Attachment 19

Hawks Glen

City of Redmond, Washington

Preliminary Storm Drainage Report

Prepared for:
Quadrant Homes
14725 SE 36th St, Suite 200
Bellevue, WA 98006

Date: June 14, 2016

Blueline Job No. 14-332

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6/14/16

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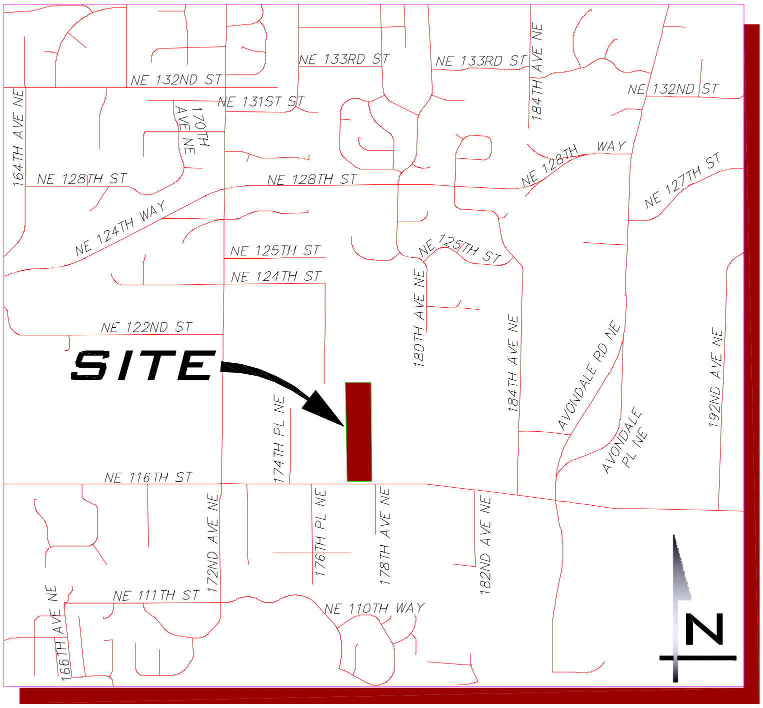
Section 1 Project Overview

The Hawks Glen project is associated with the address 17656 NE 116th St in Redmond, WA 98052 and consists of one parcel (2526059067) totaling an onsite private property area of approximately 9.77 acres. The project proposes frontage improvements along NE 116th St and 178th Ave West as well as development of the existing site into a residential neighborhood of 25 single family homes and 1 duplex with associated infrastructure, stormwater drainage facilities, and open space. More generally the site is located in the SE Section 25, Township 26N, Range 5 E. Please see the vicinity map below:



Vicinity Map
not to scale

The site is bound by a wetland and single family development to the west, NE 116th Street to the South, 178th Street NE to the east and single family development to the north. The site has access off NE 116th Street via an existing driveway which is to be abandoned. The site currently contains 1 single family residence, detached garage with asphalt driveway, gravel areas and outbuildings.

There are 5 distinct areas classified by Wetland Resources as Critical Areas. Wetland A is a category IV wetland located along the south western corner of the site. Wetland B is Category III wetland located offsite to the west whose buffer extends onto the site. Wetlands C and D are Class III wetlands that are adjacent to Monticello Creek in the northern part of the site which is wooded. Wetland E is a Category II wetland located offsite between the north eastern part of the site and 178th Ave W. The remainder of the site is predominately covered with grass and pasture areas with some existing landscaping around the existing residence.

In the developed condition the critical areas and buffers will be protected in critical area tracts and the remainder of the site will be developed which includes removal of the onsite structures, hardscape and pasture and installation of 27 residential units and associated infrastructure. Access in the developed condition will be from 178th Street NE.

See the *Developed and Existing Conditions Exhibit* included in Section 4.

The subject property was analyzed as a Single Threshold Discharge area, per section 2.3 of 2005 SWMMWW DOE Volume I. Flows exit the site through 2 separate points but join together in the same stream less than ¼ mile from the site. The project area is tributary to sub-basin 490080 according the City of Redmond GIS Watershed boundaries. Flows ultimately discharge into the Sammamish River over 5 miles from the subject property. The basin areas and path are shown in the *Downstream Path Exhibit* included in section 3 of this report.

Soils onsite were determined to be predominately silty fine sand to fine sandy silt and is considered typical of glacial deposits as shown in the Geotechnical Engineering Study included in Section 6 of this report.

The proposed improvements for this project add greater than 5,000 SF of new impervious area, thus the project, per Redmond Technical Notebook 2012, is categorized as a Large Project and required to meet Minimum Requirements #1 - #9 as detailed in Chapter 2 of the Stormwater Notebook.

Basin 5 has been requested by City staff to be modeled separately from the rest of the site. City staff has asked for the runoff from Basin 5 be directed to sheet flow into NE 116th st and into the City's east-flowing storm drain system. The City system flows east under 178th ave and discharges into the unnamed tributary to Monticello Creek a few yards upstream of the Basin 3 discharge point. Basin 5 proposes to install less than 5,000 SF of non-PGIS impervious surface and is therefore considered a "Medium Project" by section 3.4 of the 2012 City of Redmond Stormwater

Management Technical Notebook. Medium projects are required to meet Minimum Requirements #1-5, which does not include flow control. Refer to Section 4 of this report for additional details.

The stormwater elements to serve the developed drainage will be designed based on the City of Redmond 2012 Technical Notebook and the Washington State Department of Ecology's Stormwater Management Manual for Western Washington 2005 (2005 DOE Manual).

Section 2 Minimum Requirements

The project will comply with all minimum requirements of the 2005 DOE Manual and the City of Redmond 2012 Technical Notebook. Minimum requirements are listed and met as detailed below and determined from the City of Redmond (COR) Flow Chart, Figure 3.2, included at the end of this section.

Minimum Requirement #1: Preparation of Stormwater Site Plans: Preliminary Plans are provided as part of this Preliminary Storm Drainage Report.

Minimum Requirement #2: Construction Stormwater Pollution Prevention Plan (SWPPP): See Section 5. A Construction SWPPP will be provided at final engineering under separate cover.

Minimum Requirement #3: Source Control Pollution: The project is not a source of urban stormwater pollutants as described in Chapter 2, Volume IV of the 2005 DOE Manual; thus the need to reduce or eliminate stormwater pollutants is not present and no Operational or Structural source control BMPs will be required for the developed site. Minimum Requirement #2 addresses BMPs for construction sites. Source Control Pollution created during construction will be addressed by the SWPPP.

Minimum Requirement #4: Preservation of Natural Drainage Systems and Outfalls: See Sections 3 and 4 for further detail. As described in Section 3 of this report, existing drainage patterns direct runoff from the developed portion of the site to a storm drain outfall pipe and gabion basket energy dissipater installed with the plat of Fischer Village. The City rejected a proposal to direct developed flows to this gabion basket outfall and required the project to create an alternate discharge to Monticello Creek. The alternate discharge location was preferred due to the proposed construction at the existing gabion basket outfall required disturbance to steep slopes and alterations to the existing outfall and Monticello Creek Tributary compounded the difficult of future restoration of Monticello Creek. A new outfall, located on the east side of 178th Ave NE at Monticello Creek has been proposed as requested. The existing and proposed discharge locations are within the same basin and both ultimately discharge to Monticello Creek.

Minimum Requirement #5: On-Site Stormwater Management: See Section 4. The project evaluated Low-Impact-Development (LID) Stormwater Best Management Practices (BMPs) as well as the required BMP's to control roof runoff as described in Section 2.5.5 of the COR 2012 Technical Notebook.

Permeable pavement as described in Section 7.1 in Appendix C, Volume III of the 2005 DOE, is not feasible for this project due to low permeability till-soils.

Dispersion BMPs as described in Chapter III and Section 7.2 in Appendix C, Volume III of the 2005 DOE are not feasible due to limited flow paths imposed by the site.

Vegetated Roofs per Section 7.3 in Appendix C in Volume III of the 2005 DOE are not economically feasible for this single-family project due to added structural requirements to meet design criterion.

Rainwater Harvesting per Section 7.4 in Appendix C, Volume III of the 2005 DOE is not economically feasible for the project.

Reverse Slope Sidewalks per Section 7.5 in Appendix C, Volume III of the 2005 DOE are not feasible throughout the majority of the site due to topography and grading.

Minimal Excavation Foundations per Section 7.6 in Appendix C, Volume III of the 2005 DOE are not feasible for this project due to the use of grading equipment exceeding 650 psf for extensive mass grading.

Bioretention Areas per Section 7.7 in Appendix C, Volume III of the 2005 DOE are not feasible due to physical site constraints and low permeability till soils.

Disturbed landscaped areas within the project site will have compost amended soils per City of Redmond Standard Detail 632.

Where space permits, roof downspouts will be connected to perforated pipe stub out connections per DOE standards.

Minimum Requirement #6: Runoff Treatment: See Section 4. According to Section 2.5.6 of the City of Redmond 2012 Technical Notebook, a treatment facility will be required as well as onsite stormwater BMPs due to > 5,000 SF of Pollution Generating Impervious Surface (PGIS) onsite. The site will provide a combination detention and wet vault with dead storage to meet the Basic Treatment criterion per Figure 4.1 from 2005 DOE Manual; placement is shown on the Preliminary Plans under separate cover, and on the *Developed Conditions Exhibit*.

Minimum Requirement #7: Flow Control: See Section 4. According to Section 2.5.7 of the City of Redmond 2012 Technical Notebook, a flow control facility as well as onsite stormwater BMPs will be required onsite due to greater than 5,000 square feet of impervious area onsite. A detention vault will be provided and designed to meet the Standard Flow Control Requirement as specified by the City. The detention vault is shown on the Preliminary Plans under separate cover, and on the *Developed Conditions Exhibit*.

Minimum Requirement #8: Wetlands Protection: Drainage patterns to the existing onsite wetlands will be maintained.

Minimum Requirement #9 Operation and Maintenance: See Section 9. Operation and Maintenance guidelines from the 2005 DOE will be included at final engineering.

Minimum Requirement Flow Chart per Section 2.4 of the COR 2012 Technical Notebook.

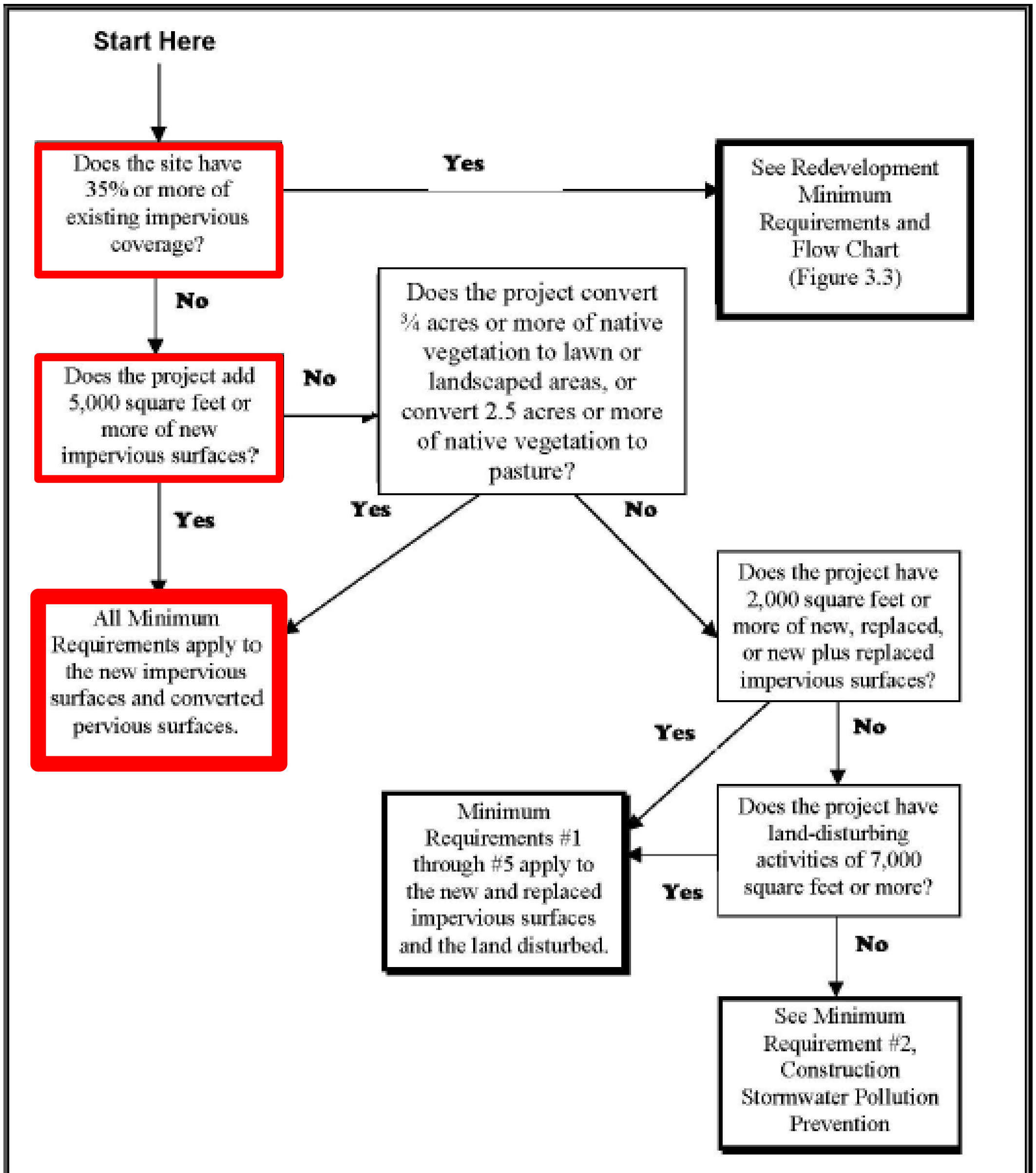


Figure 3.2 Flow Chart for Determining Requirements for New Development

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Section 3 Offsite Analysis

For the offsite analysis, a qualitative level evaluation was conducted for the Hawks Glen development project at 17656 NE 116th St, Redmond WA, on July 10th, 2015, an overcast day in the low 70's.

TASK 1: DEFINE AND MAP THE STUDY AREA

The project is comprised of one parcel (2526059067). See Section 1 of this report for *Existing and Developed Conditions Exhibits,* additionally at the end of this Section a *Downstream Path Exhibit* is included to show study area boundaries as well as the observed stormwater runoff flow path from the site, the exhibit is labeled with photo locations and any existing or potential problems observed. The project site consists of two drainage basins that are further described in Task 3 and 4.

TASK 2: RESOURCE REVIEW

The best available resource information, including King County iMAP and City of Redmond resource and GIS maps, were reviewed for existing or potential problems. The following is a summary of the findings from the information used in preparing this report.

- The site is composed of Alderwood gravelly sandy loam soils with 100% of the site at 8-15% slopes (AgC). (NRCS Web Soil Survery)
- The site is located within the Monticello Creek Drainage Basin, part of the Lake Sammamish / Sammamish River Watershed. (King County Water Features map)
- The site contains a stream, Monticello Creek, on the northern portion of the property, two wetlands adjacent to the creek, and a Type IV wetland on the southern portion of the property. (King County iMAP and Survey performed by Axis)
- The site is not located in a 100 year flood plain or a FEMA floodway. (Redmond Critical Areas Map – Flood Areas)
- The site is not located in an Erosion Hazard Area (King County iMAP)
- The site is not located in a Landslide Hazard Area (King County iMAP)
- The site is not located in a Seismic Hazard Area (King County iMAP)
- The site is not located in a Core Preservation Area. (Redmond Critical Areas Map – Fish & Wildlife).
- The site does contain slopes and gradients in excess of 40 percent. (See Existing Conditions Exhibit)

Data Source:
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.

Erosion Hazard Areas

Critical Areas Map
City of Redmond, Washington
Effective: 05/28/2005

Disclaimer: This map is created and maintained by GIS Services Group,Finance and Information Services, City of Redmond, Washington, for reference purposes only.

The City makes no guarantee as to the accuracy of the features shown on this map.

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Data Source:
FEMA Flood Insurance Rate Maps

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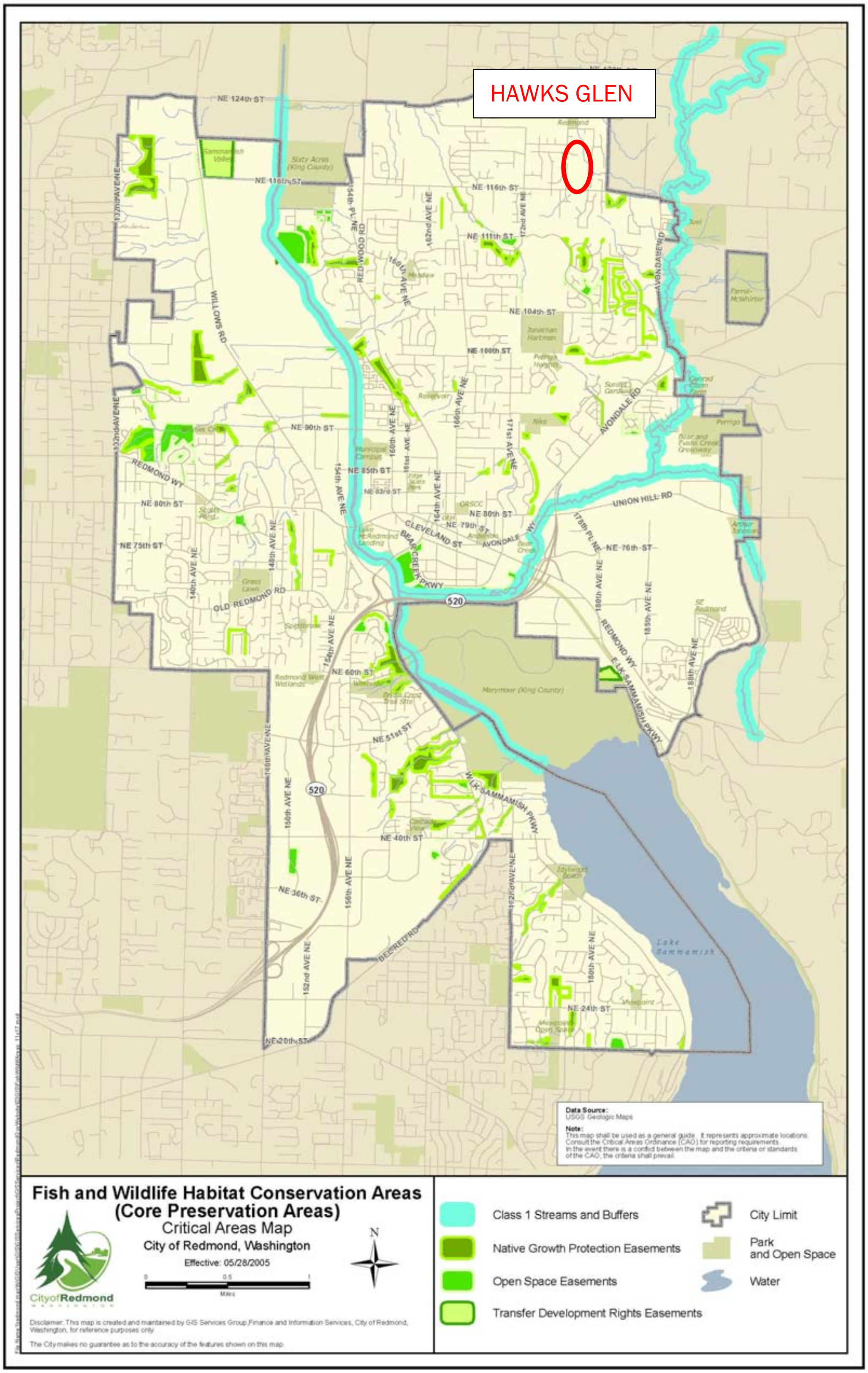

Data Source:
USGS Geologic Maps

Note:
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Fish and Wildlife Habitat Conservation Areas (Core Preservation Areas)
Critical Areas Map
City of Redmond, Washington
Effective: 05/28/2005

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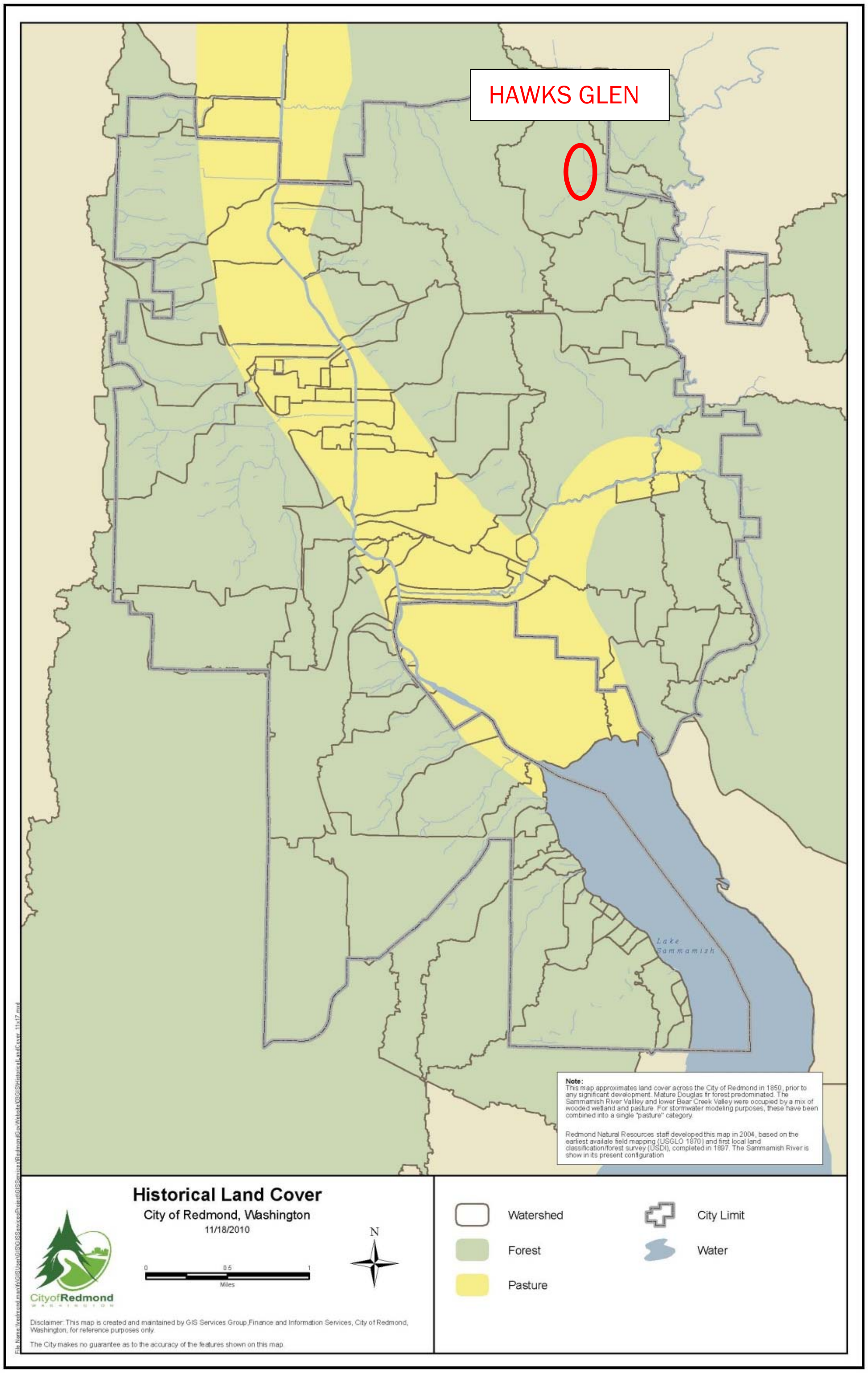

Historical Land Cover
City of Redmond, Washington
11/18/2010

Note:
This map approximates land cover across the City of Redmond in 1850, prior to any significant development. Mature Douglas fir forest predominated. The Sammamish River Vallley and lower Bear Creek Valley were occupied by a mix of wooded wetland and pasture. For stormwater modeling purposes, these have been combined into a single "pasture" category.

Redmond Natural Resources staff developed this map in 2004, based on the earliest availale field mapping (USGLO 1870) and first local land classification/forest survey (USDI), completed in 1897. The Sammamish River is show in its present configuration

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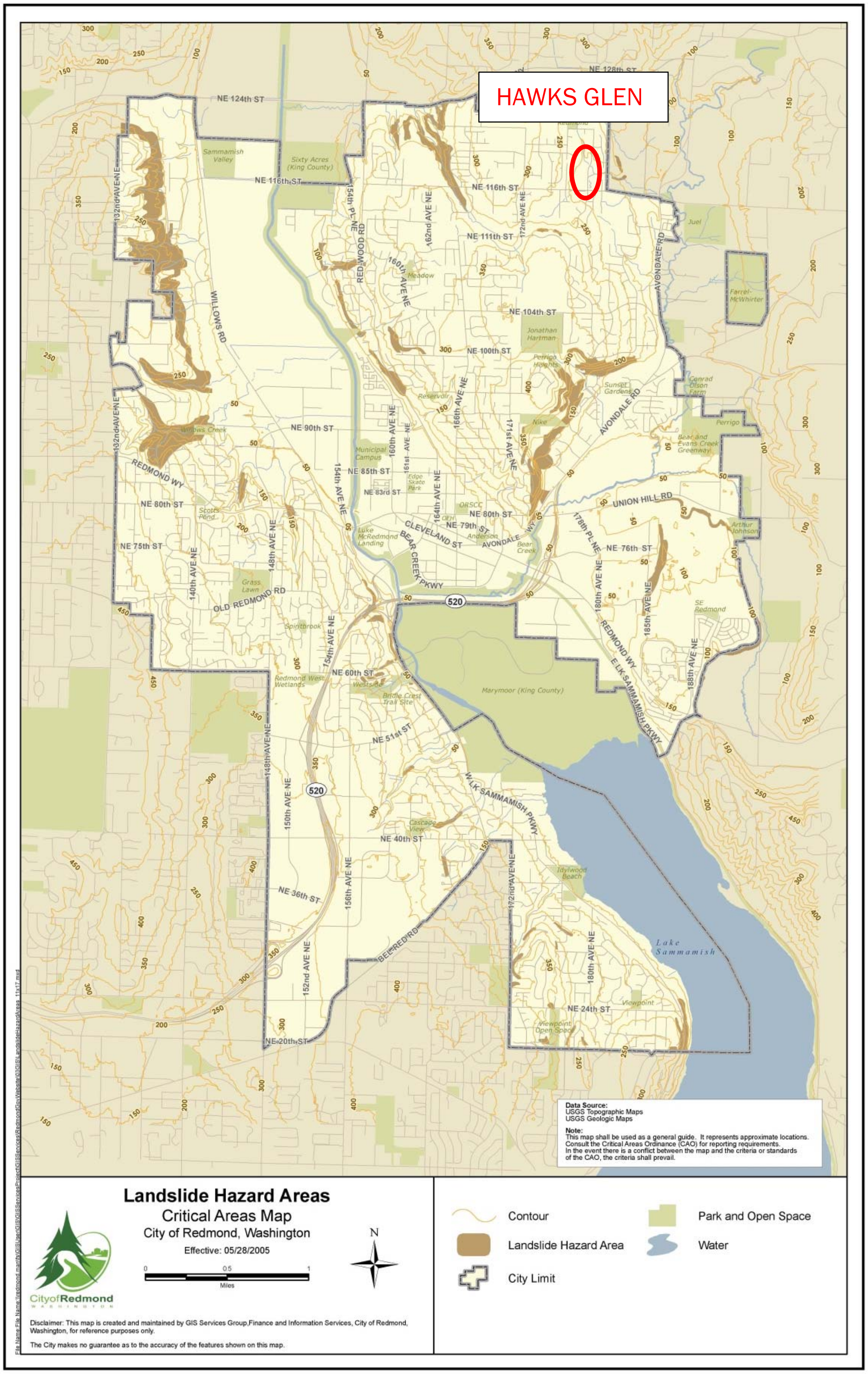

Data Source:
USGS Topographic Maps
USGS Geologic Maps

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 criteria or standards of the CAO, the criteria shall prevail.

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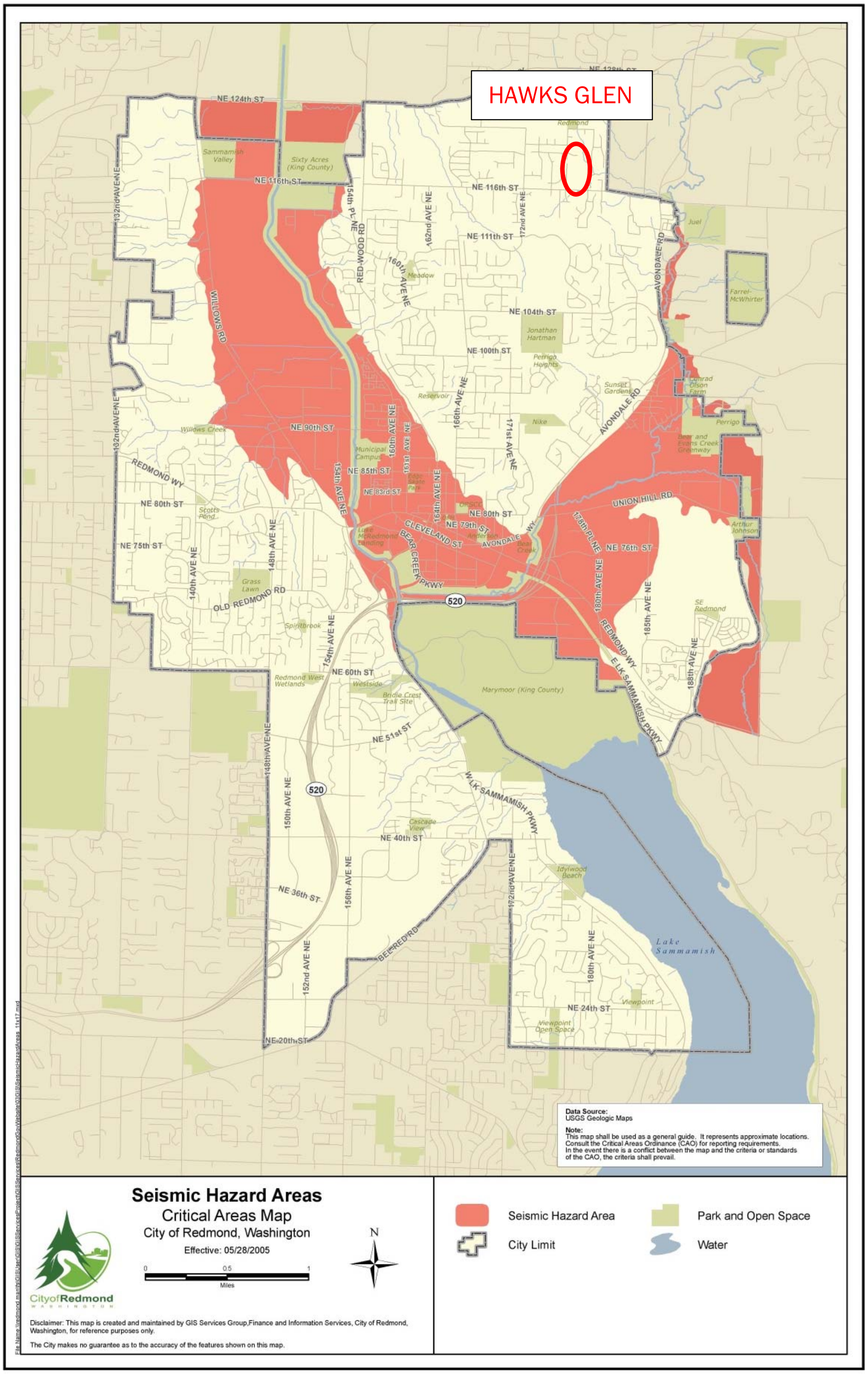
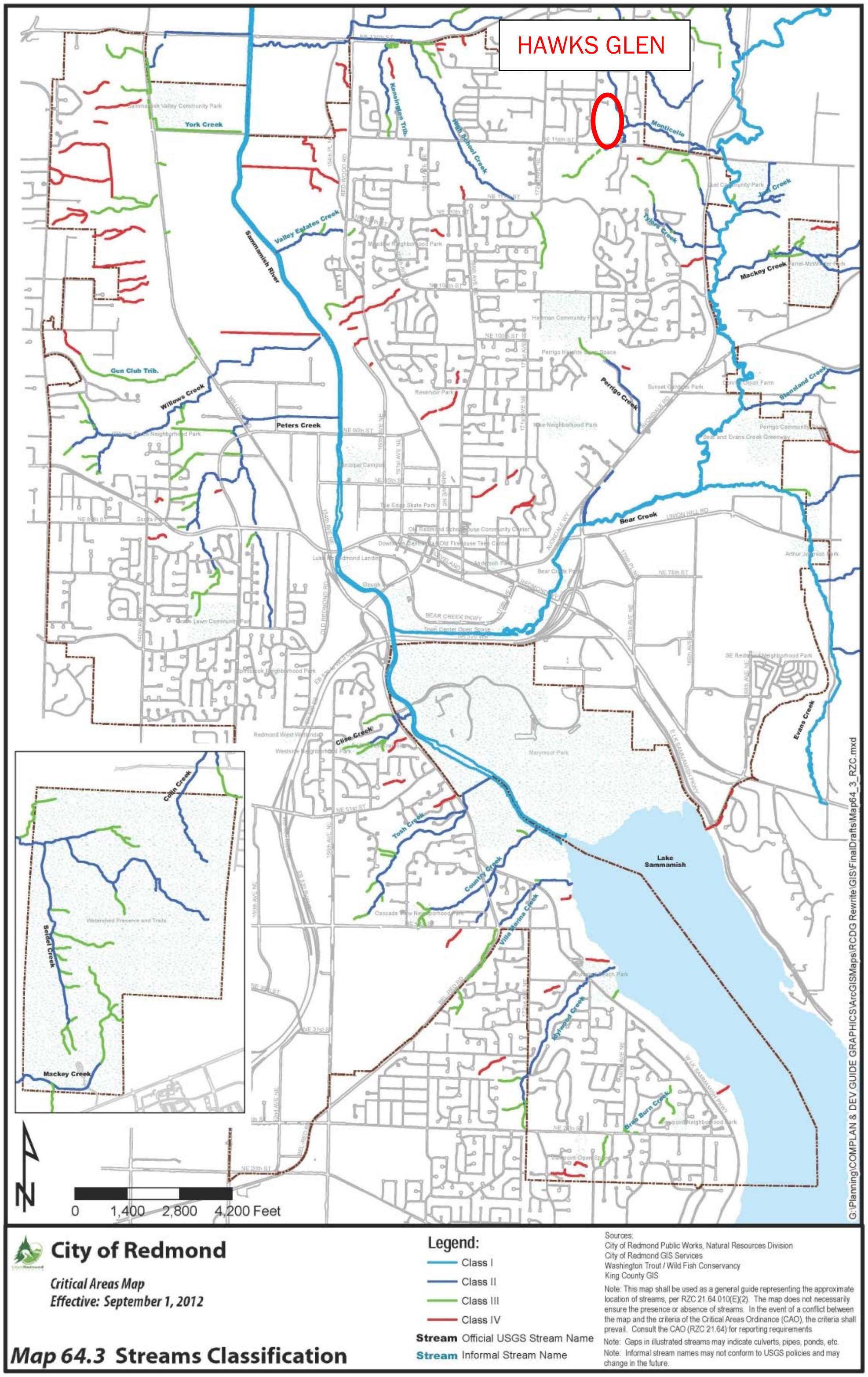


Data Source:
USGS Geologic Maps

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.

Seismic Hazard Areas
Critical Areas Map
City of Redmond, Washington
Effective: 05/28/2005

CityofRedmond
WASHINGTON



City of Redmond

Critical Areas Map
Effective: September 1, 2012

***Map 64.3* Streams Classification**

Legend:

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

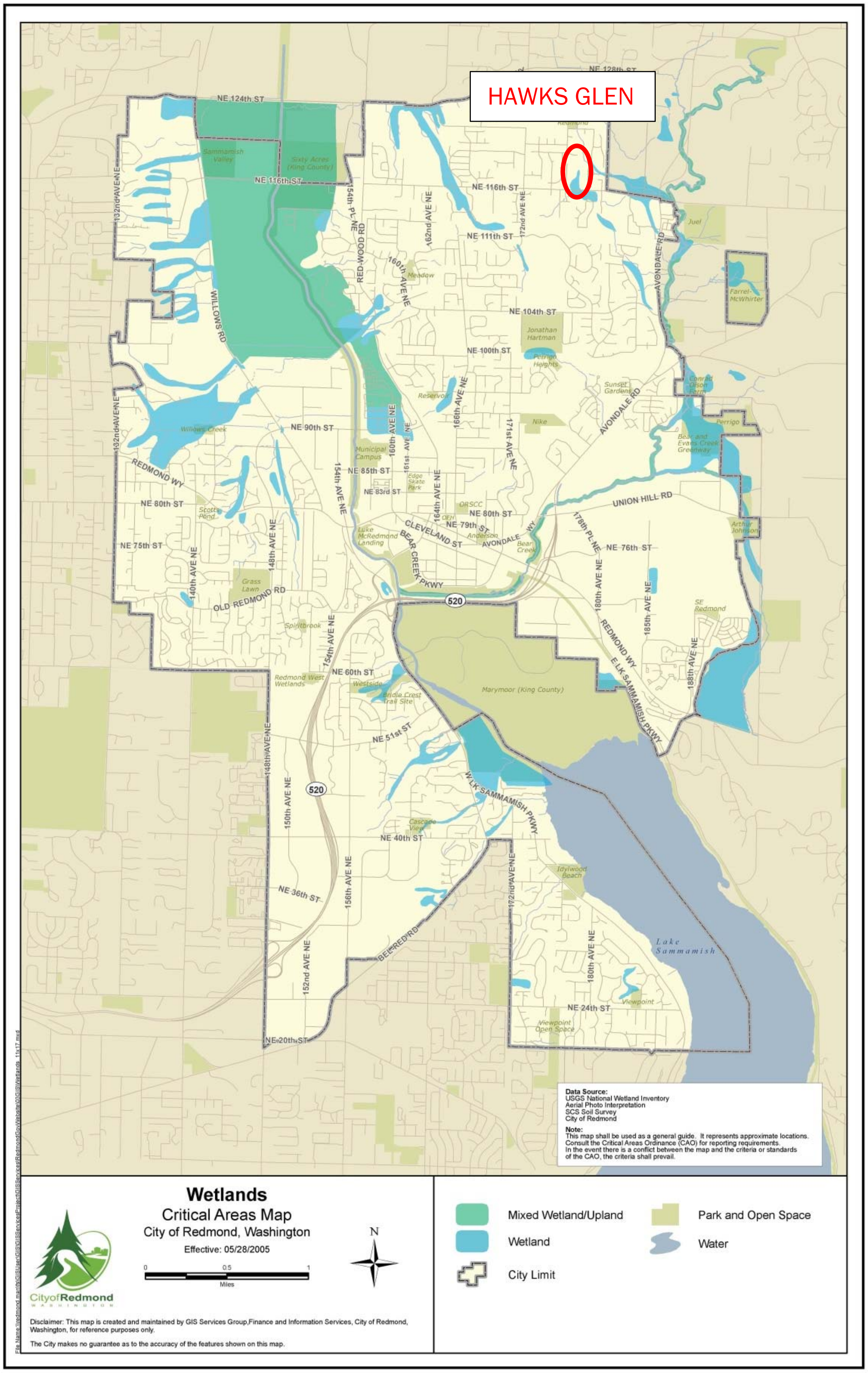
Stream Official USGS Stream Name
Stream Informal Stream Name

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.



Wetlands

Critical Areas Map

City of Redmond, Washington

Effective: 05/28/2005

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

Note:
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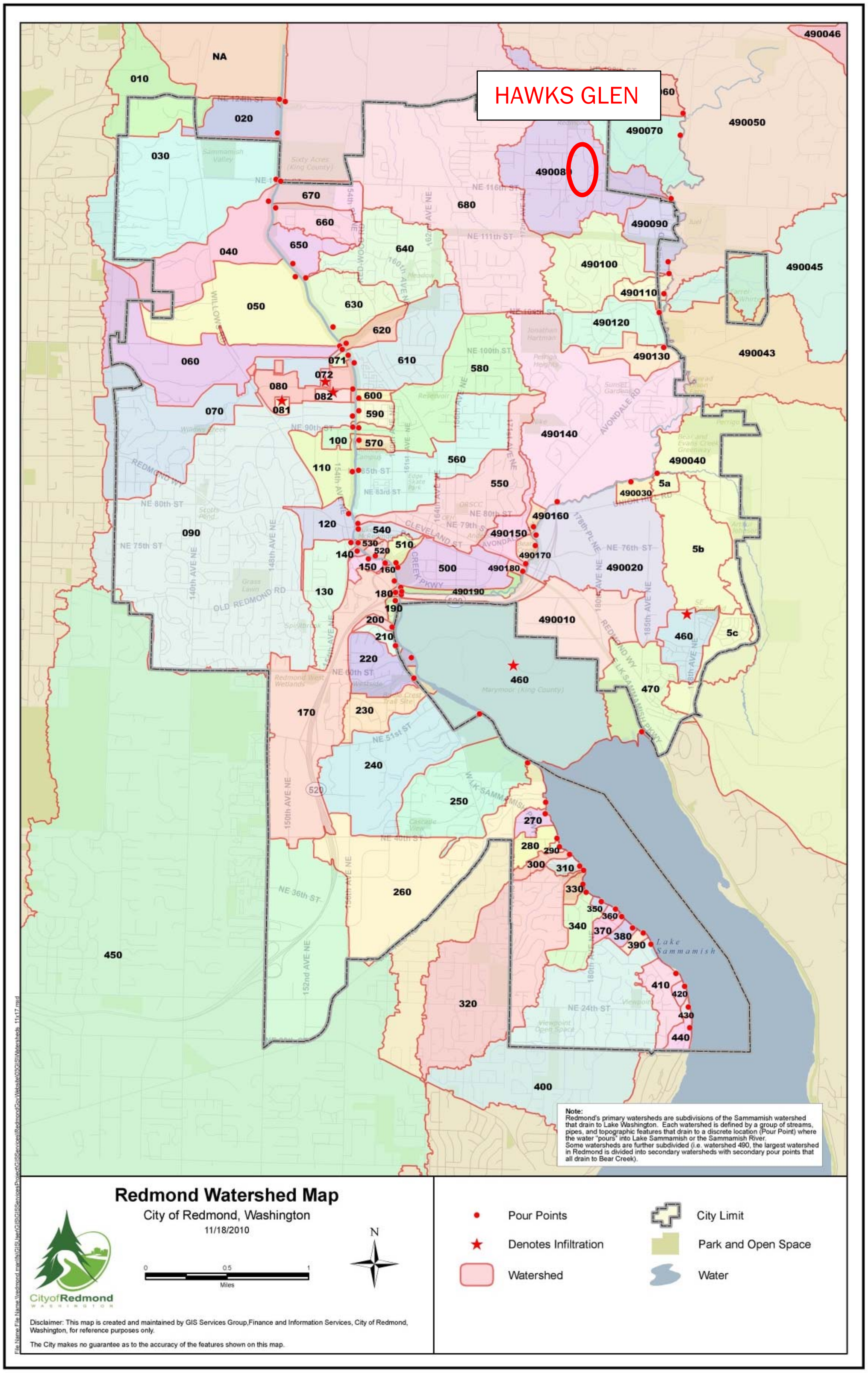

Note:
Redmond's primary watersheds are subdivisions of the Sammamish watershed that drain to Lake Washington. Each watershed is defined by a group of streams, pipes, and topographic features that drain to a discrete location (Pour Point) where the water "pours" into Lake Sammamish or the Sammamish River.
Some watersheds are further subdivided (i.e. watershed 490, the largest watershed in Redmond is divided into secondary watersheds with secondary pour points that all drain to Bear Creek).

Redmond Watershed Map

City of Redmond, Washington
11/18/2010

Disclaimer: This map is created and maintained by GIS Services Group,Finance and Information Services, City of Redmond, Washington, for reference purposes only.

The City makes no guarantee as to the accuracy of the features shown on this map.

TASK 3: FIELD INSPECTION

A field inspection was conducted for the Hawks Glen development project at 17656 NE 116th St, Redmond WA, on July 10th, 2015. The weather conditions were overcast in the low 70's. For a general description of drainage features for the site drainage basin, please see the *Existing Conditions Exhibit* and the *Developed Drainage Exhibit* included in Section 4 of this report for reference. Task 4 of this section contains a detailed drainage path description for the onsite basin as well as a *Downstream Drainage Path Exhibit*.

ONSITE BASINS

The geotechnical report included in the Section 6 prepared by Terra Associates, Inc indicates onsite native soils consist predominantly of silty fine sand to fine sandy silt and is considered typical of glacial deposits.

For discussion, the site can be broken into five basins (four onsite and one upstream) all of which combine within ¼ mile downstream of the site.

Basin 1

The north portion of the site, which is to remain undeveloped, contains a wooded ravine that drains to the northern fork of Monticello Creek which is located at the toe of the ravine and flows east through the property.

Basin 2, Basin 3, and Basin 5

The southern portion of the site currently contains a single-family residence, various sheds, and a garage along with an asphalt driveway. The residence is surrounded by open grassland to the south, east and north, and thick trees and brush offsite to the west. The south portion of the site can be broken into three basins namely Basin 2, Basin 3 and Basin 5.

Basin 2 drains east where it is collected by an existing 6" culvert located along the east property line as identified on the topographic survey for this project.

Basins 3 and 5 drain east and are collected in an existing 18" culvert located along the east property line as identified on the topographic survey for this project.

DOWNSTREAM DRAINAGE PATH

Basin 1

The north portion of the site contains gradual to moderate slopes. Runoff sheet flows into the north fork of Monticello Creek and continues east where crosses beneath 178th Ave NE in a 10’ diameter bottomless culvert. The creek continues east approximately 230 LF where it converges with an unnamed tributary to the creek. Monticello creek continues downstream approximately 2,700 ft before discharging into Bear Creek which runs for approximately 5 miles before discharging into the Sammamish River.

Basin 2

Basin 2 drains east where it is collected by an existing 6” culvert located along the east property line which enters the City storm system in 178th Ave NE and continues east where it outfalls into the existing private storm drainage pond constructed with the plat of Fischer Village. The pond is used for detention purposes. The pond outfalls to a type 2 catch basin located on the west side of 178th Ave NE. This catch basin also receives flows from an unnamed tributary to Monticello Creek located south of the catch basin (described below as part of the Basin 3 description). The combined flows drain north approximately 100 LF to a gabion basket energy dissipater. Downstream of the gabion outfall the flow is considered an unnamed tributary to Monticello Creek. Flows continue approximately 180 LF downgradient where it combines with Monticello Creek (see downstream description for Basin 1 - above).

Basin 3

Basin 3 drains east and is collected in an existing 18” culvert that directs flows east beneath 178th Ave NE and into an unnamed tributary to Monticello Creek which was constructed with the plat of Fischer Village. The tributary travels approximately 200 LF north where it enters a 24” culvert that drains to a type 2 catch basin. This catch basin also receives runoff from the existing storm pond constructed with Fischer Village. Runoff leaves the catch basin and travels north where it outfalls to a gabion basket outfall (see downstream description for Basin 2 above).

Basin 5

Basin 5, which drains east and combines with flows from Basin 3 (described above), has been requested by City staff to be modeled separately from the rest of the site. City staff has asked for the runoff from Basin 5 be directed to sheet flow into 116th st and into the City's east-flowing storm drain system. The City system flows east under 178th ave and discharges into the unnamed tributary to Monticello Creek a few yards upstream of the Basin 3 discharge point.

UPSTREAM BASINS

Basin 1

The northern portion of the site is to remain undeveloped and drainage patterns left intact. An upstream analysis was not provided for this area.

Basin 4

There are approximately 4.13 acres of upstream area tributary to Basin 2. The limits of the upstream basin were determined through review of City of Redmond GIS contours and aerial information as well as field observations. This basin includes the existing Eastview Development whose runoff is treated by an existing Washington DOE approved detention vault. Discharge from this vault is designed to equal the predeveloped forested runoff from the development area, and so the land can be modeled as forested for this project's purposes. The rest of this upstream basin will be modeled as forest except for a triangular patch of pastureland. The limits of Basin 4 were set assuming the temporary sandbags and sump installed by prior property owners, as described in Task 4 of this section, are removed.

Flows west of Basin 3 are intercepted by the existing conveyance ditch located along the west side of the driveway. This area drains south and connects to the existing storm system in NE 116th Street which then runs east and ultimately into the unnamed tributary to Monticello Creek located immediately east of 178th Avenue NE.

REPORTED DRAINAGE PROBLEMS

The best available resource information (King County iMap) was reviewed for existing or potential drainage problems. According to iMAP stormwater maps there is a drainage complaint located along the downstream path of the northern basin where Monticello Creek crosses under 178th Ave NE.

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This complaint occurs along the existing natural flow path of the creek and this portion of the creek will not receive additional runoff in the proposed condition. The City of Redmond Public Works and GIS departments have been contacted requesting Storm Utility Maps and drainage complaints they have on record.

EXISTING / POTENTIAL DRAINAGE PROBLEMS

Existing erosion potential downstream of the site was observed in the field, as well as on the City of Redmond Erosion Hazard Area Map. Properties adjacent to the downstream flow path of Monticello Creek slope down to the ravine where the creek is located. Additionally, this ravine, while heavily vegetated has very steep sides and could be subject to erosion during high flows. Drainage capacity should not be a concern owing to the well-designed detention ponds and overflow structure, as well as the very deep ravine that the creek flows through. The detention vault is sized according to DOE criteria which includes stream protection requirements. Therefore no adverse impacts to the downstream channel are expected as a result of this project.

TASK 4: DRAINAGE SYSTEM DESCRIPTION

Please see the *Existing Conditions Exhibit* and the *Developed Drainage Exhibit* in reference to the narrative included in this Report. *Downstream Drainage Photos* are included in this section for reference.

In Basin 1, runoff begins at the northern and northwestern boundaries and generally flows south-southeast into Monticello Creek. The Creek flows in a southerly direction but takes an easterly turn after approximately 450 ft before leaving the site and flowing through a large culvert running underneath 178th Ave NE.

In the southern drainage basin runoff sheet flow begins onsite at the western boundary of the property and moves south and east over gradual slopes where a subtle ridge begins to develop which generally defines the boundary between Basin 2 and Basin 3.

Flows from Basin 2 are tributary to an existing 6” culvert running underneath 178th Ave NE. Flows from Basin 3 are tributary to an 18” culvert running under 178th Ave NE. Flows from Basin 5 flow into the 116th st city system per request by City official.

Existing Sand Bags and Sump

As shown on the Existing Conditions exhibit, the site contains sand bags and a sump installed along the west property line. According to conversations between Wetland Resources staff and the prior property owner, the sand bags were installed as a temporary measure to prevent flooding of onsite buildings which occurred during large rainfall events. The sand bags directed runoff to a sump area where it was pumped around the buildings to avoid flooding. The discharge location of the pump was not stated. The City of Redmond considers shallow groundwater to be a Critical Area per RZC 21.64.050 (Critical Aquifer Recharge Area). The existing sand bags, sump, and perforated pipe are considered permanent dewatering by the City and therefore, are required to be removed. As such, the sand bags and sump will be removed as part of this development as requested by the city. An alternate drainage system will be installed along the west edge of the proposed lots to prevent upstream runoff from adversely impacting the proposed yards and homes.

Existing Perforated Pipes

The site contains existing perforated pipes that were installed and used for agricultural purposes and are located as shown on the Existing Conditions exhibit. The location of the pipes were based on an aerial photo provided by the city and therefore considered approximate. As part of the development the pipes will be removed. According to conversations between Wetland Resources staff and the prior property owner, the pipes were installed by the property owner for agricultural purposes.

Other subsurface pipes associated with proposed building footing drains will be installed as part of this development. As indicated in the CARA report prepared by Terra Associates, the predeveloped and post developed sub surface conditions are anticipated to be similar. The proposed subsurface pipes will be installed above the existing grade in order to avoid any potential for groundwater dewatering. The proposed building footing drains will discharge to the proposed stormwater facilities. This is shown in the proposed plan set under separate cover.

DOWNSTREAM PATH PHOTOS

Photo 1: Looking east into the culvert conveying flows from Monticello Creek and the undeveloped portion of the site under 178th Ave NE.

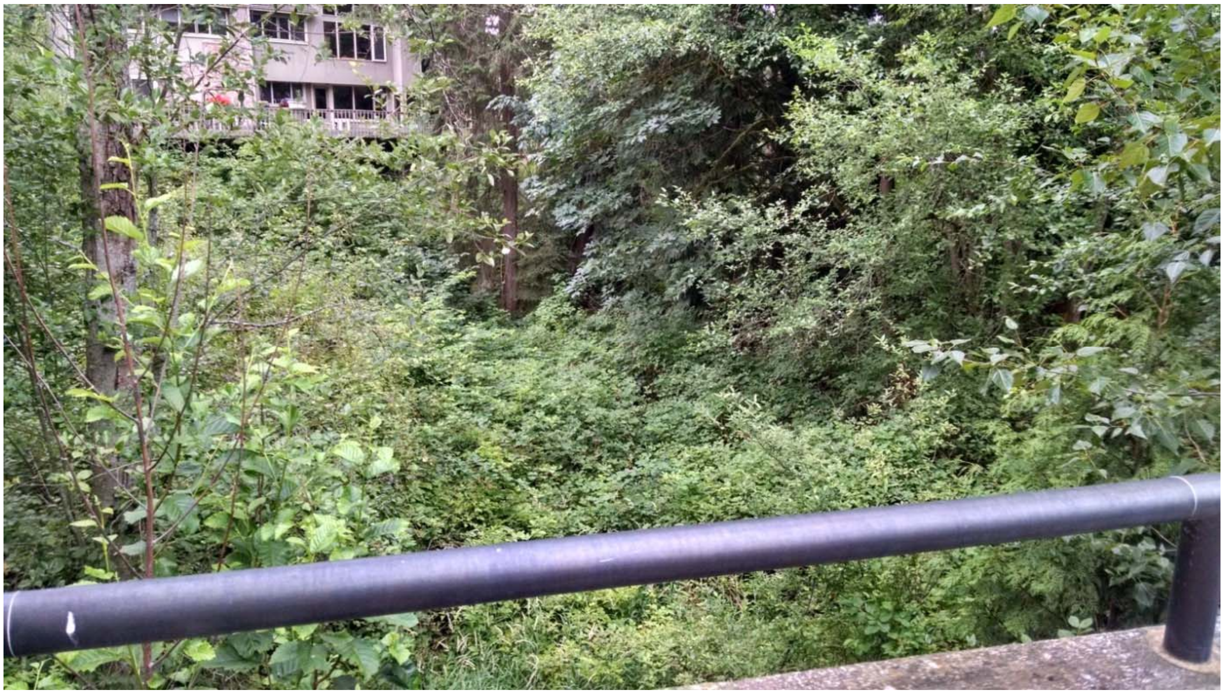

Photo 2: Looking east towards the downstream path of Monticello Creek, east of the culvert under 178th Ave NE.

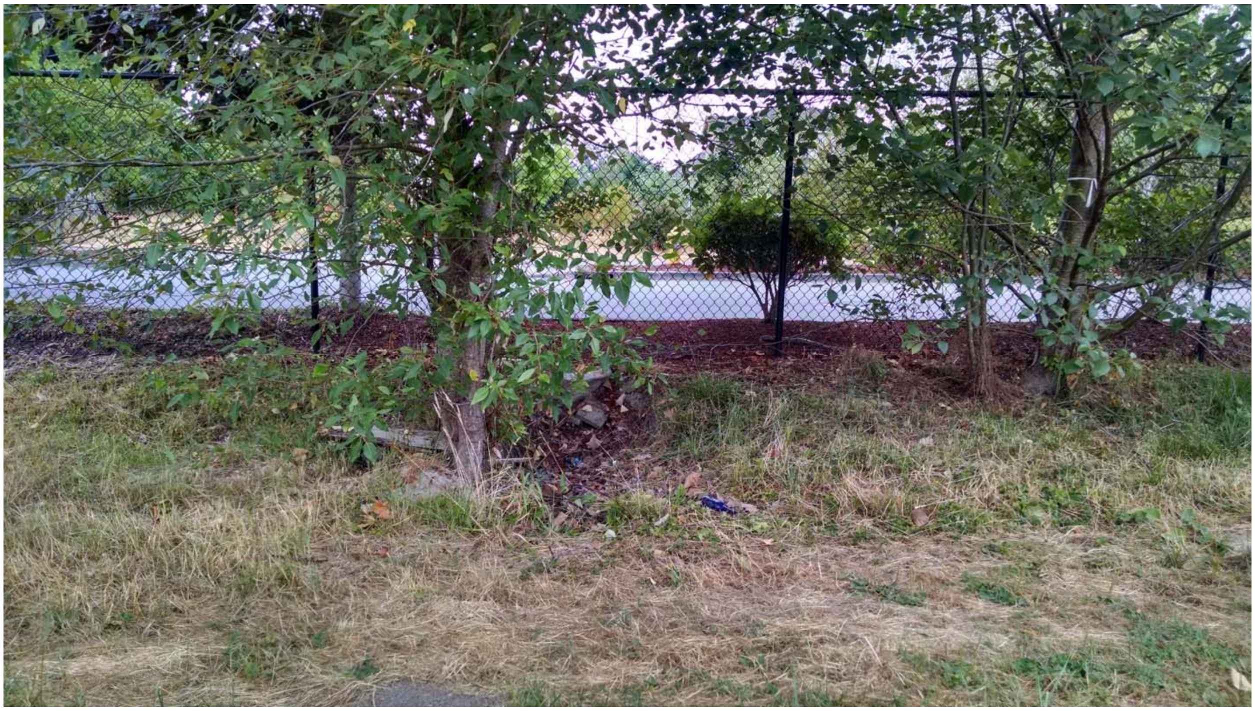

Photo 3: Looking east at the 6” culver, which runs east underneath 178th Ave NE draining the northern portion of the developed site.

Photo 4: Looking east at the 18” culvert which runs east underneath 178th Ave NE draining the southern portion of the developed site.

Photo 5: Unnamed tributary to Monticello Creek, east of 178th Ave NE, fed by southernmost onsite culvert.

Photo 6: Storm water pond for Fischer Village.

Photo 7: Overflow structure serving the above storm water pond.

Photo 8: Gabion basket outfall from the Fischer Village storm water pond outfall.

Picture 9: Looking east downstream of the gabion basket outfall.

Picture 10: Looking into the steep overgrown ravine, at the point of convergence for the tributary to Monticello Creek and Monticello Creek.

Picture 11: Looking east from Avondale Road toward the convergence of Monticello Creek and Bear creek, approximately two-thirds of a mile downstream of the site.

Picture 12: Looking north - existing temporary sandbags (to be removed).

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Picture 13: Existing subsurface perforated pipes (aerial image provided by City of Redmond).

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Section 4 PERMANENT STORMWATER CONTROL PLAN

The permanent stormwater control plan includes both flow control and water quality treatment facilities designed and sized according to the City of Redmond 2012 Technical Notebook and the adopted 2005 Stormwater Management Manual for Western Washington.

DRAINAGE SYSTEM OVERVIEW

Refer to Section 3 Offsite Analysis for a review of the existing drainage patterns for each of the five basins. Refer to *the Developed Condition* exhibit for delineation of basins described below.

Though runoff from much of the site is tributary to the existing gabion basket outfall installed with Fischer Village, the city has required the Hawks Glen project to install a new outfall to Monticello Creek. The new outfall will be located on the east side of 178th Ave NE at the edge of Monticello Creek. Runoff from the majority of the site will be tributary to this outfall whereas runoff from a small portion of the site will drain to the unnamed tributary to Monticello creek located on the east side of 178th Ave NE.

Basin 1 will remain undisturbed. It does not require detention or water quality treatment and therefore was not included in the WWHM model.

Basin 5 is the area along NE 116th Street that consists of a 25' public access easement and a 12' right of way dedication. Since runoff from this area is considered "public", the city has required that Basin 5 drain to the existing public drainage system located in NE 116th Street. Basin 5 will add less than 5,000 SF of impervious area (3,695 SF of walk + 1,285 SF PGIS = 4,980 SF of total impervious) and is considered a "Medium Project" and is therefore not required to provide water quality or flow control and will not be included in the WWHM model.

In order to mimic existing hydrology Basin 3 will be collected and directed to the unnamed tributary to Monticello creek.

The runoff from upstream Basin 4 will be collected by a v-section swale located at the rear of lots 6-16 and conveyed to the main onsite storm drain system. Runoff from the development area (Basin 2) will be combined with runoff from the upstream area (Basin 4) and be collected in a tight line conveyance system and directed to a proposed combination water quality and detention vault which discharges to the new outfall described above. Per The 2005 Washington State Department of Ecology Stormwater Management Manual for Western Washington, Appendix III-B, Section 6, Basin 4 is not eligible for detention bypass because the existing 100-year flow rate from Basin 4 is not greater than 50% of the 100-year developed peak flow rate from the onsite basin(Basin2). As such, Basin 4 is taken into account in the pre-developed and developed conditions. In both conditions Basin 4 is modeled as existing mostly forested and partially pastured to reflect the existing condition. Since the vault addresses runoff from the onsite private road and private development it will be privately owned and maintained.

Flow Control Analysis and Design

The project basin was modeled using the Western Washington Hydrology Model, Version 2012 (WWHM 2012), a continuous rainfall simulation program recognized by the Washington State Department of Ecology (DOE). Soils were modeled as Hydrologic Soil Group C with a regional scale factor of 1.0 (SeaTac). The Standard Flow Control Requirement and other conditions were met according to section 2.5.7 of the City of Redmond 2012 Technical Notebook.

Flow control BMP's required by the COR as described in Section 2.5.5 of the COR 2012 Technical Notebook will be implemented as feasible.

Pre-Developed Conditions for Point of Compliance Analysis

WWHM was utilized to determine Pre-Developed durations and peaks for the area including Basins 2, 3 and 4. Onsite areas associated with Basins 2 and 3 were modelled as forest whereas the upstream basin (Basin 4) was modeled as partial forest and partial pasture. A summary of the areas and land covers used are provided below. The WWHM output from this area was the benchmark used to show compliance with peak and duration standards.

Pre-Developed Areas (Basin 2+Basin 3+Basin 4)

Forested Areas

Basin 2	4.64 Ac
Basin 3	1.20 Ac
*Basin 4 - Eastview Development	1.48 Ac
Basin 4 - Other	1.98 Ac

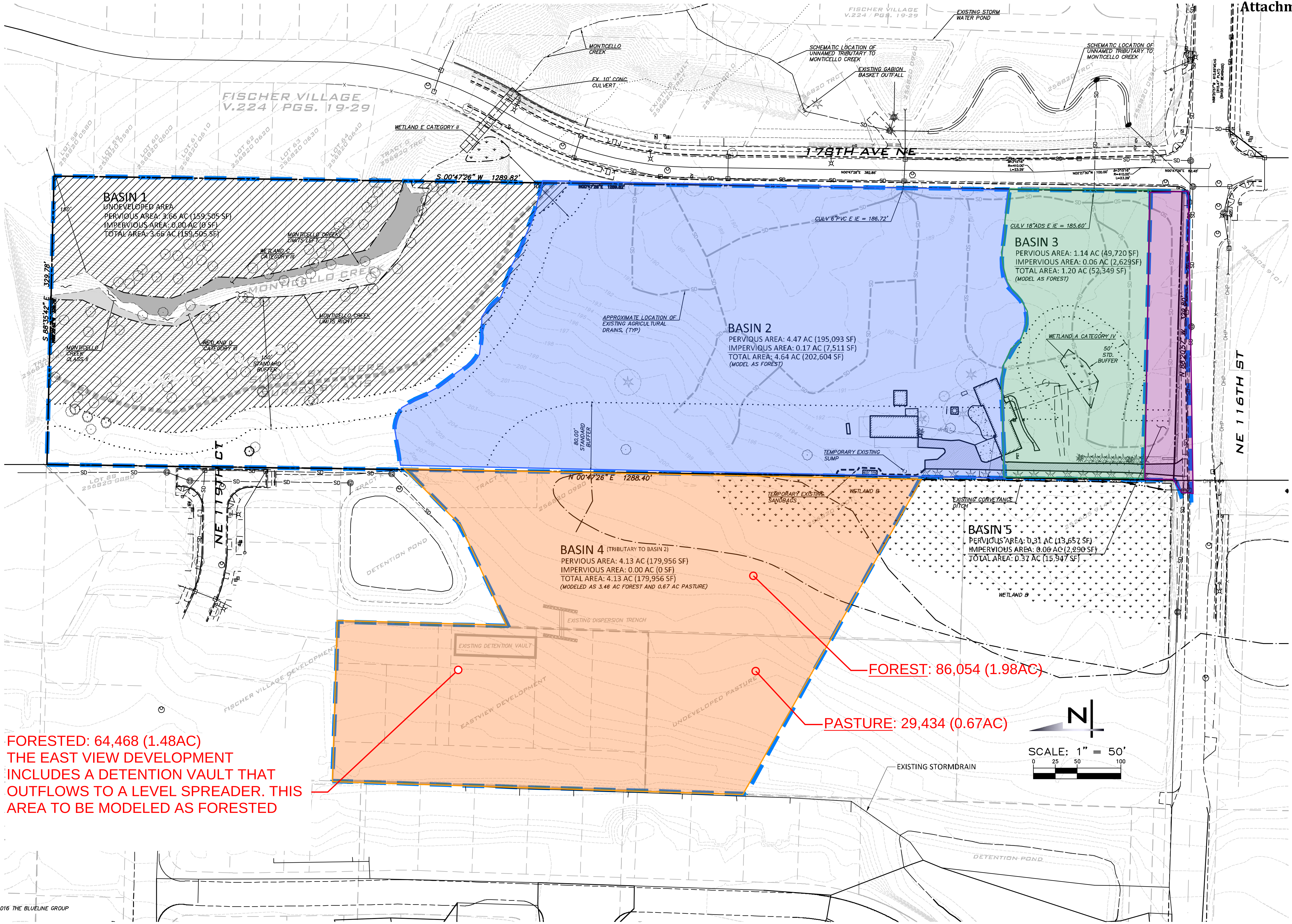
Pasture Areas	
**Basin 4	0.67 Ac
Pre-Developed Total Area (Basin 2+3+4)	**9.97 Ac**

* The existing Eastview Development located in Basin 4 (upstream) includes a detention vault that was designed to release flows based on forested conditions. The Eastview Development was therefore modelled as forest.

** Based on review of aerial photography as well as field observation, a portion of Basin 4 (upstream) is currently pasture and has been modeled as such.

Attachment 19

SE 1/4, SE 1/4, SEC 25, TWP 26N, RGE 5E, W.M.



BASIN 1
UNDEVELOPED AREA
PERVIOUS AREA: 3.66 AC (159,505 SF)
IMPERVIOUS AREA: 0.00 AC (0 SF)
TOTAL AREA: 3.66 AC (159,505 SF)

BASIN 2
PERVIOUS AREA: 4.47 AC (195,093 SF)
IMPERVIOUS AREA: 0.17 AC (7,511 SF)
TOTAL AREA: 4.64 AC (202,604 SF)
(MODEL AS FOREST)

BASIN 3
PERVIOUS AREA: 1.14 AC (49,720 SF)
IMPERVIOUS AREA: 0.06 AC (2,629SF)
TOTAL AREA: 1.20 AC (52,349 SF)
(MODEL AS FOREST)

BASIN 4 (TRIBUTARY TO BASIN 2)
PERVIOUS AREA: 4.13 AC (179,956 SF)
IMPERVIOUS AREA: 0.00 AC (0 SF)
TOTAL AREA: 4.13 AC (179,956 SF)
(MODELED AS 3.46 AC FOREST AND 0.67 AC PASTURE)

BASIN 5
PERVIOUS AREA: 0.31 AC (13,657 SF)
IMPERVIOUS AREA: 0.06 AC (2,290 SF)
TOTAL AREA: 0.37 AC (15,947 SF)

FOREST: 86,054 (1.98AC)

PASTURE: 29,434 (0.67AC)

FORESTED: 64,468 (1.48AC)
THE EAST VIEW DEVELOPMENT
INCLUDES A DETENTION VAULT THAT
OUTFLOWS TO A LEVEL SPREADER. THIS
AREA TO BE MODELED AS FORESTED

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PROJECT MANAGER:
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PROJECT ENGINEER:
JON L. KOEPFGEN, P.E.
DESIGNER:
CHRIS DIETZ
ISSUE DATE:
5/16/2016

NO	DATE	BY	REVISIONS

EXISTING CONDITIONS

HAWKS GLEN
17656 NE 116TH ST
PARCEL #2526059067
CITY OF REDMOND WASHINGTON

JOB NUMBER:
14-332
SHEET NAME:
EC
SHT 1 OF 1

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Attachment 19

DEVELOPED CONDITIONS FOR POINT OF COMPLIANCE ANALYSIS

As mentioned above, Basins 1 and 5 are excluded from the WWHM model.

Basin 2 has been updated to reflect roadway widening at tract D. The WWHM model and vault size have been updated accordingly. WWHM was utilized to determine developed durations and peaks for the area including Basins 2, 3 and 4. In the developed condition the total basin (9.97 Ac) area equals the pre-developed basin area (9.97 Ac), but the shape of the developed basins are delineated differently to maintain existing hydrologic discharge patterns and allow runoff from some of the area be directed to the stormwater vault and some of the runoff to be directed into the unnamed tributary to Monticello creek. The land coverage and areas are summarized below. Refer to the Developed Condition Exhibit for basin lines.

Developed Total Area - (Basins 2 + 4) + (Basin 3) = 9.97 Ac

Area to Vault (Basins 2 + 4)

Pervious Areas (7.13 Ac)

Forested Areas

Basin 2	0.77 Ac
*Basin 4 - Eastview Development	1.48 Ac
Basin 4 - Other	1.98 Ac

Pasture Areas

**Basin 4	0.67 Ac

Grass

Basin 2	2.19 Ac

Impervious Areas (2.18 Ac)

PGIS

Roads	0.72 Ac
Driveways	0.47 Ac

Non-PGIS

****Houses	0.94 Ac
*** Patio	0.09 Ac

Attachment 19

Total	9.31 Ac

* and ** see information in Pre-Developed Conditions section of report

*** Patio assumed to be 150 SF per lot.

**** House sizes based upon applicants current site plan

Area to Vault (Basin 3)

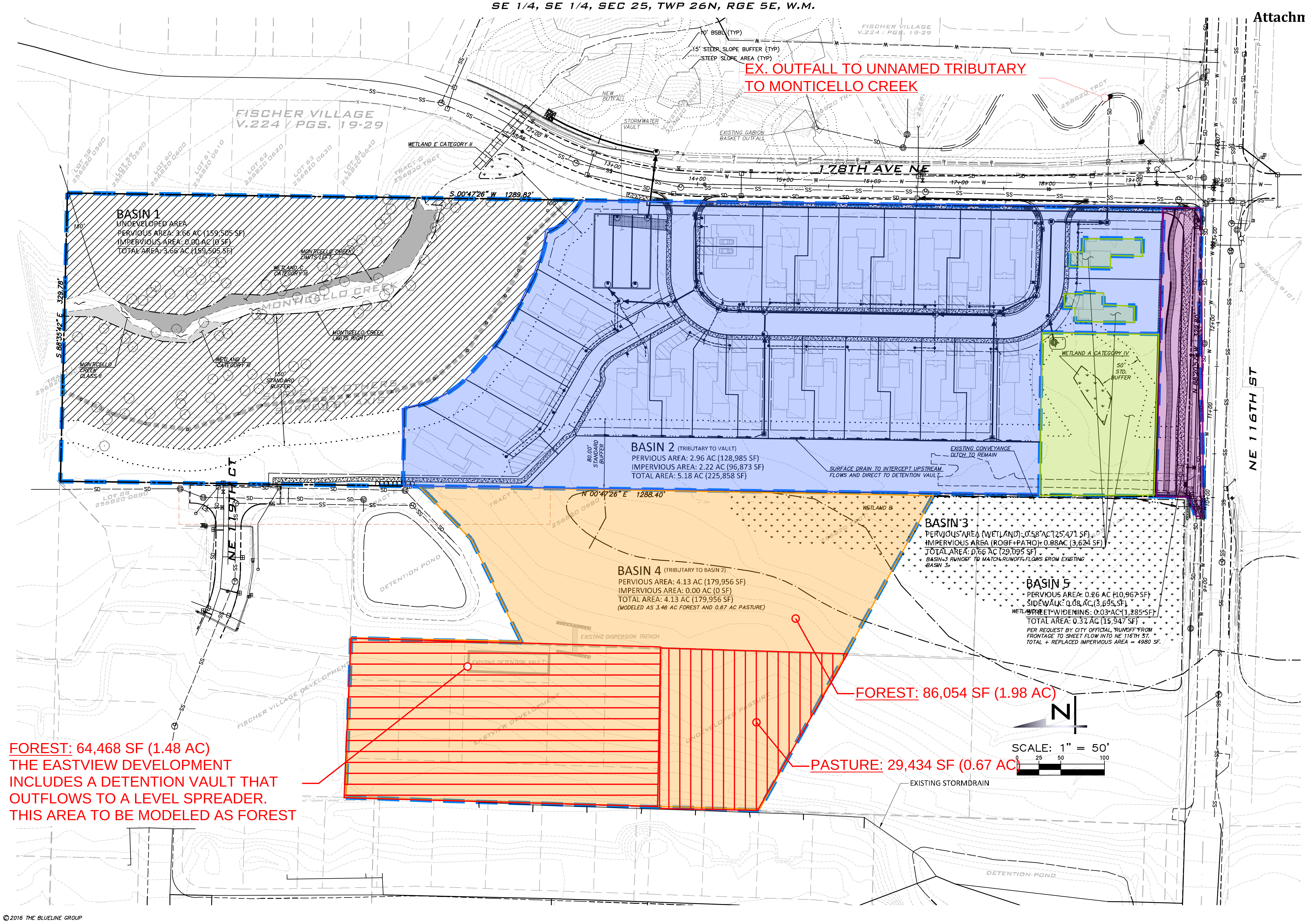
Forested Area	
Portion of Wetland and Buffer	0.58 Ac
Impervious Area	
Lots 17 and 18	0.08 Ac
Total	0.66 Ac

Developed Total Area (Basin 2+3+4)	**9.97 Ac**

Developed Conditions - Area to Unnamed tributary to Monticello Creek (Basin 3)

Basin 3 consists of a portion of the onsite wetland and wetland buffer area along with the roof area from Lots 17 and 18. The total area of the basin is designed to not be the same in the existing and developed conditions to ensure that, despite differing land cover, the developed discharge durations match the 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. This meets the flow control requirements as set forth by the COR Technical Notebook. Overflow from the wetland area and roof drains from Lots 17 and 18 will be tightlined and will connect along the east frontage. The stormdrain line will discharge to the same discharge location in the developed condition as it does in the existing conditions (POC 2). Basin 3 flow rates and durations are shown as POC 2 in the following WWHM output file.

Attachment 19



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PROJECT ENGINEER:
JON L. KOEPFGEN, P.E.

DESIGNER:
CHRIS DIETZ

ISSUE DATE:
5/16/2016

REVISIONS

NO	DATE	BY

DEVELOPED CONDITIONS

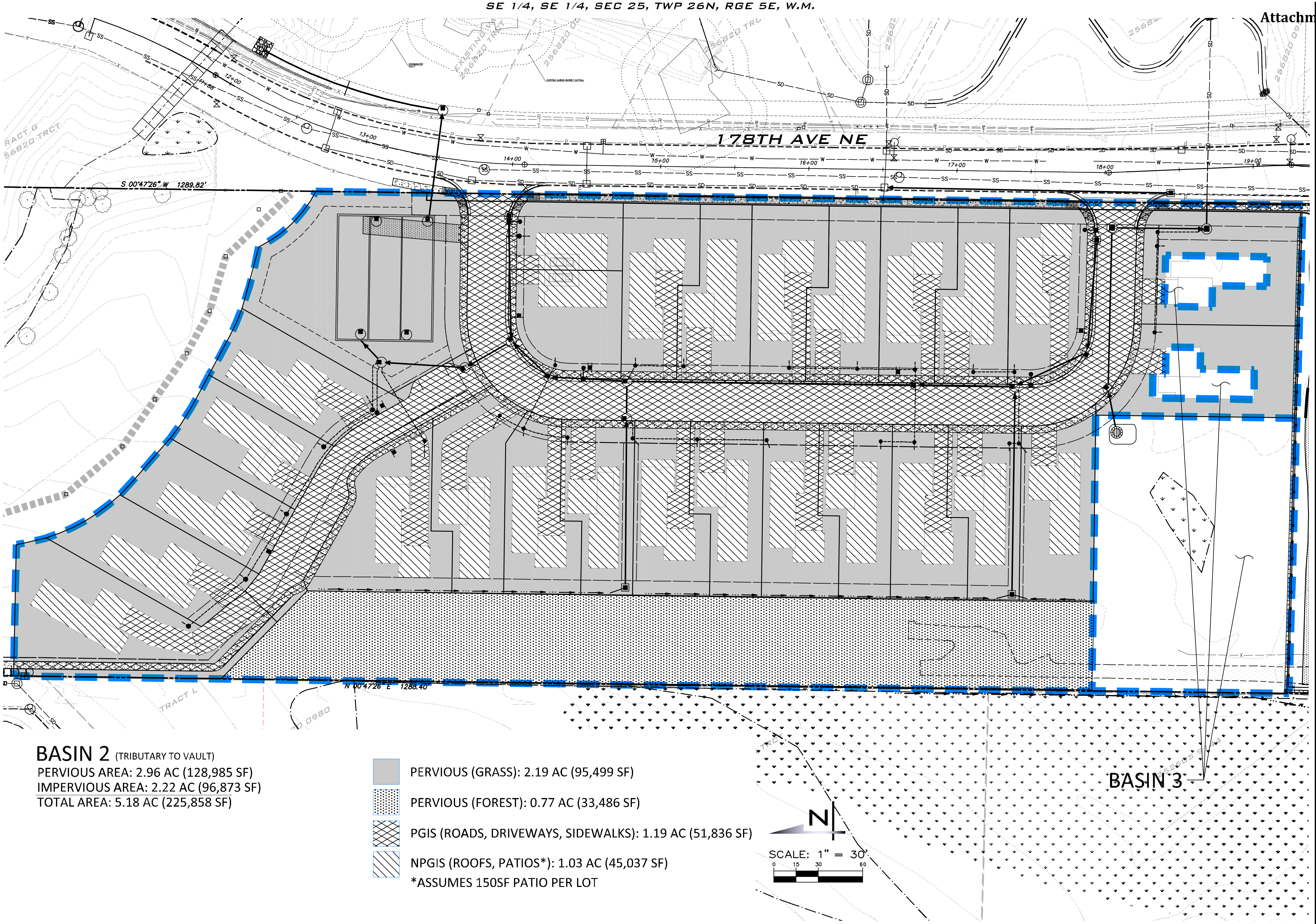
HAWKS GLEN
17656 NE 116TH ST
PARCEL #2526059067
CITY OF REDMOND WASHINGTON

JOB NUMBER:
14-332

SHEET NAME:
DC

SHT 1 OF 1

Attachment 19



BASIN 2 (TRIBUTARY TO VAULT)
PERVIOUS AREA: 2.96 AC (128,985 SF)
IMPERVIOUS AREA: 2.22 AC (96,873 SF)
TOTAL AREA: 5.18 AC (225,858 SF)

▒	PERVIOUS (GRASS): 2.19 AC (95,499 SF)
░	PERVIOUS (FOREST): 0.77 AC (33,486 SF)
▦	PGIS (ROADS, DRIVEWAYS, SIDEWALKS): 1.19 AC (51,836 SF)
▨	NPGIS (ROOFS, PATIOS*): 1.03 AC (45,037 SF)

*ASSUMES 150SF PATIO PER LOT

SCALE: 1" = 30'
0 15 30 60

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JON L. KOEPFGEN, P.E.
DESIGNER:
CHRIS DIETZ
ISSUE DATE:
5/17/2016

NO	DATE	BY	REVISIONS

BASIN 2 DEVELOPED
CONDITIONS EXHIBIT
HAWKS GLEN
17656 NE 116TH ST
PARCEL #2526059067
CITY OF REDMOND WASHINGTON

JOB NUMBER:
14-332
SHEET NAME:
DCB2
SHT 1 OF 1

WWHM ANALYSIS

According to The Standard Flow Control Requirement in section 2.5.7 of the City of Redmond 2012 Technical Notebook the development is required to 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. The detention vault passes these requirements. Please see the WWHM2012 Project Report included at the end of this section. The areas used to compute the drainage calculations associated with the developed conditions, as well as the corresponding WWHM2012 output are summarized on the following pages.

Basin 2 and Basin 4 will flow to the detention vault and be discharged at Point of Connection 1 (POC 1). Basin 3 will bypass the detention vault and will discharge to the unnamed tributary to Monticello Creek. The first WWHM2012 output shows POC 1 which is downstream of the vault where the flow path converges with the unnamed tributary to Monticello Creek. This location takes into account the bypass flows of Basin 3. As previously mentioned, Basins 1 and 5 do not required flow control or water quality treatment and will not be included in the WWHM model.

Additionally, Basin 3 discharges to a separate point of compliance (POC 2) in order to maintain current drainage patterns in the unnamed tributary. This is shown in the second WWHM2012 report. In this report Basin 3 is not shown as a bypass basin because it is modeled with the separate point of compliance.

Attachment 19

WWHM2012

PROJECT REPORT

POC 1 Downstream of Vault at Convergence With Unnamed Tributary to Monticello Creek

General Model Information

Project Name:	Hawk's Glen
Site Name:	Hawk's Glen
Site Address:	
City:	Redmond
Report Date:	6/13/2016
Gage:	Seatac
Data Start:	1948/10/01
Data End:	2009/09/30
Timestep:	15 Minute
Precip Scale:	1.00
Version Date:	2016/02/25
Version:	4.2.12

POC Thresholds

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

Landuse Basin Data

Predeveloped Land Use

Basin 3

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Forest, Mod	1.2
Pervious Total	1.2
Impervious Land Use	acre
Impervious Total	0
Basin Total	1.2

Element Flows To:

Surface	Interflow	Groundwater

Basin 2

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Forest, Mod	4.63
Pervious Total	4.63
Impervious Land Use	acre
Impervious Total	0
Basin Total	4.63

Element Flows To:

Surface	Interflow	Groundwater

Attachment 19

Basin 4

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Forest, Flat	3.4555
C, Pasture, Flat	0.6757
Pervious Total	4.1312
Impervious Land Use	acre
Impervious Total	0
Basin Total	4.1312

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Basin 2

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Lawn, Mod	2.1908
C, Forest, Flat	0.7703
Pervious Total	2.9611
Impervious Land Use	acre
ROADS FLAT	0.7232
ROOF TOPS FLAT	0.9478
DRIVEWAYS FLAT	0.4668
SIDEWALKS MOD	0.0861
Impervious Total	2.2239
Basin Total	5.185

Element Flows To:

Surface	Interflow	Groundwater
Vault 1	Vault 1	

Basin 4

Bypass:	No	
GroundWater:	No	
Pervious Land Use	acre	
C, Forest, Flat	3.4555	
C, Pasture, Flat	0.6757	
Pervious Total	4.1312	
Impervious Land Use	acre	
Impervious Total	0	
Basin Total	4.1312	

Element Flows To:

Surface	Interflow	Groundwater
Vault 1	Vault 1	

Basin 3

Bypass:	Yes
GroundWater:	No
Pervious Land Use	acre
C, Forest, Mod	0.5847
Pervious Total	0.5847
Impervious Land Use	acre
ROOF TOPS FLAT	0.0763
Impervious Total	0.0763
Basin Total	0.661

Element Flows To:

Surface	Interflow	Groundwater

Attachment 19

Routing Elements

Predeveloped Routing

Attachment 19

Mitigated Routing

Vault 1

Width: 63 ft.
Length: 84 ft.
Depth: 12.52 ft.
Discharge Structure
Riser Height: 12.02 ft.
Riser Diameter: 18 in.
Orifice 1 Diameter: 1.4 in. Elevation:0 ft.
Orifice 2 Diameter: 2.3675 inElevation:7.95 ft.
Orifice 3 Diameter: 2.85 in. Elevation:10.4 ft.
Element Flows To:
Outlet 1 Outlet 2

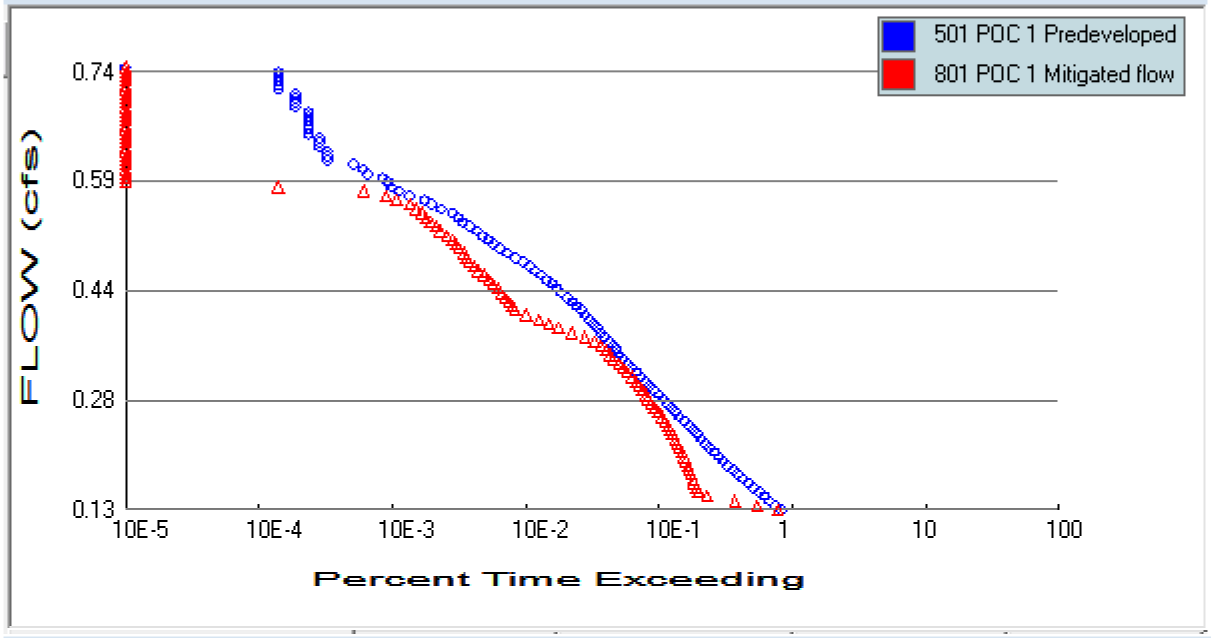
Vault Hydraulic Table

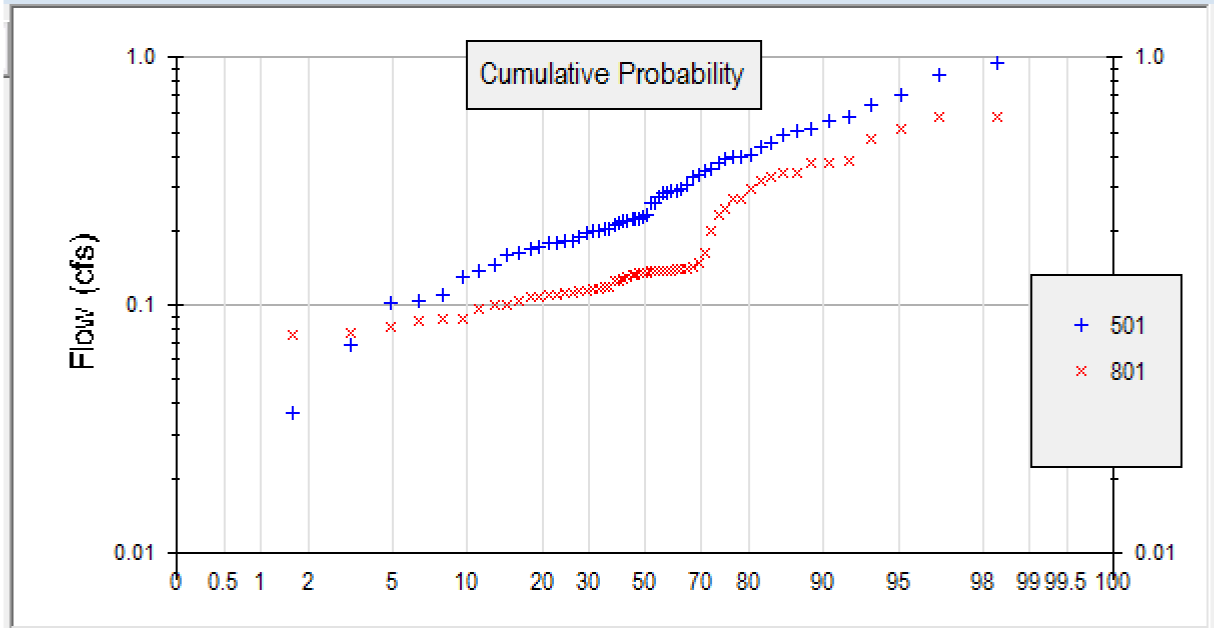
Stage(feet)	**Area(ac.)**	**Volume(ac-ft.)**	**Discharge(cfs)**	**Infilt(cfs)**
0.0000	0.121	0.000	0.000	0.000
0.1391	0.121	0.016	0.019	0.000
0.2782	0.121	0.033	0.028	0.000
0.4173	0.121	0.050	0.034	0.000
0.5564	0.121	0.067	0.039	0.000
0.6956	0.121	0.084	0.044	0.000
0.8347	0.121	0.101	0.048	0.000
0.9738	0.121	0.118	0.052	0.000
1.1129	0.121	0.135	0.056	0.000
1.2520	0.121	0.152	0.059	0.000
1.3911	0.121	0.169	0.062	0.000
1.5302	0.121	0.185	0.065	0.000
1.6693	0.121	0.202	0.068	0.000
1.8084	0.121	0.219	0.071	0.000
1.9476	0.121	0.236	0.074	0.000
2.0867	0.121	0.253	0.076	0.000
2.2258	0.121	0.270	0.079	0.000
2.3649	0.121	0.287	0.081	0.000
2.5040	0.121	0.304	0.084	0.000
2.6431	0.121	0.321	0.086	0.000
2.7822	0.121	0.338	0.088	0.000
2.9213	0.121	0.354	0.090	0.000
3.0604	0.121	0.371	0.093	0.000
3.1996	0.121	0.388	0.095	0.000
3.3387	0.121	0.405	0.097	0.000
3.4778	0.121	0.422	0.099	0.000
3.6169	0.121	0.439	0.101	0.000
3.7560	0.121	0.456	0.103	0.000
3.8951	0.121	0.473	0.105	0.000
4.0342	0.121	0.490	0.106	0.000
4.1733	0.121	0.507	0.108	0.000
4.3124	0.121	0.523	0.110	0.000
4.4516	0.121	0.540	0.112	0.000
4.5907	0.121	0.557	0.114	0.000
4.7298	0.121	0.574	0.115	0.000
4.8689	0.121	0.591	0.117	0.000
5.0080	0.121	0.608	0.119	0.000
5.1471	0.121	0.625	0.120	0.000

5.2862	0.121	0.642	0.122	0.000
5.4253	0.121	0.659	0.123	0.000
5.5644	0.121	0.676	0.125	0.000
5.7036	0.121	0.692	0.127	0.000
5.8427	0.121	0.709	0.128	0.000
5.9818	0.121	0.726	0.130	0.000
6.1209	0.121	0.743	0.131	0.000
6.2600	0.121	0.760	0.133	0.000
6.3991	0.121	0.777	0.134	0.000
6.5382	0.121	0.794	0.136	0.000
6.6773	0.121	0.811	0.137	0.000
6.8164	0.121	0.828	0.138	0.000
6.9556	0.121	0.845	0.140	0.000
7.0947	0.121	0.861	0.141	0.000
7.2338	0.121	0.878	0.143	0.000
7.3729	0.121	0.895	0.144	0.000
7.5120	0.121	0.912	0.145	0.000
7.6511	0.121	0.929	0.147	0.000
7.7902	0.121	0.946	0.148	0.000
7.9293	0.121	0.963	0.149	0.000
8.0684	0.121	0.980	0.203	0.000
8.2076	0.121	0.997	0.229	0.000
8.3467	0.121	1.014	0.249	0.000
8.4858	0.121	1.030	0.266	0.000
8.6249	0.121	1.047	0.281	0.000
8.7640	0.121	1.064	0.294	0.000
8.9031	0.121	1.081	0.307	0.000
9.0422	0.121	1.098	0.318	0.000
9.1813	0.121	1.115	0.329	0.000
9.3204	0.121	1.132	0.340	0.000
9.4596	0.121	1.149	0.350	0.000
9.5987	0.121	1.166	0.360	0.000
9.7378	0.121	1.183	0.369	0.000
9.8769	0.121	1.199	0.378	0.000
10.016	0.121	1.216	0.387	0.000
10.155	0.121	1.233	0.395	0.000
10.294	0.121	1.250	0.403	0.000
10.433	0.121	1.267	0.451	0.000
10.572	0.121	1.284	0.510	0.000
10.712	0.121	1.301	0.549	0.000
10.851	0.121	1.318	0.582	0.000
10.990	0.121	1.335	0.610	0.000
11.129	0.121	1.352	0.636	0.000
11.268	0.121	1.368	0.661	0.000
11.407	0.121	1.385	0.683	0.000
11.546	0.121	1.402	0.705	0.000
11.685	0.121	1.419	0.725	0.000
11.824	0.121	1.436	0.745	0.000
11.964	0.121	1.453	0.764	0.000
12.103	0.121	1.470	1.160	0.000
12.242	0.121	1.487	2.432	0.000
12.381	0.121	1.504	4.013	0.000
12.520	0.121	1.521	5.473	0.000
12.659	0.121	1.474	6.473	0.000

Attachment 19

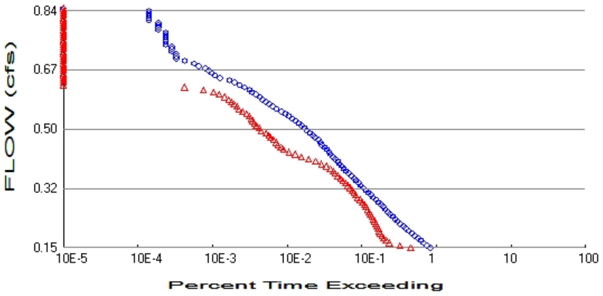
POC 1

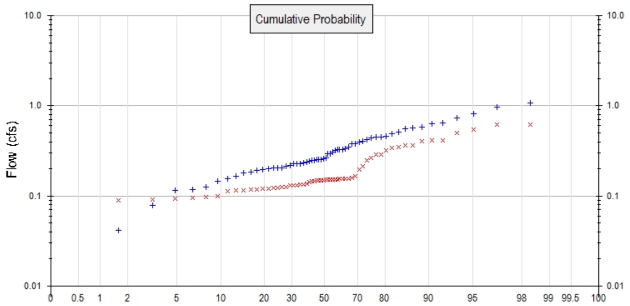




Analysis Results

POC 1





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1

Total Pervious Area:	9.9612
Total Impervious Area:	0

Mitigated Landuse Totals for POC #1

Total Pervious Area:	7.677
Total Impervious Area:	2.3002

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.297167
5 year	0.483979
10 year	0.603588
25 year	0.745486
50 year	0.843572
100 year	0.935059

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0.165603
5 year	0.264098
10 year	0.347572
25 year	0.477191
50 year	0.593571
100 year	0.728996

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1949	0.330	0.126
1950	0.399	0.212
1951	0.650	0.620
1952	0.205	0.115
1953	0.166	0.121
1954	0.255	0.148
1955	0.405	0.151
1956	0.326	0.285
1957	0.262	0.142
1958	0.293	0.154

1959	0.252	0.133
1960	0.451	0.363
1961	0.247	0.152
1962	0.155	0.096
1963	0.214	0.137
1964	0.294	0.132
1965	0.202	0.150
1966	0.192	0.124
1967	0.443	0.150
1968	0.253	0.130
1969	0.248	0.122
1970	0.203	0.125
1971	0.228	0.148
1972	0.491	0.344
1973	0.220	0.150
1974	0.242	0.158
1975	0.337	0.146
1976	0.239	0.146
1977	0.036	0.090
1978	0.206	0.156
1979	0.125	0.097
1980	0.556	0.363
1981	0.185	0.133
1982	0.381	0.195
1983	0.322	0.153
1984	0.196	0.118
1985	0.116	0.099
1986	0.512	0.266
1987	0.453	0.290
1988	0.180	0.113
1989	0.118	0.091
1990	1.073	0.409
1991	0.571	0.412
1992	0.231	0.152
1993	0.229	0.119
1994	0.078	0.089
1995	0.327	0.165
1996	0.739	0.621
1997	0.583	0.500
1998	0.147	0.118
1999	0.633	0.317
2000	0.228	0.114
2001	0.042	0.094
2002	0.258	0.153
2003	0.376	0.132
2004	0.425	0.346
2005	0.309	0.156
2006	0.350	0.156
2007	0.809	0.401
2008	0.974	0.549
2009	0.460	0.248

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	**Predeveloped**	**Mitigated**
1	1.0726	0.6214
2	0.9738	0.6204
3	0.8089	0.5488

4	0.7387	0.5001
5	0.6501	0.4123
6	0.6327	0.4091
7	0.5834	0.4010
8	0.5711	0.3631
9	0.5564	0.3629
10	0.5119	0.3462
11	0.4910	0.3444
12	0.4600	0.3175
13	0.4535	0.2897
14	0.4510	0.2853
15	0.4435	0.2655
16	0.4246	0.2481
17	0.4051	0.2120
18	0.3995	0.1949
19	0.3813	0.1650
20	0.3756	0.1582
21	0.3504	0.1562
22	0.3366	0.1562
23	0.3303	0.1555
24	0.3270	0.1535
25	0.3257	0.1527
26	0.3216	0.1527
27	0.3092	0.1521
28	0.2940	0.1518
29	0.2935	0.1507
30	0.2618	0.1502
31	0.2578	0.1502
32	0.2545	0.1498
33	0.2533	0.1483
34	0.2515	0.1480
35	0.2476	0.1457
36	0.2475	0.1456
37	0.2421	0.1416
38	0.2392	0.1371
39	0.2310	0.1330
40	0.2294	0.1328
41	0.2276	0.1319
42	0.2276	0.1316
43	0.2203	0.1303
44	0.2140	0.1257
45	0.2055	0.1250
46	0.2050	0.1237
47	0.2031	0.1224
48	0.2017	0.1209
49	0.1957	0.1194
50	0.1923	0.1179
51	0.1849	0.1177
52	0.1801	0.1149
53	0.1664	0.1144
54	0.1550	0.1132
55	0.1465	0.0993
56	0.1251	0.0970
57	0.1179	0.0959
58	0.1159	0.0937
59	0.0780	0.0909
60	0.0416	0.0896
61	0.0360	0.0893

Attachment 19

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.1486	17586	9640	54	Pass
0.1556	15926	6911	43	Pass
0.1626	14510	4996	34	Pass
0.1696	13229	4500	34	Pass
0.1767	12001	4175	34	Pass
0.1837	10889	3970	36	Pass
0.1907	9956	3788	38	Pass
0.1977	9099	3649	40	Pass
0.2047	8369	3542	42	Pass
0.2118	7679	3429	44	Pass
0.2188	7030	3317	47	Pass
0.2258	6462	3166	48	Pass
0.2328	5974	3022	50	Pass
0.2398	5538	2913	52	Pass
0.2469	5125	2796	54	Pass
0.2539	4783	2661	55	Pass
0.2609	4436	2547	57	Pass
0.2679	4124	2421	58	Pass
0.2749	3852	2306	59	Pass
0.2820	3563	2173	60	Pass
0.2890	3309	2018	60	Pass
0.2960	3033	1865	61	Pass
0.3030	2830	1757	62	Pass
0.3100	2605	1680	64	Pass
0.3171	2421	1592	65	Pass
0.3241	2248	1501	66	Pass
0.3311	2089	1403	67	Pass
0.3381	1920	1287	67	Pass
0.3451	1789	1186	66	Pass
0.3522	1678	1108	66	Pass
0.3592	1558	1015	65	Pass
0.3662	1421	939	66	Pass
0.3732	1311	880	67	Pass
0.3802	1222	802	65	Pass
0.3873	1145	719	62	Pass
0.3943	1077	618	57	Pass
0.4013	1018	513	50	Pass
0.4083	948	414	43	Pass
0.4153	885	331	37	Pass
0.4224	827	276	33	Pass
0.4294	773	226	29	Pass
0.4364	724	190	26	Pass
0.4434	678	175	25	Pass
0.4504	627	161	25	Pass
0.4575	593	153	25	Pass
0.4645	554	139	25	Pass
0.4715	510	128	25	Pass
0.4785	474	121	25	Pass
0.4855	431	111	25	Pass
0.4926	388	95	24	Pass
0.4996	362	90	24	Pass
0.5066	335	82	24	Pass
0.5136	305	78	25	Pass

Attachment 19

0.5206	276	74	26	Pass
0.5277	249	70	28	Pass
0.5347	224	66	29	Pass
0.5417	202	61	30	Pass
0.5487	181	54	29	Pass
0.5557	154	48	31	Pass
0.5628	135	45	33	Pass
0.5698	122	41	33	Pass
0.5768	111	38	34	Pass
0.5838	99	35	35	Pass
0.5908	92	31	33	Pass
0.5979	80	26	32	Pass
0.6049	72	22	30	Pass
0.6119	67	16	23	Pass
0.6189	57	9	15	Pass
0.6259	49	0	0	Pass
0.6330	42	0	0	Pass
0.6400	36	0	0	Pass
0.6470	27	0	0	Pass
0.6540	23	0	0	Pass
0.6610	21	0	0	Pass
0.6681	19	0	0	Pass
0.6751	17	0	0	Pass
0.6821	14	0	0	Pass
0.6891	12	0	0	Pass
0.6962	9	0	0	Pass
0.7032	7	0	0	Pass
0.7102	7	0	0	Pass
0.7172	7	0	0	Pass
0.7242	6	0	0	Pass
0.7313	6	0	0	Pass
0.7383	6	0	0	Pass
0.7453	5	0	0	Pass
0.7523	5	0	0	Pass
0.7593	5	0	0	Pass
0.7664	5	0	0	Pass
0.7734	5	0	0	Pass
0.7804	5	0	0	Pass
0.7874	4	0	0	Pass
0.7944	4	0	0	Pass
0.8015	4	0	0	Pass
0.8085	4	0	0	Pass
0.8155	3	0	0	Pass
0.8225	3	0	0	Pass
0.8295	3	0	0	Pass
0.8366	3	0	0	Pass
0.8436	3	0	0	Pass

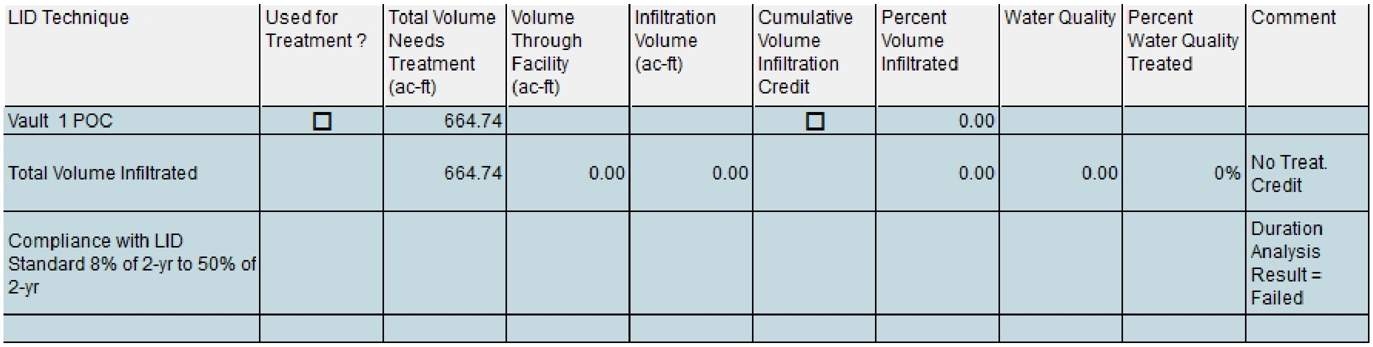
Water Quality

Water Quality BMP Flow and Volume for POC #1

On-line facility volume:	0.2512 acre-feet
On-line facility target flow:	0.1272 cfs.
Adjusted for 15 min:	0.1272 cfs.
Off-line facility target flow:	0.0801 cfs.
Adjusted for 15 min:	0.0801 cfs.

Attachment 19

LID Report



LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment
Vault 1 POC	☐	664.74			☐	0.00			
Total Volume Infiltrated		664.74	0.00	0.00		0.00	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Failed

Model Default Modifications

Total of 0 changes have been made.

PERLND Changes

No PERLND changes have been made.

IMPLND Changes

No IMPLND changes have been made.

Attachment 19

Appendix

Predeveloped Schematic

Mitigated Schematic

Attachment 19

Disclaimer

Legal Notice

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

www.clearcreeksolutions.com

WWHM2012

PROJECT REPORT

POC 2 at Unnamed
Tributary to Monticello
Creek

General Model Information

Project Name:	Hawk's Glen POC2
Site Name:	Hawk's Glen
Site Address:	
City:	Redmond
Report Date:	6/13/2016
Gage:	Seatac
Data Start:	1948/10/01
Data End:	2009/09/30
Timestep:	15 Minute
Precip Scale:	1.00
Version Date:	2016/02/25
Version:	4.2.12

POC Thresholds

Low Flow Threshold for POC1:	50 Percent of the 2 Year
High Flow Threshold for POC1:	50 Year
Low Flow Threshold for POC2:	50 Percent of the 2 Year
High Flow Threshold for POC2:	50 Year

Attachment 19

Landuse Basin Data

Predeveloped Land Use

Basin 3

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Forest, Mod	1.2
Pervious Total	1.2
Impervious Land Use	acre
Impervious Total	0
Basin Total	1.2

Element Flows To:

Surface	Interflow	Groundwater

Basin 2

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Forest, Mod	4.63
Pervious Total	4.63
Impervious Land Use	acre
Impervious Total	0
Basin Total	4.63

Element Flows To:

Surface	Interflow	Groundwater

Basin 4

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Forest, Flat	3.4555
C, Pasture, Flat	0.6757
Pervious Total	4.1312
Impervious Land Use	acre
Impervious Total	0
Basin Total	4.1312

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Basin 2

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
C, Lawn, Mod	2.1908
C, Forest, Flat	0.7703
Pervious Total	2.9611

Impervious Land Use	acre
ROADS FLAT	0.7232
ROOF TOPS FLAT	0.9478
DRIVEWAYS FLAT	0.4668
SIDEWALKS MOD	0.0861
Impervious Total	2.2239
Basin Total	5.185

Element Flows To:

Surface	Interflow	Groundwater
Vault 1	Vault 1	

Basin 4

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Forest, Flat	3.4555
C, Pasture, Flat	0.6757
Pervious Total	4.1312
Impervious Land Use	acre
Impervious Total	0
Basin Total	4.1312

Element Flows To:

Surface	Interflow	Groundwater
Vault 1	Vault 1	

Basin 3

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Forest, Mod	0.5847
Pervious Total	0.5847
Impervious Land Use	acre
ROOF TOPS FLAT	0.0763
Impervious Total	0.0763
Basin Total	0.661

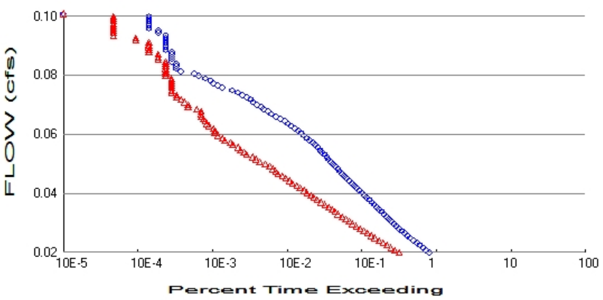
Element Flows To:

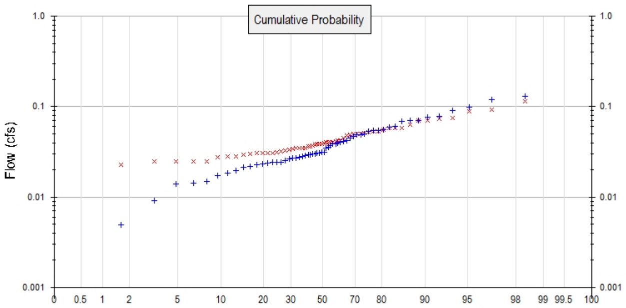
Surface	Interflow	Groundwater

Routing Elements

Predeveloped Routing

POC 2





+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #2
Total Pervious Area: 1.2
Total Impervious Area: 0

Mitigated Landuse Totals for POC #2
Total Pervious Area: 0.5847
Total Impervious Area: 0.0763

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #2

Return Period	**Flow(cfs)**
2 year	0.03573
5 year	0.058547
10 year	0.073218
25 year	0.09067
50 year	0.102758
100 year	0.114049

Flow Frequency Return Periods for Mitigated. POC #2

Return Period	**Flow(cfs)**
2 year	0.040031
5 year	0.055138
10 year	0.066109
25 year	0.081104
50 year	0.09312
100 year	0.105878

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #2

Year	**Predeveloped**	**Mitigated**
1949	0.041	0.058
1950	0.049	0.053
1951	0.078	0.053
1952	0.024	0.030
1953	0.020	0.025
1954	0.030	0.033
1955	0.049	0.041
1956	0.039	0.039
1957	0.032	0.045
1958	0.035	0.030
1959	0.030	0.028

1960	0.054	0.050
1961	0.030	0.036
1962	0.018	0.023
1963	0.025	0.035
1964	0.036	0.034
1965	0.024	0.040
1966	0.023	0.030
1967	0.055	0.058
1968	0.031	0.041
1969	0.030	0.036
1970	0.024	0.038
1971	0.027	0.040
1972	0.059	0.048
1973	0.026	0.028
1974	0.029	0.039
1975	0.041	0.050
1976	0.029	0.037
1977	0.004	0.025
1978	0.024	0.031
1979	0.015	0.041
1980	0.070	0.070
1981	0.022	0.035
1982	0.045	0.063
1983	0.039	0.035
1984	0.023	0.028
1985	0.014	0.031
1986	0.061	0.050
1987	0.054	0.049
1988	0.021	0.025
1989	0.014	0.031
1990	0.129	0.115
1991	0.069	0.075
1992	0.028	0.033
1993	0.027	0.025
1994	0.009	0.021
1995	0.039	0.035
1996	0.091	0.070
1997	0.070	0.052
1998	0.017	0.031
1999	0.077	0.073
2000	0.027	0.039
2001	0.005	0.032
2002	0.032	0.042
2003	0.047	0.052
2004	0.050	0.058
2005	0.037	0.042
2006	0.042	0.040
2007	0.098	0.093
2008	0.119	0.090
2009	0.056	0.055

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #2

Rank	**Predeveloped**	**Mitigated**
1	0.1294	0.1149
2	0.1192	0.0934
3	0.0978	0.0895
4	0.0906	0.0746

5	0.0781	0.0729
6	0.0767	0.0697
7	0.0699	0.0696
8	0.0698	0.0629
9	0.0686	0.0583
10	0.0612	0.0577
11	0.0593	0.0577
12	0.0556	0.0552
13	0.0549	0.0530
14	0.0540	0.0529
15	0.0539	0.0519
16	0.0504	0.0516
17	0.0488	0.0504
18	0.0486	0.0498
19	0.0471	0.0497
20	0.0452	0.0493
21	0.0420	0.0482
22	0.0411	0.0453
23	0.0405	0.0424
24	0.0392	0.0421
25	0.0391	0.0415
26	0.0387	0.0408
27	0.0374	0.0405
28	0.0359	0.0403
29	0.0351	0.0400
30	0.0316	0.0398
31	0.0316	0.0387
32	0.0309	0.0386
33	0.0304	0.0385
34	0.0301	0.0376
35	0.0301	0.0370
36	0.0296	0.0365
37	0.0291	0.0365
38	0.0290	0.0350
39	0.0280	0.0348
40	0.0274	0.0347
41	0.0272	0.0345
42	0.0272	0.0342
43	0.0263	0.0335
44	0.0253	0.0330
45	0.0245	0.0320
46	0.0245	0.0312
47	0.0241	0.0310
48	0.0239	0.0308
49	0.0233	0.0308
50	0.0229	0.0304
51	0.0219	0.0301
52	0.0213	0.0295
53	0.0198	0.0282
54	0.0184	0.0281
55	0.0171	0.0278
56	0.0148	0.0250
57	0.0141	0.0249
58	0.0138	0.0249
59	0.0092	0.0246
60	0.0049	0.0226
61	0.0042	0.0205

Attachment 19

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0179	17085	6746	39	Pass
0.0187	15488	5916	38	Pass
0.0196	14065	5247	37	Pass
0.0204	12805	4644	36	Pass
0.0213	11569	4113	35	Pass
0.0222	10515	3643	34	Pass
0.0230	9561	3215	33	Pass
0.0239	8754	2853	32	Pass
0.0247	8036	2535	31	Pass
0.0256	7347	2276	30	Pass
0.0264	6731	2017	29	Pass
0.0273	6192	1804	29	Pass
0.0282	5730	1610	28	Pass
0.0290	5309	1450	27	Pass
0.0299	4924	1298	26	Pass
0.0307	4569	1156	25	Pass
0.0316	4237	1029	24	Pass
0.0324	3951	935	23	Pass
0.0333	3643	856	23	Pass
0.0342	3390	767	22	Pass
0.0350	3133	688	21	Pass
0.0359	2915	610	20	Pass
0.0367	2701	538	19	Pass
0.0376	2490	485	19	Pass
0.0384	2314	441	19	Pass
0.0393	2136	392	18	Pass
0.0402	1972	362	18	Pass
0.0410	1825	318	17	Pass
0.0419	1702	288	16	Pass
0.0427	1577	250	15	Pass
0.0436	1442	228	15	Pass
0.0444	1325	204	15	Pass
0.0453	1232	185	15	Pass
0.0462	1147	161	14	Pass
0.0470	1083	149	13	Pass
0.0479	1020	136	13	Pass
0.0487	947	125	13	Pass
0.0496	886	108	12	Pass
0.0505	823	91	11	Pass
0.0513	760	81	10	Pass
0.0522	725	73	10	Pass
0.0530	674	61	9	Pass
0.0539	623	56	8	Pass
0.0547	589	50	8	Pass
0.0556	549	47	8	Pass
0.0565	506	40	7	Pass
0.0573	469	37	7	Pass
0.0582	427	31	7	Pass
0.0590	388	29	7	Pass
0.0599	356	25	7	Pass
0.0607	328	23	7	Pass
0.0616	298	23	7	Pass
0.0625	270	22	8	Pass

0.0633	241	19	7	Pass
0.0642	218	18	8	Pass
0.0650	198	17	8	Pass
0.0659	173	16	9	Pass
0.0667	152	15	9	Pass
0.0676	130	15	11	Pass
0.0685	119	15	12	Pass
0.0693	104	13	12	Pass
0.0702	95	10	10	Pass
0.0710	83	10	12	Pass
0.0719	74	9	12	Pass
0.0727	69	8	11	Pass
0.0736	61	7	11	Pass
0.0745	53	7	13	Pass
0.0753	46	6	13	Pass
0.0762	39	6	15	Pass
0.0770	29	6	20	Pass
0.0779	25	6	24	Pass
0.0787	22	6	27	Pass
0.0796	20	6	30	Pass
0.0805	17	6	35	Pass
0.0813	14	5	35	Pass
0.0822	12	5	41	Pass
0.0830	8	5	62	Pass
0.0839	7	5	71	Pass
0.0848	7	5	71	Pass
0.0856	7	5	71	Pass
0.0865	6	5	83	Pass
0.0873	6	4	66	Pass
0.0882	6	4	66	Pass
0.0890	6	4	66	Pass
0.0899	6	3	50	Pass
0.0908	5	3	60	Pass
0.0916	5	3	60	Pass
0.0925	5	3	60	Pass
0.0933	5	3	60	Pass
0.0942	5	2	40	Pass
0.0950	5	2	40	Pass
0.0959	5	1	20	Pass
0.0968	4	1	25	Pass
0.0976	4	1	25	Pass
0.0985	3	1	33	Pass
0.0993	3	1	33	Pass
0.1002	3	1	33	Pass
0.1010	3	1	33	Pass
0.1019	3	1	33	Pass
0.1028	3	1	33	Pass

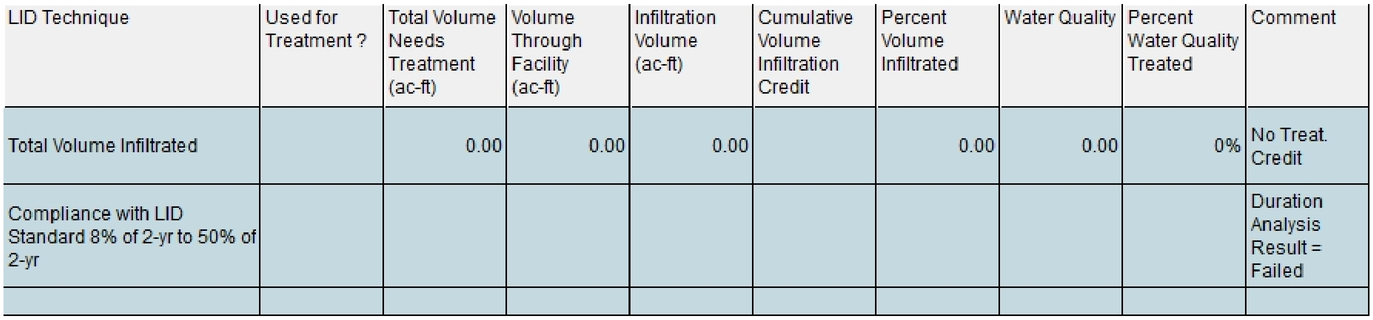
Attachment 19

Water Quality

Water Quality BMP Flow and Volume for POC #2
On-line facility volume: 0 acre-feet
On-line facility target flow: 0 cfs.
Adjusted for 15 min: 0 cfs.
Off-line facility target flow: 0 cfs.
Adjusted for 15 min: 0 cfs.

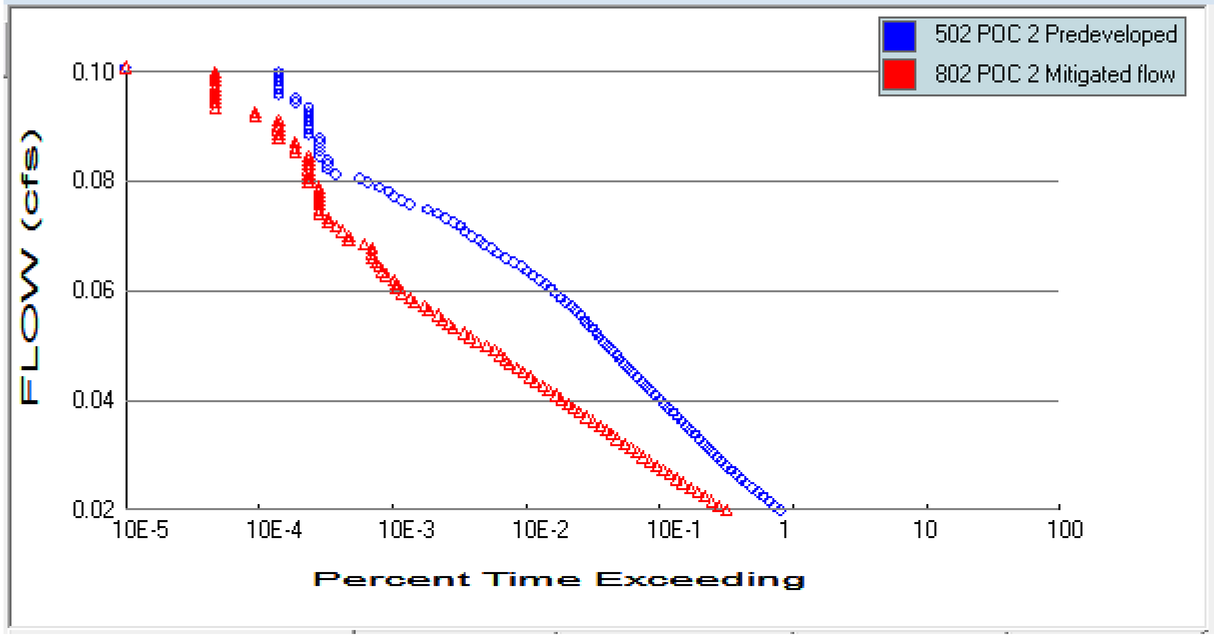
Attachment 19

LID Report

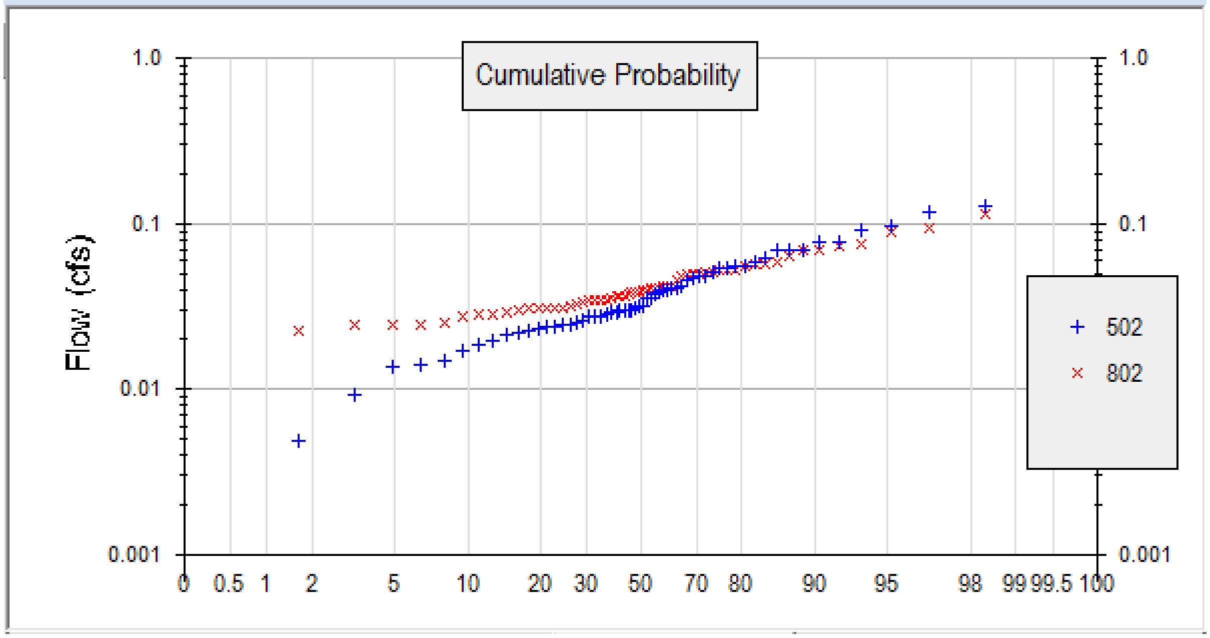


LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment
Total Volume Infiltrated		0.00	0.00	0.00		0.00	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Failed

POC 2



502 POC 2 Predeveloped
802 POC 2 Mitigated flow
FLOW (cfs)
0.10
0.08
0.06
0.04
0.02
10E-5
10E-4
10E-3
10E-2
10E-1
1
10
100
Percent Time Exceeding



Cumulative Probability
Flow (cfs)
1.0
0.1
0.01
0.001
0
0.5
1
2
5
10
20
30
50
70
80
90
95
98
99
99.5
100
502
802

Attachment 19

Model Default Modifications

Total of 0 changes have been made.

PERLND Changes

No PERLND changes have been made.

IMPLND Changes

No IMPLND changes have been made.

Attachment 19

Appendix

Predeveloped Schematic

Mitigated Schematic

Disclaimer

Legal Notice

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

www.clearcreeksolutions.com

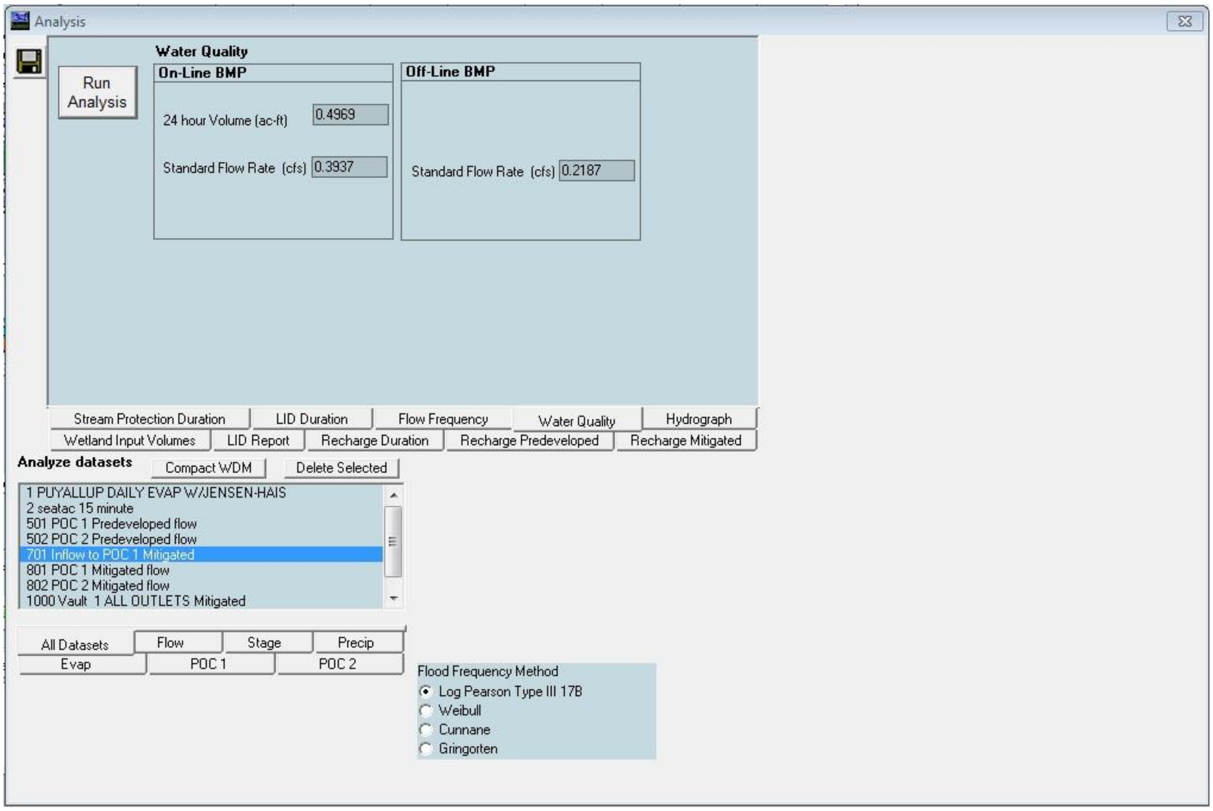
The required live storage was calculated to be 66,256 CF based on the 50-year storm peak stage provided by WWHM. As designed, the storm water facility will provide 66,256 CF of live storage.

WATER QUALITY ANALYSIS AND DESIGN

The project will provide basic water quality treatment. The project will provide treatment via a combined detention water quality stormwater vault. As specified in Minimum Requirement #6 of the DOE 2005 SWMMWW, the vault is designed to provide treatment for a volume greater than the 91st percentile, 24-hour runoff volume as indicated by WWHM 2012 for the developed conditions modeled with a 15 minute time step. The dead storage volume is required to treat 91% of the runoff volume from the developed site. The dead storage volume provided will be equal to or greater than the required volume, in addition to 0.5-feet of sediment storage.

See the excerpt included below taken from the WWHM2012 Analysis Report on the previous pages for detailed treatment flow rates and volumes required for the developed conditions land cover and detention vault.

The required dead storage volume is 21,645 CF (0.4969 Ac). As designed, the storm water vault will provide 22,050 CF of dead storage exclusive of sediment storage (21’x84’x6.25’ cell 1 and 21’x84’x6.25’ in cell 2).



Water Quality

On-Line BMP

24 hour Volume (ac-ft) 0.4969

Standard Flow Rate (cfs) 0.3937

Off-Line BMP

Standard Flow Rate (cfs) 0.2187

Analyze datasets

1 PUYALLUP DAILY EVAP W/JENSEN-HAIS
2 seatac 15 minute
501 POC 1 Predeveloped flow
502 POC 2 Predeveloped flow
701 Inflow to POC 1 Mitigated
801 POC 1 Mitigated flow
802 POC 2 Mitigated flow
1000 Vault 1 ALL OUTLETS Mitigated

Flood Frequency Method
- ● Log Pearson Type III 17B
- ○ Weibull
- ○ Cunnane
- ○ Gringorten

CONVEYANCE SYSTEM ANALYSIS AND DESIGN

The conveyance system will be designed according to the 2005 DOE Manual and the 2012 City of Redmond Technical Notebook.

System sizing details to be provided at final engineering.

Section 5 Stormwater Pollution Prevention Plan

The Stormwater Pollution Prevention Plan (SWPPP) will be designed according to Minimum Requirement #2 of the 2005 DOE Manual.

SWPPP will be provided at final engineering under a separate cover.

Section 6 Special Reports and Studies

Additional reports and studies within this section include a *Geotechnical Report*, dated August 29, 2014, prepared by Terra Associates, Inc is included on the following pages.

Attachment 19

GEOTECHNICAL REPORT

Hawks Glen
17656 NE 116th Street
Redmond, Washington

Project No. T-7103

Terra Associates, Inc.

Prepared for:

Quadrant Homes
Bellevue, Washington

August 29, 2014
Revised February 10, 2016
Revised February 25, 2016
Revised April 11, 2016
Revised June 14, 2016

Attachment 19

TERRA ASSOCIATES, Inc.

Consultants in Geotechnical Engineering, Geology
and
Environmental Earth Sciences

August 29, 2014
Revised February 10, 2016
Revised February 25, 2016
Revised April 11, 2016
Revised June 14, 2016
Project No. T-7103

Mr. Matt Perkins
Quadrant Homes
14725 SE 36th Street, Suite 200
Bellevue, Washington 98006

Subject: Geotechnical Report
Hawks Glen
17656 NE 116th Street
Redmond, Washington

Dear Mr. Perkins:

As requested, we conducted a geotechnical engineering study for the subject project. The attached report presents our findings and recommendations for the geotechnical aspects of project design and construction.

Our study indicates the site soils generally consist of about six to ten inches of topsoil overlying glacial deposits comprised predominantly of silty fine sand to fine sandy silt with varying amounts of gravel and cobbles, and occasional boulders. We observed light seepage of perched groundwater in one test pit between depths of about five to seven feet.

In our opinion, there are no geotechnical conditions that would preclude the planned residential development. Residences can be supported on conventional spread footings bearing on competent native soils underlying the organic surface soils or on structural fill placed on competent native soils. Floor slabs and pavements can be similarly supported.

12220 113th Avenue NE, Ste. 130, Kirkland, Washington 98034
Phone (425) 821-7777 • Fax (425) 821-4334

Attachment 19

Detailed recommendations addressing these issues and other geotechnical design considerations are presented in the attached report. We trust the information presented is sufficient for your current needs. If you have any questions or require additional information, please call.

Sincerely yours,
TERRA ASSOCIATES, INC.

John C. Sadler
John C. Sadler, L.E.G., L.H.G.
Project Manager

Carolyn Decker 6/14/16
Carolyn S. Decker, P.E.
Project Engineer

CAROLYN S. DECKER
STATE OF WASHINGTON
47016
REGISTERED
PROFESSIONAL ENGINEER

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Geotechnical Report
Hawks Glen
17656 NE 116th Street
Redmond, Washington

1.0 PROJECT DESCRIPTION

The proposed project is a residential development. A grading plan by The Blueline Group (Blueline) dated February 25, 2016 indicates that the property will be developed with 27 single-family residential lots located in the central and southern portions of the site. Proposed site grading consists predominantly of fills with maximum thicknesses ranging between about 2 feet and 6.5 feet.

Site stormwater will be detained in a buried vault in the northeastern portion of the planned development area. Preliminary dimensions shown on the plan indicate the vault will be 85 feet long and 65 feet wide. Based on our conversations with Blueline, we understand that the bottom of the vault will be approximately 18 feet below existing ground surface.

Building plans are not available; however, we expect that the residences would be two-story, wood-frame structures, with their main floors constructed at grade. Foundation loads should be relatively light, in the range of 2 to 3 kips per foot for bearing walls and 25 to 50 kips for isolated columns.

The recommendations contained in the following sections of this report are preliminary and based on our understanding of the above design features. We should review design drawings as they become available to verify that our recommendations have been properly interpreted and incorporated into project design and to amend or supplement our recommendations, if required.

2.0 SCOPE OF WORK

We explored subsurface conditions at the site by observing conditions in 8 test pits excavated to maximum depths of about 7 to 8.5 feet below existing surface grades using a track-mounted excavator. Using the results of our field study and laboratory testing, analyses were undertaken to develop geotechnical recommendations for project design and construction. Specifically, this report addresses the following:

- Soil and groundwater conditions
- Geologic hazards per the Redmond Zoning Code
- Seismic design parameters per the current International Building Code (IBC)
- Site preparation and grading
- Excavations
- Foundations

- Slab-on-grade floors
- Infiltration feasibility
- Stormwater detention
- Drainage
- Utilities
- Pavements

It should be noted that recommendations outlined in this report regarding drainage are associated with soil strength, design earth pressures, erosion, and stability. Design and performance issues with respect to moisture as it relates to the structure environment (i.e., humidity, mildew, mold) is beyond Terra Associates' purview. A building envelope specialist or contactor should be consulted to address these issues, as needed.

3.0 SITE CONDITIONS

3.1 Surface

The site is a 9.76-acre parcel located northwest of and adjacent to the intersection of NE 116th Street and 178th Place NE in Redmond, Washington. The approximate location of the site is shown on Figure 1.

Existing site improvements include a vacant single-family residence and several outbuildings. Existing surface grades are relatively flat with a gentle gradient down to the south-southeast. Available topographic information on a conceptual grading and utility plan by Goldsmith Land Development Services (Goldsmith) dated August 6, 2014 indicates that maximum surface gradients in the planned development area are about 6 to 7 percent. Vegetation in the planned development area consists primarily of mowed pasture grasses and lawn.

The portion of the property located north of the planned development area consists primarily of mature conifer forest. A natural drainage ravine runs south through the wooded area before exiting at the east site margin approximately 400 feet south of the northeast property corner. The available topographic information indicates that the ravine sideslopes are about 12 to 18 feet high with inclinations ranging between about 27 and 43 percent.

Gravity block retaining walls support roadway fills for NE 116th Street adjacent to the southern site margin and for 178th Place NE adjacent to the southern approximately 180 feet of the eastern site margin. The wall heights range between about 2 and 6 feet along 178th Place NE and about 7 to 8 feet along NE 116th Street.

Attachment 19

Supplemental Site Visit

In January 2016, we visited the subject site to view existing shallow perforated pipes installed previously by the property owner. Based on our observations, it appears that all of the existing on-site perforated pipes were intended to intercept and convey surface water and shallow perched interflow to the downgradient eastern side of the property. Passive dewatering devices that we observed include several shallow ditches dug along the western site margin; several rows of sand bags placed on the ground surface along the western site margin; and a network of shallow perforated pipes in the pasture areas located in the southern approximately 620 feet of the site.

We did not observe any pipes installed to drain water from ditches along the western site margin. However, we observed a 2-foot long vertical section of 2-foot diameter plastic pipe in the ditch located west of the detached garage/shop building that likely served as a sump for periodic pumping. We did not observe any indications of permanent pipes or pump installations in this area.

The ditches we observed on the western site margin contained standing water to the adjacent ground surface or just below the ground surface. We observed an accumulation of surface water on the upgradient western side of the detached garage/shop building and in a localized topographic depression in the pasture, near the eastern site margin. We also observed localized areas of surface water in the undeveloped property immediately west of the subject site.

We observed a light flow of water draining into a corrugated metal culvert at the eastern property margin, east-southeast of the residence. We anticipate that the water was discharging from one or more of the shallow perforated pipes installed in the southeastern portion of the pasture; however, we were unable to confirm this. We were unable to locate the discharge location(s) of the shallow perforated pipes in the northeastern portion of the pasture to verify that they were functioning.

3.2 Soils

The soils observed in the test pits consist of about six to ten inches of sod and overlying glacial deposits comprised predominantly of silty fine sand to fine sandy silt with varying amounts of gravel and cobbles, and occasional boulders. The soils observed in the upper approximately five to seven feet of the test pits were typically medium dense, moist, and mottled. With the exceptions of Test Pits TP-1 and TP-2, the upper medium dense soils were generally slightly clayey.

We observed medium dense to dense, weakly cemented, till-like silty sand with gravel below depths of about five to seven feet in six of the eight test pits. Approximately 2.5 feet of outwash sand overlies the till-like soils in Test Pit TP-2.

The *Geologic map of the Redmond quadrangle, King County Washington*, by J.P. Minard and Derek B. Booth (1988) shows site geology mapped as Vashon till (Qvt). The medium dense to dense, weakly cemented silty sand with gravel that we observed below depths of about five to seven feet in six of the test pits is generally consistent with the relative density and texture of till. The trace to slightly clayey, silty fine sand/fine sandy silt with scattered gravel and trace to scattered cobbles and 1.5-foot diameter boulders observed overlying the till-like deposits are interpreted to be an ice contact deposit.

Detailed descriptions of the subsurface conditions we observed in the test pits are presented on the Test Pit Logs in Appendix A. The approximate locations of the test pits are shown on Figure 2.

3.3 Groundwater

We observed light groundwater seepage between depths of about five and seven feet in Test Pit TP-2. The groundwater at this location occurs within an outwash sand layer that is perched above medium dense to dense till-like soils. The near-surface silt and silty fine sand soils observed in the test pits are typically mottled indicating that a shallow perched groundwater table has developed at times. Based on our study, the perched groundwater observed between five and seven feet is localized to a laterally-discontinuous outwash layer in the area of Test Pit TP-2, and is not representative of the shallow perched groundwater condition indicated by the presence of mottling in soils just below the topsoil.

The occurrence of shallow perched groundwater is typical for sites underlain by till and other relatively impermeable soils. We expect that perched groundwater levels and flow rates will fluctuate seasonally and will typically reach their highest levels during and shortly following the wet winter months (October through May). We expect that the groundwater conditions observed during our August 2014 field work are representative of seasonal low levels.

The development of a fluctuating seasonal perched groundwater table at the site has been documented by shallow monitoring performed by Wetland Resources, Inc. during the winter and spring of 2014. The Wetland Resources, Inc. report dated June 10, 2014 also documents the presence of saturated surface soils and localized standing water, which are both consistent with a shallow perched groundwater table.

In January 2016, we hand excavated several shallow test holes upgradient from the localized accumulation of surface water in the eastern portion of the pasture. The observed soils consist of about seven to eight inches of sod and moist to wet topsoil overlying medium dense to dense silt. Groundwater seepage observed in the test holes is perched above the silt within the topsoil layer. This is consistent with the findings of our previous studies and the Wetland Resources, Inc. monitoring. Based on our observations, it is our opinion that direct precipitation and shallow interflow from upgradient areas are the predominant sources of the surface water observed at the site.

3.4 Geologic Hazards

We evaluated site conditions for the presence of geologic hazards. Section 21.64.060 (Geologically Hazardous Areas) of the City of Redmond Zoning Code (RZC) defines geologically hazardous areas as erosion hazard areas, landslide hazard areas, and seismic hazard areas.

3.4.1 Erosion Hazard Areas

Section 21.64.060A.1.a of the RZC defines erosion hazard areas as "...lands or areas underlain by soils identified by the U.S. Department of Agriculture Soil Conservation Service (SCS) as having "severe" or "very severe" rill and inter-rill erosion hazards. This includes, but is not limited to, the following group of soils when they occur on slopes of 15 percent or greater: Alderwood-Kitsap (AkF), Alderwood gravelly sandy loam (AgD), Kitsap silt loam (KpD), Everett (EvD), and Indianola (InD)."

The Soil Conservation Service (SCS) has classified the soils underlying the west and east portions of the site as Alderwood gravelly sandy loam, 6 to 15 percent slopes (AgC). Alderwood soils are described as formed over till, which is generally consistent with the soils observed in the test pits. The SCS describes the erosion hazard of AgC soils as moderate, which does not meet the criteria for an erosion hazard area.

However, the site soils will be susceptible to erosion when exposed during construction. In our opinion, proper implementation and maintenance of Best Management Practices (BMPs) for erosion prevention and sedimentation control will adequately mitigate the erosion potential in the planned development area. Erosion protection measures as required by the City of Redmond will need to be in place prior to and during grading activity on the site.

3.4.2 Landslide Hazard Areas

Section 21.64.060A.1.b of the RZC defines landslide hazard areas as "…areas potentially subject to significant or severe risk of landslides based on a combination of geologic, topographic, and hydrogeologic factors.

They include areas susceptible because of any combination of bedrock, soil, slope, slope aspect, structure, hydrology, or other factors. They are areas of the landscape that are at a high risk of failure or that presently exhibit downslope movement of soil and/or rocks and that are separated from the underlying stationary part of the slope by a definite plane of separation. The plane of separation may be thick or thin and may be composed of multiple failure zones depending on local conditions, including soil type, slope gradient, and groundwater regime." Landslide hazard areas include the following:

i. Areas of historic failures, such as:
   a. Areas designated as quaternary slumps or landslides on maps published by the United States Geologic Survey (USGS).
   b. Those areas designated by the United States Department of Agriculture (USDA) Soil Conservation Service (SCS) as having a "severe" limitation for building site development.

ii. Areas containing a combination of slopes steeper than 15 percent, springs or groundwater seepage, and hillsides intersecting geologic contacts with a relatively permeable sediment overlying a relatively impermeable sediment or bedrock.

iii. Areas that have shown movement during the Holocene epoch (from 10,000 years ago to the present) or which are underlain or covered by mass wastage debris of that epoch.

iv. Slopes that are parallel or subparallel to planes of weakness in subsurface materials.

v. Slopes having gradients steeper than 80 percent subject to rockfall during seismic shaking.

vi. Areas potentially unstable as a result of rapid stream incision, stream bank erosion, and undercutting by wave action.

vii. Any area with a slope 40 percent or steeper with a vertical relief of 10 feet or more.

Localized areas of the ravine sideslopes in the northern portion of the site are steeper than 40 percent with slope heights ranging between about 12 feet and 18 feet. This geometry meets the criteria for a landslide hazard area given in above Item vii. These slope areas will not be impacted by the proposed site development. They are located more than 150 feet away from the planned development area, and located within, and are protected by the 150-foot stream buffer.

3.4.3 Seismic Hazard Areas

Section 21.64.060A.1.c of the RZC defines seismic hazard areas as "...lands subject to severe risk of damage as a result of earthquake-induced ground shaking, slope failure, settlement, soil liquefaction, or surface faulting."

Based on the soil and groundwater conditions we observed at the site, it is our opinion that the risk for damage resulting from earthquake induced slope failure, ground settlement, surface faulting, or soil liquefaction is negligible. Therefore, in our opinion, unusual seismic hazard areas do not exist at the site, and design in accordance with local building codes for determining seismic forces would adequately mitigate impacts associated with ground shaking.

3.5 Seismic Design Parameters

Based on the site soil conditions and our knowledge of the area geology, per the 2012 International Building Code (IBC), site class "C" should be used in structural design. Based on this site class, in accordance with the 2012 IBC, the following parameters should be used in computing seismic forces:

Seismic Design Parameters (IBC 2012)

Spectral response acceleration (Short Period), S_{Ms}	1.254 g
Spectral response acceleration (1 – Second Period), S_{M1}	0.635 g
Five percent damped .2 second period, S_{Ds}	0.836 g
Five percent damped 1.0 second period, S_{D1}	0.424 g

Values determined using the United States Geological Survey (USGS) Ground Motion Parameter Calculator accessed on August 28, 2014 at the web site http://earthquake.usgs.gov/designmaps/us/application.php.

4.0 DISCUSSION AND RECOMMENDATIONS

4.1 General

Based on our study, there are no geotechnical conditions that would preclude the planned development. Residences can be supported on conventional spread footings bearing on competent native soils underlying organic topsoil or on structural fill placed on the competent native soils. Floor slabs and pavements can be similarly supported.

The site soils contain a sufficient amount of fines (silt- and clay-sized particles) such that they will be difficult to compact as structural fill when too wet or too dry. If grading activities will take place during the winter season, the owner should be prepared to import free-draining granular material for use as structural fill and backfill.

Based on our study, it is our opinion that removal of the on-site perforated pipes would not have a significant impact on the existing shallow groundwater conditions at the site. Assuming that the shallow perforated pipes are functioning properly, it is likely that their removal would result in some increase of the duration of the seasonal perched groundwater condition at the site; however, we do not anticipate that this potential increase in duration would result in seasonal surface ponding that differs significantly from current conditions. This is supported by surface conditions shown on historical aerial photographs that show no indication of persistent surface water at the site in photographs dating to 1936.

In our opinion, the potential for interception and drainage of shallow interflow by buried utilities can be mitigated by constructing trench barriers or dams at regular intervals along the sanitary and storm sewer utilities using less permeable material. The construction interval of the trench barriers would typically be about 200 feet, but will depend on field conditions observed at the time of construction. A typical trench barrier detail is attached as Figure 3.

We anticipate that shallow interflow will be incepted in the proposed cut areas in the northwestern portion of the planned development area. Shallow interflow that is intercepted by drainage associated with rockery/retaining wall, buried structures, or footing drains will be conveyed to the on-site detention vault. The vault will release controlled flow to a closed system that conveys the water under 178th Avenue NE and discharges into the Monticello Creek drainage, which is the natural downgradient receptor of interflow from the subject site. Because all interflow collected by site drainage systems will be routed to the project stormwater system, it is our opinion that potential adverse impacts to interflow recharge to the Monticello Creek drainage will be negligible.

Detailed recommendations regarding these issues and other geotechnical design considerations are provided in the following sections of this report. These recommendations should be incorporated into the final design drawings and construction specifications.

4.2 Site Preparation and Grading

To prepare the site for construction, all vegetation, organic surface soils, and other deleterious materials should be stripped and removed from the site. We expect surface stripping depths of about six to ten inches will be required to remove the organic surficial soils. Stripped vegetation debris should be removed from the site. Organic soils will not be suitable for use as structural fill, but may be used for limited depths in nonstructural areas or for landscaping purposes. Demolition of existing structures should include removal of existing foundations and abandonment of underground septic systems and other buried utilities. Abandoned utility pipes that fall outside of new building areas can be left in place provided they are sealed to prevent intrusion of groundwater seepage and soil. Once clearing and grubbing operations are complete, cut and fill operations to establish desired building grades can be initiated.

A representative of Terra Associates, Inc. should examine all bearing surfaces to verify that conditions encountered are as anticipated and are suitable for placement of structural fill or direct support of building and pavement elements. Our representative may request proofrolling exposed surfaces with a heavy rubber tired vehicle to determine if any isolated soft and yielding areas are present. If unstable yielding areas are observed, they should be cut to firm bearing soil and filled to grade with structural fill. If the depth of excavation to remove unstable soils is excessive, use of geotextile fabric such as Mirafi 500X or equivalent in conjunction with structural fill can be considered in order to limit the depth of removal. In general, our experience has shown that a minimum of 18 inches of clean, granular structural fill over the geotextile fabric should establish a stable bearing surface.

The native soils observed at the site contain a sufficient amount of fines (silt and clay size particles) that will make them difficult to compact as structural fill if they are too wet or too dry. Accordingly, the ability to use these soils from site excavations as structural fill will depend on their moisture content and the prevailing weather conditions when site grading activities take place. Soils that are too wet to properly compact could be dried by aeration during dry weather conditions, or mixed with an additive such as cement or lime to stabilize the soil and facilitate compaction. If an additive is used, additional Best Management Practices (BMPs) for its use will need to be incorporated into the Temporary Erosion and Sedimentation Control (TESC) plan for the project. Soils that are dry of optimum should be moisture conditioned by controlled addition of water and blending prior to material placement.

If grading activities are planned during the wet winter months, or if they are initiated during the summer and extend into fall and winter, the owner should be prepared to import wet weather structural fill. For this purpose, we recommend importing a granular soil that meets the following grading requirements:

U.S. Sieve Size	Percent Passing
6 inches	100
No. 4	75 maximum
No. 200	5 maximum*

*Based on the 3/4-inch fraction.

Prior to use, Terra Associates, Inc. should examine and test all materials imported to the site for use as structural fill.

Structural fill should be placed in uniform loose layers not exceeding 12 inches and compacted to a minimum of 95 percent of the soil's maximum dry density, as determined by American Society for Testing and Materials (ASTM) Test Designation D-698 (Standard Proctor). The moisture content of the soil at the time of compaction should be within two percent of its optimum, as determined by this ASTM standard. In nonstructural areas, the degree of compaction can be reduced to 90 percent.

4.3 Excavations

All excavations at the site associated with confined spaces, such as lower building level retaining walls, must be completed in accordance with local, state, and federal requirements. Based on the Washington State Safety and Health Administration (WSHA) regulations, the medium dense to dense native soils would typically be classified as Type C soils. Unweathered, dense to very dense till and till-like soils would typically be classified as Type A soils.

Accordingly, for temporary excavations of more than 4 feet and less than 20 feet in depth, the side slopes in Type C soils should be laid back at a slope inclination of 1.5:1 (Horizontal:Vertical) or flatter. Temporary excavations in Type A soils can be laid back at inclinations of 0.75:1 or flatter. For temporary excavation slopes less than 8 feet in height in Type A soils, the lower 3.5 feet can be cut to a vertical condition with a 0.75:1 slope graded above. For temporary excavation slopes greater than 8 feet in height up to a maximum height of 12 feet, the slope above the 3.5-foot high vertical portion should be laid back to an inclination of 1:1 or flatter. No vertical cut with a backslope immediately above is allowed for excavation depths that exceed 12 feet. In this case, a 4-foot high vertical cut with an equivalent horizontal bench to the cut slope toe is required. If there is insufficient room to complete the excavations in the manners discussed above, or if excavations greater than 20 feet deep are planned, you may need to use temporary shoring to support the excavations.

Seepage of perched groundwater should be anticipated within excavations extending to the dense to very dense till and till-like soils, particularly in the vicinity of Test Pit TP-2. In our opinion, the volume of water and rate of flow into the excavation should be relatively minor and would not be expected to impact the stability of the excavations when completed as described above. Conventional sump pumping procedures along with a system of collection trenches, if necessary, should be capable of maintaining a relatively dry excavation for construction purposes in these soils.

The above information is provided solely for the benefit of the owner and other design consultants, and should not be construed to imply that Terra Associates, Inc. assumes responsibility for job site safety. It is understood that job site safety is the sole responsibility of the project contractor.

4.4 Foundations

Residential structures may be supported on conventional spread footing foundations bearing on competent native soils or on structural fill placed above the native soils. Foundation subgrades should be prepared, as recommended in Section 4.2 of this report.

Perimeter foundations exposed to the weather should bear at a minimum depth of 1.5 feet below final exterior grades for frost protection. Interior foundations can be constructed at any convenient depth below the floor slab. We recommend designing foundations for a net allowable bearing capacity of 2,500 pounds per square foot (psf). For short-term loads, such as wind and seismic, a one-third increase in this allowable capacity can be used in design. With the anticipated loads and this bearing stress applied, building settlements should be less than one-half inch total and one-fourth inch differential.

For designing foundations to resist lateral loads, a base friction coefficient of 0.35 can be used. Passive earth pressure acting on the sides of the footings may also be considered. We recommend calculating this lateral resistance using an equivalent fluid weight of 300 pounds per cubic foot (pcf). We recommend not including the upper 12 inches of soil in this computation because they can be affected by weather or disturbed by future grading activity. This value assumes the foundations will be constructed neat against competent native soil or the excavations are backfilled with structural fill, as described in Section 4.2 of this report. The recommended passive and friction values include a safety factor of 1.5.

4.5 Slab-on-Grade Floors

Slab-on-grade floors may be supported on a subgrade prepared as recommended in Section 4.2 of this report. Immediately below the floor slab, we recommend placing a four-inch thick capillary break layer composed of clean, coarse sand or fine gravel that has less than three percent passing the No. 200 sieve. This material will reduce the potential for upward capillary movement of water through the underlying soil and subsequent wetting of the floor slab.

The capillary break layer will not prevent moisture intrusion through the slab caused by water vapor transmission. Where moisture by vapor transmission is undesirable, such as covered floor areas, a common practice is to place a durable plastic membrane on the capillary break layer and then cover the membrane with a layer of clean sand or fine gravel to protect it from damage during construction, and aid in uniform curing of the concrete slab. It should be noted that if the sand or gravel layer overlying the membrane is saturated prior to pouring the slab, it will be ineffective in assisting uniform curing of the slab and can actually serve as a water supply for moisture seeping through the slab and affecting floor coverings. Therefore, in our opinion, covering the membrane with a layer of sand or gravel should be avoided if floor slab construction occurs during the wet winter months and the layer cannot be effectively drained.

4.6 Infiltration Feasibility

Based on the conditions observed in our test pits, it is our opinion that on-site infiltration is not a viable option for management of site stormwater. Based on the presence of mottling in the vast majority of soils observed at the site, it is also our opinion that the site conditions would generally not be suitable for applying other natural drainage practices (NDPs).

4.7 Stormwater Detention

As discussed, on-site detention of stormwater runoff will be provided by a buried vault located in the northeastern portion of the planned development area. We did not have the conceptual vault location or dimensions at the time of our subsurface exploration, and therefore, did not investigate subsurface conditions to the proposed bottom of vault elevation. We anticipate that dense to very dense glacial deposits exist at the planned bottom of vault elevation; however, this should be verified prior to construction.

Vault foundations supported by dense to very dense native soils at a depth greater than 8 feet may be designed for an allowable bearing capacity of 5,000 psf. For short-term loads, such as seismic, a one-third increase in this allowable capacity can be used. Friction at the base of foundations and passive earth pressure will provide resistance to these lateral loads. For designing foundations to resist lateral loads, a base friction coefficient of 0.35 can be used. Passive earth pressure acting on the sides of the vault footings may also be considered. We recommend calculating this lateral resistance using an equivalent fluid weight of 300 pounds per cubic foot (pcf).

The magnitude of earth pressures developing on the vault walls will depend in part on the quality and compaction of the wall backfill. We recommend placing and compacting wall backfill as structural fill as recommended in Section 4.2.

To prevent development of hydrostatic pressure and uplift on the vault, wall drainage must be installed. A typical recommended wall drainage detail is shown on Figure 4. If it is not possible to discharge collected water at the footing invert elevation, we recommend setting the invert elevation of the wall drainpipe equivalent to the outfall invert and connecting the drain to the outfall pipe for discharge.

With the recommended wall backfill and drainage, we recommend designing the vault walls for an earth pressure imposed by an equivalent fluid weighing 50 pcf. For any portion of the wall that falls below the invert elevation of the wall drain, an earth pressure equivalent to a fluid weighing 85 pcf should be used. For evaluating walls under seismic loading, an additional uniform earth pressure equivalent to 8H psf, where H is the height of the below-grade wall in feet, can be used. These values assume a horizontal backfill condition. If necessary, a uniform horizontal traffic surcharge value of 75 psf should be included in design of vault walls.

The vault will be subject to uplift pressures if drainage is not provided the full depth of the structure. The weight of the structure and the weight of the backfill soil above its foundation will provide resistance to uplift. A soil unit weight of 125 pcf can be used for the vault backfill provided the backfill is placed and compacted as structural fill as recommended in Section 4.2.

4.8 Drainage

Surface

Final exterior grades should promote free and positive drainage away from the building areas. We recommend providing a positive drainage gradient away from the building perimeter. If a positive gradient cannot be provided, provisions for collection and disposal of surface water adjacent to the structure should be provided.

Subsurface

We recommend installing a continuous drain along the outside lower edge of the perimeter building foundations. The drains can be laid to grade at an invert elevation equivalent to the bottom of footing grade. The drains can consist of four-inch diameter perforated PVC pipe that is enveloped in washed ½- to ¾-inch gravel-sized drainage aggregate. The aggregate should extend six inches above and to the sides of the pipe. The foundation drains and roof downspouts should be tightlined separately to an approved point of controlled discharge. All drains should be provided with cleanouts at easily accessible locations. These cleanouts should be serviced at least once each year.

4.9 Utilities

Utility pipes should be bedded and backfilled in accordance with American Public Works Association (APWA) or local jurisdictional requirements. At minimum, trench backfill should be placed and compacted as structural fill as described in Section 4.2 of this report. As noted, soils excavated on-site should generally be suitable for use as backfill material. However, the vast majority of the site soils are fine grained and moisture sensitive; therefore, moisture conditioning may be necessary to facilitate proper compaction. If utility construction takes place during the winter, it may be necessary to import suitable wet weather fill for utility trench backfilling.

4.10 Pavements

Pavement subgrade should be prepared as described in the Section 4.2 of this report. Regardless of the degree of relative compaction achieved, the subgrade must be firm and relatively unyielding before paving. The subgrade should be proofrolled with heavy rubber-tire construction equipment such as a loaded 10-yard dump truck to verify this condition.

The pavement design section is dependent upon the supporting capability of the subgrade soils and the traffic conditions to which it will be subjected. For residential access, with traffic consisting mainly of light passenger vehicles with only occasional heavy traffic, and with a stable subgrade prepared as recommended, we recommend the following pavement sections:

- Two inches of hot mix asphalt (HMA) over six inches of crushed rock base (CRB)
- Five inches full depth HMA over prepared subgrade

The paving materials used should conform to the Washington State Department of Transportation (WSDOT) specifications for ½-inch class HMA and CRB.

Long-term pavement performance will depend on surface drainage. A poorly-drained pavement section will be subject to premature failure as a result of surface water infiltrating into the subgrade soils and reducing their supporting capability. For optimum pavement performance, we recommend surface drainage gradients of at least two percent. Some degree of longitudinal and transverse cracking of the pavement surface should be expected over time. Regular maintenance should be planned to seal cracks when they occur.

5.0 ADDITIONAL SERVICES

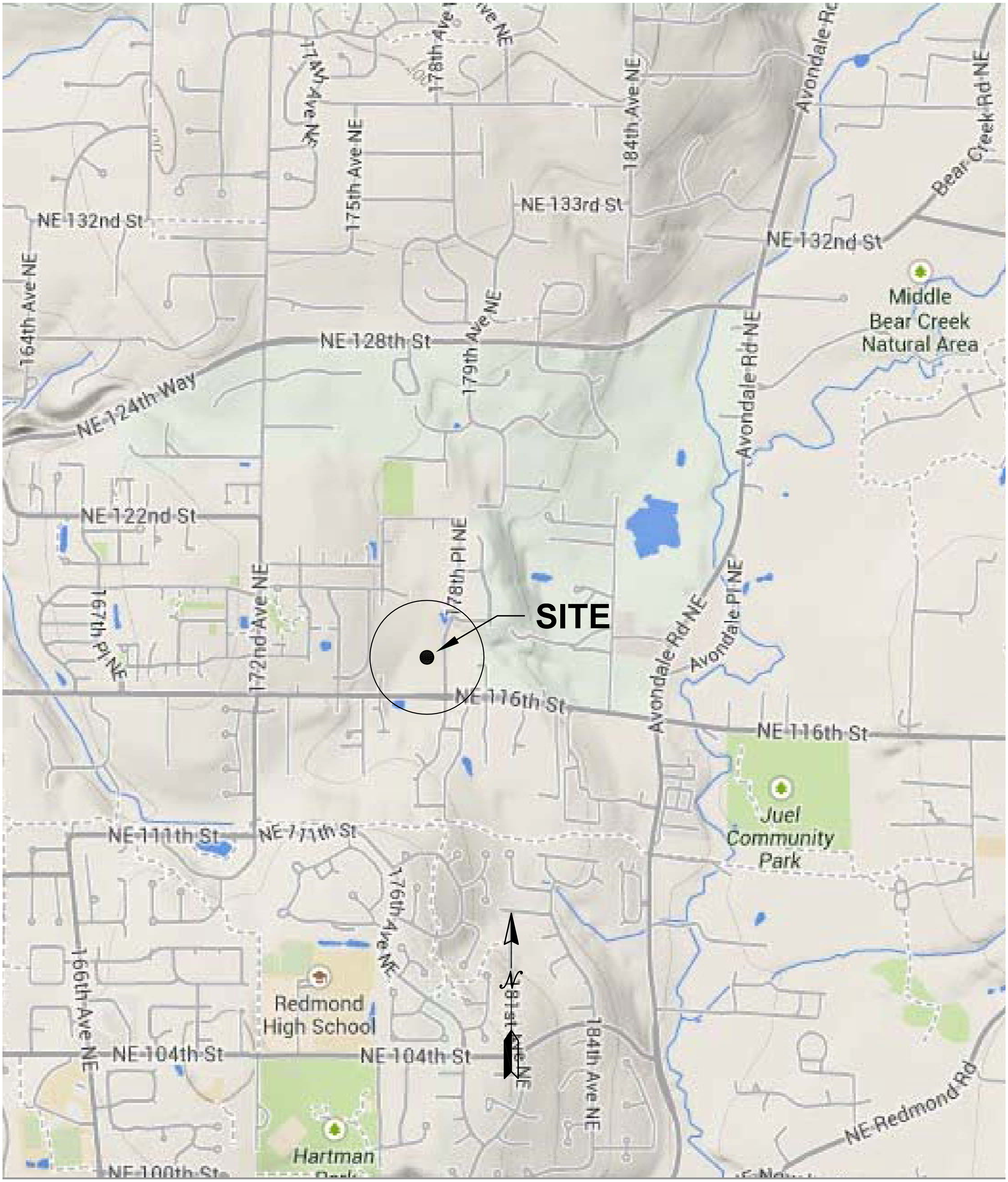
Terra Associates, Inc. should review the final designs and specifications in order to verify that earthwork and foundation recommendations have been properly interpreted and implemented in project design. We should also provide geotechnical services during construction in order to observe compliance with our design concepts, specifications, and recommendations. This will allow for design changes if subsurface conditions differ from those anticipated prior to the start of construction.

6.0 LIMITATIONS

We prepared this report in accordance with generally accepted geotechnical engineering practices. This report is the copyrighted property of Terra Associates, Inc. and is intended for specific application to the Hawks Glen project. This report is for the exclusive use of Quadrant Homes and their authorized representatives. No other warranty, expressed or implied, is made.

The analyses and recommendations presented in this report are based on data obtained from our on-site test pits. Variations in soil conditions can occur, the nature and extent of which may not become evident until construction. If variations appear evident, Terra Associates, Inc. should be requested to reevaluate the recommendations in this report prior to proceeding with construction.

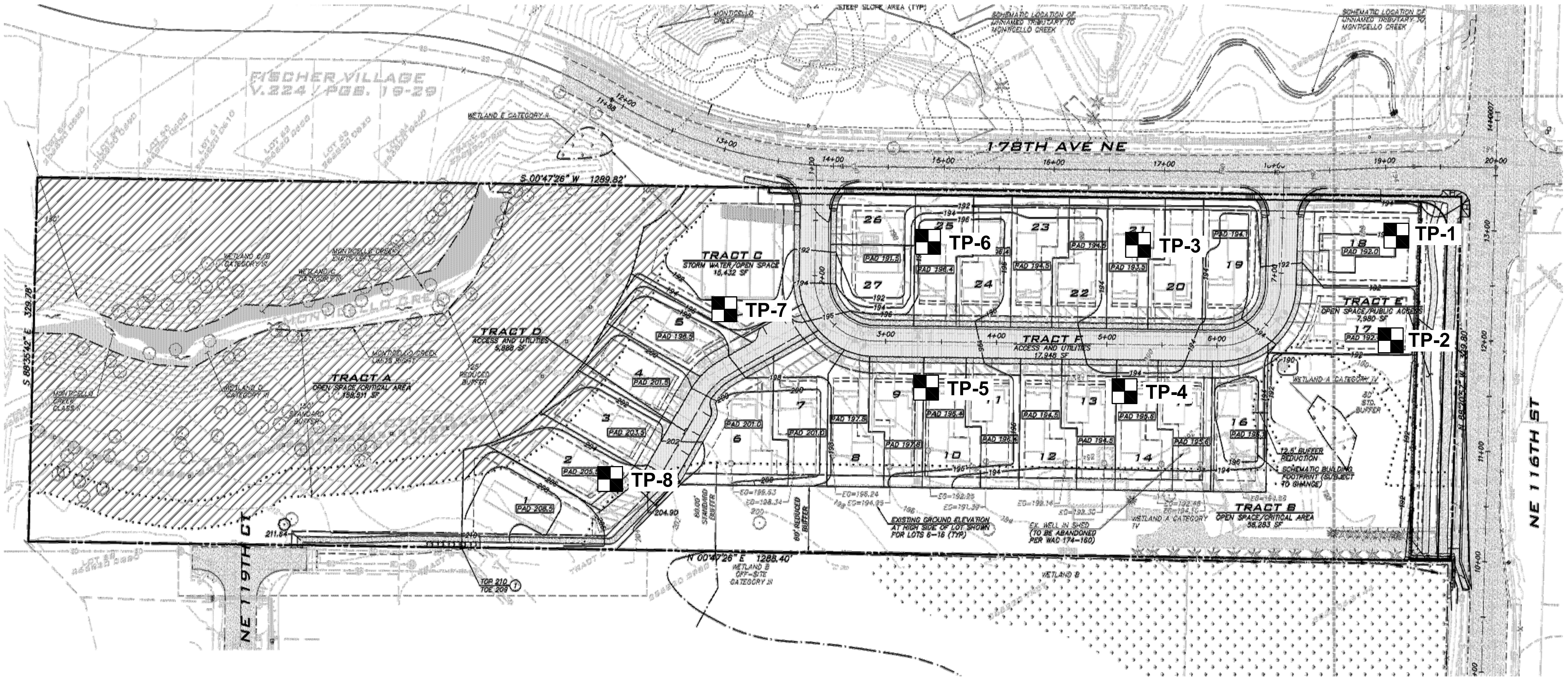
Attachment 19



Terra Associates, Inc.
Consultants in Geotechnical Engineering
Geology and
Environmental Earth Sciences

VICINITY MAP
HAWKS GLEN
REDMOND, WASHINGTON

Proj. No.T-7103	Date JUN 2016	Figure 1



NOTE:

THIS SITE PLAN IS SCHEMATIC. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE. IT IS INTENDED FOR REFERENCE ONLY AND SHOULD NOT BE USED FOR DESIGN OR CONSTRUCTION PURPOSES.

LEGEND:

▨ APPROXIMATE TEST PIT LOCATION (AUGUST 2014)

REFERENCE:

SITE PLAN BY THE BLUELINE GROUP (2-25-16)

0 100 200

APPROXIMATE SCALE IN FEET

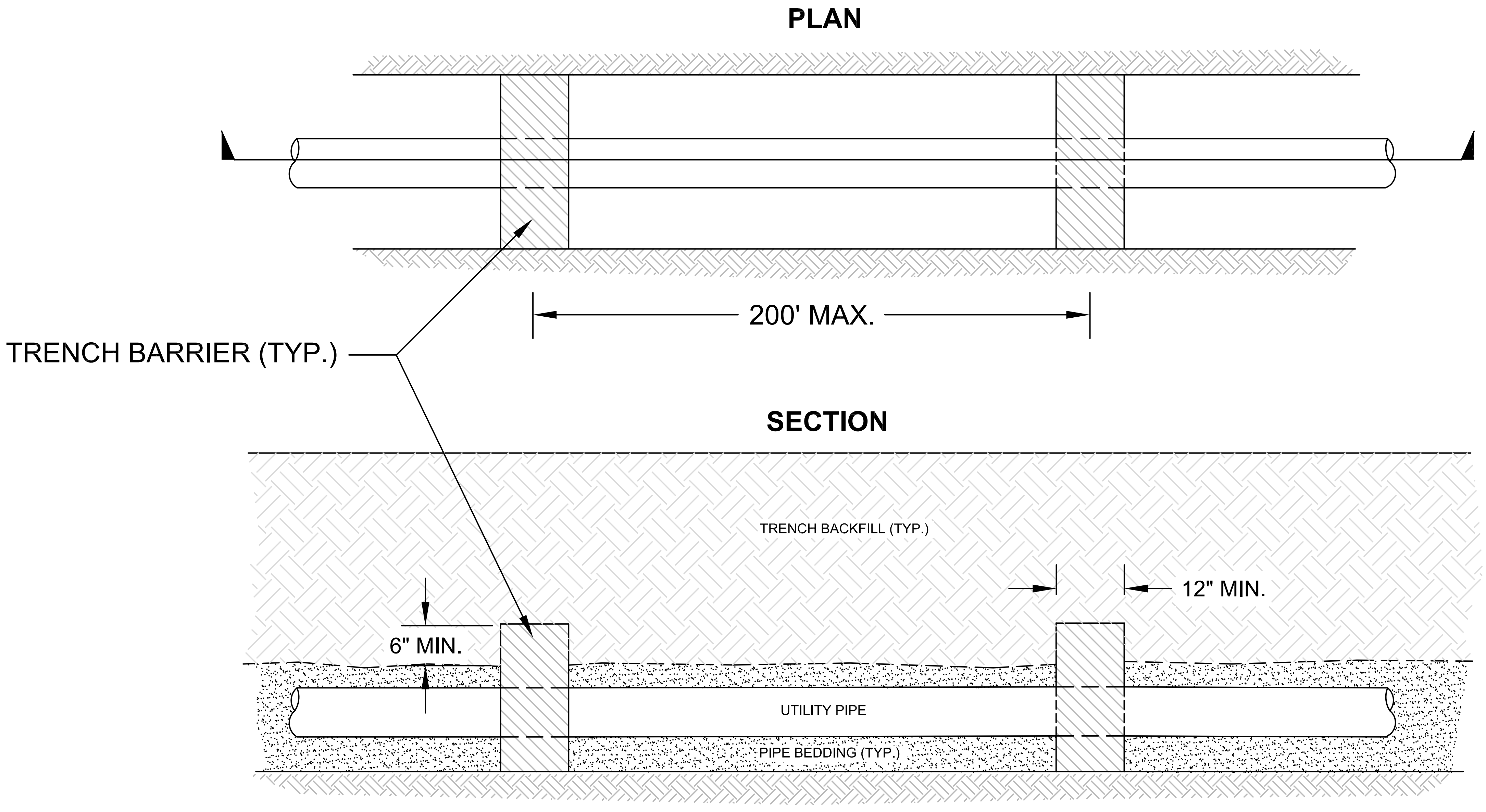
Terra Associates, Inc.

Consultants in Geotechnical Engineering
Geology and
Environmental Earth Sciences

EXPLORATION LOCATION PLAN
HAWKS GLEN
REDMOND, WASHINGTON

Proj. No.T-7103	Date JUN 2016	Figure 2

Attachment 19



NOT TO SCALE

NOTE: TRENCH BARRIER TO CONSIST OF MECHANICALLY COMPACTED SOIL HAVING AT LEAST 30 PERCENT FINES.

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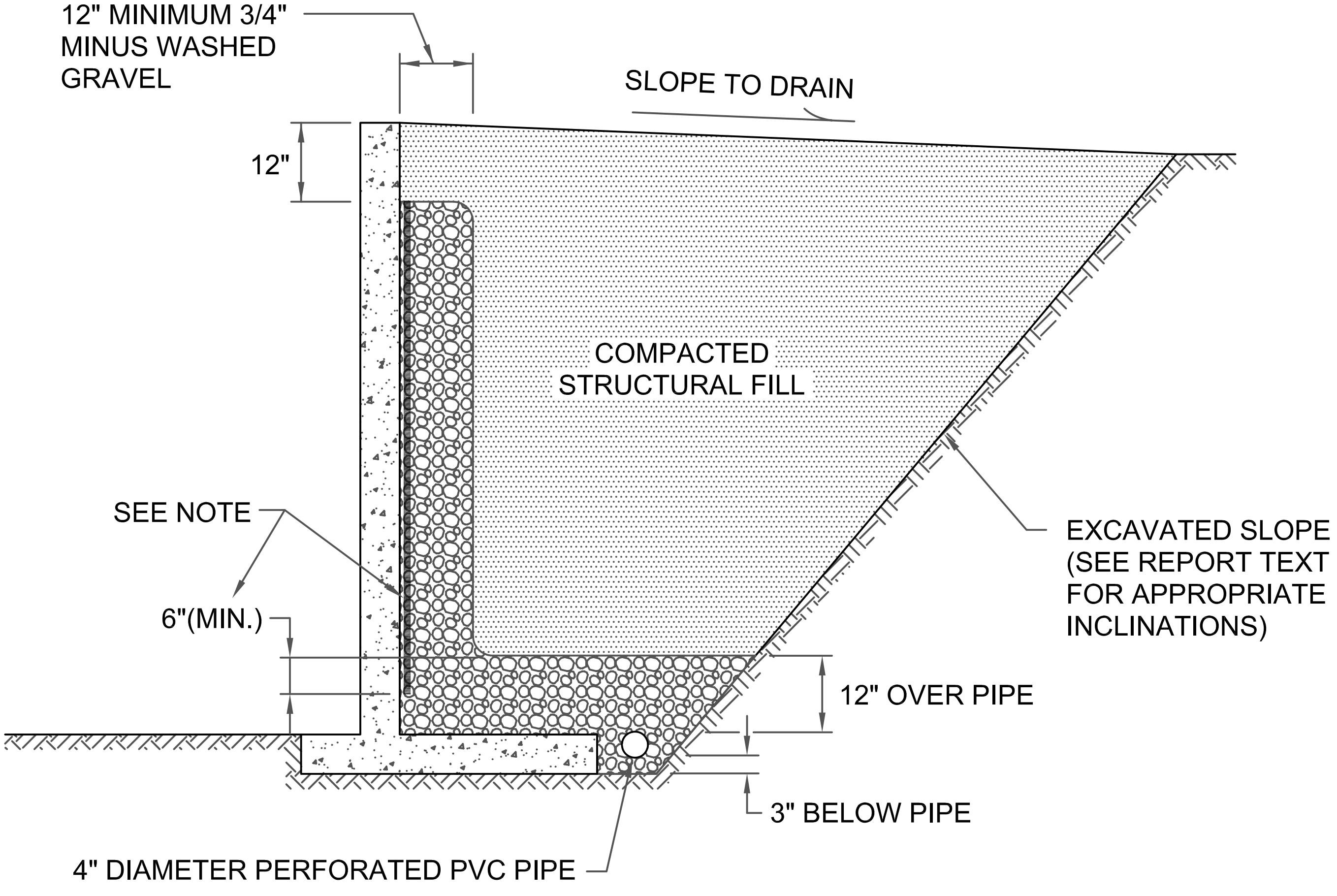
Environmental Earth Sciences

TYPICAL UTILITY TRENCH BARRIER DETAIL
HAWKS GLEN
REDMOND, WASHINGTON

Proj. No.T-7103
Date JUN 2016
Figure 3



NOT TO SCALE

NOTE:

MIRADRAIN G100N PREFABRICATED DRAINAGE PANELS OR SIMILAR PRODUCT CAN BE SUBSTITUTED FOR THE 12-INCH WIDE GRAVEL DRAIN BEHIND WALL. DRAINAGE PANELS SHOULD EXTEND A MINIMUM OF SIX INCHES INTO 12-INCH THICK DRAINAGE GRAVEL LAYER OVER PERFORATED DRAIN PIPE.

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Environmental Earth Sciences

TYPICAL WALL DRAINAGE DETAIL
HAWKS GLEN
REDMOND, WASHINGTON

Proj. No.T-7103	Date JUN 2016	Figure 4

Attachment 19

APPENDIX A
FIELD EXPLORATION AND LABORATORY TESTING

Hawks Glen
Redmond, Washington

On August 20, 2014, we investigated subsurface conditions at the site by excavating 8 test pits to maximum depths of about 7 to 8.5 feet below existing surface grades using a track-mounted excavator. The test pit locations are shown on Figure 2. The test pit locations were approximately determined in the field by sighting and pacing from existing surface features. The Test Pit Logs are presented on Figures A-2 through A-9.

An engineering geologist from our office maintained a log of each test pit as it was excavated, classified the soil conditions encountered, and obtained representative soil samples. All soil samples were visually classified in the field in accordance with the Unified Soil Classification System. A copy of this classification is presented as Figure A-1.

Representative soil samples obtained from the test pits were placed in sealed plastic bags and taken to our laboratory for further examination and testing. The moisture content of each sample was measured and is reported on the Test Pit Logs. Grain size analyses were performed on three of the soil samples. The results are shown on Figure A-10.

Attachment 19

MAJOR DIVISIONS				LETTER SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	More than 50% material larger than No. 200 sieve size	**GRAVELS** More than 50% of coarse fraction is larger than No. 4 sieve	Clean Gravels (less than 5% fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines.
				GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines.
			Gravels with fines	GM	Silty gravels, gravel-sand-silt mixtures, non-plastic fines.
				GC	Clayey gravels, gravel-sand-clay mixtures, plastic fines.
		SANDS More than 50% of coarse fraction is smaller than No. 4 sieve	Clean Sands (less than 5% fines)	SW	Well-graded sands, sands with gravel, little or no fines.
				SP	Poorly-graded sands, sands with gravel, little or no fines.
			Sands with fines	SM	Silty sands, sand-silt mixtures, non-plastic fines.
				SC	Clayey sands, sand-clay mixtures, plastic fines.
FINE GRAINED SOILS	More than 50% material smaller than No. 200 sieve size	**SILTS AND CLAYS** Liquid Limit is less than 50%		ML	Inorganic silts, rock flour, clayey silts with slight plasticity.
				CL	Inorganic clays of low to medium plasticity. (Lean clay)
				OL	Organic silts and organic clays of low plasticity.
		SILTS AND CLAYS Liquid Limit is greater than 50%		MH	Inorganic silts, elastic.
				CH	Inorganic clays of high plasticity. (Fat clay)
				OH	Organic clays of high plasticity.
HIGHLY ORGANIC SOILS				PT	Peat.

DEFINITION OF TERMS AND SYMBOLS

COHESIONLESS

Density	Standard Penetration Resistance in Blows/Foot
Very Loose	0-4
Loose	4-10
Medium Dense	10-30
Dense	30-50
Very Dense	>50

COHESIVE

Consistancy	Standard Penetration Resistance in Blows/Foot
Very Soft	0-2
Soft	2-4
Medium Stiff	4-8
Stiff	8-16
Very Stiff	16-32
Hard	>32

⌶	2" OUTSIDE DIAMETER SPILT SPOON SAMPLER
‖	2.4" INSIDE DIAMETER RING SAMPLER OR SHELBY TUBE SAMPLER
▼	WATER LEVEL (Date)
Tr	TORVANE READINGS, tsf
Pp	PENETROMETER READING, tsf
DD	DRY DENSITY, pounds per cubic foot
LL	LIQUID LIMIT, percent
PI	PLASTIC INDEX
N	STANDARD PENETRATION, blows per foot

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UNIFIED SOIL CLASSIFICATION SYSTEM
HAWKS GLEN
REDMOND, WASHINGTON

Proj. No.T-7103	Date JUN 2016	Figure A-1

Attachment 19

LOG OF TEST PIT NO. 1

FIGURE A-2

PROJECT NAME: Hawks Glen **PROJ. NO:** T-7103 **LOGGED BY:** JCS

LOCATION: Redmond, Washington **SURFACE CONDS:** Grass **APPROX. ELEV:** 186

DATE LOGGED: 8-20-14 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

DEPTH (FT.)	SOIL SAMPLE	DESCRIPTION	CONSISTENCY/ RELATIVE DENSITY	W (%)	POCKET PEN. (TSF)
1 2 3 4		10 inches Sod and Topsoil. Gray to light brown fine sandy SILT, dry to moist, mottled. (ML)	Medium Dense	27.9	
5 6		Gray-brown to brown silty fine SAND, moist, mottled. (SM)		18.0	
7 8		Gray silty SAND with gravel, moist, weakly cemented. (SM) (Till like)	Medium Dense to Dense	16.2	
9 10		Test pit terminated at 8.5 feet. No groundwater seepage.			

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

Terra Associates, Inc.
Consultants in Geotechnical Engineering, Geology and Environmental Earth Sciences

Attachment 19

LOG OF TEST PIT NO. 2

FIGURE A-3

PROJECT NAME: Hawks Glen
PROJ. NO: T-7103
LOGGED BY: JCS
LOCATION: Redmond, Washington
SURFACE CONDS: Grass
APPROX. ELEV: 187
DATE LOGGED: 8-20-14
DEPTH TO GROUNDWATER: 5'
DEPTH TO CAVING: 6' - 7'

DEPTH (FT.)	SOIL SAMPLE	DESCRIPTION	CONSISTENCY/ RELATIVE DENSITY	W (%)	POCKET PEN. (TSF)
		9 inches Sod and Topsoil. Gray to light brown fine sandy SILT, dry to moist, mottled. (ML)	Medium Dense		
1					
2					
3				26.1	
4					
		Gray SAND to SAND with silt, moist to wet, scattered gravel, trace of cobbles. (SP/SP-SM/SW/SW-SM)			
▽ 5					
				17.1	
6					
7		Gray silty SAND with gravel, moist, weakly cemented. (SM) (Till like)	Medium Dense to Dense	14.9	
8		Test pit terminated at 8 feet. Light groundwater seepage between 5 and 7 feet. Minor sloughing between 6 and 7 feet.			
9					
10					

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

Terra Associates, Inc.
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and Environmental Earth Sciences

Attachment 19

LOG OF TEST PIT NO. 3

FIGURE A-4

PROJECT NAME: Hawks Glen **PROJ. NO:** T-7103 **LOGGED BY:** JCS

LOCATION: Redmond, Washington **SURFACE CONDS:** Grass **APPROX. ELEV:** 186

DATE LOGGED: 8-20-14 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

DEPTH (FT.)	SOIL SAMPLE	DESCRIPTION	CONSISTENCY/ RELATIVE DENSITY	W (%)	POCKET PEN. (TSF)
		8 inches Sod and Topsoil. Light brown, trace to slightly clayey, fine sandy SILT, dry, mottled, trace to scattered gravel. (ML)			
1					
2				20.0	
		Gray and brown, trace to slightly clayey, fine sandy SILT, moist, mottled, trace to scattered gravel. (ML)	Medium Dense		
3					
4					
5		Gray silty fine SAND with gravel, moist, weakly cemented, mottled between 5 and 7 feet. (SM)			
6					
			Medium Dense to Dense		
7					
8		Test pit terminated at 8 feet. No groundwater seepage.			
9					
10					

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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Consultants in Geotechnical Engineering, Geology
and Environmental Earth Sciences

Attachment 19

LOG OF TEST PIT NO. 4

FIGURE A-5

PROJECT NAME: Hawks Glen **PROJ. NO:** T-7103 **LOGGED BY:** JCS

LOCATION: Redmond, Washington **SURFACE CONDS:** Grass **APPROX. ELEV:** 188

DATE LOGGED: 8-20-14 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

DEPTH (FT.)	SOIL SAMPLE	DESCRIPTION	CONSISTENCY/ RELATIVE DENSITY	W (%)	POCKET PEN. (TSF)
1 2		8 inches Sod and Topsoil. Light brown, trace to slightly clayey, fine sandy SILT, dry, mottled, trace to scattered gravel. (ML)	Medium Dense		
3 4		Gray and brown, trace to slightly clayey, fine sandy SILT, moist, mottled, trace to scattered gravel. (ML)			
5 6		Gray silty fine SAND with gravel, moist, weakly cemented, mottled between 5 and 7 feet, trace of fine charcoal fragments. (SM)	Medium Dense to Dense		
7 8 9 10		Test pit terminated at 7 feet. No groundwater seepage.			

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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Consultants in Geotechnical Engineering, Geology and Environmental Earth Sciences

Attachment 19

LOG OF TEST PIT NO. 5

FIGURE A-6

PROJECT NAME: Hawks Glen **PROJ. NO:** T-7103 **LOGGED BY:** JCS

LOCATION: Redmond, Washington **SURFACE CONDS:** Grass **APPROX. ELEV:** 188

DATE LOGGED: 8-20-14 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

DEPTH (FT.)	SOIL SAMPLE	DESCRIPTION	CONSISTENCY/ RELATIVE DENSITY	W (%)	POCKET PEN. (TSF)
		7 inches Sod and Topsoil. Light brown to light gray-brown, trace to slightly clayey, silty fine SAND with gravel to trace to slightly clayey, fine sandy SILT with gravel, dry, mottled, trace of cobbles. (SM/ML)			
1					
2					
3				11.5	
		- Becomes moist below 3.5 feet.	Medium Dense		
4					
5					
6					
7					
		Test pit terminated at 7.5 feet. No groundwater seepage.			
8					
9					
10					

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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Attachment 19

LOG OF TEST PIT NO. 6

FIGURE A-7

PROJECT NAME: Hawks Glen **PROJ. NO:** T-7103 **LOGGED BY:** JCS

LOCATION: Redmond, Washington **SURFACE CONDS:** Grass **APPROX. ELEV:** 187

DATE LOGGED: 8-20-14 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

DEPTH (FT.)	SOIL SAMPLE	DESCRIPTION	CONSISTENCY/ RELATIVE DENSITY	W (%)	POCKET PEN. (TSF)
		7 inches Sod and Topsoil. Light brown to light gray-brown, trace to slightly clayey, silty fine SAND with gravel to trace to slightly clayey, fine sandy SILT with gravel, dry, mottled, trace of cobbles. (SM/ML)			
1					
2		- Becomes moist below 2 feet.			
3					
4			Medium Dense		
5					
6					
7					
8		Test pit terminated at 8 feet. No groundwater seepage.			
9					
10					

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

Terra Associates, Inc.
Consultants in Geotechnical Engineering, Geology
and Environmental Earth Sciences

Attachment 19

LOG OF TEST PIT NO. 7

FIGURE A-8

PROJECT NAME: Hawks Glen **PROJ. NO:** T-7103 **LOGGED BY:** JCS

LOCATION: Redmond, Washington **SURFACE CONDS:** Grass **APPROX. ELEV:** 190

DATE LOGGED: 8-20-14 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

DEPTH (FT.)	SOIL SAMPLE	DESCRIPTION	CONSISTENCY/ RELATIVE DENSITY	W (%)	POCKET PEN. (TSF)
		6 inches Sod and Topsoil. Brown silty SAND with gravel, dry. (SM)			
1			Medium Dense		
2		Gray-brown to gray, trace to slightly clayey, silty fine SAND to trace to slightly clayey, fine sandy SILT, moist, mottled, scattered gravel, trace of cobbles and 1.5-foot diameter boulders. (SM/ML)			
3					
4				21.1	
5			Medium Dense to Dense		
6		Gray to gray-brown silty fine SAND with gravel, moist, mottled. (SM)			
				16.0	
7					
		Test pit terminated at 7.5 feet. No groundwater seepage.			
8					
9					
10					

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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and Environmental Earth Sciences

Attachment 19

LOG OF TEST PIT NO. 8

FIGURE A-9

PROJECT NAME: Hawks Glen **PROJ. NO:** T-7103 **LOGGED BY:** JCS

LOCATION: Redmond, Washington **SURFACE CONDS:** Grass **APPROX. ELEV:** 201

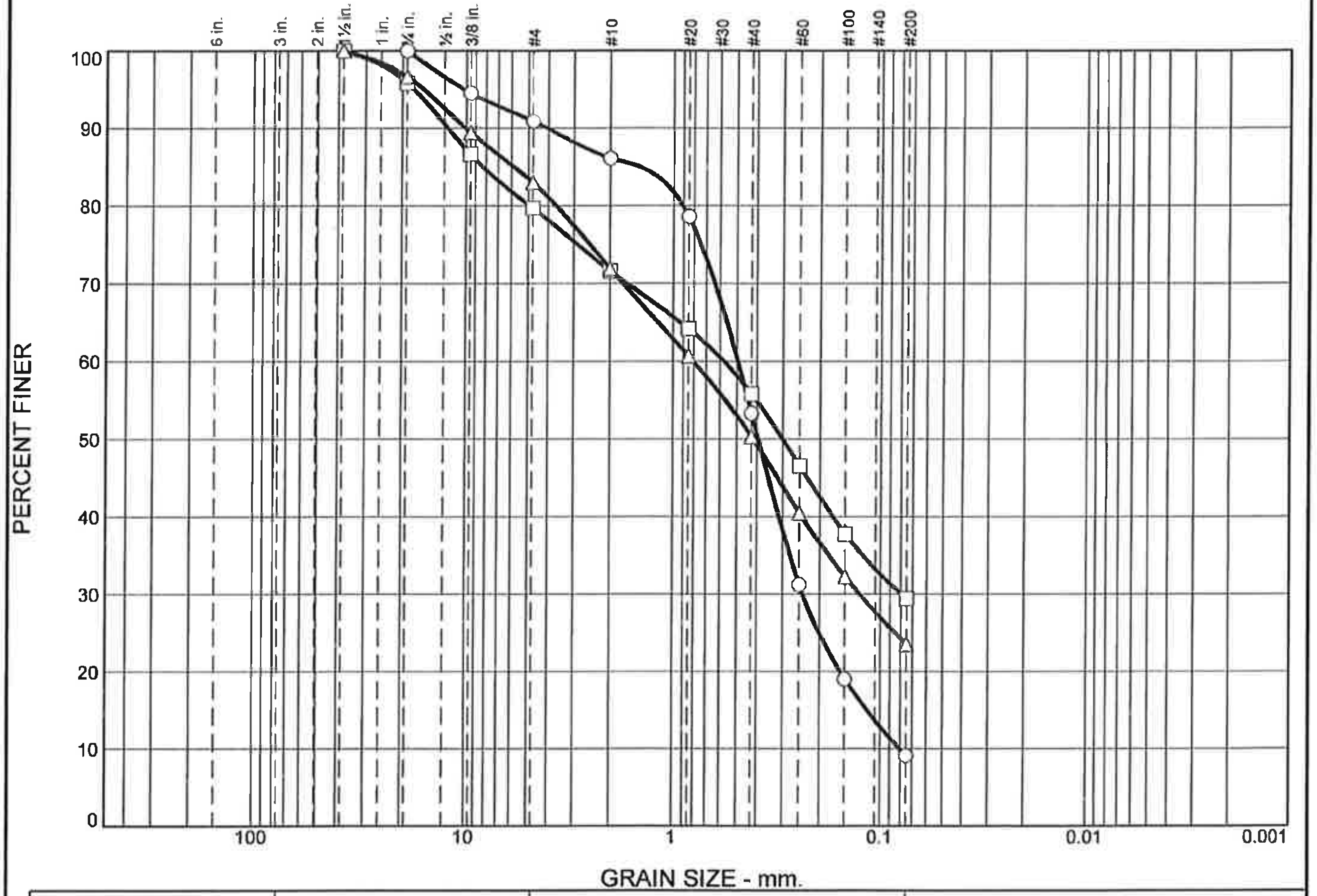
DATE LOGGED: 8-20-14 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

DEPTH (FT.)	SOIL SAMPLE	DESCRIPTION	CONSISTENCY/ RELATIVE DENSITY	W (%)	POCKET PEN. (TSF)
1		6 inches Sod and Topsoil. Red-brown silty SAND with gravel, dry. (SM)	Medium Dense		
2		Gray to light brown silty SAND with gravel, moist, mottled, scattered cobbles. (SM)			
3 4		Gray to light brown, trace to slightly clayey, silty fine SAND to trace to slightly clayey, fine sandy SILT, moist, mottled, scattered cobbles. (SM/ML)	Medium Dense to Dense		
5 6		Gray to brown-gray silty SAND with gravel, moist, weakly cemented. (SM) (Till like)	Dense	11.1	
7 8 9 10		Test pit terminated at 7 feet. No groundwater seepage.			

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

Terra Associates, Inc.
Consultants in Geotechnical Engineering, Geology and Environmental Earth Sciences

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	9.1	4.8	32.8	44.2	9.1	
□	0.0	4.2	16.1	8.1	15.8	26.4	29.4	
△	0.0	3.4	13.6	11.1	21.6	26.8	23.5	

☒	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			1.4499	0.4953	0.3948	0.2410	0.1166	0.0805	1.46	6.15
□			8.3117	0.5763	0.3024	0.0794				
△			5.8466	0.8067	0.4179	0.1277				

Material Description	USCS	AASHTO
○ SAND with silt	SW-SM	
□ silty SAND with gravel	SM	
△ silty SAND with gravel	SM	

Project No. T-7103 **Client:** Quadrant Homes
Project: Hawks Glen

○ **Location:** TP-2 **Depth:** 5.5'
□ **Location:** TP-5 **Depth:** 3'
△ **Location:** TP-8 **Depth:** 5.5'

Terra Associates, Inc.

Kirkland, WA

Remarks:
○Tested 8-28-14
□Tested 8-28-14
△Tested 8-28-14

Figure A-10

Tested By: FQ

APPENDIX B

EXISTING SHALLOW DRAINAGE REVIEW

Attachment 19

TERRA ASSOCIATES, Inc.

Consultants in Geotechnical Engineering, Geology
and
Environmental Earth Sciences

January 26, 2016
Project No. T-7103

Mr. Matt Perkins
Quadrant Homes
14725 SE 36th Street, Suite 200
Bellevue, Washington 98006

Subject: Existing Shallow Drainage Review
Hawks Glen
17656 NE 116th Street
Redmond, Washington

References:

1. Critical Aquifer Recharge Areas Report, Project No. T-7103, prepared by Terra Associates, Inc., dated September 8, 2015
2. Geotechnical Report, Ray Meadows, Project No. T-7103, prepared by Terra Associates, Inc., dated August 29, 2014

Dear Mr. Perkins:

As requested, we visited the subject site to view existing shallow drainage measures installed by the former property owner. The purpose of our work is to evaluate potential impacts to the shallow groundwater regime at the site if the existing drainage measures were removed.

Based on our observations, it appears that all of the on-site drainage measures were intended to intercept surface water and shallow perched interflow, and to convey the collected water to the downgradient eastern side of the property. Passive drainage measures that we observed include several shallow ditches dug along the western site margin; several rows of sand bags placed on the ground surface along the western site margin; and a network of shallow interceptor drains/conveyance pipes in the pasture areas located in the southern approximately 620 feet of the site.

We did not observe any pipes installed to drain water from ditches along the western site margin. However, we observed a 2-foot long vertical section of 2-foot diameter plastic pipe in the ditch located west of the detached garage/shop building that likely served as a sump for periodic pumping. We did not observe any indications of permanent pipes or pump installations in this area.

The ditches we observed on the western site margin contained standing water to the adjacent ground surface or just below the ground surface. We observed an accumulation of surface water on the upgradient western side of the detached garage/shop building and in a localized topographic depression in the pasture, near the eastern site margin. We also observed localized areas of surface water in the undeveloped property immediately west of the subject site. We were unable to locate the discharge locations of the shallow interceptor drains/conveyance pipes to verify that the drains/conveyance pipes were functioning.

Attachment 19

We hand excavated several shallow test holes upgradient from the localized accumulation of surface water in the eastern portion of the pasture. The observed soils consist of about 7 to 8 inches of sod and moist to wet topsoil overlying medium dense to dense silt. Groundwater seepage observed in the test holes is perched above the silt within the topsoil layer. This is consistent with the findings of our previous studies.

Based on our previous studies and recent field observations, it is our opinion that removal of the on-site shallow interceptor drains/conveyance pipes would not have a significant impact on the existing shallow groundwater conditions at the site. Assuming that the shallow interceptor drain/conveyance pipes are functioning properly, it is likely that their removal would result in some increase of the duration of the seasonal perched groundwater condition at the site; however, we do not anticipate that this potential increase in duration would result in seasonal surface ponding that differs significantly from current conditions. This is supported by surface conditions shown on historical aerial photographs that show no indication of persistent surface water at the site in photographs dating to 1936.

We trust the information presented is sufficient for your current needs. If you have any questions or require additional information, please call.

Sincerely yours,
TERRA ASSOCIATES, INC.

John C Sadler 1-26-16

State of Washington
Engineering Geologist
1218
Licensed Geologist
JOHN C. SADLER

John C. Sadler, L.E.G., L.H.G.
Project Manager/Engineering Geologist

Attachment 19

TERRA ASSOCIATES, Inc.
Consultants in Geotechnical Engineering, Geology
and
Environmental Earth Sciences

January 26, 2016
Revised February 25, 2016
Project No. T-7103

Mr. Matt Perkins
Quadrant Homes
14725 SE 36th Street, Suite 200
Bellevue, Washington 98006

Subject: Existing Shallow Drainage Review
Hawks Glen
17656 NE 116th Street
Redmond, Washington

References:
1. Critical Aquifer Recharge Areas Report, Project No. T-7103, prepared by Terra Associates, Inc., dated September 8, 2015
2. Geotechnical Report, Ray Meadows, Project No. T-7103, prepared by Terra Associates, Inc., dated August 29, 2014

Dear Mr. Perkins:

As requested, we visited the subject site to view existing shallow agricultural drains installed previously by the property owner. The City of Redmond considers these shallow agricultural drains dewatering devices; therefore, throughout this report, the shallow agricultural drainage measures at the site are referred to as dewatering devices. The purpose of our work is to evaluate potential impacts to the shallow groundwater regime at the site if the existing dewatering devices were removed.

Based on our observations, it appears that all of the existing on-site dewatering devices were intended to intercept and convey surface water and shallow perched interflow to the downgradient eastern side of the property. Passive dewatering devices that we observed include several shallow ditches dug along the western site margin; several rows of sand bags placed on the ground surface along the western site margin; and a network of shallow interceptor drains/conveyance pipes in the pasture areas located in the southern approximately 620 feet of the site.

We did not observe any pipes installed to drain water from ditches along the western site margin. However, we observed a 2-foot long vertical section of 2-foot diameter plastic pipe in the ditch located west of the detached garage/shop building that likely served as a sump for periodic pumping. We did not observe any indications of permanent pipes or pump installations in this area.

The ditches we observed on the western site margin contained standing water to the adjacent ground surface or just below the ground surface. We observed an accumulation of surface water on the upgradient western side of the detached garage/shop building and in a localized topographic depression in the pasture, near the eastern site margin. We also observed localized areas of surface water in the undeveloped property immediately west of the subject site.

Attachment 19

We observed a light flow of water draining into a corrugated metal culvert at the eastern property margin, east-southeast of the residence. We anticipate that the water was discharging from one or more of the shallow dewatering devices/conveyance pipes installed in the southeastern portion of the pasture; however, we were unable to confirm this. We were unable to locate the discharge location(s) of the shallow dewatering devices/conveyance pipes in the northeastern portion of the pasture to verify that they were functioning.

We hand excavated several shallow test holes upgradient from the localized accumulation of surface water in the eastern portion of the pasture. The observed soils consist of about 7 to 8 inches of sod and moist to wet topsoil overlying medium dense to dense silt. Groundwater seepage observed in the test holes is perched above the silt within the topsoil layer. This is consistent with the findings of our previous studies.

Based on our previous studies and recent field observations, it is our opinion that removal of the on-site dewatering devices would not have a significant impact on the existing shallow groundwater conditions at the site. Assuming that the shallow dewatering devices/conveyance pipes are functioning properly, it is likely that their removal would result in some increase of the duration of the seasonal perched groundwater condition at the site; however, we do not anticipate that this potential increase in duration would result in seasonal surface ponding that differs significantly from current conditions. This is supported by surface conditions shown on historical aerial photographs that show no indication of persistent surface water at the site in photographs dating to 1936.

We trust the information presented is sufficient for your current needs. If you have any questions or require additional information, please call.

Sincerely yours,
TERRA ASSOCIATES, INC.

State of Washington
Engineering Geologist
1218
Licensed Geologist
JOHN C. SADLER

2-25-16

John C. Sadler, L.E.G., L.H.G.
Project Manager/Engineering Geologist

cc: Mr. Brett Pudists, Blueline