EXHIBIT H.1

Preliminary Stormwater Plan Prepared by CPH Consultants

CP|H CONSULTANTS

Preliminary Stormwater Site Plan

Drainage Report
Johnson Ridge

Poulsbo, WA

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36495
REGISTERED
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3/30/20

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March 30, 2020

Preliminary Stormwater Site Plan

FOR

JOHNSON RIDGE

POULSBO, WA

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SECTION 1 – PROJECT OVERVIEW

This drainage report is provided to describe the existing stormwater conditions and proposed drainage improvements associated with the *Johnson Ridge* detached single-family residential project. The project proposes to subdivide and improve an approximately 13.74-acre property (Kitsap County tax parcel no. 252601-2-004-2008). It will create 61 single-family lots, private tracts, and public ROW dedication. This report is provided to identify the applicable storm drainage standards and to summarize the analysis and design provisions proposed for the project to comply with 2012 Department of Ecology Stormwater Management Manual for Western Washington, as amended in December 2014, as specified by current Poulsbo Municipal Code (PMC), section 12.02.030.

The vicinity map provided below as Figure 1 illustrates the general location of the property. The site is located at 17504 Johnson Road NE, Poulsbo WA, Kitsap County, 98370. More generally the site is located in a portion of the NW ¼, Section 25, Township 26 North, Range 1 East, W.M., Kitsap County, Washington. (see Vicinity Map below).

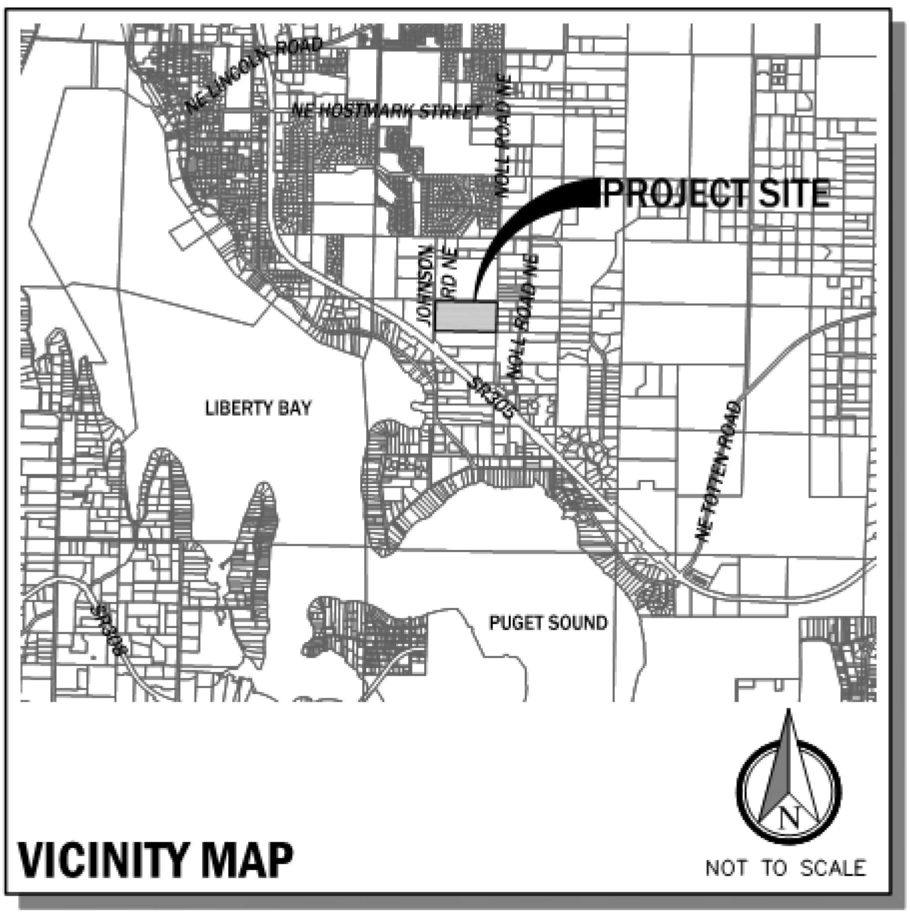


Figure 1 – Vicinity Map

The project site is currently comprised of 1 tax parcel (Kitsap County tax parcel no. 252601-2-004-2008) totaling approximately 18.71 acres adjacent to the east side of Johnson Road. It currently contains areas of trees, cleared areas that are now pasture/grass and shrubs. A single-family residence and several outbuildings used to exist on the property but have since been removed. The property is currently vacant. A number of trees of varying type, age, and health conditions exist on portions of the site. The site and surrounding parcels are zoned RL in Poulsbo, Washington. Figure 3 in the Appendix represents the existing site conditions.

The proposed development will subdivide a 13.74-acre property to create 61 new single-family residential lots. The portion of the existing parcel not being developed as part of this project is being acquired by the City for their *Noll Road Improvements* project. The *Johnson Ridge* project will create and/or replace a total of approximately 5.70 acres of impervious surfaces. Approximately 0.09 acres of impervious surface currently exist onsite. The site has two basins that flow primarily as sheet and shallow concentrated flows. The east basin flows from higher elevations along a ridge running northwest to south through the project site to lower elevations in the north and east boundaries. The west basin flows from that same ridge to lower elevations in the south and west boundaries. Steep topography in the eastern portion of the site create a ravine area within the buffer of Bjorgen Creek, and that area will remain undeveloped with the proposed project.

The developed site is required to provide Basic Water Quality treatment in addition to flow control standards in accordance with 2012 Department of Ecology Stormwater Management Manual for Western Washington (SMMWW) criteria. Flow control will be provided by a detention vaults for each basins. The vaults will be located in Tract 997 and 998. The below-grade vault proposed in the southeastern portion of the site will have a control structure discharging to a gravel trench level spreader releasing flow towards Bjorgen Creek. The below-grade vault proposed in the southwestern portion of the site will have a control structure discharging to the existing storm drainage system located in the eastern portion of the Johnson Road NE frontage. Basic water quality treatment will be provided through the use of two Modular Wetland water quality treatment facilities located downstream of the detention vaults.

On-site Soil Conditions

The soils of the project area are characterized generally by the Natural Resource Conservation Services (NRCS) as Poulsbo gravelly sandy loam with slopes ranging from 0% to 30%.

A site-specific investigation of the existing geotechnical conditions was performed by GeoResources. A copy of their Geotechnical Engineering Report (September 29, 2019) is provided in Appendix A of this report for reference. Figure 2 provides an overall drainage information summary for this project.

SECTION 2 – CONDITIONS AND REQUIREMENTS SUMMARY

Compliance with Project Drainage Requirements

The storm drainage analysis and facilities design for this project are proposed in general accordance with the 2012 Department of Ecology Stormwater Management Manual for Western Washington, as amended in December 2014, as specified by current Poulsbo Municipal Code (PMC), section 12.02.030. The project is classified as New Development and will result in greater than 5,000 square-feet of new impervious surface, therefore all nine Minimum Requirements for stormwater management specified by the manual are applicable.

Minimum Requirements

1. **Preparation of Stormwater Site Plans**: Stormwater site plans and storm drainage report herein have been prepared for the subject project. Refer to Section 7 and Appendix E of this report for the downstream analysis.
2. **Stormwater Pollution Prevention Plan (SWPPP)**: The SWPPP is summarized in Section 5. A detailed SWPPP in accordance with Department of Ecology General Construction Stormwater Permit conditions will be available on the job site prior to construction.
3. **Source Control of Pollution**: Source control Best Management Practices (BMPs) will be installed on site to the maximum extent practicable. These will include educational information in the CC&Rs for the residences regarding limiting use of phosphate fertilizers and recommendations to wash vehicles offsite at commercial car wash centers.
4. **Preservation of Natural Drainage Systems and Outfalls**: The site has two separate drainage subbasins and natural drainage patterns—one east and the other to the west. The east pattern has an ultimate discharge to Bjorgen Creek. The western portion of the site drains in a southwest direction towards Johnson Road NE. Both of these basins have an ultimate discharge to Liberty Bay in Puget Sound.
5. **On-site Storm Water Management**: Storm water will be detained, treated, and released at a controlled rate by the two onsite vaults with water quality treatment vaults located downstream. BMPs were evaluated and Post-Construction Soil Quality and Depth will be implemented.
6. **Runoff Treatment**: Basic Water Quality Treatment is required for this project. A proprietary modular wetland filtration vaults are proposed to achieve runoff treatment to the Basic water quality treatment for runoff from both basins. The water quality treatment facilities will be located downstream of the detention vaults. Figure 4 illustrates the developed site plan for the project and Appendix C contains the details for the modular wetland facilities.
7. **Flow Control**: Storm water will be detained and released at a controlled rate by two onsite vaults located in Tract 997 and 998. Design details of the flow control facilities are described in Section 6 of this report and is as required by current storm drainage requirements. Figure 4 illustrates the developed site plan for the project.
8. **Wetlands Protection**: There are no wetlands onsite. There is a wetland to the north and offsite. The City's pending Johnson Way improvements project will be constructing an arterial roadway, including a paved multi-use trail, between the site and the wetland and its buffer. Any buffer or wetland mitigation required will be provided by the City for their project. Bjorgen Creek is a Type F1 stream. It will be protected by a critical area and open space tract containing the standard 200-foot vegetated buffer per City code.
9. **Operation and Maintenance**: The on-site storm drainage facilities within the right-of-way are proposed to be publicly maintained. The vaults are also proposed to be publicly owned and maintained. Section 8 and Appendix E contain the elements of the Operation and Maintenance Manual required.

SECTION 3 – EXISTING SITE CONDITIONS

The project site is currently comprised of a single tax parcel (Kitsap County tax parcel no. 252601-2-004-2008) totaling approximately 13.74 acres. This site currently contains areas of trees, cleared areas that are now pasture/grass and shrubs. A single-family residence and several out buildings used to exist on the property but have since been removed. The property is currently vacant. A number of trees of varying type, age, and health conditions exist on portions of the site. The site and surrounding parcels are zoned RL in Poulsbo, Washington. Figure 3 in the Appendix represents the existing site conditions.

The site is comprised of two drainage sub-basins that flow primarily as sheet and shallow concentrated flows. The east basin flows from a ridge and knoll running through the project site to lower elevations in the north and east boundaries. The west basin flows from that same ridge to lower elevations in the south and west boundaries. A stream, Bjorgen Creek, exists near the eastern property boundary of the project site. Steep topography in the eastern portion of the site create a ravine area within the buffer of Bjorgen Creek, and that area will remain undeveloped with the proposed project. A wetland exists adjacent to the north of the project site where the future Noll Road will be built. There is no wetland buffer proposed. There are no observed conveyance systems onsite. Appendix E of this report contains a detailed analysis/description of the offsite and downstream drainage systems.

Soils are Poulsbo gravelly sandy loam with slopes ranging from 0 to 30 percent. Appendix A contains a copy of the site-specific geotechnical report for the project along with the applicable NRCS data.

SECTION 4 – UPSTREAM SITE CONDITIONS

The site is bordered by Johnson Road NE to the west, Bjorgen creek to the east, single family residence in the south, and the future Noll Road project to the north. Due to the existing topography it is unlikely that any runoff from surrounding properties could flow onsite. A ridge and knoll exist on the project site allowing all runoff to flow away from the site. Thus, there are no existing upstream drainage subbasins that would contribute runoff to the site.

SECTION 5 – SWPPP

Storm Water Pollution Prevention Plan (SWPPP)

1. *Mark Clearing Limits*
   To prevent disturbance of project areas not designated for construction, a construction clearing limits fence or silt fence will be installed by the Contractor. These fences will be installed in accordance with the details and specifications provided in the Plans prior to any clearing and grading activities.

2. *Establish Construction Access*
   Primary access to the site will be limited from the Johnson Road and Noll Road rights-of-way during construction. The contractor shall limit the amount of sediment transported by motor vehicles and track equipment onto paved roads or other offsite areas.

3. *Control Flow Rates*
   The proposed detention vault will serve stormwater runoff from the project site. This facility may be used in conjunction with other temporary erosion control BMP's to control the release rate and water quality of surface water from active construction areas.

4. *Install Sediment Controls*
   On-site sediment retention will be controlled by a combination of silt fence, temporary interceptor trenches, and inlet protection for existing catch basins as shown on the Plans. The contractor shall inspect and provide regular maintenance of these facilities throughout the duration of construction to ensure maximum sediment control. In addition, existing permanent storm drainage collection and conveyance facilities may be used to direct runoff from construction work areas to the on-site vault in the southeastern portion of the site to contain or provide additional capacity for storm water runoff volumes from construction areas.

5. *Stabilize Soils*
   Temporary and permanent cover measures will be provided by the Contractor to protect disturbed areas. Straw mulching is typically used to provide temporary protection from erosion at exposed soil areas. Plastic covering may also be used in order to protect cut and fill slopes, and/or to encourage grass growth in newly seeded areas. Disturbed areas that remain unworked for at least 7 days will be seeded and mulched to provide permanent cover measure and to limit erosion potential.

   Water will be used by the Contractor as allowed by local agency regulations and applicable SCDM standards to prevent wind transport of exposed soils. Exposed soils will be sprayed until wet and re-sprayed as needed during dry weather periods.

6. *Protect Slopes*
   The project does not require any disturbance of soils within steep slope or erosion hazard areas. Temporary and permanent seeding to stabilize exposed soil areas is expected to be sufficient for protecting on-site slopes—whether constructed or at disturbed native areas. Plastic covering may also be used to protect cut and fill slopes if seasonal limitations warrant and/or to encourage grass growth in newly seeded areas. The contractor shall take all practical efforts including installation of temporary interceptor ditches to direct potential storm water runoff away from the top of on-site slopes.

7. *Protect Drain Inlet*
   All storm drain inlets made operable during construction or otherwise existing in the vicinity of work areas shall be protected using pre-manufactured filter fabric catch basin inserts to protect against construction storm water runoff entering the conveyance system. The Contractor will be responsible

for maintenance of all temporary sediment control BMP's during construction, including removal of accumulated sediment, as well as for the ultimate removal of these controls and remaining accumulated sediment upon completion of construction.

8. *Stabilize Channels and Outlets*
   Methods of protection may include silt fence installation and maintenance, catch basin inserts, and temporary interceptor ditches. Stormwater runoff will generally be conveyed to the existing storm drainage system on-site for conveyance to the detention and treatment facility. Vegetated areas shall be maintained whenever possible or practical to provide for natural filtration of construction storm water discharges.

9. *Control Pollutants*
   Special provisions shall be taken to reduce the risk of pollutant contamination from the construction access, concrete handling/wash areas, and sawcutting/surfacing activities. Vehicle maintenance shall only be performed at approved on-site areas and only after proper containment devices are in place downstream of those areas. Any flammable or otherwise hazardous liquids shall be stockpiled only at the approved construction staging area.

10. *Control Dewatering*
    Runoff from dewatering operations shall be suitably filtered using approved areas of native vegetation, setting tanks or other mechanical filtration facilities, or direct discharge to the existing on-site drainage facilities if volumes meet permit standards.

11. *Maintain BMPs*
    All TESC measures will be inspected and maintained on a regular basis following the maintenance requirements identified for each plan and/or the project's Storm Water Pollution Prevention Plan (SWPPP). An ESC supervisor will be designated by the Contractor and the name, address and phone number of the ESC supervisor will be given to the regulatory jurisdiction prior to the start of construction.

    The ESC supervisor will inspect the site at least once a month during the dry season, weekly during the wet season, and within 24 hours of each runoff-producing storm event. An ESC maintenance report will be used as a written record of all maintenance in accordance with the project SWPPP

12. *Manage the Project*
    The Contractor will be responsible for the phasing of erosion and sediment controls during construction so that they are adequately coordinated with all construction activities. The Contractor will be responsible for maintenance of all temporary sediment control BMP's during construction, including removal of accumulated sediment, as well as for the ultimate removal of these controls and cleaning of existing permanent storm drainage facilities upon completion of construction.

SECTION 6 – DEVELOPED SITE CONDITIONS

The hydrologic analysis of the runoff conditions for this project is based on drainage characteristics such as basin area, soil type, and land use (i.e., pervious vs. impervious) in accordance with the applicable standards of the 2012 Department of Ecology Stormwater Management Manual for Western Washington (SMMWW). The 2012 Western Washington Hydrology Model (WWHM) software was used to evaluate the stormwater runoff conditions for the project site and to design the on-site flow control facilities. The following is a summary of the results of the analysis and the proposed drainage facility improvements for this project.

Existing Site Hydrology

The existing conditions of the site are shown by Figure 3 in the later sections of this report. The existing drainage basins are shown in Figure 5. Historic site conditions (i.e., fully forested) were considered in the WWHM analysis of the pre-developed site to establish allowable target release rates for the developed project in accordance with SWMMWW standards for Conservation (i.e., Stream Protection Duration) Flow Control. The existing land characteristics used in the WWHM model analysis are summarized in Table 6.1

Table 6.1 – Land Use Cover, Pre-Developed Site Conditions

Sub-basin Name	Description	Total Basin Area (Acres)	Land Cover (Acres)		
			Impervious	C, Lawn, Mod	C, Forest, Mod
East Basin	Pre-developed site	8.375	0.000	0.000	8.375
West Basin	Pre-developed site	5.366	0.000	0.000	5.366

The project site was analyzed as two drainage basins to determine the pre-developed runoff conditions based on the site topography and natural ridge through the central region of the site. Runoff from the East basin travels primarily as sheet and shallow concentrated flow from the north and central portions of the site steeper slopes creating a ravine at the eastern boundary that contains Bjorgen Creek. Stormwater runoff from the west basin flows primarily south and west from the same central ridge of the site to a shallow ditch and graded shoulders of Johnson Road. Flows from Johnson Ridge flow south toward SR305. These existing conditions were evaluated with the WWHM software and a report showing input and results is provided in Appendix B.

Developed Site Hydrology

The site is planned to be improved with paved public roads, storm drainage systems, and public and private utility infrastructure in support of 61 individual single-family residential lots. Primary and emergency access to the site will be provided by Johnson Road NE and Noll Road. Flow control for the east basin will be provided by a vault located in the southeast portion of the site in Tract 998. Flow control for the west basin will be provided by a vault located in the southwest portion of the site in Tract 997 which will discharge to the storm system in Johnson Road NE. This public storm system continues southerly along Johnson Road NE and ultimately crosses under SR305 and discharges to Liberty Bay. Figure 6 shows the developed site sub-basin. The developed land use conditions displayed in Table 6.2 were used as the developed site conditions for the WWHM model.

Table 6.2 – Land Use Cover, Developed Conditions

Sub-basin Name	Description	Total Area (Acres)	Land Cover (Acres)				
			Impervious	New PGIS	Replaced PGIS	C, Forest, Mod	C, Lawn, Mod
East Basin	Developed site	6.567	2.061	0.482	0.000	3.036	1.470
West Basin	Developed site	7.284	3.642	0.987	0.000	0.000	3.642

The results of the developed site runoff analysis and hydrologic model are summarized in Table 6.4 and 6.5 below, and the detailed WWHM report is provided in Appendix B.

Flow Control

The storm drainage analysis and facilities design for this project are proposed in general accordance with the 2012 Department of Ecology Stormwater Management Manual for Western Washington, as amended in December 2014, as specified by current Poulsbo Municipal Code (PMC), section 12.02.030. The hydrologic analysis of the runoff conditions for the project site is based on drainage area characteristics such as basin area, soil type, and land use (i.e., pervious, impervious). WWHM software was used to evaluate the storm water hydrology/runoff conditions for the detention vault.

The onsite storm drainage vaults have been designed to provide live storage for flow control for both basins. Discharge from the facilities is released at a controlled rate in accordance with SWMMWW standards. A notch and orifice flow control riser is proposed for the outlet control structure for the west basin vault to achieve conformance with the release to downstream systems in Johnson Road NE. A 3-orifice flow control riser is proposed for the outlet control structure for the east basin vault to achieve conformance with the release to downstream systems offsite. A 50-foot level-spreader trench will be used to disperse the vault discharge towards Bjorgen Creek. The sizes of the orifices and notch on the risers have been designed to control the release durations to match the historic, pre-developed site conditions from 50% of the 2-year event up to the 50-year event. Tables 6.4, 6.5, and 6.6 summarizes the WWHM results for the flow control analysis for the project. The full WWHM results are provided in the report in Appendix B.

Table 6.4 – East Basin and Vault Peak Design Flow Summary

Land-Use Condition	Peak Flow at Point of Compliance (cfs)			
	2-year	10-year	50-year	100-year
Pre-Developed	0.811	1.857	3.216	3.940
Developed	0.537	0.943	1.416	1.655

Table 6.5 – West Basin and Vault Peak Design Flow Summary

Land-Use Condition	Peak Flow at Point of Compliance (cfs)			
	2-year	10-year	50-year	100-year
Pre-Developed	0.532	1.212	2.092	2.560
Developed	0.250	0.434	0.646	0.753

Table 6.6a –Johnson Ridge East Vault Detention Volumes

Width	14.9'
Length	108'
Vault Live Storage Surface Area	1,609 SF
Live Storage Depth (incl. freeboard)	16.5'
Detention Volume	26,549 CF
Riser Height	16.0'
Riser Diam.	18"
Orifice 1 Diam.	2.25"
Orifice 2 Diam.	1.80"

Table 6.6b –Johnson Ridge West Vault Detention Volumes

Width	50'
Length	200'
Vault Live Storage Surface Area	10,000 SF
Live Storage Depth (incl. freeboard)	16.5'
Detention Volume	165,000 CF
Riser Height	16.0'
Riser Diam.	18"
Orifice 1 Diam.	1.80"
Orifice 2 Diam.	1.00"
Orifice 3 Diam.	3.20"

Water Quality

The SWMMWW requires all proposed projects that create greater than 5,000 sf of pollution-generating impervious surfaces (PGIS) provide water quality facilities to treat runoff of these surfaces. The project is a single-family residential project with detached homes. This moderate density residential project requires Basic Water Quality treatment. Two Modular Wetland treatment facilities are proposed downstream of detention and exceed basic water quality standards, providing enhanced treatment. See Appendix C for Modular Wetland sizing for each basin.

Conveyance Facilities

The project proposes to collect on-site runoff from the east basin and convey it to the stormwater detention vault located in Tract 998 prior to release via a level-spreader towards Bjorgen Creek. Runoff from the west basin will be collected and conveyed to the detention vault located in Tract 997 before entering the storm drainage system of Johnson Road NE. Surface runoff will be collected by roof drains, roadway and yard inlets, and a system of below grade pipes on the site. These systems convey runoff to the onsite vaults for flow control and water quality treatment as needed.

LID BMPs

The 2012 DOE SWMMWW requires the implementation of low impact development (LID) best management practices (BMPs) where feasible. Per DOE SWMMWW Figure I-2.5.1, the project site is required to implement the following BMPs where feasible:

1. BMP T5.13: Post-construction soil quality and depth

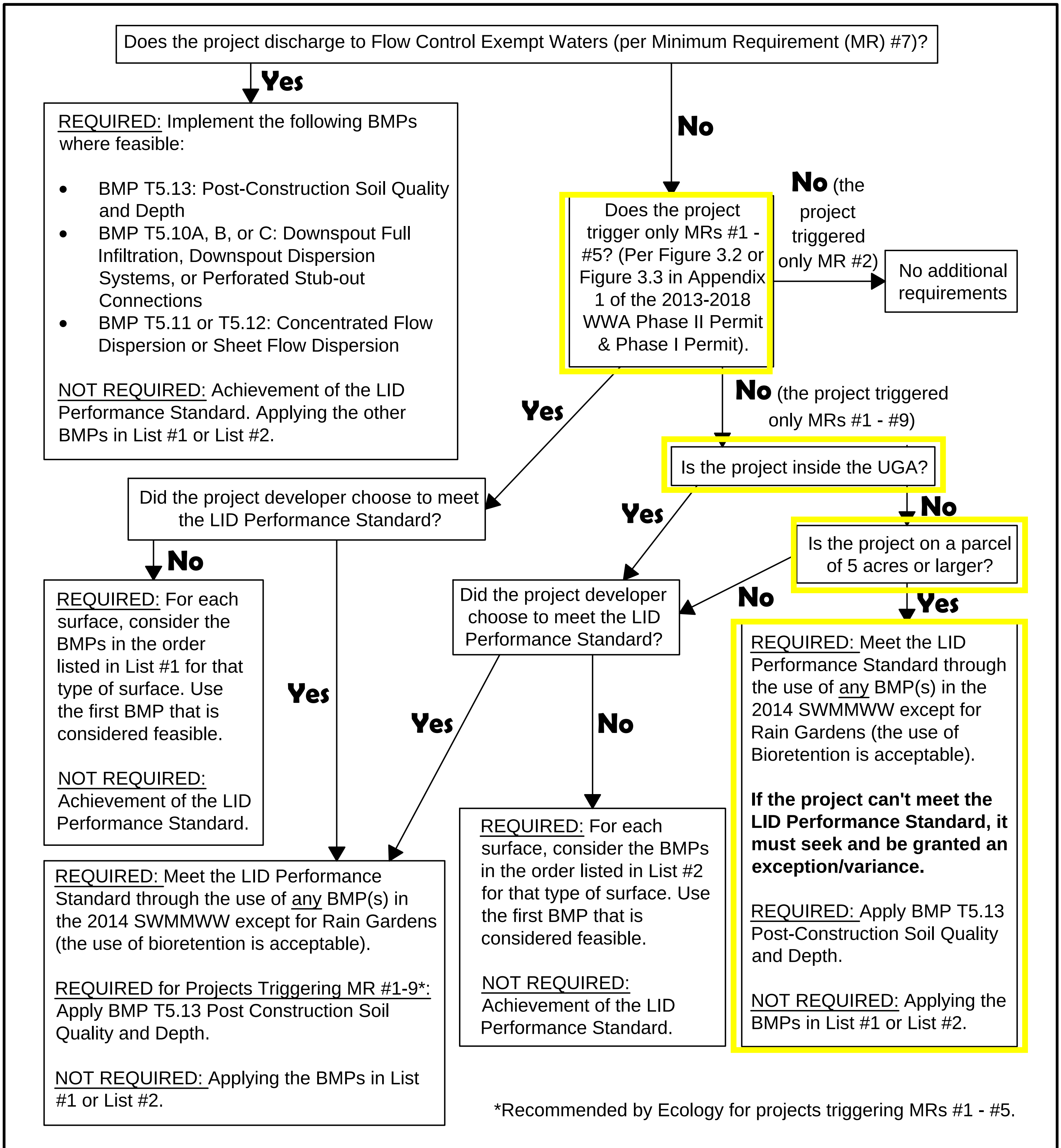
2. BMP T510A, B or C: Downspout full infiltration, downspout dispersion systems or perforated stub-out connections
3. BMP T5.11 or T5.12: Concentrated flow dispersion or sheet flow dispersion

Per DOE SWMMWW Figure I-2.5.1, the project site is required to meet the LID Performance Standard through the use of any BMP in the 2014 SWMMWW except for Rain Gardens, and BMP T5.13 Post-Construction Soil Quality and Depth is also required.

The feasibility of each of these BMPs is described in Table 6.7.

Table 6.7 – BMP Analysis

BMP	Description	Feasible?	Analysis
T5.30	Full dispersion	No	Dispersion infeasible due to insufficient flowpaths available onsite
T5.10A	Downspout Full Infiltration Systems	No	Infiltration infeasible due to glacial lacustrine deposits
T7.30	Bioretention	No	There is insufficient space available on site for bioretention.
T5.10B	Downspout Dispersion Systems	No	Dispersion infeasible due to insufficient flowpaths available onsite
T5.10C	Perforated stub out connections	No	Infiltration infeasible due to glacial lacustrine deposits
T5.11	Concentrated Flow	No	Dispersion infeasible due to insufficient flowpaths available onsite
T5.12	Sheet flow dispersion	No	Dispersion infeasible due to insufficient flowpaths available onsite
T5.13	Post-Construction Soil Quality and Depth	Yes	BMP T5.13 will be implemented for both basins of the project site.
T5.15	Rain Gardens	No	There is insufficient space available on site for bioretention.



DEPARTMENT OF ECOLOGY State of Washington

Figure I-2.5.1
Flow Chart for Determining LID MR #5 Requirements

Revised June 2015

SECTION 7 – DOWNSTREAM ANALYSIS

An analysis of the drainage conditions upstream and downstream of the site was performed to evaluate potential runoff contributions to the onsite storm water systems as well as to identify any downstream constraints. Appendix F contains the complete Offsite Drainage Analysis report detailing that analysis and findings. No downstream drainage constraints were identified that would limit storm water releases from the site to the existing downstream systems.

SECTION 8 – OPERATIONS AND MAINTENANCE MANUAL

The on-site storm drainage facilities that are the subject of this report and that are being proposed with the project will be publicly maintained. These drainage systems include catch basins, storm conveyance pipes, and a detention vault. These drainage systems have been designed in accordance with the applicable provisions of the SWMMWW, and a specific Operations and Maintenance Manual addressing the maintenance of these facilities is included in Appendix E.

FIGURES

Site Planning
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Project Management
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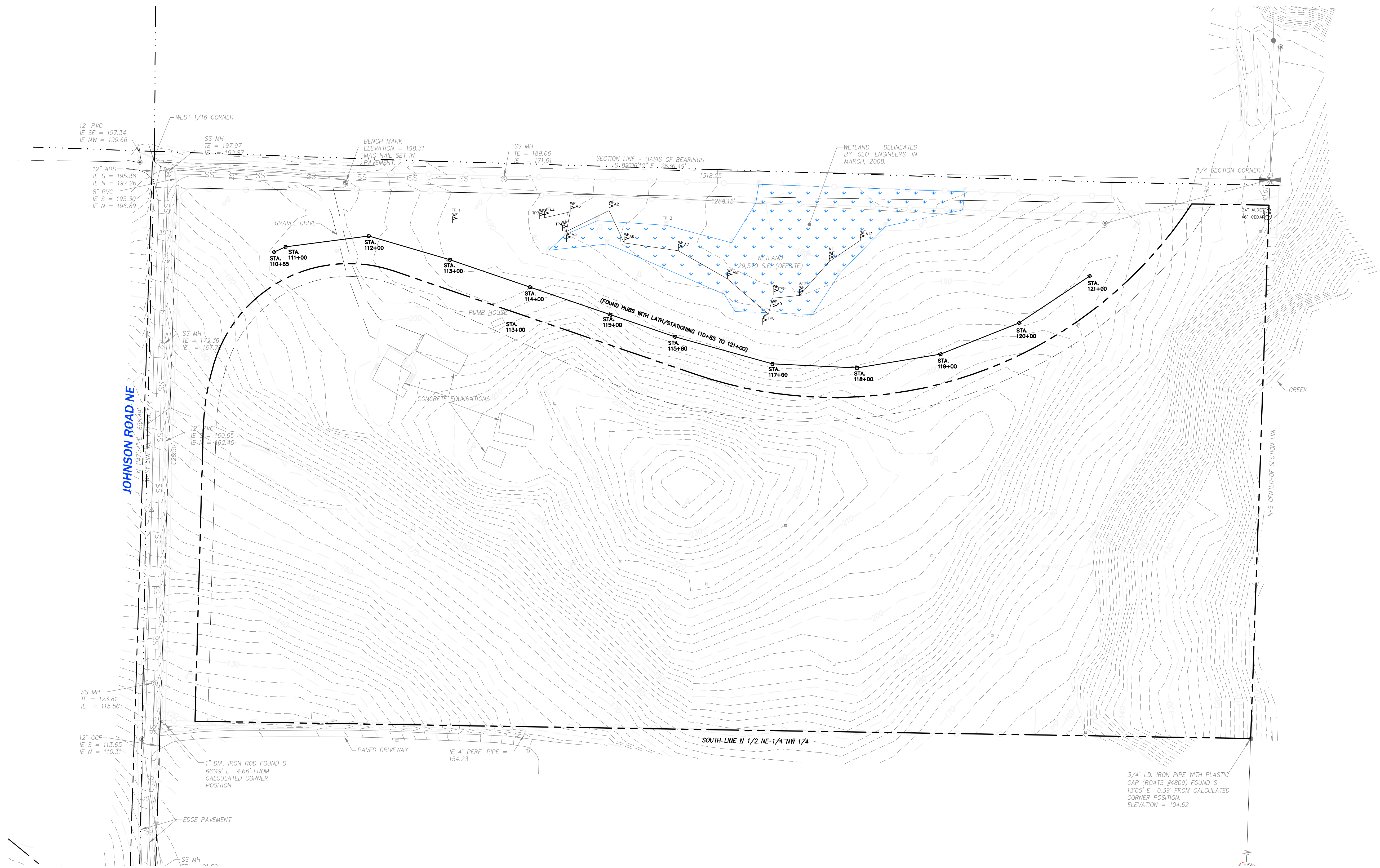

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PLAN IN FEET

JOHNSON RIDGE

FIGURE 2 - EXISTING CONDITIONS

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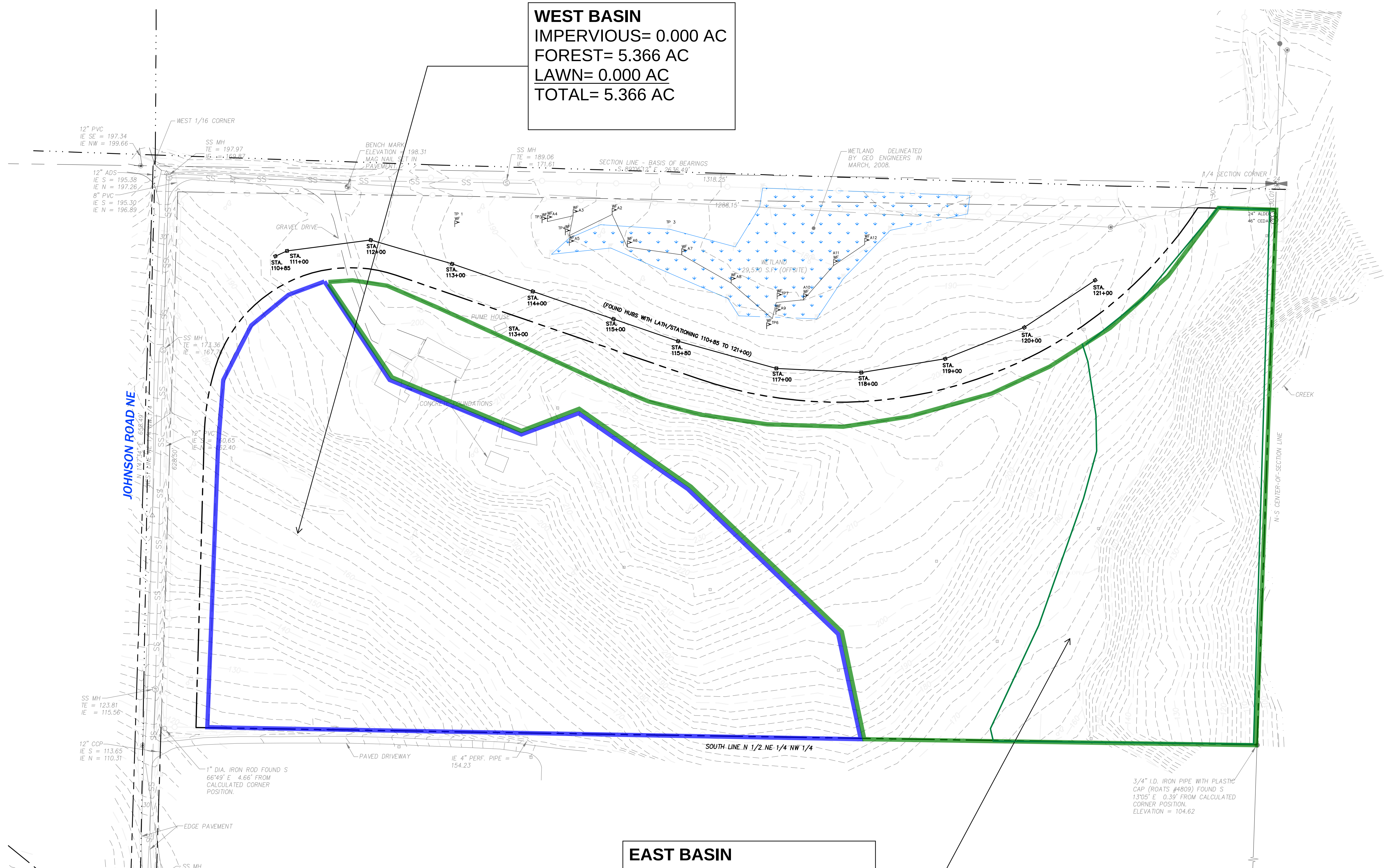
JOHNSON RIDGE

FIGURE 3 - Developed Site Conditions



WEST BASIN
IMPERVIOUS= 0.000 AC
FOREST= 5.366 AC
LAWN= 0.000 AC
TOTAL= 5.366 AC

EAST BASIN
IMPERVIOUS= 0.000 AC
FOREST= 8.375 AC
LAWN= 0.000 AC
TOTAL= 8.375 AC

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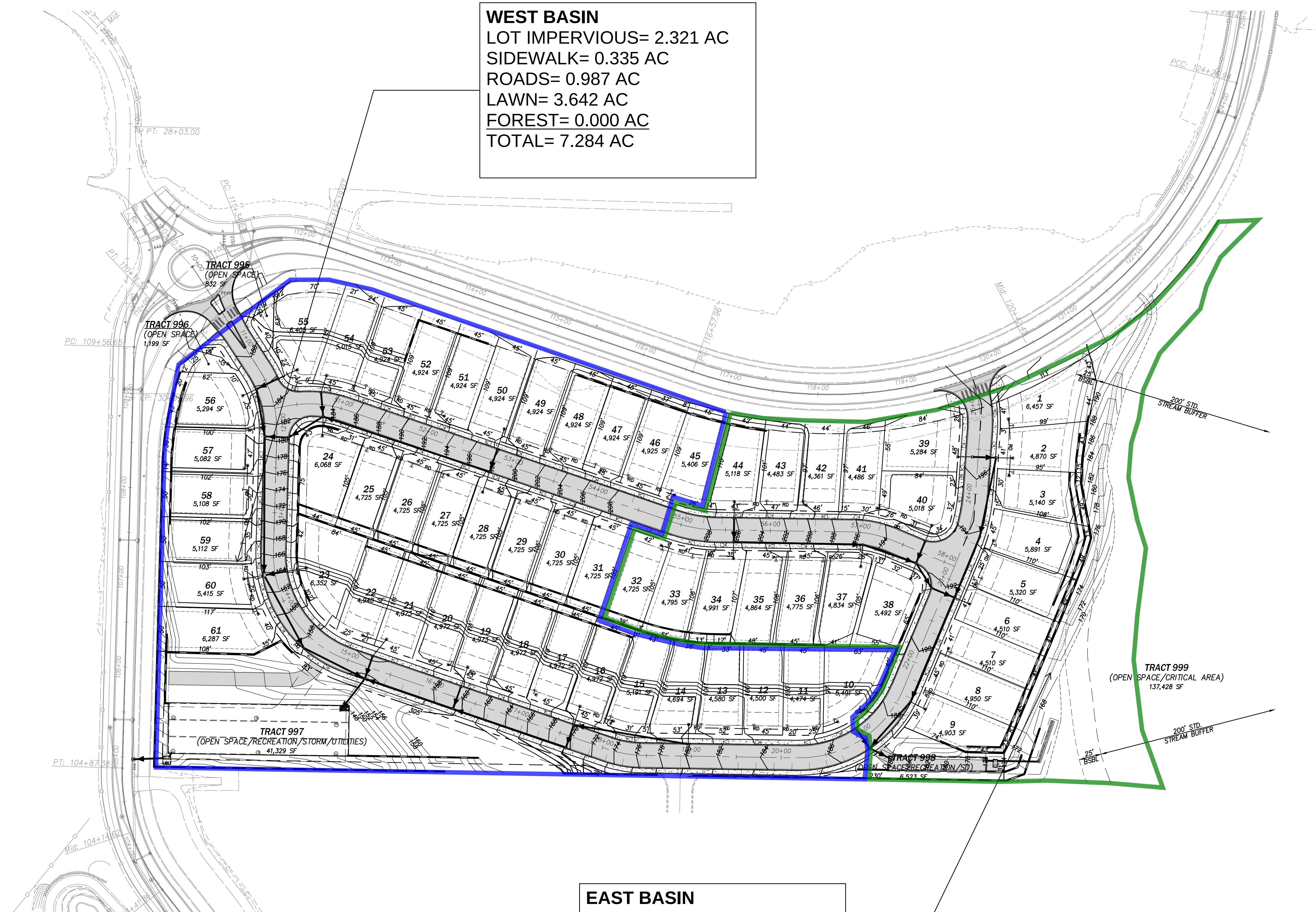
JOHNSON RIDGE

FIGURE 4 - EXISTING STORM DRAINAGE BASINS



WEST BASIN
LOT IMPERVIOUS= 2.321 AC
SIDEWALK= 0.335 AC
ROADS= 0.987 AC
LAWN= 3.642 AC
<u>FOREST= 0.000 AC</u>
TOTAL= 7.284 AC

EAST BASIN
LOT IMPERVIOUS= 1.269 AC
SIDEWALK= 0.309 AC
ROADS= 0.482 AC
LAWN= 1.470 AC
<u>FOREST= 3.036 AC</u>
TOTAL= 6.567 AC

JOHNSON RIDGE

FIGURE 5 - Developed Site Drainage Basins

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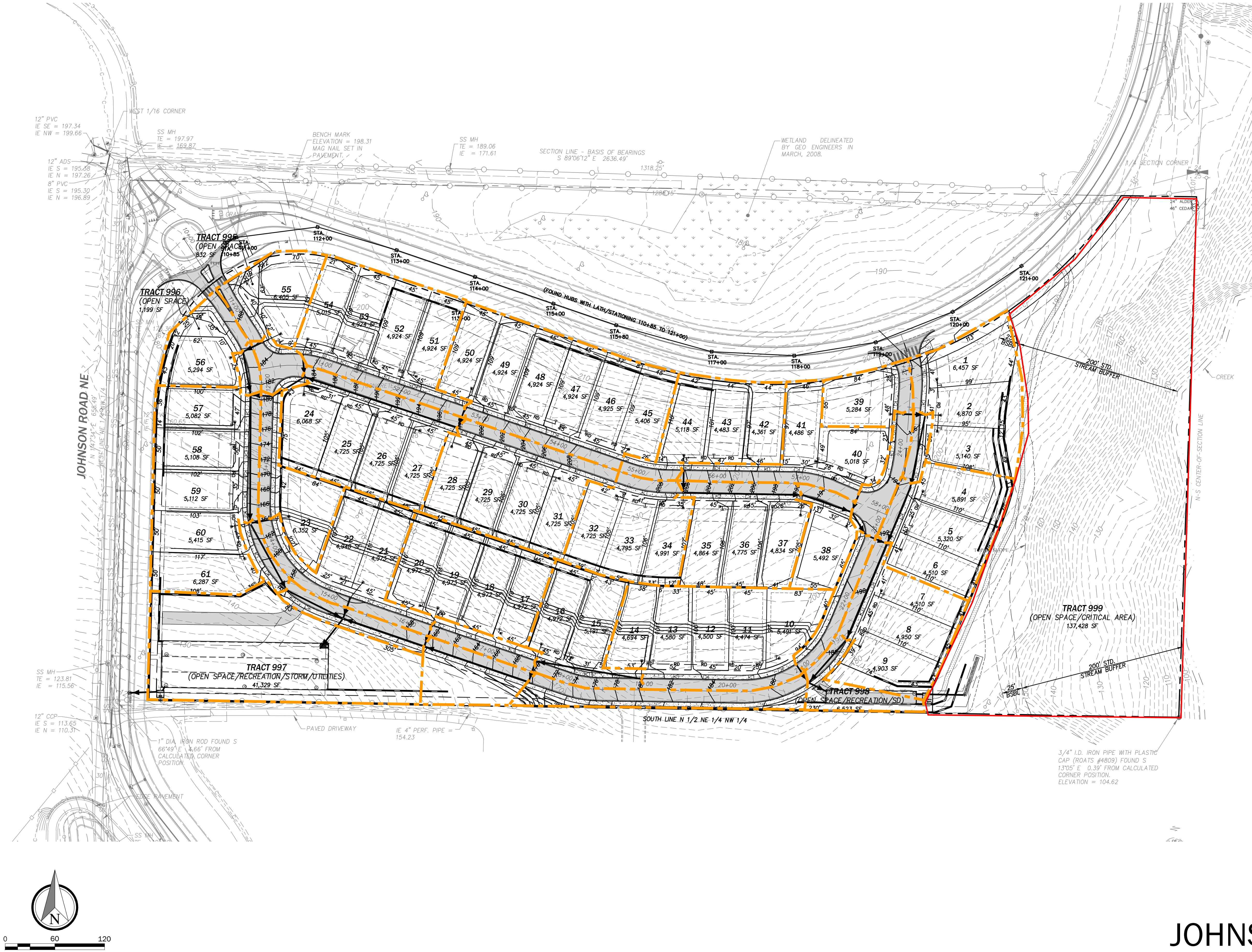

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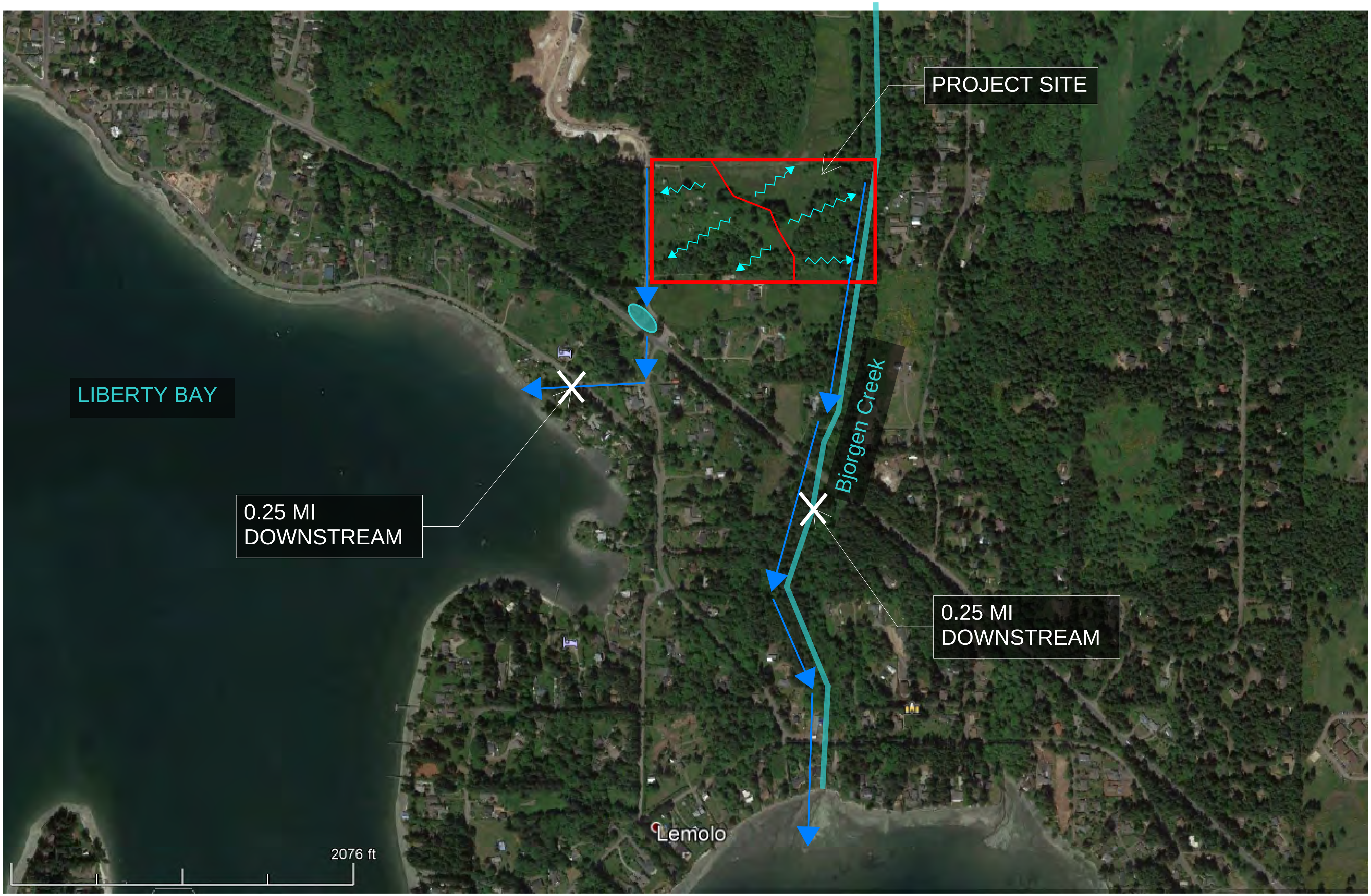
FIGURE 6 - Conveyance Subbasins



NORTH

Figure 7 - Downstream Map

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APPENDIX A

NRCS SOILS REPORT AND GEOTECHNICAL REPORT

Site Planning
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Project Management
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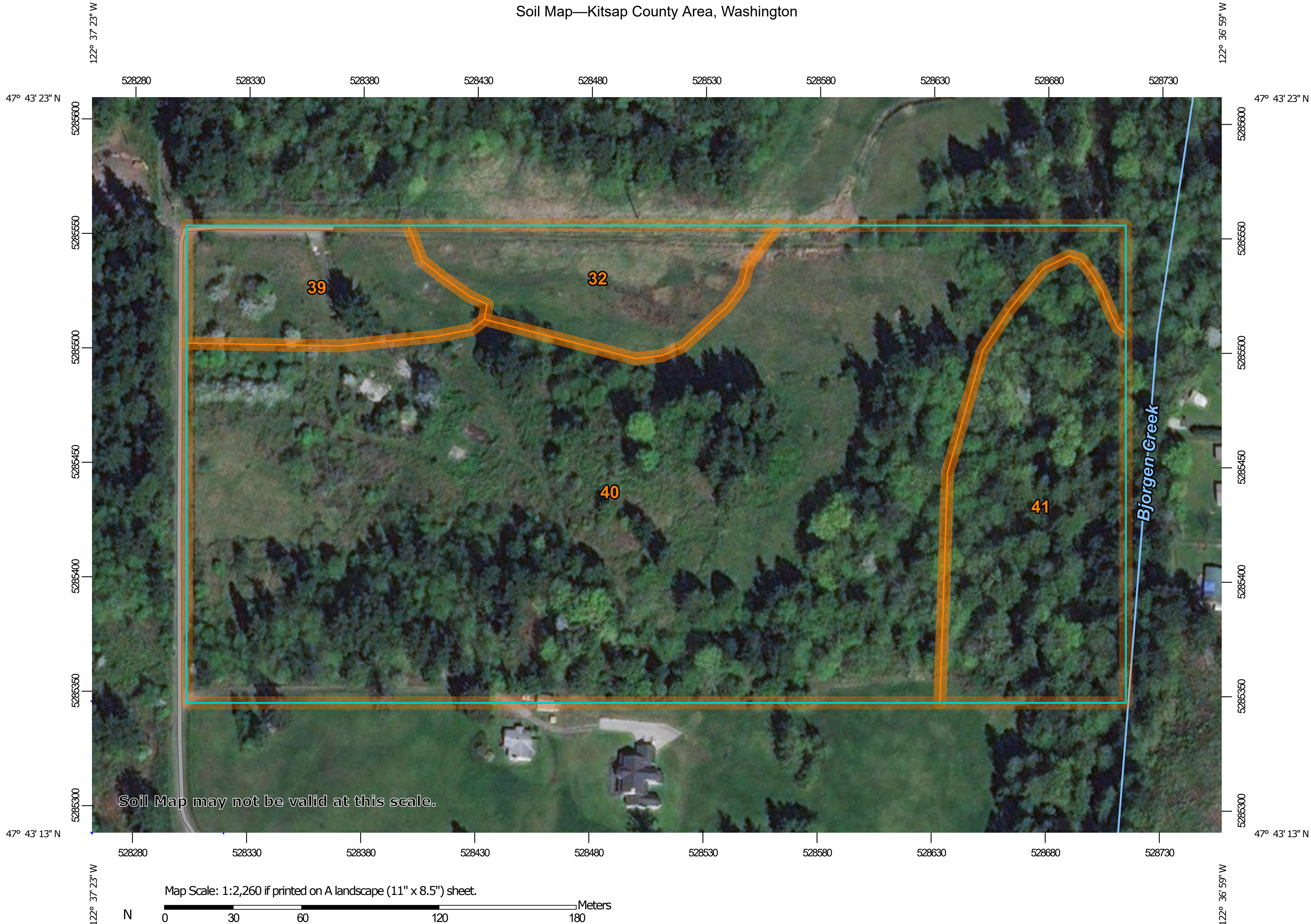

Map Scale: 1:2,260 if printed on A landscape (11" x 8.5") sheet.

Meters: 0, 30, 60, 120, 180

Feet: 0, 100, 200, 400, 600

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Unit Polygons

Soil Map Unit Lines

Soil Map Unit Points

Special Point Features

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Kitsap County Area, Washington
Survey Area Data: Version 14, Sep 10, 2018

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 29, 2016—Sep 27, 2016

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
32	McKenna gravelly loam	1.6	7.5%
39	Poulsbo gravelly sandy loam, 0 to 6 percent slopes	1.5	6.8%
40	Poulsbo gravelly sandy loam, 6 to 15 percent slopes	14.9	70.1%
41	Poulsbo gravelly sandy loam, 15 to 30 percent slopes	3.3	15.6%
Totals for Area of Interest		**21.3**	**100.0%**

July 29, 2019

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Geotechnical Engineering Report
Proposed Residential Plat
17504 Johnson Road Northwest
Poulsbo, Washington
PN: 252601-2-004-2008
Doc ID: SWW.JohnsonRoadNW.RG.rev02

INTRODUCTION

This geotechnical engineering report summarizes our site observations, subsurface explorations, laboratory testing and engineering analyses, and provides geotechnical recommendations and design criteria for the proposed residential plat to be constructed at 17504 Johnson Road Northeast in Poulsbo, Washington. The general location of the site is shown on the attached Site Location Map, Figure 1.

Our understanding of the project is based on our conversation with you, our review of a *Highest and Best Use Site Plan* prepared by AHBL dated August 3, 2018 and the *Preliminary Site Plan* prepared by CPH Consultants dated July 29, 2019, our review of the letter from the City of Poulsbo Engineering Department dated December 19, 2017 regarding the Johnson Road Extension Project, our understanding of Poulsbo development codes, and our experience in the area. We understand that you propose to construct a multi-lot residential plat with several retaining walls to accommodate the grade changes at the site. The plat will also include several open space tracts, two stormwater tracts, two roads, and two wetlands with associated buffers. A copy of the proposed site development is attached as our Site and Exploration Plan, Figure 2. Cross sections showing existing and approximate proposed grades for the development are attached as Figures 3a and 3b. We anticipate the proposed residences will be one or two story, wood framed structures founded on conventional shallow foundations.

We also reviewed the Preliminary Geotechnical Investigation: Proposed Residential Development report prepared by N.L. Olson and Associates, Inc dated December 2007. This report included the descriptive log of 15 test pits excavated at across the site.

SCOPE

The purpose of our services was to evaluate the surface and subsurface conditions across the site as a basis for providing geotechnical recommendations and design criteria for the proposed development. Specifically, the scope of services for this project included the following:

1. Reviewing the available geologic, hydrogeologic, and geotechnical data for the site area;
2. Exploring surface and subsurface conditions by reconnoitering the site and monitoring the excavation of a series of test pits at select locations across the site;
3. Describing surface and subsurface conditions, including soil type, depth to groundwater, and an estimate of seasonal high groundwater levels;
4. Addressing potential Geological Hazard Areas per City of Poulsbo Municipal Code (CPMC) 16.20.410;
5. Providing geotechnical conclusions and recommendations regarding site grading activities, including site preparation, subgrade preparation, fill placement criteria, suitability of on-site soils for use as structural fill, temporary and permanent cut slopes and drainage and erosion control measures;
6. Providing conclusions regarding shallow foundations and floor slab support and design criteria, including bearing capacity and subgrade modulus as appropriate;
7. Evaluating the global stability at the site by completing slope stability models in SLIDE 7.0 by RocScience for the existing conditions at the site;
8. Providing our opinion about the feasibility of onsite infiltration in accordance with the 2012 Stormwater Management Manual for Western Washington (SWMMWW) with 2014 Amendments, as adopted by the City of Poulsbo under CPMC 12.02.030;
9. Providing a preliminary design infiltration rate based on grain size analysis, if unconsolidated soils are encountered or small scale Pilot Infiltration Tests (PIT) if glacially consolidated soils are encountered;
10. Providing recommendations for erosion and sediment control during wet weather grading and construction; and,
11. Preparing a written *Geotechnical Engineering Report* summarizing our site observations and conclusions, and our geotechnical recommendations and design criteria, along with the supporting data.

The above scope of work was summarized in our *Proposal for Geotechnical Engineering* Services dated August 22, 2018. We received written authorization to proceed from Mr. Ken Allen on August 29, 2018.

SITE CONDITIONS

Surface Conditions

The site is located at 17504 Johnson Road Northwest in Poulsbo, Washington within an area of existing residential development. Based on the information provided on the Highest and Best Use Site Plan prepared by AHBL dated August 3, 2018 and the updated Preliminary Site Plan prepared by CPH Consultants in 2019, the site is rectangular in shape, measures 675 feet to 677 feet (north to south) wide by 1346 feet to 1352 feet deep (east to west), and encompasses about 13.74 acres. The site is bounded by a stream to the west, Johnson Road Northwest to the east and northwest, and by undeveloped land to the north and south.

The site generally slopes down in all directions from a localized high point in the center of the site. In general, the site slopes down from the high point at 15 to 25 percent, with localized areas as flat as 6 to 10 percent and as steep as 40 to 55 percent. Within the proposed area of development, the areas steeper than 40 percent have a vertical height on the order of 20 feet. There is a wetland located in the north-central portion of the site, and the topography in that area is generally flat to gently sloping towards the center of the wetland. A ravine sloping down from north to south crosses the eastern margin of the site, labeled Tract 905 on Site and Exploration Plan, Figure 2. The side walls of the ravine slope down at approximately 45 to 60 percent. The southern portion of the ravine has sidewalls that slope down at about 15 to 35 percent. The vertical height of the side walls is on the order of 60 to 70 feet. The bottom of the ravine slopes down to the south at approximately 12 to 15 percent. The total topographic relief across the site is on the order of 130 feet. The existing site topography for the site and surrounding area is shown on both the Site and Exploration Plan, Figure 2 and Site Vicinity Map, Figure 4.

Vegetation across the site generally consists of various native and invasive grasses, areas of dense blackberry bushes, and moderate stands of coniferous and deciduous trees. No areas of surficial erosion, active slope movement, or surficial seeps, springs, or standing water were observed at the site at the time of our reconnaissance.

Site Soils

The USDA Natural Resource Conservation Service (NRCS) Web Soil Survey maps the majority of the site as being underlain by Poulsbo gravelly sandy loam (39, 40, and 41) soils, and the north-central portion of the site as being underlain by McKenna gravelly loam (32) soils. The Poulsbo soils are derived from basal till with volcanic ash and are included in hydrologic soils group B/D. The 39 soils, mapped in the northwest corner of the site, form on slopes of 0 to 6 percent and have a "slight" erosion hazard when exposed. The 40 soils, mapped in the southwest, central, and northeast portions of the site, form on slopes of 6 to 15 percent and have a "moderate" erosion hazard when exposed. The 41 soils, mapped in the east-central and southeast portions of the site, form on slopes of 15 to 30 percent and have a "moderate to severe" erosion hazard when exposed. The McKenna soils are derived from glacial till, form on slopes of 0 to 6 percent, have an erosion hazard of "none," and are included in hydrologic soils group D. A copy of the soils map for this area is provided in Figure 5.

Site Geology

The *Geologic map of the Suquamish 7.5' Quadrangle and part of the Seattle North 7.5' x 15' Quadrangle, Kitsap County, Washington* (Haugerud and Troost, 2011) maps the site as being underlain by glacial till (Qvt) and Esperance sand (Qev), with several, small isolated areas mapped as landslide deposits (Qls). The glacial soils were deposited during the most recent Vashon Stade of the Fraser Glaciation, approximately 12,000 to 15,000 years ago. The glacial till consists of a heterogeneous mixture of clay, silt, sand, and gravel that was deposited at the base of the prehistoric continental glacial ice mass and was subsequently over-ridden. The Esperance sand (an outwash deposit) consist of a poorly sorted lightly stratified mixture of sand that may contain localized deposits of gravel, silt, and clay that were deposited by meltwater streams emanating from the advancing ice mass, and were subsequently overridden. As such, the glacial till and advance outwash are considered over-consolidated and exhibits high strength and low compressibility characteristics.

The mapped landslide deposits typically consist of jumbled mixtures of gravel, sand, silt and clay that are typically in a loose condition. The map describes the landslides as being mapped primarily based on morphology (landforms). The largest landslide area is in the western portion of the site, in line with the access road on the western side of the parcel. The slide deposit generally lines up with a shallow swale that is at the north of the northwest corner of the parcel, while the portion of the site where the slide debris is located is generally flat with no scarps, hummocks or other geomorphic features common of landslide deposits. There are several smaller deposits within the drainage swale on the east side of the parcel. As stated above, we observed no evidence of landslide activity on the site or in these areas during our site visit. An excerpt of the above referenced map is included as Figure 6.

The Washington State Department of Ecology Coastal Atlas maps the site and site area to be stable. No areas of recent or old (prehistoric slides) are indicated on the parcel or site area by the Coastal Atlas. A copy of the Coastal Atlas slope stability designation map for the site area is attached as Figure 7.

Subsurface Explorations

On September 6, 2018, a field representative from GeoResources, LLC (GeoResources) visited the site and monitored the excavation of 18 test pits to depths of 4.5 to 8 feet below the existing ground surface, logged the subsurface conditions encountered in each test pit, and obtained representative soil samples. The test pits were excavated by a medium sized track-mounted excavator operated by a licensed earthwork contractor working for GeoResources, LLC.

The specific number, locations, and depths of our explorations were selected based on the configuration of the proposed development, and were adjusted in the field based on consideration for underground utilities, existing site conditions, site access limitations and encountered stratigraphy. Representative soil samples obtained from the test pits were placed in sealed plastic bags and then taken to a laboratory for further examination and testing as deemed necessary. The test pits were then backfilled with the excavated soils and bucket tamped, but not otherwise compacted.

The subsurface explorations excavated as part of this evaluation indicate the subsurface conditions at specific locations only, as actual subsurface conditions can vary across the site. Furthermore, the nature and extent of such variation would not become evident until additional explorations are performed or until construction activities have begun. Based on our experience and extent of prior explorations in the area, it is our opinion that the soils encountered in the explorations are generally representative of the soils at the site.

The approximate locations and numbers of our test pits are shown on the attached Site and Exploration Plan, Figure 2. The soils encountered were visually classified in accordance with the Unified Soil Classification System (USCS) and ASTM D: 2488. The USCS is included in Appendix A as Figure A-1, while the descriptive logs of our test pits are included as Figures A-2 through A-8.

Subsurface Conditions

The subsurface conditions encountered in our explorations were relatively uniform and differed from the mapped stratigraphy at the site. Our explorations encountered 0.5 to 1.5 feet of duff and rootzone mantling 0.5 to 1.5 feet of tan, lightly iron-oxide stained, silty sand with gravel in a medium dense, moist condition. These soils were underlain by light grey, heavily iron-oxide stained sandy silt with gravel in a medium dense, moist condition that was underlain by grey sandy silty in a stiff to very stiff, moist condition that was encountered to the full depth explored. We interpret these deeper cohesive soils to be consistent with glacial lacustrine deposits, a sub-member of the mapped advance outwash. Therefore, the glacial lacustrine soils should be over-consolidated.

Test pit TP-5, in the northeast corner of the site, encountered grey silty sand with gravel in a very dense, moist condition below the lacustrine. Test pit TP-15 encountered brown silty sand with gravel in a medium dense, moist condition that appears to be consistent with the Esperance sand member mapped at the site.

The soils encountered in our test pits were generally consistent with the subsurface conditions encountered in the N.L. Olson test pits from 2007. However, the N.L. Olson logs generally described the shallow, glacial lacustrine soils to be "lean clay" while the deeper soils were typically described as very stiff to hard silt to elastic silt.

Laboratory Testing

Geotechnical laboratory tests were performed on select samples retrieved from the test pits to determine soil index and engineering properties encountered. Laboratory testing included visual soil classification per ASTM D: 2488, moisture content determinations per ASTM D: 2216, and grain size analyses per ASTM D: 422 standard procedures. The results of the laboratory tests are included in Appendix B.

The N.L. OIson report did perform Atterberg Limit tests on 4 samples of the soils collected from their test pits. The Atterberg limits generally classified the site soils as SILT (ML) with one sample being classified as an elastic silt (MH).

Groundwater Conditions

Groundwater was not observed in any of our test pits explorations at the time of excavation; however, iron oxide staining (mottling) was observed in all of our explorations at 0.5 to 1.5 feet below the existing ground surface. Mottling is often indicative of a seasonal or perched groundwater table that develops when a more permeable soil, such as silty sand, is underlain at depth by a less permeable soil, such as silt. Based on the nature of the near surface soils, we anticipate fluctuations in the local groundwater levels may occur in response to precipitation patterns, off-site construction activities, and site utilization.

ENGINEERING CONCLUSIONS AND RECOMMENDATIONS

Based on the results of our data review, site reconnaissance, subsurface explorations and our experience in the area, it is our opinion that the site is suitable for the proposed residential plat. As stated, we understand that you propose to construct several retaining walls to accommodate the grade changes at the site. We anticipate that mass grading with permanent cut and fill slopes will be utilized for the proposed development. Existing grades are shown on cross sections A-A' and B-B' (used in our slope stability to address potential landslide hazards), while both the existing and proposed grades are shown on cross sections C-C' and D-D' to depict proposed cuts and fills across the site. The cross sections are included in Appendix C.

The site soils do contain a significant amount of fines and will be difficult or impossible to reuse as structural fill when wet. Also, the site do have fines that are "plastic" and therefore do not meet Washington State Department of Transportation (WSDOT) standard specification for common borrow. So, the reuse of these soils may not be allowed by the City in public right-of-ways, but it does appear feasible to reuse these soil within the building lot areas provided the moisture content is maintained within 2 percent of optimum and below the plastic limit.

Pertinent conclusions and geotechnical recommendations regarding the design and construction of the proposed development are presented below.

Geologically Hazardous Area Categories per PMC 16.20.410.A.1

In accordance with the Poulsbo Municpal Code (PMC), the following categories shall be used in classifying geologically hazardous areas:

Geologically Hazardous Areas

a. Areas with slopes greater than thirty percent and mapped by the Coastal Zone Atlas or Quaternary Geology and Stratigraphy of Kitsap County as unstable (U), unstable old landslides (UOS) or unstable recent slides (URS).
b. Areas with slopes greater than thirty percent in grade and deemed by a qualified geologist or geotechnical engineer to meet the criteria of U, UOS, or URS.

Areas of Geologic Concern PMC 16.20.410.A.2

a. Areas designated U, UOS, or URS in the Coastal Zone Atlas or Quaternary Geology and Stratigraphy of Kitsap County, with slopes less than thirty percent; or areas found by a qualified geologist to meet the criteria for U, URS, or UOS with slopes less than thirty percent; or
b. Slopes identified as intermediate (I) in the Coastal Zone Atlas or Quaternary Geology and Stratigraphy of Kitsap County, or areas found by a qualified geologist to meet the criteria of I; or
c. Slopes fifteen percent or greater, not classified as I, U, UOS, or URS, with soils classified by the U.S. Department of Agriculture Natural Resources Conservation Service as "highly erodible" or "potentially highly erodible"; or
d. Slopes of fifteen percent or greater with springs or groundwater seepage not identified in subsections (A)(2)(a) through (c) of this section; or
e. Seismic areas subject to liquefaction from earthquakes (seismic hazard areas) such as hydric soils as identified by the Natural Resources Conservation Service, and areas that have been filled to make a site more suitable. Seismic areas may include former wetlands which have been covered with fill; or
f. Areas mapped as "severe" in all development limitations based on mapped soil units of the USDA Soil Conservation Service. These designations are listed in Table 10 of Soil Survey of Kitsap County Area, Washington.

As stated, the western portion of the site is mapped as a landslide deposits (Qls), with several smaller landslide deposits being mapped in the drainage east of the site. However, the Coastal Atlas does not map these areas as recent or historic slides, rather the Coastal Atlas maps the entire site as stable. No evidence of active or ongoing deep seated or other landslide activity was observed at the time of our site visit, therefore, we would tend to agree with the Stable designation provided by the Coastal Atlas.

Slopes steeper than 15 percent are present across the site, however the NRCS soils types in in these areas are listed as having a "moderate" erosion hazard, and these areas did not appear to be unstable at the time of our reconnaissance. The slopes steeper than 15 percent in the east-central and southeastern portions of the site are mapped as having a "moderate to severe" erosion potential.

Based on the above, the eastern portion of the site meets one of the criteria (slopes steeper than 15 percent with a high erosion potential) of an Area of Geologic Concern. No development is proposed within the portion of the site that meets the definition of an Area of Geologic Concern. Per Title 16.2.420.C, a standard buffer of 25 feet should be applied to the Area of Geologic Concern, unless otherwise specified through a geological report. Based on the proposed *Site Plan* prepared by CPH Consultants, it appears that no development is located within 25 feet the Area of Geologic Concern.

Slope Stability Analysis

We analyzed the global and internal slope stability of the existing slope geometry using subsurface profile A-A' and B-B', as shown on Figure 2. The cross sections were selected as the most critical section given the height and steepness of the slopes.

We used the computer program SLIDE version 7.021, from RocScience, 2016, to perform the slope stability analyses. The computer program SLIDE uses a number of methods to estimate the factor of safety (FS) of the stability of a slope by analyzing the shear and normal forces acting on a series of vertical "slices" that comprise a failure surface. Each vertical slice is treated as a rigid body; therefore, the forces and/or moments acting on each slice are assumed to satisfy static equilibrium (i.e., a limit equilibrium analysis). The FS is defined as the ratio of the forces available to resist movement to the forces of the driving mass. A FS of 1.0 means that the driving and resisting forces are equal; an FS less than 1.0 indicates that the driving forces are greater than the resisting forces (indicating failure). We used the Generalized Limit Equilibrium method using the Morgenstern-Price analysis, which satisfies both moment and force equilibrium, to search for the location of the most critical failure surfaces and their corresponding FS. The most critical surfaces are those with the lowest FS for a given loading condition, and are therefore the most likely to fail.

Our analyses included static and seismic conditions. For the seismic condition, a surcharge loading of 0.28g was applied. Based on our analyses, the minimum FS for the existing conditions within the proposed development area (Cross Section A-A') is 2.69 for static conditions and 1.38 for seismic conditions. Within the ravine area (Cross Section B-B'), the minimum FS is 1.86 and 1.11 for static and seismic conditions, respectively. The analyses indicate that the slope is stable in both static and seismic conditions for the existing site configuration. The cross section and slope stability results using both static and seismic conditions are included as Appendix C.

Recommended Setback from Steep Slopes

The 2015 International Building Code (IBC), Section 1808.7 requires a building setback from slopes that are steeper than 3H:1V (Horizontal: Vertical) or 33 percent with greater than 10 feet in vertical height, unless evaluated and reduced and/or a structural setback is provided by a licensed geotechnical engineer. The setback distance is calculated based on the vertical height of the slope. The typical 2015 IBC setback from the top of the slope equals one third the height of the slope or 40 feet, whichever is less, while a setback from the toe of the slope equals one half the height of the slope or 15 feet, whichever is less.

The slopes in the central portion of the site that slope down at 40 to 55 percent have a vertical height on the order of 20 feet. From the central slope, we recommend a top of slope building setback of 7 feet and a toe of slope setback of 10 feet be applied. Based on our conversations with you, we understand the site will be mass graded for the proposed residential lots. As such, we anticipate that the majority of this slope will be regraded to flatter than 33 percent or to have less than 10 feet of vertical relief in areas steeper than 33 percent. Alternatively, daylight basements may be used to accommodate grade separation across the lots and/or to meet structural setback requirements, discussed below.

A structural setback may be used where the setback from the top of the slope cannot be met. A structural setback is created by deepening the foundation elements so that, when measured horizontally from the font of the foundation to the face of the slope, the top of slope setback discussed above is met. We have provided recommendations for deepened foundations in the "**Foundation Support**" section of this report.

The ravine, which slopes down at 45 to 60 percent in the northern portion of the site and 15 to 35 percent in the southern portion of the site, has a vertical height on the order of 60 to 70 feet. From the ravine, we recommend a minimum top of slope building setback of 24 feet. We understand that the minimum recommended building setback from the ravine will be met by the City of Poulsbo prescriptive setback from an Area of Geologic Concern.

Seismic Design

Based on our observations and the subsurface units mapped at the site, we interpret the structural site conditions to correspond to a seismic Site Class "D" in accordance with the 2015 IBC documents and American Society of Civil Engineers (ASCE) standard 7-10 Chapter 20 Table 20.3-1. This is based on the anticipated range of SPT (Standard Penetration Test) blow counts for the soils types in the site area. These conditions were assumed to be representative for the subsurface conditions for the site in general based on our experience in the vicinity of the site.

The U.S. Geological Survey (USGS) completed probabilistic seismic hazard analyses (PSHA) for the entire country in November 1996, which were updated and republished in 2002 and 2008. The PSHA ground motion results can be obtained from the USGS 2015 IBC design. Table 1, below, summarizes the recommended design parameters.

TABLE 1:
2015 IBC PARAMETERS FOR DESIGN OF SEISMIC STRUCTURES

Spectral Response Acceleration (SRA) and Site Coefficients	Short Period	1 Second Period
Mapped SRA	S_s = 1.319	S_1 = 0.526
Site Coefficients (Site Class D)	F_a = 1.0	F_v = 1.5
Maximum Considered Earthquake SRA	S_{MS} = 1.319	S_{M1} = 0.789
Design SRA	S_{DS} = 0.879	S_{D1} = 0.526

Earthquake-induced geologic hazards may include liquefaction, lateral spreading, slope instability, and ground surface fault rupture. In our opinion, the potential for liquefaction and lateral spreading is not significant because of the soil gradation and the anticipated depth to groundwater. The ground surface at the site slopes down in all directions and steep slopes are located along the eastern portion of the site; however, our slope stability analyses determined the slope should be stable under design-level seismic loading. No evidence of ground fault rupture was observed in the subsurface explorations or out site reconnaissance.

According to the Department of Natural Hazard Map (Geologic Information Portal), the site is located between the east of the Dabob Bay fault zone, southwest of the Whidbey Island fault zone, and north of the Seattle Fault Zone, as shown on Figure 8. Given the distance the mapped fault zones and thickness of young, dense glacial sediments underlying the site, we interpret the potential for ground surface fault rupture is also low.

Foundation Support

Based on the subsurface soil conditions encountered across the site, we recommend that spread footings for the proposed residences be founded on the on the medium dense tan to grey silty sand to sandy silt encountered across the site or on appropriately prepared structural fill that extends to suitable native soils. The soil at the base of the excavations should be disturbed as little as possible. All loose, soft or unsuitable material should be removed or recompacted, as appropriate. A representative from our firm should observe the foundation excavations to determine if suitable bearing surfaces have been appropriately prepared, particularly in the areas where the foundation will be situated on prepared structural fill material.

All exterior footing elements should be embedded at least 18 inches below grade for frost protection. We recommend a minimum width of 2 feet for isolated footings and at least 16 inches for continuous wall footings. Footings founded as described above may be designed with a maximum allowable bearing pressure of 2,000 pounds per square foot (psf) for combined dead and long-term live loads. The weight of the footing and any overlying backfill may be neglected. The allowable bearing value may be increased by one-third for transient loads such as those induced by seismic events or wind loads.

Lateral loads may be resisted by friction on the base of footings and floor slabs and as passive pressure on the sides of footings. We recommend that an allowable coefficient of friction of 0.35 be used to calculate friction between the concrete and the underlying native recessional outwash. Passive pressure may be determined using an allowable equivalent fluid density of 350 pcf (pounds per cubic foot). Factors of safety have been applied to these values.

We estimate that settlements of footings designed and constructed as recommended will be less than 1 inch, for the anticipated load conditions, with differential settlements between comparably loaded footings of ½-inch or less over a span of 50 feet. Most of the settlements should occur essentially as loads are being applied; however, disturbance of the foundation subgrade during construction could result in larger settlements than predicted. We recommend that all foundations be provided with footing drains constructed in accordance with the 2015 IBC Section 1805.4.2.

Floor Slab Support

Slab-on-grade floors, where constructed, should be supported on the native tan to grey silty sand to sandy silt or on structural fill prepared as described above. Any areas of old fill material or glacial lacustrine should be evaluated during grading activity for suitability of structural support. Areas of organic debris should be removed.

We recommend that floor slabs be directly underlain by a minimum 4-inch thick capillary break that consists of clean, granular material, such as pea gravel or clean crushed rock. This layer should be placed in one lift, compacted to an unyielding condition, and should contain less than 2 percent fines.

A synthetic vapor retarder is recommended to control moisture migration through the slabs. This is of particular importance where the foundation elements are underlain by medium dense recessional soils, or where moisture migration through the slab is an issue, such as where adhesives are used to anchor carpet or tile to the slab.

A subgrade modulus of 350 kips per cubic foot (kcf) may be used for floor slab design. We estimate that settlement of the floor slabs designed and constructed as recommended, will be ½-inch or less over a span of 50 feet.

Subgrade/Basement Walls

Adequate drainage behind retaining structures is imperative. Positive drainage which controls the development of hydrostatic pressure can be accomplished by placing a zone of drainage behind the walls. Granular drainage material should contain less than 2 percent fines and at least 30 percent greater than the US No. 4 sieve. Assuming properly compacted structural fill is used to backfill the foundation walls, an allowable active fluid pressure of 35 pcf and an at-rest pressure of 55 pcf should be appropriate for design. A seismic surcharge of 10H should be applied in accordance with applicable building codes.

A minimum 4-inch diameter perforated or slotted PVC pipe should be placed in the drainage zone along the base and behind the wall to provide an outlet for accumulated water and direct accumulated water to an appropriate discharge location. We recommend that a nonwoven geotextile filter fabric be placed between the soil drainage material and the remaining wall backfill to reduce silt migration into the drainage zone. The infiltration of silt into the drainage zone can, with time, reduce the permeability of the granular material. The filter fabric should be placed such that it fully separates the drainage material and the backfill, and should be extended over the top of the drainage zone. Typical wall drainage and backfilling details are shown on Figure 9.

A geocomposite drain mat may also be used instead of free draining soils, provided it is installed in accordance with the manufacturer's instructions. A soil drainage zone should extend horizontally at least 18 inches from the back of the wall. The drainage zone should also extend from the base of the wall to within 1 foot of the top of the wall. The soil drainage zone should be compacted to approximately 90 percent of the maximum dry density (MDD), as determined in accordance with ASTM D:1557. Over-compaction should be avoided as this can lead to excessive lateral pressures.

Lateral loads may be resisted by friction on the base of footings and as passive pressure on the sides of footings and the buried portion of the wall, as described in the "**Foundation Support**" section. We recommend that an allowable coefficient of friction of 0.35 be used to calculate friction between the concrete and the underlying soil. Passive pressure may be determined using an allowable equivalent fluid density of 350 pcf (pounds per cubic foot). Factors of safety have been applied to these values.

Temporary Excavations

All job site safety issues and precautions are the responsibility of the contractor providing services/work. The following cut/fill slope guidelines are provided for planning purposes only. Temporary cut slopes will likely be necessary during grading operations or utility installation. All excavations at the site associated with confined spaces, such as utility trenches and retaining walls, must be completed in accordance with local, state, or federal requirements. Based on current

Washington State Safety and Health Administration (WSHA) regulations, the soils on the site would be classified as Type C soils.

According to WSHA, for temporary excavations of less than 20 feet in depth, the side slopes in Type C soils should be laid back at a slope inclination of 1½H:1V (Horizontal: Vertical) or flatter from the toe to the crest of the slope. All exposed slope faces should be covered with a durable reinforced plastic membrane during construction to prevent slope raveling and rutting during periods of precipitation. These guidelines assume that all surface loads are kept at a minimum distance of at least one half the depth of the cut away from the top of the slope and that significant seepage is not present on the slope face. Flatter cut slopes will be necessary where significant raveling or seepage occurs, or if construction materials will be stockpiled along the slope crest.

Where it is not feasible to slope the site soils back at these inclinations, a retaining structure should be considered. Where retaining structures are greater than 4-feet in height (bottom of footing to top of structure) or have slopes of greater than 15 percent above them, they should be engineered per Washington Administrative Code (WAC 51-16-080 item 5). This information is provided solely for the benefit of the owner and other design consultants, and should not be construed to imply that GeoResources assumes responsibility for job site safety. It is understood that job site safety is the sole responsibility of the project contractor.

Permanent Cut and Fill Slopes

Fill slopes constructed on grades that are steeper than 5H:1V should be constructed in accordance with Appendix J of the 2015 IBC and should utilize proper keying and benching methods, as shown on the attached IBC Appendix J Detail, Figure 10. The cut slopes in the upper silty sand soils encountered at the site should be no steeper than 2H:1V. We recommend the cut slopes in the sandy silt, glacial lacustrine soils encountered at the site be sloped no steeper than 4H:1V per the Washington State Department of Transportation Geotechnical Design Manual, Chapter 10, Section 10.3.1.

All slopes should be protected from erosion. Typical erosion control Best Management Practices (BMPs) per the Stormwater Management Manual for Western Washington (SWMMWW) should be sufficient for proposed site grading activities. Additionally, permanent slopes should be planted with a mulch, hardy vegetative groundcover or armored with quarry spalls as soon as feasible after grading is completed.

Site Drainage

All ground surfaces, pavements and sidewalks at the site should be sloped away from the structures. Surface water runoff should be controlled by a system of curbs, berms, drainage swales, and or catch basins, and conveyed to an appropriate discharge point.

We recommend that footing drains are installed for the residence in accordance with the 2015 IBC, Section 1807.4.2, and basement walls (if utilized) have a wall drain as describe above. The roof drain should not be connected to the footing drain.

Stormwater Infiltration

Based on our subsurface explorations, onsite infiltration into the native galcail lacustrine deposits is <u>not</u> feasible per the 2012 Stormwater Management Manual for Western Washington (SMMWW).

Per the 2012 SWMMWW, Volume III, Section 3.3.7, SSC-5, a minimum vertical separation of 5 feet is required between the bottom of an infiltration facility and the top of bedrock, hardpan (glacial till), a water table (seasonal, perched, or regional), or an impermeable layer. Evidence of seasonal perched groundwater (mottling) was encountered at 6 to 18 inches below the existing ground surface, generally atop the sandy silt encountered at depth across the majority of the site.

We recommend that alternative stormwater BMPs be considered for the proposed project. The minimum vertical separation and horizontal setback criteria should be considered prior to the selection of a stormwater facility. All BMPs should be designed and constructed in accordance with the 2012 SWMMWW.

EARTHWORK RECOMMENDATIONS

Site Preparation

All structural areas on the site to be graded should be stripped of vegetation, organic surface soils, and other deleterious materials including existing structures, foundations or abandoned utility lines. Organic topsoil is not suitable for use as structural fill, but may be used for limited depths in non-structural areas. Based on our subsurface exploration, we anticipate that stripping depth will likely range from about 6 to 18 inches. Areas of thicker topsoil or organic debris may be encountered in areas of heavy vegetation or depressions.

Where placement of fill material is required, the stripped/exposed subgrade areas should be compacted to a firm and unyielding surface prior to placement of new fill. Excavations for debris removal should be backfilled with structural fill compacted to the densities described in the "**Structural Fill**" section of this report.

We recommend that a member of our staff evaluate the exposed subgrade conditions after removal of vegetation and topsoil stripping is completed and prior to placement of structural fill. The exposed subgrade soil should be proof-rolled with heavy rubber-tired equipment during dry weather or probed with a ½-inch diameter steel T-probe during wet weather conditions.

Soft, loose or otherwise unsuitable areas delineated during proof-rolling or probing should be recompacted, if practical, or over-excavated and replaced with structural fill. The depth and extent of overexcavation should be evaluated by our field representative at the time of construction. The areas of old fill material should be evaluated during grading operations to determine if they need mitigation, recompaction, or removal.

Structural Fill

All material placed as fill associated with mass grading, as utility trench backfill, under building areas, or under roadways should be placed as structural fill. The structural fill should be placed in horizontal lifts of appropriate thickness to allow adequate and uniform compaction of each lift. Structural fill should be compacted to at least 95 percent of the MDD as determined in accordance with ASTM D: 1557.

The appropriate lift thickness will depend on the structural fill characteristics and compaction equipment used. We recommend that the appropriate lift thickness be evaluated by our field representative during construction. We recommend that our representative be present during site grading activities to observe the work and perform field density tests.

The suitability of material for use as structural fill will depend on the gradation and moisture content of the soil. As the amount of fines (material passing US No. 200 sieve) increases, soil becomes increasingly sensitive to small changes in moisture content and adequate compaction becomes more difficult to achieve. During wet weather, we recommend a material such as well-graded sand and gravel with less than 5 percent (by weight) passing the US No. 200 sieve based on that fraction passing the ¾-inch sieve, such as *Gravel Backfill for Walls* (WSDOT 9-03.12(2)). If prolonged dry weather prevails during the earthwork and foundation installation phase of construction, higher fines content (up to 10 to 12 percent) may be acceptable.

Material placed for structural fill should be free of debris, organic matter, trash, and cobbles greater than 6-inches in diameter. The moisture content of the fill material should be adjusted as necessary for proper compaction.

Suitability of On-Site Materials as Fill

During dry weather construction, any non-organic onsite soil may be considered for use as structural fill, provided it meets the criteria described above in the "**Structural Fill**" section and can be compacted as recommended. If the soil material is over optimum moisture at the time of excavation, it will be necessary to aerate or dry the soil prior to placement as structural fill. We generally did not observe the site soils to be excessively moist at the time of our subsurface explorations.

The glacial lacustrine soils generally encountered in our explorations generally consisted of high fines and silt, and based on laboratory results contained in the previous N.L. Olson report, have a plasticity index of 5 to 8. Because of the high fines content and plasticity, we do not recommend that these soils are used for structural fill, as these soils are highly moisture sensitive and are likely to be difficult or impossible to adequately compact during periods of wet weather or if they become saturated. These lower, silty soils may be used as fill in non-structural areas.

We recommend that completed graded-areas be restricted from traffic or protected prior to wet weather conditions. The graded areas may be protected by paving, placing asphalt-treated base, a layer of free-draining material such as pit run sand and gravel or clean crushed rock material containing less than 5 percent fines, or some combination of the above.

Erosion Control and Wet Weather Considerations

Weathering, erosion and the resulting surficial sloughing and shallow land sliding are natural processes. As noted, no evidence of surficial raveling or sloughing was observed at the site. To manage and reduce the potential for these natural processes, we recommend erosion protection measures will need to be in place prior to grading activity on the site. Erosion hazards can be mitigated by applying BMPs outlined in the 2012 SWMMWW.

In the Puget Sound area, the Washington State Department of Ecology generally defines the wet season as beginning October 1st and continuing through about April 30th, although rainy periods could occur at any time of year. Therefore, it is strongly encouraged that earthwork be scheduled during the dry weather months. Most of the soil at the site does contain sufficient fines to produce an unstable mixture when wet. Soils with high fines contents are highly susceptible to changes in water content and tends to become unstable and impossible to proof-roll and compact if the moisture content exceeds the optimum.

In addition, during wet weather months, the groundwater levels could increase, resulting in seepage into site excavations. Performing earthwork during dry weather would reduce these problems and costs associated with rainwater, construction traffic, and handling of wet soil.

LIMITATIONS

We have prepared this report for use by Schwabe, Williamson & Wyatt, CPH Consulting, and other members of the design team, for use in the design of a portion of this project. The data used in preparing this report and this report should be provided to prospective contractors for their bidding or estimating purposes only. Our report, conclusions and interpretations are based on our subsurface explorations, data from others and limited site reconnaissance, and should not be construed as a warranty of the subsurface conditions.

Variations in subsurface conditions are possible between the explorations and may also occur with time. A contingency for unanticipated conditions should be included in the budget and schedule. Sufficient monitoring, testing and consultation should be provided by our firm during construction to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes should the conditions revealed during the work differ from those anticipated, and to evaluate whether earthwork and foundation installation activities comply with contract plans and specifications.

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

If there are any changes in the loads, grades, locations, configurations or type of facilities to be constructed, the conclusions and recommendations presented in this report may not be fully applicable. If such changes are made, we should be given the opportunity to review our recommendations and provide written modifications or verifications, as appropriate.

◆ ◆ ◆

We have appreciated the opportunity to be of service to you on this project. If you have any questions or comments, please do not hesitate to call at your earliest convenience.

Respectfully submitted,
GeoResources, LLC

Veronica Raub Mauren, EIT
Staff Engineer in Training

State of Washington Licensed Geologist Engineering Geologist 925 KEITH SCOTT SCHEMBS
7/30/19

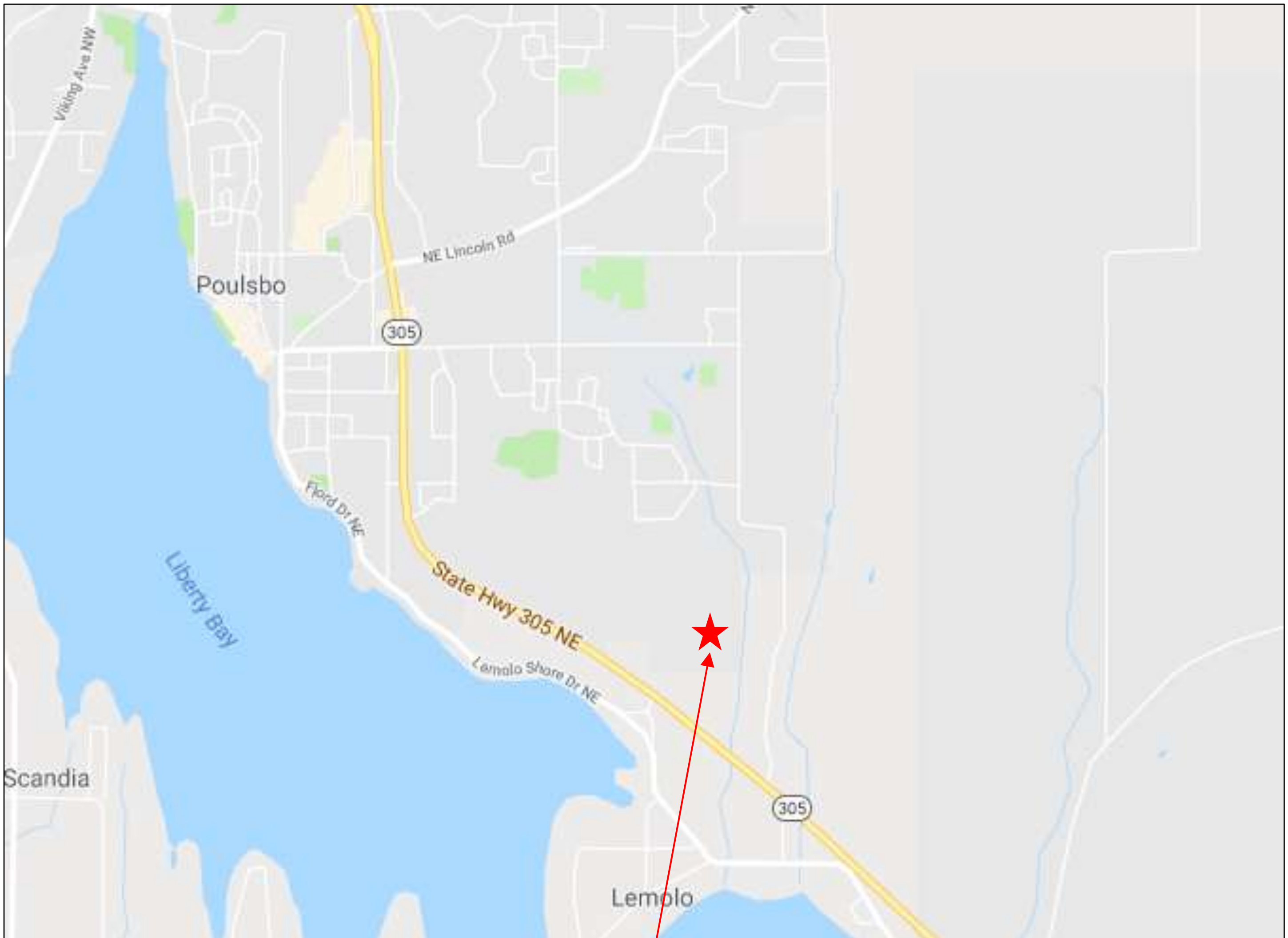
DANA CHRISTOPHER BIGGERSTAFF STATE OF WASHINGTON 50040 REGISTERED PROFESSIONAL ENGINEER
7/30/2019

Keith S. Schembs, LEG
Principal

Dana C. Biggerstaff, PE
Senior Geotechnical Engineer

VRM:KSS:DCB/vrm
DocID: SWW.JohnsonRoadNW.RG
Attachments:
Figure 1: Site Location Map
Figure 2: Site & Exploration Plan
Figure 3a: Cross Section C-C'
Figure 3b: Cross Section D-D'
Figure 4: Site Vicinity Map
Figure 5: NRCS Soils Map
Figure 6: USGS Geological Map
Figure 7: Coastal Zone Map
Figure 8: DNR Fault Zone Hazard Map
Figure 9: Typical Drainage and Backfill Detail
Figure 10: IBC Key and Bench Detail
Appendix A - Subsurface Explorations
Appendix B - Laboratory Test Results
Appendix C – Slope Stability Results

Cc: CPH Consultants
11431 Willows Road NE, Suite 120
Redmond, WA 98052
(425) 285-2390
Attn: Mr. Matt Hough



Approximate Site Location

Map created from Google Maps (https://www.google.com/maps)

N W E S

Not to Scale

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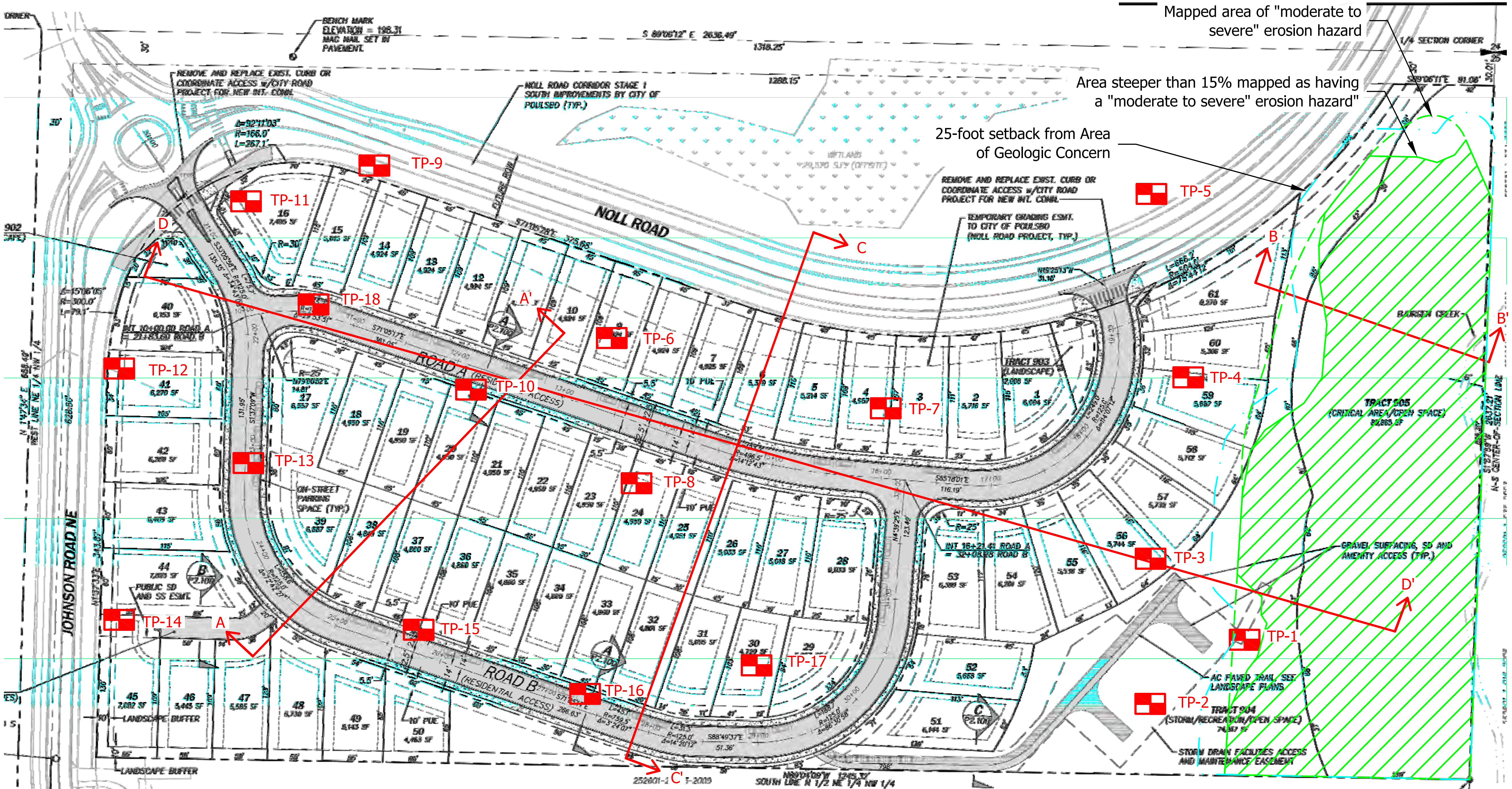
Site Location Map

Proposed Residential Plat
17504 Johnson Road NE
Poulsbo, Washington
PN: 25260120042008

DocID: SWW.JohnsonRdNW.F	July 2019	Figure 1



Notes:

Conceptual site plan prepared by CPH Consultants dated July 29, 2019.

TP-1 Approximate Test Pit Location

Cross Section

Scale:
1" = 100'

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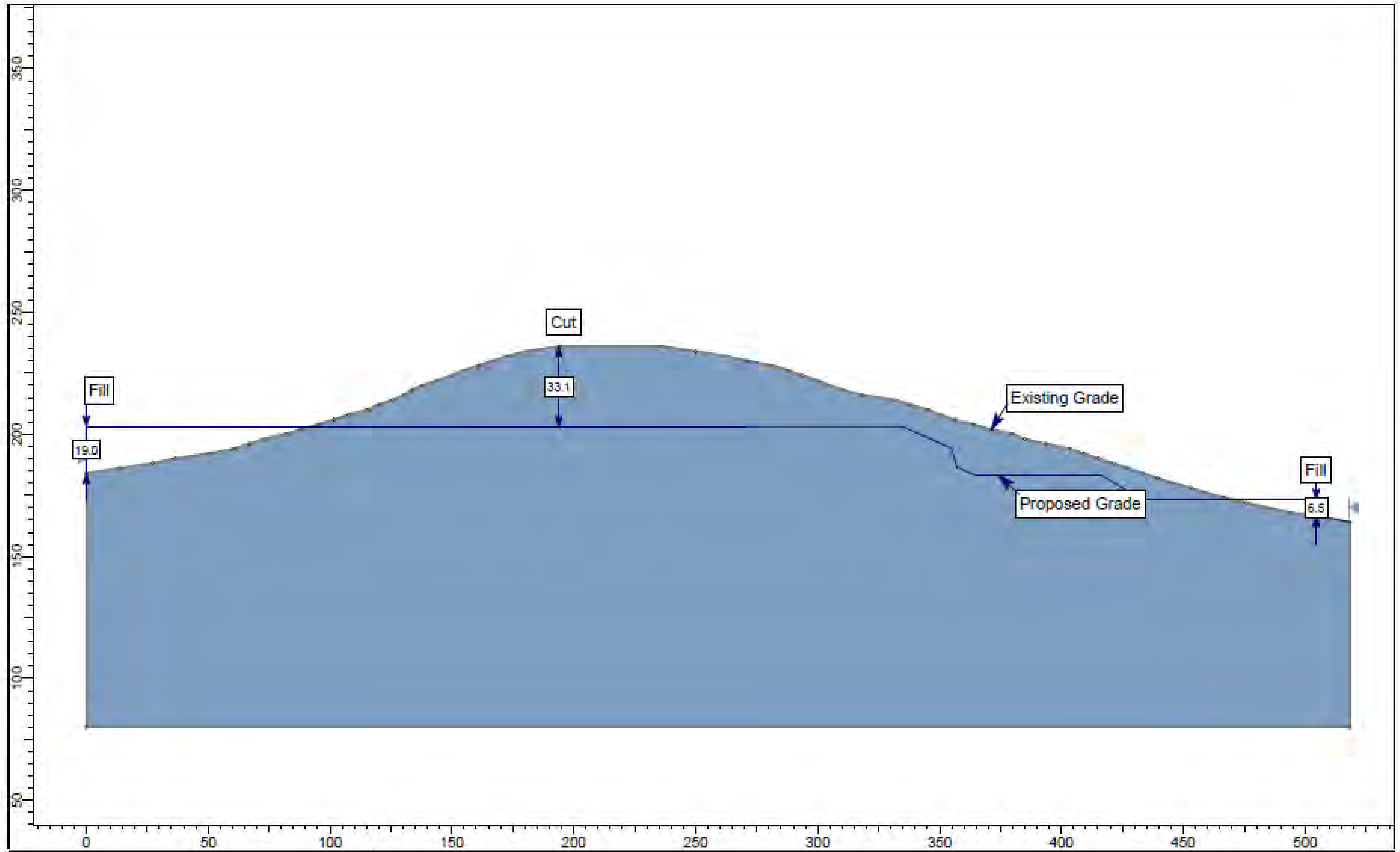
Site and Exploration Plan
Proposed Residential Plat
17504 Johnson Road Northwest
Poulsbo, Washington
PN: 252601-2-004-2008

DocID: SWW.JohnsonRdNW.F2	July 2019	Figure 2



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Drawn By: CC	Scale: 1:650	Company	GeoResources, LLC
Date	9/18/2018, 3:30:26 PM	File Name	Schwabe.JohnsonRd.Slide.slmd

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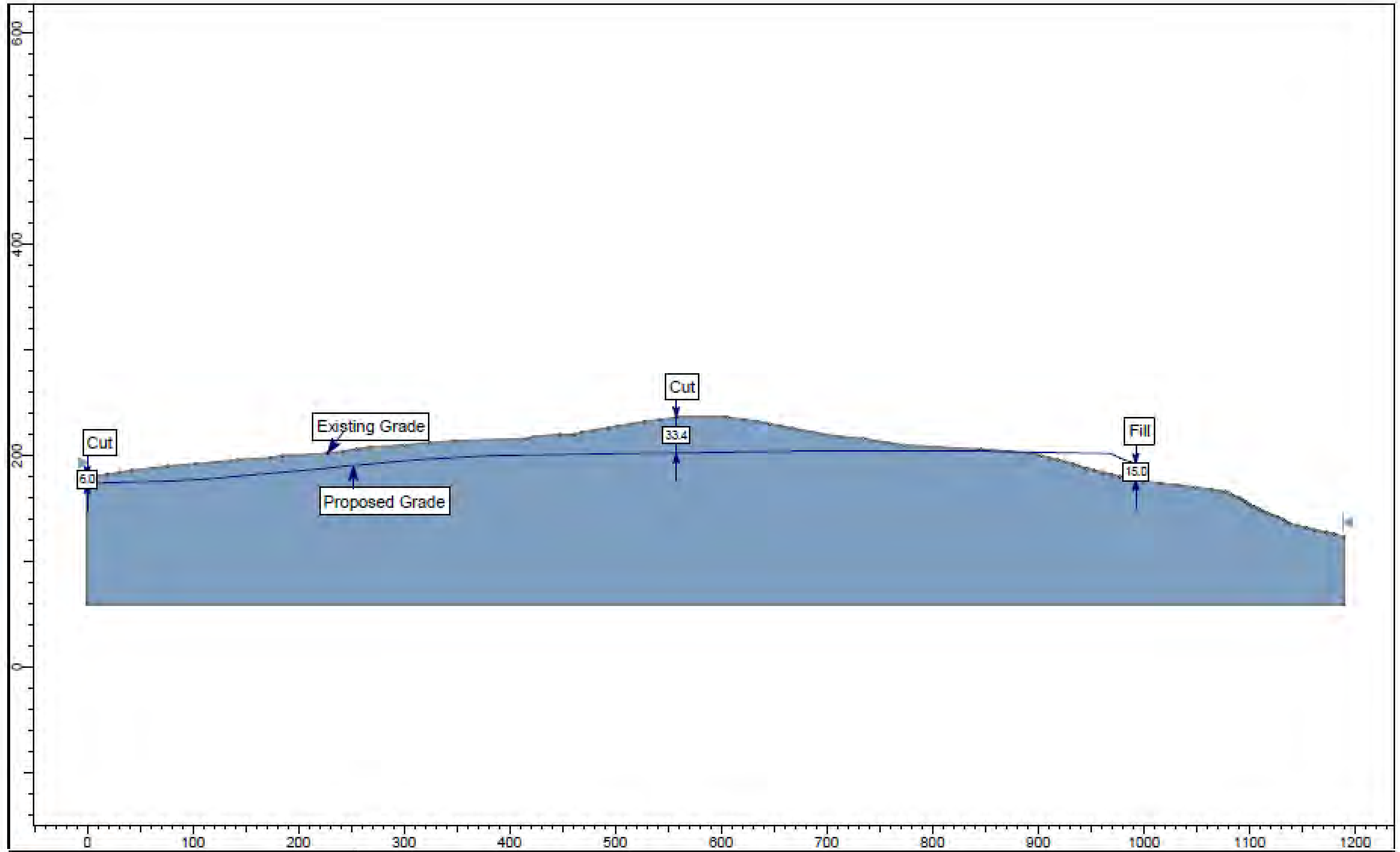
Cross Section C-C'
Proposed Residential Plat
17504 Johnson Road Northwest
Poulsbo, Washington
PN: 252601-2-004-2008

Doc ID: SWW.JohnsonRoadNW.F2	July 2019	Figure 3a



rocscience

SLIDE 7.014

Project			
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Date: 9/18/2018, 3:30:26 PM		File Name	Schwabe.JohnsonRd.Slide.slmd

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Cross Section D-d'
Proposed Residential Plat
17504 Johnson Road Northwest
Poulsbo, Washington
PN: 252601-2-004-2008

Doc ID: SWW.JohnsonRoadNW.F2	July 2019	Figure 3b

Approximate Site Location

Map created from Google Maps (https://www.google.com/maps)

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Site Vicinity Map

Proposed Residential Plat
17504 Johnson Road NE
Poulsbo, Washington
PN: 25260120042008

DocID: SWW.JohnsonRdNW.F	July 2019	Figure 4

Approximate Site Location

Map created from Web Soil Survey (http://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx)

Soil Type	Soil Name	Parent Material	Slopes	Erosion Hazard	Hydrologic Soils Group
32	McKenna gravelly loam	Glacial till	0 to 6	None	D
39	Poulsbo gravelly sandy loam	Basal till with volcanic ash in the upper part	0 to 6	Slight	B/D
40			6 to 15	Moderate	B/D
41			15 to 30	Moderate to severe	B/D

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NRCS Soils Map

Proposed Residential Plat
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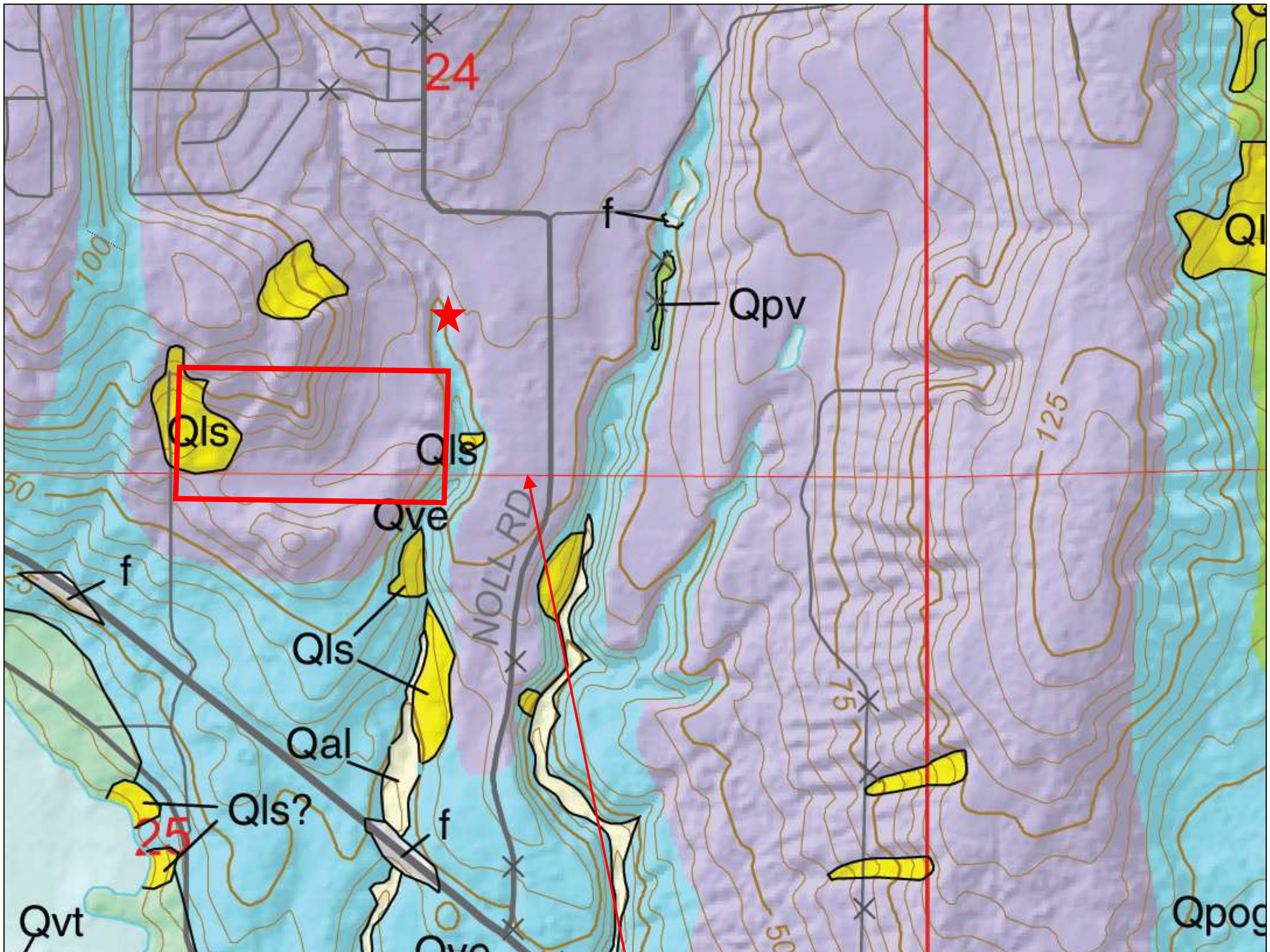
Poulsbo, Washington
PN: 25260120042008

DocID: SWW.JohnsonRdNW.F	July 2019	Figure 5



Approximate Site Location

Excerpt from the *Geologic Map of the Suquamish 7.5' Quadrangle and part of the Seattle North 7.5' x 15' Quandrangle, Kitsap County, Washington*
by Ralph A. Haugerud and Kathy Goetz Troost (2011)

Qal	Alluvium (Holocene)
Qls	Landslide deposits (Holocene and Pleistocene?)
Qvt	Vashon till
Qve	Esperance Sand Member

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USGS Geologic Map
Proposed Residential Plat
17504 Johnson Road NE
Poulsbo, Washington
PN: 25260120042008

DocID: SWW.JohnsonRdNW.F	July 2019	Figure 6

Approximate Site Location

Map created on the Washington State Department of Ecology Coastal Atlas Website
(https://fortress.wa.gov/ecy/coastalatlas/tools/Map.aspx)

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Coastal Atlas
Proposed Residential Plat
17504 Johnson Road NE
Poulsbo, Washington
PN: 252601200420008

DocID: SWW.JohnsonRdNW.F	July 2019	Figure 7

Approximate Site Location

Map created on the Washington State Department of Natural Resources
Washington Geologic Information Portal Website
(https://geologyportal.dnr.wa.gov/#natural_hazards)

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DNR Earthquake Hazard Maps

Proposed Residential Plat
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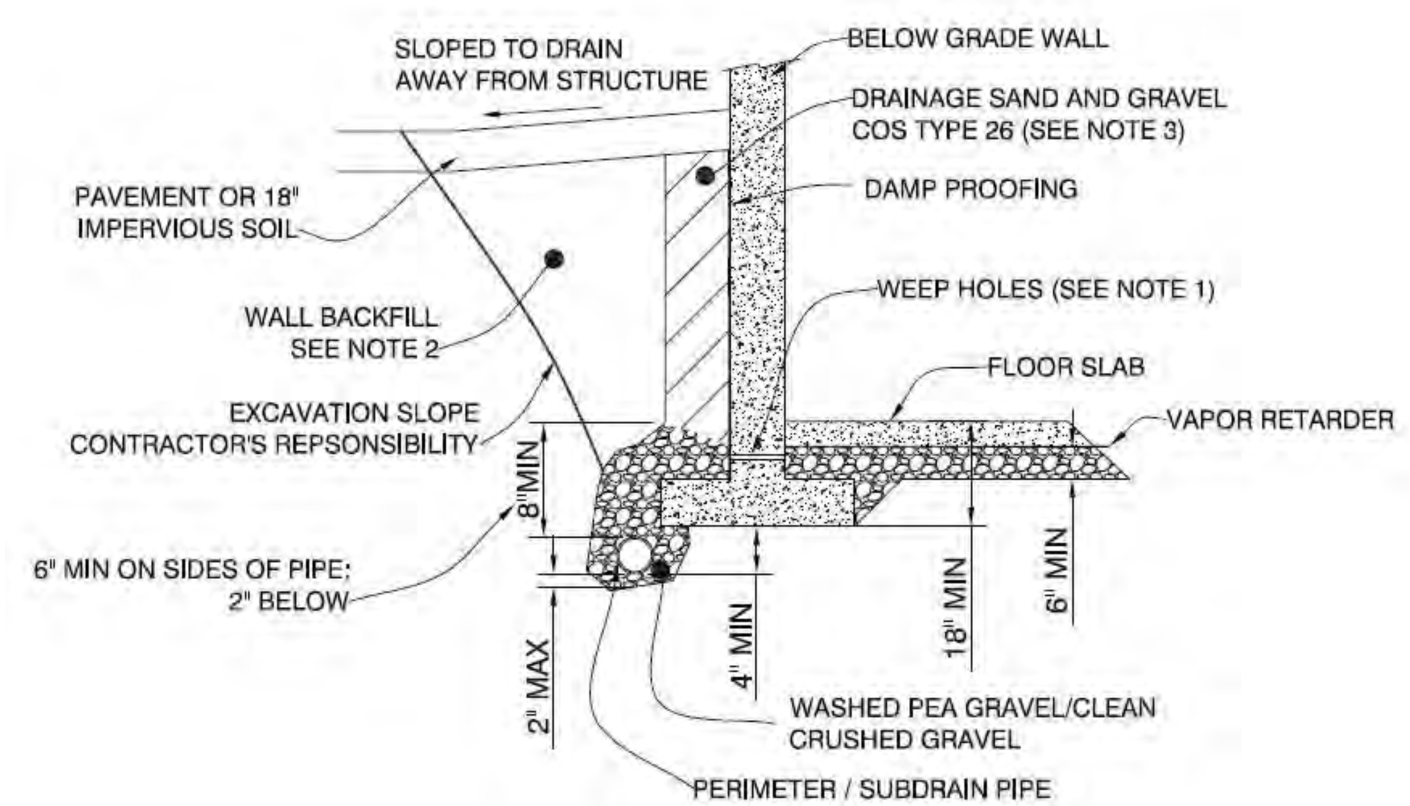
Poulsbo, Washington
PN: 25260120042008

DocID: SWW.JohnsonRdNW.F	July 2019	Figure 8



Notes

1. Washed pea gravel/crushed rock beneath floor slab could be hydraulically connected to perimeter/subdrain pipe. Use of 1" diameter weep holes as shown is one applicable method. Crushed gravel should consist of 3/4" minus. Washed pea gravel should consist of 3/8" to No. 8 standard sieve.

2. Wall backfill should meet WSDOT Gravel Backfill for walls Specification 9-03-12(2).

3. Drainage sand and gravel backfill within 18" of wall should be compacted with hand-operated equipment. Heavy equipment should not be used for backfill, as such equipment operated near the wall could increase lateral earth pressures and possibly damage the wall. The table below presents the drainage sand and gravel gradation.

4. All wall back fill should be placed in layers not exceeding 4" loose thickness for light equipment and 8" for heavy equipment and should be densely compacted. Beneath paved or sidewalk areas, compact to at least 95% Modified Proctor maximum density (ASTM: 01557-70 Method C). In landscaping areas, compact to 90% minimum.

5. Drainage sand and gravel may be replaced with a geocomposite core sheet drain placed against the wall and connected to the subdrain pipe. The geocomposite core sheet should have a minimum transmissivity of 3.0 gallons/minute/foot when tested under a gradient of 1.0 according to ASTM 04716.

6. The subdrain should consist of 4" diameter (minimum), slotted or perforated plastic pipe meeting the requirements of AASHTO M 304; 1/8-inch maximum slot width; 3/16- to 3/8-inch perforated pipe holes in the lower half of pipe, with lower third segment unperforated for water flow; tight joints; sloped at a minimum of 6"/100' to drain; cleanouts to be provided at regular intervals.

7. Surround subdrain pipe with 8 inches (minimum) of washed pea gravel (2" below pipe" or 5/8" minus clean crushed gravel. Washed pea gravel to be graded from 3/8-inch to No.8 standard sieve.

8. See text for floor slab subgrade preparation.

Materials

Drainage Sand and Gravel

Sieve Size	% Passing by Weight
¾"	100
No 4	28 – 56
No 8	20 – 50
No 50	3 – 12
No 100	0 – 2

¾" Minus Crushed Gravel

Sieve Size	% Passing by Weight
¾"	100
½"	75 – 100
¼"	0 – 25
No 100	0 – 2
(by wet sieving)	(non-plastic)

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Typical Wall Drainage and Backfill Detail

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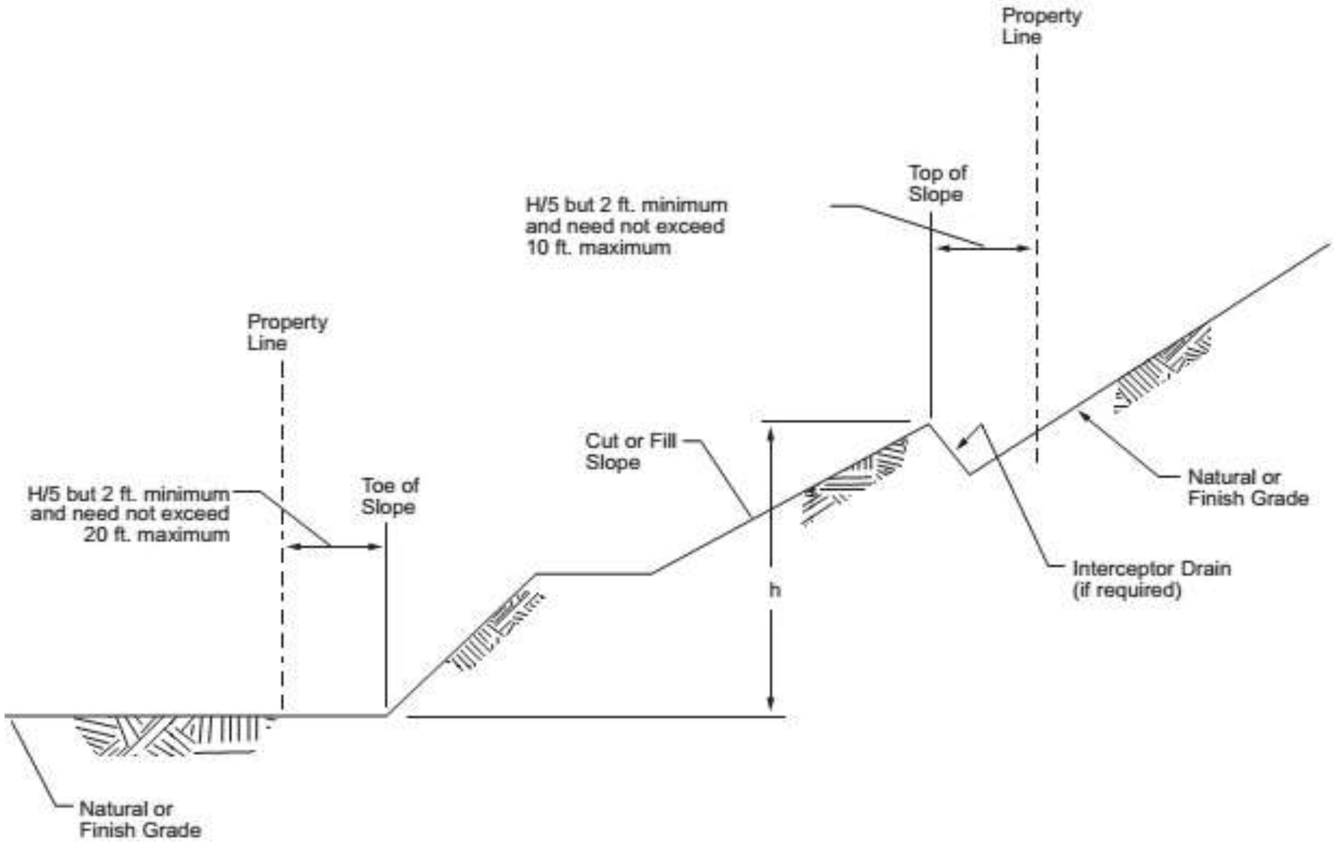
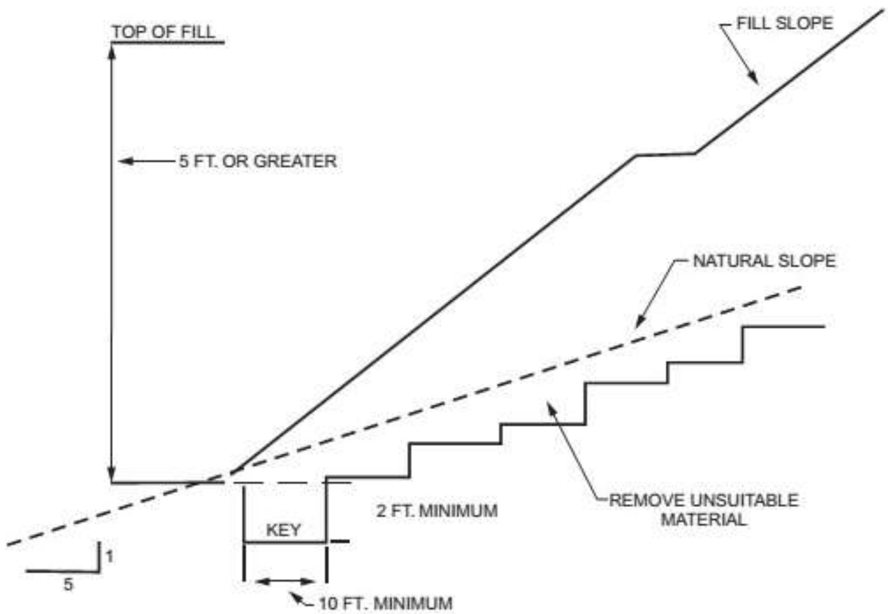
Poulsbo, Washington
PN: 25260120042008

DocID: SWW.JohnsonRdNW.F	July 2019	Figure 9





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IBC Appendix J Detail
Proposed Residential Plat
17504 Johnson Road NE
Poulsbo, Washington
PN: 25260120042008

DocID: SWW.JohnsonRdNW.F	July 2019	Figure 10

Appendix A
Subsurface Explorations

SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOL	GROUP NAME
COARSE GRAINED SOILS More than 50% Retained on No. 200 Sieve	GRAVEL More than 50% Of Coarse Fraction Retained on No. 4 Sieve	CLEAN GRAVEL	GW	WELL-GRADED GRAVEL, FINE TO COARSE GRAVEL
			GP	POORLY-GRADED GRAVEL
		GRAVEL WITH FINES	GM	SILTY GRAVEL
			GC	CLAYEY GRAVEL
	SAND More than 50% Of Coarse Fraction Passes No. 4 Sieve	CLEAN SAND	SW	WELL-GRADED SAND, FINE TO COARSE SAND
			SP	POORLY-GRADED SAND
		SAND WITH FINES	SM	SILTY SAND
			SC	CLAYEY SAND
FINE GRAINED SOILS More than 50% Passes No. 200 Sieve	SILT AND CLAY Liquid Limit Less than 50	INORGANIC	ML	SILT
			CL	CLAY
		ORGANIC	OL	ORGANIC SILT, ORGANIC CLAY
	SILT AND CLAY Liquid Limit 50 or more	INORGANIC	MH	SILT OF HIGH PLASTICITY, ELASTIC SILT
			CH	CLAY OF HIGH PLASTICITY, FAT CLAY
		ORGANIC	OH	ORGANIC CLAY, ORGANIC SILT
HIGHLY ORGANIC SOILS			PT	PEAT

NOTES:

1. Field classification is based on visual examination of soil in general accordance with ASTM D2488-90.
2. Soil classification using laboratory tests is based on ASTM D2487-90.
3. Description of soil density or consistency are based on interpretation of blow count data, visual appearance of soils, and or test data.

SOIL MOISTURE MODIFIERS:

Dry- Absence of moisture, dry to the touch

Moist- Damp, but no visible water

Wet- Visible free water or saturated, usually soil is obtained from below water table

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Unified Soils Classification System

Proposed Residential Plat
17504 Johnson Road NE
Poulsbo, Washington
PN: 25260120042008

DocID: SWW.JohnsonRdNW.F	July 2019	Figure A-1

Test Pit TP-1

Location: N portion of SE storm tract
Approximate Elevation: 168’

Depth (ft)	Soil Type	Soil Description
0 - 0.7	-	Duff/Root zone
0.7 - 1.75	SM	Tan, lightly iron oxidized silty SAND with gravel (medium dense, moist)
1.75 - 3.25	SM	Light tan and grey, heavily iron oxide stained silty SAND with gravel (medium dense, moist)
3.25 - 7.5	ML	Grey sandy SILT with occasional small gravel, some iron oxide staining to 7’ (medium stiff, moist)

Terminated at 7.5 feet below ground surface.
No caving observed at the time of excavation.
No groundwater seepage observed.

Test Pit TP-2

Location: S portion of SE storm tract
Approximate Elevation: 168’

Depth (ft)	Soil Type	Soil Description
0 - 0.8	-	Duff/Root zone
0.8 - 1.25	SM	Tan, lightly iron oxidized silty SAND with gravel (medium dense, moist)
1.25 - 2.0	ML	Light tan and grey, heavily iron oxide stained sandy SILT with some gravel (medium dense, moist)
2.0 - 7.0	ML	Grey SILT (medium stiff, moist)

Terminated at 7 feet below ground surface.
No caving observed at the time of excavation.
No groundwater seepage observed.

Test Pit TP-3

Location: SE portion of site, near Lots 32/64
Approximate Elevation: 180’

Depth (ft)	Soil Type	Soil Description
0 - 0.7	-	Duff/Root zone
0.7 - 2.25	SM	Tan, lightly iron oxidized silty SAND with gravel (medium dense, moist)
2.25 - 3.0	ML	Light tan and grey, heavily iron oxide stained sandy SILT with some gravel (medium dense, moist)
3.0 - 7.25	ML	Grey sandy SILT with some iron oxide staining to 4’ (medium stiff, moist)

Terminated at 7.25 feet below ground surface.
No caving observed at the time of excavation.
No groundwater seepage observed.

Logged by: VRM **Excavated on: September 6, 2018**

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Test Pit Exploration Logs

Proposed Residential Plat
17504 Johnson Road NE
Poulsbo, Washington
PN: 25260120042008

Test Pit TP-4

Location: Intersection of Road B and Road C
Approximate Elevation: 200’

Depth (ft)			Soil Type	Soil Description
0	-	0.5	-	Duff/Root zone
0.5	-	3.0	SM	Tan, lightly iron oxidized silty SAND with gravel (medium dense, moist)
3.0	-	4.0	SM	Grey silty SAND with gravel (medium dense to dense, moist) (glacial till?)
4.0	-	7.0	ML	Grey sandy SILT with occasional small gravel, some iron oxide staining to 7’ (medium stiff, moist)

Terminated at 7 feet below ground surface.
No caving observed at the time of excavation.
No groundwater seepage observed.

Test Pit TP-5

Location: NE portion of site, Lot 31/30
Approximate Elevation: 190’

Depth (ft)			Soil Type	Soil Description
0	-	1.5	-	Duff
1.5	-	2.0	SM	Tan, lightly iron oxidized silty SAND with gravel (medium dense, moist)
2.0	-	3.5	ML	Light tan and grey, heavily iron oxide stained sandy SILT with some gravel (medium stiff, moist)
3.5	-	4.5	SM	Medium brown, iron oxide stained silty medium SAND (moist, dense)
4.5	-	5.5	ML	Grey sandy SILT (medium stiff, moist)
5.5	-	7.0	SM	Grey silty SAND with gravel (medium dense to dense, moist) (glacial till?)

Terminated at 7 feet below ground surface.
No caving observed at the time of excavation.
No groundwater seepage observed.

Logged by: VRM **Excavated on: September 6, 2018**

Test Pit TP-6

Location: Central portion of site, Road B
Approximate Elevation: 222'

Depth (ft)			Soil Type	Soil Description
0	-	0.5	-	Duff
0.5	-	1.5	SM	Tan, lightly iron oxidized silty SAND with gravel (medium dense, moist)
1.5	-	2.0	ML	Reddish tan, iron oxide stained sandy SILT with some gravel (medium stiff, moist)
2.0	-	3.0	ML	Light grey, iron oxide stained sandy SILT with some gravel (medium stiff, moist)
3.0	-	5.5	ML	Grey sandy SILT (medium stiff, moist)

Terminated at 5.5 feet below ground surface.
No caving observed at the time of excavation.
No groundwater seepage observed.

Test Pit TP-7

Location: E-central portion of site, lot 37/36
Approximate Elevation: 220'

Depth (ft)			Soil Type	Soil Description
0	-	0.75	-	Duff
0.75	-	1.5	SM	Tan, lightly iron oxidized silty SAND with gravel (medium dense, moist)
1.5	-	3.0	ML	Light grey, heavily iron oxide stained sandy SILT with some gravel (medium stiff, moist)
3.0	-	6.5	ML	Grey sandy SILT (medium stiff, moist)

Terminated at 6.5 feet below ground surface.
No caving observed at the time of excavation.
No groundwater seepage observed.

Test Pit TP-8

Location: Central portion of site, lot 55
Approximate Elevation: 220'

Depth (ft)			Soil Type	Soil Description
0	-	1.5	SM	Root zone/light grey silty sand with gravel (fill)
1.5	-	3.5	SM	Grey silty SAND (very dense, moist) (glacial till?)
3.5	-	4.5	ML	Grey sandy SILT (medium stiff, moist)

Terminated at 4.5 feet below ground surface.
No caving observed at the time of excavation.
No groundwater seepage observed.

Logged by: VRM **Excavated on: September 6, 2018**

Test Pit TP-9

Location: NW portion of site, near proposed N access, lot 2
Approximate Elevation: 196'

Depth (ft)			Soil Type	Soil Description
0	-	0.5	-	Duff
0.5	-	1.0	SM	Tan silty SAND with gravel (medium dense, moist)
1.0	-	1.5	SM	Tan, lightly iron oxidized silty SAND with gravel (medium dense, moist)
1.5	-	3.0	ML	Light grey, iron oxide stained sandy SILT with some gravel (medium stiff, moist)
3.0	-	5.0	ML	Grey sandy SILT (medium stiff, moist)

Terminated at 5 feet below ground surface.
No caving observed at the time of excavation.
No groundwater seepage observed.

Test Pit TP-10

Location: W-central portion of site
Approximate Elevation: 212'

Depth (ft)			Soil Type	Soil Description
0	-	1.0	-	Duff/Root zone
1.0	-	2.5	ML	Light grey, heavily iron oxide stained sandy SILT with some gravel (medium stiff, moist)
2.5	-	5.0	ML	Grey sandy SILT, layers of iron oxide staining throughout (medium stiff, moist)

Terminated at 5 feet below ground surface.
No caving observed at the time of excavation.
No groundwater seepage observed.

Test Pit TP-11

Location: NW portion of site, lots 10/11
Approximate Elevation: 194'

Depth (ft)			Soil Type	Soil Description
0	-	0.5	-	Duff/Root zone
0.5	-	1.0	SM	Tan, lightly iron oxidized silty SAND with gravel (medium dense, moist)
1.0	-	3.0	ML	Light tan and grey, heavily iron oxide stained sandy SILT with some gravel (medium stiff, moist)
3.0	-	5.0	ML	Grey sandy SILT with some iron oxide staining to 4' (medium stiff, moist)

Terminated at 5 feet below ground surface.
No caving observed at the time of excavation.
No groundwater seepage observed.

Logged by: VRM **Excavated on: September 6, 2018**

Test Pit TP-12

Location: NW corner of SW stormwater tract
Approximate Elevation: 170'

Depth (ft)			Soil Type	Soil Description
0	-	0.75	-	Duff/Root zone
0.75	-	1.0	SM	Tan, lightly iron oxidized silty SAND with occasional cobbles (medium dense, moist)
1.0	-	2.0	ML	Light tan, iron oxide stained sandy SILT with some gravel (medium stiff, moist)
2.0	-	6.0	ML	Grey SILT (medium stiff, moist)

Terminated at 6 feet below ground surface.
No caving observed at the time of excavation.
No groundwater seepage observed.

Test Pit TP-13

Location: E-central portion of SW stormwater tract
Approximate Elevation: 170'

Depth (ft)			Soil Type	Soil Description
0	-	1.25	-	Duff/Root zone
1.25	-	3.25	SM	Tan, lightly iron oxidized silty SAND with gravel (medium dense, moist)
3.25	-	6.0	SM	Grey silty SAND with gravel (medium dense, moist)

Terminated at 6 feet below ground surface.
No caving observed at the time of excavation.
No groundwater seepage observed.

Test Pit TP-14

Location: SW corner of SW stormwater tract
Approximate Elevation: 137'

Depth (ft)			Soil Type	Soil Description
0	-	1.0	-	Duff/Root zone
1.0	-	3.0	SM	Tan, lightly iron oxidized silty SAND with occasional cobbles (medium dense, moist)
3.0	-	5.0	ML	Light grey and tan, iron oxide stained sandy SILT with some gravel (medium stiff, moist)
5.0	-	8.0	ML	Grey sandy SILT (medium stiff, moist)

Terminated at 8 feet below ground surface.
No caving observed at the time of excavation.
No groundwater seepage observed.

Logged by: VRM **Excavated on: September 6, 2018**

Test Pit TP-15

Location: SW portion of site, lot 77/Road A
Approximate Elevation: 164’

Depth (ft)			Soil Type	Soil Description
0	-	1.0	-	Duff/Root zone
1.0	-	2.0	SM	Tan, lightly iron oxidized silty SAND with occasional cobbles (medium dense, moist)
2.0	-	3.0	ML	Light grey and tan, iron oxide stained sandy SILT with some gravel (medium stiff, moist)
3.0	-	5.5	ML	Grey sandy SILT (medium stiff, moist)
5.5	-	7.0	SM	Brown silty SAND with gravel (medium dense, moist)

Terminated at 7 feet below ground surface.
No caving observed at the time of excavation.
No groundwater seepage observed.

Test Pit TP-16

Location: S-central portion of site, Lot 74
Approximate Elevation: 170’

Depth (ft)			Soil Type	Soil Description
0	-	0.75	-	Duff/Root zone
0.75	-	2.0	SM	Tan, lightly iron oxidized silty SAND with occasional cobbles (medium dense, moist)
2.0	-	3.0	ML	Light grey and tan, iron oxide stained sandy SILT with some gravel (medium stiff, moist)
3.0	-	5.5	ML	Grey sandy SILT, iron oxide staining from 3 to 5 feet (medium stiff, moist)

Terminated at 5.5 feet below ground surface.
No caving observed at the time of excavation.
No groundwater seepage observed.

Logged by: VRM **Excavated on: September 6, 2018**

Test Pit TP-17

Location: S-central portion of site, Lot 71
Approximate Elevation: 205'

Depth (ft)			Soil Type	Soil Description
0	-	1.0	-	Duff/Root zone
1.0	-	2.25	SM	Tan, lightly iron oxidized silty SAND with occasional cobbles (medium dense, moist)
2.25	-	3.5	ML	Light grey and tan, iron oxide stained sandy SILT with some gravel (medium stiff, moist)
3.5	-	6.0	ML	Grey sandy SILT (medium stiff, moist)

Terminated at 6 feet below ground surface.
No caving observed at the time of excavation.
No groundwater seepage observed.

Test Pit TP-18

Location: W-central portion of sire, Road B
Approximate Elevation: 200'

Depth (ft)			Soil Type	Soil Description
0	-	0.5	-	Duff/Root zone
0.5	-	1.5	SM	Tan, iron oxidized silty SAND with occasional cobbles (medium dense, moist)
1.5	-	3.0	ML	Grey, heavily mottles sandy SILT (medium stiff, moist)
3.0	-	5.0	ML	Grey sandy SILT (medium stiff, moist)

Terminated at 5 feet below ground surface.
No caving observed at the time of excavation.
No groundwater seepage observed.

Logged by: VRM **Excavated on: September 6, 2018**

Subsurface Explorations by Others

(N.L. Olson, 2007)

C:\Projects\6164 JOHANSON\dwg\MISC\6164_EXHIBIT FIG 2 WITH TEST PITS.dwg, 12/11/2007 9:40:08 AM, aencio

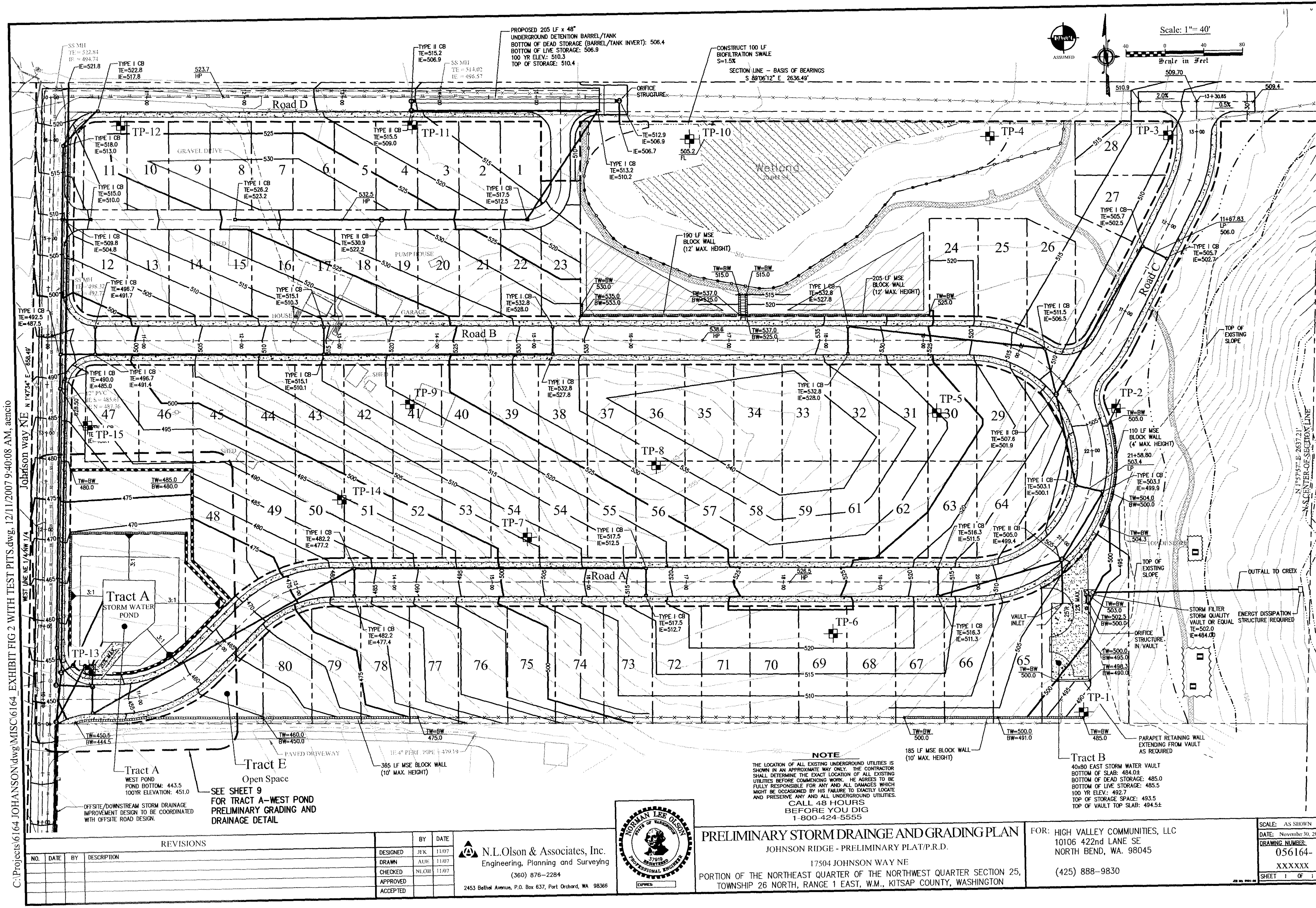

FIGURE 2

APPENDIX A

SUBSURFACE EXPLORATION DISCUSSION

TEST PIT LOGS

LAB RESULTS

The site soil conditions were explored on Nov 29, 2005 and Nov 30, 2005 by excavating fifteen (15) test pits throughout the site. The test pit excavations ranged in depth from 6 to 15 feet below current site grades. Whitworth Excavating performed the excavation work with a Kamatso PC 200 track-hoe. The approximate test pits locations are shown on the attached Site Plan, Figure 2. The test pits soil logs are presented in this Appendix.

Stratification lines designating the interface between soil types in subsurface exploration logs represent approximate boundaries. The transition between materials may be gradual. The depths represented on our test pits logs were referenced to present site grades encountered during our subsurface exploration work.

The subsurface exploration logs and related information depicts conditions only at the specific locations and at the particular time designated on the logs. The passage of time may result in a change of subsurface conditions at these exploration locations. Subsurface conditions at other locations may differ from conditions occurring at the exploration locations. The nature and extent of variations of subsurface conditions between explorations are not known. If variations appear during additional explorations or construction, reevaluation of recommendations in this report may be necessary.

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Test Pit Log

PROPOSED RESIDENTIAL DEVELOPMENT
JOHNSON ROAD
POULBO, WA

Job Number:	Logged By:	Subsurface Exploration Start Date: Nov 29, 2005	End Date: Nov 29, 2005	Ground Surface Elevation	Test Pit Number	Page
6164	WRJ			486	TP-1	1 of 1

Surface Conditions: Cedar, Maple, Ferns

General Notes — Grab samples taken at following Depths	Graphic Symbol	USCS SYMBOL	Depth (ft)	Moisture Content (%)	Description
		TOPSOIL			6 inch layer of topsoil
1 ft (S-1)		SP	1	16.3%	Brown poorly graded SAND, medium dense, moist - Contains gravel - Medium to course grained sand
3 ft (S-2) P.P. =4.5 tsf		CL	2–4 (3)	26.3%	Brown lean CLAY, very stiff to hard, fractured, moist
5 ft (S-3) P.P. = 4.5 tsf		MH	5–7 (6)	14.0%	Brown elastic SILT, very stiff to hard, moist LL=58 PL=53 PI=5
8 ft (S-4)		ML	8–9 (9)	29.3%	Gray SILT, very stiff to hard, moist
10' ft (S-5) P.P. = 4.5 tsf		CL	10–11 (11)	25.9%	Brown lean CLAY, very stiff to hard, fractured, moist
			12–18		Test Pit terminated at 12 feet. (Ground water not encountered)

Contractor	Operators Name	Sampling Method	Drawn By:	Date
Whitworth Excavating	Bob Whitworth	grab	WRJ	November 2, 2005

Equipment: Trackhoe - Komatsu PC 200

Groundwater Elevation: see note:

Checked By: Date:

Revision By: Date:

Hole Completion
- [ ] Monitoring Well
- [ ] Piezometer
- [x] Abanonded and backfilled
- [ ] Inclinometer
- [ ] ____
- [ ] ____

Notes:

(Ground water not encountered)

Appendix A.4

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Test Pit Log

PROPOSED RESIDENTIAL DEVELOPMENT
JOHNSON ROAD
POULBO, WA

Job Number	Logged By	Subsurface Exploration Start Date	Subsurface Exploration End Date	Ground Surface Elevation	Test Pit Number	Page
6238	WRJ	Nov 29, 2005	Nov 29, 2005	507	TP-10	1 of 1

General Notes Grab samples taken at following Depths	Graphic Symbol	USCS SYMBOL	Depth (ft)	Moisture Content (%)	Surface Conditions: Pasture Land
		TOPSOIL	1		1 to 4 inch thick layer of topsoil
		SP	2, 3		silty sand and sand with organics, loose and moist
3.5 ft (S-32)		CL	4	35.7%	Gray Lean CLAY, soft to medium stiff, moist
4-5 ft (S-33)		SP	5	13.3%	Brown/Gray Poorly graded SAND, medium dense, moist
+5 ft (S-34)		ML	6, 7	19.1%	Brown/gray sandy SILT, very stiff, moist
+7 ft (S-35)		SP	8	14.9%	Gray Poorly Graded Sand, medium dense, moist
8-9 ft (S-36)		GP-GM	9	4.3%	Brown poorly graded GRAVEL with silt, medium dense to dense, moist
11 ft (S-37)		ML	10, 11, 12	25.4%	Brown SILT, very stiff, moist - Becomes Gray
			13, 14, 15, 16, 17, 18		Test Pit terminated at 12 feet

Contractor: Whitworth Excavating

Operators Name: Bob Whitworth

Sampling Method: grab

Drawn By: WRJ

Date: November 2, 2005

Equipment: Trackhoe - CAT 311B

Groundwater Elevation: see note:

Checked By:

Date:

Revision By:

Date:

Hole Completion
- ☐ Monitoring Well
- ☐ Piezometer
- ☒ Abanonded and backfilled
- ☐ Inclinometer
- ☐ ____________
- ☐ ____________

Notes:

(Groundwater encountered 18 to 24 inches bgs)

Appendix A.4

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Test Pit Log

PROPOSED RESIDENTIAL DEVELOPMENT
JOHNSON ROAD
POULBO, WA

Job Number:	Logged By:	Subsurface Exploration Start Date: Nov 30, 2005	End Date: Nov 30, 2005	Ground Surface Elevation	Test Pit Number	Page
6238	WRJ			515	TP-11	1 of 1

Surface Conditions: Pasture Land

General Notes / Grab samples taken at following Depths	Graphic Symbol	USCS SYMBOL	Depth (ft)	Moisture Content (%)	Description
1 ft (S-38)		ML	1	15.5%	Fill: Brown SILT, soft to medium stiff, moist - contains cobbles
		TOPSOIL	2		6 to 12 inch thick layer of topsoil
			3		
3.6 ft (S-39)			4	31.2%	Native: Brown SILT, soft to medium stiff, moist - iron oxide stained - contains cobbles LL=35; PL=25; PI=8
			5		- Test pit side wall caved below 4 ft
6 ft (S-40)		ML	6	24.1%	- Becomes sandy silt dense
			7		
8 ft (S-41)			8	23.5%	
			9		- becomes very dense
10 ft (S-42)			10	22.6%	
11-12 ft (S-43)			11	23.4%	Becomes dark gray sandy SILT with gravel dense to very dense at 11 to 12 ft
			12		Test Pit terminated at 12 ft
			13		
			14		
			15		
			16		
			17		
			18		

Contractor	Operators Name	Sampling Method	Drawn By:	Date
Whitworth Excavating	Bob Whitworth	grab	WRJ	November 2, 2005

Equipment: Trackhoe - CAT 311B

Groundwater Elevation: see note:

Checked By: | Date:

Revision By: | Date:

Notes:

(Moderate groundwater seepage midway up test pit)

Hole Completion
- ☐ Monitoring Well
- ☐ Piezometer
- ☒ Abanonded and backfilled
- ☐ Inclinometer
- ☐ ____________
- ☐ ____________

Appendix A.4

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Test Pit Log

PROPOSED RESIDENTIAL DEVELOPMENT
JOHNSON ROAD
POULBO, WA

Job Number:	Logged By:	Subsurface Exploration		Ground Surface Elevation	Test Pit Number	Page
6238	WRJ	Start Date: Nov 30, 2005	End Date: Nov 30, 2005	518	TP-12	1 of 1

Surface Conditions: Apple Orchard and grass

General Notes Grab samples taken at following Depths	Graphic Symbol	USCS SYMBOL	Depth (ft)	Moisture Content (%)	Description
1 ft (S-45)		ML	1	21.4%	Fill: (?) Brown SILT, medium stiff to stiff, moist - Contains Cobbles and Boulders
		TOPSOIL	2		TOPSOIL
2.5 ft (S-46)		SM	3	12.7%	Native: (?) Brown silty SAND with gravel, medium dense to dense, moist
3.6 ft (S-47)		SP		18.7%	Brown/Gray Poorly graded SAND, medium dense, moist - iron oxide stained
5 ft (S-48) 8 ft (S-49)		ML	4–11	16.9% (5 ft) 24.7% (8 ft)	Native: Brown SILT, soft to medium stiff, moist - iron oxide stained - contains cobbles - Becomes sandy silt dense
			12–18		Test Pit terminated at 12 ft

Contractor	Operators Name	Sampling Method	Drawn By:	Date
Whitworth Excavating	Bob Whitworth	grab	WRJ	November 2, 2005

Equipment	Groundwater Elevation	Checked By:	Date
Trackhoe - CAT 311B	not encountered		

Revision By:	Date

Notes:

Hole Completion
- ☐ Monitoring Well
- ☐ Piezometer
- ☒ Abanonded and backfilled
- ☐ Inclinometer
- ☐ ________
- ☐ ________

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Test Pit Log

PROPOSED RESIDENTIAL DEVELOPMENT
JOHNSON ROAD
POULBO, WA

Job Number:	Logged By:	Subsurface Exploration Start Date: Nov 30, 2005	End Date: Nov 30, 2005	Ground Surface Elevation	Test Pit Number	Page
6238	WRJ			452	TP-13	1 of 1

Surface Conditions: Black berry bramble and grassy area

General Notes — Grab samples taken at following Depths	USCS SYMBOL	Depth (ft)	Moisture Content (%)	Description
	TOPSOIL	0–2		TOPSOIL
24 to 40" ft (S-50)	CL	2–3.3	24.2%	Gray lean CLAY, medium stiff to stiff, wet
5 ft (S-51)	SM	3.3–6	17.6%	Brown silty SAND with gravel, medium dense to dense, moist
8 ft (S-52)	ML	6–12	31.4%	Brown SILT, medium stiff to stiff, moist - contains fine grained sand
10 ft (S-53)			26%	- Becomes light gray at 10 ft - medium stiff to stiff
		12–18		Test Pit terminated at 12 ft (Groundwater was not encountered)

Contractor	Operators Name	Sampling Method	Drawn By:	Date
Whitworth Excavating	Bob Whitworth	grab	WRJ	November 2, 2005
Equipment: Trackhoe - CAT 311B		Groundwater Elevation: not encountered	Checked By:	Date
			Revision By:	Date

Hole Completion
- [ ] Monitoring Well
- [ ] Piezometer
- [x] Abanonded and backfilled
- [ ] Inclinometer
- [ ] ____________
- [ ] ____________

Notes:

Mottled soil conditions throughout test pit excavation

Appendix A.4

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Test Pit Log

PROPOSED RESIDENTIAL DEVELOPMENT
JOHNSON ROAD
POULBO, WA

Job Number:	Logged By:	Subsurface Exploration Start Date:	Subsurface Exploration End Date:	Ground Surface Elevation	Test Pit Number	Page
6238	WRJ	Nov 30, 2005	Nov 30, 2005	498	TP-14	1 of 1

Surface Conditions: Blackberry and grass

General Notes — Grab samples taken at following Depths	USCS SYMBOL	Depth (ft)	Moisture Content (%)	Description
	TOPSOIL	0–1		TOPSOIL
2 ft	SM	1–3		Gray silty SAND, medium dense to dense, moist - contains fine grained sand
4 ft 11 ft	ML	3–11		Light gray SILT, very stiff to hard, moist - contains fine grained sand
15 ft	MH	11–15		Dark Gray elastic SILT, stiff to very stiff, moist
		15–18		Test Pit terminated at 15 ft

Depth scale: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18

Contractor	Operators Name	Sampling Method	Drawn By:	Date
Whitworth Excavating	Bob Whitworth	grab	WRJ	November 2, 2005

Equipment	Groundwater Elevation	Checked By:	Date
Trackhoe - CAT 311B	not encountered		

Revision By: Date:

Hole Completion
- ☐ Monitoring Well
- ☐ Piezometer
- ☒ Abanonded and backfilled
- ☐ Inclinometer
- ☐ ____________
- ☐ ____________

Notes:

Mottled soil conditions throughout test pit excavation

Appendix A.4

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Test Pit Log

PROPOSED RESIDENTIAL DEVELOPMENT
JOHNSON ROAD
POULBO, WA

Job Number:	Logged By:	Subsurface Exploration Start Date: Nov 30, 2005	Subsurface Exploration End Date: Nov 30, 2005	Ground Surface Elevation	Test Pit Number	Page
6238	WRJ			488	TP-15	1 of 1

Surface Conditions: Pasture Land

General Notes — Grab samples taken at following Depths	Graphic Symbol	USCS SYMBOL	Depth (ft)	Moisture Content (%)	Description
		TOPSOIL	1		TOPSOIL
2 ft		SM	2–3		Gray silty SAND, medium dense to dense, moist - contains fine grained sand
4 ft 6 ft		ML	3–6		Light gray SILT, very stiff to hard, moist - contains fine grained sand
			6–18		Test Pit terminated at 6 ft (Groundwater was not encountered)

Contractor	Operators Name	Sampling Method	Drawn By:	Date
Whitworth Excavating	Bob Whitworth	grab	WRJ	November 2, 2005

Equipment	Groundwater Elevation	Checked By:	Date
Trackhoe - CAT 311B	not encountered		

Revision By:
Date:

Hole Completion
- ☐ Monitoring Well
- ☐ Piezometer
- ☒ Abanonded and backfilled
- ☐ Inclinometer
- ☐ ______
- ☐ ______

Notes:

Mottled soil conditions throughout test pit excavation

Appendix A.4

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Test Pit Log

PROPOSED RESIDENTIAL DEVELOPMENT
JOHNSON ROAD
POULBO, WA

Job Number:	Logged By:	Subsurface Exploration Start Date:	Subsurface Exploration End Date:	Ground Surface Elevation	Test Pit Number	Page
6238	WRJ	Nov 29, 2005	Nov 29, 2005	502	TP-2	1 of 1

Surface Conditions: Cedar, Tall Grass

General Notes / Grab samples taken at following Depths	Graphic Symbol	USCS SYMBOL	Depth (ft)	Moisture Content (%)	Description
		TOPSOIL			6 inch layer of topsoil
		CL	1–2		Brown lean CLAY, soft to medium stiff, moist
2.5 ft (S-6)		ML	2–12	33.4%	Gray SILT, very stiff to hard, moist to wet and weathered LL=33; PL=30; PI=5
4 ft (S-7) P.P. = 4.5 tsf				25.7%	Becomes light gray and very stiff to hard, moist LL=29; PL=24; PI=5
			12–18		Test Pit terminated at 12 feet. (Standing water conditions encountered)

Contractor	Operators Name	Sampling Method	Drawn By:	Date
Whitworth Excavating	Bob Whitworth	grab	WRJ	November 2, 2005

Equipment: Trackhoe - CAT 311B

Groundwater Elevation: see note:

Checked By: Date:

Revision By: Date:

Hole Completion
- ☐ Monitoring Well
- ☐ Piezometer
- ☒ Abanonded and backfilled
- ☐ Inclinometer
- ☐ ____________
- ☐ ____________

Notes:

(Standing water conditions encountered)

Appendix A.4

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Test Pit Log

PROPOSED RESIDENTIAL DEVELOPMENT
JOHNSON ROAD
POULBO, WA

Job Number:	Logged By:	Subsurface Exploration Start Date: Nov 29, 2005	End Date: Nov 29, 2005	Ground Surface Elevation	Test Pit Number	Page
6238	WRJ			516	TP-3	1 of 1

General Notes Grab samples taken at following Depths	Graphic Symbol	USCS SYMBOL	Depth (ft)	Moisture Content (%)	Surface Conditions: Brush, Douglas Fir, and Cedar
		TOPSOIL			2 to 4 inch layer of topsoil
		CL	1		Brown lean CLAY, soft to medium stiff, moist
			2		Tree roots encountered down 2 to 3 feet
2.5 ft (S-8)				20.4%	
		ML	3	23.2%	Gray SILT, hard, moist
			4		
			5		
4 ft (S-9) P.P. = 4.5 tsf			6	25.7%	
			7		
			8		
			9		
			10		
			11		
12 ft (S-10) P.P. = 4.5 tsf			12	26.5%	Becomes light gray
			13		
			14		
			15		Test Pit terminated at 12 feet.
			16		(Standing water conditions encountered)
			17		
			18		

Contractor	Operators Name	Sampling Method	Drawn By:	Date
Whitworth Excavating	Bob Whitworth	grab	WRJ	November 2, 2005

Equipment	Groundwater Elevation	Checked By:	Date
Trackhoe - CAT 311B	see note:		

Revision By: Date:

Hole Completion
- ☐ Monitoring Well
- ☐ Piezometer
- ☒ Abanonded and backfilled
- ☐ Inclinometer
- ☐ ____________
- ☐ ____________

Notes:

(Standing water conditions encountered)

Appendix A.4

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Test Pit Log

PROPOSED RESIDENTIAL DEVELOPMENT
JOHNSON ROAD
POULBO, WA

Job Number:	Logged By:	Subsurface Exploration Start Date:	End Date:	Ground Surface Elevation	Test Pit Number	Page
6238	WRJ	Nov 29, 2005	Nov 29, 2005	506	TP-4	1 of 1

General Notes / Grab samples taken at following Depths	Graphic Symbol	USCS SYMBOL	Depth (ft)	Moisture Content (%)	Surface Conditions: Pasture Land
		TOPSOIL	0–1		6 to 12 inch layer of topsoil
2 ft (S-11)		CL	1–2.5	24.1%	Brown sandy CLAY, loose, fractured, wet
30"-4' (S-12)		SP	2.5–4	17.4%	Brown poorly graded SAND, medium dense, moist - Contains gravel - Fine to medium grained sand - Mottled soil conditions and tace cobbles observed upper 4 ft of soil horizon.
4 ft (S-13) P.P. = 4 tsf		ML	4–13	29.2%	Gray SILT, very stiff to hard, moist
10-13 ft (S-14) P.P. = 4.0 tsf				28.5%	Becomes Dark Gray
			13–18		Test Pit terminated at 13 feet. (Light ground water seepage encountered at 4 ft and standing water conditions observed)

Contractor	Operators Name	Sampling Method	Drawn By:	Date
Whitworth Excavating	Bob Whitworth	grab	WRJ	November 2, 2005

Equipment	Groundwater Elevation	Checked By:	Date
Trackhoe - CAT 311B	see note:		

Revision By: | Date:

Hole Completion
- ☐ Monitoring Well
- ☐ Piezometer
- ☒ Abanonded and backfilled
- ☐ Inclinometer
- ☐ ____________
- ☐ ____________

Notes:

(Light ground water seepage encountered at 4 ft and standing water conditions observed)

N.L.Olson&Associates,Inc.
Engineering, Planning and Surveying
2453 BETHEL AVENUE
P.O. BOX 637
PORT ORCHARD, WASHINGTON 98366-0637

Test Pit Log

PROPOSED RESIDENTIAL DEVELOPMENT
JOHNSON ROAD
POULBO, WA

Job Number	Logged By	Subsurface Exploration Start Date	Subsurface Exploration End Date	Ground Surface Elevation	Test Pit Number	Page
6238	WRJ	Nov 29, 2005	Nov 29, 2005	534	TP-5	1 of 1

Surface Conditions: Pature land near burn pile

General Notes — Grab samples taken at following Depths	Graphic Symbol	USCS SYMBOL	Depth (ft)	Moisture Content (%)	Description
		TOPSOIL			2 to 4 inch layer of topsoil
1 ft (S-15)			1	16.5%	Gray SILT, soft, moist to wet and weathered - mottled 32 inches bgs
			2		
2.5 ft (S-16)				22.4%	
			3		- Becomes very stiff at 3 ft
			4		
			5	25.4%	- Becomes very stiff to hard at 5 ft
4 ft (S-17)			6		
		ML	7		
			8		
			9		
			10		- Becomes sandy SILT and dense at roughly 10 ft
			11		
14 ft (S-18)			12		
			13		
			14		
			15		Test Pit terminated at 14 feet.
			16		
			17		
			18		

Contractor	Operators Name	Sampling Method	Drawn By	Date
Whitworth Excavating	Bob Whitworth	grab	WRJ	November 2, 2005

Equipment	Groundwater Elevation	Checked By	Date
Trackhoe - CAT 311B	see note:		

Revision By: Date:

Hole Completion
- ☐ Monitoring Well
- ☐ Piezometer
- ☒ Abanonded and backfilled
- ☐ Inclinometer
- ☐ ____________
- ☐ ____________

Notes:

(Light ground water seepage encountered at 2.5 ft)
upper 2.5 feet of soil horizon disturbed by previous plowing activity

Appendix A.4

N.L.Olson&Associates,Inc.
Engineering, Planning and Surveying
2453 BETHEL AVENUE
P.O. BOX 637
PORT ORCHARD, WASHINGTON 98366-0637

Test Pit Log

PROPOSED RESIDENTIAL DEVELOPMENT
JOHNSON ROAD
POULBO, WA

Job Number:	Logged By:	Subsurface Exploration Start Date: Nov 29, 2005	End Date: Nov 29, 2005	Ground Surface Elevation	Test Pit Number	Page
6238	WRJ			521	TP-6	1 of 1

General Notes Grab samples taken at following Depths	Graphic Symbol	USCS SYMBOL	Depth (ft)	Moisture Content (%)	Surface Conditions: Black Berry Bramble
		TOPSOIL			2 to 6 inch layer of topsoil
			1		Brown SILT, soft to medium stiff, moist - mottled 36 inches bgs - upper 3 ft weathered
			2		
1-3 ft (S-19)			3	20.6%	- Becomes light gray and very stiff at 3 ft
4 ft (S-20)			4	24.3%	
			5		- Becomes very stiff to hard at 5 ft
			6		
		ML	7		
			8		
			9		
			10		- Becomes sandy SILT and dense at roughly 10 ft
			11		
			12		
13.5 ft (S-21)			13	28.5%	
			14		
			15		Test Pit terminated at 14 feet.
			16		
			17		
			18		

Contractor	Operators Name	Sampling Method	Drawn By:	Date
Whitworth Excavating	Bob Whitworth	grab	WRJ	November 2, 2005
Equipment: Trackhoe - CAT 311B		Groundwater Elevation: not encountered	Checked By:	Date
Notes:			Revision By:	Date

Hole Completion
- ☐ Monitoring Well
- ☐ Piezometer
- ☒ Abanonded and backfilled
- ☐ Inclinometer
- ☐ ____________
- ☐ ____________

Appendix A.4

N.L.Olson&Associates,Inc.
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2453 BETHEL AVENUE
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Test Pit Log

PROPOSED RESIDENTIAL DEVELOPMENT
JOHNSON ROAD
POULBO, WA

Job Number:	Logged By:	Subsurface Exploration Start Date:	Subsurface Exploration End Date:	Ground Surface Elevation	Test Pit Number	Page
6238	WRJ	Nov 29, 2005	Nov 29, 2005	524	TP-7	1 of 1

Surface Conditions: Blackberry and grassland

General Notes – Grab samples taken at following Depths	Graphic Symbol	USCS SYMBOL	Depth (ft)	Moisture Content (%)	Description
		TOPSOIL			6 inch layer of topsoil
2.5 ft (S-22) 4 ft (S-23)		ML	1–6	13.0% (at 2.5 ft) 24.5% (at 4 ft)	Brown SILT, soft to medium stiff, moist - mottled and weathered upper 36 inches - contains rootlets - contains trace gravel - Becomes light gray and very stiff at 4 ft - Becomes very stiff to hard at 5 ft
7 ft (S-24)		SM	6–7	9.2%	Light Brown silty SAND with gravel, medium dense to dense, moist - Fines content = 24% passing 200 sieve

Test Pit terminated at 7 feet.

Depth scale (ft): 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18

Contractor	Operators Name	Sampling Method	Drawn By:	Date
Whitworth Excavating	Bob Whitworth	grab	WRJ	November 2, 2005

Equipment	Groundwater Elevation	Checked By:	Date
Trackhoe - CAT 311B	not encountered		

Revision By: Date:

Notes:

Hole Completion
- ☐ Monitoring Well
- ☐ Piezometer
- ☒ Abanonded and backfilled
- ☐ Inclinometer
- ☐ ____________
- ☐ ____________

N.L.Olson&Associates,Inc.
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2453 BETHEL AVENUE
P.O. BOX 637
PORT ORCHARD, WASHINGTON 98366-0637

Test Pit Log

PROPOSED RESIDENTIAL DEVELOPMENT
JOHNSON ROAD
POULBO, WA

Job Number:	Logged By:	Subsurface Exploration Start Date:	Subsurface Exploration End Date:	Ground Surface Elevation	Test Pit Number	Page
6238	WRJ	Nov 29, 2005	Nov 29, 2005	560	TP-8	1 of 1

Surface Conditions: Grass land brush and scattered trees

General Notes - Grab samples taken at following Depths	USCS SYMBOL	Depth (ft)	Moisture Content (%)	Description
	TOPSOIL			6 to 12 inch thick layer of topsoil
0.5 to 1.5 ft (S-25); 2 ft (S-25)	SM	1–4		Brown silty SAND loose, moist - Fine to medium grained sand - Contains trace gravel - gravel content increases
6 ft (S-27)	SP-SM	4–6		Grayish brown poorly graded SAND with silt and gravel, medium dense to dense, wet - Medium to course grained sand
	SM	6–8		- Becomes fine to medium grained sand.
8.5 ft (S-28)	ML	8–12		Gray silty SAND with gravel, medium dense to dense, moist - Fine to medium grained sand - Contains Cobbles Brown SILT with gravel and cobbles, hard, moist, - iron oxide stained
		12		Test Pit terminated at 13 feet

Contractor	Operators Name	Sampling Method	Drawn By:	Date
Whitworth Excavating	Bob Whitworth	grab	WRJ	November 2, 2005

Equipment	Groundwater Elevation	Checked By:	Date
Trackhoe - CAT 311B	not encountered		

Notes:

Revision By: Date:

Hole Completion
- [ ] Monitoring Well
- [ ] Piezometer
- [x] Abanonded and backfilled
- [ ] Inclinometer
- [ ] ____________
- [ ] ____________

Appendix A.4

N.L.Olson&Associates,Inc.
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Test Pit Log

PROPOSED RESIDENTIAL DEVELOPMENT
JOHNSON ROAD
POULBO, WA

Job Number:	Logged By:	Subsurface Exploration Start Date:	End Date:	Ground Surface Elevation	Test Pit Number	Page
6238	WRJ	Nov 29, 2005	Nov 29, 2005	536	TP-9	1 of 1

Surface Conditions: Lawn area near shop

General Notes: Grab samples taken at following Depths	Graphic Symbol	USCS SYMBOL	Depth (ft)	Moisture Content (%)	Description
		TOPSOIL			6 inch layer of topsoil
0 to 2.67 ft (S-29)		ML	1–2	15.0%	Brown SILT with gravel, soft to medium stiff, moist - contains cobbles
4 ft (S-30)		SM	3–4	12.7%	Light Brown silty SAND with gravel, medium dense, moist - Becomes gray and dense
5 ft (S-31)		ML	5–6	24%	Gray SILT hard, moist - contains cobbles - Mottled
			7–18		Test Pit terminated at 6 feet.

Contractor	Operators Name	Sampling Method	Drawn By:	Date
Whitworth Excavating	Bob Whitworth	grab	WRJ	November 2, 2005

Equipment: Trackhoe - CAT 311B

Groundwater Elevation: not encountered

Checked By: 　Date:

Revision By: 　Date:

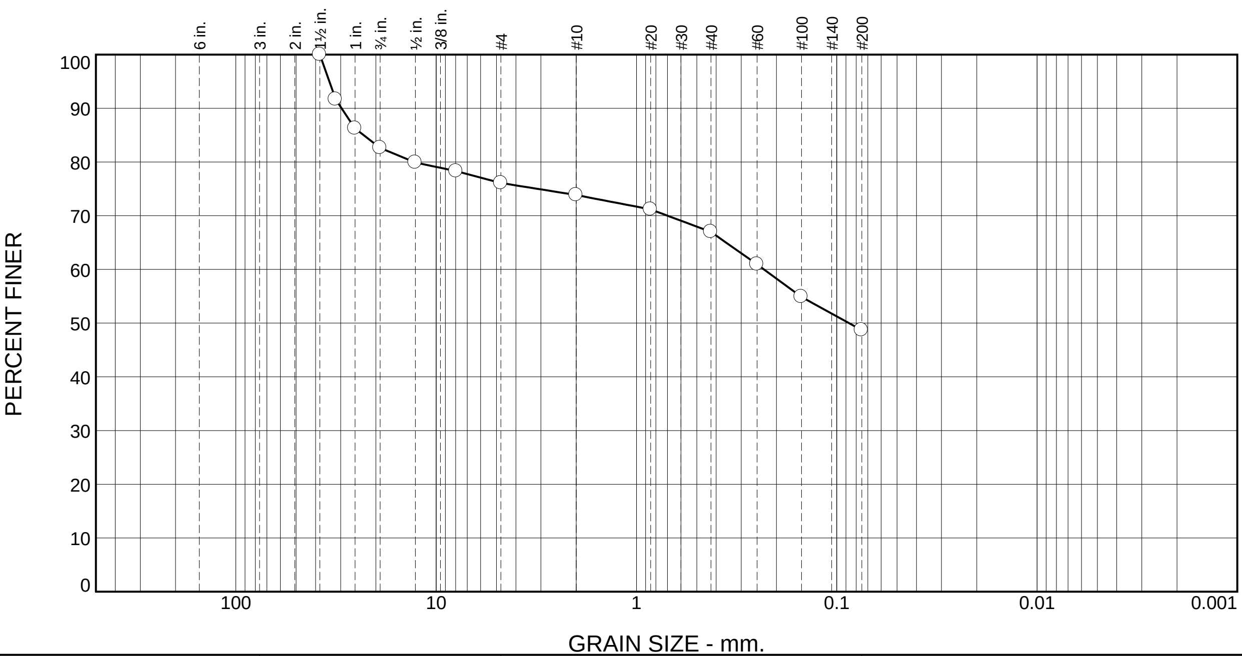
Notes:

Hole Completion
- ☐ Monitoring Well
- ☐ Piezometer
- ☒ Abanonded and backfilled
- ☐ Inclinometer
- ☐ ____________
- ☐ ____________

Appendix A.4

Appendix B
Laboratory Test Results

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	17.4	6.5	2.2	6.9	18.3	48.7	

Test Results (ASTM D 422 & ASTM D 1140)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1.5	100.0		
1.25	91.7		
1	86.2		
.75	82.6		
.5	79.9		
.3125	78.3		
#4	76.1		
#10	73.9		
#20	71.2		
#40	67.0		
#60	60.9		
#100	54.9		
#200	48.7		

* (no specification provided)

Material Description

Silty sand with gravel

Atterberg Limits (ASTM D 4318)

PL= **LL=** **PI=** NV

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}= 29.6434 D_{85}= 23.0175 D_{60}= 0.2310
D_{50}= 0.0867 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: 6/7/18 **Date Tested:** 9/7/18
Tested By: JZ
Checked By: KSS
Title: PM

Location: TP-1 **Date Sampled:** 9/6/18
Sample Number: 095452 **Depth:** 2.5'

GeoResources, LLC

Fife, WA

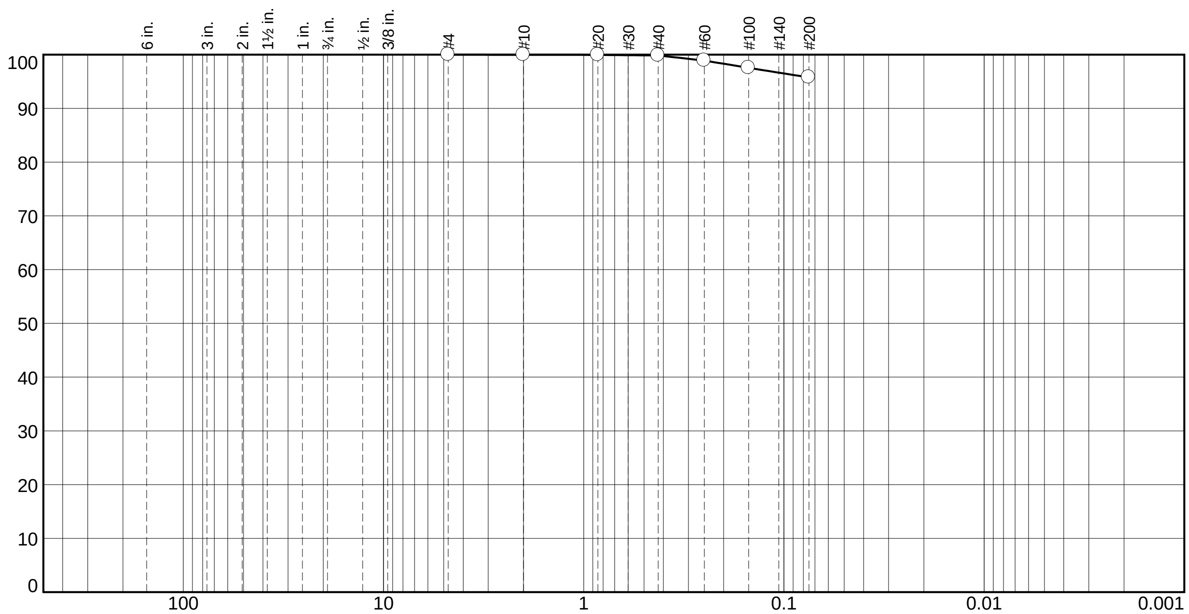
Client: Schwabe, Williamson, & Wyatt
Project: SWW.JohnsonRdNW

Project No: **Figure**

These results are for the exclusive use of the client for whom they were obtained. They apply only to the samples tested and are not indicitive of apparently identical samples.

Tested By: ____________ **Checked By:** ____________

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.2	4.0	95.8	

Test Results (ASTM D 422 & ASTM D 1140)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#4	100.0		
#10	100.0		
#20	100.0		
#40	99.8		
#60	98.9		
#100	97.5		
#200	95.8		

* (no specification provided)

Material Description

Silt

Atterberg Limits (ASTM D 4318)

PL= LL= PI= NV

Classification

USCS (D 2487)= AASHTO (M 145)=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: 9/7/18 **Date Tested:** 9/7/18

Tested By: JZ

Checked By: KSS

Title: PM

Location: TP-2
Sample Number: 095453 **Depth:** 7' **Date Sampled:** 9/6/18

GeoResources, LLC

Fife, WA

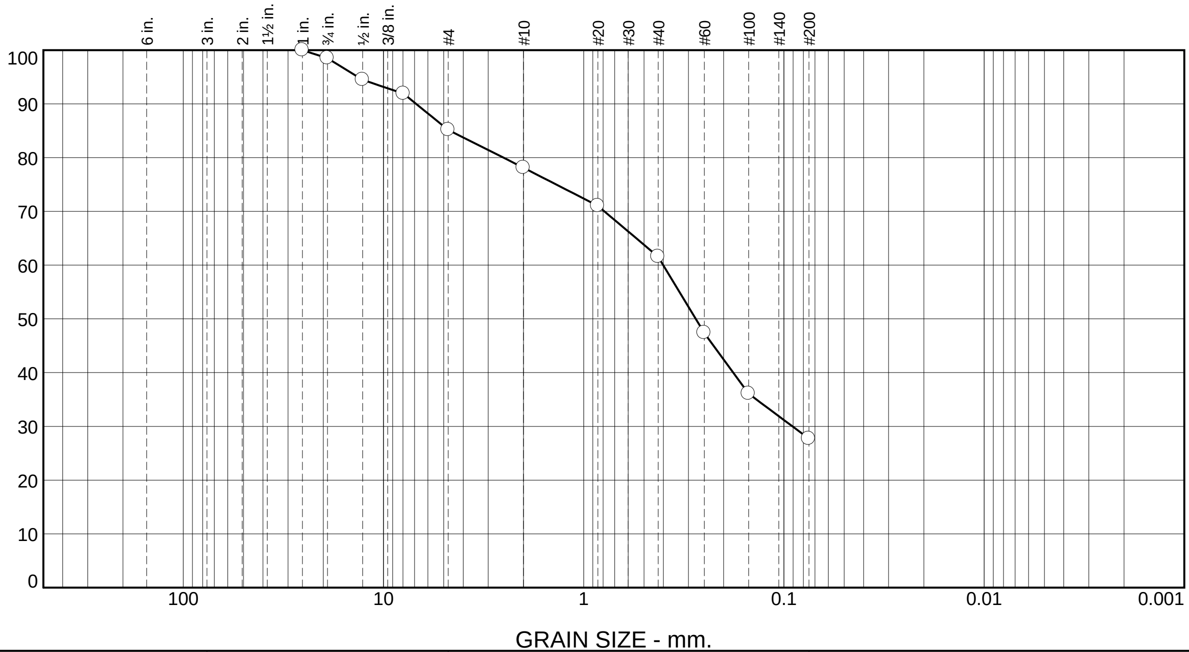
Client: Schwabe, Williamson, & Wyatt
Project: SWW.JohnsonRdNW

Project No: **Figure**

These results are for the exclusive use of the client for whom they were obtained. They apply only to the samples tested and are not indicitive of apparently identical samples.

Tested By: ____________ **Checked By:** ____________

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	1.5	13.4	7.0	16.5	33.9	27.7	

Test Results (ASTM D 422 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1	100.0		
.75	98.5		
.5	94.5		
.3125	91.9		
#4	85.1		
#10	78.1		
#20	71.0		
#40	61.6		
#60	47.4		
#100	36.1		
#200	27.7		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NV

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-2-4(0)

Coefficients

D_{90}= 6.8707 D_{85}= 4.6635 D_{60}= 0.4008
D_{50}= 0.2756 D_{30}= 0.0906 D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: 9/7/18 **Date Tested:** 9/7/18
Tested By: JZ
Checked By: KSS
Title: PM

Location: TP-8
Sample Number: 095454 **Depth:** 2'
Date Sampled: 9/6/18

GeoResources, LLC

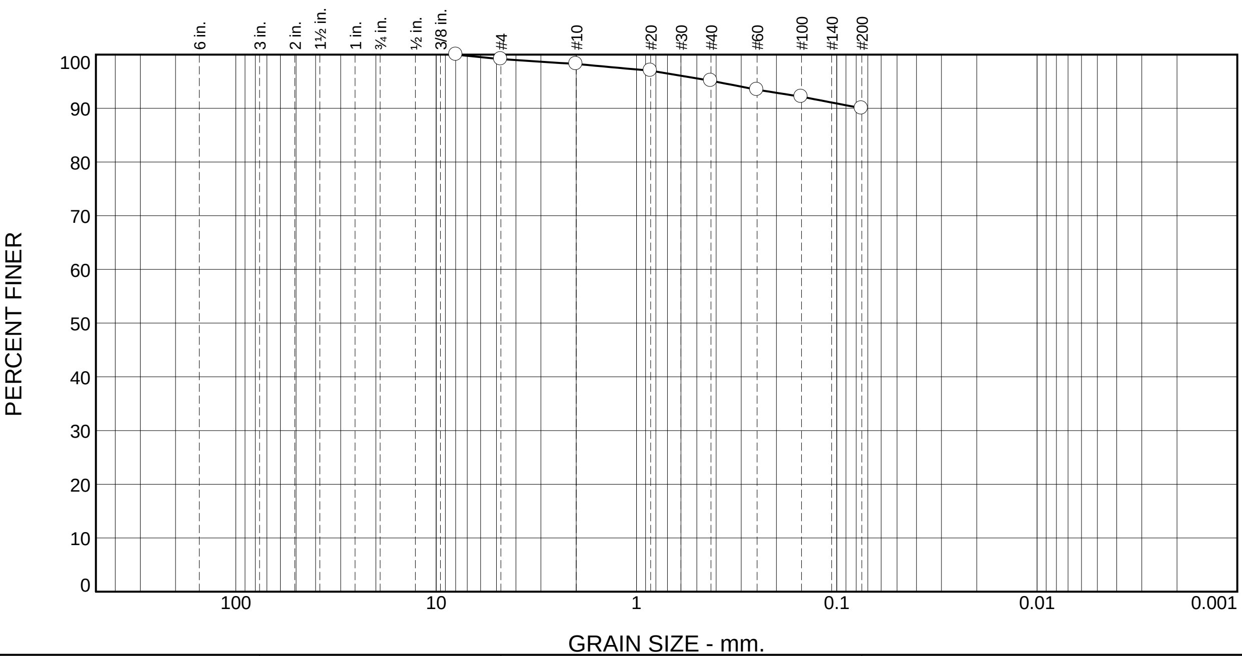
Fife, WA

Client: Schwabe, Williamson, & Wyatt
Project: SWW.JohnsonRdNW
Project No:
Figure

These results are for the exclusive use of the client for whom they were obtained. They apply only to the samples tested and are not indicitive of apparently identical samples.

Tested By: ________________ **Checked By:** ________________

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.8	0.9	3.2	5.1	90.0	

Test Results (ASTM D 422 & ASTM D 1140)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
.3125	100.0		
#4	99.2		
#10	98.3		
#20	97.0		
#40	95.1		
#60	93.5		
#100	92.2		
#200	90.0		

* (no specification provided)

Material Description

Silt

Atterberg Limits (ASTM D 4318)

PL= **LL=** **PI=** NV

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: 9/7/18 **Date Tested:** 9/7/18

Tested By: JZ

Checked By: KSS

Title: PM

Location: TP-12
Sample Number: 095455 **Depth:** 4' **Date Sampled:** 9/6/18

GeoResources, LLC

Fife, WA

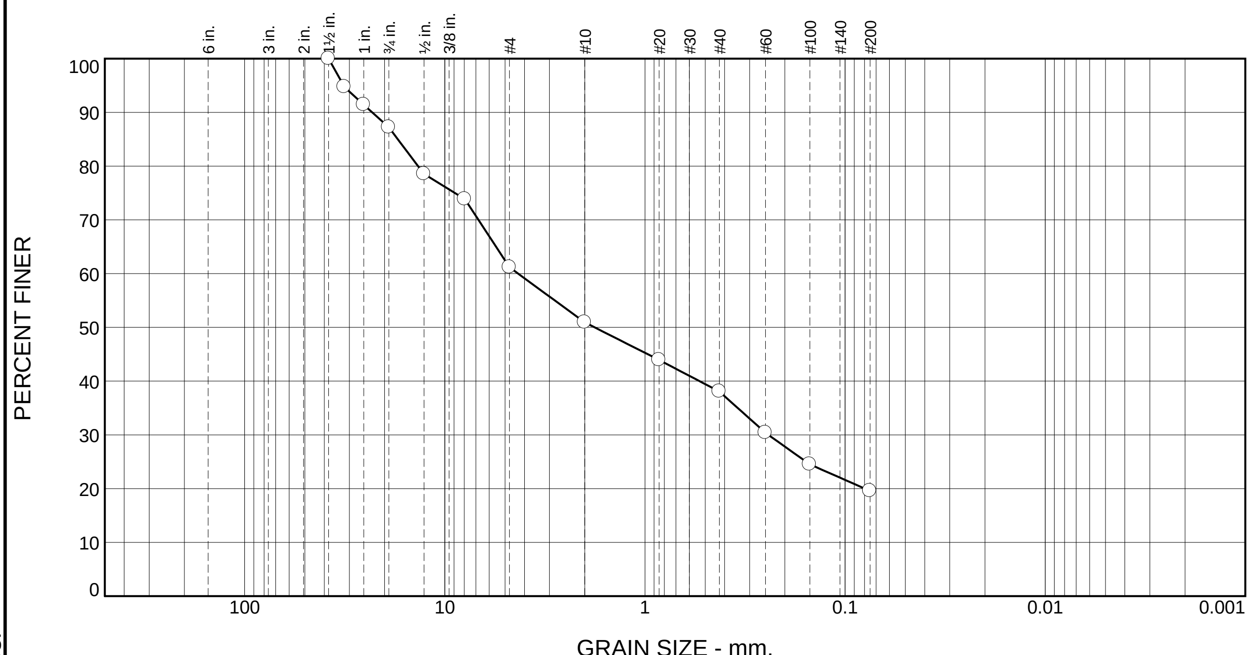
Client: Schwabe, Williamson, & Wyatt
Project: SWW.JohnsonRdNW

Project No: **Figure**

These results are for the exclusive use of the client for whom they were obtained. They apply only to the samples tested and are not indicitive of apparently identical samples.

Tested By: ________________ **Checked By:** ________________

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	12.8	26.0	10.3	12.8	18.5	19.6	

Test Results (ASTM D 422 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1.5	100.0		
1.25	94.7		
1	91.4		
.75	87.2		
.5	78.5		
.3125	73.9		
#4	61.2		
#10	50.9		
#20	43.9		
#40	38.1		
#60	30.4		
#100	24.5		
#200	19.6		

* (no specification provided)

Material Description

Silty sand with gravel

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-1-b

Coefficients

D_{90}= 23.0596 D_{85}= 17.1716 D_{60}= 4.3016
D_{50}= 1.7831 D_{30}= 0.2416 D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: 9/7/18 **Date Tested:** 9/7/18

Tested By: JZ

Checked By: KSS

Title: PM

Location: TP-13
Sample Number: 095456 **Depth:** 5.5'
Date Sampled: 9/6/18

GeoResources, LLC

Fife, WA

Client: Schwabe, Williamson, & Wyatt
Project: SWW.JohnsonRdNW

Project No: **Figure**

These results are for the exclusive use of the client for whom they were obtained. They apply only to the samples tested and are not indicitive of apparently identical samples.

Tested By: ______________ **Checked By:** ______________

Particle Size Distribution Report

% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	5.2	23.2	11.5	22.5	22.1	15.5	

Test Results (ASTM D 422 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1.25	100.0		
1	98.1		
.75	94.8		
.5	86.5		
.3125	83.1		
#4	71.6		
#10	60.1		
#20	49.9		
#40	37.6		
#60	23.8		
#100	18.4		
#200	15.5		

* (no specification provided)

Material Description

Silty sand with gravel

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NV

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-1-b

Coefficients

D_{90}= 15.0544 D_{85}= 10.2711 D_{60}= 1.9814
D_{50}= 0.8588 D_{30}= 0.3174 D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: 9/7/18 **Date Tested:** 9/7/18

Tested By: JZ

Checked By: KSS

Title: PM

Location: TP-15
Sample Number: 095457 **Depth:** 6.5' **Date Sampled:** 9/6/18

GeoResources, LLC

Fife, WA

Client: Schwabe, Williamson, & Wyatt
Project: SWW.JohnsonRdNW

Project No: **Figure**

These results are for the exclusive use of the client for whom they were obtained. They apply only to the samples tested and are not indicitive of apparently identical samples.

Tested By: ____________ **Checked By:** ____________

Subsurface Explorations by Others

(N.L. Olson, 2007)

January 6, 2006

KA No. 096-05293
Lab Report No. 5

WES JOHNSON
N.L. OLSON & ASSOCIATES, INC.
2453 Bethel Avenue
Port Orchard, Washington 98364

RE: Soil Laboratory Testing
2005 Control Samples
19501 144th Avenue Northeast
Woodinville, Washington

Dear Mr. Johnson,

In accordance with your request and authorization, we have performed laboratory tests for the above referenced project.

Laboratory testing was performed in general accordance with ASTM standards. The results of the laboratory tests are presented on the following pages. If you have any questions or if we can be of further assistance, please do not hesitate to contact our office.

Respectfully submitted,
KRAZAN & ASSOCIATES, INC.

Corbett Mercer
Project Manager
Pacific Northwest Division

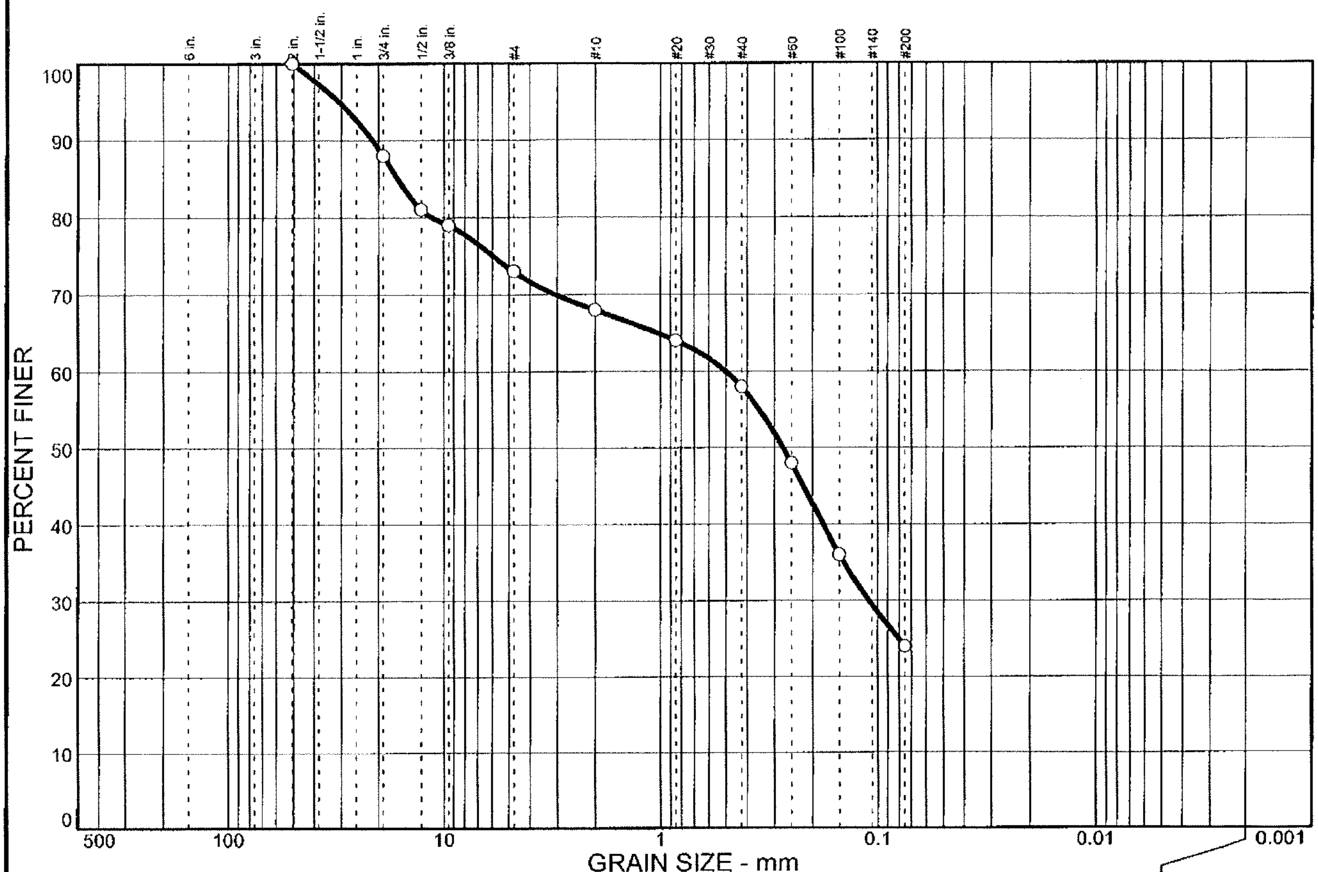
CM/ga

Moisture Content

Project No:	09605293	Client:	N.L. Olson and Associates
Project:	Johnson Road NE	Date:	12/23/05

Sample ID	Bore Hole	Sample No	Depth	Wet & Tare	Dry &Tare	Tare	Results
21499-1	TP-1	S-1	1'	406.4	364.7	108.9	16.3%
21499-2	TP-1	S-2	3'	543.8	454.6	115.3	26.3%
21499-3	TP-1	S-3	5'	578.7	519.8	98.2	14.0%
21499-4	TP-1	S-4	8'	436.5	362.1	107.9	29.3%
21499-5	TP-1	S-5	10'	332.2	283.2	93.9	25.9%
21499-6	TP-2	S-6	2.5'	250.2	215.1	110.1	33.4%
21499-7	TP-2	S-7	4'	282.0	253.3	141.7	25.7%
21499-8	TP-3	S-8	2.5'	527.5	454.9	98.3	20.4%
21499-9	TP-3	S-9	4'	490.6	416.5	97.2	23.2%
21499-10	TP-3	S-10	12'	478.1	397.3	92.3	26.5%
21499-11	TP-4	S-11	2'	482.5	407.7	97.2	24.1%
21499-12	TP-4	S-12	2.5'-4'	662.3	578.1	94.8	17.4%
21499-13	TP-4	S-13	4'	574.4	466.8	97.8	29.2%
21499-14	TP-4	S-14	11'-13'	600.2	487.7	92.4	28.5%
21499-15	TP-5	S-15	1'	483.2	430.5	111.8	16.5%
21499-16	TP-5	S-16	30"	551.1	470.8	112.9	22.4%
21499-17	TP-5	S-17	4'	524.8	440.7	109.6	25.4%
21499-18	TP-5	S-18	14'	576.9	486.3	95.0	23.2%
21499-19	TP-6	S-19	1'-3'	623.8	533.9	97.4	20.6%
21499-20	TP-6	S-20	4'	749.5	625.0	113.5	24.3%
21499-21	TP-6	S-21	13.5'	551.7	454.3	112.1	28.5%
21499-22	TP-7	S-22	2'	514.6	468.2	110.9	13.0%
21499-23	TP-7	S-23	4'	664.2	553.1	99.3	24.5%
21499-24	TP-7	S-24	7'	1304.5	1209.8	177.3	9.2%
21499-25	TP-8	S-25	6"-16"	518.5	469.6	108.4	13.5%
21499-26	TP-8	S-26	2'	330.1	305.4	98.6	11.9%
21499-27	TP-8	S-27	6'	690.3	630.3	109.3	11.5%
21499-28	TP-8	S-28	8.5'	734.6	606.3	113.2	26.0%
21499-29	TP-9	S-29	0'-32"	453.1	406.8	98.8	15.0%
21499-30	TP-9	S-30	4'	851.2	767.8	111.1	12.7%
21499-31	TP-9	S-31	5'	586.5	492.0	97.8	24.0%
21499-32	TP-10	S-32	3.5'	437.7	347.5	94.5	35.7%
21499-33	TP-10	S-33	4'-5'	520.5	470.9	98.2	13.3%
21499-34	TP-10	S-34	5'	562.5	487.8	97.5	19.1%
21499-35	TP-10	S-35	7'	643.4	572.5	97.7	14.9%
21499-36	TP-10	S-36	8'-9'	895.6	863.0	97.1	4.3%
21499-37	TP-10	S-37	11'	652.5	539.6	94.5	25.4%
21499-38	TP-11	S-38	1'	581.3	516.0	94.1	15.5%
21499-39	TP-11	S-39	43"	297.4	260.3	141.5	31.2%
21499-40	TP-11	S-40	6'	629.3	528.9	111.5	24.1%
21499-41	TP-11	S-41	8'	526.0	442.1	85.3	23.5%
21499-42	TP-11	S-42	10'	444.1	377.7	84.3	22.6%
21499-43	TP-11	S-43	11'-12'	569.3	477.3	84.7	23.4%
21499-44	TP-11	S-44	3.5'	SAMPLE	NOT	RECEIVED	W/ BAGS
21499-45	TP-12	S-45	1'	414.3	356.0	83.8	21.4%
21499-46	TP-12	S-46	2.5'	465.7	422.7	84.5	12.7%
21499-47	TP-12	S-47	44"	463.7	404.0	84.6	18.7%
21499-48	TP-12	S-48	5'	782.7	698.8	203.7	16.9%
21499-49	TP-12	S-49	8'	720.2	612.9	179.2	24.7%
21499-50	TP-13	S-50	24"-40"	919.7	770.6	155.0	24.2%
21499-51	TP-13	S-51	5'	738.8	652.8	165.4	17.6%
21499-52	TP-13	S-52	8'	876.3	703.0	151.7	31.4%
21499-53	TP-13	S-53	10'	652.1	554.0	176.0	26.0%

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0	12	15	5	10	34	24	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
2 in.	100		
.75 in.	88		
.5 in.	81		
.375 in.	79		
#4	73		
#10	68		
#20	64		
#40	58		
#60	48		
#100	36		
#200	24		

* (no specification provided)

Soil Description

Light Brown Silty sand with gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 16.3 D_{60}= 0.500 D_{50}= 0.273
D_{30}= 0.110 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO=

Remarks

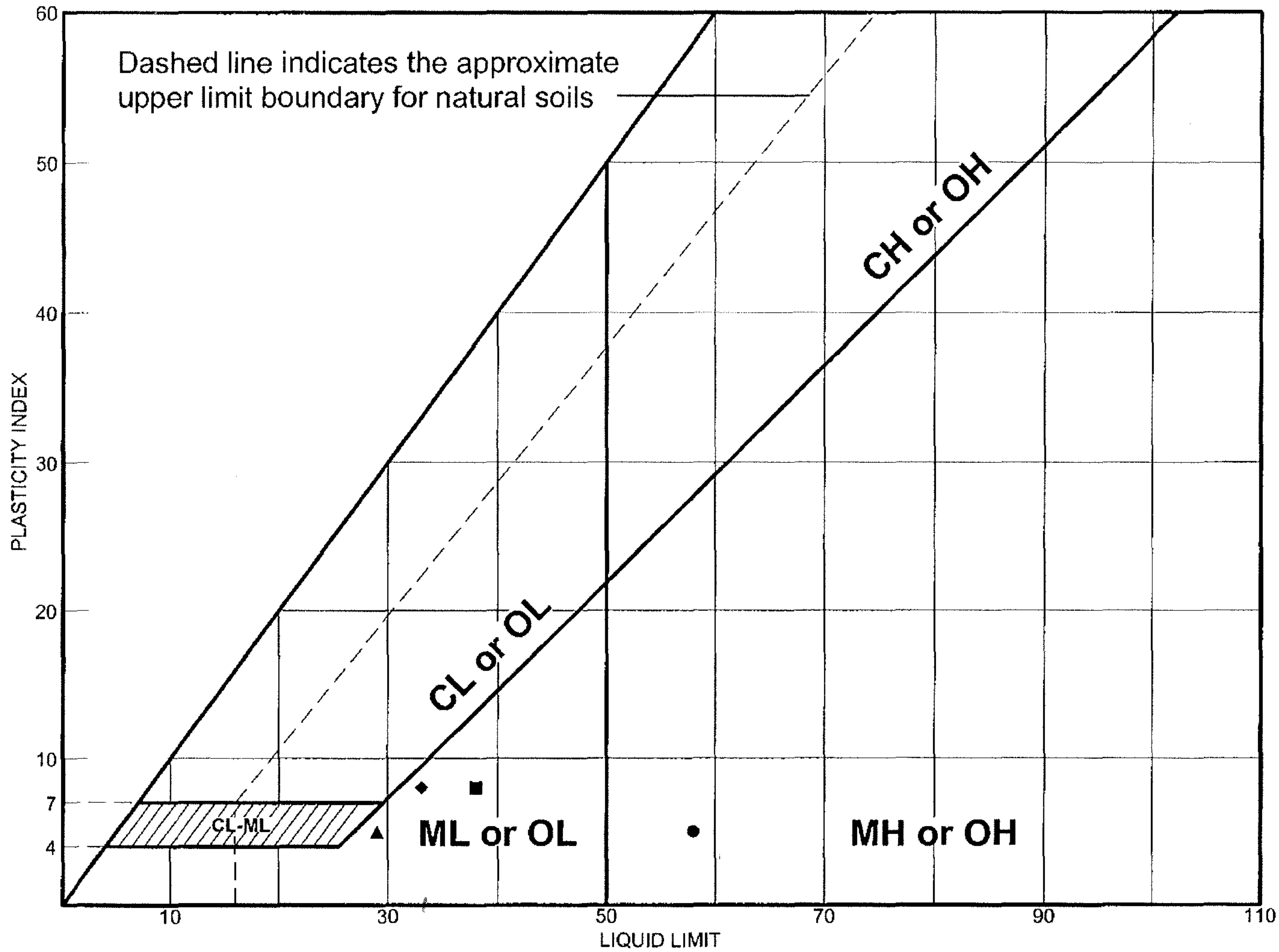
Sample ID: 21499
TP-7/S-24 @ 7'

Sample No.: 21499 **Source of Sample:** Johnson Road NE **Date:** 12-23-05
Location: Test Pit 7, Sample No. 24 **Elev./Depth:** 7'

KRAZAN & ASSOCIATES, INC.

Client: N.L. Olsen & Associates, Inc.
Project: 2005 Control Samples
Project No: 09605293

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Light gray silt with clay	58	53	5	100		
■	Light brown silt	38	30	8	100		
▲	Light brown silt with clay	29	24	5	100		
◆	Light brown silt	33	25	8	100		

Project No. 09605293 **Client:** N.L. Olsen & Associates, Inc.

Project: Johnson Road NE-(6164G)

● **Location:** Test Pit 1, Sample No. 5
■ **Location:** Test Pit 2, Sample No. 6
▲ **Location:** Test Pit 2, Sample No. 7
◆ **Location:** Test Pit 11, Sample No. 39

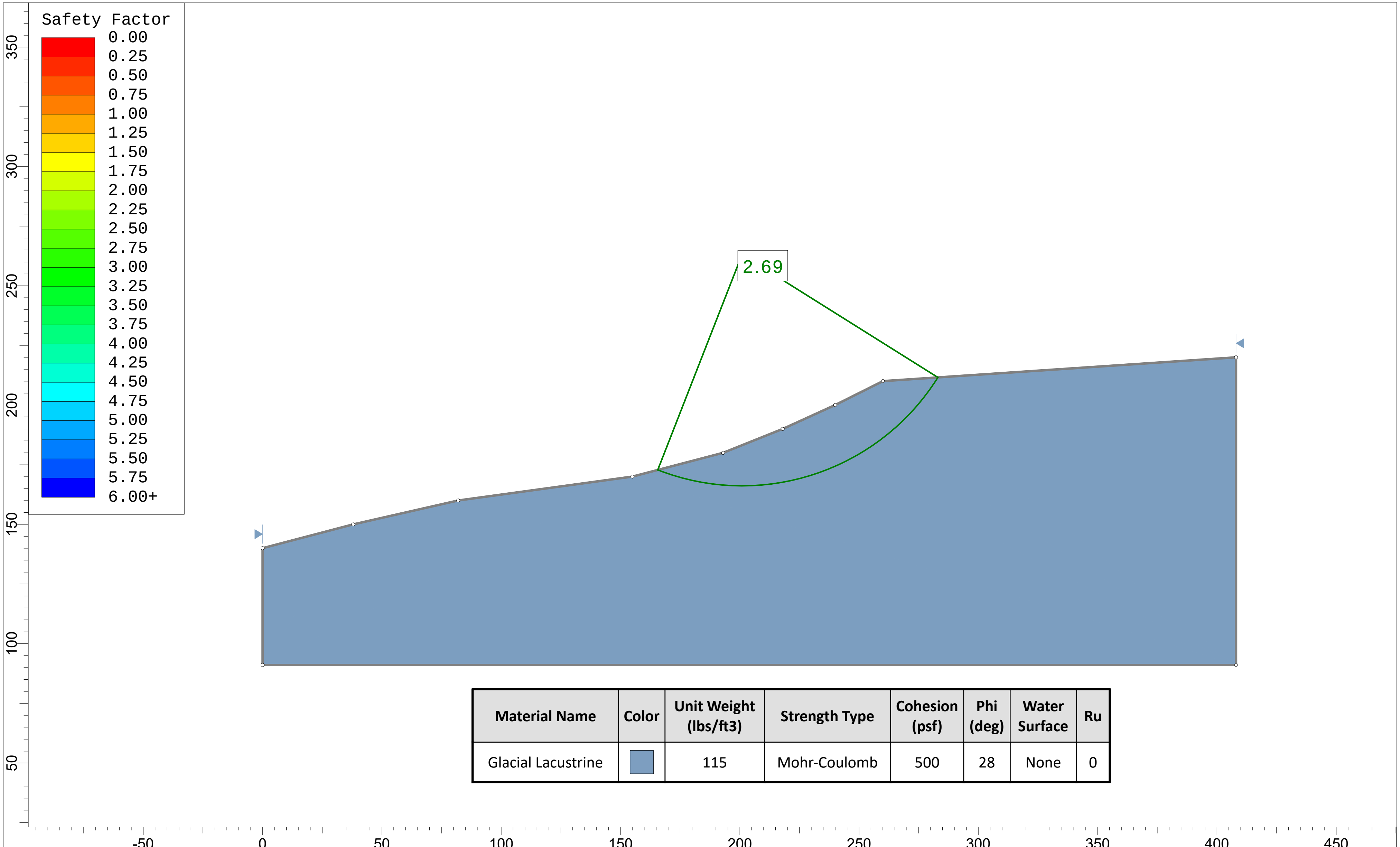
Remarks:
● Sample ID: 21499-A TP-1/S-5 @ 10'
■ Sample ID: 21499-B TP-2/S-6 @ 2.5'
▲ Sample ID: 21499-C TP-2/S-7 @ 4'
◆ Sample ID: 21499-D TP-11/S-39 @ 43"

LIQUID AND PLASTIC LIMITS TEST REPORT

KRAZAN & ASSOCIATES, INC.

Appendix C

Slope Stability Results



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Glacial Lacustrine		115	Mohr-Coulomb	500	28	None	0

Project	SLIDE - An Interactive Slope Stability Program
Analysis Description	Section A-A': Road A to Road B, Static
Drawn By	VRM
Scale	1:668
Company	GeoResources, LLC
Date	9/18/2018, 3:30:26 PM
File Name	Schwabe.JohnsonRd.Slide.slmd

rocscience

SLIDEINTERPRET 7.018

Slide Analysis Information

SLIDE - An Interactive Slope Stability Program

Project Summary

File Name:	Schwabe.JohnsonRd.Slide.slmd - Group 1 - Scenario 2
Slide Modeler Version:	7.014
Project Title:	SLIDE - An Interactive Slope Stability Program
Analysis:	Section A-A': Road A to Road B, Static
Author:	VRM
Company:	GeoResources, LLC
Date Created:	9/18/2018, 3:30:26 PM

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Failure Direction:	Right to Left
Data Output:	Standard
Maximum Material Properties:	20
Maximum Support Properties:	20

Analysis Options

Slices Type:	Vertical

Analysis Methods Used	
GLE/Morgenstern-Price with interslice force function:	Half Sine

Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

Surface Type:	Circular
Search Method:	Slope Search
Number of Surfaces:	5000
Upper Angle:	Not Defined
Lower Angle:	Not Defined
Composite Surfaces:	Disabled
Reverse Curvature:	Invalid Surfaces
Minimum Elevation:	Not Defined
Minimum Depth [ft]:	5
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

Material Properties

Property	Glacial Lacustrine
Color	
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	115
Cohesion [psf]	500
Friction Angle [deg]	28
Water Surface	None
Ru Value	0

Global Minimums

Method: gle/morgenstern-price

FS	2.691090
Center:	200.944, 263.053
Radius:	96.932
Left Slip Surface Endpoint:	165.606, 172.791
Right Slip Surface Endpoint:	283.067, 211.559
Resisting Moment:	1.84925e+007 lb-ft
Driving Moment:	6.87176e+006 lb-ft
Resisting Horizontal Force:	171756 lb
Driving Horizontal Force:	63824.2 lb
Total Slice Area:	2020.6 ft2
Surface Horizontal Width:	117.461 ft
Surface Average Height:	17.2023 ft

Valid / Invalid Surfaces

Method: gle/morgenstern-price

Number of Valid Surfaces: 4859
Number of Invalid Surfaces: 141

Error Codes:

Error Code -103 reported for 89 surfaces
Error Code -108 reported for 11 surfaces
Error Code -114 reported for 40 surfaces
Error Code -115 reported for 1 surface

Error Codes

The following errors were encountered during the computation:

-103 = Two surface / slope intersections, but one or more surface / nonslope external polygon intersections lie between them. This usually occurs when the slip surface extends past the bottom of the soil region, but may also occur on a benched slope model with two sets of Slope Limits.
-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).
-114 = Surface with Reverse Curvature.
-115 = Surface too shallow, below the minimum depth.

Slice Data

Global Minimum Query (gle/morgenstern-price) - Safety Factor: 2.69109

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	2.34922	203.03	-20.6385	Glacial Lacustrine	500	28	220.442	593.23	175.34	0	175.34
2	2.34922	599.836	-19.1615	Glacial Lacustrine	500	28	258.301	695.11	366.949	0	366.949
3	2.34922	978.381	-17.6977	Glacial Lacustrine	500	28	295.188	794.377	553.643	0	553.643
4	2.34922	1339.13	-16.2457	Glacial	500	28	330.898	890.476	734.379	0	734.379

				Lacustrine							
5	2.34922	1682.48	-14.8043	Glacial Lacustrine	500	28	365.224	982.85	908.11	0	908.11
6	2.34922	2008.8	-13.3725	Glacial Lacustrine	500	28	397.963	1070.95	1073.81	0	1073.81
7	2.34922	2318.42	-11.9491	Glacial Lacustrine	500	28	428.924	1154.27	1230.51	0	1230.51
8	2.34922	2611.6	-10.5332	Glacial Lacustrine	500	28	457.933	1232.34	1377.33	0	1377.33
9	2.34922	2888.58	-9.12378	Glacial Lacustrine	500	28	484.836	1304.74	1513.49	0	1513.49
10	2.34922	3149.58	-7.7199	Glacial Lacustrine	500	28	509.504	1371.12	1638.34	0	1638.34
11	2.34922	3394.76	-6.32067	Glacial Lacustrine	500	28	531.833	1431.21	1751.35	0	1751.35
12	2.34922	3629.27	-4.92521	Glacial Lacustrine	500	28	552.206	1486.04	1854.46	0	1854.46
13	2.34922	3911.11	-3.53268	Glacial Lacustrine	500	28	575.83	1549.61	1974.04	0	1974.04
14	2.34922	4196.44	-2.14224	Glacial Lacustrine	500	28	598.616	1610.93	2089.35	0	2089.35
15	2.34922	4466.34	-0.75306	Glacial Lacustrine	500	28	618.809	1665.27	2191.55	0	2191.55
16	2.34922	4720.86	0.635677	Glacial Lacustrine	500	28	636.419	1712.66	2280.68	0	2280.68
17	2.34922	4959.99	2.02479	Glacial Lacustrine	500	28	651.483	1753.2	2356.93	0	2356.93
18	2.34922	5183.7	3.41509	Glacial Lacustrine	500	28	664.065	1787.06	2420.62	0	2420.62
19	2.34922	5391.94	4.80741	Glacial Lacustrine	500	28	674.255	1814.48	2472.17	0	2472.17
20	2.34922	5584.63	6.20259	Glacial Lacustrine	500	28	682.147	1835.72	2512.12	0	2512.12
21	2.34922	5761.66	7.60147	Glacial Lacustrine	500	28	687.866	1851.11	2541.06	0	2541.06
22	2.34922	5922.89	9.00492	Glacial Lacustrine	500	28	691.541	1861	2559.66	0	2559.66
23	2.34922	6076.56	10.4138	Glacial Lacustrine	500	28	693.994	1867.6	2572.08	0	2572.08
24	2.34922	6238.67	11.8292	Glacial Lacustrine	500	28	696.647	1874.74	2585.51	0	2585.51
25	2.34922	6385.96	13.2519	Glacial Lacustrine	500	28	697.728	1877.65	2590.99	0	2590.99
26	2.34922	6516.56	14.6829	Glacial Lacustrine	500	28	697.253	1876.37	2588.57	0	2588.57
27	2.34922	6630.17	16.1235	Glacial Lacustrine	500	28	695.346	1871.24	2578.93	0	2578.93
28	2.34922	6726.41	17.5745	Glacial Lacustrine	500	28	692.136	1862.6	2562.69	0	2562.69
29	2.34922	6804.89	19.0373	Glacial Lacustrine	500	28	687.736	1850.76	2540.41	0	2540.41
30	2.34922	6865.14	20.5131	Glacial Lacustrine	500	28	682.24	1835.97	2512.59	0	2512.59
31	2.34922	6906.67	22.0033	Glacial Lacustrine	500	28	675.734	1818.46	2479.66	0	2479.66
32	2.34922	6930.47	23.5094	Glacial Lacustrine	500	28	668.398	1798.72	2442.54	0	2442.54

33	2.34922	6955.14	25.0328	Glacial Lacustrine	500	28	661.661	1780.59	2408.44	0	2408.44
34	2.34922	6965.54	26.5755	Glacial Lacustrine	500	28	654.486	1761.28	2372.13	0	2372.13
35	2.34922	6954.41	28.1392	Glacial Lacustrine	500	28	646.426	1739.59	2331.33	0	2331.33
36	2.34922	6920.83	29.7261	Glacial Lacustrine	500	28	637.474	1715.5	2286.03	0	2286.03
37	2.34922	6863.73	31.3386	Glacial Lacustrine	500	28	627.616	1688.97	2236.12	0	2236.12
38	2.34922	6781.92	32.9792	Glacial Lacustrine	500	28	616.802	1659.87	2181.4	0	2181.4
39	2.34922	6674.01	34.6509	Glacial Lacustrine	500	28	604.974	1628.04	2121.53	0	2121.53
40	2.34922	6538.42	36.3571	Glacial Lacustrine	500	28	592.039	1593.23	2056.07	0	2056.07
41	2.34922	6281.27	38.1016	Glacial Lacustrine	500	28	571.731	1538.58	1953.28	0	1953.28
42	2.34922	5814.58	39.8889	Glacial Lacustrine	500	28	538.259	1448.5	1783.88	0	1783.88
43	2.34922	5309.27	41.7241	Glacial Lacustrine	500	28	502.952	1353.49	1605.18	0	1605.18
44	2.34922	4766.84	43.6134	Glacial Lacustrine	500	28	465.783	1253.46	1417.06	0	1417.06
45	2.34922	4183.75	45.5641	Glacial Lacustrine	500	28	426.359	1147.37	1217.53	0	1217.53
46	2.34922	3555.64	47.5853	Glacial Lacustrine	500	28	384.2	1033.92	1004.15	0	1004.15
47	2.34922	2877.16	49.688	Glacial Lacustrine	500	28	338.707	911.492	773.904	0	773.904
48	2.34922	2141.5	51.8862	Glacial Lacustrine	500	28	289.131	778.077	522.988	0	522.988
49	2.34922	1339.92	54.1981	Glacial Lacustrine	500	28	234.509	631.086	246.537	0	246.537
50	2.34922	460.697	56.648	Glacial Lacustrine	500	28	173.59	467.147	-61.7883	0	-61.7883

Interslice Data

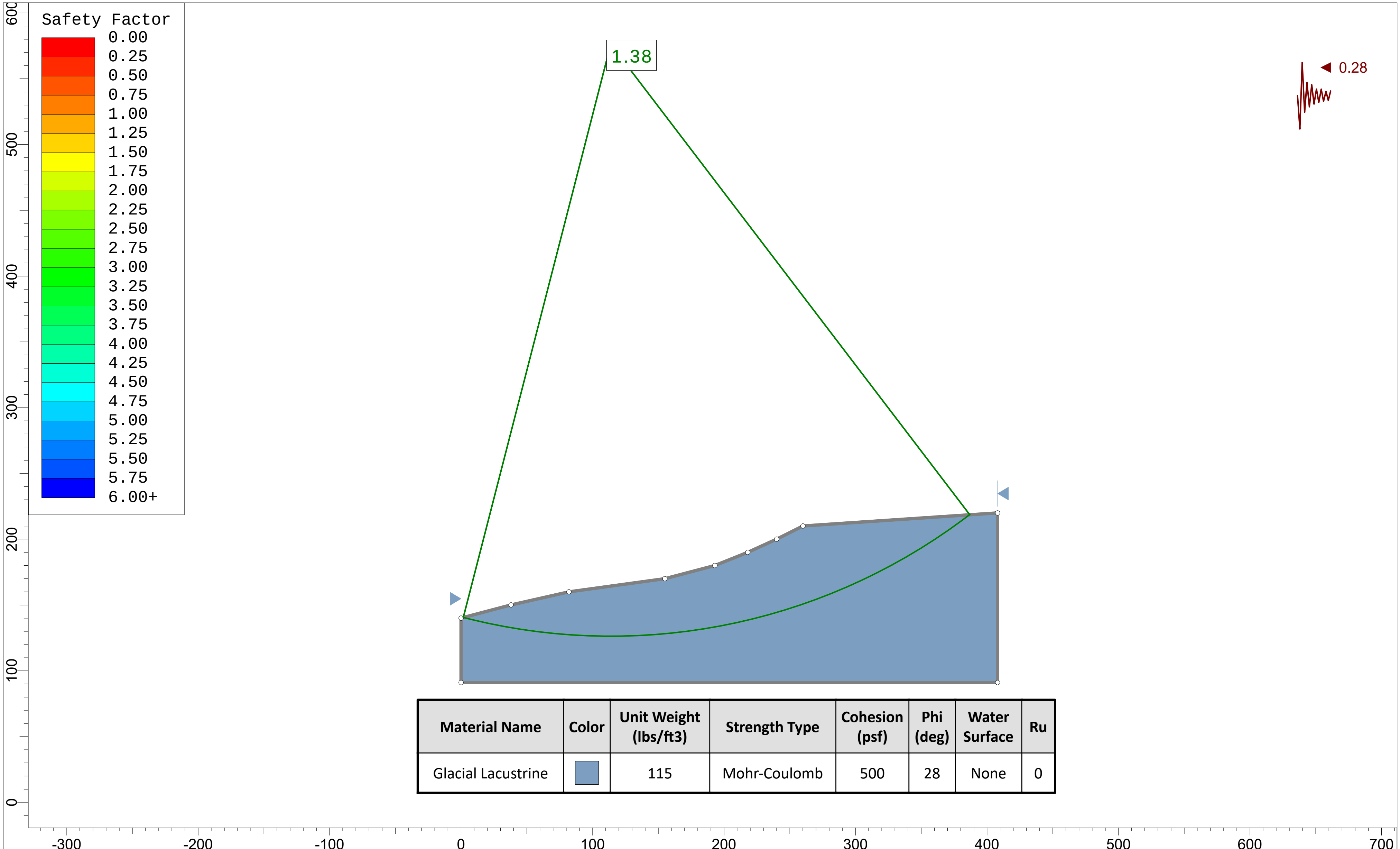
Global Minimum Query (gle/morgenstern-price) - Safety Factor: 2.69109

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	165.606	172.791	0	0	0
2	167.955	171.906	672.635	13.9643	1.18932
3	170.305	171.09	1578.54	65.4138	2.37295
4	172.654	170.34	2686.53	166.442	3.54519
5	175.003	169.656	3966.03	326.107	4.70057
6	177.352	169.035	5387.22	550.419	5.83374
7	179.701	168.476	6921.13	842.399	6.93957
8	182.051	167.979	8539.8	1202.2	8.01322
9	184.4	167.542	10216.4	1627.31	9.05028
10	186.749	167.165	11925.6	2112.77	10.0464
11	189.098	166.847	13643.4	2651.48	10.9979
12	191.448	166.586	15347.6	3234.56	11.9011
13	193.797	166.384	17019.4	3852.06	12.7531
14	196.146	166.239	18657.4	4496.83	13.551
15	198.495	166.151	20246.3	5157.88	14.2925
16	200.844	166.12	21766.6	5822.3	14.9753
17	203.194	166.146	23201.2	6476.9	15.5977
18	205.543	166.229	24534.8	7108.61	16.1582
19	207.892	166.37	25754.3	7704.81	16.6554
20	210.241	166.567	26848.7	8253.69	17.0882
21	212.59	166.822	27808.7	8744.46	17.4558
22	214.94	167.136	28626.8	9167.6	17.7574
23	217.289	167.508	29297.3	9515.07	17.9926
24	219.638	167.94	29815.9	9780.4	18.1609
25	221.987	168.432	30179.2	9958.54	18.2619
26	224.337	168.985	30383.7	10045.8	18.2955
27	226.686	169.601	30427	10040.3	18.2619
28	229.035	170.28	30308	9941.81	18.1608
29	231.384	171.024	30026	9751.74	17.9926
30	233.733	171.835	29581.2	9473.24	17.7574
31	236.083	172.714	28974.3	9110.99	17.4558
32	238.432	173.663	28206.6	8671.14	17.0882
33	240.781	174.685	27279.6	8161.12	16.6554
34	243.13	175.782	26190.6	7588.35	16.1582
35	245.48	176.957	24939.4	6962.15	15.5978
36	247.829	178.214	23527.7	6293.38	14.9753
37	250.178	179.555	21957.8	5593.89	14.2924
38	252.527	180.985	20232.3	4876.41	13.551
39	254.876	182.51	18354.9	4154.34	12.7531
40	257.226	184.134	16330.4	3441.68	11.9011
41	259.575	185.863	14164.7	2752.78	10.9978
42	261.924	187.705	11908.6	2109.76	10.0464
43	264.273	189.668	9669.61	1540.21	9.05025
44	266.623	191.763	7487.69	1054.09	8.01323
45	268.972	194.001	5409.49	658.412	6.93958
46	271.321	196.397	3493.25	356.91	5.83374
47	273.67	198.969	1813.09	149.082	4.70059
48	276.019	201.738	465.33	28.8293	3.5452
49	278.369	204.732	-422.058	-17.4898	2.37294
50	280.718	207.989	-674.525	-14.0036	1.18933
51	283.067	211.559	0	0	0

List Of Coordinates

External Boundary

X	Y
0	140
0	91.038
408	91.038
408	220
260	210
240	200
218	190
193	180
155	170
82	160
38	150



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Glacial Lacustrine		115	Mohr-Coulomb	500	28	None	0

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SLIDEINTERPRET 7.018

Project	SLIDE - An Interactive Slope Stability Program		
Analysis Description	Section A - A': Road A to Road B, Seismic		
Drawn By VRM	*Scale* 1:1212	*Company*	GeoResources, LLC
Date	9/18/2018, 3:30:26 PM	*File Name*	Schwabe.JohnsonRd.Slide.slmd

Slide Analysis Information

SLIDE - An Interactive Slope Stability Program

Project Summary

File Name:	Schwabe.JohnsonRd.Slide.slmd - Group 1 - Scenario 1
Slide Modeler Version:	7.014
Project Title:	SLIDE - An Interactive Slope Stability Program
Analysis:	Section A - A': Road A to Road B, Seismic
Author:	VRM
Company:	GeoResources, LLC
Date Created:	9/18/2018, 3:30:26 PM

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Failure Direction:	Right to Left
Data Output:	Standard
Maximum Material Properties:	20
Maximum Support Properties:	20

Analysis Options

Slices Type:	Vertical

Analysis Methods Used	
GLE/Morgenstern-Price with interslice force function:	Half Sine

Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

Surface Type:	Circular
Search Method:	Slope Search
Number of Surfaces:	5000
Upper Angle:	Not Defined
Lower Angle:	Not Defined
Composite Surfaces:	Disabled
Reverse Curvature:	Invalid Surfaces
Minimum Elevation:	Not Defined
Minimum Depth [ft]:	5
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

Loading

Seismic Load Coefficient (Horizontal): 0.28

Material Properties

Property	Glacial Lacustrine
Color	
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	115
Cohesion [psf]	500
Friction Angle [deg]	28
Water Surface	None
Ru Value	0

Global Minimums

Method: gle/morgenstern-price

FS	1.383100
Center:	113.790, 576.289
Radius:	450.038
Left Slip Surface Endpoint:	1.672, 140.440
Right Slip Surface Endpoint:	386.871, 218.572
Resisting Moment:	4.53378e+008 lb-ft
Driving Moment:	3.27798e+008 lb-ft
Resisting Horizontal Force:	969169 lb
Driving Horizontal Force:	700722 lb
Total Slice Area:	13803.1 ft2
Surface Horizontal Width:	385.199 ft
Surface Average Height:	35.8337 ft

Valid / Invalid Surfaces

Method: gle/morgenstern-price

Number of Valid Surfaces:	4855
Number of Invalid Surfaces:	145

Error Codes:

Error Code -103 reported for 89 surfaces
Error Code -108 reported for 2 surfaces
Error Code -111 reported for 13 surfaces
Error Code -114 reported for 40 surfaces
Error Code -115 reported for 1 surface

Error Codes

The following errors were encountered during the computation:

-103 = Two surface / slope intersections, but one or more surface / nonslope external polygon intersections lie between them. This usually occurs when the slip surface extends past the bottom of the soil region, but may also occur on a benched slope model with two sets of Slope Limits.
-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).
-111 = safety factor equation did not converge
-114 = Surface with Reverse Curvature.
-115 = Surface too shallow, below the minimum depth.

Slice Data

Global Minimum Query (gle/morgenstern-price) - Safety Factor: 1.3831

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	7.70398	1743.94	-13.9207	Glacial Lacustrine	500	28	502.888	695.544	367.764	0	367.764
2	7.70398	5168.35	-12.9123	Glacial Lacustrine	500	28	705.431	975.681	894.626	0	894.626
3	7.70398	8466.56	-11.908	Glacial Lacustrine	500	28	904.588	1251.14	1412.68	0	1412.68

4	7.70398	11640	-10.9073	Glacial Lacustrine	500	28	1099.2	1520.3	1918.91	0	1918.91
5	7.70398	14680.1	-9.91007	Glacial Lacustrine	500	28	1287.44	1780.66	2408.57	0	2408.57
6	7.70398	17425.6	-8.91581	Glacial Lacustrine	500	28	1458.84	2017.72	2854.43	0	2854.43
7	7.70398	19987.3	-7.92425	Glacial Lacustrine	500	28	1618.21	2238.15	3268.99	0	3268.99
8	7.70398	22428.6	-6.93508	Glacial Lacustrine	500	28	1767.85	2445.12	3658.24	0	3658.24
9	7.70398	24750.5	-5.94798	Glacial Lacustrine	500	28	1906.66	2637.1	4019.3	0	4019.3
10	7.70398	26953.6	-4.96265	Glacial Lacustrine	500	28	2033.67	2812.77	4349.68	0	4349.68
11	7.70398	28937.3	-3.97879	Glacial Lacustrine	500	28	2142.53	2963.33	4632.86	0	4632.86
12	7.70398	30344.4	-2.99611	Glacial Lacustrine	500	28	2213.35	3061.29	4817.08	0	4817.08
13	7.70398	31578	-2.0143	Glacial Lacustrine	500	28	2268.12	3137.04	4959.55	0	4959.55
14	7.70398	32694.6	-1.03309	Glacial Lacustrine	500	28	2309.93	3194.87	5068.31	0	5068.31
15	7.70398	33694.2	-0.0521812	Glacial Lacustrine	500	28	2339.01	3235.09	5143.95	0	5143.95
16	7.70398	34577	0.928713	Glacial Lacustrine	500	28	2355.78	3258.28	5187.57	0	5187.57
17	7.70398	35342.9	1.90988	Glacial Lacustrine	500	28	2360.83	3265.26	5200.71	0	5200.71
18	7.70398	35991.7	2.89161	Glacial Lacustrine	500	28	2354.88	3257.03	5185.22	0	5185.22
19	7.70398	36523.2	3.87419	Glacial Lacustrine	500	28	2338.75	3234.73	5143.29	0	5143.29
20	7.70398	36941.1	4.85791	Glacial Lacustrine	500	28	2313.59	3199.92	5077.8	0	5077.8
21	7.70398	37747.3	5.84307	Glacial Lacustrine	500	28	2304.31	3187.09	5053.67	0	5053.67
22	7.70398	38785.5	6.82996	Glacial Lacustrine	500	28	2303.36	3185.78	5051.22	0	5051.22
23	7.70398	39704.3	7.8189	Glacial Lacustrine	500	28	2294.67	3173.76	5028.62	0	5028.62
24	7.70398	40502.8	8.81019	Glacial Lacustrine	500	28	2279.2	3152.36	4988.37	0	4988.37
25	7.70398	41193.1	9.80414	Glacial Lacustrine	500	28	2258.44	3123.65	4934.36	0	4934.36
26	7.70398	42356.9	10.8011	Glacial Lacustrine	500	28	2258.87	3124.24	4935.47	0	4935.47
27	7.70398	43722.9	11.8013	Glacial Lacustrine	500	28	2268.36	3137.37	4960.17	0	4960.17
28	7.70398	44964.3	12.8053	Glacial Lacustrine	500	28	2273.21	3144.07	4972.78	0	4972.78
29	7.70398	46237.3	13.8132	Glacial Lacustrine	500	28	2280.79	3154.56	4992.5	0	4992.5
30	7.70398	47596.2	14.8255	Glacial Lacustrine	500	28	2293.84	3172.61	5026.44	0	5026.44
31	7.70398	48827.5	15.8426	Glacial Lacustrine	500	28	2303.98	3186.64	5052.83	0	5052.83
32	7.70398	50101.4	16.8649	Glacial	500	28	2318.71	3207.01	5091.15	0	5091.15

				Lacustrine							
33	7.70398	51377.7	17.8927	Glacial Lacustrine	500	28	2336.76	3231.97	5138.1	0	5138.1
34	7.70398	52194.9	18.9264	Glacial Lacustrine	500	28	2340.24	3236.79	5147.15	0	5147.15
35	7.70398	50663.3	19.9667	Glacial Lacustrine	500	28	2255.97	3120.23	4927.94	0	4927.94
36	7.70398	48573.7	21.0138	Glacial Lacustrine	500	28	2155.38	2981.1	4666.26	0	4666.26
37	7.70398	46340.3	22.0683	Glacial Lacustrine	500	28	2054.42	2841.47	4403.66	0	4403.66
38	7.70398	43960.1	23.1308	Glacial Lacustrine	500	28	1952.59	2700.63	4138.77	0	4138.77
39	7.70398	41429.7	24.2018	Glacial Lacustrine	500	28	1849.29	2557.75	3870.06	0	3870.06
40	7.70398	38745.1	25.2818	Glacial Lacustrine	500	28	1743.84	2411.91	3595.78	0	3595.78
41	7.70398	35902.5	26.3716	Glacial Lacustrine	500	28	1635.52	2262.09	3314.01	0	3314.01
42	7.70398	32897.3	27.4717	Glacial Lacustrine	500	28	1523.51	2107.17	3022.66	0	3022.66
43	7.70398	29724.7	28.5829	Glacial Lacustrine	500	28	1406.95	1945.95	2719.44	0	2719.44
44	7.70398	26379.5	29.706	Glacial Lacustrine	500	28	1284.87	1777.11	2401.89	0	2401.89
45	7.70398	22855.9	30.8418	Glacial Lacustrine	500	28	1156.26	1599.23	2067.36	0	2067.36
46	7.70398	19147.6	31.9912	Glacial Lacustrine	500	28	1020.02	1410.79	1712.95	0	1712.95
47	7.70398	15247.6	33.1553	Glacial Lacustrine	500	28	874.945	1210.14	1335.58	0	1335.58
48	7.70398	11148.3	34.335	Glacial Lacustrine	500	28	719.744	995.478	931.86	0	931.86
49	7.70398	6841.37	35.5315	Glacial Lacustrine	500	28	553.018	764.879	498.165	0	498.165
50	7.70398	2317.44	36.7462	Glacial Lacustrine	500	28	373.243	516.233	30.529	0	30.529

Interslice Data

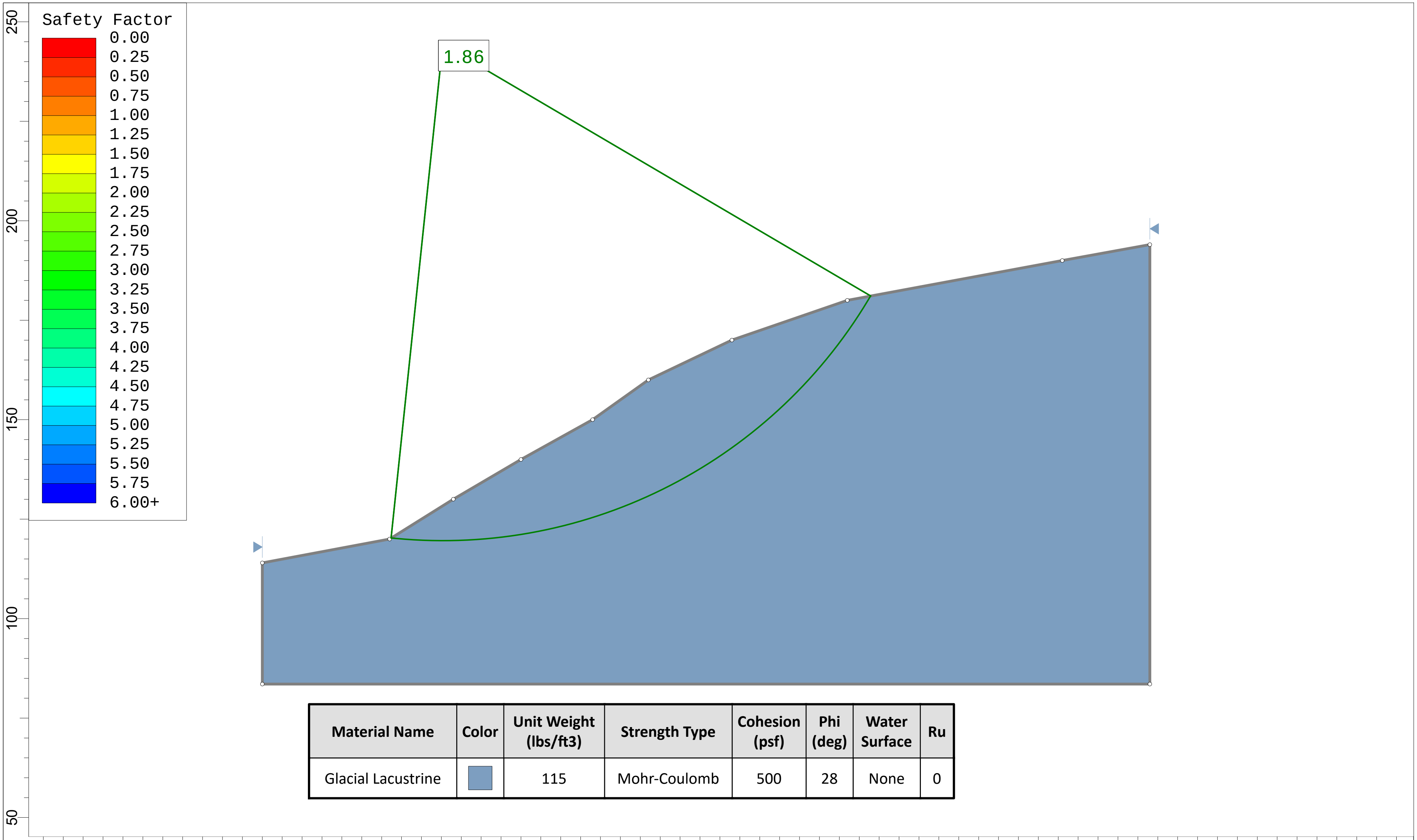
Global Minimum Query (gle/morgenstern-price) - Safety Factor: 1.3831

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	1.67213	140.44	0	0	0
2	9.37611	138.531	4090.63	128.426	1.79822
3	17.0801	136.764	9661.64	605.462	3.58584
4	24.7841	135.14	16559.4	1551.46	5.35245
5	32.488	133.655	24622.5	3061.69	7.08807
6	40.192	132.309	33678.6	5203.64	8.78325
7	47.896	131.101	43495.3	8005.84	10.4293
8	55.6	130.028	53878.9	11470.3	12.0183
9	63.3039	129.091	64655.1	15573.9	13.5432
10	71.0079	128.289	75649.2	20267.4	14.9981
11	78.7119	127.62	86689.2	25477.3	16.3777
12	86.4159	127.084	97585.7	31101.7	17.6777
13	94.1198	126.681	108094	36997.7	18.8947
14	101.824	126.41	118081	43038.6	20.026
15	109.528	126.271	127437	49096.1	21.0696
16	117.232	126.264	136070	55041.5	22.0238
17	124.936	126.389	143901	60749.9	22.8877
18	132.64	126.645	150868	66103.5	23.6608
19	140.344	127.035	156926	70995.6	24.3427
20	148.048	127.556	162046	75333.1	24.9331
21	155.752	128.211	166213	79038.8	25.4324
22	163.456	128.999	169423	82049.9	25.8405
23	171.16	129.922	171658	84308.8	26.1577
24	178.864	130.98	172910	85773.5	26.3841
25	186.568	132.174	173183	86420.8	26.5199
26	194.272	133.505	172490	86245.1	26.5651
27	201.976	134.975	170790	85226.3	26.5198
28	209.679	136.585	168050	83362.3	26.384
29	217.383	138.336	164276	80683.1	26.1577
30	225.087	140.23	159455	77222.8	25.8405
31	232.791	142.269	153561	73022.8	25.4325
32	240.495	144.455	146604	68154.6	24.9332
33	248.199	146.791	138560	62686.5	24.3427
34	255.903	149.278	129409	56700.8	23.6607
35	263.607	151.92	119238	50337.9	22.8877
36	271.311	154.719	108650	43949.8	22.0237
37	279.015	157.678	97855.5	37699.5	21.0695
38	286.719	160.801	86963.4	31696.8	20.026
39	294.423	164.092	76086.5	26042.4	18.8947
40	302.127	167.555	65341.6	20825.2	17.6777
41	309.831	171.194	54852.2	16120.7	16.3777
42	317.535	175.013	44749.6	11989	14.9981
43	325.239	179.019	35175.4	8472.93	13.5432
44	332.943	183.216	26283.9	5595.58	12.0183
45	340.647	187.611	18245.4	3358.3	10.4293
46	348.351	192.211	11249.2	1738.1	8.78325
47	356.055	197.024	5507.79	684.865	7.08805
48	363.759	202.057	1261.68	118.208	5.35247
49	371.463	207.319	-1215.05	-76.1433	3.58585
50	379.167	212.82	-1608.2	-50.4897	1.79822
51	386.871	218.572	0	0	0

List Of Coordinates

External Boundary

X	Y
0	140
0	91.038
408	91.038
408	220
260	210
240	200
218	190
193	180
155	170
82	160
38	150



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Glacial Lacustrine		115	Mohr-Coulomb	500	28	None	0

Project	SLIDE - An Interactive Slope Stability Program
Analysis Description	Section B-B': Ravine, Static
Drawn By	VRM
Scale	1:405
Company	GeoResources, LLC
Date	9/18/2018, 3:30:26 PM
File Name	Schwabe.JohnsonRd.Slide.slmd

SLIDEINTERPRET 7.018

Slide Analysis Information

SLIDE - An Interactive Slope Stability Program

Project Summary

File Name:	Schwabe.JohnsonRd.Slide.slmd - Group 2 - Scenario 2
Slide Modeler Version:	7.014
Project Title:	SLIDE - An Interactive Slope Stability Program
Analysis:	Section B-B': Ravine, Static
Author:	VRM
Company:	GeoResources, LLC
Date Created:	9/18/2018, 3:30:26 PM

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Failure Direction:	Right to Left
Data Output:	Standard
Maximum Material Properties:	20
Maximum Support Properties:	20

Analysis Options

Slices Type:	Vertical

Analysis Methods Used	
GLE/Morgenstern-Price with interslice force function:	Half Sine

Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

Surface Type:	Circular
Search Method:	Slope Search
Number of Surfaces:	5000
Upper Angle:	Not Defined
Lower Angle:	Not Defined
Composite Surfaces:	Disabled
Reverse Curvature:	Invalid Surfaces
Minimum Elevation:	Not Defined
Minimum Depth [ft]:	5
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

Material Properties

Property	Glacial Lacustrine
Color	
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	115
Cohesion [psf]	500
Friction Angle [deg]	28
Water Surface	None
Ru Value	0

Global Minimums

Method: gle/morgenstern-price

FS	1.855890
Center:	45.325, 244.327
Radius:	124.772
Left Slip Surface Endpoint:	32.367, 120.230
Right Slip Surface Endpoint:	152.885, 181.090
Resisting Moment:	2.52271e+007 lb-ft
Driving Moment:	1.3593e+007 lb-ft
Resisting Horizontal Force:	177169 lb
Driving Horizontal Force:	95463.3 lb
Total Slice Area:	2291.51 ft2
Surface Horizontal Width:	120.518 ft
Surface Average Height:	19.0139 ft

Valid / Invalid Surfaces

Method: gle/morgenstern-price

Number of Valid Surfaces: 3716
Number of Invalid Surfaces: 1284

Error Codes:

Error Code -103 reported for 42 surfaces
Error Code -108 reported for 9 surfaces
Error Code -111 reported for 1 surface
Error Code -114 reported for 1232 surfaces

Error Codes

The following errors were encountered during the computation:

-103 = Two surface / slope intersections, but one or more surface / nonslope external polygon intersections lie between them. This usually occurs when the slip surface extends past the bottom of the soil region, but may also occur on a benched slope model with two sets of Slope Limits.
-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).
-111 = safety factor equation did not converge
-114 = Surface with Reverse Curvature.

Slice Data

Global Minimum Query (gle/morgenstern-price) - Safety Factor: 1.85589

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	2.41035	240.398	-5.40521	Glacial Lacustrine	500	28	309.01	573.489	138.212	0	138.212
2	2.41035	714.671	-4.29432	Glacial Lacustrine	500	28	371.574	689.601	356.587	0	356.587
3	2.41035	1175.92	-3.18504	Glacial Lacustrine	500	28	433.47	804.473	572.628	0	572.628
4	2.41035	1624.21	-2.07696	Glacial	500	28	494.311	917.387	784.992	0	784.992

				Lacustrine							
5	2.41035	2059.56	-0.96965	Glacial Lacustrine	500	28	553.699	1027.6	992.282	0	992.282
6	2.41035	2481.99	0.137294	Glacial Lacustrine	500	28	611.238	1134.39	1193.11	0	1193.11
7	2.41035	2888.26	1.24429	Glacial Lacustrine	500	28	666.139	1236.28	1384.74	0	1384.74
8	2.41035	3263.2	2.35175	Glacial Lacustrine	500	28	716.159	1329.11	1559.33	0	1559.33
9	2.41035	3622.29	3.46009	Glacial Lacustrine	500	28	762.909	1415.88	1722.51	0	1722.51
10	2.41035	3968.41	4.56973	Glacial Lacustrine	500	28	806.476	1496.73	1874.58	0	1874.58
11	2.41035	4301.49	5.68109	Glacial Lacustrine	500	28	846.64	1571.27	2014.76	0	2014.76
12	2.41035	4621.47	6.7946	Glacial Lacustrine	500	28	883.22	1639.16	2142.45	0	2142.45
13	2.41035	4928.27	7.91069	Glacial Lacustrine	500	28	916.105	1700.19	2257.24	0	2257.24
14	2.41035	5219.45	9.02982	Glacial Lacustrine	500	28	944.954	1753.73	2357.93	0	2357.93
15	2.41035	5480.89	10.1524	Glacial Lacustrine	500	28	968.112	1796.71	2438.75	0	2438.75
16	2.41035	5725.62	11.279	Glacial Lacustrine	500	28	987.208	1832.15	2505.41	0	2505.41
17	2.41035	5956.67	12.41	Glacial Lacustrine	500	28	1002.72	1860.94	2559.56	0	2559.56
18	2.41035	6173.86	13.5459	Glacial Lacustrine	500	28	1014.77	1883.31	2601.64	0	2601.64
19	2.41035	6376.99	14.6873	Glacial Lacustrine	500	28	1023.54	1899.58	2632.24	0	2632.24
20	2.41035	6565.86	15.8347	Glacial Lacustrine	500	28	1029.22	1910.12	2652.04	0	2652.04
21	2.41035	6740.24	16.9887	Glacial Lacustrine	500	28	1032.01	1915.3	2661.8	0	2661.8
22	2.41035	6952.21	18.1498	Glacial Lacustrine	500	28	1037.76	1925.96	2681.83	0	2681.83
23	2.41035	7202.82	19.3186	Glacial Lacustrine	500	28	1046.55	1942.29	2712.56	0	2712.56
24	2.41035	7438.07	20.4959	Glacial Lacustrine	500	28	1052.84	1953.96	2734.49	0	2734.49
25	2.41035	7657.61	21.6823	Glacial Lacustrine	500	28	1056.84	1961.38	2748.46	0	2748.46
26	2.41035	7861.05	22.8786	Glacial Lacustrine	500	28	1058.8	1965.01	2755.29	0	2755.29
27	2.41035	8045.25	24.0855	Glacial Lacustrine	500	28	1058.66	1964.76	2754.81	0	2754.81
28	2.41035	8108.91	25.3039	Glacial Lacustrine	500	28	1046.82	1942.78	2713.48	0	2713.48
29	2.41035	8102.32	26.5346	Glacial Lacustrine	500	28	1028.77	1909.29	2650.5	0	2650.5
30	2.41035	8077.69	27.7787	Glacial Lacustrine	500	28	1009.86	1874.19	2584.48	0	2584.48
31	2.41035	8034.42	29.0373	Glacial Lacustrine	500	28	990.172	1837.65	2515.75	0	2515.75
32	2.41035	7971.81	30.3113	Glacial Lacustrine	500	28	969.767	1799.78	2444.52	0	2444.52

33	2.41035	7889.14	31.6022	Glacial Lacustrine	500	28	948.672	1760.63	2370.89	0	2370.89
34	2.41035	7785.55	32.9112	Glacial Lacustrine	500	28	926.892	1720.21	2294.87	0	2294.87
35	2.41035	7660.13	34.2399	Glacial Lacustrine	500	28	904.402	1678.47	2216.37	0	2216.37
36	2.41035	7502.02	35.5899	Glacial Lacustrine	500	28	880.284	1633.71	2132.2	0	2132.2
37	2.41035	7254.12	36.9632	Glacial Lacustrine	500	28	849.635	1576.83	2025.22	0	2025.22
38	2.41035	6968.7	38.3616	Glacial Lacustrine	500	28	817.074	1516.4	1911.56	0	1911.56
39	2.41035	6656.46	39.7877	Glacial Lacustrine	500	28	783.494	1454.08	1794.36	0	1794.36
40	2.41035	6315.74	41.2439	Glacial Lacustrine	500	28	748.698	1389.5	1672.91	0	1672.91
41	2.41035	5944.6	42.7334	Glacial Lacustrine	500	28	712.445	1322.22	1546.37	0	1546.37
42	2.41035	5540.82	44.2597	Glacial Lacustrine	500	28	674.444	1251.69	1413.73	0	1413.73
43	2.41035	5101.83	45.8267	Glacial Lacustrine	500	28	634.347	1177.28	1273.78	0	1273.78
44	2.41035	4624.58	47.4391	Glacial Lacustrine	500	28	591.731	1098.19	1125.03	0	1125.03
45	2.41035	4105.49	49.1027	Glacial Lacustrine	500	28	546.072	1013.45	965.658	0	965.658
46	2.41035	3540.23	50.8242	Glacial Lacustrine	500	28	496.724	921.865	793.413	0	793.413
47	2.41035	2923.55	52.6117	Glacial Lacustrine	500	28	442.875	821.928	605.457	0	605.457
48	2.41035	2238.49	54.4757	Glacial Lacustrine	500	28	382.66	710.174	395.28	0	395.28
49	2.41035	1407.57	56.4291	Glacial Lacustrine	500	28	309.146	573.741	138.686	0	138.686
50	2.41035	483.04	58.4888	Glacial Lacustrine	500	28	225.609	418.706	-152.892	0	-152.892

Interslice Data

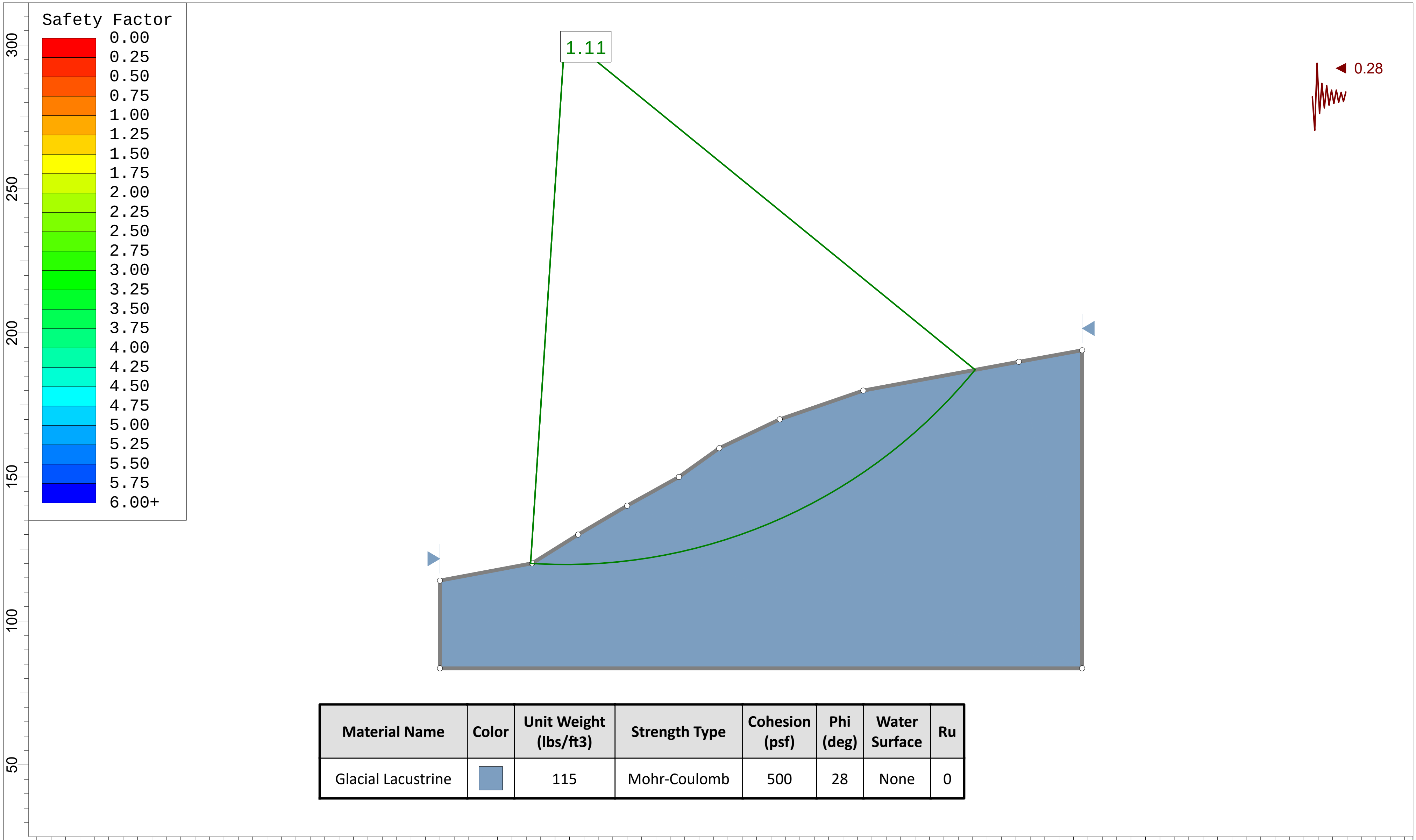
Global Minimum Query (gle/morgenstern-price) - Safety Factor: 1.85589

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	32.3675	120.23	0	0	0
2	34.7778	120.002	774.653	22.4176	1.65761
3	37.1882	119.821	1732.78	100.092	3.30595
4	39.5985	119.686	2852.03	246.302	4.93583
5	42.0089	119.599	4109.4	471.004	6.53849
6	44.4192	119.558	5481.46	780.668	8.10554
7	46.8296	119.564	6944.52	1178.22	9.62921
8	49.2399	119.616	8474.01	1662.88	11.1022
9	51.6503	119.715	10041.9	2229.61	12.5183
10	54.0606	119.861	11625.6	2870.96	13.8717
11	56.471	120.054	13203.9	3576.92	15.1576
12	58.8813	120.294	14756.9	4335.21	16.3715
13	61.2917	120.581	16265.6	5131.71	17.5102
14	63.702	120.916	17712.8	5950.9	18.5706
15	66.1124	121.299	19082.1	6776.3	19.5506
16	68.5227	121.73	20357.6	7590.53	20.4485
17	70.9331	122.211	21527.3	8377.01	21.2627
18	73.3434	122.741	22581.2	9119.91	21.9924
19	75.7538	123.322	23510.8	9804.38	22.6369
20	78.1641	123.954	24309.3	10416.9	23.1959
21	80.5745	124.638	24971.4	10945.5	23.6689
22	82.9848	125.374	25493.1	11380.1	24.0559
23	85.3952	126.164	25869.8	11711.7	24.3571
24	87.8055	127.009	26094.6	11931.6	24.572
25	90.2159	127.91	26162.7	12034.1	24.7011
26	92.6262	128.868	26070.4	12015.3	24.744
27	95.0366	129.886	25814.2	11873.8	24.7011
28	97.447	130.963	25391.9	11610.3	24.572
29	99.8573	132.103	24817.2	11235.2	24.3571
30	102.268	133.306	24101.2	10758.8	24.056
31	104.678	134.576	23248.3	10190.3	23.669
32	107.088	135.914	22263.2	9540.1	23.1958
33	109.499	137.323	21150.7	8820.17	22.6369
34	111.909	138.806	19916.1	8043.55	21.9924
35	114.319	140.366	18565.2	7224.32	21.2626
36	116.73	142.007	17104.1	6377.42	20.4484
37	119.14	143.732	15543	5519.54	19.5507
38	121.55	145.546	13912.7	4674.22	18.5707
39	123.961	147.453	12230.8	3858.75	17.5102
40	126.371	149.461	10513.1	3088.5	16.3715
41	128.782	151.574	8778.18	2377.99	15.1575
42	131.192	153.801	7048.04	1740.53	13.8718
43	133.602	156.15	5349.35	1187.72	12.5184
44	136.013	158.631	3714.74	728.954	11.1022
45	138.423	161.255	2184.77	370.67	9.62916
46	140.833	164.038	810.72	115.462	8.1055
47	143.244	166.996	-341.578	-39.1504	6.5385
48	145.654	170.15	-1186.1	-102.432	4.93584
49	148.064	173.526	-1600.38	-92.4434	3.30593
50	150.475	177.158	-1360.61	-39.3745	1.65761
51	152.885	181.09	0	0	0

List Of Coordinates

External Boundary

X	Y
0	114
0	83.544
223	83.544
223	194
201	190
147	180
118	170
97	160
83	150
65	140
48	130
32	120



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Glacial Lacustrine		115	Mohr-Coulomb	500	28	None	0

rocscience

SLIDEINTERPRET 7.018

Project	SLIDE - An Interactive Slope Stability Program
Analysis Description	Section B-B': Ravine, Seismic
Drawn By	VRM
Scale	1:560
Company	GeoResources, LLC
Date	9/18/2018, 3:30:26 PM
File Name	Schwabe.JohnsonRd.Slide.slmd

Slide Analysis Information

SLIDE - An Interactive Slope Stability Program

Project Summary

File Name:	Schwabe.JohnsonRd.Slide.slmd - Group 2 - Scenario 1
Slide Modeler Version:	7.014
Project Title:	SLIDE - An Interactive Slope Stability Program
Analysis:	Section B-B': Ravine, Seismic
Author:	VRM
Company:	GeoResources, LLC
Date Created:	9/18/2018, 3:30:26 PM

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Failure Direction:	Right to Left
Data Output:	Standard
Maximum Material Properties:	20
Maximum Support Properties:	20

Analysis Options

Slices Type:	Vertical

Analysis Methods Used	
GLE/Morgenstern-Price with interslice force function:	Half Sine

Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

Surface Type:	Circular
Search Method:	Slope Search
Number of Surfaces:	5000
Upper Angle:	Not Defined
Lower Angle:	Not Defined
Composite Surfaces:	Disabled
Reverse Curvature:	Invalid Surfaces
Minimum Elevation:	Not Defined
Minimum Depth [ft]:	5
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

Loading

Seismic Load Coefficient (Horizontal): 0.28

Material Properties

Property	Glacial Lacustrine
Color	
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	115
Cohesion [psf]	500
Friction Angle [deg]	28
Water Surface	None
Ru Value	0

Global Minimums

Method: gle/morgenstern-price

FS	1.109200
Center:	43.395, 303.284
Radius:	183.769
Left Slip Surface Endpoint:	31.474, 119.901
Right Slip Surface Endpoint:	185.855, 187.195
Resisting Moment:	4.88511e+007 lb-ft
Driving Moment:	4.40419e+007 lb-ft
Resisting Horizontal Force:	242812 lb
Driving Horizontal Force:	218908 lb
Total Slice Area:	3425.99 ft2
Surface Horizontal Width:	154.381 ft
Surface Average Height:	22.1918 ft

Valid / Invalid Surfaces

Method: gle/morgenstern-price

Number of Valid Surfaces: 3719
Number of Invalid Surfaces: 1281

Error Codes:

Error Code -103 reported for 42 surfaces
Error Code -108 reported for 1 surface
Error Code -111 reported for 6 surfaces
Error Code -114 reported for 1232 surfaces

Error Codes

The following errors were encountered during the computation:

-103 = Two surface / slope intersections, but one or more surface / nonslope external polygon intersections lie between them. This usually occurs when the slip surface extends past the bottom of the soil region, but may also occur on a benched slope model with two sets of Slope Limits.
-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).
-111 = safety factor equation did not converge
-114 = Surface with Reverse Curvature.

Slice Data

Global Minimum Query (gle/morgenstern-price) - Safety Factor: 1.1092

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	3.08762	298.839	-3.23743	Glacial Lacustrine	500	28	525.083	582.422	155.014	0	155.014
2	3.08762	1029.86	-2.2736	Glacial Lacustrine	500	28	668.959	742.009	455.154	0	455.154
3	3.08762	1749.37	-1.31043	Glacial Lacustrine	500	28	814.816	903.794	759.425	0	759.425
4	3.08762	2450.45	-0.34762	Glacial	500	28	960.141	1064.99	1062.59	0	1062.59

				Lacustrine							
5	3.08762	3133.11	0.615089	Glacial Lacustrine	500	28	1103.31	1223.79	1361.25	0	1361.25
6	3.08762	3788.88	1.57797	Glacial Lacustrine	500	28	1241.17	1376.7	1648.84	0	1648.84
7	3.08762	4396.86	2.5413	Glacial Lacustrine	500	28	1368.49	1517.93	1914.46	0	1914.46
8	3.08762	4983.86	3.50535	Glacial Lacustrine	500	28	1487.87	1650.34	2163.48	0	2163.48
9	3.08762	5552.33	4.47039	Glacial Lacustrine	500	28	1598.05	1772.56	2393.33	0	2393.33
10	3.08762	6102.21	5.43671	Glacial Lacustrine	500	28	1697.61	1882.99	2601.02	0	2601.02
11	3.08762	6633.05	6.40458	Glacial Lacustrine	500	28	1785.3	1980.26	2783.96	0	2783.96
12	3.08762	7122.85	7.37429	Glacial Lacustrine	500	28	1856.96	2059.74	2933.45	0	2933.45
13	3.08762	7580.56	8.34613	Glacial Lacustrine	500	28	1913.62	2122.59	3051.65	0	3051.65
14	3.08762	8019.25	9.32039	Glacial Lacustrine	500	28	1957.2	2170.93	3142.56	0	3142.56
15	3.08762	8438.77	10.2974	Glacial Lacustrine	500	28	1987.96	2205.05	3206.75	0	3206.75
16	3.08762	8838.95	11.2774	Glacial Lacustrine	500	28	2006.46	2225.57	3245.32	0	3245.32
17	3.08762	9228.06	12.2608	Glacial Lacustrine	500	28	2014.7	2234.71	3262.54	0	3262.54
18	3.08762	9721.79	13.2479	Glacial Lacustrine	500	28	2028.9	2250.46	3292.14	0	3292.14
19	3.08762	10236.7	14.239	Glacial Lacustrine	500	28	2038.29	2260.87	3311.71	0	3311.71
20	3.08762	10731.4	15.2344	Glacial Lacustrine	500	28	2038.67	2261.29	3312.52	0	3312.52
21	3.08762	11205.6	16.2346	Glacial Lacustrine	500	28	2031.55	2253.39	3297.63	0	3297.63
22	3.08762	11580.1	17.2399	Glacial Lacustrine	500	28	2009.15	2228.55	3250.92	0	3250.92
23	3.08762	11757.7	18.2507	Glacial Lacustrine	500	28	1962.76	2177.09	3154.16	0	3154.16
24	3.08762	11907.4	19.2675	Glacial Lacustrine	500	28	1914.12	2123.14	3052.69	0	3052.69
25	3.08762	12035.2	20.2905	Glacial Lacustrine	500	28	1865.07	2068.74	2950.37	0	2950.37
26	3.08762	12140.6	21.3204	Glacial Lacustrine	500	28	1816.53	2014.89	2849.09	0	2849.09
27	3.08762	12223.3	22.3576	Glacial Lacustrine	500	28	1769.21	1962.41	2750.4	0	2750.4
28	3.08762	12282.6	23.4025	Glacial Lacustrine	500	28	1723.71	1911.94	2655.47	0	2655.47
29	3.08762	12249.5	24.4558	Glacial Lacustrine	500	28	1673.67	1856.43	2551.07	0	2551.07
30	3.08762	12116.6	25.5179	Glacial Lacustrine	500	28	1619.04	1795.84	2437.12	0	2437.12
31	3.08762	11958.6	26.5896	Glacial Lacustrine	500	28	1567.37	1738.53	2329.34	0	2329.34
32	3.08762	11774.8	27.6713	Glacial Lacustrine	500	28	1518.54	1684.36	2227.47	0	2227.47

33	3.08762	11564.5	28.7639	Glacial Lacustrine	500	28	1472.33	1633.11	2131.07	0	2131.07
34	3.08762	11326.8	29.8681	Glacial Lacustrine	500	28	1428.47	1584.46	2039.58	0	2039.58
35	3.08762	11060.9	30.9846	Glacial Lacustrine	500	28	1386.62	1538.04	1952.28	0	1952.28
36	3.08762	10765.7	32.1143	Glacial Lacustrine	500	28	1346.39	1493.42	1868.35	0	1868.35
37	3.08762	10440.2	33.2583	Glacial Lacustrine	500	28	1307.35	1450.11	1786.89	0	1786.89
38	3.08762	10053.3	34.4174	Glacial Lacustrine	500	28	1266.36	1404.65	1701.39	0	1701.39
39	3.08762	9503.54	35.5928	Glacial Lacustrine	500	28	1214.03	1346.6	1592.22	0	1592.22
40	3.08762	8904.35	36.7857	Glacial Lacustrine	500	28	1159.63	1286.26	1478.75	0	1478.75
41	3.08762	8269.26	37.9975	Glacial Lacustrine	500	28	1103.69	1224.21	1362.05	0	1362.05
42	3.08762	7596.5	39.2297	Glacial Lacustrine	500	28	1045.34	1159.49	1240.33	0	1240.33
43	3.08762	6884.06	40.484	Glacial Lacustrine	500	28	983.642	1091.06	1111.61	0	1111.61
44	3.08762	6129.7	41.7621	Glacial Lacustrine	500	28	917.552	1017.75	973.746	0	973.746
45	3.08762	5330.89	43.0663	Glacial Lacustrine	500	28	845.919	938.293	824.309	0	824.309
46	3.08762	4484.76	44.3988	Glacial Lacustrine	500	28	767.434	851.238	660.581	0	660.581
47	3.08762	3588.05	45.7625	Glacial Lacustrine	500	28	680.6	754.922	479.438	0	479.438
48	3.08762	2636.96	47.1604	Glacial Lacustrine	500	28	583.665	647.401	277.221	0	277.221
49	3.08762	1627.15	48.5961	Glacial Lacustrine	500	28	474.53	526.349	49.5554	0	49.5554
50	3.08762	553.485	50.0739	Glacial Lacustrine	500	28	350.645	388.935	-208.885	0	-208.885

Interslice Data

Global Minimum Query (gle/morgenstern-price) - Safety Factor: 1.1092

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	31.4738	119.901	0	0	0
2	34.5614	119.727	1566.83	87.9519	3.21285
3	37.6491	119.604	3402.53	381.239	6.39308
4	40.7367	119.533	5485.57	918.918	9.50964
5	43.8243	119.515	7787.87	1731.43	12.5344
6	46.9119	119.548	10276.7	2838.98	15.443
7	49.9995	119.633	12912.9	4249.6	18.2162
8	53.0872	119.77	15650.5	5957.2	20.8388
9	56.1748	119.959	18446	7944.3	23.3005
10	59.2624	120.201	21254.4	10181.3	25.5954
11	62.35	120.494	24030	12627	27.7205
12	65.4376	120.841	26727.6	15230.6	29.6765
13	68.5253	121.241	29302.3	17932.2	31.4655
14	71.6129	121.694	31713.9	20667.5	33.0917
15	74.7005	122.2	33927.3	23370	34.5601
16	77.7881	122.761	35911.8	25973.1	35.8762
17	80.8758	123.377	37642.3	28412.9	37.046
18	83.9634	124.048	39098.3	30629.7	38.0752
19	87.051	124.775	40256	32563	38.9693
20	90.1386	125.558	41096.8	34159.8	39.7335
21	93.2262	126.399	41609.7	35377.7	40.3721
22	96.3139	127.298	41788.4	36184.4	40.8892
23	99.4015	128.256	41642.9	36568.6	41.2879
24	102.489	129.275	41207.7	36548.4	41.5708
25	105.577	130.354	40496.8	36132	41.7399
26	108.664	131.496	39525.3	35334.9	41.7961
27	111.752	132.701	38308.8	34179.8	41.7399
28	114.84	133.971	36863.4	32695.4	41.5709
29	117.927	135.307	35205.1	30915.3	41.2879
30	121.015	136.711	33367.5	28892.8	40.8892
31	124.102	138.185	31388.5	26687.4	40.3721
32	127.19	139.73	29286.2	24342.8	39.7335
33	130.278	141.35	27077.8	21903.2	38.9694
34	133.365	143.044	24779.8	19412.6	38.0753
35	136.453	144.818	22408.3	16914.1	37.046
36	139.541	146.672	19978.7	14449.5	35.8762
37	142.628	148.61	17506.2	12058.7	34.56
38	145.716	150.635	15006.6	9779.57	33.0917
39	148.803	152.75	12507.6	7654.33	31.4656
40	151.891	154.96	10081.4	5744.86	29.6765
41	154.979	157.269	7759.64	4077.45	27.7205
42	158.066	159.681	5571.2	2668.71	25.5953
43	161.154	162.202	3549.43	1528.67	23.3006
44	164.242	164.837	1733.33	659.773	20.8388
45	167.329	167.594	169.275	55.708	18.2163
46	170.417	170.48	-1086.9	-300.262	15.4431
47	173.504	173.504	-1967.17	-437.351	12.5344
48	176.592	176.675	-2387.83	-399.999	9.50965
49	179.68	180.004	-2244.69	-251.508	6.39308
50	182.767	183.506	-1406.68	-78.9622	3.21285
51	185.855	187.195	0	0	0

List Of Coordinates

External Boundary

X	Y
0	114
0	83.544
223	83.544
223	194
201	190
147	180
118	170
97	160
83	150
65	140
48	130
32	120

CP|H
CONSULTANTS

APPENDIX B

WWHM INPUT PARAMETERS AND RESULTS

Site Planning
Civil Engineering
Project Management
Land Use Consulting

WWHM2012

PROJECT REPORT

Johnson Ridge PRD
Preliminary Detention Vault Sizing
East Basin

General Model Information

Project Name:	JR_East Vault_passing200330
Site Name:	
Site Address:	
City:	
Report Date:	3/30/2020
Gage:	Quilcene
Data Start:	1948/10/01
Data End:	2009/09/30
Timestep:	15 Minute
Precip Scale:	0.800
Version Date:	2018/10/10
Version:	4.2.16

POC Thresholds

Low Flow Threshold for POC1:	50 Percent of the 2 Year
High Flow Threshold for POC1:	50 Year

Landuse Basin Data
Predeveloped Land Use

East Basin

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Forest, Mod	2.8
C, Forest, Steep	5.575
Pervious Total	8.375
Impervious Land Use	acre
Impervious Total	0
Basin Total	8.375

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

East Basin

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Lawn, Mod	1.47
C, Forest, Steep	3.036
Pervious Total	4.506
Impervious Land Use	acre
ROADS MOD	0.482
ROOF TOPS FLAT	1.269
SIDEWALKS MOD	0.309
Impervious Total	2.06
Basin Total	6.566

Element Flows To:

Surface	Interflow	Groundwater
Vault 1	Vault 1	

Routing Elements
Predeveloped Routing

Mitigated Routing

Vault 1

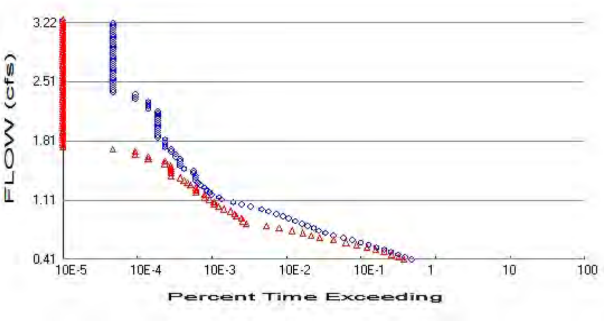
Width:	14.9 ft.	
Length:	108 ft.	
Depth:	16.5 ft.	
Discharge Structure		
Riser Height:	16 ft.	
Riser Diameter:	18 in.	
Orifice 1 Diameter:	2.25 in.	Elevation:0 ft.
Orifice 2 Diameter:	1.8 in.	Elevation:6.5 ft.
Element Flows To:		
Outlet 1	Outlet 2	

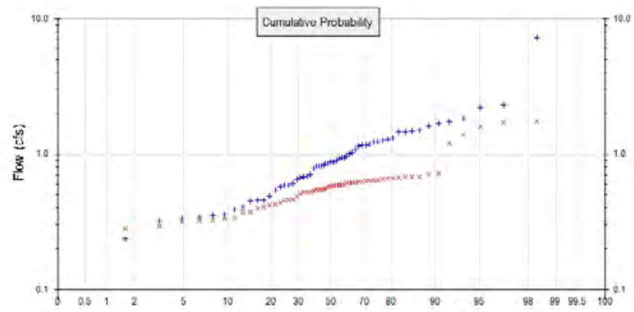
Vault Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.036	0.000	0.000	0.000
0.1833	0.036	0.006	0.058	0.000
0.3667	0.036	0.013	0.083	0.000
0.5500	0.036	0.020	0.101	0.000
0.7333	0.036	0.027	0.117	0.000
0.9167	0.036	0.033	0.131	0.000
1.1000	0.036	0.040	0.144	0.000
1.2833	0.036	0.047	0.155	0.000
1.4667	0.036	0.054	0.166	0.000
1.6500	0.036	0.061	0.176	0.000
1.8333	0.036	0.067	0.186	0.000
2.0167	0.036	0.074	0.195	0.000
2.2000	0.036	0.081	0.203	0.000
2.3833	0.036	0.088	0.212	0.000
2.5667	0.036	0.094	0.220	0.000
2.7500	0.036	0.101	0.227	0.000
2.9333	0.036	0.108	0.235	0.000
3.1167	0.036	0.115	0.242	0.000
3.3000	0.036	0.121	0.249	0.000
3.4833	0.036	0.128	0.256	0.000
3.6667	0.036	0.135	0.263	0.000
3.8500	0.036	0.142	0.269	0.000
4.0333	0.036	0.149	0.275	0.000
4.2167	0.036	0.155	0.282	0.000
4.4000	0.036	0.162	0.288	0.000
4.5833	0.036	0.169	0.294	0.000
4.7667	0.036	0.176	0.299	0.000
4.9500	0.036	0.182	0.305	0.000
5.1333	0.036	0.189	0.311	0.000
5.3167	0.036	0.196	0.316	0.000
5.5000	0.036	0.203	0.322	0.000
5.6833	0.036	0.210	0.327	0.000
5.8667	0.036	0.216	0.332	0.000
6.0500	0.036	0.223	0.337	0.000
6.2333	0.036	0.230	0.343	0.000
6.4167	0.036	0.237	0.348	0.000
6.6000	0.036	0.243	0.380	0.000
6.7833	0.036	0.250	0.404	0.000
6.9667	0.036	0.257	0.422	0.000

7.1500	0.036	0.264	0.438	0.000
7.3333	0.036	0.270	0.452	0.000
7.5167	0.036	0.277	0.465	0.000
7.7000	0.036	0.284	0.477	0.000
7.8833	0.036	0.291	0.489	0.000
8.0667	0.036	0.298	0.500	0.000
8.2500	0.036	0.304	0.510	0.000
8.4333	0.036	0.311	0.521	0.000
8.6167	0.036	0.318	0.531	0.000
8.8000	0.036	0.325	0.540	0.000
8.9833	0.036	0.331	0.550	0.000
9.1667	0.036	0.338	0.559	0.000
9.3500	0.036	0.345	0.568	0.000
9.5333	0.036	0.352	0.577	0.000
9.7167	0.036	0.359	0.585	0.000
9.9000	0.036	0.365	0.594	0.000
10.083	0.036	0.372	0.602	0.000
10.267	0.036	0.379	0.610	0.000
10.450	0.036	0.386	0.618	0.000
10.633	0.036	0.392	0.626	0.000
10.817	0.036	0.399	0.634	0.000
11.000	0.036	0.406	0.642	0.000
11.183	0.036	0.413	0.649	0.000
11.367	0.036	0.419	0.657	0.000
11.550	0.036	0.426	0.664	0.000
11.733	0.036	0.433	0.671	0.000
11.917	0.036	0.440	0.678	0.000
12.100	0.036	0.447	0.685	0.000
12.283	0.036	0.453	0.692	0.000
12.467	0.036	0.460	0.699	0.000
12.650	0.036	0.467	0.706	0.000
12.833	0.036	0.474	0.713	0.000
13.017	0.036	0.480	0.720	0.000
13.200	0.036	0.487	0.726	0.000
13.383	0.036	0.494	0.733	0.000
13.567	0.036	0.501	0.739	0.000
13.750	0.036	0.508	0.746	0.000
13.933	0.036	0.514	0.752	0.000
14.117	0.036	0.521	0.758	0.000
14.300	0.036	0.528	0.765	0.000
14.483	0.036	0.535	0.771	0.000
14.667	0.036	0.541	0.777	0.000
14.850	0.036	0.548	0.783	0.000
15.033	0.036	0.555	0.789	0.000
15.217	0.036	0.562	0.795	0.000
15.400	0.036	0.568	0.801	0.000
15.583	0.036	0.575	0.807	0.000
15.767	0.036	0.582	0.813	0.000
15.950	0.036	0.589	0.818	0.000
16.133	0.036	0.596	1.596	0.000
16.317	0.036	0.602	3.522	0.000
16.500	0.036	0.609	5.475	0.000
16.683	0.036	0.597	6.667	0.000

Analysis Results
POC 1





+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 8.375
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 4.506
Total Impervious Area: 2.06

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	0.811489
5 year	1.381618
10 year	1.857091
25 year	2.580505
50 year	3.215724
100 year	3.93974

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	Flow(cfs)
2 year	0.536694
5 year	0.765206
10 year	0.942827
25 year	1.199625
50 year	1.416055
100 year	1.655437

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	Predeveloped	Mitigated
1949	1.609	0.716
1950	0.488	0.395
1951	1.147	0.651
1952	0.543	0.459
1953	0.672	0.549
1954	1.674	0.630
1955	1.501	0.678
1956	7.238	0.557
1957	1.235	0.614
1958	1.727	0.545

1959	1.463	1.196
1960	0.854	0.661
1961	2.193	0.551
1962	0.590	0.588
1963	0.783	0.574
1964	0.652	0.409
1965	0.352	0.319
1966	1.829	0.487
1967	1.176	0.667
1968	1.165	0.583
1969	0.845	0.549
1970	0.874	0.609
1971	1.461	0.590
1972	1.226	0.576
1973	0.710	0.582
1974	0.946	0.677
1975	1.004	0.535
1976	1.259	0.596
1977	0.584	0.455
1978	1.020	0.522
1979	0.812	0.611
1980	0.604	0.507
1981	0.452	0.339
1982	0.391	0.332
1983	0.874	1.395
1984	0.341	0.293
1985	0.238	0.315
1986	0.813	0.625
1987	0.691	0.521
1988	0.573	0.528
1989	0.320	0.281
1990	0.357	0.322
1991	0.681	0.641
1992	0.829	0.702
1993	0.448	0.376
1994	1.081	1.591
1995	0.923	0.642
1996	1.154	0.657
1997	0.820	0.617
1998	0.960	0.587
1999	1.478	1.704
2000	0.458	0.424
2001	0.222	0.453
2002	2.307	0.618
2003	1.316	1.722
2004	0.405	0.371
2005	0.903	0.419
2006	1.275	0.644
2007	0.879	0.434
2008	0.935	0.675
2009	0.334	0.266

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	7.2380	1.7215
2	2.3069	1.7036
3	2.1926	1.5909

4	1.8294	1.3953
5	1.7272	1.1957
6	1.6735	0.7162
7	1.6094	0.7022
8	1.5011	0.6779
9	1.4783	0.6773
10	1.4630	0.6753
11	1.4607	0.6673
12	1.3157	0.6606
13	1.2746	0.6569
14	1.2591	0.6514
15	1.2349	0.6441
16	1.2260	0.6422
17	1.1762	0.6415
18	1.1652	0.6300
19	1.1535	0.6254
20	1.1467	0.6181
21	1.0808	0.6168
22	1.0197	0.6142
23	1.0036	0.6112
24	0.9602	0.6094
25	0.9456	0.5959
26	0.9354	0.5903
27	0.9228	0.5882
28	0.9029	0.5867
29	0.8790	0.5828
30	0.8740	0.5820
31	0.8735	0.5763
32	0.8540	0.5739
33	0.8455	0.5567
34	0.8291	0.5509
35	0.8197	0.5494
36	0.8133	0.5491
37	0.8117	0.5454
38	0.7830	0.5355
39	0.7099	0.5281
40	0.6906	0.5221
41	0.6805	0.5209
42	0.6720	0.5069
43	0.6522	0.4868
44	0.6038	0.4588
45	0.5902	0.4548
46	0.5840	0.4529
47	0.5731	0.4343
48	0.5431	0.4238
49	0.4875	0.4194
50	0.4576	0.4090
51	0.4520	0.3952
52	0.4480	0.3758
53	0.4048	0.3714
54	0.3909	0.3387
55	0.3573	0.3321
56	0.3519	0.3217
57	0.3408	0.3194
58	0.3342	0.3146
59	0.3203	0.2933
60	0.2381	0.2813
61	0.2217	0.2658

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.4057	10230	8021	78	Pass
0.4341	8224	6731	81	Pass
0.4625	6682	5501	82	Pass
0.4909	5360	4348	81	Pass
0.5193	4350	3364	77	Pass
0.5477	3426	2560	74	Pass
0.5760	2689	1869	69	Pass
0.6044	2116	1345	63	Pass
0.6328	1626	909	55	Pass
0.6612	1227	598	48	Pass
0.6896	914	459	50	Pass
0.7180	708	357	50	Pass
0.7463	585	253	43	Pass
0.7747	494	170	34	Pass
0.8031	414	115	27	Pass
0.8315	346	62	17	Pass
0.8599	283	56	19	Pass
0.8883	226	53	23	Pass
0.9166	191	45	23	Pass
0.9450	156	43	27	Pass
0.9734	123	38	30	Pass
1.0018	100	31	31	Pass
1.0302	70	26	37	Pass
1.0586	54	23	42	Pass
1.0870	41	23	56	Pass
1.1153	29	20	68	Pass
1.1437	27	17	62	Pass
1.1721	21	17	80	Pass
1.2005	20	13	65	Pass
1.2289	18	13	72	Pass
1.2573	17	13	76	Pass
1.2856	15	11	73	Pass
1.3140	14	10	71	Pass
1.3424	13	9	69	Pass
1.3708	13	8	61	Pass
1.3992	13	6	46	Pass
1.4276	12	6	50	Pass
1.4559	12	6	50	Pass
1.4843	9	6	66	Pass
1.5127	8	6	75	Pass
1.5411	8	5	62	Pass
1.5695	8	5	62	Pass
1.5979	8	3	37	Pass
1.6262	7	3	42	Pass
1.6546	7	2	28	Pass
1.6830	6	2	33	Pass
1.7114	6	1	16	Pass
1.7398	5	0	0	Pass
1.7682	5	0	0	Pass
1.7965	5	0	0	Pass
1.8249	5	0	0	Pass
1.8533	4	0	0	Pass
1.8817	4	0	0	Pass

1.9101	4	0	0	Pass
1.9385	4	0	0	Pass
1.9668	4	0	0	Pass
1.9952	4	0	0	Pass
2.0236	4	0	0	Pass
2.0520	4	0	0	Pass
2.0804	4	0	0	Pass
2.1088	4	0	0	Pass
2.1371	4	0	0	Pass
2.1655	4	0	0	Pass
2.1939	3	0	0	Pass
2.2223	3	0	0	Pass
2.2507	3	0	0	Pass
2.2791	3	0	0	Pass
2.3074	2	0	0	Pass
2.3358	2	0	0	Pass
2.3642	2	0	0	Pass
2.3926	1	0	0	Pass
2.4210	1	0	0	Pass
2.4494	1	0	0	Pass
2.4777	1	0	0	Pass
2.5061	1	0	0	Pass
2.5345	1	0	0	Pass
2.5629	1	0	0	Pass
2.5913	1	0	0	Pass
2.6197	1	0	0	Pass
2.6481	1	0	0	Pass
2.6764	1	0	0	Pass
2.7048	1	0	0	Pass
2.7332	1	0	0	Pass
2.7616	1	0	0	Pass
2.7900	1	0	0	Pass
2.8184	1	0	0	Pass
2.8467	1	0	0	Pass
2.8751	1	0	0	Pass
2.9035	1	0	0	Pass
2.9319	1	0	0	Pass
2.9603	1	0	0	Pass
2.9887	1	0	0	Pass
3.0170	1	0	0	Pass
3.0454	1	0	0	Pass
3.0738	1	0	0	Pass
3.1022	1	0	0	Pass
3.1306	1	0	0	Pass
3.1590	1	0	0	Pass
3.1873	1	0	0	Pass
3.2157	1	0	0	Pass

Water Quality

Water Quality BMP Flow and Volume for POC #1

On-line facility volume:	0.7554 acre-feet
On-line facility target flow:	0.4128 cfs.
Adjusted for 15 min:	0.4128 cfs.
Off-line facility target flow:	0.239 cfs.
Adjusted for 15 min:	0.239 cfs.

LID Report

LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment
Vault 1 POC	☐	846.29			☐	0.00			
Total Volume Infiltrated		846.29	0.00	0.00		0.00	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Failed

Model Default Modifications

Total of 0 changes have been made.

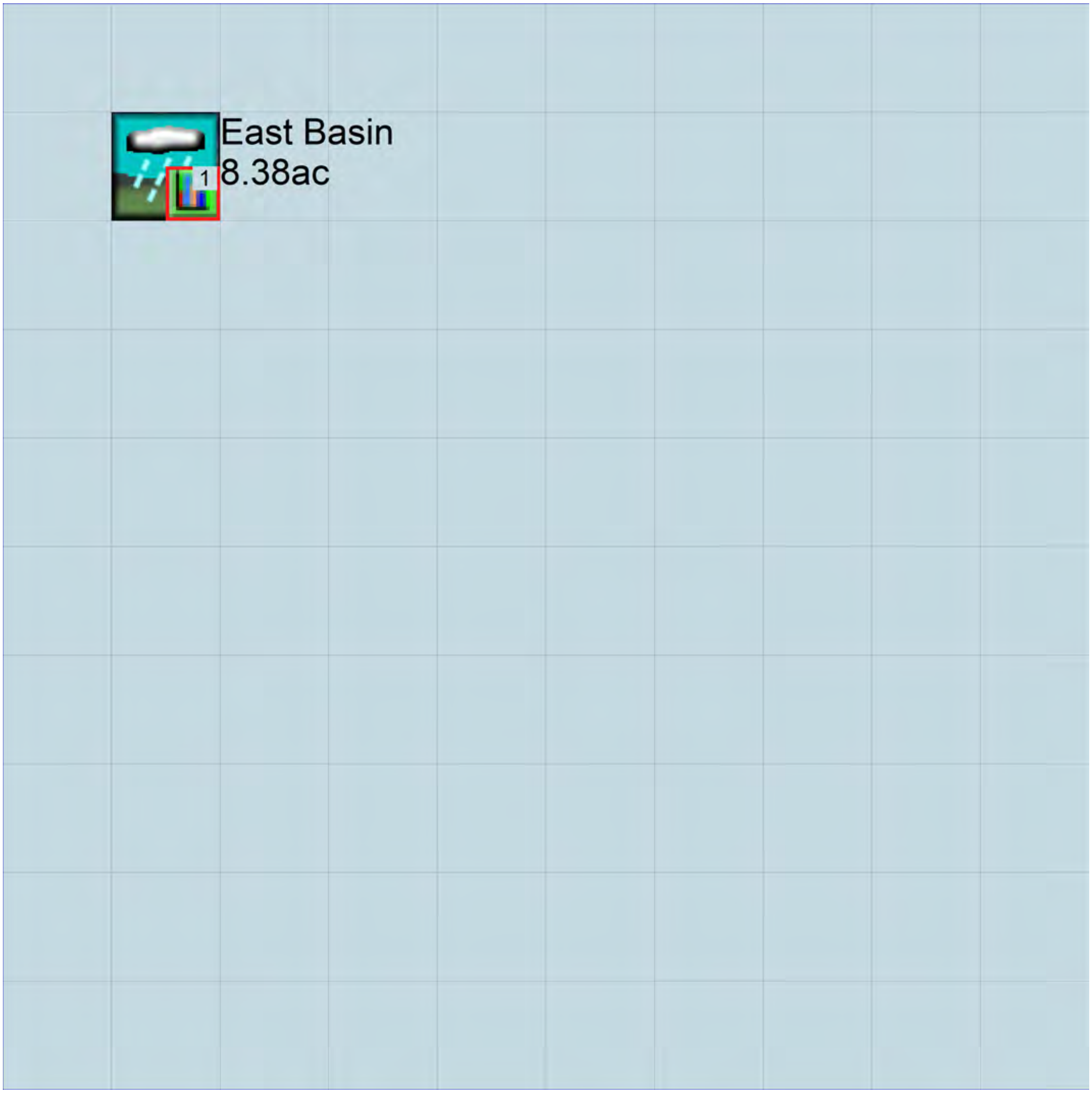
PERLND Changes

No PERLND changes have been made.

IMPLND Changes

No IMPLND changes have been made.

Appendix
Predeveloped Schematic



Mitigated Schematic

Predeveloped UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1948 10 01        END    2009 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                   UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                              ***
WDM        26   JR_East Vault_passing200330.wdm
MESSU      25   PreJR_East Vault_passing200330.MES
           27   PreJR_East Vault_passing200330.L61
           28   PreJR_East Vault_passing200330.L62
           30   POCJR_East Vault_passing2003301.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      11
      PERLND      12
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        East Basin                MAX                      1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                          in  out           ***
   11     C, Forest, Mod          1    1    1    1   27    0
   12     C, Forest, Steep        1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   11         0    0    1    0    0    0    0    0    0    0    0    0
   12         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ***************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
```

```
   11         0    0    4    0    0    0    0    0    0    0    0    0    1    9
   12         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   11         0    0    0    0    0    0    0    0    0    0    0
   12         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   11             0       4.5      0.08       400       0.1       0.5     0.996
   12             0       4.5      0.08       400      0.15       0.5     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   11             0         0         2         2         0         0         0
   12             0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                                    ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   11           0.2       0.5      0.35         6       0.5       0.7
   12           0.2       0.3      0.35         6       0.3       0.7
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
              ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
   11             0         0         0         0       2.5         1         0
   12             0         0         0         0       2.5         1         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                     in  out           ***
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
  END IWAT-PARM2

  IWAT-PARM3
```

```
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
East Basin***
PERLND  11                         2.8     COPY   501     12
PERLND  11                         2.8     COPY   501     13
PERLND  12                       5.575     COPY   501     12
PERLND  12                       5.575     COPY   501     13

******Routing******
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1



<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                 ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG            ***
                                           in  out                           ***
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ****************** PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                      ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *       *  *  *  *  *         ***
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                         ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit       for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
  END HYDR-INIT
END RCHRES
```

```
SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    0.8            PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    0.8            IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.76           PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.76           IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    501 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13


END MASS-LINK

END RUN
```

Mitigated UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1948 10 01        END    2009 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                   UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                             ***
WDM        26   JR_East Vault_passing200330.wdm
MESSU      25   MitJR_East Vault_passing200330.MES
           27   MitJR_East Vault_passing200330.L61
           28   MitJR_East Vault_passing200330.L62
           30   POCJR_East Vault_passing2003301.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      17
      PERLND      12
      IMPLND       2
      IMPLND       4
      IMPLND       9
      RCHRES       1
      COPY         1
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Vault  1                    MAX                    1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                          in  out           ***
   17     C, Lawn, Mod            1    1    1    1   27    0
   12     C, Forest, Steep        1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   17         0    0    1    0    0    0    0    0    0    0    0    0
   12         0    0    1    0    0    0    0    0    0    0    0    0
```

```
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ***************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
   17         0    0    4    0    0    0    0    0    0    0    0    0    1    9
   12         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   17         0    0    0    0    0    0    0    0    0    0    0
   12         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   17              0       4.5      0.03       400       0.1       0.5     0.996
   12              0       4.5      0.08       400      0.15       0.5     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   17              0         0         2         2         0         0         0
   12              0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                               ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   17            0.1      0.25      0.25         6       0.5      0.25
   12            0.2       0.3      0.35         6       0.3       0.7
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
              ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
   17              0         0         0         0       2.5         1         0
   12              0         0         0         0       2.5         1         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                      in  out           ***
    2      ROADS/MOD              1    1    1   27    0
    4      ROOF TOPS/FLAT         1    1    1   27    0
    9      SIDEWALKS/MOD          1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    2         0    0    1    0    0    0
    4         0    0    1    0    0    0
    9         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   *********
    2         0    0    4    0    0    0    1    9
    4         0    0    4    0    0    0    1    9
```

```
    9         0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
    2         0    0    0    0    0
    4         0    0    0    0    0
    9         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    2            400      0.05       0.1      0.08
    4            400      0.01       0.1       0.1
    9            400      0.05       0.1      0.08
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    2              0         0
    4              0         0
    9              0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    2              0         0
    4              0         0
    9              0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
East Basin***
PERLND  17                        1.47     RCHRES   1      2
PERLND  17                        1.47     RCHRES   1      3
PERLND  12                       3.036     RCHRES   1      2
PERLND  12                       3.036     RCHRES   1      3
IMPLND   2                       0.482     RCHRES   1      5
IMPLND   4                       1.269     RCHRES   1      5
IMPLND   9                       0.309     RCHRES   1      5

******Routing******
PERLND  17                        1.47     COPY     1     12
PERLND  12                       3.036     COPY     1     12
IMPLND   2                       0.482     COPY     1     15
IMPLND   4                       1.269     COPY     1     15
IMPLND   9                       0.309     COPY     1     15
PERLND  17                        1.47     COPY     1     13
PERLND  12                       3.036     COPY     1     13
RCHRES   1                           1     COPY   501     16
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1


<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK
```

```
RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                 ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG             ***
                                         in  out                               ***
    1     Vault  1               1    1    1    1   28    0    1
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
    1        1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ****************** PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
    1        4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                        ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *     *  *  *  *  *        *  *  *  *  *         ***
    1        0  1  0  0    4  0  0  0  0      0  0  0  0  0       2  2  2  2  2
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
    1             1      0.02       0.0       0.0       0.5       0.0
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                           ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit       for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
    1             0         4.0  0.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
  FTABLE      1
   91    4
     Depth      Area    Volume  Outflow1 Velocity  Travel Time***
      (ft)   (acres) (acre-ft)   (cfs)   (ft/sec)    (Minutes)***
  0.000000  0.036942  0.000000  0.000000
  0.183333  0.036942  0.006773  0.058823
  0.366667  0.036942  0.013545  0.083188
  0.550000  0.036942  0.020318  0.101884
  0.733333  0.036942  0.027091  0.117645
  0.916667  0.036942  0.033864  0.131531
  1.100000  0.036942  0.040636  0.144085
  1.283333  0.036942  0.047409  0.155630
  1.466667  0.036942  0.054182  0.166376
  1.650000  0.036942  0.060955  0.176468
  1.833333  0.036942  0.067727  0.186014
  2.016667  0.036942  0.074500  0.195093
  2.200000  0.036942  0.081273  0.203768
  2.383333  0.036942  0.088045  0.212088
  2.566667  0.036942  0.094818  0.220094
  2.750000  0.036942  0.101591  0.227819
  2.933333  0.036942  0.108364  0.235291
  3.116667  0.036942  0.115136  0.242532
  3.300000  0.036942  0.121909  0.249563
```

3.483333	0.036942	0.128682	0.256402
3.666667	0.036942	0.135455	0.263063
3.850000	0.036942	0.142227	0.269559
4.033333	0.036942	0.149000	0.275903
4.216667	0.036942	0.155773	0.282103
4.400000	0.036942	0.162545	0.288171
4.583333	0.036942	0.169318	0.294113
4.766667	0.036942	0.176091	0.299938
4.950000	0.036942	0.182864	0.305651
5.133333	0.036942	0.189636	0.311260
5.316667	0.036942	0.196409	0.316770
5.500000	0.036942	0.203182	0.322185
5.683333	0.036942	0.209955	0.327511
5.866667	0.036942	0.216727	0.332751
6.050000	0.036942	0.223500	0.337910
6.233333	0.036942	0.230273	0.342992
6.416667	0.036942	0.237045	0.347999
6.600000	0.036942	0.243818	0.380740
6.783333	0.036942	0.250591	0.404605
6.966667	0.036942	0.257364	0.422670
7.150000	0.036942	0.264136	0.438233
7.333333	0.036942	0.270909	0.452290
7.516667	0.036942	0.277682	0.465302
7.700000	0.036942	0.284455	0.477529
7.883333	0.036942	0.291227	0.489137
8.066667	0.036942	0.298000	0.500236
8.250000	0.036942	0.304773	0.510906
8.433333	0.036942	0.311545	0.521207
8.616667	0.036942	0.318318	0.531185
8.800000	0.036942	0.325091	0.540877
8.983333	0.036942	0.331864	0.550313
9.166667	0.036942	0.338636	0.559517
9.350000	0.036942	0.345409	0.568509
9.533333	0.036942	0.352182	0.577307
9.716667	0.036942	0.358955	0.585926
9.900000	0.036942	0.365727	0.594379
10.08333	0.036942	0.372500	0.602676
10.26667	0.036942	0.379273	0.610829
10.45000	0.036942	0.386045	0.618845
10.63333	0.036942	0.392818	0.626733
10.81667	0.036942	0.399591	0.634500
11.00000	0.036942	0.406364	0.642152
11.18333	0.036942	0.413136	0.649694
11.36667	0.036942	0.419909	0.657133
11.55000	0.036942	0.426682	0.664473
11.73333	0.036942	0.433455	0.671719
11.91667	0.036942	0.440227	0.678873
12.10000	0.036942	0.447000	0.685942
12.28333	0.036942	0.453773	0.692927
12.46667	0.036942	0.460545	0.699832
12.65000	0.036942	0.467318	0.706660
12.83333	0.036942	0.474091	0.713414
13.01667	0.036942	0.480864	0.720097
13.20000	0.036942	0.487636	0.726710
13.38333	0.036942	0.494409	0.733257
13.56667	0.036942	0.501182	0.739740
13.75000	0.036942	0.507955	0.746160
13.93333	0.036942	0.514727	0.752519
14.11667	0.036942	0.521500	0.758820
14.30000	0.036942	0.528273	0.765064
14.48333	0.036942	0.535045	0.771252
14.66667	0.036942	0.541818	0.777387
14.85000	0.036942	0.548591	0.783470
15.03333	0.036942	0.555364	0.789502
15.21667	0.036942	0.562136	0.795484
15.40000	0.036942	0.568909	0.801419
15.58333	0.036942	0.575682	0.807306
15.76667	0.036942	0.582455	0.813148
15.95000	0.036942	0.589227	0.818945
16.13333	0.036942	0.596000	1.596163

```
  16.31667  0.036942  0.602773  3.522203
  16.50000  0.036942  0.609545  5.475170
  END FTABLE  1
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    0.8            PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    0.8            IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.76           PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.76           IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
RCHRES   1 HYDR   RO      1 1        1     WDM   1000 FLOW     ENGL      REPL
RCHRES   1 HYDR   STAGE   1 1        1     WDM   1001 STAG     ENGL      REPL
COPY     1 OUTPUT MEAN    1 1     48.4     WDM    701 FLOW     ENGL      REPL
COPY   501 OUTPUT MEAN    1 1     48.4     WDM    801 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK        2
PERLND     PWATER SURO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    2

  MASS-LINK        3
PERLND     PWATER IFWO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    3

  MASS-LINK        5
IMPLND     IWATER SURO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    5

  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13

  MASS-LINK       15
IMPLND     IWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   15

  MASS-LINK       16
RCHRES     ROFLOW                          COPY           INPUT  MEAN
  END MASS-LINK   16


END MASS-LINK

END RUN
```

Predeveloped HSPF Message File

Mitigated HSPF Message File

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WWHM2012

PROJECT REPORT

Johnson Ridge PRD
Preliminary Detention Vault Sizing
West Basin

General Model Information

Project Name:	West Basin vault 200330
Site Name:	Johnson Ridge - West Vault
Site Address:	
City:	
Report Date:	3/30/2020
Gage:	Quilcene
Data Start:	1948/10/01
Data End:	2009/09/30
Timestep:	15 Minute
Precip Scale:	0.800
Version Date:	2018/10/10
Version:	4.2.16

POC Thresholds

Low Flow Threshold for POC1:	50 Percent of the 2 Year
High Flow Threshold for POC1:	50 Year

Landuse Basin Data
Predeveloped Land Use

West Basin

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Forest, Mod	1.366
C, Forest, Steep	4
Pervious Total	5.366
Impervious Land Use	acre
Impervious Total	0
Basin Total	5.366

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

West Basin

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Lawn, Mod	3.642
Pervious Total	3.642
Impervious Land Use	acre
ROADS MOD	0.987
ROOF TOPS FLAT	2.321
SIDEWALKS MOD	0.335
Impervious Total	3.643
Basin Total	7.285

Element Flows To:

Surface	Interflow	Groundwater
Vault 1	Vault 1	

Routing Elements
Predeveloped Routing

Mitigated Routing

Vault 1

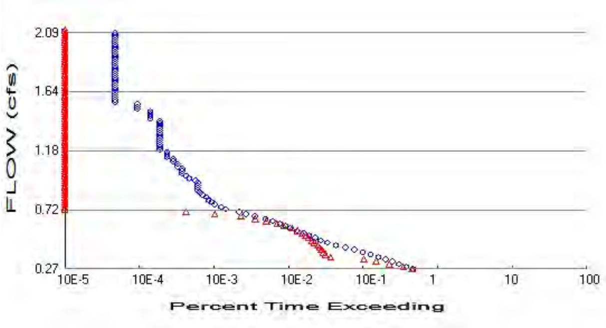
Width:	54 ft.	
Length:	184 ft.	
Depth:	16.5 ft.	
Discharge Structure		
Riser Height:	16 ft.	
Riser Diameter:	18 in.	
Orifice 1 Diameter:	1.8 in.	Elevation:0 ft.
Orifice 2 Diameter:	1 in.	Elevation:7.3 ft.
Orifice 3 Diameter:	3.2 in.	Elevation:11.8 ft.
Element Flows To:		
Outlet 1	Outlet 2	

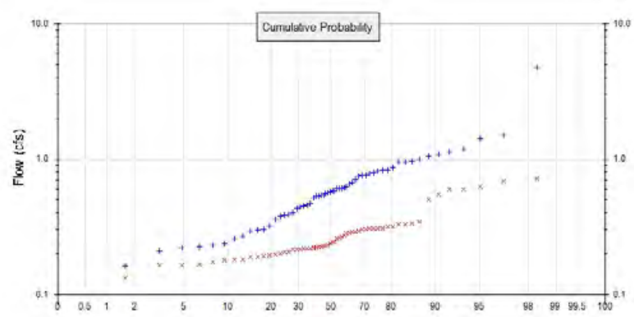
Vault Hydraulic Table

Stage(feet)	**Area(ac.)**	**Volume(ac-ft.)**	**Discharge(cfs)**	**Infilt(cfs)**
0.0000	0.228	0.000	0.000	0.000
0.1833	0.228	0.041	0.037	0.000
0.3667	0.228	0.083	0.053	0.000
0.5500	0.228	0.125	0.065	0.000
0.7333	0.228	0.167	0.075	0.000
0.9167	0.228	0.209	0.084	0.000
1.1000	0.228	0.250	0.092	0.000
1.2833	0.228	0.292	0.099	0.000
1.4667	0.228	0.334	0.106	0.000
1.6500	0.228	0.376	0.112	0.000
1.8333	0.228	0.418	0.119	0.000
2.0167	0.228	0.460	0.124	0.000
2.2000	0.228	0.501	0.130	0.000
2.3833	0.228	0.543	0.135	0.000
2.5667	0.228	0.585	0.140	0.000
2.7500	0.228	0.627	0.145	0.000
2.9333	0.228	0.669	0.150	0.000
3.1167	0.228	0.710	0.155	0.000
3.3000	0.228	0.752	0.159	0.000
3.4833	0.228	0.794	0.164	0.000
3.6667	0.228	0.836	0.168	0.000
3.8500	0.228	0.878	0.172	0.000
4.0333	0.228	0.920	0.176	0.000
4.2167	0.228	0.961	0.180	0.000
4.4000	0.228	1.003	0.184	0.000
4.5833	0.228	1.045	0.188	0.000
4.7667	0.228	1.087	0.192	0.000
4.9500	0.228	1.129	0.195	0.000
5.1333	0.228	1.170	0.199	0.000
5.3167	0.228	1.212	0.202	0.000
5.5000	0.228	1.254	0.206	0.000
5.6833	0.228	1.296	0.209	0.000
5.8667	0.228	1.338	0.213	0.000
6.0500	0.228	1.380	0.216	0.000
6.2333	0.228	1.421	0.219	0.000
6.4167	0.228	1.463	0.222	0.000
6.6000	0.228	1.505	0.225	0.000
6.7833	0.228	1.547	0.229	0.000

6.9667	0.228	1.589	0.232	0.000
7.1500	0.228	1.630	0.235	0.000
7.3333	0.228	1.672	0.243	0.000
7.5167	0.228	1.714	0.253	0.000
7.7000	0.228	1.756	0.261	0.000
7.8833	0.228	1.798	0.267	0.000
8.0667	0.228	1.840	0.273	0.000
8.2500	0.228	1.881	0.279	0.000
8.4333	0.228	1.923	0.284	0.000
8.6167	0.228	1.965	0.289	0.000
8.8000	0.228	2.007	0.294	0.000
8.9833	0.228	2.049	0.298	0.000
9.1667	0.228	2.090	0.303	0.000
9.3500	0.228	2.132	0.307	0.000
9.5333	0.228	2.174	0.312	0.000
9.7167	0.228	2.216	0.316	0.000
9.9000	0.228	2.258	0.320	0.000
10.083	0.228	2.300	0.324	0.000
10.267	0.228	2.341	0.328	0.000
10.450	0.228	2.383	0.332	0.000
10.633	0.228	2.425	0.336	0.000
10.817	0.228	2.467	0.340	0.000
11.000	0.228	2.509	0.343	0.000
11.183	0.228	2.550	0.347	0.000
11.367	0.228	2.592	0.351	0.000
11.550	0.228	2.634	0.354	0.000
11.733	0.228	2.676	0.358	0.000
11.917	0.228	2.718	0.456	0.000
12.100	0.228	2.760	0.517	0.000
12.283	0.228	2.801	0.561	0.000
12.467	0.228	2.843	0.599	0.000
12.650	0.228	2.885	0.631	0.000
12.833	0.228	2.927	0.661	0.000
13.017	0.228	2.969	0.688	0.000
13.200	0.228	3.010	0.714	0.000
13.383	0.228	3.052	0.738	0.000
13.567	0.228	3.094	0.761	0.000
13.750	0.228	3.136	0.783	0.000
13.933	0.228	3.178	0.804	0.000
14.117	0.228	3.220	0.824	0.000
14.300	0.228	3.261	0.843	0.000
14.483	0.228	3.303	0.862	0.000
14.667	0.228	3.345	0.880	0.000
14.850	0.228	3.387	0.898	0.000
15.033	0.228	3.429	0.916	0.000
15.217	0.228	3.470	0.933	0.000
15.400	0.228	3.512	0.949	0.000
15.583	0.228	3.554	0.965	0.000
15.767	0.228	3.596	0.981	0.000
15.950	0.228	3.638	0.997	0.000
16.133	0.228	3.680	1.783	0.000
16.317	0.228	3.721	3.719	0.000
16.500	0.228	3.763	5.681	0.000
16.683	0.228	3.690	6.882	0.000

Analysis Results
POC 1





+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 5.366
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 3.642
Total Impervious Area: 3.643

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.532365
5 year	0.90352
10 year	1.21232
25 year	1.681269
50 year	2.092385
100 year	2.560381

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0.249595
5 year	0.35331
10 year	0.433478
25 year	0.548851
50 year	0.64569
100 year	0.752451

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1949	1.059	0.284
1950	0.319	0.199
1951	0.753	0.281
1952	0.359	0.215
1953	0.441	0.288
1954	1.089	0.330
1955	0.990	0.198
1956	4.713	0.304
1957	0.811	0.332
1958	1.125	0.207

1959	0.958	0.716
1960	0.562	0.238
1961	1.424	0.219
1962	0.390	0.221
1963	0.515	0.316
1964	0.431	0.188
1965	0.229	0.191
1966	1.186	0.206
1967	0.776	0.599
1968	0.763	0.307
1969	0.553	0.244
1970	0.571	0.304
1971	0.956	0.228
1972	0.797	0.225
1973	0.466	0.242
1974	0.616	0.621
1975	0.654	0.181
1976	0.825	0.216
1977	0.382	0.228
1978	0.666	0.229
1979	0.532	0.265
1980	0.398	0.224
1981	0.295	0.216
1982	0.257	0.190
1983	0.582	0.313
1984	0.224	0.178
1985	0.161	0.132
1986	0.532	0.295
1987	0.452	0.275
1988	0.376	0.221
1989	0.208	0.181
1990	0.236	0.216
1991	0.449	0.308
1992	0.539	0.690
1993	0.296	0.167
1994	0.711	0.500
1995	0.602	0.301
1996	0.750	0.547
1997	0.537	0.291
1998	0.626	0.343
1999	0.968	0.596
2000	0.303	0.195
2001	0.147	0.163
2002	1.498	0.261
2003	0.861	0.328
2004	0.268	0.164
2005	0.605	0.173
2006	0.830	0.301
2007	0.576	0.216
2008	0.609	0.257
2009	0.221	0.114

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	4.7131	0.7164
2	1.4983	0.6905
3	1.4240	0.6205

4	1.1865	0.5985
5	1.1254	0.5957
6	1.0888	0.5469
7	1.0585	0.4998
8	0.9899	0.3432
9	0.9678	0.3322
10	0.9580	0.3305
11	0.9556	0.3284
12	0.8611	0.3165
13	0.8299	0.3129
14	0.8254	0.3077
15	0.8112	0.3069
16	0.7968	0.3043
17	0.7756	0.3040
18	0.7628	0.3011
19	0.7534	0.3007
20	0.7501	0.2950
21	0.7106	0.2910
22	0.6663	0.2877
23	0.6536	0.2843
24	0.6260	0.2808
25	0.6164	0.2746
26	0.6086	0.2652
27	0.6047	0.2613
28	0.6016	0.2573
29	0.5819	0.2443
30	0.5760	0.2424
31	0.5707	0.2380
32	0.5617	0.2292
33	0.5530	0.2282
34	0.5389	0.2276
35	0.5371	0.2253
36	0.5323	0.2235
37	0.5317	0.2207
38	0.5149	0.2206
39	0.4658	0.2188
40	0.4520	0.2164
41	0.4488	0.2163
42	0.4412	0.2158
43	0.4306	0.2156
44	0.3980	0.2150
45	0.3903	0.2065
46	0.3824	0.2063
47	0.3762	0.1987
48	0.3591	0.1982
49	0.3188	0.1946
50	0.3031	0.1908
51	0.2956	0.1898
52	0.2952	0.1876
53	0.2684	0.1813
54	0.2574	0.1811
55	0.2355	0.1777
56	0.2293	0.1729
57	0.2236	0.1672
58	0.2207	0.1643
59	0.2082	0.1630
60	0.1607	0.1316
61	0.1467	0.1143

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.2662	10044	9657	96	Pass
0.2846	8158	7381	90	Pass
0.3031	6562	4832	73	Pass
0.3215	5298	3183	60	Pass
0.3400	4336	2194	50	Pass
0.3584	3414	790	23	Pass
0.3769	2701	671	24	Pass
0.3953	2113	628	29	Pass
0.4138	1630	591	36	Pass
0.4322	1238	559	45	Pass
0.4506	923	528	57	Pass
0.4691	706	475	67	Pass
0.4875	585	438	74	Pass
0.5060	492	393	79	Pass
0.5244	405	363	89	Pass
0.5429	344	324	94	Pass
0.5613	283	281	99	Pass
0.5798	225	236	104	Pass
0.5982	194	184	94	Pass
0.6167	165	150	90	Pass
0.6351	131	108	82	Pass
0.6536	105	77	73	Pass
0.6720	75	49	65	Pass
0.6905	57	22	38	Pass
0.7089	46	9	19	Pass
0.7273	31	0	0	Pass
0.7458	27	0	0	Pass
0.7642	22	0	0	Pass
0.7827	20	0	0	Pass
0.8011	18	0	0	Pass
0.8196	17	0	0	Pass
0.8380	15	0	0	Pass
0.8565	14	0	0	Pass
0.8749	13	0	0	Pass
0.8934	13	0	0	Pass
0.9118	13	0	0	Pass
0.9303	13	0	0	Pass
0.9487	12	0	0	Pass
0.9671	10	0	0	Pass
0.9856	9	0	0	Pass
1.0040	8	0	0	Pass
1.0225	8	0	0	Pass
1.0409	8	0	0	Pass
1.0594	7	0	0	Pass
1.0778	7	0	0	Pass
1.0963	6	0	0	Pass
1.1147	6	0	0	Pass
1.1332	5	0	0	Pass
1.1516	5	0	0	Pass
1.1701	5	0	0	Pass
1.1885	4	0	0	Pass
1.2070	4	0	0	Pass
1.2254	4	0	0	Pass

1.2438	4	0	0	Pass
1.2623	4	0	0	Pass
1.2807	4	0	0	Pass
1.2992	4	0	0	Pass
1.3176	4	0	0	Pass
1.3361	4	0	0	Pass
1.3545	4	0	0	Pass
1.3730	4	0	0	Pass
1.3914	4	0	0	Pass
1.4099	4	0	0	Pass
1.4283	3	0	0	Pass
1.4468	3	0	0	Pass
1.4652	3	0	0	Pass
1.4837	3	0	0	Pass
1.5021	2	0	0	Pass
1.5205	2	0	0	Pass
1.5390	2	0	0	Pass
1.5574	1	0	0	Pass
1.5759	1	0	0	Pass
1.5943	1	0	0	Pass
1.6128	1	0	0	Pass
1.6312	1	0	0	Pass
1.6497	1	0	0	Pass
1.6681	1	0	0	Pass
1.6866	1	0	0	Pass
1.7050	1	0	0	Pass
1.7235	1	0	0	Pass
1.7419	1	0	0	Pass
1.7603	1	0	0	Pass
1.7788	1	0	0	Pass
1.7972	1	0	0	Pass
1.8157	1	0	0	Pass
1.8341	1	0	0	Pass
1.8526	1	0	0	Pass
1.8710	1	0	0	Pass
1.8895	1	0	0	Pass
1.9079	1	0	0	Pass
1.9264	1	0	0	Pass
1.9448	1	0	0	Pass
1.9633	1	0	0	Pass
1.9817	1	0	0	Pass
2.0002	1	0	0	Pass
2.0186	1	0	0	Pass
2.0370	1	0	0	Pass
2.0555	1	0	0	Pass
2.0739	1	0	0	Pass
2.0924	1	0	0	Pass

Water Quality

Water Quality BMP Flow and Volume for POC #1

On-line facility volume:	0.4443 acre-feet
On-line facility target flow:	0.2242 cfs.
Adjusted for 15 min:	0.2242 cfs.
Off-line facility target flow:	0.1464 cfs.
Adjusted for 15 min:	0.1464 cfs.

LID Report

LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment
Vault 1 POC	☐	1144.04			☐	0.00			
Total Volume Infiltrated		1144.04	0.00	0.00		0.00	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Failed

Model Default Modifications

Total of 0 changes have been made.

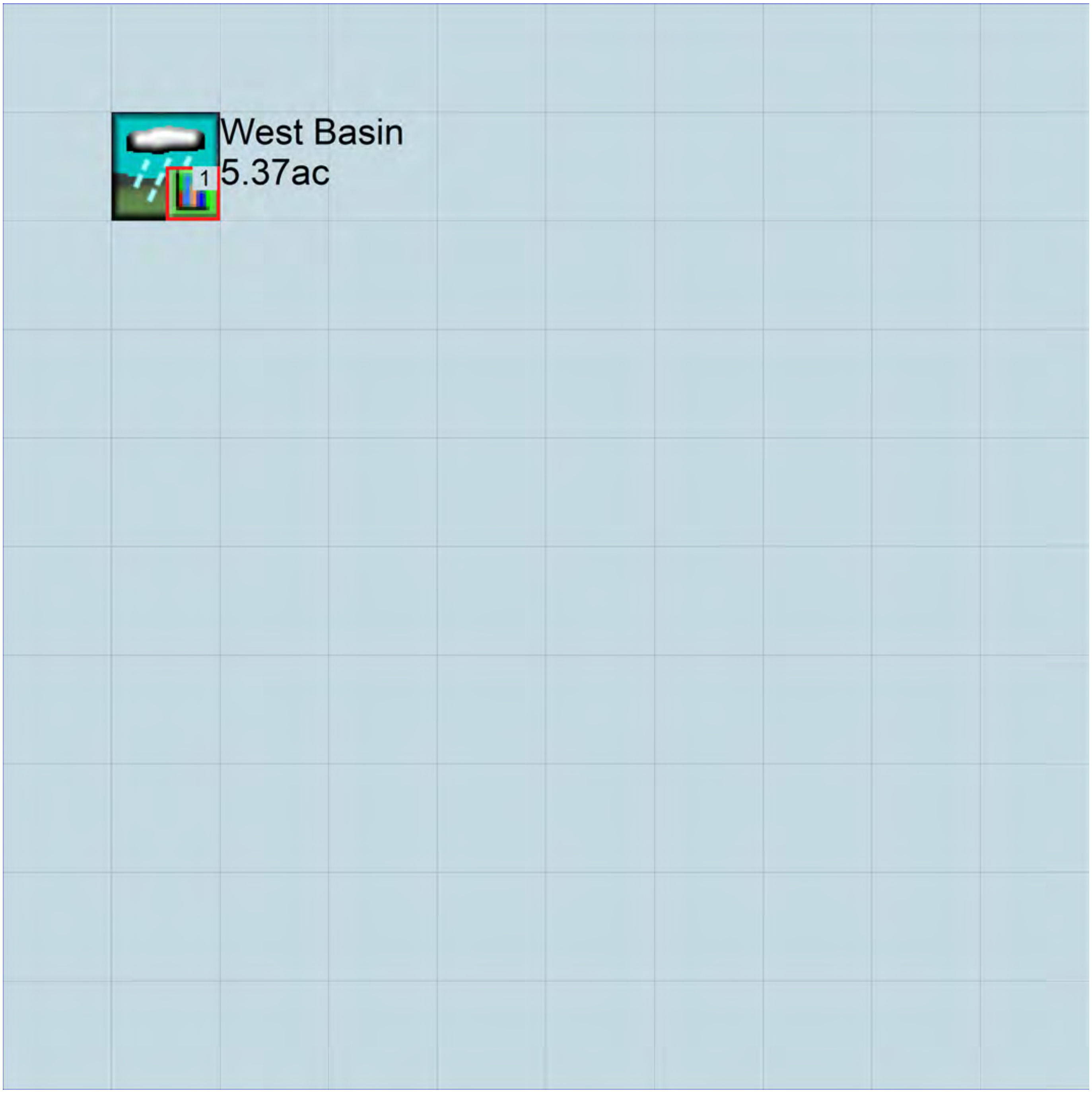
PERLND Changes

No PERLND changes have been made.

IMPLND Changes

No IMPLND changes have been made.

Appendix
Predeveloped Schematic



Mitigated Schematic

Predeveloped UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1948 10 01        END    2009 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                   UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                             ***
WDM        26   West Basin vault 200330.wdm
MESSU      25   PreWest Basin vault 200330.MES
           27   PreWest Basin vault 200330.L61
           28   PreWest Basin vault 200330.L62
           30   POCWest Basin vault 2003301.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      11
      PERLND      12
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        West Basin                  MAX                      1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                            User  t-series Engl Metr ***
                                            in  out           ***
   11      C, Forest, Mod          1    1    1    1   27    0
   12      C, Forest, Steep        1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   11         0    0    1    0    0    0    0    0    0    0    0    0
   12         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ***************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
```

```
  11         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  12         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
  11         0    0    0    0    0    0    0    0    0    0    0
  12         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
  11              0       4.5      0.08       400       0.1       0.5     0.996
  12              0       4.5      0.08       400      0.15       0.5     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
  11              0         0         2         2         0         0         0
  12              0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                                ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
  11            0.2       0.5      0.35         6       0.5       0.7
  12            0.2       0.3      0.35         6       0.3       0.7
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
              ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
  11              0         0         0         0       2.5         1         0
  12              0         0         0         0       2.5         1         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                     in  out            ***
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
  END IWAT-PARM2

  IWAT-PARM3
```

```
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
West Basin***
PERLND  11                       1.366     COPY   501     12
PERLND  11                       1.366     COPY   501     13
PERLND  12                           4     COPY   501     12
PERLND  12                           4     COPY   501     13

******Routing******
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1



<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                 ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG            ***
                                          in  out                            ***
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ****************** PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                      ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *        *  *  *  *  *        ***
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                         ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit       for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
  END HYDR-INIT
END RCHRES
```

```
SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    0.8            PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    0.8            IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.76           PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.76           IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    501 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13


END MASS-LINK

END RUN
```

Mitigated UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1948 10 01        END    2009 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                   UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                              ***
WDM        26   West Basin vault 200330.wdm
MESSU      25   MitWest Basin vault 200330.MES
           27   MitWest Basin vault 200330.L61
           28   MitWest Basin vault 200330.L62
           30   POCWest Basin vault 2003301.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      17
      IMPLND       2
      IMPLND       4
      IMPLND       9
      RCHRES       1
      COPY         1
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Vault  1                    MAX                   1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1        1    1
  501        1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                          in  out           ***
   17      C, Lawn, Mod           1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   17         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
```

```
    <PLS > ***************** Print-flags ***************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
   17         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   17         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   17              0       4.5      0.03       400       0.1       0.5     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   17              0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                               ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   17            0.1      0.25      0.25         6       0.5      0.25
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
              ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
   17              0         0         0         0       2.5         1         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                     in  out           ***
    2      ROADS/MOD             1    1    1   27    0
    4      ROOF TOPS/FLAT        1    1    1   27    0
    9      SIDEWALKS/MOD         1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    2         0    0    1    0    0    0
    4         0    0    1    0    0    0
    9         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    2         0    0    4    0    0    0    1    9
    4         0    0    4    0    0    0    1    9
    9         0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
    2         0    0    0    0    0
    4         0    0    0    0    0
    9         0    0    0    0    0
```

```
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    2            400      0.05       0.1      0.08
    4            400      0.01       0.1       0.1
    9            400      0.05       0.1      0.08
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    2              0         0
    4              0         0
    9              0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    2              0         0
    4              0         0
    9              0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
West Basin***
PERLND  17                       3.642     RCHRES   1      2
PERLND  17                       3.642     RCHRES   1      3
IMPLND   2                       0.987     RCHRES   1      5
IMPLND   4                       2.321     RCHRES   1      5
IMPLND   9                       0.335     RCHRES   1      5

******Routing******
PERLND  17                       3.642     COPY     1     12
IMPLND   2                       0.987     COPY     1     15
IMPLND   4                       2.321     COPY     1     15
IMPLND   9                       0.335     COPY     1     15
PERLND  17                       3.642     COPY     1     13
RCHRES   1                           1     COPY   501     16
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1



<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                 ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG            ***
                                            in  out                          ***
    1     Vault  1                1    1    1    1   28    0    1
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
```

```
    1         1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ****************** PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
    1         4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                         ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *       *  *  *  *  *        ***
    1        0  1  0  0    4  0  0  0  0       0  0  0  0  0       2  2  2  2  2
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50         ***
  <------><--------><--------><--------><--------><--------><-------->         ***
    1             1      0.03       0.0       0.0       0.5       0.0
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                            ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit       for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
    1            0         4.0  0.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
  FTABLE      1
   91    4
     Depth      Area    Volume  Outflow1 Velocity  Travel Time***
      (ft)   (acres) (acre-ft)   (cfs)   (ft/sec)    (Minutes)***
  0.000000  0.228099  0.000000  0.000000
  0.183333  0.228099  0.041818  0.037646
  0.366667  0.228099  0.083636  0.053240
  0.550000  0.228099  0.125455  0.065206
  0.733333  0.228099  0.167273  0.075293
  0.916667  0.228099  0.209091  0.084180
  1.100000  0.228099  0.250909  0.092215
  1.283333  0.228099  0.292727  0.099603
  1.466667  0.228099  0.334545  0.106480
  1.650000  0.228099  0.376364  0.112939
  1.833333  0.228099  0.418182  0.119049
  2.016667  0.228099  0.460000  0.124859
  2.200000  0.228099  0.501818  0.130411
  2.383333  0.228099  0.543636  0.135736
  2.566667  0.228099  0.585455  0.140860
  2.750000  0.228099  0.627273  0.145804
  2.933333  0.228099  0.669091  0.150586
  3.116667  0.228099  0.710909  0.155220
  3.300000  0.228099  0.752727  0.159721
  3.483333  0.228099  0.794545  0.164097
  3.666667  0.228099  0.836364  0.168360
  3.850000  0.228099  0.878182  0.172518
  4.033333  0.228099  0.920000  0.176578
  4.216667  0.228099  0.961818  0.180546
  4.400000  0.228099  1.003636  0.184429
  4.583333  0.228099  1.045455  0.188232
  4.766667  0.228099  1.087273  0.191960
  4.950000  0.228099  1.129091  0.195617
  5.133333  0.228099  1.170909  0.199206
  5.316667  0.228099  1.212727  0.202733
  5.500000  0.228099  1.254545  0.206198
  5.683333  0.228099  1.296364  0.209607
```

```
  5.866667  0.228099  1.338182  0.212961
  6.050000  0.228099  1.380000  0.216263
  6.233333  0.228099  1.421818  0.219515
  6.416667  0.228099  1.463636  0.222720
  6.600000  0.228099  1.505455  0.225879
  6.783333  0.228099  1.547273  0.228995
  6.966667  0.228099  1.589091  0.232069
  7.150000  0.228099  1.630909  0.235102
  7.333333  0.228099  1.672727  0.243052
  7.516667  0.228099  1.714545  0.253687
  7.700000  0.228099  1.756364  0.261140
  7.883333  0.228099  1.798182  0.267591
  8.066667  0.228099  1.840000  0.273479
  8.250000  0.228099  1.881818  0.278990
  8.433333  0.228099  1.923636  0.284220
  8.616667  0.228099  1.965455  0.289230
  8.800000  0.228099  2.007273  0.294058
  8.983333  0.228099  2.049091  0.298734
  9.166667  0.228099  2.090909  0.303277
  9.350000  0.228099  2.132727  0.307704
  9.533333  0.228099  2.174545  0.312027
  9.716667  0.228099  2.216364  0.316256
  9.900000  0.228099  2.258182  0.320401
  10.08333  0.228099  2.300000  0.324467
  10.26667  0.228099  2.341818  0.328461
  10.45000  0.228099  2.383636  0.332388
  10.63333  0.228099  2.425455  0.336252
  10.81667  0.228099  2.467273  0.340057
  11.00000  0.228099  2.509091  0.343807
  11.18333  0.228099  2.550909  0.347505
  11.36667  0.228099  2.592727  0.351153
  11.55000  0.228099  2.634545  0.354754
  11.73333  0.228099  2.676364  0.358310
  11.91667  0.228099  2.718182  0.456737
  12.10000  0.228099  2.760000  0.517497
  12.28333  0.228099  2.801818  0.561917
  12.46667  0.228099  2.843636  0.599012
  12.65000  0.228099  2.885455  0.631676
  12.83333  0.228099  2.927273  0.661281
  13.01667  0.228099  2.969091  0.688608
  13.20000  0.228099  3.010909  0.714149
  13.38333  0.228099  3.052727  0.738242
  13.56667  0.228099  3.094545  0.761128
  13.75000  0.228099  3.136364  0.782987
  13.93333  0.228099  3.178182  0.803957
  14.11667  0.228099  3.220000  0.824149
  14.30000  0.228099  3.261818  0.843650
  14.48333  0.228099  3.303636  0.862534
  14.66667  0.228099  3.345455  0.880861
  14.85000  0.228099  3.387273  0.898681
  15.03333  0.228099  3.429091  0.916039
  15.21667  0.228099  3.470909  0.932971
  15.40000  0.228099  3.512727  0.949510
  15.58333  0.228099  3.554545  0.965686
  15.76667  0.228099  3.596364  0.981522
  15.95000  0.228099  3.638182  0.997041
  16.13333  0.228099  3.680000  1.783729
  16.31667  0.228099  3.721818  3.719001
  16.50000  0.228099  3.763636  5.680979
  END FTABLE  1
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    0.8            PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    0.8            IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.76           PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.76           IMPLND   1 999 EXTNL  PETINP
```

```
END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
RCHRES   1 HYDR   RO      1 1        1      WDM   1000 FLOW     ENGL      REPL
RCHRES   1 HYDR   STAGE   1 1        1      WDM   1001 STAG     ENGL      REPL
COPY     1 OUTPUT MEAN    1 1     48.4      WDM    701 FLOW     ENGL      REPL
COPY   501 OUTPUT MEAN    1 1     48.4      WDM    801 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK        2
PERLND     PWATER SURO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    2

  MASS-LINK        3
PERLND     PWATER IFWO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    3

  MASS-LINK        5
IMPLND     IWATER SURO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    5

  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13

  MASS-LINK       15
IMPLND     IWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   15

  MASS-LINK       16
RCHRES     ROFLOW                          COPY           INPUT  MEAN
  END MASS-LINK   16

END MASS-LINK

END RUN
```

Predeveloped HSPF Message File

Mitigated HSPF Message File

Disclaimer

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CP|H
CONSULTANTS

APPENDIX C

MODULAR WETLAND DETAILS

Site Planning
Civil Engineering
Project Management
Land Use Consulting

July 2017

GENERAL USE LEVEL DESIGNATION FOR BASIC, ENHANCED, AND PHOSPHORUS TREATMENT

For the

MWS-Linear Modular Wetland

Ecology's Decision:

Based on Modular Wetland Systems, Inc. application submissions, including the Technical Evaluation Report, dated April 1, 2014, Ecology hereby issues the following use level designation:

1. General use level designation (GULD) for the MWS-Linear Modular Wetland Stormwater Treatment System for Basic treatment
   - Sized at a hydraulic loading rate of 1 gallon per minute (gpm) per square foot (sq ft) of wetland cell surface area. For moderate pollutant loading rates (low to medium density residential basins), size the Prefilters at 3.0 gpm/sq ft of cartridge surface area. For high loading rates (commercial and industrial basins), size the Prefilters at 2.1 gpm/sq ft of cartridge surface area.
2. General use level designation (GULD) for the MWS-Linear Modular Wetland Stormwater Treatment System for Phosphorus treatment
   - Sized at a hydraulic loading rate of 1 gallon per minute (gpm) per square foot (sq ft) of wetland cell surface area. For moderate pollutant loading rates (low to medium density residential basins), size the Prefilters at 3.0 gpm/sq ft of cartridge surface area. For high loading rates (commercial and industrial basins), size the Prefilters at 2.1 gpm/sq ft of cartridge surface area.
3. General use level designation (GULD) for the MWS-Linear Modular Wetland Stormwater Treatment System for Enhanced treatment
   - Sized at a hydraulic loading rate of 1 gallon per minute (gpm) per square foot (sq ft) of wetland cell surface area. For moderate pollutant loading rates (low to medium density residential basins), size the Prefilters at 3.0 gpm/sq ft of cartridge surface area. For high loading rates (commercial and industrial basins), size the Prefilters at 2.1 gpm/sq ft of cartridge surface area.

4. Ecology approves the MWS - Linear Modular Wetland Stormwater Treatment System units for Basic, Phosphorus, and Enhanced treatment at the hydraulic loading rate listed above. Designers shall calculate the water quality design flow rates using the following procedures:
   - Western Washington: For treatment installed upstream of detention or retention, the water quality design flow rate is the peak 15-minute flow rate as calculated using the latest version of the Western Washington Hydrology Model or other Ecology-approved continuous runoff model.
   - Eastern Washington: For treatment installed upstream of detention or retention, the water quality design flow rate is the peak 15-minute flow rate as calculated using one of the three methods described in Chapter 2.2.5 of the Stormwater Management Manual for Eastern Washington (SWMMEW) or local manual.
   - Entire State: For treatment installed downstream of detention, the water quality design flow rate is the full 2-year release rate of the detention facility.
5. These use level designations have no expiration date but may be revoked or amended by Ecology, and are subject to the conditions specified below.

<u>Ecology's Conditions of Use:</u>

Applicants shall comply with the following conditions:

1. Design, assemble, install, operate, and maintain the MWS – Linear Modular Wetland Stormwater Treatment System units, in accordance with Modular Wetland Systems, Inc. applicable manuals and documents and the Ecology Decision.
2. Each site plan must undergo Modular Wetland Systems, Inc. review and approval before site installation. This ensures that site grading and slope are appropriate for use of a MWS – Linear Modular Wetland Stormwater Treatment System unit.
3. MWS – Linear Modular Wetland Stormwater Treatment System media shall conform to the specifications submitted to, and approved by, Ecology.
4. The applicant tested the MWS – Linear Modular Wetland Stormwater Treatment System with an external bypass weir. This weir limited the depth of water flowing through the media, and therefore the active treatment area, to below the root zone of the plants. This GULD applies to MWS – Linear Modular Wetland Stormwater Treatment Systems whether plants are included in the final product or not.
5. Maintenance: The required maintenance interval for stormwater treatment devices is often dependent upon the degree of pollutant loading from a particular drainage basin. Therefore, Ecology does not endorse or recommend a "one size fits all" maintenance cycle for a particular model/size of manufactured filter treatment device.
   - Typically, Modular Wetland Systems, Inc. designs MWS - Linear Modular Wetland systems for a target prefilter media life of 6 to 12 months.
   - Indications of the need for maintenance include effluent flow decreasing to below the design flow rate or decrease in treatment below required levels.
   - Owners/operators must inspect MWS - Linear Modular Wetland systems for a minimum of twelve months from the start of post-construction operation to determine site-specific

maintenance schedules and requirements. You must conduct inspections monthly during the wet season, and every other month during the dry season. (According to the SWMMWW, the wet season in western Washington is October 1 to April 30. According to SWMMEW, the wet season in eastern Washington is October 1 to June 30). After the first year of operation, owners/operators must conduct inspections based on the findings during the first year of inspections.

- Conduct inspections by qualified personnel, follow manufacturer's guidelines, and use methods capable of determining either a decrease in treated effluent flowrate and/or a decrease in pollutant removal ability.
- When inspections are performed, the following findings typically serve as maintenance triggers:
    - Standing water remains in the vault between rain events, or
    - Bypass occurs during storms smaller than the design storm.
    - If excessive floatables (trash and debris) are present (but no standing water or excessive sedimentation), perform a minor maintenance consisting of gross solids removal, not prefilter media replacement.
    - Additional data collection will be used to create a correlation between pretreatment chamber sediment depth and pre-filter clogging (see *Issues to be Addressed by the Company* section below)

6. Discharges from the MWS - Linear Modular Wetland Stormwater Treatment System units shall not cause or contribute to water quality standards violations in receiving waters.

Applicant:	Modular Wetland Systems, Inc.
Applicant's Address:	*PO. Box 869* *Oceanside, CA 92054*

Application Documents:

- *Original Application for Conditional Use Level Designation*, Modular Wetland System, Linear Stormwater Filtration System Modular Wetland Systems, Inc., January 2011
- *Quality Assurance Project Plan*: Modular Wetland system – Linear Treatment System performance Monitoring Project, draft, January 2011.
- *Revised Application for Conditional Use Level Designation*, Modular Wetland System, Linear Stormwater Filtration System Modular Wetland Systems, Inc., May 2011
- *Memorandum: Modular Wetland System-Linear GULD Application Supplementary Data, April 2014*
- *Technical Evaluation Report: Modular Wetland System Stormwater Treatment System Performance Monitoring, April 2014.*

Applicant's Use Level Request:

General use level designation as a Basic, Enhanced, and Phosphorus treatment device in accordance with Ecology's Guidance for Evaluating Emerging Stormwater Treatment Technologies Technology Assessment Protocol – Ecology (TAPE) January 2011 Revision.

Applicant's Performance Claims:

- The MWS – Linear Modular wetland is capable of removing a minimum of 80-percent of TSS from stormwater with influent concentrations between 100 and 200 mg/l.
- The MWS – Linear Modular wetland is capable of removing a minimum of 50-percent of Total Phosphorus from stormwater with influent concentrations between 0.1 and 0.5 mg/l.
- The MWS – Linear Modular wetland is capable of removing a minimum of 30-percent of dissolved Copper from stormwater with influent concentrations between 0.005 and 0.020 mg/l.
- The MWS – Linear Modular wetland is capable of removing a minimum of 60-percent of dissolved Zinc from stormwater with influent concentrations between 0.02 and 0.30 mg/l.

Ecology Recommendations:

- Modular Wetland Systems, Inc. has shown Ecology, through laboratory and field-testing, that the MWS - Linear Modular Wetland Stormwater Treatment System filter system is capable of attaining Ecology's Basic, Total phosphorus, and Enhanced treatment goals.

Findings of Fact:

<u>Laboratory Testing</u>

The MWS-Linear Modular wetland has the:

- Capability to remove 99 percent of total suspended solids (using Sil-Co-Sil 106) in a quarter-scale model with influent concentrations of 270 mg/L.
- Capability to remove 91 percent of total suspended solids (using Sil-Co-Sil 106) in laboratory conditions with influent concentrations of 84.6 mg/L at a flow rate of 3.0 gpm per square foot of media.
- Capability to remove 93 percent of dissolved Copper in a quarter-scale model with influent concentrations of 0.757 mg/L.
- Capability to remove 79 percent of dissolved Copper in laboratory conditions with influent concentrations of 0.567 mg/L at a flow rate of 3.0 gpm per square foot of media.
- Capability to remove 80.5-percent of dissolved Zinc in a quarter-scale model with influent concentrations of 0.95 mg/L at a flow rate of 3.0 gpm per square foot of media.
- Capability to remove 78-percent of dissolved Zinc in laboratory conditions with influent concentrations of 0.75 mg/L at a flow rate of 3.0 gpm per square foot of media.

Field Testing

- Modular Wetland Systems, Inc. conducted monitoring of an MWS-Linear (Model # MWS-L-4-13) from April 2012 through May 2013, at a transportation maintenance facility in Portland, Oregon. The manufacturer collected flow-weighted composite samples of the system's influent and effluent during 28 separate storm events. The system treated approximately 75 percent of the runoff from 53.5 inches of rainfall during the monitoring period. The applicant sized the system at 1 gpm/sq ft. (wetland media) and 3gpm/sq ft. (prefilter).
- Influent TSS concentrations for qualifying sampled storm events ranged from 20 to 339 mg/L. Average TSS removal for influent concentrations greater than 100 mg/L (n=7) averaged 85 percent. For influent concentrations in the range of 20-100 mg/L (n=18), the upper 95 percent confidence interval about the mean effluent concentration was 12.8 mg/L.
- Total phosphorus removal for 17 events with influent TP concentrations in the range of 0.1 to 0.5 mg/L averaged 65 percent. A bootstrap estimate of the lower 95 percent confidence limit (LCL95) of the mean total phosphorus reduction was 58 percent.
- The lower 95 percent confidence limit of the mean percent removal was 60.5 percent for dissolved zinc for influent concentrations in the range of 0.02 to 0.3 mg/L (n=11). The lower 95 percent confidence limit of the mean percent removal was 32.5 percent for dissolved copper for influent concentrations in the range of 0.005 to 0.02 mg/L (n=14) at flow rates up to 28 gpm (design flow rate 41 gpm). Laboratory test data augmented the data set, showing dissolved copper removal at the design flow rate of 41 gpm (93 percent reduction in influent dissolved copper of 0.757 mg/L).

Issues to be addressed by the Company:

1. Modular Wetland Systems, Inc. should collect maintenance and inspection data for the first year on all installations in the Northwest in order to assess standard maintenance requirements for various land uses in the region. Modular Wetland Systems, Inc. should use these data to establish required maintenance cycles.
2. Modular Wetland Systems, Inc. should collect pre-treatment chamber sediment depth data for the first year of operation for all installations in the Northwest. Modular Wetland Systems, Inc. will use these data to create a correlation between sediment depth and pre-filter clogging.

Technology Description:
Download at http://www.modularwetlands.com/

Contact Information:
Applicant: Zach Kent
BioClean A Forterra Company.
398 Vi9a El Centro
Oceanside, CA 92058
zach.kent@forterrabp.com

Applicant website: http://www.modularwetlands.com/

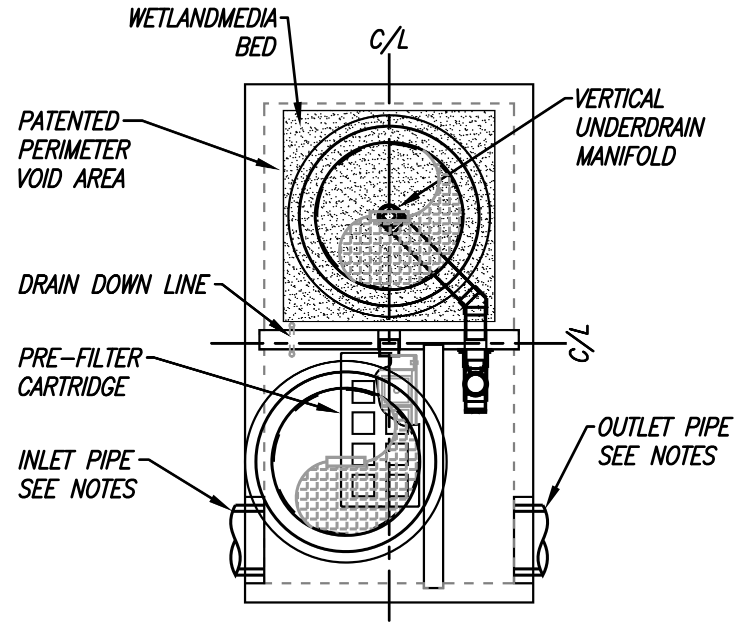
Ecology web link: http://www.ecy.wa.gov/programs/wg/stormwater/newtech/index.html

Ecology: Douglas C. Howie, P.E.
Department of Ecology
Water Quality Program
(360) 407-6444
douglas.howie@ecy.wa.gov

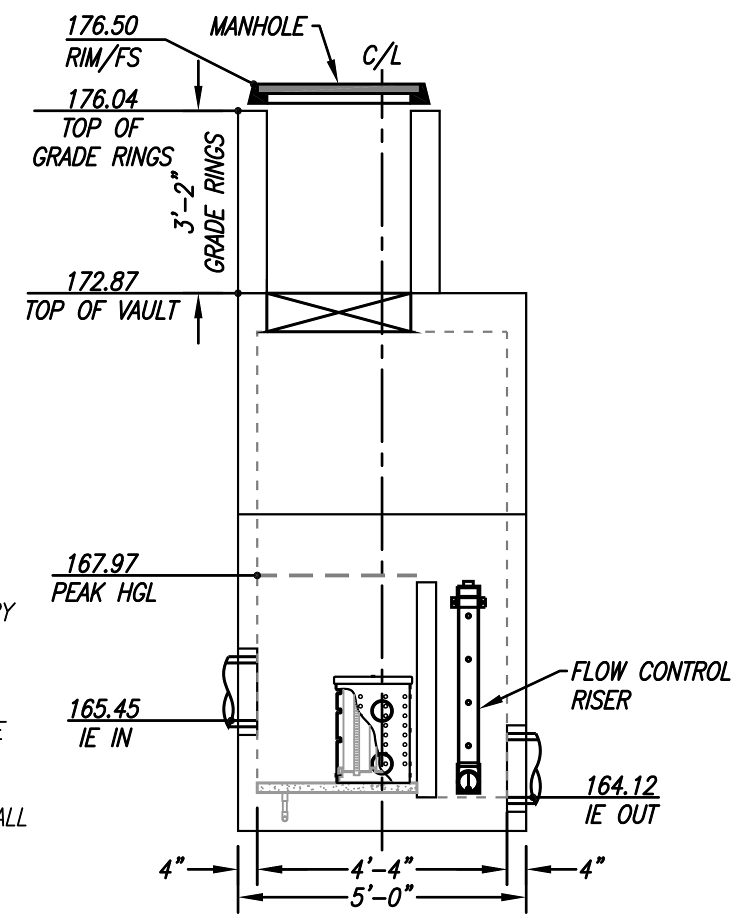
Revision History

Date	Revision
June 2011	Original use-level-designation document
September 2012	Revised dates for TER and expiration
January 2013	Modified Design Storm Description, added Revision Table, added maintenance discussion, modified format in accordance with Ecology standard
December 2013	Updated name of Applicant
April 2014	Approved GULD designation for Basic, Phosphorus, and Enhanced treatment
December 2015	Updated GULD to document the acceptance of MWS-Linear Modular Wetland installations with or without the inclusion of plants
July 2017	Revised Manufacturer Contact Information (name, address, and email)

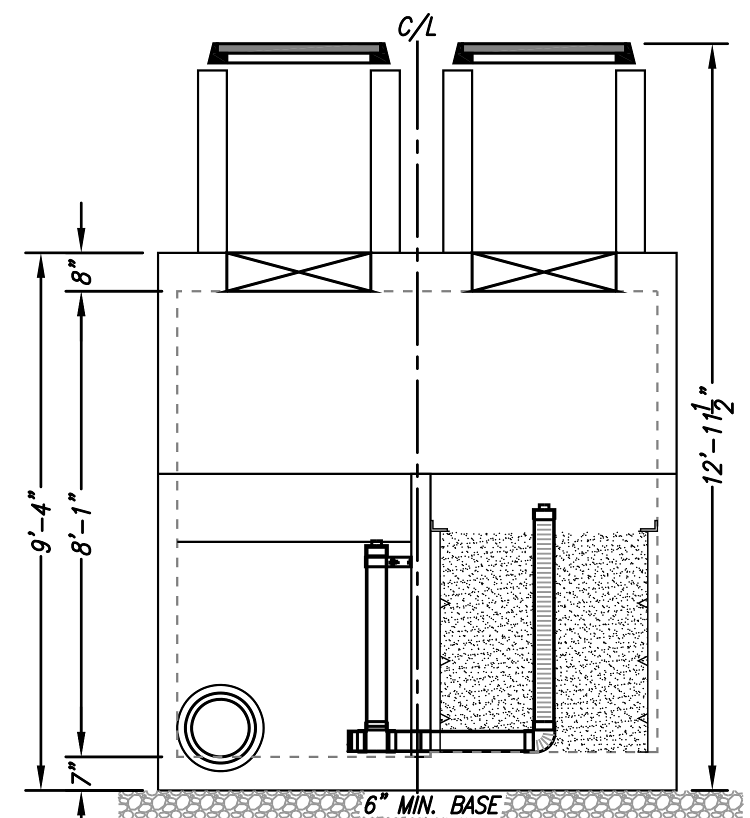
SITE SPECIFIC DATA			
PROJECT NUMBER	10291		
PROJECT NAME	JOHNSON RIDGE		
PROJECT LOCATION	POULSBO, WA		
TREATMENT REQUIRED			
VOLUME BASED (CF)	2-YEAR RELEASE RATE (CFS)		
	0.1161		
PEAK BYPASS REQUIRED (CFS) – IF APPLICABLE			0.5005
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE	165.45	LCPE	12"
OUTLET PIPE	164.12	LCPE	12"
	PRETREATMENT	BIOFILTRATION	DISCHARGE
RIM ELEVATION	176.50	176.50	176.50
SURFACE LOAD	PEDESTRIAN	PEDESTRIAN	PEDESTRIAN
FRAME & COVER	ø30"	ø30"	N/A
WETLANDMEDIA VOLUME (CY)			1.91
ORIFICE SIZE (DIA. INCHES)			5 EA ø0.85"
NOTES:			



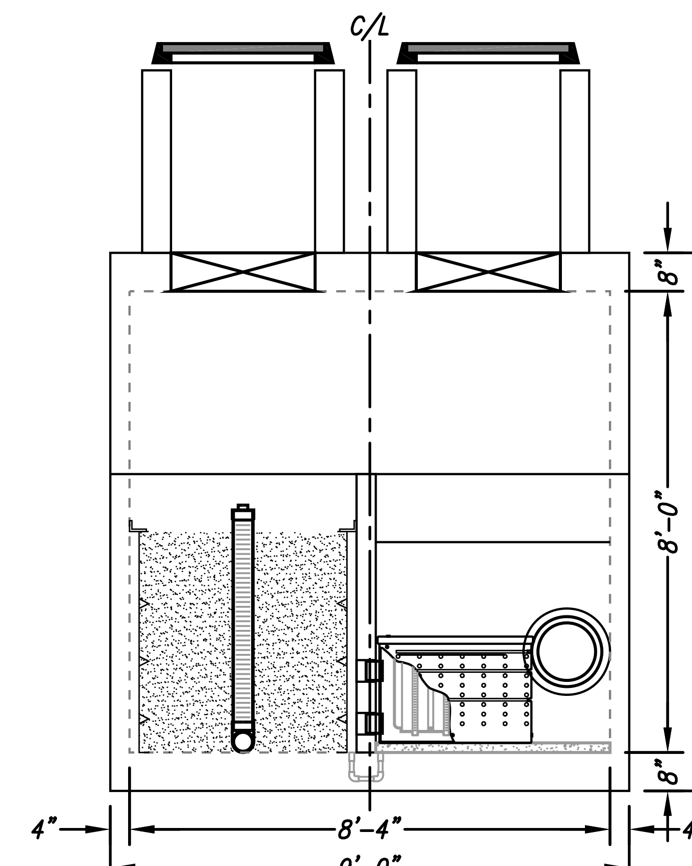
PLAN VIEW



ELEVATION VIEW



RIGHT END VIEW



LEFT END VIEW

INSTALLATION NOTES

1. CONTRACTOR TO PROVIDE ALL LABOR, EQUIPMENT, MATERIALS AND INCIDENTALS REQUIRED TO OFFLOAD AND INSTALL THE SYSTEM AND APPURTENANCES IN ACCORDANCE WITH THIS DRAWING AND THE MANUFACTURERS SPECIFICATIONS, UNLESS OTHERWISE STATED IN MANUFACTURERS CONTRACT.
2. UNIT MUST BE INSTALLED ON LEVEL BASE. MANUFACTURER RECOMMENDS A MINIMUM 6" LEVEL ROCK BASE UNLESS SPECIFIED BY THE PROJECT ENGINEER. CONTRACTOR IS RESPONSIBLE TO VERIFY PROJECT ENGINEERS RECOMMENDED BASE SPECIFICATIONS.
3. ALL PIPES MUST BE FLUSH WITH INSIDE SURFACE OF CONCRETE. (PIPES CANNOT INTRUDE BEYOND FLUSH). INVERT OF OUTFLOW PIPE MUST BE FLUSH WITH DISCHARGE CHAMBER FLOOR. ALL GAPS AROUND PIPES SHALL BE SEALED WATER TIGHT WITH A NON-SHRINK GROUT PER MANUFACTURERS STANDARD CONNECTION DETAIL AND SHALL MEET OR EXCEED REGIONAL PIPE CONNECTION STANDARDS.
4. CONTRACTOR TO SUPPLY AND INSTALL ALL EXTERNAL CONNECTING PIPES.
5. CONTRACTOR RESPONSIBLE FOR INSTALLATION OF ALL RISERS, MANHOLES, AND HATCHES. CONTRACTOR TO GROUT ALL MANHOLES AND HATCHES TO MATCH FINISHED SURFACE UNLESS SPECIFIED OTHERWISE.
6. DRIP OR SPRAY IRRIGATION REQUIRED ON ALL UNITS WITH VEGETATION.
7. CONTRACTOR RESPONSIBLE FOR CONTACTING MODULAR WETLANDS FOR ACTIVATION OF UNIT. MANUFACTURES WARRANTY IS VOID WITH OUT PROPER ACTIVATION BY A MODULAR WETLANDS REPRESENTATIVE.

GENERAL NOTES

1. MANUFACTURER TO PROVIDE ALL MATERIALS UNLESS OTHERWISE NOTED.
2. ALL DIMENSIONS, ELEVATIONS, SPECIFICATIONS AND CAPACITIES ARE SUBJECT TO CHANGE. FOR PROJECT SPECIFIC DRAWINGS DETAILING EXACT DIMENSIONS, WEIGHTS AND ACCESSORIES PLEASE CONTACT MANUFACTURER.

INTERNAL BYPASS DISCLOSURE:

THE DESIGN AND CAPACITY OF THE PEAK CONVEYANCE METHOD TO BE REVIEWED AND APPROVED BY THE ENGINEER OF RECORD. HGL(S) AT PEAK FLOW SHALL BE ASSESSED TO ENSURE NO UPSTREAM FLOODING. PEAK HGL AND BYPASS CAPACITY SHOWN ON DRAWING ARE USED FOR GUIDANCE ONLY.

2-YEAR RELEASE RATE (CFS)	0.1161
OPERATING HEAD (FT)	3.5
PRETREATMENT LOADING RATE (GPM/SF)	2.0
WETLAND MEDIA LOADING RATE (GPM/SF)	1.0

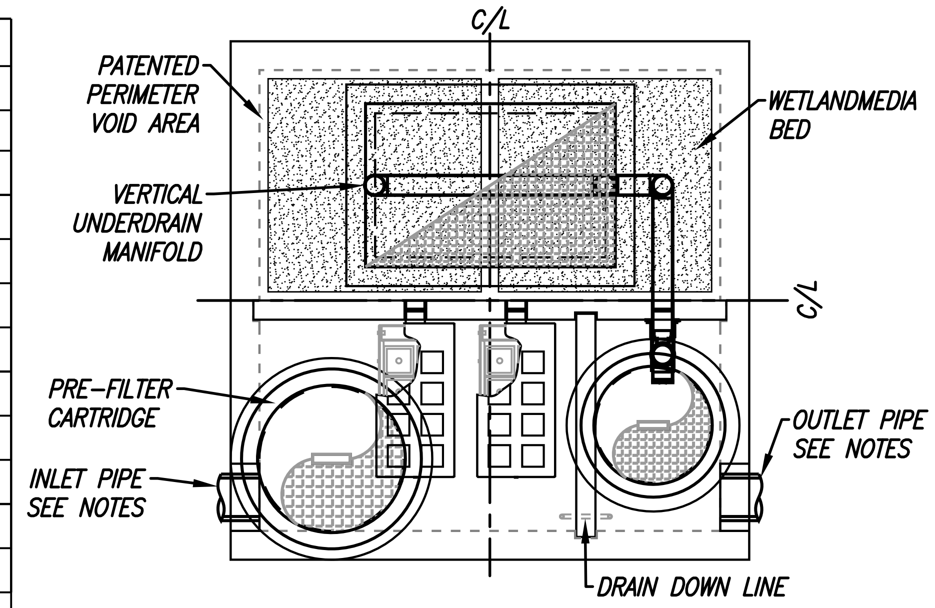
Bio Clean
A Forterra Company

MWS-L-4-8-8'-0"-V-UG
STORMWATER BIOFILTRATION SYSTEM
STANDARD DETAIL

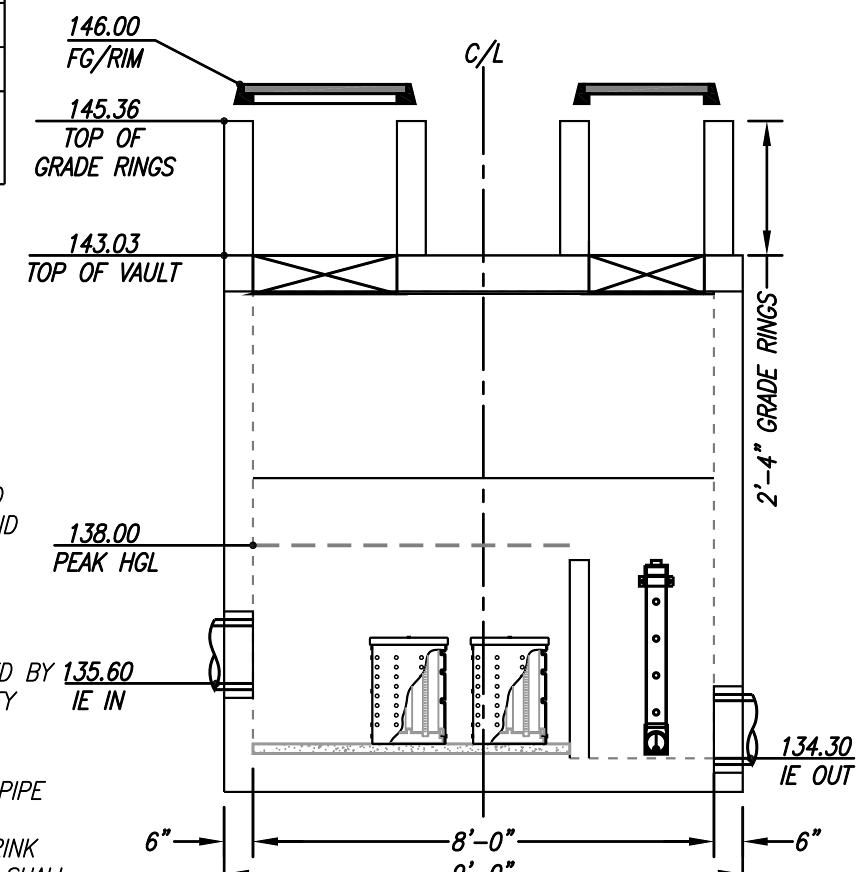
1/15/20ASPOLAR

SITE SPECIFIC DATA

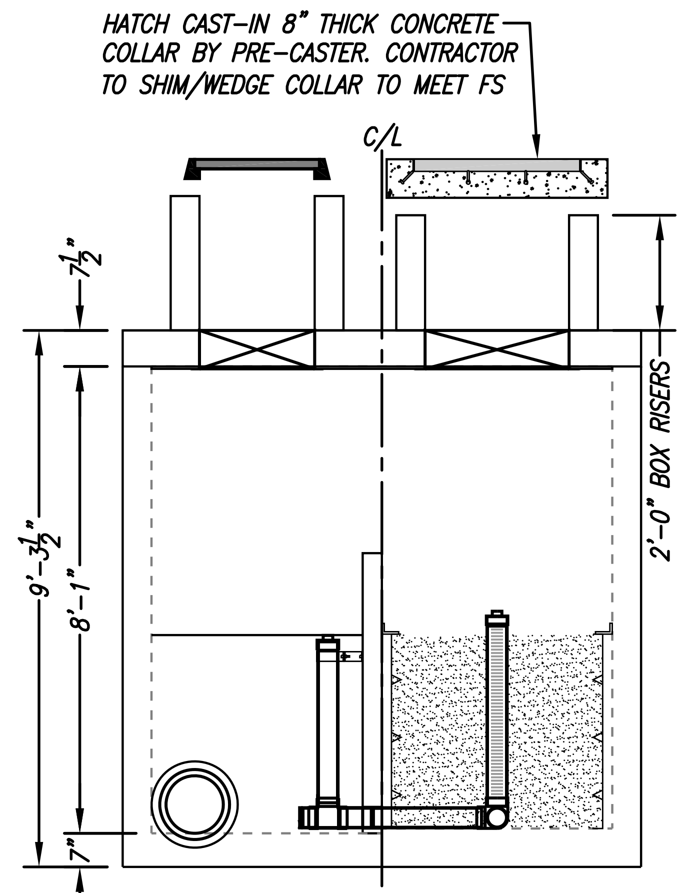
PROJECT NUMBER	10291		
PROJECT NAME	JOHNSON RIDGE		
PROJECT LOCATION	POULSBO, WA		
TREATMENT REQUIRED			
VOLUME BASED (CF)		2-YEAR RELEASE RATE (CFS)	
		0.2096	
PEAK BYPASS REQUIRED (CFS) - IF APPLICABLE			1.54741
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE	135.60	LCPE	12"
OUTLET PIPE	134.30	LCPE	12"
	PRETREATMENT	BIOFILTRATION	DISCHARGE
RIM ELEVATION	146.00	146.00	146.00
SURFACE LOAD	PEDESTRIAN	PEDESTRIAN	PEDESTRIAN
FRAME & COVER	ø30"	30" X 48"	ø24"
WETLANDMEDIA VOLUME (CY)			3.35
ORIFICE SIZE (DIA. INCHES)			5 EA ø1.15"
NOTES:			



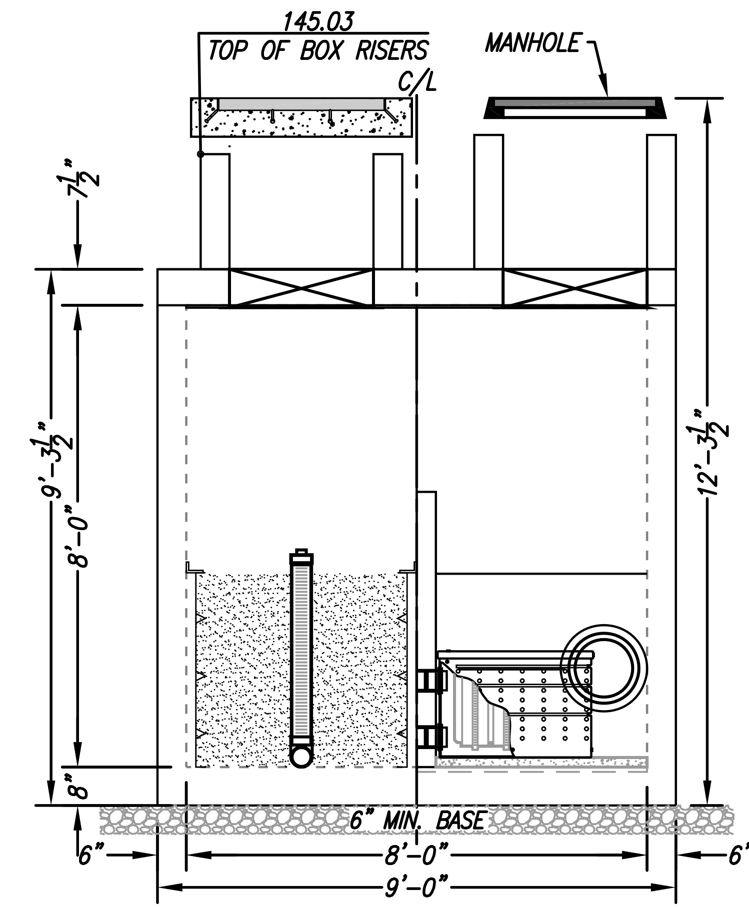
PLAN VIEW



ELEVATION VIEW



RIGHT END VIEW



LEFT END VIEW

INSTALLATION NOTES

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2-YEAR RELEASE RATE (CFS)	0.2096
OPERATING HEAD (FT)	3.2
PRETREATMENT LOADING RATE (GPM/SF)	1.8
WETLAND MEDIA LOADING RATE (GPM/SF)	1.0

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MWS-L-8-8-8'-0"-V-UG
STORMWATER BIOFILTRATION SYSTEM
STANDARD DETAIL

CP|H CONSULTANTS

APPENDIX D

CONVEYANCE CALCULATIONS

Conveyance calculations will be provided with final engineering.

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APPENDIX E

O&M MANUAL

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APPENDIX F

DOWNSTREAM DRAINAGE ANALYSIS

OFFSITE DRAINAGE ANALYSIS

FOR

JOHNSON RIDGE

POULSBO, WA

TABLE OF CONTENTS

INTRODUCTION

This Offsite Drainage Analysis is provided as a qualitative investigation of the storm drainage conditions upstream and downstream of the proposed *Johnson Ridge* project. The proposed development consists of 61 single-family attached residences; public roads, sidewalks, and associated utilities over an approximately 13.7-acre site within the City of Poulsbo.

The project is located in the southwestern portion of the City of Poulsbo. The vicinity map provided below as Figure 1 illustrates the general location of the property. The site is located at 17504 Johnson Road NE, Poulsbo WA, Kitsap County, 98370. More generally the site is located in a portion of the NW ¼, Section 25, Township 26 North, Range 1 East, W.M., Kitsap County, Washington. (see Vicinity Map below).

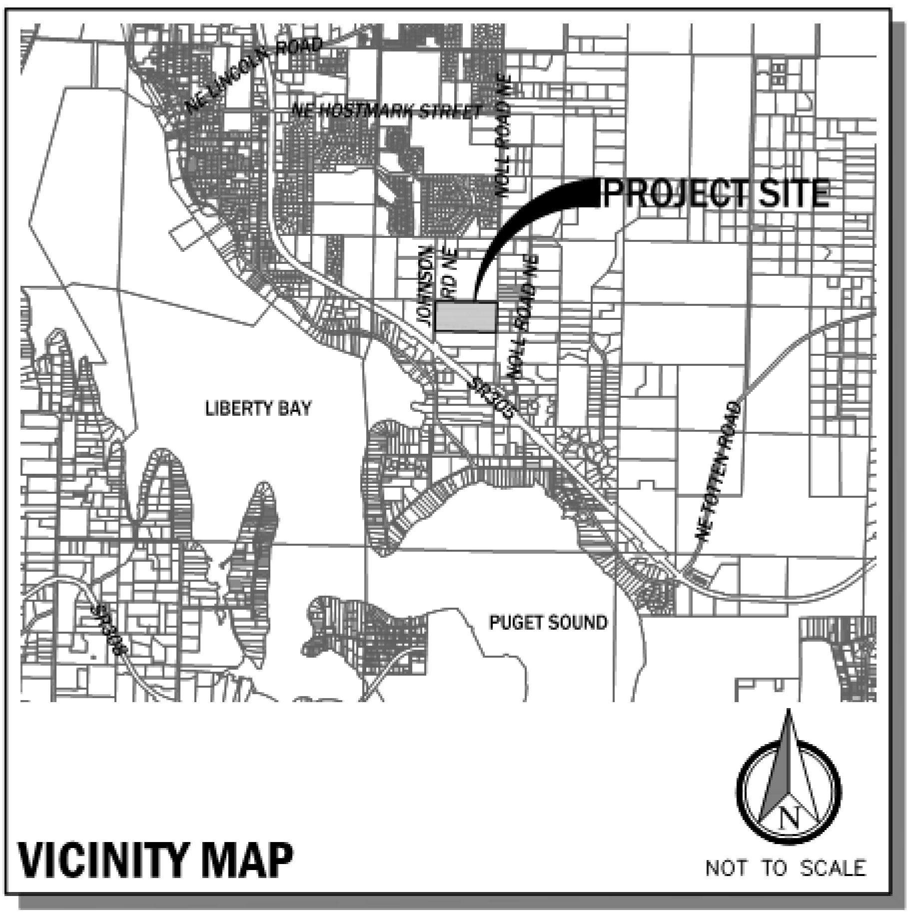


Figure 1– Location/Vicinity Map

TASK 1 – DEFINE AND MAP THE STUDY AREA

Existing Site Conditions

The project site is comprised of a single tax parcel (Kitsap County tax parcel no. 252601-2-004-2008) totaling approximately 13.7 acres adjacent to the east side of Johnson Road. It currently contains areas of trees, cleared areas that are now pasture/grass and shrubs. A single-family residence and several outbuildings used to exist on the property but have since been removed. The property is currently vacant.

A number of trees of varying type, age, and health conditions exist on portions of the site. The site and surrounding parcels are zoned RL in Poulsbo, Washington. The project site generally slopes toward Johnson Rd NE in the southwest and toward Bjorgen Creek in the northeast. The soils of the area are characterized generally by the Natural Resource Conservation Services (NCRS) as Poulsbo gravelly sandy loam with slopes ranging from 0% to 30%. The existing site is comprised of two drainage basins and the existing site conditions are represented in Figure 2.

Developed Site Conditions

The proposed preliminary PRD subdivision project will create a total of 61 single-family detached residences. Total site impervious coverage for proposed individual lots is limited to 50% by the zoning designation. The proposed site plan is shown in Figure 4.

Stormwater runoff generated by new impervious surfaces will be collected by a series of roof drains and catch basins along the proposed road. Runoff in the east basin will be conveyed to a Modular Wetland water quality treatment facility and underground detention vault to meet basic water quality and flow control standards. Runoff in the west basin will also be conveyed to a Modular Wetland water quality treatment facility and underground detention vault to meet water quality standards and flow control. The developed site conditions are shown in Figure 3.

TASK 2 – REVIEW ALL AVAILABLE INFORMATION ON THE STUDY AREA

Kitsap County GIS Data in additional to other available reports/resources from the City were reviewed to identify any potential sensitive areas on or in the proximity of the project site. The following is a summary of those findings:

- WETLANDS: There are no wetlands on the project site. There is an offsite wetland north of the site opposite the City's proposed Johnson Parkway improvements. The rating of this wetland along with any required impacts and mitigation measures are not known as those would be attributed to the City's project. This wetland is not affected by any of this project's improvements.
- STREAMS AND 100-YEAR FLOODPLAIN: Bjorgen Creek, a Type F1 stream, exists along the eastern boundary of the project site. This stream has a 200-foot standard buffer which is being maintained by the project.

The soils of the area are characterized generally by the Natural Resource Conservation Services (NCRS) as Poulsbo gravelly sandy loam with slopes ranging from 0% to 30%. The NRCS soils summary has been provided in Appendix A of this report.

TASK 3 – FIELD INSPECT THE STUDY AREA

A field inspection was performed on July 17, 2019 on a cloudy day with a temperature of approximately 65 degrees. It was raining slightly at the time of the inspection. Photos taken during the field inspection are provided in Appendix B.

Onsite Drainage Basin
The existing topography of the site has slopes ranging from 0% to 30%. Due to topography, the project site is comprised of two drainage basins with surface runoff traveling primarily as sheet flow away from a knoll and ridge running northwest to southeast across the site. The east basin slopes away from the ridge towards Bjorgen Creek in the east. Bjorgen Creek creates a ravine area containing steep slopes up to 30%. The west basin slopes southwest towards Johnson Rd NE with runoff entering the existing drainage system. The drainage basins are comprised of grass, pasture, and shrubs with numerous trees. Existing structures onsite have been demolished sometime before.

Downstream Drainage Basin
Runoff from the project site flows offsite east into Bjorgen Creek and west into the drainage system of Johnson Rd NE. The drainage system along Johnson Rd NE flows south for approximately 0.3 miles before discharging to Liberty Bay. Bjorgen Creek flows south approximately 0.8 miles before also discharging to Liberty Bay. The soils are categorized as Poulsbo gravelly sandy loam with slopes ranging from 0% to 30%. No water pooling or concentration was observed at the time of inspection. No running water was observed at any point in Bjorgen Creek and the stream bed appeared overgrown. A downstream map and photos are attached in Appendix D.

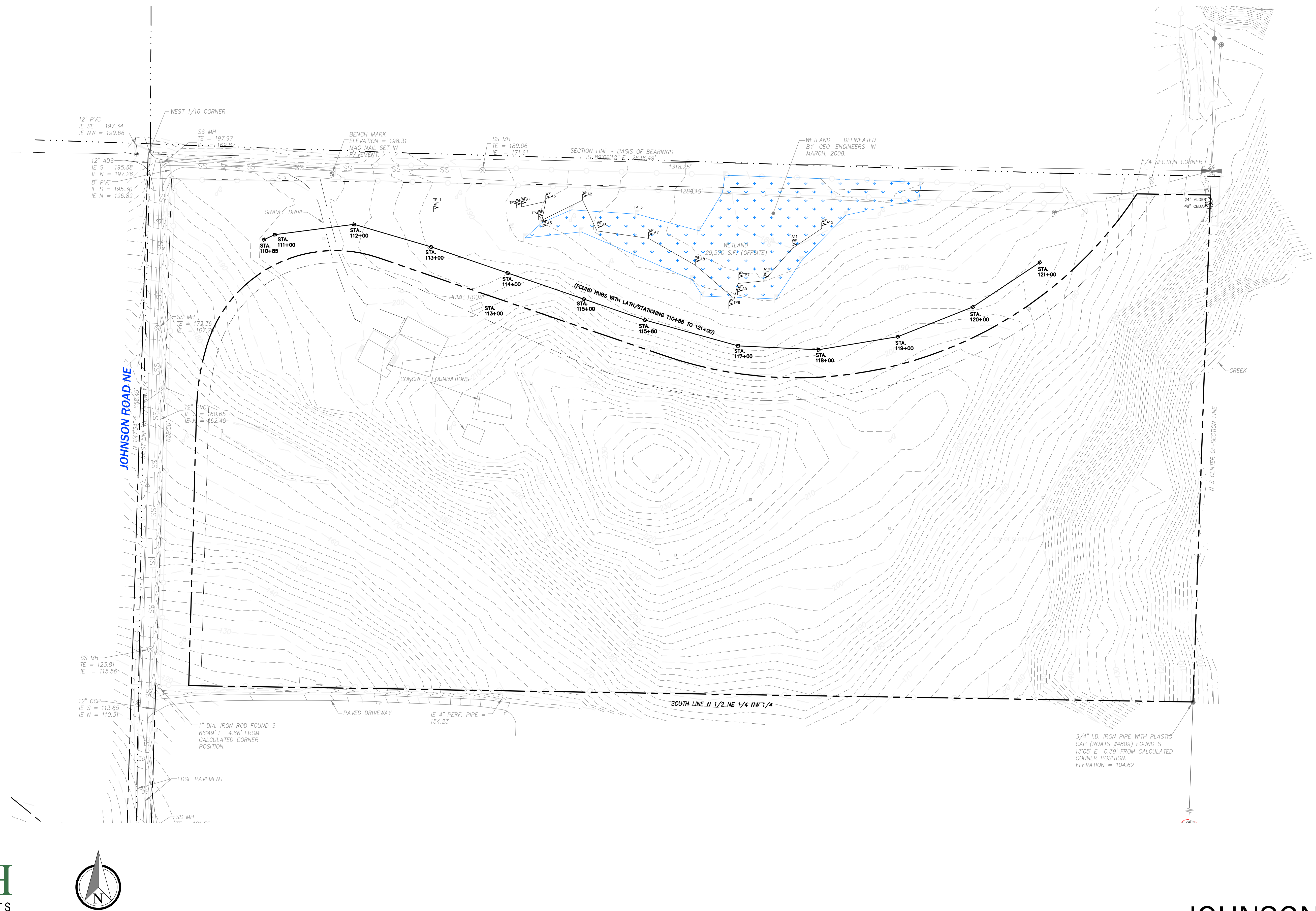
Upstream Drainage Basin
The project site is currently bordered by a single-family residences to the north and south, with Johnson Rd NE and Bjorgen Creek to the west and east, respectively. The proposed Noll Road project will be adjacent to the north of the Johnson Ridge project site when completed. Due to the topography of the site it is unlikely that any offsite runoff could reach the project site. The knoll and ridge located in the center of the project site form a high point, creating no upstream basins.

TASK 4 – DESCRIBE THE DRAINAGE SYSTEM, AND ITS EXISTING AND PREDICTED DRAINAGE AND WATER QUALITY PROBLEMS

The proposed stormwater collection and conveyance systems supporting this project will comply with 2012 Department of Ecology Stormwater Management Manual for Western Washington, as amended in December 2014, as specified by current Poulsbo Municipal Code (PMC), section 12.02.030. The site is planned to be improved with roadway, storm drainage, and utility infrastructure in support of 61 single-family attached residences.

The project proposes to collect on-site runoff from the east basin and convey it to the water quality treatment facility and stormwater detention vault prior to release via a level-spreader towards Bjorgen Creek. Bjorgen Creek was dry at the time of site visit with no indication of potential problems. Runoff from the west basin will be collected and conveyed through a Modular Wetland water quality treatment facility before entering a stormwater detention vault that discharges to the storm drainage system of Johnson Road NE. Surface runoff will be collected by roof drains, roadway and yard inlets, and a system of below grade pipes on the site. Basic water quality standards will be met for both basins. Runoff will enter the proposed drainage system of the Noll Road project and discharge via the proposed outfall to Liberty Bay. No problems are predicted with this plan.

FIGURES

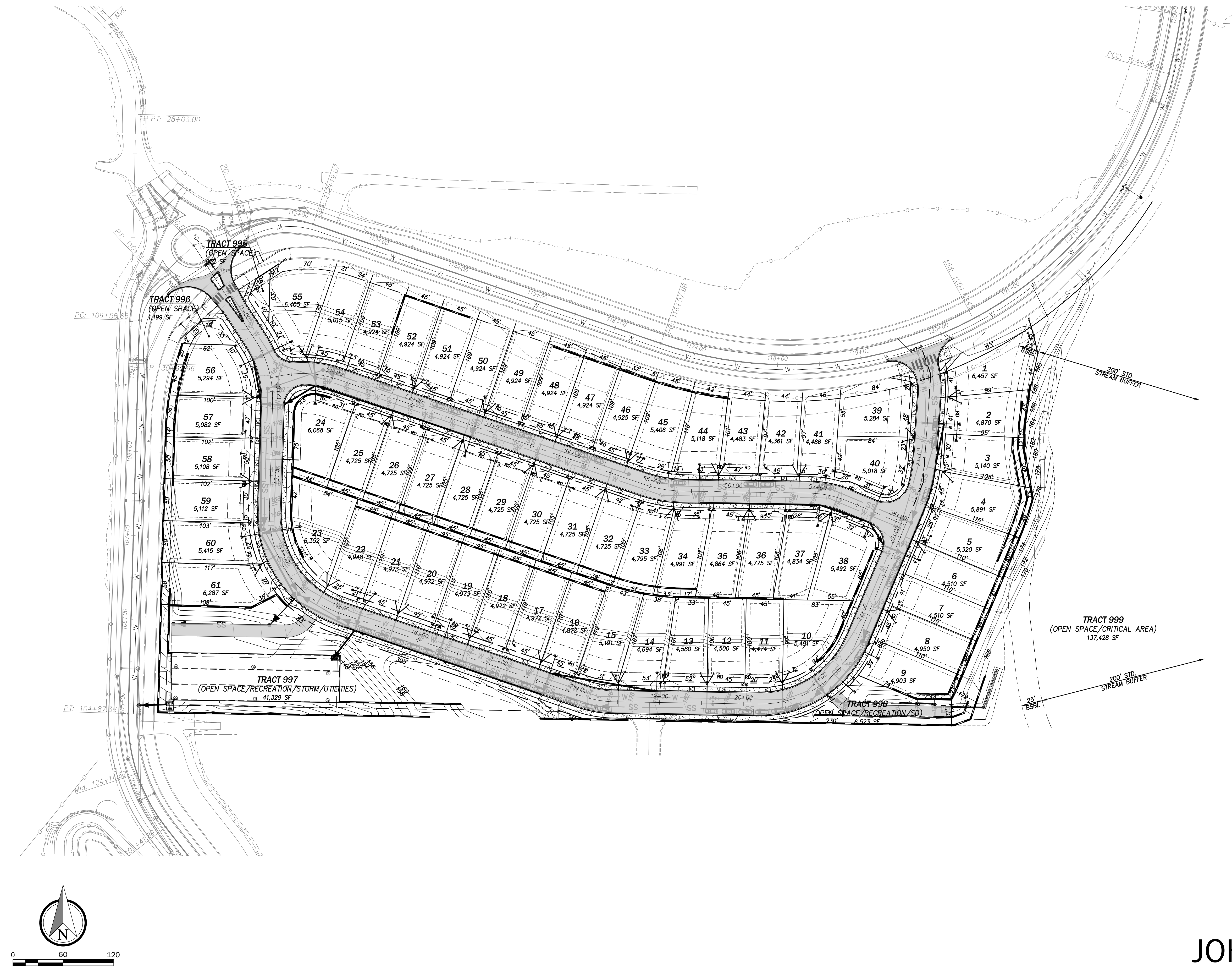


CPH CONSULTANTS

Site Planning • Civil Engineering
Land Use Consulting • Project Management
11431 Willows Rd. NE, Suite 120
Redmond, WA 98052
Phone: (425) 285-2390 | FAX: (425) 285-2389
www.cphconsultants.com

JOHNSON RIDGE

FIGURE 2 - EXISTING CONDITIONS



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P:\project\0174\18002\Reports\TIR\CAD\Figure 3 developed conditions.dwg
2/10/2020 10:38 AM ANNA STARR

JOHNSON RIDGE

FIGURE 3 - Developed Site Conditions

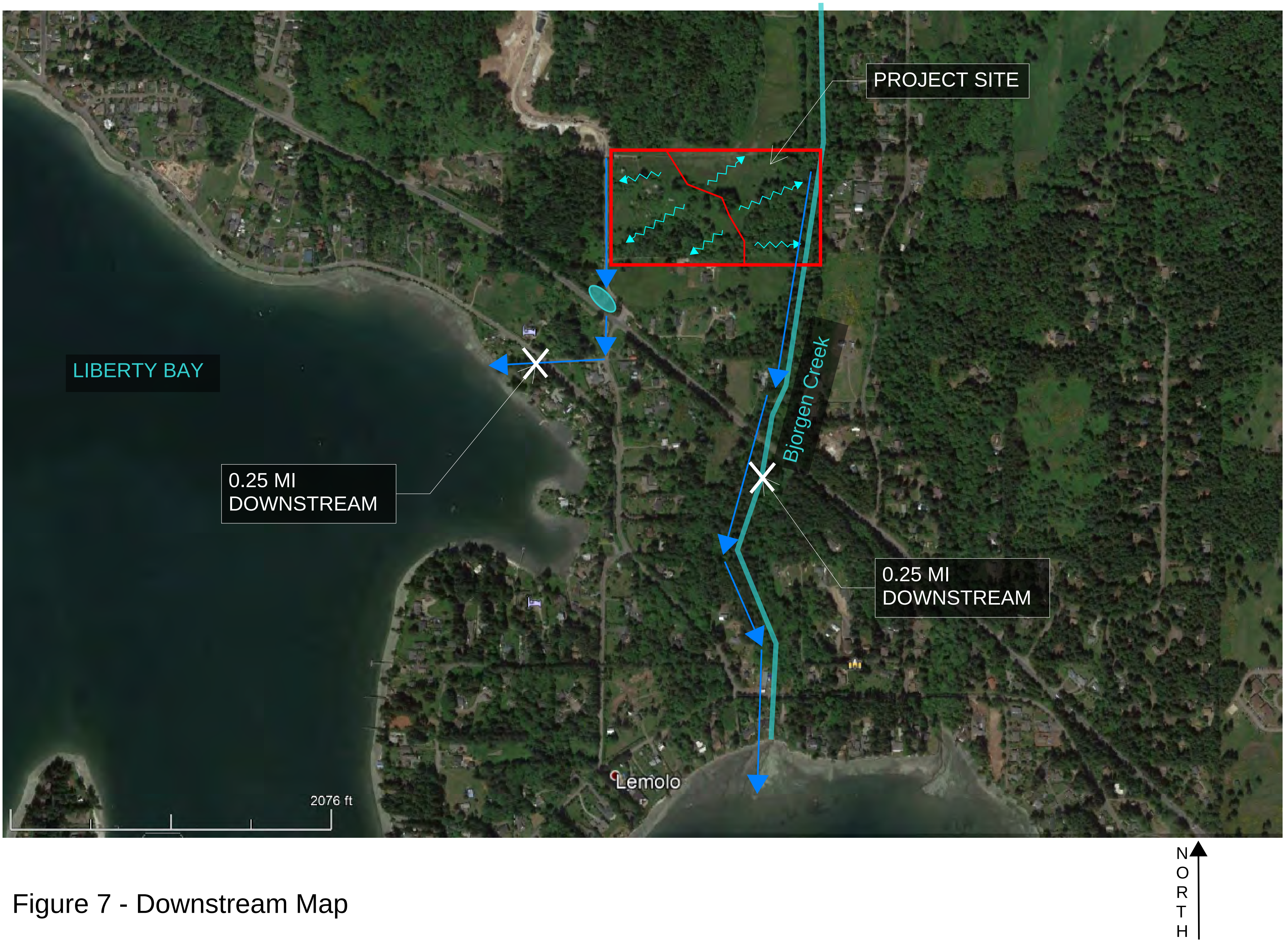

Figure 7 - Downstream Map

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CONSULTANTS

APPENDIX A

NRCS SOILS REPORT

Map Scale: 1:2,260 if printed on A landscape (11" x 8.5") sheet.

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Kitsap County Area, Washington
Survey Area Data: Version 14, Sep 10, 2018

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 29, 2016—Sep 27, 2016

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
32	McKenna gravelly loam	1.6	7.5%
39	Poulsbo gravelly sandy loam, 0 to 6 percent slopes	1.5	6.8%
40	Poulsbo gravelly sandy loam, 6 to 15 percent slopes	14.9	70.1%
41	Poulsbo gravelly sandy loam, 15 to 30 percent slopes	3.3	15.6%
Totals for Area of Interest		**21.3**	**100.0%**

CPH CONSULTANTS

APPENDIX B

PHOTOS

Site Planning
Civil Engineering
Land Use Consulting
Project Management

Photo 1: Northwest corner of the property, looking south along Johnson Rd NE

Photo 2: North boundary of the property, looking south across project site. Pasture, trees, shrubs and blackberry bushes cover the site.

Photo 3: Center of the property, looking south across project site. Pasture, trees, shrubs and blackberry bushes cover the site.

Photo 4: Looking east towards the knoll and ridge that separates the two drainage basins.

Photo 5: southwest corner of the property, looking east along the adjacent property's access.

Photo 6: Looking east towards Bjorgen Creek where steep slopes are present on site.

Photo 7: Approximately 0.25 mi downstream where Bjorgen Creek crosses SR-305. No running water observed.

Photo 8: Approximately 0.25 mi downstream where Bjorgen Creek crosses SR-305. No running water observed.

Photo 9: Approximately 0.25 mi downstream where the proposed drainage system of the Noll Road project will outfall.

Photo 10: Liberty Bay where the west basin of the project site will have a direct discharge.

EXHIBIT H.2

Peer Review Preliminary Stormwater Plan
Prepared by BHC Consultants

BHC CONSULTANTS
Engineers Planners

BHC Consultants, LLC
1601 Fifth Avenue, Suite 500
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March 11, 2020

Michael Bateman, PE
City of Poulsbo Engineering Department
200 NE Moe St, Poulsbo, WA 98370
Ph: 360-394-9744 Fax: 360-697-8269

Re: Johnson Ridge Preliminary Stormwater Site Plan – Peer Review

Dear Mr. Bateman:

BHC Consultants, LLC (BHC) is under contract with the City of Poulsbo (City) to assist in the review of the following documents prepared by CPH Consultants for Johnson Ridge development project:

- Preliminary Stormwater Site Plan, dated February 10, 2020
- Stormwater sheets (sheets 6 to 10) of the Preliminary Subdivision and PRD Application Plans, dated February 15, 2020

The purpose of this review is to evaluate the above documents for conformance with the following:

- 2012 Stormwater Management Manual for Western Washington, as amended in December 2014 (SMMWW)
- Poulsbo Municipal Code (PMC), Section 13.17

This letter provides comments on the documents where revisions or clarifications are needed to demonstrate conformance with the requirements listed above.

Preliminary Stormwater Site Plan:

1. Section 2 – Conditions and Requirements Summary (Page 4) – SMMWW Volume I, Chapter 3, Page 77 provides guidance on preparation of erosion and sediment control plan. Please prepare and provide an erosion and sediment control plan for review.
2. Section 2 – Conditions and Requirements Summary (Page 4) – The total basin areas in predeveloped and developed conditions shall remain approximately the same because the basins will not meet discharge at the natural location minimum requirement if the basin areas change. The Plan shows that there is a change in the areas for both the basins. The total basin area for East basin is 8.375 and 6.566 acres in predeveloped and developed conditions, respectively. Similarly, the total basin area for West basin is 5.366 and 7.284 acres in predeveloped and developed conditions, respectively. Please revisit the site plan and evaluate if the basin areas can be adjusted to approximately match with the predeveloped conditions and/or provide additional information to describe how the downstream receiving waterbodies are being considered and why an

exception/variance to the SMMWW should be considered. Please refer to SMMWW Volume I, Chapter 2, Page 74 for information on exceptions/variances.

3. Section 2 – Conditions and Requirements Summary (Page 4), Runoff Treatment – There is a discrepancy in the text described in this section and in Appendix F. Please verify and correct the conflicting statement and confirm that modular wetlands will be used for water quality treatment.

4. Section 2 – Conditions and Requirements Summary (Page 4), Flow Control – There is a discrepancy between the text described in this section and Appendix F, Task 4. In Appendix F, Task 4, it was stated that runoff from the West basin is exempt from flow control and will be direct discharged to Liberty Bay, while Flow Control is required for the East basin. Please correct the discrepancy and confirm that detention facilities will be provided for both East and West basins.

5. Section 2 – Conditions and Requirements Summary (Page 4), Wetlands Protection and Section 3 – Existing Site Conditions (Page 5) – State clearly what category the wetlands have been determined to be, and how far the project is from the wetland buffer on the north. And state why no protection or mitigation is proposed. State clearly what type of creek Bjorgen Creek has been determined to be, and the dimension of the creek buffer. State why no creek protection or mitigation is proposed.

6. Section 2 – Conditions and Requirements Summary (Page 4), Operations and Maintenance – Is there an agreement for the maintenance of the detention vaults? State clearly who will be responsible for maintaining the water quality treatment units.

7. Section 3 – Existing Site Conditions (Page 5) – Describe the existing downstream drainage conveyance system (outfalls, pipe types and sizes, capacity issues, etc.) for both East and West basins either in this section or in Appendix F. This is required for the up and downstream analyses in order to conform with Volume I, Chapter 2, Page 73 of the SMMWW.

8. Section 6 – Developed Site Conditions (Page 10), Table 6.2 – SMMWW Volume I, Chapter 3, Page 86 requires totals of new pollution-generating hard surfaces and replaced pollution-generating hard surfaces. Revise the table to provide those totals for both East and West basins.

9. Section 6 – Developed Site Conditions (Page 10), Table 6.2 – Total area for the East basin is incorrect and does not include 3.03 acres of the site that will remain undeveloped. Please correct the area.

10. Section 6 – Developed Site Conditions (Page 10), Table 6.5 – The peak design flows provided in this table do not match the Western Washington Hydrology Model (WWHM) output results provided as Appendix B. Please verify and correct the design flows provided on the table.

11. Section 6 – Developed Site Conditions (Page 10), Flow Control – SMMWW Volume III Chapter 3, Page 460 requires a geotechnical engineer or a licensed geologist, hydrogeologist, or engineering geologist evaluate runoff discharged towards landslide hazard areas. Please conduct the appropriate review, especially as related to the location and performance of the level spreader, and present the evaluation for review by

the City. If it is already been reviewed and approved by the City, please provide the approval evidence as an appendix to the stormwater site plan report.

12. Section 6 – Developed Site Conditions (Page 11), Table 6.6a and 6.6b – Both table titles refer to East vault. Please correct the table titles.

13. Section 6 – Developed Site Conditions (Page 11), Table 6.6a and 6.6b – Provide vault sizes/dimensions in the tables. Update the table to match with the Preliminary Subdivision and PRD Application Plans.

14. Section 6 – Developed Site Conditions (Page 11), Water Quality – Describe how basic water quality treatment was selected for the project. SMMWW Volume V, Chapter 2, Page 773, provides a treatment facility selection process for the water quality facility selection. It is a step-by-step procedure; please follow this process to document how the water quality treatment best management practice (BMP) was selected for the project. If this process was followed, please clearly document how each step was addressed. State any references used or provide excerpts from those documents as appendices. State why a certain requirement in the step-by-step procedure does not apply to the project site.

15. Section 6 – Developed Site Conditions (Page 11), Water Quality – SMMWW Volume I, Chapter 2, Section I-2.5.6, Page 62 provides guidelines for determining water quality design storm volume. Provide those calculations.

16. Section 6 – Developed Site Conditions (Page 11), Low Impact Development (LID) BMPs – The LID BMP requirements for the West basin are provided. Please describe the LID BMP requirements for the East basin as well.

17. Section 6 – Developed Site Conditions (Page 12), LID BMPs – The first paragraph is confusing. Please clarify. Is it applicable to both East and West basins?

18. Section 6 – Developed Site Conditions (Page 12), LID BMPs – Figure I-2.5.1 – Please use different colors to highlight the flow chart for East and West basins. Alternately, separate flow charts for the East and West basins could be prepared. Ultimately, be clear about how LID BMPs were selected and document why the selection is appropriate.

19. Figure 4 – Existing Storm Drainage Basins – Show the part of the parcel that will remain undeveloped.

20. Figure 5 – Developed Site Drainage Basins – Some of the lots on the east side are within the stream and geological concern area buffers. Please revise so that the lots are out of the buffers or prepare and submit a mitigation plan.

21. Appendix B – WWHM Input Parameters and Results – East Basin Vault, General Model Information – The project location and hence the rain gage are incorrect for this model. The gage shall be Quilcene instead of SeaTac. Please revise the model to correct the location.

22. Appendix B – WWHM Input Parameters and Results – East Basin Vault – Landuse Basin Data, Predeveloped Land Use – Slope for the C Forest shall be steep and not

moderate based on the slopes provided in the geotechnical report and Figure 2 of this report. Please revise the model input. In addition, area of the East basin that will remain undeveloped shall not be included in the model. Please revise and re-run the model.

23. Appendix B – WWHM Input Parameters and Results – West Basin Vault – Landuse Basin Data, Predeveloped Land Use – Slope for the C Forest shall be steep and not moderate based on the slopes provided in the geotechnical report and Figure 2 of this report. Please revise the model input.

24. Appendix C – Modular Wetland Details – Provide Ecology's letter approving this product for basic water quality treatment.

The following comments are related to the Preliminary Subdivision and PRD Application Plans:

1. SMMWW Volume I, Chapter 3, Page 77 provides guidance on preparation of erosion and sediment control plan. Please prepare and provide an erosion and sediment control plan for review.

2. SMMWW Volume I, Chapter 3, Page 88 provides guidance on the drawings for the proposed water quality treatment facilities. Please provide the drawings in accordance with the guidelines.

3. SMMWW Volume II, Chapter 4, Page 348 provides guidance on details for a level spreader. Please provide details for the proposed level spreader in accordance with the guidelines.

4. Sheets 7 and 8, Preliminary Road Profiles – City of Poulsbo Construction Standards and Specifications – 2008, Section 3 – Sanitary Sewer, requires a minimum vertical separation between storm and sanitary lines of 1 foot. Please verify if this requirement is met.

5. Sheet 9, Storm Vault Details – West – Access road shall extend to the outlet structure.

6. Sheets 9 and 10, Storm Vault Details – West and Storm Vault Details – East – SMMWW Volume III, Chapter 3, page 492 requires removable panels over the entire vault or the bottom of the vault be sloped. Provide removable panels over the entire vault or slope the bottom in accordance with the section. Provide access to each "v" in accordance with the section.

7. Sheets 9 and 10, Storm Vault Details – West and Storm Vault Details – East – SMMWW Volume III, Chapter 3, page 493 requires ladders and hand holds provided at the outlet pipe and inlet pipe. Please provide ladders and handholds at the outlet and inlet pipes.

8. Sheets 9 and 10, Storm Vault Details – West and Storm Vault Details – East – Provide details on how the riser is connected to the vault and how the orifice is welded to the riser.

9. Sheets 9 and 10, Storm Vault Details – West and Storm Vault Details – East – Data provided in the Detention Vault table does not match with data provided in Tables 6.4 and 6.5 of the Stormwater Site Plan. Please verify and correct.

Please let me know if you have questions or comments regarding this letter. We look forward to supporting the City with resubmittal reviews for this project.

Sincerely,

Becca Ochiltree

Digitally signed by Becca Ochiltree
DN: cn=Becca Ochiltree, o=BHC Consultants, ou, email=becca.ochiltree@bhcconsultants.com, c=US
Date: 2020.03.11 17:49:21 -07'00'

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Cc: Carla Talich, P.E, BHC Sr.Project Manager
Chris Kelsey, P.E, BHC Sr.Project Manager