90% Prep Drainage Report

for

Garbarino

Prepared for

Milestone NW
11232 NE 15th St., Suite 101
Bellevue, WA 98004

Prepared by

Land Development Consultants, Inc
20210 142nd Ave NE
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(425) 806-1869

February 2016
Revised: September 2019
Job No: 15-104

TABLE OF CONTENTS

Section	Title
1	Project Overview
2	Conditions and Requirements Summary
3	Off-site / Downstream Analysis
4	Flow Control and Water Quality Facility Analysis and Design
5	Conveyance System Analysis and Design
6	Special Reports and Studies
7	Other Permits
8	Erosion and Sediment Control Analysis and Design
9	Bond Quantities, Facility Summaries, and Declaration of Covenants
10	Operations and Maintenance Manual

NOTE: For CCR use the O&M Manual Template in Appendix I of the STN

NOTE: For CCR add an Appendix for the Geotechnical Report so it can be attached to the Stormwater Report for final approval. The Geotechnical Report may remain a separate document for review until the final report is printed for the mylar submittal

1.0 PROJECT OVERVIEW

The Garbarino project includes parcels #1246700321, #1236700329 and a portion of #1246700333 and is addressed at 10042 136th Ave NE, Redmond, WA within the Rose Hill neighborhood. The project site is located within the southeast quarter of the southwest quarter of Section 34, Township 26 N, Range 5 E, W.M. See the Vicinity Map, Figure 1, for the exact location of the site.

The site area includes 2.72 acres which will be disturbed during development. The project proposes to construct 15 single-family lots and associated infrastructure, according to rustic roads street standards.

According to the King County and USGS Soil Survey, the site is underlain with Alderwood Gravelly Sandy Loam with 0 to 8 percent slopes and 8 to 15 percent slopes. Please refer to Appendix 3-C for detailed soil information. The soil has low to moderate runoff potential and a slight to moderate erosion potential. Slopes on the areas to be developed range from 0 to 15 percent.

Runoff currently exits the site via overland flow across the eastern property boundary. Flows continue easterly down a steep grade where they enter the City of Redmond storm drainage network in the Willows Creek center office complex at the base of the slope. Flows eventually reach the Sammamish River. Per King County I map due diligence research, drainage complaints have been filed for four parcels in the immediate vicinity of the site. The parcels associated with these complaints all lie generally upstream of the site and will not be affected by proposed development activities or resulting changes in post-development hydrology. For a visual depiction of drainage complaints in the vicinity of the site, refer to Appendix 3-G.

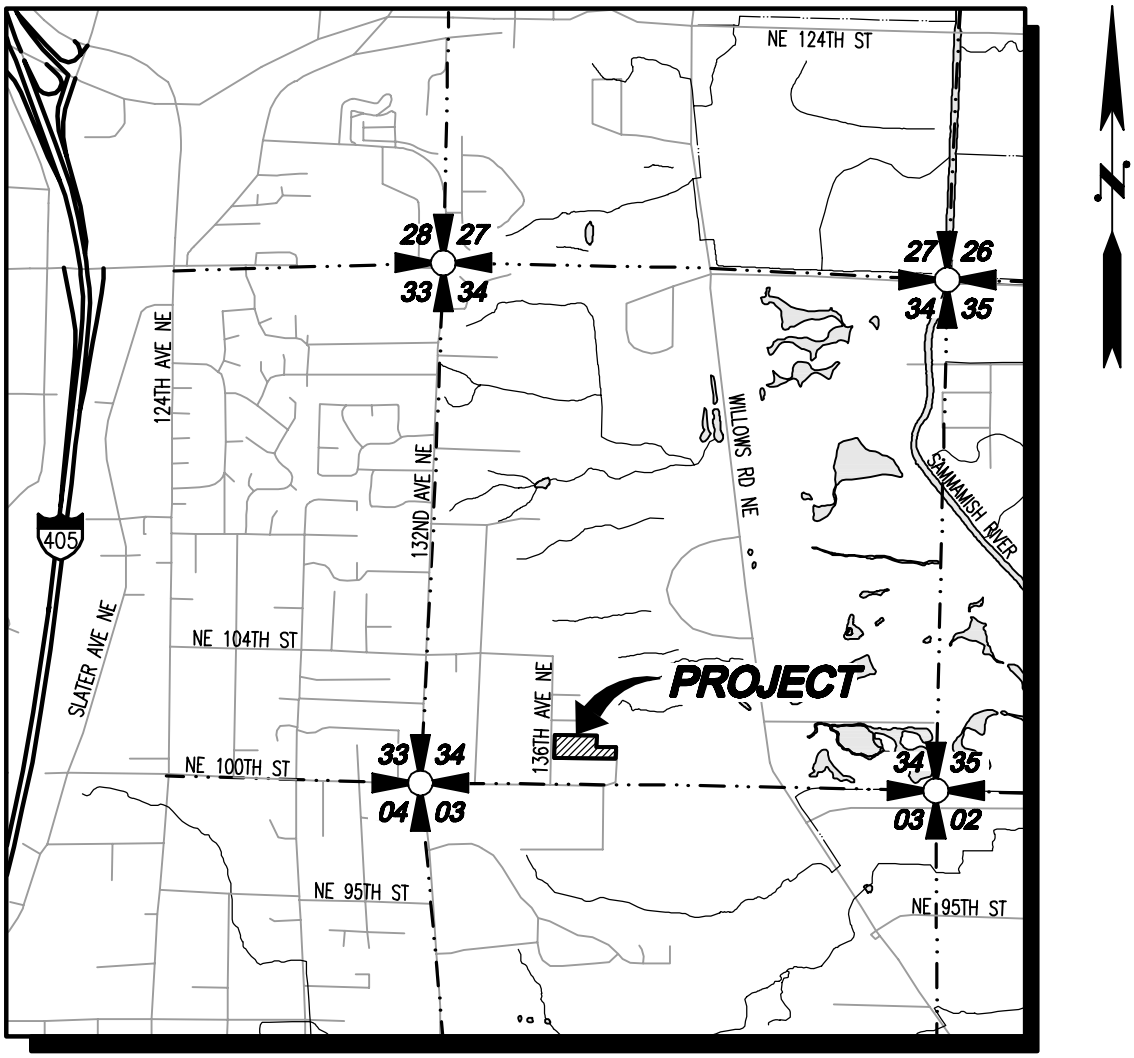
According to City of Redmond Erosion Hazard Area Map (see appendix H), Frequently Flooded Area Map (see appendix I), Landslide Hazard Area Map (see appendix J), Seismic Hazard Area Map (see appendix K), Stream Classification Map (see appendix L),

and Wetland Map (see appendix M) the project site does not belong to any hazardous areas.

A drainage plan has been devised for the Rose Hill neighborhood. The proposed stormwater discharge plan for the site complies with the Rose Hill stormwater discharge plan in Figure 3.1 (Appendix 3-F). The site is located in a Wellhead Protection Zone 4 (see appendix 3-D).

Flow control will be achieved by means of a Combined Detention/Wetvault located at the eastern end of the site. The proposed Combined Detention/Wetvault will comply with flow control requirements found in the City of Redmond 2017 Stormwater Management Technical Notebook and the 2014 DOE Manual. Water quality will be achieved through the use of dead storage within the Combined Detention/Wetvault facility.

State the origin of this plan (for Rose Hill Neighborhood). It's a drainage discharge plan?



VICINITY MAP

SCALE: 1"=2000'

Drawing: P:\2015\15-104 Garbarino\Exhibits\15104E-VM.dwg Plotted: Nov 02, 2015 - 10:30am

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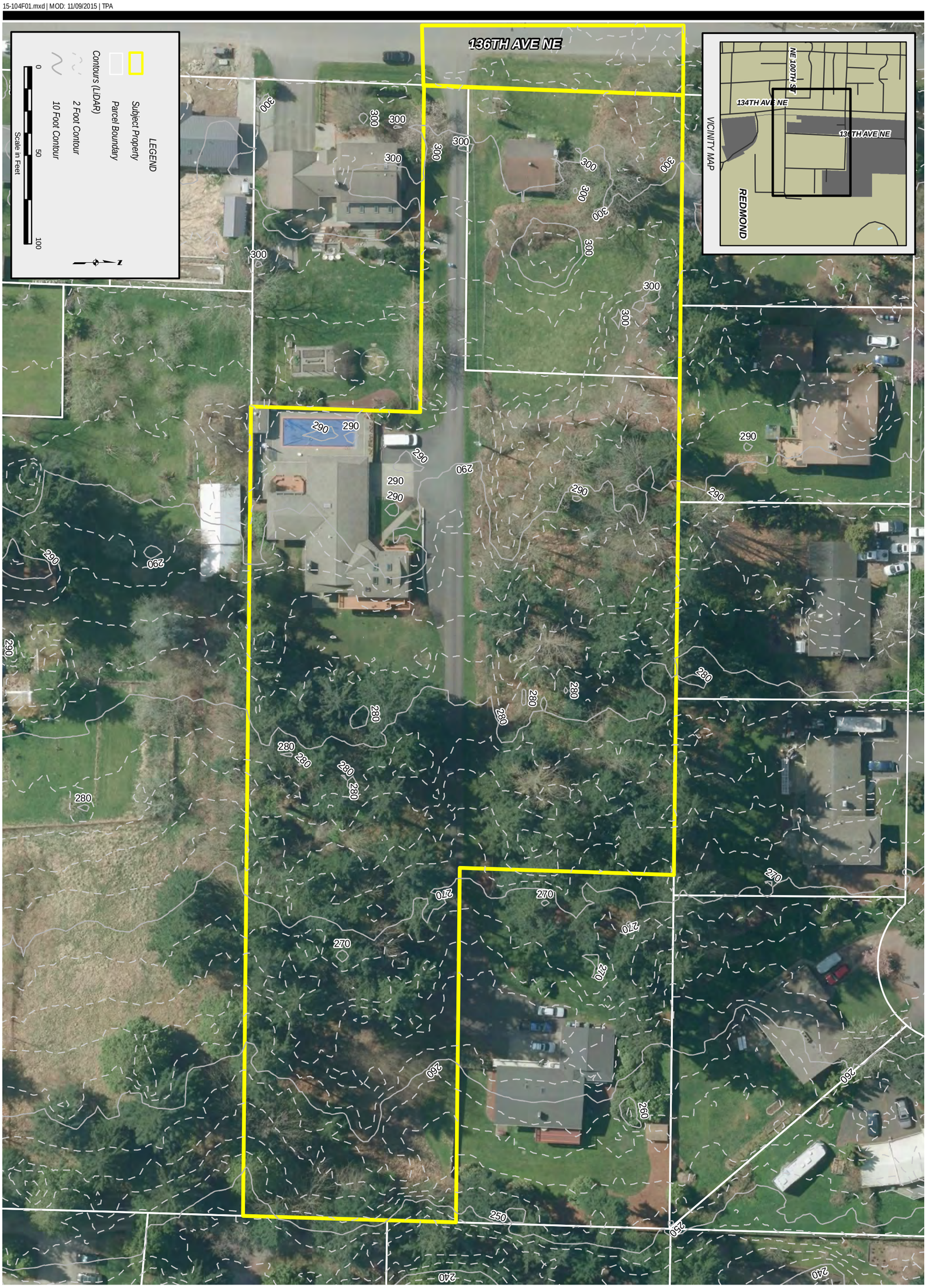
MILESTONE NW

GARBARINO

VICINITY MAP

15-104F01.mxd | MOD: 11/09/2015 | TPA



PROJECTION: WASHINGTON STATE PLANE, NORTH ZONE, NAD 83 HARN, FEET

REVISION:
JOB NUMBER: 15-104
DRAWING NAME: 15-104F2.0
DESIGNER: T.ABBOTT
DRAWING BY: T.ABBOTT
DATE: 11-09-15
SCALE: AS SHOWN
JURISDICTION: REDMOND

FIGURE: 2.0

MILESONTE NW

GARBARINO

EXISTING CONDITIONS MAP

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SOURCE INFORMATION

SOURCE AGENCY	DESCRIPTION
CITY OF REDMOND	COLOR AERIAL PHOTO (2009)
KING COUNTY GIS	CONTOURS - GENERATED FROM BARE EARTH LIDAR (KING COUNTY). THIS DATA HAS A STATED VERTICAL ACCURACY OF APPROXIMATELY 1 FOOT.
KING COUNTY GIS	PARCEL BOUNDARY, HYDROLOGY

2.0 CONDITIONS AND REQUIREMENTS SUMMARY

This project is vested under the Redmond Municipal Code (RMC), Redmond Zoning Code (RZC), specific zoning code referenced RIN, and the Redmond Stormwater Technical Notebook. The 2014 Ecology Manual as modified by the Western Washington Phase II Municipal Stormwater Permit regulates issues not addressed by the RMC, RZC and Stormwater Notebook. Existing residential construction exists on the properties; however, this project will be considered new development per Section 2.4 of the 2017 City of Redmond Stormwater Technical Notebook, which notes that all single-family developments including the subdivision of property will be classified as such. Figure I-2.4.1 of the 2017 Redmond Stormwater Technical Notebook was utilized to determine the applicability minimum requirements for the project. The project proposed to add more than 10,000 square feet of new impervious surface and more than 5,000 SF of new PGIS, designating the project as "New Development" per Figure I-2.4.1. See copy of Figure I-2.4.1 in Appendix 2-A for the highlighted assumptions of the project designation based on proposed landcover quantities. All minimum requirements apply to the new impervious surfaces and converted pervious surfaces. The minimum requirements are addressed as follows.

Requirement #1: Preparation of Stormwater Site Plans

This drainage report and associated plans contains all information and requirements for Stormwater Site Plans listed in Chapter 3, Volume I of the 2014 Ecology Manual. The project is listed in a Wellhead Zone as shown in the City of Redmond Wellhead Protection Zone Map. See copy attached in appendix 3-D for reference. As per section 2.5.6 of the 2017 City of Redmond Stormwater Management Technical Notebook, "Basic" treatment facilities are required by this project.

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

The Construction Stormwater Pollution Prevention Plan will be included as a separate document at a future submittal.

Requirement #3: Source Control of Pollution

Source control BMPs are not required for residential development per the 2014 Ecology Manual.

Requirement #4: Preservation of Natural Drainage System and Outfalls

Natural drainage patterns will be maintained onsite and discharge from the project site will occur in historical patterns across the easterly property line. All discharge from the site is within the same threshold discharge basin. The proposed discharge of the site's runoff will not cause significant adverse impact to downstream receiving waters or downgradient properties. Mitigated flows will be released at required rates and durations.

Requirement #5: On-Site Stormwater Management

See Section 4 of this report for how this minimum requirement is addressed.

Pending the Geotechnical investigation of the site soils and underlying geology onsite stormwater management BMP's will be more fully addressed in a future submittal.

Preliminary investigation of USGS soil mapping indicates that the site is underlain by till soils, and onsite stormwater management will be limited to applications of soil augmentation per COR Det. 632 on all disturbed area to be landscaped.

Requirement #6: Runoff Treatment

See Section 4 of this report for how this minimum requirement is addressed. A Combined Detention/Wetvault will be utilized to address basic water quality treatment requirements.

Requirement #7: Flow Control

See Section 4 of this report for how this minimum requirement is addressed. Flow Control requirements will be met for the project with a Combined Detention/Wetvault that will release flow at required, mitigated rates based an approved continuous runoff model (WWHM 4).

Requirement #8: Wetlands Protection

Per the City's Critical Areas Mapping, there are no wetlands on the project site.

Requirement #9: Operations and Maintenance

A Maintenance and Operations Manual will be created for this project. Please refer to Appendix 10-A in Section 10 for this document.

APPENDIX 2-A

FLOW CHART

FOR DETERMINING REQUIREMENTS OF NEW DEVELOPMENTS

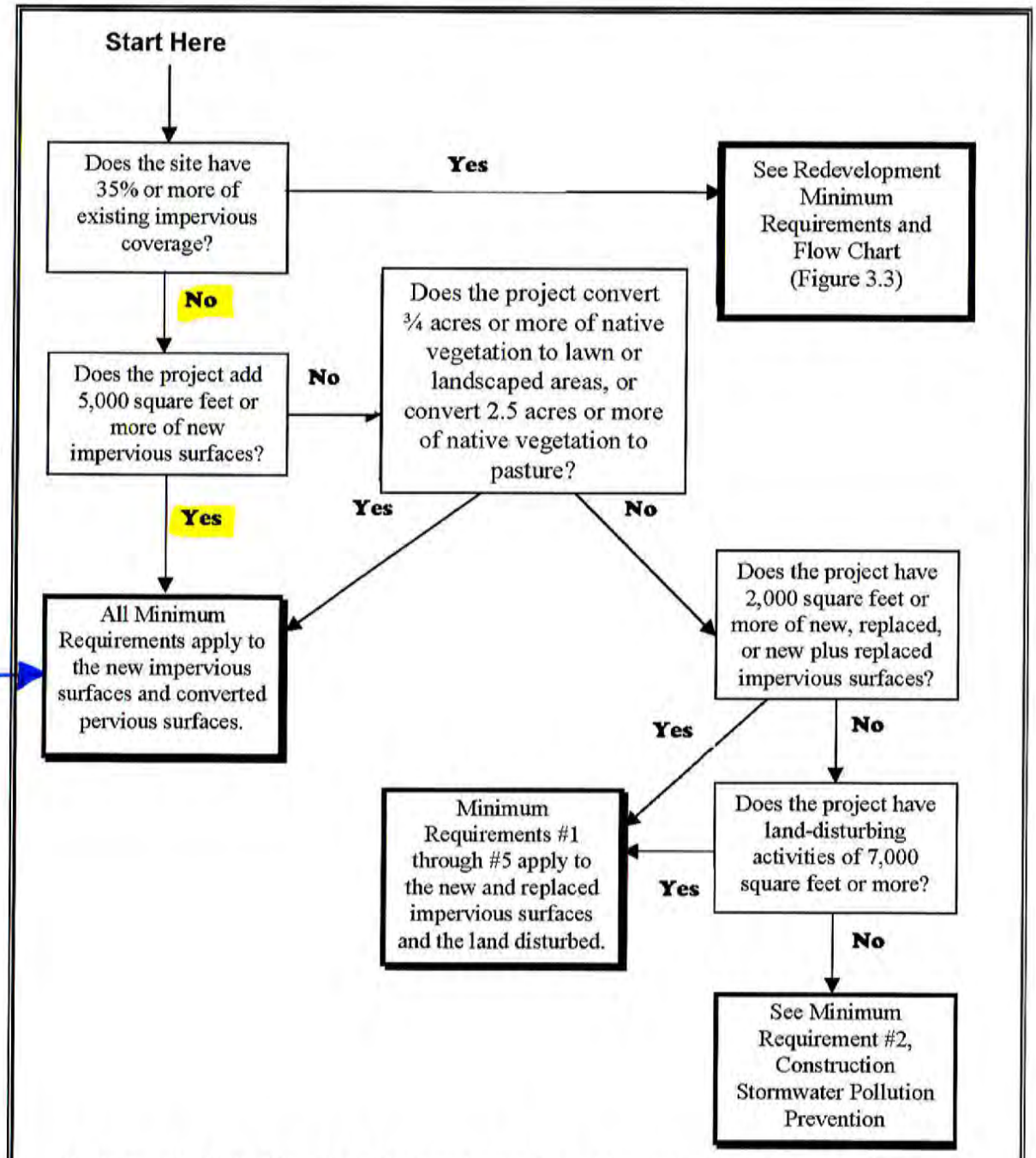


Figure 3.2 Flow Chart for Determining Requirements for New Development

3.0 OFF-SITE ANALYSIS

On Wednesday November 11, 2015, A Downstream Analysis was performed at the site. The weather was dry and approximately 49°F. The ground was damp due to continual rain over the previous days, no overland flow or pooling was observed. Per King County Imap diligence research no drainage complaints were found on or adjacent to the site within a 0.25-mile analysis. The following observations were verified during this visit.

Upstream Analysis

From the site observation and evaluation of available, King County LiDAR and aerial photography, there is no appreciable upstream run-on flow adjacent parcels to the site.

Field Inspection/Downstream Analysis

Flow path #1:

Onsite stormwater runoff flows generally west to east. On the east side of the property there are two flow paths that carry runoff from the site; (1) Southeastern Culvert and ❹ Northeastern culvert described below. Both enter a 12" concrete culvert❶ and travel east to where the culvert outfalls into an open drainage channel. Flows follow this channel easterly down a steep slope to where they enter the City of Redmond storm drainage network via structure with trash rack❷ at the base of the slope. Stormwater flows through a 12" PVC pipe from the structure to a catch basin❸ in the parking lot behind PRO Sports Club parcel #9430050050. The flows collected in the City of Redmond MS4, cross Willows Road and are conveyed east to the Sammamish River.

Flow path #2:

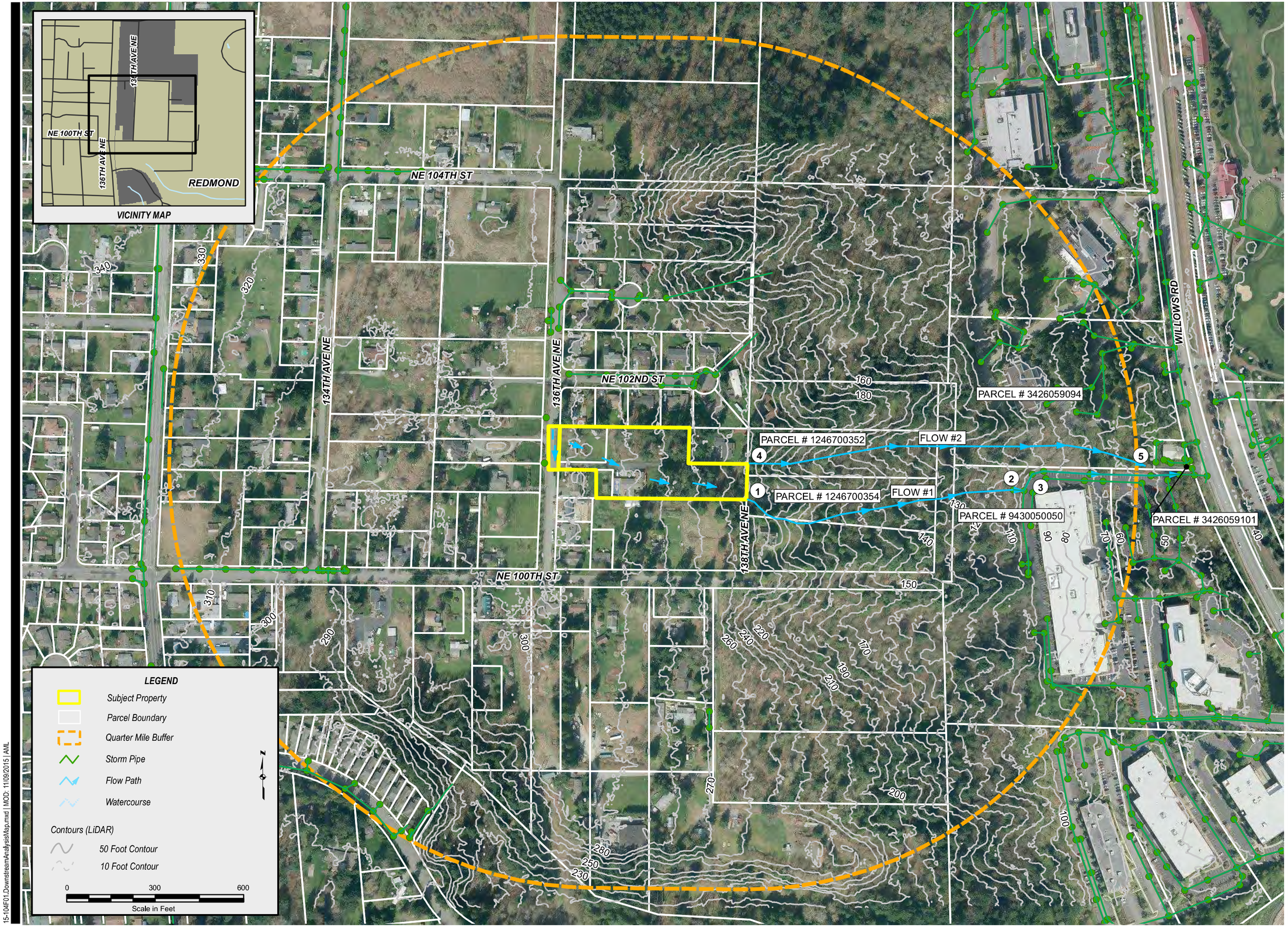
The Northeastern portion of the runoff❹ flows over the Eastern property boundary via overland flow and crosses a gravel access easement via sheet flow. Runoff enters a defined ravine and drains roughly 500ft down the steeply sloped hill of parcel #1246700352 and then splits into two channels. The southern channelized flow to❺ is

collected on parcel #34260559101 where it enters the City of Redmond storm drainage network on the private property of parcel #34260559101. At this point, flow crosses the 0.25 mile boundary of analysis. See Figure 6, Downstream Analysis Map, located in Appendix 3-A, for a detailed map of the downstream flow paths.

APPENDIX 3-A

DOWNSTREAM

ANALYSIS & MAPPING



15-104F01.DownstreamAnalysisMap.mxd | MOD: 11/09/2015 | AML

SOURCE INFORMATION

SOURCE AGENCY	DESCRIPTION
CITY OF REDMOND	COLOR AERIAL PHOTO (2009)
KING COUNTY GIS	CONTOURS - GENERATED FROM BARE EARTH LIDAR (KING COUNTY). THIS DATA HAS A STATED VERTICAL ACCURACY OF APPROXIMATELY 1 FOOT.
KING COUNTY GIS	PARCEL BOUNDARY, HYDROLOGY

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MILESTONE NW

GARBARINO
DOWNSTREAM ANALYSIS MAP

PROJECTION: WASHINGTON STATE PLANE, NORTH ZONE, NAD 83 HARN, FEET

REVISION:
JOB NUMBER: 15-104
DRAWING NAME: 15-104F2.0
DESIGNER: T.ABBOTT
DRAWING BY: A.LAUCK
DATE: 11-11-15
SCALE: AS SHOWN
JURISDICTION: REDMOND

FIGURE:
3.0

Stormwater flows under 138th Ave NE here via a culvert❶. The culvert outfalls into the brush in the center of the photo.

Stormwater enters this structure❷ at the base of the hill

Discharge ❹ looking downgradient on parcel #1246700352

Natural channel❺ looking upstream on parcel #3426059094

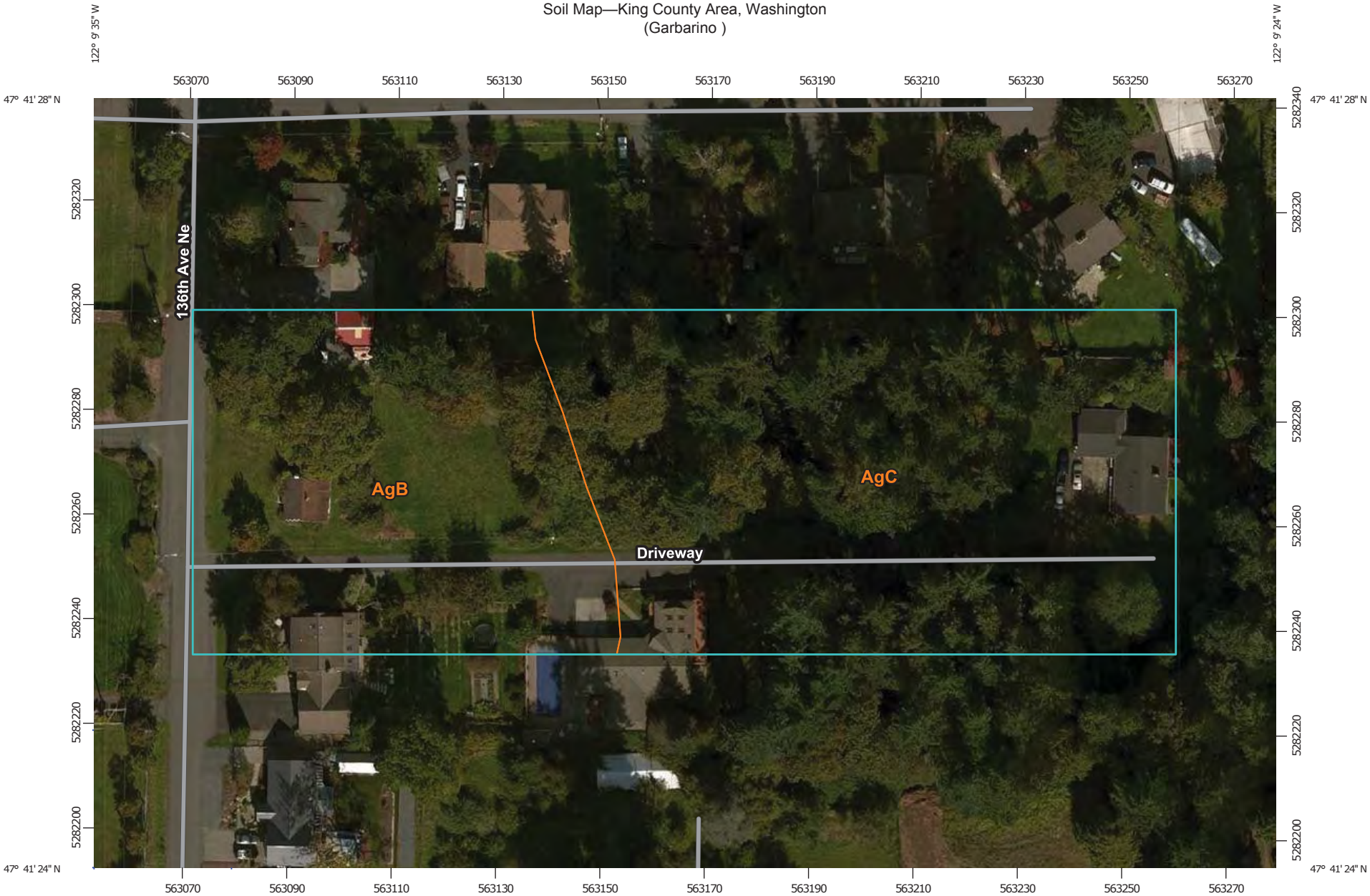
APPENDIX 3-B

CRITICAL AREAS MAPPING

APPENDIX 3-C

SCS AND USGS SOIL SURVEY MAPPING

Soil Map—King County Area, Washington
(Garbarino)



Map Scale: 1:1,040 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 15 30 60 90

Feet: 0 50 100 200 300

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

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Unit Polygons

Soil Map Unit Lines

Soil Map Unit Points

Special Point Features

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

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

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

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

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

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

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

Soil Survey Area: King County Area, Washington
Survey Area Data: Version 11, Sep 14, 2015

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

Date(s) aerial images were photographed: Aug 31, 2013—Oct 6, 2013

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

Map Unit Legend

King County Area, Washington (WA633)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
AgB	Alderwood gravelly sandy loam, 0 to 8 percent slopes	1.2	39.7%
AgC	Alderwood gravelly sandy loam, 8 to 15 percent slopes	1.9	60.3%
Totals for Area of Interest		**3.1**	**100.0%**

King County Area, Washington

AgC—Alderwood gravelly sandy loam, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2t626
Elevation: 50 to 800 feet
Mean annual precipitation: 20 to 60 inches
Mean annual air temperature: 46 to 52 degrees F
Frost-free period: 160 to 240 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Alderwood and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Alderwood

Setting

Landform: Ridges, hills
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Nose slope, talf
Down-slope shape: Linear, convex
Across-slope shape: Convex
Parent material: Glacial drift and/or glacial outwash over dense glaciomarine deposits

Typical profile

A - 0 to 7 inches: gravelly sandy loam
Bw1 - 7 to 21 inches: very gravelly sandy loam
Bw2 - 21 to 30 inches: very gravelly sandy loam
Bg - 30 to 35 inches: very gravelly sandy loam
2Cd1 - 35 to 43 inches: very gravelly sandy loam
2Cd2 - 43 to 59 inches: very gravelly sandy loam

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: 20 to 39 inches to densic material
Natural drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: About 18 to 37 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 2.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: B

Other vegetative classification: Limited Depth Soils (G002XN302WA), Limited Depth Soils (G002XS301WA), Limited Depth Soils (G002XF303WA)

Minor Components

Everett

Percent of map unit: 5 percent
Landform: Eskers, kames, moraines
Landform position (two-dimensional): Shoulder, footslope
Landform position (three-dimensional): Crest, base slope
Down-slope shape: Convex
Across-slope shape: Convex

Indianola

Percent of map unit: 5 percent
Landform: Eskers, kames, terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear

Shalcar

Percent of map unit: 3 percent
Landform: Depressions
Landform position (three-dimensional): Dip
Down-slope shape: Concave
Across-slope shape: Concave

Norma

Percent of map unit: 2 percent
Landform: Depressions, drainageways
Landform position (three-dimensional): Dip
Down-slope shape: Concave, linear
Across-slope shape: Concave

Data Source Information

Soil Survey Area: King County Area, Washington
Survey Area Data: Version 11, Sep 14, 2015

King County Area, Washington

AgB—Alderwood gravelly sandy loam, 0 to 8 percent slopes

Map Unit Setting

National map unit symbol: 2t625
Elevation: 50 to 800 feet
Mean annual precipitation: 25 to 60 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 160 to 240 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Alderwood and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Alderwood

Setting

Landform: Ridges, hills
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Crest, talf
Down-slope shape: Linear, convex
Across-slope shape: Convex
Parent material: Glacial drift and/or glacial outwash over dense glaciomarine deposits

Typical profile

A - 0 to 7 inches: gravelly sandy loam
Bw1 - 7 to 21 inches: very gravelly sandy loam
Bw2 - 21 to 30 inches: very gravelly sandy loam
Bg - 30 to 35 inches: very gravelly sandy loam
2Cd1 - 35 to 43 inches: very gravelly sandy loam
2Cd2 - 43 to 59 inches: very gravelly sandy loam

Properties and qualities

Slope: 0 to 8 percent
Depth to restrictive feature: 20 to 39 inches to densic material
Natural drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: About 18 to 37 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 2.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: B

Other vegetative classification: Limited Depth Soils (G002XN302WA), Limited Depth Soils (G002XF303WA), Limited Depth Soils (G002XS301WA)

Minor Components

Mckenna

Percent of map unit: 5 percent
Landform: Depressions, drainageways
Landform position (three-dimensional): Dip
Down-slope shape: Concave, linear
Across-slope shape: Concave

Everett

Percent of map unit: 5 percent
Landform: Eskers, kames, moraines
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Interfluve, crest
Down-slope shape: Convex
Across-slope shape: Convex

Shalcar

Percent of map unit: 3 percent
Landform: Depressions
Landform position (three-dimensional): Dip
Down-slope shape: Concave
Across-slope shape: Concave

Norma

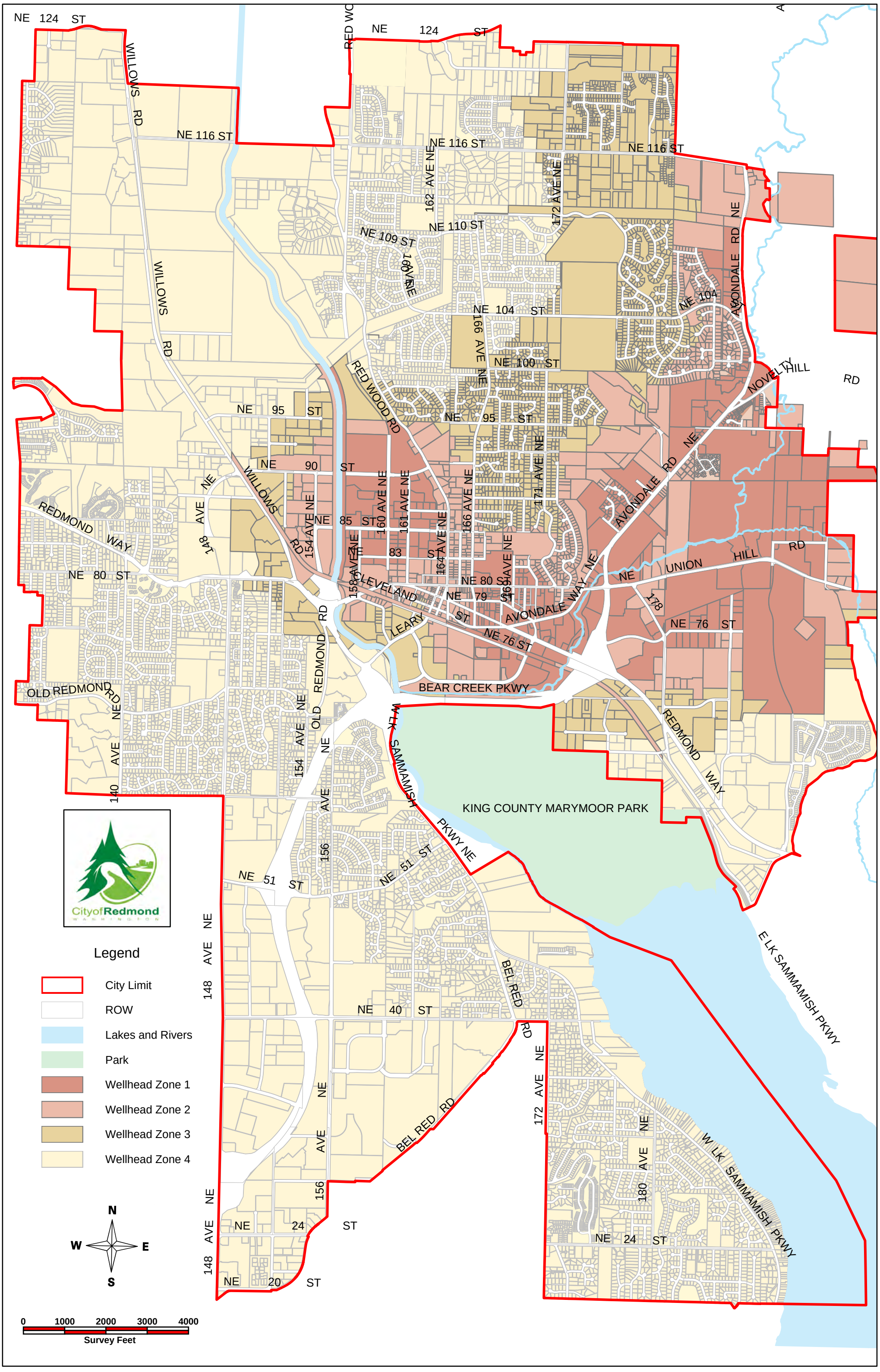
Percent of map unit: 2 percent
Landform: Depressions, drainageways
Landform position (three-dimensional): Dip
Down-slope shape: Concave, linear
Across-slope shape: Concave

Data Source Information

Soil Survey Area: King County Area, Washington
Survey Area Data: Version 11, Sep 14, 2015

APPENDIX 3-D

REDMOND WELLHEAD PROTECTION MAP


NE 124 ST
WILLOWS RD
NE 116 ST
RED WOOD RD
162 AVE NE
172 AVE NE
NE 110 ST
NE 109 ST
160 AVE NE
NE 104 ST
166 AVE NE
NE 100 ST
AVONDALE RD NE
NOVELTY HILL RD
NE 95 ST
171 AVE NE
NE 90 ST
REDMOND WAY
148 AVE NE
154 AVE NE
NE 85 ST
160 AVE NE
161 AVE NE
164 AVE NE
166 AVE NE
NE 83 ST
158 AVE NE
NE 80 ST
CLEVELAND ST
NE 79 ST
LEARY WAY NE
NE 76 ST
178 AVE NE
NE UNION HILL RD
BEAR CREEK PKWY
OLD REDMOND RD
154 AVE NE
140 AVE NE
156 AVE NE
WILK SAMMAMISH PKWY NE
KING COUNTY MARYMOOR PARK
NE 51 ST
148 AVE NE
BEL RED RD
NE 40 ST
172 AVE NE
180 AVE NE
W LK SAMMAMISH PKWY
E LK SAMMAMISH PKWY
NE 24 ST
NE 20 ST
CityofRedmond
WASHINGTON
Legend
City Limit
ROW
Lakes and Rivers
Park
Wellhead Zone 1
Wellhead Zone 2
Wellhead Zone 3
Wellhead Zone 4
N
W
E
S
0 1000 2000 3000 4000
Survey Feet

APPENDIX 3-E

REDMOND WATERSHED MAP

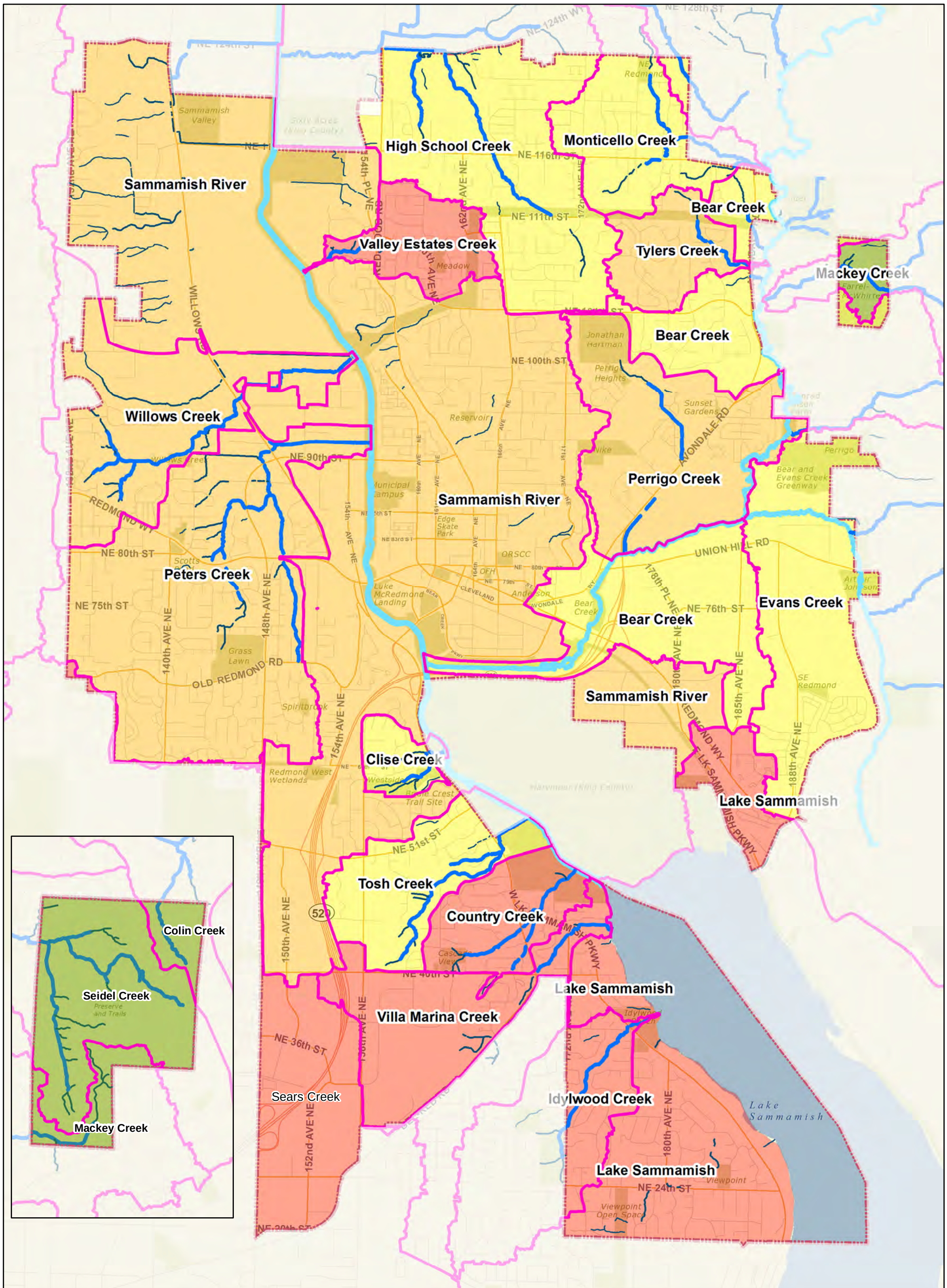


Figure 4.3 - Management Priorities for Watersheds in the City of Redmond

City of Redmond, Washington
09/11/2013

0 3,000 6,000 Feet

CityofRedmond WASHINGTON

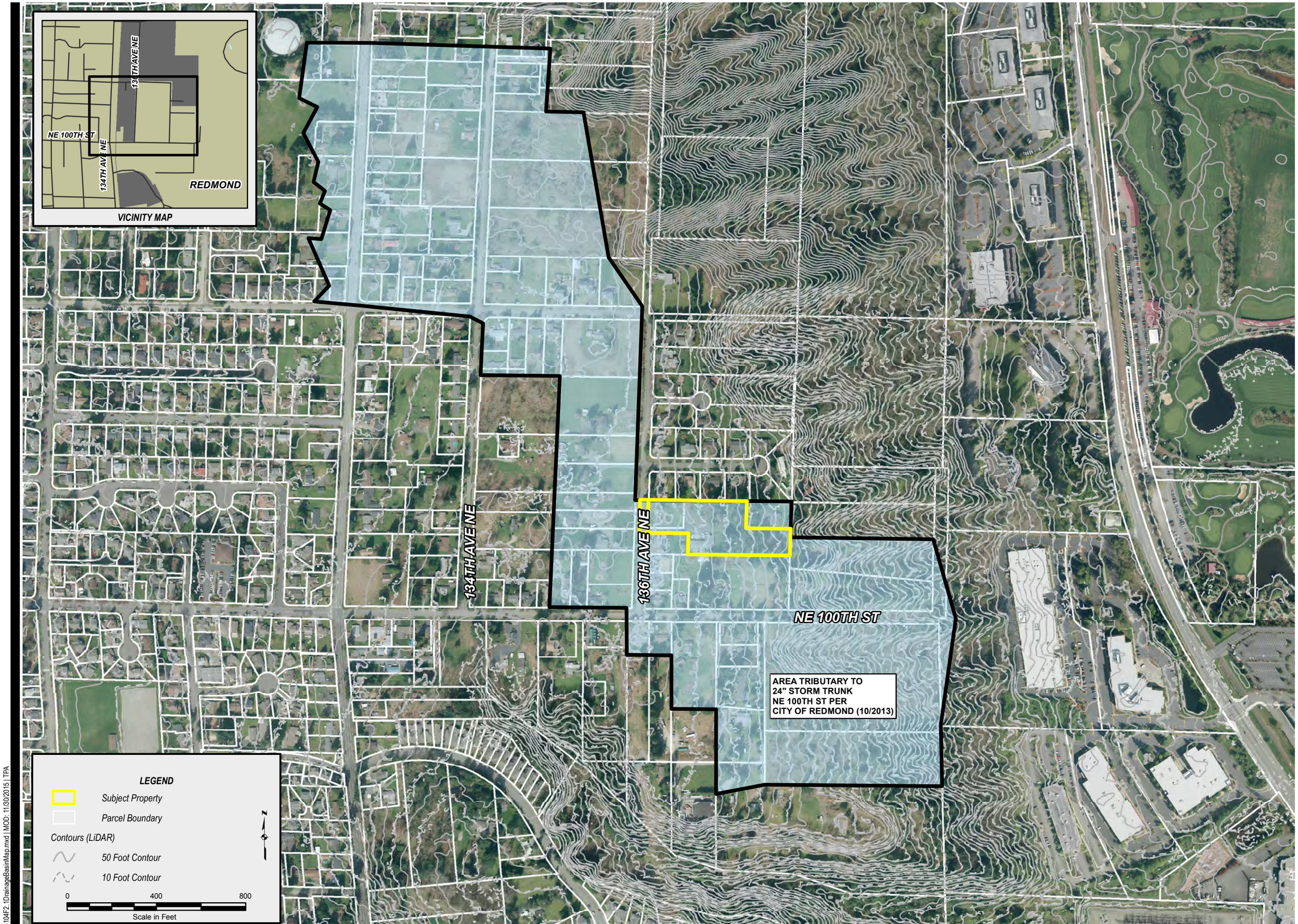
Disclaimer: This map is created and maintained by the Natural Resources Division of the City of Redmond, Washington, for reference purposes only. The City makes no guarantee as to the accuracy or completeness of the features shown on this map.

Legend

- Class I Stream
- Class II Stream
- Class III Stream
- Class IV Stream
- City Limits
- Watershed Boundary
- Protection
- Highest Restoration
- Restoration
- Restoration/Development

APPENDIX 3-F

REDMOND DRAINAGE BASIN MAP



15-104F2.1DrainageBasinMap.mxd | MOD: 11/30/2015 | TPA

SOURCE INFORMATION

SOURCE AGENCY	DESCRIPTION
CITY OF REDMOND	COLOR AERIAL PHOTO (2009)
KING COUNTY GIS	CONTOURS - GENERATED FROM BARE EARTH LIDAR (KING COUNTY). THIS DATA HAS A STATED VERTICAL ACCURACY OF APPROXIMATELY 1 FOOT.
KING COUNTY GIS	PARCEL BOUNDARY, HYDROLOGY

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Commercial
Infrastructure
Residential

MILESTONE NW

GARBARINO

ROSE HILL DRAINAGE BASIN

PROJECTION: WASHINGTON STATE PLANE, NORTH ZONE, NAD 83 HARN, FEET

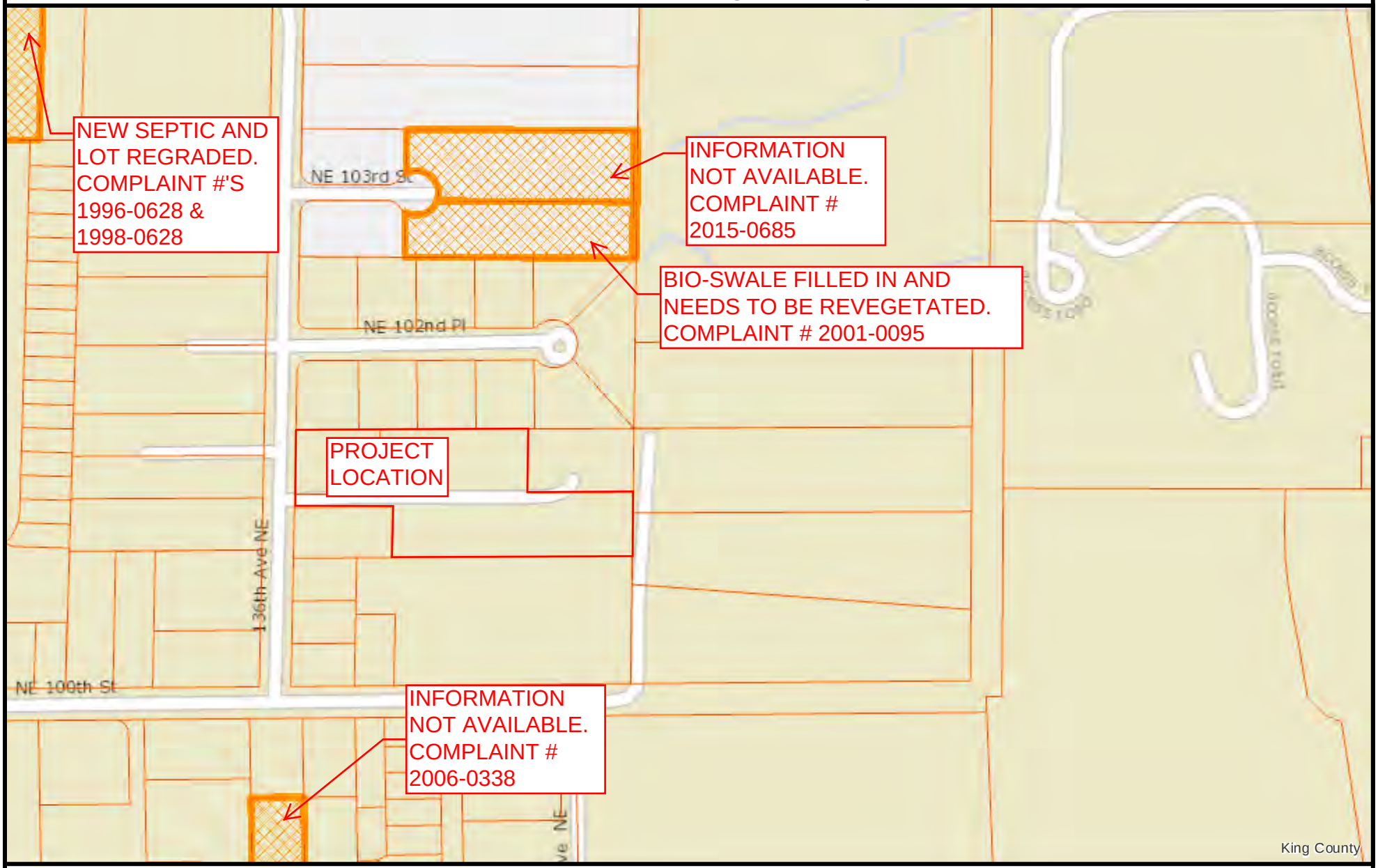
REVISION:
JOB NUMBER: 15-104
DRAWING NAME: 15-104F2.1
DESIGNER: T.ABBOTT
DRAWING BY: T.ABBOTT
DATE: 11-30-15
SCALE: AS SHOWN
JURISDICTION: REDMOND CO.

FIGURE:
3.1

APPENDIX 3-G

DRAINAGE COMPLAINTS

Garbarino - Drainage Complaints



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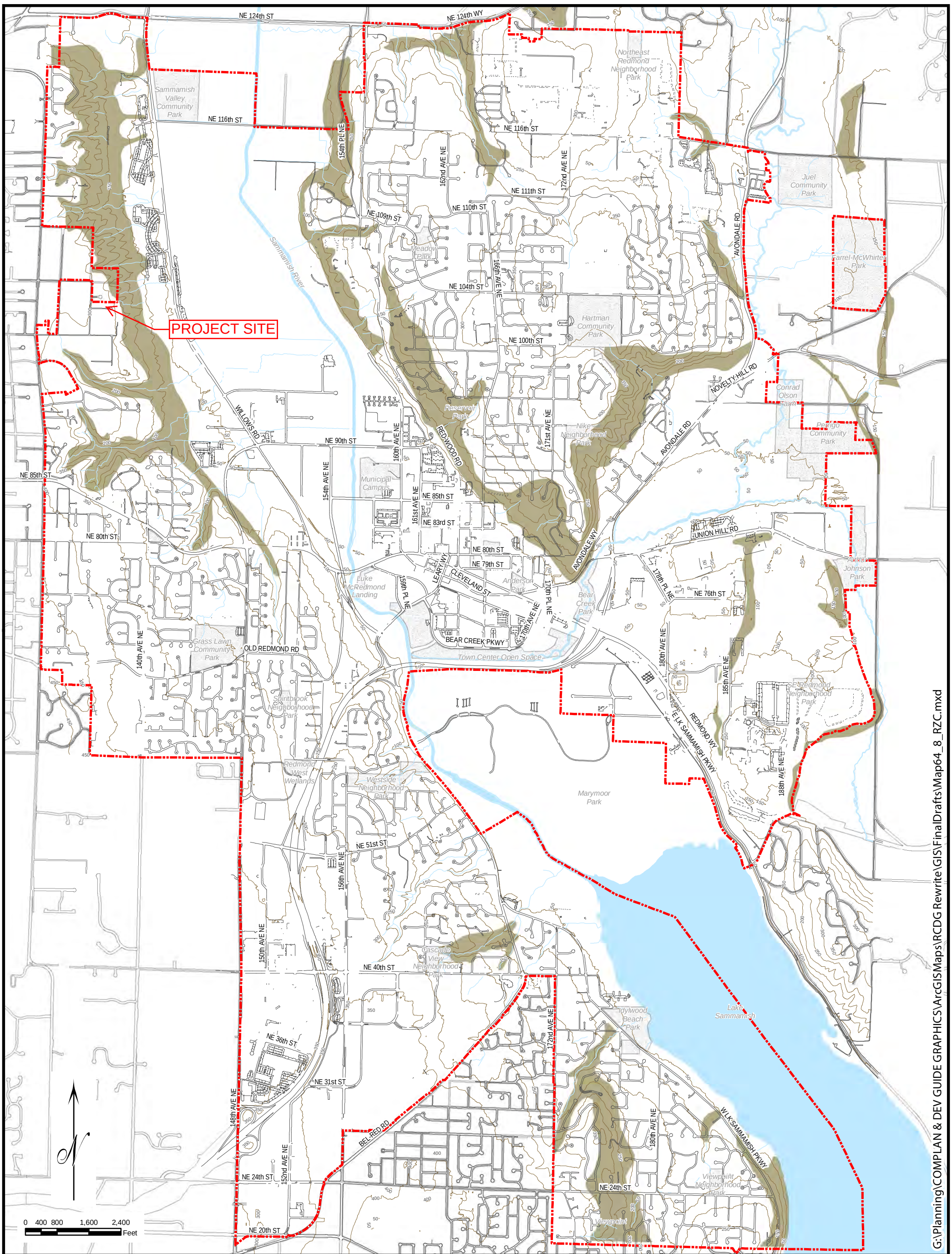
Date: 11/30/2015 Notes:

N

King County GIS Center

APPENDIX 3-H

EROSION HAZARD AREA MAP



City of Redmond

Critical Areas Map
Effective: April 16, 2011

Map 64.8 Erosion Hazard Areas

Legend:

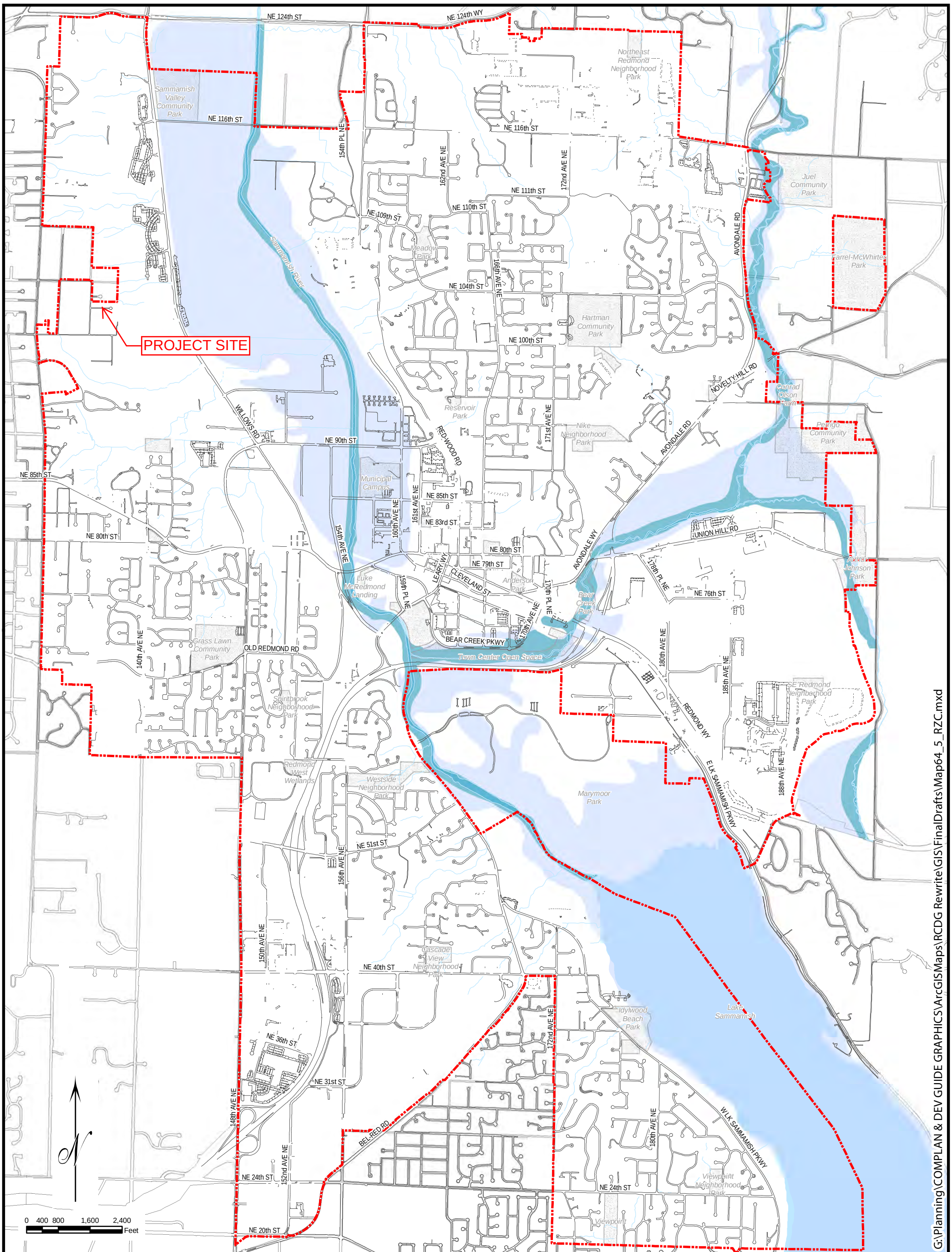
- Erosion Hazard Areas
- Contours
- Redmond City Limits

Sources:
SCS Soil Survey

Note:
This map shall be used as a general guide. It represents approximate locations. Consult the Critical Areas Ordinance (CAO) for reporting requirements. In the event there is a conflict between the map and the criteria or standards of the CAO, the criteria shall prevail.

APPENDIX 3-I

FREQUENTLY FLOODED AREA MAP



City of Redmond

Critical Areas Map
Effective: April 16, 2011

Map 64.5 Frequently Flooded Areas

Legend:

- 100 Year Floodplain
- FEMA Floodway
- Redmond City Limits

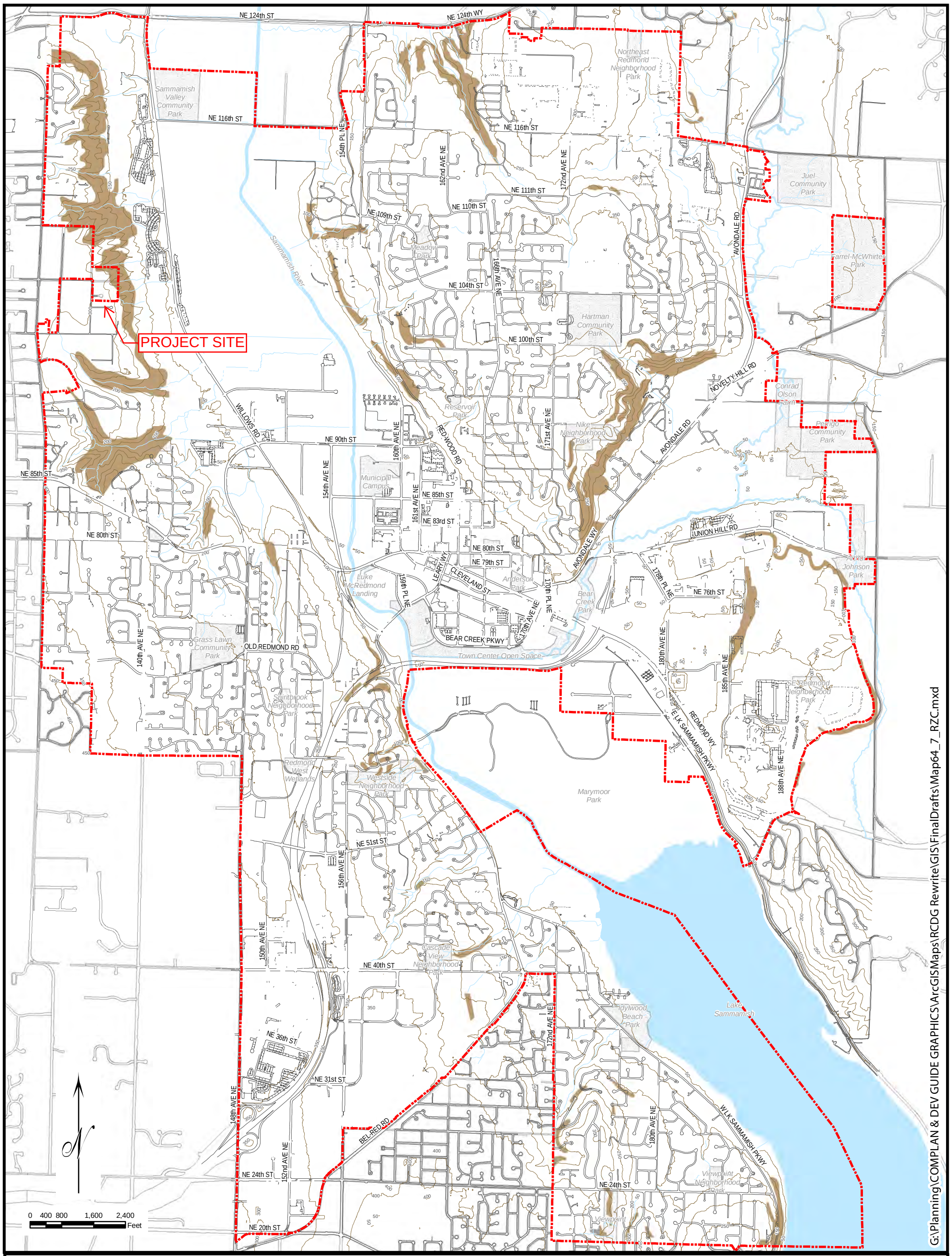
Sources:
FEMA Flood Insurance Rate Maps

Note:
This map shall be used as a general guide. It represents approximate locations. Consult the Critical Areas Ordinance (CAO) for reporting requirements. In the event there is a conflict between the map and the criteria or standards of the CAO, the criteria shall prevail.

G:\Planning\COMPLAN & DEV GUIDE GRAPHICS\ArcGISMaps\RCDG Rewrite\GIS\FinalDrafts\Map64_5_RZC.mxd

APPENDIX 3-J

LANDSLIDE HAZARD AREA MAP



G:\Planning\COMPLAN & DEV GUIDE GRAPHICS\ArcGISMaps\RCDG Rewrite\GIS\FinalDrafts\Map64_7_RZC.mxd

City of Redmond

Critical Areas Map
Effective: April 16, 2011

Map 64.7 Landslide Hazard Areas

Legend:

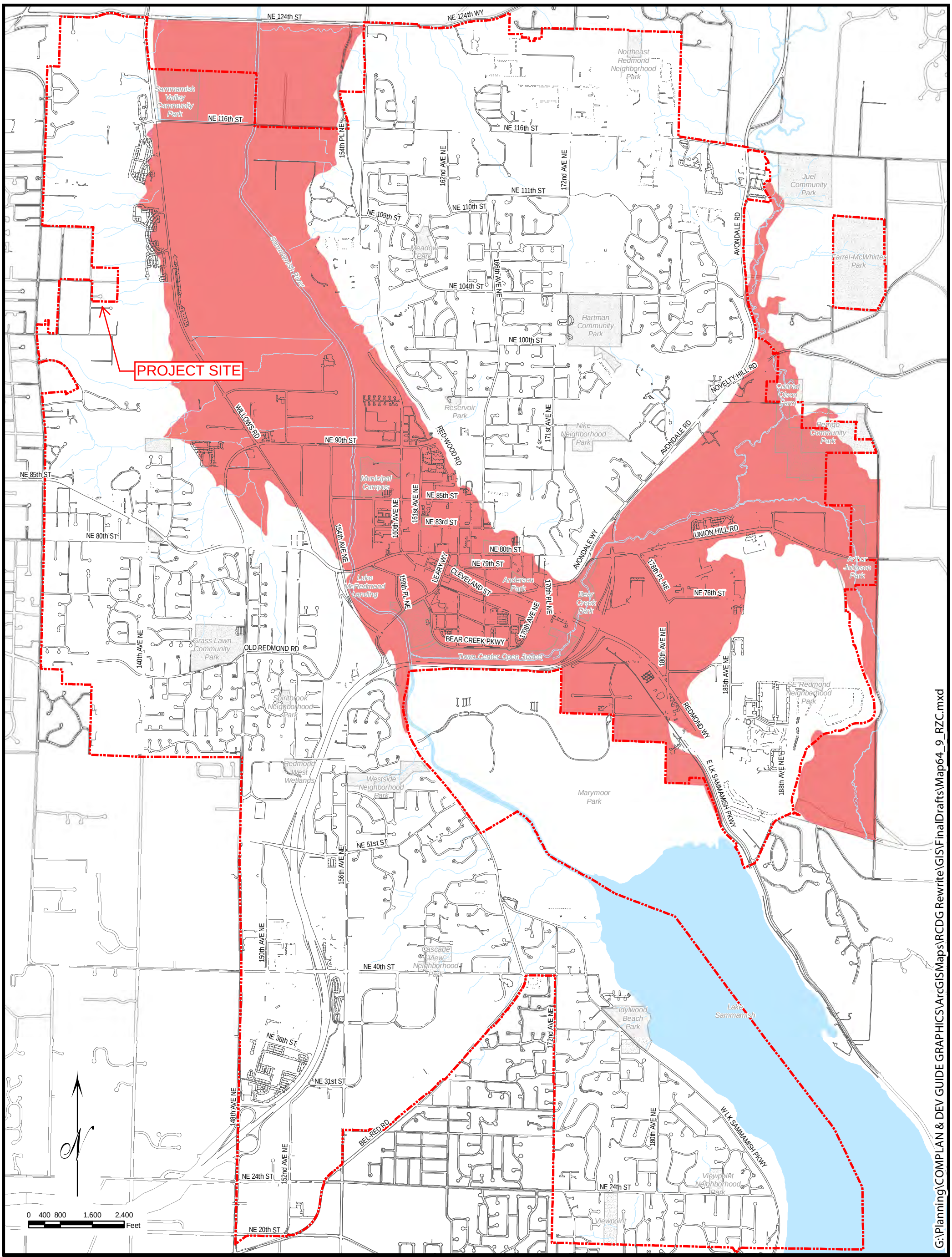
- Landslide Hazard Areas
- Contours
- Redmond City Limits

Sources:
USGS Topographic Maps
USGS Geologic Maps

Note:
This map shall be used as a general guide. It represents approximate locations. Consult the Critical Areas Ordinance (CAO) for reporting requirements. In the event there is a conflict between the map and the criterial or standards of the CAO, the criteria shall prevail.

APPENDIX 3-K

SEISMIC HAZARD AREA MAP



G:\Planning\COMPLAN & DEV GUIDE GRAPHICS\ArcGISMaps\RCDG Rewrite\GIS\FinalDrafts\Map64_9_RZC.mxd

City of Redmond

Critical Areas Map
Effective: April 16, 2011

Map 64.9 Seismic Hazard Areas

Legend:

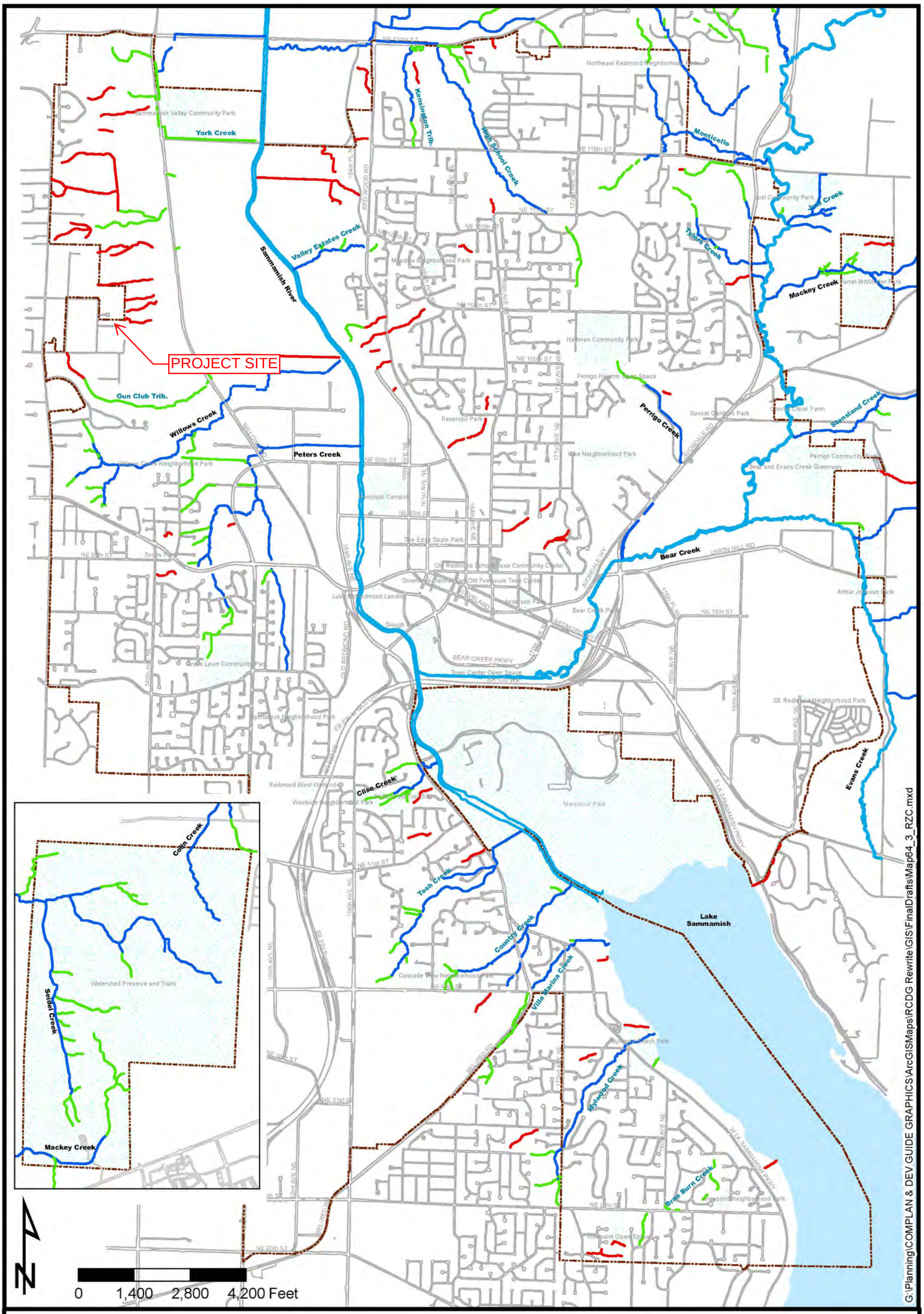
- Seismic Hazard Areas
- Redmond City Limits

Sources:
USGS Geologic Maps

Note:
This map shall be used as a general guide. It represents approximate locations. Consult the Critical Areas Ordinance (CAO) for reporting requirements. In the event there is a conflict between the map and the criteria or standards of the CAO, the criteria shall prevail.

APPENDIX 3-L

STREAM CLASSIFICATION MAP



City of Redmond

Critical Areas Map
Effective: September 1, 2012

Map 64.3 Streams Classification

Legend:

- Class I
- Class II
- Class III
- Class IV

Stream Official USGS Stream Name
Stream Informal Stream Name

Sources:
City of Redmond Public Works, Natural Resources Division
City of Redmond GIS Services
Washington Trout / Wild Fish Conservancy
King County GIS

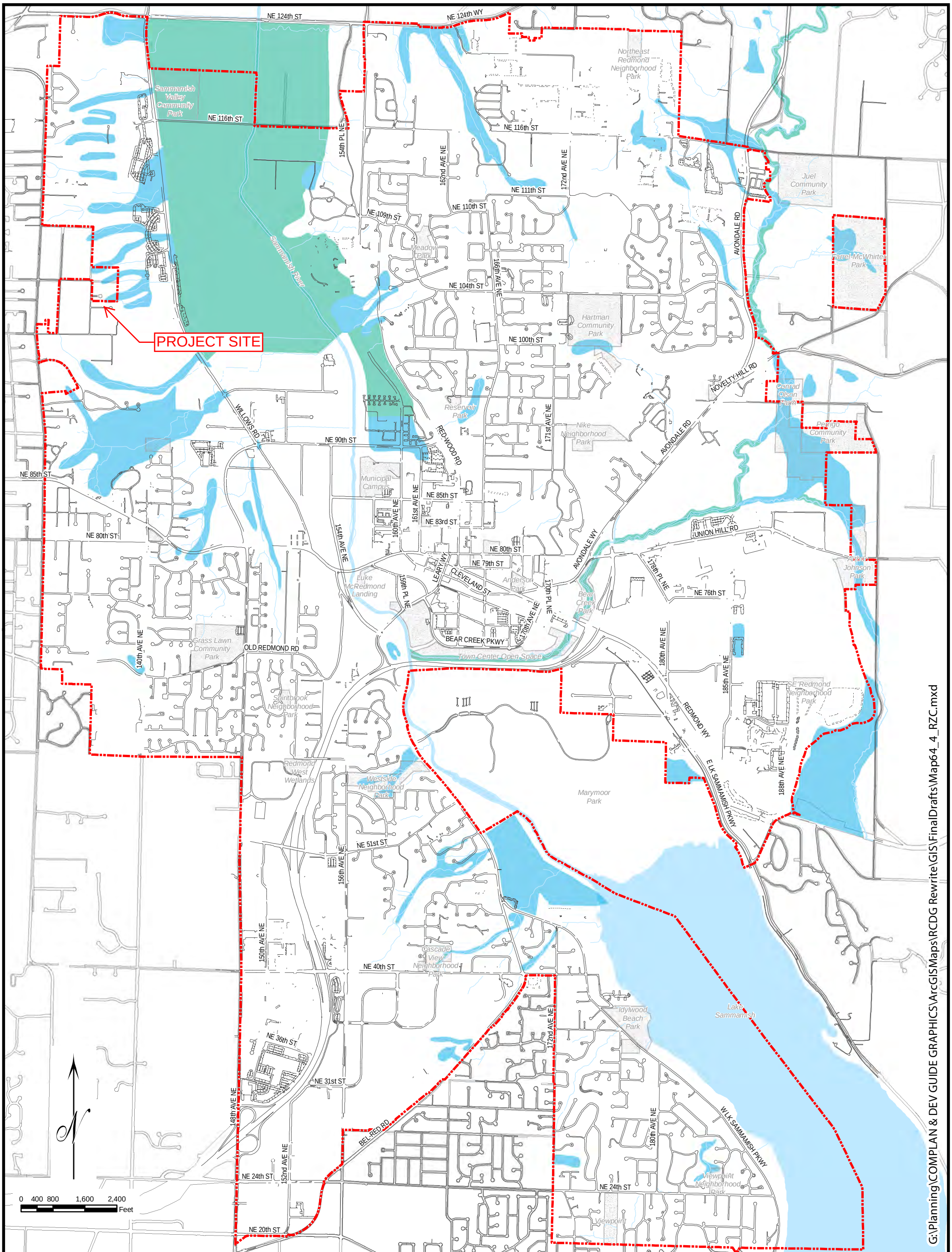
Note: This map shall be used as a general guide representing the approximate location of streams, per RZC 21.64.010(E)(2). The map does not necessarily ensure the presence or absence of streams. In the event of a conflict between the map and the criteria of the Critical Areas Ordinance (CAO), the criteria shall prevail. Consult the CAO (RZC 21.64) for reporting requirements

Note: Gaps in illustrated streams may indicate culverts, pipes, ponds, etc.

Note: Informal stream names may not conform to USGS policies and may change in the future.

APPENDIX 3M

WETLAND MAP



City of Redmond

Critical Areas Map
Effective: April 16, 2011

Map 64.4 Wetlands

Legend:

- Mixed Wetland/Upland
- Wetland
- Redmond City Limits

Sources:
USGS National Wetland Inventory
Aerial Photo Interpretation
SCS Soil Survey
City of Redmond

Note:
This map shall be used as a general guide. It represents approximate locations. Consult the Critical Areas Ordinance (CAO) for reporting requirements. In the event there is a conflict between the map and the criteria or standards of the CAO, the criteria shall prevail.

4.0 FLOW CONTROL AND WATER QUALITY FACILITY ANALYSIS AND DESIGN

The flow control and water quality requirements are vested under the Redmond Municipal Code (RMC), Redmond Zoning Code (RZC) and Redmond Stormwater Technical Notebook (2017). The 2014 Ecology Manual as modified by the Western Washington Phase II Municipal Stormwater Permit regulates issues not addressed by the RMC, RZC and Stormwater Notebook.

4.1 Pre-Developed Hydrology

(Onsite Basin)

The Onsite Basin is approximately 2.60 acres and is primarily covered with trees, some lawn area associated with existing landscaping and an existing residence. All acreage will be modeled as "forested" in the pre-developed condition.

Modeled Land Coverage:

Till Forested = 2.60 Acres

Frontage Basin

The Frontage Basin is approximately 0.09 acres. Frontage improvements associated with the project and pre-existing pavement in the 136th Ave NE ROW will be collected and routed to the onsite detention system in the developed condition. The 136th Ave NE frontage basin runoff currently flows west into a shallow swale/depression in the 136th Ave NE ROW. It is assumed that the small amount of flow from the pavement in the 136th Ave ROW that is tributary to this shallow swale infiltrates in this shallow depression as there is no visible outlet to the shallow swale/depression.

Because the frontage basin includes an area of pre-existing pavement (approximately 0.03 acres), this area has been included in the predeveloped modeling land cover. The existing pervious area to be converted in the developed condition has been modeled in the forested condition. WWHM modeled areas for this frontage basin in the predeveloped condition have been entered as follows:

Modeled Land Coverage:

Till Forested = 0.09 Acres

Basin areas and land covers for all predeveloped basins are additionally itemized and quantified in the spreadsheets below. For visual representation of the site basins in the predeveloped condition see Figure 3.0, "Predeveloped Hydrology Map".

Basin Calcs	*LDC, Inc.*	
	20210 142nd Ave NE Woodinville, WA 98072	Tel: (425) 806-1869 Fax: (425) 482-2893

Project Name:	Garbarino	Project No.:	15-104
Description:	Existing Basin(s)	Date:	5/14/2019
		Calc. By:	SJW

Existing Basins

Modeled Basin

	Area (Acres)	Impervious (%)	Impervious (Acres)	Lawn (Acres)	Forested (Acres)
Onsite Basin	**2.60**	**0%**	**0.00**	**0.00**	**2.60**
Total Onsite Area	**2.60**	**0%**	**0.00**	**0.00**	**2.60**

136th Ave NE Frontage	Area (Acres)	Impervious (%)	Impervious (Acres)	Lawn (Acres)	Forested (Acres)
Frontage	0.09	100%	0.00	0.00	0.09
Total	**0.09**	**0%**	**0.00**	**0.00**	**0.09**

Total Predeveloped Modeled Area	**2.69**	**0%**	**0**	**0**	**2.69**

15-104F03PredevelopedHydrologyMap.mxd | MOD: 1/21/2016 | TPA

SOURCE INFORMATION

SOURCE AGENCY	DESCRIPTION
CITY OF REDMOND	COLOR AERIAL PHOTO (2009)
KING COUNTY GIS	CONTOURS - GENERATED FROM BARE EARTH LIDAR (KING COUNTY). THIS DATA HAS A STATED VERTICAL ACCURACY OF APPROXIMATELY 1 FOOT.
KING COUNTY GIS	PARCEL BOUNDARY, HYDROLOGY

LDC
THE CIVIL ENGINEERING GROUP
Commercial
Infrastructure
Residential
14201 NE 200th St., #100
Woodinville, WA 98072
Ph. 425.806.1869
Fx. 425.482.2893
www.LDCcorp.com

MILESTONE NW

GARBARINO

PREDEVELOPED HYDROLOGY MAP

PROJECTION: WASHINGTON STATE PLANE, NORTH ZONE, NAD 83 HARN, FEET

REVISION:
JOB NUMBER: 15-104
DRAWING NAME: 15-104F3.0
DESIGNER: T.ABBOTT
DRAWING BY: A.LAUCK
DATE: 1-21-16
SCALE: AS SHOWN
JURISDICTION: REDMOND

FIGURE:

4.0

4.2 Developed Site Hydrology

The developed site for Garbarino will consist of impervious surface roofs, driveways, sidewalks, pavement, and landscaped areas. The Developed Site Hydrology for the site is are shown in Figure 4.

All developed basin runoff is conveyed to a single Combined Detention/Wetvault. Individual Basins are identified below, and are the basis for the developed condition and the Combined Detention/Wetvault sizing in WWHM. For visual representation of all basins in the forthcoming section, see Figure 4.0 "Developed Hydrology Map."

Water quality is provided via a Wetvault as identified within the Water Quality section 4.3.

<u>Onsite Basin</u>

In the developed condition the Onsite Basin is approximately 2.48 acres and includes the developed project site and open space. A portion of the basin cannot be collected and has been modeled as bypass. The Combined Detention/Wetvault will be constructed in the open space (Tract B) located on the southeast portion of the plat.

Modeled Land Coverage:

Till Lawn =	1.11 Acres
Pavement =	0.39 Acres
Roofs =	0.65 Acres
Driveway =	0.15 Acres
Sidewalk =	0.18 Acres

<u>Bypass</u>

In the developed condition a portion of the Onsite Basin in Tract B cannot be collected and has been modeled as bypass. See Figure 4.0 "Developed Hydrology Map" for the location of this bypass area. The following area coverages have been modeled as bypass in WWHM:

Modeled Land Coverage:

Till Lawn =	0.11 Acres
Pavement =	0.01 Acres

Frontage Basin

Runoff from the 136th Ave NE frontage improvements associated with the project will be collected and routed to the Combined Detention/Wetvault. The following area coverages have been modeled to account for this frontage area in WWHM:

Modeled Land Coverage:

Till Lawn =	0.02 Acres
Pavement =	0.05 Acres
Sidewalk =	0.02 Acres

Upstream Off-Site - Developed Condition

Based on topographical data that is no upstream drainage that flows onto the site.

Basin Calcs	*LDC, Inc.*	
	142201 NE 200th St. # 100 Woodinville, WA 98072	Tel: (425) 806-1869 Fax: (425) 482-2893

Project Name:	Garbarino	Project No.:	15-104
Description:	Developed Basin(s)	Date:	5/14/2019
		Calc. By:	SJW

Developed Basin

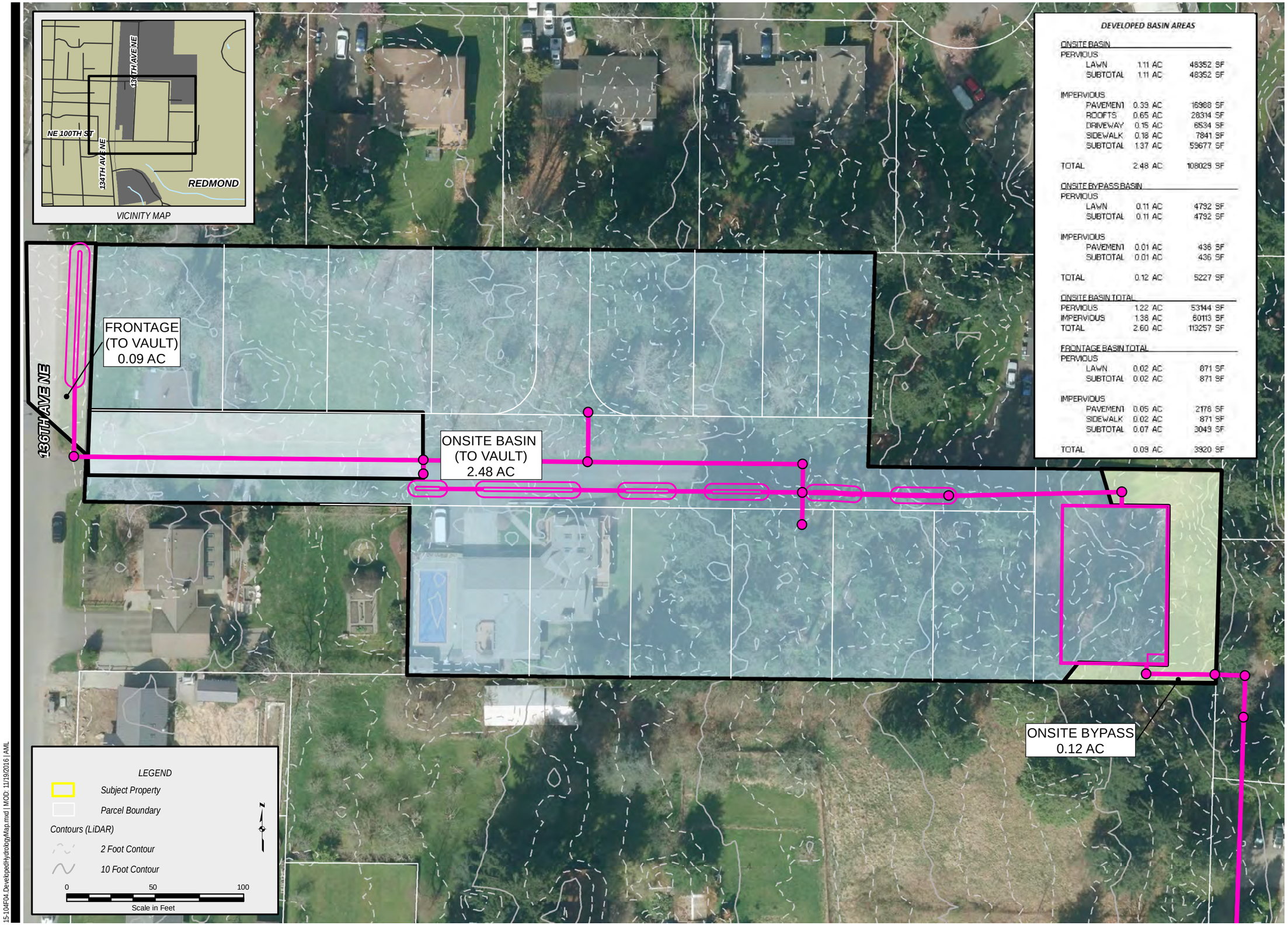
Onsite Basin (routed to Vault)

	Area (Acres)	Impervious (%)	Impervious (Acres)	Lawn (Acres)	Forested (Acres)	PGIS (Acres)
Lots	**1.62**	**55%**	**0.89**	**0.73**	**0.00**	**0.14**
Roofs	0.65	100.0%	0.65	0.00	0.00	0.00
Patio	0.10	100.0%	0.10	0.00	0.00	0.00
Lawn/Landscape	0.73	0.0%	0.00	0.73	0.00	0.00
Driveways	0.14	100.0%	0.14	0.00	0.00	0.14
ROW / Access Tracts	**0.59**	**68%**	**0.40**	**0.19**	**0.00**	**0.32**
Pavement	0.32	100%	0.32	0.00	0.00	0.32
Sidewalk	0.08	100%	0.08	0.00	0.00	0.00
Lawn/Landscape	0.19	0%	0.00	0.19	0.00	0.00
Driveways	0.00	0%	0.00	0.00	0.00	0.00
Open Space/Tracts	**0.27**	**27%**	**0.07**	**0.20**	**0.00**	**0.07**
Pavement	0.07	0%	0.07	0.00	0.00	0.07
Sidewalk	0.00	0%	0.00	0.00	0.00	0.00
Lawn/Landscape	0.20	0%	0.00	0.20	0.00	0.00
Total Onsite To Vault	**2.48**	**55%**	**1.37**	**1.11**	**0.00**	**0.54**
Onsite Bypass	**0.12**	**8%**	**0.01**	**0.11**	**0.00**	**0.01**
Pavement	0.01	0%	0.01	0.00	0.00	0.01
Lawn/Landscape	0.11	0%	0.00	0.11	0.00	0.00
Total Bypass	**0.12**	**8%**	**0.01**	**0.11**	**0.00**	**0.01**
Total Developed Area Onsite	**2.60**	**53%**	**1.38**	**1.22**	**0.00**	**0.55**

Offsite Frontge - 136th Ave NE

	Area (Acres)	Impervious (%)	Impervious (Acres)	Lawn (Acres)	Forested (Acres)	PGIS (Acres)
Frontage (to Vault)*	0.09	78%	0.07	0.02	0.00	0.01
Total To Vault	**2.57**	**56%**	**1.44**	**1.13**	**0.00**	**0.55**

* Includes 0.03 acres of existing pavement in 1`36th Ave that will remain in the developed condition.



DEVELOPED BASIN AREAS

ONSITE BASIN		
PERVIOUS		
LAWN	1.11 AC	48352 SF
SUBTOTAL	1.11 AC	48352 SF
IMPERVIOUS		
PAVEMENT	0.39 AC	16988 SF
ROOFTS	0.65 AC	28314 SF
DRIVEWAY	0.15 AC	6534 SF
SIDEWALK	0.18 AC	7841 SF
SUBTOTAL	1.37 AC	59677 SF
TOTAL	2.48 AC	108029 SF
ONSITE BYPASS BASIN		
PERVIOUS		
LAWN	0.11 AC	4792 SF
SUBTOTAL	0.11 AC	4792 SF
IMPERVIOUS		
PAVEMENT	0.01 AC	436 SF
SUBTOTAL	0.01 AC	436 SF
TOTAL	0.12 AC	5227 SF
ONSITE BASIN TOTAL		
PERVIOUS	1.22 AC	53144 SF
IMPERVIOUS	1.38 AC	60113 SF
TOTAL	2.60 AC	113257 SF
FRONTAGE BASIN TOTAL		
PERVIOUS		
LAWN	0.02 AC	871 SF
SUBTOTAL	0.02 AC	871 SF
IMPERVIOUS		
PAVEMENT	0.05 AC	2178 SF
SIDEWALK	0.02 AC	871 SF
SUBTOTAL	0.07 AC	3049 SF
TOTAL	0.09 AC	3920 SF

SOURCE INFORMATION

SOURCE AGENCY	DESCRIPTION
CITY OF REDMOND	COLOR AERIAL PHOTO (2009)
KING COUNTY GIS	CONTOURS - GENERATED FROM BARE EARTH LIDAR (KING COUNTY). THIS DATA HAS A STATED VERTICAL ACCURACY OF APPROXIMATELY 1 FOOT.
KING COUNTY GIS	PARCEL BOUNDARY, HYDROLOGY

LDC
THE CIVIL ENGINEERING GROUP
14201 NE 200th St., #100
Woodinville, WA 98072
Ph. 425.806.1869
Fx. 425.482.2893
www.LDCcorp.com

Commercial
Infrastructure
Residential

MILESTONE NW

GARBARINO

DEVELOPED HYDROLOGY MAP

PROJECTION: WASHINGTON STATE PLANE, NORTH ZONE, NAD 83 HARN, FEET

REVISION:
JOB NUMBER: 15-104
DRAWING NAME: 15-104F4.1
DESIGNER: T.ABBOTT
DRAWING BY: A.LAUCK
DATE: 9-9-19
SCALE: AS SHOWN
JURISDICTION: REDMOND

FIGURE:
4.1

15-104F04.DevelopedHydrologyMap.mxd | MOD: 11/19/2016 | AML

4.3 Design Standards for Water Quality

The flow control and water quality requirements are vested under the 2017 Redmond Stormwater Technical Notebook and the 2014 DOE Manual.

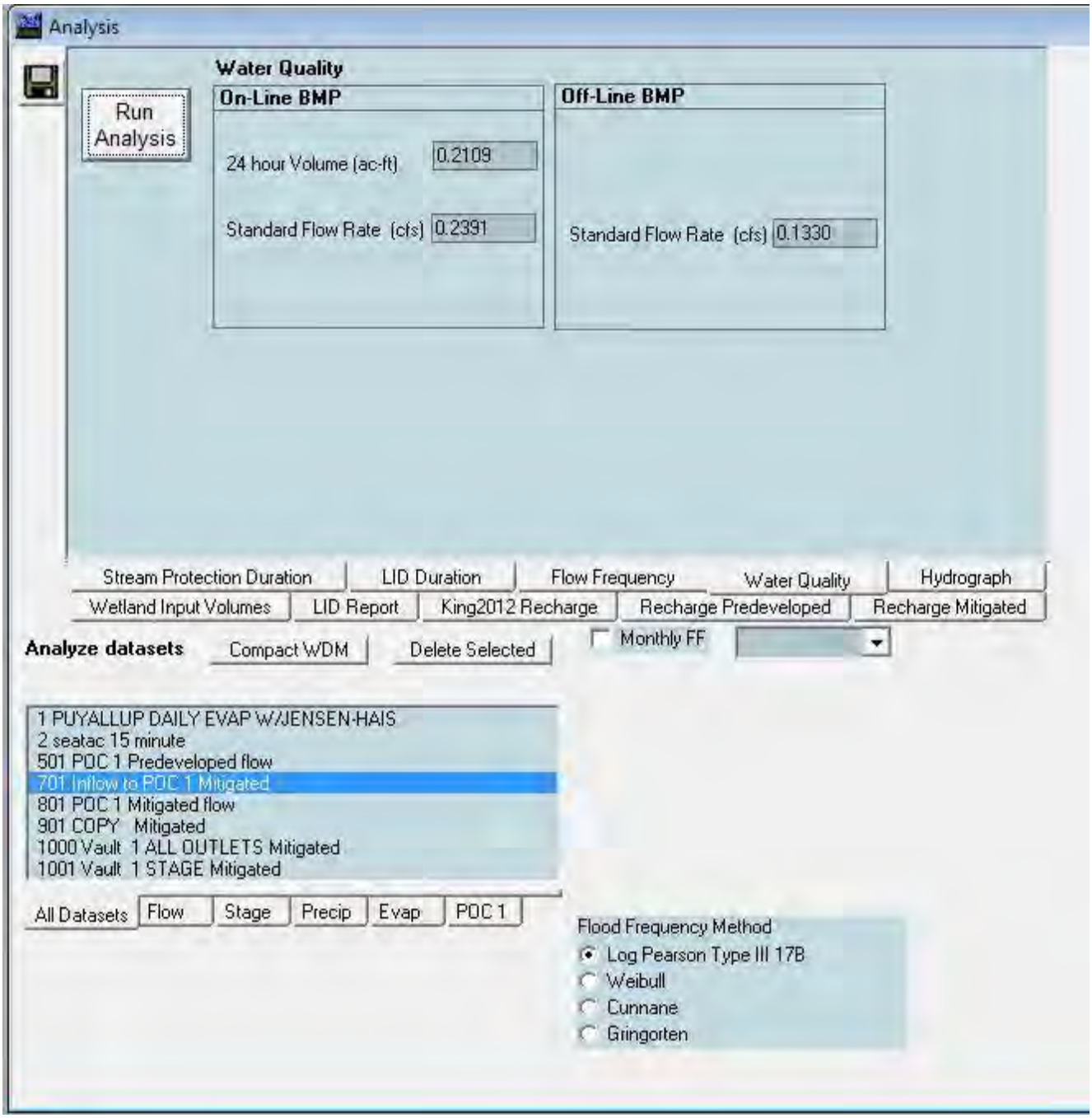
LID BMP's such as infiltration, permeable pavement, and biofiltration and bio-retention are likely not feasible on the site due to hard-pan glacial till soils according to USGS and NRCS Soil Survey research. As LID BMP's are not feasible, other than perforated downspout stubs and the application of BMP T5.13 (or COR equivalent COR Stnd. Detail 632) on landscaped areas, the water quality minimum requirements will be met through use of a Combined Detention/Wetvault and associated dead storage volume. Neither Enhanced nor phosphorus treatment is required, so "Basic" treatment is the minimum treatment level.

4.3.1 On-Site Stormwater Management

According to USGS and NRCS soils data, infiltration is not likely feasible on the site due to hard pan glacial till soils. LID BMP's such as infiltration and permeable pavement will not be used to manage stormwater onsite. Dispersion is also infeasible due to steep slopes onsite. In effort to meet LID standards to the maximum feasible extent given site soil and slope constraints, perforated roof downspouts according to Section 2.5.5 in the 2017 City of Redmond Technical Notebook in conjunction with soil augmentation according to City of Redmond standard detail 632 will be used to manage roof runoff.

4.4 Water Quality Treatment Sizing

According to water quality treatment design flow calculations (see WWHM output), the WQT Design Flow (based on the 6-month, 24-hour storm event using the WWHM 701 data series) a water quality storage volume of 0.2109 ac-ft (9,186 CF) is required. Dead storage area of 17,402 CF with a 5.25' storage depth has been provided within the Combined Detention/Wetvault.


Analysis
Run Analysis
Water Quality
On-Line BMP
24 hour Volume (ac-ft) 0.2109
Standard Flow Rate (cfs) 0.2391
Off-Line BMP
Standard Flow Rate (cfs) 0.1330
Stream Protection Duration
LID Duration
Flow Frequency
Water Quality
Hydrograph
Wetland Input Volumes
LID Report
King2012 Recharge
Recharge Predeveloped
Recharge Mitigated
Analyze datasets
Compact WDM
Delete Selected
Monthly FF
1 PUYALLUP DAILY EVAP W/JENSEN-HAIS
2 seatac 15 minute
501 POC 1 Predeveloped flow
701 Inflow to POC 1 Mitigated
801 POC 1 Mitigated flow
901 COPY Mitigated
1000 Vault 1 ALL OUTLETS Mitigated
1001 Vault 1 STAGE Mitigated
All Datasets
Flow
Stage
Precip
Evap
POC 1
Flood Frequency Method
Log Pearson Type III 17B
Weibull
Cunnane
Gringorten

4.4 Flow Control System

Flow control for the project site will be achieved through the use of a Combined Detention/Wetvault located in Tract B at the eastern end of the site. The facility was sized using WWHM and the total aggregate site areas identified in the Predeveloped and Developed Hydrology sections above. The flow control was designed as a standalone detention facility, meeting the release rates and durations required for the proposed site. Based on the system sizing, a detention vault providing 32,318 cf of detention at 6.5' deep, not including 1' of freeboard, is required. The proposed vault will be providing 53,035 cf, which exceeds the required detention volume. Water quality will be achieved by providing dead storage at 4.75' across 2 cells of dead storage area. The critical detention and Wetvault statistics as modeled in WWHM are as follows:

Modeled Combined Detention/Wetvault

Facility Dimensions:	88' x 56.5'
Facility Bottom Area:	4,972 ft^2
Facility Internal Sides:	Vertical
Facility Bottom Elev.:	239.25
Facility Begin Live Storage:	244.5
Effective Depth:	7.5'
Riser Height:	6.5'
Top of Riser Elevation:	251.00
Dead Storage Depth:	4.75'

Include dead storage volume in table, not just depth to check WWHM and plans

Flow Rates and Water Surface Elevations by Storm Event

Storm Event	Predeveloped Rate (cfs)	Unmitigated Rate (cfs)	Mitigated Rate (cfs)	Water Surface Elevations
2-Year	0.0800	0.6693	0.0547	248.39
10-Year	0.1638	1.0329	0.1097	249.76
50-Year	0.2298	1.3892	0.1799	251.01
100-Year	0.2550	1.5523	0.2154	251.02

APPENDIX 4-A

HYDROLOGIC MODELING
CALCULATIONS and COMBINED DETENTION/WETVAULT OUTPUT
FROM WWHM4

WWHM2012 20190827_90% Remodel

File Edit View Help Summary Report

Basin Help

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

Subbasin Name: Onsite Basin

Flows To : Surface Interflow Groundwater

Area in Basin

Show Only Selected

Available Pervious Acres

C, Forest, Mod 2.6

Available Impervious Acres

Frontage Predeveloped

Subbasin Name: Frontage Basin

Flows To : Surface Interflow Groundwater

Area in Basin

Show Only Selected

Available Pervious Acres

C, Forest, Flat .09

Available Impervious Acres

WWHM2012 20190827_90% Remodel

File Edit View Help Summary Report

Basin Help

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

Onsite Basin Mitigated

Subbasin Name: Onsite Basin

Designate as Bypass for POC:

Flows To :	Surface	Interflow	Groundwater
	Vault 1	Vault 1	

Area in Basin

Show Only Selected

Available Pervious	Acres
C, Lawn, Mod	1.11

Available Impervious	Acres
ROADS/MOD	.39
ROOF TOPS/FLAT	.85
DRIVEWAYS/FLAT	.15
SIDEWALKS/MOD	.18

Frontage Mitigated

Subbasin Name: Frontage Basin

Designate as Bypass for POC:

Flows To :	Surface	Interflow	Groundwater
	Vault 1	Vault 1	

Area in Basin

Show Only Selected

Available Pervious	Acres
C, Lawn, Flat	.02

Available Impervious	Acres
ROADS/FLAT	.05
SIDEWALKS/FLAT	.02

Onsite Bypass Mitigated

Subbasin Name: Onsite Bypass

Designate as Bypass for POC:

Flows To :	Surface	Interflow	Groundwater

Area in Basin

Show Only Selected

Available Pervious	Acres
C, Lawn, Flat	.11

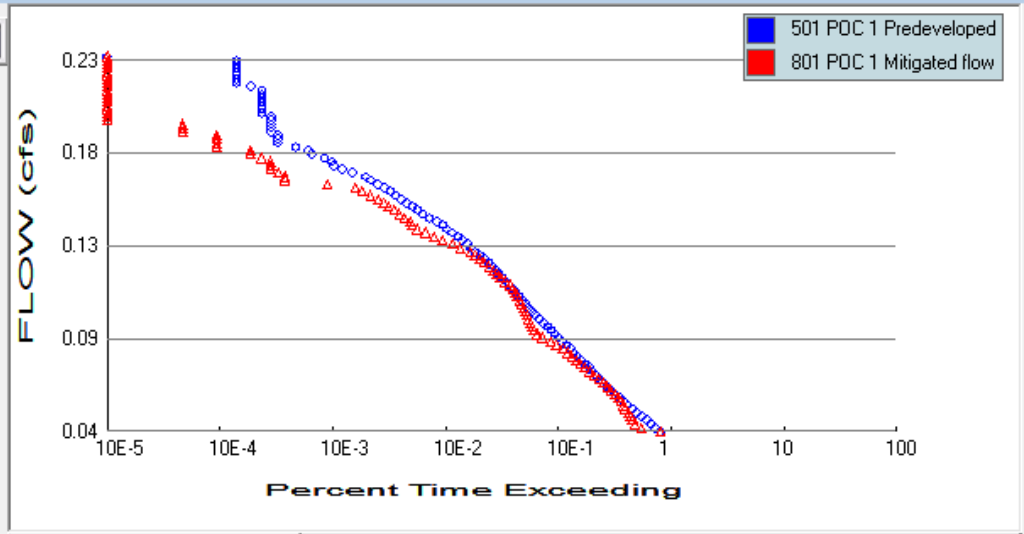
Available Impervious	Acres
ROADS/MOD	.01

WWHM2012 20190827_90% Remodel

File Edit View Help Summary Report

Analysis Help

Analysis



Stream Protection Duration | LID Duration | Flow Frequency | Water Quality | Hydrograph

Wetland Input Volumes | LID Report | King2012 Recharge | Recharge Predeveloped | Recharge Mitigated

Analyze datasets Compact WDM Delete Selected Monthly FF

501 POC 1 Predeveloped flow
801 POC 1 Mitigated flow

All Datasets | Flow | Stage | Precip | Evap | POC 1

Flood Frequency Method
- (•) Log Pearson Type III 17B
- ( ) Weibull
- ( ) Cunnane
- ( ) Gringorten

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0400	17154	17201	100	Pass
0.0419	15528	11573	74	Pass
0.0438	14108	10228	72	Pass
0.0457	12838	9691	75	Pass
0.0477	11616	9285	79	Pass
0.0496	10560	8887	84	Pass
0.0515	9610	8427	87	Pass
0.0534	8795	8004	91	Pass
0.0553	8079	7640	94	Pass
0.0572	7381	7212	97	Pass
0.0592	6763	6742	99	Pass
0.0611	6222	6252	100	Pass
0.0630	5760	5813	100	Pass
0.0649	5330	5330	100	Pass
0.0668	4943	4877	98	Pass
0.0687	4594	4404	95	Pass
0.0707	4259	4030	94	Pass
0.0726	3968	3651	92	Pass
0.0745	3662	3343	91	Pass
0.0764	3407	3059	89	Pass
0.0783	3155	2819	89	Pass
0.0803	2935	2594	88	Pass
0.0822	2721	2334	85	Pass
0.0841	2505	2043	81	Pass
0.0860	2331	1826	78	Pass
0.0879	2152	1551	72	Pass
0.0898	1988	1381	69	Pass
0.0918	1838	1290	70	Pass
0.0937	1717	1251	72	Pass
0.0956	1587	1209	76	Pass
0.0975	1454	1167	80	Pass
0.0994	1337	1124	84	Pass
0.1013	1244	1086	87	Pass
0.1033	1158	1049	90	Pass

WWHM2012
PROJECT REPORT

Project Name: 20190828_90% Remodel
Site Name: Garbarino
Site Address:
City : Redmond
Report Date: 8/27/2019
Gage : Seatac
Data Start : 1948/10/01
Data End : 2009/09/30
Precip Scale: 1.00
Version Date: 2017/07/05
Version : 4.2.13

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

High Flow Threshold for POC 1: 50 year

PREDEVELOPED LAND USE

Name : Onsite Basin
Bypass: No

GroundWater: No

Pervious Land Use	acre
C, Forest, Mod	2.6
Pervious Total	2.6

Impervious Land Use	acre
Impervious Total	0
Basin Total	2.6

Element Flows To:

Surface	Interflow	Groundwater

Name : Frontage
Bypass: No

GroundWater: No

Pervious Land Use	acre
C, Forest, Flat	.09

Pervious Total	**0.09**

Impervious Land Use	**acre**
Impervious Total	**0**
Basin Total	**0.09**

Element Flows To:

Surface	**Interflow**	**Groundwater**

MITIGATED LAND USE

Name : Onsite Basin
Bypass: No

GroundWater: No

Pervious Land Use	**acre**
C, Lawn, Mod	**1.11**
Pervious Total	**1.11**

Impervious Land Use	**acre**
ROADS MOD	**0.39**
ROOF TOPS FLAT	**0.65**
DRIVEWAYS FLAT	**0.15**
SIDEWALKS MOD	**0.18**
Impervious Total	**1.37**
Basin Total	**2.48**

Element Flows To:

Surface	**Interflow**	**Groundwater**
Vault 1	Vault 1	

Name : Frontage
Bypass: No

GroundWater: No

Pervious Land Use	**acre**
C, Lawn, Flat	**.02**

Pervious Total **0.02**

Impervious Land Use	**acre**
ROADS FLAT	**0.05**
SIDEWALKS FLAT	**0.02**

Impervious Total **0.07**

Basin Total **0.09**

Element Flows To:

Surface	**Interflow**	**Groundwater**
Vault 1	Vault 1	

Name : Onsite Bypass
Bypass: Yes

GroundWater: No

Pervious Land Use	**acre**
C, Lawn, Flat	**.11**

Pervious Total **0.11**

Impervious Land Use	**acre**
ROADS MOD	**0.01**

Impervious Total **0.01**

Basin Total **0.12**

Element Flows To:

Surface	**Interflow**	**Groundwater**

Name : Vault 1
Width : 56.5 ft.
Length : 88 ft.
Depth: 7.5 ft.
Discharge Structure
Riser Height: 6.5 ft.
Riser Diameter: 12 in.
Orifice 1 Diameter: 0.875 in. **Elevation:** 0 ft.
Orifice 2 Diameter: 1.109375 in. **Elevation:** 3.7 ft.
Orifice 3 Diameter: 1.234375 in. **Elevation:** 5 ft.

Element Flows To:

Outlet 1 **Outlet 2**

Vault Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)	
0.0000	0.114	0.000	0.000	0.000	
0.0833	0.114	0.009	0.006	0.000	
0.1667	0.114	0.019	0.008	0.000	
0.2500	0.114	0.028	0.010	0.000	
0.3333	0.114	0.038	0.012	0.000	
0.4167	0.114	0.047	0.013	0.000	
0.5000	0.114	0.057	0.014	0.000	
0.5833	0.114	0.066	0.015	0.000	
0.6667	0.114	0.076	0.017	0.000	
0.7500	0.114	0.085	0.018	0.000	
0.8333	0.114	0.095	0.019	0.000	
0.9167	0.114	0.104	0.019	0.000	
1.0000	0.114	0.114	0.020	0.000	
1.0833	0.114	0.123	0.021	0.000	
1.1667	0.114	0.133	0.022	0.000	
1.2500	0.114	0.142	0.023	0.000	
1.3333	0.114	0.152	0.024	0.000	
1.4167	0.114	0.161	0.024	0.000	
1.5000	0.114	0.171	0.025	0.000	
1.5833	0.114	0.180	0.026	0.000	
1.6667	0.114	0.190	0.026	0.000	
1.7500	0.114	0.199	0.027	0.000	
1.8333	0.114	0.209	0.028	0.000	
1.9167	0.114	0.218	0.028	0.000	
2.0000	0.114	0.228	0.029	0.000	
2.0833	0.114	0.237	0.030	0.000	
2.1667	0.114	0.247	0.030	0.000	
2.2500	0.114	0.256	0.031	0.000	
2.3333	0.114	0.266	0.031	0.000	
2.4167	0.114	0.275	0.032	0.000	
2.5000	0.114	0.285	0.032	0.000	
2.5833	0.114	0.294	0.033	0.000	
2.6667	0.114	0.304	0.033	0.000	
2.7500	0.114	0.313	0.034	0.000	
2.8333	0.114	0.323	0.035	0.000	
2.9167	0.114	0.332	0.035	0.000	
3.0000	0.114	0.342	0.036	0.000	
3.0833	0.114	0.351	0.036	0.000	
3.1667	0.114	0.361	0.037	0.000	
3.2500	0.114	0.371	0.037	0.000	
3.3333	0.114	0.380	0.037	0.000	
3.4167	0.114	0.390	0.038	0.000	
3.5000	0.114	0.399	0.038	0.000	
3.5833	0.114	0.409	0.039	0.000	
3.6667	0.114	0.418	0.039	0.000	
3.7500	0.114	0.428	0.047	0.000	
3.8333	0.114	0.437	0.052	0.000	2yr = 0.054684 cfs
3.9167	0.114	0.447	0.056	0.000	
4.0000	0.114	0.456	0.059	0.000	

4.0833	0.114	0.466	0.062	0.000	
4.1667	0.114	0.475	0.065	0.000	
4.2500	0.114	0.485	0.067	0.000	
4.3333	0.114	0.494	0.069	0.000	
4.4167	0.114	0.504	0.071	0.000	
4.5000	0.114	0.513	0.073	0.000	
4.5833	0.114	0.523	0.075	0.000	
4.6667	0.114	0.532	0.077	0.000	
4.7500	0.114	0.542	0.079	0.000	
4.8333	0.114	0.551	0.081	0.000	
4.9167	0.114	0.561	0.082	0.000	
5.0000	0.114	0.570	0.084	0.000	
5.0833	0.114	0.580	0.098	0.000	
5.1667	0.114	0.589	0.104	0.000	
5.2500	0.114	0.599	0.109	0.000	10yr=0.109702 cfs
5.3333	0.114	0.608	0.114	0.000	
5.4167	0.114	0.618	0.118	0.000	
5.5000	0.114	0.627	0.122	0.000	
5.5833	0.114	0.637	0.126	0.000	
5.6667	0.114	0.646	0.130	0.000	
5.7500	0.114	0.656	0.133	0.000	
5.8333	0.114	0.665	0.136	0.000	
5.9167	0.114	0.675	0.139	0.000	
6.0000	0.114	0.684	0.142	0.000	
6.0833	0.114	0.694	0.145	0.000	
6.1667	0.114	0.703	0.148	0.000	
6.2500	0.114	0.713	0.151	0.000	
6.3333	0.114	0.722	0.154	0.000	
6.4167	0.114	0.732	0.156	0.000	
6.5000	0.114	0.741	0.159	0.000	50yr=0.178899 cfs
6.5833	0.114	0.751	0.416	0.000	100yr=0.215386 cfs
6.6667	0.114	0.760	0.868	0.000	
6.7500	0.114	0.770	1.384	0.000	
6.8333	0.114	0.780	1.852	0.000	
6.9167	0.114	0.789	2.184	0.000	
7.0000	0.114	0.799	2.377	0.000	
7.0833	0.114	0.808	2.582	0.000	
7.1667	0.114	0.818	2.750	0.000	
7.2500	0.114	0.827	2.908	0.000	
7.3333	0.114	0.837	3.058	0.000	
7.4167	0.114	0.846	3.200	0.000	
7.5000	0.114	0.856	3.337	0.000	
7.5833	0.114	0.865	3.467	0.000	
7.6667	0.000	0.000	3.593	0.000	

ANALYSIS RESULTS

Stream Protection Duration

Predeveloped Landuse Totals for POC #1
Total Pervious Area:2.69
Total Impervious Area:0

Mitigated Landuse Totals for POC #1
Total Pervious Area:1.24
Total Impervious Area:1.45

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	0.079972
5 year	0.130994
10 year	0.163791
25 year	0.202798
50 year	0.229814
100 year	0.255046

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	Flow(cfs)
2 year	0.054684
5 year	0.085019
10 year	0.109702
25 year	0.146711
50 year	0.178899
100 year	0.215386

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

Year	Predeveloped	Mitigated
1949	0.092	0.047
1950	0.109	0.061
1951	0.175	0.144
1952	0.055	0.033
1953	0.044	0.041
1954	0.068	0.041
1955	0.109	0.042
1956	0.088	0.076
1957	0.071	0.043
1958	0.079	0.046
1959	0.067	0.037
1960	0.121	0.118
1961	0.066	0.064
1962	0.041	0.031
1963	0.057	0.041
1964	0.080	0.046
1965	0.053	0.072
1966	0.051	0.039
1967	0.122	0.054

1968	0.069	0.040
1969	0.067	0.039
1970	0.054	0.041
1971	0.061	0.048
1972	0.133	0.103
1973	0.059	0.069
1974	0.065	0.044
1975	0.091	0.046
1976	0.065	0.042
1977	0.009	0.032
1978	0.055	0.056
1979	0.033	0.031
1980	0.155	0.118
1981	0.049	0.040
1982	0.101	0.096
1983	0.087	0.043
1984	0.052	0.036
1985	0.031	0.035
1986	0.137	0.069
1987	0.121	0.091
1988	0.048	0.037
1989	0.032	0.035
1990	0.289	0.127
1991	0.154	0.101
1992	0.063	0.058
1993	0.061	0.034
1994	0.021	0.031
1995	0.088	0.061
1996	0.203	0.143
1997	0.157	0.140
1998	0.038	0.041
1999	0.171	0.106
2000	0.061	0.052
2001	0.011	0.030
2002	0.071	0.074
2003	0.105	0.044
2004	0.113	0.137
2005	0.084	0.042
2006	0.094	0.073
2007	0.218	0.203
2008	0.266	0.140
2009	0.124	0.076

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

Rank	Predeveloped	Mitigated
1	0.2888	0.2028
2	0.2664	0.1443
3	0.2181	0.1431
4	0.2025	0.1401
5	0.1750	0.1396
6	0.1710	0.1368
7	0.1567	0.1267
8	0.1553	0.1183
9	0.1538	0.1178
10	0.1372	0.1062

11	0.1327	0.1025
12	0.1244	0.1010
13	0.1225	0.0961
14	0.1212	0.0911
15	0.1206	0.0764
16	0.1129	0.0762
17	0.1090	0.0735
18	0.1088	0.0725
19	0.1050	0.0723
20	0.1012	0.0693
21	0.0942	0.0686
22	0.0917	0.0636
23	0.0907	0.0613
24	0.0879	0.0606
25	0.0877	0.0581
26	0.0867	0.0559
27	0.0837	0.0539
28	0.0803	0.0518
29	0.0786	0.0479
30	0.0706	0.0467
31	0.0706	0.0464
32	0.0690	0.0457
33	0.0681	0.0456
34	0.0674	0.0439
35	0.0672	0.0437
36	0.0664	0.0434
37	0.0652	0.0429
38	0.0648	0.0424
39	0.0627	0.0418
40	0.0613	0.0416
41	0.0611	0.0414
42	0.0609	0.0414
43	0.0589	0.0413
44	0.0567	0.0407
45	0.0549	0.0407
46	0.0549	0.0404
47	0.0541	0.0400
48	0.0535	0.0386
49	0.0523	0.0385
50	0.0514	0.0371
51	0.0491	0.0365
52	0.0478	0.0363
53	0.0444	0.0354
54	0.0413	0.0346
55	0.0382	0.0343
56	0.0332	0.0326
57	0.0316	0.0324
58	0.0310	0.0315
59	0.0206	0.0309
60	0.0110	0.0305
61	0.0094	0.0297

Stream Protection Duration
POC #1
The Facility PASSED

The Facility PASSED.

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0400	17154	17201	100	Pass
0.0419	15528	11573	74	Pass
0.0438	14108	10228	72	Pass
0.0457	12838	9691	75	Pass
0.0477	11616	9285	79	Pass
0.0496	10560	8887	84	Pass
0.0515	9610	8427	87	Pass
0.0534	8795	8004	91	Pass
0.0553	8079	7640	94	Pass
0.0572	7381	7212	97	Pass
0.0592	6763	6742	99	Pass
0.0611	6222	6252	100	Pass
0.0630	5760	5813	100	Pass
0.0649	5330	5330	100	Pass
0.0668	4943	4877	98	Pass
0.0687	4594	4404	95	Pass
0.0707	4259	4030	94	Pass
0.0726	3968	3651	92	Pass
0.0745	3662	3343	91	Pass
0.0764	3407	3059	89	Pass
0.0783	3155	2819	89	Pass
0.0803	2935	2594	88	Pass
0.0822	2721	2334	85	Pass
0.0841	2505	2043	81	Pass
0.0860	2331	1826	78	Pass
0.0879	2152	1551	72	Pass
0.0898	1988	1381	69	Pass
0.0918	1838	1290	70	Pass
0.0937	1717	1251	72	Pass
0.0956	1587	1209	76	Pass
0.0975	1454	1167	80	Pass
0.0994	1337	1124	84	Pass
0.1013	1244	1086	87	Pass
0.1033	1158	1049	90	Pass
0.1052	1093	1006	92	Pass
0.1071	1026	970	94	Pass
0.1090	960	926	96	Pass
0.1109	894	895	100	Pass
0.1128	837	846	101	Pass
0.1148	776	793	102	Pass
0.1167	730	728	99	Pass
0.1186	680	653	96	Pass
0.1205	633	607	95	Pass
0.1224	595	565	94	Pass
0.1244	560	519	92	Pass
0.1263	511	467	91	Pass
0.1282	475	427	89	Pass
0.1301	431	391	90	Pass
0.1320	390	353	90	Pass
0.1339	359	287	79	Pass
0.1359	333	245	73	Pass
0.1378	303	199	65	Pass
0.1397	274	168	61	Pass

0.1416	246	143	58	Pass
0.1435	222	119	53	Pass
0.1454	202	107	52	Pass
0.1474	179	103	57	Pass
0.1493	153	92	60	Pass
0.1512	133	83	62	Pass
0.1531	120	75	62	Pass
0.1550	108	66	61	Pass
0.1570	96	60	62	Pass
0.1589	86	54	62	Pass
0.1608	77	46	59	Pass
0.1627	69	39	56	Pass
0.1646	62	34	54	Pass
0.1665	54	19	35	Pass
0.1685	47	8	17	Pass
0.1704	42	8	19	Pass
0.1723	32	7	21	Pass
0.1742	26	6	23	Pass
0.1761	22	6	27	Pass
0.1780	21	6	28	Pass
0.1800	18	5	27	Pass
0.1819	14	4	28	Pass
0.1838	13	4	30	Pass
0.1857	10	2	20	Pass
0.1876	7	2	28	Pass
0.1895	7	2	28	Pass
0.1915	7	2	28	Pass
0.1934	6	1	16	Pass
0.1953	6	1	16	Pass
0.1972	6	1	16	Pass
0.1991	6	0	0	Pass
0.2011	6	0	0	Pass
0.2030	5	0	0	Pass
0.2049	5	0	0	Pass
0.2068	5	0	0	Pass
0.2087	5	0	0	Pass
0.2106	5	0	0	Pass
0.2126	5	0	0	Pass
0.2145	5	0	0	Pass
0.2164	4	0	0	Pass
0.2183	3	0	0	Pass
0.2202	3	0	0	Pass
0.2221	3	0	0	Pass
0.2241	3	0	0	Pass
0.2260	3	0	0	Pass
0.2279	3	0	0	Pass
0.2298	3	0	0	Pass

Highlight and make notation of WQ volume, if this is the volume used to size vault

Water Quality BMP Flow and Volume for POC #1
On-line facility volume: 0.2109 **acre-feet**
On-line facility target flow: 0.2391 **cfs.**
Adjusted for 15 min: 0.2391 **cfs.**
Off-line facility target flow: 0.133 **cfs.**
Adjusted for 15 min: 0.133 **cfs.**

LID Report

LID Technique Used for Total Volume Volume Infiltration Cumulative Percent Water Quality Percent Comment
Treatment? Needs Through Volume Volume Volume Water Quality
Treatment Facility (ac-ft.) Infiltration Infiltrated Treated
(ac-ft) (ac-ft) Credit

Vault 1 POC N 288.74 N 0.00
Total Volume Infiltrated 288.74 0.00 0.00 0.00 0.00 0% No Treat. Credit
Compliance with LID Standard 8 Duration Analysis Result = Failed

---

Perlnd and Implnd Changes

No changes have been made.

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5.0 CONVEYANCE SYSTEM ANALYSIS AND DESIGN

Onsite Conveyance

Conveyance sizing and design were completed based on runoff established from SBUH analysis as allowed by City reference to WSDOT Hydrology Manual. The SBUH model has been established and run in StormShed 3G (as approved by the WSDOT Hydrology Manual, and approved by CoR), and utilizes Mannings, Darcy Weisbach, and Hazen Williams (for pressure calculations) to track friction losses and transitional losses for HGL calculations, consistent with guidance from DOE and WSDOT. Partial flows are computed to establish velocities and HGL within the pipes. For a delineation of all conveyance basins, see Figure 5.0, "Conveyance Basin Map."

Pipe Network

Backwater

Backwater/loss evaluation reveals that 10, 25 and 50-year event flows are carried completely within the pipe and swale system as designed per COR STN 8.4.3 and there are no locations within the conveyance system where hydraulic grade is above system maximum elevations in any of these three events. The 50-year water surface elevation of 250.99 was used as a conservative estimate for all tailwater considerations in the Combined Detention/Wetvault. The following tables in summarize the Stormshed 3G data from each storm event. Stormshed 3G data in each event can be found in Appendix 5-B.

Table 5.1 - HGL Analysis: 10-Year Event

CB #	HGL	CB Rim EL	Difference (ft)
CB-1	251.13	257.22	6.09
CB-2A	259.78	263.82	4.04
CB-2	271.70	274.25	2.55
CB-6	271.70	274.75	3.05
CB-3	271.75	274.43	2.68
CB-4	282.47	286.54	4.07
CB-5	283.54	287.00	3.46
CB-16A	286.81	292.10	5.29
CB-16B	287.58	291.94	4.36
CB-16	297.05	303.09	6.04

Table 5.2 - HGL Analysis: 25-Year Event

CB #	HGL	CB Rim EL	Difference (ft)
CB-1	251.19	257.22	6.03
CB-2A	259.86	263.82	3.96
CB-2	271.82	274.25	2.43
CB-6	271.82	274.75	2.93
CB-3	271.89	274.43	2.54
CB-4	282.56	286.54	3.98
CB-5	283.57	287.00	3.43
CB-16A	286.85	292.10	5.25
CB-16B	287.60	291.94	4.34
CB-16	297.13	303.09	5.96

Table 5.3 - HGL Analysis: 50-Year Event

CB #	HGL	CB Rim EL	Difference (ft)
CB-1	251.22	257.22	6.00
CB-2A	259.90	263.82	3.92
CB-2	271.87	274.25	2.38
CB-6	271.87	274.75	2.88
CB-3	271.95	274.43	2.48
CB-4	282.61	286.54	3.93
CB-5	283.58	287.00	3.42
CB-16A	286.87	292.10	5.23
CB-16B	287.60	291.94	4.34
CB-16	297.17	303.09	5.92

Onsite Culvert Capacity

A Manning's equation evaluation was performed on the smallest diameter culvert with the shallowest slope onsite. For the purposes of conservative sizing, the 50-year peak flow from all onsite conveyance basins was used as a conservative estimate for peak flow evaluated in the culvert. The 50-year peak flow for each conveyance basin can be found in the Stormshed data found in Appendix 5-B. Evaluation indicates that the pipe capacity provided is greater than the pipe capacity required and thus is adequately designed. Manning's equation analysis of the pipe can be found in Appendix 5-B. A summary of the pipe capacity is as follows:

<u>Intake (STA 11+66.52) to Outfall (STA 11+90.02):</u>

Diameter:	12"
Minimum Slope:	5.15%
Pipe Capacity:	8.78 cfs
50-Year Maximum Pipe Flow:	1.55 cfs (100 yr, Umitigated – WWHM 701)
Evaluation:	System Adequate

Onsite Swale Capacity

A Manning's equation evaluation was performed on the swale with the shallowest slope onsite (Swale 1 as indicated on Figure 5.0, "Conveyance Basin Map") and on the swale with the greatest slope. The 50-year peak flow from all onsite conveyance basins was used as a conservative estimate for peak flow evaluated in the swale. The 50-year peak flow for each conveyance basin can be found in the Stormshed data found in Appendix 5-B. Manning's n values of 0.030 for each swale were obtained from WSDOT Hydraulics Manual Appendix 4-1.III.B.2 under the assumption that the swales are 24" in width and will retain a maintained, grassed land cover in the developed condition. Due to the potential for erosive flows, stabilization will be provided by means of a permanent erosion control blanket to be installed within proposed swales.

Evaluation indicates that greater than 0.5' freeboard is attained in the swale design in the 50-year storm event and thus is adequately designed. Manning's equation analysis of the swale can be found in Appendix 5-B. A summary of the swale capacity is as follows:

<u>Swale 1 (STA 12+09.85 to STA 12+30.71):</u>

Bottom Width:	2'
Depth:	1.5'
Side Slopes:	2:1 (MAX)
Channel slope:	5.78%
50-Year Maximum Flow:	1.39 cfs (WWHM 701– See Appendix 5-B)
Flow Depth:	0.18'
Freeboard:	1.32'
Maximum Velocity:	3.35 fps
Evaluation:	System Adequate

Swale 2 (STA 13+81.31 to STA 14+09.73):

Bottom Width:	2’
Depth:	1.5’
Side Slopes:	2:1 (MAX)
Channel slope:	10.98%
50-Year Maximum Flow:	1.39 cfs (WWHM 701 – See Appendix 5-B)
Flow Depth:	0.15’
Freeboard:	1.35’
Maximum Velocity:	4.14 fps
Evaluation:	System Adequate

Combined Detention/Wetvault Release

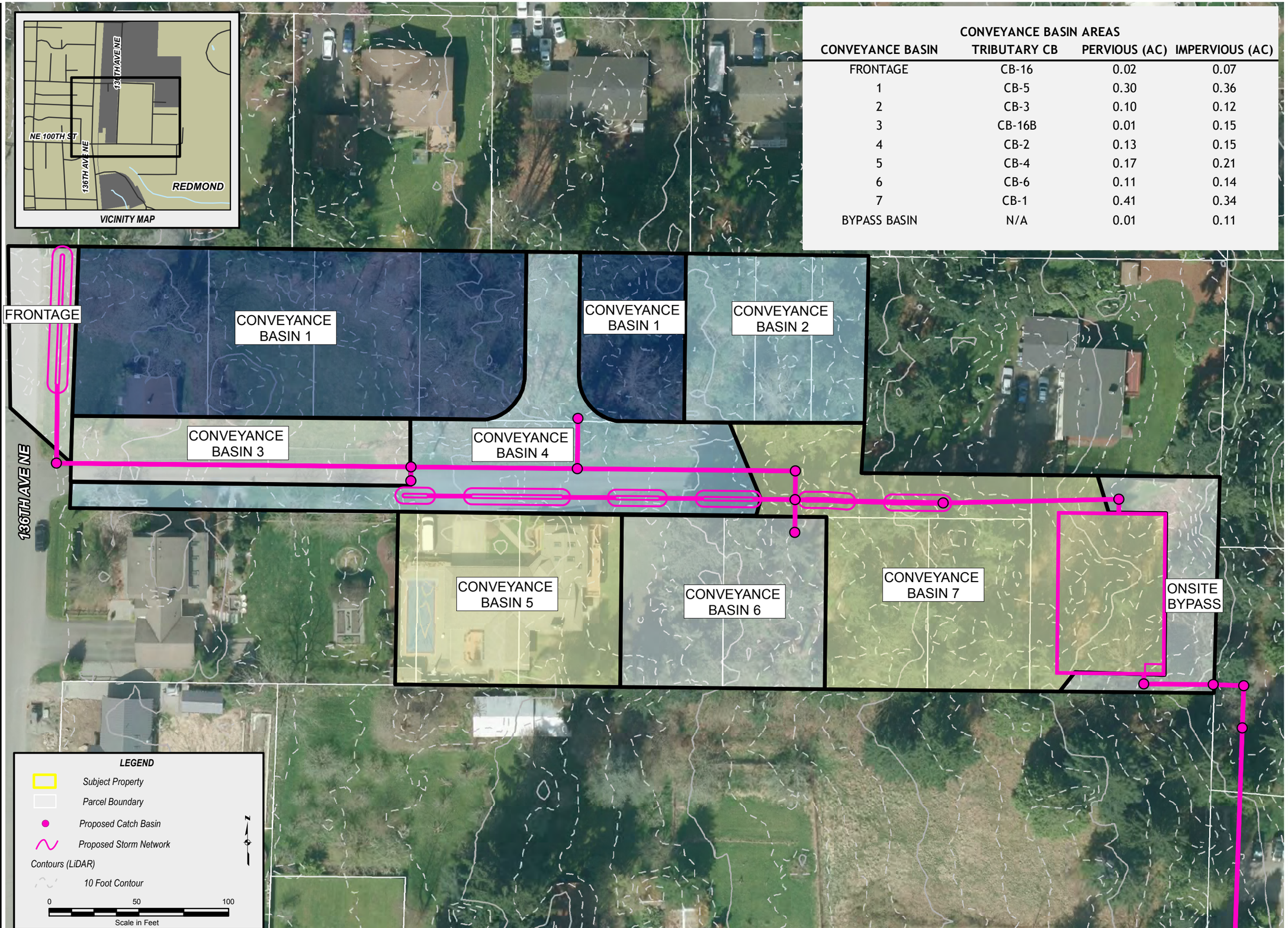
The Combined Detention/Wetvault discharge system is comprised of the primary flow intake(s), the Combined Detention/Wetvault detention volume, the Combined Detention/Wetvault outfall and the control structure. The conveyance capacity analysis for the pipe downstream of the Combined Detention/Wetvault was performed as a Manning’s equation evaluation of the Combined Detention/Wetvault discharge pipe. The smallest diameter (12”) pipe at the shallowest slope was analyzed against the 100-year unmitigated flow. A screen shot of the 100-Year Storm unmitigated release from the Combined Detention/Wetvault (from the WWHM 701 data series) can be found below.

Combined Detention/Wetvault Discharge Pipe (CB-8 to CB-9):

Diameter:	12”
Minimum Slope:	0.60%
Pipe Capacity:	3.00 cfs
100-Year Maximum Pipe Flow:	1.55 cfs (100 yr, Umitigated – WWHM 701)
Evaluation:	System Adequate

APPENDIX 5-A

STORMSHED 3G CONVEYANCE MODELING CALCULATIONS



CONVEYANCE BASIN AREAS

CONVEYANCE BASIN	TRIBUTARY CB	PERVIOUS (AC)	IMPERVIOUS (AC)
FRONTAGE	CB-16	0.02	0.07
1	CB-5	0.30	0.36
2	CB-3	0.10	0.12
3	CB-16B	0.01	0.15
4	CB-2	0.13	0.15
5	CB-4	0.17	0.21
6	CB-6	0.11	0.14
7	CB-1	0.41	0.34
BYPASS BASIN	N/A	0.01	0.11

SOURCE INFORMATION

SOURCE AGENCY	DESCRIPTION
CITY OF REDMOND	COLOR AERIAL PHOTO (2009)
KING COUNTY GIS	CONTOURS - GENERATED FROM BARE EARTH LIDAR (KING COUNTY). THIS DATA HAS A STATED VERTICAL ACCURACY OF APPROXIMATELY 1 FOOT.
KING COUNTY GIS	PARCEL BOUNDARY, HYDROLOGY

LDC
THE CIVIL ENGINEERING GROUP
Commercial
Infrastructure
Residential
14201 NE 200th St. #100
Woodinville, WA 98072
Ph. 425.806.1869
Fx. 425.482.2893
www.LDCcorp.com

MILESONTE NW

GARBARINO

CONVEYANCE BASIN MAP

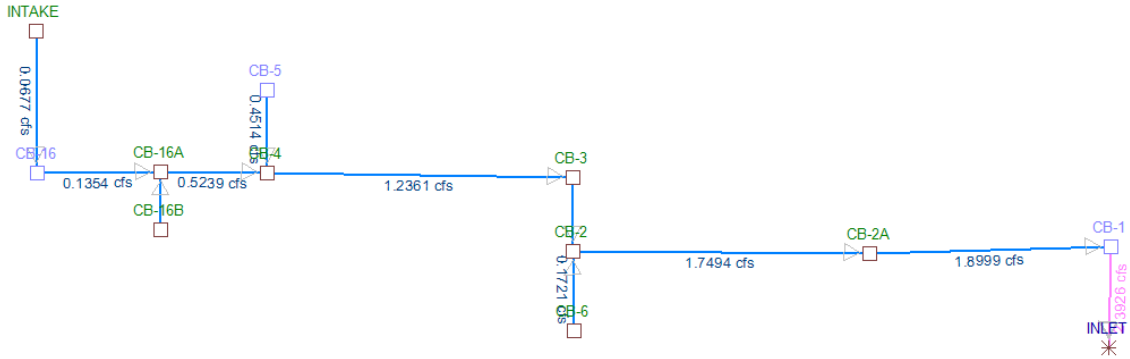
PROJECTION: WASHINGTON STATE PLANE, NORTH ZONE, NAD 83 HARN, FEET

REVISION:
JOB NUMBER: 15-104
DRAWING NAME: 15-104F5.0
DESIGNER: T.ABBOTT
DRAWING BY: A.LAUCK
DATE: 1-19-16
SCALE: AS SHOWN
JURISDICTION: REDMOND

FIGURE:
5.0

15-104 ConveyanceBasinMap.mxd | MOD: 1/19/2016 | AML

Garbarino 50-year Storm



ROUTEHYD [] THRU [GARBARINO] USING [50 YEAR] AND [TYPE1A.RAC] NOTZERO RELATIVE SCS/SBUH

Gravity Analysis using 24 hr duration storm

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Depth ratio	Size	nVel (ft/s)	fVel (ft/s)	Infil Vol (cf)	CBasin / Hyd
PIPE 8	0.09	0.0677	18.6383	0.0036	0.0439	0.0439	12 in Diam	5.6001	23.7311	0.00	FRONTAGE
PIPE 3	0.18	0.1354	11.6303	0.0116	0.0759	0.0759	12 in Diam	4.9736	14.8082	0.00	FRONTAGE
PIPE 12	0.16	0.1278	19.9851	0.0064	0.0571	0.0571	12 in Diam	7.1593	25.4458	0.00	BASIN 3
PIPE 11	0.72	0.5239	11.6495	0.045	0.1444	0.1444	12 in Diam	7.497	14.8327	0.00	BASIN 5
PIPE 6	0.66	0.4514	12.6817	0.0356	0.1289	0.1289	12 in Diam	7.6211	16.1469	0.00	BASIN 1
PIPE 5	1.76	1.2361	15.3682	0.0804	0.1914	0.1914	12 in Diam	11.7705	19.5674	0.00	BASIN 5
PIPE 4	1.98	1.3866	4.0794	0.3399	0.4019	0.4019	12 in Diam	4.6969	5.1941	0.00	BASIN 2
PIPE 7	0.25	0.1721	4.0302	0.0427	0.141	0.141	12 in Diam	2.5484	5.1314	0.00	BASIN 6
PIPE 9	2.51	1.7494	19.2492	0.0909	0.2037	0.2037	12 in Diam	15.2431	24.5088	0.00	BASIN 4
PIPE 10	2.73	1.8999	20.4022	0.0931	0.2062	0.2062	12 in Diam	16.269	25.9769	0.00	BASIN 2
PIPE 1	3.48	2.3926	23.0768	0.1037	0.2169	0.2169	12 in Diam	19.0538	29.3823	0.00	BASIN 7

HGL Analysis

From Node	To Node	HG El (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	Adjusted HG El (ft)	Max El (ft)	Max El minus HG El
							250.99	------
CB-1	INLET	251.1780	0.0909	0.1284	------	251.2155	257.2200	6.00
CB-2A	CB-1	259.8685	------	0.0351	------	259.9036	263.8200	3.92
CB-2	CB-2A	271.3811	------	0.4517	0.0338	271.8666	274.2500	2.38
CB-3	CB-2	271.9363	0.0385	0.0503	------	271.9481	274.4300	2.48
CB-4	CB-3	282.1653	------	0.0035	0.4365	282.6053	286.5400	3.93
CB-16A	CB-4	286.6665	------	0.0026	0.2044	286.8735	292.1000	5.23
CB-16	CB-16A	296.5170	------	0.6490	------	297.1660	303.0900	5.92
INTAKE	CB-16	302.0267	------	------	------	302.0267	303.4500	1.42
CB-16B	CB-16A	287.6016	------	------	------	287.6016	291.9400	4.34
CB-5	CB-4	283.5800	------	------	------	283.5800	287.0000	3.42
CB-6	CB-2	271.8679	------	------	------	271.8679	274.7500	2.88

Conduit Notes

Reach	HW Depth (ft)	HW/D ratio	Q (cfs)	TW Depth (ft)	Dc (ft)	Dn (ft)	Comment
PIPE 1	8.8280	8.8280	2.39	8.6400	0.6624	0.2169	Outlet Control
PIPE 10	0.7985	0.7985	1.90	7.4655	0.5877	0.2062	SuperCrit flow, Inlet end controls
PIPE 9	0.7611	0.7611	1.75	0.8336	0.5630	0.2037	SuperCrit flow, Inlet end controls
PIPE 4	1.3163	1.3163	1.39	1.2466	0.4983	0.4019	Outlet Control
PIPE 5	0.6253	0.6253	1.24	1.2281	0.4691	0.1914	SuperCrit flow, Inlet end controls
PIPE 11	0.3865	0.3865	0.52	1.0653	0.3004	0.1444	SuperCrit flow, Inlet end controls
PIPE 3	0.1770	0.1770	0.14	0.5935	0.1502	0.0759	SuperCrit flow, Inlet end controls
PIPE 8	0.0767	0.0767	0.07	0.8260	0.1056	0.0439	SuperCrit flow, Inlet end controls

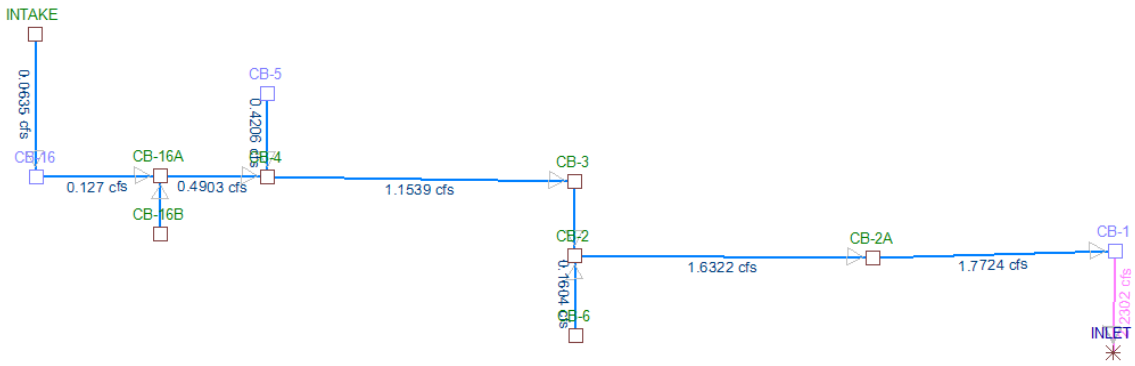
PIPE 12	0.1216	0.1216	0.13	0.5935	0.1439	0.0571	SuperCrit flow, Inlet end controls
PIPE 6	0.3500	0.3500	0.45	1.0653	0.2783	0.1289	SuperCrit flow, Inlet end controls
PIPE 7	1.2477	1.2477	0.17	1.2466	0.1698	0.1410	Outlet Control

Node and Reach invert report

Node and Reach invert report				
Node	INTAKE		Out ie	301.95 ft
	Reach	PIPE 8	I.E. Out	301.95 ft
Node	CB-16		Out ie	296.34 ft
	Reach	PIPE 8	I.E. In	296.34 ft
	Reach	PIPE 3	I.E. Out	296.34 ft
Node	CB-16B		Out ie	287.48 ft
	Reach	PIPE 12	I.E. Out	287.48 ft
Node	CB-16A		Out ie	286.28 ft
	Reach	PIPE 3	I.E. In	286.28 ft
	Reach	PIPE 12	I.E. In	286.28 ft
	Reach	PIPE 11	I.E. Out	286.28 ft
Node	CB-5		Out ie	283.23 ft
	Reach	PIPE 6	I.E. Out	283.23 ft
Node	CB-4		Out ie	281.54 ft
	Reach	PIPE 11	I.E. In	281.54 ft
	Reach	PIPE 6	I.E. In	281.54 ft
	Reach	PIPE 5	I.E. Out	281.54 ft
Node	CB-3		Out ie	270.72 ft
	Reach	PIPE 5	I.E. In	270.72 ft
	Reach	PIPE 4	I.E. Out	270.72 ft
Node	CB-6		Out ie	270.73 ft
	Reach	PIPE 7	I.E. Out	270.73 ft
Node	CB-2		Out ie	270.62 ft
	Reach	PIPE 4	I.E. In	270.62 ft
	Reach	PIPE 7	I.E. In	270.62 ft
	Reach	PIPE 9	I.E. Out	270.62 ft

Node	CB-2A		Out ie	259.07 ft
	Reach	PIPE 9	I.E. In	259.07 ft
	Reach	PIPE 10	I.E. Out	259.07 ft
Node	CB-1		Out ie	243.75 ft
	Reach	PIPE 10	I.E. In	243.75 ft
	Reach	PIPE 1	I.E. Out	243.75 ft

Garbarino 25-year Storm



ROUTEHYD [] THRU [GARBARINO] USING [25 YR] AND [TYPE1A.RAC] NOTZERO RELATIVE SCS/SBUH

Gravity Analysis using 24 hr duration storm

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Depth ratio	Size	nVel (ft/s)	fVel (ft/s)	Infil Vol (cf)	CBasin / Hyd
PIPE 8	0.09	0.0635	18.6383	0.0034	0.0427	0.0427	12 in Diam	5.4678	23.7311	0.00	FRONTAGE
PIPE 3	0.18	0.127	11.6303	0.0109	0.0734	0.0734	12 in Diam	4.9015	14.8082	0.00	FRONTAGE
PIPE 12	0.16	0.1203	19.9851	0.006	0.0554	0.0554	12 in Diam	7.0429	25.4458	0.00	BASIN 3
PIPE 11	0.72	0.4903	11.6495	0.0421	0.1401	0.1401	12 in Diam	7.3296	14.8327	0.00	BASIN 5
PIPE 6	0.66	0.4206	12.6817	0.0332	0.1247	0.1247	12 in Diam	7.4532	16.1469	0.00	BASIN 1
PIPE 5	1.76	1.1539	15.3682	0.0751	0.1852	0.1852	12 in Diam	11.522	19.5674	0.00	BASIN 5
PIPE 4	1.98	1.2941	4.0794	0.3172	0.3852	0.3852	12 in Diam	4.6399	5.1941	0.00	BASIN 2
PIPE 7	0.25	0.1604	4.0302	0.0398	0.1361	0.1361	12 in Diam	2.4996	5.1314	0.00	BASIN 6
PIPE 9	2.51	1.6322	19.2492	0.0848	0.1966	0.1966	12 in Diam	14.9535	24.5088	0.00	BASIN 4

HGL Analysis

From Node	To Node	HG El (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	Adjusted HG El (ft)	Max El (ft)	Max El minus HG El
							250.99	------
CB-1	INLET	251.1533	0.0791	0.1118	------	251.1860	257.2200	6.03
CB-2A	CB-1	259.8296	------	0.0338	------	259.8634	263.8200	3.96
CB-2	CB-2A	271.3451	------	0.4408	0.0329	271.8189	274.2500	2.43
CB-3	CB-2	271.8795	0.0335	0.0438	------	271.8898	274.4300	2.54
CB-4	CB-3	282.1384	------	0.0033	0.4160	282.5577	286.5400	3.98
CB-16A	CB-4	286.6520	------	0.0025	0.1990	286.8535	292.1000	5.25
CB-16	CB-16A	296.5105	------	0.6187	------	297.1292	303.0900	5.96
INTAKE	CB-16	302.0222	------	------	------	302.0222	303.4500	1.43
CB-16B	CB-16A	287.5956	------	------	------	287.5956	291.9400	4.34
CB-5	CB-4	283.5659	------	------	------	283.5659	287.0000	3.43
CB-6	CB-2	271.8200	------	------	------	271.8200	274.7500	2.93

Conduit Notes

Reach	HW Depth (ft)	HW/D ratio	Q (cfs)	TW Depth (ft)	Dc (ft)	Dn (ft)	Comment
PIPE 1	8.8033	8.8033	2.23	8.6400	0.6387	0.2101	Outlet Control
PIPE 10	0.7596	0.7596	1.77	7.4360	0.5668	0.1991	SuperCrit flow, Inlet end controls
PIPE 9	0.7251	0.7251	1.63	0.7934	0.5428	0.1966	SuperCrit flow, Inlet end controls
PIPE 4	1.2595	1.2595	1.29	1.1989	0.4806	0.3852	Outlet Control
PIPE 5	0.5984	0.5984	1.15	1.1698	0.4526	0.1852	SuperCrit flow, Inlet end controls
PIPE 11	0.3720	0.3720	0.49	1.0177	0.2903	0.1401	SuperCrit flow, Inlet end controls
PIPE 3	0.1705	0.1705	0.13	0.5735	0.1432	0.0734	SuperCrit flow, Inlet end controls
PIPE 8	0.0722	0.0722	0.06	0.7892	0.1022	0.0427	SuperCrit flow, Inlet end controls
PIPE	0.1156	0.1156	0.12	0.5735	0.1387	0.0554	SuperCrit flow, Inlet

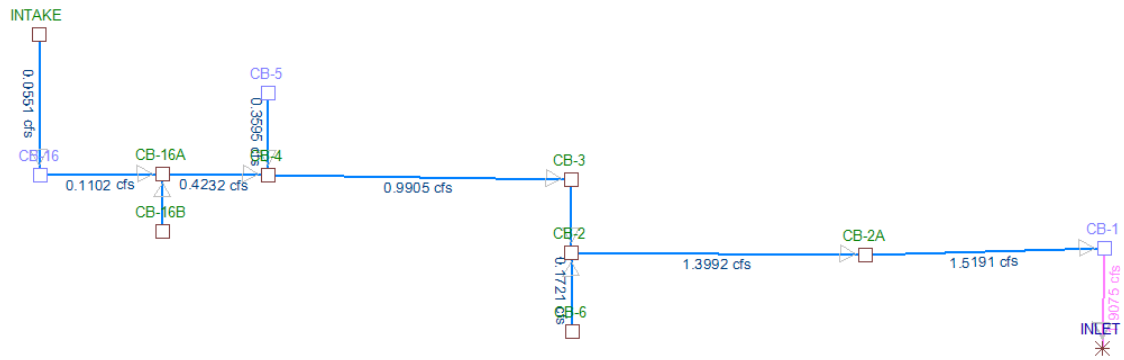
12							end controls
PIPE 6	0.3359	0.3359	0.42	1.0177	0.2682	0.1247	SuperCrit flow, Inlet end controls
PIPE 7	1.1998	1.1998	0.16	1.1989	0.1637	0.1361	Outlet Control

Node and Reach invert report

Node and Reach invert report				
Node	INTAKE		Out ie	301.95 ft
	Reach	PIPE 8	I.E. Out	301.95 ft
Node	CB-16		Out ie	296.34 ft
	Reach	PIPE 8	I.E. In	296.34 ft
	Reach	PIPE 3	I.E. Out	296.34 ft
Node	CB-16B		Out ie	287.48 ft
	Reach	PIPE 12	I.E. Out	287.48 ft
Node	CB-16A		Out ie	286.28 ft
	Reach	PIPE 3	I.E. In	286.28 ft
	Reach	PIPE 12	I.E. In	286.28 ft
	Reach	PIPE 11	I.E. Out	286.28 ft
Node	CB-5		Out ie	283.23 ft
	Reach	PIPE 6	I.E. Out	283.23 ft
Node	CB-4		Out ie	281.54 ft
	Reach	PIPE 11	I.E. In	281.54 ft
	Reach	PIPE 6	I.E. In	281.54 ft
	Reach	PIPE 5	I.E. Out	281.54 ft
Node	CB-3		Out ie	270.72 ft
	Reach	PIPE 5	I.E. In	270.72 ft
	Reach	PIPE 4	I.E. Out	270.72 ft
Node	CB-6		Out ie	270.73 ft
	Reach	PIPE 7	I.E. Out	270.73 ft
Node	CB-2		Out ie	270.62 ft
	Reach	PIPE 4	I.E. In	270.62 ft
	Reach	PIPE 7	I.E. In	270.62 ft
	Reach	PIPE 9	I.E. Out	270.62 ft
Node	CB-2A		Out ie	259.07 ft
	Reach	PIPE 9	I.E. In	259.07 ft

	Reach	PIPE 10	I.E. Out	259.07 ft
Node	CB-1		Out ie	243.75 ft
	Reach	PIPE 10	I.E. In	243.75 ft
	Reach	PIPE 1	I.E. Out	243.75 ft

Garbarino 10-year Storm



ROUTEHYD [] THRU [GARBARINO] USING [10 YEAR] AND [TYPE1A.RAC] NOTZERO RELATIVE SCS/SBUH

Gravity Analysis using 24 hr duration storm

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Depth ratio	Size	nVel (ft/s)	fVel (ft/s)	Infil Vol (cf)	CBasin / Hyd
PIPE 8	0.09	0.0551	18.6383	0.003	0.0404	0.0404	12 in Diam	5.1593	23.7311	0.00	FRONTAGE
PIPE 3	0.18	0.1102	11.6303	0.0095	0.0684	0.0684	12 in Diam	4.7208	14.8082	0.00	FRONTAGE
PIPE 12	0.16	0.1053	19.9851	0.0053	0.052	0.052	12 in Diam	6.7611	25.4458	0.00	BASIN 3
PIPE 11	0.72	0.4232	11.6495	0.0363	0.1301	0.1301	12 in Diam	7.0437	14.8327	0.00	BASIN 5
PIPE 6	0.66	0.3595	12.6817	0.0283	0.1158	0.1158	12 in Diam	7.0896	16.1469	0.00	BASIN 1
PIPE 5	1.76	0.9905	15.3682	0.0644	0.172	0.172	12 in Diam	10.9971	19.5674	0.00	BASIN 5
PIPE 4	1.98	1.1103	4.0794	0.2722	0.3564	0.3564	12 in Diam	4.4212	5.1941	0.00	BASIN 2
PIPE 7	0.25	0.1372	4.0302	0.034	0.1262	0.1262	12 in Diam	2.3887	5.1314	0.00	BASIN 6
PIPE 9	2.51	1.3992	19.2492	0.0727	0.1824	0.1824	12 in Diam	14.2767	24.5088	0.00	BASIN 4
PIPE 10	2.73	1.5191	20.4022	0.0745	0.1845	0.1845	12 in Diam	15.2539	25.9769	0.00	BASIN 2
PIPE 1	3.48	1.9075	23.0768	0.0827	0.1941	0.1941	12 in Diam	17.8067	29.3823	0.00	BASIN 7

HGL Analysis

From Node	To Node	HG El (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	Adjusted HG El (ft)	Max El (ft)	Max El minus HG El
							250.99	------
CB-1	INLET	251.1095	0.0581	0.0821	------	251.1335	257.2200	6.09
CB-2A	CB-1	259.7514	------	0.0308	------	259.7822	263.8200	4.04
CB-2	CB-2A	271.2723	------	0.4003	0.0298	271.7024	274.2500	2.55
CB-3	CB-2	271.7470	0.0247	0.0323	------	271.7546	274.4300	2.68
CB-4	CB-3	282.0835	------	0.0031	0.3815	282.4681	286.5400	4.07
CB-16A	CB-4	286.6218	------	0.0023	0.1856	286.8098	292.1000	5.29
CB-16	CB-16A	296.4967	------	0.5509	------	297.0476	303.0900	6.04
INTAKE	CB-16	302.0126	------	------	------	302.0126	303.4500	1.44
CB-16B	CB-16A	287.5829	------	------	------	287.5829	291.9400	4.36
CB-5	CB-4	283.5365	------	------	------	283.5365	287.0000	3.46
CB-6	CB-2	271.7033	------	------	------	271.7033	274.7500	3.05

Conduit Notes

Reach	HW Depth (ft)	HW/D ratio	Q (cfs)	TW Depth (ft)	Dc (ft)	Dn (ft)	Comment
PIPE 1	8.7595	8.7595	1.91	8.6400	0.5890	0.1941	Outlet Control
PIPE 10	0.6814	0.6814	1.52	7.3835	0.5228	0.1845	SuperCrit flow, Inlet end controls
PIPE 9	0.6523	0.6523	1.40	0.7122	0.5007	0.1824	SuperCrit flow, Inlet end controls
PIPE 4	1.1270	1.1270	1.11	1.0824	0.4435	0.3564	Outlet Control
PIPE 5	0.5435	0.5435	0.99	1.0346	0.4180	0.1720	SuperCrit flow, Inlet end controls
PIPE 11	0.3418	0.3418	0.42	0.9281	0.2691	0.1301	SuperCrit flow, Inlet end controls
PIPE 3	0.1567	0.1567	0.11	0.5298	0.1340	0.0684	SuperCrit flow, Inlet end controls
PIPE 8	0.0626	0.0626	0.06	0.7076	0.0950	0.0404	SuperCrit flow, Inlet end controls
PIPE	0.1029	0.1029	0.11	0.5298	0.1317	0.0520	SuperCrit flow, Inlet

12							end controls
PIPE 6	0.3065	0.3065	0.36	0.9281	0.2474	0.1158	SuperCrit flow, Inlet end controls
PIPE 7	1.0831	1.0831	0.14	1.0824	0.1512	0.1262	Outlet Control

Node and Reach invert report

Node and Reach invert report				
Node	INTAKE		Out ie	301.95 ft
	Reach	PIPE 8	I.E. Out	301.95 ft
Node	CB-16		Out ie	296.34 ft
	Reach	PIPE 8	I.E. In	296.34 ft
	Reach	PIPE 3	I.E. Out	296.34 ft
Node	CB-16B		Out ie	287.48 ft
	Reach	PIPE 12	I.E. Out	287.48 ft
Node	CB-16A		Out ie	286.28 ft
	Reach	PIPE 3	I.E. In	286.28 ft
	Reach	PIPE 12	I.E. In	286.28 ft
	Reach	PIPE 11	I.E. Out	286.28 ft
Node	CB-5		Out ie	283.23 ft
	Reach	PIPE 6	I.E. Out	283.23 ft
Node	CB-4		Out ie	281.54 ft
	Reach	PIPE 11	I.E. In	281.54 ft
	Reach	PIPE 6	I.E. In	281.54 ft
	Reach	PIPE 5	I.E. Out	281.54 ft
Node	CB-3		Out ie	270.72 ft
	Reach	PIPE 5	I.E. In	270.72 ft
	Reach	PIPE 4	I.E. Out	270.72 ft
Node	CB-6		Out ie	270.73 ft
	Reach	PIPE 7	I.E. Out	270.73 ft
Node	CB-2		Out ie	270.62 ft
	Reach	PIPE 4	I.E. In	270.62 ft
	Reach	PIPE 7	I.E. In	270.62 ft
	Reach	PIPE 9	I.E. Out	270.62 ft
Node	CB-2A		Out ie	259.07 ft
	Reach	PIPE 9	I.E. In	259.07 ft

	Reach	PIPE 10	I.E. Out	259.07 ft
Node	CB-1		Out ie	243.75 ft
	Reach	PIPE 10	I.E. In	243.75 ft
	Reach	PIPE 1	I.E. Out	243.75 ft

Basin Conveyance Data

BASIN 1 EVENT SUMMARY

Event	Peak Q (cfs)	Peak T (hrs)	Hyd Vol (acft)	Area (ac)	Method
2 yr 24 hr	0.2546	8.00	0.0892	0.66	SBUH
10 year	0.3595	8.00	0.1246	0.66	SBUH
25 yr	0.4206	8.00	0.1453	0.66	SBUH
50 year	0.4514	8.00	0.1557	0.66	SBUH
100 year	0.5289	8.00	0.1819	0.66	SBUH

All results based on storm duration of **24.0** hours. This is ok if all precipitations are appropriate for the storm duration. If some design event precipitations are for different duration storms, those results are incorrect

RECORD ID: BASIN 1

Design Method	SBUH	**Rainfall type**	TYPE1A.RAC
Hyd Intv	10.00 min	**Peaking Factor**	484.00
Storm Duration	24.00 hrs	**Abstraction Coeff**	0.20
Pervious Area	0.30 ac	**DCIA**	0.36 ac
Pervious CN	86.00	**DC CN**	98.00
Pervious TC	6.10 min	**DC TC**	6.10 min

Pervious CN Calc

Description	SubArea	Sub cn
Open spaces, lawns,parks (>75% grass)	0.30 ac	86.00
Pervious Composited CN (AMC 2)		86.00

Pervious TC Calc

Type	Description	Length	Slope	Coeff	Misc	TT
Sheet		0.00 ft	0.0%	6.1	0.00 in	6.10 min
Pervious TC						6.10 min

DCI - CN Calc

Description	SubArea	Sub cn
Impervious surfaces (pavements, roofs, etc)	0.36 ac	98.00
DC Composited CN (AMC 2)		98.00

DCI - TC Calc

Type	Description	Length	Slope	Coeff	Misc	TT
Sheet		0.00 ft	0.0%	6.1	0.00 in	6.10 min
Pervious TC						6.10 min

BASIN 2 EVENT SUMMARY

Event	Peak Q (cfs)	Peak T (hrs)	Hyd Vol (acft)	Area (ac)	Method
2 yr 24 hr	0.0849	8.00	0.0297	0.22	SBUH
10 year	0.1198	8.00	0.0415	0.22	SBUH
25 yr	0.1402	8.00	0.0484	0.22	SBUH
50 year	0.1505	8.00	0.0519	0.22	SBUH
100 year	0.1763	8.00	0.0606	0.22	SBUH

All results based on storm duration of **24.0** hours. This is ok if all precipitations are appropriate for the storm duration. If some design event precipitations are for different duration storms, those results are incorrect

RECORD ID: BASIN 2

Design Method	SBUH	**Rainfall type**	TYPE1A.RAC
Hyd Intv	10.00 min	**Peaking Factor**	484.00
Storm Duration	24.00 hrs	**Abstraction Coeff**	0.20
Pervious Area	0.10 ac	**DCIA**	0.12 ac
Pervious CN	86.00	**DC CN**	98.00
Pervious TC	6.10 min	**DC TC**	6.10 min

Pervious CN Calc		
Description	**SubArea**	**Sub cn**
Open spaces, lawns,parks (>75% grass)	0.10 ac	86.00
Pervious Composited CN (AMC 2)		86.00

Pervious TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	6.1	0.00 in	6.10 min
Pervious TC						6.10 min

DCI - CN Calc		
Description	**SubArea**	**Sub cn**
Impervious surfaces (pavements, roofs, etc)	0.12 ac	98.00
DC Composited CN (AMC 2)		98.00

DCI - TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	6.1	0.00 in	6.10 min
Pervious TC						6.10 min

BASIN 3 EVENT SUMMARY

Event	Peak Q (cfs)	Peak T (hrs)	Hyd Vol (acft)	Area (ac)	Method
2 yr 24 hr	0.079	8.00	0.0268	0.16	SBUH
10 year	0.1053	8.00	0.036	0.16	SBUH
25 yr	0.1203	8.00	0.0412	0.16	SBUH
50 year	0.1278	8.00	0.0439	0.16	SBUH
100 year	0.1466	8.00	0.0505	0.16	SBUH

All results based on storm duration of **24.0** hours. This is ok if all precipitations are appropriate for the storm duration. If some design event precipitations are for different duration storms, those results are incorrect

RECORD ID: BASIN 3

Design Method	SBUH	**Rainfall type**	TYPE1A.RAC
Hyd Intv	10.00 min	**Peaking Factor**	484.00
Storm Duration	24.00 hrs	**Abstraction Coeff**	0.20
Pervious Area	0.01 ac	**DCIA**	0.15 ac
Pervious CN	86.00	**DC CN**	98.00
Pervious TC	6.10 min	**DC TC**	6.10 min

Pervious CN Calc		
Description	**SubArea**	**Sub cn**
Open spaces, lawns,parks (>75% grass)	0.01 ac	86.00
Pervious Composited CN (AMC 2)		86.00

Pervious TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	6.1	0.00 in	6.10 min
Pervious TC						6.10 min

DCI - CN Calc		
Description	**SubArea**	**Sub cn**
Impervious surfaces (pavements, roofs, etc)	0.15 ac	98.00
DC Composited CN (AMC 2)		98.00

DCI - TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	6.1	0.00 in	6.10 min
Pervious TC						6.10 min

BASIN 4 EVENT SUMMARY

Event	Peak Q (cfs)	Peak T (hrs)	Hyd Vol (acft)	Area (ac)	Method
2 yr 24 hr	0.1072	8.00	0.0376	0.28	SBUH
10 year	0.1517	8.00	0.0526	0.28	SBUH
25 yr	0.1777	8.00	0.0614	0.28	SBUH
50 year	0.1907	8.00	0.0658	0.28	SBUH
100 year	0.2236	8.00	0.0769	0.28	SBUH

All results based on storm duration of **24.0** hours. This is ok if all precipitations are appropriate for the storm duration. If some design event precipitations are for different duration storms, those results are incorrect

RECORD ID: BASIN 4

Design Method	SBUH	**Rainfall type**	TYPE1A.RAC
Hyd Intv	10.00 min	**Peaking Factor**	484.00
Storm Duration	24.00 hrs	**Abstraction Coeff**	0.20
Pervious Area	0.13 ac	**DCIA**	0.15 ac
Pervious CN	86.00	**DC CN**	98.00
Pervious TC	6.10 min	**DC TC**	6.10 min

Pervious CN Calc		
Description	**SubArea**	**Sub cn**
Open spaces, lawns,parks (>75% grass)	0.13 ac	86.00
Pervious Composited CN (AMC 2)		86.00

Pervious TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	6.1	0.00 in	6.10 min
Pervious TC						6.10 min

DCI - CN Calc		
Description	**SubArea**	**Sub cn**
Impervious surfaces (pavements, roofs, etc)	0.15 ac	98.00
DC Composited CN (AMC 2)		98.00

DCI - TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	6.1	0.00 in	6.10 min
Pervious TC						6.10 min

BASIN 5 EVENT SUMMARY

Event	Peak Q (cfs)	Peak T (hrs)	Hyd Vol (acft)	Area (ac)	Method
2 yr 24 hr	0.1473	8.00	0.0516	0.38	SBUH
10 year	0.2078	8.00	0.072	0.38	SBUH
25 yr	0.243	8.00	0.0839	0.38	SBUH
50 year	0.2607	8.00	0.0899	0.38	SBUH
100 year	0.3053	8.00	0.105	0.38	SBUH

All results based on storm duration of **24.0** hours. This is ok if all precipitations are appropriate for the storm duration. If some design event precipitations are for different duration storms, those results are incorrect

RECORD ID: BASIN 5

Design Method	SBUH	**Rainfall type**	TYPE1A.RAC
Hyd Intv	10.00 min	**Peaking Factor**	484.00
Storm Duration	24.00 hrs	**Abstraction Coeff**	0.20
Pervious Area	0.17 ac	**DCIA**	0.21 ac
Pervious CN	86.00	**DC CN**	98.00
Pervious TC	6.10 min	**DC TC**	6.10 min

Pervious CN Calc		
Description	**SubArea**	**Sub cn**
Open spaces, lawns,parks (>75% grass)	0.17 ac	86.00
Pervious Composited CN (AMC 2)		86.00

Pervious TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	6.1	0.00 in	6.10 min
Pervious TC						6.10 min

DCI - CN Calc		
Description	**SubArea**	**Sub cn**
Impervious surfaces (pavements, roofs, etc)	0.21 ac	98.00
DC Composited CN (AMC 2)		98.00

DCI - TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	6.1	0.00 in	6.10 min
Pervious TC						6.10 min

BASIN 6 EVENT SUMMARY

Event	Peak Q (cfs)	Peak T (hrs)	Hyd Vol (acft)	Area (ac)	Method
2 yr 24 hr	0.0974	8.00	0.0341	0.25	SBUH
10 year	0.1372	8.00	0.0475	0.25	SBUH
25 yr	0.1604	8.00	0.0554	0.25	SBUH
50 year	0.1721	8.00	0.0593	0.25	SBUH
100 year	0.2014	8.00	0.0693	0.25	SBUH

All results based on storm duration of **24.0** hours. This is ok if all precipitations are appropriate for the storm duration. If some design event precipitations are for different duration storms, those results are incorrect

RECORD ID: BASIN 6

Design Method	SBUH	**Rainfall type**	TYPE1A.RAC
Hyd Intv	10.00 min	**Peaking Factor**	484.00
Storm Duration	24.00 hrs	**Abstraction Coeff**	0.20
Pervious Area	0.17 ac	**DCIA**	0.21 ac
Pervious CN	86.00	**DC CN**	98.00
Pervious TC	6.10 min	**DC TC**	6.10 min

Pervious CN Calc		
Description	**SubArea**	**Sub cn**
Open spaces, lawns,parks (>75% grass)	0.11 ac	86.00
Pervious Composited CN (AMC 2)		86.00

Pervious TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	6.1	0.00 in	6.10 min
Pervious TC						6.10 min

DCI - CN Calc		
Description	**SubArea**	**Sub cn**
Impervious surfaces (pavements, roofs, etc)	0.14 ac	98.00
DC Composited CN (AMC 2)		98.00

DCI - TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	6.1	0.00 in	6.10 min
Pervious TC						6.10 min

BASIN 7 EVENT SUMMARY

Event	Peak Q (cfs)	Peak T (hrs)	Hyd Vol (acft)	Area (ac)	Method
2 yr 24 hr	0.2702	8.00	0.0957	0.75	SBUH
10 year	0.3885	8.00	0.1352	0.75	SBUH
25 yr	0.4578	8.00	0.1584	0.75	SBUH
50 year	0.4928	8.00	0.1701	0.75	SBUH
100 year	0.5809	8.00	0.1996	0.75	SBUH

All results based on storm duration of **24.0** hours. This is ok if all precipitations are appropriate for the storm duration. If some design event precipitations are for different duration storms, those results are incorrect

RECORD ID: BASIN 7

Design Method	SBUH	**Rainfall type**	TYPE1A.RAC
Hyd Intv	10.00 min	**Peaking Factor**	484.00
Storm Duration	24.00 hrs	**Abstraction Coeff**	0.20
Pervious Area	0.17 ac	**DCIA**	0.21 ac
Pervious CN	86.00	**DC CN**	98.00
Pervious TC	6.10 min	**DC TC**	6.10 min

Pervious CN Calc		
Description	**SubArea**	**Sub cn**
Open spaces, lawns,parks (>75% grass)	0.41 ac	86.00
Pervious Composited CN (AMC 2)		86.00

Pervious TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	6.1	0.00 in	6.10 min
Pervious TC						6.10 min

DCI - CN Calc		
Description	**SubArea**	**Sub cn**
Impervious surfaces (pavements, roofs, etc)	0.34 ac	98.00
DC Composited CN (AMC 2)		98.00

DCI - TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	6.1	0.00 in	6.10 min
Pervious TC						6.10 min

FRONTAGE EVENT SUMMARY

Event	Peak Q (cfs)	Peak T (hrs)	Hyd Vol (acft)	Area (ac)	Method
2 yr 24 hr	0.0405	8.00	0.0139	0.09	SBUH
10 year	0.0551	8.00	0.0189	0.09	SBUH
25 yr	0.0635	8.00	0.0218	0.09	SBUH
50 year	0.0677	8.00	0.0233	0.09	SBUH
100 year	0.0782	8.00	0.0269	0.09	SBUH

All results based on storm duration of **24.0** hours. This is ok if all precipitations are appropriate for the storm duration. If some design event precipitations are for different duration storms, those results are incorrect

RECORD ID: FRONTAGE

Design Method	SBUH	**Rainfall type**	TYPE1A.RAC
Hyd Intv	10.00 min	**Peaking Factor**	484.00
Storm Duration	24.00 hrs	**Abstraction Coeff**	0.20
Pervious Area	0.17 ac	**DCIA**	0.21 ac
Pervious CN	86.00	**DC CN**	98.00
Pervious TC	6.10 min	**DC TC**	6.10 min

Pervious CN Calc		
Description	**SubArea**	**Sub cn**
Open spaces, lawns,parks (>75% grass)	0.02 ac	86.00
Pervious Composited CN (AMC 2)		86.00

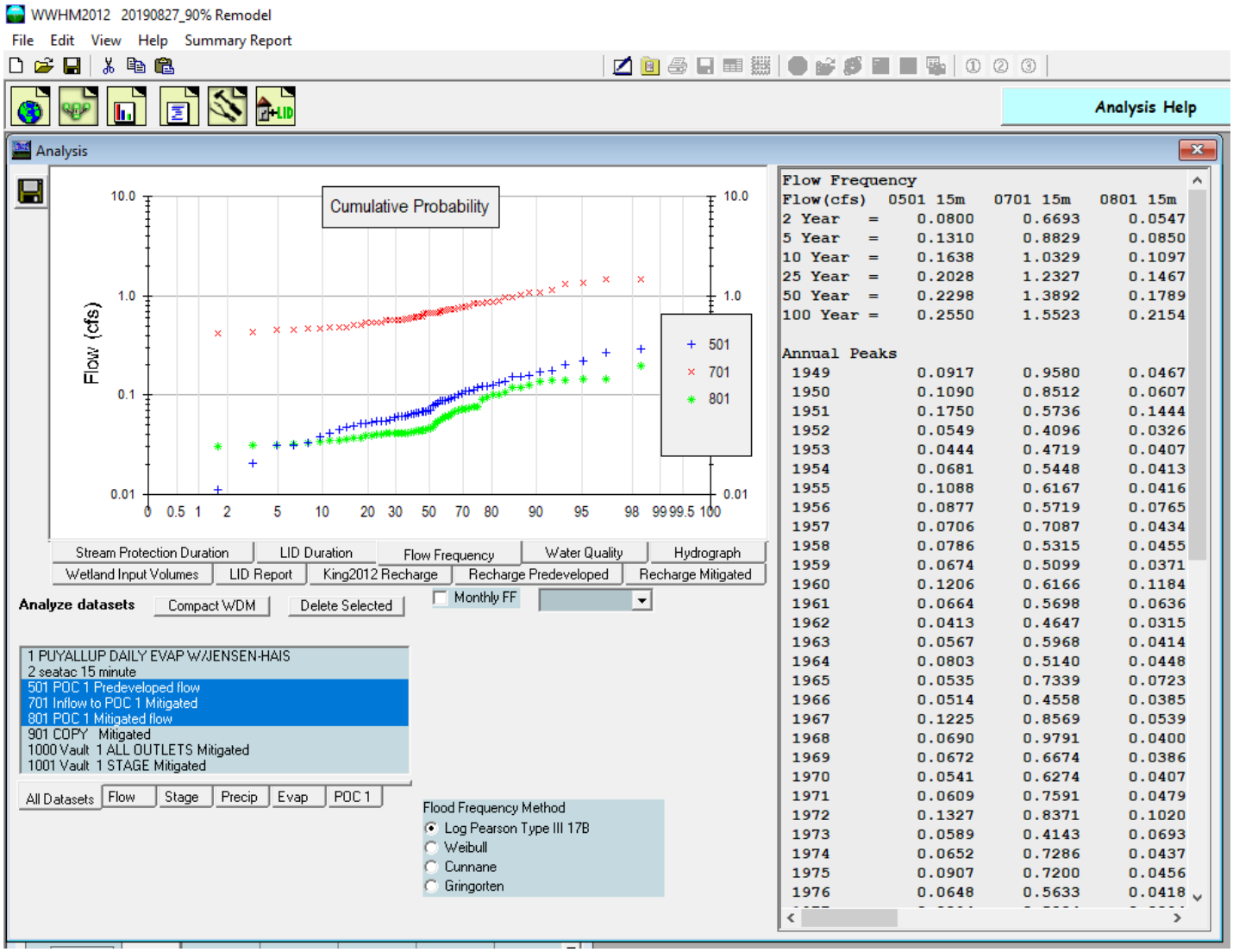
Pervious TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	6.1	0.00 in	6.10 min
Pervious TC						6.10 min

DCI - CN Calc		
Description	**SubArea**	**Sub cn**
Impervious surfaces (pavements, roofs, etc)	0.07 ac	98.00
DC Composited CN (AMC 2)		98.00

DCI - TC Calc						
Type	**Description**	**Length**	**Slope**	**Coeff**	**Misc**	**TT**
Sheet		0.00 ft	0.0%	6.1	0.00 in	6.10 min
Pervious TC						6.10 min

APPENDIX 5-B

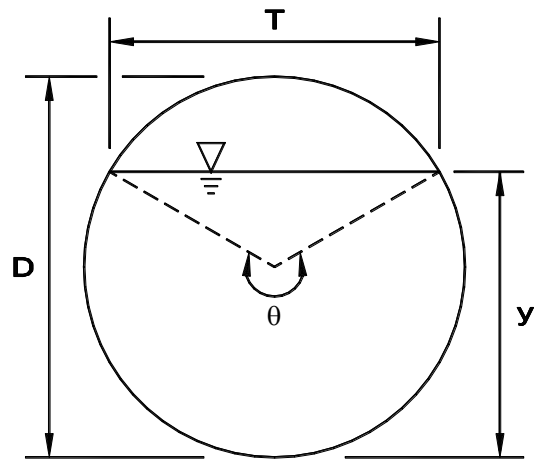
CONVEYANCE CAPACITY CALCULATIONS


WWHM2012 20190827_90% Remodel
File Edit View Help Summary Report
Analysis Help
Analysis
Cumulative Probability
Flow (cfs)
10.0
1.0
0.1
0.01
0 0.5 1 2 5 10 20 30 50 70 80 90 95 98 99 99.5 100
501
701
801
Stream Protection Duration
LID Duration
Flow Frequency
Water Quality
Hydrograph
Wetland Input Volumes
LID Report
King2012 Recharge
Recharge Predeveloped
Recharge Mitigated
Analyze datasets
Compact WDM
Delete Selected
Monthly FF
1 PUYALLUP DAILY EVAP WJENSEN-HAIS
2 seatac 15 minute
501 POC 1 Predeveloped flow
701 Inflow to POC 1 Mitigated
801 POC 1 Mitigated flow
901 COPY Mitigated
1000 Vault 1 ALL OUTLETS Mitigated
1001 Vault 1 STAGE Mitigated
All Datasets
Flow
Stage
Precip
Evap
POC 1
Flood Frequency Method
Log Pearson Type III 17B
Weibull
Cunnane
Gringorten
Flow Frequency
Flow(cfs) 0501 15m 0701 15m 0801 15m
2 Year = 0.0800 0.6693 0.0547
5 Year = 0.1310 0.8829 0.0850
10 Year = 0.1638 1.0329 0.1097
25 Year = 0.2028 1.2327 0.1467
50 Year = 0.2298 1.3892 0.1789
100 Year = 0.2550 1.5523 0.2154
Annual Peaks
1949 0.0917 0.9580 0.0467
1950 0.1090 0.8512 0.0607
1951 0.1750 0.5736 0.1444
1952 0.0549 0.4096 0.0326
1953 0.0444 0.4719 0.0407
1954 0.0681 0.5448 0.0413
1955 0.1088 0.6167 0.0416
1956 0.0877 0.5719 0.0765
1957 0.0706 0.7087 0.0434
1958 0.0786 0.5315 0.0455
1959 0.0674 0.5099 0.0371
1960 0.1206 0.6166 0.1184
1961 0.0664 0.5698 0.0636
1962 0.0413 0.4647 0.0315
1963 0.0567 0.5968 0.0414
1964 0.0803 0.5140 0.0448
1965 0.0535 0.7339 0.0723
1966 0.0514 0.4558 0.0385
1967 0.1225 0.8569 0.0539
1968 0.0690 0.9791 0.0400
1969 0.0672 0.6674 0.0386
1970 0.0541 0.6274 0.0407
1971 0.0609 0.7591 0.0479
1972 0.1327 0.8371 0.1020
1973 0.0589 0.4143 0.0693
1974 0.0652 0.7286 0.0437
1975 0.0907 0.7200 0.0456
1976 0.0648 0.5633 0.0418

Open Channel Flow Calculator For Circular Pipes	*Land Development Consultants, Inc.*	
	14201 NE 200th St. Ste. 100 Woodinville, WA 98072	Tel: (425) 806-1869 Fax: (425) 482-2893

Project Name:	Garbarino	Project No.:	15-104
Description:	Onsite Culvert	Date:	2/3/2016
		Calc. By:	TPA

Pipe Diameter (D) =	12	in
Pipe Slope (S) =	5.15	%
Flow Depth (y) =	1.00	ft
Flowrate (Q) =	8.78	cfs
Mannings Coeff. (n) =	0.012	
Theta Angle (θ) =	6.28	rad
Wetted Area (A) =	0.79	ft^2
Wet. Perimeter (P) =	3.14	ft
Hydraulic Radius (R) =	0.25	ft
Top Width (T) =	0.00	ft
Flow Velocity =	11.18	fps



Solve | Reset Form

Formulas:

Theta Angle (θ): If y ≥ r : $\theta = 2\pi - 2a\cos(\frac{y-r}{r})$ where: r = Pipe Radius

If y ≤ r : $\theta = 2a\cos(\frac{r-y}{r})$ where: r = Pipe Radius

Wetted Area (A): $A = \frac{1}{8}(\theta - \sin\theta)d^2$

Wetted Perimeter (P): $P = \frac{1}{2}\theta d$

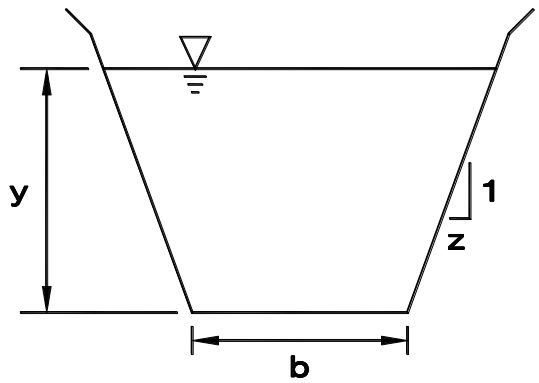
Hydraulic Radius (R): $R = \frac{A}{P}$

Top Width (T): $T = \sin\left(\theta/2\right)d$

Open Channel Flow Calculator For Triangular/Trapezoidal Channels	*Land Development Consultants, Inc.*	
	20210 142nd Ave NE Woodinville, WA 98072	Tel: (425) 806-1869 Fax: (425) 482-2893

Project Name:	Garbarino	Project No.:	15-109
Description:	Swale (STA. 12+10 to STA. 12+31)	Date:	8/10/2018
		Calc. By:	SJW

Bottom Width (b) =	2.00	ft
Side Slopes (z) =	2.00	:1
Channel Slope (S) =	5.78	%
Flow Depth (y) =	0.18	ft
Flowrate (Q) =	1.39	cfs
Mannings Coeff. (n) =	0.030	
Wetted Area (A) =	0.41	ft^2
Wet. Perimeter (P) =	2.79	ft
Hydraulic Radius (R) =	0.15	ft
Top Width (T) =	2.71	ft
Flow Velocity =	3.35	fps



Solve | Reset Form

Formulas:

Wetted Area (A): $A = (b + zy)y$

Wetted Perimeter (P): $P = b + 2y\sqrt{1+z^2}$

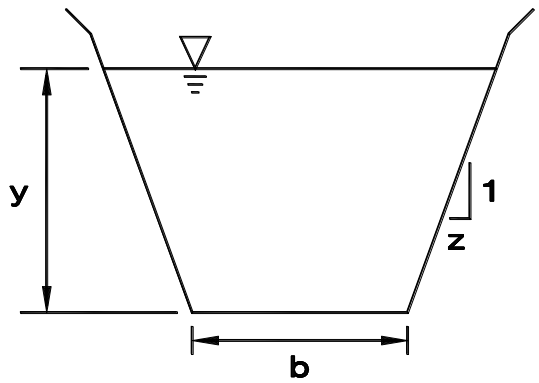
Hydraulic Radius (R): $R = \frac{A}{P}$

Top Width (T): $T = b + 2zy$

Open Channel Flow Calculator For Triangular/Trapezoidal Channels	*Land Development Consultants, Inc.*	
	20210 142nd Ave NE Woodinville, WA 98072	Tel: (425) 806-1869 Fax: (425) 482-2893

Project Name:	Garbarino	Project No.:	15-104
Description:	Swale (STA. 13+81 to STA. 14+10)	Date:	8/10/2018
		Calc. By:	SJW

Bottom Width (b) =	2.00	ft
Side Slopes (z) =	2.00	:1
Channel Slope (S) =	10.98	%
Flow Depth (y) =	0.15	ft
Flowrate (Q) =	1.39	cfs
Mannings Coeff. (n) =	0.030	
Wetted Area (A) =	0.34	ft^2
Wet. Perimeter (P) =	2.65	ft
Hydraulic Radius (R) =	0.13	ft
Top Width (T) =	2.59	ft
Flow Velocity =	4.14	fps



Solve | Reset Form

Formulas:

Wetted Area (A): $A = (b + zy)y$

Wetted Perimeter (P): $P = b + 2y\sqrt{1+z^2}$

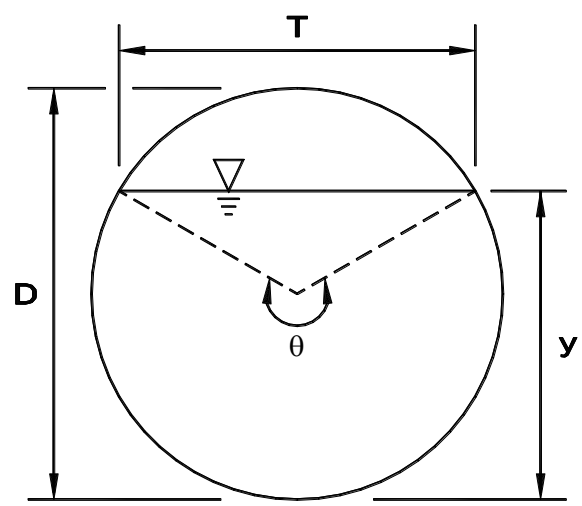
Hydraulic Radius (R): $R = \frac{A}{P}$

Top Width (T): $T = b + 2zy$

Open Channel Flow Calculator For Circular Pipes	*Land Development Consultants, Inc.*	
	14201 NE 200th St. Ste. 100 Woodinville, WA 98072	Tel: (425) 806-1869 Fax: (425) 482-2893

Project Name:	Garbarino	Project No.:	15-104
Description:	Vault Discharge Line CB-8 to CB-9	Date:	1/19/2016
		Calc. By:	TPA

Pipe Diameter (D) =	12	in
Pipe Slope (S) =	0.60	%
Flow Depth (y) =	1.00	ft
Flowrate (Q) =	3.00	cfs
Mannings Coeff. (n) =	0.012	
Theta Angle (θ) =	6.28	rad
Wetted Area (A) =	0.79	ft^2
Wet. Perimeter (P) =	3.14	ft
Hydraulic Radius (R) =	0.25	ft
Top Width (T) =	0.00	ft
Flow Velocity =	3.82	fps



Solve | Reset Form

Formulas:

Theta Angle (θ): If y ≥ r : $\theta = 2\pi - 2a\cos(\frac{y-r}{r})$ where: r = Pipe Radius

If y ≤ r : $\theta = 2a\cos(\frac{r-y}{r})$ where: r = Pipe Radius

Wetted Area (A): $A = \frac{1}{8}(\theta - \sin\theta)d^2$

Wetted Perimeter (P): $P = \frac{1}{2}\theta d$

Hydraulic Radius (R): $R = \frac{A}{P}$

Top Width (T): $T = \sin\left(\theta/2\right)d$

6.0 SPECIAL REPORTS AND STUDIES

A Geotechnical Report will be submitted as an additional document separately from this Report.

7.0 OTHER PERMITS

Other permits that may be required for the proposed development are as follows:

- Clearing and Grading Permit
- National Pollution Discharge Elimination System (NPDES)
- Right-of-Way permit
- Utility Permit
- Building Permits

8.0 EROSION AND SEDIMENT CONTROL ANALYSIS AND DESIGN

The Stormwater Pollution Prevention Plan for the project, which is written according to the guidelines of Volume II, Section 3 of the 2014 DOE Manual and the requirements of the 2017 Redmond Stormwater Technical Notebook, will be submitted as a separate document as project design progresses.

9.0 BOND QUANTITIES, FACILITY SUMMARIES, AND DECLARATION OF COVENANT

A Bond Quantities Worksheet will be completed as necessary for a future submittal.

10.0 OPERATIONS AND MAINTENANCE MANUAL

The proposed storm drainage system consists of swales, buried pipes, catch basins and a Combined Detention/Wetvault facility, each of which will require periodic maintenance and inspection. An Operations and Maintenance Manual will be submitted to the City as a separate document.

APPENDIX 10-A

OPERATIONS AND MAINTENANCE CRITERIA