ATTACHMENT 21

BLUELINE

Larkin Subdivision

City of Redmond, Washington

Date: February 6, 2018
Revision Date: November 12, 2018

Preliminary Storm Drainage Report

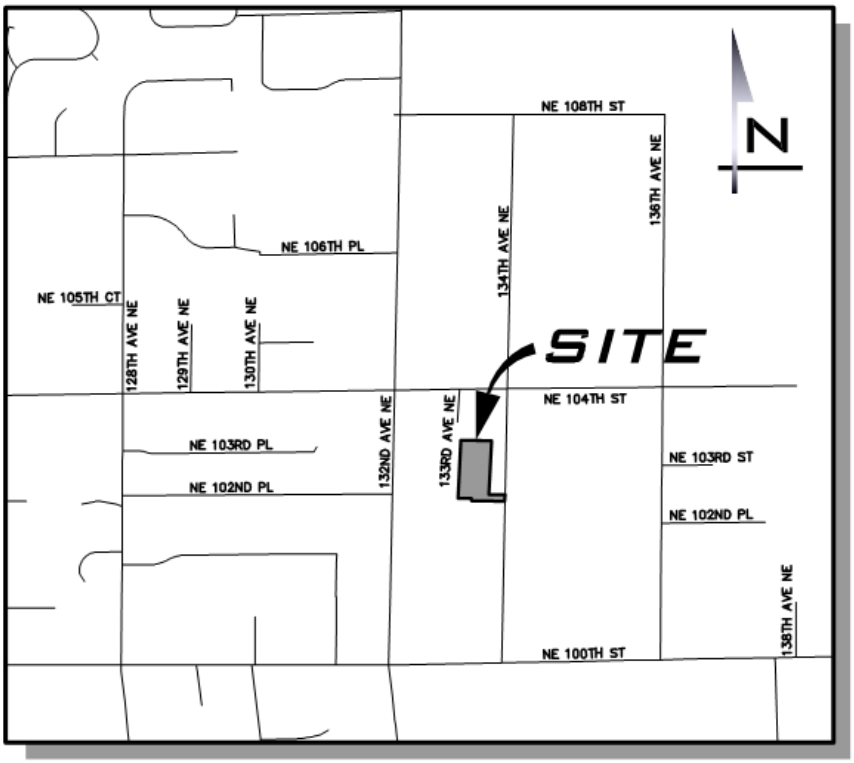
Prepared for
Rose Hill 12, LLC
2630 116th Ave NE, Suite 200
Bellevue, WA 98004

Blueline Job No. 17-134
Prepared by: Lyndsey Munkel, PE
Lucas Zirotti, EIT
Reviewed by: Todd Oberg, PE

Table of Contents

Section 1 Project Overview

The project is located at 10201 134th Ave NE in Redmond, WA 98033. More generally, the site is located in the SW ¼ of Section 34, Township 26 N, Range 5 E, W.M. Refer to the vicinity map below.



VICINITY MAP

NOT TO SCALE

The project site consists of one parcel (#1246700141) totaling approximately 2.47 acres. The project proposes 14 single family residences with associated access drives, utilities, and landscaping. Given the length of frontage associated with the development, improvements along 134th Ave NE are minor. Refer to the *Developed Conditions Exhibit* included in Section 4.

The site contains a single-family residence, associated outbuildings including a detached garage with associated pavement, and an existing gravel driveway. The parcel is a flag lot bounded on all sides by and single-family residences, with a small amount of frontage on the end of the panhandle to the east.

Per the preliminary geotechnical report, the site is underlain primarily by Vashon till. Till soils are not typically suitable for infiltration BMPs. See Section 6 for Geotechnical Engineering Study prepared by Earthwork Solutions NW.

The site contains a single drainage basin which is part of Redmond Watershed 060 and is ultimately tributary to the Sammamish River. In the existing condition, the site drainage sheet flows southeasterly across the site and discharges from the SW corner of the site where it is intercepted by drainage structures in 134th Ave NE. The developed conditions will maintain the existing drainage pattern by discharging site stormwater to the existing stormwater infrastructure installed within 134th Ave NE.

The project was designed to satisfy the requirements of the Department of Ecology's 2012 Stormwater Management Manual for Western Washington as amended in 2014 (DOE Manual) as adopted by the City of Redmond Stormwater Technical Notebook Issue No. 7A (Technical Notebook). The project is subject to Minimum Requirements 1 - 9 as defined in Chapter 2 of the Technical Notebook.

Section 2 Minimum Requirements

The project will comply with Minimum Requirements 1 - 9 of the Technical Notebook. Minimum requirements are listed and met as detailed below and determined from the City of Redmond flow chart included at the end of this section.

Minimum Requirement #1: Preparation of Stormwater Site Plans: All projects meeting the thresholds in section 2.4 shall prepare a stormwater Site Plan for City review. Refer to the Preliminary Plat Submittal included under separate cover for detailed information about the proposed stormwater design.

Minimum Requirement #2: Construction Stormwater Pollution Prevention (SWPP): See Section 5. A Construction SWPPP will be provided with the final engineering submittal.

Minimum Requirement #3: Source Control of Pollution: All known, available and reasonable source control BMPs must be applied to all projects. Source control BMPs will be selected, designed, and maintained in accordance with the DOE Manual and the Technical Notebook.

Minimum Requirement #4: Preservation of Natural Drainage Systems and Outfalls: See Sections 3 and 4. Runoff for the proposed development will be routed to leave the site at the existing natural discharge locations and will not cause adverse impacts downstream.

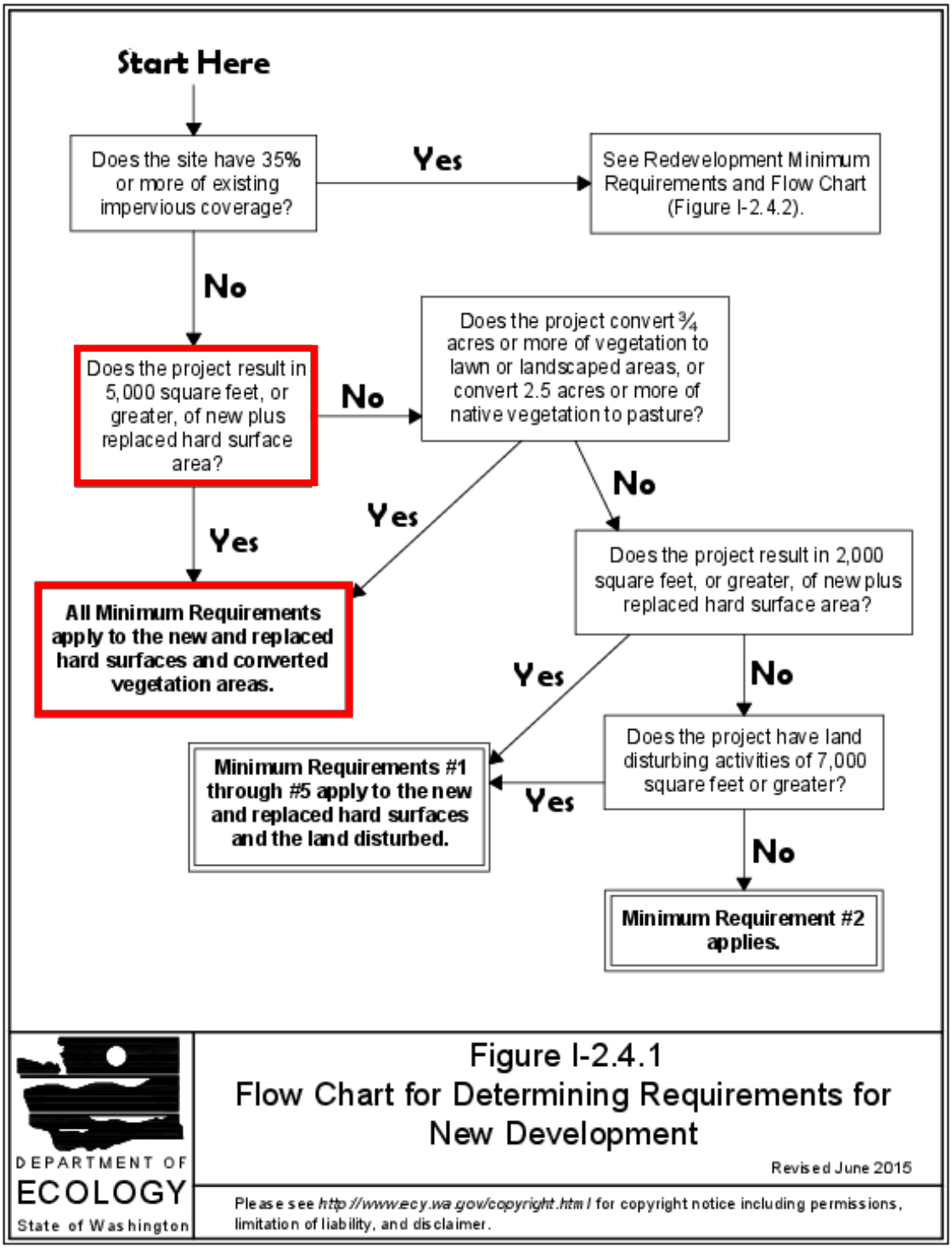
Minimum Requirement #5: On-Site Stormwater Management: See Section 4 for LID Stormwater BMPs.

Minimum Requirement #6: Runoff Treatment: See Section 4. The project is subject to Basic water quality treatment requirements as defined by the DOE Manual. Water quality requirements will be met by a combination detention/wetvault and lined bioretention swale.

Minimum Requirement #7: Flow Control: See Section 4. The project is subject to the Flow Control Requirements as stated in Section 2.5.7 of the Technical Notebook and the DOE Manual. Flow control requirements will be met through the use of a combination detention/wetvault.

Minimum Requirement #8: Wetlands Protection: The project will not discharge stormwater into a wetland either directly or indirectly through a conveyance system. Therefore, this Minimum Requirement is not applicable. Refer to Reconnaissance Report in Section 6.

Minimum Requirement #9 Operation and Maintenance: See Section 8. An operation and maintenance manual will be included with the final engineering submittal.



Section 3 Offsite Analysis

An offsite analysis was conducted on November 9, 2017 an overcast day, with temperatures around 48° F and scattered rain to observe the downstream flow path of the site.

TASK 1: DEFINE AND MAP THE STUDY AREA

The project is comprised of one parcel (#1246700141). See Section 4 of this report for the *Existing Conditions Exhibit* and the *Developed Conditions Exhibit.* A Photo Exhibit and Downstream Path Exhibit are provided at the end of this section that show the study area boundaries and the observed stormwater runoff flow path from the site. The project site consists of one drainage basin which is further described in Task 3 and 4.

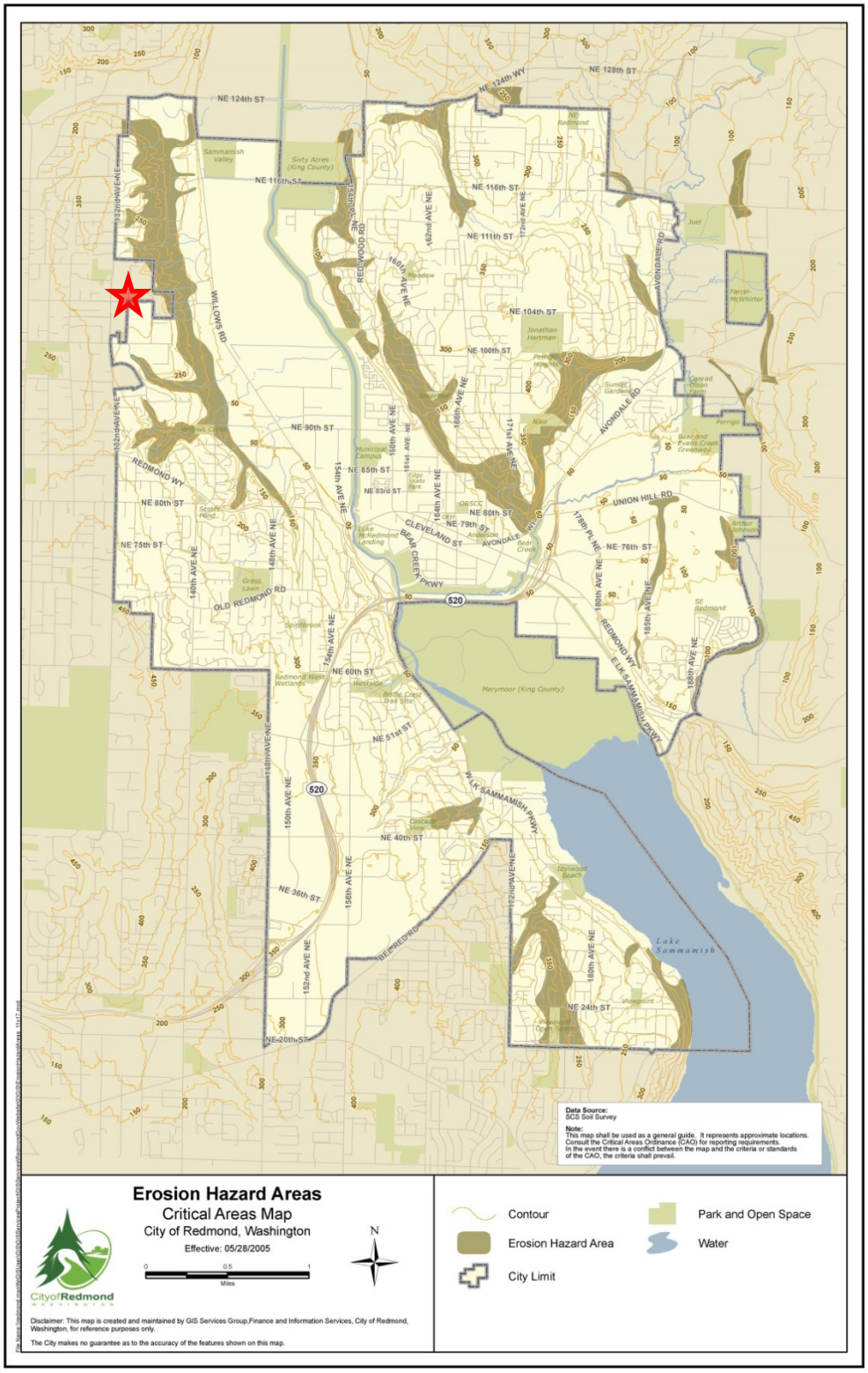
TASK 2: RESOURCE REVIEW

The best available resource information was reviewed for existing or potential problems. The following is a summary of the findings from the information used in preparing this report.

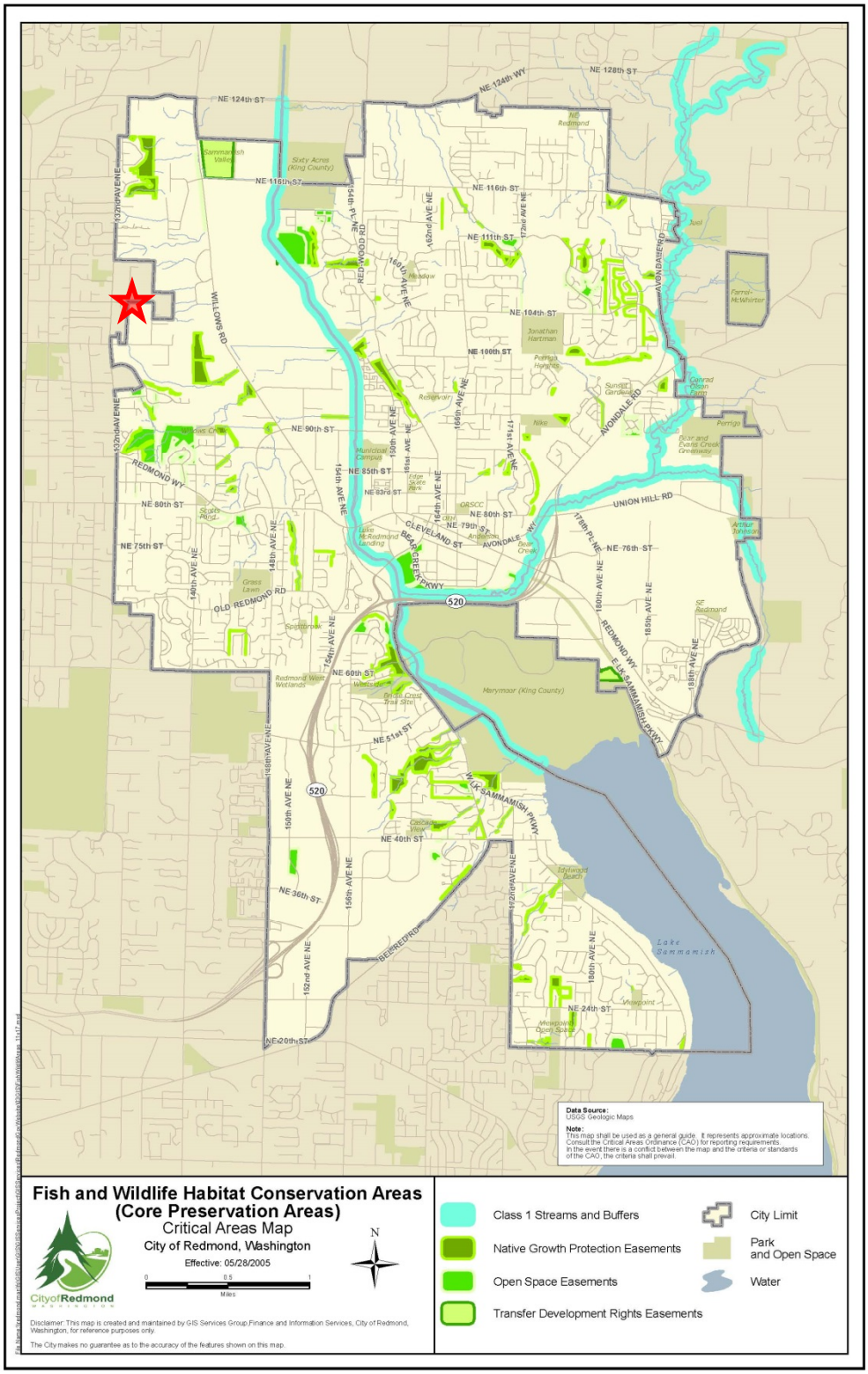
- The site is underlain primarily by Vashon till, as sited in the *Geotechnical Engineering Study* included in Section 6.
- The site does not contain a stream or wetland. (COR Critical Areas Map – Wetlands)
- The site is not located in an Erosion Hazard Area. (COR Critical Areas Map – Erosion Hazard Areas)
- The site is not located in a Core Preservation Area. (COR Critical Areas Map – Fish and Wildlife Habitat Conservation Areas)
- The site is not located in a 100-year flood plain or a FEMA floodway. (COR Critical Areas Map – Frequently Flooded Areas)
- The site is not located in a Landslide Hazard Area. (COR Critical Areas Map –Landslide Hazard Areas)
- The site is not located in a Seismic Hazard Area. (COR Critical Areas Map –Seismic Hazard Areas)
- The site is located in Redmond Watershed 060 and ultimately to the Sammamish River (COR Redmond Watershed Map)
- The site does not contain slopes in excess of 40 percent. (See *Existing Conditions Exhibit*)
- Per email coordination with the City of Redmond, there are no drainage complaints within ¼ mile of the site. Refer to emails included at the end of this section.

CRITICAL AREAS MAPS

COR – Erosion Hazard Areas

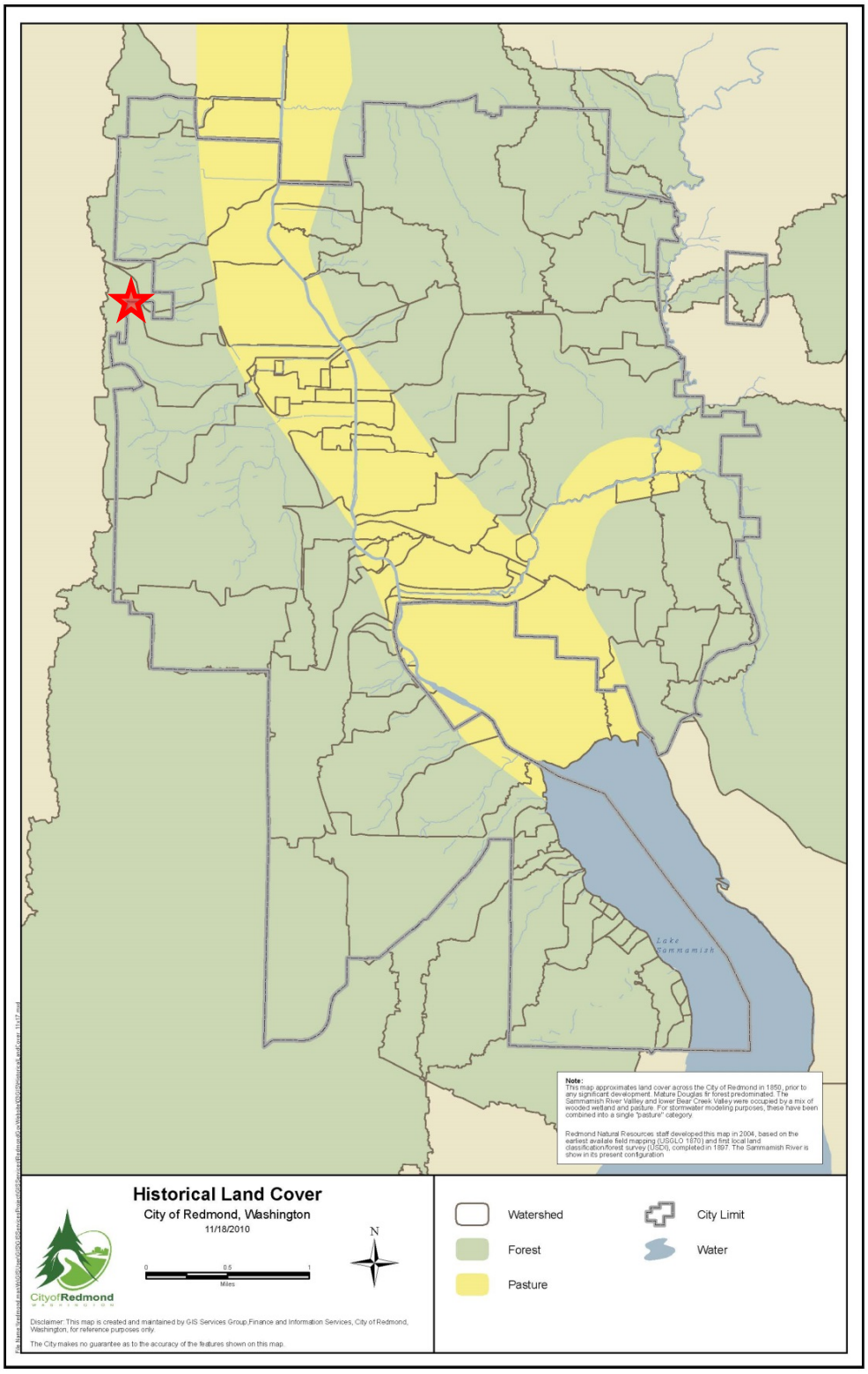


COR – Fish and Wildlife Habitat Conservation Areas (Core Preservation Areas)

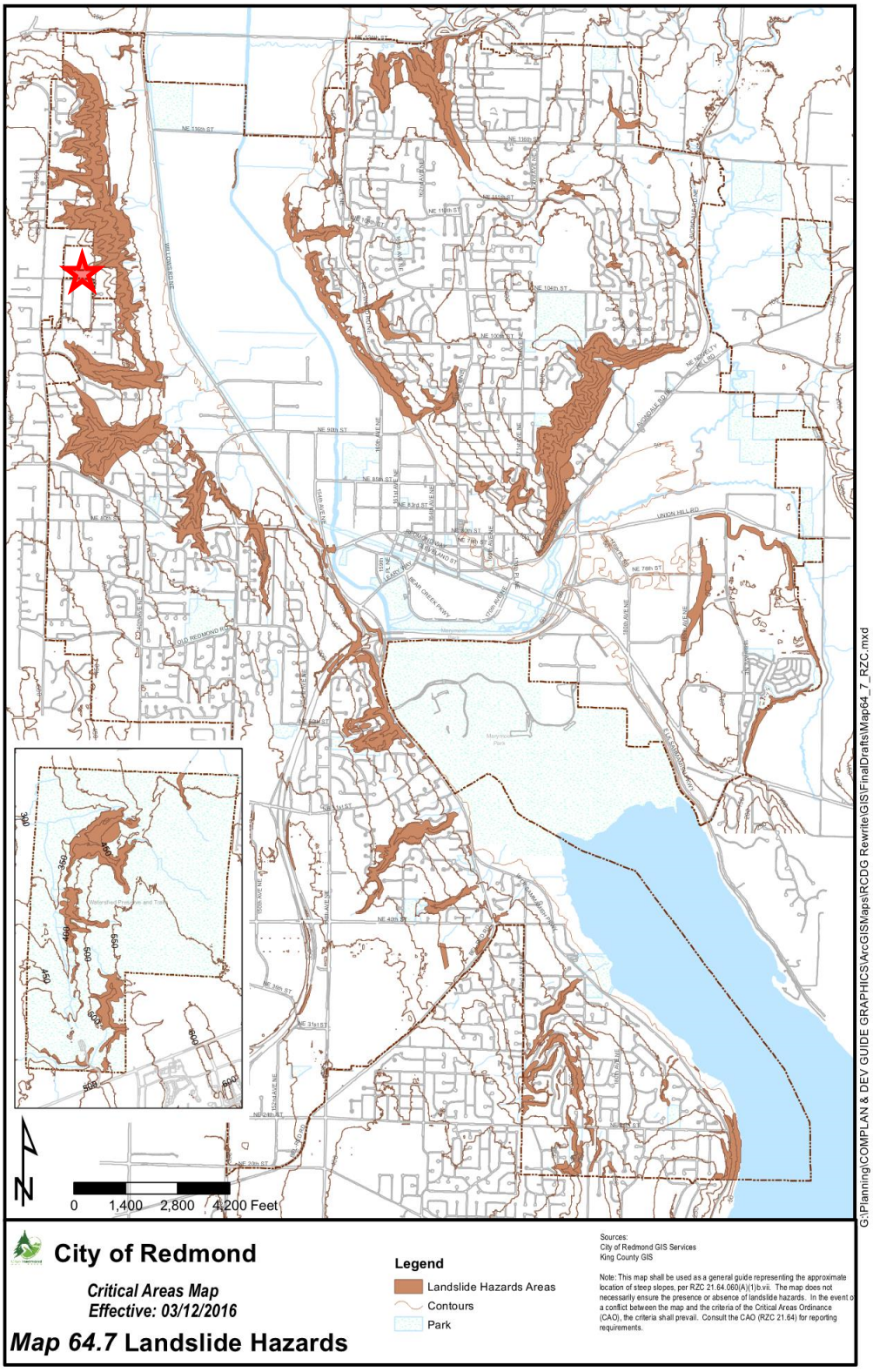


COR – Frequently Flooded Areas

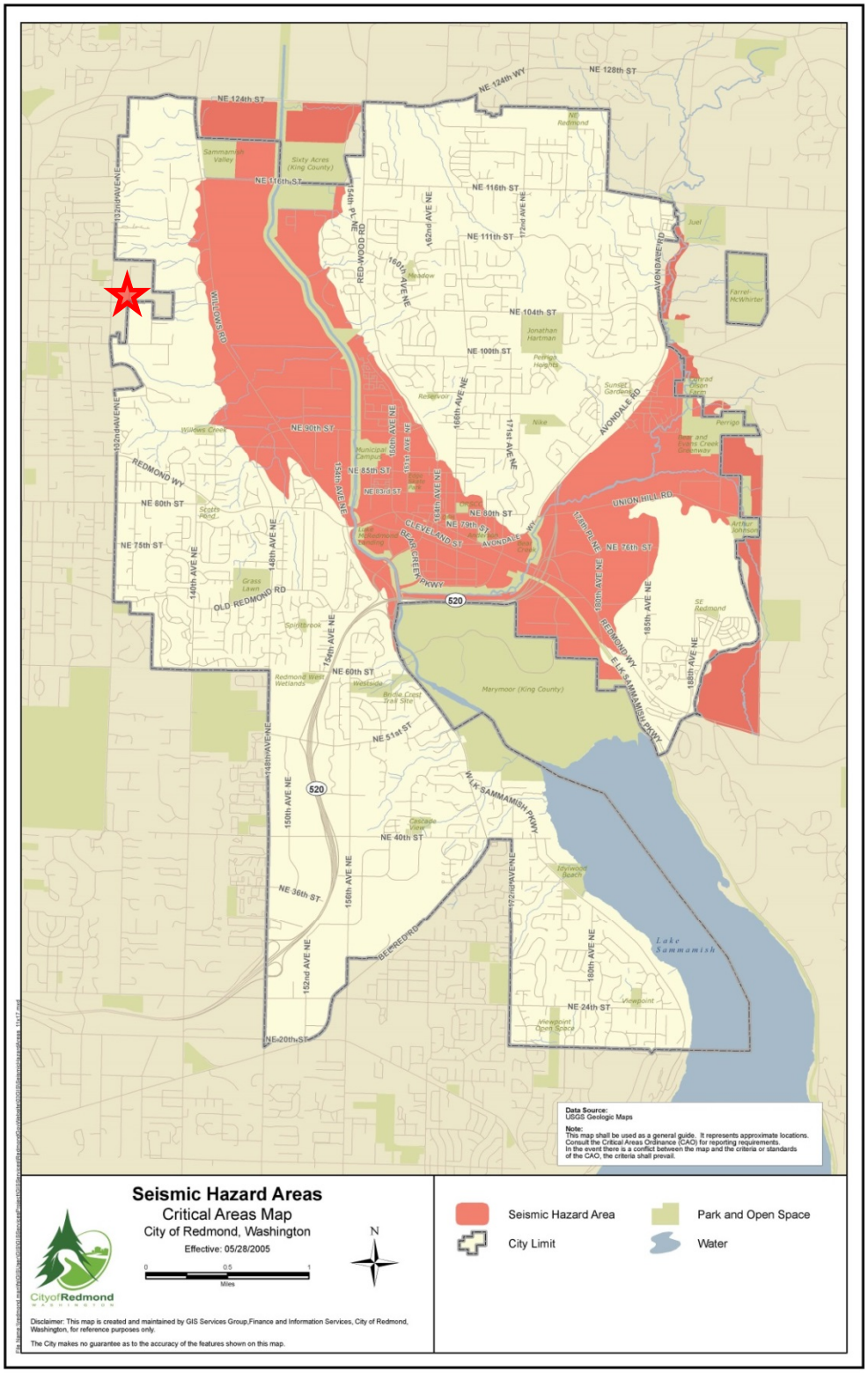
COR – Historical Land Cover



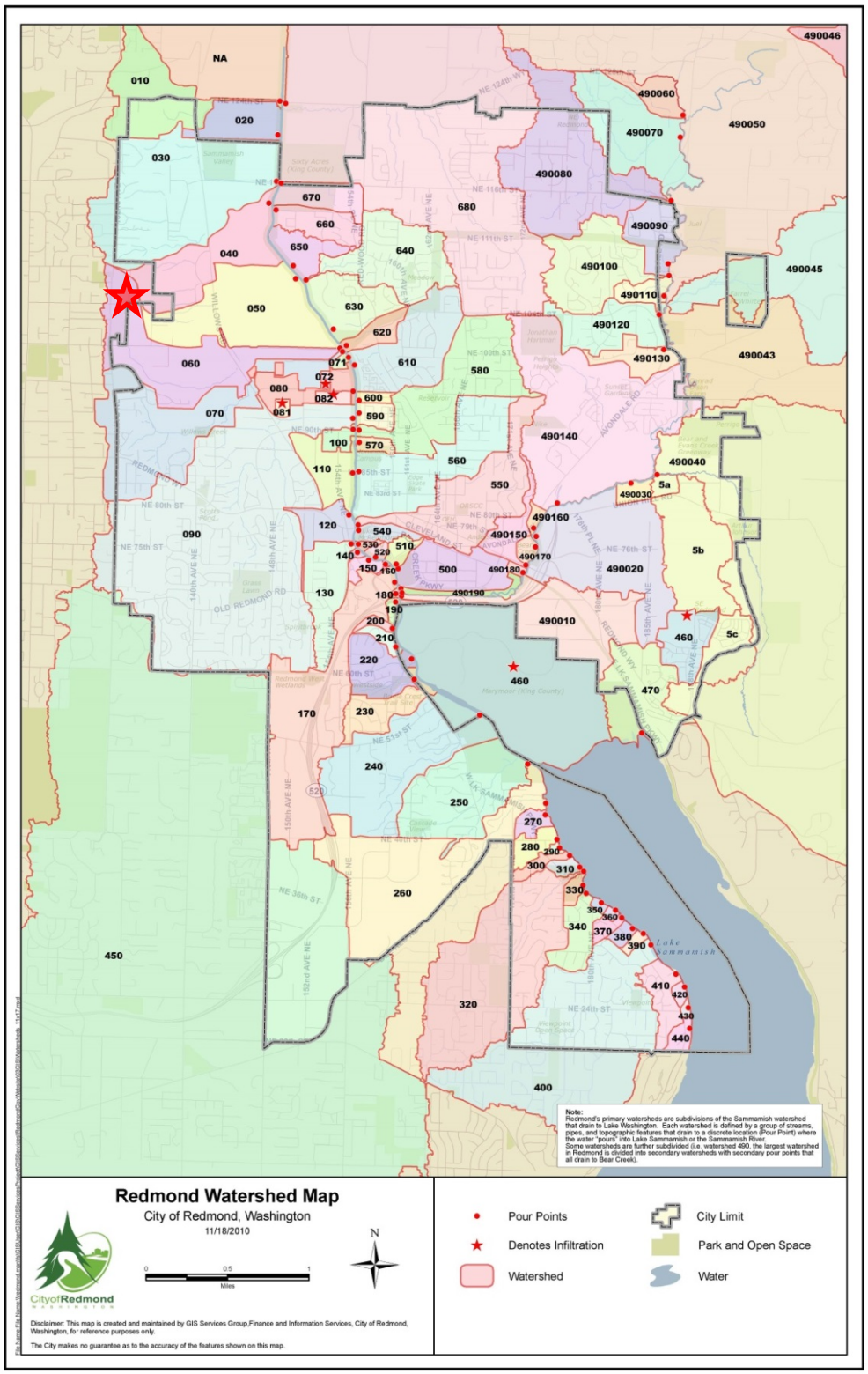
COR – Landslide Hazard Areas



COR – Seismic Hazard Areas



COR – Redmond Watershed Map



TASK 3: FIELD INSPECTION

A field inspection was conducted for the project at 10201 134th Ave NE on November 9, 2017, a cloudy day with temperatures around 48° F and scattered rain. Task 4 of this section contains a detailed drainage path description for the onsite basin as well as a *Downstream Path Exhibit*.

ONSITE BASIN

The site consists of one drainage basin with topography that drains in a southeasterly direction. The site includes one single-family residence, various sheds, and paved and gravel access. The residence is surrounded by lawn with residential landscaping dissipating into scattered trees.

Per the preliminary geotechnical report, the site is underlain primarily by Vashon till. Till soils are not typically suitable for infiltration BMPs. See Section 6 for Geotechnical Engineering Study prepared by Earthwork Solutions NW.

UPSTREAM BASIN

In the existing condition, surface runoff from adjacent properties west of the site sheet flows onto the site. The upstream area tributary to the site is approximately 1.84 acres. Lidar GIS data and aerial images were used to identify the existing structures and grading west of the project. In the developed condition, 1.18 acres of the upstream runoff will be collected and conveyed to the detention/wetvault and the remaining 0.66 acres of upstream runoff will bypass the site. Refer to the *Upstream Areas Exhibit* provided in Section 4.1 of this report.

TASK 4: DRAINAGE SYSTEM DESCRIPTION

Downstream drainage paths were investigated approximately ¼ mile downstream from the site. Refer to the *Downstream Drainage Exhibit* for paths and photo locations referred to in this section.

DOWNSTREAM DRAINAGE PATH

Runoff from the site sheet flows south and east (Photo 1) and is collected in the public drainage ditch along 134th Ave NE. Flows are then conveyed along the drainage ditch on the west side of 134th Ave NE (Photo 2) where they continue south for approximately 600 ft through the ditch and driveway culverts. Flows then enter a tight-lined drainage system (Photo 3) and are routed east to the NE corner of NE 100th St and 134th Ave NE. (Photo 4). Flows continue east to a catch basin where flows are piped across NE 100th St (Photo 5). Flows outfall to a natural drainage channel where it continues for approximately 700 ft to the ¼ mile downstream point.

ATTACHMENT 21

SITE

DOWNSTREAM PATH

APPROXIMATE 1/4 MILE POINT

NE 102nd ST

NE 101st ST

NE 100th CT

NE 100th ST

NE 97th ST

132nd AVE NE

133rd AVE NE

134th AVE NE

134th PL NE

136th AVE NE

137th PL NE

138th AVE NE

STORMWATER SYSTEM MAP

City of Redmond

LEGEND

Redmond MH	Valve	Redmond Underdrain	Pump
Redmond CB	Cleanout	Non-Redmond Underdrain	City Limits
Redmond MH CS	Redmond Pipe	Redmond Vault	Ponds
Redmond CB CS	Non-Redmond Pipe	Non-Redmond Vault	Streams
Redmond Unknown	Non-Redmond Culvert	Redmond Bioswale	Contours
Redmond Inlet/Area Drain	Redmond Culvert	Non-Redmond Bioswale	
Non-Redmond Chambers	SW SideSewer		

N

0 100 200 400 Feet

DATE 4/30/2018

FOR INFORMATION ONLY

THIS MAP AND RELATED DATA IS INTENDED TO ASSIST IN FIELD LOCATIONS AND IS NOT GUARANTEED TO BE ACCURATE. FIELD VERIFICATION IS REQUIRED FOR ALL DEVELOPMENT OR CONSTRUCTION PLANS.

Q:\NRDivision\NRFunctions\04MappingGISDatabase\PERSONNEL\DSwayne\BluelineGroup2.mxd

DOWNSTREAM PHOTOS

Photo 1 – Looking west – Runoff sheet flows southeast from the site.

Photo 2 – Looking south – Flows are collected in the drainage ditch on the west side of 134th Ave NE where they are conveyed south (~600 ft) through a series of driveway culverts.

Photo 3 – Looking southwest – Flows enter the tight line system through this culvert and are conveyed south to the catch basin in the gravel.

Photo 4 – Looking east – Flows are conveyed east to this catch basin on the east side of 134th Ave NE, and continue through to the next two catch basins as shown in the photo.

Photo 5 – Looking south – Catch basin with a large custom grate, flows are conveyed south across the roadway to outfall into a stream.

Photo 6 – Looking southeast – Flows exit the tight line system and enter the natural drainage channel.

Lyndsey Munkel

From: Alex Weatbrook
Sent: Friday, November 03, 2017 2:27 PM
To: Lyndsey Munkel
Subject: FW: Request for Drainage Information - Parcel #1246700141 - Blueline 17-134
Attachments: 17-132.pdf; 17-134.pdf

Alex Weatbrook | Engineer
BLUELINE | www.thebluelinegroup.com
d 425.250.7257 | **o** 425.216.4051 | **f** 425.216.4052
LAND MATTERS : : Civil Engineering : : Land Use Planning

From: Don Swayne [mailto:dswayne@REDMOND.GOV]
Sent: Friday, November 03, 2017 2:25 PM
To: Alex Weatbrook <aweatbrook@thebluelinegroup.com>
Subject: RE: Request for Drainage Information - Parcel #1246700141 - Blueline 17-134

Alex,

I see no drainage complaints within 1000 feet of sites. Let me know if you have any other questions.

Don Swayne
City of Redmond
425 556-2735

From: Alex Weatbrook [mailto:aweatbrook@thebluelinegroup.com]
Sent: Friday, November 03, 2017 1:46 PM
To: Don Swayne <dswayne@REDMOND.GOV>
Cc: Lyndsey Munkel <LMunkel@thebluelinegroup.com>
Subject: Request for Drainage Information - Parcel #1246700141 - Blueline 17-134

Hi Don,

I am working on a development in Redmond on 134th Ave NE Parcel 1246700141, and I would like to get Redmond's storm utility maps for reference on the surrounding drainage system. Could you provide me with the City's storm map for this area? Also, is the City aware of any drainage issues or complaints in the area of the downstream path?

I've attached a PDF showing our parcel.

Thank you,

Alex Weatbrook | Engineer
BLUELINE | www.thebluelinegroup.com
d 425.250.7257 | **o** 425.216.4051 | **f** 425.216.4052
LAND MATTERS : : Civil Engineering : : Land Use Planning

P.S. This is one of two emails that I've sent you regarding projects in the same area.

Section 4 Permanent Stormwater Control Plan

The permanent stormwater control plan includes both flow control and water quality treatment facilities designed and sized according to the Technical Notebook and DOE Manual.

4.1 Flow Control Analysis And Design

Per Section 2.9.3.1 of the Technical Notebook, WWHM, the most current version, is preferred. The project basin was modeled using the Western Washington Hydrology Model, Version 2012 (WWHM 2012).

EXISTING CONDITIONS BASIN

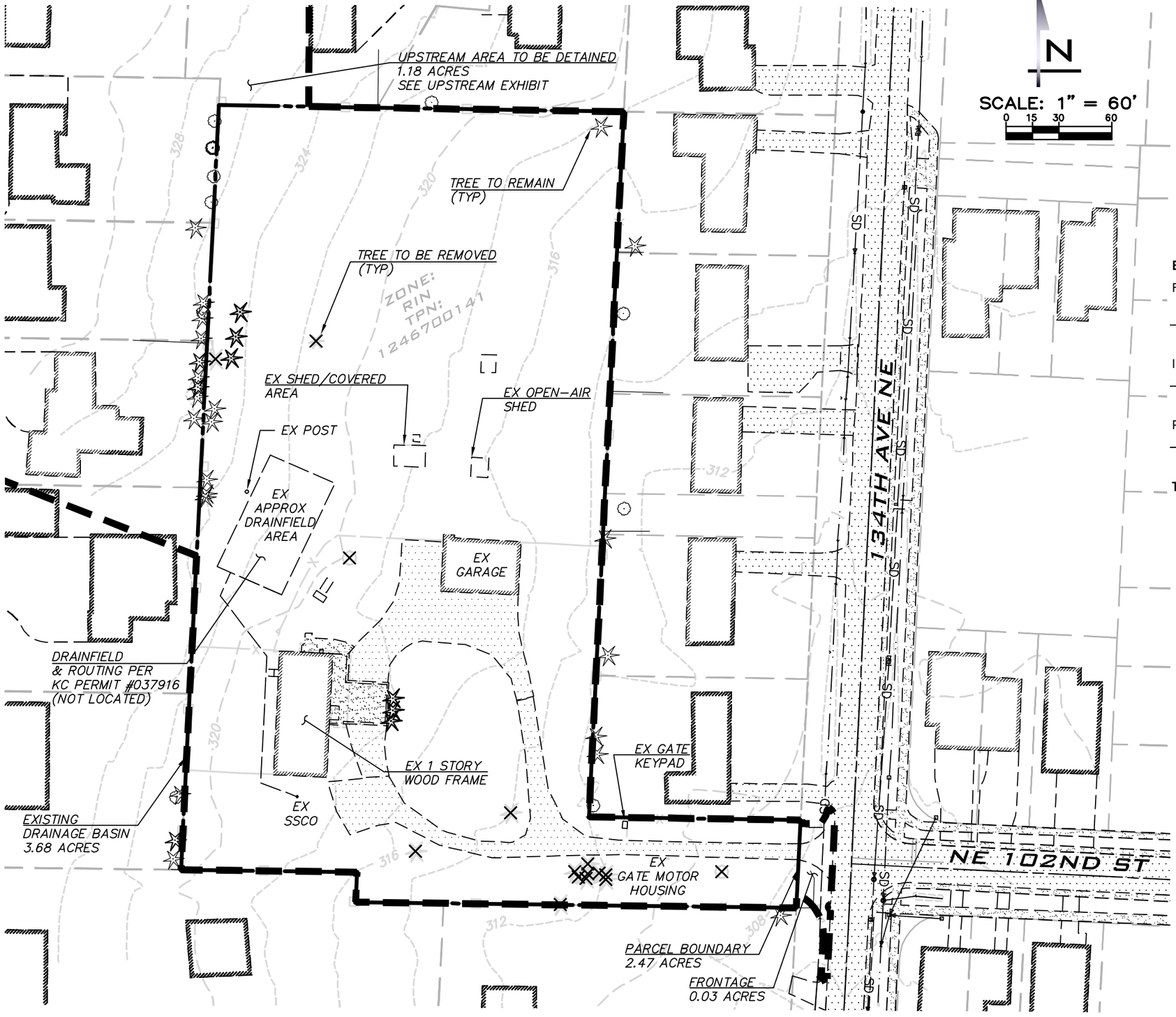
The existing basin consists of parcel #1246700141 (2.47 acres), minor frontage improvements along 134th Ave NE (0.03 acres), and a portion of the upstream area west of the site (1.18 acres). Refer to the *Existing Conditions Exhibit* included on the following page.

Per Section 2.5.7 of the Technical Notebook, the pre-developed condition to be matched shall be a forested land cover.

EXISTING CONDITIONS AREAS

Forest		
Parcel Area	2.47	ac
Frontage (134th Ave NE)	0.03	ac
Total Forest (Soil Group C, Till)	2.50	ac
Impervious		
Upstream Area	0.77	ac
Total Forest (Soil Group C, Till)	0.77	ac
Pervious		
Upstream Area	0.41	ac
Total Forest (Soil Group C, Till)	0.41	ac
Total Existing Condition	3.68	ac

EXISTING CONDITIONS EXHIBIT



N

SCALE: 1" = 60'

0 15 30 60

EXISTING CONDITIONS AREAS

Forest		
Parcel Area	2.47	ac
Frontage (134th Ave NE)	0.03	ac
Total Forest (Soil Group C, Till)	2.50	ac
Impervious		
Upstream Area	0.77	ac
Total Forest (Soil Group C, Till)	0.77	ac
Pervious		
Upstream Area	0.41	ac
Total Forest (Soil Group C, Till)	0.41	ac
Total Existing Condition	3.68	ac

LEGEND

EXISTING FEATURES

- ADJACENT PLAT/PARCEL LINE
- SURFACE FEATURES
- BUILDING FOOTPRINT
- 320 10' CONTOURS
- 322 2' CONTOURS
- SD STORM DRAIN PIPE
- X WIRE FENCE
- BOUNDARY
- DRAINAGE BASIN
- SD PIPE FLOW
- CATCH BASIN, TYPE I
- ASPHALT
- CONCRETE
- GRAVEL

BLUELINE

EXISTING CONDITIONS
LARKIN SUBDIVISION
PRELIMINARY STORM DRAINAGE REPORT

SCALE	AS NOTED
PROJECT MANAGER	TODD A OBERG, PE
DESIGNED BY	BRIAN DENNEY
DRAWN BY	LYNDSEY MUNKEL, PE
PLOT DATE	August 13, 2018

JOB NUMBER: 17–134

FIGURE: EC

Aug 13, 2018 – 5:39pm – User Izirotti
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DEVELOPED CONDITIONS BASIN

The project proposes the creation of 14 single-family lots with associated access and landscaping, a combination detention/wetvault, associated utilities, and frontage improvements. The majority of developed runoff for the site will be routed to the onsite detention/wetvault and discharged to the storm drain conveyance system installed within 134th Ave NE. Refer to the Preliminary Plat Submittal.

The developed basin consists of parcel #1246700141 (2.47 acres), minor frontage improvements along 134th Ave NE (0.03 acres), and a portion of the upstream area west of the site (1.18 acres).

The majority of the parcel and future right-of-way areas (2.32 acres) will be routed to the detention/wetvault for flow control and water quality treatment. A portion of Road A and frontage improvements along 134th Ave NE cannot physically be routed to the detention/wetvault. The majority of this bypassed area will be routed to a lined bioretention swale for water quality treatment. Flow control credits are not taken for areas routed to the lined bioretention swale. Areas that cannot physically be routed to the detention vault have been modeled as bypass. A portion of the upstream area west of the site (1.18 acres) will be routed through the detention/wetvault.

The site is located within the City of Redmond's Residential Innovative (RIN) Zone which allows a maximum of 65% impervious coverage. Parcel areas will be modeled as the maximum allowed per zoning. Future right-of-way areas will be modeled based on the current site plan. Access tracts will be modeled at 95% impervious coverage and open space tracts will be modeled as 10% impervious coverage based on the current site plan.

Per the City of Redmond typical section for the RIN zone (COR DG16 Rustic Street Section), a 10' drainage swale is required along the north side of Road A and the east side of Road B. This drainage swale will be proposed as a lined bioretention swale along a portion of Road A.

Refer to the developed conditions areas, WWHM 2012 printouts, and the *Developed Conditions Exhibit* included on the following pages.

DEVELOPED CONDITIONS AREAS: TRIBUTARY TO DETENTION/WETVAULT

Pervious		
Parcel Area	0.51	ac
Road A & Road B	0.13	ac
Tracts	0.18	ac
Upstream Area	0.41	ac
Total Pervious (Soil Group C, Till)	1.23	ac
Impervious		
Parcel Area (65% Allowed per Zoning)	0.95	ac
Road A & Road B	0.50	ac
Tracts	0.05	ac
Upstream Area	0.77	ac
Total Impervious	2.27	ac
Total Tributary to Detention/Wetvault	3.50	ac

DEVELOPED CONDITIONS BYPASS AREAS (TRIBUTARY TO BIORETENTION SWALE)*

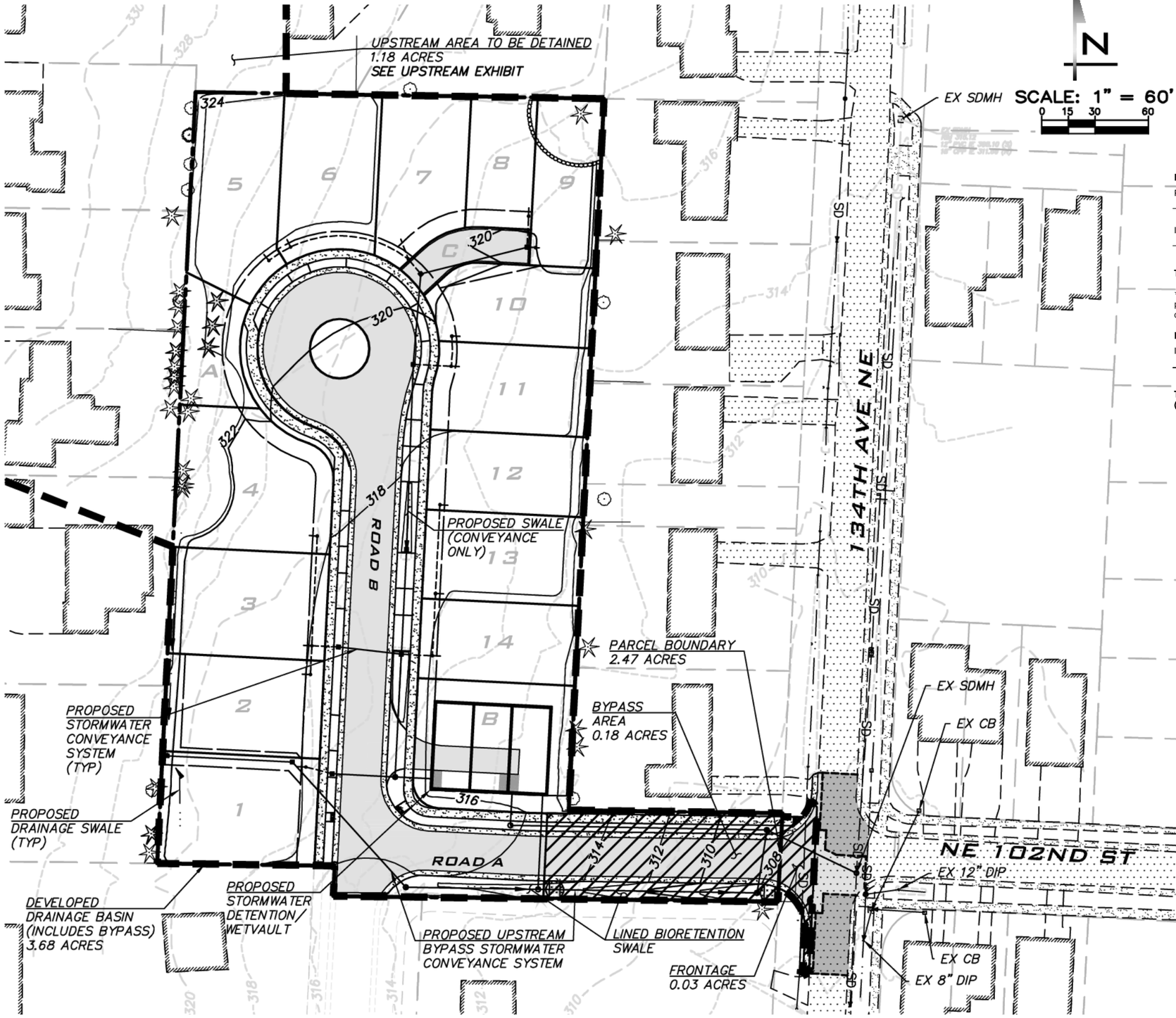
Pervious		
Road A	0.05	ac
Total Pervious (Soil Group C, Till)	0.05	ac
Impervious		
Road A	0.10	ac
Total Impervious	0.10	ac
Total Bypass Area Tributary to Bioretention Swale	0.15	ac

*Flow control credits are not taken for areas routed to the lined bioretention swale. Areas that cannot physically be routed to the detention vault have been conservatively modeled as bypass. Flow control credit associated with the lined bioretention swale will be evaluated at final engineering.

DEVELOPED CONDITIONS BYPASS AREAS (NOT TRIBUTARY TO BIORETENTION SWALE)

Impervious		
Frontage	0.03	ac
Total Impervious	0.03	ac
Total Bypass Area (Not Tributary to Bioretention Swale)	0.03	ac

DEVELOPED CONDITIONS EXHIBIT



DEVELOPED CONDITIONS AREAS: TRIBUTARY TO DETENTION/WETVAULT

Pervious		
Parcel Area	0.51	ac
Road A & Road B	0.13	ac
Tracts	0.18	ac
Upstream Area	0.41	ac
Total Pervious (Soil Group C, Till)	1.23	ac
Impervious		
Parcel Area (65% Allowed per Zoning)	0.95	ac
Road A & Road B	0.50	ac
Tracts	0.05	ac
Upstream Area	0.77	ac
Total Impervious	2.27	ac
Total Tributary to Detention/Wetvault	3.50	ac

DEVELOPED CONDITIONS BYPASS AREAS (TRIBUTARY TO BIORETENTION SWALE)*

Pervious		
Road A	0.05	ac
Total Pervious (Soil Group C, Till)	0.05	ac
Impervious		
Road A	0.10	ac
Total Impervious	0.10	ac
Total Bypass Area Tributary to Bioretention Swale	0.15	ac

*Flow control credits are not taken for areas routed to the lined bioretention swale. Areas that cannot physically be routed to the detention vault have been conservatively modeled as bypass. Flow control credit associated with the lined bioretention swale will be evaluated at final engineering.

DEVELOPED CONDITIONS BYPASS AREAS (NOT TRIBUTARY TO BIORETENTION SWALE)

Impervious		
Frontage	0.03	ac
Total Impervious	0.03	ac
Total Bypass Area (Not Tributary to Bioretention Swale)	0.03	ac

LEGEND

EXISTING FEATURES

- ADJACENT PLAT/PARCEL LINE
- SURFACE FEATURES
- BUILDING FOOTPRINT
- SD — STORM DRAIN PIPE
- BOUNDARY
- SD PIPE FLOW
- CATCH BASIN, TYPE I

PROPOSED FEATURES

- FLOW & CURB
- 320 — 10' CONTOURS
- 322 — 2' CONTOURS
- ROCKERY
- RIGHT-OF-WAY
- LOT LINE
- DRAINAGE BASIN
- CONCRETE SIDEWALK/ DRIVEWAY

PROPOSED STORM DRAINAGE

- STORM DRAIN PIPE
- ROOF & FOOTING DRAIN
- VAULT OUTLINE
- SWALE OR DITCH
- CATCH BASIN, TYPE I
- STORM CLEANOUT
- YARD DRAIN
- CATCH BASIN, TYPE II

BLUELINE

DEVELOPED CONDITIONS EXHIBIT
LARKIN SUBDIVISION
PRELIMINARY STORM DRAINAGE REPORT

SCALE	AS NOTED
PROJECT MANAGER	TODD OBERG, PE
DESIGNED BY	BRIAN DENNEY
DRAWN BY	LYNDSEY MUNKEL, PE
PLOT DATE	November 14, 2018

JOB NUMBER: 17-134

FIGURE: DC

Nov 14, 2018 - 10:19am - User LMunkel
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UPSTREAM BASIN

As described in Section 3 of this report, the upstream area tributary to the site is 1.84 acres. Refer to the *Upstream Areas Exhibit* included on the following pages.

Per Volume 3, Appendix B of the DOE Manual if the existing 100-year peak flow rate from any upstream off-site areas is greater than 50% of the 100-year developed peak flow rate (undetained) for the project site, then the runoff from the off-site area must not flow to the on-site flow control facility. The upstream areas and the corresponding WWHM output, are summarized below and the following page.

The impervious coverage for the existing residential area is assumed to be 65% maximum impervious per Redmond Zoning Code 21.08.070, resulting in 1.20 acres of upstream impervious area.

TOTAL UPSTREAM AREA

Pervious		
Upstream Area	0.64	ac
Total Pervious (Soil Group C, Till)	0.64	ac
Impervious		
Upstream Area (65%)	1.20	ac
Total Impervious	1.20	ac
Total Upstream Area	**1.84**	**ac**

Flow Frequency Return Periods for Predeveloped. Upstream Basin POC #1	
Return Period	**Flow(cfs)**
2 year	0.4987
5 year	0.6467
10 year	0.7492
25 year	0.8843
50 year	0.9892
100 year	1.0978

DEVELOPED CONDITIONS AREAS: UNDETAINED

Pervious		
Site Pervious	0.87	ac
Total Pervious (Soil Group C, Till)	0.87	ac
Impervious		
Site Impervious	1.63	ac
Total Impervious	1.63	ac
Total Undetained Developed Conditions Areas	**2.50**	**ac**

Flow Frequency Return Periods for Predeveloped. Upstream Basin POC #1	
Return Period	**Flow(cfs)**
2 year	0.6775
5 year	0.8785
10 year	1.0178
25 year	1.2014
50 year	1.3439
100 year	1.4914

The existing 100-year peak flow for the 1.84 acres of upstream area (1.098 cfs) is more than 50% of the developed, undetained 100-year peak flow (0.746 cfs).

An upstream area of 1.18 acres will be collected and conveyed to the detention facility as the peak flowrate from this area is less than 50% of the developed, undetained 100-year peak flow. The adjusted upstream areas and the corresponding WWHM output, are summarized below and on the following page.

UPSTREAM AREA (TRIBUTARY TO DETENTION/WET VAULT)

Pervious		
Upstream Area	0.41	ac
Total Pervious (Soil Group C, Till)	0.41	ac
Impervious		
Upstream Area (65%)	0.77	ac
Total Impervious	0.77	ac
Total Upstream Area Tributary to Detention/Wet Vault	**1.18**	**ac**

Flow Frequency Return Periods for Predeveloped. Upstream Basin POC #1	
Return Period	**Flow(cfs)**
2 year	0.3200
5 year	0.4149
10 year	0.4806
25 year	0.5673
50 year	0.6346
100 year	0.7042

DEVELOPED CONDITIONS AREAS: UNDETAINED

Pervious		
Site Pervious	0.87	ac
Total Pervious (Soil Group C, Till)	0.87	ac
Impervious		
Site Impervious	1.63	ac
Total Impervious	1.63	ac
Total Undetained Developed Conditions Areas	**2.50**	**ac**

Flow Frequency Return Periods for Predeveloped. Upstream Basin POC #1	
Return Period	**Flow(cfs)**
2 year	0.6775
5 year	0.8785
10 year	1.0178
25 year	1.2014
50 year	1.3439
100 year	1.4914

The existing 100-year peak flow for the 1.18 acres of upstream area tributary to the vault (0.704 cfs) is less than a 50% of the developed, undetained 100-year peak flow (0.746 cfs). The flow control facility is designed to compensate for the uncontrolled bypass area such that the net effect at the point of convergence downstream is the same with or without bypass.

The remaining 0.66 acres will bypass the detention facility as the peak flowrate from this area is less than 50% of the developed, undetained 100-year peak flow. The upstream bypass area will not create a significant adverse impact to downstream drainage systems or properties, while meeting water quality requirements.

UPSTREAM BYPASS AREA

Pervious		
Bypass Area	0.23	ac
Total Pervious (Soil Group C, Till)	0.23	ac
Impervious		
Bypass Area	0.43	ac
Total Impervious	0.43	ac
Total Upstream Bypass Area	**0.66**	**ac**

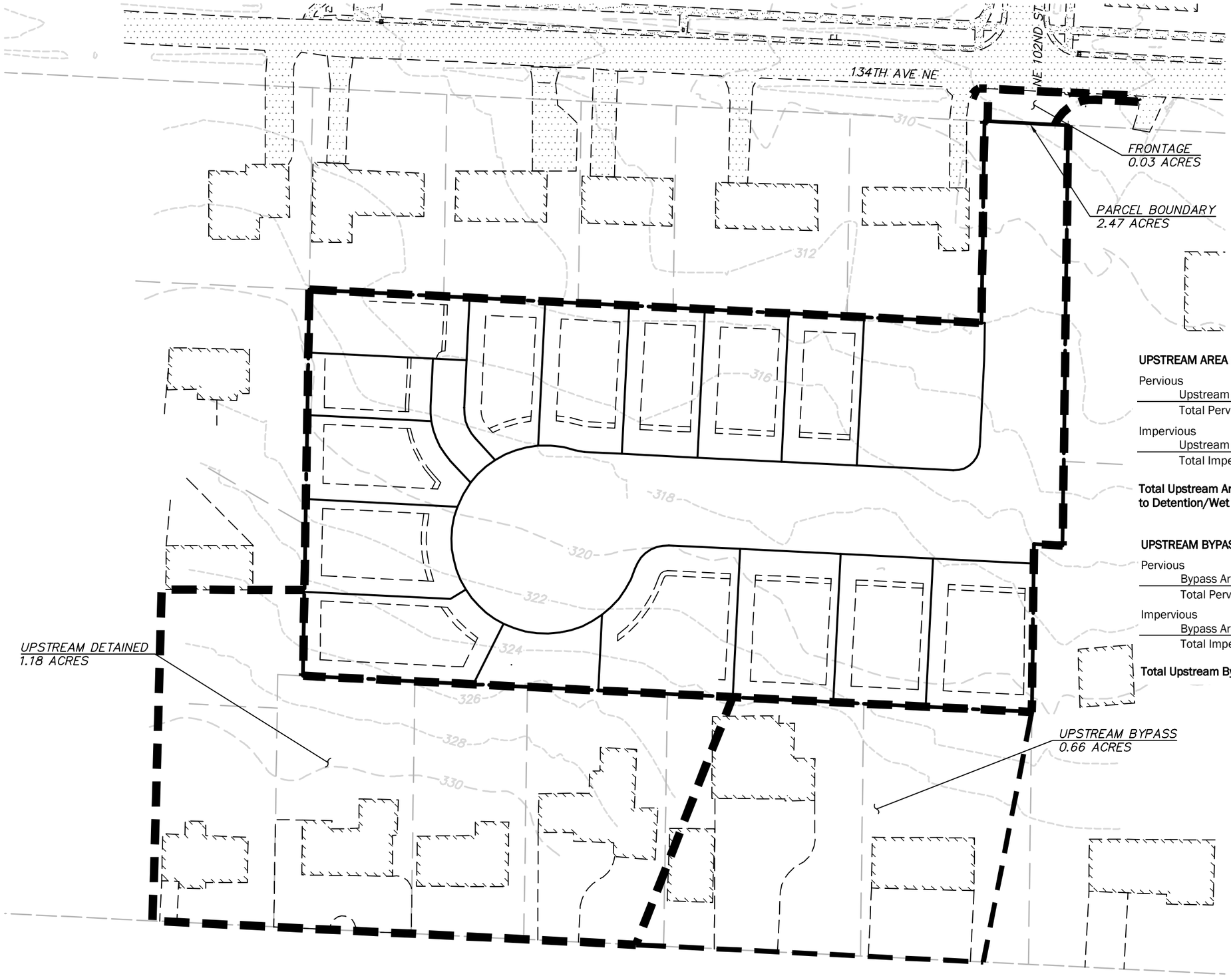
Flow Frequency Return Periods for Predeveloped. Upstream Basin POC #1	
Return Period	**Flow(cfs)**
2 year	0.1788
5 year	0.2318
10 year	0.2686
25 year	0.3170
50 year	0.3546
100 year	0.3936

The existing 100-year peak flow for the 0.66 acres of upstream bypass area (0.394 cfs) does not exceed 0.4 cfs per Volume 3, Appendix B. Runoff from the bypass area will not create a significant adverse impact to downstream drainage systems or properties and will meet water quality requirements.

Runoff from both the 0.66 acres of upstream bypass area and the detention facility will converge within a quarter mile downstream of the project site discharge point.

ATTACHMENT 21

UPSTREAM AREAS EXHIBIT



N

SCALE: 1" = 60'

0 15 30 60

UPSTREAM AREA (TRIBUTARY TO DETENTION/WET VAULT)

Pervious		
Upstream Area	0.41	ac
Total Pervious (Soil Group C, Till)	0.41	ac
Impervious		
Upstream Area (65%)	0.77	ac
Total Impervious	0.77	ac
Total Upstream Area Tributary to Detention/Wet Vault	**1.18**	**ac**

UPSTREAM BYPASS AREA

Pervious		
Bypass Area	0.23	ac
Total Pervious (Soil Group C, Till)	0.23	ac
Impervious		
Bypass Area	0.43	ac
Total Impervious	0.43	ac
Total Upstream Bypass Area	**0.66**	**ac**

BLUELINE

UPSTREAM AREAS EXHIBIT
LARKIN SUBDIVISION
PRELIMINARY STORM DRAINAGE REPORT

SCALE	AS NOTED
PROJECT MANAGER	DEANNA MARTIN, PE
DESIGNED BY	BRIAN DENNEY
DRAWN BY	LUCAS ZIROTTI, EIT
PLOT DATE	November 9, 2018

JOB NUMBER: 17–134

FIGURE: US

Nov 09, 2018 – 2:25pm – User lzirotti
E:\Projects\17134\dwg\Exhibits\Drainage\17134 US.dwg

WWHM2012
PROJECT REPORT

Project Name: 17134 Vault
Site Name: Larkin Property
Site Address: 134th Ave NE
City : Redmond
Report Date: 11/8/2018
Gage : Seatac
Data Start : 1948/10/01
Data End : 2009/09/30
(adjusted) **Precip Scale:** 0.00
Version Date: 2018/10/10
Version : 4.2.16

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

High Flow Threshold for POC 1: 50 year

PREDEVELOPED LAND USE

Name : Basin 1
Bypass: No

GroundWater: No

Pervious Land Use	acre
C, Forest, Flat	2.5
C, Lawn, Flat	.41
Pervious Total	2.91

Impervious Land Use	acre
ROADS FLAT	0.77
Impervious Total	0.77
Basin Total	3.68

Element Flows To:
Surface **Interflow** **Groundwater**

MITIGATED LAND USE

Name : Developed Site
Bypass: No

GroundWater: No

Pervious Land Use	acre
C, Lawn, Flat	1.23
Pervious Total	**1.23**

Impervious Land Use	acre
ROADS FLAT	2.27
Impervious Total	**2.27**
Basin Total	**3.5**

Element Flows To:

Surface	Interflow	Groundwater
Vault 1	Vault 1	

Name : Vault 1
Width : 48 ft.
Length : 61 ft.
Depth: 10.6 ft.
Discharge Structure
Riser Height: 9.6 ft.
Riser Diameter: 12 in.
Orifice 1 Diameter: 1.6875 in. **Elevation:** 0 ft.
Orifice 2 Diameter: 1.8125 in. **Elevation:** 6.1 ft.
Orifice 3 Diameter: 2.5 in. **Elevation:** 8.7 ft.

Element Flows To:

Outlet 1	Outlet 2

Vault Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.067	0.000	0.000	0.000
0.1178	0.067	0.007	0.026	0.000
0.2356	0.067	0.015	0.037	0.000
0.3533	0.067	0.023	0.045	0.000
0.4711	0.067	0.031	0.053	0.000
0.5889	0.067	0.039	0.059	0.000
0.7067	0.067	0.047	0.065	0.000
0.8244	0.067	0.055	0.070	0.000
0.9422	0.067	0.063	0.075	0.000
1.0600	0.067	0.071	0.079	0.000
1.1778	0.067	0.079	0.083	0.000
1.2956	0.067	0.087	0.088	0.000
1.4133	0.067	0.095	0.091	0.000
1.5311	0.067	0.102	0.095	0.000

1.6489	0.067	0.110	0.099	0.000
1.7667	0.067	0.118	0.102	0.000
1.8844	0.067	0.126	0.106	0.000
2.0022	0.067	0.134	0.109	0.000
2.1200	0.067	0.142	0.112	0.000
2.2378	0.067	0.150	0.115	0.000
2.3556	0.067	0.158	0.118	0.000
2.4733	0.067	0.166	0.121	0.000
2.5911	0.067	0.174	0.124	0.000
2.7089	0.067	0.182	0.127	0.000
2.8267	0.067	0.190	0.129	0.000
2.9444	0.067	0.197	0.132	0.000
3.0622	0.067	0.205	0.135	0.000
3.1800	0.067	0.213	0.137	0.000
3.2978	0.067	0.221	0.140	0.000
3.4156	0.067	0.229	0.142	0.000
3.5333	0.067	0.237	0.145	0.000
3.6511	0.067	0.245	0.147	0.000
3.7689	0.067	0.253	0.150	0.000
3.8867	0.067	0.261	0.152	0.000
4.0044	0.067	0.269	0.154	0.000
4.1222	0.067	0.277	0.156	0.000
4.2400	0.067	0.285	0.159	0.000
4.3578	0.067	0.292	0.161	0.000
4.4756	0.067	0.300	0.163	0.000
4.5933	0.067	0.308	0.165	0.000
4.7111	0.067	0.316	0.167	0.000
4.8289	0.067	0.324	0.169	0.000
4.9467	0.067	0.332	0.171	0.000
5.0644	0.067	0.340	0.173	0.000
5.1822	0.067	0.348	0.175	0.000
5.3000	0.067	0.356	0.177	0.000
5.4178	0.067	0.364	0.179	0.000
5.5356	0.067	0.372	0.181	0.000
5.6533	0.067	0.380	0.183	0.000
5.7711	0.067	0.387	0.185	0.000
5.8889	0.067	0.395	0.187	0.000
6.0067	0.067	0.403	0.189	0.000
6.1244	0.067	0.411	0.205	0.000
6.2422	0.067	0.419	0.226	0.000
6.3600	0.067	0.427	0.240	0.000
6.4778	0.067	0.435	0.251	0.000
6.5956	0.067	0.443	0.261	0.000
6.7133	0.067	0.451	0.270	0.000
6.8311	0.067	0.459	0.278	0.000
6.9489	0.067	0.467	0.285	0.000
7.0667	0.067	0.475	0.293	0.000
7.1844	0.067	0.482	0.300	0.000
7.3022	0.067	0.490	0.306	0.000
7.4200	0.067	0.498	0.312	0.000
7.5378	0.067	0.506	0.319	0.000
7.6556	0.067	0.514	0.325	0.000
7.7733	0.067	0.522	0.330	0.000
7.8911	0.067	0.530	0.336	0.000
8.0089	0.067	0.538	0.341	0.000
8.1267	0.067	0.546	0.347	0.000
8.2444	0.067	0.554	0.352	0.000

8.3622	0.067	0.562	0.357	0.000
8.4800	0.067	0.570	0.362	0.000
8.5978	0.067	0.577	0.367	0.000
8.7156	0.067	0.585	0.393	0.000
8.8333	0.067	0.593	0.439	0.000
8.9511	0.067	0.601	0.466	0.000
9.0689	0.067	0.609	0.489	0.000
9.1867	0.067	0.617	0.509	0.000
9.3044	0.067	0.625	0.527	0.000
9.4222	0.067	0.633	0.543	0.000
9.5400	0.067	0.641	0.559	0.000
9.6578	0.067	0.649	0.721	0.000
9.7756	0.067	0.657	1.345	0.000
9.8933	0.067	0.665	2.074	0.000
10.011	0.067	0.672	2.611	0.000
10.129	0.067	0.680	2.918	0.000
10.247	0.067	0.688	3.172	0.000
10.364	0.067	0.696	3.405	0.000
10.482	0.067	0.704	3.621	0.000
10.600	0.067	0.712	3.824	0.000
10.718	0.066	0.674	4.015	0.000

Name : Basin 2
Bypass: Yes

GroundWater: No

Pervious Land Use	**acre**
C, Lawn, Flat	**.05**
Pervious Total	**0.05**

Impervious Land Use	**acre**
ROADS FLAT	**0.13**
Impervious Total	**0.13**
Basin Total	**0.18**

Element Flows To:

Surface	**Interflow**	**Groundwater**

ANALYSIS RESULTS

Stream Protection Duration

Predeveloped Landuse Totals for POC #1
Total Pervious Area:2.91
Total Impervious Area:0.77

Mitigated Landuse Totals for POC #1
Total Pervious Area:1.28
Total Impervious Area:2.4

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	0.359141
5 year	0.477617
10 year	0.561365
25 year	0.673432
50 year	0.761581
100 year	0.853825

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	Flow(cfs)
2 year	0.188
5 year	0.263824
10 year	0.323234
25 year	0.409696
50 year	0.483015
100 year	0.564532

Stream Protection Duration
Annual Peaks for Predeveloped and Mitigated. POC #1

Year	Predeveloped	Mitigated
1949	0.511	0.169
1950	0.476	0.187
1951	0.365	0.340
1952	0.247	0.150
1953	0.234	0.154
1954	0.300	0.151
1955	0.316	0.200
1956	0.306	0.186
1957	0.403	0.193
1958	0.279	0.163
1959	0.249	0.159
1960	0.393	0.314
1961	0.332	0.165
1962	0.235	0.129
1963	0.317	0.162
1964	0.286	0.160
1965	0.393	0.170
1966	0.262	0.143
1967	0.486	0.209
1968	0.444	0.162
1969	0.333	0.171
1970	0.341	0.163
1971	0.380	0.194
1972	0.455	0.214
1973	0.237	0.145

1974	0.362	0.147
1975	0.425	0.212
1976	0.315	0.165
1977	0.253	0.129
1978	0.322	0.169
1979	0.426	0.130
1980	0.552	0.206
1981	0.347	0.174
1982	0.572	0.372
1983	0.367	0.179
1984	0.267	0.147
1985	0.333	0.166
1986	0.385	0.290
1987	0.424	0.308
1988	0.249	0.144
1989	0.311	0.122
1990	0.913	0.336
1991	0.640	0.334
1992	0.274	0.155
1993	0.204	0.154
1994	0.207	0.112
1995	0.308	0.182
1996	0.495	0.329
1997	0.408	0.359
1998	0.301	0.171
1999	0.665	0.205
2000	0.357	0.164
2001	0.328	0.155
2002	0.456	0.301
2003	0.417	0.144
2004	0.624	0.649
2005	0.356	0.200
2006	0.331	0.183
2007	0.777	0.437
2008	0.642	0.571
2009	0.442	0.226

Stream Protection Duration
Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	0.9129	0.6494
2	0.7773	0.5710
3	0.6655	0.4371
4	0.6416	0.3716
5	0.6404	0.3594
6	0.6236	0.3400
7	0.5721	0.3356
8	0.5519	0.3339
9	0.5108	0.3288
10	0.4953	0.3138
11	0.4860	0.3081
12	0.4763	0.3012
13	0.4558	0.2899
14	0.4554	0.2262
15	0.4437	0.2140
16	0.4423	0.2118

17	0.4257	0.2092
18	0.4251	0.2056
19	0.4239	0.2052
20	0.4165	0.1999
21	0.4081	0.1997
22	0.4027	0.1935
23	0.3932	0.1930
24	0.3927	0.1869
25	0.3847	0.1857
26	0.3805	0.1830
27	0.3675	0.1822
28	0.3645	0.1795
29	0.3620	0.1736
30	0.3574	0.1714
31	0.3559	0.1708
32	0.3472	0.1703
33	0.3409	0.1692
34	0.3334	0.1692
35	0.3329	0.1662
36	0.3323	0.1651
37	0.3310	0.1649
38	0.3283	0.1635
39	0.3218	0.1630
40	0.3166	0.1626
41	0.3156	0.1619
42	0.3147	0.1615
43	0.3107	0.1600
44	0.3079	0.1590
45	0.3060	0.1555
46	0.3009	0.1553
47	0.2997	0.1545
48	0.2858	0.1542
49	0.2786	0.1513
50	0.2742	0.1497
51	0.2665	0.1469
52	0.2624	0.1465
53	0.2527	0.1452
54	0.2495	0.1444
55	0.2485	0.1436
56	0.2469	0.1427
57	0.2372	0.1301
58	0.2348	0.1294
59	0.2343	0.1292
60	0.2073	0.1224
61	0.2039	0.1118

Stream Protection Duration
POC #1
The Facility PASSED

The Facility PASSED.

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.1796	2607	2321	89	Pass
0.1854	2336	1881	80	Pass
0.1913	2095	1514	72	Pass

0.1972	1888	1224	64	Pass
0.2031	1723	1055	61	Pass
0.2090	1584	976	61	Pass
0.2148	1418	908	64	Pass
0.2207	1297	865	66	Pass
0.2266	1168	823	70	Pass
0.2325	1059	781	73	Pass
0.2384	969	752	77	Pass
0.2442	885	715	80	Pass
0.2501	808	681	84	Pass
0.2560	746	659	88	Pass
0.2619	691	624	90	Pass
0.2678	639	588	92	Pass
0.2736	583	544	93	Pass
0.2795	525	499	95	Pass
0.2854	469	446	95	Pass
0.2913	426	408	95	Pass
0.2971	385	366	95	Pass
0.3030	356	326	91	Pass
0.3089	326	285	87	Pass
0.3148	301	244	81	Pass
0.3207	276	216	78	Pass
0.3265	246	183	74	Pass
0.3324	231	162	70	Pass
0.3383	208	148	71	Pass
0.3442	198	132	66	Pass
0.3501	188	116	61	Pass
0.3559	177	108	61	Pass
0.3618	170	98	57	Pass
0.3677	156	91	58	Pass
0.3736	147	85	57	Pass
0.3795	139	77	55	Pass
0.3853	129	75	58	Pass
0.3912	118	72	61	Pass
0.3971	110	68	61	Pass
0.4030	105	63	60	Pass
0.4088	101	57	56	Pass
0.4147	95	54	56	Pass
0.4206	85	51	60	Pass
0.4265	77	51	66	Pass
0.4324	70	48	68	Pass
0.4382	69	43	62	Pass
0.4441	63	43	68	Pass
0.4500	62	42	67	Pass
0.4559	60	42	70	Pass
0.4618	58	40	68	Pass
0.4676	53	38	71	Pass
0.4735	48	37	77	Pass
0.4794	44	35	79	Pass
0.4853	41	35	85	Pass
0.4912	37	32	86	Pass
0.4970	33	31	93	Pass
0.5029	32	28	87	Pass
0.5088	30	26	86	Pass
0.5147	28	25	89	Pass
0.5205	27	24	88	Pass
0.5264	27	23	85	Pass

0.5323	25	22	88	Pass
0.5382	25	20	80	Pass
0.5441	25	20	80	Pass
0.5499	23	17	73	Pass
0.5558	20	16	80	Pass
0.5617	19	14	73	Pass
0.5676	18	13	72	Pass
0.5735	17	8	47	Pass
0.5793	16	6	37	Pass
0.5852	16	5	31	Pass
0.5911	15	5	33	Pass
0.5970	15	5	33	Pass
0.6029	14	5	35	Pass
0.6087	13	4	30	Pass
0.6146	11	4	36	Pass
0.6205	10	3	30	Pass
0.6264	8	2	25	Pass
0.6322	7	2	28	Pass
0.6381	7	2	28	Pass
0.6440	5	2	40	Pass
0.6499	5	2	40	Pass
0.6558	5	0	0	Pass
0.6616	5	0	0	Pass
0.6675	4	0	0	Pass
0.6734	4	0	0	Pass
0.6793	4	0	0	Pass
0.6852	3	0	0	Pass
0.6910	3	0	0	Pass
0.6969	2	0	0	Pass
0.7028	2	0	0	Pass
0.7087	2	0	0	Pass
0.7145	2	0	0	Pass
0.7204	2	0	0	Pass
0.7263	2	0	0	Pass
0.7322	2	0	0	Pass
0.7381	2	0	0	Pass
0.7439	2	0	0	Pass
0.7498	2	0	0	Pass
0.7557	2	0	0	Pass
0.7616	2	0	0	Pass

Water Quality BMP Flow and Volume for POC #1
On-line facility volume: 0.3167 **acre-feet**
On-line facility target flow: 0.3624 **cfs.**
Adjusted for 15 min: 0.3624 **cfs.**
Off-line facility target flow: 0.2034 **cfs.**
Adjusted for 15 min: 0.2034 **cfs.**

Perlnd and Implnd Changes

No changes have been made.

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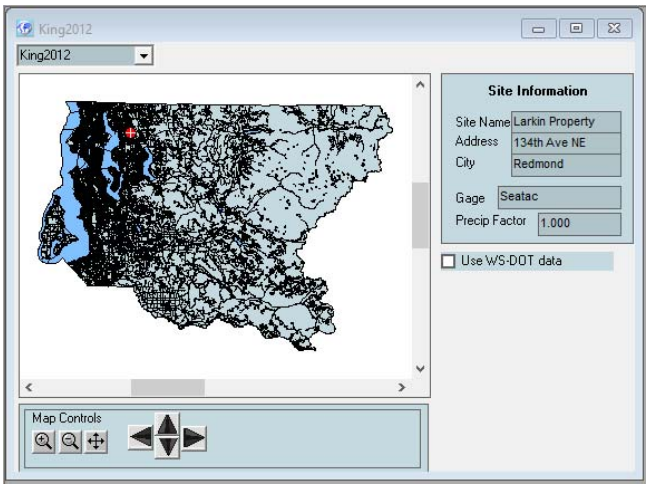
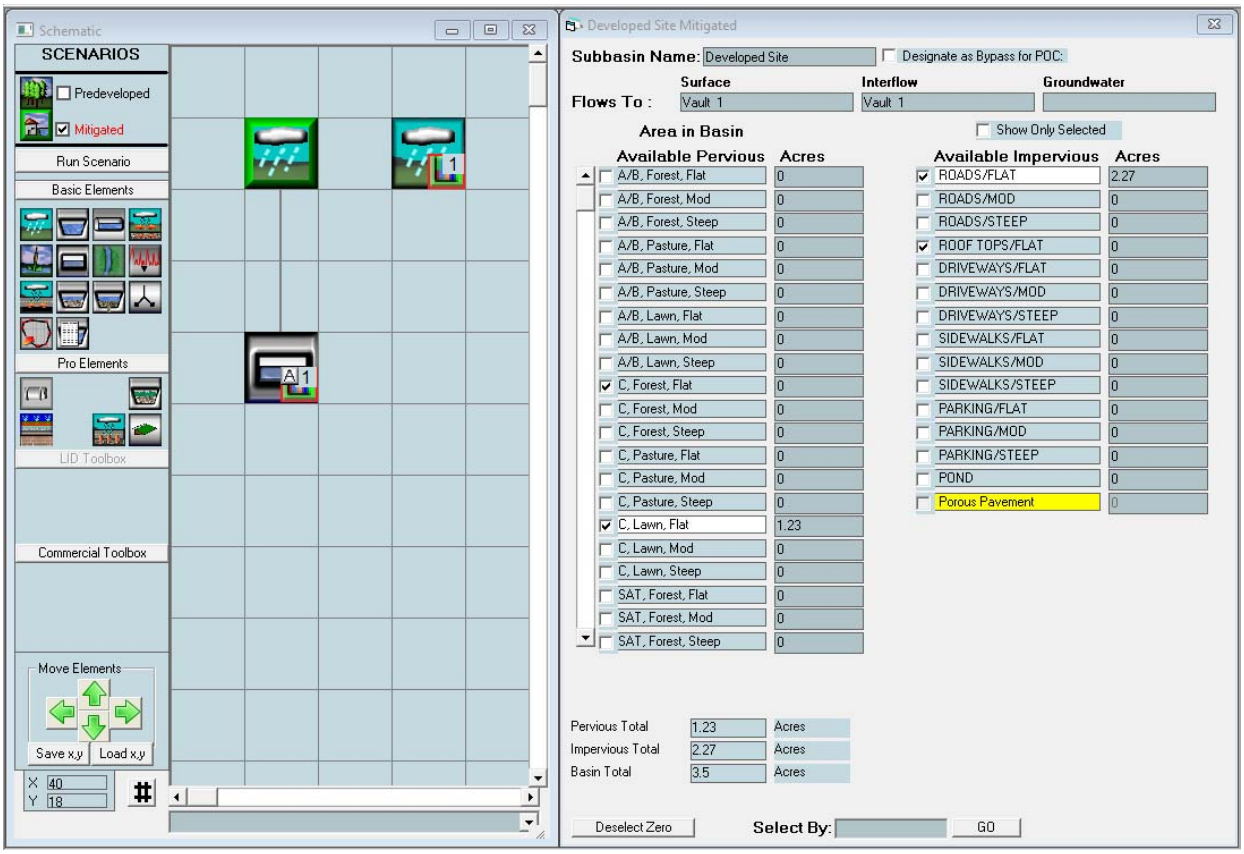
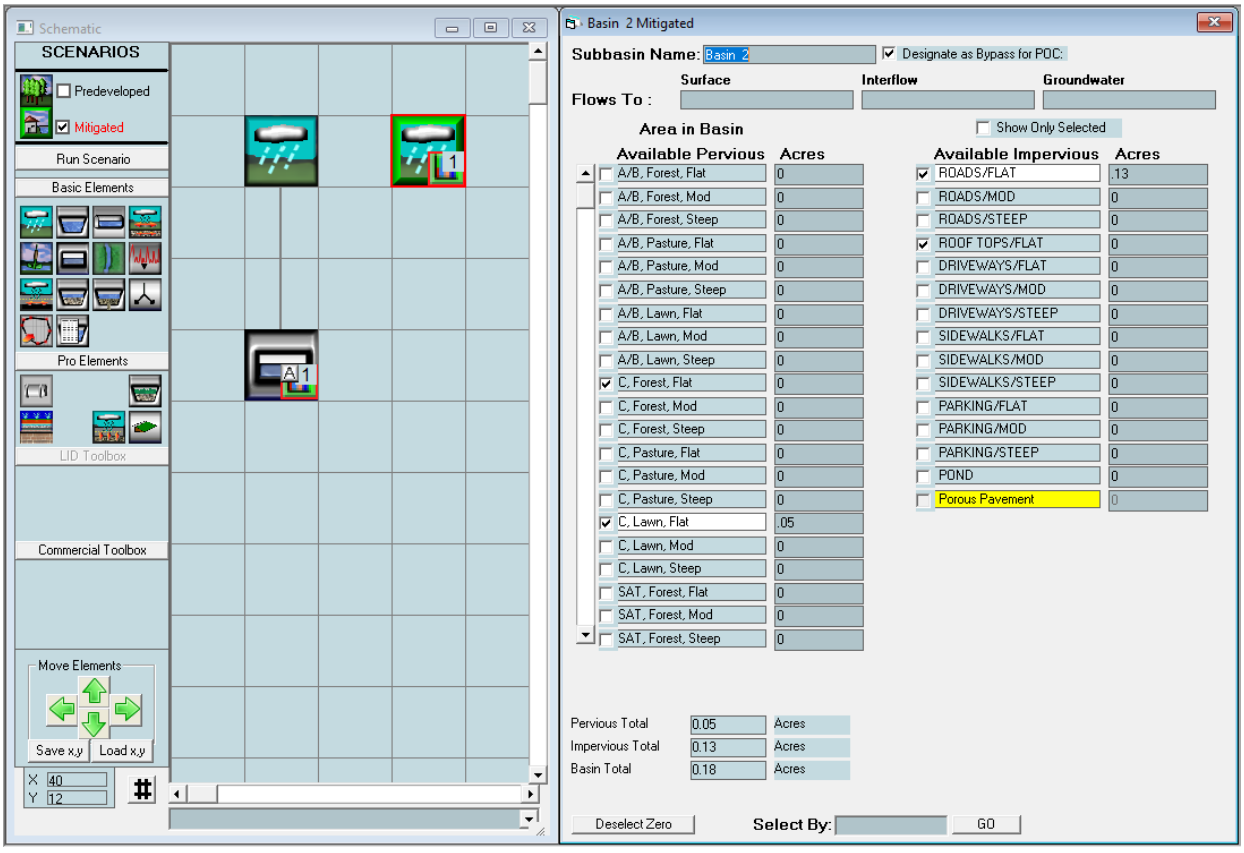


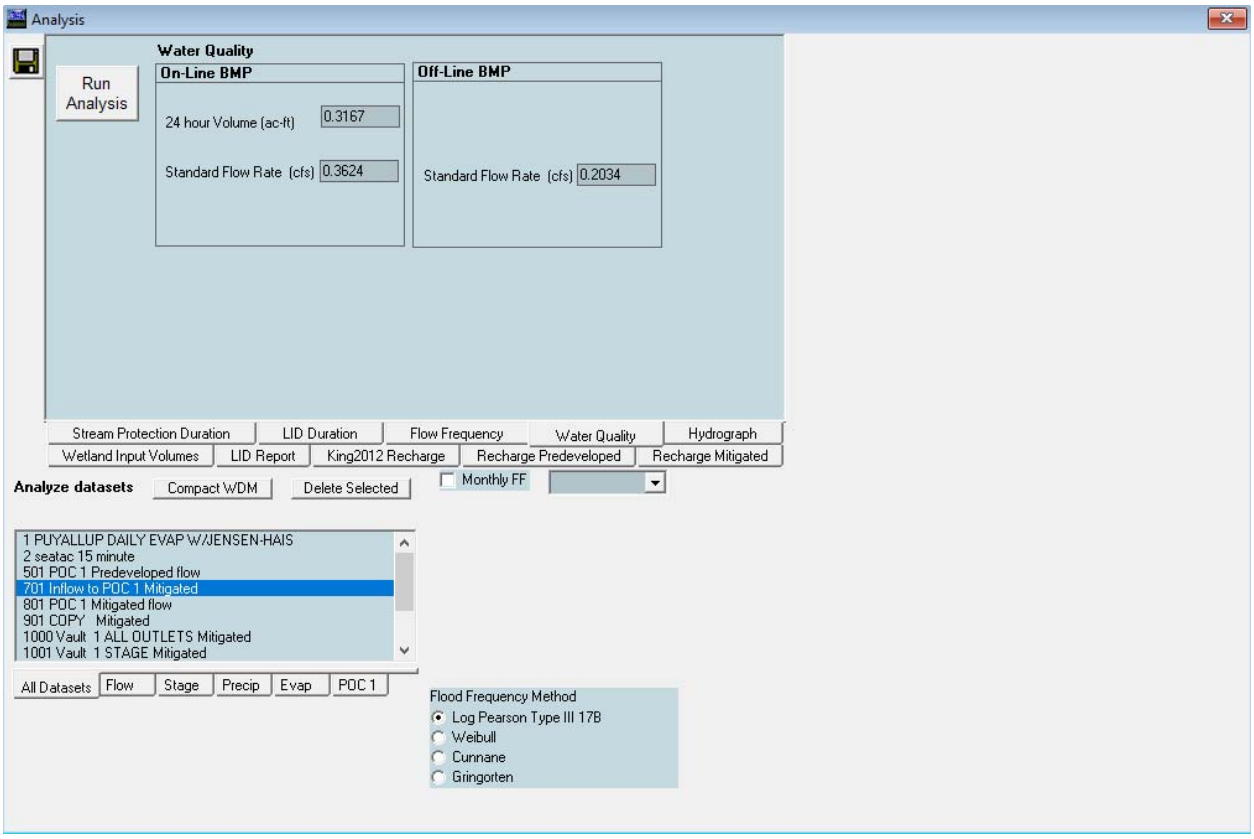

Schematic
SCENARIOS
Predeveloped
Mitigated
Run Scenario
Basic Elements
Pro Elements
LID Toolbox
Commercial Toolbox
Move Elements
Save x,y
Load x,y
X 40
Y 18
Developed Site Mitigated
Subbasin Name: Developed Site
Designate as Bypass for POC:
Flows To :
Surface
Interflow
Groundwater
Vault 1
Vault 1
Area in Basin
Show Only Selected
Available Pervious
Acres
A/B, Forest, Flat 0
A/B, Forest, Mod 0
A/B, Forest, Steep 0
A/B, Pasture, Flat 0
A/B, Pasture, Mod 0
A/B, Pasture, Steep 0
A/B, Lawn, Flat 0
A/B, Lawn, Mod 0
A/B, Lawn, Steep 0
C, Forest, Flat 0
C, Forest, Mod 0
C, Forest, Steep 0
C, Pasture, Flat 0
C, Pasture, Mod 0
C, Pasture, Steep 0
C, Lawn, Flat 1.23
C, Lawn, Mod 0
C, Lawn, Steep 0
SAT, Forest, Flat 0
SAT, Forest, Mod 0
SAT, Forest, Steep 0
Available Impervious
Acres
ROADS/FLAT 2.27
ROADS/MOD 0
ROADS/STEEP 0
ROOF TOPS/FLAT 0
DRIVEWAYS/FLAT 0
DRIVEWAYS/MOD 0
DRIVEWAYS/STEEP 0
SIDEWALKS/FLAT 0
SIDEWALKS/MOD 0
SIDEWALKS/STEEP 0
PARKING/FLAT 0
PARKING/MOD 0
PARKING/STEEP 0
POND 0
Porous Pavement 0
Pervious Total 1.23 Acres
Impervious Total 2.27 Acres
Basin Total 3.5 Acres
Deselect Zero
Select By:
GO


Schematic
SCENARIOS
Predeveloped
Mitigated
Run Scenario
Basic Elements
Pro Elements
LID Toolbox
Commercial Toolbox
Move Elements
Save x,y
Load x,y
X 40
Y 12
Basin 2 Mitigated
Subbasin Name: Basin 2
Designate as Bypass for POC:
Flows To :
Surface
Interflow
Groundwater
Area in Basin
Show Only Selected
Available Pervious
Acres
A/B, Forest, Flat 0
A/B, Forest, Mod 0
A/B, Forest, Steep 0
A/B, Pasture, Flat 0
A/B, Pasture, Mod 0
A/B, Pasture, Steep 0
A/B, Lawn, Flat 0
A/B, Lawn, Mod 0
A/B, Lawn, Steep 0
C, Forest, Flat 0
C, Forest, Mod 0
C, Forest, Steep 0
C, Pasture, Flat 0
C, Pasture, Mod 0
C, Pasture, Steep 0
C, Lawn, Flat .05
C, Lawn, Mod 0
C, Lawn, Steep 0
SAT, Forest, Flat 0
SAT, Forest, Mod 0
SAT, Forest, Steep 0
Available Impervious
Acres
ROADS/FLAT .13
ROADS/MOD 0
ROADS/STEEP 0
ROOF TOPS/FLAT 0
DRIVEWAYS/FLAT 0
DRIVEWAYS/MOD 0
DRIVEWAYS/STEEP 0
SIDEWALKS/FLAT 0
SIDEWALKS/MOD 0
SIDEWALKS/STEEP 0
PARKING/FLAT 0
PARKING/MOD 0
PARKING/STEEP 0
POND 0
Porous Pavement 0
Pervious Total 0.05 Acres
Impervious Total 0.13 Acres
Basin Total 0.18 Acres
Deselect Zero
Select By:
GO

4.2 WATER QUALITY ANALYSIS AND DESIGN

The project will provide basic water quality treatment. The project will provide treatment for parcel, future right-of-way areas, and upstream areas tributary to the vault via a combined detention/wetvault. Per Section 2.5.6 of the Technical Notebook, when using an approved continuous runoff model, the water quality design storm volume shall be equal to the simulated daily volume that represents the upper limit of the range of daily volumes that accounts for 91% of the entire runoff volume over a multi-decade period of record. The dead storage volume provided will be equal to or greater than the required volume, in addition to 1' of sediment storage.

Per the WWHM 2012 printout below, the required volume for dead storage for the developed site is equal to 0.3167 ac-ft (13,796 CF). The dead storage will be provided below the outlet elevation within the vault. Dead storage will be 6.4' feet deep. The total dead storage volume is provided with a portion of vault cells 1 and 2 each having dimensions of 40' x 20.84' x 6.4' and a portion of cell 3 having dimensions of 40' x 13' x 6.4' totaling 13,998 CF, which exceeds the minimum required.



The project will provide treatment for the portions of Road A (0.15 acres) that cannot physically be routed to the vault via lined bioretention swale. Per Section 7.4 of the DOE Manual (BMP T7.30), soil depth must be a minimum of 18 inches to provide water quality treatment. At least 1.5' of bioretention soil media will be provided in order to satisfy water quality requirements.

4.3 LID FEASIBILITY ANALYSIS

The City of Redmond adopted Ecology's 2012 Stormwater Management Manual for Western Washington as amended in 2014. The project requires LID to be evaluated per Table I-2.5.1: Onsite Stormwater Management Requirements for Projects Triggering Minimum Requirements #1-#9 found in the 2014 SWMMWW. Redevelopment on any parcel inside the UGA must meet the Low Impact Development Performance Standard and BMP T5.13 or List #2.

See below for a feasibility evaluation of each BMP from List #2.

Lawn and landscaped areas:

Post-Construction Soil Quality and Depth in accordance with BMP T5.13 in Chapter 5 of Volume V of the SWMMWW.

BMP T5.13 will be implemented in non-impervious areas.

Roofs:

Full Dispersion in accordance with BMP T5.30 in Chapter 5 of Volume V of the *SWMMWW*, or Downspout Full Infiltration Systems in accordance with BMP T5.10A in Section 3.1.1 of Volume III of the *SWMMWW*.

Full dispersion per BMP T5.30 is not feasible as the site does not allow 65% of the area to be preserved in a forested condition. Downspout Full Infiltration Systems will not be implemented onsite. Per the geotechnical engineer, onsite soils are not suitable for infiltration.

Bioretention (See Chapter 7 of Volume V of the *SWMMWW*) facilities that have a minimum horizontally projected surface area below the overflow which is at least 5% of the of the total surface area draining to it.

Poor soils in combination with small lot size dictated by zoning precludes the use of bioretention.

Downspout Dispersion Systems in accordance with BMP T5.10B in Section 3.1.2 of Volume III of the *SWMMWW.*

BMP T5.10B will not be implemented as the available flow path does not meet BMP design criteria.

Perforated Stub-out Connections in accordance with BMP T5.10C in Section 3.1.3 of Volume III of the *SWMMWW*.

BMP T5.10C will be implemented where feasible, as evaluated during final engineering.

Other hard surfaces:

Full Dispersion in accordance with BMP T5.30 in Chapter 5 of Volume V of the *SWMMWW*.

Full dispersion per BMP T5.30 is not feasible as the site does not allow 65% of the area to be preserved in a forested condition.

Permeable pavement in accordance with BMP T5.15 in Chapter 5 of Volume V of the *SWMMWW*.

Permeable pavement will not be implemented onsite. Per the geotechnical engineer, onsite soils are not suitable for infiltration.

Bioretention (See Chapter 7, Volume V of the *SWMMWW*) facilities that have a minimum horizontally projected surface area below the overflow which is at least 5% of the total surface area draining to it.

Though onsite soils are poor and not suitable for infiltration, lined bioretention swales will be utilized for areas that will not be treated using dead storage (Road A). The swales will be part of the storm water conveyance system and also provide opportunities for water quality treatment and some level of flow attenuation.

Sheet Flow Dispersion in accordance with BMP T5.12, or Concentrated Flow Dispersion in accordance with BMP T5.11 in Chapter 5 of Volume V of the *SWMMWW*.

BMP T5.11 and BMP T5.12 will not be implemented as the available flow path does not meet BMP design criteria.

4.4 CONVEYANCE SYSTEM ANALYSIS AND DESIGN

The conveyance system will be designed in accordance with the Technical Notebook and the DOE Manual. Conveyance system analysis and design will be provided at final engineering.

Section 5 Stormwater Pollution Prevention Plan

Design of the SWPPP will be completed in accordance with the Technical Notebook and the DOE Manual. The SWPPP will be provided with the final engineering submittal.

Section 6 Special Reports and Studies

Additional reports and studies within this section include the following:

- Geotechnical Engineering Study, dated November 1, 2017, prepared by Earth Solutions NW, LLC
- Wetland Reconnaissance, dated October 26, 2017, prepared by Aquatica Environmental Consulting, LLC

These reports are included on the following pages.

ATTACHMENT 21

Earth Solutions NW LLC

Geotechnical Engineering
Geology
Environmental Scientists
Construction Monitoring

GEOTECHNICAL ENGINEERING STUDY
PROPOSED RESIDENTIAL DEVELOPMENT
10201 - 134th AVENUE NORTHEAST
KING COUNTY (REDMOND), WASHINGTON

ES-5564

1805 - 136th Place N.E., Suite 201 Bellevue, WA 98005
(425) 449-4704 Fax (425) 449-4711
www.earthsolutionsnw.com

PREPARED FOR

ROSE HILL 12, LLC

November 1, 2017

Chase G. Halsen
Staff Geologist

Henry T. Wright, P.E.
Senior Project Engineer

RAYMOND A COGLAS
STATE OF WASHINGTON
36018
REGISTERED
PROFESSIONAL ENGINEER

11/2/17

Raymond A. Coglas, P.E.
Principal Engineer

GEOTECHNICAL ENGINEERING STUDY
PROPOSED RESIDENTIAL DEVELOPMENT
10201 – 134TH AVENUE NORTHEAST
KING COUNTY (REDMOND), WASHINGTON

ES-5564

Earth Solutions NW, LLC
1805 – 136th Place Northeast, Suite 201
Bellevue, Washington 98005
Phone: 425-449-4704 | Fax: 425-449-4711
www.earthsolutionsnw.com

Important Information About Your Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

The following information is provided to help you manage your risks.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you —* should apply the report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual

subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, a number of mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

Rely, on Your ASFE-Member Geotechncial Engineer for Additional Assistance

Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you ASFE-member geotechnical engineer for more information.

ASFE
The Best People on Earth

8811 Colesville Road/Suite G106, Silver Spring, MD 20910
Telephone: 301/565-2733 Facsimile: 301/589-2017
e-mail: info@asfe.org www.asfe.org

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ATTACHMENT 21

Earth Solutions NW LLC

- Geotechnical Engineering
- Construction Monitoring
- Environmental Sciences

November 1, 2017
ES-5564

Rose Hill 12, LLC
2630 – 116th Avenue Northeast, Suite 200
Bellevue, Washington 98004

Attention: Mr. Mike Walsh

Dear Mr. Walsh:

Earth Solutions NW, LLC (ESNW) is pleased to present this report titled "Geotechnical Engineering Study, Proposed Residential Development, 10201 – 134th Avenue Northeast, King County (Redmond), Washington". Based on the results of our study, the proposed residential development is feasible from a geotechnical standpoint. The executed subsurface exploration indicates the subject site is underlain primarily by dense glacial till deposits. At the time of our September 2017 fieldwork, groundwater seepage was not observed at the test pit locations. However, it is our opinion that the contractor be prepared to respond to and manage areas of groundwater seepage encountered during earthwork activities and construction.

Based on the results of our study, the proposed residential structures can be supported on a conventional foundation system bearing on competent native soil, compacted native soil, or new structural fill. In general, we anticipate competent native soils suitable for support of new foundations to be encountered beginning at depths of about two to four feet below the existing ground surface elevation. Where loose or unsuitable soil conditions are exposed at foundation subgrade elevations, compaction of the soils to the specifications of structural fill, or overexcavation and replacement with structural fill will be necessary.

Construction of a stormwater detention vault within the northwestern site area is feasible from a geotechnical standpoint. Based on our field observations, grade cuts for the vault are likely to expose very dense, undisturbed Vashon till deposits at depth. In our opinion, the till should not be considered feasible for infiltration facility design, especially when encountered in a dense, compact state. In general, the Vashon till should be considered impervious for design purposes. As necessary, ESNW can provide further evaluation of, and recommendations for, stormwater flow control BMPs upon request.

Pertinent geotechnical recommendations are provided in this study. We appreciate the opportunity to be of service to you on this project. If you have questions regarding the content of this geotechnical engineering study, please call.

Sincerely,

EARTH SOLUTIONS NW, LLC

Chase G. Halsen
Staff Geologist

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ES-5564

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Continued

ES-5564

GEOTECHNICAL ENGINEERING STUDY
PROPOSED RESIDENTIAL DEVELOPMENT
10201 – 134th AVENUE NORTHEAST
KING COUNTY (REDMOND), WASHINGTON

ES-5564

INTRODUCTION

General

This geotechnical engineering study was prepared for the proposed residential development to be constructed west of the intersection between Northeast 102nd Street and 134th Avenue Northeast in the Redmond area of unincorporated King County, Washington. The purpose of this study was to provide geotechnical recommendations for currently proposed development plans. Our scope of services for completing this study included the following:

- Completing subsurface exploration for the purpose of characterizing site soil and groundwater conditions;
- Laboratory testing of soil samples obtained during subsurface exploration;
- Engineering analyses and recommendations for the proposed development, and;
- Preparation of this report.

The following documents and resources were reviewed as part of our report preparation;

- Pre-Application Exhibit, prepared by The Blueline Group, LLC, dated August 9, 2017;
- Geologic Map of the Kirkland Quadrangle, Washington, prepared by James P. Minard, dated 1983;
- Web Soil Survey online resource, maintained by the Natural Resources Conservation Service under the United States Department of Agriculture, and;
- King County Liquefaction Susceptibility, endorsed by the Washington State Department of Natural Resources, May 2010.

Project Description

We understand the subject site will be developed with 14 building sites, a stormwater detention vault (vault) within the northwestern site area, various tract areas, and associated residential improvements. We anticipate grading activities will include cuts and/or fills of approximately five feet or less to establish design grades. Cuts required for construction of the vault will likely be on the order of 10 to 12 feet. Retaining walls and/or rockeries may be incorporated into final designs to accommodate grade transitions, where necessary.

At the time of report submission, specific building load plans were not available for review; however, based on our experience with similar developments, the proposed residential structures will likely be two to three stories in height and constructed using relatively lightly loaded wood framing supported on conventional foundations. Perimeter footing loads will likely be about 1 to 2 kips per lineal foot (klf). Slab-on-grade loading is anticipated to be approximately 150 pounds per square foot (psf).

If the above design assumptions are incorrect or change, ESNW should be contacted to review the recommendations in this report. ESNW should review the final design to verify the geotechnical recommendations provided in this report have been incorporated into the plans.

SITE CONDITIONS

Surface

The subject site is located west of the intersection between Northeast 102nd Street and 134th Avenue Northeast in the Redmond area of unincorporated King County, Washington. The approximate location of the subject site is depicted on Plate 1 (Vicinity Map). The irregular shaped property is comprised of one tax parcel (King County Parcel No. 124670-0141) totaling approximately 2.48 acres.

The site is bordered in each direction by existing residential development. Ingress and egress to the site is provided from the western edge of 134th Avenue Northeast. Local topography in the area maintains a general easterly/southeasterly declination which carries across the site; approximately 15 feet of elevation change occurs within the confines of the property. The site is developed with a single-family residence, detached garage, various outbuildings, and associated improvements of which will be demolished and removed during proposed redevelopment activities. Although not developed, remaining portions of the site consist of maintained grass landscaping areas.

Subsurface

An ESNW representative observed, logged, and sampled nine test pits, excavated at accessible locations within the property boundaries, on September 21, 2017 using a mini-trackhoe and operator retained by our firm. The test pits were completed for purposes of assessment and classification of site soil and shallow groundwater conditions. The approximate locations of the test pits are depicted on Plate 2 (Subsurface Exploration Plan). Please refer to the test pit logs provided in Appendix A for a more detailed description of subsurface conditions. Representative soil samples collected at the test pit locations were analyzed in general accordance with Unified Soil Classification System (USCS) and United States Department of Agriculture (USDA) methods and procedures.

Topsoil and Fill

Near-surface soil conditions generally consisted of topsoil throughout the upper 2 to 16 inches of existing grades, with an average depth of four to eight inches. The topsoil was identified by the dark brown color and abundant fine organic material. Loose to medium dense silty sand fill was encountered at most test pit locations, extending up to an approximate depth of two feet below the existing ground surface (bgs). Deeper fill was encountered at TP-6, extending to a depth of four feet. Abundant concrete debris and organic inclusions was observed within the fill section in this area. Based on our surficial observations and test pits in direct vicinity to the deeper fill areas, it appears this section is isolated and non-extensive. Fill, however, should be anticipated within near existing site features and areas of general improvements.

Native Soil

Underlying topsoil, native soils were encountered primarily as silty sand (USCS: SM), consistent with the typical makeup of Vashon till. The upper, loose to medium dense deposits may be characterized as "weathered", and the lower, dense to very dense deposits may be characterized as "unweathered". The unweathered Vashon till was observed to be weakly cemented at the majority of the test pit locations. Native soils were observed primarily in a moist condition, extending to the maximum exploration depth of approximately nine feet bgs.

Geologic Setting

The referenced geologic map resource identifies Vashon till (Qvt) across the site and surrounding areas. According to the geologic map resource, Vashon till is chiefly a non-sorted mixture of clay, silt, sand, pebbles, cobbles, and boulders. The till is compact and commonly referred to as "hardpan", due to the compaction caused by the great weight of substantially thick, overriding ice. The referenced WSS resource identifies Alderwood gravelly sandy loam (Map Unit Symbols: AgB) across the site and immediately adjacent areas. The Alderwood series was formed in ridges and hillslopes, derived from glacial drift and or glacial outwash soil over dense glacimarine deposits. Based on our field observations, native soils likely to be exposed during grading activities will be consistent with the geologic setting of glacial till as outlined in this section.

Groundwater

Groundwater intrusion was not encountered at the test pit locations during our fieldwork completed on September 2017. However, groundwater seepage should be expected in site excavations, especially those required for the installation of utilities and construction of the vault. Groundwater seepage rates and elevations fluctuate depending on many factors, including precipitation duration and intensity, the time of year, and soil conditions. In general, groundwater elevations and flow rates are higher during the winter, spring and early summer months.

DISCUSSION AND RECOMMENDATIONS

General

Based on the results of our study, the proposed residential development is feasible from a geotechnical standpoint. The primary geotechnical considerations associated with the proposed development include foundation subgrade preparation, foundation and retaining wall design parameters, drainage considerations, and infiltration, and the suitability of the on-site soils for use as structural fill.

Based on the results of our study, the proposed residential structures can be supported on a conventional foundation system bearing on competent native soil, compacted native soil, or new structural fill. In general, we anticipate competent native soils suitable for support of new foundations to be encountered beginning at depths of about two to four feet bgs. Where loose or unsuitable soil conditions are exposed at foundation subgrade elevations, compaction of the soils to the specifications of structural fill, or overexcavation and replacement with structural fill will be necessary.

Construction of a vault within the northwestern site area is feasible from a geotechnical standpoint. Based on our field observations, grade cuts for the vault are likely to expose very dense, undisturbed Vashon till at depth. The till should not be considered feasible for infiltration facility design, especially when encountered in a dense, compact state. In general, the Vashon till should be considered impervious for design purposes. As necessary, ESNW can provide further evaluation of, and recommendations for, stormwater flow control BMPs upon request.

This study has been prepared for the exclusive use of Rose Hill 12, LLC and their representatives. No warranty, expressed or implied, is made. This study has been prepared in a manner consistent with the level of care and skill ordinarily exercised by other members of the profession currently practicing under similar conditions in this area.

Site Preparation and Earthwork

Initial site preparation activities will consist of installing temporary erosion control measures, establishing grading limits, and performing clearing and site stripping. Subsequent earthwork activities will involve mass grading operations and related infrastructure improvements.

Site Stripping Recommendations

Topsoil stripping will likely extend to an average depth of four to eight inches. Topsoil and organic-rich soil are not suitable for foundation support, nor is it suitable for use as structural fill. Topsoil or organic-rich soil can be used in non-structural areas if desired. An ESNW representative should observe stripping operations to confirm the necessary stripping depth. Over stripping should be avoided as it may result in unnecessary removal of site soils.

Temporary Erosion Control

Prior to the installation of either initial or final pavement sections, temporary construction entrances and drive lanes, consisting of at least six inches of quarry spalls, should be considered to both minimize off-site soil tracking and provide a stable access entrance surface. Geotextile fabric may also be placed beneath the quarry spalls for greater stability of the temporary construction entrance. Erosion control measures should consist of silt fencing placed around the site perimeter. Soil stockpiles should be covered or otherwise protected to reduce soil erosion. Temporary approaches for controlling surface water runoff should be established prior to beginning earthwork activities. Additional Best Management Practices (BMPs), as specified by the project civil engineer and indicated on the plans, should be incorporated into construction activities.

In-situ and Imported Soils

From a geotechnical standpoint, on-site soils may be suitable for use as structural fill. On-site soils are moisture sensitive, and successful use of on-site soils as structural fill will largely be dictated by the moisture content at the time of placement and compaction. Existing fill soils may be considered suitable for use as structural fill provided that they are free of debris and deleterious material and are able to achieve an appropriate moisture content. ESNW should evaluate the suitability of existing fill material prior to use as structural fill. Remedial measures, such as soil aeration and/or cement treatment (where approved by the local jurisdiction or utility district), may be necessary as part of site grading and earthwork activities. If the on-site soils cannot be successfully compacted, the use of an imported soil may be necessary. In our opinion, a contingency should be provided in the project budget for export of soil that cannot be successfully compacted as structural fill if grading activities take place during periods of extended rainfall activity. Soils with fines contents greater than 5 percent typically degrade rapidly when exposed to periods of rainfall.

Imported soil intended for use as structural fill should consist of a well-graded, granular soil with a moisture content that is at (or slightly above) the optimum level. During wet weather conditions, imported soil intended for use as structural fill should consist of a well-graded, granular soil with a fines content of 5 percent or less (where the fines content is defined as the percent passing the Number 200 sieve, based on the minus three-quarter-inch fraction).

Subgrade Preparation

Following site stripping and removal of existing structures and outbuildings, cuts and/or fills will be completed to establish proposed subgrade elevations across the site. ESNW should observe the subgrade(s) during initial site preparation activities to confirm soil conditions are as anticipated and to provide supplementary recommendations for subgrade preparation, as necessary. The process of removing existing structures may produce voids where old foundations and/or crawl space areas may have been present. Complete restoration of voids resulting from demolition activities must be executed as part of overall subgrade and building pad preparation activities. The following guidelines for preparing building subgrade areas should be incorporated into the final design:

- Where voids and related demolition disturbances extend below planned subgrade elevations, restoration of these areas should be completed. Structural fill should be used to restore voids or unstable areas resulting from the removal of existing structural elements.

- Recompact, or overexcavate and replace areas of existing fill exposed at building subgrade elevations. Overexcavations should extend into competent native soils and structural fill should be utilized to restore subgrade elevations as necessary.

- ESNW should confirm subgrade conditions, as well as the required level of recompaction and/or overexcavation and replacement, during site preparation activities. ESNW should also evaluate the overall suitability of prepared subgrade areas following site preparation activities.

Establishment of uniform, compact subgrades will be essential in minimizing post-construction settlement. Areas in which soft fine-grained soils are present should be overexcavated and restored to design grades using suitable structural fill, as recommended by ESNW at the time of construction.

Structural Fill

Structural fill is defined as compacted soil placed in foundation, slab-on-grade, and roadway areas. Fills placed to construct permanent slopes and throughout retaining wall and utility trench backfill areas are also considered structural fill. Soils placed in structural areas should be placed in loose lifts of 12 inches or less and compacted to a relative compaction of 90 percent, based on the laboratory maximum dry density as determined by the Modified Proctor Method (ASTM D-1557). For soil placed in utility trenches underlying structural areas, compaction requirements are dictated by the local city, county, or utility district, and in general are specified as 95 percent relative compaction. The upper 12 inches of pavement subgrade should be compacted to a relative compaction of at least 95 percent.

Excavations and Slopes

Excavation activities are likely to expose competent, dense to very dense native soils. Provided appropriate methods of sloping and shoring (as necessary) for the excavations are incorporated into the design and construction, overall stability of site excavations is anticipated to be good. Based on the soil conditions observed at the test pit locations, the following allowable temporary slope inclinations, as a function of horizontal to vertical (H:V) inclination, may be used. The applicable Federal Occupation Safety and Health Administration (OSHA) and Washington Industrial Safety and Health Act (WISHA) soil classifications are also provided:

- Loose to medium dense soil — 1.5H:1V (Type C)
- Areas containing groundwater seepage — 1.5H:1V (Type C)
- Areas containing fill, regardless of density — 1.5H:1V (Type C)
- Dense to very dense native soil — 0.75H:1V (Type A)

Steeper temporary slope inclinations within undisturbed, very dense native deposits may be feasible based on the soil and groundwater conditions exposed within the excavations. Steeper inclinations may be considered, and must be subsequently approved, by ESNW at the time of construction.

Permanent slopes should be planted with vegetation to enhance stability and to minimize erosion, and should maintain a gradient of 2H:1V or flatter. The presence of perched groundwater may cause localized sloughing of temporary slopes due to excess seepage forces. An ESNW representative should observe temporary and permanent slopes to confirm the slope inclinations are suitable for the exposed soil conditions and to provide additional excavation and slope recommendations, as necessary. If the recommended temporary slope inclinations cannot be achieved, temporary shoring may be necessary to support excavations.

Foundations

Based on the results of our study, the proposed residential structures can be supported on a conventional foundation system bearing on competent native soil, compacted native soil, or new structural fill. In general, we anticipate competent native soils suitable for support of new foundations to be encountered beginning at depths of about two to four feet bgs. Where loose or unsuitable soil conditions are exposed at foundation subgrade elevations, compaction of the soils to the specifications of structural fill, or overexcavation and replacement with structural fill will be necessary.

Provided the structures will be supported as described above, the following parameters can be used for design of the new foundations:

- Allowable soil bearing capacity — 2,500 psf
- Passive earth pressure — 350 pcf (equivalent fluid)
- Coefficient of friction — 0.40

A one-third increase in the allowable soil bearing capacity can be assumed for short-term wind and seismic loading conditions.

With structural loading as expected, total settlement in the range of one inch is anticipated, with differential settlement of about one-half inch. The majority of the settlements should occur during construction, as dead loads are applied.

Seismic Considerations

The 2015 International Building Code recognizes the American Society of Civil Engineers (ASCE) for seismic site class definitions. In accordance with Table 20.3-1 of the ASCE Minimum Design Loads for Buildings and Other Structures manual, Site Class D should be used for design.

The referenced liquefaction susceptibility map indicates the site and surrounding areas maintain low liquefaction susceptibility. Liquefaction is a phenomenon where saturated and loose soils suddenly lose internal strength and behave as a fluid. This behavior is in response to soil grain contraction and increased pore water pressures resulting from an earthquake or other intense ground shaking. In our opinion, site susceptibility to liquefaction may be considered negligible. The dense to very dense in-situ nature of the native soils and the absence of a uniformly established, shallow groundwater table were the primary bases for this consideration.

Slab-on-Grade Floors

Slab-on-grade floors should be supported on a firm and unyielding subgrade consisting of competent native soil or structural fill. Unstable or yielding areas of the subgrade should be recompacted or overexcavated and replaced with suitable structural fill prior to construction of the slab. ESNW should observe exposed slab subgrade conditions at the time of construction and provide supplement recommendations, as necessary.

A capillary break consisting of a minimum of four inches of free-draining crushed rock or gravel should be placed below the slab. The free-draining material should have a fines content of 5 percent or less defined as the percent passing the Number 200 sieve, based on the minus three-quarters inch fraction. In areas where slab moisture is undesirable, installation of a vapor barrier below the slab should be considered. If used, the vapor barrier should consist of a material specifically designed to function as a vapor barrier and should be installed in accordance with the product specifications.

Retaining Walls

If retaining walls will be utilized, they should be designed to resist earth pressures and applicable surcharge loads. The following parameters can be used for retaining wall design:

- Active earth pressure (yielding condition) — 35 pcf
- At-rest earth pressure (restrained condition) — 50 pcf
- Traffic surcharge (passenger vehicles) — 70 psf (rectangular distribution)
- Passive earth pressure — 350 pcf
- Coefficient of friction — 0.40
- Seismic surcharge — 6H psf* (where applicable)

**Where H equals retained height*

Drainage should be provided behind retaining walls such that hydrostatic pressures do not develop. If drainage is not provided, hydrostatic pressures should be included in the wall design.

Retaining walls should be backfilled with free-draining material that extends along the height of the wall, and a distance of at least 18 inches behind the wall; a drainage mat can be considered in lieu of free-draining backfill and should be evaluated by ESNW during construction. The upper one foot of the wall backfill can consist of a less permeable soil, if desired. A perforated drain pipe should be placed along the base of the wall, and should be connected to an approved discharge location. A typical retaining wall drainage detail is provided as Plate 3.

Preliminary Stormwater Vault Design

Vault foundations should be supported on competent native soil or crushed rock placed atop competent native soil. Final stormwater vault designs must incorporate adequate separation from property boundaries such that temporary excavations to construct the vault structure can be successfully completed. ESNW must review site plans regarding vault placement, proposed depth of excavation, and offsets from both on and off-site features prior to construction activities. The review will assist in preliminarily assessing adequate temporary slope inclinations or the necessity of shoring implementations during construction of the vault. Perimeter drains should be installed around the vault and conveyed to an approved discharge point. The presence of perched groundwater seepage should be anticipated during excavation activities for the vault.

The following parameters can be used for preliminary stormwater vault design:

- Allowable soil bearing capacity (dense native at-depth) 5,000 psf
- Active earth pressure (unrestrained) 35 pcf
- Active earth pressure (unrestrained, hydrostatic) 80 pcf
- At-rest earth pressure (restrained) 50 pcf
- At-rest earth pressure (restrained, hydrostatic) 95 pcf
- Coefficient of friction 0.40
- Passive earth pressure 350 pcf
- Seismic surcharge 6H psf*

*Where H equals the retained height

Retaining walls should be backfilled with at least 18 inches of free-draining material or suitable sheet drainage that extends along the height of the walls. The upper one foot of the wall backfill can consist of a less permeable soil, if desired. A perforated drain pipe should be placed along the base of the vault wall and connected to an approved discharge location. If the elevation of the vault bottom is such that gravity flow to an outlet is not possible, the portion of the vault below the drain should be designed to include hydrostatic pressure. Design values accounting for hydrostatic pressure are included above.

ESNW should observe grading operations for the vault and the subgrade conditions prior to concrete forming and pouring to confirm conditions are as anticipated, and to provide supplemental recommendations as necessary. Additionally, ESNW should be contacted to review final vault designs to confirm that appropriate geotechnical parameters have been incorporated

Drainage

Groundwater seepage was not encountered at the test pit locations at the time of our September 2017 fieldwork. However, groundwater seepage should be expected in site excavations. Where localized zones of groundwater seepage are encountered, temporary measures to control groundwater seepage may be needed. Temporary measures to control groundwater seepage and surface water runoff during construction will likely involve passive elements such as interceptor trenches and sumps, as necessary.

Surface grades must be designed to direct water away from buildings. The grade adjacent to buildings should be sloped away from the buildings at a gradient of at least 2 percent for a horizontal distance of at least four feet and up to ten feet (as building and property setbacks allow). In our opinion, perimeter footing drains should be installed at or below the invert of the building footings. A typical footing drain detail is provided on Plate 4 of this report.

Infiltration Feasibility

As indicated in the *Subsurface* section of this study, native soils encountered during our fieldwork were characterized primarily as dense to very dense glacial till deposits. According to the results of USDA textural analyses performed on representative soil samples, the native soils classify primarily as gravelly sandy loam. Irrespective of gravel content, the fines contents of the native loam were about 29 to 40 percent at the tested locations.

From a geotechnical standpoint, native soils are not feasible for infiltration facility design. The dense to very dense in-situ state of the native soils would hinder the long-term performance of an infiltration device. In our opinion, the native soils should be considered impervious for design purposes.

Preliminary Pavement Sections

The performance of site pavements is largely related to the condition of the underlying subgrade. To ensure adequate pavement performance, the subgrade should be in a firm and unyielding condition when subjected to proof rolling with a loaded dump truck. Structural fill in pavement areas should be compacted to the specifications previously detailed in this report. Soft, wet, or otherwise unsuitable subgrade areas may still exist after base grading activities. Areas containing unsuitable or yielding subgrade conditions will require remedial measures, such as over-excavation and/or placement of thicker crushed rock or structural fill sections, prior to pavement.

We anticipate new pavement sections will be subjected primarily to passenger vehicle traffic. For lightly loaded pavement areas subjected primarily to passenger vehicles, the following preliminary pavement sections may be considered:

- A minimum of two inches of hot mix asphalt (HMA) placed over four inches of crushed rock base (CRB), or;

- A minimum of two inches of HMA placed over three inches of asphalt treated base (ATB).

The HMA, ATB and CRB materials should conform to WSDOT specifications. All soil base material should be compacted to a relative compaction of 95 percent, based on the laboratory maximum dry density as determined by ASTM D1557. Final pavement design recommendations, including recommendations for heavy traffic areas, access roads, and frontage improvement areas, can be provided once final traffic loading has been determined. Road standards utilized by the governing jurisdiction may supersede the recommendations provided in this report.

Utility Support and Trench Backfill

In our opinion, native soils will generally be suitable for support of utilities. Remedial measures, such as overexcavation and replacement with structural fill and/or installation of geotextile fabric, however, may be necessary in some areas to provide support for utilities. Groundwater may be encountered within deeper utility excavations, and caving of trench walls may occur where groundwater is encountered. Temporary construction dewatering, as well as temporary trench shoring, may be necessary during utility excavation and installation as conditions warrant.

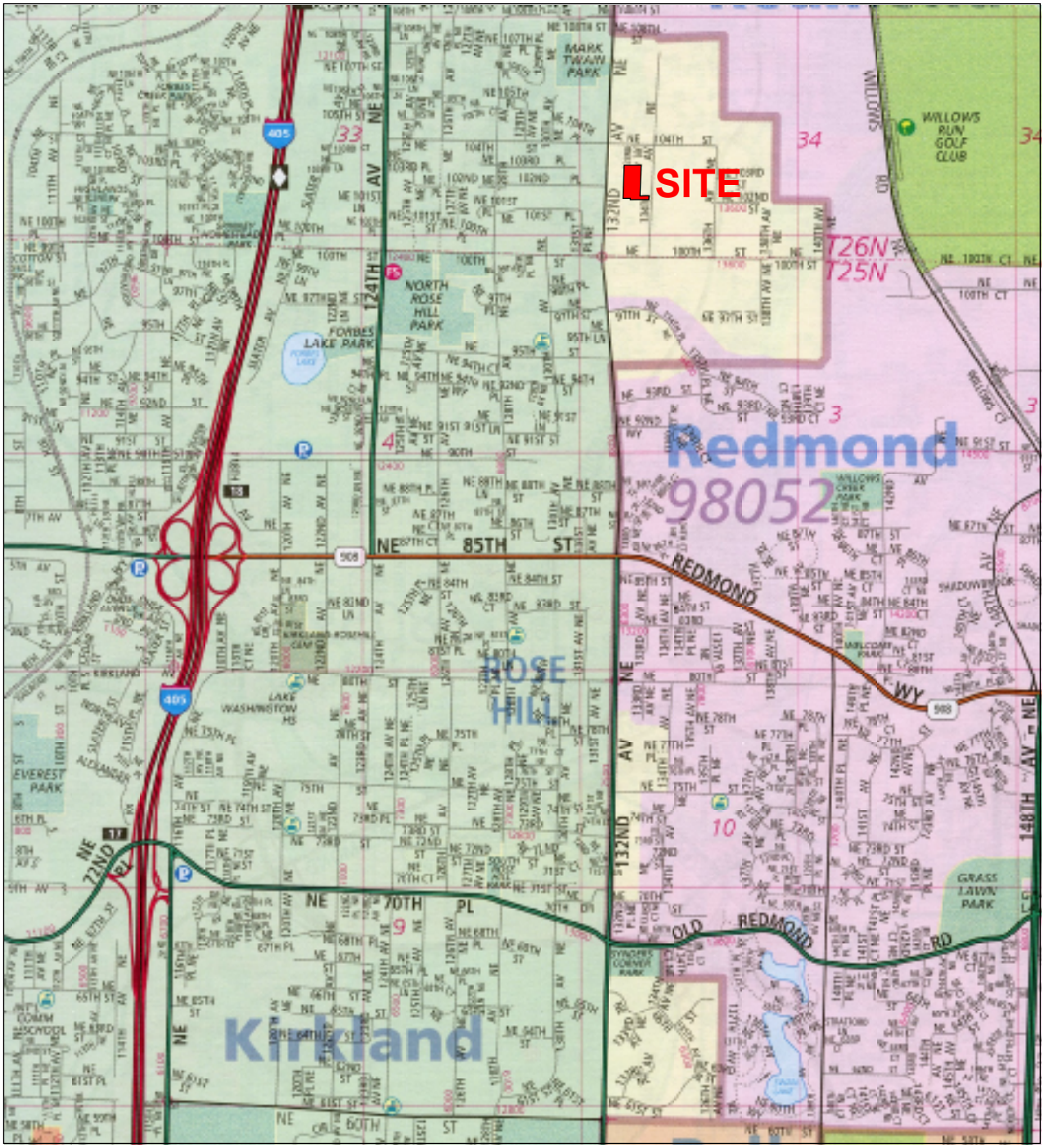
In general, native soils may be suitable for use as structural backfill throughout utility trench excavations, provided the soils are at (or slightly above) the optimum moisture content at the time of placement and compaction. Structural trench backfill should not be placed dry of the optimum moisture content. Each section of the site utility lines must be adequately supported in appropriate bedding material. Utility trench backfill should be placed and compacted to the specifications of structural fill as previously detailed in this report, or to the applicable specifications of the governing jurisdiction or other responsible jurisdiction or agency.

LIMITATIONS

The recommendations and conclusions provided in this geotechnical engineering study are professional opinions consistent with the level of care and skill that is typical of other members in the profession currently practicing under similar conditions in this area. A warranty is not expressed or implied. Variations in the soil and groundwater conditions observed at the test locations may exist, and may not become evident until construction. ESNW should reevaluate the conclusions in this geotechnical engineering study if variations are encountered.

Additional Services

ESNW should have an opportunity to review the final design with respect to the geotechnical recommendations provided in this report. ESNW should also be retained to provide testing and consultation services during construction.



Reference:
King County, Washington
Map 536
By The Thomas Guide
Rand McNally
32nd Edition

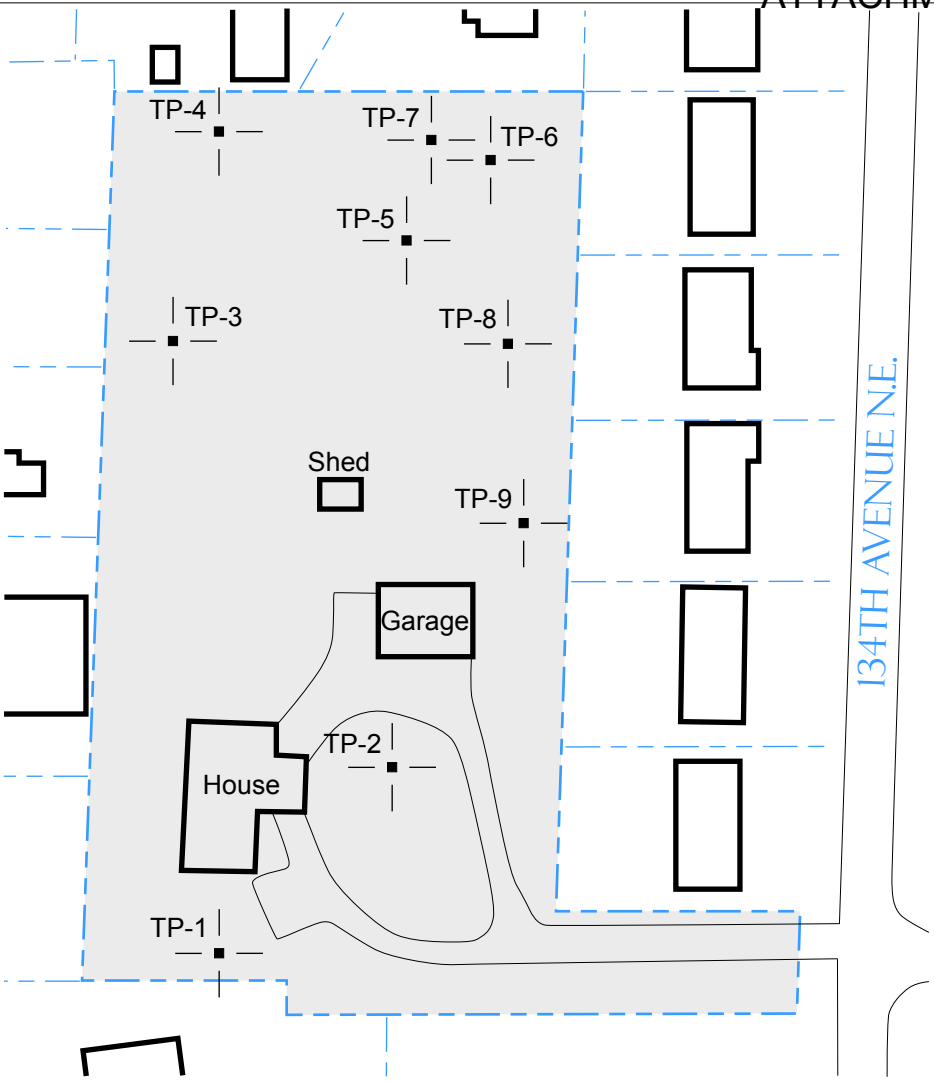
NORTH

NOTE: This plate may contain areas of color. ESNW cannot be responsible for any subsequent misinterpretation of the information resulting from black & white reproductions of this plate.

Earth Solutions NW LLC
Geotechnical Engineering, Construction Monitoring and Environmental Sciences

Vicinity Map
Larkin Property
King County (Redmond), Washington

Drwn. CAM	Date 10/12/2017	Proj. No. 5564
Checked CGH	Date Oct. 2017	Plate 1



LEGEND

TP-1 — Approximate Location of ESNW Test Pit, Proj. No. ES-5564, Sept. 2017

Subject Site

Existing Building

NORTH

NOT - TO - SCALE

NOTE: The graphics shown on this plate are not intended for design purposes or precise scale measurements, but only to illustrate the approximate test locations relative to the approximate locations of existing and / or proposed site features. The information illustrated is largely based on data provided by the client at the time of our study. ESNW cannot be responsible for subsequent design changes or interpretation of the data by others.

NOTE: This plate may contain areas of color. ESNW cannot be responsible for any subsequent misinterpretation of the information resulting from black & white reproductions of this plate.

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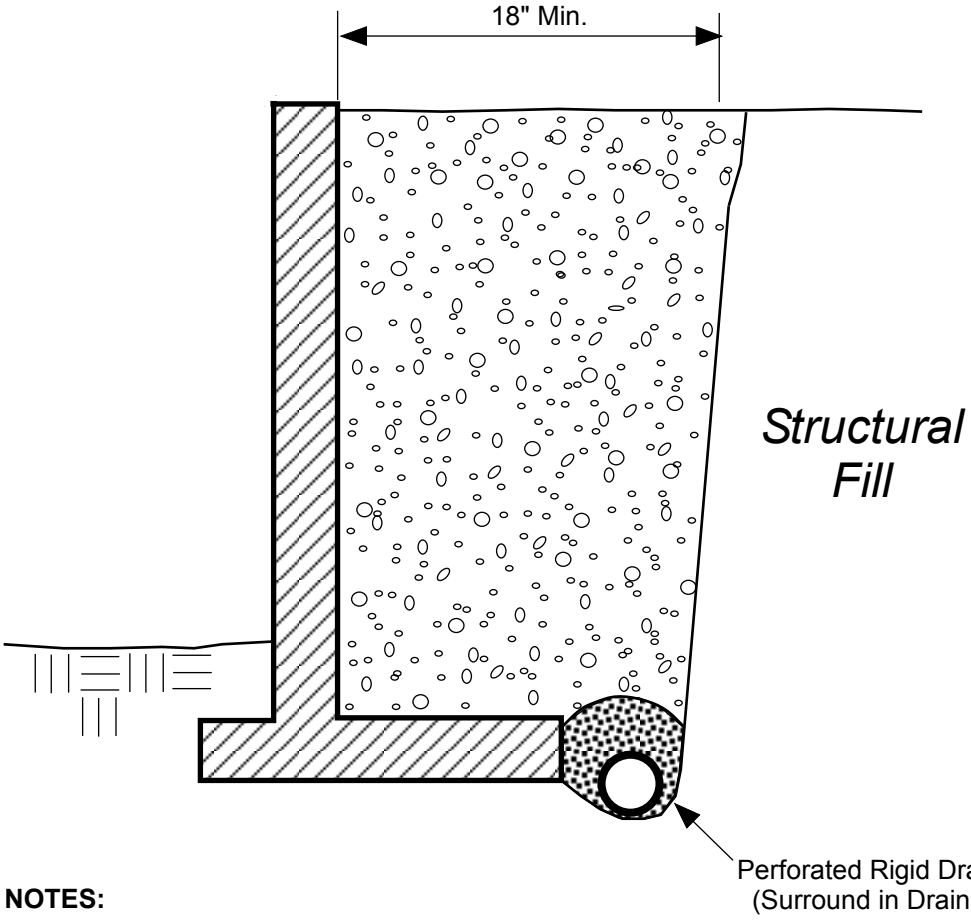
Geotechnical Engineering, Construction Monitoring and Environmental Sciences

Test Pit Location Plan
Larkin Property
King County (Redmond), Washington

Drwn. CAM	Date 10/12/2017	Proj. No. 5564
Checked CGH	Date Oct. 2017	Plate 2



NOTES:

- Free-draining Backfill should consist of soil having less than 5 percent fines. Percent passing No. 4 sieve should be 25 to 75 percent.
- Sheet Drain may be feasible in lieu of Free-draining Backfill, per ESNW recommendations.
- Drain Pipe should consist of perforated, rigid PVC Pipe surrounded with 1-inch Drain Rock.

SCHEMATIC ONLY - NOT TO SCALE
NOT A CONSTRUCTION DRAWING

LEGEND:

Free-draining Structural Backfill

1-inch Drain Rock

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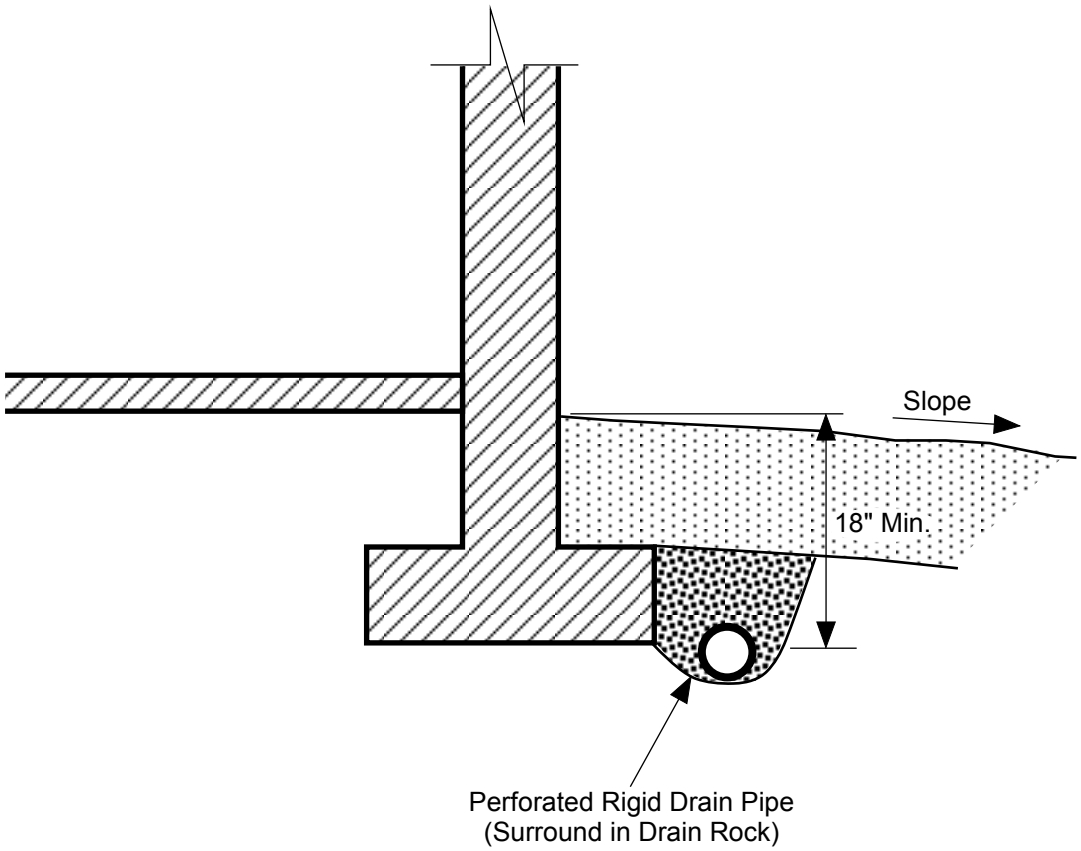
RETAINING WALL DRAINAGE DETAIL
Larkin Property
King County (Redmond), Washington

Drwn. CAM	Date 10/26/2017	Proj. No. 5564
Checked CGH	Date Oct. 2017	Plate 3



NOTES:

- Do NOT tie roof downspouts to Footing Drain.
- Surface Seal to consist of 12" of less permeable, suitable soil. Slope away from building.

SCHEMATIC ONLY - NOT TO SCALE
NOT A CONSTRUCTION DRAWING

LEGEND:

Surface Seal: native soil or other low-permeability material.

1-inch Drain Rock

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FOOTING DRAIN DETAIL
Larkin Property
King County (Redmond), Washington

Drwn. CAM	Date 10/26/2017	Proj. No. 5564
Checked CGH	Date Oct. 2017	Plate 4

Appendix A

Subsurface Exploration

ES-5564

Subsurface conditions at the subject site were explored on September 21, 2017 by excavating nine test pits using a mini trackhoe and operator retained by our firm, excavated to a maximum exploration depth of nine feet bgs. The approximate locations of the test pits are illustrated on Plate 2 of this study. The test pit logs are provided in this Appendix.

The final logs represent the interpretations of the field logs and the results of laboratory analyses. The stratification lines on the logs represent the approximate boundaries between soil types. In actuality, the transitions may be more gradual.

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SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS
			GRAPH	LETTER	
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	SAND AND SANDY SOILS	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

DUAL SYMBOLS are used to indicate borderline soil classifications.

The discussion in the text of this report is necessary for a proper understanding of the nature of the material presented in the attached logs.

Earth Solutions NW
1805 - 136th Place N.E., Suite 201
Bellevue, Washington 98005
Telephone: 425-449-4704
Fax: 425-449-4711

TEST PIT NUMBER TP-1

CLIENT Rose Hill 12, LLC
PROJECT NAME Larkin Property
PROJECT NUMBER ES-5564
PROJECT LOCATION King County (Redmond), Washington
DATE STARTED 9/21/17 **COMPLETED** 9/21/17
GROUND ELEVATION _____ **TEST PIT SIZE** _____
EXCAVATION CONTRACTOR NW Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD _____
AT TIME OF EXCAVATION ---
LOGGED BY CGH **CHECKED BY** HTW
AT END OF EXCAVATION ---
NOTES Depth of Topsoil & Sod 1"-2": grass
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0		MC = 10.80%	SM		Brown silty SAND, loose to medium dense, moist (Fill) -root intrusions to 3' -minor plastic/brick debris
		MC = 4.00% Fines = 17.50%			2.0 Tan silty SAND with gravel, medium dense, damp [USDA Classification: very gravelly sandy LOAM] -becomes dense
5		MC = 12.00%	SM		-becomes gray, very dense (Unweathered Till), weakly cemented -minor iron oxide staining
		MC = 8.70%			7.0 Test pit terminated at 7.0 feet below existing grade. No groundwater encountered during excavation. No caving observed. Bottom of test pit at 7.0 feet.

GENERAL BH / TP / WELL 5564.GPJ GINT US.GDT 10/12/17

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Bellevue, Washington 98005
Telephone: 425-449-4704
Fax: 425-449-4711

TEST PIT NUMBER TP-2

CLIENT Rose Hill 12, LLC
PROJECT NAME Larkin Property
PROJECT NUMBER ES-5564
PROJECT LOCATION King County (Redmond), Washington
DATE STARTED 9/21/17 **COMPLETED** 9/21/17
GROUND ELEVATION _____ **TEST PIT SIZE** _____
EXCAVATION CONTRACTOR NW Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD _____
AT TIME OF EXCAVATION ---
LOGGED BY KTK **CHECKED BY** HTW
AT END OF EXCAVATION ---
NOTES Depth of Topsoil & Sod 1"-2": grass
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			SM		Brown silty SAND with gravel, loose to medium dense, moist (Fill)
					-trace roots to 2'
				1.0	Brown silty SAND with gravel, medium dense, moist
					-weakly cemented
		MC = 8.40%			-light to moderate iron oxide staining to 5.5'
		MC = 11.50%			
		MC = 13.70%	SM		
5					
		MC = 10.30%			-becomes gray (Unweathered Till)
		MC = 7.30%		6.5	
					Test pit terminated at 6.5 feet below existing grade. No groundwater encountered during excavation. No caving observed.
					Bottom of test pit at 6.5 feet.

ATTACHMENT 21

Earth Solutions NW
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Fax: 425-449-4711

TEST PIT NUMBER TP-3

CLIENT Rose Hill 12, LLC
PROJECT NAME Larkin Property
PROJECT NUMBER ES-5564
PROJECT LOCATION King County (Redmond), Washington
DATE STARTED 9/21/17 **COMPLETED** 9/21/17
GROUND ELEVATION _____ **TEST PIT SIZE** _____
EXCAVATION CONTRACTOR NW Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD _____
AT TIME OF EXCAVATION ---
LOGGED BY CGH **CHECKED BY** HTW
AT END OF EXCAVATION ---
NOTES Depth of Topsoil & Sod 4"-5": grass
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL		Dark brown TOPSOIL (Fill), root intrusions to 3'
				0.5	
			SM		Brown silty SAND, loose to medium dense, damp (Fill)
				1.0	
		MC = 14.40%			Brown silty SAND, loose to medium dense, moist
					-becomes gray, dense (Unweathered Till), increased gravel content
		MC = 11.50% Fines = 28.20%	SM		-moderate iron oxide staining [USDA Classification: gravelly sandy LOAM]
5					-becomes weakly cemented
		MC = 9.70%			
				6.5	Test pit terminated at 6.5 feet below existing grade. No groundwater encountered during excavation. No caving observed. Bottom of test pit at 6.5 feet.

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Earth Solutions NW
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Telephone: 425-449-4704
Fax: 425-449-4711

TEST PIT NUMBER TP-4

CLIENT Rose Hill 12, LLC
PROJECT NAME Larkin Property
PROJECT NUMBER ES-5564
PROJECT LOCATION King County (Redmond), Washington
DATE STARTED 9/21/17 **COMPLETED** 9/21/17
GROUND ELEVATION _____ **TEST PIT SIZE** _____
EXCAVATION CONTRACTOR NW Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD _____
AT TIME OF EXCAVATION ---
LOGGED BY KTK **CHECKED BY** HTW
AT END OF EXCAVATION ---
NOTES Depth of Topsoil & Sod 10": grass
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL		Dark brown TOPSOIL, trace roots to 3.5'
				0.9	
			SM		Tan silty SAND with gravel, medium dense, moist (Weathered Till)
		MC = 6.00%			
		MC = 6.80%			-moderate iron oxide staining to 6'
5					
		MC = 6.00%			-becomes gray, dense (Unweathered Till)
		MC = 7.30%		7.0	
					Test pit terminated at 7.0 feet below existing grade. No groundwater encountered during excavation. No caving observed.
					Bottom of test pit at 7.0 feet.

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ATTACHMENT 21

Earth Solutions NW
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Bellevue, Washington 98005
Telephone: 425-449-4704
Fax: 425-449-4711

TEST PIT NUMBER TP-5

CLIENT Rose Hill 12, LLC
PROJECT NAME Larkin Property
PROJECT NUMBER ES-5564
PROJECT LOCATION King County (Redmond), Washington
DATE STARTED 9/21/17 **COMPLETED** 9/21/17
GROUND ELEVATION _____ **TEST PIT SIZE** _____
EXCAVATION CONTRACTOR NW Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD _____
AT TIME OF EXCAVATION ---
LOGGED BY CGH **CHECKED BY** HTW
AT END OF EXCAVATION ---
NOTES Depth of Topsoil & Sod 16": grass
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL		Dark brown TOPSOIL (Fill), root intrusions to 1.5'
				1.4	-concrete debris
					Brown silty SAND, loose to medium dense, damp
		MC = 7.90%			
			SM		-becomes gray, dense (Unweathered Till)
		MC = 8.50%			
5					
		MC = 9.70%		6.0	
					Test pit terminated at 6.0 feet below existing grade. No groundwater encountered during excavation. No caving observed.
					Bottom of test pit at 6.0 feet.

GENERAL BH / TP / WELL 5564.GPJ GINT US.GDT 10/12/17

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Bellevue, Washington 98005
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TEST PIT NUMBER TP-6

CLIENT Rose Hill 12, LLC
PROJECT NAME Larkin Property
PROJECT NUMBER ES-5564
PROJECT LOCATION King County (Redmond), Washington
DATE STARTED 9/21/17 **COMPLETED** 9/21/17
GROUND ELEVATION _____ **TEST PIT SIZE** _____
EXCAVATION CONTRACTOR NW Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD _____
AT TIME OF EXCAVATION ---
LOGGED BY CGH **CHECKED BY** HTW
AT END OF EXCAVATION ---
NOTES Surface Conditions: exposed soils
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			ML		Black sandy SILT, loose, saturated (Fill) 0.5
		MC = 15.70%	SM		Brown silty SAND, loose, moist (Fill) -abundant concrete debris, organics/straw/roots at 1.5' -large boulders 4.0
5		MC = 9.10%	SM		Gray silty SAND with gravel, dense, moist (Unweathered Till) -minor iron oxide staining 5.5
					Test pit terminated at 5.5 feet below existing grade. No groundwater encountered during excavation. No caving observed. Bottom of test pit at 5.5 feet.

ATTACHMENT 21

TEST PIT NUMBER TP-7

Earth Solutions NW
1805 - 136th Place N.E., Suite 201
Bellevue, Washington 98005
Telephone: 425-449-4704
Fax: 425-449-4711

CLIENT Rose Hill 12, LLC
PROJECT NAME Larkin Property
PROJECT NUMBER ES-5564
PROJECT LOCATION King County (Redmond), Washington
DATE STARTED 9/21/17 **COMPLETED** 9/21/17
GROUND ELEVATION _____ **TEST PIT SIZE** _____
EXCAVATION CONTRACTOR NW Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD _____
AT TIME OF EXCAVATION ---
LOGGED BY CGH **CHECKED BY** HTW
AT END OF EXCAVATION ---
NOTES Depth of Topsoil & Sod 6"-7": grass
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL		0.5 Dark brown TOPSOIL (Fill), root intrusions to 1.5'
			SM		Tan silty SAND, medium dense, damp (Fill) 1.5
		MC = 8.80%	SM		Brown silty SAND with gravel, medium dense, moist
					-becomes gray, dense (Unweathered Till)
5		MC = 12.20%			-minor iron oxide staining 5.0
					Test pit terminated at 5.0 feet below existing grade. No groundwater encountered during excavation. No caving observed.
					Bottom of test pit at 5.0 feet.

GENERAL BH / TP / WELL 5564.GPJ GINT US.GDT 10/12/17

ATTACHMENT 21

Earth Solutions NW
1805 - 136th Place N.E., Suite 201
Bellevue, Washington 98005
Telephone: 425-449-4704
Fax: 425-449-4711

TEST PIT NUMBER TP-8

CLIENT Rose Hill 12, LLC
PROJECT NAME Larkin Property
PROJECT NUMBER ES-5564
PROJECT LOCATION King County (Redmond), Washington
DATE STARTED 9/21/07 **COMPLETED** 9/21/17
GROUND ELEVATION _____ **TEST PIT SIZE** _____
EXCAVATION CONTRACTOR NW Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD _____
AT TIME OF EXCAVATION ---
LOGGED BY CGH **CHECKED BY** HTW
AT END OF EXCAVATION ---
NOTES Depth of Topsoil & Sod 10"-12": grass
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL		Dark brown TOPSOIL, root intrusions to 2.5'
				1.0	Brown silty SAND, loose to medium dense, moist
		MC = 10.10%			
		MC = 12.00%			-becomes gray, dense (Unweathered Till) -minor iron oxide staining
5			SM		
		MC = 12.90%			-becomes very dense
		MC = 12.30% Fines = 32.00%		9.0	[USDA Classification: gravelly sandy LOAM]
					Test pit terminated at 9.0 feet below existing grade. No groundwater encountered during excavation. No caving observed. Bottom of test pit at 9.0 feet.

ATTACHMENT 21

Earth Solutions NW
1805 - 136th Place N.E., Suite 201
Bellevue, Washington 98005
Telephone: 425-449-4704
Fax: 425-449-4711

TEST PIT NUMBER TP-9

CLIENT Rose Hill 12, LLC
PROJECT NAME Larkin Property
PROJECT NUMBER ES-5564
PROJECT LOCATION King County (Redmond), Washington
DATE STARTED 9/21/17 **COMPLETED** 9/21/17
GROUND ELEVATION _____ **TEST PIT SIZE** _____
EXCAVATION CONTRACTOR NW Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD _____
AT TIME OF EXCAVATION ---
LOGGED BY CGH **CHECKED BY** HTW
AT END OF EXCAVATION ---
NOTES Depth of Topsoil & Sod 4": grass
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL		0.4 Dark brown TOPSOIL (Fill), root intrusions to 3'
			SM		Tan silty SAND with gravel, medium dense, moist (Fill)
					-asphalt rubble, concrete debris
		MC = 11.20%			2.0
					Brown silty SAND with gravel, medium dense, moist
					-becomes gray, dense (Unweathered Till)
5		MC = 11.70% Fines = 33.60%	SM		[USDA Classification: gravelly sandy LOAM]
		MC = 10.40%			7.0
					Test pit terminated at 7.0 feet below existing grade. No groundwater encountered during excavation. No caving observed.
					Bottom of test pit at 7.0 feet.

Appendix B

Laboratory Test Results

ES-5564

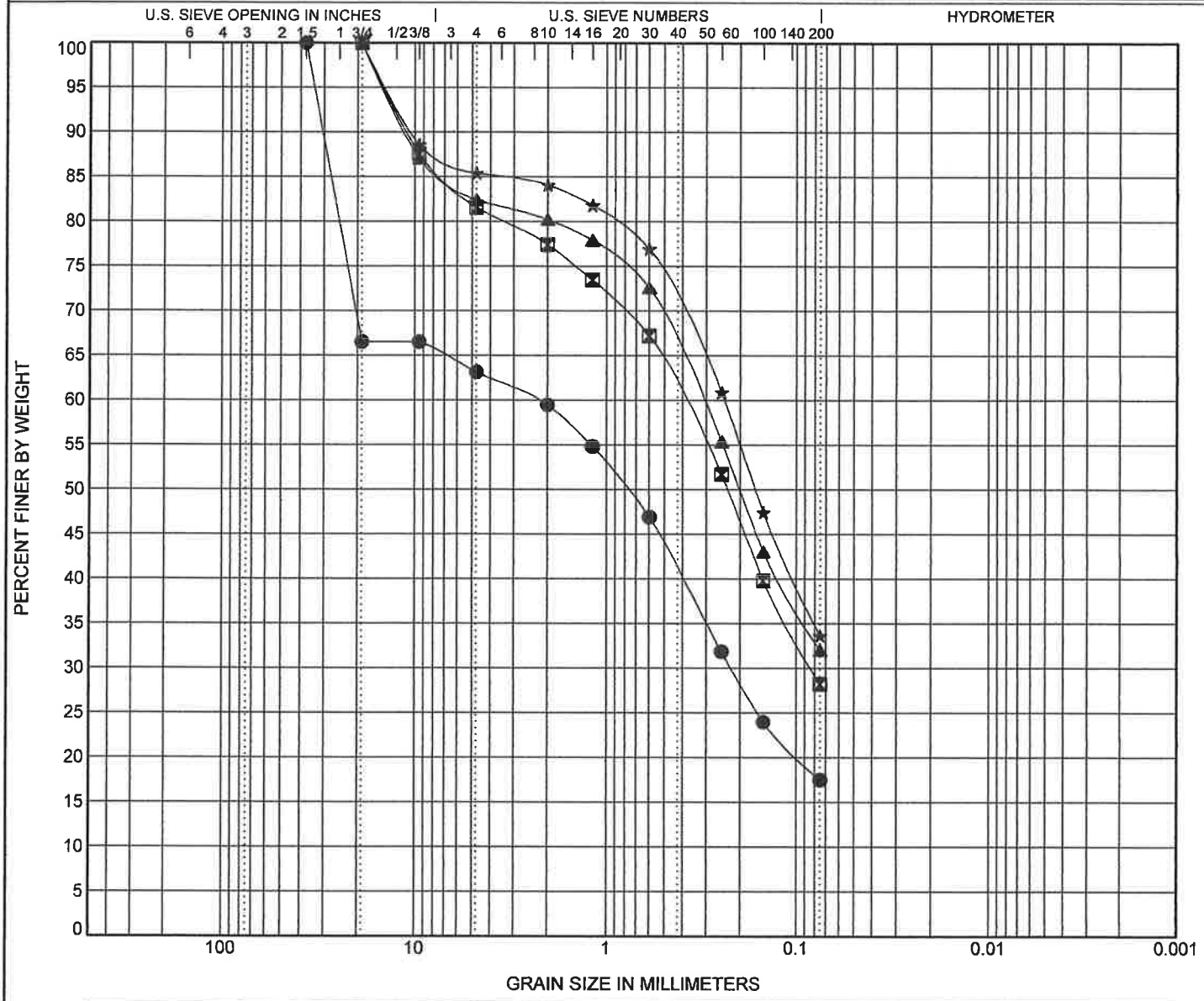
Earth Solutions NW, LLC
1805 - 136th PL N.E., Suite 201
Bellevue, WA 98005
Telephone: 425-449-4704
Fax: 425-449-4711

ATTACHMENT 21

GRAIN SIZE DISTRIBUTION

CLIENT Rose Hill 12, LLC **PROJECT NAME** Larkin Property

PROJECT NUMBER ES-5564 **PROJECT LOCATION** King County (Redmond), Washington



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification		Classification	Cc	Cu
● TP-1	2.50ft.	USDA: Tan Very Gravelly Sandy Loam. USCS: SM with Gravel.		
⊠ TP-3	4.00ft.	USDA: Gray Gravelly Sandy Loam. USCS: SM with Gravel.		
▲ TP-8	9.00ft.	USDA: Gray Gravelly Sandy Loam. USCS: SM with Gravel.		
★ TP-9	5.00ft.	USDA: Gray Gravelly Sandy Loam. USCS: SM.		

Specimen Identification		D100	D60	D30	D10	LL	PL	PI	%Silt	%Clay
● TP-1	2.5ft.	37.5	2.263	0.222					17.5	
⊠ TP-3	4.0ft.	19	0.399	0.083					28.2	
▲ TP-8	9.0ft.	19	0.316						32.0	
★ TP-9	5.0ft.	19	0.242						33.6	

GRAIN SIZE USDA ES-5564 LARKIN PROPERTY.GPJ GINT US LAB.GDT 10/2/17

Report Distribution

ES-5564

EMAIL ONLY

Rose Hill 12, LLC
2630 – 116th Avenue Northeast, Suite 200
Bellevue, Washington 98004

Attention: Mr. Mike Walsh

AQUATICA
Environmental Consulting, LLC
PO Box 308
Duvall, Washington 98019

October 26, 2017

#17-312

Mr. Mike Walsh, Principal
Terrene Homes
2630 116th AVE NE, Ste 200
Bellevue, WA 98004

REFERENCE: Wetland Reconnaissance
SUBJECT: Parcel #1246700141, Kirkland/Redmond Area

Dear Mike:

On October 26, 2017, I visited the 2.4-acre parcel located at 10201 134th Avenue NE (**Figure 1**), to evaluate the property and surrounding area for wetlands and streams.

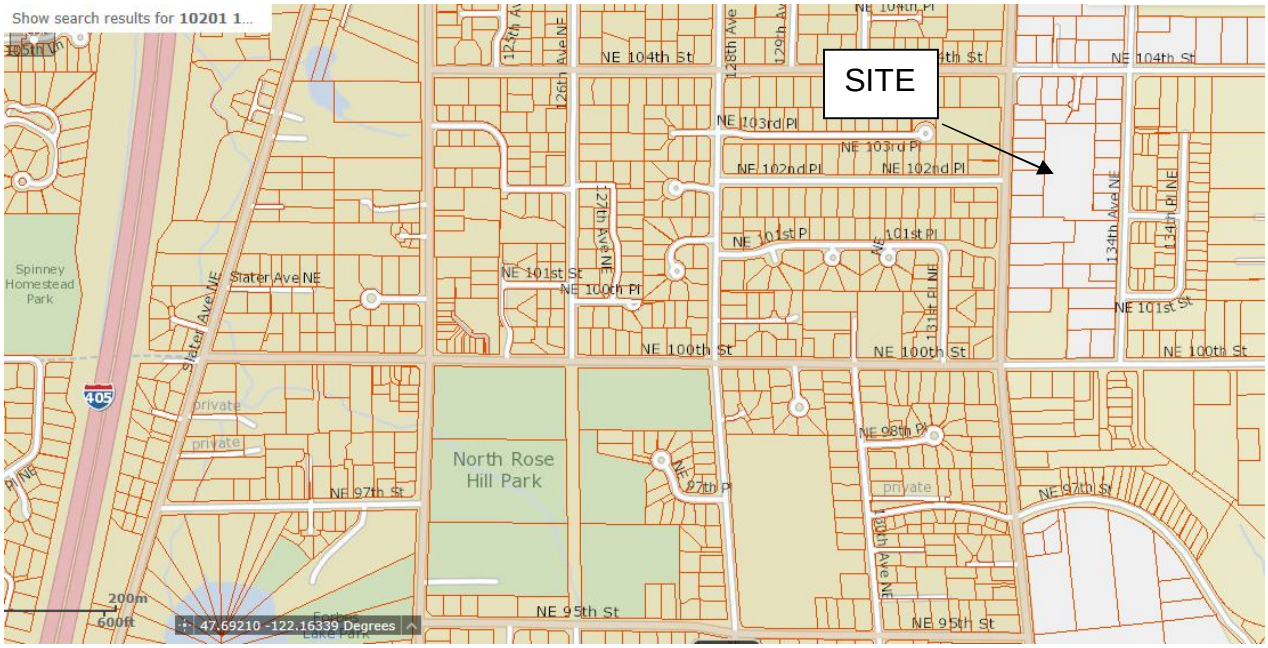


Figure 1. Vicinity Map (Source: King County 2017)

Prior to the site visit, background information reviewed included weather data, the King County iMAP and the Natural Resources Conservation Service (NRCS) soil maps.

After an unusually dry summer, the Seattle area has had a wet fall. September had three times the average rainfall for the month, and as of the date of this site visit, October had already had almost a half an inch more rainfall that what is usually recorded for the month.

iMAP, does not depict any wetlands or streams on the subject property (**Figure 2**). The NRCS has mapped the subject property and the surrounding area as Alderwood sandy, gravelly loam, 0-8 percent slopes. Alderwood soils are typically upland soils although may contain inclusions of small areas of hydric soils in depressions and drainageways not included at the mapped scale.

Figure 2. King County iMAP (Source: King County 2017)

The subject property is located within an area of single family houses, which surround the property on all sides. The property has been maintained as lawn, with a few scattered western red cedar (*Thuja plicata*) and Douglas fir (*Pseudotsuga menziesii*) trees. The lawn is mowed and is made up of common

lawn grasses such as bentgrass (*Agrostis stolonifera*.), rye grass (*Lolium perenne*) with cat's ear (*Hypochaeris radicata*) common in the lawn areas. The soil was not hydric, and was observed to be a 10YR 4/3 sandy loam. No evidence of wetland hydrology was observed on the property. There was no evidence of wetlands on or near the subject property. Data from a sample plot from one of the lower elevation portions of the lawn is attached.

There is a roadside ditch along 134th Avenue NE, that crosses a small portion of the property. This ditch was reviewed north of the property and does not appear to convey natural waters, but rather runoff from developed areas. The bottom of the ditch was predominantly vegetated and there was little sorting of substrate materials. Despite recent heavy rainfall there was no water in the ditch. This ditch appears to function as a stormwater conveyance, and not as a stream.

Should you have any questions, please call me at (425) 802-8988.

Sincerely,

Aquatica Environmental Consulting, LLC

Teresa Opolka
Wetland Ecologist, PWS

Attachment

ATTACHMENT 21

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: 1246700141 City/County: Redmond/King Sampling Date: 10/26/17

Applicant/Owner: Terrene Homes State: WA Sampling Point: DP#1

Investigator(s): T.Opolka Section, Township, Range: SW 34/26/5

Landform (hillslope, terrace, etc.): Slope Local relief (concave, convex, none): none Slope (%): <5

Subregion (LRR): A Lat: Long: Datum:

Soil Map Unit Name: Alderwood sandy gravelly loam, 0-8% slopes NWI classification: upland lawn

Are climatic / hydrologic conditions on the site typical for this time of year? Yes x No (If no, explain in Remarks.)

Are Vegetation , Soil , or Hydrology significantly disturbed? N Are "Normal Circumstances" present? Yes X No

Are Vegetation , Soil , or Hydrology naturally problematic? N (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes x	No	
Hydric Soil Present?	Yes	No x	**Is the Sampled Area within a Wetland?** Yes No x
Wetland Hydrology Present?	Yes	No x	

Remarks: abnormally wet year

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 15'rad.)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	0 = Total Cover		
Sapling/Shrub Stratum (Plot size: 6'dia)			
1.			
2.			
3.			
4.			
5.			
	0 = Total Cover		
Herb Stratum (Plot size: 6'rad)			
1. *Hypochaeris radicata*	20	Y	FACU
2. *Agrostis stolonifera*	40	Y	FAC
3. *Lolium perenne*	40	Y	FAC
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	100 = Total Cover		
Woody Vine Stratum (Plot size: 6' rad.)			
1.			
2.			
	0 = Total Cover		

% Bare Ground in Herb Stratum 0

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 66 (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species	x 1 =
FACW species	x 2 =
FAC species	x 3 =
FACU species	x 4 =
UPL species	x 5 =
Column Totals: (A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

- 1 - Rapid Test for Hydrophytic Vegetation
- x 2 - Dominance Test is >50%
- 3 - Prevalence Index is ≤3.0[1]
- 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- 5 - Wetland Non-Vascular Plants[1]
- Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes x No

Remarks:

SOIL

Sampling Point: DP#1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-7	10YR4/3	100					sandy	
7-15	10YR4/4	100					sandy loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes _____ No X

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A, and 4B**)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Stunted or Stressed Plants (D1) (**LRR A**)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A, and 4B**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)
- ___ Raised Ant Mounds (D6) (**LRR A**)
- ___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes _____ No X Depth (inches): _____

Water Table Present? Yes _____ No X Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes _____ No X Depth (inches): _____

Wetland Hydrology Present? Yes _____ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Section 7 Other Permits

No other permits are required at this time.

Section 8 Operation and Maintenance

An operation and maintenance manual will be included with the final engineering submittal. The operation and maintenance manual will be prepared in accordance with the COR O&M Manual Template found in Appendix L of the Technical Notebook.

Section 9 Bond Quantities

A bond quantity worksheet will be provided with the final engineering submittal, if required.