APPENDIX B

GEOTECHNICAL ASSESSMENT; SKAMANIA QUARRY; SKAMANIA COUNTY, WASHINGTON
PREPARED BY NV5
DATED AUGUST 17, 2021

August 17, 2021

J.L. Storedahl and Sons, Inc.
2233 Talley Way
Kelso, WA 98626

Attention: Bo Storedahl

Geotechnical Assessment
Skamania Quarry
Skamania County, Washington
Project: Storedahl-12-01

INTRODUCTION

NV5 is pleased to submit this report summarizing our geotechnical assessment of the proposed Skamania Quarry project located approximately 3.5 miles northwest of the community of Skamania off of McCloskey Creek Road in unincorporated Skamania County, Washington. The location of the proposed mine permit boundary is shown on Figure 1.

This report is intended to address Skamania County Code (SCC) Sections 19.07.030 and 19.07.040 for Geologically Hazardous Areas, which require a geotechnical assessment if a subject property contains or is within 100 feet of mapped landslides, scarps, and flanks as documented by the Washington State Department of Natural Resources (DNR) landslide inventory mapping of the area. The absence of additional geologic hazard areas on the site or in its vicinity, as defined by the above code sections, is also documented in this study. This report is intended to provide supporting documentation for J.L. Storedahl and Sons, Inc.'s Conditional Use Permit application with Skamania County for use of the subject property as an aggregate mine.

This report discusses the geologic hazards associated with the existing conditions at the project site and the potential effects to geologic hazards with respect to the proposed mining and reclamation activities. Current slope gradients at the site are shown in Figure 2. The slope gradients, elevation data, and contours presented on Figures 2 through 5 are based on analysis of light detection and ranging (LiDAR) elevation data available from DNR using Esri ArcMap 10.8 software. The geologic hazard areas presented on Figures 3 and 4 are based on data available from DNR's Washington Geologic Information Portal website (2021) as well as geologic hazard mapping completed by Mickelson et al. (2018).

SITE CONDITIONS

GEOLOGIC SETTING

The site is situated on the crest of a southwestern- to northeastern-oriented ridge, with McCloskey Creek running in the adjacent valley to the west. The Columbia River lies 2.25 miles south of the site. The highest elevations on site are found along the site's central axis and the lowest on its flanks, with elevations ranging from approximately 1,840 to 2,340 feet above mean sea level (MSL) across the site. Geologic mapping by Evarts and Fleck (2017) indicates that the site is primarily underlain by a sequence of basalt flows from the Columbia River Basalt Group, which in turn unconformably overlie the upper volcanic member of the Eagle Creek Formation.

The Eagle Creek Formation consists of weakly lithified volcaniclastic rocks and local interbedded lava flows deposited by activity and erosion of the ancestral Cascade Volcanic Arc. The upper volcanic member of the Eagle Creek Formation, as mapped on site, is composed of lithic pyroclastic flow and lahar deposits, along with other sedimentary and volcaniclastic deposits. It has been dated to be approximately 19.5 million years old.

Basalt flows of the Grand Ronde Basalt and the Wampum Basalt cap the stratigraphy at the site, both being members of the Columbia River Basalt Group, which is a voluminous sequence of flood basalts originating in vent complexes centered on present-day southeastern Washington and northeastern Oregon. These basalt flows are typically blocky to columnar in texture and are well exposed along the Columbia River Gorge. These flows are approximately 15 million years old.

Several phases of subsurface drilling were conducted at the site to evaluate aggregate resource potential in 2016 and 2018, including 53 borings on the site to maximum depths in excess of 140 feet below ground surface (BGS). Drilling indicated basalts of the Columbia River Basalt Group extend to at least the maximum depths explored in the northern and southern portions of the site, consistent with the geologic mapping of Evarts and Fleck (2017).

Evarts and Fleck (2017) also map a structural horst bisecting the site from east to west across the central portion of the project area. The older Eagle Creek Formation is upthrown against the younger Columbia River Basalt Group to the north and south.

SURFACE CONDITIONS AND FIELD OBSERVATIONS

An engineering geologist from our office conducted a field reconnaissance on April 1, 2021 to observe the existing site characteristics. Slope gradients derived from LiDAR analysis of existing slopes are presented on Figure 2.

The proposed mine project area has historically been used for forestry, with several prior rounds of harvest, replanting, and regrowth occurring on the property. Currently, the majority of the site has been clear-cut, with the last harvest occurring in phases between 2013 and the present. Clear-cut areas were subsequently replanted. Saplings and juvenile trees now occupy most of the site surface, along with large slash piles and debris from logging. A band of mature timber bisects the northern third of the site, and this was being actively harvested during our reconnaissance. Areas on the periphery of the parcels and adjacent to drainages were left

unharvested by recent logging operations. A small bedrock excavation exists in the south-central portion of the site and has been historically used as a timber pit, providing aggregate for logging roads and staging areas in the vicinity. The excavation exposes hard, fresh to slightly weathered basalt belonging to the Columbia River Basalt Group covered by only a few feet of weathered rock and topsoil.

Much of the slopes along the eastern and western flanks of the northern ridge are 40 percent or greater, with the central and southern portions of the site generally showing slopes of 25 percent or less. Based on our observations of exposed soil and road cuts across the site, topsoil was observed to be approximately 2 feet thick, with subsoil of approximately 2 to 4 feet thick.

A small landslide is mapped by DNR on the western edge of the site, as shown on Figures 3 and 4. Our field observations confirmed the presence of the slide, and its mapped extent is generally accurate. The interpreted scarp and slide mass have been smoothed over by erosion, suggesting it is an ancient feature. We did not observe ground cracking or other indications of recent slide movement. Outcrop exposed by prior timber disturbance near the toe of the slide mass, as well as material excavated by animal burrows in the scarp and slide mass, consisted of tephra, volcaniclastic material, and large blocks of andesite. Based on the geologic mapping by Evarts and Fleck (2017) and their unit descriptions, we believe the slide is located near the northern edge of the structural horst that crosses the site, mapped as the upper member of the Eagle Creek Formation. A small water seep was observed at the toe of the slide.

GROUNDWATER

Based on our review of water well logs available from the Washington State Department of Ecology (DOE), the closest recorded wells to the site were drilled as water sources for residences along McCloskey Creek Road, Kellet Road, and Mabee Mines Road approximately 1.5 miles southwest of the proposed site. Surface elevations of these wells range between 1,450 and 1,650 feet MSL, and static water levels are recorded within a range of 20 to 480 feet BGS, with most static water levels ranging between 20 and 50 feet BGS. Current plans call for mining to a maximum depth of 2,050 feet MSL, which is significantly higher than water levels observed in adjacent wells and the surface groundwater elevation in McCloskey Creek, west of the site. No consistent, permanent groundwater table was encountered in the subsurface borings drilled at the site. Based on this information and the site's location on a relatively isolated topographic high, we do not consider local groundwater to be a contributing factor to geologic hazards at the proposed site.

Perched water is likely to be encountered in geologic zones of reduced permeability during the wet season, where rainwater can infiltrate and temporarily mound atop less permeable units. The seep observed at the far toe of the landslide during our surface reconnaissance is typical of this phenomenon, and some of the borings encountered isolated water levels at varying depths. We interpret these features to represent locally perched water and not a contiguous aquifer or site-wide water level.

SURFACE WATER

Surface runoff on site is currently split between McCloskey Creek to the west and several streams located northeast, east, and south of the site. Proposed mine stormwater plans call for the collection of runoff from all disturbed areas to be directed inward to infiltrate in the floor of the mine. Current plans place a 200-foot or greater buffer zone between the proposed permit boundary and nearby water bodies and wetlands in the vicinity (Figures 2 through 4), and even greater distance from proposed surface disturbance. The seep mapped at the base of the DNR-mapped slide is greater than 500 feet from the edge of proposed mining disturbance on site.

GEOLOGICALLY HAZARDOUS AREAS

Geologically hazardous areas identified in SCC 19.07.010 include erosion hazard areas, landslide hazard areas, seismic hazard areas, and volcanic hazard areas. SCC 19.07.040 further outlines specific criteria for landslide hazard reporting and evaluation. This report has been prepared to address these criteria and discuss each of the regulated hazards.

EROSION HAZARD AREAS

According to SCC 19.07.010(A), erosion hazard areas correspond to areas identified by the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) as having "severe" or "very severe" erosion susceptibility. According to USDA NRCS, three soils are mapped on site: Skoly stony loam, 2 to 15 percent slopes; Skoly stony loam, 30 to 65 percent slopes; and Mountzion clay loam, 2 to 15 percent slopes. These soils are characterized as having only "slight" (Skoly) to "moderate" (Mountzion) potential for erosion hazard. As such, these soils do not have "severe" or "very severe" erosion susceptibility.

The proposed mining will disturb fine-grained soil in the project area and potentially make it susceptible to erosion. In accordance with standard mining practices and requirements from DNR, all topsoil within the mined area will be stored in stockpiles and vegetated to stabilize the piles from erosion. Removal of vegetation and topsoil will occur in discrete phases in advance of segmental mining of the site, and re-distribution and re-vegetation of topsoil will occur as portions of the mine are exhausted, with the intent of returning affected areas back to use as timber lands. Recommendations for stabilizing temporary soil stockpiles are provided below.

LANDSLIDE HAZARD AREAS

Landslide hazard areas are defined under SCC 19.02, with additional applicable standards defined in SCC 19.07.010. DNR (2021) mapping and our field observations indicate a small, shallow landslide is located on the western edge of the proposed site, as shown in Figures 3 and 4. At distances greater than 100 feet east of the proposed site, the head scarp of a much larger, deep-seated failure is well defined and mapped by multiple sources (DNR, 2021; Evarts and Fleck, 2017) as part of a massive landslide complex associated with erosion along the Columbia River. Other landslide features were not noted in our field observations, nor in mapping completed by DNR. We discuss these landslide hazards in the "Conclusions and Recommendations" section.

SEISMIC HAZARD AREAS

Seismic hazard areas are defined under SCC 19.02 as areas subject to severe risk of damage as a result of earthquake-induced ground shaking, slope failure, settlement, soil liquefaction, debris flows, or lahars. SCC Section 19.07.010(C)1 additionally qualifies seismic hazard areas based on seismic design category maps created by DNR. Based on the Site Class Map of Skamania County, Washington (Palmer et al., 2004), the site is mapped as Site Class B, which does not indicate a severe risk for ground shaking amplification, slope failure, or settlement. The mapped hazard for liquefaction is classified as "not applicable" due to the presence of shallow bedrock. No active faults are mapped by the U.S. Geological Survey (USGS) (2017) within the site area; fault rupture is not considered a hazard for the site.

VOLCANIC HAZARD AREAS

Volcanic hazard areas regulated under SCC 19.07 include near-volcano hazards and lahar zones as mapped by USGS. Based on USGS hazard mapping presented on DNR's (2021) Geologic Information Portal website, the site is not mapped in either zone.

CONCLUSIONS AND RECOMMENDATIONS

Based on our research and site observations, it is our opinion that the proposed mine project will not have a significant impact on the geologic hazard areas identified on site and in the vicinity. The massive landslide complex to the east associated with the Columbia River is significantly far from the proposed project, which will remove material through mining from areas upslope of the headscarp and thus reduce driving forces that might affect landslide stability. The smaller landslide hazard mapped by DNR at the site can be effectively mitigated by employing the mine plan presented on Figures 3 through 5 and implementing the recommendations summarized below.

ON-SITE LANDSLIDE

We interpret the small landslide mapped on the western edge of the site to be an ancient feature that does not show indications of recent displacement. We recommend the proposed mine project avoid the headscarp area of this feature and not place materials near the headscarp, which could add weight and possibly cause retrogression of the scarp.

The proposed mine plan presented on Figures 2 through 5 follows our recommendations. A minimum 50-foot setback has been incorporated into the plan between the top of the small landslide headscarp to the proposed limits of the mine excavation and operations area to prevent mine activity from affecting the scarp. Additionally, grading of the operations area and mining in the northern portion of the site near this feature will be conducted by removing material, thus reducing potential driving forces for possible additional sliding.

SLOPE RECOMMENDATIONS

Based on our observations of exposed basalt in the current timber pit and from extensive drilling of the site, benched highwalls in basalt bedrock are likely to be competent and stable over the life cycle of the mine. Final slopes for the proposed mine should be completed at gradients of 2H:1V as shown on Figures 4 and 5.

A temporary overburden and topsoil stockpile is proposed for the eastern-central sloped area shown on Figures 2 through 5. Vegetation should be cleared and topsoil removed from the area and separately stockpiled before the overburden soil is placed. Where the temporary stockpile will be placed over existing slopes greater than 15 percent, the ground surface should be graded into a benched geometry to avoid slide-plane development below the fill. Slopes for the temporary overburden and topsoil stockpile should be constructed at a gradient of 3H:1V or flatter, which is shown on Figure 5. This gradient is equivalent to the natural slope below the proposed fill location.

Final reclaimed slopes may receive overburden backfill to lessen slope gradients and promote revegetation of the final slopes, depending on the amount of overburden soil encountered and distributed around the site during mining. Final slopes that receive overburden backfill should vary between 2H:1V and 3H:1V. Reclamation fill slopes should be placed in lifts using bulldozers or other heavy equipment and track compacted into place to a firm, unyielding condition. Lifts should generally not exceed 2 feet in thickness. If the fill material has significant fines, it should be placed during dry weather or when not excessively above optimum moisture content.

STORMWATER MANAGEMENT

Stormwater from the mine disturbance area should be routed away from the top of steep slopes to avoid decreasing slope stability. Surface water drainage from the proposed topsoil storage and operations area should be routed to the northern mine excavation to the greatest extent possible and then to the mine floor. Stormwater in extraction areas should be directed to the interior of the mined excavation and then to the floor for infiltration. Figure 4 shows the final site topography at the completion of mining in accordance with these recommendations.

Best management practices (BMPs) should be implemented to reduce or control erosion before the site is disturbed. Stormwater plans will be required as part of the DNR Surface Mine Reclamation Permit and the DOE Sand and Gravel General Permit for the mine, which will identify stormwater control measures and BMPs to control stormwater and prevent soil from leaving the site by erosion.

STABILIZING SOIL STOCKPILES

Temporary stockpiles of topsoil and overburden soil intended to be left in place for more than one week should be stabilized to prevent soil loss and erosion. Stockpiles can be seeded with erosion control grass mixture or mulched with weed-free straw or compost. Seeding should take place as soon as practical following stockpile placement.

PRESERVE VEGETATION

The proposed mine plan includes clear limits for mining disturbance to preserve undisturbed vegetated buffers outside of the mining. Vegetation should be preserved on slopes outside the mine area to stabilize soil from erosion and to comply with existing reclamation requirements.

LIMITATIONS

We have prepared this report for use by J.L. Storedahl and Sons and members of the design and construction teams for the proposed mining and reclamation of the site, and for obtaining land

use approval for same. The data and report can be used for estimating purposes, but our report, conclusions, and interpretations should not be construed as warranty of the subsurface conditions and are not applicable to areas other than the subject property.

The scope of our services does not include services related to construction safety precautions, and our recommendations are not intended to direct the contractor's methods, techniques, sequences, or procedures, except as specifically described in this report for consideration in design.

Within the limitations of scope, schedule, and budget, our services have been executed in accordance with generally accepted practices in this area at the time the report was prepared. No warranty, express or implied, should be understood.

♦ ♦ ♦

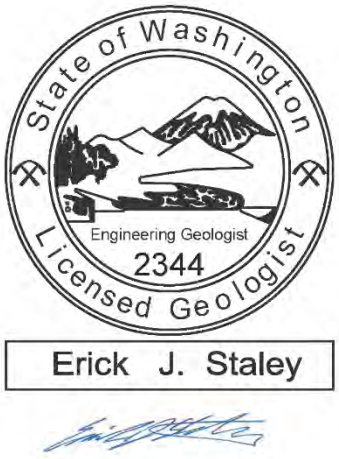
Please call if you have questions concerning this report or if we can provide additional services.

Sincerely,

NV5

John C. Hook
Technical Specialist/Geologist

Erick J. Staley, L.E.G.
Principal Engineering Geologist



Signed 08/17/2021

JCH:EJS:sn
Attachments
One copy submitted (via email only)
Document ID: Storedahl-12-01-081721-geolr-geohaz.docx

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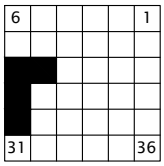
USGS, 2017. *Quaternary Fault and Fold Database of the United States*. Retrieved April 2, 2021 from https://usgs.maps.arcgis.com/apps/webappviewer/index.html?id=5a6038b3a1684561a9b0aadf88412fcf

FIGURES

T 2 N



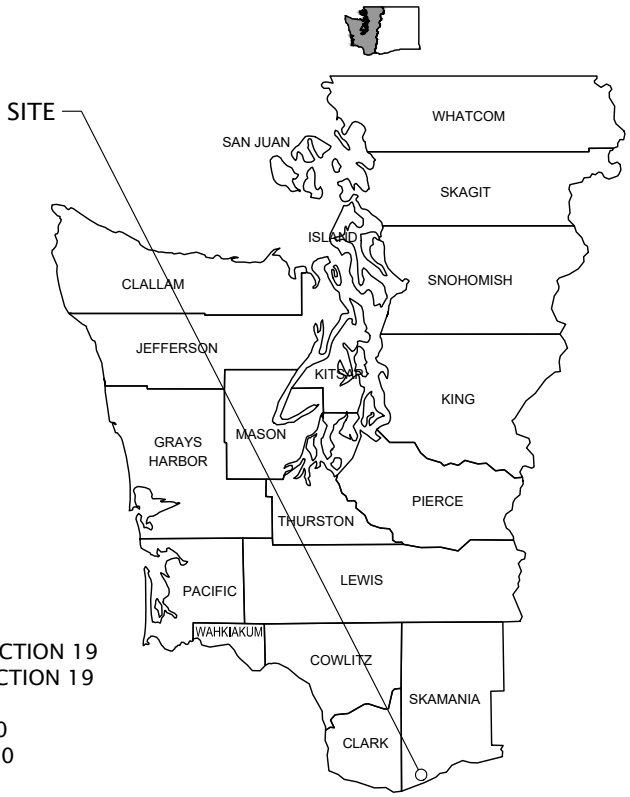
R 6 E

SITE COORDINATES:

LATITUDE: 45° 38' 24" N

LONGITUDE: 122° 6' 43" W

WESTERN WASHINGTON



DIRECTIONS TO SITE

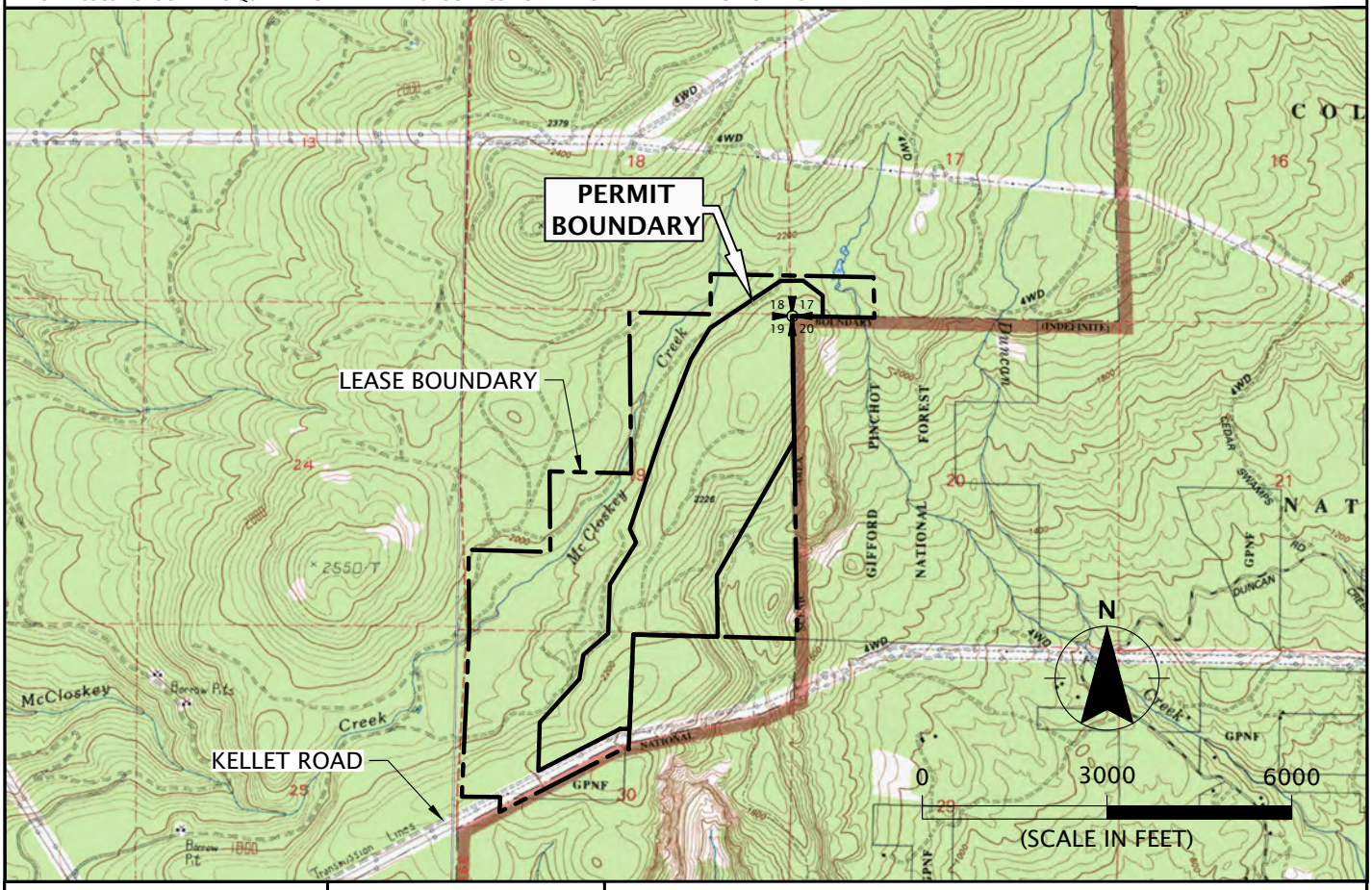
SKAMANIA QUARRY IS LOCATED NORTHEAST OF WASHOUGAL, WA. FROM WASHOUGAL, DRIVE EASTBOUND ON HIGHWAY 14 FOR APPROXIMATELY 8 MILES. TURN LEFT (NORTH) ONTO SALMON FALLS ROAD. DRIVE NORTHBOUND FOR ROUGHLY 1 MILE, THEN TURN RIGHT (EAST) ONTO MABEE MINES ROAD. FOLLOW MABEE MINES ROAD FOR APPROXIMATELY 2 MILES, THEN TURN RIGHT ONTO KELLET ROAD. FOLLOW KELLET ROAD FOR APPROXIMATELY 1.75 MILES. SKAMANIA QUARRY IS LOCATED ON THE LEFT (NORTHERN) SIDE OF KELLET ROAD.

LEGAL DESCRIPTION

THE PERMIT BOUNDARY IS LOCATED IN PORTIONS OF THE FOLLOWING QUARTER-QUARTER SECTIONS:

- SW QUARTER OF THE SW QUARTER OF SECTION 17
- SE QUARTER OF THE SE QUARTER OF SECTION 18
- NW, NE, SE, AND SW QUARTERS OF THE NE QUARTER OF SECTION 19
- NW, NE, SE, AND SW QUARTERS OF THE SE QUARTER OF SECTION 19
- SE QUARTER OF THE SW QUARTER OF SECTION 19
- NE AND SE QUARTERS OF THE NW QUARTER OF SECTION 30
- NW AND SW QUARTERS OF THE NE QUARTER OF SECTION 30

NOTE: USGS TOPOGRAPHIC QUADRANGLE MAP REPRODUCED USING MAPTECH TERRAIN NAVIGATOR PRO®.



NV5	STOREDAHL & SONS, INC.	**VICINITY MAP** SKAMANIA QUARRY
	STOREDAHL-12-01 AUGUST 2021	SKAMANIA COUNTY, WA SECS. 17, 18, 19 & 30, TOWNSHIP 2N, RANGE 6E, W.M.
		FIGURE 1

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File Name: J:\S-Z\Storedahl\Storedahl-12\Storedahl-12-01\Figures\CAD\Storedahl-12-01-VM03.dwg | Layout: FIGURE 1

LEGEND:

- PERMIT BOUNDARY (273.6 ACRES)
- 200-FOOT OFFSET FROM PERMIT BOUNDARY
- BPA EASEMENT (APPROXIMATE)
- 2300' EXISTING TOPOGRAPHY (20-FOOT INTERVALS; 100-FOOT INDEX)
- 18 17 / 19 20 SECTION CORNER
- MCCLOSKEY CREEK
- STREAMS AND DRAINAGES
- WETLAND
- LIMITS OF MINING DISTURBANCE AND RECLAMATION
- OPERATIONS/PROCESSING AREA (14.3 ACRES)
- TOPSOIL/OVERBURDEN AREA (15.9 ACRES)

SLOPES TABLE		
COLOR	MIN. SLOPE	MAX. SLOPE
	15%	25%
	25%	40%
	40%	>40%

50 FT

300 FT

SITE ACCESS

N

0 600 1200

(SCALE IN FEET)

NOTES:

1. EXISTING TOPOGRAPHY CREATED FROM LIDAR (2019) OBTAINED FROM WASHINGTON DNR.
2. CREEKS, STREAMS, AND DRAINAGES OBTAINED FROM WASHINGTON DNR FOREST PRACTICES APPLICATION REVIEW SYSTEM.
3. WETLAND LOCATIONS OBTAINED FROM NATIONAL WETLAND INVENTORY.
4. LANDSLIDES AND SCARPS MAPPED BY DNR (2021).
5. FOR STORMWATER EROSION CONTROL MEASURES, SEE NARRATIVE.

EXISTING CONDITIONS - SLOPE GRADIENT MAP

SKAMANIA QUARRY

SKAMANIA COUNTY, WA

SECS. 17, 18, 19 & 30, TOWNSHIP 2N, RANGE 6E, W.M.

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STOREDAHL-12-01

AUGUST 2021

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FIGURE 2

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LEGEND:

- PERMIT BOUNDARY (273.6 ACRES)
- 200-FOOT OFFSET FROM PERMIT BOUNDARY
- BPA EASEMENT (APPROXIMATE)
- EXISTING TOPOGRAPHY (20-FOOT INTERVALS; 100-FOOT INDEX)
- SECTION CORNER
- MCCLOSKEY CREEK
- STREAMS AND DRAINAGES
- WETLAND
- SCARP
- LANDSLIDE
- LIMITS OF MINING DISTURBANCE AND RECLAMATION
- OPERATIONS/PROCESSING AREA (14.3 ACRES)
- TOPSOIL/OVERBURDEN AREA (15.9 ACRES)

108 FT

300 FT

50 FT

SITE ACCESS

N

0 600 1200

(SCALE IN FEET)

NOTES:

1. EXISTING TOPOGRAPHY CREATED FROM LIDAR (2019) OBTAINED FROM WASHINGTON DNR.
2. CREEKS, STREAMS, AND DRAINAGES OBTAINED FROM WASHINGTON DNR FOREST PRACTICES APPLICATION REVIEW SYSTEM.
3. WETLAND LOCATIONS OBTAINED FROM NATIONAL WETLAND INVENTORY.
4. LANDSLIDES AND SCARPS MAPPED BY DNR (2021).
5. FOR STORMWATER EROSION CONTROL MEASURES, SEE NARRATIVE.

EXISTING CONDITIONS - LANDSLIDE HAZARD AREAS
SKAMANIA QUARRY

SKAMANIA COUNTY, WA
SECS. 17, 18, 19 & 30, TOWNSHIP 2N, RANGE 6E, W.M.

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AUGUST 2021

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FIGURE 3

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LEGEND:

- PERMIT BOUNDARY (273.6 ACRES)
- 200-FOOT OFFSET FROM PERMIT BOUNDARY
- BPA EASEMENT (APPROXIMATE)
- LIMITS OF RECLAMATION
- EXISTING TOPOGRAPHY (20-FOOT INTERVALS; 100-FOOT INDEX)
- FINAL TOPOGRAPHY (20-FOOT INTERVALS; 100-FOOT INDEX)
- SECTION CORNER (18 17 / 19 20)
- MCCLOSKEY CREEK
- STREAMS AND DRAINAGES
- WETLAND
- SCARP
- LANDSLIDE
- CROSS SECTION (A A')

108 FT

300 FT

50 FT

SITE ACCESS

N

0 600 1200

(SCALE IN FEET)

NOTES:

1. EXISTING TOPOGRAPHY CREATED FROM LIDAR (2019) OBTAINED FROM WASHINGTON DNR.
2. CREEKS, STREAMS, AND DRAINAGES OBTAINED FROM WASHINGTON DNR FOREST PRACTICES APPLICATION REVIEW SYSTEM.
3. WETLAND LOCATIONS OBTAINED FROM NATIONAL WETLAND INVENTORY.
4. LANDSLIDES AND SCARPS MAPPED BY DNR (2021).

FINAL TOPOGRAPHY - LANDSLIDE HAZARD AREAS
SKAMANIA QUARRY

SKAMANIA COUNTY, WA
SECS. 17, 18, 19 & 30, TOWNSHIP 2N, RANGE 6E, W.M.

FIGURE 4

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AUGUST 2021

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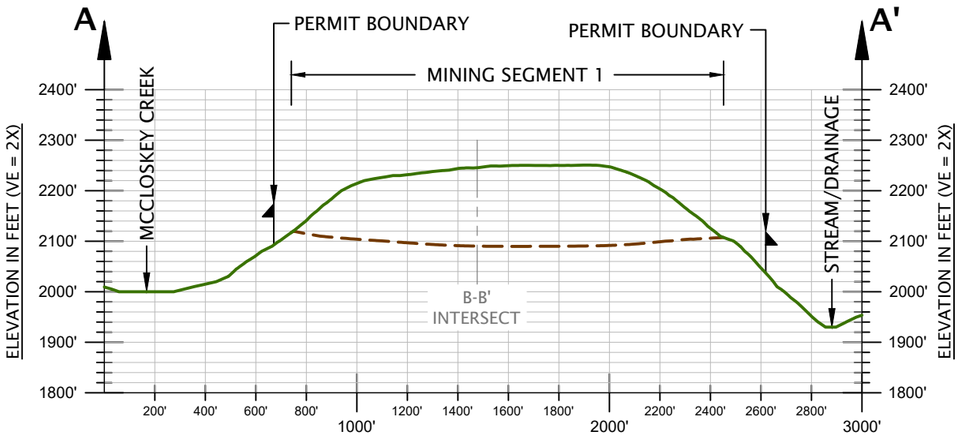
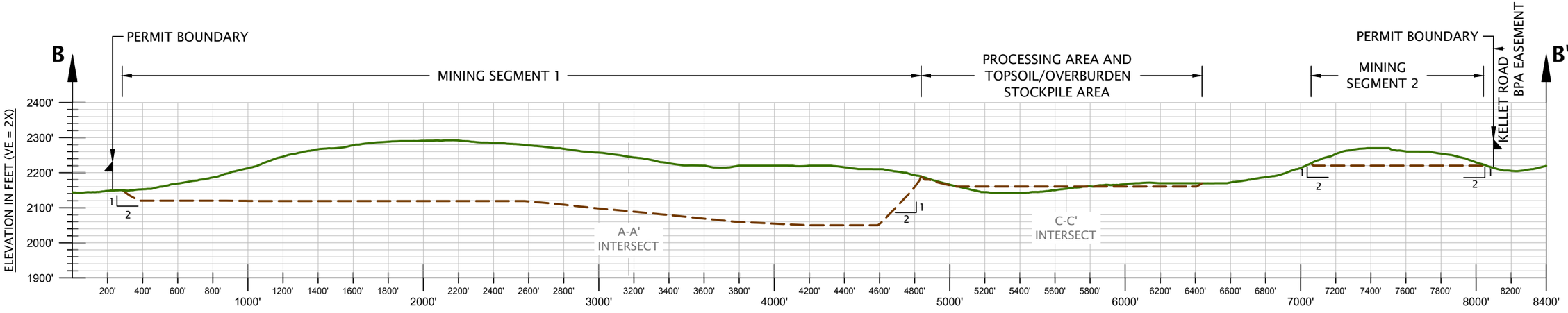


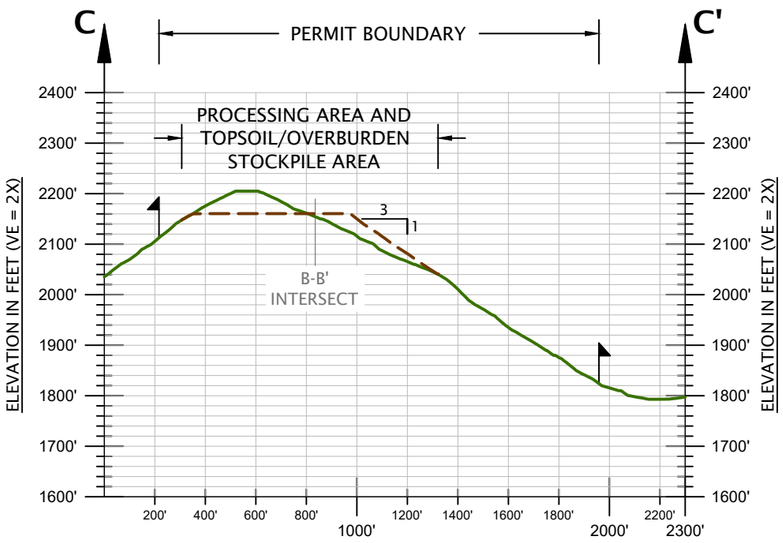
LEGEND:

EXISTING TOPOGRAPHY

FINAL TOPOGRAPHY

PERMANENT MARKER





VERTICAL EXAGGERATION = 2X

0 300 600

(VERTICAL SCALE IN FEET)

0 600 1200

(HORIZONTAL SCALE IN FEET)

CROSS SECTIONS A-A', B-B', AND C-C'

SKAMANIA QUARRY

SKAMANIA COUNTY, WA

SECS. 17, 18, 19 & 30, TOWNSHIP 2N, RANGE 6E, W.M.

FIGURE 5

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