EASTSIDE CONSULTANTS, INC.
ENGINEERS-SURVEYORS
www.eastsideconsultants.com

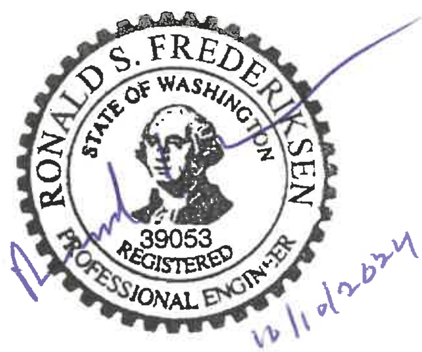
# TECHNICAL INFORMATION REPORT

# FOR

# MILL CREEK INDUSTRIAL WAREHOUSE

**City of Mill Creek File No.**
**Eastside Consultants, Inc. File No. 23116**

**October 10, 2024**




***Prepared by:***
*Eastside Consultants, Inc.*
*1320 NW Mall Street, Ste B*
*Issaquah, WA 98027*
*(425) 392-5351*

***Prepared for:***
*17200 MillCreek, LLC*
*18632 29th Ave SE*
*Bothel, WA 98012*

## TABLE OF CONTENTS

## Section I: Project Overview

Existing Conditions:
The site is located at 172xx Bothell Everett Highway SE, Millcreek, WA. It is also known as Tax Parcel No. 00602000000700. It is across the street from the intersection of Bothell Everett Highway and 173rd Street SW in the SE ¼ of Section 7, Township 27 North, Range 5 East, W.M. The existing site is 199,368 sf in size or 4.583 acres. The existing site conditions consists of a gently sloping upper bench consisting of mostly fill material that then slopes down at an approximately 40 to 45 percent slope to a wetland area below. The site has no existing impervious. The site has mostly cottonwood and alders on it. This means per Fig. I-3.1, we are under Requirements for new development

Generally, the site slopes westerly at 1% to 5% with underlying fill material made up of material from the excavation of Bothel Everett Highway and also containing concrete chunks, etc. No groundwater was encountered.

Proposed Conditions:
The proposed project consists of constructing a new 18,198 sf warehouse facility with access from Bothell Everett Highway. The onsite impervious area consists of the roof area of the warehouse that will be 18,198 sf with an additional 2,361 sf of concrete walkway, 14,624 sf of pavement, 413 sf of stairways, 199 sf of concrete curb, and a 141 sf concrete trash enclosure. This is a total of 35,795 sf on new onsite impervious. This will be taken to an onsite Detention facility since the site is infeasible for infiltration and dispersion.

We will also be installing offsite improvements consisting of 2,180 sf of sidewalk and curb and gutter, and 912 sf of new asphalt for a total of 3,092 sf on new/replaced offsite impervious. The Bothell Everett Highway already has a drainage system in place.

Since the soils are not conclusive for infiltration and there is no room for a dispersion trench with a 50 foot flowpath, infiltration and dispersion will not be feasible. The facilities will be designed per the 2019 Department of Ecology Manual.

Since we are adding 14,624 sf of new Pollution Generating Impervious Surface, water quality will be per a combined detention/wetvault..

## Section II: Existing Conditions Summary

The site is located at 172xx Bothell Everett Highway SE, Millcreek, WA. It is also known as Tax Parcel No. 00602000000700. It is across the street from the intersection of Bothell Everett Highway and 173rd Street SW in the SE ¼ of Section 7, Township 27 North, Range 5 East, W.M. The existing site is 199,368 sf in size or 4.58 acres. The existing site conditions consists of a gently sloping upper bench consisting of mostly fill material that then slopes down at an approximately 40 to 45 percent slope to a wetland area below. The site has no existing impervious. The site has mostly cottonwood and alders on it. This means per Fig. I-3.1 and I-3.2 we are under Requirements for new development

Generally, the site slopes westerly at 1% to 5% with underlying fill material made up of material from the excavation of Bothel Everett Highway and also containing concrete chunks, etc. No groundwater was encountered.

## Section III: Off-Site Analysis Report

# LEVEL 1 DRAINAGE ANALYSIS

# FOR

**Mill Creek Warehouse**

**Eastside Consultants, Inc. File No. 22204**

**February 12, 2024**


***Prepared by:***
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***Prepared for:***
*Nitin Goyal*
*17200 Millcreek*

**Task 1 – Define Map and Study Area**

The downstream drainage path consists of one flow path. The runoff flows to the Northwest border of the property. The runoff travels Southwesterly into Nickel Creek and will eventually end in Lake Sammamish. See the Downstream Drainage Map Section for a map defining the area. The site is located within the Cedar-Sammamish.

**Task 2 – Resource Review**

A review of the PDS Map Portal revealed that there is are no erosion hazards near the site. A review of the PDS Map Portal revealed that there is a seismic hazard at the site (site class C to D). A review of the PDS Map Portal revealed that there are fish bearing streams near the site. The site will drain into Nickel Creek. A review of the PDS Map Portal revealed that there is a potential land slide hazards found West of the site. A review of the PDS Map Portal revealed that the site is located on a wetland.

**Task 3 – Field Inspection**

Upstream basin

Downstream Basin

**Task 4 – Drainage System Description**

Downstream Basin

The flow path will start from the Northwest corner of the property (Point A). The flow will travel West and go into Nickel Creek (Point B). The flow will continue Southwesterly through Nickel Creek (Points B-F).

**Task 5 – Mitigation of Existing or Potential Problems**

No issues were found during the downstream investigation. This project will not create a significant impact to the downstream conveyance system.

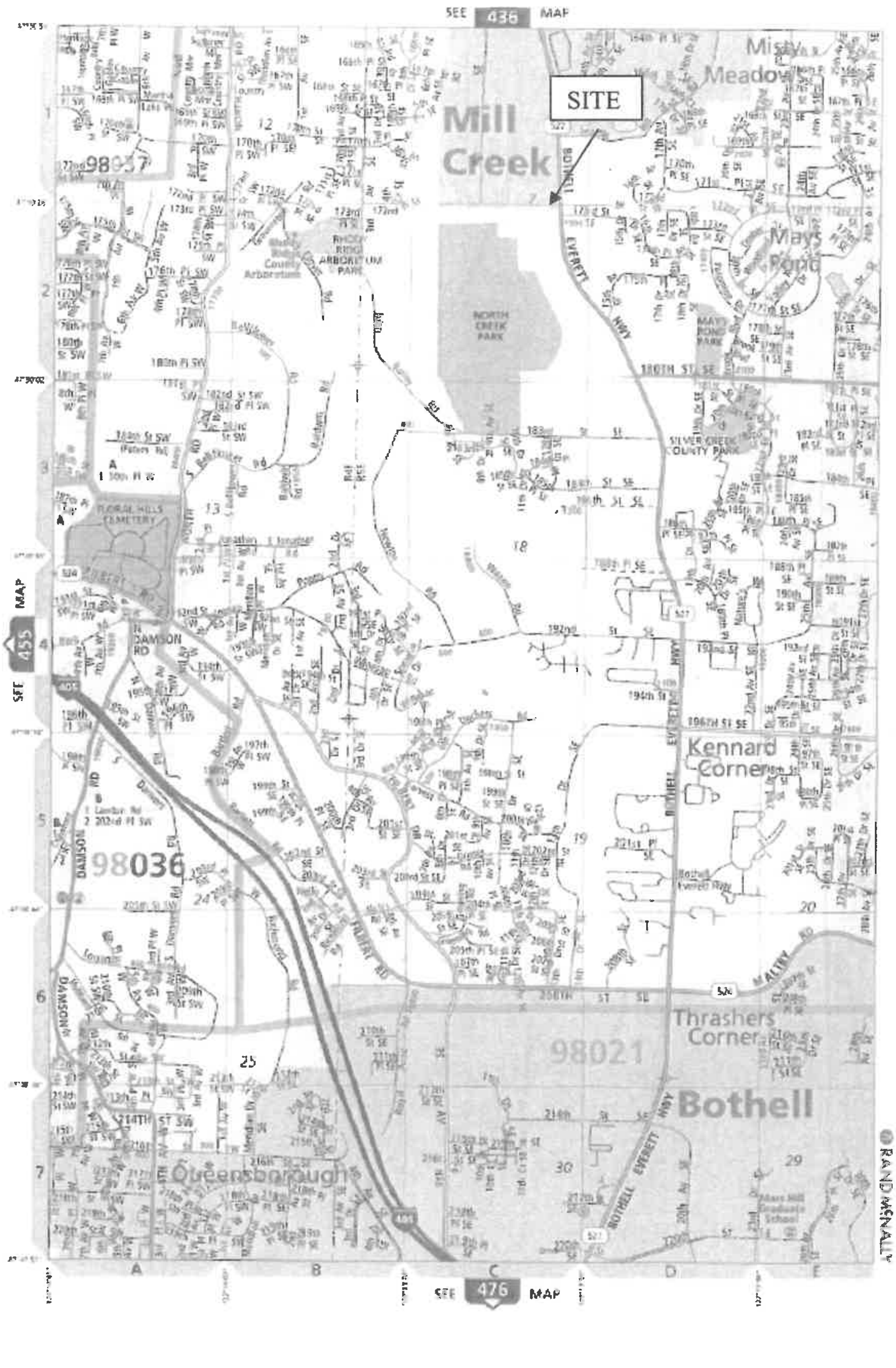
# QUAD, SOILS, AND VICINITY MAPS

# SOILS MAP
(Web Soil Survey from USDA NRCS)

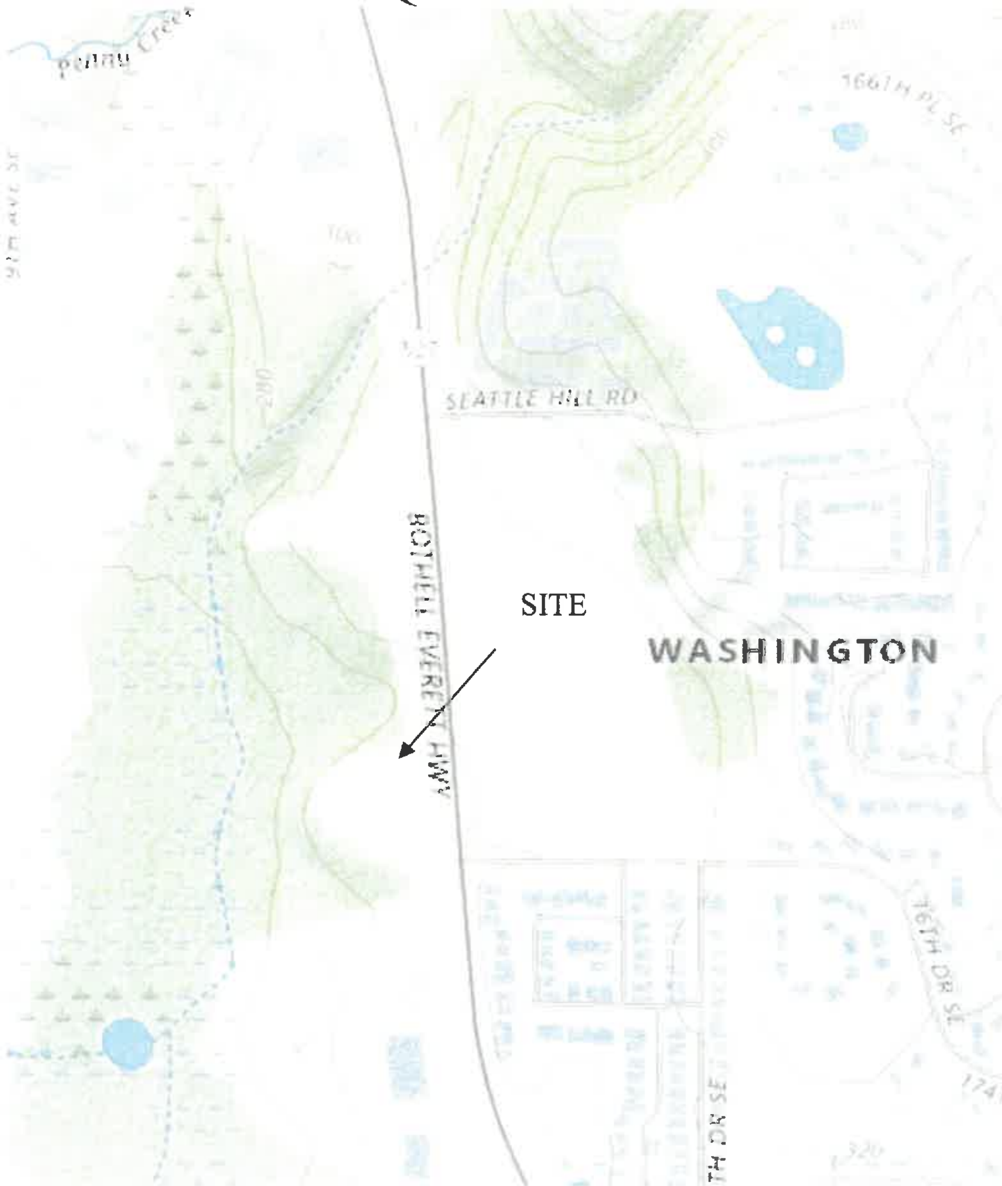
**Snohomish County Area, Washington (WA661)**
Snohomish County Area, Washington (WA661)

| Map Unit Symbol | Map Unit Name | Acres in AOI | Percent of AOI |
|---|---|---|---|
| 1 | Alderwood gravelly sandy loam, 0 to 8 percent slopes | 0.0 | 0.0% |
| 2 | Alderwood gravelly sandy loam, 8 to 15 percent slopes | 0.0 | 0.1% |
| 3 | Alderwood gravelly sandy loam, 15 to 30 percent slopes | 12.0 | 18.2% |
| 17 | Everett very gravelly sandy loam, 0 to 8 percent slopes | 28.4 | 43.0% |
| 18 | Everett very gravelly sandy loam, 8 to 15 percent slopes | 16.9 | 25.6% |
| 34 | Mukilteo muck | 8.7 | 13.2% |
| **Totals for Area of Interest** | | **66.2** | **100.0%** |

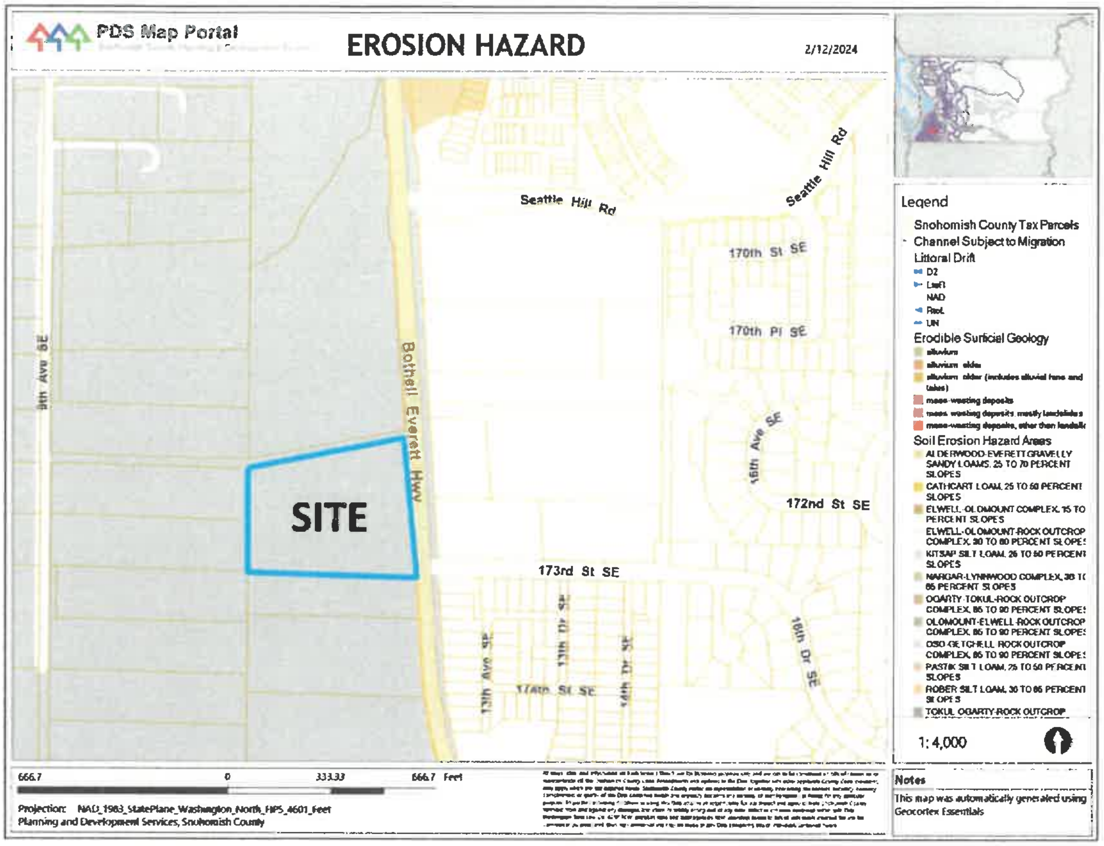
VICINITY MAP


SEE 436 MAP
SITE
Mill Creek
Misty Meadow
Mays Pond
NORTH CREEK PARK
MAYS POND PARK
180TH ST SE
SILVER CREEK COUNTY PARK
EVERETT HWY
FLORAL HILLS CEMETERY
DAMSON RD
SEE 455 MAP
Kennard Corner
98036
98021
MALTBY RD
208TH ST SE
Thrashers Corner
Bothell
BOTHELL EVERETT HWY
Queensborough
214TH ST SW
SEE 476 MAP
A
B
C
D
E
© RAND McNALLY

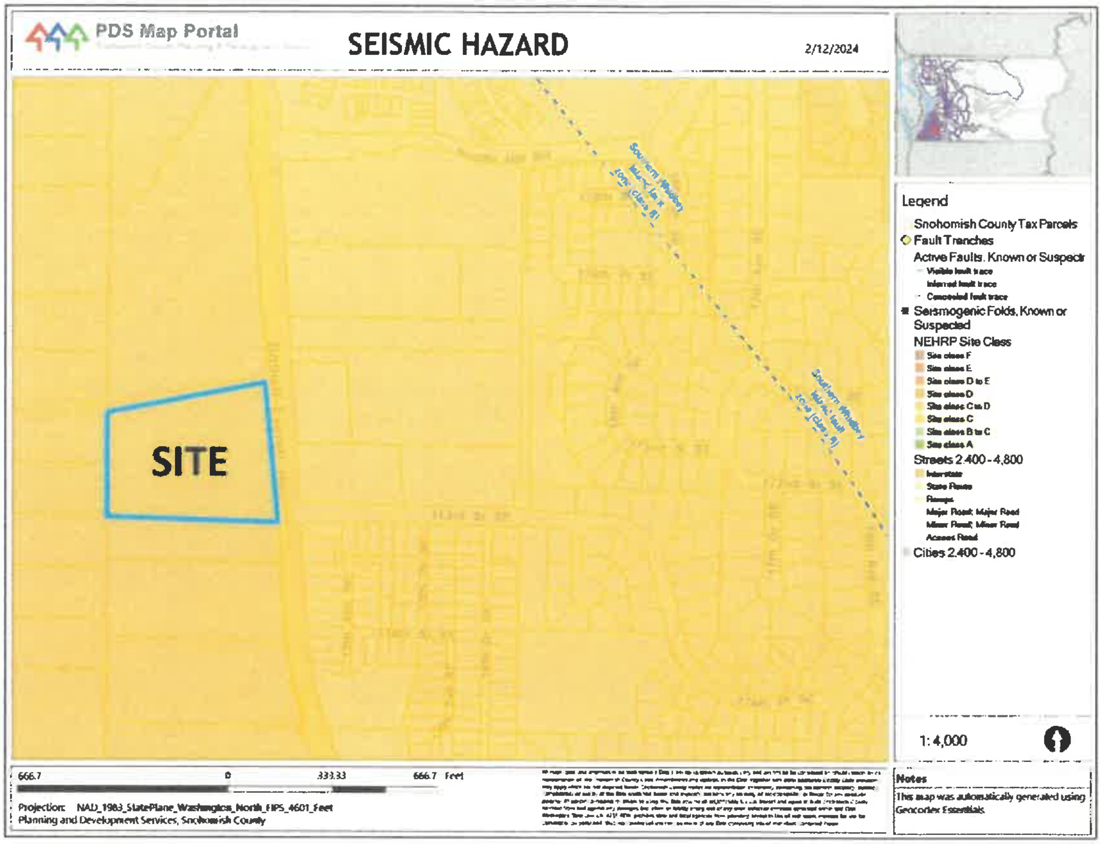
# QUAD MAP

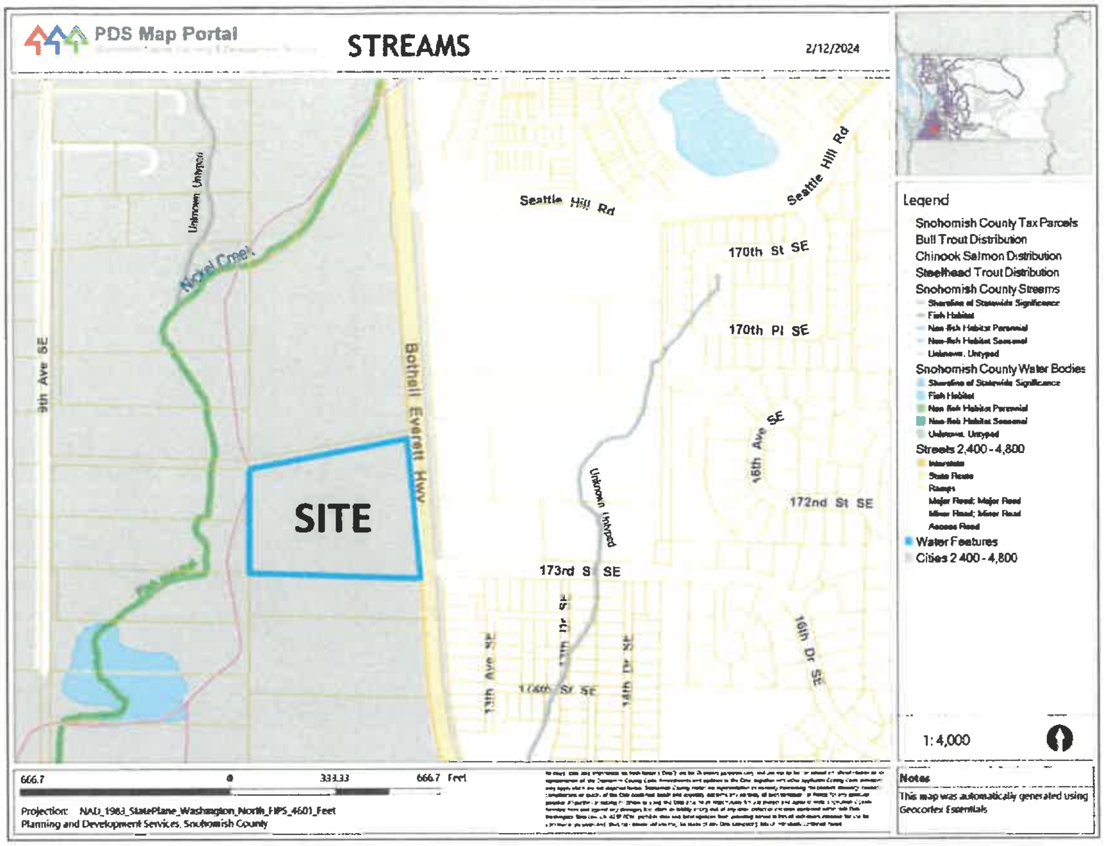

Penny Creek
166TH PL SE
SEATTLE HILL RD
BOTHELL EVERETT HWY
SITE
WASHINGTON

# 1990 SENSITIVE AREA FOLIO MAPS

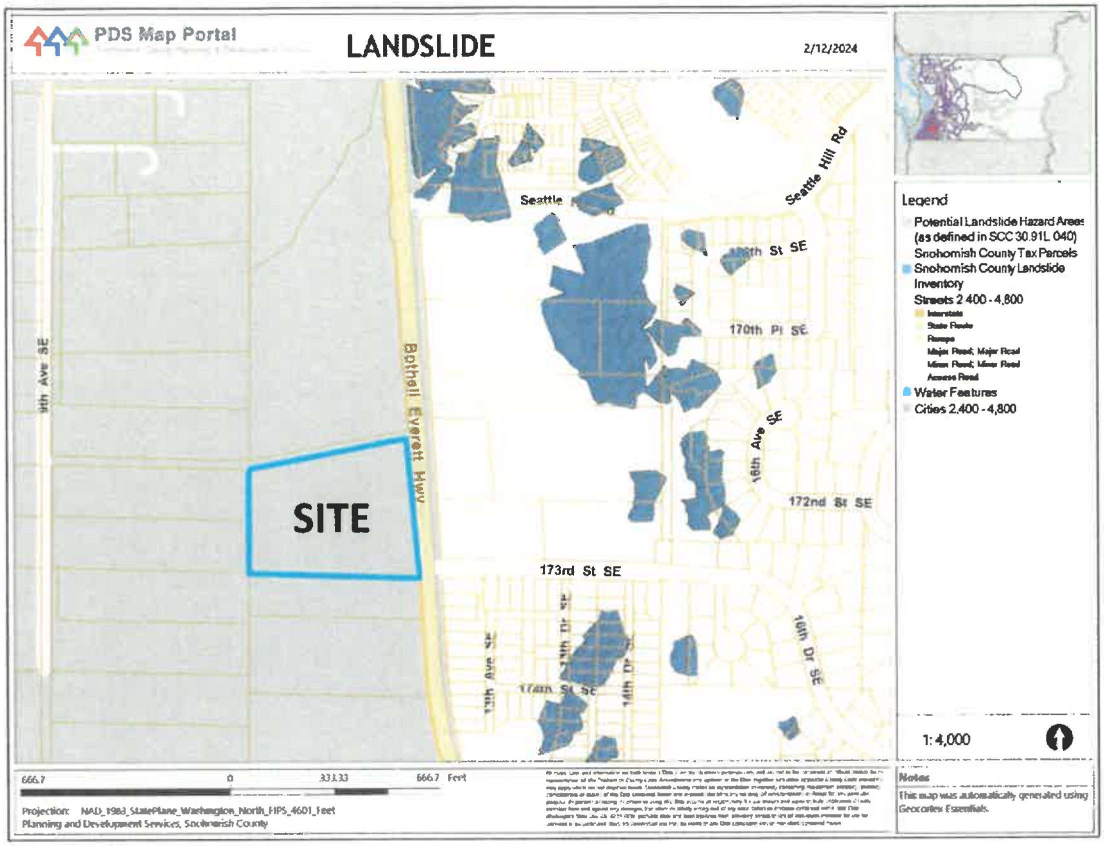


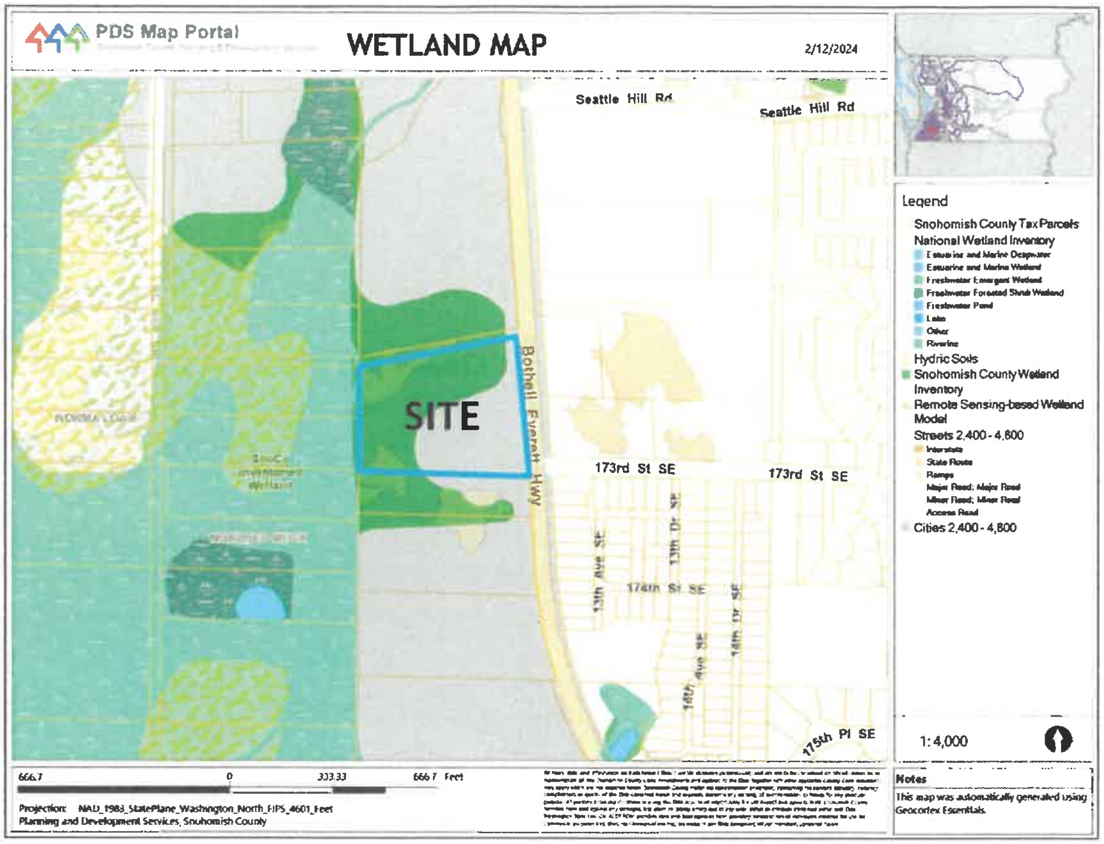
PDS Map Portal
EROSION HAZARD
2/12/2024
Seattle Hill Rd
Seattle Hill Rd
170th St SE
170th Pl SE
16th Ave SE
172nd St SE
173rd St SE
174th St SE
13th Ave SE
13th Dr SE
14th Dr SE
18th Dr SE
9th Ave SE
Bothell Everett Hwy
SITE
Legend
Snohomish County Tax Parcels
Channel Subject to Migration
Littoral Drift
D2
NAD
UN
Erodible Surficial Geology
mass-wasting deposits
Soil Erosion Hazard Areas
ALDERWOOD-EVERETT GRAVELLY SANDY LOAMS, 25 TO 70 PERCENT SLOPES
CATHCART LOAM, 25 TO 60 PERCENT SLOPES
ELWELL-OLOMOUNT COMPLEX, 15 TO PERCENT SLOPES
ELWELL-OLOMOUNT-ROCK OUTCROP COMPLEX, 30 TO 80 PERCENT SLOPES
KITSAP SILT LOAM, 25 TO 60 PERCENT SLOPES
NARGAR-LYNNWOOD COMPLEX, 30 TO 65 PERCENT SLOPES
OGARTY-TOKUL-ROCK OUTCROP COMPLEX, 65 TO 90 PERCENT SLOPES
OLOMOUNT-ELWELL-ROCK OUTCROP COMPLEX, 65 TO 90 PERCENT SLOPES
OSO-GETCHELL ROCK OUTCROP COMPLEX, 65 TO 90 PERCENT SLOPES
PASTIK SILT LOAM, 25 TO 50 PERCENT SLOPES
ROBER SILT LOAM, 30 TO 65 PERCENT SLOPES
TOKUL-OGARTY-ROCK OUTCROP
1: 4,000
666.7
0
333.33
666.7 Feet
Projection: NAD_1983_StatePlane_Washington_North_FIPS_4601_Feet
Planning and Development Services, Snohomish County
Notes
This map was automatically generated using Geocortex Essentials


PDS Map Portal
SEISMIC HAZARD
2/12/2024
SITE
Legend
Snohomish County Tax Parcels
Fault Trenches
Active Faults, Known or Suspected
Seismogenic Folds, Known or Suspected
NEHRP Site Class
Streets 2,400 - 4,800
Cities 2,400 - 4,800
1: 4,000
666.7 0 333.33 666.7 Feet
Projection: NAD_1983_StatePlane_Washington_North_FIPS_4601_Feet
Planning and Development Services, Snohomish County
Notes
This map was automatically generated using Geocortex Essentials


PDS Map Portal
STREAMS
2/12/2024
Seattle Hill Rd
Seattle Hill Rd
170th St SE
170th Pl SE
16th Ave SE
172nd St SE
173rd St SE
Bothell Everett Hwy
9th Ave SE
Nickel Creek
Unknown Untyped
SITE
13th Ave SE
13th Dr SE
14th Dr SE
16th Dr SE
Legend
Snohomish County Tax Parcels
Bull Trout Distribution
Chinook Salmon Distribution
Steelhead Trout Distribution
Snohomish County Streams
Snohomish County Water Bodies
Streets 2,400 - 4,800
Water Features
Cities 2,400 - 4,800
1: 4,000
666.7
0
333.33
666.7 Feet
Projection: NAD_1983_StatePlane_Washington_North_FIPS_4601_Feet
Planning and Development Services, Snohomish County
Notes
This map was automatically generated using Geocortex Essentials

# LANDSLIDE HAZARD AREA

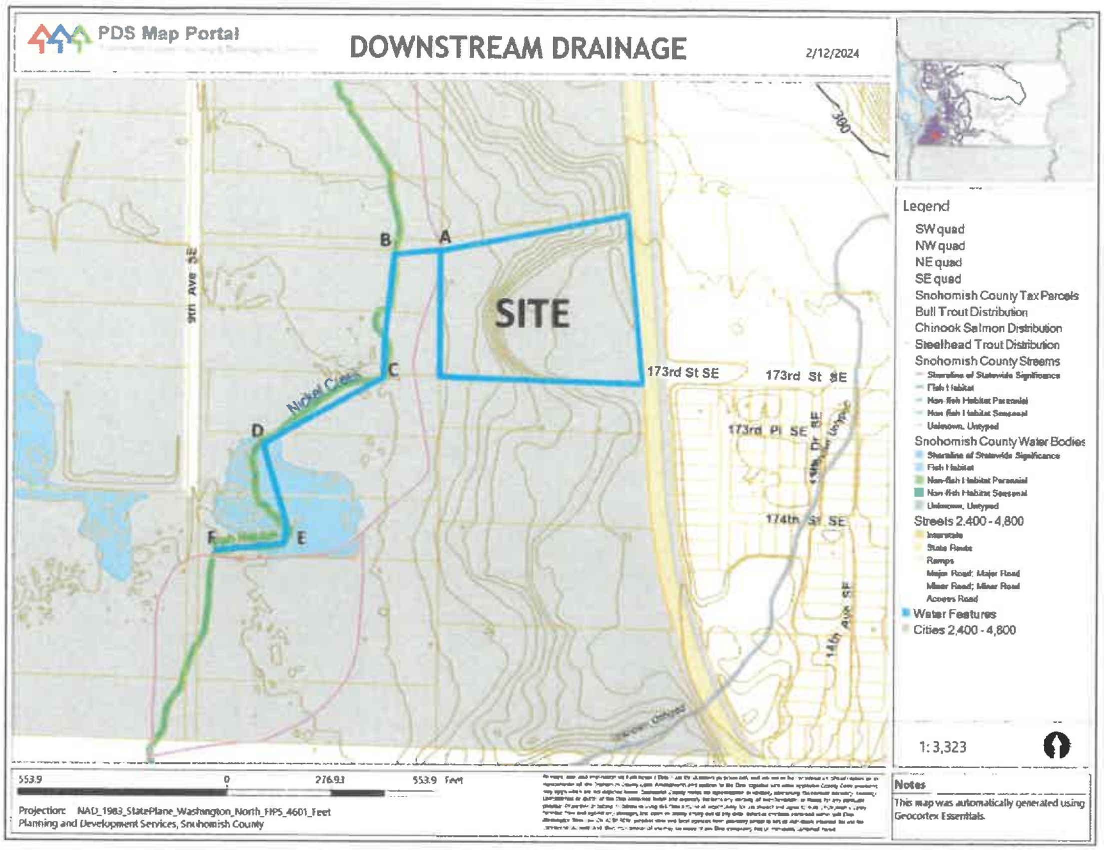




PDS Map Portal
WETLAND MAP
2/12/2024
Seattle Hill Rd
Seattle Hill Rd
SITE
Bothell Everett Hwy
173rd St SE
173rd St SE
13th Ave SE
13th Dr SE
174th St SE
14th Dr SE
14th Ave SE
175th Pl SE
Legend
Snohomish County Tax Parcels
National Wetland Inventory
Hydric Soils
Snohomish County Wetland Inventory
Remote Sensing-based Wetland Model
Streets 2,400 - 4,800
Cities 2,400 - 4,800
1: 4,000
666.7
0
333.33
666.7 Feet
Projection: NAD_1983_StatePlane_Washington_North_FIPS_4601_Feet
Planning and Development Services, Snohomish County
Notes
This map was automatically generated using Geocortex Essentials.

# DRAINAGE COMPLAINTS

# DOWNSTREAM DRAINAGE MAPS


PDS Map Portal
DOWNSTREAM DRAINAGE
2/12/2024
SITE
A
B
C
D
E
F
Nickel Creek
9th Ave SE
173rd St SE
173rd St SE
173rd Pl SE
174th St SE
14th Ave SE
300
Legend
SW quad
NW quad
NE quad
SE quad
Snohomish County Tax Parcels
Bull Trout Distribution
Chinook Salmon Distribution
Steelhead Trout Distribution
Snohomish County Streams
Shoreline of Statewide Significance
Fish Habitat
Non-fish Habitat Perennial
Non-fish Habitat Seasonal
Unknown, Untyped
Snohomish County Water Bodies
Shoreline of Statewide Significance
Fish Habitat
Non-fish Habitat Perennial
Non-fish Habitat Seasonal
Unknown, Untyped
Streets 2,400 - 4,800
Interstate
State Route
Ramps
Major Road; Major Road
Minor Road; Minor Road
Access Road
Water Features
Cities 2,400 - 4,800
1: 3,323
553.9 0 276.93 553.9 Feet
Projection: NAD_1983_StatePlane_Washington_North_FIPS_4601_Feet
Planning and Development Services, Snohomish County
Notes
This map was automatically generated using Geocortex Essentials.

# OFF-SITE ANALYSIS DRAINAGE SYSTEM TABLE

## OFF-SITE ANALYSIS DRAINAGE SYSTEM TABLE
## SURFACE WATER DESIGN MANUAL, CORE REQUIREMENT #2

**Basin:** Cedar-Sammamish **Subbasin Name:** North Creek **Subbasin Number:**

| Symbol | Drainage Component Type, Name, and Size | Drainage Component Description | Slope | Distance from site discharge | Existing Problems | Potential Problems | Observations of field inspector, resource reviewer, or resident |
|---|---|---|---|---|---|---|---|
| see map | Type: sheet flow, swale, stream, channel, pipe, pond; Size: diameter, surface area | drainage basin, vegetation, cover, depth, type of sensitive area, volume | % | ¼ ml = 1,320 ft. | constrictions, under capacity, ponding, overtopping, flooding, habitat or organism destruction, scouring, bank sloughing, sedimentation, incision, other erosion | | tributary area, likelihood of problem, overflow pathways, potential impacts |
| A | Site Discharge | | | 0 | | | |
| A-B | Nickel Creek | | 4 | 0' –117' | | | |
| B-C | Nickel Creek | | 1 | 117' –450' | | | |
| C-D | Nickel Creek | | 1 | 450' –821' | | | |
| D-E | Nickel Creek | | 1 | 821'-1037' | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| E-F | Nickel Creek | | 1 | 1037'-1211' | | | |
| F | | | | 1211' | | | |

**Section IV: Permanent Stormwater Control Plan**

The proposed project consists of constructing a new 18,198 sf warehouse facility with access from Bothell Everett Highway. The onsite impervious area consists of the roof area of the warehouse that will be 18,198 sf with an additional 2,361 sf of concrete walkway, 14,624 sf of pavement, 413 sf of stairways, 199 sf of concrete curb, and a 141 sf concrete trash enclosure. This is a total of 35,795 sf on new onsite impervious. This will be taken to an onsite Detention facility since the site is infeasible for infiltration and dispersion.

We will also be installing offsite improvements consisting of 2,180 sf of sidewalk and curb and gutter, and 912 sf of new asphalt for a total of 3,092 sf on new/replaced offsite impervious. The Bothell Everett Highway already has a drainage system in place.

Since the soils are not conclusive for infiltration and there is no room for a dispersion trench with a 50 foot flowpath, infiltration and dispersion will not be feasible. The facilities will be designed per the 2019 Department of Ecology Manual.

Since we are adding 14,624 sf of new Pollution Generating Impervious Surface, water quality will be per a combined detention/wetvault.

## ADHERENCE TO DOE MINIMUM TECHNICAL REQUIREMENTS 1-9

### Minimum Requirements 1-9

Since there are no Existing Impervious on the site, and based on the included Fig. I-3.1, we are under Requirements for New-Development and since we are over 5,000 sf of new and/or replaced impervious surface, we need to apply Minimum Requirements 1-9.

#### Minimum Requirement Number 1: Preparation of Stormwater Site Plan

A Stormwater Site Plan has been prepared to address the runoff from Warehouse and parking lot.

#### Minimum Requirement Number 2: Construction Stormwater Pollution Prevention Plan (SWPPP)

A Construction Stormwater Pollution Prevention Plan will be prepared for the site. A copy will be submitted during Civil Review.

**Minimum Requirement Number 3: Source Control of Pollution**

The source control of pollutants will be from automobiles.

**Minimum Requirement Number 4: Preservation of Natural Drainage Systems and Outfalls.**

The system outfalls to the same system and basin as it previously did. Infiltration was analyzed but deemed not feasible by the Geotechnical Engineer, but the use of Low Impact Designs such as rain gardens, bio-retention planters, or pervious pavements could be used if a suitable overflow component is included in the design. Dispersion is also not feasible due to site constraints.

**Minimum Requirement Number 5: On-Site Stormwater Management**

Infiltration was analyzed but deemed not feasible by the Geotechnical Engineer, Due to the nature of the fill and surrounding steep slopes, all LID's are deemed infeasible. All new landscape areas within the project site are required to have compost amended soils per BMP T5.13: Post-Construction Soil Quality and Depth.

<u>Using List #2</u>

**Lawn and Landscaped Areas**

- Post construction soil quality and depth is feasible for all lawn and landscaped areas

**Roofs**

1) Full Dispersion or Downspout Full Infiltration
    - Full Dispersion is infeasible per BMP T5.30.
        - This BMP is infeasible if a native vegetated flow path of 100 feet is not available due to step slopes
    - Downspout Full Infiltration is infeasible per BMP T5.10A
        - This BMP is infeasible per the Geotechnical Report, the soils are composed of fill materials
2) Bioretention is feasible per BMP T7.30.
        - This BMP is infeasible per the Geotechnical Report, the soils are composed of fill materials

**Hard Surfaces**

1) Full Dispersion is infeasible per BMP T5.30 requirements.
   - This BMP is infeasible if a native vegetated flow path of 100 feet is not available. The site does not have a native vegetated flow path of 100 feet.
2) Permeable Pavement is feasible per BMP T5.15.
   This BMP is infeasible per the Geotechnical Report, the soils are composed of fill materials
3) Bioretention cell is feasible per BMP T5.15.
   This BMP is infeasible per the Geotechnical Report, the soils are composed of fill materials

**Minimum Requirement Number 6: Runoff Treatment**

Since we are only adding 14,624 sf of PGIS, we will be using a combined

Detention/Wetvault for Water Quality Treatment

**Minimum Requirement Number 7: Flow Control**

We will be providing a 20' wide by 144' long by 13' tall combined detention/water quality vault.

**Minimum Requirement Number 8: Wetlands Protection**

The subject site does not discharge to a wetland, therefore this requirement is not applicable

**Minimum Requirement Number 9: Operation and Maintenance**

An Operation and Maintenance Manual will be prepared during the next submittal phase.

## DETENTION SYSTEM AND WATER QUALITY ANALYSIS AND DESIGN

### 1. Overview

The existing and developed flows are analyzed for the road right-of-way area draining to the site and the site area.
Site Area = 199,649 sf or 4.583 acres
Disturbed Site Area = 49,756 sf
R.O.W. Area being Disturbed = 4,214 sf sf (Un-detained Improvements)

See Maps in Appendix B

Soils: Alderwood Soils (AgC, Group C)
**TILL SOILS**
**Seatac 1.00**

Design Standards:

1. 2019 Stormwater Management Manual for Western Washington
2. Used 2012 WWHM

### 2. Existing Site Hydrology

Site Area to Detention = 49,756 sf or 1.143 acres

Modeled as Forested Area Moderate = 49,756 sf or 1.143 acres

Using WWHM2012. (See Printout)
Q-100 = 0.0669 cfs
Q-10 = 0.0413 cfs
Q-2 = 0.0218 cfs

## 3. Developed Site Hydrology

Site Area to Detention = 49,756 sf or 1.143 acres

Impervious Area to Detention:

Parking Area = 14,624 sf
Stairs = 413 sf
Concrete curb = 199 sf
Trash Enclosure = 141 sf
Roof Area = 18,198 sf
Sidewalks Area = 2,361 sf
Total = 35,795 sf

Pervious Area to be counted as lawn:

A = 49,756 – 35,795 = 13,961 sf or 0.321 acres

**Total Impervious = 35,795 sf or 0.822 acres**
**Total Lawn = 13,961 sf or 0.321 acres**

Using WWHM2012. (See Printout)

Q-100 = 0.0773 cfs
Q-10 = 0.0283 cfs
Q-2 = 0.0100 cfs

## 4. Detention

See Calculations in Appendix A

Using WWHM12. (see printout)

Required Storage Volume = 3,459 cf
Depth = 9.5 ft
Bottom Orifice = 0.30 in
Second Orifice = 0.68 in @ 5.67 feet
Third Orifice = 0.43 in @ 6.92 feet

## 4a. Water Quality

Since we are adding 14,624 sf of new Pollution Generating Impervious Surface, water quality will be per a combined detention/wetvault.

On-line Volume = 0.0829 acre feet or 3,611 cf
Volume Provided = 3'X140'X20' = 8,400 CF

## Section V: Construction Stormwater Pollution Prevention Plan

A CSWPPP plan will be prepared during the Civil Plan Review

**Sediment Trap Sizing**

Site Area to Trap = 49,756 sf or 1.142 acres

10- year storm = 0.0568 cfs

SA = 2 x $Q_{10}$/0.00096

SA = 2 x 0.0568/0.00096

SA = 119 sf required

SA provided = 583 SF

**WWHM2012**
**PROJECT REPORT**

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**Project Name:** 23116 TESC
**Site Name:**
**Site Address:**
**City :**
**Report Date:** 10/10/2024
**Gage :** Everett
**Data Start :** 1948/10/01
**Data End :** 2009/09/30
**Precip Scale:** 1.00
**Version Date:** 2021/08/18
**Version :** 4.2.18

---

**Low Flow Threshold for POC 1 :** 50 Percent of the 2 Year

---

**High Flow Threshold for POC 1:** 50 year

---

**PREDEVELOPED LAND USE**

**Name :** Basin 1
**Bypass:** No

**GroundWater:** No

| Pervious Land Use | acre |
|---|---|
| C, Forest, Flat | 1.142 |

**Pervious Total** 1.142

| Impervious Land Use | acre |
|---|---|

**Impervious Total** 0

**Basin Total** 1.142

---

**Element Flows To:**

| Surface | Interflow | Groundwater |
|---|---|---|

---

**MITIGATED LAND USE**

**Name :** Basin 1
**Bypass:** No

**GroundWater:** No

| Pervious Land Use | acre |
|---|---|
| C, Pasture, Flat | 1.142 |
| Pervious Total | 1.142 |

| Impervious Land Use | acre |
|---|---|
| Impervious Total | 0 |
| Basin Total | 1.142 |

---

Element Flows To:

| Surface | Interflow | Groundwater |
|---|---|---|

---

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ANALYSIS RESULTS

Stream Protection Duration

---

Predeveloped Landuse Totals for POC #1
Total Pervious Area:1.142
Total Impervious Area:0

---

Mitigated Landuse Totals for POC #1
Total Pervious Area:1.142
Total Impervious Area:0

---

Flow Frequency Return Periods for Predeveloped. POC #1

| Return Period | Flow(cfs) |
|---|---|
| 2 year | 0.021786 |
| 5 year | 0.03339 |
| 10 year | 0.041338 |
| 25 year | 0.051537 |
| 50 year | 0.059196 |
| 100 year | 0.06688 |

Flow Frequency Return Periods for Mitigated. POC #1

| Return Period | Flow(cfs) |
|---|---|
| 2 year | 0.029742 |
| 5 year | 0.045357 |
| 10 year | 0.056819 |
| 25 year | 0.072507 |
| 50 year | 0.085043 |
| 100 year | 0.098292 |

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## Section VI: Special Reports and Studies

Geotechnical Information Study by Pacific Geo Engineering dated February 17, 2024.
(See Appendix D)

Arborist Report by FACET dated October 9, 2024 (See Appendix E)

Critical Areas Report by FACET dated October 10, 2024

## Section VII: Other Permits

Building Permit

ROW Use Permit

**Section VIII: Bond Quantity Worksheet**

An Operation and Maintenance Manual will be included during the Civil Review phase

# Appendix A: Stormwater Calculations

# WWHM2012

# PROJECT REPORT

## General Model Information

| | |
|---|---|
| Project Name: | 23116 |
| Site Name: | |
| Site Address: | |
| City: | |
| Report Date: | 10/10/2024 |
| Gage: | Everett |
| Data Start: | 1948/10/01 |
| Data End: | 2009/09/30 |
| Timestep: | Hourly |
| Precip Scale: | 1.000 |
| Version Date: | 2021/08/18 |
| Version: | 4.2.18 |

### 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*

### Basin 1

| | |
|---|---|
| Bypass: | No |
| GroundWater: | No |
| Pervious Land Use | acre |
| C, Forest, Flat | 1.142 |
| Pervious Total | 1.142 |
| Impervious Land Use | acre |
| Impervious Total | 0 |
| Basin Total | 1.142 |

Element Flows To:

| Surface | Interflow | Groundwater |
|---|---|---|

## *Mitigated Land Use*

## Basin 1

| | |
|---|---|
| Bypass: | No |
| GroundWater: | No |
| Pervious Land Use | acre |
| A B, Lawn, Flat | 0.321 |
| Pervious Total | 0.321 |
| Impervious Land Use | acre |
| ROOF TOPS FLAT | 0.822 |
| Impervious Total | 0.822 |
| Basin Total | 1.143 |

Element Flows To:

| Surface | Interflow | Groundwater |
|---|---|---|
| Vault 1 | Vault 1 | |

# Routing Elements
## Predeveloped Routing

## *Mitigated Routing*

## Vault 1

| | | |
|---|---|---|
| Width: | 19.3243075841576 ft. | |
| Length: | 139.135014605935 ft. | |
| Depth: | 9.5 ft. | |
| Discharge Structure | | |
| Riser Height: | 8.5 ft. | |
| Riser Diameter: | 18 in. | |
| Orifice 1 Diameter: | 0.3 in. | Elevation:0 ft. |
| Orifice 2 Diameter: | 0.68 in. | Elevation:5.6695 ft. |
| Orifice 3 Diameter: | 0.43 in. | Elevation:6.92208333333336 ft. |
| Element Flows To: | | |
| Outlet 1 | Outlet 2 | |

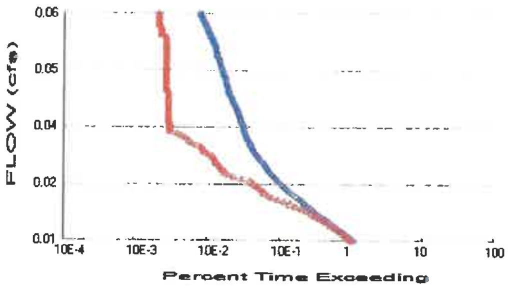
Vault Hydraulic Table

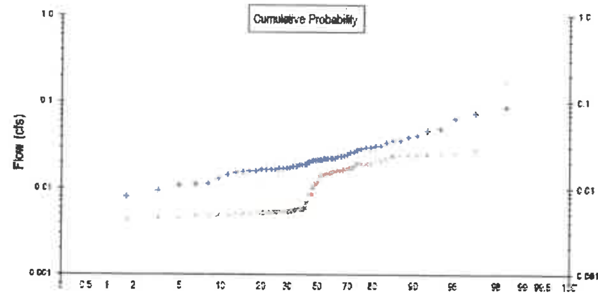
| Stage(feet) | Area(ac.) | Volume(ac-ft.) | Discharge(cfs) | Infilt(cfs) |
|---|---|---|---|---|
| 0.0000 | 0.061 | 0.000 | 0.000 | 0.000 |
| 0.1056 | 0.061 | 0.006 | 0.000 | 0.000 |
| 0.2111 | 0.061 | 0.013 | 0.001 | 0.000 |
| 0.3167 | 0.061 | 0.019 | 0.001 | 0.000 |
| 0.4222 | 0.061 | 0.026 | 0.001 | 0.000 |
| 0.5278 | 0.061 | 0.032 | 0.001 | 0.000 |
| 0.6333 | 0.061 | 0.039 | 0.001 | 0.000 |
| 0.7389 | 0.061 | 0.045 | 0.002 | 0.000 |
| 0.8444 | 0.061 | 0.052 | 0.002 | 0.000 |
| 0.9500 | 0.061 | 0.058 | 0.002 | 0.000 |
| 1.0556 | 0.061 | 0.065 | 0.002 | 0.000 |
| 1.1611 | 0.061 | 0.071 | 0.002 | 0.000 |
| 1.2667 | 0.061 | 0.078 | 0.002 | 0.000 |
| 1.3722 | 0.061 | 0.084 | 0.002 | 0.000 |
| 1.4778 | 0.061 | 0.091 | 0.003 | 0.000 |
| 1.5833 | 0.061 | 0.097 | 0.003 | 0.000 |
| 1.6889 | 0.061 | 0.104 | 0.003 | 0.000 |
| 1.7944 | 0.061 | 0.110 | 0.003 | 0.000 |
| 1.9000 | 0.061 | 0.117 | 0.003 | 0.000 |
| 2.0056 | 0.061 | 0.123 | 0.003 | 0.000 |
| 2.1111 | 0.061 | 0.130 | 0.003 | 0.000 |
| 2.2167 | 0.061 | 0.136 | 0.003 | 0.000 |
| 2.3222 | 0.061 | 0.143 | 0.003 | 0.000 |
| 2.4278 | 0.061 | 0.149 | 0.003 | 0.000 |
| 2.5333 | 0.061 | 0.156 | 0.003 | 0.000 |
| 2.6389 | 0.061 | 0.162 | 0.004 | 0.000 |
| 2.7444 | 0.061 | 0.169 | 0.004 | 0.000 |
| 2.8500 | 0.061 | 0.175 | 0.004 | 0.000 |
| 2.9556 | 0.061 | 0.182 | 0.004 | 0.000 |
| 3.0611 | 0.061 | 0.188 | 0.004 | 0.000 |
| 3.1667 | 0.061 | 0.195 | 0.004 | 0.000 |
| 3.2722 | 0.061 | 0.202 | 0.004 | 0.000 |
| 3.3778 | 0.061 | 0.208 | 0.004 | 0.000 |
| 3.4833 | 0.061 | 0.215 | 0.004 | 0.000 |
| 3.5889 | 0.061 | 0.221 | 0.004 | 0.000 |
| 3.6944 | 0.061 | 0.228 | 0.004 | 0.000 |
| 3.8000 | 0.061 | 0.234 | 0.004 | 0.000 |
| 3.9056 | 0.061 | 0.241 | 0.004 | 0.000 |

| | | | | |
|---|---|---|---|---|
| 4.0111 | 0.061 | 0.247 | 0.004 | 0.000 |
| 4.1167 | 0.061 | 0.254 | 0.005 | 0.000 |
| 4.2222 | 0.061 | 0.260 | 0.005 | 0.000 |
| 4.3278 | 0.061 | 0.267 | 0.005 | 0.000 |
| 4.4333 | 0.061 | 0.273 | 0.005 | 0.000 |
| 4.5389 | 0.061 | 0.280 | 0.005 | 0.000 |
| 4.6444 | 0.061 | 0.286 | 0.005 | 0.000 |
| 4.7500 | 0.061 | 0.293 | 0.005 | 0.000 |
| 4.8556 | 0.061 | 0.299 | 0.005 | 0.000 |
| 4.9611 | 0.061 | 0.306 | 0.005 | 0.000 |
| 5.0667 | 0.061 | 0.312 | 0.005 | 0.000 |
| 5.1722 | 0.061 | 0.319 | 0.005 | 0.000 |
| 5.2778 | 0.061 | 0.325 | 0.005 | 0.000 |
| 5.3833 | 0.061 | 0.332 | 0.005 | 0.000 |
| 5.4889 | 0.061 | 0.338 | 0.005 | 0.000 |
| 5.5944 | 0.061 | 0.345 | 0.005 | 0.000 |
| 5.7000 | 0.061 | 0.351 | 0.008 | 0.000 |
| 5.8056 | 0.061 | 0.358 | 0.010 | 0.000 |
| 5.9111 | 0.061 | 0.364 | 0.012 | 0.000 |
| 6.0167 | 0.061 | 0.371 | 0.013 | 0.000 |
| 6.1222 | 0.061 | 0.377 | 0.014 | 0.000 |
| 6.2278 | 0.061 | 0.384 | 0.015 | 0.000 |
| 6.3333 | 0.061 | 0.390 | 0.016 | 0.000 |
| 6.4389 | 0.061 | 0.397 | 0.017 | 0.000 |
| 6.5444 | 0.061 | 0.403 | 0.018 | 0.000 |
| 6.6500 | 0.061 | 0.410 | 0.018 | 0.000 |
| 6.7556 | 0.061 | 0.417 | 0.019 | 0.000 |
| 6.8611 | 0.061 | 0.423 | 0.020 | 0.000 |
| 6.9667 | 0.061 | 0.430 | 0.021 | 0.000 |
| 7.0722 | 0.061 | 0.436 | 0.023 | 0.000 |
| 7.1778 | 0.061 | 0.443 | 0.024 | 0.000 |
| 7.2833 | 0.061 | 0.449 | 0.025 | 0.000 |
| 7.3889 | 0.061 | 0.456 | 0.026 | 0.000 |
| 7.4944 | 0.061 | 0.462 | 0.027 | 0.000 |
| 7.6000 | 0.061 | 0.469 | 0.028 | 0.000 |
| 7.7056 | 0.061 | 0.475 | 0.029 | 0.000 |
| 7.8111 | 0.061 | 0.482 | 0.029 | 0.000 |
| 7.9167 | 0.061 | 0.488 | 0.030 | 0.000 |
| 8.0222 | 0.061 | 0.495 | 0.031 | 0.000 |
| 8.1278 | 0.061 | 0.501 | 0.032 | 0.000 |
| 8.2333 | 0.061 | 0.508 | 0.032 | 0.000 |
| 8.3389 | 0.061 | 0.514 | 0.033 | 0.000 |
| 8.4444 | 0.061 | 0.521 | 0.034 | 0.000 |
| 8.5500 | 0.061 | 0.527 | 0.212 | 0.000 |
| 8.6556 | 0.061 | 0.534 | 1.005 | 0.000 |
| 8.7611 | 0.061 | 0.540 | 2.097 | 0.000 |
| 8.8667 | 0.061 | 0.547 | 3.298 | 0.000 |
| 8.9722 | 0.061 | 0.553 | 4.417 | 0.000 |
| 9.0778 | 0.061 | 0.560 | 5.294 | 0.000 |
| 9.1833 | 0.061 | 0.566 | 5.864 | 0.000 |
| 9.2889 | 0.061 | 0.573 | 6.333 | 0.000 |
| 9.3944 | 0.061 | 0.579 | 6.741 | 0.000 |
| 9.5000 | 0.061 | 0.586 | 7.126 | 0.000 |
| 9.6056 | 0.061 | 0.592 | 7.492 | 0.000 |
| 9.7111 | 0.000 | 0.000 | 7.840 | 0.000 |

# Analysis Results

## POC 1




+ Predeveloped    x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 1.142
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 0.321
Total Impervious Area: 0.822

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

| **Return Period** | **Flow(cfs)** |
|---|---|
| 2 year | 0.021786 |
| 5 year | 0.03339 |
| 10 year | 0.041338 |
| 25 year | 0.051537 |
| 50 year | 0.059196 |
| 100 year | 0.06688 |

Flow Frequency Return Periods for Mitigated. POC #1

| **Return Period** | **Flow(cfs)** |
|---|---|
| 2 year | 0.01002 |
| 5 year | 0.019342 |
| 10 year | 0.028279 |
| 25 year | 0.043613 |
| 50 year | 0.058613 |
| 100 year | 0.07729 |

## Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

| **Year** | **Predeveloped** | **Mitigated** |
|---|---|---|
| 1949 | 0.008 | 0.005 |
| 1950 | 0.029 | 0.019 |
| 1951 | 0.017 | 0.015 |
| 1952 | 0.015 | 0.005 |
| 1953 | 0.017 | 0.005 |
| 1954 | 0.026 | 0.017 |
| 1955 | 0.039 | 0.024 |
| 1956 | 0.028 | 0.025 |
| 1957 | 0.036 | 0.005 |
| 1958 | 0.026 | 0.015 |

| | | |
|---|---|---|
| 1959 | 0.022 | 0.016 |
| 1960 | 0.022 | 0.005 |
| 1961 | 0.021 | 0.018 |
| 1962 | 0.024 | 0.005 |
| 1963 | 0.036 | 0.005 |
| 1964 | 0.021 | 0.006 |
| 1965 | 0.021 | 0.015 |
| 1966 | 0.011 | 0.005 |
| 1967 | 0.029 | 0.015 |
| 1968 | 0.031 | 0.017 |
| 1969 | 0.014 | 0.012 |
| 1970 | 0.016 | 0.006 |
| 1971 | 0.023 | 0.026 |
| 1972 | 0.022 | 0.005 |
| 1973 | 0.016 | 0.007 |
| 1974 | 0.019 | 0.017 |
| 1975 | 0.017 | 0.005 |
| 1976 | 0.017 | 0.015 |
| 1977 | 0.013 | 0.004 |
| 1978 | 0.017 | 0.005 |
| 1979 | 0.048 | 0.004 |
| 1980 | 0.018 | 0.005 |
| 1981 | 0.019 | 0.004 |
| 1982 | 0.022 | 0.016 |
| 1983 | 0.019 | 0.014 |
| 1984 | 0.021 | 0.020 |
| 1985 | 0.029 | 0.024 |
| 1986 | 0.073 | 0.025 |
| 1987 | 0.030 | 0.021 |
| 1988 | 0.016 | 0.011 |
| 1989 | 0.021 | 0.005 |
| 1990 | 0.022 | 0.006 |
| 1991 | 0.023 | 0.016 |
| 1992 | 0.016 | 0.006 |
| 1993 | 0.011 | 0.005 |
| 1994 | 0.009 | 0.010 |
| 1995 | 0.021 | 0.019 |
| 1996 | 0.040 | 0.024 |
| 1997 | 0.087 | 0.170 |
| 1998 | 0.015 | 0.009 |
| 1999 | 0.022 | 0.019 |
| 2000 | 0.011 | 0.014 |
| 2001 | 0.003 | 0.004 |
| 2002 | 0.022 | 0.024 |
| 2003 | 0.016 | 0.005 |
| 2004 | 0.024 | 0.009 |
| 2005 | 0.019 | 0.005 |
| 2006 | 0.047 | 0.027 |
| 2007 | 0.033 | 0.022 |
| 2008 | 0.064 | 0.019 |
| 2009 | 0.018 | 0.006 |

## Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

| Rank | Predeveloped | Mitigated |
|---|---|---|
| 1 | 0.0870 | 0.1698 |
| 2 | 0.0726 | 0.0275 |
| 3 | 0.0640 | 0.0258 |

| | | |
|---|---|---|
| 4 | 0.0485 | 0.0255 |
| 5 | 0.0468 | 0.0249 |
| 6 | 0.0402 | 0.0243 |
| 7 | 0.0388 | 0.0242 |
| 8 | 0.0360 | 0.0239 |
| 9 | 0.0359 | 0.0238 |
| 10 | 0.0331 | 0.0217 |
| 11 | 0.0307 | 0.0211 |
| 12 | 0.0304 | 0.0199 |
| 13 | 0.0294 | 0.0193 |
| 14 | 0.0292 | 0.0192 |
| 15 | 0.0289 | 0.0192 |
| 16 | 0.0278 | 0.0192 |
| 17 | 0.0262 | 0.0177 |
| 18 | 0.0261 | 0.0174 |
| 19 | 0.0242 | 0.0168 |
| 20 | 0.0235 | 0.0167 |
| 21 | 0.0233 | 0.0162 |
| 22 | 0.0230 | 0.0161 |
| 23 | 0.0225 | 0.0158 |
| 24 | 0.0225 | 0.0153 |
| 25 | 0.0223 | 0.0152 |
| 26 | 0.0219 | 0.0148 |
| 27 | 0.0218 | 0.0147 |
| 28 | 0.0217 | 0.0147 |
| 29 | 0.0215 | 0.0142 |
| 30 | 0.0214 | 0.0137 |
| 31 | 0.0212 | 0.0116 |
| 32 | 0.0211 | 0.0113 |
| 33 | 0.0207 | 0.0103 |
| 34 | 0.0206 | 0.0086 |
| 35 | 0.0205 | 0.0085 |
| 36 | 0.0189 | 0.0067 |
| 37 | 0.0188 | 0.0059 |
| 38 | 0.0188 | 0.0057 |
| 39 | 0.0186 | 0.0057 |
| 40 | 0.0181 | 0.0057 |
| 41 | 0.0181 | 0.0056 |
| 42 | 0.0174 | 0.0054 |
| 43 | 0.0171 | 0.0054 |
| 44 | 0.0170 | 0.0054 |
| 45 | 0.0169 | 0.0054 |
| 46 | 0.0167 | 0.0053 |
| 47 | 0.0165 | 0.0053 |
| 48 | 0.0164 | 0.0052 |
| 49 | 0.0164 | 0.0052 |
| 50 | 0.0160 | 0.0051 |
| 51 | 0.0160 | 0.0050 |
| 52 | 0.0154 | 0.0050 |
| 53 | 0.0152 | 0.0050 |
| 54 | 0.0141 | 0.0049 |
| 55 | 0.0129 | 0.0049 |
| 56 | 0.0114 | 0.0048 |
| 57 | 0.0111 | 0.0048 |
| 58 | 0.0109 | 0.0045 |
| 59 | 0.0093 | 0.0045 |
| 60 | 0.0080 | 0.0043 |
| 61 | 0.0030 | 0.0036 |

## Duration Flows
The Facility PASSED

| Flow(cfs) | Predev | Mit | Percentage | Pass/Fail |
|---|---|---|---|---|
| 0.0109 | 5593 | 5204 | 93 | Pass |
| 0.0114 | 5053 | 4820 | 95 | Pass |
| 0.0119 | 4588 | 4446 | 96 | Pass |
| 0.0124 | 4167 | 4087 | 98 | Pass |
| 0.0128 | 3757 | 3702 | 98 | Pass |
| 0.0133 | 3372 | 3357 | 99 | Pass |
| 0.0138 | 3064 | 2994 | 97 | Pass |
| 0.0143 | 2777 | 2696 | 97 | Pass |
| 0.0148 | 2517 | 2356 | 93 | Pass |
| 0.0153 | 2281 | 2122 | 93 | Pass |
| 0.0158 | 2076 | 1869 | 90 | Pass |
| 0.0163 | 1862 | 1641 | 88 | Pass |
| 0.0167 | 1675 | 1437 | 85 | Pass |
| 0.0172 | 1528 | 1242 | 81 | Pass |
| 0.0177 | 1391 | 1056 | 75 | Pass |
| 0.0182 | 1275 | 877 | 68 | Pass |
| 0.0187 | 1170 | 740 | 63 | Pass |
| 0.0192 | 1067 | 608 | 56 | Pass |
| 0.0197 | 980 | 495 | 50 | Pass |
| 0.0202 | 896 | 404 | 45 | Pass |
| 0.0207 | 807 | 361 | 44 | Pass |
| 0.0211 | 731 | 323 | 44 | Pass |
| 0.0216 | 667 | 298 | 44 | Pass |
| 0.0221 | 616 | 274 | 44 | Pass |
| 0.0226 | 565 | 251 | 44 | Pass |
| 0.0231 | 528 | 227 | 42 | Pass |
| 0.0236 | 494 | 203 | 41 | Pass |
| 0.0241 | 467 | 160 | 34 | Pass |
| 0.0246 | 430 | 122 | 28 | Pass |
| 0.0250 | 407 | 104 | 25 | Pass |
| 0.0255 | 376 | 92 | 24 | Pass |
| 0.0260 | 357 | 84 | 23 | Pass |
| 0.0265 | 343 | 80 | 23 | Pass |
| 0.0270 | 326 | 76 | 23 | Pass |
| 0.0275 | 311 | 70 | 22 | Pass |
| 0.0280 | 288 | 67 | 23 | Pass |
| 0.0285 | 269 | 65 | 24 | Pass |
| 0.0289 | 256 | 61 | 23 | Pass |
| 0.0294 | 239 | 54 | 22 | Pass |
| 0.0299 | 229 | 48 | 20 | Pass |
| 0.0304 | 222 | 46 | 20 | Pass |
| 0.0309 | 211 | 43 | 20 | Pass |
| 0.0314 | 207 | 38 | 18 | Pass |
| 0.0319 | 198 | 32 | 16 | Pass |
| 0.0324 | 190 | 29 | 15 | Pass |
| 0.0328 | 184 | 26 | 14 | Pass |
| 0.0333 | 179 | 23 | 12 | Pass |
| 0.0338 | 173 | 20 | 11 | Pass |
| 0.0343 | 170 | 16 | 9 | Pass |
| 0.0348 | 167 | 16 | 9 | Pass |
| 0.0353 | 164 | 16 | 9 | Pass |
| 0.0358 | 160 | 16 | 10 | Pass |
| 0.0363 | 154 | 15 | 9 | Pass |

| | | | | |
|---|---|---|---|---|
| 0.0368 | 152 | 15 | 9 | Pass |
| 0.0372 | 149 | 15 | 10 | Pass |
| 0.0377 | 143 | 15 | 10 | Pass |
| 0.0382 | 140 | 15 | 10 | Pass |
| 0.0387 | 136 | 15 | 11 | Pass |
| 0.0392 | 131 | 15 | 11 | Pass |
| 0.0397 | 126 | 15 | 11 | Pass |
| 0.0402 | 120 | 15 | 12 | Pass |
| 0.0407 | 118 | 15 | 12 | Pass |
| 0.0411 | 116 | 15 | 12 | Pass |
| 0.0416 | 109 | 15 | 13 | Pass |
| 0.0421 | 106 | 15 | 14 | Pass |
| 0.0426 | 104 | 15 | 14 | Pass |
| 0.0431 | 103 | 14 | 13 | Pass |
| 0.0436 | 100 | 14 | 14 | Pass |
| 0.0441 | 98 | 14 | 14 | Pass |
| 0.0446 | 96 | 14 | 14 | Pass |
| 0.0450 | 95 | 14 | 14 | Pass |
| 0.0455 | 93 | 14 | 15 | Pass |
| 0.0460 | 89 | 14 | 15 | Pass |
| 0.0465 | 89 | 14 | 15 | Pass |
| 0.0470 | 85 | 14 | 16 | Pass |
| 0.0475 | 82 | 14 | 17 | Pass |
| 0.0480 | 81 | 14 | 17 | Pass |
| 0.0485 | 78 | 14 | 17 | Pass |
| 0.0489 | 77 | 14 | 18 | Pass |
| 0.0494 | 76 | 14 | 18 | Pass |
| 0.0499 | 71 | 14 | 19 | Pass |
| 0.0504 | 71 | 14 | 19 | Pass |
| 0.0509 | 71 | 14 | 19 | Pass |
| 0.0514 | 68 | 14 | 20 | Pass |
| 0.0519 | 68 | 14 | 20 | Pass |
| 0.0524 | 67 | 14 | 20 | Pass |
| 0.0529 | 64 | 14 | 21 | Pass |
| 0.0533 | 63 | 14 | 22 | Pass |
| 0.0538 | 61 | 14 | 22 | Pass |
| 0.0543 | 57 | 14 | 24 | Pass |
| 0.0548 | 56 | 12 | 21 | Pass |
| 0.0553 | 54 | 12 | 22 | Pass |
| 0.0558 | 52 | 12 | 23 | Pass |
| 0.0563 | 51 | 12 | 23 | Pass |
| 0.0568 | 49 | 11 | 22 | Pass |
| 0.0572 | 48 | 11 | 22 | Pass |
| 0.0577 | 45 | 11 | 24 | Pass |
| 0.0582 | 45 | 11 | 24 | Pass |
| 0.0587 | 42 | 11 | 26 | Pass |
| 0.0592 | 42 | 11 | 26 | Pass |

## Water Quality

Water Quality BMP Flow and Volume for POC #1

| | |
|---|---|
| On-line facility volume: | 0.0829 acre-feet |
| On-line facility target flow: | 0.1136 cfs. |
| Adjusted for 15 min: | 0.1284 cfs. |
| Off-line facility target flow: | 0.066 cfs. |
| Adjusted for 15 min: | 0.0746 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 | ☐ | 116.65 | | | ☐ | 0.00 | | | |
| Total Volume Infiltrated | | 116.65 | 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 = Passed |
| | | | | | | | | | |

# Model Default Modifications

Total of 0 changes have been made.

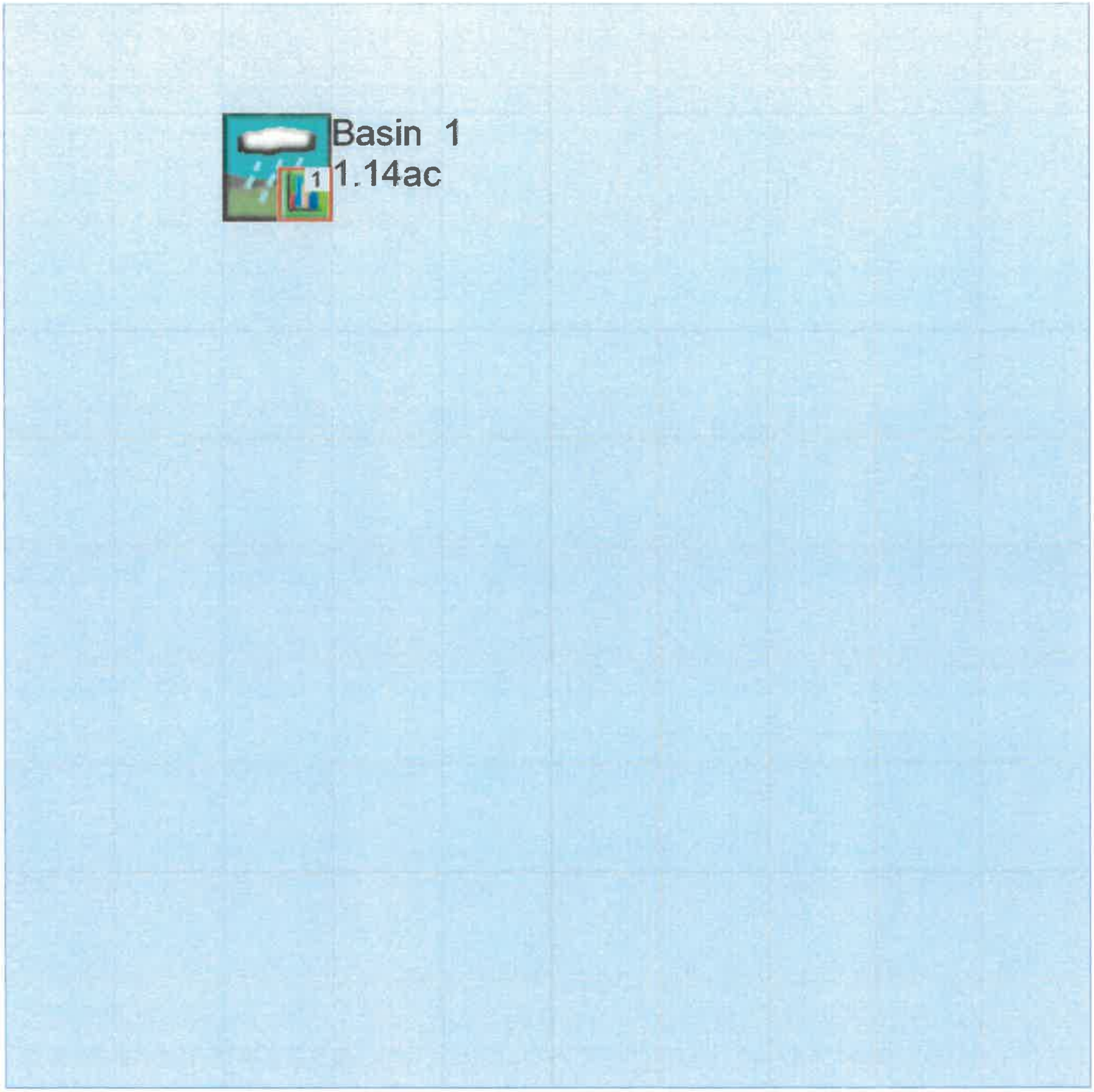
## PERLND Changes

No PERLND changes have been made.

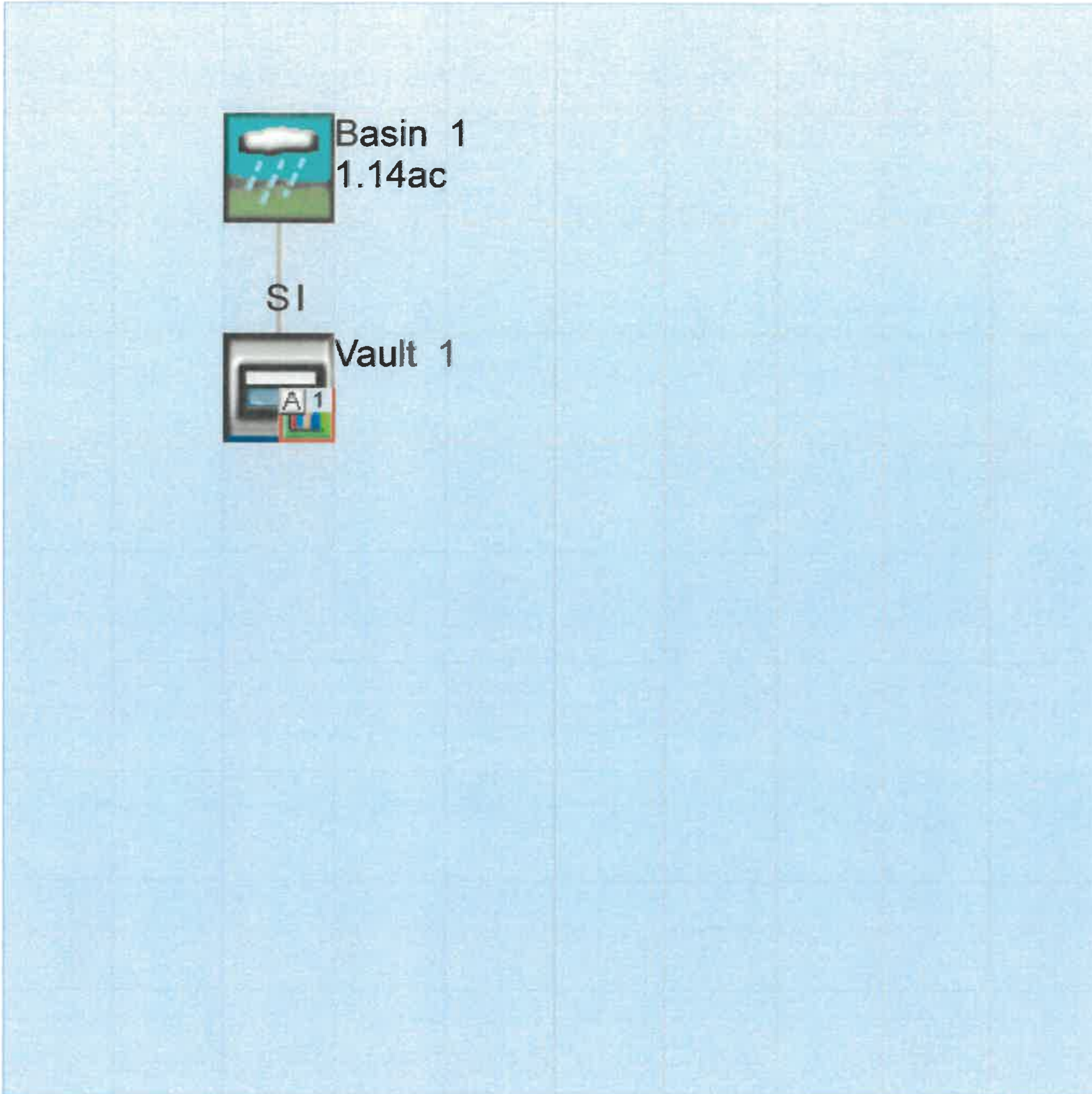
## IMPLND Changes

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   23116.wdm
MESSU      25   Pre23116.MES
           27   Pre23116.L61
           28   Pre23116.L62
           30   POC231161.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:60
      PERLND      10
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Basin  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           ***
   10      C, Forest, Flat        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 ***
   10         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  *********
   10         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 ***
   10          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
   10              0       4.5      0.08       400      0.05       0.5     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3          ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   10              0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                               ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   10            0.2       0.5      0.35         6       0.5       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
   10              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#   ***
Basin  1***
PERLND  10                     1.142     COPY   501     12
PERLND  10                     1.142     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   12.1        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    1          SUM  PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1          SUM  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     12.1       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   23116.wdm
MESSU      25   Mit23116.MES
           27   Mit23116.L61
           28   Mit23116.L62
           30   POC231161.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:60
      PERLND       7
      IMPLND       4
      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          ***
    7      A/B, Lawn, Flat         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 ***
    7         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  *********
```

```
    7          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 ***
    7         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
    7            0         5       0.8       400      0.05       0.3     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
    7            0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                                    ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
    7            0.1       0.5      0.25         0       0.7      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
    7            0         0         0         0         3         1         0
  END PWAT-STATE1

END PERLND

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

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

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    4         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     ***
    4         0    0    0    0    0
  END IWAT-PARM1

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

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
```

```
    # -  # ***PETMAX    PETMIN
    4           0         0
  END IWAT-PARM3

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

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Basin  1***
PERLND   7                       0.321     RCHRES   1      2
PERLND   7                       0.321     RCHRES   1      3
IMPLND   4                       0.822     RCHRES   1      5

******Routing******
PERLND   7                       0.321     COPY     1     12
IMPLND   4                       0.822     COPY     1     15
PERLND   7                       0.321     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   12.1        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
   92   4
     Depth      Area    Volume  Outflow1 Velocity  Travel Time***
      (ft)   (acres) (acre-ft)    (cfs)  (ft/sec)    (Minutes)***
  0.000000  0.061724  0.000000  0.000000
  0.105556  0.061724  0.006515  0.000793
  0.211111  0.061724  0.013031  0.001122
  0.316667  0.061724  0.019546  0.001374
  0.422222  0.061724  0.026061  0.001587
  0.527778  0.061724  0.032576  0.001774
  0.633333  0.061724  0.039092  0.001944
  0.738889  0.061724  0.045607  0.002099
  0.844444  0.061724  0.052122  0.002244
  0.950000  0.061724  0.058638  0.002380
  1.055556  0.061724  0.065153  0.002509
  1.161111  0.061724  0.071668  0.002632
  1.266667  0.061724  0.078183  0.002749
  1.372222  0.061724  0.084699  0.002861
  1.477778  0.061724  0.091214  0.002969
  1.583333  0.061724  0.097729  0.003073
  1.688889  0.061724  0.104245  0.003174
  1.794444  0.061724  0.110760  0.003272
  1.900000  0.061724  0.117275  0.003366
  2.005556  0.061724  0.123790  0.003459
  2.111111  0.061724  0.130306  0.003549
  2.216667  0.061724  0.136821  0.003636
  2.322222  0.061724  0.143336  0.003722
  2.427778  0.061724  0.149852  0.003805
  2.533333  0.061724  0.156367  0.003887
  2.638889  0.061724  0.162882  0.003967
  2.744444  0.061724  0.169397  0.004046
  2.850000  0.061724  0.175913  0.004123
  2.955556  0.061724  0.182428  0.004199
  3.061111  0.061724  0.188943  0.004273
  3.166667  0.061724  0.195459  0.004346
  3.272222  0.061724  0.201974  0.004418
  3.377778  0.061724  0.208489  0.004489
  3.483333  0.061724  0.215004  0.004558
  3.588889  0.061724  0.221520  0.004627
  3.694444  0.061724  0.228035  0.004694
  3.800000  0.061724  0.234550  0.004761
  3.905556  0.061724  0.241066  0.004827
  4.011111  0.061724  0.247581  0.004891
  4.116667  0.061724  0.254096  0.004955
  4.222222  0.061724  0.260612  0.005018
  4.327778  0.061724  0.267127  0.005081
  4.433333  0.061724  0.273642  0.005142
  4.538889  0.061724  0.280157  0.005203
  4.644444  0.061724  0.286673  0.005263
  4.750000  0.061724  0.293188  0.005323
  4.855556  0.061724  0.299703  0.005382
  4.961111  0.061724  0.306219  0.005440
  5.066667  0.061724  0.312734  0.005497
  5.172222  0.061724  0.319249  0.005554
  5.277778  0.061724  0.325764  0.005611
  5.383333  0.061724  0.332280  0.005667
```

```
  5.488889  0.061724  0.338795  0.005722
  5.594444  0.061724  0.345310  0.005777
  5.700000  0.061724  0.351826  0.008022
  5.805556  0.061724  0.358341  0.010513
  5.911111  0.061724  0.364856  0.012106
  6.016667  0.061724  0.371371  0.013384
  6.122222  0.061724  0.377887  0.014486
  6.227778  0.061724  0.384402  0.015471
  6.333333  0.061724  0.390917  0.016370
  6.438889  0.061724  0.397433  0.017204
  6.544444  0.061724  0.403948  0.017985
  6.650000  0.061724  0.410463  0.018723
  6.755556  0.061724  0.416978  0.019425
  6.861111  0.061724  0.423494  0.020095
  6.966667  0.061724  0.430009  0.021797
  7.072222  0.061724  0.436524  0.023301
  7.177778  0.061724  0.443040  0.024491
  7.283333  0.061724  0.449555  0.025548
  7.388889  0.061724  0.456070  0.026521
  7.494444  0.061724  0.462585  0.027433
  7.600000  0.061724  0.469101  0.028299
  7.705556  0.061724  0.475616  0.029126
  7.811111  0.061724  0.482131  0.029920
  7.916667  0.061724  0.488647  0.030686
  8.022222  0.061724  0.495162  0.031427
  8.127778  0.061724  0.501677  0.032146
  8.233333  0.061724  0.508192  0.032845
  8.338889  0.061724  0.514708  0.033526
  8.444444  0.061724  0.521223  0.034191
  8.550000  0.061724  0.527738  0.212691
  8.655556  0.061724  0.534254  1.005475
  8.761111  0.061724  0.540769  2.097811
  8.866667  0.061724  0.547284  3.298211
  8.972222  0.061724  0.553799  4.417300
  9.077778  0.061724  0.560315  5.294298
  9.183333  0.061724  0.566830  5.864593
  9.288889  0.061724  0.573345  6.333372
  9.394444  0.061724  0.579861  6.741814
  9.500000  0.061724  0.586376  7.126810
  9.605556  0.061724  0.592891  7.491989
  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    1          SUM  PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1          SUM  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      12.1      WDM    701 FLOW     ENGL      REPL
COPY   501 OUTPUT MEAN   1 1      12.1      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

## Legal Notice

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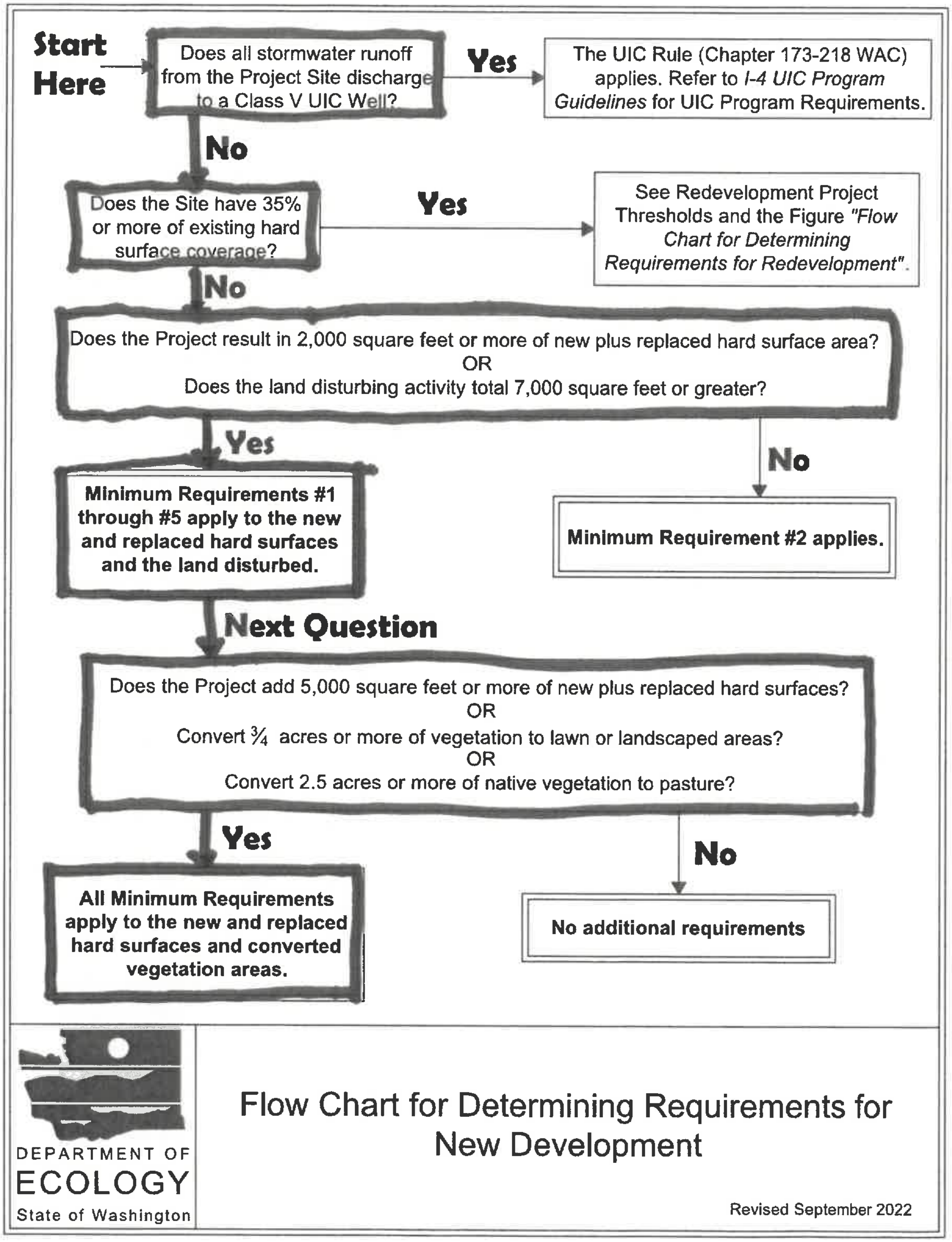
6200 Capitol Blvd. Ste F
Olympia, WA. 98501
Toll Free 1(866)943-0304
Local (360)943-0304

www.clearcreeksolutions.com

**Appendix B: Fig. I-3.1**

**Figure I-3.1: Flow Chart for Determining Requirements for New Development**

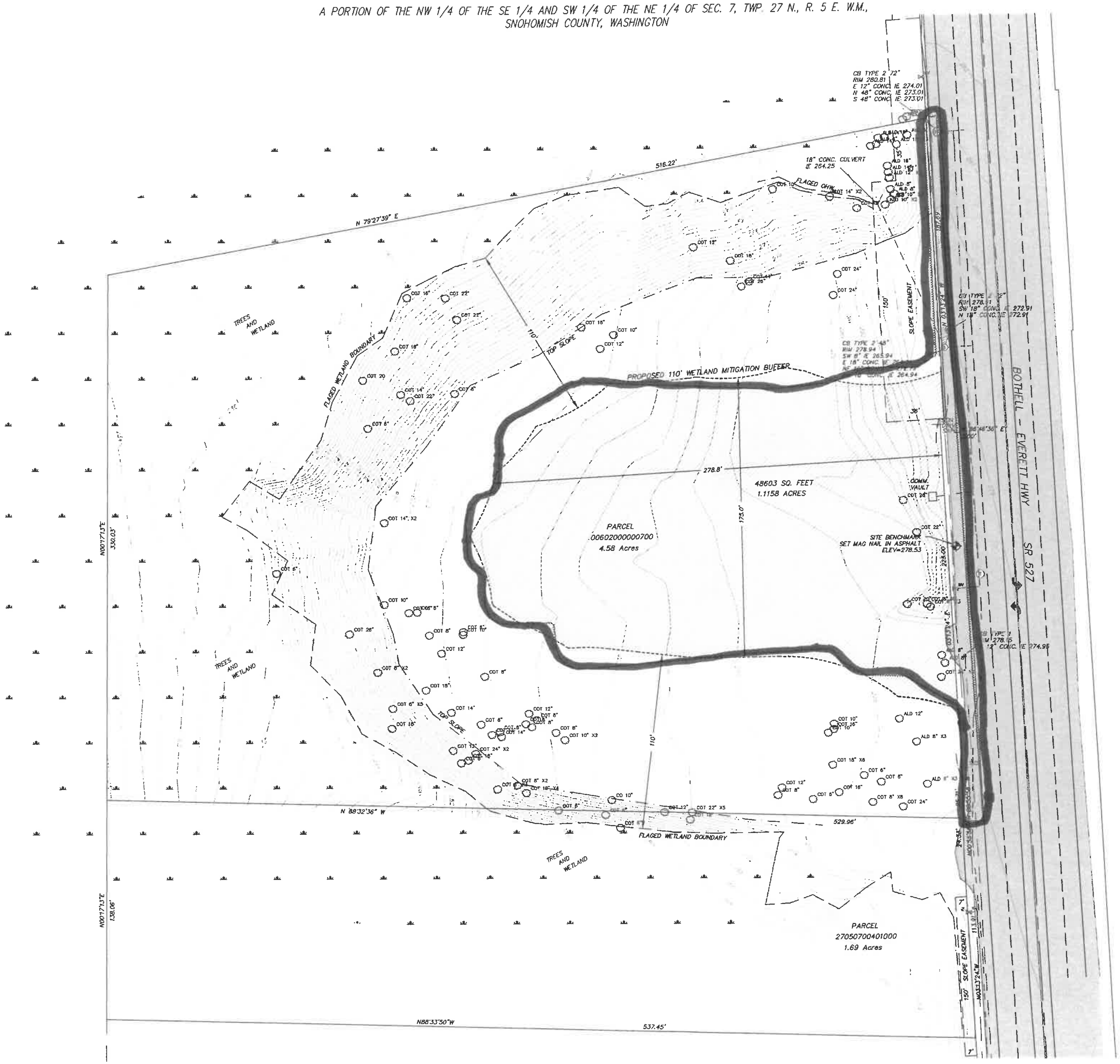


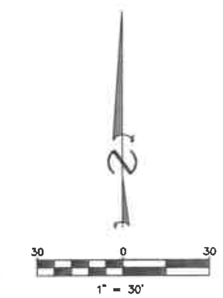
# Appendix C: Maps

# EXISTING CONDITIONS MAP

EXISTING MAP

A PORTION OF THE NW 1/4 OF THE SE 1/4 AND SW 1/4 OF THE NE 1/4 OF SEC. 7, TWP. 27 N., R. 5 E. W.M., SNOHOMISH COUNTY, WASHINGTON




OWNER
17200 Millcreek LLC
18632 29th Ave SE
Bothell, WA 98012

TAX PARCEL NUMBER
00602000000700

## LEGAL DESCRIPTION

TRACT 7, TWIN VALLEY GARDEN TRACTS, ACCORDING TO THE PLAT THEREOF RECORDED IN VOLUME 10 OF PLATS, PAGE 21, RECORDS OF SNOHOMISH COUNTY, WASHINGTON;

EXCEPT THAT PORTION CONVEYED TO THE STATE OF WASHINGTON BY DEED RECORDED UNDER AUDITOR'S FILE NO. 9205220328, RECORDS OF SNOHOMISH COUNTY, WASHINGTON.

## BASIS OF BEARING/HORIZONTAL DATUM:

WASHINGTON STATE PLANE COORDINATE SYSTEM ZONE NORTH NAD83/11 BASED PER WSRN GPS OBSERVATIONS.

## DATUM:

NAVD 88

PROJECT BENCHMARK

WSDOT CONTROL POINT GP31527-4AZ, FOUND BRASS DISK SET IN ROUND CONCRETE MONUMENT.

EL = 303.73

SITE BENCHMARK

SET MAG NAIL IN ASPHALT SHOULDER

EL = 278.53

LEGEND

- PP — UTILITY POLE
- WV — WATER VALVE
- FH — FIRE HYDRANT
- WATER METER BOX
- IRRIGATION CONTROL VALVE
- GV — GAS VALVE
- COMMUNICATION MANHOLE
- ELECTRIC BOX
- SIGN — STREET SIGN

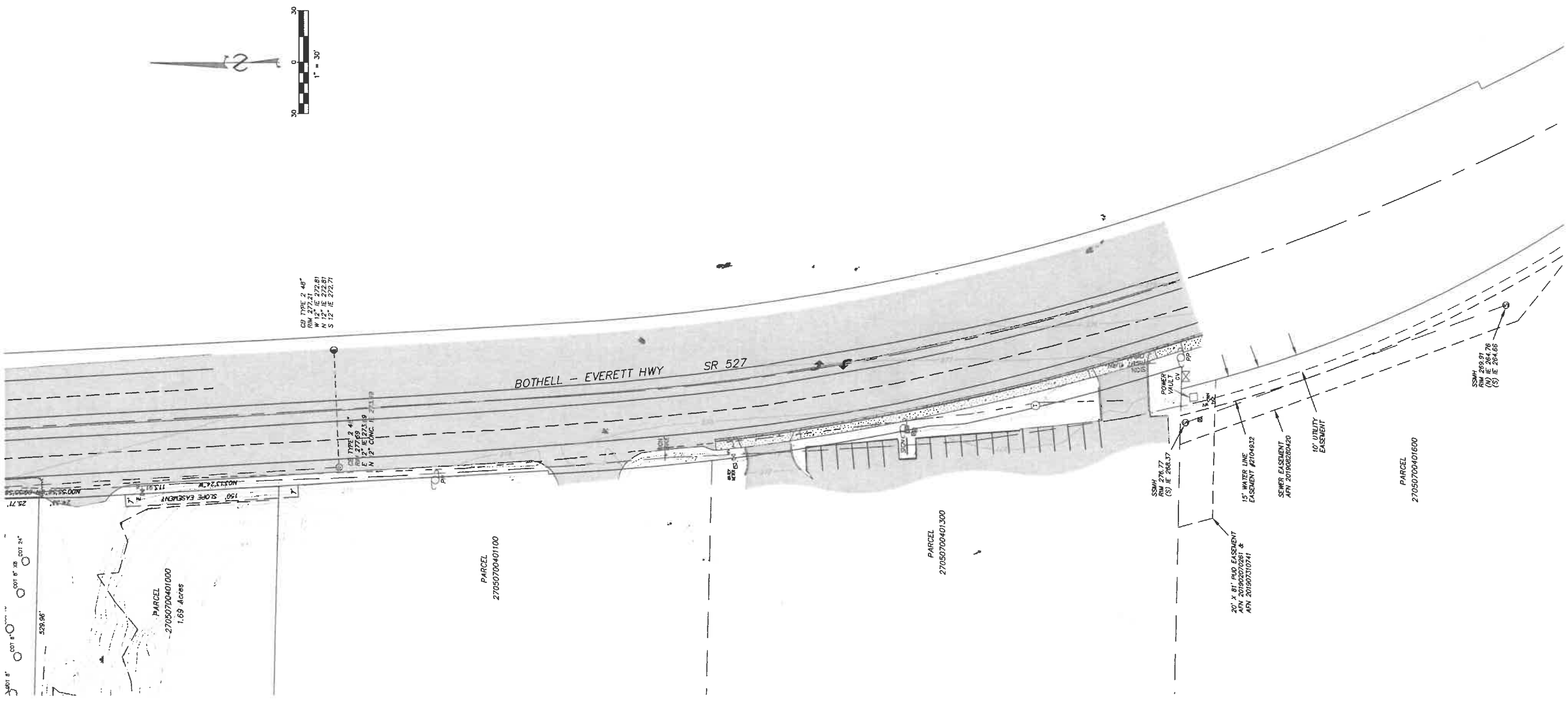
| date | revision/issued | by |
|---|---|---|

# BOUNDARY AND TOPOGRAPHIC SURVEY
## 17200 MILLCREEK LLC


D. R. DOWNING LAND SURVEYING, INC
4229 - 76th ST. N.E. #202
MARYSVILLE, WASHINGTON 98270 PHONE: (360) 653-5385


| | |
|---|---|
| dwn by: | S. Downing |
| ck by: | D. Downing |
| date: | 7/9/24 |
| job no. | 23-007 |
| SHEET NO. | 1 OF 2 SHTS. |

A PORTION OF THE NW 1/4 OF THE SE 1/4 AND SW 1/4 OF THE NE 1/4 OF SEC. 7, TWP. 27 N., R. 5 E. W.M.,
SNOHOMISH COUNTY, WASHINGTON




LEGEND

| | |
|---|---|
| PP | UTILITY POLE |
| WV | WATER VALVE |
| FH | FIRE HYDRANT |
| | WATER METER BOX |
| | IRRIGATION CONTROL VALVE |
| GV | GAS VALVE |
| | COMMUNICATION MANHOLE |
| | ELECTRIC BOX |
| SIGN | STREET SIGN |

BASIS OF BEARING/HORIZONTAL DATUM:

WASHINGTON STATE PLANE COORDINATE SYSTEM ZONE NORTH NAD83/11 BASED PER WSRN GPS OBSERVATIONS.

DATUM:

NAVD 88

PROJECT BENCHMARK

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EL = 303.73

SITE BENCHMARK

SET MAG NAIL IN ASPHALT SHOULDER

EL = 278.53

| date | revision/issued | by |
|---|---|---|

BOUNDARY AND TOPOGRAPHIC SURVEY
17200 MILLCREEK LLC


D. R. DOWNING LAND SURVEYING, INC
4229 - 76th ST. N.E. #202
MARYSVILLE, WASHINGTON 98270 PHONE: (360) 653-5385


dwn by: S. Downing
ck by: D. Downing
date: 7/9/24
job no. 23-007
SHEET NO. 2 OF 2 SHTS.

# DEVELOPED CONDITIONS MAP

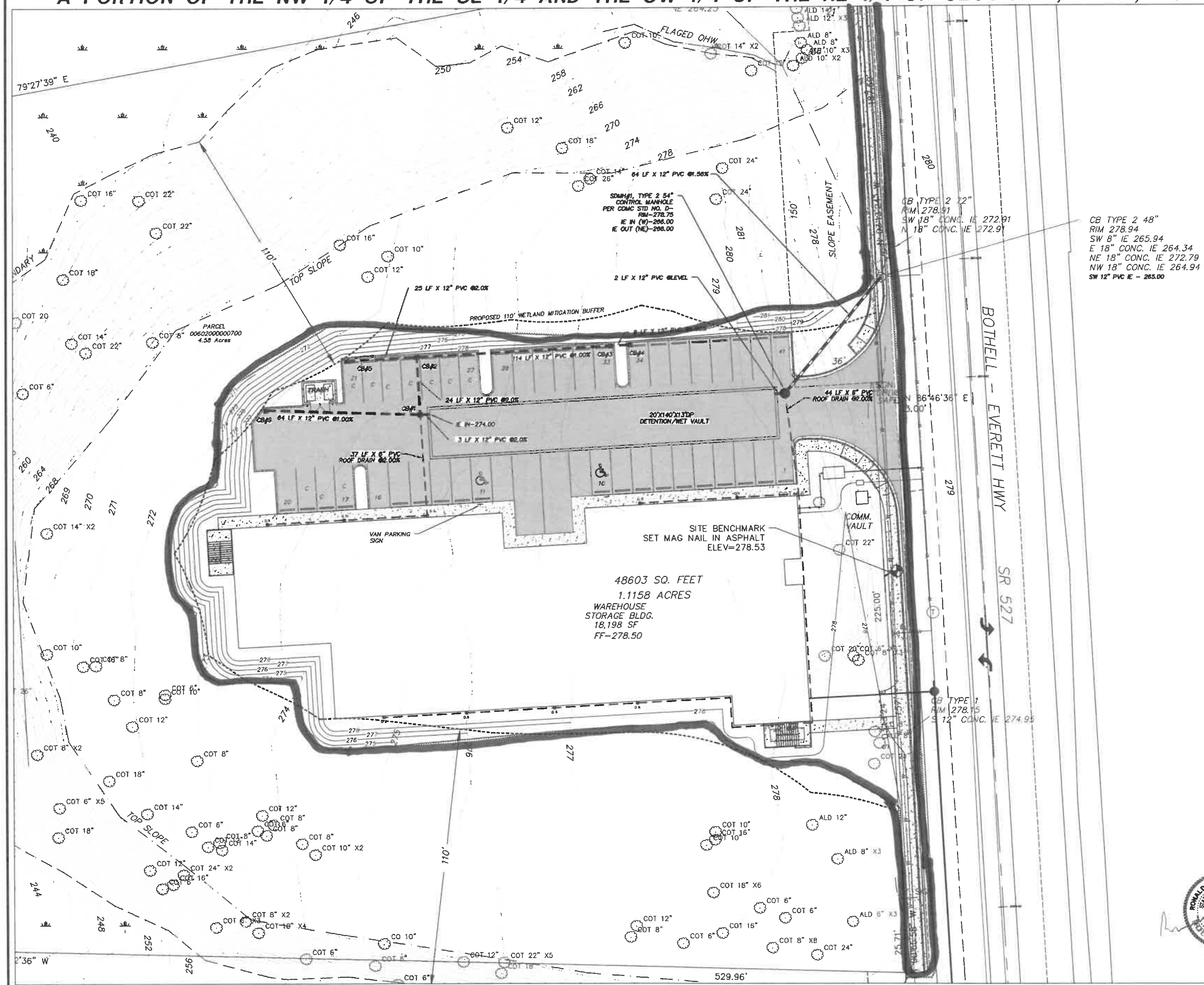
DEVELOPED MAP

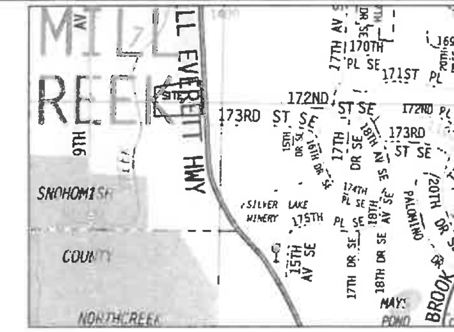
# 17200 MILLCREEK, LLC WAREHOUSE STORAGE FACILITY

## BINDING SITE PLAN PERMIT

## CITY OF MILL CREEK, WA

## A PORTION OF THE NW 1/4 OF THE SE 1/4 AND THE SW 1/4 OF THE NE 1/4 OF SECTION 7, T.27N., R.5E. W.M.




VICINITY MAP
N.T.S.

### PROJECT INFORMATION

| | |
|---|---|
| PROPERTY OWNER: | 17200 MILLCREEK, LLC<br>18632 29TH AVE SE<br>BOTHELL, WA 98012 |
| TAX PARCEL NUMBER: | 006020-000-007-00 |
| PROJECT ADDRESS: | 23613 51ST AVENUE SE<br>WOODINVILLE, WA 98072 |
| ZONING: | BP BUSINESS PARK |
| JURISDICTION: | CITY OF MILL CREEK |
| PARCEL ACREAGE: | 99,959 S.F. (2.295 ACRES) AS SURVEYED |

### LEGAL DESCRIPTION

TRACT 7, TWIN VALLEY GARDEN TRACTS, ACCORDING TO THE PLAT THEREOF RECORDED IN VOLUME 10 OF PLATS, PAGE 21, RECORDS OF SNOHOMISH COUNTY, WASHINGTON;

EXCEPT THAT PORTION CONVEYED TO THE STATE OF WASHINGTON BY DEED RECORDED UNDER AUDITOR'S FILE NO. 9205220328, RECORDS OF SNOHOMISH COUNTY, WASHINGTON.

### BASIS OF BEARINGS/HORIZONTAL DATUM

WASHINGTON STATE PLANE COORDINATE SYSTEM ZONE NORTH NAD83/11 BASED PER WSRN GPS OBSERVATIONS.

### GENERAL NOTES

1. THIS SURVEY WAS COMPLETED WITHOUT BENEFIT OF A CURRENT TITLE REPORT. EASEMENTS AND OTHER ENCUMBRANCES MAY EXIST ON THIS PROPERTY THAT ARE NOT SHOWN HEREON.
2. INSTRUMENTATION FOR THIS SURVEY WAS A 3-SECOND SPECTRAPRECISION FOCUS 35 TOTAL STATION AND AN EMLID REACH RS2 GPS RECEIVER. PROCEDURES USED IN THIS SURVEY MEET OR EXCEED STANDARDS SET BY WAC 332-130-090.
3. THE INFORMATION ON THIS MAP REPRESENTS THE RESULTS OF A SURVEY MADE IN MARCH 2022 & JANUARY 2023 AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THAT TIME.
4. UTILITIES SHOWN ON THIS SURVEY ARE BASED UPON ABOVE GROUND OBSERVATIONS AND AS-BUILT PLANS WHERE AVAILABLE. ACTUAL LOCATIONS OF UNDERGROUND UTILITIES MAY VARY AND UTILITIES NOT SHOWN ON THIS SURVEY MAY EXIST ON THIS SITE.
5. ALL MONUMENTS WERE LOCATED DURING THIS SURVEY UNLESS OTHERWISE NOTED.

### VERTICAL DATUM

NAVD 88

PROJECT BENCHMARK

WSDOT CONTROL POINT GP31527-4AZ, FOUND BRASS DISK SET IN ROUND CONCRETE MONUMENT.

EL = 303.73

SITE BENCHMARK

SET MAG NAIL IN ASPHALT SHOULDER

EL = 278.53

### LEGEND

| | |
|---|---|
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| WV | WATER VALVE |
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| | WATER METER BOX |
| | IRRIGATION CONTROL VALVE |
| GV | GAS VALVE |
| | COMMUNICATION MANHOLE |
| | ELECTRIC BOX |
| SIGN | STREET SIGN |

RONALD S. FREDERIKSEN STATE OF WASHINGTON PROFESSIONAL ENGINEER

10/10/2024

GRAPHIC SCALE
20' 0 20'
1"=20'

SEC.7 T.27N.R. 5E. W.M.

7

| REVISIONS | BY | DATE |
|---|---|---|



MILL CREEK WAREHOUSE FACILITY
CSWPPP PLAN

17200 MILL CREEK, LLC
ATTN: NITIN GOYAL
18632 29TH AVE SE
BOTHEL, WA 98012

ENGINEERS - SURVEYORS
EASTSIDE CONSULTANTS, INC.
1320 N.W. MALL ST., SUITE B
ISSAQUAH, WASHINGTON 98027
PH:(425)392-5351 FAX:392-4676

JOB NO. 23116
DATE 11/23
SCALE 1"=30'
DESIGNED R.S.F.
DRAWN R.S.F.
CHECKED S.KITZ
APPROVED R.S.F.

SHEET 8 OF 9

**Appendix D: Geotechnical Report**

# GEOTECHNICAL ENGINEERING STUDY

***For***

## 172XX WAREHOUSE

172XX BOTHELL EVERETT HWY
MILCREEK, WA

***Prepared For***

**17200 MILCREEK LLC.**
18632, 29TH AVE SE
BOTHELL, WA 98012

***Prepared By***


PGE Pacific Geo Engineering
*Geotechnical Engineering, Consulting & Inspection*
P.O. BOX 1419, ISSAQUAH, WASHINGTON 98027


**PGE PROJECT NUMBER 23-712**

February 17, 2024

February 17, 2024

Client: 17200 Millcreek LLC
18632, 29th Ave SE
Bothell, Snohomish County
WA 98012

Attn. Kyle Miller

Re: Geotechnical Engineering Study
Proposed Warehouse
172XX, Bothell Everett Hwy
Millcreek, WA 98122
PGE Project No. **23-712**

Dear Mr. Miller:

As per the request, Pacific Geo Engineering, LLC (PGE) has completed the geotechnical engineering study for the subject property in Everett, Washington, which is shown in Vicinity Map, Figure 1. This study is completed in accordance with the mutually agreed upon scope of services described in our final executed proposal no. 23-11-779, dated November 20th, 2023, which was authorized on November 28, 20203, by Mr. Nitin Goyal.

Our geotechnical engineering study report summarizes the results of our site reconnaissance, subsurface explorations, engineering analyses and evaluation, and engineering recommendations pertinent to the geotechnical aspect of the proposed development.

The primary purpose of our limited study was to explore the site to determine the depths of the existing fills and the underlying native soils in the site by digging test pits upto approximately 30 feet depth below the grades. A previous geotechnical engineering study was performed in this site by Nelson Geotechnical Associates on May 26, 2023 (NGA File No. 1434123), which included exploring the site by digging test pits upto approximately 9 to 11 feet depths below the current grades. These depths were not sufficient hence did not provide any definite answer on what depth the fills extend below the grades and where the native soils presence. Based on the research of the history of the site by NGA it was approximated by NGA that the fill depths may extend as much as 30 feet depth or so below the current grades. Based on this, the current study was initiated by the client to explore the site again with digging the test pits deeper upto 30 feet. However, with the current study by PGE still did not reveal the full thickness of the fills since the fills were found extending below 30 feet depth in the majority of the site, except in the southeast corner of the site where the fills were terminated at shallower depths and the native advice outwash sands were encountered at approximately 12 feet depth below the grades.

During our study, the fill and the native soils characteristics were evaluated, groundwater conditions were determined, and these data were used to supplement with geotechnical and geological information. The information obtained were used as a basis for formation of geotechnical recommendations for the design and construction of building foundations and floor slab, allowable bearing capacity value, site preparation, grading and earthwork, overexcavations, fill placement and compaction, and site drainage and erosion control measures. We have also evaluated the site's geological hazards such as the erosion, landslide, and seismic and the liquefaction susceptibility of the site soils under seismic conditions.

Our scope of services is planned to obtain as much subsurface information as possible within the time and budgetary constraints of the project. The scope of services was developed based on the preliminary understanding of the proposed development obtained from the owner and the project plans.

## 1.0 Proposed Development

The subject property is shown in Site & Exploration Plan, Figure 2. Based on the current plan the proposed warehouse will be a double-story building to be built at the current grades. Although no project specific design loads are presently available to us, based on our experience with similar commercial construction we anticipate that the continuous perimeter wall loads will be in the range of 6 to 8 kips per lineal foot, interior isolated column loads in the range of 50 to 60 kips.

The conclusions and recommendations contained in this report are based upon our current understanding of the project plan of the proposed development as described above. We recommend that PGE should be allowed to review the final plan set, for the design grades, the actual features of the proposed development, and the construction plans so that PGE can verify that our assumptions and recommendations made in this report are relevant to the final plan and that the conclusions and the recommendations provided in this report are incorporated into the final plan. This would help PGE to reevaluate and verify, and if necessary, to modify our recommendations provided in this report to address any discrepancies and changes between our recommendations and the final plan. We believe this is critical for the safety of the residence and the development, and helpful for project's success.

## 2.0 Scope of Services

This report addresses the geotechnical aspects of site development only. It does not address any buried tanks, septic systems, environmental, wetland, biological, or mold aspects of the site conditions, such as the potential presence of toxic or hazardous materials in the soil, surface water, groundwater, or air in and around this site. If the environmental aspects of site development need to be addressed, it should be done by a qualified environmental consultant.

Based on the scope of this geotechnical study delineated in the contract agreement, the following items are accomplished during this study.

## 2.1 Engineering Evaluation

The results from the field and laboratory tests were evaluated and engineering analyses were performed to develop the design information and the geotechnical engineering recommendations for the following items of the proposed development:

Soil & Groundwater Conditions

- Descriptions of the subsurface conditions, including the soil and the groundwater conditions;
- Soil Test Pit Logs;
- Depth to water table and any sign of high water table, if encountered;

General Site Development & Earthwork & Grading

- Earthwork including site preparation, temporary excavation, and fill placement and its compaction;
- Use of on-site soils as structural fills;
- Imported structural fills requirement guidelines;
- Temporary and permanent excavation slopes;
- Site drainage including permanent subsurface drainage systems and temporary groundwater control measures, if necessary;

Structure

- Foundation type recommendations;
- Allowable bearing capacity value for supporting the proposed footings of the new addition;
- Estimated total and differential settlements for the recommended bearing capacity value and observed soil conditions;
- Frictional and passive values for the resistance of lateral forces;
- Subgrade preparation for spread footings;
- Seismic design recommendations, including the site co-efficient as per ASCE7-16 Standard & 2018 IBC.

Geologic Hazard Mitigations

- Geologic hazards evaluation: erosion, seismic, and landslide;
- Erosion control measures;
- Liquefaction potential evaluation of native soil;
- Slope stability evaluation, based on site soil & groundwater conditions.

## 3.0 Surface and Subsurface Features

### 3.1 Site Location

The subject property is located on the west side of the Bothell Everett Highway, in Millcreek, Washington, as shown in Figure 1. The north, south, and the west of the subject property are bounded by vacant lands and the east by the highway. The subject property has access from the highway as can be seen in Figure 2.

### 3.2 Site Descriptions

The project site is located within a region dominated by single family residences, mixed used commercial buildings, and open vacant lands in the north, south and west. The site almost a level flat ground like a plateau and covered with grasses in the open areas and medium to large size trees and bushes around the north, south, and west perimeters of the site.

The site is an irregular shaped area, like a semi-circle with its base along the highway. The site has approximately 4.6 acres area. It is currently vacant and undeveloped. The site is almost a level ground where the proposed warehouse is planned, which slopes down with moderate to steep gradients in the range 26 to 45 degrees i.e., 58% to 100% gradients. The toe of the slope is relatively level ground. The plateau area is sparsely vegetated with grass, black berries in the middle open areas and underbushes, black berries, young trees, and large trees around the perimeter the middle area. The slopes are coved with heavy vegetations, comprised of a canopy of small to large trees and underbushes.

## 4.0 Field Investigation

Our field exploration was performed on December 5, 2023. A total of seven (7) test pits were excavated in the site. The test pit locations are shown in Figure 2 attached with this report. The locations of the test pits in Figure 2 should be considered accurate only to the degree implied by the measuring methods. The test pits were completed using a backhoe rented by PGE. Test pits were backfilled with loosely compacted excavated soils. The specific number, location, and depth of the test pits were selected in relation to the existing and proposed site features, accessibility, underground utility conflicts, purpose of evaluation, and budget considerations.

An experienced geologist from PGE observed the field exploration works including the test pit excavations, assist in sampling, continually logging the subsurface conditions in the test pits, collecting representative bulk samples from different soil layers at different depths of the test pits, visually-manually classifying the soil samples in the field according to the methods presented in ASTM D-2488-93 (based on the soil samples' density/consistency, moisture condition, grain size, and plasticity estimations) and the 'Key to Exploration Logs', and observing the pertinent site features. Samples were designated according to the test pit number and sampling depth, stored in watertight plastic containers, and later on transported to our laboratory for further visual examination and testing.

Results of the field investigation are presented in the later part of the report. The final descriptions of the soils were prepared with our observation and interpretation of the test pit excavation, visual examination of the samples in the field and later on in the laboratory. The soils were classified according to the methods presented on the Figure 'Key to Exploration Log'.

## 5.0 Soil and Groundwater Conditions

A topsoil layer of approximately 12 to 18 inches thickness covers the explored areas. The topsoils were consisted of black, silt, containing heavy roots and organics. The soils were in soft and wet conditions.

The topsoils were underlain by unconsolidated, soft to loose, saturated, uncontrolled fills.

Test pits, TP-1, TP-6, and TP-7 were excavated upto approximately 15 feet depth below the grades. The fills were found upto approximately 12 feet depth below the grades, and below this depth native, outwash, brown sand was encountered.

Test pits, TP-2 to TP-5 were excavated upto approximately 30 feet depth till the excavating machine boom max out its stretched length. The fills were found extending upto the bottom of these test pits. No native soil was observed at the bottom of the test depth hence it can be inferred that the fills extend below the test depths.

The fills were in general, consisted of dark grayish, silt, clay, with varying amounts of sand, gravels, and occasionally cobbles and boulders. However, the major constituents of the fills were small to large to very large sizes of asphalt and concrete pavement pieces, and some tires, metal parts, glasses, organic soils, peat, and other junk materials. The major issue encountered while digging the test pits was severe, large scale, caving that took place all the way from the top to the bottom of the test pits. In addition, groundwater table was encountered in the test pits at approximately 10 to 12 feet depths below the grades. The presence of groundwater worsened the stability condition of the fills when digging was progressing through the fills. A normal test pit excavation area was expanded to much larger in plan area due to the constant caving-in of the fills. Due to the continue cave-in situations and backfilling of the test pits with cave-in fills the excavations had to terminated. Based on some of the deeper test pits, the fills may be present even more than 30 feet depth maximum dug in this site.

We recommend that a drilling program using a truck-mounted mobile drilling rig may be considered in this site to drill deeper than 30 feet depth to determine the actual depths of the fills and the presence of native soils. However, it should be noted that the large asphalt and concrete pavement pieces may pose obstructions to the progress of the drilling through the pieces. A cave-in condition may also occur during the drilling.

Trace of gasoline was noticed in test pit TP-5 at approximately 15 feet depth below the grades, which was evidenced by the strong gasoline odor and visible sheen in the surface of one of the large piece of concrete sidewalk. The gasoline was not noticed in any other test pits within their exploration depths.

Groundwater Condition

Groundwater was noticed in the test pits during our exploration. The groundwater table was encountered in 10 to 12 feet depths below the grades. It is to be noted that fluctuations in the groundwater level and the amount may be expected due to the seasonal variations in the amount of rainfall, surface runoff, and other factors not apparent at the time of our explorations. Typically, the water level rises higher and the flow rates increase during the wet winter months. The possibility of the fluctuations and the presence of the groundwater should be considered when designing the proposed development.

The preceding discussion on the subsurface conditions of the site is intended as a general review to highlight the major subsurface stratification features and material characteristics.

The subsurface explorations excavated as part of this site evaluation indicate the subsurface conditions at the test pit locations only and as such differing subsurface conditions may be present away from the test pit locations in other unexplored areas of the site, because of the different nature of deposition and the alteration of topography by past grading and/or filling. The nature and extent of any variations between the test pit locations may not become fully evident until additional explorations are performed or until construction activities have begun.

## 6.0 Geologic Hazards – Sensitive Area Evaluation

The potential geologic hazards i.e., the landslide, seismic, and erosion in the subject property are evaluated, which are discussed in the following subsections.

### 6.1 Landslide Hazard

The majority of the site is a level flat, plateau however its rim around has steep downhill slopes with gradients in the range of 58 percent to 100 percent towards the north, west, and south side of the plateau. This is shown in Figure 2. As our soil explorations reveal the plateau and the slopes around the rim are underlain by uncontrolled fills. Based on the research of the historical aerial imagery of the property, the plateau was built during 1980's to early 1990's with placing the existing fills. In our opinion, given the presence of uncontrolled fills, groundwater, and the steep slopes, the possibility for elevated slope failure, soil creep, and erosion triggered sloughing off of slopes may occur in the event of extreme weather conditions or seismic activity.

Mitigation

The landslide hazards can be mitigated by adopting sufficient setback distance from the crest of the slope to the proposed warehouse and the parking area. Also, using of deep foundation support for the structure or altering the soil conditions in the fill area under the structure and the paved area would also help in reducing the steep slope hazard. The alteration of the existing fills includes overexcavation of the fills completely upto native soil depth and then backfilling the void areas with adequately compacted, imported, structural fills. These options are discussed later on in details.

### 6.2 Erosion Hazard

Typically, uncontrolled surface water with runoff over unprotected site surfaces during construction activities is considered the single most important factor that impacts the erosion potential of a site. The erosion process may be accelerated significantly when factors such as soils with high fines, sloped surface, and wet weather combines together. Taking into consideration the factors such as the presence of native soil with high fines and the wet winter months, the site is likely to experience severe erosion hazard in this site. However, if the disturbance of the existing ground due to the construction activity takes place during the dry summer months, the site is likely to have minor erosion hazard. It is our opinion that the erosion hazard potential of the site soils can be controlled and kept minimum if appropriate control measures that are recommended in the following section are implemented and maintained throughout the earthwork and the grading activities. Therefore, if the measures are adopted then the erosion hazard potential in this site will be not a limiting factor for the proposed development.

**Erosion Control Measures**

Excavation and construction of the project can readily be accomplished without adversely impacting the site and surrounding properties by exercising care and being proactive with the maintenance and potential upgrading of the erosion control system through the entire construction process.

Mitigation

All erosion sediment control measures must conform to the King County requirements. As a minimum, we recommend implementing the following erosion and sediment control Department of Ecology (DOE) best Management Practices (BMPs) prior to, during, and immediately after clearing and grading activities at the site.

- Mass grading activities and the earthwork should be completed within the dry summer period.
- Measurements such as the control of surface water must be maintained during construction.
- Any cut slopes and soil stockpiles should be covered with plastic during wet weather.
- Soil stockpiles should be minimized.
- Following rough grading, it may be necessary to mulch or hydroseed bare areas that will not be immediately covered with landscaping or an impervious surface.
- Vegetation clearing must be kept very limited within the proposed constriction area to reduce the exposed surface areas. It is recommended that following the clearing of the vegetations, grading the open exposed areas should be covered with mulch or hydro seed.
- No disturbance or removal of the existing vegetations, tress, and undergrowths should be made beyond the proposed construction area and the vegetation clearing limit.
- Limit disturbance to areas where construction is imminent. If possible, site clearing and grading should be performed in stages, with successive stages not being cleared until erosion control measures for the previous stages are in place.
- Determine staging areas for temporary stockpiles of excavated soils as part of the excavation planning.
- One of the most important considerations, particularly during wet weather, is to immediately cover any bare soil areas to prevent accumulated water or runoff from the work area from becoming silty in the first place.
- Provide temporary cover for denuded areas including cut slopes and soil stockpiles during periods of inactivity. From October 1 to April 30, no soil shall remain un-stabilized for more than 48 hours. From May 1 to September 13, no soil shall remain un-stabilized for more than seven days. Temporary cover may consist of straw mulch or plastic sheeting that is securely anchored to the ground surface. Plastic covering should be placed and anchored, as specified in BMP C123 provided in Chapter 4.1 of the Stormwater Management Manual for Western Washington. Mulching should be conform to the guide lines outlined in the BMP C121 provided in Chapter 4.1 of the Stormwater Management Manual for Western Washington
- Establish permanent covers for exposed areas that will not be worked for period of 30 days or more by seeding in conjunction with a mulch cover or appropriate hydroseeding. Seeding should conform

to the specifications outlined in BMP C120 provided in Chapter 4.1 of the Stormwater Management Manual for Western Washington.

- The temporary erosion control measures needed during the site development will depend heavily on the weather conditions that are encountered during the site work.
- Temporary erosion and sedimentary control (TESC) plan, as a part of the Best Management Practices (BMP) must be developed and implemented as well. The TESC plan should include the use of geotextile barriers (silt fences) along any down-slope, straw bales to de-energize downward flow, controlled surface grading, limited work areas, equipment washing, storm drain inlet protection, and sediment traps. The TESC plan may need to be reviewed and modified periodically to address the changing site conditions during ongoing progress of the construction and the weather.
- A permanent erosion control plan is to be implemented following the completion of the construction. Permanent erosion control measurements such as establishment of landscaping, replantation of trees and groundcover vegetations as soon as feasible in areas that are necessarily disturbed by earthwork activities, control of downspouts and surface drains, control of sheet flow over the excavation slope, prevention of discharging water over the excavation slope and at the toe of the slope are to be implemented following the completion of the construction.
- Install temporary or permanent tightline pipes, where necessary and practical, to convey stormwater from above slope to appropriate downslope facilities on flatter terrain.
- Install permanent stormwater runoff diversion systems, such as swales, curbs, berms, or pipes, to prevent flow directly over any final slope grades.
- 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-graining 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.

Containment

- Install a silt fence along the downhill side of the construction area that will be disturbed. The silt fence should be placed before cleaning and grading is initiated and should conform to the specifications outlined in BMP C233 provided in Chapter 4.2 of the Stormwater Management Manual for Western Washington.
- Construct interceptor dikes and shallow drainage swales to intercept surface water flow and route the flow away from the construction tare to be stabilized and approved point of controlled discharge. Some small detention ponds with pipe slope drains may be incorporated with the swales in order to collect and transport the runoff to the discharge point.
- Provide on-site sediment retention for collected runoff. Runoff should not flow freely over the top of the slope or off the site.

- The on-site contractor should perform daily review and maintenance of all erosion and sedimentation control measures at the site to ensure their proper working order.

Provided the recommended erosion and sedimentation control BMP's are properly implemented and maintained, it is our opinion that the planned development will not increase the potential for erosion at the site or on adjacent properties.

## 6.3 Seismic Hazard

Liquefaction Potential

Earthquake-induced geologic hazards may include liquefaction, lateral spreading, slope instability, and ground surface fault rupture. Liquefaction is a phenomenon, which takes place due to the reduction or complete loss of soil strength due to an increase in pore water pressure in cohensionless soils during the seismic vibrations induced by a major earthquake event. Liquefaction primarily affects geologically recent deposits of loose, fine-grained sands and granular silts that are below the groundwater table.

Based on the fills and groundwater conditions encountered in the subject site, it our opinion that the site may experience liquefaction during major earthquake event. The presence of loose, saturated, silt, clay, and sand mixture with ground water would likely trigger liquefaction in this site, which in turn may cause settlement of the ground known as dynamic settlement. The dynamic settlement, if exceeds the allowable design limits, may cause the structure to undergo differential settlement resulting cracks in the foundation, slabs, walls, and paved areas. This may require major maintenances.

Mitigation

Similar to the landslide hazard, the liquefaction hazard can also be mitigated by supporting the structure using deep foundation or altering the soil conditions in the fill area for the structure and the paved area. The alteration of fills includes overexcavation of the fills to native soil depth and then backfilling of the void areas with adequately compacted, imported, structural fills.

Regional Seismicity

The site is located in the Puget Sound region of western Washington, which is seismically active. Seismicity in this region is attributed primarily to the interaction between the Pacific, Juan de Fuca and North American plates. The Juan de Fuca plate is subducting beneath the North American plate at the Cascadia Subduction Zone (CSZ). This produces both intercrustal (between plates) and intracrustal (within a plate) earthquakes. In the following sections we discuss the design criteria and potential hazards associated with the regional seismicity. Provided the design criteria listed below are followed, the proposed structure should have no greater seismic risk damage than other appropriately designed structures in the Puget Sound area.

Seismic Site Class

Based on the NEHRP Site Class Map, the subject property is mapped as a seismic Site Class 'D'.

Seismic Design Parameters

As per the WA State Interactive Geologic Information Portal, Seismic Map, the NEHRP Seismic Site Class is mapped as Site Class 'D'. According to the SEA OSHPD Seismic Design Maps, and as per the 2016 ASCE 7-16 code standards, Table 20.3-1, for the seismic Site Class 'C', the following seismic design parameters should be used for the structural design of the building.

## 7.0 Conclusions and Recommendations

## 7.1 General

It should be noted that if the subsurface conditions are found to be different in the unexplored areas of the site than what it is found in the current explored areas then the recommendations provided in this report may need to be revisited and altered, to incorporate the changes if to be found on the subsurface conditions. This may calls for possible changes in the final design of the project as well. A contingency plan should be in place by the owner considering the above scenario.

We interpret the fills as 'uncontrolled and undocumented' fills, which are subjected to severe, unpredicted static settlement and dynamic settlement of unknown magnitude. Based on the above possibility, we propose two alternatives to consider as the foundations for the proposed structure.

Drilled Piers

We recommend that the areas in the site where the existing fill thicknesses are excessive, like in TP-2 to TP-5, a drilled pier foundation system would be better option to transfer the load from the structure to the 'competent' native strata. In these areas, the existing fill thicknesses are more than 30 feet hence their complete removal option is impractical and not cost-effective hence drilled pier seems better option. The warehouse should be fully supported on 16 to 24-inch diameter reinforced concrete piers, to be embedded a minimum of 10 feet depth into the competent native soils below the fills. An open-hole drilling method is likely a feasible option. Severe caving is expected while drilling for the piers hence pile casing will be required. The hole should be cleared of any sloughing materials from the surrounding fills and water prior to pouring concrete. The holes should not be left open for extended period and the concrete should be kept ready on-site for immediate pouring. If the drilled piers are to be used then the floor slab should be structural floor slab spanning between the piers and to be fully supported on the drilled piers. The drilled piers should be drilled through the existing fills and to bear directly on the firm and stable 'competent' native grade below the fills. The depth of the drilled piers cannot be recommended since the depths of the existing fills are unknown in the above test pit areas and in the remaining areas of the site.

Overerxcavation of Fills

This option with a ribbed mat foundation may be considered suitable in the area of the site where the fill thicknesses are approximately 12 feet, which is much less than the 30 feet. This option can be considered in the test pit TP-1, TP-6, and TP-7 areas.

In this option, the existing fills should be completely overexcavated upto the native soils. Then we recommend that a compacted 'fill pad' consisted of clean 2- to 4-inch rock spalls or 2-inch ballast rocks be placed above the native soils upto the height of approximately 5 feet below the current grades. The rock layer must be placed in individually compacted one-foot thick layer. Each layer must be compacted with a roller using static mode only to minimize cave in of the excavation faces to be triggered by the ground-borne vibration of the roller. The rolling will help rearranging the rocks and bringing each rock layer in non-yielding condition. The remaining void areas above the quarry spalls then be backlfilled with adequately compacted, clean, 5/8-inch crushed rock layer with less than 2 to 3 percent fines by weight of the material passing #200 sieve. A walk-behind, heavy-duty, big vibratory roller should be used for compaction of this layer. The layer must be compacted to minimum of 95 % of the fills' maximum dry density value to be determined based on the laboratory Modified Proctor test method ASTM D1557, as described in Section 7.2.11, 'Fill Placement and Compaction Requirements'.

Once the building pad is built, a heavily reinforced mat foundation with thickened edge is to be built. The rigid mat foundation is robust because of its structural nature, which has the increased stiffness, structural rigidity, and the flexural strength (because of the doubly reinforced layers placed near the top and bottom of the mat foundation). A mat foundation is essentially a very large spread footing that usually encompasses the entire footprint of the structure. Due to its larger size the mat foundation is able to transfer the building load into the underlying ground in a much reduced amount requiring a lower allowable bearing capacity value than a conventional spread footing would otherwise require to support the structure. The mat foundation is able to distribute the building load into the ground in a more uniform way to keep the settlement across the foundation in a more uniform way, hence lowering the amount of differential settlement.

We predict that the combination of the mat foundation and the 'fill pad' will help to reduce the static settlement to approximately 1 inch or less and the differential settlement to ½ inch or less, respectively. The combined system of mat foundation and the 'fill pad' is predicted to reduce the dynamic differential settlement across the mat foundation.

Paved Areas

Other hard surfaces such as paved areas, patios, or walkways that are supported on the underlying compressible soils have some risk of future settlement, cracking, and the need for maintenance. To reduce this risk, we recommend that over-excavation a minimum of 24 inches of the upper loose soils from these areas and replacing this material with adequately compacted structural fills consisted of clean, 5/8-inch crushed rock layer with less than 2 to 3 percent fines by weight of the material passing #200 sieve. The fills must be compacted with a roller using static mode only to minimize the ground borne vibration. The fills must be compacted o minimum of 95 % of the fills' maximum dry density value to be determined based on the laboratory Modified Proctor test method ASTM D1557, as described in Section 7.2.11, 'Fill Placement and Compaction Requirements'. The final native subgrade at the overexcavation depth should be proofrolled and compacted to a firm and unyielding condition prior to placing the structural fills following the recommendations provided in Section 7.2.4, 'Final Subgrade Preparation'. We recommend that a roller with static mode only will be used to minimize the ground-borne vibration. If the final native subgrade cannot be proofrolled adequately to achieve the firm and unyielding conditions due to the softness and wet condition of the subgrade soil at the over-excavation level, it might be necessary to place a layer of geo-grid such as Mirafi 500X or equivalent on the exposed surface prior to placing the fills. The final decision of using the geogrid layer should be decided on-site by the geotechnical engineer. The above recommendation is only for exterior hard surface to be supported on grade and does not apply for the interior of the building. However, the potential of long-term cracking of the hard surfaces would still exist and require repairs.

In addition to the above recommendations, we recommend that the hard surface sections such as concrete patios, or walkways should be thickened and reinforced with rebar to further reduce the effects of settlement due to the underlying compressible soils. However, the potential of long-term cracking of the hard surfaces would still exist and require repairs.

It is essential that an experienced geotechnical engineer should verify the final native subgrade, overexcavation, placing and compaction of 'fill pad', and allowable bearing pressure.

The horizontal limits of the fill placement under any load-bearing structure should extend laterally beyond the each side of the fill pad for a horizontal distance equal to the depth of the fill pad. This is to avoid the loading from the structure (which is assumed exerts pressure through an imaginary line at 1H:1V inclination or at $45^0$ angle from below the footings) to pass through the fill thickness instead the loading line to pass below the fill thickness.

The depths and the degree of the competence of the final native subgrades may be different across the site, which should be taken into consideration by the project contractor during the bidding process of the project. If the depth of the overerxcavation is greater than estimated in this report, we advise the owner to keep a contingency plan keep in-place in this regard. The greater overexcavation depth may also require temporary or permanent shoring of the excavations to protect the existing houses that are in proximity to the proposed building perimeter. We recommend the owner should also keep a contingency plan ready if the shoring is called for in this site. The actual depth of overexcavations to be required must be verified and approved on-site by the on-site geotechnical engineer. The redensification of the final native subgrades, preparation of the final native subgrades as 'competent' native subgrades, and the fill placement and compaction must be monitored and approved by the PGE's on-site geotechnical engineer prior to placing the footings, slab-on-grade floor, and concrete paved driveway, side-walk, and patio directly above the new fills.

The toposoils and the existing fills have high fines content and unsuitable materials hence cannot be considered as acceptable structural fills.

The remainder of this section (7.0) presents specific engineering recommendations on the pertinent geotechnical aspects that are anticipated for the design and construction of the proposed development. These recommendations should be incorporated into the final design and drawings, and construction specifications.

## 7.2 Site Preparation

Preparation of the site should involve clearing, stripping, subgrade preparation and proofrolling, cutting, filling, excavations, and drainage installations. The following paragraphs provide specific recommendations on these issues.

### 7.2.1 Clearing and Grubbing

Initial site preparation for construction of the proposed warehouse, driveway, parking area, any other load-bearing structure, and placing new fills on the subgrades should include stripping of vegetation and topsoil from the construction areas. Based on the topsoil thickness encountered at our test pit locations, we anticipate topsoil stripping depths of about 12 to 18 inches, however, thicker layers of topsoil may be present in unexplored portions of the site. It should be realized that if the stripping operation takes place during wet winter months, it is typical a greater stripping depth might be necessary to remove the near-surface moisture-sensitive silty soils disturbed during the stripping; therefore, stripping is best performed during dry weather period. Stripped vegetation debris should be removed from the site. Stripped organic topsoil will not be suitable for use as structural fill but may be used for future landscaping purposes.

### 7.2.2 Overexcavations

Once the clearing of the vegetations and the topsoils from the proposed development area will be completed, the overexcavations of the unsuitable fills can be initiated to establish the 'competent' native subgrades.

### 7.2.3 Redensification

After the clearing of the vegetations and topsoils, and following the completion of the overerxcavations upto the final subgrades of the paved areas, and other hard surfaces, as a part of the subgrade preparation, we recommend that all final subgrades that are supposed to be supporting the load-bearing structure should be redensified to enhance the in-situ density of the final native subgrades, improving their bearing capacity hence reducing their potentials of undergoing excessive settlement. Typically, the redensification is effective for the upper one to two feet of soil below the final native subgrades. The depth of the in-situ density increase depends on the compaction equipment to be used. Typically, the redensification of the final native subgrades is done using a big, heavy-weight, double-drum, vibratory roller. The redensification is achieved by having the compaction equipment make several passes as to be found necessary by the on-site geotechnical engineer. One pass is considered to consist of a passage of the compactor in each direction, forwards and backwards, over the same strip of subgrade. The redensification process should be carried out over the whole of the excavated "at grade" footing subgrade and slab-on-grade areas, and any other load-bearing structures such as the new fill pad and sidewalk.

### 7.2.4 Subgrade Preparation

Any exposed subgrades that are intended to provide direct support for new construction such as ribbed mat, paved areas, and other hard surfaces, should be adequately proofrolled to evaluate their conditions and to identify the presence of any isolated soft and yielding areas and to verify that stable subgrades are achieved to support the proposed structures, and any new fills. Proofrolling should be done with a loaded dump truck or a front-end loader or a big vibratory roller under the supervision of the PGE's on-site geotechnical engineer. If it is found by the on-site geotechnical engineer that the soil is too wet near the subgrade to be proofrolled or it not feasible to proofroll the subgrade, then an alternative method (i.e., visual evaluation and probing with a 1/2-inch diameter steel T-probe) can be used by the geotechnical engineer to identify the presence of any isolated soft and yielding areas and to verify that stable subgrades are achieved to support the proposed structures and any new fills.

If any subgrade area is found in soft and moist conditions, ruts and pumps excessively, and cannot be stabilized in place by compaction the affected soils should be over-excavated completely to firm and unyielding suitable bearing materials, and to be replaced with new structural fills to desired final native subgrade levels. If the depth of overexcavation to remove unstable soils becomes excessive, a geotextile fabric, such as Mirafi 500X or equivalent in conjunction with structural fills may be considered to achieve a firm bearing final subgrades to support the proposed structures and any new fills.

Any final native subgrades and foundation bearing surfaces should not be exposed to standing water. If water is present in the final native subgrades or in the base of the footing excavation, it must be removed completely to bring the subgrades into dry condition before placing any new fills and formwork and rebars. Protection of exposed soil, such as placing a 6-inch thick layer of crushed rock or a 3- to 4-inch layer of lean-mix concrete, could be used to limit disturbance to bearing surfaces.

If the base of an overerxcavated area is excessively soft and wet and needs stabilization then we recommend considering a 6 to 12-inch layer of ballast rock or quarry spalls should be placed to form a base on which the structural fill needs to be placed and compacted to achieve the final grade. Ballast rock should meet the requirements for Class B Foundation Material in Section 9-03.17 and quarry spalls should meet the requirements in Section 9-13.1(5) of the 2024 WSDOT Standard Specifications. The ballast rock or quarry spalls should be pushed into the subgrade with the back of a backhoe bucket or with the use of a large-vibratory steel drummed roller without the use of vibration. Such decision should be made the on-site geotechnical engineer during the actual construction of the project.

### 7.2.5 Backfilling of Test Pit Area

The loosely backfilled soils in the areas of exploratory test borings should be overexcavated completely to the firm native soils and backfilled with adequately compacted new, imported structural fills to the final grades, following the procedures described later on in Section 7.2.11, 'Fill Placement and Compaction Requirements' of this report. The new, imported structural fills should be granular materials like sand and gravel meeting the requirements provided in Section 7.2.10, 'Structural Fills' of this report. Prior to placing the new fills the final native subgrades at the bottom of the overexcavated areas must be proofrolled adequately to firm and unyielding conditions as recommended earlier in Section 7.2.4, 'Subgrade Preparation' of this report and accepted by PGE's on-site geotechnical engineer prior to placing new fills.

### 7.2.6 Dry Weather Construction

Since the near surface native soils have some fines content, we prefer the proposed construction should be completed during the dry season to mitigate any erosion related issues that may otherwise arise during the construction activities in the wet season. Erosion particularly happens, when uncontrolled surface runoff is allowed to flow over unprotected excavation areas of the site during the wet winter months.

### 7.2.7 Wet Weather Construction

If the construction takes place during the wet weather, the near surface alluvium (silt), which is anticipated as to be highly moisture sensitive, will be found highly susceptible to degradation and disturbed when get wet. Therefore, it may be necessary to adopt some remedial measures to enhance the subgrade conditions in this site if the construction takes place in the winter. The contractor should include a contingency in the earthwork budget for this possibility. The appropriate remedial measure is best determined by the geotechnical engineer during the actual construction of the project. The following remedial measures may be considered in this regard:

- The earth contractor must use reasonable care during site preparation and excavation so that the subgrade soils are remained firm, unyielding, and stable.
- Removal of the affected soil that is already wet exposing suitable bearing subgrades and replacing with imported free-draining materials as structural fills that can be compacted.
- Aeration of the surficial materials during favorable dry weather by methods such as scarifying or windrowing repeatedly and expose to sunlight to dry near optimum moisture content prior to placement and compaction
- Chemical modification of the subgrades with admixtures like hydrated lime or Portland cement, depending on the soil type.
- Limiting the size of areas that are stripped of topsoil and left exposed.
- Limiting construction traffic over unprotected soils.
- Sloping excavated surfaces to promote runoff.
- Limiting the size and type of construction equipment used.
- Providing gravel or quarry spalls "working mat" over areas of protected subgrade.
- Removing wet surficial soil prior to commencing fill placement each day.
- Sealing the exposed ground surface by rolling with a smooth drum compactor or rubber-tired roller at the end of each day.
- Providing upgradient perimeter ditches or low earthen berms and using temporary sumps to collect runoff and prevent water from ponding and damaging exposed subgrades.
- Mechanical stabilization with a coarse crushed aggregate (such as sand and gravel, crushed rock, or quarry spalls) compacted into the subgrade, possibly in conjunction with a geotextile fabric, such as Mirafi 500X.
- In the event earthwork takes place during the wet season, we recommend that special precautionary measurements should be adopted to minimize the impact of water and construction activities on the moisture sensitive soils.

- It is recommended that earthwork be progressed part by part in small sections to minimize the soil's exposure to wet weather. Traversing of construction equipment can cause considerable disturbance to the exposed subgrades, therefore, should be restricted within the specific drive areas. This will also prevent excessive widespread disturbance of the subgrades. Construction of a new working surface from an advancing working surface could be used to avoid trafficking the exposed subgrade soils.
- Any excavations or removal of unsuitable soils should be immediately followed by the placement of backfill or concrete in footings.
- At the end of each day, no loose on-site soils and exposed subgrades be left uncompacted or properly tamped, which will help seal the subgrade and thereby to minimize the potential for moisture infiltration into the underlying layers of fills or subgrades.
- In case site filling must proceed during wet weather the contractor should include a contingency in the earthwork budget for the possibility of using imported clean, granular fill. For general structural fill purposes, we recommend that using well-graded sand and gravel, such as 'Ballast' or 'Gravel Borrow' per 2024 WSDOT Standard Specifications 9-03.9(1) and 9-03.14(1), respectively. Alternatively, 'free-draining' soil similar to the one described earlier in the Structure Fill Table may also be considered suitable as filling material for the wet weather construction. This type of fill refers to soils that have a fines content of 5 percent or less (by weight) based on the minus ¾-inch soil fraction.

### 7.2.8 Subgrade Degradation Prevention

The near surface alluvium deposit (silt) containing high percentage of fines when will be used as subgrades will be susceptible to degradation during the wet weather conditions. To protect against subgrade degradation due to construction traffic we recommend a 'working mat' be placed over final prepared subgrades. We recommend this 'working mat' consists of 12 inches thick free draining materials consist of crushed rocks or quarry spalls, possibly in conjunction with a geotextile fabric, such as Mirafi 500X placed underneath the crushed rocks or quarry spalls layer. Construction traffic should be limited to these 'working mat' areas. The stabilization materials can be as per the requirements recommended later on in Section 7.2.10, 'Stabilization Materials'.

### 7.2.9 Reuse of Native Soils as Structural Fills

The ability to use native soils as structural fills, to be obtained during the mass grading activities, will depend on the factors such as the quality of the native soils, i.e., the presence of excessive roots and organics, fines content, larger-size particles, moisture content, soil types and their gradation, and the prevailing weather conditions during the time of the construction i.e., dry or wet weather. The weather plays a significant role in determining if the native soils can be compacted adequately during the wet weather period, especially when the native soils content higher percentages of fines.

Typically, native soils containing unsuitable materials such as the excessive roots and organics are not considered suitable for use as structural fills.

The native soils below the topsoils contain higher percentages of fines compared to the typical 'imported structural fills' that contains 5% or lesser fines, therefore considered as somewhat moisture sensitive soils. Typically, when the fines content (that portion passing the U.S. No. 200 sieve) of soil increases, the soil becomes increasingly sensitive to small changes in moisture content, which makes the soils' compaction more difficult or impossible. Soils containing more than about 5 percent fines by weight cannot be consistently compacted to the recommend degree when the moisture content is more than about 2 percent above or below the optimum. Especially, if the soils with higher fines content are used during the wet weather period, typically between October and May, significant reduction in the soils strength and support capabilities occur. Also, when these soils become wet they may be slow to dry and thus significantly retard the progress of grading and compaction activities. Therefore, the native soil cannot be used as structural fills during the wet weather period. However, this soil can be used as borrow materials for general filling purposes during the dry season, provided the optimum moisture content of the soils can be maintained during the compaction.

In addition to the higher percentage of fines, if the native soils are found in excessively over the optimum moisture content, then the soils would pose problems during their compaction. This may require moisture conditioning of the native soils prior to their placement and compaction.

Other criteria that is to be considered prior to use native soils as structural fills is the presence of significant amount of larger-size particles such cobbles and boulders. Typically, this type of soil is not considered suitable to use as structural fills, since the cobbles and the boulders pose problems during the compaction of the fills. Therefore, the native soils if considered to be used as borrow materials then the cobbles and the boulders must be removed from the native soils. This can be accomplished either by screening the native soils on-site or by selectively handpicking the larger-size particles, whichever methodology is feasible and economical. The PGE's on-site geotechnical engineer should inspect the final fill product to verify that the fills do not contain larger size particles. The final fills should contain a maximum of 2 to 3-inch particle diameter for being able to be adequately compacted.

The suitability of using the native soils should be verified and approved by the on-site geotechnical engineer prior to their use. If the native soils cannot be used after the inspection and asked by PGE's on-site geotechnical engineer to discard then imported new structural fills are to be brought in to the site for backfilling purposes. In the event that whether the fill materials are to be imported to the site, we recommend that the imported fill materials be verified and approved by the on-site geotechnical engineer prior to their use. We recommend that a contingency plan should be in place in the project budget if the native soils are to be exported out and new structural fills need to be imported into the site.

### 7.2.10 Structural Fill

General Requirements

The existing unsuitable fills cannot be reused as fills for any purposes. The existing fills must be disposed of by transporting away from the site to prevent their further use in the site. If there will be excavated native soils to be found containing topsoil, unsuitable materials such as excessive roots and organics, wood debris and pieces, trash, left over construction debris are not considered suitable for use as structural fills, and should be properly disposed off site.

For this site, we recommend that imported, new, structural fills should be used for backfilling purposes. The workability of material for use as structural fill will depend on the gradation and moisture content of the soil. Structural fill is defined as non-organic soil, free of any debris and deleterious materials, and well-graded and free-draining granular material, such as sand and gravel or crushed rock with a maximum particle size of 3 inches for any individual particle and less that 5 percent fines by weight based on the minus ¾-inch fraction. We recommend that washed crushed rock or select granular fill, as described below, be used for structural fill during wet weather. If prolonged dry weather prevails during the earthwork phase of construction, materials with somewhat higher fines content may be acceptable. Weather and site conditions should be considered when determining the type of import fill materials purchased and brought to the site for use as structural fill. Frozen material should not be used as structural fills. All materials should be approved by the project geotechnical engineer prior to use. A sample of each fill material type should be submitted to the project geotechnical engineer for evaluation and approval prior to use.

A typical gradation for structural fill is presented in the following table.

**Table 2 - Structural Fill**

| U.S. Standard Sieve Size | Percent Passing by Dry Weight |
|---|---|
| 3 inch | 100 |
| ¾ inch | 50 –100 |
| No. 4 | 25 – 65 |
| No. 10 | 10 – 50 |
| No. 40 | 0 – 20 |
| No. 200 | 5 Maximum* |

* Based on the ¾ inch fraction.

WSDOT Structural Fills

For reference purpose, the following table provides the specifications for various types of structural fills that can be considered in this site for use as new, imported structural fills.

| **Table 3 - WSDOT 2024 Structural Fills Specifications** | |
|---|---|
| Fill Type | Recommended Materials |
| Structural Fill | 9-03.9(1) Ballast<br>9-03.9(3) Crushed Surfacing Base Course<br>9-03-12(1)A Gravel Back fill for Foundation Class A<br>9-03.14(1) Gravel Borrow |
| Common Fill | Section 9-03.14(3) Common Borrow |
| Free-draining Granular Fill | 9-03.9(2) Permeable Ballast<br>9-03.12(2) Gravel Backfill for Walls<br>9-03.12(4) Gravel Backfill for Drains |

For most applications, we recommend that structural fill consist of material similar to 'Gravel Borrow' or 'Select Borrow' as described in Section 9-03.14(1) or Section 9-03.14(2), respectively, of the WSDOT 2024 Standard Specifications.

Select Granular Fill

Imported materials with gradation characteristics similar to WSDOT 2024 Standard Specification 9-03.9 (Aggregates for Ballast and Crushed Surfacing), or 9-03.14 (Gravel Borrow) is suitable for use as select granular fill, provided that the fines content is less than 5 percent (based on the minus ¾-inch fraction) and the maximum particle size is 6 inches.

Other Fill Materials

Other materials may also be considered suitable for use as structural fill provided they are approved by the project geotechnical engineer. Such materials typically used include clean, well-graded sand and gravel (pit-run); clean sand; various mixtures of gravel; crushed rock; controlled-density-fill (CDF, it should meet the requirements in Section 2-09.3(1)E of the WSDOT 2024 Standard Specifications); and lean-mix concrete (LMC). Recycled asphalt, concrete, and glass, which are derived from pulverizing the parent materials also potentially useful as structural fill in certain applications. These materials must be thoroughly crushed to a size deemed appropriate by the geotechnical engineer (usually less than 2 inches). The structural fills should have a maximum 2 to 3-inch particle diameter.

Pipe Bedding

Trench backfill to be placed beneath, adjacent to, and for at least 2 feet above utilities line should consist of well-graded granular material with a maximum particle size of 1 inch and less than 10 percent by dry weight passing the US Standard No. 200 Sieve, and should meet the standards of 'Gravel Backfill for Pipe Zone Bedding' described in Section 9-03.12(3) of the 2024 WSDOT Standard Specifications. Trench backfill must be free of debris, organic material and rock fragments larger than 1 inch.

Trench backfills

We recommend that the trench backfills to be placed 2 feet above the pipe and upto the final pavement subgrade level should be consisted of materials similar to 'Gravel Borrow' described in Section 9-03.14(1) or 'Select Borrow' as described in Section 9-03.14(2), of the 2024 WSDOT Standard Specifications. Trench backfill must be free of debris, organic material and rock fragments larger than 3 inch.

Stabilization Material

Stabilization rock should consist of pit or quarry run rock that is well-graded, angular, crushed rock consisting of 4- or 6-inch-minus material with less than 5 percent passing the US Standard No. 4 Sieve. The material should be free of organic matter and other deleterious material. WSDOT SS 9-13.(15) - Quarry Spalls can be used as a general specification for this material with the stipulation of limiting the maximum size to 6 inches.

**7.2.11 Fill Placement and Compaction Requirements**

Generally, quarry spalls, controlled density fills (CDF), lean mix concrete (LMC) do not require special placement and compaction procedures. In contrast, clean sand, crushed rock, soil mixtures and recycled concrete should be placed under special placement and compaction procedures and specifications described here.

The structural fills under structural elements should be placed in uniform loose lifts not exceeding 12 inches in thickness for a big, heavy-weight, double-drum, vibratory roller or a big, heavy-duty, hand-guided, walk-behind, vibratory plate compactor, and 4 to 6 inches in loose thickness when hand-guided equipment such as jumping jack or a vibratory plate compactor is used.

No heavy compaction equipment such as hoe pack or big vibratory roller should be used to compact the backfills to be placed behind footing stem walls, within the horizontal distance equal to the heights of the walls. Use of the heavy compaction equipment will impose excess surcharge load on the walls, which may cause permanent lateral instability to the walls. We recommend that the fills behind the footing stem walls should be placed in 4 inches lifts and to be compacted with a hand held smaller and lighter compaction equipment.

Each lift of fills whether 12 inches or 4 inches or 6 inches should be compacted to a minimum of 95 percent of the fill's maximum dry density as to be determined in the laboratory by ASTM Test Designation D-1557 (Modified Proctor) method, or to the applicable minimum City or County standard, whichever is the more conservative.

The fill should be moisture conditioned such that its final moisture content at the time of compaction should be at or near (typically within about 2 percent) of its optimum moisture content, as determined by the ASTM Test Designation D-1557 (Modified Proctor) method. This should help enhance the compatibility of the materials and avoid the risks involved with wet, moisture sensitive soils. Fills should not be placed on frozen subgrades.

If the fill materials are on the wet side of optimum, they can be dried by relatively inexpensively periodic windrowing and aeration or by intermixing lime or cement powder to absorb excess moisture. An ordinary Portland cement powder can be used in this regard. In using concrete we have found that the hydration of the cement not only results in water absorption, but also develops some "concrete-like" strength within the soil and cement matrix. In our experience the soil cement matrix can sometimes generates a compressive strength in excess of two thousand (2,000) psi. If this option is selected, we recommend that for a preliminary estimation purpose, the cement powder may be intermixed at a rate of about 3% by weight of the soil. The actual cement content should be decided during the mass grading activity depending on the wet weather, soils' natural moisture content, and the soil types. This form of soil treatment is not suitable for any type soils that are considered as free-daring backfills.

The compacted structural fill pad should extend outside all foundations and other load bearing structures elements for a minimum distance equal to the thickness of the fill pad.

Because of the sensitivity of this project we recommend that any and all structural fills and /or load bearing backfills be tested for determining the in-place density and the water content of the fills as per the Nuclear Density Gauge method (ASTM D6938). This test results will help to verify that the backfills have the achieved the appropriate degree of compaction and the moisture content. We recommend that compaction of the fills be tested periodically throughout the fill placement. A field compaction testing program should be prepared by the contractor with the assistance from the project geotechnical engineer. If field density tests indicate that the last lift of compacted fills has not been achieved the required percent of compaction or the surface is pumping and weaving under loading, then the fill should be scarified, moisture-conditioned to near optimum moisture content, re-compacted, and re-tested prior to placing additional lifts.

We recommend that a minimum of one test be performed for one hundred (100) square feet of compacted or backfill surface area or for every one hundred (100) cubic feet of fill or backfill, whichever generates the greater number of compaction tests.

We also recommend that to verify the compaction of the fill pad in both horizontal and vertical directions, when the fill thickness will be more than one foot, the compaction test locations and the elevations should be spaced in both directions. In this manner it should be possible to show with a reasonable degree of accuracy the "density profile" through the backfill. This is an important element of the QA/QC program of the project in the event there is a problem with the fill or backfill performance and subsequent litigation.

### 7.2.12 Site Drainage

Surface Drainage

The final site grades of the finished development must be such that surface runoff will flow by gravity away from the building and other structure, such as the pavement and sidewalks, using sloped and drainage gradients towards the local stormwater collection system. We recommend providing a minimum drainage gradient of about 2% for a minimum distance of about 10 feet from the building perimeter. Surface water should not be allowed to pond and soak into the ground surface near buildings or paved areas during or after constructions. A combination of using controlled surface drainage and capping of the building surroundings by concrete, asphalt, or low permeability silty soils will help minimize or preclude surface water infiltration around the perimeter of the building and beneath the garage basement floor slab. Paved areas should be graded to direct runoff to catch basins and or other collection facilities. Collected water should be directed to the on-site drainage facilities by means of properly sized smooth walled PVC pipe. Interceptor ditches or trenches or low earthen berms should be installed along the upgrade perimeters of the site to prevent surface water runoff from precipitation or other sources entering in to the lower area of the lot. It should be noted that surface water runoff from precipitation flows as a sheet flow over slope is considered to be the primary cause of surficial sloughing and triggering slope failure. Therefore, the surface drainage system should be designed in such a way that stormwater runoff over the finished lot must not create any sheet flow over the sloped areas of the site, instead, the stormwater runoff must be collected in drain pipes to discharge in approved discharge points at the toe of the slope. Surface drainage system and the water collection facilities should be designed by a professional civil engineer.

Footing Excavation Drain

Water must not be allowed to pond in the foundation excavations or on prepared subgrades either during or after construction. If due to the rainfall, runoff, seasonal fluctuations, groundwater seepage is encountered within footing depths, we recommend that the bottom of excavation should be sloped toward one corner to facilitate removal of any collected rainwater, groundwater, or surface runoff, and then direct the water to ditches, and to collect it in prepared sump pits from which the water can be pumped and discharged into an approved storm drainage system. Water handling needs will typically be lower during the summer and early fall months.

Footing Drain

Footing drains should be used where (1) crawl spaces or basements will be below a structure, (2) a slab below the outside grade, and (3) the outside grade does not slope downward from a building. To reduce the potential for groundwater and surface water to seep into the interior spaces of the building we recommend that an exterior footing drain system be constructed around the perimeter of the building footings. The drains must be laid with a gradient sufficient to promote positive flow by gravity to a controlled point of approved discharge. The foundation drains should be tightlined separately from the roof drains to this discharge point. Footing drains should consist of at least 6-inch diameter, heavy-walled, perforated PVC pipe or equivalent. The pipe should be surrounded by at least 6 inches of free-draining gravel over the pipe and 3 inches of free-draining gravel below the pipe. The free-draining material may consist of open-graded drain rocks consisted of ¾" minus washed gravels should be wrapped up by a non-woven geotextile filter fabric (Mirafi 140N) to limit the ingress of fines into the gravel and the pipe. The free-draining material should contain less than 2 percent by weight passing the U.S. Standard No. 200 sieve (based on a wet sieve analysis of that portion passing the U.S. Standard No. 4 sieve). The drains should be located along the outside perimeter of the spread footings or the footing stem walls. Also, the invert of the footing pipe should be placed at approximately the same elevation as the bottom of the footing or 12 inches below the adjacent floor slab grade, whichever is deeper, so that water will not seep through walls or floor slabs. The footing drains should discharge to an approved drain system and include cleanouts to allow periodic maintenance and inspection.

Downspout or Roof Drain

These should be installed once the building roof in place. They should discharge directly in tightlines to a positive, permanent stormwater collection system. Under no circumstances connect these tightlines to the perimeter footing drains. The drain is shown in Figure 5 of this report.

### 7.2.13 Permanent Cut and Fill Slopes

For permanent newly constructed cut and fill slopes, the side slopes should be laid back at a minimum slope inclination of 3H:1V or greater, depending on the soils to be encountered in any particular area of the site. The above slope inclination is especially required when the permanent slopes are built for holding the water in detention ponds, retention ponds. Designing the final slope grades in such a way would reduce the long-term raveling, sloughing, and erosion. Use of flatter slopes, such as 3.5H:1V or even much flatter would further reduce the long-term erosion and facilitate revegetation. The appropriate final slope gradients are to be decided based on the existing native slope gradients, soil conditions, and the desired final slope grades in any particular area of the slope. The on-site geotechnical engineer should observe the soil conditions during the construction can recommend appropriate slope inclination. Where the above slopes are not feasible, protective facings and/or retaining structures should be considered. All permanent slopes should be re-vegetated as soon as practical to reduce the surface erosion and sloughing. Temporary erosion protection described earlier in Subsection 6.2, 'Erosion Control Measures' of this report should be used until permanent protection is established.

### 7.2.14 Temporary Excavations

As we understand from the project plan that if the overerxcavations of existing fills option is chosen then a significant depth of overexcvation through the existing fills will be required for removing the unsuitable fills. The overexcavations depths may be 12 to 15 feet depth below the grades. The inclination of the overexcavation embankment should be made on-site when the actual excavation will take place as per the recommendations of on-site geotechnical engineer.

As a general rule, all temporary soil excavations in excess of 4 feet in height and less than 20 feet in depth, the side slopes should be adequately sloped back or properly shored in accordance with Safety Standards for Construction Work Part N, WAS 296-155-657 to prevent sloughing and collapse. It is extremely impossible to estimate any excavation slope inclination due to the unpredicted nature of the uncontrolled fills. However, estimation of the proper inclination of excavation side slopes should be made on-site after inspecting the soil and groundwater conditions, which will be revealed during the actual construction in the site. This is particular critical in this site since the excavation slopes in the uncontrolled fills cannot be predicted. All temporary soil cuts greater than 4 feet in height, if cannot be sloped back because of the limited horizontal distance to be available between the top of the excavation line and the property line, a properly shoring system is to be considered to prevent sloughing and collapse of the slope. Also, if severe cave-in is observed along the edge of the highway then also a temporary or permanent shoring of the excavations will be needed to prevent cave-in into the highway. We recommend the owner should keep a contingency plan ready if the shoring is called for in this site.

It should be recognized that slopes of the above gradients do ravel and require occasional maintenance. All temporary exposed slopes and excavations should be protected as soon as possible using appropriate methods to prevent erosion to occur during periods of wet weather. This can be achieved by installing a durable reinforced plastic membrane, jute matting, or other erosion control mats with proper anchorage to the ground. In addition, we recommend that experienced personnel of the contractor should regularly check the slope condition to notice if any signs of raveling or sloughing off is underway to prevent any catastrophic slope failure.

Any excavation side inclinations will assume that the ground surface behind the cut slopes is level, that surface loads from equipment and materials are kept a sufficient distance away from the top of the slope. If these assumptions are not valid, we should be contacted for additional recommendations. Flatter slopes may be required if soils are loose or caving and/or water, are encountered along the slope faces. If such conditions occur and the excavation cannot stand by itself, or the excavation slope cannot be flattened because of the space limitations between the excavation line and the boundary of the property, temporary shoring may be considered. The shoring will assist in preventing slopes from failure and provide protection to field personnel during excavation. Because of the diversity available of shoring stems and construction techniques, the design of temporary shoring is most appropriately left up to the contractor engaged to complete the installation. We can assist in designing the shoring system by providing with detailed shoring design parameters including earth-retaining parameters, if required.

Where sloped embankments are used, the top of the slopes should be barricaded to prevent vehicles and storage loads within 10 feet of the top of the slopes. Greater setbacks may be necessary when considering heavy vehicles, such as concrete trucks and cranes. If the temporary construction embankments are to be maintained during the rainy season, berms are suggested along the top of the slopes to prevent runoff water from entering the excavation and eroding the slope faces. All temporary slopes should be protected from surface water runoff.

The owner and the contractor should be aware that in no case should the excavation slopes be greater than the limits specified in local, state, and federal safety regulations, particularly, the Occupational Safety and Health Administration (OSHA) regulations in the "Construction Standards for Excavations, 29 CFR, part 1926, Subpart P, dated October 31, 1989" of the Federal Register, Volume 54, the United States Department of Labor. As mentioned above, we also recommend that the owner and the contractor should follow the local and state regulations such as WSDOT Section 2-09.3(3) B, Washington Industrial Safety and Health Act (WISHA), Chapter 49.17RCW, and Washington Administrative Code (WAC) Chapter 296-115, Part N. These documents are to better insure the safety of construction worker entering trenches or excavation. It is mandated by these regulations that excavations, whether they are for utility trenches or footings, be constructed in accordance with the guidelines provided in the above documents. We understand that these regulations are being strictly enforced and, if they are not closely followed, both the owner and the contractor could be liable for substantial penalties.

Stability of temporary excavations is a function of many factors including the presence of, and abundance of groundwater and seepage, the type and density of the various soil strata, the depth of excavation, surcharge loadings adjacent to the excavation, and the length of time and weather conditions while the excavation remains open. It is exceedingly difficult under these unknown and variable circumstances to pre-establish a safe and maintenance-free temporary excavation slope angle at this time of the study. We therefore, strongly recommend that all temporary, as well as permanent, cuts and excavations in excess of 4 feet be examined by a representative of PGE during the actual construction to verify that the recommended slope inclinations are appropriate for the actual soil and groundwater seepage conditions exposed in the cuts. If the conditions observed during the actual construction are different than anticipated during this study then, the proper inclination of the excavation and cut slopes or requirements of temporary shoring should be determined depending on the condition of the excavations and the slopes.

The above information is provided solely for the benefit of the owner and other design consultants, and under no circumstances should be construed to imply that PGE assumes responsibility for construction site safety or the contractor's activities; such responsibility is not being implied and should not be inferred. Therefore, the contractor is solely responsible for designing and constructing stable, temporary excavations and should shore, slope, or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. The contractor's "responsible person", as defined in 29 CFR Part 1926, should evaluate the soil exposed in the excavations as part of the contractor's safety procedures.

We expect that the excavation can be completed using conventional equipments such as bulldozers or backhoes.

#### 7.2.15 Utility Support and Backfill

Based on the soils encountered at the site within the exploration depths, the majority of the soils appear to be adequate for supporting utility lines; however, softer soils may be encountered at isolated locations, where, it should be removed to a depth that will provide adequate support for the utility. A major concern with utility lines is generally related to the settlement of the trench backfill along utility alignments and pavements. The trench backfill settlement causes misalignment of the utility lines and breaking apart of the joints. Therefore, it is important that each section of utility be adequately supported on proper bedding material and properly backfilled. We recommend that the on-site geotechnical engineer should evaluate the final subgrades of the bottom of the utility trench to verify if the subgrade is competent to support the utility lines and the backfills, or the subgrades need some proofrolling and recompaction, or require overexcavation of unsuitable loose fills and replacement with suitable structural fills.

We recommend that if needed the bottom grades of the utility trench must be adequately proofrolled and compacted to firm and unyielding conditions. A layer of geo-grid such as Mirafi 500X or equivalent should be placed on the proofrolled subgrades prior to placing the bedding materials and laying the utility lines. This should be decided on-site by the geotechnical engineer on-site based on the observed subgrade conditions at the bottom of the trench.

It is recommend that utility trenching, installation, and backfilling conform to all applicable Federal, State, and local regulations such as WISHA and OSHA for open excavations.

Pipe Bedding & Pipe Zone

Trench backfill to be placed beneath, adjacent to, and for at least 2 feet above utilities line should consist of well-graded granular material with a maximum particle size of 1 inch and less than 10 percent by dry weight passing the US Standard No. 200 Sieve, and should meet the standards of 'Gravel Backfill for Pipe Zone Bedding' described in Section 9-03.12(3) of the 2024 WSDOT Standard Specifications. Trench backfill must be free of debris, organic material and rock fragments larger than 1 inch. The bedding materials should be hand tamped to ensure support is provided around the pipe haunches. Trench backfill should be carefully placed and hand tamped to about 12 inches above the crown of the pipe before any heavy compaction equipment is brought into use. In order to reduce the potential for damaging the utilities, heavy compaction equipment should not be permitted to operate directly over utilities until a minimum of two (2) feet of backfill will be placed. In general, pipe bedding should be placed in loose lifts not exceeding 6 inches in thickness and compacted to at least 90 percent of the fills' maximum dry density value as to be determined by the laboratory Modified Proctor (ASTM D1557) test method. The fill materials within the pipe bedding and pipe zone, their thicknesses and compactions should be suitable for the utility system and materials installed, and in accordance with any applicable manufacturers' recommendations or local building department. Pipe bedding materials should be placed on relatively undisturbed native soil. Based on our field explorations, we anticipate relatively coarse-grained soils comprised of poorly graded gravel with cobbles. Some overexcavation and removal of cobbles should be anticipated at the pipe invert elevation to maintain a uniform grade for the utility installation. Where overexcavation is needed, additional pipe bedding materials should be placed to restore the grade.

Trench Backfills

We recommend that the backfills to be placed 2 feet above the pipe and upto the final pavement subgrade level should be consisted of materials similar to 'Gravel Borrow' described in Section 9-03.14(1) or 'Select Borrow' as described in Section 9-03.14(2), of the 2024 WSDOT Standard Specifications. Where excavations occur in the wet, alternative such as 'Select Granular Fill' described earlier in Section 7.2.10 should be considered. Trench backfill must be free of roots, debris, organic matter and rock fragments larger than 3 inches. Other materials may be appropriate depending on manufacturer specifications and/or local jurisdiction requirements. For site utilities located within the City of Airway Heights right-of-ways, bedding and backfill should be completed in accordance with the city specifications. As a minimum, 5/8 inch pea gravel or clean sand may be used for bedding and backfill materials. The trench backfills to be placed 2 feet above the pipe and upto the final pavement subgrade level should be compacted to 95 percent of the fills' maximum dry density value as to be determined by the laboratory Modified Proctor (ASTM D-1557) test method. The backfill should be placed in lifts not exceeding 4 inches if compacted with hand-operated equipment or 8 inches if compacted with heavy equipment. Catch basins, utility vaults, and other structures installed flush with the pavement should be designed and constructed to transfer wheel loads to the base of the structure.

The utility trenches should not be left open for extended periods to prevent water entry, accumulation, and softening of the subgrade. Should soft soils be encountered at the bottom of the trench, it should be overexcavated and replaced with select fills. As an alternative to undercutting, a Geotextile fabric or crushed rock may be used to stabilize the trench subgrade. Where water is encountered in the trench excavations, it should be removed prior to fill placement. Alternatively, quarry spalls or pea gravel could be used below the water level if allowed by the local authority or the project specifications.

## 7.3 Construction Monitoring

Since this project involves so many aspects of geotechnical engineering related construction activities such as the identification of the existing fills, removals of the fills, overexcavations, excavation inclination, final native subgrades preparation and proofrolling, fill placement and compaction of fills, footing embedment depth, and verification of the allowable bearing capacity value, retaining wall construction, and pavement installation, we recommend that PGE's on-site geotechnical engineer should inspect all the above activities. A list of inspection items are provided later on in Section 9.0, 'Geotechnical Special Inspection' of this report. It is recommended that the above construction activities be monitored by a representative from our firm since we have the prior knowledge, familiarity, and better understanding with our recommendations.

## 7.4 Ribbed Mat Foundation Recommendations

Allowable Bearing Capacity

The ribbed mat footing placed directly above the adequately compacted new structural fills may be designed for an allowable net bearing capacity value of 1500 psf. The "net allowable bearing pressure" refers to the pressure that can be imposed on the soil at foundation level resulting from the total of all dead loads plus the long-term live loads, exclusive of the weight of the footing or any backfill placed above the footing, i.e., these loadings can be ignored in calculating footing sizes.

For short-term loads, such as wind and seismic (earthquake), a 1/3 increase in the above net allowable capacity can be used. We recommend that continuous footings have a minimum width of 18 inches and individual column footings a minimum width of 24 inches. All exterior footings should bear at least 18 inches below the final adjacent finish grade to provide adequate confinement of the bearing materials and frost protection.

Settlement

Based on our settlement potential evaluation of the shallow foundation options, we anticipate that properly designed and constructed foundations supported on the recommended bearing materials should experience total settlement of less than 1 inch for the allowable bearing pressures presented above. Differential settlement could be on the order of ¼ to ½ inch between similarly loaded foundations over a distance of 50 feet of continuous footings. This estimation was done without the aid of any laboratory consolidation test data, but on the basis of our experience with similar types of structures and subsoil conditions. The soil response to applied stresses caused by building and other loads is expected to be predominantly elastic in nature with most of the settlements occurring during construction as loads are applied; however, the estimated settlement could occur over a longer time, and disturbance of the foundation subgrades during construction could result in larger settlements than predicted.

Lateral Load Resistance

Lateral foundation loads can be resisted by friction between the foundation base and the underlying supporting soil, and by passive earth pressure acting on the face of the embedded portion of the foundation below the grades. For frictional resistance, a coefficient of 0.35 can be used. For passive earth pressure, the available resistance can be computed using an equivalent fluid pressure of 300 pcf, which includes a factor of safety of 1.5. This value assumes the foundation must be poured "neat" against the undisturbed native soils or structural fill placed and compacted as described earlier in Section 7.2.11, 'Fill Placement and Compaction Requirements' of this report. The passive earth pressure and friction components may be combined provided that the passive component does not exceed two-thirds of the total resistance.

Footing Subgrade Inspection

We recommend that PGE representative examine the bearing materials prior to placing forms or rebar. Variations in the quality and strength of the potential bearing soils can occur with depth and distance away from the test pits. Therefore, a careful evaluation of the bearing material and the design bearing capacity value as recommended in this report must be verified at the proposed footing locations at the time of footing construction.

### 7.5 Structural Floor Slab

As recommended earlier in Section 7.1, 'General', the concrete, structural floor slab should be supported over a minimum of one foot thick, new structural fill, to be compacted adequately to 95% or more of fills' dry density value to be determined from laboratory Modified Proctor test. The new fills must be placed on native subgrades that must be prepared as 'competent' native subgrades, which is defined as subgrades that are adequately proofrolled and redensified to firm and unyielding conditions.

Capillary Break Layer: After the final slab subgrade preparation is completed, the slab should be provided with a capillary break layer to retard the upward wicking of ground moisture beneath the floor slab. The capillary break layer would consist of a minimum of 6-inch thick clean, free-draining, granular material, such as sand or pea gravel. The structural fill requirements specified earlier in Section 7.2.10, 'Structural Fill', could be used as capillary break materials except that there should be no more than 2 percent of fines passing the no. 200 sieve. Alternatively, 'Gravel Backfill for Drains' per 2023 WSDOT Standard Specifications 9-03.12(4) can be used as capillary break materials. This layer should be placed and compacted to an unyielding condition.

Vapor Barrier - Visqueen or Plastic Membrane: The capillary break layer will not prevent moisture intrusion through the slab caused by water vapor transmission. In areas where moisture by vapor transmission through the slab is undesirable, such as covered floor areas where carpeting or vinyl tiles are used, we recommend the use of an impermeable vapor barrier such as a layer of durable plastic sheeting (such as Crossstuff, Moistop, or Visqueen) over the capillary break layer and beneath the slab to prevent the upward migration of ground moisture vapors through the slab. A 10 to 15-mil thick plastic membrane is typically adequate for this purpose. This membrane will help prevent moisture vapor transmission up through the slab and the associated moisture related damage to interior furnishings and salt generation in the surface of concrete slab. This is particularly importance where moisture migration through the slab is an issue, where adhesives are used to anchor carpet or tile to the slab.

We recommend floor designers and contractors refer to the 2003 American Concrete Institute (ACI) Manual of Concrete Practice, Part 2, 302.1R-96, for further information regarding vapor barrier installation below the slab-on-grade floor.

Curing Sand Layer: During the casting of the slab, care should be taken to avoid puncturing the Visqueen or the plastic vapor barrier membrane. At owner's or architecture's discretion, the membrane may be covered with 2 inches thick clean, moist sand layer bas a 'curing course' to guard against damage during construction and to facilitate uniform curing of the overlying concrete slab. This sand layer will also help to prevent bleeding of the cement slurry down into the underlying capillary break layer through joints or tears in the Visqueen or the plastic membrane. The addition of 2 inches thick sand layer over the vapor barrier is a non-structural recommendation.

The final slab subgrade consisted of adequately compacted, new imported structural fills, a modulus of subgrade reaction value of about 150 pounds per cubic inch (pci) can be used to estimate slab deflections, which could arise due to elastic compression of the subgrades.

We recommend that all building utilities should be installed before the capillary break layer, the plastic membrane vapor barrier, and the sand layer are installed to avoid damaging them. Damage to either element could result in a non-functioning system and that could lead to upward migration of ground moisture to the floor slab.

## 8.0 Additional Services

Additional services described below can be performed by PGE in the event the project requires such services. These services will be performed upon written authorization of the client or the civil engineer, and with additional cost to perform such services, under a separate contract between PGE and the client.

## 8.1 Design Phase Engineering Services

As the geotechnical engineer of record for the proposed development, at owner's option, PGE can perform a review of the final project plans and specifications to verify that the geotechnical recommendations of this report have been properly interpreted and incorporated into the project final design and specifications, and that the impact of the final site grades, the proposed building and its footing, and any other structure.

## 8.2 Construction-time Testing and Inspection

As the geotechnical engineer of record for the proposed development, PGE can provide geotechnical consultation, material testing, and construction monitoring services during the construction phase of the project described earlier in Section 7.3, 'Construction Monitoring' of this report. For continuity, and as typically required by the local regulatory authority, PGE should be retained to provide the geotechnical services during construction. Also, participation of PGE during the construction will help PGE engineers to make on-site engineering decisions in the event that any variations in subsurface conditions are encountered or any revisions in design and plan are made. These services are important for the project to confirm that the earthwork and the general site development are in compliance with the general intent of design concepts, specifications, and the geotechnical recommendations presented in this report. PGE can assist the owner before construction begins to develop an appropriate monitoring and testing plan to aid in accomplishing a fast and cost-effective construction process.

## 9.0 Geotechnical Special Inspections

The construction of the proposed development in this site involves several aspects of the geotechnical engineering that are considered to be critical for the successful completion of the project and continue that throughout the project life. Therefore, PGE recommends that the following geotechnical special inspection services to be performed during the construction of the proposed development. According to PGE, the following items should be considered as a minimum but not limited to.

- A professional geotechnical engineer should be retained to provide geotechnical consultation, material testing, and construction monitoring services during the construction of the project.
- A pre-construction meeting should be held on-site to discuss the geotechnical aspects of the development and the special inspection services to be performed during the construction.
- The site preparation activities including but not limited to stripping, cut and filling, final subgrade preparation for foundation, floor slab, paved driveway, and retaining wall be monitored by a geotechnical engineer or his representative under the engineer's supervision.
- A list of the possible items that require special geotechnical inspection and approval by the geotechnical engineer is as follows:

➢ Stripping of topsoils.
➢ Overexcavations of unsuitable native soils and existing fills, if there will be any under the proposed development area.
➢ Redensification of any exposed, final subgrades that are intended to provide direct support for any load bearing structure such as new fill pad, floor slab, grad beams, footing, and paved driveway and parking.
➢ Preparation of 'competent' subgrades by proofrolling prior to placing footings, floor slab, grade beams, new fill pad, and paved driveway and parking.
➢ Any structural fills to be used in this site, and structural fills placement and its compaction.
➢ Temporary or permanent excavation slope and excavation stability.
➢ The footing bearing materials, bearing capacity value, and the embedment depth of the footings prior to placing forms and rebar.
➢ Subgrade preparation for new fills, and any other load-bearing structures.
➢ Subgrade preparation for paved driveway and parking.
➢ Site drainage.
➢ Installation of drainage system such as footing excavation drain and footing drain, and daylighting of such drains and downspout or roof drains.
➢ Bedding and the backfilling materials, and backfilling of utility lines.
➢ Any other items specified in the approved project plans to be prepared by other consultants relevant to the geotechnical aspect of the project.

## 10.0 Report Limitations

The conclusions and recommendations presented in this report are based on our soil investigation, the laboratory test results, geological literature review, and our engineering evaluation. The study was performed using a mutually agreed-upon scope of work between PGE and the client.

It should be noted that PGE cannot take the responsibility regarding the accuracy of the information provided in the project plan prepared by other consultants. If any of the information considered during this study is not correct or if there are any revisions to the plans for this project, PGE should be notified immediately of such information and the revisions so that necessary amendment of our geotechnical recommendations can be made. If such information and revisions are not notified to PGE, no responsibility should be implied on PGE for the impact of such information and the revisions on the project.

Variations in subsurface (soil and groundwater) conditions may reveal during the construction of the proposed below grade infiltration system. The nature and the extent of the subsurface variations may not be evident until construction occurs. If any subsurface conditions are encountered at the site that are different from those described in this report, we should be notified immediately to review the applicability of our recommendations if there are any changes in the project scope.

This report may be used only by the client and for the purposes stated, within a reasonable time from its issuance. Land use, site conditions (both off and on-site), or others factors including advances in our understanding of applied science, may change over time and could materially affect our findings. Therefore, this report should not be relied upon after 24 months from its issuance. PGE should be notified if the project is delayed by more than 24 months from the date of this report so that we may review to determine that the conclusions and recommendations of this report remain applicable to the changed conditions.

The scope of our work does not include services related to construction safety precautions. Our recommendations are not intended to direct the contractor's means and method, techniques, sequences or procedures, measurement or dimensions, and contractor's, sub-contractor's, and other engineer's decisions and activities on-site except as specifically described in our report for consideration in design. Such a responsibility is not being implied and should not be inferred, but remains with the owner and his or her contractor and other team members. Furthermore, it should be clearly understood that PGE does not in any way 'direct' or 'supervise' the contractor and his staff or his subcontractors and their employees, or any other project team member. This responsibility also remains solely with the owner and his or her general contractor. Additionally, the scope of our work specifically excludes the assessment of environmental characteristics, particularly those involving hazardous substances.

This report including its evaluation, conclusions, specifications, recommendations, or professional advice has been prepared for planning and design purposes for specific application to the proposed project in accordance with the generally accepted standards of local practice at the time this report was written. No warranty, express or implied, is made.

This report is the property of our client Millcreek 17200, LLC, and has been prepared for the exclusive use of our client and its authorized representatives for the specific application to the proposed development at the subject site in Millcreek, Washington.

It is the client's responsibility to see that all parties to this project, including the civil engineer, designer, contractor, subcontractor, future homeowner, etc., are made aware of this report in its entirety. The use of information contained in this report for bidding purposes should be done at the contractor's option and risk. Any party other than the client who wishes to use this report shall notify PGE of such intended use and for permission to copy this report. Based on the intended use of the report, PGE may require that additional work be performed to update the report and to reissue the report. Noncompliance with any of these requirements will release PGE from any liability resulting from the use this report.

It is critical for the successful completion of the project that the owner, and the project team including the architect, civil engineer, structural engineer, contractor and their subs, must read the entire report thoroughly to get familiarize with the content and the recommendations provided in this report. We recommend that a full copy of the report accepted by the local regulatory authority during its permit application process should be kept available on-site all time for the contractor's and city inspector's easy reference. No decision on design or construction should be based on any portion of the brief summary letter or of the report text taken out of context. This may result in misinterpretation of our recommendations and their intent.

## Closure

We trust the information presented in this report is sufficient for your current needs. We appreciate the opportunity to provide the geotechnical services at this phase of the project and look forward to continued participation during the design and construction phase of this project. Should you have any questions or concerns, which have not been addressed, or if we may be of additional assistance, please do not hesitate to call us at 425-218-9316.

Respectfully submitted,

Santanu Mowar, P.E.

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Attachments:

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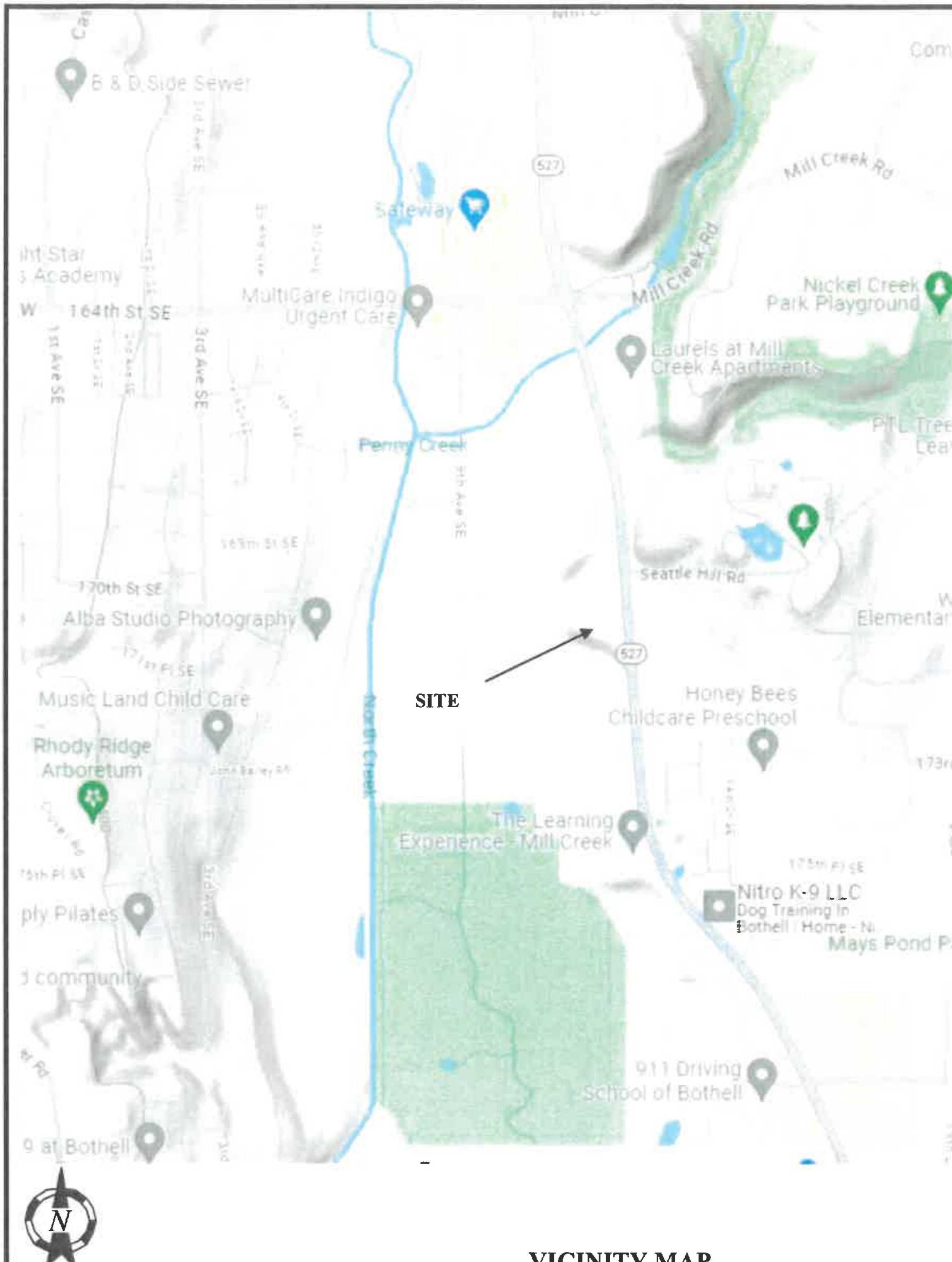
|---|---|
| Figure 1 | Vicinity Map |
| Figure 2 | Site Plan & Exploration Plan |




## VICINITY MAP

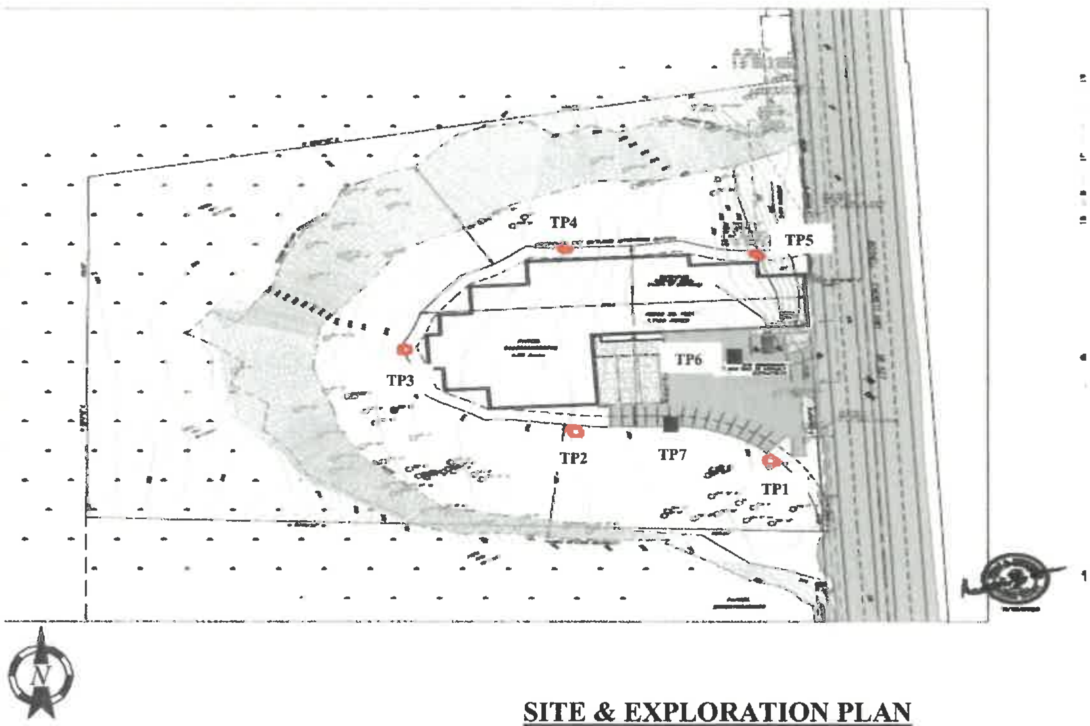
**Not to Scale**

| | | |
|---|---|---|
| **Project No: 23-712** | **PROJECT** | **PGE Pacific Geo Engineering** Geotechnical Engineering, Consulting & Inspection |
| **Date: January 8, 2023** | **172XX Warehouse** | |
| **Drawn by:** | **172XX Bothell Everett Hwy** | |
| **Client: 172XX, Millcreek, LLC** | **Millcreek, WA** | **Figure 1** |

17200 MILLCREEK, LLC WAREHOUSE STORAGE FACILITY

CITY OF MILL CREEK, WA

A PORTION OF THE NW 1/4 OF THE SE 1/4 AND THE SW 1/4 OF THE NE 1/4 OF SECTION 7, T.27N., R.5E. W.M.




## SITE & EXPLORATION PLAN

Not to Scale

| LEGEND: | Project No.: 23-712 | PROJECT | PGE Pacific Geo Engineering |
|---|---|---|---|
| ● Approximate Test Pit Location | Date:January 8, 2023 | 172XX Warehouse | |
| | Drawn By: | 172XX, Bothell Everett Hwy | |
| | Client: 172XX Millcreek, LLC | Millcreek, WA | Figure 2 |

**PGE Pacific Geo Engineering**
Geotechnical Engineering, Consulting & Inspection

# KEY TO EXPLORATION LOG

## Sample Descriptions:

Classification of soils in this report is based on visual field and laboratory observations, which include density/consistency, moisture condition, grain size, and plasticity estimates, and should not be construed to imply field or laboratory testing unless presented herein. Visual-manual classification methods in accordance with ASTM D-2488-17 were used as an identification guide. Where laboratory data available, soil classifications are in general accordance with ASTM D2487-17. Soil density/consistency in borings is related primarily to the Standard Penetration Resistance values. Soil density/consistency in test pits is estimated based on visual observations of excavations. Undrained shear strength = ½ unconfined compression strength.

| RELATIVE DENSITY OR CONSITENCY VS. SPT N-VALUE | | | | | |
|---|---|---|---|---|---|
| COARSE GRAINED SOILS: SAND OR GRAVEL | | | FINE GRAINED SOILS: SILT OR CLAY | | |
| Density | N (Blows/ft.) | Approx. Relative Density (%) | Consistency | N (Blows/ft.) | Approx. Undrained Shear Strength (psf) |
| Very Loose | 0 – 4 | 0- 15 | Very Soft | 0 – 2 | <250 |
| Loose | 4 – 10 | 15 – 35 | Soft | 2 – 4 | 250 –500 |
| Medium Dense | 10 – 30 | 35 – 65 | Medium Stiff | 4 – 8 | 500 – 1000 |
| Dense | 30 – 50 | 65 – 85 | Stiff | 8 – 15 | 1000 – 2000 |
| Very Dense | >50 | 85 – 100 | Very Stiff<br>Hard | 15 – 30<br>> 50 | 2000 – 4000<br>> 4000 |

| MOISTURE CONTENT DEFINITIONS | |
|---|---|
| Dry | Absence of moisture, dusty, dry to the touch |
| Moist | Damp but no visible water |
| Wet | Visible free water, from below water table |

| DESCRIPTIONS FOR SOIL STRATA AND STRUCTURE | | | | | |
|---|---|---|---|---|---|
| General Thickness or Spacing | | Structure | | General Attitude | |
| Parting | < 1/16 in | Pocket | Erratic, discontinuous deposit of limited extent | Near Horizontal | 0 - 10 deg |
| Seam | 1/16 - 1/2 in | Lens | Lenticular deposit | Low Angle | 10 - 45 deg |
| Layer | ½ - 12 in | Varved | Alternating seams of silt and clay | High Angle | 45 - 80 deg |
| Stratum | > 12 in | Laminated | Alternating seams | Near Vertical | 80 - 90 deg |
| Scattered | < 1 per ft | Interbedded | Alternating Layers | | |
| Numerous | > 1 per ft | Fractured | Breaks easily along definite fractured planes | | |
| | | Slickensided | Polished, glossy, fractured planes | | |
| | | Blocky, Diced | Breaks easily into small angular lumps | | |
| | | Sheared | Disturbed texture, mix of strengths | | |
| | | Homogeneous | Same color and appearance throughout | | |

# PGE Pacific Geo Engineering LLC

**Geotechnical Engineering, Consulting & Inspection**

## UNIFIED SOIL CLASSIFICATION SYSTEM

| Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A] | | | | Soil Classification: Group Symbol | Group Name[B] |
|---|---|---|---|---|---|
| Coarse-Grained Soils More than 50% retained on No. 200 sieve | Gravels More than 50% of coarse fraction retained on No. 4 sieve | Clean Gravels Less than 5% fines[C] | $Cu \geq 4$ and $1 \leq Cc \leq 3$[E] | GW | Well-graded gravel[F] |
| | | | $Cu < 4$ and/or $1 > Cc > 3$[E] | GP | Poorly graded gravel[F] |
| | | Gravels with Fines More than 12% fines[C] | Fines classify as ML or MH | GM | Silty gravel[F, G, H] |
| | | | Fines classify as CL or CH | GC | Clayey gravel[F, G, H] |
| | Sands 50% or more of coarse fraction passes No. 4 sieve | Clean Sands Less than 5% fines[E] | $Cu \geq 6$ and $1 \leq Cc \leq 3$[E] | SW | Well-graded sand[I] |
| | | | $Cu < 6$ and/or $1 > Cc > 3$[E] | SP | Poorly graded sand[I] |
| | | Sands with Fines More than 12% fines[D] | Fines classify as ML or MH | SM | Silty sand[G, H, I] |
| | | | Fines classify as CL or CH | SC | Clayey sand[G, H, I] |
| Fine-Grained Soils 50% or more passes the No. 200 sieve | Silts and Clays Liquid limit less than 50 | inorganic | PI > 7 and plots on or above "A" line[J] | CL | Lean clay[K, L, M] |
| | | | PI < 4 or plots below "A" line[J] | ML | Silt[K, L, M] |
| | | organic | (Liquid limit — oven dried) / (Liquid limit — not dried) < 0.75 | OL | Organic clay[K, L, M, N]; Organic silt[K, L, M, O] |
| | Silts and Clays Liquid limit 50 or more | inorganic | PI plots on or above "A" line | CH | Fat clay[K, L, M] |
| | | | PI plots below "A" line | MH | Elastic silt[K, L, M] |
| | | organic | (Liquid limit — oven dried) / (Liquid limit — not dried) < 0.75 | OH | Organic clay[K, L, M, P]; Organic silt[K, L, M, Q] |
| Highly organic soils | Primarily organic matter, dark in color, and organic odor | | | PT | Peat |

[A]Based on the material passing the 3-in. (75-mm) sieve.

[B]If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C]Gravels with 5 to 12% fines require dual symbols:
GW-GM well-graded gravel with silt
GW-GC well-graded gravel with clay
GP-GM poorly graded gravel with silt
GP-GC poorly graded gravel with clay

[D]Sands with 5 to 12% fines require dual symbols:
SW-SM well-graded sand with silt
SW-SC well-graded sand with clay
SP-SM poorly graded sand with silt
SP-SC poorly graded sand with clay

[E]$Cu = D_{60}/D_{10}$ $\quad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

[F]If soil contains ≥ 15% sand, add "with sand" to group name.

[G]If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H]If fines are organic, add "with organic fines" to group name.

[I]If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J]If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K]If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel", whichever is predominant.

[L]If soil contains ≥ 30% plus. No. 200 predominantly sand, add "sandy" to group name.

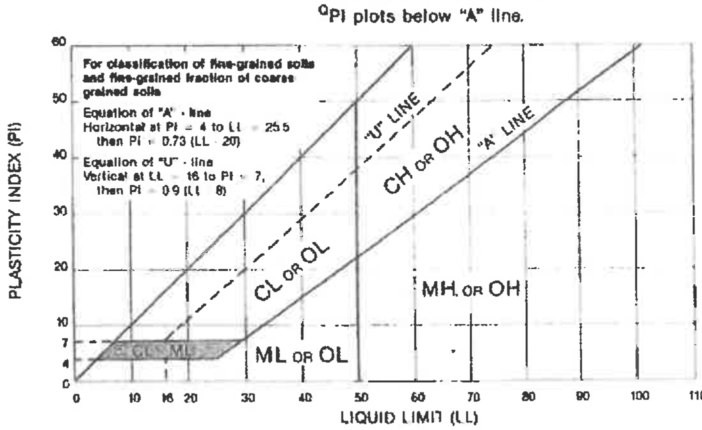
[M]If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

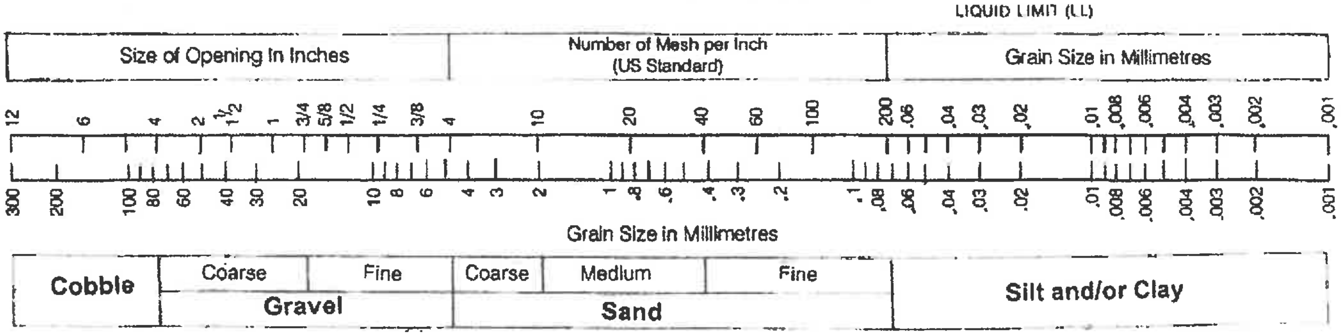
[N]PI ≥ 4 and plots on or above "A" line.

[O]PI < 4 or plots below "A" line.

[P]PI plots on or above "A" line.

[Q]PI plots below "A" line.



# Appendix E: Arborist Report

October 9, 2024

Nitin Goyal
17200 Mill Creek, LLC
Via email: nitin@prosrvc.com

## Re: Arborist Report for Mill Creek Industrial

Facet Reference Number: 2305.0336.00

Dear Nitin:

We are pleased to present you with the findings of our tree inventory and assessment for your property at 17200 Bothell Everett Hwy (parcel #00602000000700) located in The City of Mill Creek, WA. Deb Powers and Evan W Earhart, ISA Certified Arborists® and Qualified Tree Risk Assessors with Facet (formerly DCG/Watershed), visited the subject property on January 11th and 16th, 2024 to inventory and assess trees within the study area.

The intent of this tree inventory was to screen for, identify, and assess any trees meeting the City of Mill Creek's significant tree definition that are within the study area. Tree attributes including species, size, and condition, were assessed and are summarized in the enclosed Tree Inventory Table. Tree locations are shown on the associated Mitigation Plan.

This arborist report has been prepared for the following purposes:

- Describe the tree inventory and assessment methods;
- Summarize tree inventory and assessment results;
- Document relevant municipal code and outline any necessary tree replacement or replanting requirements.
- Provide construction strategies for the protection of trees to be retained.

# Introduction

## Background

The project is located along Bothell-Everett Highway within the City of Mill Creek. It is situated within Section 07 of Township 27 North, Range 05 East of the Public Land Survey System. A vicinity and project area map are provided below in Figure 1. The project proponent, is proposing construction of a warehouse storage building and associated parking area on the parcel.

## Study Area

The study area includes the subject property and vegetation on adjacent properties which may be impacted by the proposed project. Individual tree assessments and inventory were contained to the flat terraced area and steep slope. The subject property totals approximately 198,633 square feet in size (according to Snohomish County Online Property Information, January 24, 2024 / Snohomish County Assessor) and is currently vacant and undeveloped. The site is located near the North Creek Park complex and contains critical areas including wetlands, wetland buffer, and fish and wildlife areas. See Figure 1 for a map of the study area and site vicinity.

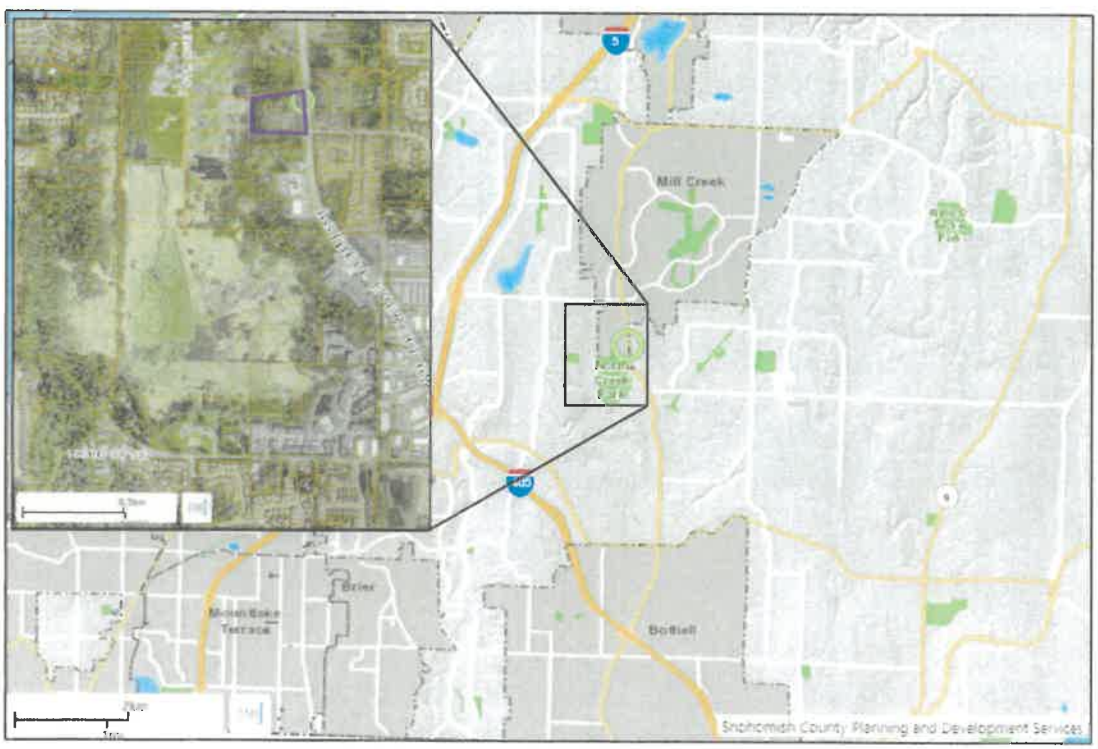



Figure 1. Vicinity and subject parcel map. Subject parcel outlined in purple.

## Current Site Conditions

The large, undeveloped site is characterized by a large flat terrace that steeply slopes down to the north, south, and west. Tree canopy coverage is dominated by red alder (*Alnus rubra*) and black cottonwood (*Populus trichocarpa*). Himalayan blackberry and scotch broom are invasive species that have spread throughout the terraced area. No conifer species were observed in the terraced area. The southern slope adjacent to the stream is dominated by red alder and black cottonwood trees with an understory of osoberry (*Oemleria cerasiformis*), salmonberry (*Rubus spectabilis*) and trailing blackberry (*Rubus ursinus*). Trees in the study area are discussed in detail below.

# Methods

All significant trees in the study area were identified and assessed in the field using a Basic Assessment according to International Society of Arboriculture (ISA) standards to collect species name (scientific and common), number of stems, diameter, height, average crown radius, overall condition rating, and general assessment notes. Attributes were recorded for six off-site trees with root zones that may extend into the public right-of way.

According to Mill Creek Municipal Code (MCMC) 15.10.015, **significant trees** are defined as:

> *a tree that is a minimum of six inches at the height of four and one-half feet, diameter at breast height. The height shall be measured above the ground line on the upslope side of the tree.*

All inventoried trees were assigned a unique identification number. Each assessed on-site tree (trees located on the subject property) was tagged with a 1.25-inch aluminum tag that was affixed near the base of the trunk level. Some trees were not physically tagged, due to steep terrain preventing access. Off-site trees were assigned a digital ID number. See Tree Inventory Table for details.

D. R. Downing Land Surveying, Inc. located some of the subject trees and provided survey data (Boundary & Topographic Survey, April 18, 2024) to DCG/Watershed prior to the tree inventory. Survey data and proposed site plans, including proposed structure location, were provided to DCG/Watershed in AutoCAD and PDF formats. The geospatial locations of surveyed trees were pre-populated in ArcGIS Field Maps application using the provided survey data. Tree attributes were collected in the field using an iPad. Tree points were added for significant trees not captured during the land survey.

## Diameter

The diameter-at-breast-height (DBH) of all significant trees in the study area was measured at 4.5 feet above the average surface of the ground. Methodology for measuring and calculating the diameter of trees with multiple trunks, major leans, or on steep slopes followed those outlined in the *Guide for Plant Appraisal, 10th Edition*, written by the Council of Tree and Landscape Appraisers (CTLA) and published by ISA (CTLA 2020). To measure trees with multiple trunks, the total diameter of multi-stemmed trees was calculated by taking the square root of the sum of each diameter squared; this allows for comparison to other single-stemmed trees and for more accurate permitting and tree retention calculations.

## Estimated Height

Baseline measurements for tree heights were established using a 200L TruPulse laser rangefinder by Laser Technology. The height of adjacent trees was visually estimated based upon these measurements.

## Canopy Radius

Canopy radius, also known as dripline, was measured horizontally from the center of the trunk to the outermost branch tips. For trees with uneven crowns, the average of two perpendicular radii was recorded.

## Condition

A basic visual assessment was used to evaluate the health and condition of trees within the study area in accordance with ISA and CTLA standards. The condition determination was based on current conditions and considered the health, structural integrity, and form of the tree, in addition to characteristics of each species. Each tree was given an overall condition rating from Excellent to Very Poor as summarized below in Table 1. For the purposes of this report, any tree found in Very Poor or Dead condition is not considered to be "healthy", and therefore does not meet the criteria for a significant tree.

Table 1. Tree Condition Ratings (adapted from CTLA 2020).

| Rating Category | Condition Components | | | Percent Rating |
|---|---|---|---|---|
| | Health | Structure | Form | |
| Excellent - 1 | High vigor and nearly perfect health with little or no twig dieback, discoloration, or defoliation. | Nearly ideal and free of defects. | Nearly ideal for the species. Generally symmetric. Consistent with the intended use. | 81% to 100% |
| Good - 2 | Vigor is normal for species. No significant damage due to diseases or pests. Any twig dieback, defoliation, or discoloration is minor. | Well-developed structure. Defects are minor and can be corrected. | Minor asymmetries/deviations from species norm. Mostly consistent with the intended use. Function and aesthetics are not compromised. | 61% to 80% |
| Fair - 3 | Reduced vigor. Damage due to insects or diseases may be significant and associated with defoliation but is not likely to be fatal. Twig dieback, defoliation, discoloration, and/or dead branches may compromise up to 50% of the crown. | A single defect of a significant nature or multiple moderate defects. Defects are not practical to correct or would require multiple treatments over several years. | Major asymmetries/deviations from species norm and/or intended use. Function and/or aesthetics are compromised. | 41% to 60% |
| Poor - 4 | Unhealthy and declining in appearance. Poor vigor. Low foliage density and poor foliage color are present. Potentially fatal pest infestation. Extensive twig and/or branch dieback. | A single serious defect or multiple significant defects. Recent change in tree orientation. Observed structural problems cannot be corrected. Failure may occur at any time. | Largely asymmetric/abnormal. Detracts from intended use and/or aesthetics to a significant degree. | 21% to 40% |
| Very Poor - 5 | Poor vigor. Appears dying and in the last stages of life. Little live foliage. | Single or multiple severe defects. Failure is probable or imminent. | Visually unappealing. Provides little or no function in the landscape. | 6% to 20% |
| Dead - 6 | | | | 0% to 5% |

# Results

## Tree Inventory and Assessment Findings

A total of 129 trees were assessed within the study area. Of those trees, 118 trees were located on-site and met the criteria for a significant tree. An additional 6 off-site trees were also inventoried and assessed. Inventoried on-site trees include 66 black cottonwoods (*Populus trichocarpa)*, 50 red alders (*Alnus rubra*), one Douglas-fir (*Pseudotsuga menziesii*), and one western red cedar (*Thuja plicata*).

Off-site trees in the study area included five red alders (*Alnus rubra),* and one black cottonwood (*Populus trichocarpa).*

A detailed table of all trees inventoried can be found in the enclosed Tree Inventory Table.

### Diameter

Significant on-site trees range in DBH from 6.1 inches to 40.5 inches. The average diameter is 16.3 inches.

### Height

The estimated height of on-site significant trees ranges from 24 feet to 100 feet. The average height is 61.5 feet.

### Canopy radius

The average canopy radius of all on-site significant trees ranges from 6 feet to 30 feet, with an average radius of 14.3 feet.

### Condition

Of the 118 significant on-site trees, the majority (89) were found to be in *Good* condition with normal vigor, well-developed structure and no significant damage, defects or disease. 24 trees were in *Fair* condition, showing signs of reduced vigor, twig dieback, defoliation, or with significant damage or defects. 5 trees were in *Poor* condition with poor vigor, extensive twig and branch dieback, or had some significant defects. The remaining trees were found to be in *Dead* or *Very Poor* condition, with poor vigor, little live foliage, or with multiple severe defects. These trees were not deemed significant in this study.

Of the 6 off-site trees, three trees were in *Good* condition, two in *Fair* condition, and one tree in *Poor* condition.

## Applicable Regulations

**Permit required.** Per MCMC 15.10.20 a permit is required whenever cutting a significant tree or clearing land greater than 500 square feet, unless exempted under MCMC 15.10.030.

**Prohibited cutting and clearing.** Tree cutting and clearing of natural vegetation is prohibited in scenarios described in MCMC 15.10.040.

*A. Within any roadway buffer/cutting preserve or designated property buffer without the prior written approval of the director of community development.*

*B. On slopes of 25 percent or steeper gradient or on unstable slopes less than 25 percent.*

*C. Within 100 feet of the top of the bank of any watercourse with a year-round flow, unless a setback reduction has been approved pursuant to Chapter 18.06 MCMC.*

*D. When any tree is identified on an approved tree preservation plan.*

*E. Within a regulated critical area or required critical area buffer in accordance with the provisions of Chapter 18.06 MCMC.*

**Protection standards.** Protection fencing is required, per MCMC 15.10.045, to be installed two feet outside the drip line of protected trees and natural vegetation to be retained.

Storage of soil or operation of equipment is **prohibited** within the dripline of a retained tree.

If grade is altered near retained trees, retaining walls or rockeries, located outside of the drip line of subject trees, may be required to minimize impacts to tree health.

# Discussion

The following section discusses the potential impacts of the proposed development and outlines best management practices to protect and preserve trees during construction that should be considered during this project.

## Potential Impacts of Proposed Development

### Trees Requiring Removal

The following trees listed in Table 2 are located directly within the proposed building footprint and will need to be removed to accommodate proposed improvements:

Table 2. Trees requiring removal due to the proposed building footprint.

| TAG # | TREE NAME | # STEMS | COMB DBH (IN) | HEIGHT (FT) | RADIUS (FT) | CONDITION | REMOVAL | SIGNIFICANT |
|---|---|---|---|---|---|---|---|---|
| 4615 | Populus trichocarpa (Black cottonwood) | 1 | 18.5 | 85 | 15 | Fair | Yes | Yes |
| 4616 | Populus trichocarpa (Black cottonwood) | 3 | 21.9 | 45 | 12 | Fair | Yes | Yes |
| 4617 | Populus trichocarpa (Black cottonwood) | 1 | 11.4 | 80 | 12 | Poor | Yes | Yes |
| 4618 | Alnus rubra (Red alder) | 1 | 8.2 | 24 | 10 | Fair | Yes | Yes |
| 4619 | Alnus rubra (Red alder) | 1 | 8.7 | 24 | 12 | Good | Yes | Yes |
| 4620 | Populus trichocarpa (Black cottonwood) | 2 | 40.5 | 95 | 18 | Good | Yes | Yes |
| 4653 | Populus trichocarpa (Black cottonwood) | 1 | 17.5 | 90 | 14 | Good | Yes | Yes |
| 4654 | Populus trichocarpa (Black cottonwood) | 1 | 30.8 | 85 | 22 | Good | Yes | Yes |
| 4655 | Populus trichocarpa (Black cottonwood) | 1 | 17.8 | 90 | 20 | Good | Yes | Yes |

## Additional Definitions

The ANSI A300 Tree Care standards define **critical zoot zone (CRZ)** has "the minimum volume of roots necessary for tree health and stability." It can be approximated by an area with a radius of one foot for every diameter inch of the trunk. However, topography and site conditions may greatly affect where critical roots are growing. Per MCMC 15.10.045, protecting fencing is required two feet beyond the dripline of trees to be retained. Given the varied nature of dripline in alders and cottonwoods, we recommend CRZ as a more formulaic approach to measure root extent and consistently apply tree protection across the site. The root zone radius noted on the Mitigation Plan is based upon the trunk diameter method listed above (Matheny 1998, p. 73).

The **tree protection zone (TPZ)** is the area within the critical root zone in which certain activities are prohibited or restricted to prevent or minimize potential injury to designated trees, especially during construction or development. The TPZ should encompass as much of the CRZ as possible. However, the TPZ may be adjusted in size or shape to accommodate the existing infrastructure, planned construction, and specific site conditions, as well as the tree canopy conformation and visible root orientation, species response to construction impacts, size, condition, and maturity. All construction activities, including staging and driving machinery, should be located outside of the TPZ. For the purpose of this project, the edge of the TPZ is at the tree protection fence.

### Warehouse Building

The construction of a large warehouse on the property will have impacts on those trees with CRZs that extend into the construction area. The TPZs of the three trees listed below are established to accommodate work areas (See Sheet 8 of the Mitigation Plan). Prior to clearing and grading at the site, the root zone of impacted trees to be preserved should be visually established by spreading four to six inches of arborist woodchips (free of invasive species) within the TPZ, prior to any clearing and grading work. The purpose of this mulch is to provide a soil amendment that will allow the trees to be more resilient to impacts. Areas outside the TPZ can be excluded from the woodchip area, but temporary compaction protection measures, such as plywood sheets, must be placed in the CRZ radius until it is no longer practical. The area where woodchips are required is labeled in Sheet 8 of the Mitigation Plan as the Additional Root Protection Area.

## Trees Requiring Protection

**Tree no. 4621** is a red alder (*Alnus rubra)* with a DBH of 13.5 inches. It was observed in *fair* condition with a noted trunk scar. This species is known to have poor to moderate tolerance of construction impacts and are "intolerant of root injury" (Matheny 1998, p. 168). With minimal impacts occurring within only 3.5% of the CRZ, the tree should remain viable for long-term retention if protection measures are enacted throughout the project.

**Tree no. 4686** and **Tree no. 4687** are two black cottonwoods (*Populus trichocarpa)* with DBHs of 15.8, and 24.2, respectively. They were both observed in *good* condition. Per the Mitigation Plan, the grade will be raised by approximately six feet within the CRZ of these trees. Per MCMC 15.10.045.B,

> *Retaining walls or rockeries to preserve terrain elevation may be required where the grade level adjoining the trees or natural vegetation to be preserved is to be raised or lowered. Retaining walls and rockeries shall be located at or outside the drip line of the subject trees.*

This species is known to have poor tolerance of construction impacts where mature trees are "prone to windthrow and trunk failure" (Matheny et al. 1998). Although permanent impacts will occur within 12.4% and 16.4% of their respective CRZs, these trees also exist within a group of trees with sufficient root area to the north, west and east, and should remain viable for long-term retention if protection measures are enacted throughout the project.

## Additional Root Protection Area

Trees nos. 4621, 4686, and 4687 have a known poor tolerance to construction impacts and will need additional measures of protection. Spreading four to six inches of arborist woodchips in this area will reduce evaporative moisture loss and help to ensure these trees will remain viable for long-term retention. To reduce the potential for increased moisture and disease, an area free of woodchips will be maintained 2 inches from tree trunks. These trees will also require supplemental watering during the summer months . As listed above, Tree nos. 4686 and 4687 will require additional steps, per MCMC, to protect from grade changes caused by construction. For reference, further best practices regarding grade changes near trees are also included in the following section of this report.

## Tree Protection Recommendations

All retained trees near construction area, including those on-site, in the ROW, and on adjacent properties will require protection measures during all phases of the project. Trees can be damaged quickly and irreversibly by construction activities, especially by heavy machinery and exposure to chemicals. The following best management practices follow the industry standards for tree protection (ANSI A300 Part 5, 2019), and should be adhered to whenever work is being performed.

The TPZ and other tree protection measures for preserved trees should be shown on the site development plans, including grading and drainage plans and temporary erosion and sediment control (TESC) plans.

### Tree Protection Fencing Requirements

- Fencing should be placed at the outer edges of the tree protection zone.
- Fencing should be four to six feet high, and constructed of chain link, wire-mesh, or high-visibility plastic fencing.
- Fencing should include visible warning signs, such as "Tree Protection Area – Keep Out", spaced no further than 15 feet apart.
- Fencing and signage should be installed prior to the start of construction and remain in place for the duration of the project.

### Minimize Root Zone Disturbance

All construction activities, including staging and driving machinery, should be located outside of the CRZ. For temporary impacts in the CRZ but outside the TPZ that are unavoidable, the arborist recommends using one of the following temporary measures to minimize soil compaction and root damage:

- Install six to twelve inches of wood chip mulch over the CRZ.
- Lay down a ¾-inch thick plywood sheet over at least four inches of wood chip mulch.
- Apply four to six inches of gravel over staked geotextile fabric.
- Place commercial logging mats on top of a 4-inch mulch layer.

The gravel, geotextile fabric, mats, and all mulch over four-inches thick **must** be removed after the temporary disturbance is finished.

### Minimize Grade Changes

As discussed above, the grade will be raised by approximately six feet within the CRZ of Tree nos. 4686 and 4687. However, the grade should not be altered inside the tree protection fencing. Most tree roots grow in the top six to 18 inches of soil and are highly susceptible to damage from grade changes. If the grade is lowered, roots critical to health and stability will be removed. If the grade is raised, roots can suffocate from lack of oxygen.

If an increase in grade within the TPZ is recommended and approved, these best management practices should be followed:

- Do not place fill or other organic matter against the trunk.
- Do not compact soils.
- If the fill to be applied is no more than two to four inches, it should be a coarser texture than the existing soil.

If a decrease in grade within the TPZ is recommended and approved, these best management practices should be followed:

- No more than six inches of soil should be removed from the existing grade.
- Consider retaining walls or terraces to avoid excessive soil loss. Support for retaining walls should not impact major structural roots. Soil excavation by hand or hydro-vac prior to mechanical augering is recommended to avoid root impacts.
- Spread two to four inches of mulch over the exposed area to buffer the root's environment change.
- Apply supplemental water during dry months to encourage new root growth Root pruning

### Canopy pruning

All construction activities should stay out of the canopy zone. However, if the canopy of a tree will conflict with construction, the canopy could be raised to avoid aerial conflicts after consulting with the project arborist or designee. Any pruning of trees should be overseen by a certified professional through the International Society of Arboriculture (ISA) or Tree Care Industry Association (TCIA). No other pruning should be necessary and could negatively impact the health of the trees.

### Maintenance

The signs of stress from the impacts of construction may not show up for five to ten years after being impacted. Applying additional woodchip mulch and providing supplemental irrigation may be necessary to reduce tree stress during construction, and in the years following construction.

## Limitations of This Study

The findings of this report are based on the best available science and arboriculture industry standards and are limited to the scope, budget, and site conditions at the time of the assessment. Although the information in this report is based on sound methodology, internal physical flaws (such as cracking or root rot) or other conditions that are not visible cannot be detected with this limited basic visual screening. Trees are inherently unpredictable. Even vigorous and healthy trees can fail due to high winds, heavy snow, ice storms, rain, age, or other causes.

This report is based on the current observable conditions and may not represent future conditions of the trees. Changes in site conditions, including clearing and grading, will alter the condition of the existing retained trees in a way that is not predictable.

The conclusions contained within this report have been made for permitting purposes only and are not intended for tree risk assessment purposes.

Please call if you have any questions or if we can provide you with any additional information.

Sincerely,

Evan W. Earhart

Evan W. Earhart
ISA Certified Arborist® PN-9234A
Tree Risk Assessment Qualified

*Attachments:*
*Tree Table*

## References

American National Standard (ANSI) A300 (Part 5). 2023. Tree, Shrub, and Other Woody Plant Management Standard Practices (Management of Trees and Shrubs During Site Planning, Site Development, and Construction). Londonderry, NH: Tree Care Industry Association.

Council of Tree & Landscape Appraisers (CTLA). 2020. Guide for Plant Appraisal: 10th Edition, Revised. Atlanta, GA: International Society of Arboriculture.

Dunster, J. 2017. Tree Risk Assessment Manual, Second Edition. Champaign, IL: International Society of Arboriculture.

Facet. 2024. 17200 Mill Creek LLC Mitigation Plan.

Matheny, Nelda, and James R Clark. *Trees and Development: A Technical Guide to Preservation of Trees During Land Development*. International Society of Arboriculture, 1998.

Mill Creek Municipal Code. Ch. 15.10 Land Clearing and Tree Cutting. Accessed 16 January 2024.

| TAG # | TREE NAME | # STEMS | COMB DBH (IN) | HEIGHT (FT) | RADIUS (FT) | CONDITION | REMOVAL | SIGNIFICANT | NOTES |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Alnus rubra (Red alder) | 5 | **30.6** | 78 | 22 | Fair | No | Yes | Estimated. Offsite. |
| 2 | Populus trichocarpa (Black cottonwood) | 1 | **15.0** | 75 | 18 | Good | No | Yes | Estimated. Offsite. |
| 3 | Alnus rubra (Red alder) | 1 | **9.0** | 45 | 1 | Very Poor | No | Yes | Estimated. Offsite. One live branch. |
| 4 | Alnus rubra (Red alder) | 1 | **8.0** | 65 | 8 | Good | No | Yes | Estimated. Offsite. |
| 5 | Alnus rubra (Red alder) | 4 | **16.2** | 55 | 14 | Good | No | Yes | Estimated. Offsite. |
| 6 | Alnus rubra (Red alder) | 1 | **6.0** | 30 | 2 | Dead | No | No | Estimated. Offsite. |
| 4615 | Populus trichocarpa (Black cottonwood) | 1 | **18.5** | 85 | 15 | Fair | Yes | Yes | Seven sprouts coming from the base. Bark wound near base. |
| 4616 | Populus trichocarpa (Black cottonwood) | 3 | **21.9** | 45 | 12 | Fair | Yes | Yes | Sapsuckers. |
| 4617 | Populus trichocarpa (Black cottonwood) | 1 | **11.4** | 80 | 12 | Poor | Yes | Yes | 1.5 foot trunk wound |
| 4618 | Alnus rubra (Red alder) | 1 | **8.2** | 24 | 10 | Fair | Yes | Yes | |
| 4619 | Alnus rubra (Red alder) | 1 | **8.7** | 24 | 12 | Good | Yes | Yes | |
| 4620 | Populus trichocarpa (Black cottonwood) | 2 | **40.5** | 95 | 18 | Good | Yes | Yes | |
| 4621 | Populus trichocarpa (Black cottonwood) | 1 | **13.5** | 55 | 10 | Fair | No | Yes | Trunk wound |
| 4622 | Alnus rubra (Red alder) | 1 | **12.8** | 50 | 15 | Good | No | Yes | |
| 4623 | Populus trichocarpa (Black cottonwood) | 3 | **17.6** | 50 | 12 | Fair | No | Yes | |
| 4624 | Populus trichocarpa (Black cottonwood) | 1 | **13.9** | 68 | 25 | Good | No | Yes | |
| 4625 | Populus trichocarpa (Black cottonwood) | 1 | **12.1** | 60 | 20 | Good | No | Yes | |
| 4626 | Populus trichocarpa (Black cottonwood) | 1 | **20.8** | 70 | 20 | Good | No | Yes | |
| 4627 | Populus trichocarpa (Black cottonwood) | 1 | **7.1** | 40 | 8 | Poor | No | Yes | Trunk wound, cavity, |
| 4628 | Populus trichocarpa (Black cottonwood) | 1 | **7.5** | 30 | 8 | Fair | No | Yes | |
| 4629 | Populus trichocarpa (Black cottonwood) | 3 | **39.8** | 65 | 15 | Good | No | Yes | Root damage. |
| 4630 | Populus trichocarpa (Black cottonwood) | 1 | **21.9** | 75 | 12 | Good | No | Yes | |
| 4631 | Alnus rubra (Red alder) | 1 | **7.0** | 35 | 6 | Good | No | Yes | |
| 4632 | Alnus rubra (Red alder) | 1 | **7.0** | 35 | 6 | Good | No | Yes | |
| 4633 | Alnus rubra (Red alder) | 1 | **10.3** | 40 | 10 | Good | No | Yes | |
| 4634 | Alnus rubra (Red alder) | 2 | **8.6** | 35 | 10 | Fair | No | Yes | |
| 4635 | Populus trichocarpa (Black cottonwood) | 1 | **21.7** | 90 | 10 | Good | No | Yes | |
| 4636 | Alnus rubra (Red alder) | 1 | **10.3** | 60 | 6 | Good | No | Yes | |
| 4637 | Alnus rubra (Red alder) | 1 | **7.8** | 45 | 10 | Poor | No | Yes | |
| 4638 | Alnus rubra (Red alder) | 2 | **20.6** | 50 | 10 | Good | No | Yes | |
| 4639 | Alnus rubra (Red alder) | 2 | **14.1** | 50 | 20 | Poor | No | Yes | |
| 4640 | Alnus rubra (Red alder) | 2 | **13.2** | 45 | 15 | Good | No | Yes | |
| 4641 | Alnus rubra (Red alder) | 1 | **9.1** | 35 | 10 | Good | No | Yes | |
| 4642 | Populus trichocarpa (Black cottonwood) | 1 | **33.5** | 95 | 25 | Good | No | Yes | |
| 4643 | Alnus rubra (Red alder) | 1 | **13.2** | 65 | 14 | Good | No | Yes | |
| 4644 | Alnus rubra (Red alder) | 5 | **18.0** | 45 | 20 | Good | No | Yes | |
| 4645 | Alnus rubra (Red alder) | 1 | **11.3** | 45 | 14 | Good | No | Yes | |
| 4646 | Alnus rubra (Red alder) | 1 | **7.1** | 32 | 6 | Good | No | Yes | |
| 4647 | Alnus rubra (Red alder) | 1 | **7.1** | 32 | 6 | Fair | No | Yes | |
| 4648 | Populus trichocarpa (Black cottonwood) | 1 | **17.9** | 55 | 20 | Good | No | Yes | |

| TAG # | TREE NAME | # STEMS | COMB DBH (IN) | HEIGHT (FT) | RADIUS (FT) | CONDITION | REMOVAL | SIGNIFICANT | NOTES |
|---|---|---|---|---|---|---|---|---|---|
| 4649 | Populus trichocarpa (Black cottonwood) | 1 | **11.8** | 45 | 12 | Good | No | Yes | |
| 4650 | Alnus rubra (Red alder) | 1 | **10.3** | 60 | 12 | Good | No | Yes | |
| 4651 | Populus trichocarpa (Black cottonwood) | 1 | **10.9** | 55 | 8 | Good | No | Yes | |
| 4652 | Populus trichocarpa (Black cottonwood) | 1 | **12.1** | 75 | 14 | Fair | No | Yes | Trunk wound. |
| 4653 | Populus trichocarpa (Black cottonwood) | 1 | **17.5** | 90 | 14 | Good | Yes | Yes | |
| 4654 | Populus trichocarpa (Black cottonwood) | 1 | **30.8** | 85 | 22 | Good | Yes | Yes | |
| 4655 | Populus trichocarpa (Black cottonwood) | 1 | **17.8** | 90 | 20 | Good | Yes | Yes | |
| 4656 | Populus trichocarpa (Black cottonwood) | 1 | **23.8** | 90 | 23 | Good | No | Yes | |
| 4657 | Populus trichocarpa (Black cottonwood) | 1 | **23.1** | 80 | 19 | Good | No | Yes | |
| 4658 | Alnus rubra (Red alder) | 2 | **18.1** | 60 | 10 | Good | No | Yes | |
| 4659 | Alnus rubra (Red alder) | 2 | **14.0** | 55 | 8 | Good | No | Yes | |
| 4660 | Alnus rubra (Red alder) | 5 | **16.9** | 55 | 20 | Good | No | Yes | |
| 4661 | Alnus rubra (Red alder) | 1 | **11.9** | 60 | 10 | Good | No | Yes | |
| 4662 | Alnus rubra (Red alder) | 1 | **6.5** | 50 | 6 | Good | No | Yes | |
| 4663 | Alnus rubra (Red alder) | 3 | **15.3** | 60 | 15 | Good | No | Yes | |
| 4664 | Alnus rubra (Red alder) | 1 | **10.6** | 60 | 10 | Good | No | Yes | |
| 4665 | Alnus rubra (Red alder) | 1 | **9.2** | 50 | 6 | Fair | No | Yes | |
| 4666 | Alnus rubra (Red alder) | 1 | **8.8** | 40 | 10 | Fair | No | Yes | |
| 4667 | Alnus rubra (Red alder) | 1 | **8.0** | 45 | 8 | Fair | No | Yes | |
| 4668 | Alnus rubra (Red alder) | 1 | **8.6** | 55 | 10 | Good | No | Yes | |
| 4669 | Alnus rubra (Red alder) | 3 | **16.0** | 65 | 20 | Poor | No | Yes | One stem in Fair condition. Two stems in Poor condition. |
| 4670 | Alnus rubra (Red alder) | 1 | **8.2** | 65 | 15 | Good | No | Yes | |
| 4671 | Alnus rubra (Red alder) | 1 | **6.2** | 35 | 6 | Good | No | Yes | |
| 4672 | Alnus rubra (Red alder) | 1 | **8.5** | 55 | 12 | Good | No | Yes | |
| 4673 | Alnus rubra (Red alder) | 1 | **6.1** | 55 | 12 | Good | No | Yes | |
| 4674 | Alnus rubra (Red alder) | 2 | **15.4** | 60 | 14 | Good | No | Yes | |
| 4675 | Alnus rubra (Red alder) | 1 | **8.2** | 60 | 12 | Good | No | Yes | |
| 4676 | Alnus rubra (Red alder) | 1 | **7.8** | 60 | 12 | Good | No | Yes | |
| 4677 | Alnus rubra (Red alder) | 1 | **7.2** | 50 | 8 | Good | No | Yes | |
| 4678 | Alnus rubra (Red alder) | 1 | **6.5** | 60 | 12 | Good | No | Yes | |
| 4679 | Alnus rubra (Red alder) | 1 | **10.5** | 65 | 14 | Good | No | Yes | |
| 4680 | Alnus rubra (Red alder) | 1 | **9.2** | 60 | 14 | Good | No | Yes | |
| 4681 | Alnus rubra (Red alder) | 1 | **9.8** | 55 | 10 | Fair | No | Yes | |
| 4682 | Alnus rubra (Red alder) | 1 | **7.1** | 45 | 6 | Fair | No | Yes | Northern most tree along stream adjacent to property line |
| 4683 | Populus trichocarpa (Black cottonwood) | 2 | **28.3** | 68 | 15 | Good | No | Yes | |
| 4684 | Populus trichocarpa (Black cottonwood) | 1 | **30.0** | 75 | 26 | Excellent | No | Yes | |
| 4685 | Populus trichocarpa (Black cottonwood) | 1 | **28.0** | 65 | 22 | Fair | No | Yes | Not tagged due to terrain, prior broken top at 35' but vigorous leader |
| 4686 | Populus trichocarpa (Black cottonwood) | 2 | **17.0** | 65 | 12 | Fair | No | Yes | stem 1 is snagged at 20' |
| 4687 | Populus trichocarpa (Black cottonwood) | 2 | **20.9** | 65 | 20 | Good | No | Yes | Stem 2 trunk cavity |

| TAG # | TREE NAME | # STEMS | COMB DBH (IN) | HEIGHT (FT) | RADIUS (FT) | CONDITION | REMOVAL | SIGNIFICANT | NOTES |
|---|---|---|---|---|---|---|---|---|---|
| 4688 | Populus trichocarpa (Black cottonwood) | 2 | **16.4** | 65 | 12 | Fair | No | Yes | |
| 4689 | Populus trichocarpa (Black cottonwood) | 1 | **10.8** | 65 | 12 | Fair | No | Yes | |
| 4690 | Populus trichocarpa (Black cottonwood) | 1 | **23.0** | 60 | 15 | Excellent | No | Yes | |
| 4691 | Alnus rubra (Red alder) | 1 | **9.8** | 35 | 8 | Good | No | Yes | |
| 4692 | Alnus rubra (Red alder) | 1 | **12.0** | 35 | 10 | Fair | No | Yes | |
| 4693 | Populus trichocarpa (Black cottonwood) | 2 | **33.3** | 60 | 18 | Good | No | Yes | Not physically tagged, due to terrain. |
| 4695 | Alnus rubra (Red alder) | 1 | **10.0** | 45 | 15 | Good | No | Yes | Not physically tagged, due to terrain. |
| 4696 | Populus trichocarpa (Black cottonwood) | 1 | **30.0** | 95 | 18 | Good | No | Yes | Not physically tagged, due to terrain. |
| 4697 | Populus trichocarpa (Black cottonwood) | 1 | **23.0** | 90 | 16 | Good | No | Yes | Not physically tagged, due to terrain. |
| 4698 | Populus trichocarpa (Black cottonwood) | 1 | **30.0** | 90 | 20 | Good | No | Yes | Not physically tagged, due to terrain. |
| 4699 | Alnus rubra (Red alder) | 1 | **8.0** | 45 | 10 | Good | No | Yes | Not physically tagged, due to terrain. |
| 4700 | Alnus rubra (Red alder) | 1 | **8.0** | 45 | 10 | Good | No | Yes | Not physically tagged, due to terrain. |
| 4840 | Alnus rubra (Red alder) | 1 | **8.0** | 45 | 10 | Good | No | Yes | Not physically tagged, due to terrain. |
| 4841 | Populus trichocarpa (Black cottonwood) | 1 | **31.0** | 95 | 20 | Good | No | Yes | Not physically tagged, due to terrain. |
| 4842 | Populus trichocarpa (Black cottonwood) | 1 | **22.0** | 95 | 14 | Good | No | Yes | Not physically tagged, due to terrain. |
| 4844 | Populus trichocarpa (Black cottonwood) | 1 | **31.0** | 95 | 20 | Good | No | Yes | Not physically tagged, due to terrain. |
| 4845 | Populus trichocarpa (Black cottonwood) | 1 | **1.0** | 31 | 20 | Good | No | No | Not physically tagged, due to terrain. |
| 4846 | Populus trichocarpa (Black cottonwood) | 2 | **38.2** | 85 | 20 | Good | No | Yes | Not physically tagged, due to terrain. |
| 4847 | Populus trichocarpa (Black cottonwood) | 1 | **14.9** | 75 | 14 | Good | No | Yes | |
| 4848 | Populus trichocarpa (Black cottonwood) | 1 | **18.0** | 80 | 20 | Good | No | Yes | Trunk split at 30' |
| 4849 | Populus trichocarpa (Black cottonwood) | 1 | **14.0** | 65 | 10 | Dead | No | Yes | |
| 4850 | Populus trichocarpa (Black cottonwood) | 2 | **10.0** | 45 | 10 | Dead | No | Yes | |
| 4851 | Populus trichocarpa (Black cottonwood) | 1 | **12.0** | 45 | 10 | Very Poor | No | Yes | |
| 4852 | Populus trichocarpa (Black cottonwood) | 2 | **12.5** | | | Dead | No | Yes | Recently downed via backhoe. |
| 4853 | Populus trichocarpa (Black cottonwood) | 1 | **18.0** | 50 | 15 | Good | No | Yes | Not physically tagged, due to terrain. |
| 4854 | Populus trichocarpa (Black cottonwood) | 1 | **30.0** | 70 | 22 | Good | No | Yes | Not physically tagged, due to terrain. |
| 4855 | Populus trichocarpa (Black cottonwood) | 1 | **30.0** | 92 | 30 | Good | No | Yes | Not physically tagged, due to terrain. |
| 4856 | Populus trichocarpa (Black cottonwood) | 1 | **28.0** | 95 | 20 | Good | No | Yes | Not physically tagged, due to terrain. |
| 4857 | Populus trichocarpa (Black cottonwood) | 1 | **19.0** | 85 | 15 | Good | No | Yes | |
| 4858 | Populus trichocarpa (Black cottonwood) | 1 | **15.7** | 80 | 12 | Fair | No | Yes | Broken top. |
| 4859 | Populus trichocarpa (Black cottonwood) | 1 | **10.7** | 60 | 15 | Good | No | Yes | |
| 4860 | Populus trichocarpa (Black cottonwood) | 1 | **10.0** | 60 | 15 | Fair | No | Yes | |
| 4861 | Populus trichocarpa (Black cottonwood) | 1 | **13.7** | 50 | 15 | Fair | No | Yes | |
| 4862 | Populus trichocarpa (Black cottonwood) | 1 | **13.7** | 50 | 10 | Good | No | Yes | |
| 4863 | Populus trichocarpa (Black cottonwood) | 1 | **9.5** | 45 | 6 | Fair | No | Yes | |
| 4864 | Populus trichocarpa (Black cottonwood) | 1 | **12.5** | 55 | 15 | Good | No | Yes | |
| 4865 | Populus trichocarpa (Black cottonwood) | 2 | **10.4** | 45 | 15 | Fair | No | Yes | |
| 4866 | Populus trichocarpa (Black cottonwood) | 1 | **7.5** | 45 | 17 | Good | No | Yes | Severe lean |
| 4867 | Populus trichocarpa (Black cottonwood) | 1 | **6.7** | 33 | 7 | Good | No | Yes | |
| 4868 | Populus trichocarpa (Black cottonwood) | 2 | **18.2** | 65 | 18 | Good | No | Yes | |
| 4869 | Populus trichocarpa (Black cottonwood) | 2 | **33.9** | 90 | 25 | Good | No | Yes | |

| TAG # | TREE NAME | # STEMS | COMB DBH (IN) | HEIGHT (FT) | RADIUS (FT) | CONDITION | REMOVAL | SIGNIFICANT | NOTES |
|---|---|---|---|---|---|---|---|---|---|
| 4870 | Populus trichocarpa (Black cottonwood) | 1 | **17.5** | 80 | 20 | Good | No | Yes | |
| 4871 | Populus trichocarpa (Black cottonwood) | 1 | **8.0** | 35 | 10 | Good | No | Yes | Not physically tagged, due to terrain. |
| 4872 | Populus trichocarpa (Black cottonwood) | 3 | **22.0** | 80 | 12 | Good | No | Yes | Not physically tagged, due to terrain. |
| 4873 | Populus trichocarpa (Black cottonwood) | 1 | **30.0** | 90 | 23 | Good | No | Yes | Not physically tagged, due to terrain. |
| 4874 | Populus trichocarpa (Black cottonwood) | 2 | **31.6** | 95 | 23 | Good | No | Yes | Not physically tagged, due to terrain. |
| 4875 | Populus trichocarpa (Black cottonwood) | 1 | **30.0** | 80 | 25 | Good | No | Yes | Not physically tagged, due to terrain. |
| 4876 | Populus trichocarpa (Black cottonwood) | 1 | **18.0** | 65 | 15 | Good | No | Yes | Not physically tagged, due to terrain. |
| 4877 | Pseudotsuga menziesii (Douglas-fir) | 1 | **36.0** | 100 | 28 | Good | No | Yes | Not physically tagged, due to terrain. |
| 4878 | Thuja plicata (Western red cedar) | 1 | **28.0** | 95 | 20 | Fair | No | Yes | Dieback. Thin upper canopy. |