PRELIMINARY
STORM DRAINAGE REPORT

FOR

BEUCA PROPERTY

REDMOND, WASHINGTON

Project Manager:	James A. Olsen, P.E.
Prepared by:	Sheri Murata, P.E.
First Submittal:	March 2013
Revised:	August 2013, December 2013, February 2014 April 2014
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ATTACHMENT 18

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1. Project Overview

The Beuca Property is a proposed residential development consisting of single-family detached units. The Beuca Property project is located in Section 25, Township 26 North, Range 5 East, W.M, on the north side of NE 122nd Street and west of 166th Place NE (see Figure 1-1 - Vicinity Map). The project properties total 3.59 acres. The total area to be developed is 4.02 acres; this includes future frontage improvements. To the north, west and east of the site are single family residential areas. The south side of the project is bounded by NE 122nd Street. This project is located within the City of Redmond.

The proposed site consists of two parcels as follows:

Table 1-1	
KC Parcel #	**Site Area (SF)**
2526059029	**110,642**
2526059151	**45,738**

Drainage from the property sheet flows across adjacent properties to the west and south into an existing ditch and culvert system on the north side of NE 122nd Street that conveys the flows west toward NE 124th Street.

Proposed development of the property will include the demolition of all structures on the property and construction of 15 single-family units (1 duplex) on 14 lots, along with associated roadway, utilities, open space, and drainage detention and treatment. Frontage improvements along NE 122nd Street and 166th Place NE and ROW improvements within the offsite NE 123rd Place will also be included as part of the development.

A single detention vault will be located in Tract A near the southwest corner of the property and designed per Redmond's design criteria. The detained flows will then be conveyed west to NE 122nd Street and into the existing ditch system located on the north side of NE 122nd Street or into the proposed tight line pipe system to be constructed as part of the Shadow Creek development immediately west of the Beuca Property project.

Basic water quality treatment is provided through dead storage and is computed using the 6-month, 24-hour storm volume as determined using Water Works software. Flow control is provided with 9.2 feet of live storage and will match developed discharge durations to 50% of the pre-developed 2-year peak flow to the full 50-year peak flow as determined by King County Runoff Time Series (KCRTS).

Wellhead Protection Zone Limitations

The project site is within Wellhead Protection Zone 4, per the City of Redmond's Wellhead Protection Zone Map (see Figure 2-1).

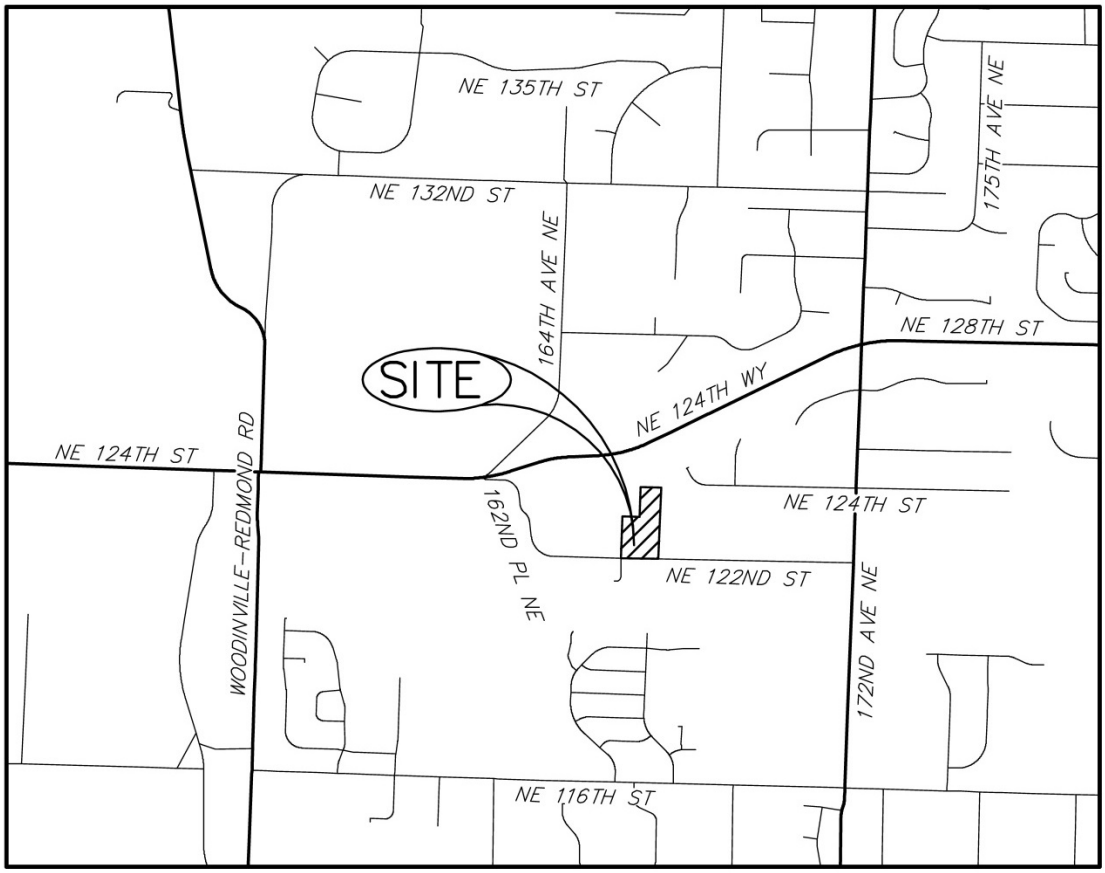


Figure 1-1: Vicinity Map

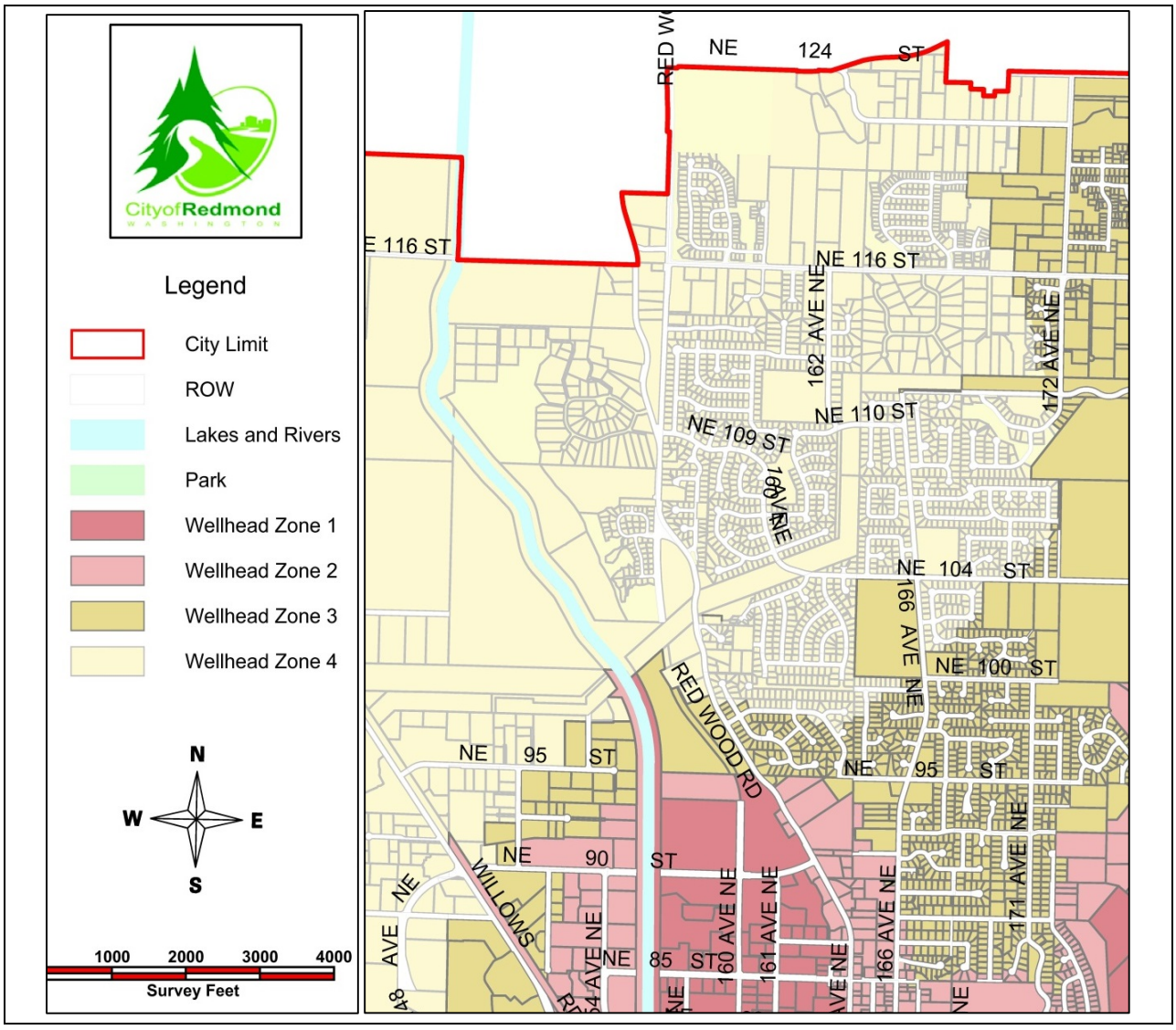


Figure 1-2: City of Redmond Wellhead Protection Zone Map

New Search | Property Tax Bill | Map This Property | Glossary of Terms | Area Report | Print Property Detail

PARCEL DATA

Parcel	252605-9029
Name	BEUCA PETRU+MARIA
Site Address	16628 NE 122ND ST 98052
Residential Area	072-004 (NE Appraisal District)
Property Name	

Jurisdiction	REDMOND
Levy Code	2019
Property Type	R
Plat Block / Building Number	
Plat Lot / Unit Number	
Quarter-Section-Township-Range	SW-25-26-5

Legal Description

LOT 1 OF KCSP #680046 REC # 8009150625 SD PLAT DAF - W 1/2 OF NE 1/4 OF NW 1/4 OF SW 1/4 SD SEC LESS S 30 FT FOR RD & LESS W 8 FT OF N 352 FT OF S 382 FT & LESS W 165 FT OF N 278 FT

LAND DATA

Highest & Best Use As If Vacant	SINGLE FAMILY
Highest & Best Use As Improved	PRESENT USE
Present Use	Single Family(Res Use/Zone)
Base Land Value SqFt	0
Base Land Value	1,011,000
% Base Land Value Impacted	90
Base Land Valued Date	1/22/2008
Base Land Value Tax Year	2009
Land SqFt	110,642
Acres	2.54

Percentage Unusable	0
Unbuildable	NO
Restrictive Size Shape	NO
Zoning	R4
Water	PRIVATE
Sewer/Septic	PRIVATE
Road Access	PUBLIC
Parking	
Street Surface	PAVED

Views

Rainier	
Territorial	
Olympics	
Cascades	
Seattle Skyline	
Puget Sound	
Lake Washington	
Lake Sammamish	
Lake/River/Creek	
Other View	

Waterfront

Waterfront Location	
Waterfront Footage	
Lot Depth Factor	
Waterfront Bank	
Tide/Shore	
Waterfront Restricted Access	
Waterfront Access Rights	NO
Poor Quality	
Proximity Influence	NO

Designations

Historic Site	
Current Use	
Nbr Bldg Sites	
Adjacent to Golf Fairway	NO
Adjacent to Greenbelt	NO
Other Designation	NO
Deed Restrictions	NO
Development Rights Purchased	NO
Easements	YES
Native Growth Protection Easement	NO
DNR Lease	NO

Nuisances

Topography	NO
Traffic Noise	
Airport Noise	
Power Lines	NO
Other Nuisances	NO

Problems

Water Problems	NO
Transportation Concurrency	NO
Other Problems	NO

Environmental

Environmental	NO

BUILDING

Reference Links:

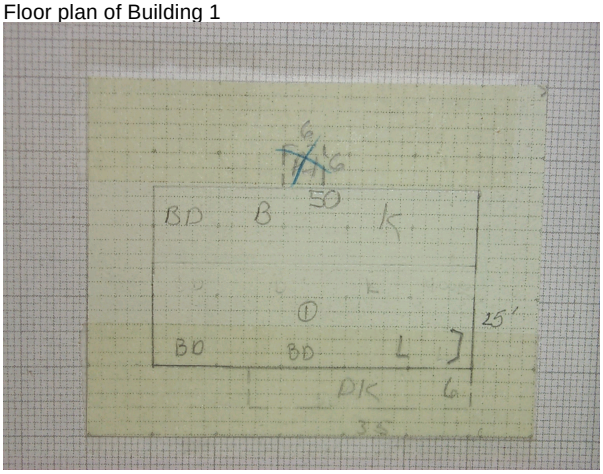
- King County Tax Links
- Property Tax Advisor
- Washington State Department of Revenue (External link)
- Washington State Board of Tax Appeals (External link)
- Board of Appeals/Equalization
- Districts Report
- iMap
- Recorder's Office

  Scanned images of surveys and other map documents

Building Number	1
Year Built	1957
Year Renovated	0
Stories	1
Living Units	1
Grade	7 Average
Grade Variant	0
Condition	Fair
Basement Grade	5 Fair
1st Floor	1,250
1/2 Floor	0
2nd Floor	0
Upper Floor	0
Finished Basement	240
Total Living	1,490
Total Basement	1,250
Basement Garage	620
Unfinished 1/2	0
Unfinished Full	0
Attached Garage	0
Bedrooms	3
Full Baths	1
3/4 Baths	0
1/2 Baths	1
Heat Source	Electricity
Heat System	Elec BB
Deck Area SqFt	0
Open Porch SqFt	0
Enclosed Porch SqFt	0
Brick/Stone	0
Fireplace Single Story	0
Fireplace Muilti Story	1
Fireplace Free Standing	0
Fireplace Additional	1
AddnlCost	0
Obsolescence	0
Net Condition	0
Percentage Complete	0
Daylight Basement	YES
View Utilization	

Picture of Building 1

Floor plan of Building 1



TAX ROLL HISTORY

Account	Valued Year	Tax Year	Omit Year	Levy Code	Appraised Land Value	Appraised Imps Value	Appraised Total Value	New Dollars	Taxable Land Value	Taxable Imps Value	Taxable Total Value	Tax Value Reason
252605902904	2012	2013		2019	$813,000	$1,000	$814,000	$0	$813,000	$1,000	$814,000	
252605902904	2011	2012		2019	$809,000	$1,000	$810,000	$0	$809,000	$1,000	$810,000	
252605902904	2010	2011		2026	$859,000	$1,000	$860,000	$0	$859,000	$1,000	$860,000	
252605902904	2009	2010		2026	$859,000	$1,000	$860,000	$0	$859,000	$1,000	$860,000	
252605902904	2008	2009		2026	$1,011,000	$1,000	$1,012,000	$0	$1,011,000	$1,000	$1,012,000	
252605902904	2007	2008		2026	$345,000	$201,000	$546,000	$0	$345,000	$201,000	$546,000	
252605902904	2006	2007		2026	$311,000	$161,000	$472,000	$0	$311,000	$161,000	$472,000	
252605902904	2005	2006		2026	$297,000	$113,000	$410,000	$0	$297,000	$113,000	$410,000	
252605902904	2004	2005		7260	$270,000	$110,000	$380,000	$0	$270,000	$110,000	$380,000	
252605902904	2003	2004		7260	$258,000	$85,000	$343,000	$0	$258,000	$85,000	$343,000	
252605902904	2002	2003		7260	$250,000	$82,000	$332,000	$0	$250,000	$82,000	$332,000	
252605902904	2001	2002		7260	$283,000	$145,000	$428,000	$0	$283,000	$145,000	$428,000	
252605902904	2000	2001		7260	$260,000	$133,000	$393,000	$0	$260,000	$133,000	$393,000	
252605902904	1999	2000		7260	$173,000	$68,000	$241,000	$0	$173,000	$68,000	$241,000	
252605902904	1998	1999		7260	$156,000	$52,000	$208,000	$0	$156,000	$52,000	$208,000	
252605902904	1997	1998		7260	$0	$0	$0	$0	$137,000	$46,000	$183,000	
252605902904	1996	1997		7260	$0	$0	$0	$0	$137,400	$42,900	$180,300	
252605902904	1994	1995		7260	$0	$0	$0	$0	$137,400	$42,900	$180,300	
252605902904	1992	1993		7260	$0	$0	$0	$0	$147,000	$17,700	$164,700	
252605902904	1990	1991		7260	$0	$0	$0	$0	$88,500	$79,500	$168,000	
252605902904	1988	1989		7260	$0	$0	$0	$0	$63,000	$52,300	$115,300	
252605902904	1986	1987		7260	$0	$0	$0	$0	$63,000	$26,200	$89,200	
252605902904	1984	1985		7260	$0	$0	$0	$0	$45,500	$46,300	$91,800	
252605902904	1982	1983		7260	$0	$0	$0	$0	$45,500	$46,300	$91,800	

SALES HISTORY

Excise Number	Recording Number	Document Date	Sale Price	Seller Name	Buyer Name	Instrument	Sale Reason
1876664	20020329003097	3/24/2002	$332,000.00	ANDERSON MARI	BEUCA PETRU+MARIA	Warranty Deed	None

REVIEW HISTORY

Tax Year	Review Number	Review Type	Appealed Value	Hearing Date	Settlement Value	Decision	Status
2012	1101098	Local Appeal	$810,000	3/19/2012	$810,000	SUSTAIN	Completed
2004	R66097	Review - Assessment	$0	1/1/1900	$0		Completed
2003	0200574	Local Appeal	$455,000	11/10/2003	$332,000	REVISE	Completed

PERMIT HISTORY

HOME IMPROVEMENT EXEMPTION

New Search | Property Tax Bill | Map This Property | Glossary of Terms | Area Report | Print Property Detail

PARCEL DATA

Parcel	252605-9151	Jurisdiction	REDMOND
Name	BUECA PETRU+MARIA	Levy Code	2019
Site Address	16632 NE 122ND ST 98052	Property Type	R
Residential Area	072-004 (NE Appraisal District)	Plat Block / Building Number	
Property Name		Plat Lot / Unit Number	
		Quarter-Section-Township-Range	SW-25-26-5

Legal Description

PP ACT 39931670 MOBILE HOME LOT 2 OF KCSP #680046 REC # 8009150625 SD PLAT DAF - W 1/2 OF NE 1/4 OF NW 1/4 OF SW 1/4 SD SEC LESS S 30 FT FOR RD & LESS W 8 FT OF N 352 FT OF S 382 FT & LESS W 165 FT OF N 278 FT

LAND DATA

Highest & Best Use As If Vacant	SINGLE FAMILY	Percentage Unusable	0
Highest & Best Use As Improved	(unknown)	Unbuildable	NO
Present Use	Vacant(Single-family)	Restrictive Size Shape	NO
Base Land Value SqFt	0	Zoning	R4
Base Land Value	550,000	Water	PRIVATE
% Base Land Value Impacted	100	Sewer/Septic	PRIVATE
Base Land Valued Date	1/22/2008	Road Access	PRIVATE
Base Land Value Tax Year	2009	Parking	
Land SqFt	45,738	Street Surface	PAVED
Acres	1.05		

Views

Rainier	
Territorial	
Olympics	
Cascades	
Seattle Skyline	
Puget Sound	
Lake Washington	
Lake Sammamish	
Lake/River/Creek	
Other View	

Waterfront

Waterfront Location	
Waterfront Footage	
Lot Depth Factor	
Waterfront Bank	
Tide/Shore	
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Waterfront Access Rights	NO
Poor Quality	
Proximity Influence	NO

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Adjacent to Golf Fairway	NO
Adjacent to Greenbelt	NO
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Easements	NO
Native Growth Protection Easement	NO
DNR Lease	NO

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Power Lines	NO
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- Districts Report
- iMap
- Recorder's Office

  Scanned images of surveys and other map documents

Accessory Of Building Number:

Accessory Type	Picture	Description	SqFt	Grade	Eff Year	%	Value	Date Valued
PRK:DET GAR			670	5 Fair	1985			
Real		0 0/0	0					

TAX ROLL HISTORY

Account	Valued Year	Tax Year	Omit Year	Levy Code	Appraised Land Value	Appraised Imps Value	Appraised Total Value	New Dollars	Taxable Land Value	Taxable Imps Value	Taxable Total Value	Tax Value Reason
252605915104	2012	2013		2019	$441,000	$1,000	$442,000	$0	$441,000	$1,000	$442,000	
252605915104	2011	2012		2019	$439,000	$1,000	$440,000	$0	$439,000	$1,000	$440,000	
252605915104	2010	2011		2026	$467,000	$1,000	$468,000	$0	$467,000	$1,000	$468,000	
252605915104	2009	2010		2026	$467,000	$1,000	$468,000	$0	$467,000	$1,000	$468,000	
252605915104	2008	2009		2026	$550,000	$5,000	$555,000	$0	$550,000	$5,000	$555,000	
252605915104	2007	2008		2026	$235,000	$55,000	$290,000	$0	$235,000	$55,000	$290,000	
252605915104	2006	2007		2026	$212,000	$55,000	$267,000	$0	$212,000	$55,000	$267,000	
252605915104	2005	2006		2026	$202,000	$52,000	$254,000	$0	$202,000	$52,000	$254,000	
252605915104	2004	2005		7260	$184,000	$52,000	$236,000	$0	$184,000	$52,000	$236,000	
252605915104	2003	2004		7260	$176,000	$52,000	$228,000	$0	$176,000	$52,000	$228,000	
252605915104	2002	2003		7260	$171,000	$51,000	$222,000	$0	$171,000	$51,000	$222,000	
252605915104	2001	2002		7260	$179,000	$49,000	$228,000	$0	$179,000	$49,000	$228,000	
252605915104	2000	2001		7260	$165,000	$45,000	$210,000	$0	$165,000	$45,000	$210,000	
252605915104	1999	2000		7260	$138,000	$56,000	$194,000	$0	$138,000	$56,000	$194,000	
252605915104	1998	1999		7260	$125,000	$54,000	$179,000	$0	$125,000	$54,000	$179,000	
252605915104	1997	1998		7260	$0	$0	$0	$0	$110,000	$48,000	$158,000	
252605915104	1996	1997		7260	$0	$0	$0	$0	$110,000	$44,500	$154,500	
252605915104	1994	1995		7260	$0	$0	$0	$0	$110,000	$44,500	$154,500	
252605915104	1992	1993		7260	$0	$0	$0	$0	$112,500	$41,896	$154,396	
252605915104	1991	1992		7260	$0	$0	$0	$0	$55,500	$42,396	$97,896	
252605915104	1990	1991		7260	$0	$0	$0	$0	$55,500	$42,396	$97,896	
252605915104	1989	1990		7260	$0	$0	$0	$0	$45,000	$44,378	$89,378	
252605915104	1988	1989		7260	$0	$0	$0	$0	$45,000	$44,378	$89,378	
252605915104	1987	1988		7260	$0	$0	$0	$0	$45,000	$39,874	$84,874	
252605915104	1986	1987		7260	$0	$0	$0	$0	$45,000	$45,492	$90,492	
252605915104	1985	1986		7260	$0	$0	$0	$0	$20,000	$45,420	$65,420	
252605915104	1984	1985		7260	$0	$0	$0	$0	$20,000	$0	$20,000	
252605915104	1983	1984		7260	$0	$0	$0	$0	$20,000	$0	$20,000	
252605915104	1982	1983		7260	$0	$0	$0	$0	$20,000	$45,400	$65,400	

SALES HISTORY

Excise Number	Recording Number	Document Date	Sale Price	Seller Name	Buyer Name	Instrument	Sale Reason
2092171	200412230011 48	12/16/2004	$238,600.00	ANDERSON KAREN G	BUECA PETRU+MARIA	Statutory Warranty Deed	None
1759187	200006150013 58	5/30/2000	$0.00	HARRIS GERALD L	ANDERSON KAREN G	Quit Claim Deed	Divorce Settlement
1425007	199504210674	4/17/1995	$0.00	HARRIS KAREN C	HARRIS GERALD L+KAREN G	Quit Claim Deed	Settlement

REVIEW HISTORY

Tax Year	Review Number	Review Type	Appealed Value	Hearing Date	Settlement Value	Decision	Status
2012	1101099	Local Appeal	$440,000	3/19/2012	$440,000	SUSTAIN	Completed

PERMIT HISTORY

HOME IMPROVEMENT EXEMPTION

2. Conditions and Requirement Summary

The proposed project is classified as a "Large Project" per Section 3.5, pg 57, within the City of Redmond Clearing, Grading, and Stormwater Management Technical Notebook, Issue No. 6 dated February 23, 2012 (Technical Notebook). Per Figure 3.2 (shown below) and Section 3.5, "all minimum requirements apply to the new impervious surfaces and converted pervious surfaces."

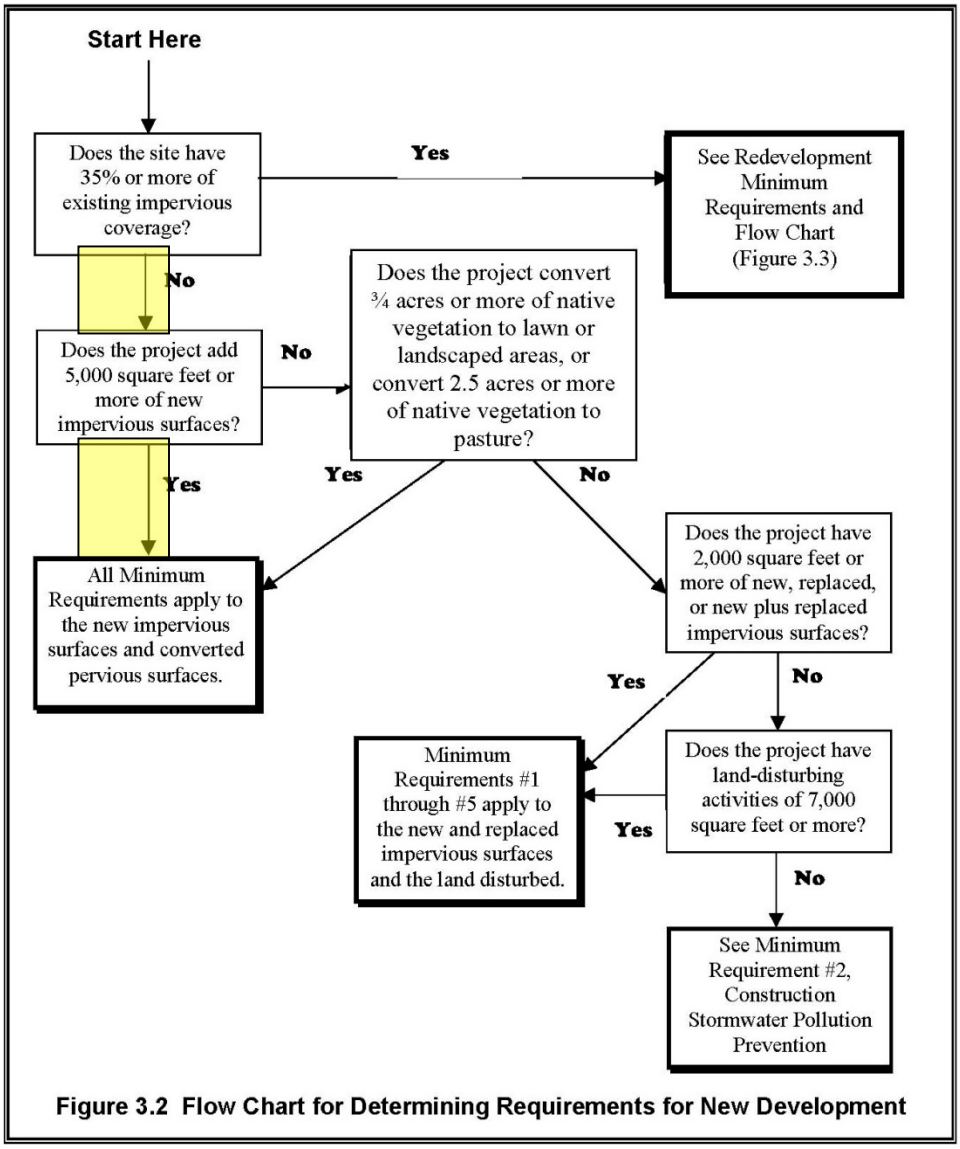


Figure 3.2 Flow Chart for Determining Requirements for New Development

The City of Redmond Clearing, Grading, and Stormwater Management Technical Notebook, Issue Number 6 discusses wellhead protection within the City and corresponding restrictions and limitations.

Section 2.5.5, beginning on page 24 of the Technical Notebook, provides the following summary regarding **Groundwater Protection** in Wellhead Protection Zone 4:

"In Wellhead Protection Zone 4, runoff from pollution generating impervious surfaces can be infiltrated without treatment provided the soil profile provides treatment per Chapter 3.3 of Volume III of the 2005 Ecology Manual. Infiltration of runoff from non-pollution generating impervious areas considered to be clean, including most roofs and sidewalks, is strongly encouraged where feasible."

As noted above, infiltration is encouraged in Wellhead Protection Zone 4 provided the soil profile supports the applicable water quality treatment requirements.

Minimum Requirement #1: Preparation of Stormwater Site Plans: Preliminary Civil Plans under separate cover and Preliminary Storm Drainage Report herein have been prepared for the subject project. The proposed project is classified as a "Large Project" per Section 3.5, pg 57, within the Technical Notebook.

Minimum Requirement #2: Construction Stormwater Pollution Prevention: All new development and redevelopment shall comply with the Construction SWPPP Element #1 through Element #12 listed in the 2005 DOE Stormwater Manual. The Beuca Property project disturbs more than 7,000 square feet of land and will require a Construction SWPPP. Erosion/Sedimentation Control and Construction Stormwater Pollution Prevention Plans will be completed during final engineering design.

Minimum Requirement #3: Source Control of Pollution: RMC 13.06.066 requires that applicable adopted source control BMPs (operational and structural) be used on all sites except Single Family Residential sites. As this project is a Single Family Residential site Source Control BMPs do not apply.

Minimum Requirement #4: Preservation of Natural Drainage Systems and Outfalls:
Natural drainage patterns shall be maintained, and discharges from the project site shall occur at the natural location, to the maximum extent practicable. The manner by which runoff is discharged from the project site must not cause a significant adverse impact to downstream receiving waters and down gradient properties. Discharge from the site is to the existing natural discharge location. See Section 3 of this Report for the downstream analysis and discussion of the natural discharge location. The storm water runoff for the project site will be conveyed to the existing ditch system on the north side of NE 122nd Street or to the proposed tight line pipe system to be constructed as part of the Shadow Creek project.

All outfalls require energy dissipation. All outfalls will be designed with appropriately sized energy dissipation. See Section 4 of this report for further drainage basin analysis.

Minimum Requirement #5: On-Site Stormwater Management: Projects shall employ On-site Stormwater Management Best Management Practices (BMPs) to infiltrate, disperse, and retain stormwater runoff onsite to the maximum extent feasible without causing flooding or erosion impacts. Roof Downspout Control BMPs, functionally equivalent to those described in Chapter 3 of Volume III of the 2005 DOE Stormwater Manual, and Soil Quality BMPs, functionally equivalent to those in Chapter 5 of Volume V of the DOE Stormwater Manual, shall be required to reduce the hydrologic disruption of developed sites.

Per Figure 3.1 in Volume III Chapter 3 of the DOE Manual, roof downspouts should be connected to street drainage system with perforated stub-outs. For this project, the design for the perforated stub-outs apply to single family detached homes and requires a minimum setback of 25' from the utility trenches or foundation drains and 50' setback from any structure, property line, or steep slope per Section 2.9.3.3,

page 42, of the City of Redmond Technical Notebook. This cannot be accommodated for with the current site layout therefore, roof stubs will be solid PVC connected to the tight-lined storm drainage system.

Additional On-Site Stormwater Management BMPs per Section 8.7 of the Technical Notebook will be assessed and applied to the project site as appropriate during the final engineering phase of the project. This typically would include amending onsite soils with compost material to increase interflow runoff time.

Compost amended soil will be applied in landscape areas and will follow guidelines in Appendix Q of the 2012 (Issue #6) Redmond Stormwater Technical Notebook, "Guidelines for Landscaping with Compost-Amended Soils," the 2012 City of Redmond Standard Drawing #632, "Soil Amendment and Depth," or DOE BMP T5.13, "Post-Construction Soil Quality and Depth.".

Minimum Requirement #6: Runoff Treatment: The following require construction of stormwater treatment facilities (see Table 2.1 included below):

- Projects in which the total of pollution generating impervious surface (PGIS) is 5,000 square feet or more in a threshold discharge area of the project, or
- Projects in which the total of pollution-generating pervious surfaces (PGPS) is three-quarters (3/4) of an acre or more in a threshold discharge area, and from which there is a surface discharge in a natural or man-made conveyance system from the site.

This project results in a total of approximately 30,000 square feet of PGIS and therefore requires construction of a stormwater treatment facility.

Table 2.1 Treatment Requirements by Threshold Discharge Area

	<3/4 acres of PGPS	>3/4 acres PGPS	<5,000 sf PGIS	>5,000 sf PGIS
Treatment Facilities		X		X
On-site Stormwater BMPS	X	X	X	X

PGPS = pollution generating pervious surfaces
PGIS = pollution generating impervious surfaces
sf = square feet

Based on the *Treatment-Type Thresholds* in Section 2.5.6 of the Technical Notebook, the project site requires Basic Treatment. Design of the treatment facilities is described in Section 4 of this Report. Placement of the treatment facilities is shown on the Preliminary Civil Plans.

Minimum Requirement #7: Flow Control: Per Section 2.5.7 of the Technical Notebook, the following require construction of flow control facilities and/or land use management BMPs that will achieve the standard flow control requirement for western Washington (see Table 2.2 included below):

- Projects in which the total effective impervious surfaces is 10,000 square feet or more in a threshold discharge area; or
- Projects that convert ¾ acres or more of native vegetation to lawn or landscape, or convert 2.5 acres or more of native vegetation to pasture in a threshold discharge area, and from which there is a surface discharge in a natural or man-made conveyance system from the site; or

- Projects that disturb one acre or more, that through a combination of impervious surfaces and converted pervious surfaces cause a 0.1 cubic feet per second increase in the 100-year flow frequency from a threshold discharge area as estimated using the Western Washington Hydrology Model or other approved model.

Table 2.2 Flow Control Requirements by Threshold Discharge Area

	Flow Control Facilities	On-site Stormwater Management BMPs
<3/4 acres conversion to lawn/landscape, or <2.5 acres to pasture		X
> 3/4 acres conversion to lawn/landscape, or > 2.5 acres to pasture	X	X
<10,000 square feet of effective impervious area per TDA		X
>10,000 square feet of effective impervious area per TDA	X	X
>0.1 cubic feet per second increase in the 100-year flood frequency for sites 1 acre or larger	X	X

This project results in an excess of 10,000 square feet of effective impervious surfaces and therefore requires construction of a flow control facility.

Per Section 2.5.7 of the Technical Notebook, the Standard Flow Control Requirements applies with the pre-developed condition to be modeled as forested land cover. Stormwater discharges shall match developed discharge durations to pre-developed durations for the range of pre-developed discharge rates from 50% of the 2-year peak flow up to the full 50-year peak flow.

Design of the flow control facility is described in Section 4 of this Report. Placement of the flow control facility is shown on the Preliminary Civil Plans.

Minimum Requirement #8: Wetlands Protection: This requirement applies only to projects whose stormwater discharges into a wetland, either directly or indirectly through a conveyance system. There are no wetlands located on site or off site in proximity to the project. No additional protection measures are required.

Minimum Requirement #9: Operation and Maintenance: Per Section 2.5.9 of the Technical Notebook, an operation and maintenance manual that is consistent with the provisions in Volume V of the 2005 DOE Manual is required for all proposed public and private stormwater facilities including flow control and treatment facilities, conveyance systems, constructed source controls, and green infrastructure. The operations and maintenance manual shall be a stand-alone document prepared in accordance with the City of Redmond O&M Manual Template (see Appendix N of the Technical Notebook). The development proposal shall include provisions for maintenance of facilities in perpetuity.

The Operation and Maintenance Manual will be included at final design.

3. Off-Site Analysis

Upstream

See Section 4 of this Report for a description of the upstream area that will be considered upstream to the proposed detention/water quality treatment facility.

Downstream Resource Review

The following resources were reviewed in preparation of this report.

Redmond Sensitive Areas Maps

These maps were reviewed for *Erosion Hazard* (Map 64.8), *Wetlands* (Map 64.4), *Landslide Hazard* (Map 64.7), and *Seismic Hazard* (Map 64.9). The project site does not fall within or near any sensitive areas noted on the City Sensitive Area maps.

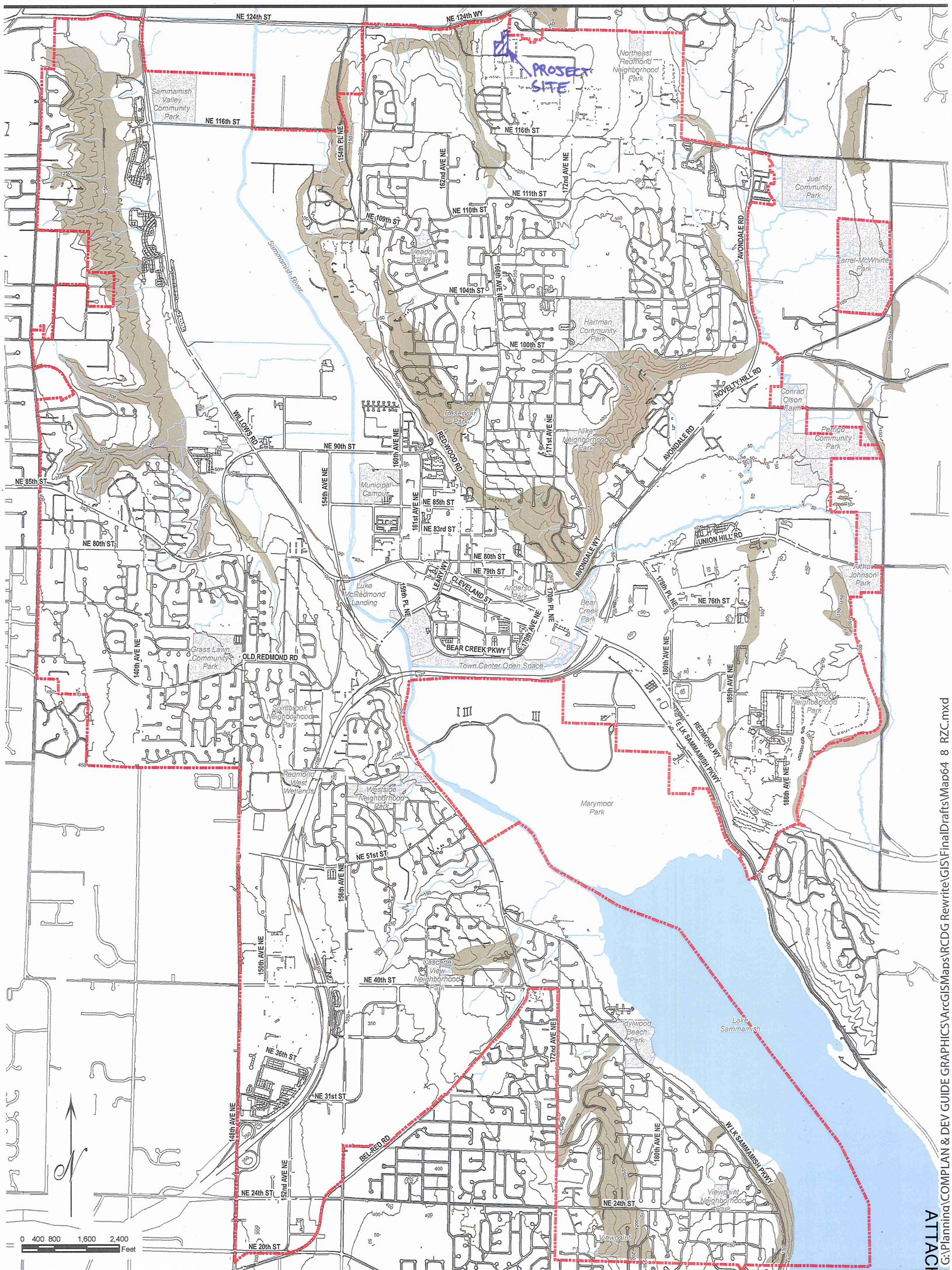
FEMA – Flood Insurance Rate Map (FIRM #53033C0380F)

This panel is not available and is reported to be in Zone X, with no flood areas identified on or near the site. This was also confirmed on the City of Redmond Parcel Viewer online interactive GIS map system.

USDA Natural Resources Conservation Service Soil Survey

The soil for this property is classified as AgC (Alderwood gravelly sandy loam, 6 to 15 percent slopes) from the *Natural Resources Conservation Service Soil Survey*.

ATTACHMENT 18



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.

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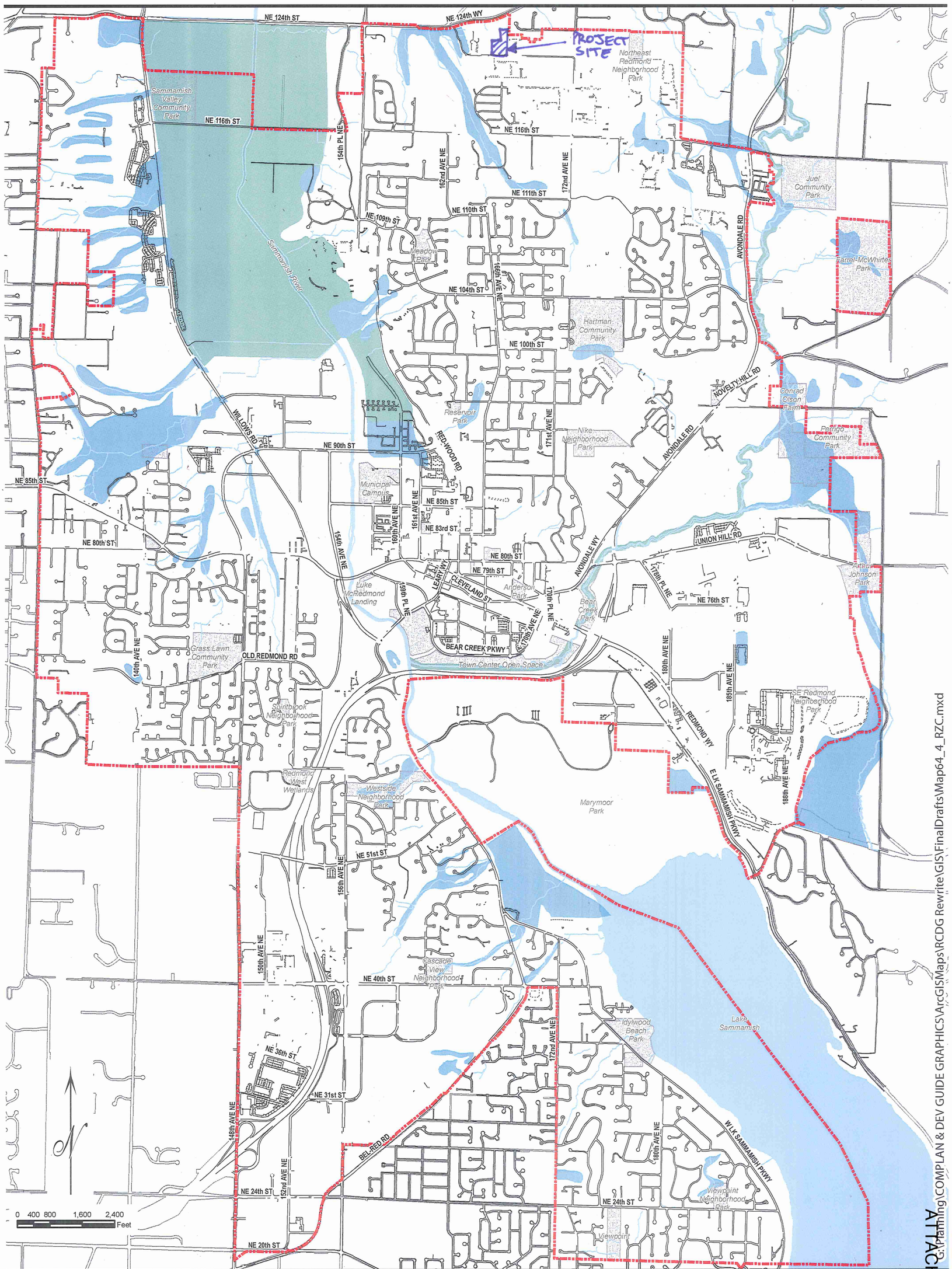
ATTACHMENT 18



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.

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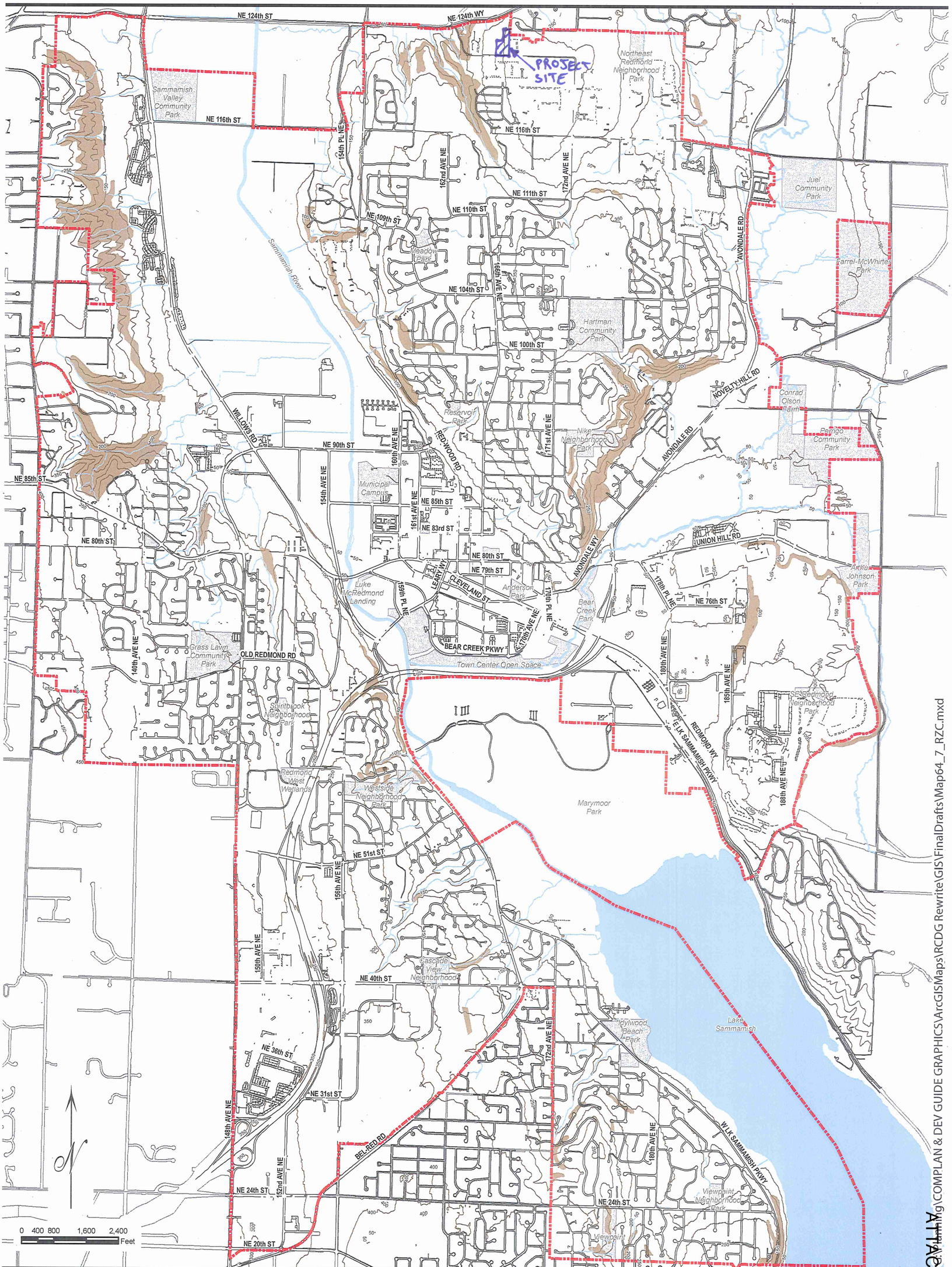

City of Redmond

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.

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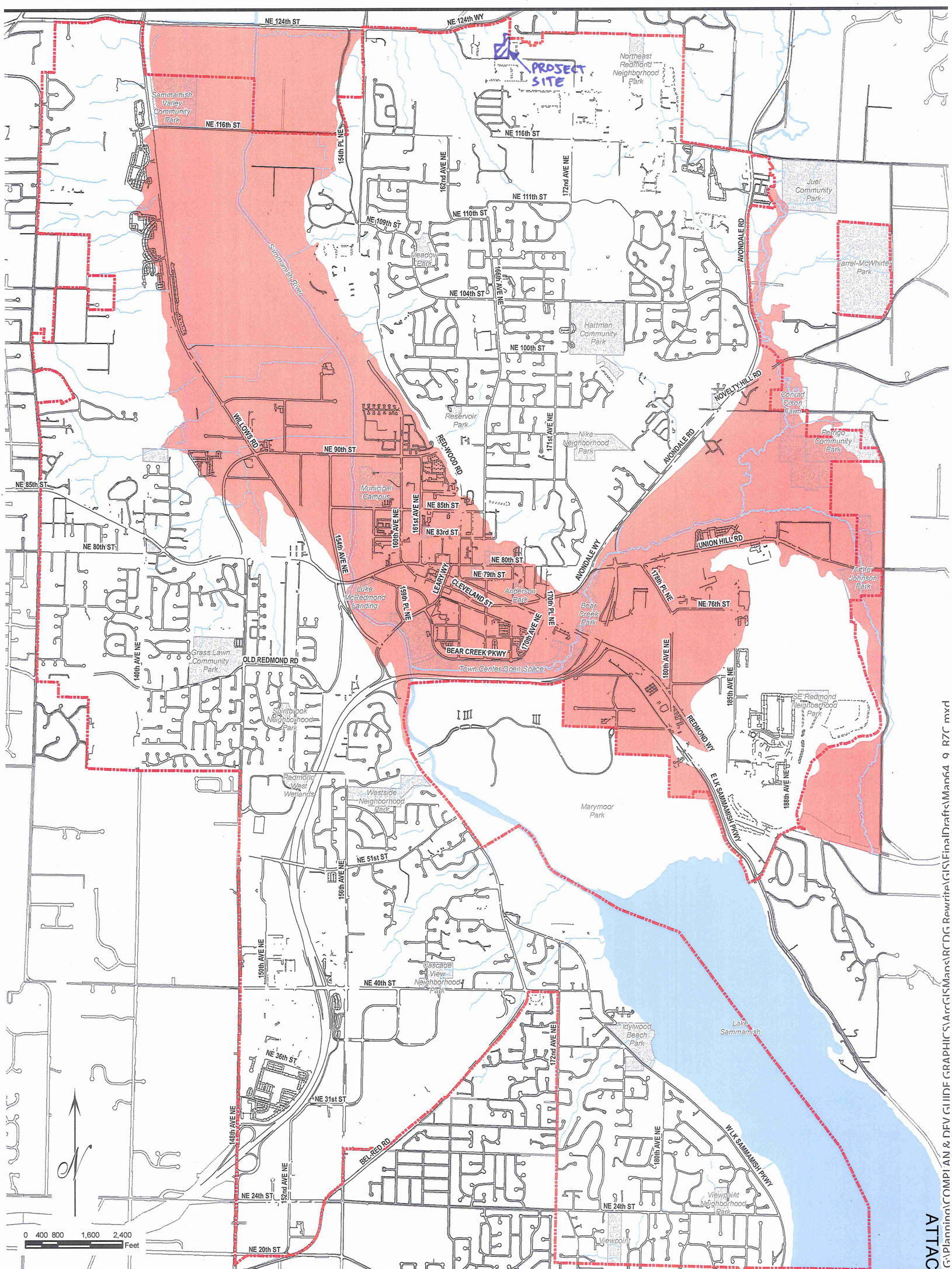
ATTACHMENT 18



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.

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ATTACHMENT 18

ATTACHMENT 18

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Units

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
- Gully
- Short Steep Slope
- Other

Political Features
- Cities

Water Features
- Streams and Canals

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

MAP INFORMATION

Map Scale: 1:6,000 if printed on A size (8.5" × 11") sheet.

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 accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 10N NAD83

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 7, Jul 2, 2012

Date(s) aerial images were photographed: 7/24/2006

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.

ATTACHMENT 18

Map Unit Legend

King County Area, Washington (WA633)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
AgC	Alderwood gravelly sandy loam, 6 to 15 percent slopes	3.6	100.0%
Totals for Area of Interest		**3.6**	**100.0%**

Downstream Field Investigation:

Date of Field Inspection: July 16, 2013
Weather Conditions: Sunny, 70° F

The existing topography of the site slopes from the northeast to the southwest across the adjacent properties to the west into the existing ditch that flows west on the north side of NE 122nd Street (please view the "Beuca Property Downstream Inspection" map that proceeds this downstream analysis. The exhibits mentioned in this investigation are located on the map, and their pictures follow). The ditch has a bottom width ranging between 1 and 2 feet, and is between 1 and 2 feet deep. The ditch is lined with a mixture of gravel, grass, dirt and sand. The drainage flows approximately 21 feet until it passes beneath a gravel driveway through a 12" concrete pipe that is 18 feet long. Both the pipe inlet and outlet are half filled with sediment, but there are no signs of flooding (see Exhibits A and B). The ditch continues 108 feet westerly until reaching another driveway in which the stormwater also flows through an 18 foot long 12" concrete pipe that has an inlet and outlet half filled with sediment (see Exhibits C and D). Maintenance on these concrete pipes is recommended. The ditch continues another 90 feet westerly until it reaches a third gravel driveway where the stormwater drains through a 27 foot long 12" concrete pipe, and the inlet and outlet are clear of any sediment as though the pipe has been properly maintained (see Exhibit E). The ditch continues about 8 feet westerly until it reaches a 12" plastic pipe with a vertical metal grate inlet (see Exhibit F). The pipe connects to a Type 1 catch basin 18 feet downstream that is part of a curb and gutter conveyance system (see Exhibit G). This curb and gutter system is a part of the recently built Woodlands Ridge housing development. The 12" plastic pipe runs westerly 57 feet until it reaches another Type 1 catch basin (see Exhibit H). Then, the stormwater continues westerly through another 12" plastic pipe to a third and final Type 1 catch basin 180 feet downstream. The third catch basin releases stormwater through an 18 foot long 12" plastic pipe to a ditch system (see Exhibit I). The ditch system is also on the north side of NE 122nd Street, and it has a bottom width of about 2 feet and a depth between 1 and 2 feet. The ditch continues west along the north side of NE 122nd Street as the roadway curves from heading east-west to north-south (see Exhibit J). About a third of the way through the turn, another 57 feet, the stormwater enters a 15" corrugated plastic pipe with a vertical metal grate inlet (see Exhibit K), and exits on the same side of the roadway into a ditch that has a bottom width of 2 feet and a top width of about 6 feet. At this point, the ditch becomes lined with riprap (see Exhibit L). This ditch continues along the east side of what is now 162nd Place NE. The stormwater is conveyed northerly until it flows through another 15" corrugated plastic pipe 190 feet downstream (see Exhibit M). This outlet of the pipe is 130 feet downstream where the stormwater exits into a ditch that is also lined with riprap for 90 feet, then becomes lined with tall grass (see Exhibit N). The ditch continues another 160 feet until it reaches the southeast corner of NE 124th Street and 162nd Place NE, where the drainage merges with stormwater flowing westerly down NE 124th Street. The downstream inspection from this point onward is described below, as part of the Cooper Property P.R.D. downstream analysis from June 2007. The Cooper Property downstream conveyance system characteristics were verified the same day as the downstream inspection above. The downstream analysis was based on field reconnaissance.

The following is taken from the Cooper Property P.R. D. downstream analysis dated June 2007 (revised May 2008).

Downstream:

Date of Field Inspection: December 7, 2006
Weather Conditions: Cloudy, mid 40° F

Drainage within the north-flowing ditch along 162nd Place NE concentrates all site drainage at the northwest corner of the [Cooper] property where it enters into an 18" culvert located at the southeast corner of the intersection of NE 124th Street and 162nd Place NE. Drainage is conveyed west through the 18" culvert under 162nd Place NE. On the southwest corner of the intersection of NE 124th Street and 162nd Place NE, the drainage was bubbling out of the ground, but no culvert exit could be located. It was assumed that the culvert exit was plugged due to sedimentation. The drainage continues west in a roadside channel located along the south side of NE 124th Street. At the driveway of 16215, the drainage enters a culvert, however the culvert exit could not be found. On the immediate west side of the driveway the ditch was dry. Approximately 50 feet further west on NE 124th Street, drainage reappears in the ditch. The drainage continues west in a grass-lined trapezoidal channel which is approximately one foot wide at the bottom, and is approximately three to four feet deep. Approximately 550 feet downstream from the subject site, the drainage in the ditch and another water course converge and cross north under NE 124th Street through a 42" CMP. In the event of a significant rainfall some of the drainage could continue west on the south side of NE 124th Street through an 18" CMP and a 24" CMP. These culvers have higher invert elevations than the 42" CMP, therefore it was concluded that the majority of the drainage would head to the north side of NE 124th Street. On the north side of NE 124th Street, the drainage turns west and is conveyed through a swale that is approximately six feet wide and three feet deep. This swale has a few weirs/drops intermediately spaced. There are several 36" concrete culverts placed along the channel at existing driveways. The swale appears to parallel NE 124th Street further to the west; however the field inspection was terminated at this point which was beyond ¼ mile downstream.

Based on field observations, there were no visible signs of erosion and/or flooding within the downstream system though signs of sedimentation within existing culverts were noted. An additional field reconnaissance was performed on Nov. 20, 2012, following record rainfall. The ditches were flowing ¼ full with no erosion evident. The storm system at 162nd Place NE was flowing and didn't appear to be restricted in flow.

ATTACHMENT 18

Beuca Propetry Downstream Inspection

ATTACHMENT 18

Date: 7/16/2013 Source: King County iMAP - Property Information (http://www.metrokc.gov/GIS/iMAP)

King County

Exhibit A

Exhibit B

Exhibit C

Exhibit D

Exhibit E

Exhibit F

Exhibit G

Exhibit H

Exhibit I

Exhibit J

Exhibit K

Exhibit L

Exhibit M

Exhibit N

Capacity Analysis:

The offsite ditch downstream (south) of the Beuca Property in Redmond, WA, was field verified on July 16, 2013 and calculated using Manning's equation for capacity. The weather was sunny and approximately 70° F. The offsite ditch is on the north side of NE 122nd Street and slopes down to the west, follows the curve to the north, then continues down to the north until it reaches the southeast corner of the intersection of NE 124th Street and 162nd Place. The ditch begins as naturally lined with a mixture of gravel, grass, dirt, and sand. The geometry of the ditch was field verified as approximately 220 feet long, between 1 and 2 feet deep, and between 1 and 2 feet wide at the bottom. The corresponding side slope on either side is 1.5H:1V. The ditch meets the new tight-lined conveyance system constructed as a part of the Woodlands Ridge housing development. Downstream of the Woodlands Ridge conveyance system is another naturally lined ditch. Midway through the turn from west to north, the naturally lined ditch empties into a larger ditched that has been reinforced with quarry rock as part of recent development activity. The geometry of the ditch was field verified as approximately 280 feet long, 2 feet wide at the bottom, and 7 feet wide at the top (maximum design flow depth). The corresponding side slope on either side is 2.5H:1V and the entire length of the ditch is rock lined.

Although topographic survey information was field verified as approximately 14%, a conservative assumption was used and 10% was chosen as the slope input for both ditches.

During the field visit it was noted that there is measurable flow into the culvert at the downstream end but that flow is not visible in the ditch itself due to the geometry and rock lining. For the rock-lined ditch, a conservative flow depth of 6" was chosen as a result to provide for anticipated ditch flow characteristics during high flow storm events, and to provide adequate freeboard. In this case, a maximum flow depth of 18" was measured in the field, providing a minimum freeboard of 12". For the naturally lined ditch, a

conservative flow depth of 6” was used, providing a minimum freeboard of 6”. Because the geometry of the ditch varies along the flow path, minimums of a bottom width of 1 foot and a top width of 4 feet were used.

The 2009 King County Surface Water Design Manual was used to determine the methodology for calculating the conveyance capacity of both offsite ditches. The first calculation shown is for the naturally lined ditch, and the second calculation is for the rock-lined ditch further downstream. Section 4.4 (page 4-55) discusses open channels and specifically “Rock-lined channels” like the one the Beuca Property proposes to discharge to. Conveyance capacity may be calculated using Manning’s equation, or Equation 4-2 (page 4-20) of the 2009 KCSWDM.

Naturally-lined Ditch Capacity Calculation:

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$$

Q = ditch capacity at design flow depth (***6.99 cfs***)

n = Manning’s roughness coefficient (***0.027*** – Table 4.4.1.B)

A = area (***0.875 sf*** – field verified, use Figure 4.4.1.E)

R = hydraulic radius = area / wetted perimeter (***0.31 ft*** – field verified, use Figure 4.4.1.E)

S = ditch slope (***0.10 ft/ft*** – field verified, conservative)

y_1 = ***0.5 ft*** – (6” flow depth assumption)

b = 1***.0 ft*** – (field verified)

z = 1***.5*** (field verified)

Using the field verified measurements for the offsite naturally-lined ditch, Manning’s equation and corresponding design inputs the corresponding conveyance capacity of the ditch at 6” flow depth is ***6.99 cfs***.

Rock-lined Ditch Capacity Calculation:

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$$

Q = ditch capacity at design flow depth (***9.5 cfs***)

n = Manning's roughness coefficient (***0.040*** – Table 4.4.1.B)

A = area (***1.63 sf*** – field verified, use Figure 4.4.1.E)

R = hydraulic radius = area / wetted perimeter (***0.35 ft*** – field verified, use Figure 4.4.1.E)

S = ditch slope (***0.10 ft/ft*** – field verified, conservative)

y_1 = ***0.5 ft*** – (6" flow depth assumption)

b = ***2.0 ft*** – (field verified)

z = ***2.5*** (field verified)

Using the field verified measurements for the offsite rock-lined ditch, Manning's equation and corresponding design inputs the corresponding conveyance capacity of the ditch at 6" flow depth is ***9.5 cfs***.

TABLE 4.4.1.B VALUES OF ROUGHNESS COEFFICIENT "*n*" FOR OPEN CHANNELS

Type of Channel and Description	Manning's "*n*"* (Normal)
A. Constructed Channels	
a. Earth, straight and uniform	
1. Clean, recently completed	0.018
2. Gravel, uniform section, clean	0.025
3. With short grass, few weeds	0.027
b. Earth, winding and sluggish	
1. No vegetation	0.025
2. Grass, some weeds	0.030
3. Dense weeds or aquatic plants in deep channels	0.035
4. Earth bottom and rubble sides	0.030
5. Stony bottom and weedy banks	0.035
6. Cobble bottom and clean sides	0.040
c. Rock lined	
1. Smooth and uniform	0.035
2. Jagged and irregular	0.040
d. Channels not maintained, weeds and brush uncut	
1. Dense weeds, high as flow depth	0.080
2. Clean bottom, brush on sides	0.050
3. Same as #2, highest stage of flow	0.070
4. Dense brush, high stage	0.100
B. Natural Streams	
B-1 Minor streams (top width at flood stage < 100 ft.)	
a. Streams on plain	
1. Clean, straight, full stage no rifts or deep pools	0.030
2. Same as #1, but more stones and weeds	0.035
3. Clean, winding, some pools and shoals	0.040
4. Same as #3, but some weeds	0.040
5. Same as #4, but more stones	0.050
6. Sluggish reaches, weedy deep pools	0.070
7. Very weedy reaches, deep pools, or floodways with heavy stand of timber and underbrush	0.100
b. Mountain streams, no vegetation in channel, banks usually steep, trees and brush along banks submerged at high stages	
1. Bottom: gravel, cobbles, and few boulders	0.040
2. Bottom: cobbles with large boulders	0.050
B-2 Floodplains	
a. Pasture, no brush	
1. Short grass	0.030
2. High grass	0.035
b. Cultivated areas	
1. No crop	0.030
2. Mature row crops	0.035
3. Mature field crops	0.040
c. Brush	
1. Scattered brush, heavy weeds	0.050
2. Light brush and trees	0.060
3. Medium to dense brush	0.070
4. Heavy, dense brush	0.100
d. Trees	
1. Dense willows, straight	0.150
2. Cleared land with tree stumps, no sprouts	0.040
3. Same as #2, but with heavy growth of sprouts	0.060
4. Heavy stand of timber, a few down trees, little undergrowth, flood stage below branches	0.100
5. Same as #4, but with flood stage reaching branches	0.120

* *Note: These "n" values are "normal" values for use in analysis of channels. For conservative design of channel capacity, the maximum values listed in other references should be considered. For channel bank stability, the minimum values should be considered.*

FIGURE 4.4.1.E GEOMETRIC ELEMENTS OF COMMON SECTIONS

Section	Area A	Wetted perimeter P	Hydraulic radius R	Top width W	Hydraulic depth D	Section factor Z
Rectangle	by	$b+2y$	$\frac{by}{b+2y}$	b	y	$by^{1.5}$
Trapezoid	$(b+zy)y$	$b+2y\sqrt{1+z^2}$	$\frac{(b+zy)y}{b+2y\sqrt{1+z^2}}$	$b+2zy$	$\frac{(b+zy)y}{b+2zy}$	$\frac{[(b+zy)y]^{1.5}}{\sqrt{b+2zy}}$
Triangle	zy^2	$2y\sqrt{1+z^2}$	$\frac{zy}{2\sqrt{1+z^2}}$	$2zy$	$^1/_2 y$	$\frac{\sqrt{2}}{2} zy^{2.5}$
Circle	$^1/_8(\theta-\sin\theta)d_o^2$	$^1/_2\theta d_o$	$^1/_4(1-\frac{\sin\theta}{\theta})d_o$	$(\sin(^1/_2\theta)d_o)$ or $2\sqrt{y(d_o-y)}$	$^1/_8\left(\frac{\theta-\sin\theta}{\sin{^1/_2}\theta}\right)d_o$	$\frac{\sqrt{2}}{32}\frac{(\theta-\sin\theta)^{1.5}}{(\sin{^1/_2}\theta)^{0.5}}d_o^{2.5}$
Parabola	$^2/_3 Ty$	$T+\frac{8y^2}{3T}$ *	$\frac{2T^2y}{3T^2+8y^2}$ *	$\frac{3A}{2y}$	$^2/_3 y$	$^2/_9\sqrt{6}Ty^{1.5}$
Round-cornered Rectangle (y>r)	$(\frac{\pi}{2}-2)r^2+(b+2r)y$	$(\pi-2)r+b+2y$	$\frac{(\frac{\pi}{2}-2)r^2+(b+2r)y}{(\pi-2)r+b+2y}$	$b+2r$	$\frac{(\frac{\pi}{2}-2)r^2}{(b+2r)}+y$	$\frac{[(\frac{\pi}{2}-2)r^2+(b+2r)y]^{1.5}}{\sqrt{b+2y}}$
Round-bottomed Triangle	$\frac{T^2}{4z}-\frac{r^2}{z}(1-z\cot^{-1}z)$	$\frac{T}{z}\sqrt{1+z^2}-\frac{2r}{z}(1-z\cot^{-1}z)$	$\frac{A}{P}$	$2[z(y-r)+r\sqrt{1+z^2}]$	$\frac{A}{T}$	$A\sqrt{\frac{A}{T}}$

*Satisfactory approximation for the interval 0<x≤1, where x=4y/T. When x>1, use the exact expression $P=(^T/_2)\left[\sqrt{1+x^2}+{^1/_x}\ln\left(x+\sqrt{1+x^2}\right)\right]$

In order to confirm adequate capacity in the offsite ditch, the conveyance capacity calculated above was compared to the anticipated detained flows contributing to the ditch from the upstream development area. The offsite ditch collects flows from upstream developments via the Prescott Glen pond, in addition to surface water from NE 122nd Street. Some of the upstream development on the north side of NE 122nd Street is routed to the south and into the Prescott Glen pond. The Sycamore Park, Wexford Glen, Thorn Property and Prescott Glen developments are all tributary to the Prescott Glen pond and discharge into the offsite ditch on the south side of NE 122nd Street before it crosses under the street and combines with flows from the north side of NE 122nd Street (after adding the Federspiel Property detained flows). The existing ditch on the east side of 162nd Avenue NE conveys flows from the entire tributary area on both sides of NE 122nd Street and therefore must be able to contain the 25 year release rates from all of the upstream stormwater facilities and any bypass areas not collected by the facilities.

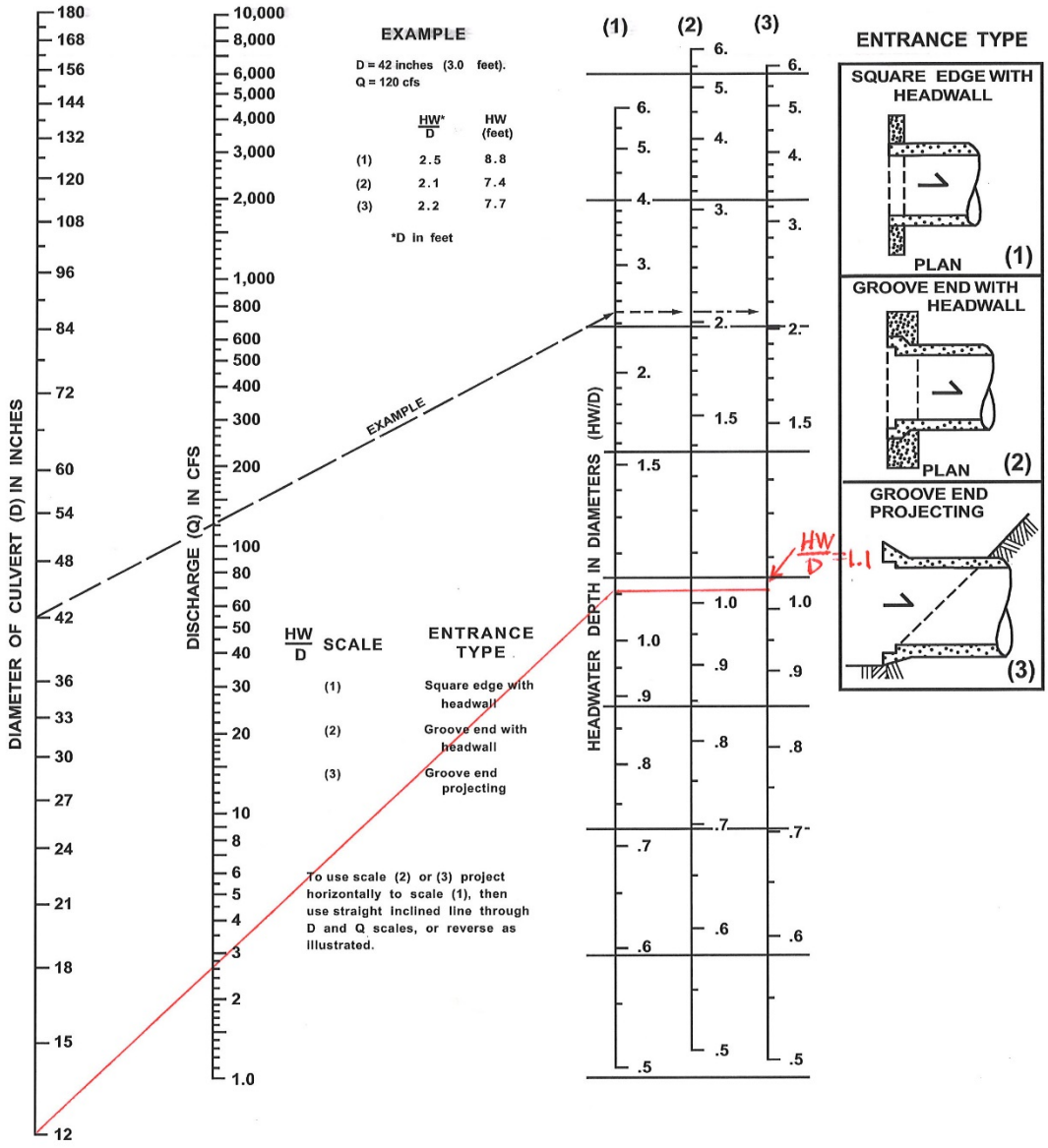
The proposed Thorn Property project includes all of the upstream areas mentioned except the Federspiel Property. The point of compliance is downstream of the pond and therefore includes bypass area as well related to full build out of NE 122nd Street. The corresponding 25 year discharge for the mitigated (detained) Thorn Property (modified Prescott Glen pond) point of compliance is 1.22 cfs. The corresponding 25 year discharge for the mitigated (detained) Federspiel Property point of compliance is 0.15 cfs. The total combined 25 year discharge into the offsite ditch before it combines on the north side of NE 122nd Street, therefore, is 1.22 cfs + 0.15 cfs, or ***1.37 cfs***.

The 25 year discharge for the detained Beuca Property is 0.30 cfs. Documentation was not available at the time of this report for the two additional subdivisions to the west but they are similar in size to Beuca so a conservative assumption of 0.5 cfs was made for each with a combined flow at the point of compliance with the south side of NE 122nd Street of 1.30 cfs. Therefore, the total anticipated flow in the downstream portion of the ditch after convergence with all upstream development area is 2.67 cfs (1.37 cfs + 1.30 cfs), well below the calculated capacity of 6.99 cfs or 9.5 cfs shown above.

In all cases checked, the capacity of the offsite ditch at an assumed flow depth of 6” is more than adequate for the anticipated fully developed flows tributary to the ditch, including a minimum 18” freeboard including the extension of the ditch toward NE 124th Street on the east side of 162nd Avenue NE.

The capacity of the downstream culverts were also examined. The plugged culverts in Exhibits C and D will be cleaned out by the developer prior to construction of the plat. The 2.67 cfs will produce the headwater depth will be about 1.1 feet based on Figure 4.3.1.B shown on the following page. Therefore, the 12-inch diameter culvert will be flowing full but not overtop the existing driveway.

FIGURE 4.3.1.B
HEADWATER DEPTH FOR SMOOTH INTERIOR PIPE CULVERTS WITH INLET CONTROL



4. Flow Control and Water Quality Facility Analysis and Design

Design Standards

The detention / water quality facilities will be designed per the Washington State Department of Ecology's Stormwater Management Manual for Western Washington, February 2005 Edition (DOE Manual) and the City of Redmond Clearing, Grading, and Stormwater Management Technical Notebook Issue 6.

The drainage analysis for flow control and water quality treatment design was modeled using the King County Runoff Time Series (KCRTS) software as allowed per Chapter 2.1.1 within Volume III of the 2005 DOE Manual and WWHM software. The vault will match developed discharge durations to 50% of the pre-developed 2-year peak flow to the full 50-year peak flow and provide dead storage

The site is located in the Sea-Tac rainfall region with a location scale factor of 1.0. Per the NRCS Soil Survey, the site soils are entirely Alderwood gravelly sandy loam, (AgC), KCRTS group Till and Hydrologic Group C.

A. Pre-developed Conditions

The existing basin boundary area is defined as that area that will be improved through development of the subject property. The subject property is approximately 3.59 acres in size and consists of 1 home with associated outbuildings and landscaping. The site is comprised entirely in one drainage basin, flowing northeast to southwest.

Pre-developed conditions for the project area was analyzed assuming 100% pervious ground cover consisting of forested land cover as defined in Section 2.3, pg 8, in the Technical Notebook under the definition of "Pre-developed condition." Due to topographic constraints, a portion of the entry road, approximately 0.08 acres of 166th Place NE and the frontage will not drain to the vault. Therefore, an equivalent amount of existing offsite area will be treated in in lieu of this area.

All upstream offsite area was modeled as existing conditions consisting of either forest, grass or impervious area. The upstream areas consist of:

- *Upstream Area - North of NE 123rd Way*
  The 0.47 acres of forest and 0.14 acres of landscaping is from a single home (fully dispersed through the existing forested area), the preserved Tract D, and a portion of lots 7-10 and Tract E of the Wexford Glen development.

- *Upstream Area - NE 123rd Way*
  There is approximately 0.15 ac of ROW from NE 123rd Way in the Wexford development that currently discharge through a flow spreader on the project site.

- *Upstream Area - Between NE 122nd Street and NE 123rd Way*
  The 0.66 acres of landscaping are from the back yards of Lots 11 through 16 along with Tracts B and C of the Wexford Glen development that is located east of the project site.

- *Existing Pavement Collected along NE 122nd Street*
  There is 0.05 acres of existing pavement from NE 122nd Street that will drain to the vault as a result of completed the frontage improvements.

See Table 4-1 and Figure 4-1: Pre-Developed Conditions for a summary of the pre-developed areas.

Table 4-1: Pre-Developed Conditions Areas	
Land Cover	Area (acres)
Impervious	0.12
Till-Grass	0.80
Till-Forest	4.00
Total	4.92

The hourly pre-developed peaks from the areas in Table 4-1 are shown below.

```
Flow Frequency Analysis
  Time Series File:12034_predev.tsf
  Project Location:Sea-Tac

  ---Annual Peak Flow Rates---      -----Flow Frequency Analysis-------
 Flow Rate  Rank  Time of Peak       - - Peaks - -  Rank  Return  Prob
   (CFS)                              (CFS)             Period
   0.336      2   2/09/01 18:00        0.512         1  100.00   0.990
   0.127      7   1/05/02 16:00        0.336         2   25.00   0.960
   0.300      3   2/28/03  3:00        0.300         3   10.00   0.900
   0.045      8   8/26/04  2:00        0.282         4    5.00   0.800
   0.169      6   1/05/05  8:00        0.255         5    3.00   0.667
   0.282      4   1/18/06 16:00        0.169         6    2.00   0.500
   0.255      5  11/24/06  4:00        0.127         7    1.30   0.231
   0.512      1   1/09/08  6:00        0.045         8    1.10   0.091
Computed Peaks                         0.453             50.00   0.980
```

B. Developed Conditions

Proposed development of the property will include the demolition of all structures on the property and construction of 15 single-family units (1 duplex) on 14 lots, along with associated roadway, utilities, open space, and drainage detention and treatment. Frontage improvements along NE 122nd Street and 166th Place NE and ROW improvements within the offsite NE 123rd Place will also be included as part of the development.

A single detention vault will be located in Tract A near the southwest corner of the property and designed per Redmond's design criteria. The detained flows will then be conveyed west to NE 122nd Street and into the existing ditch system located on the north side of NE 122nd Street or into the proposed tight line pipe system to be constructed as part of the Shadow Creek development immediately west of the Beuca Property project.

The offsite area assumptions are the same as the pre-developed conditions and the impervious coverage calculations for the developed site are delineated below.

- *Impervious Coverage for the Proposed/Existing ROW*
  The impervious coverage within the ROWs was determined in CAD

- *Impervious Coverage for the Proposed Access Tract*
  The impervious coverage within the proposed access tracts was assumed to be 100%.

- *Impervious Coverage for Open Space /Drainage Tracts*
  The impervious coverage within the open space/drainage tracts was assumed to be 20%.

- *Impervious Coverage for the Lots*
  The impervious coverage within the lots areas are determined to be 80% of the allowable impervious area per zoning code. The project is in R-3 zoning, which is allowed 60% impervious coverage. With a total lot area of 2.15 acres, the total lot impervious coverage is 2.12 acres * 80% * 60% = 1.02 acres.

See Table 4-2 and Figure 4-2: Developed Conditions for a summary of the developed conditions areas.

Table 4-2: Developed Conditions Areas

Land Cover	Area (acres)
Impervious	2.02
Till-Grass	2.43
Till-Forest	0.47
Total	4.92

Flow Frequency Analysis
Time Series File:12034_dev.tsf
Project Location:Sea-Tac

---Annual Peak Flow Rates---			----Flow Frequency Analysis-------			
Flow Rate (CFS)	Rank	Time of Peak	- - Peaks - - (CFS)	Rank	Return Period	Prob
0.725	5	2/09/01 2:00	1.50	1	100.00	0.990
0.550	7	1/05/02 16:00	0.876	2	25.00	0.960
0.876	2	2/27/03 7:00	0.796	3	10.00	0.900
0.548	8	8/26/04 2:00	0.767	4	5.00	0.800
0.670	6	10/28/04 16:00	0.725	5	3.00	0.667
0.767	4	1/18/06 16:00	0.670	6	2.00	0.500
0.796	3	10/26/06 0:00	0.550	7	1.30	0.231
1.50	1	1/09/08 6:00	0.548	8	1.10	0.091
Computed Peaks			1.29		50.00	0.980

166TH PL NE

NE 122ND ST

EXISTING BASIN BOUNDARY
AREA = 3.52 AC

SHADOWBROOK

FUTURE TRACT B

EXISTING PAVEMENT COLLECTED ALONG NE 122ND ST
0.05 AC

UPSTREAM AREA
BETWEEN NE 122ND ST
AND NE 123RD WAY
0.66 AC

TOTAL OFFSITE AREA
1.40 AC

NE 123RD WAY

EXISTING ROW
FROM NE 123RD WAY
0.07 AC

UPSTREAM AREA
NORTH OF 123RD WAY
0.61 AC

WEXFORD GLEN

TRACT E

LEGEND

- TELEPHONE RISER
- STORM DRAIN MANHOLE
- FOUND SURVEY MONUMENT (AS NOTED)
- TELEVISION RISER
- WATER VALVE
- SPRINKLER CONTROL BOX
- POWER TRANSFORMER
- SANITARY SEWER MANHOLE
- GAS MARKER
- POWER METER
- WATER METER
- MONITORING WELL
- FOUND 1/2" REBAR WITH YELLOW PLASTIC CAP "CORE 31555" EXCEPT AS NOTED OTHERWISE
- FLOW ARROW
- TRIBUTARY BASIN LINE

SCALE: 1" = 80'

0 40 80 160

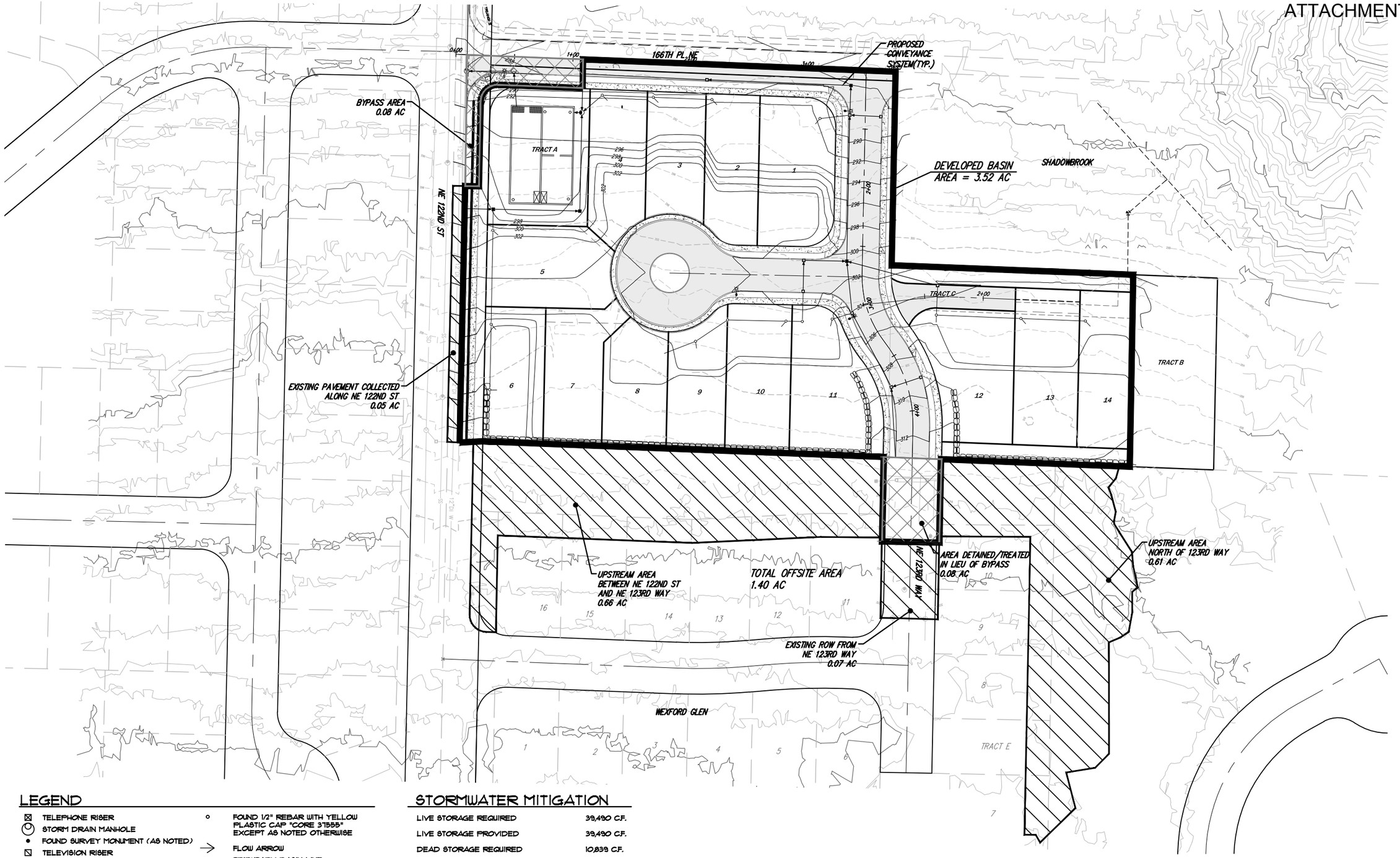
NO. | REVISIONS | DATE

CORE DESIGN
ENGINEERING • PLANNING • SURVEYING
14711 NE 29th Place Suite 101
Bellevue, Washington 98007
425.885.7877 Fax 425.885.7963

FIGURE 4-1: PRE-DEVELOPED CONDITIONS
BEUCA PROPERTY
THE QUADRANT CORPORATION
14725 SE 36TH STREET, SUITE 100
BELLEVUE, WA 98006

DATE	DECEMBER 2012	
DESIGNED	JAMES A. OLSEN	
DRAWN	HOLLI H. HOPKINS	
APPROVED	JAMES A. OLSEN	JAMES A. OLSEN, P.E. PROJECT MANAGER
SHEET		OF

PROJECT NUMBER
12034



LEGEND

- TELEPHONE RISER
- STORM DRAIN MANHOLE
- FOUND SURVEY MONUMENT (AS NOTED)
- TELEVISION RISER
- WATER VALVE
- SPRINKLER CONTROL BOX
- POWER TRANSFORMER
- SANITARY SEWER MANHOLE
- GAS MARKER
- POWER METER
- WATER METER
- MONITORING WELL
- FOUND 1/2" REBAR WITH YELLOW PLASTIC CAP "CORE 37555" EXCEPT AS NOTED OTHERWISE
- FLOW ARROW
- TRIBUTARY BASIN LINE

STORMWATER MITIGATION

LIVE STORAGE REQUIRED	39,490 C.F.
LIVE STORAGE PROVIDED	39,490 C.F.
DEAD STORAGE REQUIRED	10,839 C.F.
DEAD STORAGE PROVIDED	11,232 C.F.

SCALE: 1" = 80'

0 40 80 160

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14711 NE 29th Place Suite 101
Bellevue, Washington 98007
425.885.7877 Fax 425.885.7963

NO. | REVISIONS | DATE

FIGURE 4-2: DEVELOPED CONDITIONS
BEUCA PROPERTY
THE QUADRANT CORPORATION
14725 SE 36TH STREET, SUITE 100
BELLEVUE, WA 98006

DATE	DECEMBER 2012	
DESIGNED	JAMES A. OLSEN	
DRAWN	HOLLI H. HOPKINS	
APPROVED	JAMES A. OLSEN	JAMES A. OLSEN, P.E. PROJECT MANAGER
SHEET		OF

PROJECT NUMBER 12034

C. Detention Calculations

The 82 x 50 foot (inner dimensions) detention vault will be located near the south west property boundary in Tract A and has 9.2 feet of live storage. Refer to the end of the section for the full KCRTS output.

KCRTS Vault Calculation

```
         Type of Facility: Detention Vault
         Facility Length:       82.00  ft
          Facility Width:       51.00  ft
           Facility Area:     4182.    sq. ft
 Effective Storage Depth:        9.00  ft
       Stage 0 Elevation:      279.50  ft
          Storage Volume:    37638.    cu. ft
              Riser Head:        9.00  ft
          Riser Diameter:       12.00  inches
      Number of orifices:        3
                                        Full Head    Pipe
    Orifice #      Height  Diameter  Discharge  Diameter
                    (ft)     (in)      (CFS)      (in)
       1            0.00     1.13        0.103
       2            5.30     1.63        0.138    4.0
       3            6.90     1.50        0.088    4.0
          Top Notch Weir: None
    Outflow Rating Curve: None
```

The proposed detention vault includes a three orifice control structure. The first orifice is 1 1/8 inch diameter and is at the bottom of the riser. The second orifice is 5.3 feet above the live/dead interface elevation and is 1-5/8 inches in diameter. The third orifice is 6.9 feet above the live /dead interface elevation and is 1-1/2 inch in diameter. The proposed vault will have a storage volume of 38,501 cubic feet at 9.2 feet of live storage.

Hyd	Inflow	Outflow	Peak			Storage	
		Target	Calc	Stage	Elev	(Cu-Ft)	(Ac-Ft)
1	1.50	*******	1.26	9.21	288.71	38501.	0.884
2	0.73	*******	0.33	8.99	288.49	37608.	0.863
3	0.72	0.30	0.26	7.71	287.21	32264.	0.741
4	0.88	*******	0.22	7.21	286.71	30159.	0.692
5	0.77	*******	0.18	6.91	286.41	28900.	0.663
6	0.45	0.17	0.11	5.53	285.03	23110.	0.531
7	0.55	*******	0.07	4.54	284.04	18972.	0.436
8	0.55	*******	0.06	2.72	282.22	11382.	0.261

The 2-year target outflow is 0.17 cfs and the vault will release 0.11 cfs. The 10-year target outflow is 0.30 cfs and the vault will release 0.26 cfs. Both the 2-year and 10-year vault release rates are below the pre-developed targets. See Figure 4-3 Flow Frequency Analysis below.

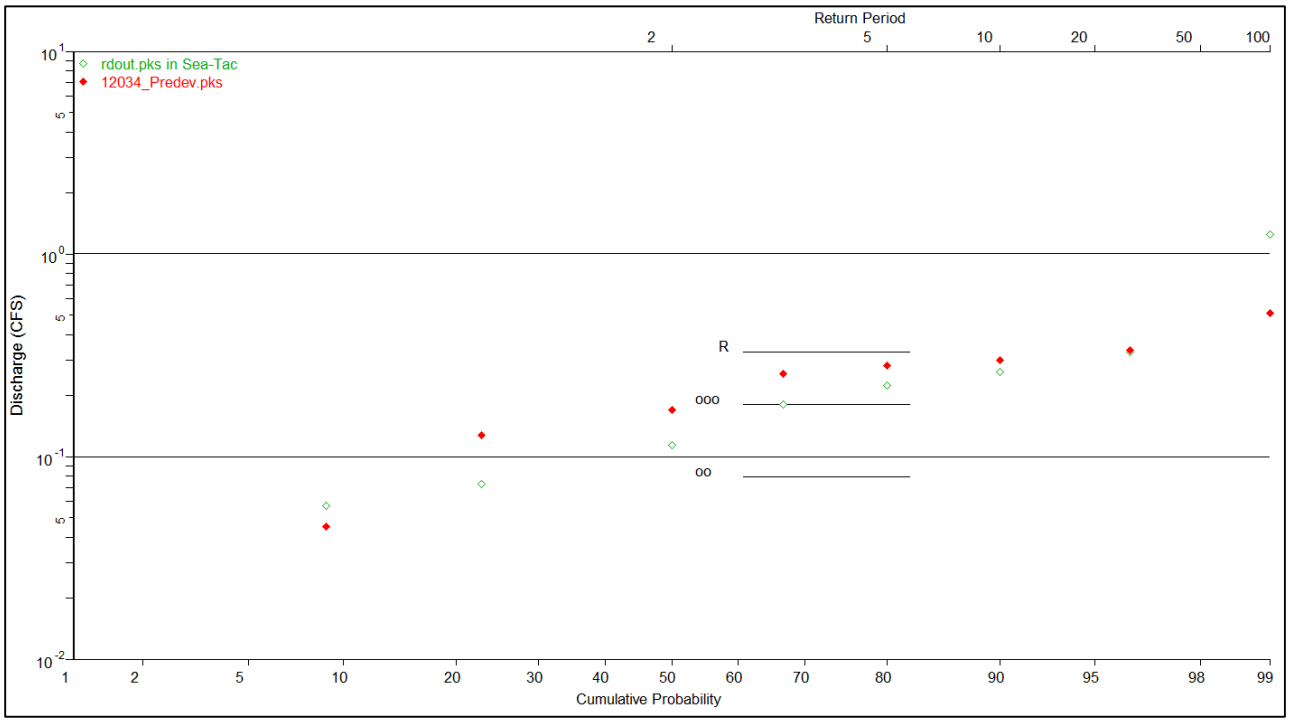

Figure 4-3 Flow Frequency Analysis

The flow duration comparison analysis results for the provided detention vault are shown below in Figure 4-4 Flow Durations Analysis. There is less than 10% excursion between the 2-year and 50-year release rate and the curve is entirely under the target curve for the required range of 50% 2-year to 2-year. Therefore, the proposed detention facility meets the flow duration requirement.

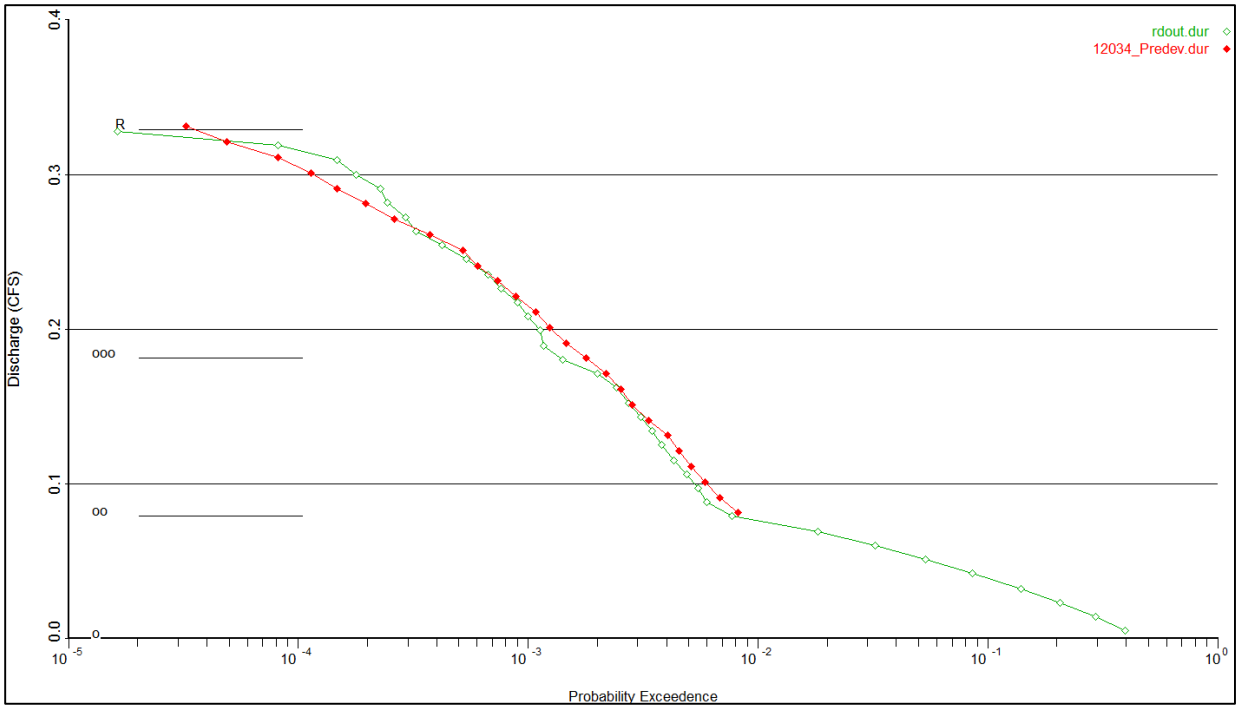

Figure 4-4 Flow Durations Analysis

```
Duration Comparison Anaylsis
   Base File: 12034_predev.tsf
    New File: rdout.tsf
Cutoff Units: Discharge in CFS

            -----Fraction of Time----- ---------Check of Tolerance-------
  Cutoff    Base      New      %Change Probability   Base     New %Change
   0.085 |  0.77E-02  0.63E-02  -18.2 |  0.77E-02   0.085   0.078    -7.1
   0.104 |  0.57E-02  0.52E-02   -9.4 |  0.57E-02   0.104   0.094    -9.8
   0.123 |  0.44E-02  0.39E-02  -11.5 |  0.44E-02   0.123   0.114    -7.6
   0.142 |  0.33E-02  0.31E-02   -5.4 |  0.33E-02   0.142   0.138    -3.2
   0.162 |  0.25E-02  0.24E-02   -2.6 |  0.25E-02   0.162   0.160    -1.2
   0.181 |  0.18E-02  0.13E-02  -25.5 |  0.18E-02   0.181   0.175    -3.5
   0.200 |  0.12E-02  0.11E-02  -10.5 |  0.12E-02   0.200   0.185    -7.8
   0.220 |  0.88E-03  0.85E-03   -3.7 |  0.88E-03   0.220   0.218    -1.0
   0.239 |  0.62E-03  0.62E-03    0.0 |  0.62E-03   0.239   0.239     0.0
   0.258 |  0.42E-03  0.41E-03   -3.8 |  0.42E-03   0.258   0.255    -1.4
   0.278 |  0.21E-03  0.28E-03   30.8 |  0.21E-03   0.278   0.293     5.7
   0.297 |  0.13E-03  0.20E-03   50.0 |  0.13E-03   0.297   0.312     4.9
   0.316 |  0.65E-04  0.98E-04   50.0 |  0.65E-04   0.316   0.324     2.3
   0.336 |  0.16E-04  0.00E+00 -100.0 |  0.16E-04   0.336   0.328    -2.2

Maximum positive excursion = 0.022 cfs (  7.8%)
occurring at 0.287 cfs on the Base Data:12034_predev.tsf
and at 0.310 cfs on the  New Data:rdout.tsf

Maximum negative excursion = 0.011 cfs (-12.4%)
occurring at 0.092 cfs on the Base Data:12034_predev.tsf
and at 0.081 cfs on the  New Data:rdout.tsf
```

D. Water Quality Calculations

Basic Treatment is required for the project site and a combined detention/wetpool vault will be designed and located near the southwest property boundary. Per page 10-4 in Volume V of the 2005 Stormwater Management Manual for Western Washington, basic water quality treatment volume is defined as the volume of runoff from the water quality design storm – the 6-month, 24-hour storm event. Per page 4-1 in Volume V of the 2005 Stormwater Management Manual for Western Washington, the 6-month, 24-hour precipitation amount is assumed to be 72% - 2-year, 24-hour amount.

The drainage analysis for water quality sizing was modeled using WaterWorks hydrology software utilizing SBUH methodology. The proposed vault will be utilized for both detention and water quality treatment.

The precipitation rates used for this analysis are as follows:

6-month, 24-hour storm (72% 2-year, 24-hour storm) → 1.3 in.
2-year, 24-hour storm → 1.8 in.

DEVELOPED AND UPSTREAM TRIBUTARY CONDITIONS	Total Area = 4.77 acres	Pervious/ Impervious Areas		CN (avg)
GROUND COVER	AREA(acre)		CN	
Forest	0.47		73	
Lawn (Landscaping)	2.43	2.90	86	83.89
Impervious	2.02	2.02	98	98
Time of concentration	Assumed			10 min.

The required volume of dead storage for the developed basin is equal to 11,059 cubic feet. See WaterWorks basin summary report below. Four feet of dead storage will be provided in Cell 1 and 2.5 feet of storage will be provided in Cell 2 for a total dead storage volume of 11,706 cubic feet.

```
2/11/2014   8:6:34 pm      Dodds Engineers, Incorporated      page   1
                                    BECU
=============================================================================
                               BASIN SUMMARY


BASIN ID: dev6mo       NAME: Beuca dev 6 month
SBUH METHODOLOGY
TOTAL AREA.......:   4.85 Acres     BASEFLOWS:   0.00 cfs
RAINFALL TYPE....:    TYPE1A                    PERV           IMP
PRECIPITATION....:   1.30 inches    AREA..:    2.90 Acres    2.02 Acres
TIME INTERVAL....:     10.00 min    CN....:   83.89         98.00
                                               TC....:   10.00 min    10.00 min
PEAK RATE:   0.58 cfs  VOL:   0.25 Ac-ft  TIME:    480 min
```

ATTACHMENT 18

5. Conveyance System and Analysis and Design

Conveyance design and analysis will be provided at the final design phase of the project.

6. Special Reports and Studies

The reports listed are provided spearately. Any additional special reports and studies will be provided at final design.

- Geotechnical Report
  Prepared for: Beuca Plat
  Prepared by: Theodore J. Schepper, PE
  Dated: April 27, 2012
  Terra Associates, Inc.
  12525 Willows Road, Suite 101
  Kirkland, WA 98034

- Infiltration Feasibility (LID Assessment)
  Prepared for: Beuca Plat
  Prepared by: Carolyn Decker, PE
  Dated: September 7, 2012
  Terra Associates, Inc.
  12525 Willows Road, Suite 101
  Kirkland, WA 98034

PROJECT LID FEASIBILITY

Site Soils

Based on a review of the Beuca Plat project, the soils on site "consist of glacially consolidated silty sand with gravel (glacial till)." LID elements constructed on till soils do not typically perform well due to their reliance on infiltration (glacial till soils, unless weathered, typically have low permeability). However, the Puget Sound Partnership's *LID Technical Guidance Manual for Puget Sound* notes that:

1) Bioretention facilities and permeable pavements can perform adequately in soils exhibiting minimum infiltration rates as low as 0.1 in/hr; and

2) Hydrologic soil groups A, B and C are considered to be appropriate for implementing LID elements.

The project Geotechnical Engineer (Terra Associates) conducted site observations and analyses to determine the feasibility of the on-site soils supporting infiltration. The recommendation from the Geotechnical Engineer is that on lot infiltration is not feasible for the project site (refer to the "Infiltration Feasibility" letter included at the back of this Section). This recommendation includes roof infiltration and bioretention BMPs.

Based on the above discussion and corresponding Geotechnical Engineer recommendations, typical bioretention facilities, roof infiltration and permeable pavements are not feasible on the Beuca Plat project.

Wellhead Protection Zones

The City of Redmond has identified four (4) Wellhead Protection Zones throughout the City in order to help manage the variable, and often shallow, groundwater impacts to land development activities. The City Wellhead Protection Zone map in the project vicinity is included in Section 1 of this report.

The Beuca Plat project is located in Wellhead Protection Zone 4. Once identified on the City map, the applicable Wellhead Protection Zone sets or modifies two key design parameters including:

- Soil classification for hydrologic analysis (detention facility sizing)
- Infiltration limitations

The Beuca Plat project, therefore, will be limited in any application of LID features that rely on infiltration. Flow control credits are provided based on clear demonstration of the site suitability criteria for the soils. Infiltration within Wellhead Protection Zone 4 is allowed by the City of Redmond for all non-pollution generating impervious surfaces or pollution generating impervious surfaces following Enhanced Treatment.

Hydrology

One of the primary considerations for applying and integrating LID elements into a project is the hydrologic impact. Since a primary objective of sustainable site design and LID is to better mimic the natural hydrologic cycle, the overall impact a project has on its environment is theoretically reduced by managing the stormwater very near to the point where it falls.

The City of Redmond provides some direct benefit to the hydrologic modeling (detention facility sizing), required of a project, when certain LID elements are proposed. The Beuca Plat project would benefit from implementation of LID elements in the hydrologic modeling of the proposed detention facility.

Feasible Project-specific LID Elements

Based on the site assessment and geotechnical recommendations no LID elements are feasible or proposed.

7. Other Permits

Additional permits will be addressed during the final design phase and may include the following:

- NPDES Permit
- Right-Of-Way Use Permit
- Forest Practices Permit

8. CSWPPP Analysis and Design

TESC calculations and design will be provided at the final design phase of the project.

9. Bond Quantities, Facility Summaries and Declaration of Covenant

An engineering cost estimate will be provided prior to final engineering approval for this project.

10. Operations and Maintenance Manual

An operations and maintenance manual will be provided for all storm water facilities at the final design phase of the project.

ATTACHMENT 18