPED AND PROVIDED BY OTHERS. THE SUBSURFACE INTERPRETATIONS PRESENTED IN THIS GEOLOGIC CROSS-SECTION SHOULD NOT BE CONSTRUED AS A WARRANTY OF ACTUAL SUBSURFACE CONDITIONS AT THE SITE. OUR EXPERIENCE HAS SHOWN THAT SOIL AND GROUNDWATER CONDITIONS CAN VARY SIGNIFICANTLY OVER SMALL DISTANCES.

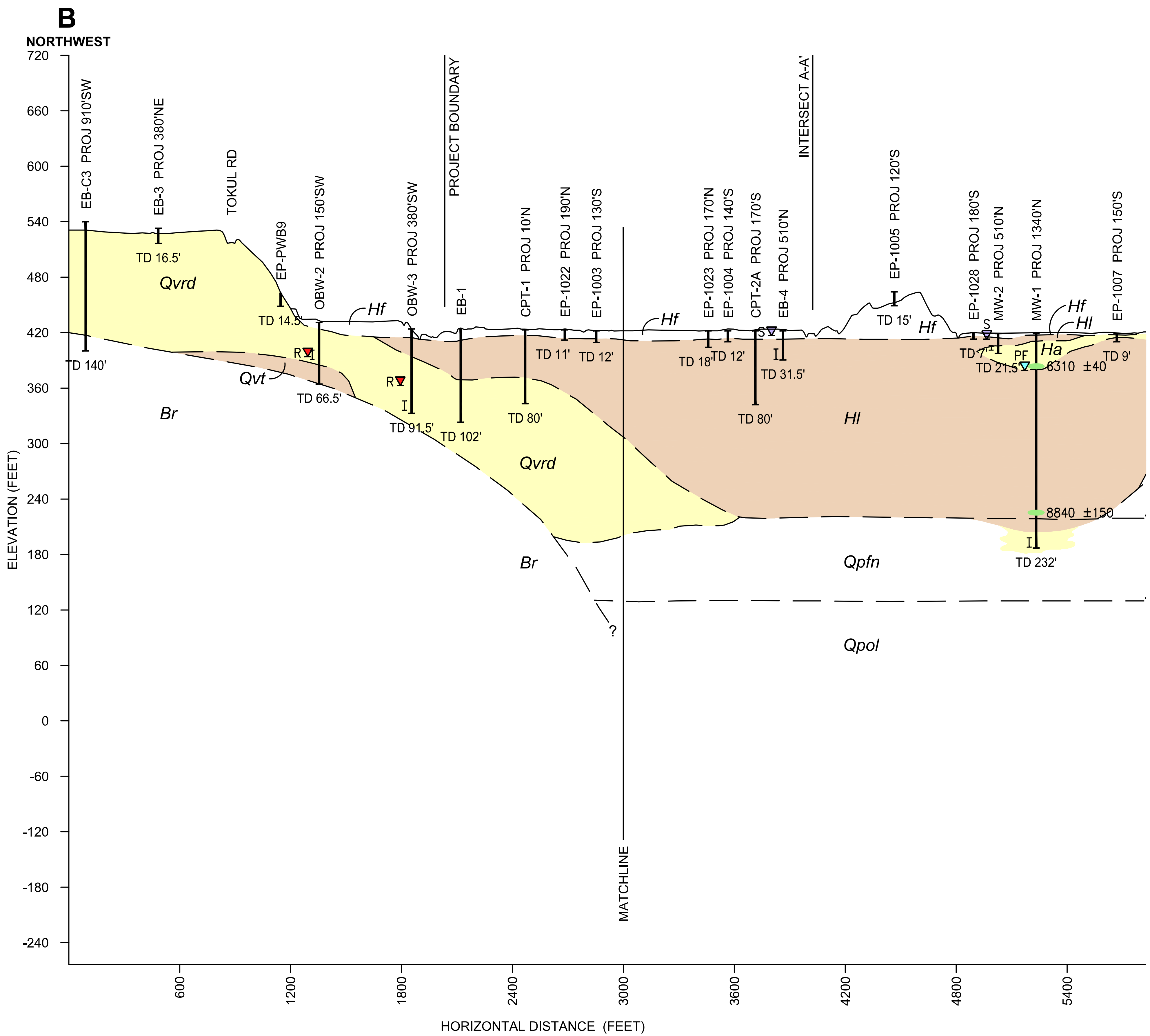
BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION

associated earth sciences incorporated

HYDROGEOLOGIC
CROSS-SECTION A - A' SOUTH
EIS SNOQUALMIE MILL SITE
SNOQUALMIE, WASHINGTON

PROJ NO.	DATE:	FIGURE:
120126H012	5/18	8

120126 Snoqualmie Mill Site \ 120126 Geo Sects 3-18.dwg LAYOUT: F8 Sect A-A South



LEGEND:

Hf	HOLOCENE FILL
Hp	HOLOCENE PEAT
Ha	HOLOCENE ALLUVIUM
Hl	HOLOCENE LACUSTRINE
Qvrd	VASHON RECESSIONAL OUTWASH DELTA - COARSE GRAINED
Qvr	VASHON RECESSIONAL OUTWASH UNDIFFERENTIATED
Qvt	VASHON LODGEMENT TILL
Qva	VASHON ADVANCE OUTWASH
Qvlc	VASHON ADVANCE LACUSTRINE
Qpfn	PRE-FRASER NONGLACIAL UNDIFFERENTIATED
Qpogt	PRE-OLYMPIA GLACIAL TILL
Qpol	PRE-OLYMPIA LACUSTRINE
Qpof	PRE-OLYMPIA FLUVIAL FINE GRAINED
Qpoc	PRE-OLYMPIA FLUVIAL COARSE GRAINED
Qpou	PRE-OLYMPIA UNDIFFERENTIATED
Br	BEDROCK
	COARSE GRAINED
	LOW PERMEABILITY - FLOW BARRIER
	EXPLORATION / WELL
	SCREENED INTERVAL
	AQUIFER:
S	SHALLOW
R	TOKUL CREEK DELTA
PF	PRE-FRASER
D	DEEP
	GROUNDWATER FLOW DIRECTION
TD	TOTAL DEPTH OF BORING
	GEOLOGIC CONTACT
	^{14}C CAL BP

VERTICAL EXAGGERATION = 5X

NOTE: LOCATION AND DISTANCES SHOWN ARE APPROXIMATE

NOTES:
1. THE SUBSURFACE CONDITIONS PRESENTED IN THIS GEOLOGIC CROSS-SECTION ARE BASED ON AN INTERPRETATION OF CONDITIONS ENCOUNTERED IN WIDELY SPACED EXPLORATIONS COMPLETED AT THE SUBJECT SITE AND RELEVANT SITE INFORMATION DEVELOPED AND PROVIDED BY OTHERS. THE SUBSURFACE INTERPRETATIONS PRESENTED IN THIS GEOLOGIC CROSS-SECTION SHOULD NOT BE CONSTRUED AS A WARRANTY OF ACTUAL SUBSURFACE CONDITIONS AT THE SITE. OUR EXPERIENCE HAS SHOWN THAT SOIL AND GROUNDWATER CONDITIONS CAN VARY SIGNIFICANTLY OVER SMALL DISTANCES.

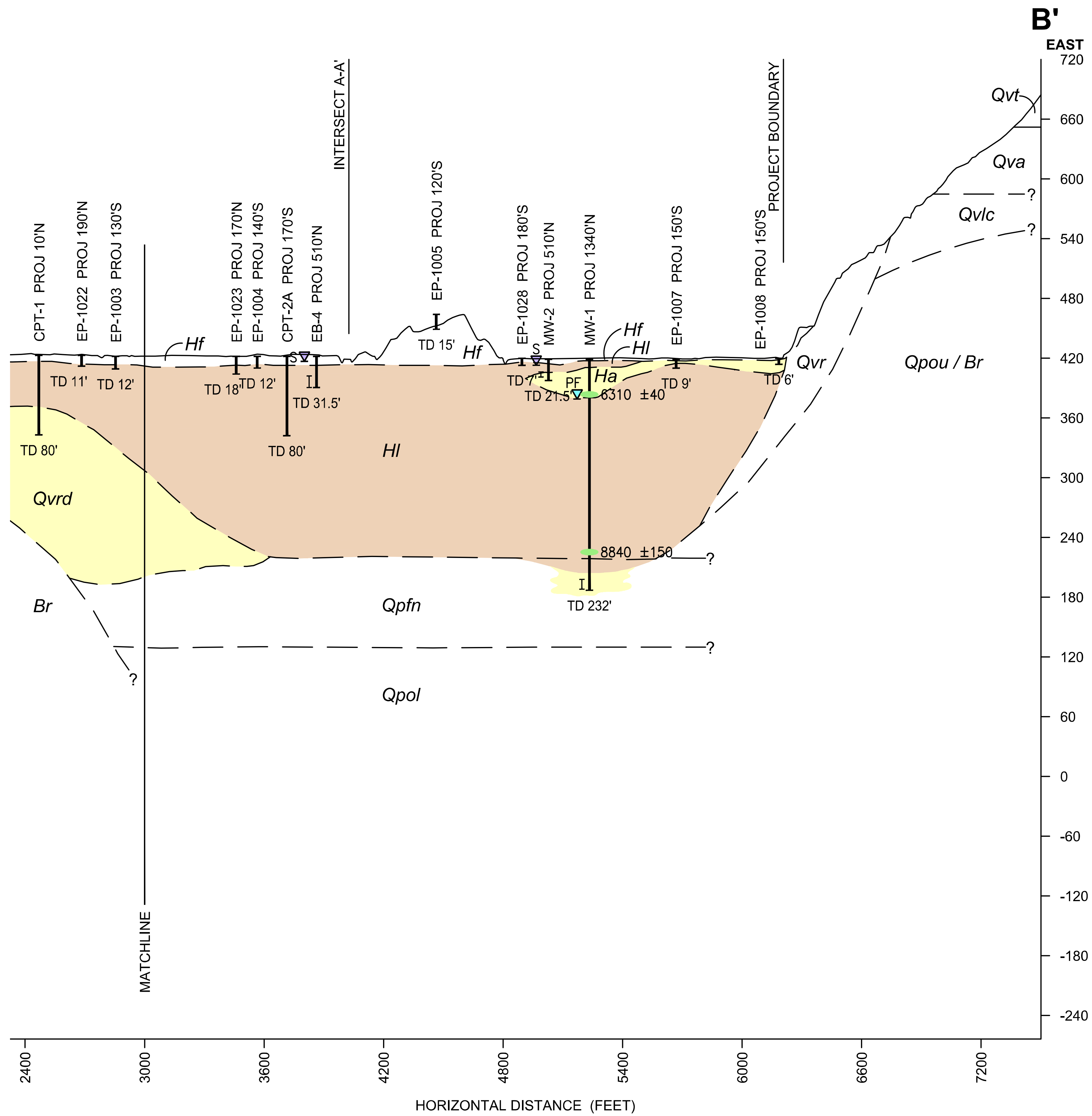
BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION

associated earth sciences incorporated

HYDROGEOLOGIC CROSS-SECTION B - B' NORTHWEST

EIS SNOQUALMIE MILL SITE
SNOQUALMIE, WASHINGTON

PROJ NO. 120126H012 | DATE: 5/18 | FIGURE: 9



LEGEND:

Hf	HOLOCENE FILL
Hp	HOLOCENE PEAT
Ha	HOLOCENE ALLUVIUM
Hl	HOLOCENE LACUSTRINE
Qvrd	VASHON RECESSIONAL OUTWASH DELTA - COARSE GRAINED
Qvr	VASHON RECESSIONAL OUTWASH UNDIFFERENTIATED
Qvt	VASHON LODGEMENT TILL
Qva	VASHON ADVANCE OUTWASH
Qvlc	VASHON ADVANCE LACUSTRINE
Qpfn	PRE-FRASER NONGLACIAL UNDIFFERENTIATED
Qpogt	PRE-OLYMPIA GLACIAL TILL
Qpol	PRE-OLYMPIA LACUSTRINE
Qpof	PRE-OLYMPIA FLUVIAL FINE GRAINED
Qpoc	PRE-OLYMPIA FLUVIAL COARSE GRAINED
Qpou	PRE-OLYMPIA UNDIFFERENTIATED
Br	BEDROCK
	COARSE GRAINED
	LOW PERMEABILITY - FLOW BARRIER
	EXPLORATION / WELL
	SCREENED INTERVAL
	AQUIFER:
S	SHALLOW
R	TOKUL CREEK DELTA
PF	PRE-FRASER
D	DEEP
	GROUNDWATER FLOW DIRECTION
TD	TOTAL DEPTH OF BORING
	GEOLOGIC CONTACT
	^{14}C CAL BP

VERTICAL EXAGGERATION = 5X

NOTE: LOCATION AND DISTANCES SHOWN ARE APPROXIMATE

NOTES:
1. THE SUBSURFACE CONDITIONS PRESENTED IN THIS GEOLOGIC CROSS-SECTION ARE BASED ON AN INTERPRETATION OF CONDITIONS ENCOUNTERED IN WIDELY SPACED EXPLORATIONS COMPLETED AT THE SUBJECT SITE AND RELEVANT SITE INFORMATION DEVELOPED AND PROVIDED BY OTHERS. THE SUBSURFACE INTERPRETATIONS PRESENTED IN THIS GEOLOGIC CROSS-SECTION SHOULD NOT BE CONSTRUED AS A WARRANTY OF ACTUAL SUBSURFACE CONDITIONS AT THE SITE. OUR EXPERIENCE HAS SHOWN THAT SOIL AND GROUNDWATER CONDITIONS CAN VARY SIGNIFICANTLY OVER SMALL DISTANCES.

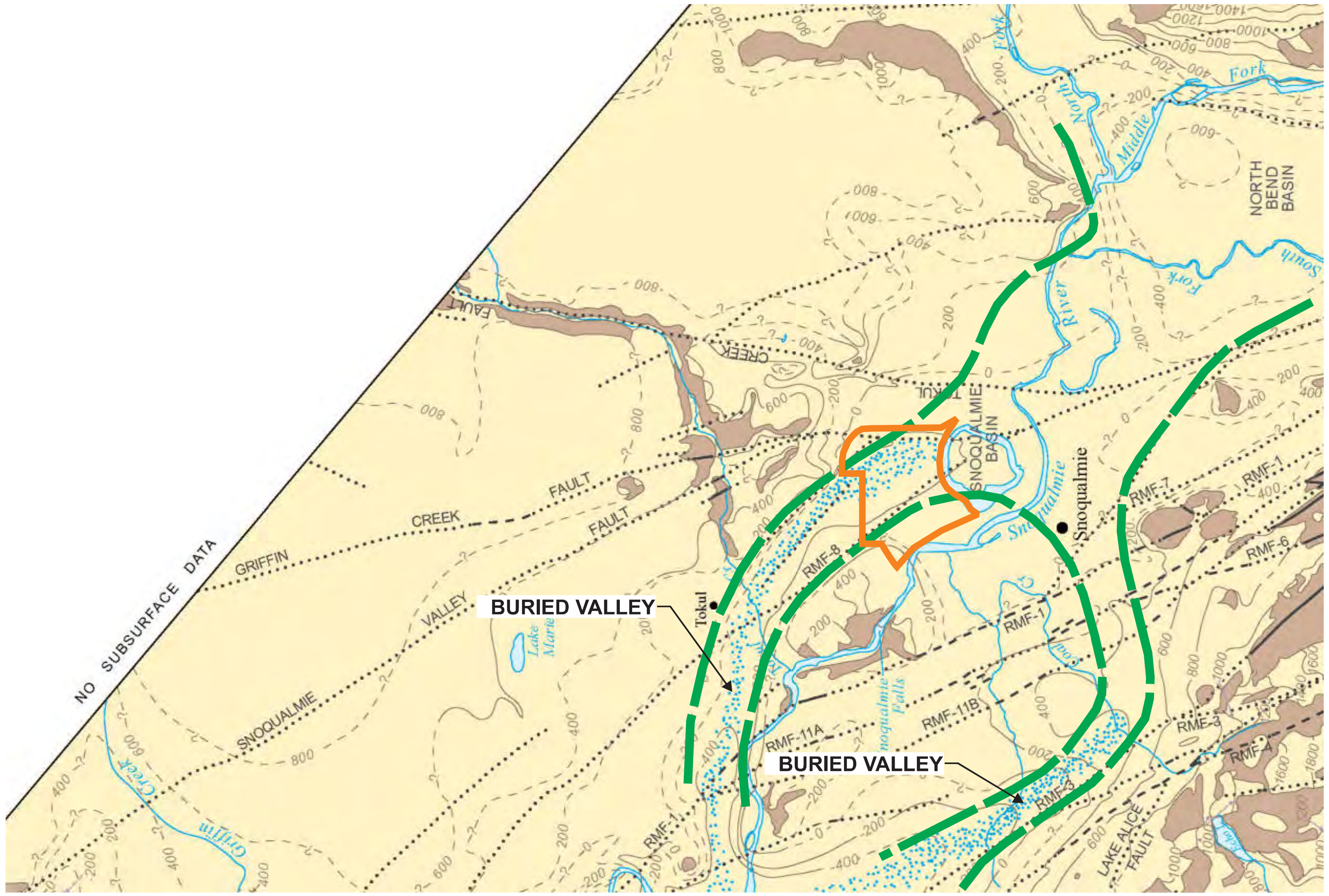
BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION

associated earth sciences incorporated

HYDROGEOLOGIC CROSS-SECTION B - B' EAST

EIS SNOQUALMIE MILL SITE
SNOQUALMIE, WASHINGTON

PROJ NO.	DATE:	FIGURE:
120126H012	5/18	10



N

0 2500 5000
FEET

LEGEND:

- ANCIENT SNOQUALMIE RIVER CHANNEL
- SUBSURFACE BEDROCK CONTOUR
- SUBSURFACE BEDROCK CONTOUR INFERRED
- BEDROCK OUTCROP OR SHALLOW BEDROCK OVERLAIN BY THIN QUATERNARY DEPOSITS
- FAULT - DASHED WHERE INFERRED; DOTTED WHERE CONCEALED
- PROJECT BOUNDARY
- BURIED VALLEY

CONTOUR INTERVAL = 200'

NOTE: LOCATION AND DISTANCES SHOWN ARE APPROXIMATE.

NOTES:
1. BASE MAP REFERENCE: DNR (DRAGOVICH J.D.) 2009, GEOLOGIC MAP #75 PLATE 2 OF 2

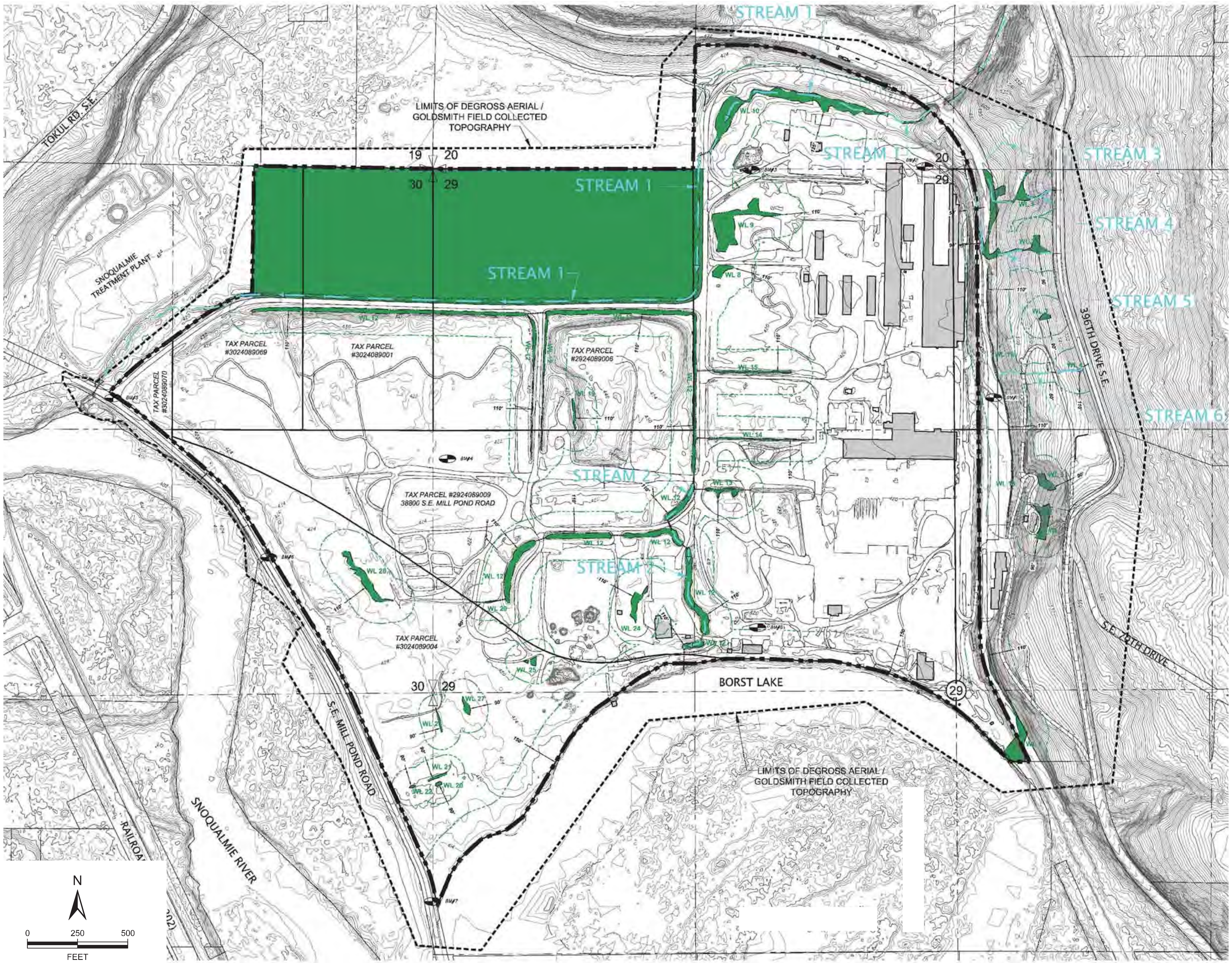
associated earth sciences incorporated

BURIED VALLEY MAP

SNOQUALMIE MILL SITE
SNOQUALMIE, WASHINGTON

PROJ NO.	DATE:	FIGURE:
120126H012	4/18	11

120126 Snoqualmie Mill Site \ 120126H012 F11 Explanation.cdr



LEGEND:

SITE BOUNDARY

WETLAND BUFFER

WETLANDS

STREAMS

CONTOUR INTERVAL = 2'

NOTE: LOCATION AND DISTANCES SHOWN ARE APPROXIMATE.

NOTES:
1. BASE MAP REFERENCE: GOLDSMITH, SNOQUALMIE MILL SITE, WETLANDS AND STREAMS EXHIBIT, FIGURE 4-3, 5/17

BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION.

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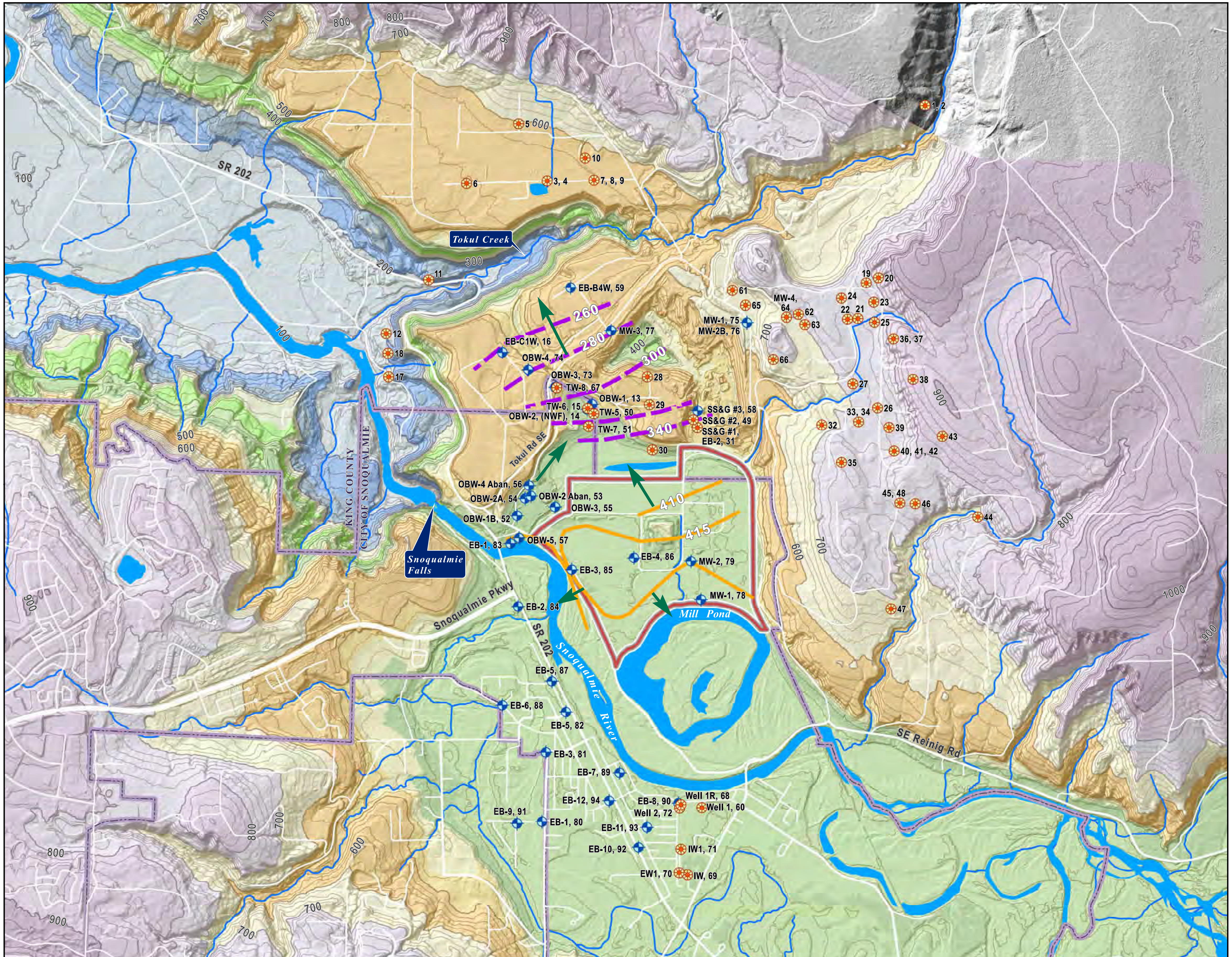
SURFACE WATER FEATURES

SNOQUALMIE MILL SITE
SNOQUALMIE, WASHINGTON

PROJ NO. 120126H012 | DATE: 3/18 | FIGURE: 12

120126 Mill Site \ 120126H012 F12 Surface Water.cdr



LEGEND:

- GROUNDWATER FLOW DIRECTION
- WATER SUPPLY WELL, AESI LABEL FOR WELL REPORT
- MONITORING WELL, AESI LABEL FOR WELL LOG
- TOKUL CREEK DELTA AQUIFER
- SNOQUALMIE RIVER SHALLOW AQUIFER
- CITY BOUNDARY
- CONTOUR 100 FT
- CONTOUR 20 FT

NOTE: MUCH OF MILL SITE IS AT ELEVATION 415 - 425'
NO WELL REPORTS AVAILABLE FOR 61 - 66

DATA SOURCES / REFERENCES:
PSLC 2016 KING CO., DELIVERY 4 FLOWN
3/26/16 - 8/27/16, GRID CELL SIZE IS 3'. CONTOURS FROM LIDAR
PSLC: CEDAR RIVER WATERSHED 2014
DELIVERY2 = CEDAR RIVER/LAKE, JULY 2014.
WA STATE PLANE NORTH (FIPS 4601), NAD83(HARN)
NAVD88 GEOID03 (GEOID03), US SURVEY FEET
LIDAR PROJECTS MOSAICED USING BLEND IN OVERLAP
KING CO: PARCELS, STREETS, HYDRO 1/18
LOCATIONS AND DISTANCES SHOWN ARE APPROXIMATE

N
0 850 1700
FEET

BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION

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WELL LOCATIONS GROUNDWATER ELEVATION

SNOQUALMIE MILL SITE
SNOQUALMIE, WASHINGTON

PROJ NO.	DATE:	FIGURE:
120126H012	4/18	13

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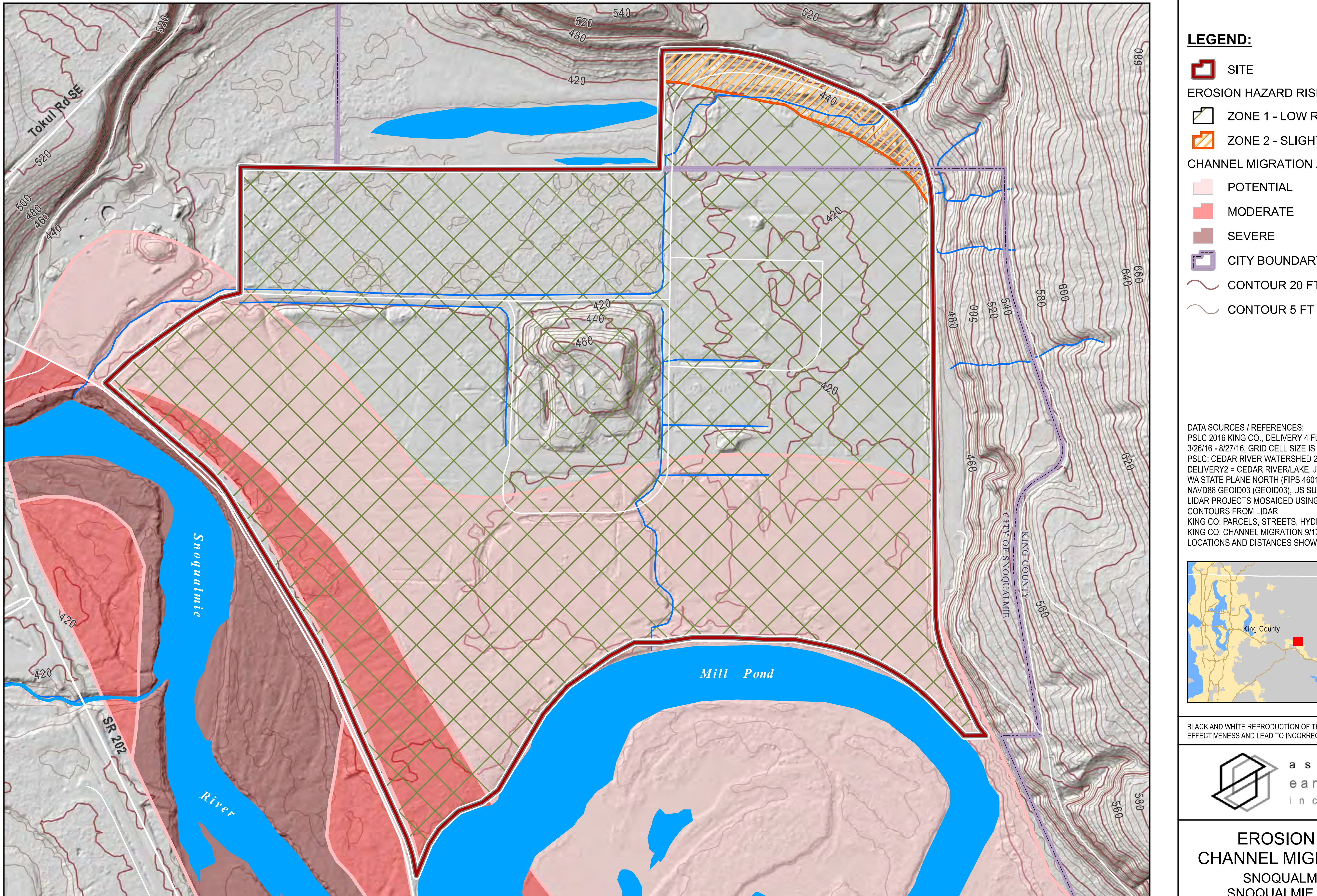

LEGEND:

- SITE
- EROSION HAZARD RISK
  - ZONE 1 - LOW RISK
  - ZONE 2 - SLIGHT TO MODERATE RISK
- CHANNEL MIGRATION ZONE
  - POTENTIAL
  - MODERATE
  - SEVERE
- CITY BOUNDARY
- CONTOUR 20 FT
- CONTOUR 5 FT

DATA SOURCES / REFERENCES:
PSLC 2016 KING CO., DELIVERY 4 FLOWN
3/26/16 - 8/27/16, GRID CELL SIZE IS 3'.
PSLC: CEDAR RIVER WATERSHED 2014
DELIVERY2 = CEDAR RIVER/LAKE, JULY 2014.
WA STATE PLANE NORTH (FIPS 4601), NAD83(HARN)
NAVD88 GEOID03 (GEOID03), US SURVEY FEET
LIDAR PROJECTS MOSAICED USING BLEND IN OVERLAP
CONTOURS FROM LIDAR
KING CO: PARCELS, STREETS, HYDRO 1/18
KING CO: CHANNEL MIGRATION 9/17
LOCATIONS AND DISTANCES SHOWN ARE APPROXIMATE

BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION

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EROSION HAZARDS CHANNEL MIGRATION ZONES

SNOQUALMIE MILL SITE
SNOQUALMIE, WASHINGTON

PROJ NO.	DATE:	FIGURE:
120126H012	4/18	14

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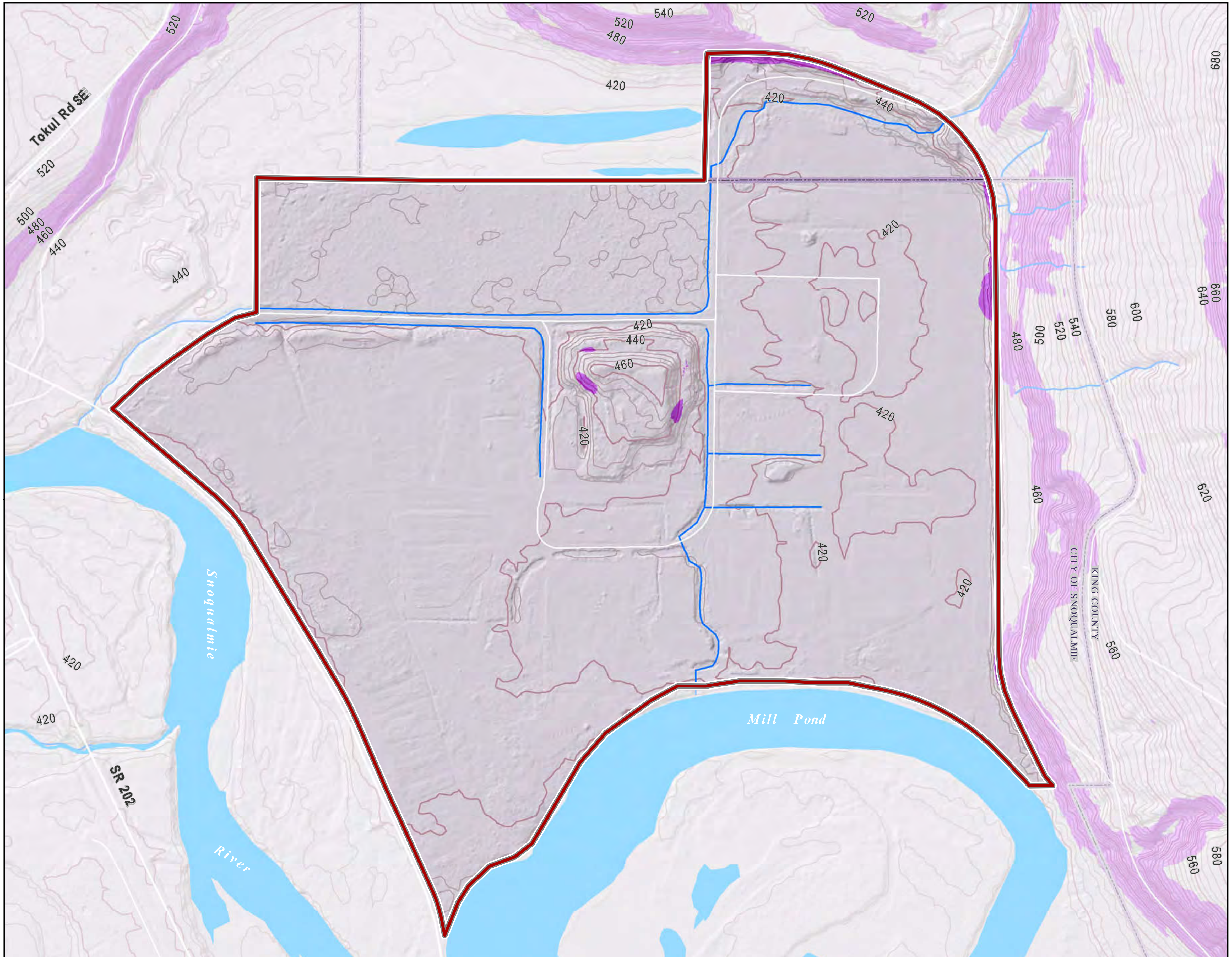

LEGEND:

- SITE
- LANDSLIDE / STEEP SLOPE HAZARD ZONE 1
- LANDSLIDE / STEEP SLOPE HAZARD ZONE 2
- CITY BOUNDARY
- CONTOUR 20 FT
- CONTOUR 5 FT

DATA SOURCES / REFERENCES:
PSLC 2016 KING CO., DELIVERY 4 FLOWN 3/26/16 - 8/27/16, GRID CELL SIZE IS 3'.
PSLC: CEDAR RIVER WATERSHED 2014
DELIVERY2 = CEDAR RIVER/LAKE, JULY 2014.
WA STATE PLANE NORTH (FIPS 4601), NAD83(HARN)
NAVD88 GEOID03 (GEOID03), US SURVEY FEET
LIDAR PROJECTS MOSAICED USING BLEND IN OVERLAP
CONTOURS FROM LIDAR
KING CO: PARCELS, STREETS, HYDRO 1/18

LOCATIONS AND DISTANCES SHOWN ARE APPROXIMATE

N

0 250 500
FEET

BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION

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LANDSLIDE AND STEEP SLOPE HAZARDS

SNOQUALMIE MILL SITE
SNOQUALMIE, WASHINGTON

PROJ NO.	DATE:	FIGURE:
120126H012	4/18	15

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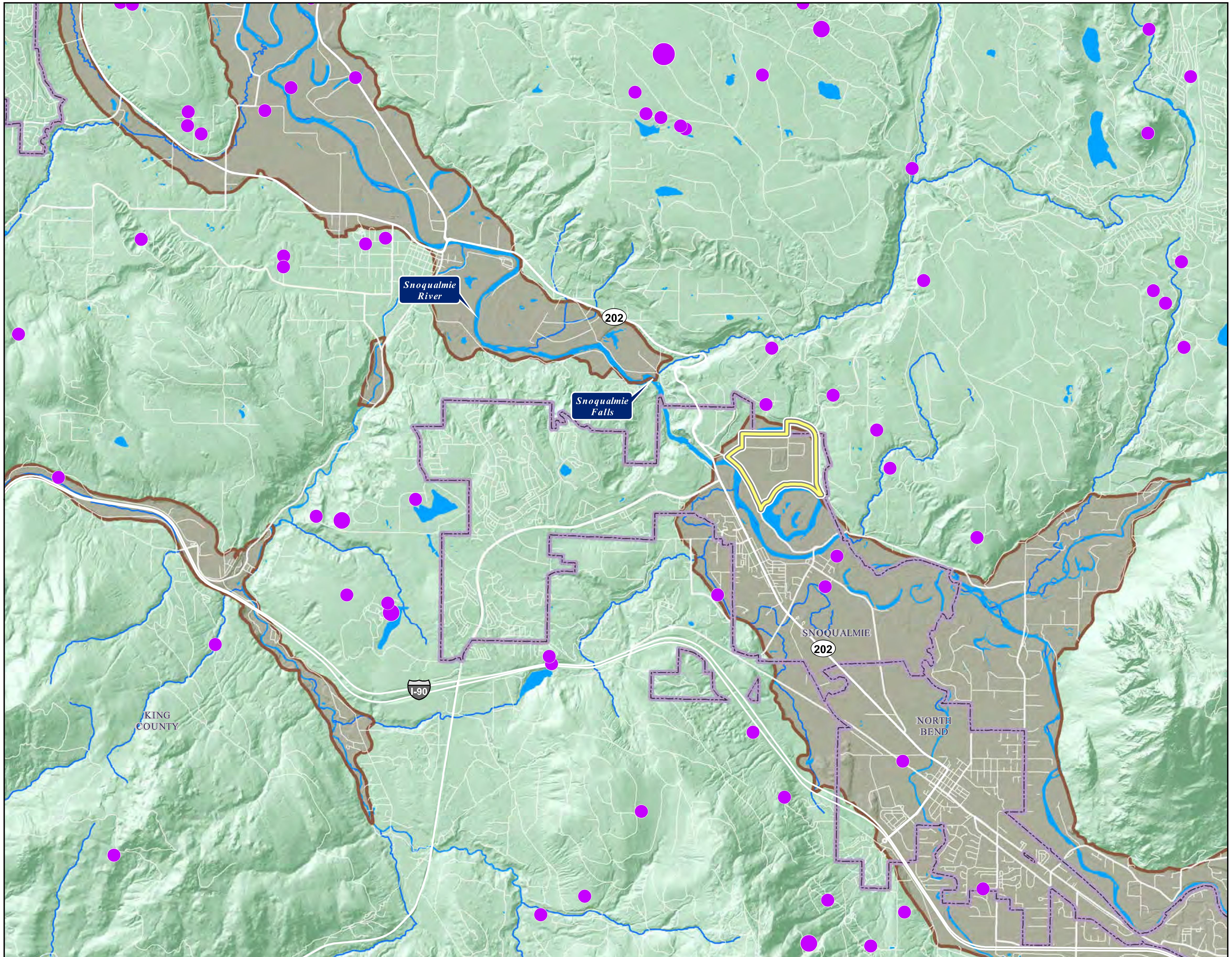

LEGEND:

- SITE
- EARTHQUAKE_MAGNITUDE
  - 2 - 2.9
  - 3 - 3.9
  - >3.99
- SEISMIC HAZARD AREA (KING CO.)
- CITY BOUNDARY

DATA SOURCES / REFERENCES:
PSLC: 2005 SUPERMOSIC HILLSHADE, 6' CELL
KING CO: PARCELS, STREETS, HYDRO 1/18
KING CO: SEISMIC HAZARD AREA 1/13
WADNR: PNWSN 4/13

LOCATIONS AND DISTANCES SHOWN ARE APPROXIMATE

BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION

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EARTHQUAKE LOCATIONS

SNOQUALMIE MILL SITE
SNOQUALMIE, WASHINGTON

PROJ NO.	DATE:	FIGURE:
120126H012	4/18	16

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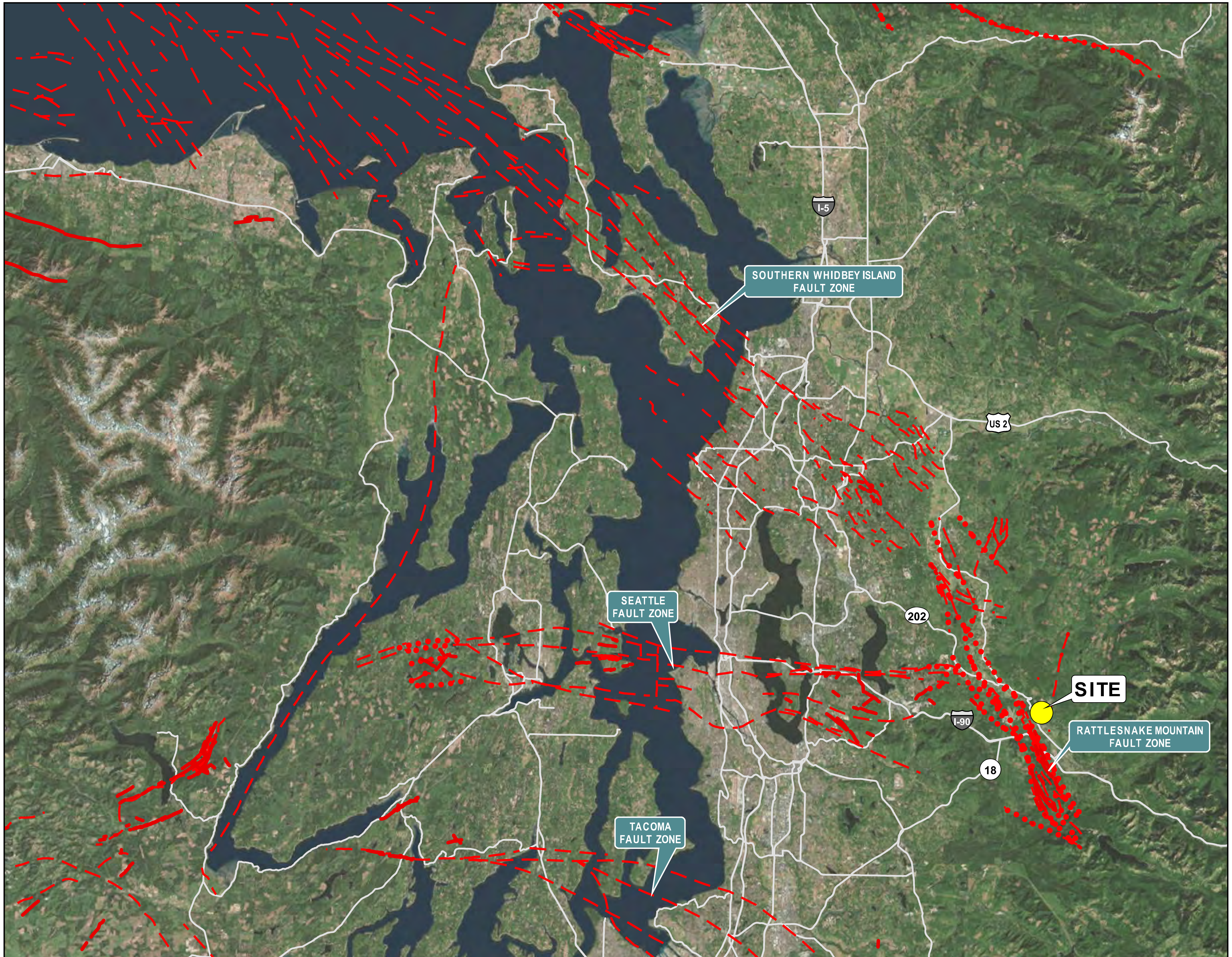


LEGEND:

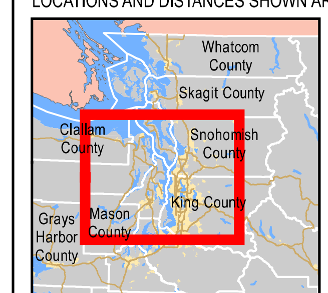
FAULT VISIBILITY DESCRIPTION

- CONCEALED FAULT TRACE
- INFERRED FAULT TRACE
- VISIBLE FAULT TRACE

DATA SOURCES / REFERENCES:

WADNR REGIONAL ACTIVE FAULTS 4/13
AERIAL: ESRI, DIGITAL GLOBE, GEOEYE, EARTHSTAR GEOGRAPHICS, CNE S/A AIRBUS DS, USDA

LOCATIONS AND DISTANCES SHOWN ARE APPROXIMATE



BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION

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REGIONAL FAULTS

SNOQUALMIE MILL SITE
SNOQUALMIE, WASHINGTON

PROJ NO.	DATE:	FIGURE:
120126H012	4/18	17

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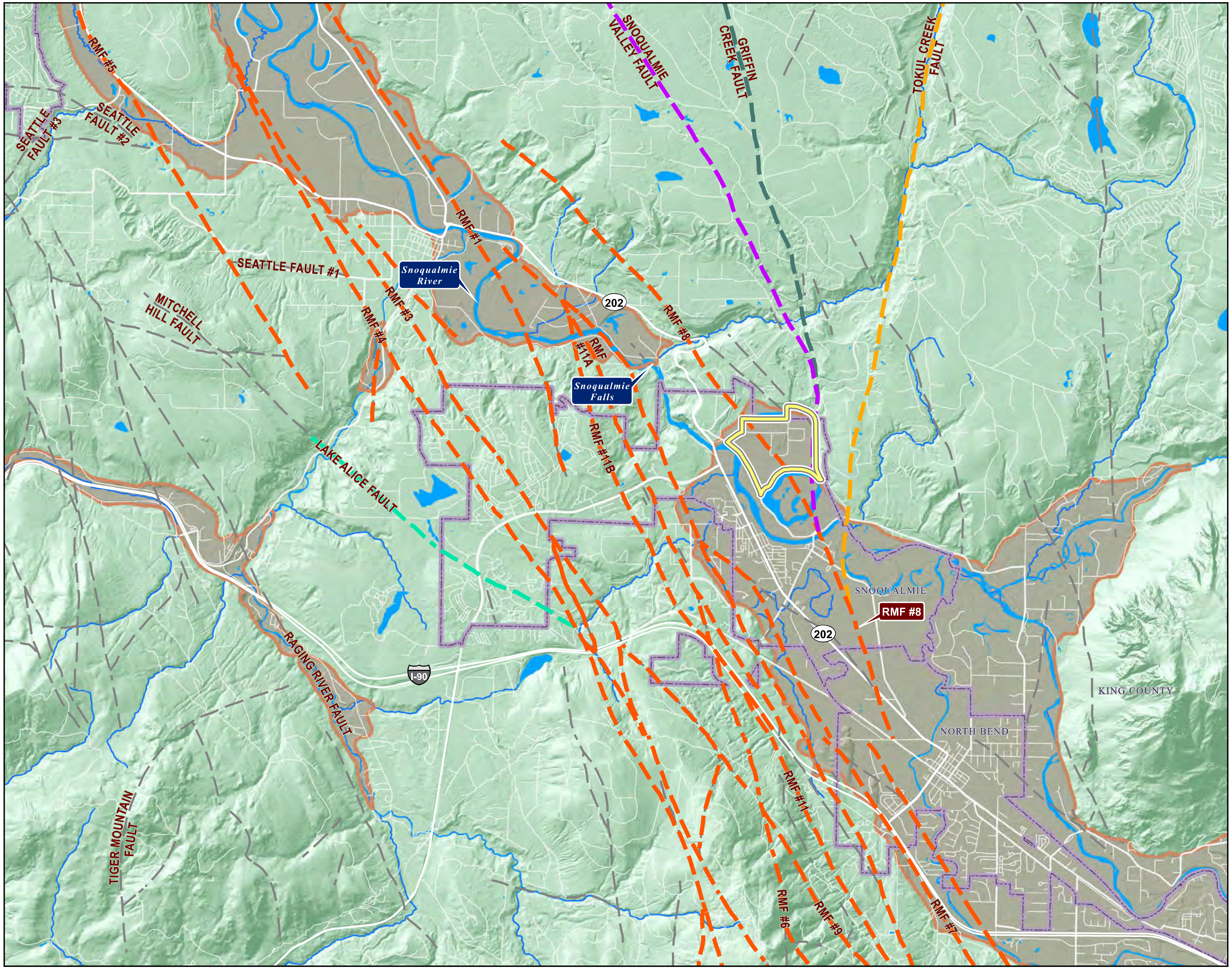
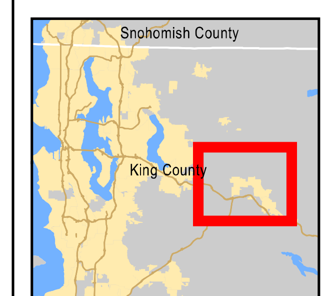


LEGEND:

- SITE
- SNOQUALMIE VALLEY
- RATTLESNAKE MOUNTAIN FAULT ZONE (RMF)
- GRIFFIN CREEK
- LAKE ALICE
- TOKUL CREEK
- FAULTS, MISC
- SEISMIC HAZARD AREA (KING CO.)
- CITY BOUNDARY

DATA SOURCES / REFERENCES:
PSLC: 2005 SUPERMOSIC HILLSHADE, 6' CELL
KING CO: PARCELS, STREETS, HYDRO 1/18
KING CO: SEISMIC HAZARD AREA 1/13
WADNR: 24K FAULTS 12/16

LOCATIONS AND DISTANCES SHOWN ARE APPROXIMATE



N
0 2500 5000
FEET

BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION

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SEISMIC HAZARD FAULT LOCATIONS

SNOQUALMIE MILL SITE
SNOQUALMIE, WASHINGTON

PROJ NO.	DATE:	FIGURE:
120126H012	4/18	18

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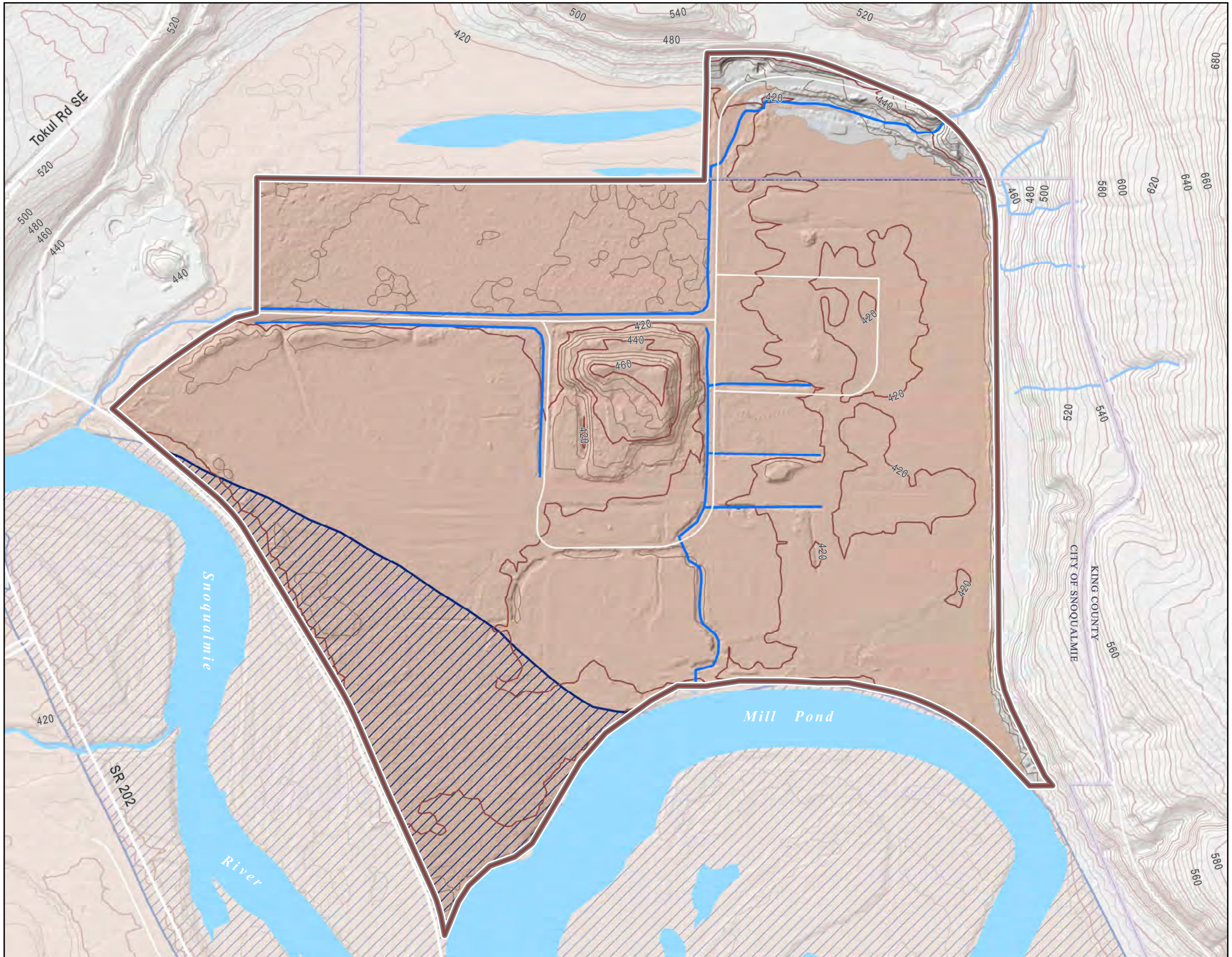


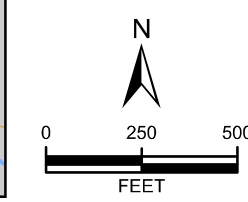
LEGEND:

- SITE
- FLOODWAY
- 100 YR FLOODPLAIN
- CITY BOUNDARY
- CONTOUR 20 FT
- CONTOUR 5 FT

NOTE: SITE RANGES FROM ABOUT 415' TO 425'
MILL POND AT TIME OF LIDAR FLIGHT IS ELEVATION OF 411.5'. LIDAR WATER IS FLATTENED.
SNOQUALMIE RIVER AT EAST CITY LIMITS IS ABOUT 402.8
SNOQUALMIE RIVER AT SR 202 IS ABOUT 400.5

DATA SOURCES / REFERENCES:
PSLC 2016 KING CO., DELIVERY 4 FLOWN 3/26/16 - 8/27/16, GRID CELL SIZE IS 3'.
PSLC: CEDAR RIVER WATERSHED 2014
DELIVERY2 = CEDAR RIVER/LAKE, JULY 2014.
WA STATE PLANE NORTH (FIPS 4601), NAD83(HARN)
NAVD88 GEOID03 (GEOID03), US SURVEY FEET
LIDAR PROJECTS MOSAICED USING BLEND IN OVERLAP
CONTOURS FROM LIDAR
KING CO: PARCELS, STREETS, HYDRO. 1/18, FLOODWAY AND FLOODPLAIN 3/18,

LOCATIONS AND DISTANCES SHOWN ARE APPROXIMATE



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FLOOD HAZARDS

SNOQUALMIE MILL SITE
SNOQUALMIE, WASHINGTON

PROJ NO.	DATE:	FIGURE:
120126H012	4/18	19

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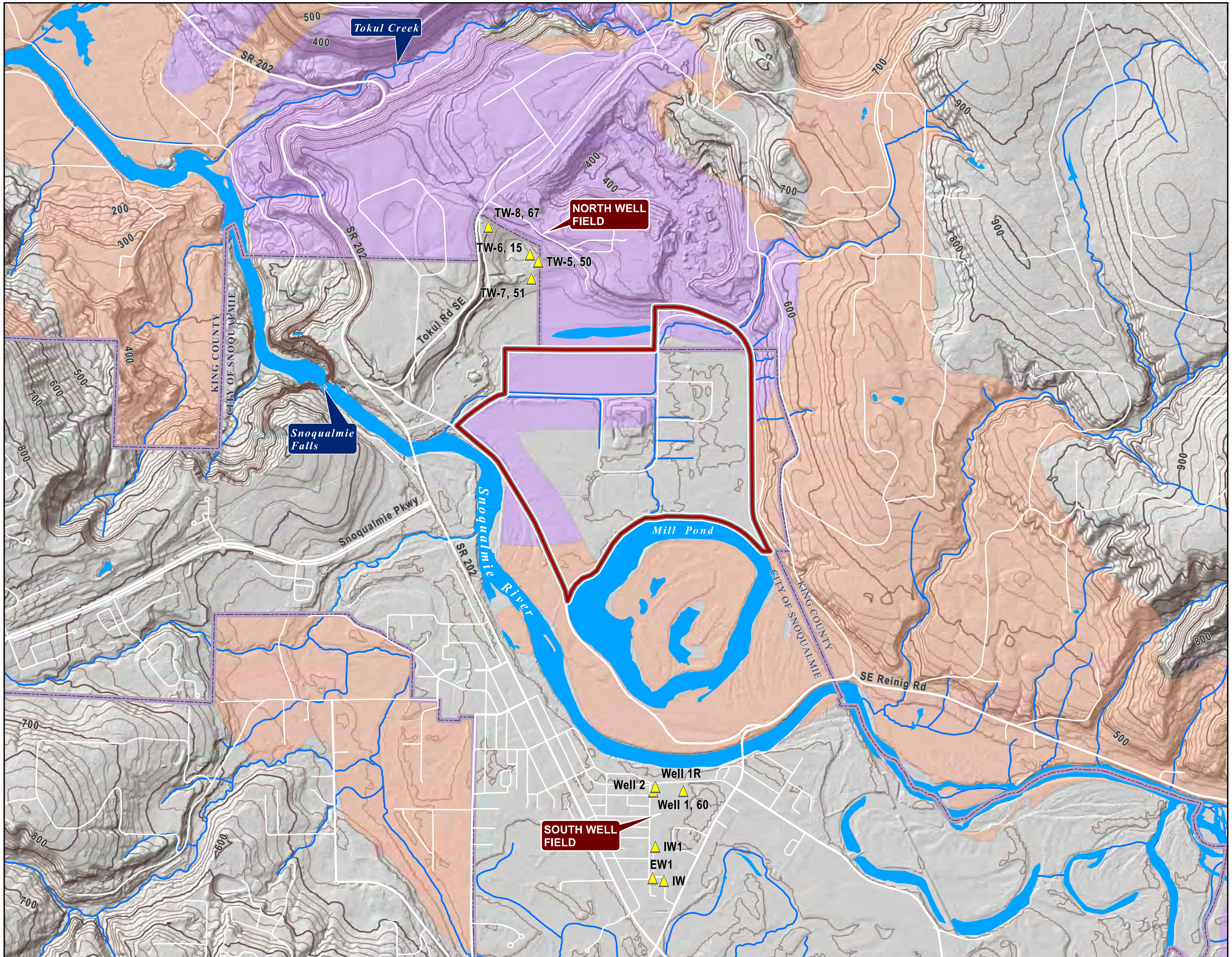

LEGEND:

SITE

WATER SUPPLY WELL, AESI LABEL FOR WELL REPORT

CRITICAL AQUIFER RECHARGE AREA CATEGORY

1 - HIGH SUSCEPTIBILITY

2 - MODERATE SUSCEPTIBILITY

CITY BOUNDARY

CONTOUR 100 FT

CONTOUR 20 FT

DATA SOURCES / REFERENCES:
PSLC 2016 KING CO., DELIVERY 4 FLOWN 3/26/16 - 8/27/16, GRID CELL SIZE IS 3'.
PSLC: CEDAR RIVER WATERSHED 2014
DELIVERY2 = CEDAR RIVER/LAKE, JULY 2014.
WA STATE PLANE NORTH (FIPS 4601), NAD83(HARN)
NAVD88 GEOID03 (GEOID03), US SURVEY FEET
LIDAR PROJECTS MOSAICED USING BLEND IN OVERLAP
CONTOURS FROM LIDAR
KING CO: PARCELS, STREETS, HYDRO 1/18, CARA 9/17

LOCATIONS AND DISTANCES SHOWN ARE APPROXIMATE

N

0 750 1500
FEET

BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION

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CRITICAL AQUIFER RECHARGE AREAS

SNOQUALMIE MILL SITE
SNOQUALMIE, WASHINGTON

PROJ NO.	DATE:	FIGURE:
120126H012	4/18	20

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