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STORMWATER SITE PLAN

Preliminary Plat of Woods Creek Highlands

13327 Chain Lake Road
Monroe, Washington 98272

City File No. TBD

Woods Creek Development, Inc.
800 5th Ave, #101-155
Seattle, WA 98104

December 14, 2018

Our Job No. 20354

BARRY J. TALKINGTON
STATE OF WASHINGTON
41423
REGISTERED
PROFESSIONAL ENGINEER

12/14/18

BARGHAUSEN CONSULTING ENGINEERS, INC.
18215 72ND AVENUE SOUTH KENT, WA 98032 (425) 251-6222 (425) 251-8782 FAX
BRANCH OFFICES ♦ TUMWATER, WA ♦ KLAMATH FALLS, OR ♦ LONG BEACH, CA ♦ ROSEVILLE, CA ♦ SAN DIEGO, CA
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STORMWATER SITE PLAN

Preliminary Plat of Woods Creek Highlands

TABLE OF CONTENTS

1.0 PROJECT OVERVIEW

Figure 1.0.1 – Vicinity Map

2.0 CONDITIONS AND REQUIREMENTS SUMMARY

2.1 Analysis of the Minimum Requirements

3.0 EXISTING CONDITIONS SUMMARY

Figure 3.0.1 – Soil Survey Map

Figure 3.0.2 – Sensitive Areas Map

Figure 3.0.3 – Assessor's Map

Figure 3.0.4 – FEMA Map

4.0 OFF-SITE ANALYSIS REPORT

Figure 4.0.1 – Downstream Drainage Course

Figure 4.0.2 – Snohomish County Drainage Inventory Map

Figure 4.0.3 – City of Monroe Streams and Wetlands Map

5.0 PERMANENT STORMWATER CONTROL PLAN

5.1 Existing Site Hydrology

Figure 5.1.1 – Predeveloped Drainage Basin Map

5.2 Developed Site Hydrology

Figure 5.2.1 – Developed Drainage Basin Map

5.3 Performance Standards and Goals

Figure 5.3.1 – Flow Chart for Determining Requirements for New Development

Figure 5.3.2 – Flow Chart for Determining LID MR#5 Requirements

5.4 Low Impact Development Features

5.5 Flow Control System

Figure 5.5.1 – Detention Vault Sizing Calculations

5.6 Water Quality System

Figure 5.6.1 – Treatment Facility Selection Flow Chart

5.7 Conveyance System Analysis and Design

6.0 CONSTRUCTION STORMWATER POLLUTION PREVENTION PLAN

7.0 SPECIAL REPORTS AND STUDIES

7.1 Subsurface Exploration, Geologic Hazard, and Preliminary Geotechnical Engineering Report prepared by Associated Earth Sciences Inc. dated November 29, 2018

8.0 OTHER PERMITS

9.0 OPERATIONS AND MAINTENANCE MANUAL

10.0 BOND QUANTITIES WORKSHEET

Tab 1.0

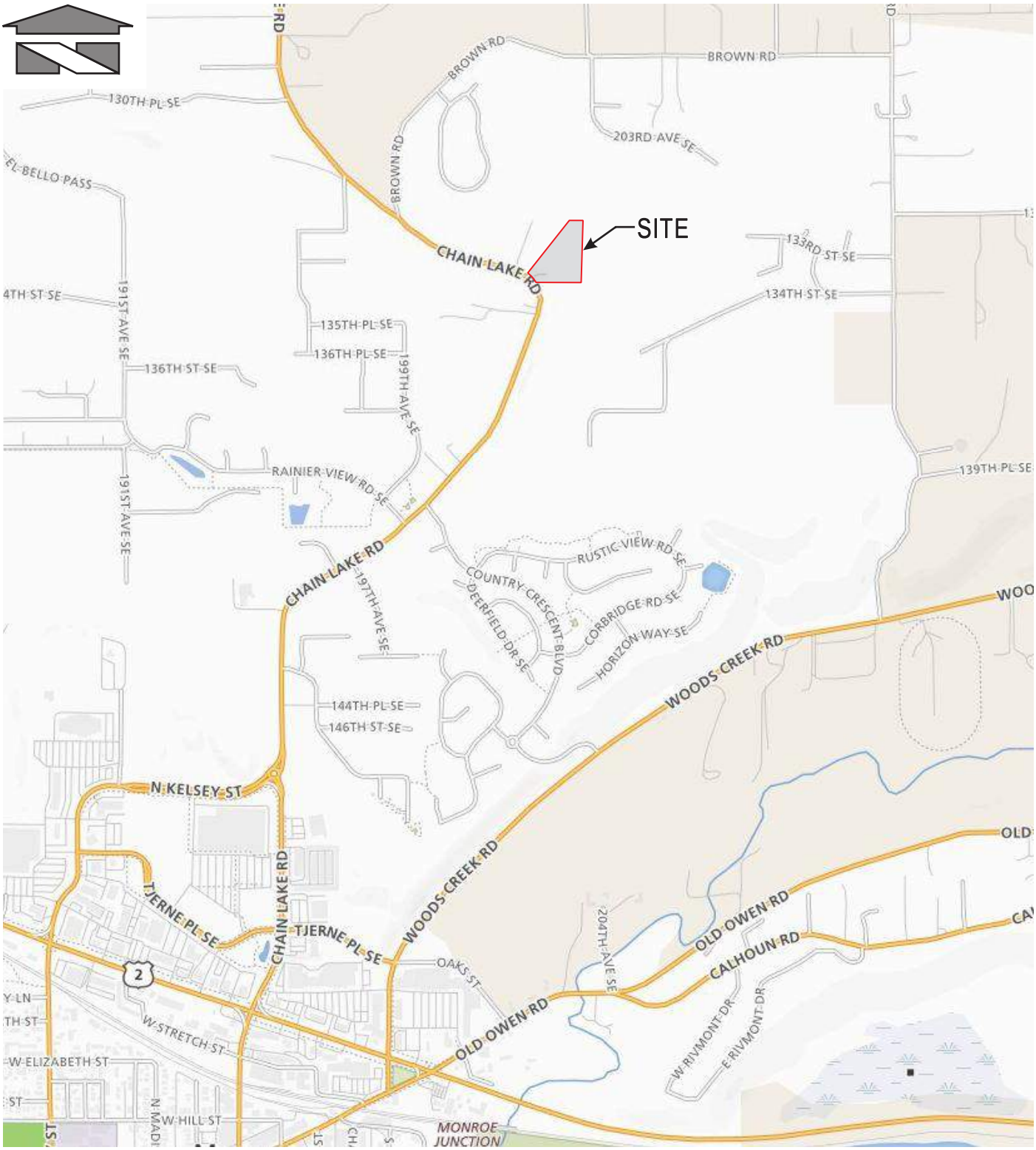
1.0 PROJECT OVERVIEW

The Woods Creek Highlands project is a proposed single-family residential development consisting of 24 lots located on a 4.83 acre site. The proposed development is located at 13327 Chain Lake Road in the City of Monroe and Snohomish County. The project will clear, grade, and construct roads, utility extensions, features, and eventually single-family residences on the lots. The project is located in the northeast quarter of the northeast quarter of the northwest quarter of Section 31, Township 28 North, Range 7 East, Willamette Meridian and occupies Snohomish County Tax Lot No. 28073100200400. A Vicinity Map has been included for reference (see Figure – 1.0.1 - located within this section).

The property contains predominantly undeveloped forest land with an existing building, garage and shed near the southwest corner of the site that will be abandoned. The site consists of a single drainage basin with topography sloping in a southeast manner at a moderate grade. Approximately one-third of the drainage basin consists of upstream forested area from the adjacent property to the west. Surface runoff can generally be expected to follow the existing topography and discharge near the southeast corner of the site. Surface runoff from the developed project site will be collected and conveyed via an underground pipe network into an existing dispersion trench approximately 110 feet southeast of the project site. Water quality treatment will be provided by a StormFilter vault (or approved equal) downstream of the detention facility.

NRCS soil survey identifies the underlying soils as Tokul Gravelly Medial Loam, which is common throughout the region and is generally considered to be a glacially consolidated till. This type of soil is typically characterized as a dense "hardpan" soil, with moderate runoff rates and low permeability. All on-site drainage calculations were modeled as till soils. For further reference please refer to the Geotechnical Report by Associated Earth Sciences, Inc. dated November 29, 2018, located in Section 7.0 of this report.

Site drainage designs are based on the 2012 Stormwater Management Manual for Western Washington (2014 SWMMWW), as Amended in December 2014. Please refer to Section 5.5 of this Stormwater Site Plan for further details regarding the drainage facility design.



REFERENCE: Rand McNally (2018)

Scale: *Horizontal:* ***N.T.S.*** *Vertical:* ***N/A***	*For:* Woods Creek Highlands Monroe, Washington	Job Number 20354
BARGHAUSEN CONSULTING ENGINEERS, INC. 18215 72ND AVENUE SOUTH KENT, WA 98032 (425) 251-6222 (425) 251-8782 CIVIL ENGINEERING, LAND PLANNING, SURVEYING, ENVIRONMENTAL SERVICES	*Title:* VICINITY MAP	FIGURE 1.0.1
		DATE: 11/28/18

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Tab 2.0

2.0 CONDITIONS AND REQUIREMENTS SUMMARY

This section contains the following information:

2.1 Analysis of the Minimum Requirements

2.1 Analysis of the Minimum Requirements

Minimum Requirements	How Project Has Addressed Requirement
No. 1: Preparation of Stormwater Site Plans	This Minimum Requirement has been fulfilled by the preparation and completion of this Stormwater Site Plan.
No. 2: Construction Stormwater Pollution Prevention (SWPP)	A completed Construction Stormwater Pollution Prevention Plan (SWPPP) will be submitted separately from, or together with, this report during Final Engineering Review.
No. 3: Source Control of Pollution	The project is not classified as a high-use site, and no hazardous materials requiring source control BMPs are proposed to be stored on-site.
No. 4: Preservation of Natural Drainage Systems and Outfalls	The existing site topography slopes southeast at a moderate grade. Surface runoff can generally be expected to follow existing ground topography and discharge at the southeast corner of the site. The project proposes to collect surface runoff and provide flow control via a detention vault located near the southeast corner of the site. Runoff will then discharge into an existing conveyance system which connects to a dispersion trench to the southeast of the project site. The project also consists of right-of-way widening along Chain Lake Road on the southwest corner of the site. The existing conveyance system along this road section consists of a roadside ditch that flows downstream in a southeast fashion and connects to an underground pipe network through a concrete culvert. The project proposes to remove the concrete culvert and connect the ditch to the pipe network with a pipe flowing southeast below the widened road.
No. 5: On-site Stormwater Management	Due to the native soil condition being Vashon lodgement till, infiltration is not feasible therefore Low Impact Development (LID) requirements become impractical for the site. The developer has opted not to meet the LID Performance Standard for Flow Control, therefore the project will be providing the individual lot BMPs. All soil in the lawn and landscaped areas for the site will be amended to meet the post-Construction Soil Quality and Depth requirement. Each individual lot will have a perforated stub-out connection for rooftops.
No. 6: Runoff Treatment	This project proposes the use of a StormFilter vault (or approved equal) to treat the runoff from the tributary drainage basin.
No. 7: Flow Control	Flow Control for the site is provided by a detention vault which is sized by matching developed discharge durations to forested durations for the range of pre-developed discharge rates from 50 percent of the two-year peak flow up to the full 50-year peak flow. As required by the 2014 SWMMWW.
No. 8: Wetlands Protection	There are no documented wetlands recorded for Woods Creek Highlands.
No. 9: Operation and Maintenance	The drainage facility for this project will be a public facility, owned and maintained by the City. An Operation and Maintenance Manual will be provided in Section 9.0 of this Stormwater Site Plan during Final Engineering Review.

Tab 3.0

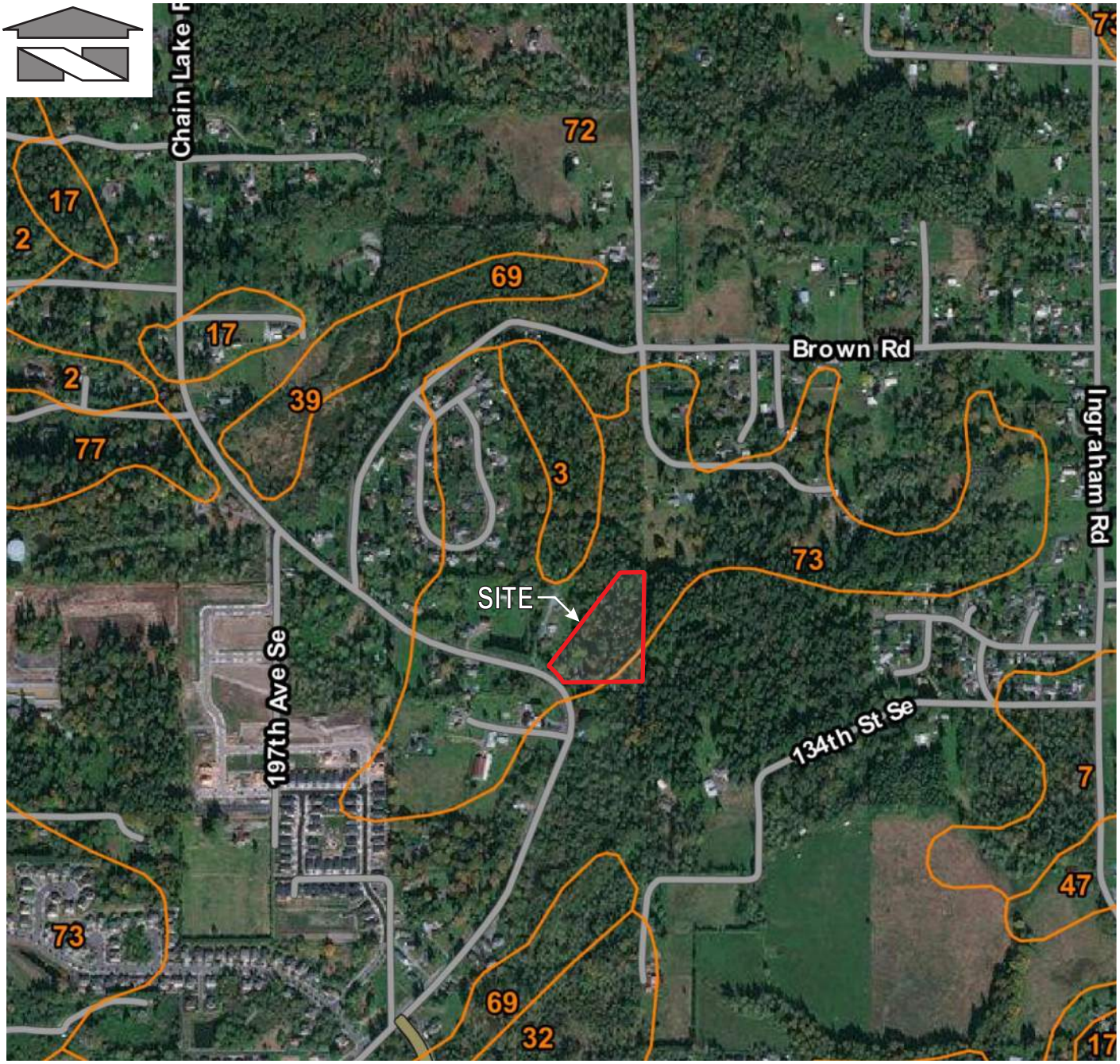
3.0 EXISTING CONDITIONS SUMMARY

The plat of the Woods Creek Highlands project is a proposed single family residential development consisting of 24 lots located on a 4.83 acre site with a tax parcel number of 28073100200400. An Assessors Map (Figure 3.0.3) has been included within this section of the report for visual reference of the parcels around the site. The project is located in the northeast quarter of the northeast quarter of the northwest quarter of Section 31, Township 28 North, Range 7 East, Willamette Meridian in the City of Monroe and Snohomish County. Please reference the Vicinity Map (Figure 1.0.1), located in Section 1.0 of this report for a visualization of the exact location of the project site.

The site consists of heavily forested area sloping in a southeast manner with grades ranging from 0 to 12 percent. To the immediate east and south of the site is an existing subdivision with conveyance systems in place. To the north and west of the site are large forested properties that are mostly undeveloped. Due to the topography of the area surrounding the site, approximately 2.6 acres of upstream runoff is expected from the property to the west.

The elevations for the site range from 342 to 307 feet. On-site soils are mapped as tokul gravelly medial loam, which is common throughout the region and is generally considered to be a glacially consolidated till. This type of soil is typically characterized as a dense 'hardpan' soil, with moderate runoff rates and low permeability. For further information please reference the Soil Survey Map (Figure 3.0.1) located in this section of the report.

The site is located in Zone X outside of the 500-year floodplain. Please reference the FEMA Map (Figure 3.0.4) located within this section of the report.



REFERENCE: USDA, Natural Resources Conservation Service

LEGEND:

72 = Tokul gravelly medial loam, 0-8% slopes

73 = Tokul gravelly medial loam, 8-15% slopes

Scale:

Horizontal: **N.T.S.** Vertical: **N/A**

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For:

Woods Creek Highlands
Monroe, Washington

Title:

SOIL SURVEY MAP

Job Number

20354

FIGURE 3.0.1

DATE: 11/28/18

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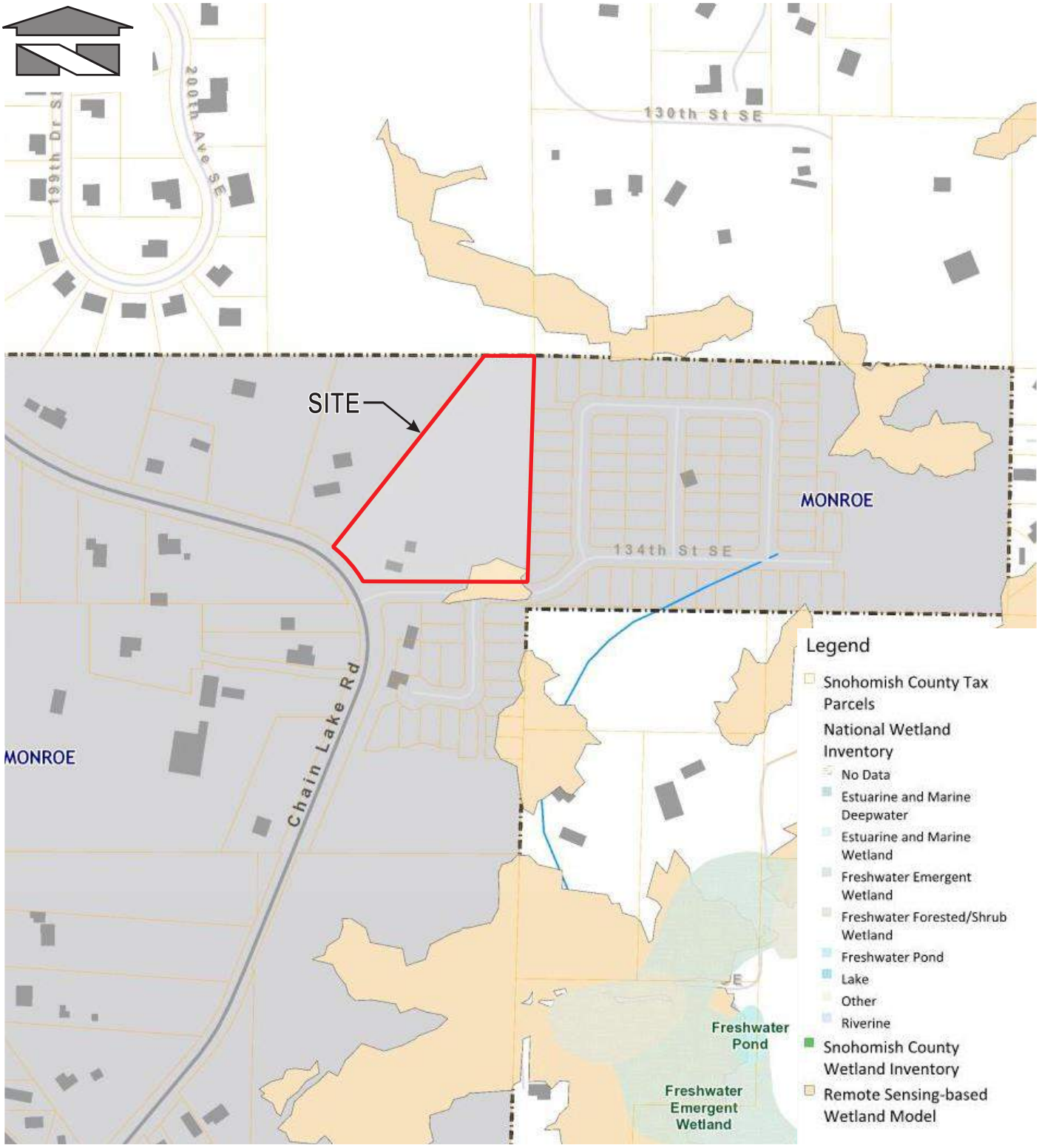

REFERENCE: Snohomish County PDS Map Portal (2018)

Scale:

Horizontal: ***N.T.S.*** *Vertical:* ***N/A***

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CIVIL ENGINEERING, LAND PLANNING, SURVEYING, ENVIRONMENTAL SERVICES

For:

Woods Creek Highlands
Monroe, Washington

Title:

SENSITIVE AREAS MAP

Job Number

20354

FIGURE 3.0.2

DATE: 11/28/18

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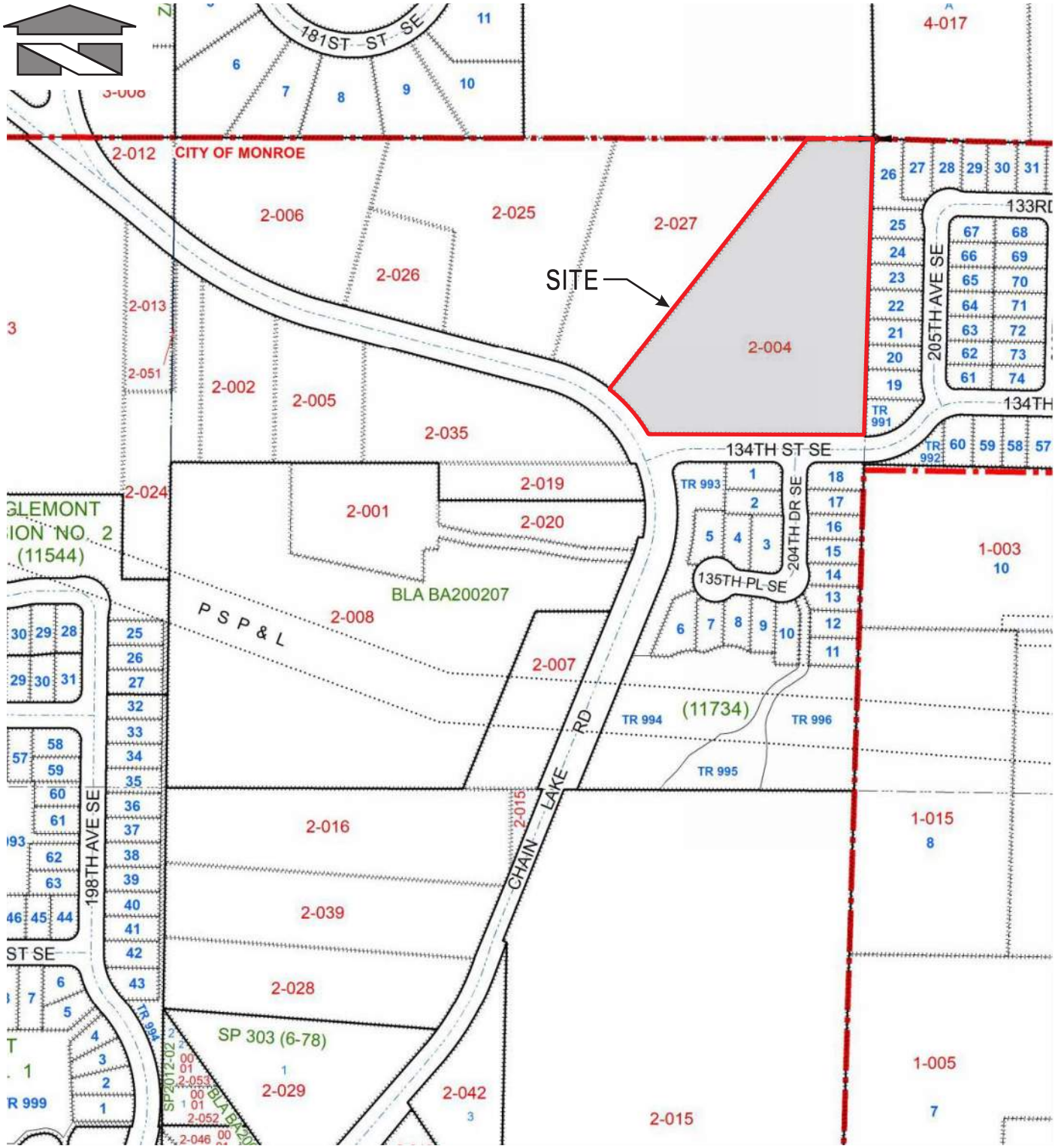

REFERENCE: Snohomish County Department of Assessments (Oct. 2018)

Scale: Horizontal: N.T.S. Vertical: N/A	For: Woods Creek Highlands Monroe, Washington	Job Number 20354
BARGHAUSEN CONSULTING ENGINEERS, INC. 18215 72ND AVENUE SOUTH KENT, WA 98032 (425) 251-6222 (425) 251-8782 CIVIL ENGINEERING, LAND PLANNING, SURVEYING, ENVIRONMENTAL SERVICES	Title: ASSESSOR MAP	FIGURE 3.0.3
		DATE: 11/28/18

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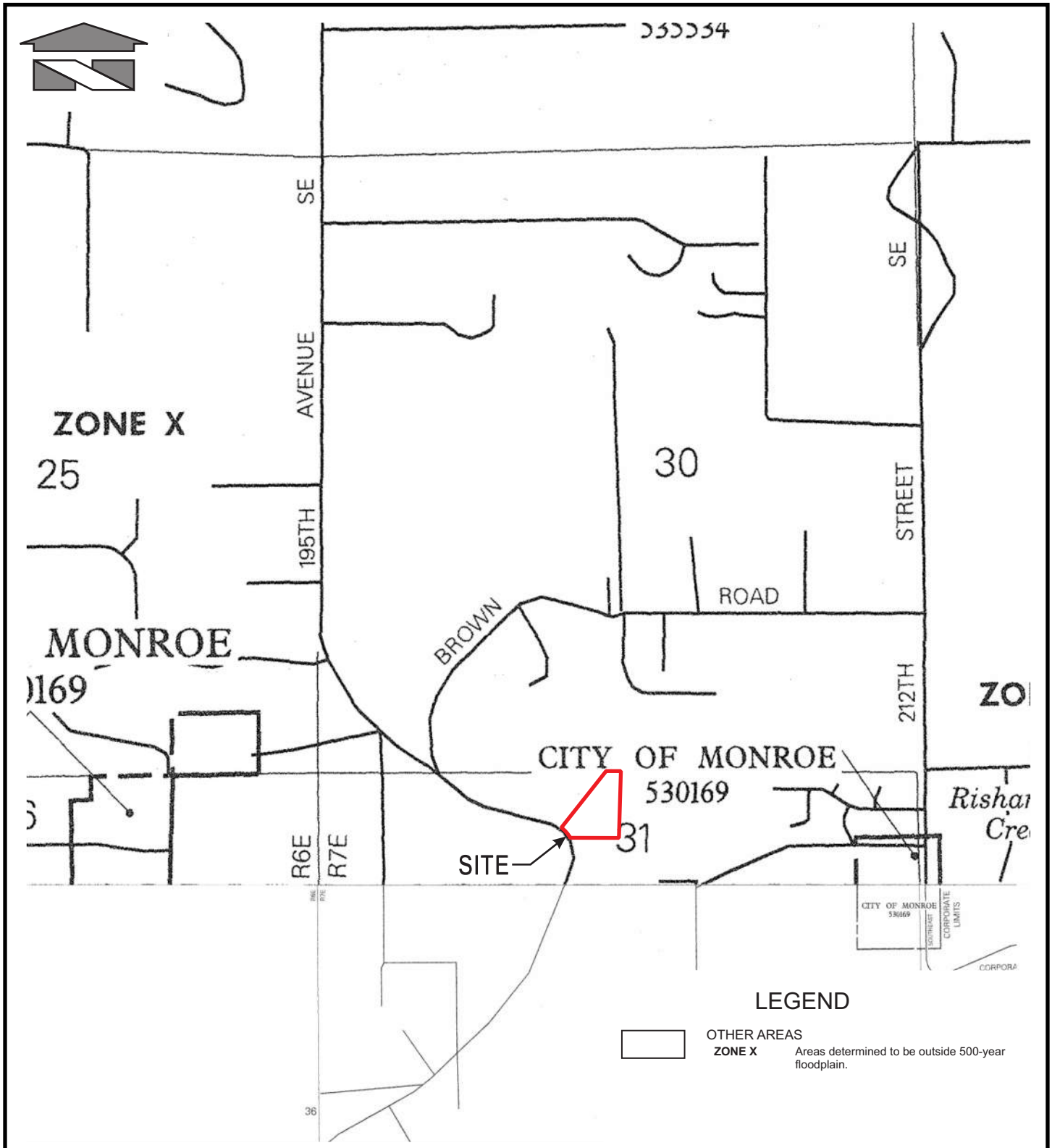

REFERENCE: Federal Emergency Management Agency (Portion of Map 53061C1100 E, Nov. 1999)

Scale: Horizontal: **N.T.S.** Vertical: **N/A**	*For:* Woods Creek Highlands Monroe, Washington	Job Number 20354
BARGHAUSEN CONSULTING ENGINEERS, INC. 18215 72ND AVENUE SOUTH KENT, WA 98032 (425) 251-6222 (425) 251-8782 CIVIL ENGINEERING, LAND PLANNING, SURVEYING, ENVIRONMENTAL SERVICES	*Title:* FEMA MAP	FIGURE 3.0.4
		DATE: 11/28/18

P:\20000s\20354\exhibit\graphics\20354 fema.cdr

Tab 4.0

4.0 OFF-SITE ANALYSIS REPORT

The project is subject to the provisions of the City of Monroe design and development standards, as well as the 2014 Stormwater Management Manual for Western Washington, issued by the Washington State Department of Ecology. This report and accompanying plans are intended to satisfy the site plan preparation requirements outlined in the regulatory documents listed above. The DOE Stormwater Manual requires completion of the following four tasks as part of the site plan preparation process:

Task 1: Define and map the study area

The project study area includes the project site itself, as well as a tributary upstream basin, and a downstream flowpath for a distance of one-quarter mile.

Task 2: Review all available information on the study area

- **Critical Drainage Area Map**

The City of Monroe Stream and Wetlands Map indicates a Category II wetland located in the downstream path of the project site. See Figure 4.0.3 - City of Monroe Stream and Wetlands Map located in this section of the report.

- **Floodplain/Floodway (FEMA) Map**

Referencing Figure 3.0.4 - FEMA Map located in section 3.0 of the report shows that the project site and surrounding area are not shown to be within a flood hazard area.

- **Offsite Analysis Reports**

The Snohomish County Drainage inventory was used to identify existing drainage structures/facilities surrounding the site. See Figure 4.0.2 - Snohomish County Drainage inventory Map located in this section of the report.

- **Basin Plans**

The project site drains to the Woods Creek watershed. This creek feeds into the Skykomish River which eventually connects to the Snohomish River.

- **Sensitive Area Information**

The City of Monroe Critical Areas Map showed a Category II wetland approximately 400 feet southwest of the property and a Type 3 stream approximately 500 feet south of the property.

The National Wetlands Inventory was review and deemed to have no significant wetlands on-site.

- **Drainage Complaints**

After speaking to Vince Bertrand of the City of Monroe, there have not been any drainage complaints near the project site.

- **Soils Map**

NRCS soil survey identifies the underlying soils as Tokul Gravelly Medial Loam, which is common throughout the region and is generally considered to be a glacially consolidated till. This type of soil is typically characterized as a dense "hardpan" soil, with moderate runoff rates and low

permeability. For further information please see Figure 3.0.1 - Soil Survey Map provided in Section 3.0.

Task 3: Field inspect the study area

A downstream drainage analysis for the site is presented in this section. The site consists of a single drainage basin that flows into the Woods Creek Watershed which eventually drains into the Skykomish River. (Figure 4.0.3 – City of Monroe Stream and Wetlands Map). The drainage course from the site was assessed on November 29, 2018 with weather conditions being cloudy and damp.

The downstream conveyance system is described below and illustrated in Figure 4.0.1 – Downstream Drainage Course. Further descriptions of drainage features are summarized in Section 5.2 of this report.

Upstream Drainage Analysis

The project is bounded to the east and south by subdivisions with conveyance systems in place therefore no runoff is expected from these developments. The project is bounded to the north and west by large forested sites that are mostly undeveloped. Due to the topography around the site sloping in a southeast manner, there is approximately 2.6 acres of forested runoff expected from the property to the west. Please refer to Figure 5.1.1 – Predeveloped Drainage Basin Map for further detail.

On-site Drainage

The topography of the site slopes in a southeast manner towards the southeast corner of the property. The property is heavily forested and has no existing drainage system. Because of this, runoff is assumed to sheet flow gently toward the southeast corner of the site. See photos below for details:

Onsite – West boundary sloping southeast

Onsite – Southeast corner sloping east

Downstream Drainage Course (See Figure 4.0.1 – Downstream Drainage Course)

A detailed downstream drainage analysis was conducted by Barghausen Consulting Engineers, Inc. on November 29, 2018. The time was around 10:00 AM and conditions were moderately cloudy and damp with steady rainfall occurring in the last 24 hours.

The above photos were taken at the southeast corner of the site boundary line. The first photo shows the rockery at the southeast corner of the property looking west along 134th Street S.E. This rockery will be removed to accommodate the drainage facility in this area. The second photo was also taken at the southeast corner of the property and looks southeast towards the forested area. The stormwater runoff from the detention facility will connect to the existing conveyance system and flow southeast towards the forested area.

Once reaching the open space tract to the southeast, stormwater will flow into an existing dispersion trench system approximately 50 feet in length. Runoff from this system will sheet flow south through the forest area for approximately 300 feet before reaching a wetland per the City of

Monroe Streams and Wetlands Map. From there, runoff will continue to sheet flow south before reaching one-quarter mile downstream. The photos above show the dispersion trench system and the forest area to the south. Due to fencing and overgrowth of vegetation, photos of the existing wetland could not be obtained. Please see Figure 4.0.1 – Downstream Drainage Course for further detail.

After conducting a thorough downstream investigation, it can be confidently determined, with minor upgrades and maintenance, that the development of this project will not negatively impact the downstream system. The existing conveyance system shows an ability to convey the stormwater runoff from the developed site. Any impacts are further mitigated by the proposed detention facility because the discharges are designed to match developed discharge durations to pre-developed durations for the range of pre-developed discharge rates from 50 percent of the two-year peak flow up to the full 50-year peak flow.

See the drainage design in Section 5.0 of this report for further information on the sizing of the detention facility.

Bypass Area Along Chain Lake Road

Due to frontage improvements along Chain Lake Road, the stormwater runoff from this section of the property will bypass the proposed detention facility. Because of this, photos of the existing conveyance system along this area were obtained during the site visit.

The first photo above shows the existing ditch along the project boundary and Chain Lake Road. The ditch showed heavy vegetation and flows in a southeast manner along the road. The second photo shows the existing culvert at the end of the ditch that connects the ditch and the catch basin further south. This culvert will be removed and replaced by an underground pipe below the widened road that will connect the ditch and the catch basin.

Once reaching the catch basin at the road intersection, runoff will begin to flow south along Chain Lake Road through the bio infiltration swale of the existing development. Water will then discharge into the existing wetland to the east through two separate catch basins along the swale. This is shown in the photos above. Based on the existing topography of the area, flow from the wetland eventually merges with the main flow from the site before reaching one-quarter mile downstream.

Task 4: Describe the drainage system and its existing and predicted problems

Downstream Drainage Complaints

Per Vince Bertrand from the City of Monroe, there have not been any drainage complaints within one-quarter mile downstream of Woods Creek Highlands.

DOWNSTREAM DRAINAGE COURSE
FOR
PRELIMINARY PLAT OF WOODS CREEK HIGHLANDS
CITY OF MONROE, SNOHOMISH COUNTY, WA

1"=150'

0 75 150 300

No.	Date	By	Ckd.	Appr.	Revision

Title: DOWNSTREAM DRAINAGE COURSE FOR PRELIMINARY PLAT OF WOODS CREEK HIGHLANDS

For: WOODS CREEK DEVELOPMENT, INC.
1800 136TH PL NE, STE 100
BELLEVUE, WA

Scale: Horizontal 1" = 150' Vertical N/A

Designed VN
Drawn VN
Checked BJT
Approved BJT
Date 12/3/18

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Job Number 20354

Sheet FIG 4.0.1 of

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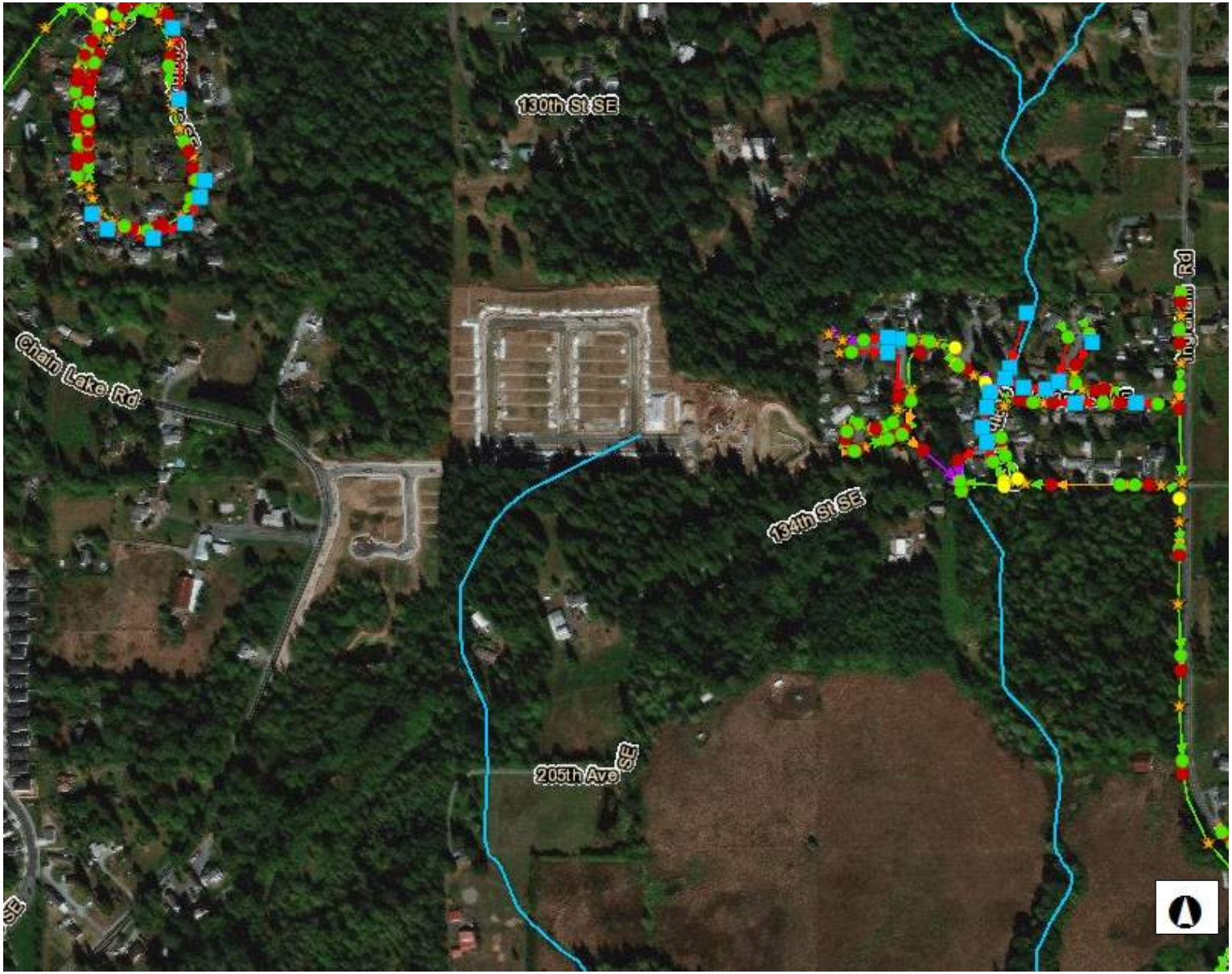
Snohomish County Public Works

Snohomish County Drainage Inventory Online Mapping Tool

Surface Water Management

11/29/2018

Figure 4.0.2



Legend

- Catch Basin
- Media Filter Structure
- Energy Dissipator
- Overflow Control
- Auxiliary Point
  - Pipe In
  - Pipe Out
  - Pipe Invert
  - Other Auxiliary Point
- Thalweg
- Xsections
- Culvert
- Enclosed Pipe
- Open Channel
- Other Flow Network
- Fence
- Facility Access
- Closed Detention
- Permeable Pavement
- Pond
- Water Quality Feature
- Watercourse
- County Boundary

0.3 0 0.14 0.3 Miles

WGS_1984_Web_Mercator_Auxiliary_Sphere

Surface Water Management, Snohomish County Public Works

All maps, data, and information set forth herein ("Data"), are for illustrative purposes only and are not to be considered an official citation to, or representation of, the Snohomish County Code. Amendments and updates to the Data, together with other applicable County Code provisions, may apply which are not depicted herein. Snohomish County makes no representation or warranty concerning the content, accuracy, currency, completeness or quality of the Data contained herein and expressly disclaims any warranty of merchantability or fitness for any particular purpose. All persons accessing or otherwise using this Data assume all responsibility for use thereof and agree to hold Snohomish County harmless from and against any damages, loss, claim or liability arising out of any error, defect or omission contained within said Data. Washington State Law, Ch. 42.56 RCW, prohibits state and local agencies from providing access to lists of individuals intended for use for commercial purposes and, thus, no commercial use may be made of any Data comprising lists of individuals contained herein.

Figure 4.0.3

City of Monroe

Stream & Wetlands

STREAMS

- Type 1
- Type 3
- Type 3u*
- Type 4
- Type 5
- Unclassifed Stream
- # Stream Inventory No.

*Unless determined an artifical waterway

WETLANDS

- Cat I
- Cat II
- Cat III
- Cat IV
- Unclassified Wetlands
- # Wetland Inventory No.

BOUNDARIES

- Urban Growth Area
- Monroe City Limits
- Shoreline Boundary

BUFFERS*

- Combined Critcal Areas Buffers

* Type 4 stream buffer shown as 150 ft on each side of the channel., Type 4 streams, beyond a quarter mile of a stream with salmonids, have a buffer of 75 ft on each side of the channel. See MMC 20.05 for specific buffers.

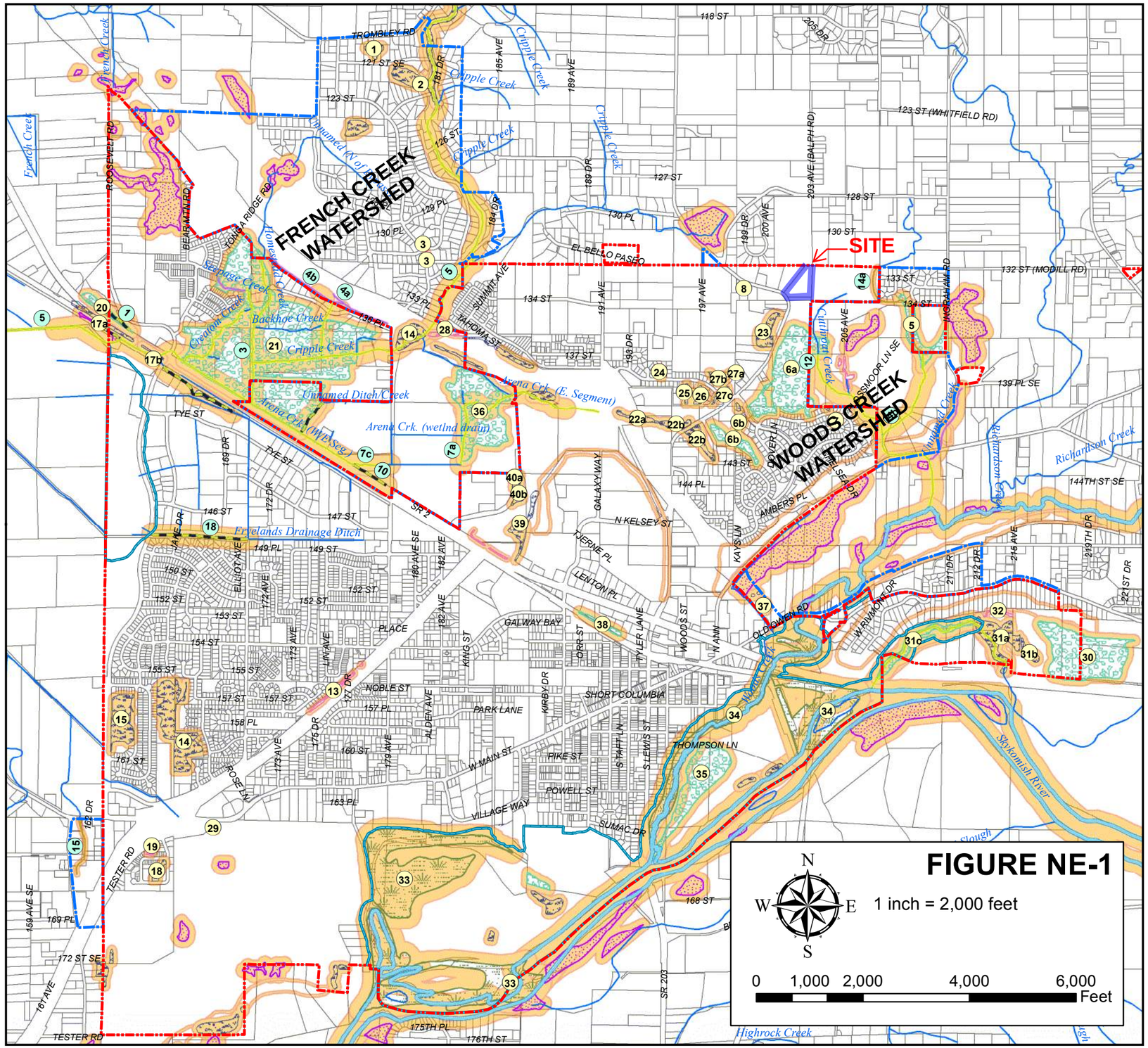
Notes:

1) The locations decpicted are approximate boundaries for critical areas within the city limits. This maps provides only approximate boundaries of known features and is not a substitute for more detailed maps and/or studies to identify the exact locations of known features or additional critical area features not illustrated on the map.
2) The points where streams change classification are approximate and subject to confirmation and refinement.
3) Classifications are subject to refinement based upon additional or updated fish use and seasonality of water flow information.

Map data shown is the property of the sources listed below. Inaccuracies may exist, and the City of Monroe implies no warranties or guarantees regarding any aspect of data depiction. This map is not an actual survey of individually noted critical areas. Streams have been categorized using the water typing system defined in Monroe Municipal Code Chapter 20.05 (equivalent to WAC 222-16-031). Wetlands were classified using the Washington Department of Ecology's Washington State Wetland Rating system for Western Washington. Wetland size, shape and location are approximate based on a reconnaissance level evaluation. The City of Monroe and the Urban Growth Area may contain additional critical areas not identified on this map. Therefore this map is to be used for reference purposes only.

Source: City of Monroe GIS, 2008;
The Watershed Company;
Snohomish County GIS, 2007

Project: Streams & Wetlands 11x17
Location: Y:\GIS\Departments\CD\Comprehensive Plan\Comp Plan 2013\For_Commerce
Revised: 10-08-13
Author: M. Sartorius



Tab 5.0

5.0 PERMANENT STORMWATER CONTROL PLAN

This section contains the following information:

5.1 Existing Site Hydrology

5.2 Developed Site Hydrology

5.3 Performance Standards and Goals

5.4 Low Impact Development Features

5.5 Flow Control System

5.6 Water Quality System

5.7 Conveyance System Analysis and Design

5.1 Existing Site Hydrology

The project site consists of a drainage basin approximately 7.52 acres in size. This area includes a 2.65 acre upstream basin from the adjacent property to the west. The general topography indicates that stormwater will flow toward the southeast corner of the site. The predeveloped site area is mostly undeveloped forest area with an existing home, garage and shed near the southwest corner.

- Predeveloped Basin is 7.52 acres in size and includes the detention vault. The on-site basin area has been modeled as 6.38 acres of moderate slope and 1.14 acres of flat slope. The off-site area has been modeled as 2.15 acres of moderate slope and 0.50 acres of flat slope. All of these areas were classified as fully forested.

For further detail on this information, please see the Figure 5.1.1 – Predeveloped Drainage Basin of this report.

PREDEVELOPED DRAINAGE BASIN MAP
FOR
PRELIMINARY PLAT OF WOODS CREEK HIGHLANDS
CITY OF MONROE, SNOHOMISH COUNTY, WA

1"=50'

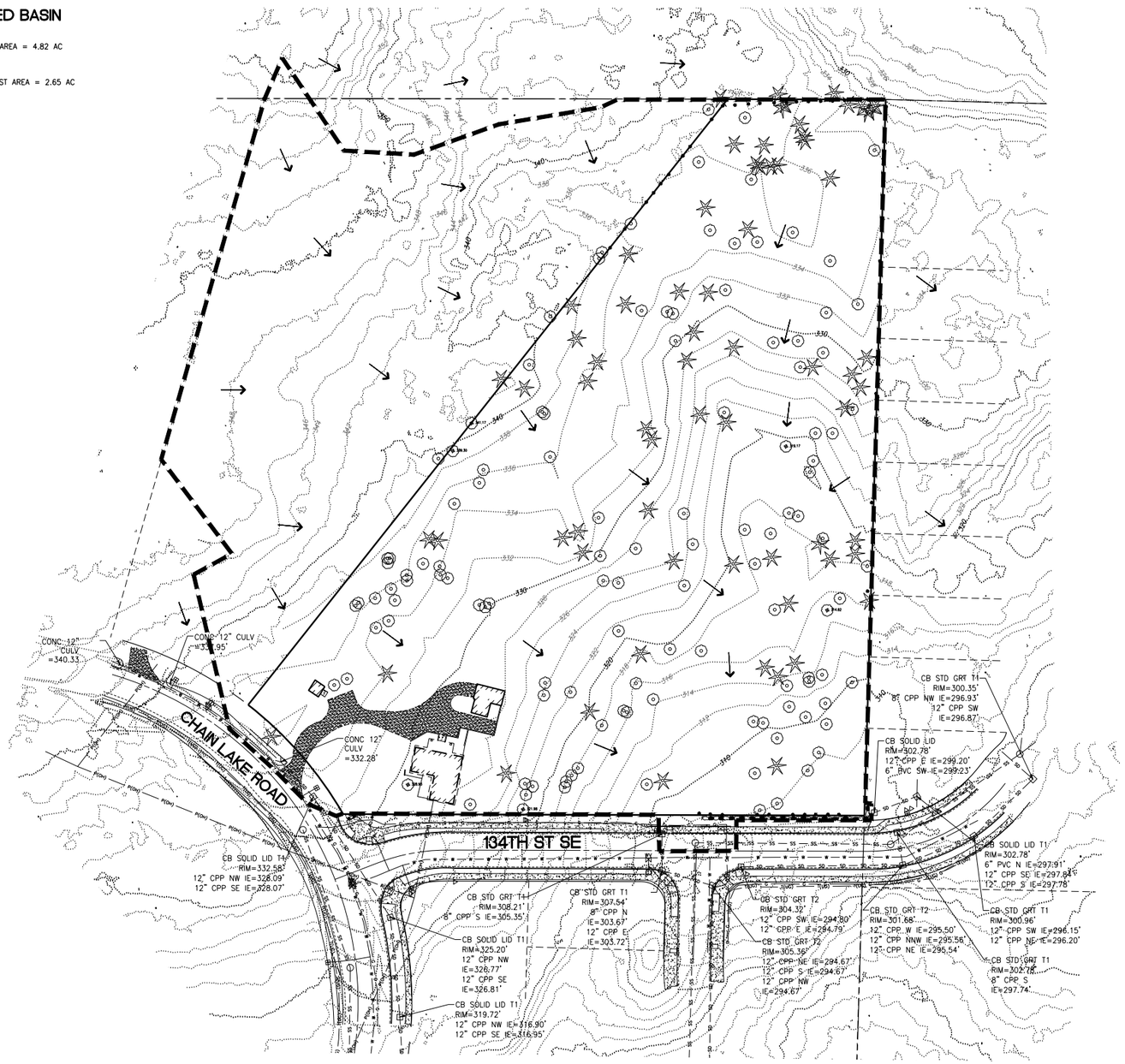
0 25 50 100

PREDEVELOPED BASIN

TOTAL AREA = 7.47 AC

TOTAL ONSITE TILL FOREST AREA = 4.82 AC
MODERATE = 4.18 AC
FLAT = 0.64 AC

TOTAL UPSTREAM TILL FOREST AREA = 2.65 AC
MODERATE = 2.15 AC
FLAT = 0.50 AC



No.	Date	By	Ckd.	Appr.	Revision

Title: PREDEVELOPED DRAINAGE BASIN MAP FOR PRELIMINARY PLAT OF WOODS CREEK HIGHLANDS

For: WOODS CREEK DEVELOPMENT, INC.
1800 136TH PL NE, STE 100
BELLEVUE, WA

Scale: Horizontal 1" = 50' Vertical N/A

Designed VIV
Drawn VIV
Checked BJT
Approved BJT
Date 12/3/18

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CIVIL ENGINEERING, LAND PLANNING, SURVEYING, ENVIRONMENTAL SERVICES

Job Number 20354

Sheet FIG 5.1.1 of

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5.2 Developed Site Hydrology

The Plat of Woods Creek Highlands will consist of 24 new single-family residences. New impervious surfaces include sidewalk, driveways and roof areas. The project will have landscaped pervious areas which include open space and park areas. The drainage facility serving this development will be located below the park area near the southeast corner of the site.

A conveyance system consisting of catch basins and storm pipes will be constructed in the roadways to collect drainage from impervious surfaces and lots and route them to the drainage facility located in Tract A.

Water quality for the project will be provided by a StormFilter vault (or approved equal) immediately downstream of the detention facility. For further information on water quality treatment and sizing, please reference Section 5.6 of this report.

This detention vault has been sized using WWHM2012 stormwater program. Discharges are designed to match developed discharge durations to predeveloped durations for the range of predeveloped discharge rates from 50 percent of the 2-year peak flow up to the full 50-year peak flow.

Drainage Basin

The detention vault has been sized to accommodate the entire drainage basin tributary to this site. For purposes of sizing the vault, we assumed the maximum impervious coverage as follows: newly constructed lot areas were assumed to be 60 percent impervious, new right-of-way area onsite and frontage improvements are assumed to be 100 percent impervious. The developed drainage basin tributary to the detention vault can be broken down as follows:

Impervious	On-Site Pervious	Off-Site Pervious	Total Area
2.83 Ac(1)	1.86 Ac(2)	2.55 Ac(3)	7.24 Ac

Notes:

1. Onsite Roads and Sidewalks (100% of ROW) = 1.19 Ac
   Lot Area @ 60% impervious = 1.64 Ac
2. Modeled as till lawn.
3. Modeled as forested.

Additionally, there were two small areas of the developed site where runoff could not be routed back to the drainage facility due to relative elevations. The first area consists of 0.13 acres of right-of-way located near the southeast corner of the site. The second area consists of 0.10 acres of frontage improvements near the southwest corner of the site. After reviewing the SWMMWW, below is a list of considerations that were met to incorporate the bypass area to the detention vault design:

1. The point of convergence for both bypass areas and the drainage basin are the same.

2. The bypass area near the southeast corner of the site was routed back to the StormFilter vault, therefore the total area that will remain untreated is less than 5000 square feet.

The bypass areas described above were included in the sizing of the proposed detention vault (Note: landscape strips on bypass areas were modeled as pervious). Per the WWHM2012 calculations, the detention volume provided for the detention vault is 83,000 cubic feet. For further detail please refer to Section 5.5 of this report.

See Section 5.4 of this report for LID Performance Standard for Flow Control.

DEVELOPED DRAINAGE BASIN MAP
FOR
PRELIMINARY PLAT OF WOODS CREEK HIGHLANDS
CITY OF MONROE, SNOHOMISH COUNTY, WA

1"=50'

0 25 50 100

DEVELOPED BASIN

TOTAL BASIN AREA = 7.47 AC
TOTAL R/W AREA = 1.42 AC
TOTAL LOT AREA = 2.74 AC

BASIN
BASIN AREA BREAKDOWN:

TOTAL AREA TO VAULT = 7.24 AC

TOTAL IMPERVIOUS SURFACE AREA = 2.83 AC
ROADS AND SIDEWALKS (R/W) = 1.19 AC
LOTS @ 60% IMPERVIOUS = 1.64 AC

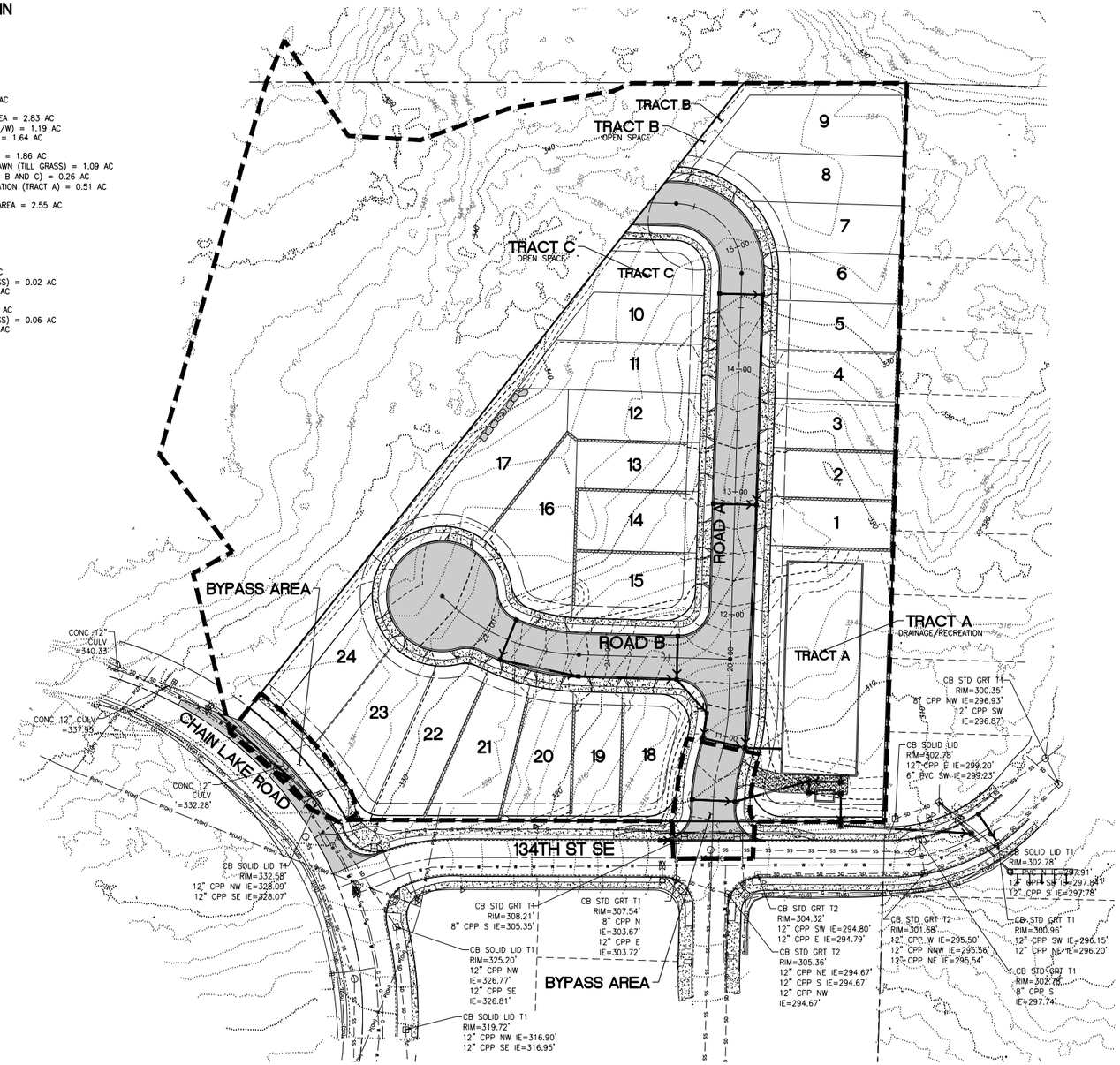
TOTAL PERVIOUS SURFACE AREA = 1.86 AC
LOTS @ 40% PERVIOUS LAWN (TILL GRASS) = 1.09 AC
OPEN SPACE AREA (TRACT B AND C) = 0.26 AC
DRAINAGE FACILITY/RECREATION (TRACT A) = 0.51 AC

TOTAL UPSTREAM TILL FOREST AREA = 2.55 AC
MODERATE = 2.05 AC
FLAT 0.50 AC

TOTAL BYPASS AREA = 0.23 AC

ONSITE BYPASS AREA = 0.13 AC
PERVIOUS AREA (TILL GRASS) = 0.02 AC
IMPERVIOUS AREA = 0.11 AC

OFF-SITE BYPASS AREA = 0.10 AC
PERVIOUS AREA (TILL GRASS) = 0.06 AC
IMPERVIOUS AREA = 0.04 AC



No.	Date	By	Ckd.	Appr.	Revision

Title: DEVELOPED DRAINAGE BASIN MAP FOR PRELIMINARY PLAT OF WOODS CREEK HIGHLANDS

For: WOODS CREEK DEVELOPMENT, INC.
1800 136TH PL NE, STE 100
BELLEVUE, WA

Scale: Horizontal 1" = 50' Vertical N/A

Designed VIV
Drawn VIV
Checked BJT
Approved BJT
Date 12/4/18

BARGHAUSEN CONSULTING ENGINEERS, INC.
18215 72ND AVENUE SOUTH
KENT, WA 98032
(425)251-6222
(425)251-8782 FAX
CIVIL ENGINEERING, LAND PLANNING, SURVEYING, ENVIRONMENTAL SERVICES

Job Number 20354
Sheet FIG 5.2.1 of

File:P:\20000s\20354\exhibit\20354-prn20.dwg Date/time:12/13/2018 3:24 PM WARAS Xref: ----

5.3 Performance Standards and Goals

The project is subject to the provisions of the City of Monroe's design standards and guidelines, as well as the 2012 Stormwater Management Manual for Western Washington (2014 SWMMWW), as Amended in December 2014 , by the Washington State Department of Ecology. This report, along with the accompanying plans, are intended to satisfy the Stormwater Site Plan preparation requirements outlined in the regulatory documents listed above.

Hydrologic modeling was performed using the 2012 Western Washington Hydrology Model hence forth referred to as WWHM2012. WWHM2012 is a locally calibrated continuous simulation model developed by the Washington State Department of Ecology. The model evaluates several decades of hydrologic data to derive peak flow rate and duration information per Figure 5.3.1 Treatment Facility Selection Flow Chart. Please reference, Section 5.5 of this report for further information.

Water quality treatment will be provided via a StormFilter vault (or approved equal). Please reference Section 5.6 of this report for further information.

This project has opted to use the List #2 per the Flow Chart for Determining LID MR #5 Requirements (Figure 5.3.2), located within this section of the report. In order to meet the requirements for List #2, all individual on-site lots will have the following BMPs on top of the 60% maximum impervious surface coverage per lot. All soil in the lawn and landscaped areas for the site will be amended to meet the post-Construction Soil Quality and Depth requirement. Each individual lot will have a perforated stub-out connection for rooftops. Due to lot configurations and size, Full Dispersion, Downspout Dispersion Systems for rooftop runoff and Bioretention Systems are not feasible. For more information on the LID Features for the project please reference Section 5.4 of this report.

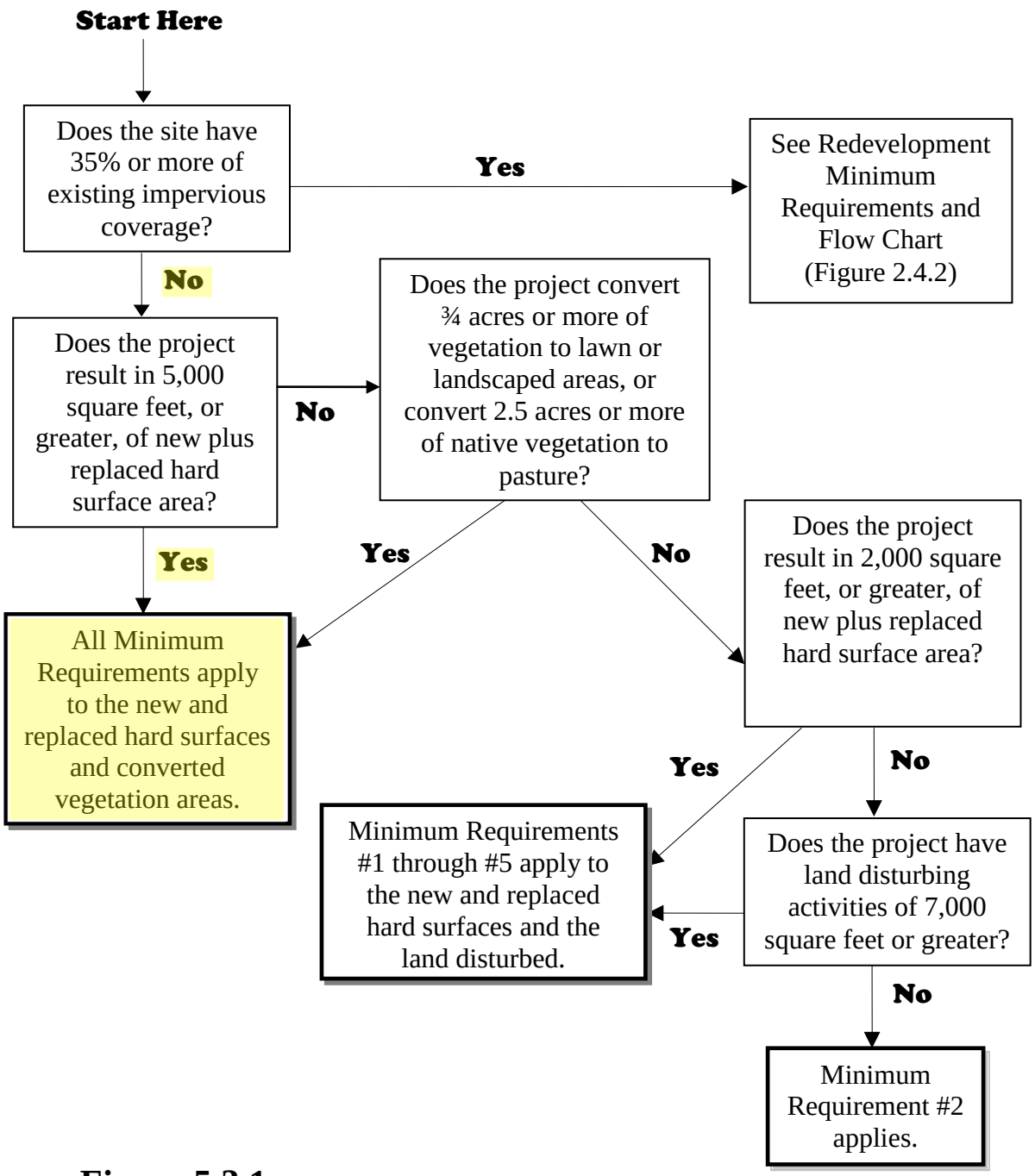
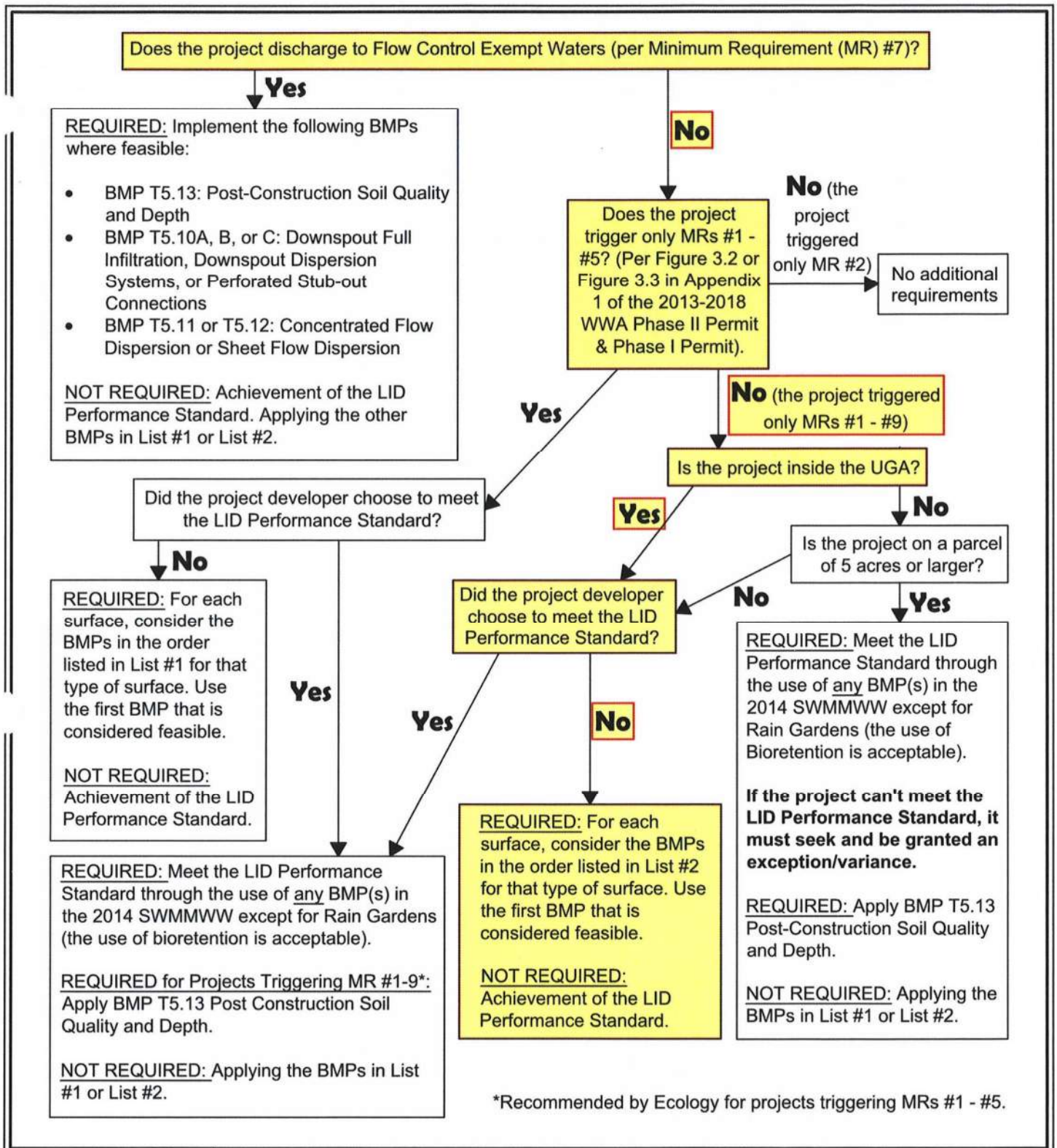


Figure 5.3.1

Figure 2.4.1 – Flow Chart for Determining Requirements for New Development



DEPARTMENT OF ECOLOGY
State of Washington

Figure 5.3.2 Figure I-2.5.1
Flow Chart for Determining LID MR #5 Requirements

Revised June 2015

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5.4 Low Impact Development Features

Woods Creek Highlands is subject to Low Impact Development performance standard requiring the analysis of List #1 and #2 per the 2014 SWMMWW. List #1 requires matching developed discharged durations to pre-developed durations for the range of pre-developed discharge rates from 8% of the 2-year peak flow to 50% of the 2-year peak flow. List #1 becomes unpractical when developing large residence plats, resulting in drainage facility roughly the same size as the plat. Therefore, Woods Creek Highlands has opted to use List #2 per the Flow Chart for Determining LID Requirements (Figure 5.3.2), located within Section 5.3 of this report. In order to meet the requirements for List #2 all individual on-site lots will have the following BMPs on top of the 60 percent maximum impervious surface coverage per lot. All soil in the lawn and landscaped areas for the site will be amended to meet BMP T5.13 Post-Construction Soil Quality and Depth.

Additionally, each individual lot will have a Perforated Stub-Out Connection in compliance with BMP T5.10C, for all rooftop areas. Due to lot configurations and size, Full Dispersion, Downspout Dispersion Systems for rooftop runoff and Bioretention Systems are not feasible. Infiltration is not feasible for this site as the existing soil conditions consists of Vashon lodgement till. Due to its high density and high silt content, this type of soil is not receptive to stormwater infiltration. Please see the Geotechnical Report by Associated Earth Sciences Inc. in Section 7.0 of this report for further details.

Flow Control for the detention vault is provided by matching developed discharge durations to forested durations for the range of pre-developed discharge rates from 50 percent of the two-year peak flow up to the full 50-year peak flow. For details on the sizing of the detention vault please reference Section 5.5 of this report.

5.5 Flow Control System

Surface runoff from the site will be routed to the detention vault located in Tract A. A detailed breakdown of the basin areas can be located in Section 5.2 of this report. This facility has been sized using the WWHM2012 stormwater program. Discharges are designed to match developed discharge durations to predeveloped durations for the range of predeveloped discharge rates from 50 percent of the 2-year peak flow up to the full 50-year peak flow. The volume provided for the detention vault is 83,000 cubic feet. These design calculations are provided within this section of the report.

WWHM2012

WOODS CREEK HIGHLANDS - DETENTION VAULT

PROJECT REPORT

General Model Information

Project Name:	WOODS CREEK HIGHLANDS
Site Name:	
Site Address:	
City:	
Report Date:	12/13/2018
Gage:	Everett
Data Start:	1948/10/01
Data End:	2009/09/30
Timestep:	15 Minute
Precip Scale:	1.200
Version Date:	2018/10/10
Version:	4.2.16

POC Thresholds

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

Landuse Basin Data

Predeveloped Land Use

WOODS CREEK HIGHLANDS - DETENTION VAULT

Basin 1

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Forest, Flat	1.14
C, Forest, Mod	6.33
Pervious Total	7.47
Impervious Land Use	acre
Impervious Total	0
Basin Total	7.47

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

WOODS CREEK HIGHLANDS - DETENTION VAULT

Basin 1

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Forest, Flat	0.5
C, Forest, Mod	2.05
C, Lawn, Flat	1.86
Pervious Total	4.41
Impervious Land Use	acre
ROADS FLAT	1.19
ROOF TOPS FLAT	1.64
Impervious Total	2.83
Basin Total	7.24

Element Flows To:

Surface	Interflow	Groundwater
Vault 1	Vault 1	

Basin 2

Bypass:	Yes
GroundWater:	No
Pervious Land Use	acre
C, Forest, Flat	0.08
Pervious Total	0.08
Impervious Land Use	acre
ROADS FLAT	0.15
Impervious Total	0.15
Basin Total	0.23

Element Flows To:

Surface	Interflow	Groundwater

Routing Elements
Predeveloped Routing

Mitigated Routing

WOODS CREEK HIGHLANDS - DETENTION VAULT

Vault 1

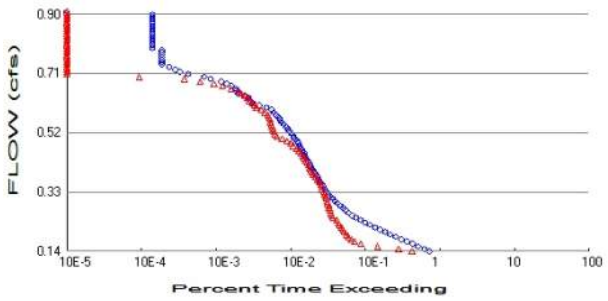
Width:	60 ft.	REQUIRED = 78,720 CF
Length:	164 ft.	(9,840 SF)
Depth:	9 ft.	
Discharge Structure		
Riser Height:	8 ft.	
Riser Diameter:	18 in.	
Orifice 1 Diameter:	1.6 in.	Elevation:0 ft.
Orifice 2 Diameter:	2.91 in.	Elevation:4.7 ft.
Orifice 3 Diameter:	1.49 in.	Elevation:6.39 ft.
Element Flows To:		
Outlet 1	Outlet 2	

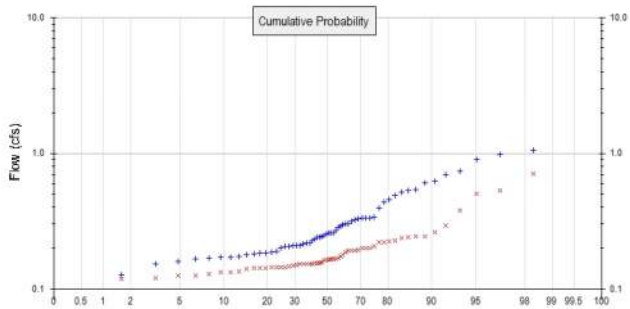
Vault Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.225	0.000	0.000	0.000
0.1000	0.225	0.022	0.022	0.000
0.2000	0.225	0.045	0.031	0.000
0.3000	0.225	0.067	0.038	0.000
0.4000	0.225	0.090	0.043	0.000
0.5000	0.225	0.112	0.049	0.000
0.6000	0.225	0.135	0.053	0.000
0.7000	0.225	0.158	0.058	0.000
0.8000	0.225	0.180	0.062	0.000
0.9000	0.225	0.203	0.065	0.000
1.0000	0.225	0.225	0.069	0.000
1.1000	0.225	0.248	0.072	0.000
1.2000	0.225	0.271	0.076	0.000
1.3000	0.225	0.293	0.079	0.000
1.4000	0.225	0.316	0.082	0.000
1.5000	0.225	0.338	0.085	0.000
1.6000	0.225	0.361	0.087	0.000
1.7000	0.225	0.384	0.090	0.000
1.8000	0.225	0.406	0.093	0.000
1.9000	0.225	0.429	0.095	0.000
2.0000	0.225	0.451	0.098	0.000
2.1000	0.225	0.474	0.100	0.000
2.2000	0.225	0.497	0.103	0.000
2.3000	0.225	0.519	0.105	0.000
2.4000	0.225	0.542	0.107	0.000
2.5000	0.225	0.564	0.109	0.000
2.6000	0.225	0.587	0.112	0.000
2.7000	0.225	0.609	0.114	0.000
2.8000	0.225	0.632	0.116	0.000
2.9000	0.225	0.655	0.118	0.000
3.0000	0.225	0.677	0.120	0.000
3.1000	0.225	0.700	0.122	0.000
3.2000	0.225	0.722	0.124	0.000
3.3000	0.225	0.745	0.126	0.000
3.4000	0.225	0.768	0.128	0.000
3.5000	0.225	0.790	0.130	0.000
3.6000	0.225	0.813	0.131	0.000
3.7000	0.225	0.835	0.133	0.000

3.8000	0.225	0.858	0.135	0.000
3.9000	0.225	0.881	0.137	0.000
4.0000	0.225	0.903	0.138	0.000
4.1000	0.225	0.926	0.140	0.000
4.2000	0.225	0.948	0.142	0.000
4.3000	0.225	0.971	0.144	0.000
4.4000	0.225	0.993	0.145	0.000
4.5000	0.225	1.016	0.147	0.000
4.6000	0.225	1.039	0.149	0.000
4.7000	0.225	1.061	0.150	0.000
4.8000	0.225	1.084	0.224	0.000
4.9000	0.225	1.106	0.256	0.000
5.0000	0.225	1.129	0.281	0.000
5.1000	0.225	1.152	0.302	0.000
5.2000	0.225	1.174	0.320	0.000
5.3000	0.225	1.197	0.337	0.000
5.4000	0.225	1.219	0.353	0.000
5.5000	0.225	1.242	0.368	0.000
5.6000	0.225	1.265	0.382	0.000
5.7000	0.225	1.287	0.395	0.000
5.8000	0.225	1.310	0.408	0.000
5.9000	0.225	1.332	0.420	0.000
6.0000	0.225	1.355	0.432	0.000
6.1000	0.225	1.378	0.443	0.000
6.2000	0.225	1.400	0.454	0.000
6.3000	0.225	1.423	0.465	0.000
6.4000	0.225	1.445	0.481	0.000
6.5000	0.225	1.468	0.505	0.000
6.6000	0.225	1.490	0.522	0.000
6.7000	0.225	1.513	0.538	0.000
6.8000	0.225	1.536	0.552	0.000
6.9000	0.225	1.558	0.566	0.000
7.0000	0.225	1.581	0.579	0.000
7.1000	0.225	1.603	0.591	0.000
7.2000	0.225	1.626	0.604	0.000
7.3000	0.225	1.649	0.615	0.000
7.4000	0.225	1.671	0.627	0.000
7.5000	0.225	1.694	0.638	0.000
7.6000	0.225	1.716	0.649	0.000
7.7000	0.225	1.739	0.659	0.000
7.8000	0.225	1.762	0.670	0.000
7.9000	0.225	1.784	0.680	0.000
8.0000	0.225	1.807	0.690	0.000
8.1000	0.225	1.829	1.202	0.000
8.2000	0.225	1.852	2.114	0.000
8.3000	0.225	1.874	3.220	0.000
8.4000	0.225	1.897	4.361	0.000
8.5000	0.225	1.920	5.377	0.000
8.6000	0.225	1.942	6.148	0.000
8.7000	0.225	1.965	6.648	0.000
8.8000	0.225	1.987	7.103	0.000
8.9000	0.225	2.010	7.496	0.000
9.0000	0.225	2.033	7.868	0.000
9.1000	0.225	2.055	8.223	0.000
9.2000	0.000	0.000	8.562	0.000

Analysis Results
POC 1





+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 7.47
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 4.49
Total Impervious Area: 2.98

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.272206
5 year	0.432602
10 year	0.559637
25 year	0.745219
50 year	0.902582
100 year	1.077109

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0.172267
5 year	0.238433
10 year	0.290754
25 year	0.367444
50 year	0.432897
100 year	0.506054

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1949	0.296	0.143
1950	0.304	0.163
1951	0.259	0.134
1952	0.210	0.152
1953	0.171	0.144
1954	1.051	0.190
1955	0.330	0.192
1956	0.289	0.244
1957	0.393	0.194
1958	0.334	0.239

1959	0.269	0.161
1960	0.254	0.165
1961	0.532	0.295
1962	0.258	0.152
1963	0.434	0.173
1964	0.338	0.125
1965	0.218	0.152
1966	0.128	0.121
1967	0.259	0.221
1968	0.315	0.166
1969	0.983	0.243
1970	0.180	0.130
1971	0.332	0.200
1972	0.210	0.206
1973	0.205	0.154
1974	0.539	0.179
1975	0.206	0.143
1976	0.218	0.149
1977	0.160	0.140
1978	0.187	0.145
1979	0.607	0.201
1980	0.284	0.145
1981	0.184	0.125
1982	0.239	0.170
1983	0.492	0.145
1984	0.246	0.262
1985	0.324	0.187
1986	0.733	0.528
1987	0.334	0.381
1988	0.173	0.152
1989	0.214	0.132
1990	0.234	0.167
1991	0.241	0.157
1992	0.184	0.155
1993	0.172	0.116
1994	0.167	0.165
1995	0.245	0.241
1996	0.455	0.227
1997	0.903	0.704
1998	0.153	0.156
1999	0.200	0.142
2000	0.169	0.201
2001	0.060	0.118
2002	0.228	0.153
2003	0.178	0.132
2004	0.300	0.220
2005	0.209	0.151
2006	0.696	0.224
2007	0.518	0.192
2008	0.618	0.506
2009	0.188	0.147

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	1.0508	0.7040
2	0.9829	0.5285
3	0.9033	0.5060

4	0.7331	0.3809
5	0.6957	0.2950
6	0.6181	0.2622
7	0.6067	0.2439
8	0.5391	0.2429
9	0.5323	0.2409
10	0.5184	0.2387
11	0.4920	0.2267
12	0.4551	0.2237
13	0.4342	0.2215
14	0.3930	0.2196
15	0.3384	0.2055
16	0.3345	0.2012
17	0.3342	0.2009
18	0.3316	0.1999
19	0.3297	0.1940
20	0.3242	0.1920
21	0.3154	0.1917
22	0.3035	0.1904
23	0.3001	0.1866
24	0.2958	0.1791
25	0.2886	0.1730
26	0.2842	0.1696
27	0.2694	0.1672
28	0.2589	0.1660
29	0.2587	0.1652
30	0.2582	0.1649
31	0.2540	0.1634
32	0.2464	0.1611
33	0.2449	0.1570
34	0.2409	0.1555
35	0.2391	0.1554
36	0.2339	0.1540
37	0.2278	0.1532
38	0.2179	0.1524
39	0.2177	0.1518
40	0.2142	0.1518
41	0.2099	0.1517
42	0.2096	0.1513
43	0.2090	0.1492
44	0.2061	0.1466
45	0.2049	0.1452
46	0.1998	0.1449
47	0.1883	0.1445
48	0.1875	0.1440
49	0.1843	0.1428
50	0.1836	0.1426
51	0.1803	0.1423
52	0.1785	0.1401
53	0.1731	0.1344
54	0.1721	0.1320
55	0.1708	0.1318
56	0.1686	0.1297
57	0.1671	0.1254
58	0.1603	0.1245
59	0.1530	0.1207
60	0.1277	0.1184
61	0.0602	0.1158

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.1361	15500	8975	57	Pass
0.1438	13261	5948	44	Pass
0.1516	10962	3127	28	Pass
0.1593	9129	1873	20	Pass
0.1671	7649	1528	19	Pass
0.1748	6536	1375	21	Pass
0.1826	5450	1274	23	Pass
0.1903	4639	1185	25	Pass
0.1980	3918	1114	28	Pass
0.2058	3369	1067	31	Pass
0.2135	2883	1022	35	Pass
0.2213	2485	963	38	Pass
0.2290	2123	930	43	Pass
0.2368	1838	884	48	Pass
0.2445	1598	783	48	Pass
0.2522	1420	762	53	Pass
0.2600	1282	738	57	Pass
0.2677	1166	719	61	Pass
0.2755	1067	704	65	Pass
0.2832	992	689	69	Pass
0.2909	916	676	73	Pass
0.2987	836	658	78	Pass
0.3064	778	642	82	Pass
0.3142	718	626	87	Pass
0.3219	677	610	90	Pass
0.3297	638	593	92	Pass
0.3374	611	572	93	Pass
0.3451	581	556	95	Pass
0.3529	557	541	97	Pass
0.3606	525	520	99	Pass
0.3684	502	488	97	Pass
0.3761	484	455	94	Pass
0.3839	462	433	93	Pass
0.3916	440	418	95	Pass
0.3993	423	403	95	Pass
0.4071	403	384	95	Pass
0.4148	388	373	96	Pass
0.4226	368	355	96	Pass
0.4303	353	339	96	Pass
0.4380	340	322	94	Pass
0.4458	329	309	93	Pass
0.4535	321	293	91	Pass
0.4613	307	273	88	Pass
0.4690	292	253	86	Pass
0.4768	283	232	81	Pass
0.4845	272	213	78	Pass
0.4922	259	191	73	Pass
0.5000	243	165	67	Pass
0.5077	233	140	60	Pass
0.5155	220	134	60	Pass
0.5232	206	128	62	Pass
0.5310	195	123	63	Pass
0.5387	185	120	64	Pass

0.5464	171	118	69	Pass
0.5542	163	115	70	Pass
0.5619	154	113	73	Pass
0.5697	147	110	74	Pass
0.5774	136	106	77	Pass
0.5852	126	95	75	Pass
0.5929	117	86	73	Pass
0.6006	101	74	73	Pass
0.6084	81	70	86	Pass
0.6161	67	65	97	Pass
0.6239	61	60	98	Pass
0.6316	58	56	96	Pass
0.6393	51	52	101	Pass
0.6471	42	46	109	Pass
0.6548	40	43	107	Pass
0.6626	39	34	87	Pass
0.6703	34	26	76	Pass
0.6781	30	20	66	Pass
0.6858	25	13	52	Pass
0.6935	18	8	44	Pass
0.7013	15	2	13	Pass
0.7090	9	0	0	Pass
0.7168	7	0	0	Pass
0.7245	6	0	0	Pass
0.7323	5	0	0	Pass
0.7400	4	0	0	Pass
0.7477	4	0	0	Pass
0.7555	4	0	0	Pass
0.7632	4	0	0	Pass
0.7710	4	0	0	Pass
0.7787	4	0	0	Pass
0.7864	4	0	0	Pass
0.7942	3	0	0	Pass
0.8019	3	0	0	Pass
0.8097	3	0	0	Pass
0.8174	3	0	0	Pass
0.8252	3	0	0	Pass
0.8329	3	0	0	Pass
0.8406	3	0	0	Pass
0.8484	3	0	0	Pass
0.8561	3	0	0	Pass
0.8639	3	0	0	Pass
0.8716	3	0	0	Pass
0.8794	3	0	0	Pass
0.8871	3	0	0	Pass
0.8948	3	0	0	Pass
0.9026	3	0	0	Pass

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	☐	809.99			☐	0.00			
Total Volume Infiltrated		809.99	0.00	0.00		0.00	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Failed

Model Default Modifications

Total of 0 changes have been made.

PERLND Changes

No PERLND changes have been made.

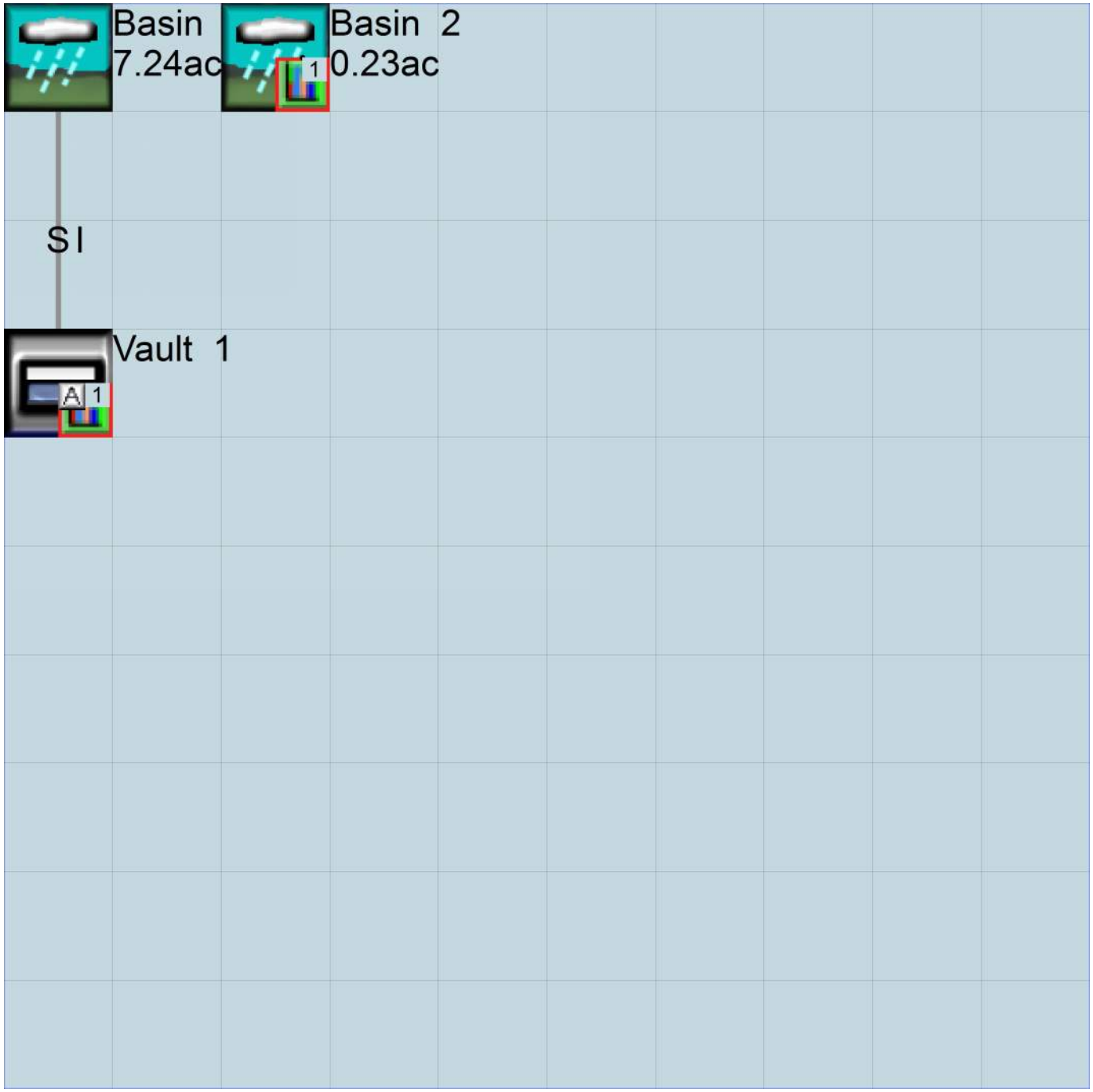
IMPLND Changes

No IMPLND changes have been made.

Appendix

Predeveloped Schematic

Mitigated Schematic



Predeveloped UCI File

```
RUN

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

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                               ***
WDM        26   WOODS CREEK HIGHLANDS.wdm
MESSU      25   PreWOODS CREEK HIGHLANDS.MES
           27   PreWOODS CREEK HIGHLANDS.L61
           28   PreWOODS CREEK HIGHLANDS.L62
           30   POCWOODS CREEK HIGHLANDS1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      10
      PERLND      11
      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
   11     C, Forest, Mod          1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections ****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   10         0    0    1    0    0    0    0    0    0    0    0    0
   11         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
  11         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
  11         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
  11              0       4.5      0.08       400       0.1       0.5     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
  10              0         0         2         2         0         0         0
  11              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
  11            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
  11              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                        1.14     COPY   501     12
PERLND  10                        1.14     COPY   501     13
PERLND  11                        6.33     COPY   501     12
PERLND  11                        6.33     COPY   501     13

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

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



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

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

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

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

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

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

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

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1.2            PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1.2            IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.76           PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.76           IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

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

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

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


END MASS-LINK

END RUN
```

Mitigated UCI File

```
RUN

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

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                               ***
WDM        26   WOODS CREEK HIGHLANDS.wdm
MESSU      25   MitWOODS CREEK HIGHLANDS.MES
           27   MitWOODS CREEK HIGHLANDS.L61
           28   MitWOODS CREEK HIGHLANDS.L62
           30   POCWOODS CREEK HIGHLANDS1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      10
      PERLND      11
      PERLND      16
      IMPLND       1
      IMPLND       4
      RCHRES       1
      COPY         1
      COPY       501
      COPY       601
      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
  601         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
   11     C, Forest, Mod          1    1    1    1   27    0
   16     C, 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 ***
   10         0    0    1    0    0    0    0    0    0    0    0    0
   11         0    0    1    0    0    0    0    0    0    0    0    0
   16         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
   11         0    0    4    0    0    0    0    0    0    0    0    0    1    9
   16         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
   11         0    0    0    0    0    0    0    0    0    0    0
   16         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
   11              0       4.5      0.08       400       0.1       0.5     0.996
   16              0       4.5      0.03       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
   11              0         0         2         2         0         0         0
   16              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
   11            0.2       0.5      0.35         6       0.5       0.7
   16            0.1      0.25      0.25         6       0.5      0.25
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
              ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
   10              0         0         0         0       2.5         1         0
   11              0         0         0         0       2.5         1         0
   16              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           ***
    1      ROADS/FLAT             1    1    1   27    0
    4      ROOF TOPS/FLAT         1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

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

```
    4         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    1         0    0    4    0    0    0    1    9
    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     ***
    1         0    0    0    0    0
    4         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    1            400      0.01       0.1       0.1
    4            400      0.01       0.1       0.1
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    1              0         0
    4              0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    1              0         0
    4              0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Basin  1***
PERLND  10                        0.5     RCHRES   1      2
PERLND  10                        0.5     RCHRES   1      3
PERLND  11                       2.05     RCHRES   1      2
PERLND  11                       2.05     RCHRES   1      3
PERLND  16                       1.86     RCHRES   1      2
PERLND  16                       1.86     RCHRES   1      3
IMPLND   1                       1.19     RCHRES   1      5
IMPLND   4                       1.64     RCHRES   1      5
Basin  2***
PERLND  10                       0.08     COPY   501     12
PERLND  10                       0.08     COPY   601     12
PERLND  10                       0.08     COPY   501     13
PERLND  10                       0.08     COPY   601     13
IMPLND   1                       0.15     COPY   501     15
IMPLND   1                       0.15     COPY   601     15

******Routing******
PERLND  10                        0.5     COPY     1     12
PERLND  11                       2.05     COPY     1     12
PERLND  16                       1.86     COPY     1     12
IMPLND   1                       1.19     COPY     1     15
IMPLND   4                       1.64     COPY     1     15
PERLND  10                        0.5     COPY     1     13
PERLND  11                       2.05     COPY     1     13
PERLND  16                       1.86     COPY     1     13
RCHRES   1                          1     COPY   501     16
```

```
END SCHEMATIC

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



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

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

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

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

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

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

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
  FTABLE      1
   92    4
     Depth      Area    Volume  Outflow1 Velocity  Travel Time***
      (ft)   (acres) (acre-ft)   (cfs)   (ft/sec)    (Minutes)***
  0.000000  0.225895  0.000000  0.000000
  0.100000  0.225895  0.022590  0.021968
  0.200000  0.225895  0.045179  0.031068
  0.300000  0.225895  0.067769  0.038050
  0.400000  0.225895  0.090358  0.043937
  0.500000  0.225895  0.112948  0.049123
  0.600000  0.225895  0.135537  0.053811
```

0.700000	0.225895	0.158127	0.058123
0.800000	0.225895	0.180716	0.062136
0.900000	0.225895	0.203306	0.065905
1.000000	0.225895	0.225895	0.069470
1.100000	0.225895	0.248485	0.072861
1.200000	0.225895	0.271074	0.076101
1.300000	0.225895	0.293664	0.079208
1.400000	0.225895	0.316253	0.082198
1.500000	0.225895	0.338843	0.085083
1.600000	0.225895	0.361433	0.087874
1.700000	0.225895	0.384022	0.090578
1.800000	0.225895	0.406612	0.093204
1.900000	0.225895	0.429201	0.095758
2.000000	0.225895	0.451791	0.098246
2.100000	0.225895	0.474380	0.100672
2.200000	0.225895	0.496970	0.103041
2.300000	0.225895	0.519559	0.105357
2.400000	0.225895	0.542149	0.107623
2.500000	0.225895	0.564738	0.109842
2.600000	0.225895	0.587328	0.112017
2.700000	0.225895	0.609917	0.114151
2.800000	0.225895	0.632507	0.116246
2.900000	0.225895	0.655096	0.118304
3.000000	0.225895	0.677686	0.120326
3.100000	0.225895	0.700275	0.122315
3.200000	0.225895	0.722865	0.124272
3.300000	0.225895	0.745455	0.126199
3.400000	0.225895	0.768044	0.128097
3.500000	0.225895	0.790634	0.129967
3.600000	0.225895	0.813223	0.131810
3.700000	0.225895	0.835813	0.133629
3.800000	0.225895	0.858402	0.135422
3.900000	0.225895	0.880992	0.137193
4.000000	0.225895	0.903581	0.138940
4.100000	0.225895	0.926171	0.140666
4.200000	0.225895	0.948760	0.142372
4.300000	0.225895	0.971350	0.144057
4.400000	0.225895	0.993939	0.145722
4.500000	0.225895	1.016529	0.147369
4.600000	0.225895	1.039118	0.148997
4.700000	0.225895	1.061708	0.150608
4.800000	0.225895	1.084298	0.224870
4.900000	0.225895	1.106887	0.256547
5.000000	0.225895	1.129477	0.281205
5.100000	0.225895	1.152066	0.302222
5.200000	0.225895	1.174656	0.320908
5.300000	0.225895	1.197245	0.337933
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5.500000	0.225895	1.242424	0.368459
5.600000	0.225895	1.265014	0.382401
5.700000	0.225895	1.287603	0.395655
5.800000	0.225895	1.310193	0.408320
5.900000	0.225895	1.332782	0.420473
6.000000	0.225895	1.355372	0.432176
6.100000	0.225895	1.377961	0.443478
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6.300000	0.225895	1.423140	0.465042
6.400000	0.225895	1.445730	0.481391
6.500000	0.225895	1.468320	0.505402
6.600000	0.225895	1.490909	0.522834
6.700000	0.225895	1.513499	0.538345
6.800000	0.225895	1.536088	0.552740
6.900000	0.225895	1.558678	0.566352
7.000000	0.225895	1.581267	0.579360
7.100000	0.225895	1.603857	0.591874
7.200000	0.225895	1.626446	0.603971
7.300000	0.225895	1.649036	0.615706
7.400000	0.225895	1.671625	0.627122
7.500000	0.225895	1.694215	0.638250
7.600000	0.225895	1.716804	0.649118

```
  7.700000  0.225895  1.739394  0.659748
  7.800000  0.225895  1.761983  0.670158
  7.900000  0.225895  1.784573  0.680365
  8.000000  0.225895  1.807163  0.690383
  8.100000  0.225895  1.829752  1.202401
  8.200000  0.225895  1.852342  2.114361
  8.300000  0.225895  1.874931  3.220675
  8.400000  0.225895  1.897521  4.360983
  8.500000  0.225895  1.920110  5.377101
  8.600000  0.225895  1.942700  6.148323
  8.700000  0.225895  1.965289  6.648602
  8.800000  0.225895  1.987879  7.103422
  8.900000  0.225895  2.010468  7.496645
  9.000000  0.225895  2.033058  7.868927
  9.100000  0.225895  2.055647  8.223330
  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    1.2            PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1.2            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
WDM      1 EVAP     ENGL    0.76           RCHRES   1     EXTNL  POTEV

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
RCHRES   1 HYDR   RO     1 1        1      WDM   1000 FLOW     ENGL      REPL
RCHRES   1 HYDR   STAGE  1 1        1      WDM   1001 STAG     ENGL      REPL
COPY     1 OUTPUT MEAN   1 1     48.4      WDM    701 FLOW     ENGL      REPL
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    801 FLOW     ENGL      REPL
COPY   601 OUTPUT MEAN   1 1     48.4      WDM    901 FLOW     ENGL      REPL
END EXT TARGETS

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

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

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

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

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

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

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

```
END MASS-LINK

END RUN
```

Predeveloped HSPF Message File

Mitigated HSPF Message File

Disclaimer

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5.6 Water Quality System

Runoff treatment for the drainage basin will be provided by a StormFilter vault (or approved equal). The treatment vault will be located immediately downstream of the detention vault, therefore it will be designed to handle flows over the full 2 year mitigated release rate. The StormFilter sizing calculations and details will be provided during Final Engineering.

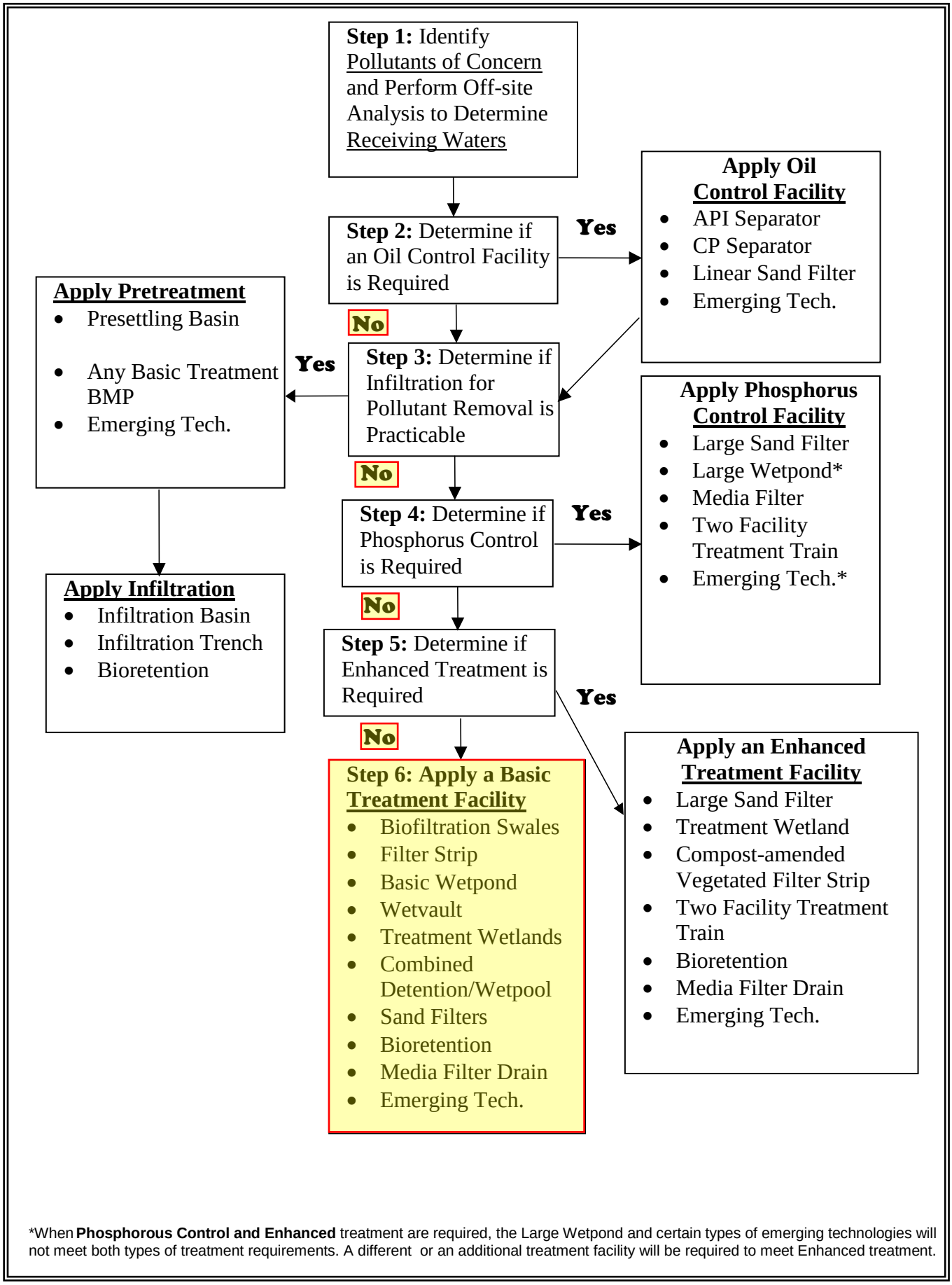


Figure 5.6.1 **Figure 2.1.1 – Treatment Facility Selection Flow Chart**

5.7 Conveyance System Analysis and Design

The on-site conveyance system will be sized in final engineering using the rational method and Manning's formula for the 25-year storm event.

Tab 6.0

6.0 CONSTRUCTION STORMWATER POLLUTION PREVENTION PLAN

The following is a list of the thirteen SWPPP elements and how they will be addressed for this project:

Element #1 - Preserve Vegetation / Mark Clearing Limits: Clearing Limits will be delineated on the engineering plans and will be flagged in the field.

Element #2 - Establish Construction Access: A stabilized gravel construction entrance will be shown on the engineering plans.

Element #3 - Control Flow Rates: A temporary sediment pond will be shown on the engineering plans. Once the permanent detention facilities are constructed the temporary sediment pond can be removed. The permanent facilities can be used throughout the remainder of construction.

Element #4 - Install Sediment Controls: Silt fence will be shown on the engineering plans for perimeter protection. In addition, temporary ditches to divert runoff to the sediment pond will be shown on the engineering plans.

Element #5 - Stabilize Soils: Cover measures will be addressed in the TESC notes on the engineering plans.

Element #6 - Protect Slopes: There are no significant slopes onsite, existing or proposed that require additional measures beyond the soil stabilization measures to be shown on the engineering plans.

Element #7 - Protect Permanent Drain Inlets: A detail for catch basin inserts will be shown on the final engineering plans along with a note specifying that they be installed once the permanent storm system is completed. A note will also be included that the contractor shall keep public roadways clear of dirt and debris.

Element #8 - Stabilize Channels and Outlets: Notes regarding outfall protection will be shown on the engineering plans. Temporary ditches shall be armored with rip rap for slopes greater than 5%.

Element #9 - Control Pollutants: A note will be added to the engineering plans that the contractor shall dispose of all pollutants and waste materials in a safe and timely manner.

Element #10 - Control Dewatering: Notes will be added to the engineering plans stating that water in underground utility trenches or low spots are to be routed to the temporary sediment pond via temporary ditches or perforated rock drains.

Element #11 - Maintain Best Management Practices: Once the engineering plans are completed the contractor shall maintain all erosion control measures in accordance with Snohomish County Standards and manufactures recommendations. In addition the contractor shall maintain a stockpile of erosion control materials onsite.

Element #12 - Manage the Project: Once the engineering plans are completed, the clearing, grading, and seasonal work shall be performed in accordance with Snohomish County Code. The contractor shall inspect, maintain, and repair all BMPs as needed to assure continued performance of their intended function. In addition to the engineering plans the contractor will be required to follow and maintain the Construction SWPPP which has been prepared according to Department of Ecology NPDES requirements. The completed SWPPP and TESC Plans will be provided during Final Engineering Review.

Element #13 - Protect Low Impact Development BMPs: Contractor shall keep all heavy equipment off existing soils under LID facilities, i.e. Perforated Stub-Out Connections, that have be excavated to final grade to retain the infiltration rate of the soils.

Tab 7.0

7.0 SPECIAL REPORTS AND STUDIES

This section contains the following information:

7.1 Subsurface Exploration, Geologic Hazard, and Preliminary Geotechnical Engineering Report by Associated Earth Sciences Inc., Dated November 29, 2018

associated
earth sciences
incorporated

Subsurface Exploration, Geologic Hazard, and Preliminary Geotechnical Engineering Report

WOODS CREEK HIGHLANDS

Monroe, Washington

Prepared For:

WOODS CREEK DEVELOPMENT, LLC

November 29, 2018
Project No. 180487E001

Associated Earth Sciences, Inc.
911 5th Avenue
Kirkland, WA 98033
P (425) 827 7701
F (425) 827 5424

associated
earth sciences
incorporated

November 29, 2018
Project No. 180487E001

Woods Creek Development, LLC
1800 136th Place NE, Suite 100
Bellevue, Washington 98005

Attention: Mr. Jonathan Chou

Subject: Subsurface Exploration, Geologic Hazard, and Preliminary Geotechnical Engineering Report
Woods Creek Highlands
Monroe, Washington

Dear Mr. Chou:

We are pleased to present the enclosed copy of the referenced report. This report summarizes the results of our subsurface exploration, geologic hazard, and geotechnical engineering studies and offers preliminary recommendations for the design and development of the proposed project. This report is based on a "Conceptual Site Plan" by Barghausen Consulting Engineers, dated June 15, 2018. We recommend that we be allowed to review project plans when they are developed and update our recommendations as needed.

We have enjoyed working with you on this study and are confident that the recommendations presented in this report will aid in the successful completion of your project. If you should have any questions, or if we can be of additional help to you, please do not hesitate to call.

Sincerely,
ASSOCIATED EARTH SCIENCES, INC.
Kirkland, Washington

Kurt D. Merriman, P.E.
Senior Principal Engineer

KDM/ld - 180487E001-2 - Projects\20180487\KE\WP

SUBSURFACE EXPLORATION, GEOLOGIC HAZARD, AND PRELIMINARY GEOTECHNICAL ENGINEERING REPORT

WOODS CREEK HIGHLANDS

Monroe, Washington

Prepared for:
Woods Creek Development, LLC
1800 136th Place NE, Suite 100
Bellevue, Washington 98005

Prepared by:
Associated Earth Sciences, Inc.
911 5th Avenue
Kirkland, Washington 98033
425-827-7701
Fax: 425-827-5424

November 29, 2018
Project No. 180487E001

I. PROJECT AND SITE CONDITIONS

1.0 INTRODUCTION

This report presents the results of our subsurface exploration, geologic hazard, and preliminary geotechnical engineering study for the proposed new residential development. The site location is shown on the "Vicinity Map," Figure 1. The approximate locations of explorations completed for this study are shown on the "Site and Exploration Plan," Figure 2. This report is based on a "Conceptual Site Plan," which was used as a basis for Figure 2. Interpretive exploration logs and associated laboratory test results are included in the Appendix. The conclusions and recommendations contained in this report should be reviewed and modified, or verified, to reflect final plans when they are developed.

1.1 Purpose and Scope

The purpose of this study was to provide subsurface data to be used in the design of the project. Our study included a review of selected geologic literature, excavating exploration pits, and performing geologic studies to assess the type, thickness, distribution, and physical properties of the subsurface sediments and shallow groundwater. Geotechnical engineering studies were completed to formulate our recommendations for site preparation, site grading, structural fill, new foundation designs, slab-on-grade floors, retaining walls, construction, and drainage. This report summarizes our current fieldwork and offers recommendations for development based on our present understanding of the project. We recommend that we be allowed to review project plans when they are finalized and update the recommendations in this report as needed.

1.2 Authorization

This report has been prepared for the exclusive use of Woods Creek Development, LLC and its agents for specific application to this project. Our work was performed in accordance with our scope of work and cost proposal, dated October 1, 2018. We were authorized to proceed by means of a signed proposal.

Within the limitations of scope, schedule, and budget, our services have been performed in accordance with generally accepted geotechnical engineering and engineering geology practices in effect in this area at the time our report was prepared. No other warranty, express or implied, is made.

2.0 PROJECT AND SITE DESCRIPTION

The subject site consists of one tax parcel totaling approximately 4.82 acres. Site topography includes descending slopes towards the southeast corner of the parcel. The site includes areas of woods and an existing home in the southwest corner. The site does not contain slopes that meet the City of Monroe definition for Landslide Hazard Areas (*Monroe Municipal Code* [MMC] 20.05.120.B.2). The site may contain Erosion Hazard Areas in accordance with MMC 20.05.120.B.1. Erosion Hazard designation may invoke construction site management requirements applicable to Erosion Hazard Areas, but is not expected to affect the project design as proposed.

Current plans call for construction of 22 new single-family residential lots, new paved access roads, and other typical improvements. No grading plans were available at the time this report was prepared. We anticipate that shallow cut and fill areas will form residential construction sites with final grades typically within approximately 4 feet of existing grade. A substantial stormwater facility area is proposed near the southeast corner of the project.

3.0 SUBSURFACE EXPLORATION

Our field study included excavation of five exploration pits with a tracked excavator. The locations of the exploration pits were measured in the field using a georeferenced plan, and the locations depicted on Figure 2 are taken from plans provided to us by Barghausen Consulting Engineers. Interpretive exploration logs are presented in Appendix A.

The various types of sediments, as well as the depths where characteristics of the sediments changed, are indicated on the exploration logs presented in Appendix A. The depths indicated on the logs where conditions changed may represent gradational variations between sediment types in the field.

The conclusions and recommendations presented in this report are based on the explorations completed for this study. The number, locations, and depths of our explorations were completed within site and budget constraints. Because of the nature of exploratory work below ground, extrapolation of subsurface conditions between field explorations is necessary. It should be noted that differing subsurface conditions may sometimes be present due to the random nature of deposition and the alteration of topography by past grading and/or filling. The nature and extent of any variations between the field explorations may not become fully evident until construction. If variations are observed at that time, it may be necessary to re-evaluate specific recommendations in this report and make appropriate changes.

3.1 Exploration Pits

The exploration pits were excavated using a tracked excavator. The pits permitted direct, visual observation of subsurface conditions. Materials encountered in the exploration pits were studied and classified in the field by a geologist from our firm. All exploration pits were backfilled after examination and logging. Selected samples were then placed in water-tight containers and transported to our laboratory for further visual classification and testing, as necessary.

4.0 SUBSURFACE CONDITIONS

Subsurface conditions at the project site were inferred from the field explorations accomplished for this study, visual reconnaissance of the site, and review of selected geologic literature. The general distribution of geologic units is shown on the exploration logs. The explorations typically encountered native materials consisting of dense lodgement till. One exploration pit in the southwest corner of the site, within the planned location of the site drainage facility encountered dense advance outwash deposits beneath the lodgement till cap. One exploration pit encountered soft recessional lacustrine sediments above the lodgement till.

We reviewed a published geologic map of the project, *Geologic Map of the Monroe 7.5-Minute Quadrangle, King and Snohomish Counties, Washington*, by Joe D. Dragovich et al., 2011. The referenced map indicates that the site is expected to be underlain at shallow depths by Vashon lodgement till. Fluvial outwash deposits were also mapped nearby. Our on-site explorations and interpretations are generally consistent with the conditions depicted on the published map.

4.1 Stratigraphy

Forest Duff/Root Zone

A surficial layer of forest duff and organic topsoil was encountered at the location of each of the exploration pits. This organic layer ranged from approximately 1 to 2 feet in thickness. Observed topsoil thickness is shown on the attached subsurface exploration logs. Due to their high organic content, these materials are not considered suitable for foundation, roadway, or slab-on-grade floor support, or for use in a structural fill.

Vashon Recessional Lacustrine

One exploration pit encountered soft to medium stiff silt with varying amounts of sand and gravel interpreted as Vashon recessional lacustrine sediments. Recessional lacustrine

sediments were deposited in the low-energy environments of proglacial lakes. Recessional lacustrine sediments typically contain a significant fine-grained fraction, and are sensitive to excess moisture during placement in structural fill applications. Reuse of advance outwash in structural fill applications will require drying to achieve moisture contents within 1 to 2 percent of optimum for compaction purposes.

Vashon Lodgement Till

All five exploration pits encountered typically loose to very dense, silty sand with gravel and cobbles interpreted as Vashon lodgement till. The lodgement till observed in our explorations graded from loose to very dense with increasing depth. Lodgement till was deposited at the base of an active ice sheet and was subsequently compacted by the weight of the overlying glacial ice. Lodgement till typically possesses high-strength and low-compressibility attributes that are favorable for support of foundations, floor slabs, and paving, with proper preparation. Lodgement till is silty and moisture-sensitive. In the presence of moisture contents above the optimum moisture content for compaction purposes, lodgement till can be easily disturbed by vehicles and earthwork equipment. Careful management of moisture-sensitive soils, as recommended in this report, will be needed to reduce the potential for disturbance of wet lodgement till soils and costs associated with repairing disturbed soils. Reuse of excavated lodgement till sediments in structural fill applications will require drying to achieve moisture contents within 1 to 2 percent of optimum for compaction purposes.

Vashon Advance Outwash

One exploration pit encountered medium dense to dense, stratified sand with silt and gravel interpreted as Vashon advance outwash. Advance outwash was deposited by meltwater streams from an advancing ice sheet. Advance outwash is suitable for support of structural loads when prepared as recommended in this report. Advance outwash typically contains a significant fine-grained fraction, and is sensitive to excess moisture during placement in structural fill applications. Reuse of advance outwash in structural fill applications will require drying to achieve moisture contents within 1 to 2 percent of optimum for compaction purposes. The advance outwash extended beyond the maximum depth explored of 15 feet in the exploration pit where it was observed. The advance outwash was observed within the planned stormwater facility area and generally appears favorable for infiltration; further analysis is required to determine infiltration rates.

4.2 Hydrology

One of the exploration pits, exploration pit EP-5, encountered groundwater seepage 2.5 feet below existing ground surface. Observed groundwater seepage was interpreted to represent perched groundwater and appears to be associated with observed surface water onsite. Perched groundwater occurs where downward infiltration of surface water is impeded by

low-permeability soil layers such as lodgement till, and the groundwater migrates laterally and generally downslope. Groundwater conditions should be expected to vary in response to changes in season, weather, on- and off-site land use, and other factors.

4.3 Laboratory Test Results

One laboratory grain-size analysis was performed in accordance with the *American Society for Testing and Materials* (ASTM) D-422 on a representative selected sample collected during our subsurface exploration for this project. Laboratory test results are included in Appendix B.

II. GEOLOGIC HAZARDS AND MITIGATIONS

The following discussion of potential geologic hazards is based on the geologic, slope, and shallow groundwater conditions as observed and discussed herein.

5.0 LANDSLIDE HAZARDS AND MITIGATIONS

Most of the site is characterized by slopes of gentle to moderate inclination. Steeper slopes exist near the northeast part of the site. MMC Section 20.05.120.B.2 in part defines Landslide Hazard Areas as areas with historic failures and slopes that meet all of the following: slopes steeper than 15 percent, hillsides intersecting geologic contacts with a relatively permeable sediment overlaying a relatively impermeable sediment or bedrock, springs or groundwater seepage. Additionally, Landslide Hazard Areas are in part defined as areas that have slopes that are parallel or subparallel to planes of weakness, any area with a slope of 40 percent or steeper and with a vertical relief of 10 or more feet except areas composed of consolidated rock. Based on the soils encountered in our subsurface explorations and review of available existing topographic information of the site, none of the slopes on this site meet the MMC definition for Landslide Hazard Areas.

6.0 SEISMIC HAZARDS AND MITIGATIONS

Earthquakes occur regularly in the Puget Upland. Most of these events are small and are not felt by people. However, large earthquakes have occurred, including the 2001, 6.8-magnitude event; the 1965, 6.5-magnitude event; and the 1949, 7.2-magnitude event. The 1949 earthquake appears to have been the largest in this region during recorded history and was centered in the Olympia area. Evaluation of earthquake return rates indicates that an earthquake of the magnitude between 5.5 and 6.0 is likely within a given 20-year period.

Generally, there are four types of potential geologic hazards associated with large seismic events: 1) surficial ground rupture, 2) seismically induced landslides, 3) liquefaction, and 4) ground motion. The potential for each of these hazards to adversely impact the proposed project is discussed below.

6.1 Surficial Ground Rupture

There are several inferred faults near the subject site with the closest being the Johnsons Swamp Fault located approximately 0.25 miles to the northeast. Data pertaining to the Johnsons Swamp Fault are limited, but published data sources reviewed for this report cite no evidence of surficial ground rupture on this fault. The recurrence interval for movement along this fault is unknown, although it is hypothesized to be on the order of several thousand years. Due to the distance between the site and mapped faults the risk of damage to the project from surficial ground rupture due to faulting is low, in our opinion.

6.2 Seismically Induced Landslides

The lodgement till and recessional lacustrine sediments underlying the site typically present a low risk of landsliding under the slope inclinations present at the site. No quantitative slope stability analysis was completed for this study, and none is warranted for the project as currently proposed, in our opinion.

6.3 Liquefaction

Liquefaction is a process through which unconsolidated soil loses strength as a result of vibrations, such as those which occur during a seismic event. During normal conditions, the weight of the soil is supported by both grain-to-grain contacts and by the fluid pressure within the pore spaces of the soil below the water table. Extreme vibratory shaking can disrupt the grain-to-grain contact, increase the pore pressure, and result in a temporary decrease in soil shear strength. The soil is said to be liquefied when nearly all of the weight of the soil is supported by pore pressure alone. Liquefaction can result in deformation of the sediment and settlement of overlying structures. Areas most susceptible to liquefaction include those areas underlain by non-cohesive silt and sand with low relative densities, accompanied by a shallow water table.

Our explorations suggest that the potential risk of damage to the proposed development by liquefaction is low due to the dense glacially consolidated lodgement till sediments observed at shallow depths and the lack of extensive shallow groundwater.

6.4 Ground Motion/Seismic Site Class (2015 *International Building Code*)

Structural design of the buildings should follow 2015 *International Building Code* (IBC) standards. We recommend that the project be designed in accordance with Site Class “D” as defined in IBC Table 20.3-1 of *American Society of Civil Engineers* (ASCE) *7 - Minimum Design Loads for Buildings and Other Structures*.

6.5 Erosion Control

Project plans should include implementation of temporary erosion controls in accordance with local best management practices. Control methods should include limiting earthwork to seasonally drier periods, typically April 1 to October 31, use of perimeter silt fences, and straw mulch in exposed areas. Removal of existing vegetation should be limited to those areas that are required to construct the project, and new landscaping and vegetation with equivalent erosion mitigation potential should be established as soon as possible after grading is complete. During construction, surface water should be collected as close as possible to the source to minimize silt entrainment that could require treatment or detention prior to discharge. Timely implementation of permanent drainage control measures should also be a part of the project plans, and will help reduce erosion and generation of silty surface water onsite.

III. PRELIMINARY DESIGN RECOMMENDATIONS

7.0 INTRODUCTION

Our exploration indicates that, from a geotechnical engineering standpoint, the proposed project is feasible provided the recommendations contained herein are properly followed. The following report sections provide additional recommendations regarding site preparation, grading, foundations, floor support, drainage, stormwater infiltration feasibility, and paving.

8.0 SITE PREPARATION

Site preparation of building and paving areas should include removal of all grass, trees, brush, debris, and any other deleterious materials. All existing fill should be removed. We recommend that any existing septic systems, wells, heating oil storage tanks, and other similar structures be decommissioned and removed in accordance with applicable regulations. Existing buildings, foundations, and any other buried structures should be removed from below foundation areas. Buried utilities should be removed from foundation areas, and should be abandoned in place or removed from below planned new paving. Any depressions below planned final grades caused by demolition activities should be backfilled with structural fill, as discussed under the "Structural Fill" section of this report.

Existing topsoil should be stripped from structural areas. The actual observed in-place depth of topsoil and grass at the exploration locations is presented on the exploration logs in the Appendix. After stripping, remaining roots and stumps should be removed from structural areas. All soils disturbed by stripping and grubbing operations should be recompacted as described below for structural fill.

Once excavation to subgrade elevation is complete, the resulting surface should be proof-rolled with a loaded dump truck or other suitable equipment. Any soft, loose, yielding areas or areas exposing existing fill should be excavated to expose suitable bearing soils. The subgrade should then be compacted to at least 95 percent of the modified Proctor maximum dry density, as determined by the ASTM D-1557 test procedure. Structural fill can then be placed to achieve desired grades, if needed.

8.1 Temporary Cut Slopes

In our opinion, stable construction slopes should be the responsibility of the contractor and should be determined during construction. For estimating purposes, however, temporary, unsupported cut slopes can be planned at 1.5H:1V (Horizontal:Vertical) in unsaturated existing recessional lacustrine sediments. Temporary slopes of 1.0H:1V can be planned in unsaturated lodgement till sediments.

These slope angles are for areas where groundwater seepage is not present at the faces of the slopes, which may require temporary dewatering in the form of pumped sumps or other measures. If ground or surface water is present when the temporary excavation slopes are exposed, flatter slope angles may be required. As is typical with earthwork operations, some sloughing and raveling may occur, and cut slopes may have to be adjusted in the field. In addition, WISHA/OSHA regulations should be followed at all times.

8.2 Site Disturbance

Most of the on-site soils contain fine-grained material, which makes them moisture-sensitive and subject to disturbance when wet. The contractor must use care during site preparation and excavation operations so that the underlying soils are not softened. If disturbance occurs, the softened soils should be removed and the area brought to grade with structural fill.

8.3 Winter Construction

The existing lodgement till and recessional lacustrine sediments contain substantial silt and are considered highly moisture-sensitive. Portions of the advance outwash sediments are expected to be somewhat less moisture-sensitive. Soils excavated onsite will likely require drying during favorable dry weather conditions to allow their reuse in structural fill applications. Care should be taken to seal all earthwork areas during mass grading at the end of each workday by grading all surfaces to drain and sealing them with a smooth-drum roller. Stockpiled soils that will be reused in structural fill applications should be covered whenever rain is possible.

If winter construction is expected, crushed rock fill could be used to provide construction staging areas. The stripped subgrade should be observed by the geotechnical engineer, and should then be covered with a geotextile fabric, such as Mirafi 500X or equivalent. Once the fabric is placed, we recommend using a crushed rock fill layer at least 10 inches thick in areas where construction equipment will be used.

9.0 STRUCTURAL FILL

All references to structural fill in this report refer to subgrade preparation, fill type, placement, and compaction of materials, as discussed in this section. If a percentage of compaction is specified under another section of this report, the value given in that section should be used. For backfill of buried utilities in the right-of-way, the backfill should be placed and compacted in accordance with the City of Monroe codes and standards.

After stripping, planned excavation, and any required overexcavation have been performed to the satisfaction of the geotechnical engineer/engineering geologist, the surface of the exposed ground should be recompacted to a firm and unyielding condition. If the subgrade contains too much moisture, adequate recompaction may be difficult or impossible to obtain, and should

probably not be attempted. In lieu of recompaction, the area to receive fill should be blanketed with washed rock or quarry spalls to act as a capillary break between the new fill and the wet subgrade. Where the exposed ground remains soft and further overexcavation is impractical, placement of an engineering stabilization fabric may be necessary to prevent contamination of the free-draining layer by silt migration from below.

After recompaction of the exposed ground is tested and approved, or a free-draining rock course is laid, structural fill may be placed to attain desired grades. Structural fill is defined as non-organic soil, acceptable to the geotechnical engineer, placed in maximum 8-inch loose lifts, with each lift being compacted to 95 percent of ASTM D-1557. The top of the compacted fill should extend horizontally outward a minimum distance of 3 feet beyond the locations of the perimeter footings or roadway edges before sloping down at a maximum angle of 2H:1V.

The contractor should note that any proposed fill soils must be evaluated by Associated Earth Sciences, Inc. (AESI) prior to their use in fills. This would require that we have a sample of the material at least 72 hours in advance to perform a Proctor test and determine its field compaction standard.

Soils in which the amount of fine-grained material (smaller than the No. 200 sieve) is greater than approximately 5 percent (measured on the minus No. 4 sieve size) should be considered moisture-sensitive. The lodgement till and recessional lacustrine sediments are estimated to contain substantially more than 5 percent fine-grained material. Use of moisture-sensitive soil in structural fills should be limited to favorable dry weather and dry subgrade conditions. Construction equipment traversing the site when the soils are wet can cause considerable disturbance.

If fill is placed during wet weather or if proper compaction cannot be obtained, a select, import material consisting of a clean, free-draining gravel and/or sand should be used. Free-draining fill consists of non-organic soil, with the amount of fine-grained material limited to 5 percent by weight when measured on the minus No. 4 sieve fraction, and at least 25 percent retained on the No. 4 sieve.

In order to reuse excavated on-site soils in structural fill applications, it will be necessary to moisture-condition wet site soils by aeration and drying during favorable dry weather conditions. Alternatives to drying site soils include using imported granular soils suitable for use in structural fill, or treating wet soils with Portland cement.

10.0 FOUNDATIONS

Spread footings may be used for building support when they are founded on approved structural fill placed as described above, or on undisturbed natural soils that are prepared as recommended in this report. Based on our observations, suitable foundation bearing soils are expected to be approximately 1 to 3 feet below existing grade in most areas. One should refer

to Figure 2, and to exploration logs in the Appendix for the observed depth to bearing soils at the exploration pit locations.

For residential structures, footings may be designed for an allowable foundation soil bearing pressure of 3,000 pounds per square foot (psf), including both dead and live loads. An increase of one-third may be used for short-term wind or seismic loading. Perimeter footings should be buried at least 18 inches into the surrounding soil for frost protection. However, all foundations must penetrate to the prescribed bearing strata, and no foundations should be constructed in or above loose, organic, or existing fill soils.

Anticipated settlement of footings founded as recommended should be on the order of ¾ inch or less, with differential settlement of ½ inch or less. However, disturbed material not removed from footing trenches prior to footing placement could result in increased settlements. All footing areas should be inspected by AESI prior to placing concrete to verify that the foundation subgrades are undisturbed and construction conforms to the recommendations contained in this report. Such inspections may be required by the City of Monroe. Perimeter footing drains should be provided as discussed under the "Drainage Considerations" section of this report.

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

11.0 FLOOR SUPPORT

If crawl-space floors are used, an impervious moisture barrier should be provided above the soil surface within the crawl space. Slab-on-grade floors may be used over medium dense to very dense native soils, or over structural fill placed as recommended in the "Site Preparation" and "Structural Fill" sections of this report. Slab-on-grade floors should be cast atop a minimum of 4 inches of washed pea gravel or washed crushed "chip" rock with less than 3 percent passing the U.S. No. 200 sieve to act as a capillary break. The floors should also be protected from dampness by covering the capillary break layer with an impervious moisture barrier at least 10 mils in thickness.

12.0 DRAINAGE CONSIDERATIONS

All footings, basement walls, and retaining walls should be provided with a drain at the footing elevation. Drains should consist of rigid, perforated, polyvinyl chloride (PVC) pipe surrounded

by washed pea gravel. The level of the perforations in the pipe should be set downward and at the bottom of the footing at all locations, and the drain collectors should be constructed with sufficient gradient to allow gravity discharge away from the buildings. In addition, all foundation walls taller than 3 feet should be lined with a minimum, 12-inch-thick, washed gravel blanket drain provided to within 1 foot of finish grade that ties into the footing drain. A prefabricated drainage mat is not an acceptable alternative to the gravel blanket drain unless the entire excavation backfill consists of free-draining structural fill. Roof and surface runoff should not discharge into the footing drain system, but should be handled by a separate, rigid, tightline drain.

In planning, exterior grades adjacent to foundations should be sloped downward away from the structures to achieve surface drainage. These recommendations apply to conventional shallow foundation walls and landscape walls less than about 4 feet tall. One should refer to the following section for walls up to 10 feet tall.

13.0 STORMWATER INFILTRATION FEASIBILITY

Across the site, with the exception of EP-1, Vashon lodgement till was observed to the maximum depth explored within each of the exploration pits. Due to the high density and the high silt content of the lodgement till, lodgement till is not suitable as a stormwater infiltration receptor.

EP-1 is located within the southeast corner of the parcel and within the planned stormwater facility location. In this exploration pit we encountered medium dense to dense sand with varying amounts of silt and gravel, interpreted as Vashon advance outwash. Advance outwash can serve as a stormwater infiltration receptor where it is laterally and vertically extensive and unsaturated. Infiltration systems that use advance outwash as the receptor typically make use of “pit drains” below the facilities to improve infiltration rates through finer-grained sedimentary strata. A grain-size analysis was performed on this material and can be found in Appendix B at the back of this report.

Additional testing beyond the scope of our current study is recommended if the project will use stormwater infiltration. The gradation of the Vashon advance outwash generally appears favorable; further analysis is required to determine infiltration rates.

14.0 CAST-IN-PLACE RETAINING WALLS AND BASEMENT WALLS

All backfill behind foundation walls or around foundation units should be placed as per our recommendations for structural fill and as described in this section of the report. Horizontally backfilled walls that are free to yield laterally at least 0.1 percent of their height may be designed to resist active lateral earth pressure represented by an equivalent fluid equal to

35 pounds per cubic foot (pcf). Fully restrained, horizontally backfilled, rigid walls that cannot yield should be designed for at-rest conditions and an equivalent fluid of 50 pcf. Walls with sloping backfill up to a maximum gradient of 2H:1V should be designed using an equivalent fluid of 55 pcf for yielding conditions or 75 pcf for fully restrained conditions. If parking areas are adjacent to walls, a surcharge equivalent to 2 feet of soil should be added to the wall height in determining lateral design forces.

As required by the 2015 IBC, retaining wall design should include a seismic surcharge pressure in addition to the equivalent fluid pressures presented above. Considering the site soils and the recommended wall backfill materials, we recommend a seismic surcharge pressure of 8H and 11H psf, where H is the wall height in feet for the “active” and “at-rest” loading conditions, respectively. The seismic surcharge should be modeled as a rectangular distribution with the resultant applied at the midpoint of the walls.

The lateral pressures presented above are based on the conditions of a uniform backfill consisting of excavated on-site soils, or imported structural fill compacted to 90 percent of ASTM D-1557. A higher degree of compaction is not recommended, as this will increase the pressure acting on the walls. A lower compaction may result in settlement of the slab-on-grade or other structures supported above the walls. Thus, the compaction level is critical and must be tested by our firm during placement. Surcharges from adjacent footings or heavy construction equipment must be added to the above values. Perimeter footing drains should be provided for all retaining walls, as discussed under the “Drainage Considerations” section of this report.

It is imperative that proper drainage be provided so that hydrostatic pressures do not develop against the walls. This would involve installation of a minimum 1-foot-wide blanket drain to within 1 foot of finish grade for the full wall height using imported, washed gravel against the walls. If situations exist where a footing drain is not feasible for a foundation wall or retaining wall, the wall should be designed for saturated lateral earth pressures and a hydrostatic surcharge. We should be allowed to offer situation-specific recommendations if this situation arises. The use of drainage improvements as recommended herein does not alleviate the need for waterproofing where finished spaces are planned on the interior side of basement walls. Backfilled walls with finished interior space should be waterproofed in accordance with recommendations of the building designer.

15.0 PASSIVE RESISTANCE AND FRICTION FACTOR

Foundation design may assume a base friction coefficient of 0.30 for concrete footings cast against native sediments or structural fill as described in this report. Passive resistance against foundation elements backfilled with structural fill as described in this report may be assumed to be 250 pcf, expressed as an equivalent fluid. These are allowable values and include a factor of safety.

16.0 PAVEMENT RECOMMENDATIONS

We understand that the proposed project will include construction of paved driveways and access roads which connect to Chain Lake Road.

After the area to be paved is stripped, any existing fill soils are removed, and the native soils are recompacted, the area should be proof-rolled with a loaded truck under the observation of AESI. Any soft, wet, organic, or yielding areas should be repaired as recommended during construction. If warranted, engineering stabilization fabric, such as Mirafi 500X (or equivalent), should be placed over the subgrade with the edges overlapped in accordance with the manufacturer's recommendations. Following subgrade preparation, clean structural fill should be placed over the fabric and compacted to 95 percent of ASTM D-1557. Where fabric is exposed, spreading should be performed such that the dozer remains on the fill material and is not allowed to operate on uncovered fabric. When 12 inches of fill has been placed, the fabric should be proof-rolled with a loaded dump truck to pretension the fabric and identify soft spots in the fill. Upon completing the proof-rolling operation, additional structural fill should be placed and compacted to attain desired grades.

The City of Monroe provides two standard paving sections for residential roads outlined within the street standards. They are: Planned Residential Development (303A) and Short Plat (303B). The section for 303A is 3 inches of Class B hot mix asphalt (HMA) above 4 inches of crushed surfacing top course (CSTC) above gravel borrow. The section for 303B is 3 inches of Class B HMA compacted in two lifts, above 4 inches of CSTC above gravel borrow. All depths given are compacted depths. All paving materials, base course materials, and placement procedures should comply with Washington State Department of Transportation (WSDOT) *Standard Specifications for Road, Bridge, and Municipal Construction*.

For private paving of driveways outside of the right-of-way, we recommend a pavement section consisting of 3 inches of Class ½-inch HMA underlain by 4 inches of $^{5}/_{8}$-inch crushed surfacing top course as a minimum. The crushed rock must be compacted to 95 percent of maximum density.

17.0 RECOMMENDATIONS FOR FUTURE STUDY

As project design progresses, we recommend the following tasks be completed by AESI:

- Exploration borings to determine vertical and lateral extent of the Vashon advance outwash if the project will use stormwater infiltration.
- Infiltration rate testing on the Vashon advance outwash observed beneath the lodgement till within the stormwater facility area.

18.0 PROJECT DESIGN AND CONSTRUCTION MONITORING

This report is based on the previously referenced conceptual site plan that was current at the time it was written. We are available to provide additional geotechnical consultation as the project design develops and possibly changes from that upon which this report is based. We recommend that AESI perform a geotechnical review of the plans prior to construction. In this way, our earthwork and foundation recommendations may be properly interpreted and implemented in the design.

We are also available to provide geotechnical engineering and monitoring services during construction. The integrity of the foundations for buildings and of retaining walls depends on proper site preparation and construction procedures. In addition, engineering decisions may have to be made in the field in the event that variations in subsurface conditions become apparent. Construction monitoring services are not part of the current scope of work. If these services are desired, please let us know, and we will prepare a cost proposal.

We have enjoyed working with you on this study and are confident these recommendations will aid in the successful completion of your project. If you should have any questions or require further assistance, please do not hesitate to call.

Sincerely,
ASSOCIATED EARTH SCIENCES, INC.
Kirkland, Washington

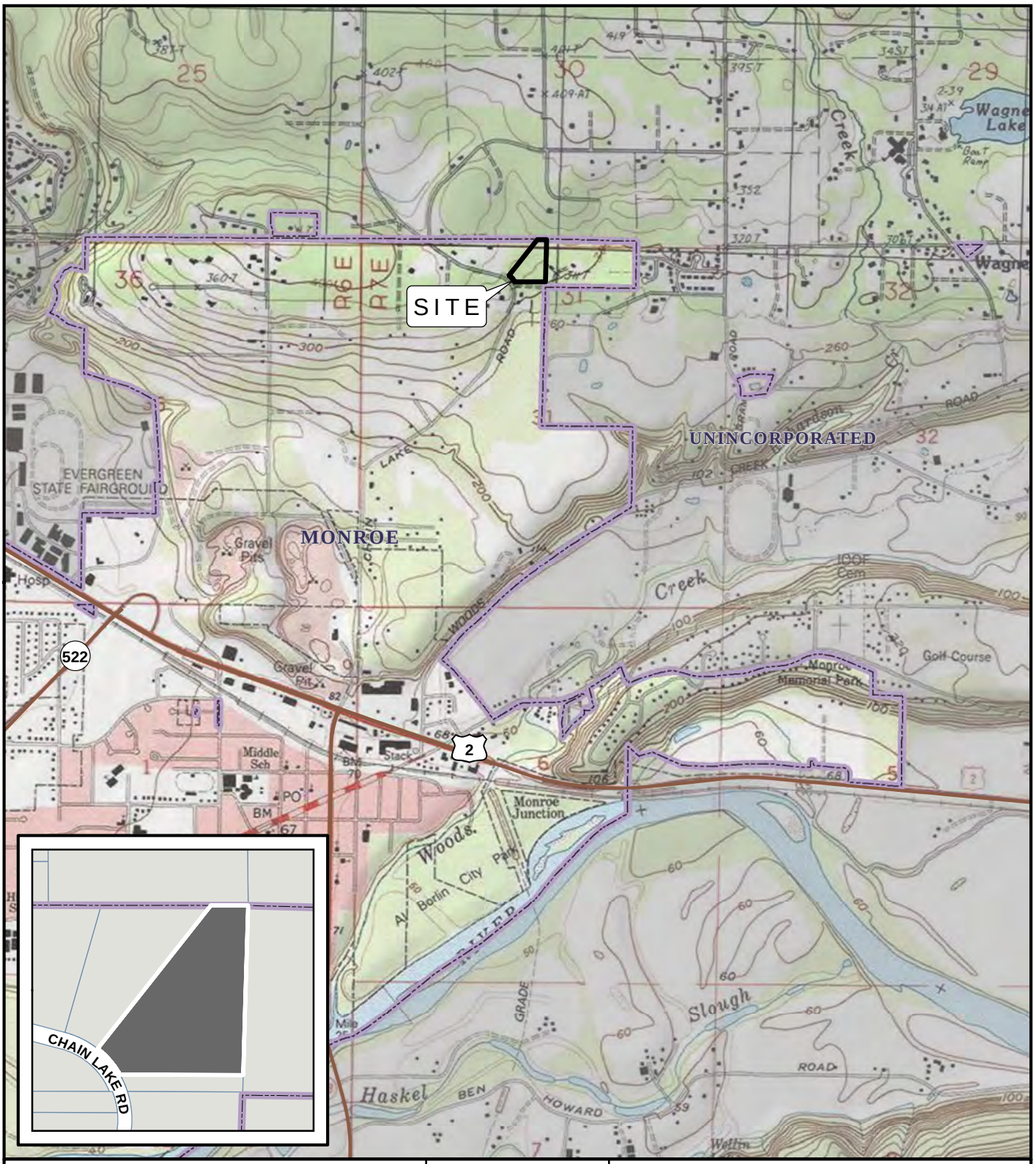
Charles R. Christopher, G.I.T.
Staff Geologist

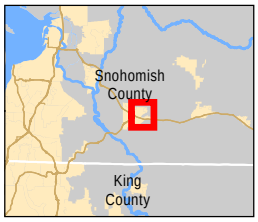
Bruce W. Guenzler, L.E.G.
Associate Geologist

KURT D. MERRIMAN
STATE OF WASHINGTON
23580
REGISTERED
PROFESSIONAL ENGINEER

Kurt D. Merriman, P.E.
Senior Principal Engineer

Attachments:	Figure 1:	Vicinity Map
	Figure 2:	Site and Exploration Plan
	Appendix A:	Exploration Logs
	Appendix B:	Laboratory Testing Results





DATA SOURCES / REFERENCES:
USGS: 7.5' SERIES TOPOGRAPHIC MAPS, ESRI/I-CUBED/NATIONAL GEOGRAPHIC SOCIETY 2013
SNOHOMISH CO: STREETS, CITY LIMITS, PARCELS, 1/18
LOCATIONS AND DISTANCES SHOWN ARE APPROXIMATE

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

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VICINITY MAP

WOODS CREEK HIGHLANDS
MONROE, WASHINGTON

PROJ NO.	DATE:	FIGURE:
180487E001	11/18	1

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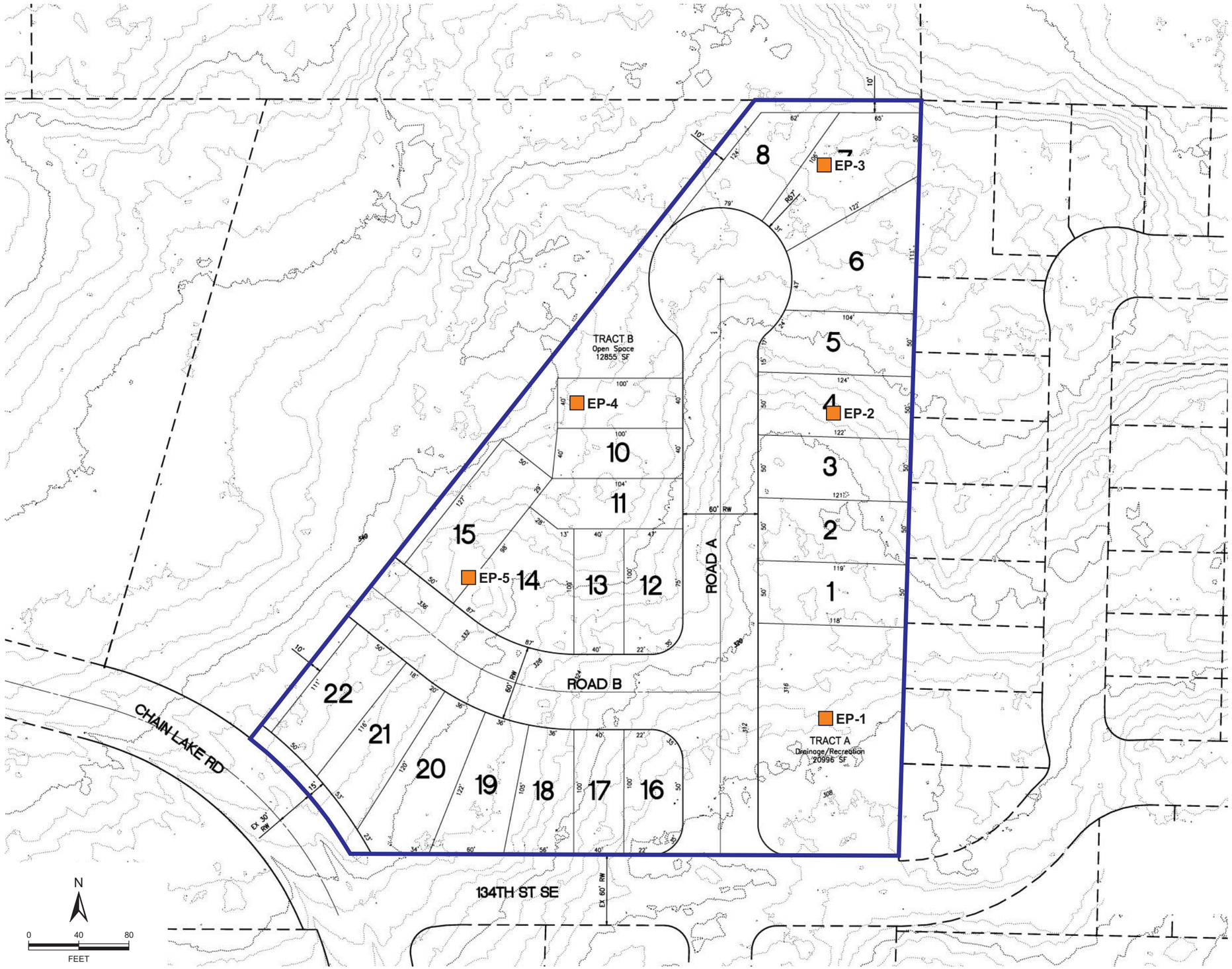

LEGEND:

EP EXPLORATION PIT

SITE BOUNDARY

CONTOUR INTERVAL = 2'

NOTE: LOCATION AND DISTANCES SHOWN ARE APPROXIMATE.

NOTES:

1. BASE MAP REFERENCE: BARGHAUSEN, WOODS CREEK HIGHLANDS, CONCEPTUAL SITE PLAN FOR WOODS CREEK HIGHLANDS, SHEET 1, 6/15/18.

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

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SITE AND EXPLORATION PLAN

WOODS CREEK HIGHLANDS
MONROE, WASHINGTON

PROJ NO.	DATE:	FIGURE:
180487E001	11/18	2

180487 Woods Creek \ 180487E001 F2 S-E Plan.cdr

APPENDIX A

Exploration Logs

Coarse-Grained Soils - More than 50% (1) Retained on No. 200 Sieve	Gravels - More than 50% (1) of Coarse Fraction Retained on No. 4 Sieve	≤5% Fines (5)	GW	Well-graded gravel and gravel with sand, little to no fines
			GP	Poorly-graded gravel and gravel with sand, little to no fines
		≥12% Fines (5)	GM	Silty gravel and silty gravel with sand
			GC	Clayey gravel and clayey gravel with sand
	Sands - 50% (1) or More of Coarse Fraction Passes No. 4 Sieve	≤5% Fines (5)	SW	Well-graded sand and sand with gravel, little to no fines
			SP	Poorly-graded sand and sand with gravel, little to no fines
		≥12% Fines (5)	SM	Silty sand and silty sand with gravel
			SC	Clayey sand and clayey sand with gravel
Fine-Grained Soils - 50% (1) or More Passes No. 200 Sieve	Silts and Clays Liquid Limit Less than 50		ML	Silt, sandy silt, gravelly silt, silt with sand or gravel
			CL	Clay of low to medium plasticity; silty, sandy, or gravelly clay, lean clay
			OL	Organic clay or silt of low plasticity
	Silts and Clays Liquid Limit 50 or More		MH	Elastic silt, clayey silt, silt with micaceous or diatomaceous fine sand or silt
			CH	Clay of high plasticity, sandy or gravelly clay, fat clay with sand or gravel
			OH	Organic clay or silt of medium to high plasticity
Highly Organic Soils			PT	Peat, muck and other highly organic soils

Terms Describing Relative Density and Consistency

Coarse-Grained Soils

Density	SPT(2) blows/foot
Very Loose	0 to 4
Loose	4 to 10
Medium Dense	10 to 30
Dense	30 to 50
Very Dense	>50

Fine-Grained Soils

Consistency	SPT(2) blows/foot
Very Soft	0 to 2
Soft	2 to 4
Medium Stiff	4 to 8
Stiff	8 to 15
Very Stiff	15 to 30
Hard	>30

Test Symbols

G = Grain Size
M = Moisture Content
A = Atterberg Limits
C = Chemical
DD = Dry Density
K = Permeability

Component Definitions

Descriptive Term	Size Range and Sieve Number
Boulders	Larger than 12"
Cobbles	3" to 12"
Gravel	3" to No. 4 (4.75 mm)
Coarse Gravel	3" to 3/4"
Fine Gravel	3/4" to No. 4 (4.75 mm)
Sand	No. 4 (4.75 mm) to No. 200 (0.075 mm)
Coarse Sand	No. 4 (4.75 mm) to No. 10 (2.00 mm)
Medium Sand	No. 10 (2.00 mm) to No. 40 (0.425 mm)
Fine Sand	No. 40 (0.425 mm) to No. 200 (0.075 mm)
Silt and Clay	Smaller than No. 200 (0.075 mm)

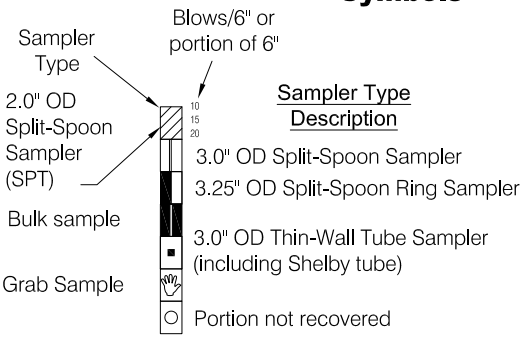
(3) Estimated Percentage

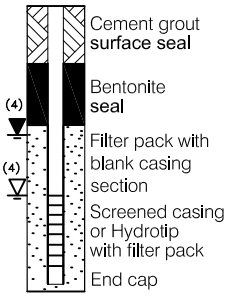
Component	Percentage by Weight
Trace	<5
Some	5 to <12
Modifier (silty, sandy, gravelly)	12 to <30
Very *modifier* (silty, sandy, gravelly)	30 to <50

Moisture Content

Dry - Absence of moisture, dusty, dry to the touch
Slightly Moist - Perceptible moisture
Moist - Damp but no visible water
Very Moist - Water visible but not free draining
Wet - Visible free water, usually from below water table

Symbols





(1) Percentage by dry weight
(2) (SPT) Standard Penetration Test (ASTM D-1586)
(3) In General Accordance with Standard Practice for Description and Identification of Soils (ASTM D-2488)
(4) Depth of ground water
▼ ATD = At time of drilling
▽ Static water level (date)
(5) Combined USCS symbols used for fines between 5% and 12%

Classifications of soils in this report are based on visual field and/or 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 and/or laboratory classification methods of ASTM D-2487 and D-2488 were used as an identification guide for the Unified Soil Classification System.

LOG OF EXPLORATION PIT NO. EP-1

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered. **DESCRIPTION**
	Forest Duff / Root Zone
1	
2	**Vashon Lodgment Till**
3	Dense to very dense, moist, moderately oxidized orangish brown, silty, fine SAND, trace gravel; excavates in occasional clasts; occasional rootlets; unsorted; partially cemented (SM).
4	Becomes very dense.
5	Very dense, moist, light brownish gray, gravelly, fine SAND, some silt to silty; occasional roots; cemented; unsorted (SM).
6	
7	
8	Becomes moist to very moist, silty, and gravelly.
9	Dense to very dense, very moist, brownish gray, silty, gravelly, fine SAND; excavates in silty, fine sand, trace gravel clasts; unsorted; cemented (SM).
10	
11	**Vashon Advance Outwash**
12	Dense, very moist to wet, slightly oxidized grayish brown, fine SAND, some silt, trace gravel; slightly stratified in clasts; excavates in occasional clasts (SM).
13	Layer (1 to 2 feet thick) of gravelly, fine SAND; abundant cobbles.
14	
15	Very dense, very moist to wet, brownish gray, fine SAND, some silt to silty, some gravel; unsorted; partially cemented (SM).
16	Bottom of exploration pit at depth 15 feet No seepage. No caving.
17	
18	
19	
20	

Woods Creek Highlands
Monroe, WA

Logged by: CRC

Approved by: JHS

associated earth sciences incorporated

Project No. 180487E001

11/2/18

LOG OF EXPLORATION PIT NO. EP-2

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered. **DESCRIPTION**
	Forest Duff / Root Zone
1	**Weathered Vashon Lodgment Till**
2	Loose to medium dense, moist, oxidized orangish brown, silty, fine SAND, trace gravel; unsorted; occasional rootlets (SM).
3	Organic/rootlet zone (2 to 3 inches thick) at 3 feet.
4	
5	**Vashon Lodgment Till**
6	Very dense, moist, brownish gray, silty, fine SAND, some gravel; unsorted; cemented (SM).
7	Abundant cobbles.
8	
9	Very dense, moist, grayish orangish brown, silty, fine to medium SAND, some gravel to gravelly; cemented (SM).
10	Bottom of exploration pit at depth 9 feet No seepage. No caving.
11	
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19	
20	

Woods Creek Highlands
Monroe, WA

Logged by: CRC

Approved by: JHS

associated earth sciences incorporated

Project No. 180487E001

11/2/18

LOG OF EXPLORATION PIT NO. EP-3

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered. **DESCRIPTION**
	Forest Duff / Root Zone
1	**Vashon Recessional Lacustrine**
2	Soft to medium stiff, moist, orangish tan, sandy, SILT, trace gravel; occasional rootlets; unsorted; excavates in occasional clasts (ML).
3	
4	
5	
6	
	Vashon Lodgment Till
7	Very dense, moist, slightly oxidized grayish brown, gravelly, fine to medium SAND, trace to some silt; occasional rootlets; occasional clasts; partially cemented (SM).
8	
9	Abundant cobbles.
10	
11	Very dense, moist to very moist, brownish gray, gravelly, fine SAND, trace to some silt; cemented clasts of silty, fine sand, trace gravel (SM). Very dense, moist, brownish gray, silty, gravelly, fine to medium SAND; unsorted; cemented (SM).
12	
13	Bottom of exploration pit at depth 12 feet No seepage. No caving.
14	
15	
16	
17	
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19	
20	

Woods Creek Highlands
Monroe, WA

Logged by: CRC
Approved by: JHS

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Project No. 180487E001

11/2/18

LOG OF EXPLORATION PIT NO. EP-4

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered. **DESCRIPTION**
	Forest Duff / Root Zone
1	**Weathered Vashon Lodgment Till**
2	Loose to medium dense, moist, orangish brown with heavy oxidation in top foot, silty, fine SAND, trace to some gravel; occasional rootlets; unsorted (SM)
3	
4	**Vashon Lodgment Till**
5	Very dense, moist, tannish gray, very silty, fine SAND, trace to some gravel; unsorted; cemented (SM).
6	Lens (1 foot thick) of abundant cobbles.
7	
8	
9	Very dense, moist, gray, silty, fine SAND, some gravel; unsorted; cemented; excavated in clasts (SM).
10	Bottom of exploration pit at depth 9.5 feet No seepage. No caving.
11	
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Woods Creek Highlands
Monroe, WA

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11/2/18

LOG OF EXPLORATION PIT NO. EP-5

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered. **DESCRIPTION**
	Forest Duff / Topsoil
1	
	Vashon Lodgment Till
2	
3	Very dense, very moist to wet, brownish gray, silty, fine to medium SAND, some gravel; occasional rootlets (SM).
4	
5	As above; wet.
6	Bottom of exploration pit at depth 5.5 feet Rapid seepage at 2.5 feet. Caving 1.5 to 2.5 feet.
7	
8	
9	
10	
11	
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Woods Creek Highlands
Monroe, WA

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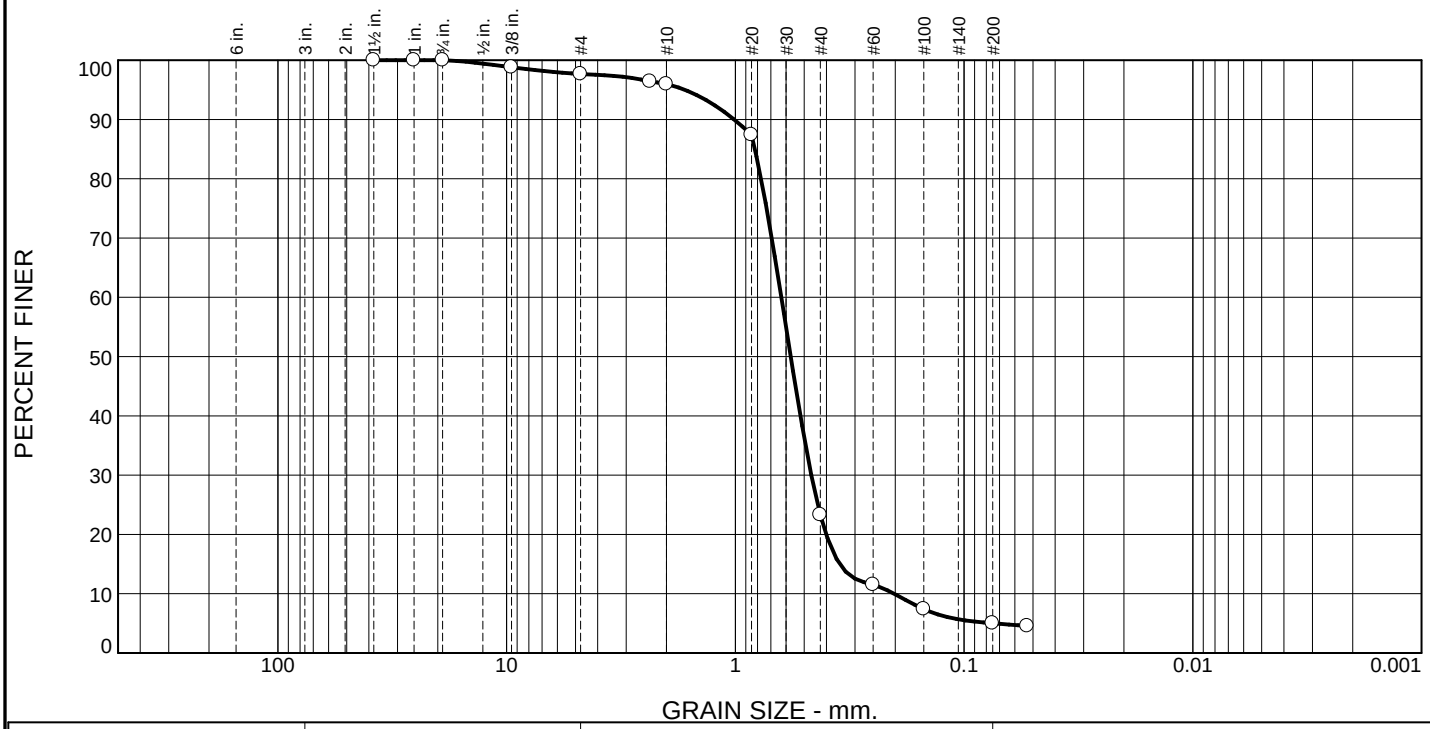
Project No. 180487E001

11/2/18

APPENDIX B

Laboratory Testing Results

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	2.3	1.7	72.7	18.3	5.0	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1.5	100.0		
1	100.0		
.75	100.0		
.375	98.8		
#4	97.7		
#8	96.4		
#10	96.0		
#20	87.4		
#40	23.3		
#60	11.5		
#100	7.4		
#200	5.0		
#270	4.6		

* (no specification provided)

Material Description

SAND, some silt, trace gravel

Atterberg Limits (ASTM D 4318)

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

Classification

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

Coefficients

D_{90}= 1.0131 D_{85}= 0.8215 D_{60}= 0.6296
D_{50}= 0.5729 D_{30}= 0.4657 D_{15}= 0.3500
D_{10}= 0.2026 C_u= 3.11 C_c= 1.70

Remarks

Collected by: CC

Date Received: 11/08/2018 **Date Tested:** 11/12/2018

Tested By: BN

Checked By: BG

Title:

Location: Onsite
Sample Number: EP-1 **Depth:** 11'

Date Sampled: 11/02/2018

associated earth sciences incorporated

Client: Woods Creek Development
Project: Woods Creek Highlands

Project No: 180487 E001 **Figure**

Tab 8.0

8.0 OTHER PERMITS

Other permits required for this project will be addressed during Final Engineering Review.

Tab 9.0

9.0 OPERATIONS AND MAINTENANCE MANUAL

An Operations and Maintenance Manual will be provided in this section during Final Engineering Review.

Tab 10.0

10.0 BOND QUANTITIES WORKSHEET

A bond quantities worksheet will be provided in this section during Final Engineering Review.