

# Alderwood South Apartments

## *Drainage Report*

Prepared for

***The Wolff Company***

542 First Ave South, #400  
Seattle, WA 98104

Prepared by

***LDC, Inc.***

20210 241nd Ave NE  
Woodinville, WA 98072  
(425) 806-1869



October 2018

Job No: 17-166

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## **APPENDICES**

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## **SECTION I.0: PROJECT OVERVIEW**

The proposed Alderwood South Apartments project is comprised of parcel #00372600100305. The project proposes the development of the existing parcel for the construction of 240 apartments in 10 separate buildings. An additional clubhouse structure with commercial space is also proposed along Alderwood Mall Blvd. The project address is 2927 Alderwood Mall Blvd, Lynnwood, WA. The site is located within the North ½ of the SE ¼ of Section 15, Township 27N, Range 4E within incorporated City of Lynnwood. See Vicinity Map in Appendix 1 for location.

### **EXISTING SITE**

The existing site is comprised of recently graded area. Prior to summer of 2017, the site contained parking and infrastructure for school buses owned by the Edmonds School District. The site was recently remediated due to contamination issues caused by the previous site use. The site is now predominately bare ground, as it has been graded back to the previously existing topographical condition.

Access to the existing site is from Alderwood Mall Blvd and there is an existing connection out to 33<sup>rd</sup> Ave W that will remain largely for a secondary fire access. Site topographical conditions contain slight slopes and the site collects into an existing closed-pipe City of Lynnwood drainage system that carries flow south.

According to the Snohomish County Soil Survey, the portion of the site that will be developed is of an Urban Land type while a smaller portion is underlain by Mukilteo Muck. Refer to Soil Maps in appendix 3 detailed soil information. For more technical onsite soils information, please see the Geotechnical report as referenced in Section 7.0 of this report. According to the Engineering Geology Report produced by RH2, there are limiting till layers that underly the site at depths of 7-10 feet. These limiting till layers will not be conducive to infiltration and thus cause infiltration to be infeasible on the site.

## PROPOSED DEVELOPMENT

The Alderwood South Apartments project proposes to construct 10 apartment buildings, totaling 240 apartment units, and a clubhouse that includes commercial space along Alderwood Mall Blvd. Construction to support these facilities will include associated sidewalks and paved drive aisle access with associated wet and dry utilities. Development and construction will disturb 8.93 acres. The proposed apartments and clubhouse will gain access from an onsite access and parking lot system internal to the site.

Roof drainage and impervious surface runoff from the developed area will be collected and routed to a detention pipe facility. All onsite runoff will be collected, mitigated and released at historic rates per DOE requirements. Discharge from the facility at controlled rates will enter an existing City of Lynnwood drainage line that routes existing site runoff and upstream runoff through an easement that exists on the project site. Drainage has been designed in accordance with the requirements of the City of Lynnwood Standards and the 2014 update to the 2012 Department of Ecology (DOE) Manual for Western Washington.

## PROPOSED FLOW CONTROL AND WATER QUALITY

In compliance with the requirements of the 2012 DOE Manual, all runoff from developed/disturbed surfaces will be collected, mitigated and released based on existing drainage patterns at mitigated rates. Flow control mitigation of onsite stormwater runoff will be achieved by collecting and routing and routing flow to a detention pipe facility that will be located beneath the onsite drive aisles and within the open space area central to the site. Hydrologic stormwater detention calculations have been completed using WWHM2012. See section 4.4 for additional description and calculations concerning the proposed stormwater flow control measures.

Detained stormwater will be treated prior to discharge into the existing City of Lynnwood stormwater system. Due to the multi-family nature of the site, the DOE Manual requires an “Enhanced” water quality treatment level. A Modular Wetland, a

GULD-approved water quality structure, has been proposed to treat flow to an “enhanced” level. See section 4.5 for additional water quality treatment information.

### CORE REQUIREMENTS

Per the 2012 DOE Manual, Core Requirements 1-9 apply to the proposed development.

**Minimum Requirement #1: Preparation of Stormwater Site Plans:** This Report along with the Stormwater Site Plans (Part of the Alderwood South Apartments Construction Civil Plans) satisfies this minimum requirement.

**Minimum Requirement #2: Construction Stormwater Pollution Prevention:** See Section 2 of this Report for the SWPPP BMP Elements, and the SWPPP (submitted as a separate document) for a complete discussion of erosion control BMP’s and their use specific to the site.

**Minimum Requirement #3: Source Control of Pollution:** Permanent source control BMPs are not applicable for the subject site since the associated activities for the new residence do not fall within the types of facilities listed within Volume IV of the Drainage Manual (Residential developments are not required to implement source control BMP’s). BMPs for erosion and sedimentation control are specified in the Construction Plans and the SWPPP.

**Minimum Requirement #4: Preservation of Natural Drainage Systems and Outfalls:** The site contains one natural discharge location. Onsite runoff drains to an existing closed-pipe drainage system running north/south through an easement on the site that discharges site flow south across the Interstate 5 ROW. Flow then enters an unnamed tributary of Swamp Creek. Discharge travels as stream flow south to Swamp Creek. Please see downstream analysis in Section 3.0 of this report for further information regarding the location of existing natural outfalls and the downstream flowpath. The proposed flow routing in the developed condition will convey treated,

mitigated stormwater discharge into the existing pipe in the same way as the predeveloped condition.

**Minimum Requirement #5: Onsite Stormwater Management:**

Geotechnical investigation of site soils and underlying geology reveal soils contain a layer of till soils that prevents infiltration of onsite stormwater. Per the till nature of these soils, the geotechnical engineer has not recommended infiltration. Infiltration facilities are not anticipated to be used as Onsite Stormwater Management BMP's or for stormwater control. BMP T5.13 soils and perforated stub-out roof drain connections are utilized in order to satisfy LID and Onsite Stormwater Management requirements to the maximum feasible extent.

**Minimum Requirement #6: Runoff Treatment:** As the proposed development is multi-family residential in nature, "Enhanced" water quality treatment is required. This site will use a Modular Wetland structure for basic water quality treatment. See Onsite Stormwater Analysis in Section 4.4 of this report for design parameters.

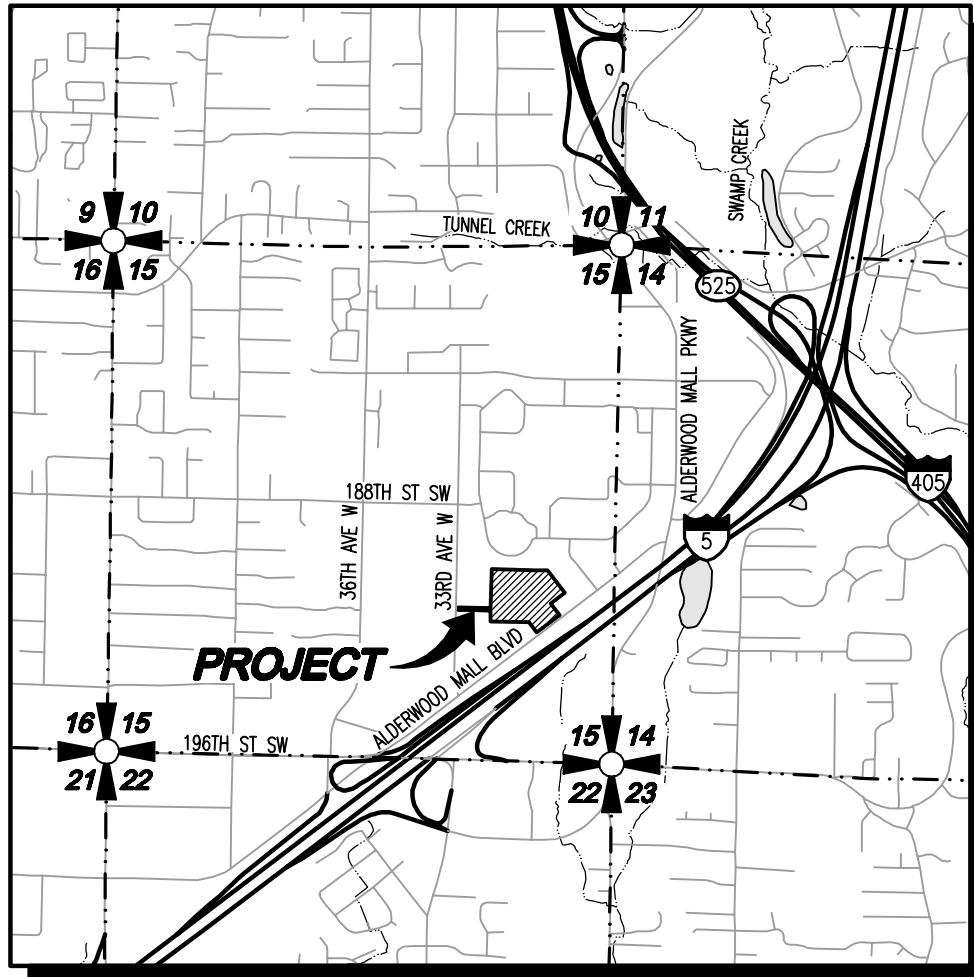
**Minimum Requirement #7: Flow Control:** This site will use a detention pipe system located beneath the onsite drive aisles and the central open space area to satisfy flow control requirements. See Onsite Stormwater Analysis in Section 4.5 of this report for design calculations performed in WWHM2012 and design specifics.

**Minimum Requirement #8: Wetlands Protection:** There are no wetlands on or adjacent to the project site.

**Minimum Requirement #9: Operation and Maintenance:** See Operations and Maintenance in Section 6.0 of this report.

## **Appendix 1: Project Overview**

1. Figure 1.0 - Vicinity Map
2. Figure 2.0 - Existing Conditions Map
3. Figure 3.0 - Proposed Development Map



## **VICINITY MAP**

SCALE: 1"=2000'

Drawing: P:\Civil\2017\17-166 Alderwood South Apartments\Exhibits\17166E-VLM.dwg Plotted: Jun 08, 2018 - 4:08pm

**15<sup>th</sup> ANNIVERSARY**  
**LDC** | Surveying  
 Engineering  
 Planning

20210 142nd Avenue NE  
 Woodinville, WA 98072

Ph. 425.806.1869  
 Fx. 425.482.2893

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**ALDERWOOD SOUTH  
 APARTMENTS**

**VICINITY MAP**





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**ALDERWOOD SOUTH  
APARTMENTS**

EXISTING CONDITIONS MAP

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

REVISION:  
JOB NUMBER: 17-166  
DRAWING NAME: 17-166F02  
DESIGNER: TABBOTT  
DRAWING BY: TABBOTT  
DATE: 01-22-18  
SCALE: AS SHOWN  
JURISDICTION: LYNNWOOD

**FIGURE:**

**2.0**

**LDC**  
THE CIVIL ENGINEERING GROUP

14201 NE 200th St., #100  
Woodinville, WA 98072

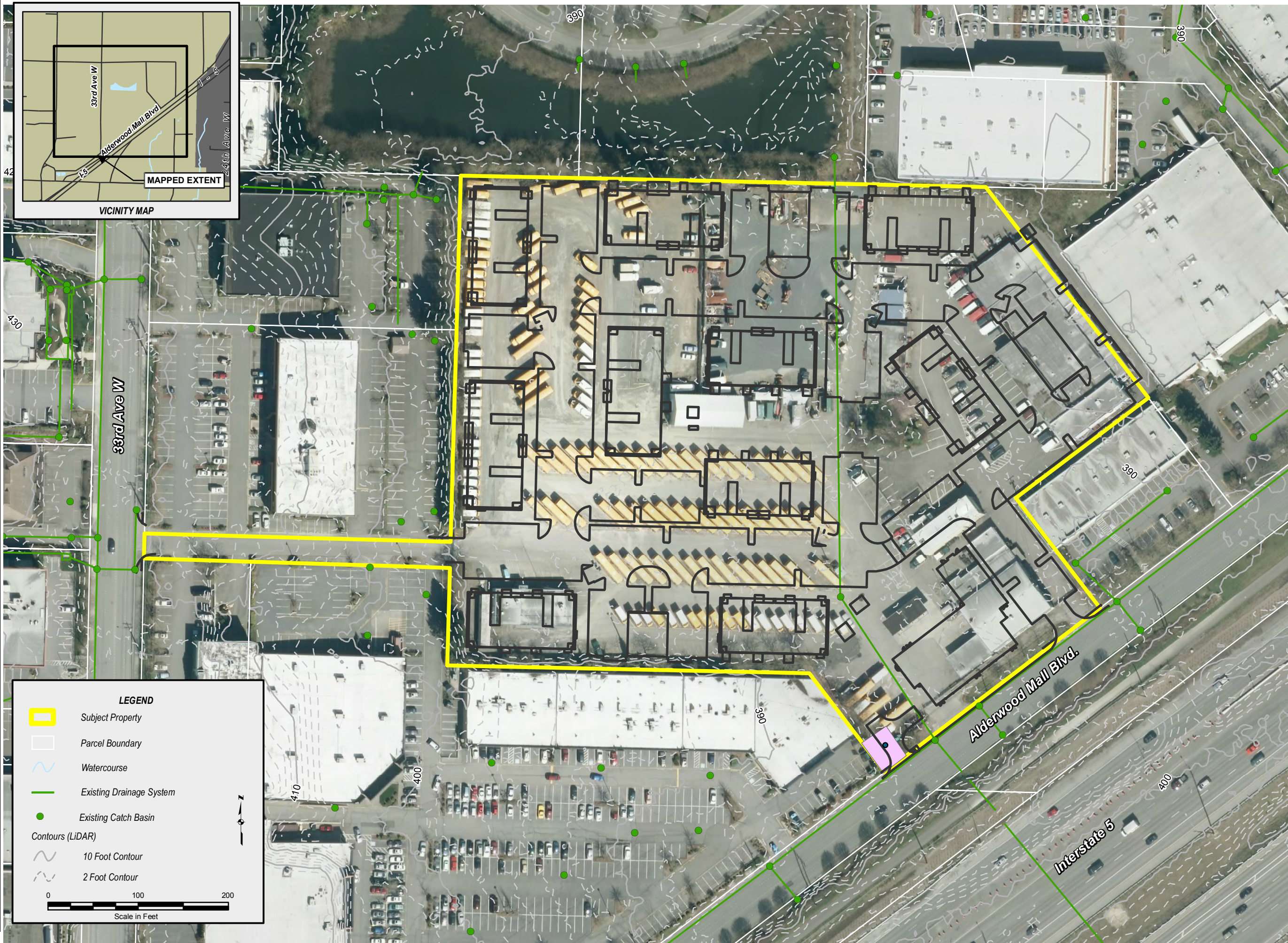
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Fk: 425.482.2893

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Infrastructure  
Residential

SOURCE INFORMATION	
SOURCE AGENCY	DESCRIPTION
CITY OF LYNNWOOD GIS	PARCEL BOUNDARY, EXISTING DRAINAGE
SNOMOMISH COUNTY GIS	CONTOURS GENERATED FROM BARE EARTH LIDAR (KING COUNTY).
	THIS DATA HAS A STATED VERTICAL ACCURACY OF APPROXIMATELY 1 FOOT.





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**ALDERWOOD SOUTH  
APARTMENTS**  
PROPOSED DEVELOPMENT MAP

PROJECTION: WASHINGTON  
STATE PLANE, NORTH ZONE,  
NAD 83 HARN, FEET  
REVISION:  
JOB NUMBER: 17-166  
DRAWING NAME: 17-166F03  
DESIGNER: TABBOTT  
DRAWING BY: TABBOTT  
DATE: 01-22-18  
SCALE: AS SHOWN  
JURISDICTION: LYNNWOOD

FIGURE:  
**3.0**

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	THIS DATA HAS A STATED VERTICAL ACCURACY OF APPROXIMATELY 1 FOOT.



## **SECTION 2.0: RISK ASSESSMENT ANALYSIS AND TEMPORARY EROSION AND SEDIMENT CONTROL DESIGN**

### **Temporary Erosion and Sediment Control**

A Stormwater Pollution Prevention Plan (SWPPP) will be provided prior to construction. The SWPPP report is modeled under the guidelines of Volume II, Section 3.0 of the 2014 DOE Manual. Construction SWPPP Elements #1 through #13 are addressed below.

**Element #1 - Mark Clearing Limits:** All clearing limits will be delineated with high visibility plastic fence or silt fence. See sheets ER-01 of the construction plans for locations and details.

**Element #2 - Establish Construction Access:** As the site is being constructed near an existing roadway, there is no need for a construction access entrance to the site.

**Element #3 - Control Flow Rates:** Detention of construction period runoff will be provided by a temporary sediment pond located near the northwestern portion of the site. The pond and associated riser will provide sediment and flow control as construction-period runoff is directed to the pond. See sheets ER-01 and ER-02 of the plans for location and details of the drainage system, temporary sediment pond design specifics and other flow and sediment control BMP's.

**Element #4 - Install Sediment Controls:** Silt fence, catch basin protection, the temporary sediment pond and check dams will be utilized to contain sediments within the project's clearing limits. See sheets ER-01 and ER-02 of the plans for locations and details.

**Element #5 - Stabilize Soils:** Exposed soils will be stabilized as specified in the Grading and Erosion Control Notes. See sheet ER-02 of the plans for notes.

**Element #6 - Protect Slopes:** Slopes are minor on the subject site. Slopes shall be protected as specified under Element #5.

**Element #7 - Protect Drain Inlets:** Storm drain inlet protection will be utilized to contain sediments within the project's clearing limits. See sheets ER-01 and ER-02 of the plans for locations and details.

**Element #8 - Stabilize Channels and Outlets:** Temporary interceptor swales shall be stabilized with mulch or seeding. See sheets ER-01 and ER-02 of the plans for locations and details.

**Element #9 - Control Pollutants:** Pollutants shall be controlled as specified in the Pollutant Control Notes. See sheet ER-02 of the plans for notes.

**Element #10 - Control De-Watering:** Disposal options for de-watering water are as specified in the De-Watering Control Notes. See sheet ER-02 of the plans for notes.

**Element #11 - Maintain BMPs:** Maintenance of the BMPs is specified within the Construction Sequence and Grading and Erosion Control Notes. See sheet ER-02 of the plans for the Construction Sequence and notes.

**Element #12: Manage the Project:** The Grading and Erosion Control Notes specify seasonal work limitations. Maintenance of the BMPs is specified within the Construction Sequence and Grading and Erosion Control Notes. See sheet ER-02 of the plans for the Construction Sequence and notes.

**Element #13: Protect LID BMPs:** There are no LID BMPs proposed for this site. If there becomes a need in the field that requires LID BMPs, then the BMPs should be protected according to the above elements and guidelines.

### **3.0 OFF-SITE ANALYSIS REPORT**

#### **Task 1. Study Area Definition and Maps**

Snohomish County LiDAR, survey, and 2012 aerial photography were the best topographical references available for the area containing the site. The limits of downstream analysis extended roughly 0.3 miles (See Figure 4.0, “Downstream Analysis Map”).

#### **Task 2. Resource Review**

All of the resources below have been reviewed for existing and potential issues near the project site:

- **Adopted Basin Plans**  
No Adopted Basin Plans were located that include the project site.
- **Drainage Basin**  
Per the City of Lynnwood GIS data, this site is located within the Swamp Creek Basin.
- **Floodplain / Floodway (FEMA) maps**  
According to FEMA mapping this project is not within a floodplain.
- **Critical Areas Map**  
There are no critical areas located on or near the site.
- **Drainage Complaints**  
There are no relevant complaints or known issues closely related to the project site.
- **Road Drainage Problems**  
No issues were identified near the proposed site.

- **Snohomish County Soil Survey**

According to the Snohomish County Soil Survey, the portion of the site that will be developed is of an Urban Land type while a smaller portion is underlain by Mukilteo Muck. Refer to Soil Maps in appendix 3 detailed soil information. For more technical onsite soils information, please see the Geotechnical report as referenced in Section 7.0 of this report.

According to the Engineering Geology Report produced by RH2, there are limiting till layers that underly the site at depths of 7-10 feet. These limiting till layers will not be conducive to infiltration and thus cause infiltration to be infeasible on the site.

- **Wetland Inventory Maps**

There are no wetlands associated with the site.

- **Migrating River Studies**

Migrating River Studies are considered to be not applicable to the proposed site development.

- **Section 303d List of Polluted Waters**

Please refer to Appendix 3, for Washington State Department of Ecology's water quality assessment results regarding the unnamed tributary to Swamp Creek. The limits of the proposed project are tributary to Lake Washington.

- **Water Quality Problems**

The unnamed tributary to Swamp Creek contains several water quality listings. These listings can be found in Appendix 3.

- **Stormwater Compliance Plans**

Not applicable to the proposed project.

### **Task 3. Field Inspection/Downstream Analysis**

On July 7<sup>th</sup>, 2018, an Upstream and Downstream Analyses were performed at the site. The weather was partly cloudy and approximately 68°F. The following observations were verified during this visit.

Upstream areas are defined as any areas that flow onto developed portions of the site. There is a visible upstream area associated with the project upon site analysis. The adjacent parcel's, (#00372600100701), existing closed stormwater system releases runoff into a ditch running east adjacent to the north boundary of the project site. Upstream contributing area consists of commercial buildings and associated drive aisles. Runoff travels east through the ditch for approximately 270 feet until flow is redirected south onsite into a debris barried pipe at the northern boundary of the site❶. Flow traveling south from the ditch inlet for approximately 125 LF into a catch basin❷ and then 300 LF south until it is redirected southeast 120 LF into a catch basin❸. A pipe appears to exit the catch basin southeast but it is not apparent what downstream system it feeds into❹.

The subject property is currently developed with existing impervious cover such as gravel and asphalt with a small vegetative island in the central portion of the site. The majority of the site is moderately sloping with slopes directing flow towards the northern and south eastern portion of the site.

There are multiple apparent storm systems on the project site. The first main storm conveyance system is described in the upstream analysis portion of this section. The second storm system running through the site is a 54" closed pipe system. Flow enters off the northern site boundary from a manmade pond through a debris caged manhole❺ and travels south parallel to a 12" sewer system for approximately 490 LF until it is redirected southeast❻❼. Flow travels approximately 190 LF until it continues off site, under Interstate 5, and

is released into a wetland on the other side of Interstate 5⑧. Flow continues south through the wetland for almost 900 feet and reaches a culvert passing under 196<sup>th</sup> St SW before it exits the 0.25 mile buffer⑨.

See Figure 4.0, “Downstream Analysis Map”, located in Appendix 3, for a representation of the downstream flow paths.

#### **Task 4. Drainage System Description and Problem Descriptions**

Based on the resources available and the anticipated downstream flow path, there is no evidence of existing or anticipated downstream drainage problems. All downstream appurtenances and open channels are adequately sized to sufficiently convey flows resulting from large storm events. No additional problems are foreseen due to the proposed development.

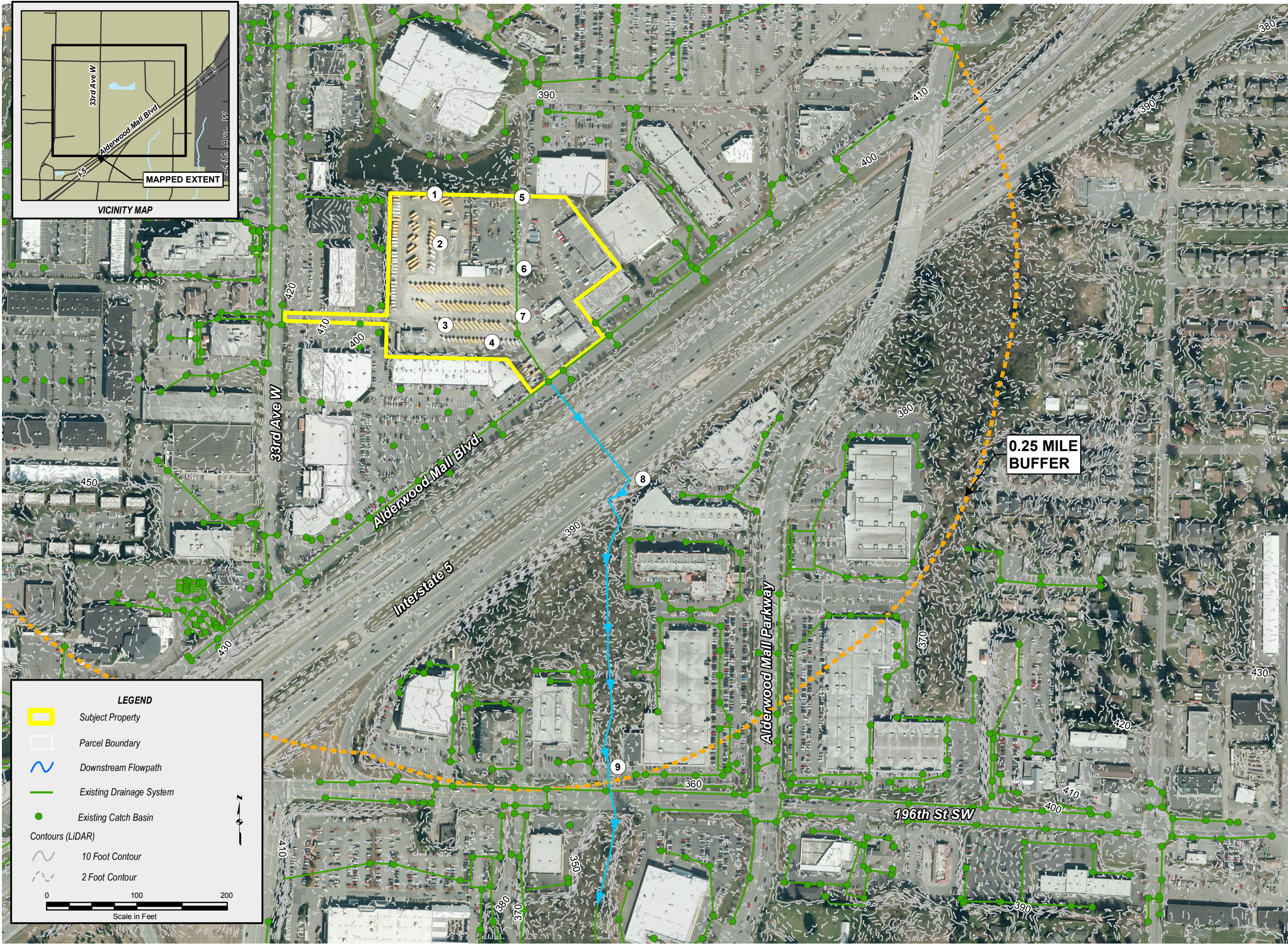
#### **Task 5. Mitigation of Existing or Potential Drainage Issues**

No evidence of existing or potential problems with upstream or downstream drainage conveyance infrastructure was found. Mitigation is not required.

### **Appendix 3: Resource Review**

1. Figure 4.0 - Downstream Analysis Map
2. FEMA Floodplain Map - Panel #53061C1309E
3. USGS Soils Map
4. USGS Soils Description
5. 303d Listings
6. Downstream Site Visit Pictures





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APARTMENTS**

DOWNSTREAM ANALYSIS MAP

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

REVISION:  
JOB NUMBER: 17-166  
DRAWING NAME: 17-166F04  
DESIGNER: TABBOTT  
DRAWING BY: TABBOTT  
DATE: 01-22-18  
SCALE: AS SHOWN  
JURISDICTION: LYNNWOOD

SOURCE INFORMATION	
SOURCE AGENCY	DESCRIPTION
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SNOMISH COUNTY GIS	CONTOURS GENERATED FROM BARE EARTH LIDAR (KING COUNTY).
	THIS DATA HAS A STATED VERTICAL ACCURACY OF APPROXIMATELY 1 FOOT.

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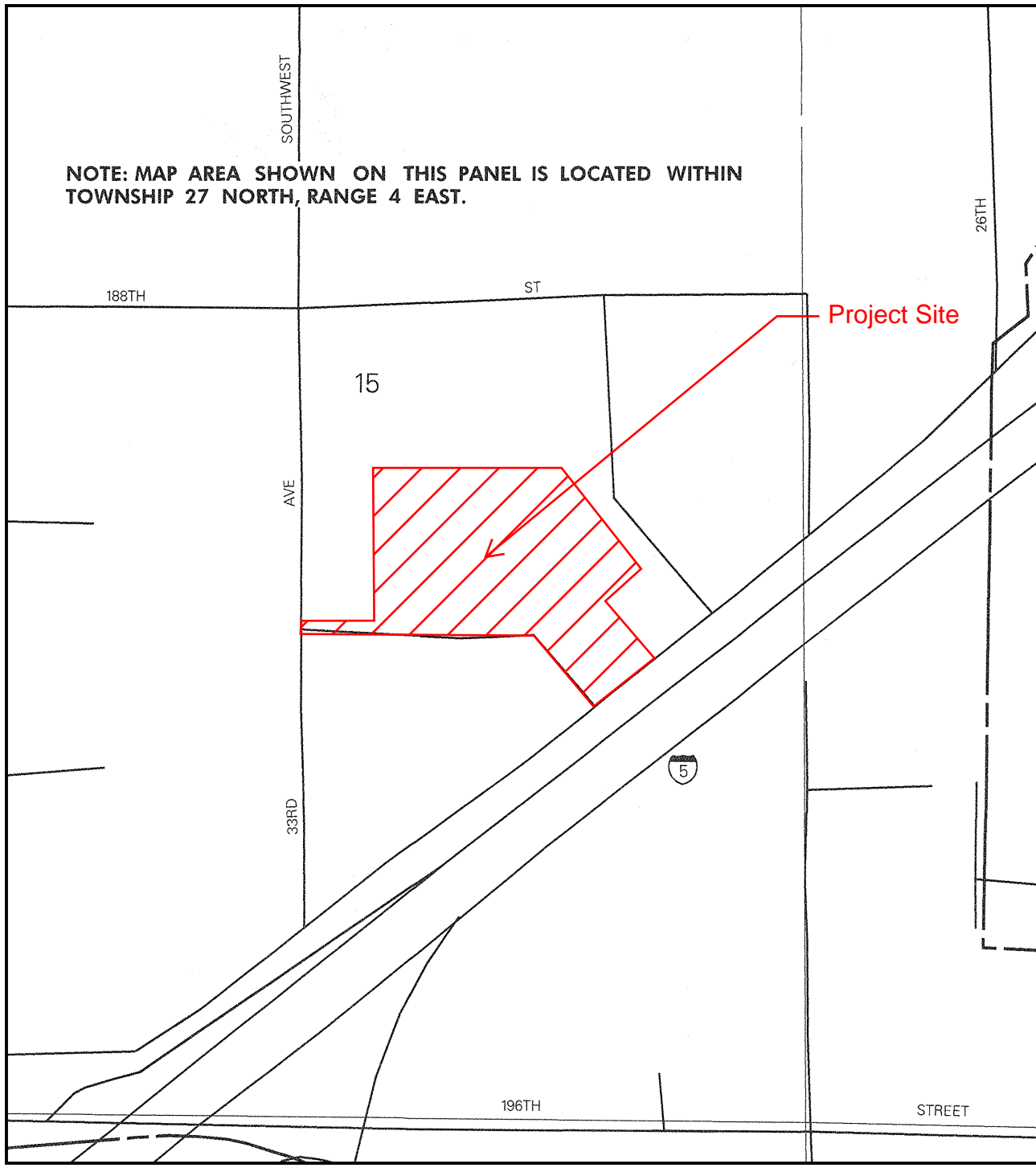
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Fx: 425.452.2893

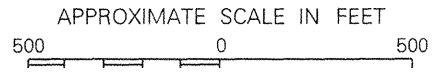
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FIGURE:  
**4.0**





NOTE: MAP AREA SHOWN ON THIS PANEL IS LOCATED WITHIN TOWNSHIP 27 NORTH, RANGE 4 EAST.



NATIONAL FLOOD INSURANCE PROGRAM

**FIRM**  
FLOOD INSURANCE RATE MAP

SNOHOMISH COUNTY,  
WASHINGTON AND  
INCORPORATED AREAS

**PANEL 1309 OF 1575**  
(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS: COMMUNITY	NUMBER	PANEL	SUFFIX
LYNNWOOD, CITY OF	530167	1309	E
SNOHOMISH COUNTY, UNINCORPORATED AREAS	535534	1309	E

**MAP NUMBER**  
**53061C1309 E**

**EFFECTIVE DATE:**  
**NOVEMBER 8, 1999**



Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at [www.msc.fema.gov](http://www.msc.fema.gov)


Soil Map—Snohomish County Area, Washington  
(Alderwood South Apartments)



Soil Map—Snohomish County Area, Washington  
(Alderwood South Apartments)


## MAP LEGEND

### Area of Interest (AOI)

 Area of Interest (AOI)

### Soils

 Soil Map Unit Polygons

 Soil Map Unit Lines

 Soil Map Unit Points

### Special Point Features



Blowout



Borrow Pit



Clay Spot



Closed Depression



Gravel Pit



Gravelly Spot



Landfill



Lava Flow



Marsh or swamp



Mine or Quarry



Miscellaneous Water



Perennial Water



Rock Outcrop



Saline Spot



Sandy Spot



Severely Eroded Spot



Sinkhole



Slide or Slip



Sodic Spot



Spoil Area



Stony Spot



Very Stony Spot



Wet Spot



Other



Special Line Features

### Water Features



Streams and Canals

### Transportation



Rails



Interstate Highways



US Routes



Major Roads



Local Roads

### Background



Aerial Photography

## MAP INFORMATION

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

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

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

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

Source of Map: Natural Resources Conservation Service

Web Soil Survey URL:

Coordinate System: Web Mercator (EPSG:3857)

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

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

Soil Survey Area: Snohomish County Area, Washington

Survey Area Data: Version 17, Nov 22, 2017

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

Date(s) aerial images were photographed: Jul 7, 2014—Jul 8, 2014

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

## Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
6	Alderwood-Urban land complex, 8 to 15 percent slopes	0.1	0.9%
34	Mukilteo muck	0.8	9.0%
78	Urban land	8.1	90.2%
<b>Totals for Area of Interest</b>		<b>8.9</b>	<b>100.0%</b>



## Snohomish County Area, Washington

### 34—Mukilteo muck

#### Map Unit Setting

*National map unit symbol:* 2hyr

*Elevation:* 0 to 1,000 feet

*Mean annual precipitation:* 40 to 70 inches

*Mean annual air temperature:* 48 to 52 degrees F

*Frost-free period:* 150 to 250 days

*Farmland classification:* Prime farmland if drained

#### Map Unit Composition

*Mukilteo, drained, and similar soils:* 85 percent

*Minor components:* 15 percent

*Estimates are based on observations, descriptions, and transects of the mapunit.*

#### Description of Mukilteo, Drained

##### Setting

*Landform:* Depressions

*Parent material:* Herbaceous organic material

##### Typical profile

*H1 - 0 to 4 inches:* muck

*H2 - 4 to 35 inches:* mucky peat

*H3 - 35 to 54 inches:* mucky peat

*H4 - 54 to 60 inches:* fine sandy loam

##### Properties and qualities

*Slope:* 0 to 1 percent

*Depth to restrictive feature:* More than 80 inches

*Natural drainage class:* Very poorly drained

*Capacity of the most limiting layer to transmit water (Ksat):*

Moderately high to high (0.57 to 1.98 in/hr)

*Depth to water table:* About 0 to 12 inches

*Frequency of flooding:* None

*Frequency of ponding:* None

*Available water storage in profile:* Very high (about 25.0 inches)

##### Interpretive groups

*Land capability classification (irrigated):* None specified

*Land capability classification (nonirrigated):* 3w

*Hydrologic Soil Group:* B/D

*Other vegetative classification:* Soils with Few Limitations  
(G002XN502WA)

*Hydric soil rating:* Yes

#### Minor Components

##### Terric medisaprists, undrained

*Percent of map unit:* 5 percent

*Landform:* Depressions

*Other vegetative classification:* Wet Soils (G002XN102WA)

*Hydric soil rating:* Yes

**Orcas**

*Percent of map unit:* 5 percent

*Landform:* Depressions

*Other vegetative classification:* Wet Soils (G002XN102WA)

*Hydric soil rating:* Yes

**Mukilteo, undrained**

*Percent of map unit:* 5 percent

*Other vegetative classification:* Wet Soils (G002XN102WA)

*Hydric soil rating:* Yes

## Data Source Information

Soil Survey Area: Snohomish County Area, Washington

Survey Area Data: Version 17, Nov 22, 2017

## **Snohomish County Area, Washington**

### **78—Urban land**

#### **Map Unit Composition**

*Urban land:* 100 percent

*Estimates are based on observations, descriptions, and transects of the mapunit.*

## **Data Source Information**

Soil Survey Area: Snohomish County Area, Washington

Survey Area Data: Version 17, Nov 22, 2017

<b>Listing ID: 73136</b>	
<b>Main Listing Information</b>	
<b>Listing ID:</b> 73136	<b>2014 Category:</b> 5
<b>Waterbody Name:</b> UNNAMED CREEK (TRIB TO SWAMP CREEK)	<b>2012 Category:</b> 3
<b>Medium:</b> Water	<b>2008 Category:</b> 3
<b>Parameter:</b> Temperature	<b>2004 Category:</b> 3
<b>WQI Project:</b> None Assigned	<b>On 1998 303(d) List?:</b> N
<b>Designated Use:</b> None Assigned	<b>On 1996 303(d) List?:</b> N
<b>Assessment Unit</b>	
<b>Assessment Unit ID:</b> 17110012000566	
<b>Location Identification</b>	
<b>Counties:</b> Snohomish	<b>WRIA:</b> 8 - Cedar-Sammamish
<b>Waterbody ID (WBID):</b> None Assigned	<b>Waterbody Class:</b> None Assigned
<b>Town/Range/Section (Legacy):</b> 27N-4E-23	
<b>Basis</b>	
Location ID: SWAMP CREEK C -- In 2009, 9 of 11 sample values (82%) showed an excursion of the criteria (16°C) for this waterbody;	
<b>Remarks</b>	
No Remarks Entered	
<b>EIM</b>	
<b>User Study ID:</b>	<b>User Location ID:</b>
G0700316	SWAMP CREEK C



<b>Listing ID: 78038</b>			
<b>Main Listing Information</b>			
<b>Listing ID:</b> 78038		<b>2014 Category:</b> 5	
<b>Waterbody Name:</b> UNNAMED CREEK (TRIB TO SWAMP CREEK)		<b>2012 Category:</b> 3	
<b>Medium:</b> Water		<b>2008 Category:</b> 3	
<b>Parameter:</b> Dissolved Oxygen		<b>2004 Category:</b> 3	
<b>WQI Project:</b> None Assigned		<b>On 1998 303(d) List?:</b> N	
<b>Designated Use:</b> None Assigned		<b>On 1996 303(d) List?:</b> N	
<b>Assessment Unit</b>			
<b>Assessment Unit ID:</b> 17110012000566			
<b>Location Identification</b>			
<b>Counties:</b> Snohomish		<b>WRIA:</b> 8 - Cedar-Sammamish	
<b>Waterbody ID (WBID):</b> None Assigned		<b>Waterbody Class:</b> None Assigned	
<b>Town/Range/Section (Legacy):</b> 27N-4E-23			
<b>Basis</b>			
Location ID: [SWAMP CREEK C] -- In 2009, 5 of 5 sample values (100%) showed an excursion of the criterion (9.5 mg/L) for this waterbody;			
<b>Remarks</b>			
<b>Remark</b>	<b>Modified By</b>	<b>Modified On</b>	<b>Visibility</b>
Ten percent or more of the samples collected in a single year were excursions of the criterion, and at least 3 excursions exist from all data considered.	Jessica Archer	10/3/2014	Public
<b>EIM</b>			
<b>User Study ID:</b>		<b>User Location ID:</b>	
G0700316		SWAMP CREEK C	

Listing ID: 70242			
Main Listing Information			
Listing ID: 70242	2014 Category: 5		
Waterbody Name: UNNAMED CREEK (TRIB TO SCRIBER CREEK)	2012 Category: 3		
Medium: Other	2008 Category: 3		
Parameter: Bioassessment	2004 Category: 3		
WQI Project: None Assigned	On 1998 303(d) List?: N		
Designated Use: None Assigned	On 1996 303(d) List?: N		
Assessment Unit			
Assessment Unit ID: 17110012000566			
Location Identification			
Counties: Snohomish	WRIA: 8 - Cedar-Sammamish		
Waterbody ID (WBID): None Assigned	Waterbody Class: None Assigned		
Town/Range/Section (Legacy): 27N-4E-23			
Basis			
Location ID [SCRTR203] was sampled by Snohomish County in 2005, 2008 - the Benthic Index of Biotic Integrity (B-IBI) score was 20 in 2005 and 14 in 2008.			
Location ID [SCRTR25] was sampled by Snohomish County in 2005, 2008 - the Benthic Index of Biotic Integrity (B-IBI) score was 18 in 2005 and 14 in 2008.			
Remarks			
Remark	Modified By	Modified On	Visibility
The source of the benthic macroinvertebrate community data and associated B-IBI scores is the Puget Sound Stream Benthos database, which is maintained by King County.	Patrick Lizon	12/22/2015	Private
The listing has been reassessed under the current Policy 1-11 and has been moved from Category 3 to Category 5 based on new data.	Curtis Cooper	8/14/2015	Private
The listing has been placed in Category 5 because the two most recent data points indicate that biological integrity is degraded or because two or more B-IBI/RIVPACS data points in the most recent five data points indicate biological degradation and the scores do not qualify for Category 1 or Category 2. A B-IBI score $\leq 27$ and a RIVPACS score less than 0.73 indicates degraded biological integrity. A data point is the lowest bioassessment score observed for a given year.	Curtis Cooper	8/14/2015	Public
EIM			
No EIM Records Entered			



Image①: Runoff from upstream basin enters onsite and into debris barriered intake pipe.



Image②: Intake pipe continues south on site into deep manhole (right pipe) continues directing flow south (left pipe).





Image⑨: Flow enters another catch basin (left submerged pipe) and is redirected southeast in submerged pipe (right).



Image④: Flows enters catch basin and continues southeast off site.





Image⑤: Flow enters into 54" debris caged manhole entering the site in the northern border.



Image⑥: Flow is directed south into a solid lid catch basin system



Image 7: Flow enters into another downstream deep catch basin and is directed south east offsite under Interstate 5.





Image⑧: After flow travels under Intersate 5, flow is discharged from 54" pipe into a protected wetland.



Image⑨: Flow travels through wetland to culvert intake at 196<sup>th</sup> St SW when it crosses 0.25 mile boundary.

## SECTION 4.0: DETENTION AND WATER QUALITY FACILITY ANALYSIS AND DESIGN

### 4.1 Predeveloped Hydrology/Land Cover

The predeveloped and developed conditions were modeled in WWHM2012, which is a continuous hydrologic modeling for the purpose of detention sizing and flow-duration control. Based on the site location, WWHM2012 used a Precipitation Scale factor of 1.0.

As the existing onsite structures to remain within the project boundaries do not total 35% or greater impervious land cover, the project is considered new development. The pre-developed condition (forested) is applied to all surfaces that will be converted for development.

All onsite development has been located in Basins A and the Frontage Basin in the predeveloped condition. Basin A will consist of all developed area that will be detained and mitigated by the proposed detention system while the Frontage Basin cannot be collected in the detention system due to topographical constraints and will modeled as bypass in the developed condition.

For visual representation of Basins A and the Frontage Basin, see Figure 5.0, “Predeveloped Hydrology Map”. The land cover values for Basins A and the Frontage Basin have been modeled in WWHM2012 as follows:

#### Basin A:

Table 4-1.1 - Predeveloped Conditions Areas: Basin A - WWHM

Basin A	
Land Cover	Area
Forested, Flat	8.72 AC
Total	8.72 AC



## Frontage Basin:

Table 4-1.2 - Predeveloped Conditions Areas: Frontage Basin - WWHM

Frontage Basin	
Land Cover	Area
Forested, Flat	0.08 AC
Total	0.08 AC

## 4.2 Developed Site Hydrology

Development associated with the proposed Alderwood South Apartments project will disturb approximately 8.93 AC in the developed condition. Onsite development will consist of constructing building pads, drive aisles, parking and open spaces. There will be frontage improvements along Alderwood Mall Blvd. and 33<sup>rd</sup> Ave. W that will consist of a reconstruction of sidewalk, curb, gutter, and driveway. Approximately 6.52 AC of new impervious cover will be constructed coincident with all improvements.

Developed site runoff will be collected in an onsite stormwater conveyance system and will be routed to a detention pipe facility located beneath the onsite drive aisles and within open spaces area central to the site. In compliance with the requirements within the 2012 DOE Manual, all runoff from onsite developed/disturbed surfaces will be collected, treated, and released to existing/historic flow paths within allowable flow rates per WWHM2012. The basins providing flow in the developed condition have been modeled with their proposed land covers in WWHM2012 in order to determine the facility size necessary to detain developed condition runoff from the site.

### *Pervious Land Cover*

Pervious land cover in Basin A has been modeled as pasture land cover in WWHM2012. Pervious land cover in each developed basin has been modeled as pasture. In Section 7.2 of the 2012 Low Impact Development Technical Guidance Manual for Puget Sound (LID Manual), referenced in Appendix III-C of the 2012 DOE manual, it is prescribed that if landscaped areas are underlain with BMP T5.13 soils, the area may be modeled as pasture. These landscaped areas will be underlain with BMP T5.13 soil mixtures in the developed condition and thus have been modeled as pasture land cover in WWHM.

### **Basin A:**

Basin A is 8.72 AC and is comprised of all onsite developed area. Runoff from these developed condition surfaces will be detained and mitigated in the detention pipe

facility. Basin A has been modeled using WWHM2012 with the following areas and ground cover designations:

Table 4-2.1 - Developed Conditions Areas: Basin A - WWHM

<b>Basin A</b>	
Land Cover	Area
Roof, Flat	2.25 AC
Pavement, Flat	3.36 AC
Sidewalk, Flat	0.83 AC
Pasture, C, Flat	2.28 AC
Total	8.72 AC

**Frontage Basin:**

The Frontage Basin is 0.08 AC and is comprised of frontage sidewalk area along Alderwood Mall Blvd. Runoff from these developed condition surfaces cannot be collected into the onsite detention system due to topographical constraints and has been modeled as bypassing detention. The Frontage Basin has been modeled using WWHM2012 with the following areas and ground cover designations:

Table 4-2.2 - Developed Conditions Areas: Frontage Basin - WWHM

<b>Frontage Basin</b>	
Land Cover	Area
Sidewalk, Flat	0.08 AC
Total	0.08 AC

### **4.3 Water Quality Treatment**

Due to the multi-family nature of the project, an “Enhanced” level of water quality treatment will be required for onsite improvements. Water Quality Treatment for developed condition flows within Basin A is accomplished using a Modular Wetland structure located downstream of detention. A summary for the structure and its applicability can be found below. See Appendix 4 for the Modular Wetland standard detail provided by Bio Clean.

#### **Modular Wetland**

The proposed Modular Wetland structure is a GULD-certified structure for “Enhanced” treatment and will be used for this project site.

Per the requirements of the 2012 DOE Manual, the Water Quality Design Flow Rate (WQDFR) for the Modular Wetland is equal to the 2-year peak release rate (as it is downstream of the detention pipe facility). This rate is also listed below in a summary of the structure’s design characteristics. This rate was used to size a Modular Wetland to a unit size of 6’ x 8’.

#### 4.4 Detention

The proposed detention pipe facility will be used to mitigate developed condition flows and was designed in compliance with the 2012 DOE Manual requirements to model hydrologic conditions and detention in a continuous runoff model (WWHM2012) where the following evaluation parameters are employed:

*“Flow duration is computed by counting the number of flow values that exceed a specified flow level. The specified flow levels used by WWHM in the flow duration analysis are listed below.*

- 1. 50% of the 2-year predevelopment peak flow.*
- 2. 100% of the 2-year predevelopment peak flow.*
- 3. 100% of the 50-year predevelopment peak flow.*

*There are three criteria by which flow duration values are compared:*

- 1. If the postdevelopment flow duration values exceed any of the predevelopment flow levels between 50% and 100% of the 2-year predevelopment peak flow values (100 Percent Threshold) then the flow duration requirement has not been met.*
- 2. If the postdevelopment flow duration values exceed any of the predevelopment flow levels between 100% of the 2-year and 100% of the 50-year predevelopment peak flow values more than 10 percent of the time (110 Percent Threshold) then the flow duration requirement has not been met.*
- 3. If more than 50 percent of the flow duration levels exceed the 100 percent threshold then the flow duration requirement has not been met.”*

The detention pipe facility detains and releases collected stormwater runoff from Basin A. Flow discharges from the detention system and enters the existing closed-pipe drainage system.

A summary of the modeled and provided detention pipe dimensions, discharge rates and water surface elevations can be found below. See Appendix 4 for WWHM2012 output and volume calculations.

**Detention Pipe System**

**Modeled Storage:** 96,133 CF  
**Volume Provided:** 96,868 CF (3,426' x 6'Ø)  
**Begin Live Storage:** 378.00  
**Riser Height:** 5.0'  
**Top of Riser Elevation:** 383.00

Table 4.4.1 - Detention Pipe Flow Rates and Water Surface Elevation by Storm Event

<b>Storm Event</b>	<b>Predeveloped Rate (cfs)</b>	<b>Unmitigated Rate (cfs)</b>	<b>Mitigated Rates (cfs)</b>	<b>Water Surface Elevation</b>
2-Year	0.19	2.77	0.14	382.01
10-Year	0.34	4.48	0.43	383.03
50-Year	0.48	6.27	1.01	383.13
100-Year	0.54	7.13	1.42	383.17

#### 4.5 Low Impact Design Feasibility:

The project design has accounted for Low Impact Design as much as is feasible, given site conditions. In referencing the 2012 DOE Manual, Section 2.5.5 (Minimum Requirement #5: Onsite Stormwater Management) in Volume I was applied to the site in order to determine LID BMP feasibility. This section directs projects within the Urban Growth Area to adhere to List #2 or the LID Performance Standard. Adherence to List #2 was chosen for this site and the first feasible BMPs were chosen to be applied to the site. A summary of the feasible and non-feasible BMPs are listed below:

##### Lawn and Landscaped Area:

- **Post Construction Soil Quality and Depth (BMP T5.13): *Feasible*.** Site will be underlain with BMP T5.13 soils in all pervious areas.

##### Roofs:

1. **Full Dispersion or Full Downspout Infiltration (BMPs T5.30 or T5.10A): *Infeasible*.** Due to the number of units allowed/proposed and the amount of usable open space required by the zoning and density requirements of the project, site dimensions do not leave enough room for compliant flowpaths for dispersion. Additionally, the Geotechnical Report does not list infiltration as feasible for this site.
2. **Bioretention: *Infeasible*.** Due to the number of units allowed/proposed and the amount of usable open space required by the zoning and density requirements of the project, site dimensions do not leave enough room for Bioretention facilities to be used feasibly to any benefit. Additionally, the Geotechnical Report does not list infiltration, a key part of bioretention, as feasible for this site.
3. **Downspout Dispersion Systems (BMP T5.10B): *Infeasible*.** Due to the number of units allowed/proposed and the amount of usable open space required by the zoning and density requirements of the



project, site dimensions do not leave enough room for compliant flowpaths for dispersion.

4. **Perforated Stub-out Connections (BMP T5.10C): *Feasible*.**

Perforated Stub-out connections will be used from roof downspouts to main line connections on each building.

Other Hard Surfaces:

1. **Full Dispersion (BMP T5.30): *Infeasible*.** Due to the number of units allowed/proposed and the amount of usable open space required by the zoning and density requirements of the project, site dimensions do not leave enough room for compliant flowpaths for dispersion.
2. **Permeable Pavement (BMP T5.15): *Infeasible*.** The Geotechnical Report does not list infiltration as feasible for this site.
3. **Bioretention: *Infeasible*.** Due to the number of units allowed/proposed and the amount of usable open space required by the zoning and density requirements of the project, site dimensions do not leave enough room for Bioretention facilities to be used feasibly to any benefit. Additionally, the Geotechnical Report does not list infiltration, a key part of bioretention, as feasible for this site.
4. **Sheet Flow Dispersion or Concentrated Flow Dispersion (BMPs T5.12 or T5.11): *Infeasible*.** Due to the number of units allowed/proposed and the amount of usable open space required by the zoning and density requirements of the project, site dimensions do not leave enough room for compliant flowpaths for dispersion.

## **Appendix 4: Detention and Water Quality Analysis Data**

1. Figure 5.0 - Predeveloped Hydrology
2. Figure 6.0 - Developed Hydrology
3. Modular Wetland Standard Detail
4. Detention Pipe WWHM2012 Output



17-166 Predeveloped Hydrology Map.mxd | MOD: 7/13/2018 | TPA



PREDEVELOPED BASIN AREAS	
BASIN A	
FORESTED	8.72 AC
TOTAL =	8.72 AC
FRONTAGE BASIN	
FORESTED	0.08 AC
TOTAL =	0.08 AC

THE WOLFF COMPANY

**ALDERWOOD SOUTH  
APARTMENTS**

PREDEVELOPED HYDROLOGY MAP

PROJECTION: WASHINGTON STATE PLANE, NORTH ZONE, NAD 83 HARN, FEET
REVISION:
JOB NUMBER: 17-166
DRAWING NAME: 17-166F05
DESIGNER: TABBOTT
DRAWING BY: TABBOTT
DATE: 01-22-18
SCALE: AS SHOWN
JURISDICTION: LYNNWOOD

FIGURE:  
**5.0**

Commercial  
Infrastructure  
Residential

**LDC**  
THE CIVIL ENGINEERING GROUP

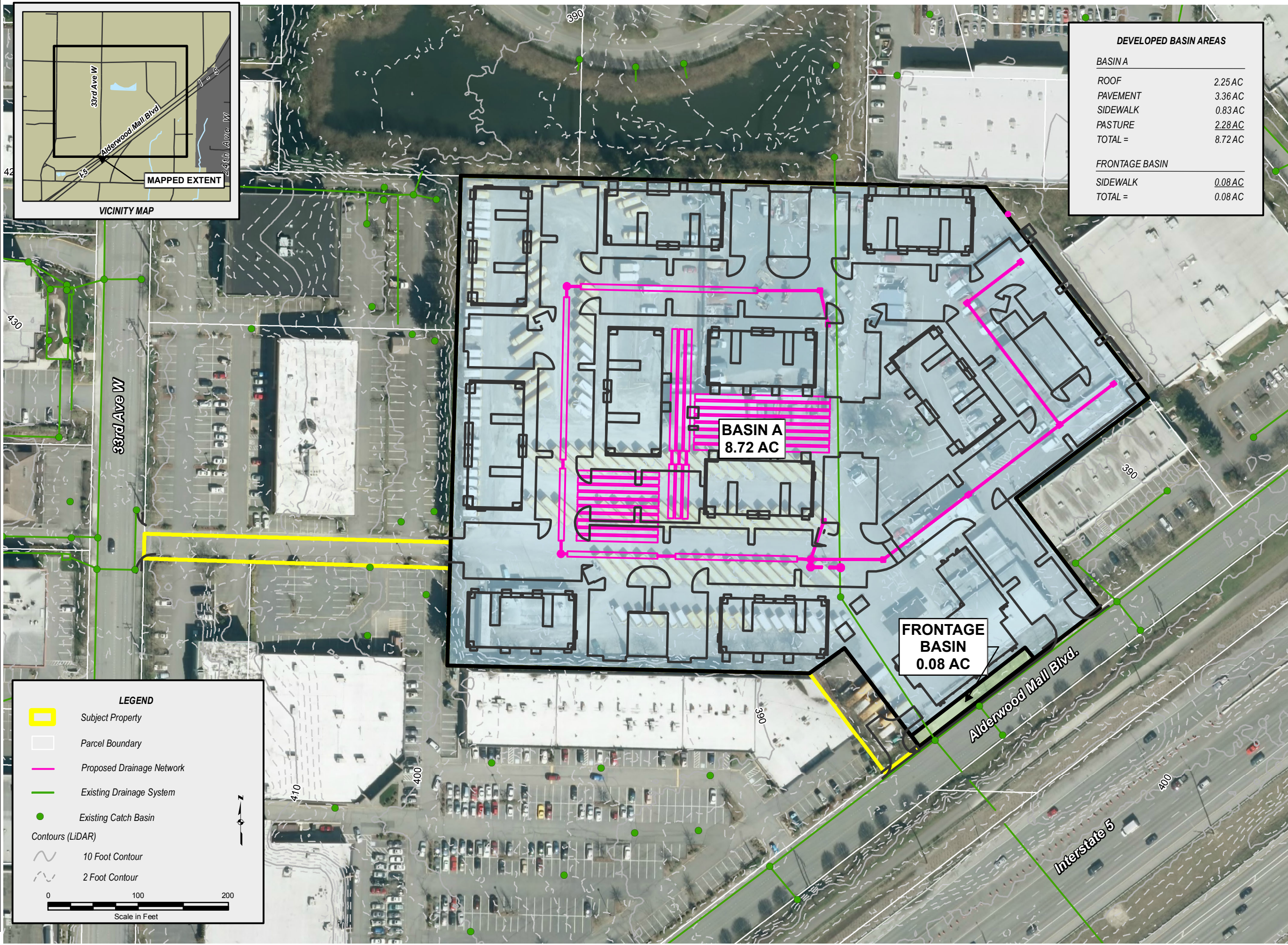
14201 NE 200th St., #100  
Woodinville, WA 98072  
Ph: 425.806.1869  
Fk: 425.482.2893

www.LDCcorp.com

SOURCE INFORMATION	
SOURCE AGENCY	DESCRIPTION
CITY OF LYNNWOOD GIS	PARCEL BOUNDARY, EXISTING DRAINAGE
SNOMOMISH COUNTY GIS	CONTOURS GENERATED FROM BARE EARTH LIDAR (KING COUNTY).
	THIS DATA HAS A STATED VERTICAL ACCURACY OF APPROXIMATELY 1 FOOT.



17-166 Developed Hydrology Map.mxd | MOD: 12/3/2018 | TPA



DEVELOPED BASIN AREAS	
BASIN A	
ROOF	2.25 AC
PAVEMENT	3.36 AC
SIDEWALK	0.83 AC
PASTURE	2.28 AC
TOTAL =	8.72 AC
FRONTAGE BASIN	
SIDEWALK	0.08 AC
TOTAL =	0.08 AC

THE WOLFF COMPANY

**ALDERWOOD SOUTH  
APARTMENTS**

DEVELOPED HYDROLOGY MAP

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

REVISION:  
JOB NUMBER: 17-166  
DRAWING NAME: 17-166F06  
DESIGNER: TABBOTT  
DRAWING BY: TABBOTT  
DATE: 01-22-18  
SCALE: AS SHOWN  
JURISDICTION: LYNNWOOD

FIGURE:  
**6.0**

**LDC**  
THE CIVIL ENGINEERING GROUP

Commercial  
Infrastructure  
Residential

14201 NE 200th St., #100  
Woodinville, WA 98072  
Ph: 425.806.1869  
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SOURCE INFORMATION	
SOURCE AGENCY	DESCRIPTION
CITY OF LYNNWOOD GIS	PARCEL BOUNDARY, EXISTING DRAINAGE
SNOMOMISH COUNTY GIS	CONTOURS GENERATED FROM BARE EARTH LIDAR (KING COUNTY). THIS DATA HAS A STATED VERTICAL ACCURACY OF APPROXIMATELY 1 FOOT.



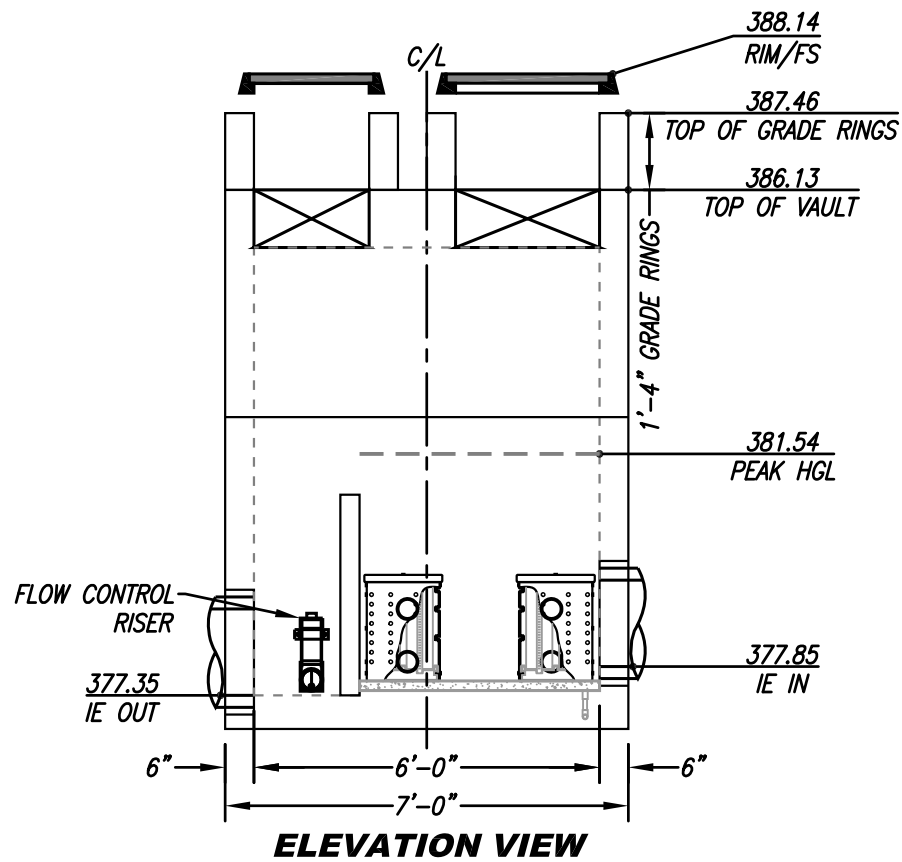
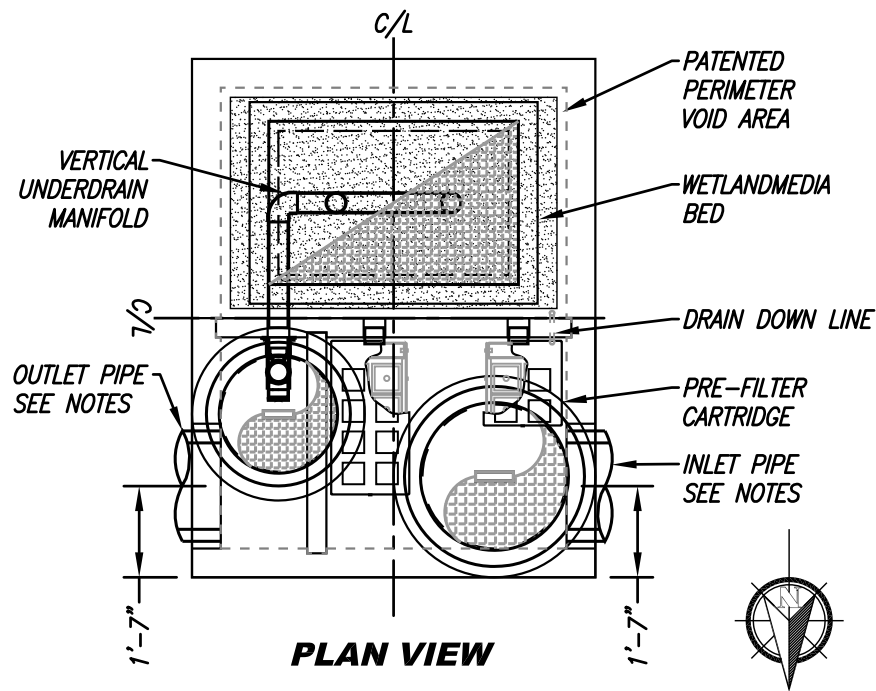
SITE SPECIFIC DATA			
PROJECT NUMBER		7353	
PROJECT NAME		ALDERWOOD SOUTH APARTMENTS	
PROJECT LOCATION		LYNNWOOD, WA	
STRUCTURE ID		----	
TREATMENT REQUIRED			
VOLUME BASED (CF)		2-YEAR RELEASE RATE (CFS)	
		0.1374	
TREATMENT HGL AVAILABLE (FT)			N/A
PEAK BYPASS REQUIRED (CFS) – IF APPLICABLE			7.13
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE	377.85	PVC	18”
OUTLET PIPE	377.35	PVC	18”
	PRETREATMENT	BIOFILTRATION	DISCHARGE
RIM ELEVATION	388.14	388.14	388.14
SURFACE LOAD	FIRE TRUCK LOADING, SEE NOTES BELOW		
FRAME & COVER	ø30”	30” X 48”	ø24”
WETLANDMEDIA VOLUME (CY)			3.65
WETLANDMEDIA DELIVERY METHOD			PER CONTRACT
ORIFICE SIZE (DIA. INCHES)			ø1.67”
NOTES: PRELIMINARY, NOT FOR CONSTRUCTION. FIRE TRUCK GVW IS 76.6 KIPS. THE FRONT STEER AXLE AND TILLER TRAILER AXLES ARE 22.8 KIPS. THE DRIVE AXLE ON THE TRACTOR IS 31 KIPS. THE OUTRIGGER IS 45 KIPS DISTRIBUTED OVER 24” X 24” PADS. ENGINEER TO VERIFY FIRE TRUCK LOADING.			

INSTALLATION NOTES

- CONTRACTOR TO PROVIDE ALL LABOR, EQUIPMENT, MATERIALS AND INCIDENTALS REQUIRED TO OFFLOAD AND INSTALL THE SYSTEM AND APPURTENANCES IN ACCORDANCE WITH THIS DRAWING AND THE MANUFACTURERS SPECIFICATIONS, UNLESS OTHERWISE STATED IN MANUFACTURERS CONTRACT.
- UNIT MUST BE INSTALLED ON LEVEL BASE. MANUFACTURER RECOMMENDS A MINIMUM 6" LEVEL ROCK BASE UNLESS SPECIFIED BY THE PROJECT ENGINEER. CONTRACTOR IS RESPONSIBLE TO VERIFY PROJECT ENGINEERS RECOMMENDED BASE SPECIFICATIONS.
- ALL PIPES MUST BE FLUSH WITH INSIDE SURFACE OF CONCRETE. (PIPES CANNOT INTRUDE BEYOND FLUSH). INVERT OF OUTFLOW PIPE MUST BE FLUSH WITH DISCHARGE CHAMBER FLOOR. ALL GAPS AROUND PIPES SHALL BE SEALED WATER TIGHT WITH A NON-SHRINK GROUT PER MANUFACTURERS STANDARD CONNECTION DETAIL AND SHALL MEET OR EXCEED REGIONAL PIPE CONNECTION STANDARDS.
- CONTRACTOR TO SUPPLY AND INSTALL ALL EXTERNAL CONNECTING PIPES.
- CONTRACTOR RESPONSIBLE FOR INSTALLATION OF ALL RISERS, MANHOLES, AND HATCHES. CONTRACTOR TO GROUT ALL MANHOLES AND HATCHES TO MATCH FINISHED SURFACE UNLESS SPECIFIED OTHERWISE.
- CONTRACTOR RESPONSIBLE FOR CONTACTING MODULAR WETLANDS FOR ACTIVATION OF UNIT. MANUFACTURES WARRANTY IS VOID WITH OUT PROPER ACTIVATION BY A MODULAR WETLANDS REPRESENTATIVE.

GENERAL NOTES

- MANUFACTURER TO PROVIDE ALL MATERIALS UNLESS OTHERWISE NOTED.
- ALL DIMENSIONS, ELEVATIONS, SPECIFICATIONS AND CAPACITIES ARE SUBJECT TO CHANGE. FOR PROJECT SPECIFIC DRAWINGS DETAILING EXACT DIMENSIONS, WEIGHTS AND ACCESSORIES PLEASE CONTACT MANUFACTURER.



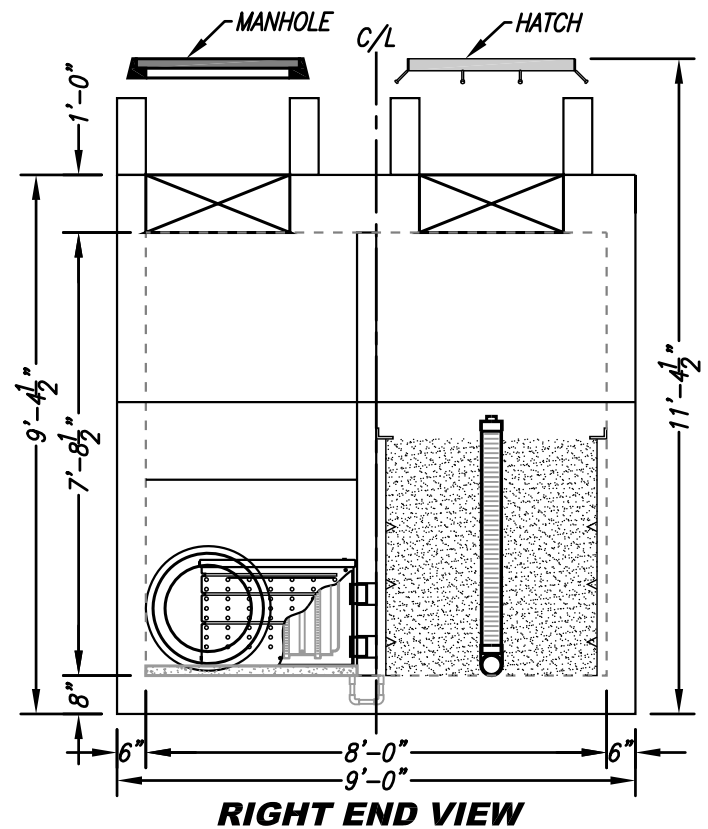
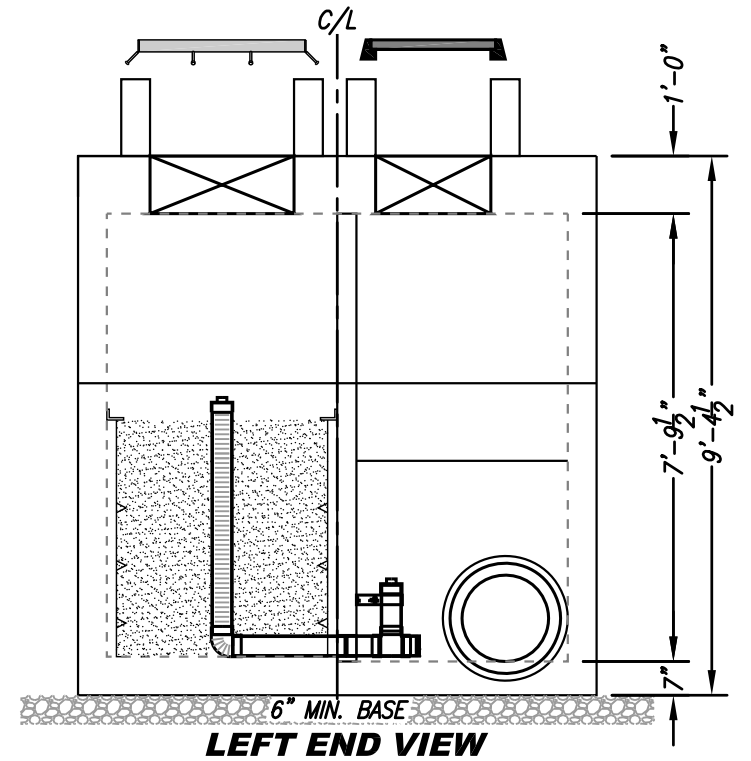
INTERNAL BYPASS DISCLOSURE:

THE DESIGN AND CAPACITY OF THE PEAK CONVEYANCE METHOD TO BE REVIEWED AND APPROVED BY THE ENGINEER OF RECORD. HGL(S) AT PEAK FLOW SHALL BE ASSESSED TO ENSURE NO UPSTREAM FLOODING. PEAK HGL AND BYPASS CAPACITY SHOWN ON DRAWING ARE USED FOR GUIDANCE ONLY.

THE PRODUCT DESCRIBED MAY BE PROTECTED BY ONE OR MORE OF THE FOLLOWING US PATENTS: 7,425,262; 7,470,362; 7,674,378; 8,303,816; RELATED FOREIGN PATENTS OR OTHER PATENTS PENDING

PROPRIETARY AND CONFIDENTIAL:

THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF MODULAR WETLANDS SYSTEMS. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF MODULAR WETLANDS SYSTEMS IS PROHIBITED.



2-YEAR RELEASE RATE (CFS)	0.1374
OPERATING HEAD (FT)	3.4
PRETREATMENT LOADING RATE (GPM/SF)	1.6
WETLAND MEDIA LOADING RATE (GPM/SF)	1.0

**Bio Clean**  
A Forterra Company

**MWS-L-6-8-V-UG-HC**  
**STORMWATER BIOFILTRATION SYSTEM**  
**STANDARD DETAIL**

# Detention Pipe Output

## WWHM2012 PROJECT REPORT

---

**Project Name:** Design Review Modeling\_20180415  
**Site Name:**  
**Site Address:**  
**City** :  
**Report Date:** 7/19/2018  
**Gage** : Everett  
**Data Start** : 1948/10/01  
**Data End** : 2009/09/30  
**Precip Scale:** 1.00  
**Version Date:** 2017/07/05  
**Version** : 4.2.13

---

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

---

**High Flow Threshold for POC 1:** 50 year

---

### PREDEVELOPED LAND USE

**Name** : Basin A  
**Bypass:** No

**GroundWater:** No

<u>Pervious Land Use</u>	<u>acre</u>
C, Forest, Flat	8.72

Pervious Total	8.72
----------------	------

<u>Impervious Land Use</u>	<u>acre</u>
Impervious Total	0

Basin Total	8.72
-------------	------

---

### Element Flows To:

Surface	Interflow	Groundwater
---------	-----------	-------------

---

**Name** : Frontage Basin Bypass  
**Bypass:** No

**GroundWater:** No

<u>Pervious Land Use</u>	<u>acre</u>
C, Forest, Flat	.08

Pervious Total	0.08
----------------	------

<u>Impervious Land Use</u>	<u>acre</u>
----------------------------	-------------

Impervious Total	0
------------------	---

Basin Total	0.08
-------------	------

---

Element Flows To:		
Surface	Interflow	Groundwater

---

#### MITIGATED LAND USE

Name : Basin A

Bypass: No

GroundWater: No

<u>Pervious Land Use</u>	<u>acre</u>
C, Pasture, Flat	2.28

Pervious Total	2.28
----------------	------

<u>Impervious Land Use</u>	<u>acre</u>
----------------------------	-------------

ROADS FLAT	3.36
------------	------

ROOF TOPS FLAT	2.25
----------------	------

SIDEWALKS FLAT	0.83
----------------	------

Impervious Total	6.44
------------------	------

Basin Total	8.72
-------------	------

---

Element Flows To:		
Surface	Interflow	Groundwater
Tank 1	Tank 1	

---

Name : Tank 1

Tank Name: Tank 1

#### Dimensions

Depth: 6 ft.

Tank Type : Circular

Diameter : 6 ft.  
 Length : 3400 ft.  
Discharge Structure  
 Riser Height: 5 ft.  
 Riser Diameter: 18 in.  
 Notch Type: Rectangular  
 Notch Width: 0.020 ft.  
 Notch Height: 1.600 ft.  
 Orifice 1 Diameter: 1.34375 in. Elevation: 0 ft.  
 Orifice 2 Diameter: 1.3125 in. Elevation: 3.95 ft.

Element Flows To:  
 Outlet 1                      Outlet 2

---

Tank Hydraulic Table				
Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.000	0.000	0.000	0.000
0.0667	0.098	0.004	0.012	0.000
0.1333	0.138	0.012	0.017	0.000
0.2000	0.168	0.022	0.021	0.000
0.2667	0.193	0.034	0.025	0.000
0.3333	0.214	0.048	0.028	0.000
0.4000	0.233	0.063	0.031	0.000
0.4667	0.250	0.079	0.033	0.000
0.5333	0.266	0.096	0.035	0.000
0.6000	0.281	0.114	0.038	0.000
0.6667	0.294	0.134	0.040	0.000
0.7333	0.306	0.154	0.042	0.000
0.8000	0.318	0.174	0.043	0.000
0.8667	0.329	0.196	0.045	0.000
0.9333	0.339	0.218	0.047	0.000
1.0000	0.349	0.241	0.049	0.000
1.0667	0.358	0.265	0.050	0.000
1.1333	0.366	0.289	0.052	0.000
1.2000	0.374	0.314	0.053	0.000
1.2667	0.382	0.339	0.055	0.000
1.3333	0.389	0.365	0.056	0.000
1.4000	0.396	0.391	0.058	0.000
1.4667	0.402	0.418	0.059	0.000
1.5333	0.408	0.445	0.060	0.000
1.6000	0.414	0.472	0.062	0.000
1.6667	0.419	0.500	0.063	0.000
1.7333	0.424	0.528	0.064	0.000
1.8000	0.429	0.556	0.065	0.000
1.8667	0.433	0.585	0.066	0.000
1.9333	0.437	0.614	0.068	0.000
2.0000	0.441	0.644	0.069	0.000
2.0667	0.445	0.673	0.070	0.000
2.1333	0.448	0.703	0.071	0.000
2.2000	0.451	0.733	0.072	0.000
2.2667	0.454	0.763	0.073	0.000
2.3333	0.456	0.793	0.074	0.000
2.4000	0.458	0.824	0.075	0.000



2.4667	0.460	0.855	0.077	0.000	
2.5333	0.462	0.885	0.078	0.000	
2.6000	0.464	0.916	0.079	0.000	
2.6667	0.465	0.947	0.080	0.000	
2.7333	0.466	0.978	0.081	0.000	
2.8000	0.467	1.009	0.082	0.000	
2.8667	0.467	1.041	0.083	0.000	
2.9333	0.468	1.072	0.083	0.000	
3.0000	0.468	1.103	0.084	0.000	
3.0667	0.468	1.134	0.085	0.000	
3.1333	0.467	1.165	0.086	0.000	
3.2000	0.467	1.197	0.087	0.000	
3.2667	0.466	1.228	0.088	0.000	
3.3333	0.465	1.259	0.089	0.000	
3.4000	0.464	1.290	0.090	0.000	
3.4667	0.462	1.321	0.092	0.000	
3.5333	0.460	1.351	0.095	0.000	
3.6000	0.458	1.382	0.098	0.000	
3.6667	0.456	1.413	0.102	0.000	
3.7333	0.454	1.443	0.106	0.000	
3.8000	0.451	1.473	0.111	0.000	
3.8667	0.448	1.503	0.115	0.000	
3.9333	0.445	1.533	0.120	0.000	
4.0000	0.441	1.562	0.135	0.000	2 year = 0.137668 cfs
4.0667	0.437	1.592	0.146	0.000	
4.1333	0.433	1.621	0.155	0.000	
4.2000	0.429	1.650	0.163	0.000	
4.2667	0.424	1.678	0.171	0.000	
4.3333	0.419	1.706	0.179	0.000	
4.4000	0.414	1.734	0.187	0.000	
4.4667	0.408	1.761	0.195	0.000	
4.5333	0.402	1.788	0.204	0.000	
4.6000	0.396	1.815	0.212	0.000	
4.6667	0.389	1.841	0.221	0.000	
4.7333	0.382	1.867	0.230	0.000	
4.8000	0.374	1.892	0.267	0.000	
4.8667	0.366	1.917	0.277	0.000	
4.9333	0.358	1.941	0.288	0.000	
5.0000	0.349	1.965	0.299	0.000	10 year = 0.42745 cfs
5.0667	0.339	1.988	0.575	0.000	50 year = 1.011687 cfs
5.1333	0.329	2.010	1.075	0.000	100 year = 1.418496 cfs
5.2000	0.318	2.032	1.710	0.000	
5.2667	0.306	2.052	2.432	0.000	
5.3333	0.294	2.072	3.193	0.000	
5.4000	0.281	2.092	3.944	0.000	
5.4667	0.266	2.110	4.640	0.000	
5.5333	0.250	2.127	5.240	0.000	
5.6000	0.233	2.143	5.719	0.000	
5.6667	0.214	2.158	6.074	0.000	
5.7333	0.193	2.172	6.336	0.000	
5.8000	0.168	2.184	6.662	0.000	
5.8667	0.138	2.194	6.923	0.000	
5.9333	0.098	2.202	7.173	0.000	
6.0000	0.000	2.206	7.416	0.000	
6.0667	0.000	0.000	7.650	0.000	

Name : Frontage Basin Bypass  
Bypass: Yes

GroundWater: No

<u>Pervious Land Use</u>	<u>acre</u>
C, Pasture, Flat	.03
Pervious Total	0.03
<u>Impervious Land Use</u>	<u>acre</u>
SIDEWALKS FLAT	0.05
Impervious Total	0.05
Basin Total	0.08

---

Element Flows To:		
Surface	Interflow	Groundwater

---

---

#### ANALYSIS RESULTS

##### Stream Protection Duration

---

Predeveloped Landuse Totals for POC #1  
Total Pervious Area:8.8  
Total Impervious Area:0

---

Mitigated Landuse Totals for POC #1  
Total Pervious Area:2.31  
Total Impervious Area:6.49

---

##### Flow Frequency Return Periods for Predeveloped. POC #1

<u>Return Period</u>	<u>Flow(cfs)</u>
2 year	0.188637
5 year	0.27921
10 year	0.341221
25 year	0.421199
50 year	0.481704
100 year	0.542867

##### Flow Frequency Return Periods for Mitigated. POC #1

<u>Return Period</u>	<u>Flow(cfs)</u>
2 year	0.137668
5 year	0.278222

<b>10 year</b>	0.42745
<b>25 year</b>	0.709489
<b>50 year</b>	1.011687
<b>100 year</b>	1.418496

---

**Stream Protection Duration**

**Annual Peaks for Predeveloped and Mitigated. POC #1**

<b>Year</b>	<b>Predeveloped</b>	<b>Mitigated</b>
1949	0.107	0.090
1950	0.209	0.134
1951	0.169	0.087
1952	0.134	0.090
1953	0.111	0.082
1954	0.417	0.100
1955	0.283	0.275
1956	0.250	0.298
1957	0.278	0.160
1958	0.188	0.098
1959	0.202	0.105
1960	0.179	0.113
1961	0.187	0.221
1962	0.163	0.087
1963	0.197	0.098
1964	0.166	0.080
1965	0.187	0.118
1966	0.102	0.093
1967	0.230	0.099
1968	0.270	0.119
1969	0.202	0.114
1970	0.147	0.093
1971	0.207	0.425
1972	0.184	0.106
1973	0.147	0.173
1974	0.258	0.118
1975	0.148	0.088
1976	0.141	0.096
1977	0.118	0.094
1978	0.148	0.092
1979	0.266	0.102
1980	0.166	0.089
1981	0.136	0.082
1982	0.178	0.167
1983	0.252	0.096
1984	0.185	0.560
1985	0.245	0.241
1986	0.604	1.869
1987	0.268	0.851
1988	0.148	0.185
1989	0.125	0.082
1990	0.195	0.167
1991	0.208	0.125
1992	0.159	0.143
1993	0.103	0.078
1994	0.097	0.133
1995	0.199	0.213
1996	0.345	0.190



1997	0.659	2.877
1998	0.125	0.091
1999	0.181	0.127
2000	0.100	0.218
2001	0.033	0.072
2002	0.191	0.217
2003	0.139	0.097
2004	0.218	0.197
2005	0.161	0.102
2006	0.373	0.217
2007	0.317	0.194
2008	0.505	1.480
2009	0.158	0.133

---

**Stream Protection Duration**

**Ranked Annual Peaks for Predeveloped and Mitigated. POC #1**

<b>Rank</b>	<b>Predeveloped</b>	<b>Mitigated</b>
1	0.6593	2.8773
2	0.6035	1.8690
3	0.5049	1.4805
4	0.4175	0.8505
5	0.3726	0.5598
6	0.3454	0.4252
7	0.3173	0.2978
8	0.2830	0.2751
9	0.2777	0.2406
10	0.2696	0.2206
11	0.2684	0.2177
12	0.2656	0.2175
13	0.2581	0.2168
14	0.2523	0.2125
15	0.2501	0.1966
16	0.2446	0.1938
17	0.2302	0.1902
18	0.2182	0.1855
19	0.2086	0.1725
20	0.2077	0.1673
21	0.2070	0.1671
22	0.2024	0.1603
23	0.2017	0.1431
24	0.1988	0.1340
25	0.1967	0.1332
26	0.1952	0.1327
27	0.1906	0.1272
28	0.1876	0.1248
29	0.1875	0.1186
30	0.1867	0.1179
31	0.1853	0.1176
32	0.1839	0.1142
33	0.1813	0.1132
34	0.1794	0.1065
35	0.1784	0.1054
36	0.1688	0.1024
37	0.1664	0.1022
38	0.1663	0.0996
39	0.1630	0.0992

40	0.1605	0.0981
41	0.1586	0.0977
42	0.1582	0.0965
43	0.1485	0.0962
44	0.1482	0.0961
45	0.1475	0.0937
46	0.1472	0.0933
47	0.1471	0.0931
48	0.1414	0.0918
49	0.1387	0.0914
50	0.1357	0.0903
51	0.1342	0.0897
52	0.1255	0.0892
53	0.1249	0.0879
54	0.1185	0.0874
55	0.1106	0.0868
56	0.1066	0.0823
57	0.1034	0.0819
58	0.1020	0.0819
59	0.0999	0.0795
60	0.0965	0.0780
61	0.0328	0.0723

---

**Stream Protection Duration**

**POC #1**

**The Facility PASSED**

**The Facility PASSED.**

<b>Flow(cfs)</b>	<b>Predev</b>	<b>Mit</b>	<b>Percentage</b>	<b>Pass/Fail</b>
0.0943	22822	21731	95	Pass
0.0982	20649	18339	88	Pass
0.1021	18660	15926	85	Pass
0.1061	16818	13757	81	Pass
0.1100	15539	12435	80	Pass
0.1139	14012	10754	76	Pass
0.1178	12690	9289	73	Pass
0.1217	11482	7995	69	Pass
0.1256	10412	7510	72	Pass
0.1295	9420	7140	75	Pass
0.1334	8543	6789	79	Pass
0.1374	7745	6447	83	Pass
0.1413	6988	6083	87	Pass
0.1452	6340	5749	90	Pass
0.1491	5786	5401	93	Pass
0.1530	5281	4977	94	Pass
0.1569	4949	4669	94	Pass
0.1608	4526	4263	94	Pass
0.1648	4156	3948	94	Pass
0.1687	3769	3623	96	Pass
0.1726	3420	3296	96	Pass
0.1765	3095	3048	98	Pass
0.1804	2781	2757	99	Pass
0.1843	2522	2468	97	Pass
0.1882	2310	2182	94	Pass
0.1921	2111	1967	93	Pass

0.1961	1951	1806	92	Pass
0.2000	1852	1667	90	Pass
0.2039	1723	1528	88	Pass
0.2078	1611	1378	85	Pass
0.2117	1501	1251	83	Pass
0.2156	1409	1123	79	Pass
0.2195	1337	1014	75	Pass
0.2234	1268	949	74	Pass
0.2274	1202	887	73	Pass
0.2313	1141	805	70	Pass
0.2352	1083	771	71	Pass
0.2391	1025	748	72	Pass
0.2430	952	734	77	Pass
0.2469	922	724	78	Pass
0.2508	884	706	79	Pass
0.2548	851	696	81	Pass
0.2587	815	681	83	Pass
0.2626	775	667	86	Pass
0.2665	737	653	88	Pass
0.2704	702	624	88	Pass
0.2743	677	578	85	Pass
0.2782	655	534	81	Pass
0.2821	639	508	79	Pass
0.2861	620	475	76	Pass
0.2900	606	436	71	Pass
0.2939	589	392	66	Pass
0.2978	577	345	59	Pass
0.3017	564	298	52	Pass
0.3056	551	285	51	Pass
0.3095	540	279	51	Pass
0.3134	525	276	52	Pass
0.3174	515	276	53	Pass
0.3213	497	271	54	Pass
0.3252	473	270	57	Pass
0.3291	458	268	58	Pass
0.3330	448	267	59	Pass
0.3369	439	265	60	Pass
0.3408	430	263	61	Pass
0.3447	418	260	62	Pass
0.3487	406	257	63	Pass
0.3526	396	255	64	Pass
0.3565	385	252	65	Pass
0.3604	375	251	66	Pass
0.3643	362	247	68	Pass
0.3682	355	246	69	Pass
0.3721	349	245	70	Pass
0.3761	338	241	71	Pass
0.3800	333	239	71	Pass
0.3839	320	236	73	Pass
0.3878	313	235	75	Pass
0.3917	306	234	76	Pass
0.3956	302	231	76	Pass
0.3995	296	229	77	Pass
0.4034	289	225	77	Pass
0.4074	283	221	78	Pass
0.4113	277	216	77	Pass
0.4152	270	213	78	Pass

0.4191	260	208	80	Pass
0.4230	252	204	80	Pass
0.4269	248	202	81	Pass
0.4308	240	200	83	Pass
0.4347	234	199	85	Pass
0.4387	229	197	86	Pass
0.4426	216	196	90	Pass
0.4465	206	193	93	Pass
0.4504	200	193	96	Pass
0.4543	195	189	96	Pass
0.4582	188	184	97	Pass
0.4621	184	178	96	Pass
0.4661	176	177	100	Pass
0.4700	173	177	102	Pass
0.4739	166	175	105	Pass
0.4778	161	173	107	Pass
0.4817	154	169	109	Pass

---

**Water Quality BMP Flow and Volume for POC #1**

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.

---

**LID Report**

LID Technique	Used for	Total Volume	Volume	Infiltration	Cumulative
Percent	Water Quality	Percent	Comment	Through	Volume
Volume	Treatment?	Needs	Facility	(ac-ft.)	Volume
Infiltrated	Water Quality	Treatment			Infiltration
	Treated	(ac-ft)	(ac-ft)		Credit
Tank 1 POC	N	1012.00			N
0.00					
Total Volume Infiltrated		1012.00	0.00	0.00	
0.00	0.00	0%	No Treat.	Credit	
Compliance with LID Standard 8					
Duration Analysis Result = Failed					

---

**Perln and Implnd Changes**

No changes have been made.

---

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## 5.0 CONVEYANCE ANALYSIS AND DESIGN

The proposed collection and conveyance system is comprised of catch basins, storm drainage pipe and a detention pipe facility. Catch basins have been located such that each section of storm drainage pipe can adequately convey associated tributary area flows. All storm drainage pipe was sized at a 12" minimum diameter, unless conveyance flow necessitated a pipe diameter increase to 18".

The onsite conveyance system was designed for the 50-year, 24-hour storm event (precipitation rate = 3.00 in. obtained from NOAA ATLAS 2, Volume IX), using the Rational Method with Everett IDF Tables. The Uniform Flow Method (Manning's Equation) was performed to ensure that during the 50-year, 24-hour storm event, no catch basin structures would be within 0.5' of overtopping. The conveyance analysis for the drainage system was completed using StormShed 3G and the Rational Method. For visual representation of contributing conveyance basins used in analysis see Figure 7.0 "Conveyance Basin Map" in Appendix 5. Also see Appendix 5 for full Stormshed output data and a map showing the location of all catch basin and pipe numbers analyzed in Stormshed.

The following catch basin summary table summarizes the Stormshed 3G output for the 50-Year storm design event:

Table 5.1 - Vault Tributary Line Conveyance Table

<b><i>DETENTION SYSTEM TRIBUTARY SYSTEM</i></b>			
<b>CB #</b>	<b>Rim</b>	<b>HGL</b>	<b>Distance to Overtopping (ft)</b>
CB-3A	387.69	383.29	4.40
CB-04	387.32	383.39	3.93
CB-05	385.38	383.43	1.95
CB-06	386.65	384.68	1.97
CB-6A	387.73	384.68	3.05
CB-07	387.65	385.48	2.17
CB-08	388.95	385.55	3.40
CB-11	385.55	384.29	1.26
CB-12	386.27	384.34	1.93

### Downstream Discharge

The conveyance capacity analysis for the pipe downstream of the detention vault was performed as a Manning's equation evaluation of the discharge pipe. This pipe design was analyzed against the 100-year unmitigated flow.

### Downstream Discharge:

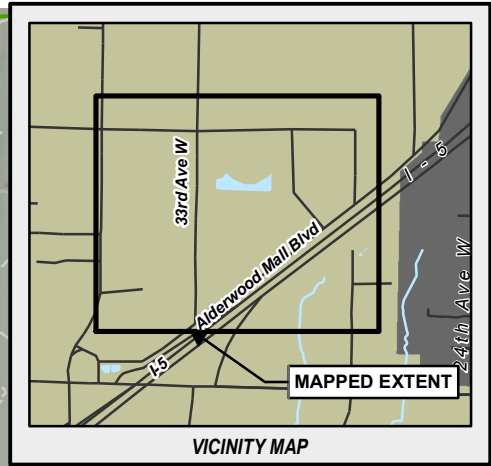
Diameter:	18"
Minimum Slope:	0.54%
Pipe Capacity:	11.18 cfs
100-Year Maximum Pipe Flow:	7.13 cfs (WWHM - 100 Year Unmitigated)
Evaluation:	System Adequate

## **Appendix 5: Conveyance Data and Analysis**

- Figure 7.0: Conveyance Basin Map
- StormShed3G Output Data
- Manning's Analysis: Downstream Discharge



17-166 Developed Hydrology Map.mxd | MOD: 12/3/2018 | TPA



Subject Property

Parcel Boundary

Proposed Drainage Network

Existing Drainage System

Existing Catch Basin

Contours (LiDAR)

10 Foot Contour

2 Foot Contour

0100200

Scale in Feet

Conveyance Basin Areas		
Conveyance Basin	Impervious (AC)	Pervious (AC)
1	0.28	0.22
2	0.30	0.19
3	0.30	0.08
4	0.08	0.07
5	0.15	0.04
6	1.09	0.19
7	0.17	0.19
8	1.93	0.57
9	0.32	0.20
10	0.40	0.15
11	0.40	0.17
12	0.58	0.08
13	0.40	0.09
14	0.05	0.06
TOTAL	6.44	2.28

THE WOLFF COMPANY

ALDERWOOD SOUTH APARTMENTS

CONVEYANCE BASIN MAP

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

REVISION:  
JOB NUMBER: 17-166  
DRAWING NAME: 17-166F07  
DESIGNER: TABBOTT  
DRAWING BY: M.JUREWICZ  
DATE: 07-18-18  
SCALE: AS SHOWN  
JURISDICTION: LYNNWOOD

FIGURE:  
7.0

LDC

THE CIVIL ENGINEERING GROUP

14201 NE 200th St., #100  
Woodinville, WA 98072

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Fx: 425.482.2893

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Commercial

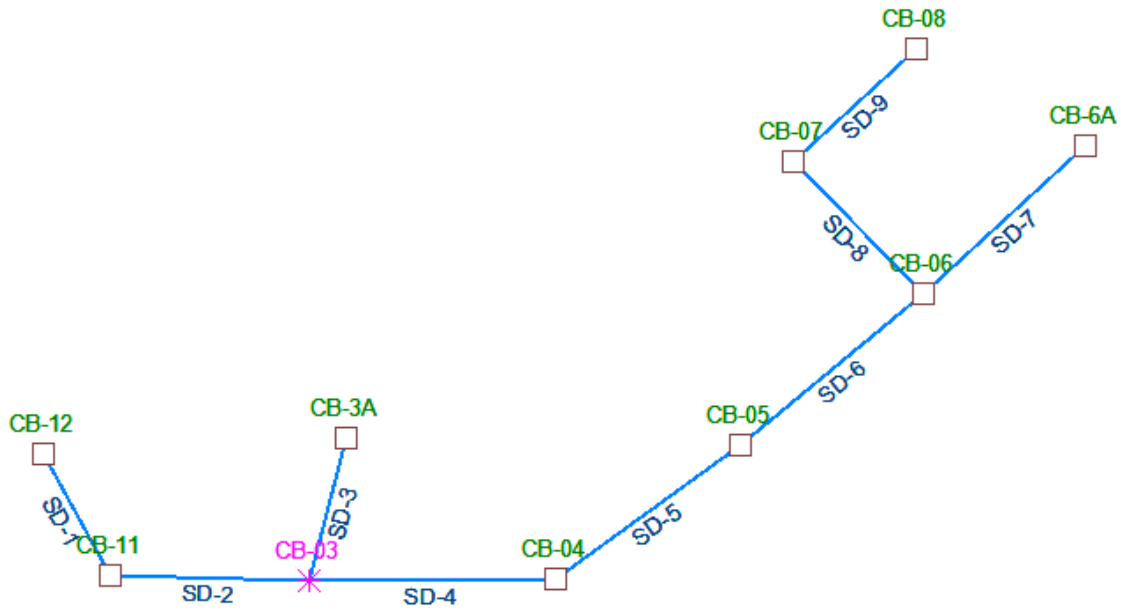
Infrastructure

Residential

SOURCE INFORMATION	
SOURCE AGENCY	DESCRIPTION
CITY OF LYNNWOOD GIS	PARCEL BOUNDARY, EXISTING DRAINAGE
SNYHOMISH COUNTY GIS	CONTOURS GENERATED FROM BARE EARTH LIDAR (KING COUNTY).
	THIS DATA HAS A STATED VERTICAL ACCURACY OF APPROXIMATELY 1 FOOT.



## StormShed Conveyance Model



### Rational Method Analysis - Detention Pipe Tributary System

Reach ID	Area (ac)	TC (min)	i (in/hr)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Size	nVel (ft/s)	fVel (ft/s)	CArea
SD-1	0.50	5.00	3.4947	1.0344	12.7967	0.0808	0.1919	12 in Diam	9.8145	16.2933	Basin 1
SD-2	1.78	5.0662	3.4679	4.5603	5.8932	0.7738	0.6609	12 in Diam	8.2794	7.5034	Basin 6
SD-3	0.52	5.00	3.4947	1.1463	16.8649	0.068	0.1766	12 in Diam	12.2551	21.473	Basin 9
SD-9	0.49	5.00	3.4947	1.0764	3.7683	0.2856	0.3658	12 in Diam	4.1372	4.798	Basin 2
SD-8	0.68	5.3021	3.3768	1.5229	3.6488	0.4174	0.4506	12 in Diam	4.4353	4.6457	Basin 5
SD-7	0.15	5.00	3.4947	0.3005	3.6731	0.0818	0.1931	12 in Diam	2.8265	4.6768	Basin 4
SD-6	1.21	5.9409	3.1594	2.6002	5.2002	0.50	0.5001	12 in Diam	6.6198	6.6211	Basin 3
SD-5	2.06	6.2632	3.0632	4.264	10.7578	0.3964	0.6571	18 in Diam	5.7271	6.0876	Basin 13;Basin 7
SD-4	2.86	6.6095	2.9683	5.9158	10.7578	0.5499	0.7947	18 in Diam	6.2233	6.0876	Basin 12;Basin 14

### HGL Analysis - Detention Pipe Tributary System

#### HGL Analysis

From Node	To Node	HG El (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	Adjusted HG El (ft)	Max El (ft)
							383.13
CB-11	CB-03	384.2970	0.0269	0.0169	-----	384.2869	385.5500

CB-12	CB-11	384.3364	-----	-----	-----	384.3364	386.2700
CB-3A	CB-03	383.2868	-----	-----	-----	383.2868	387.6900
CB-04	CB-03	383.4598	0.0904	0.0235	-----	383.3929	387.3200
CB-05	CB-04	383.5998	0.1702	0.0027	-----	383.4323	385.3800
CB-06	CB-05	384.5846	-----	0.0862	0.0088	384.6796	386.6500
CB-07	CB-06	385.1082	-----	0.3701	-----	385.4784	387.6500
CB-08	CB-07	385.5460	-----	-----	-----	385.5460	388.9500
CB-6A	CB-06	384.6849	-----	-----	-----	384.6849	387.7300
CB-11	CB-03	384.2970	0.0269	0.0169	-----	384.2869	385.5500
CB-12	CB-11	384.3364	-----	-----	-----	384.3364	386.2700
CB-3A	CB-03	383.2868	-----	-----	-----	383.2868	387.6900
CB-04	CB-03	383.4598	0.0904	0.0235	-----	383.3929	387.3200
CB-05	CB-04	383.5998	0.1702	0.0027	-----	383.4323	385.3800
CB-06	CB-05	384.5846	-----	0.0862	0.0088	384.6796	386.6500
CB-07	CB-06	385.1082	-----	0.3701	-----	385.4784	387.6500
CB-08	CB-07	385.5460	-----	-----	-----	385.5460	388.9500
CB-6A	CB-06	384.6849	-----	-----	-----	384.6849	387.7300
CB-11	CB-03	384.2970	0.0269	0.0169	-----	384.2869	385.5500
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CB-06	CB-05	384.5846	-----	0.0862	0.0088	384.6796	386.6500
CB-07	CB-06	385.1082	-----	0.3701	-----	385.4784	387.6500
CB-08	CB-07	385.5460	-----	-----	-----	385.5460	388.9500
CB-6A	CB-06	384.6849	-----	-----	-----	384.6849	387.7300

### **Conduit Notes - Detention Pipe Tributary System**

#### **Conduit Notes**

Reach	HW Depth (ft)	HW/D ratio	Q (cfs)	TW Depth (ft)	Dc (ft)	Dn (ft)	Comment
SD-2	4.5970	4.5970	4.56	3.4300	0.8908	0.6609	Outlet Control
SD-1	3.7349	3.7349	1.03	3.6869	0.4275	0.1919	Outlet Control
SD-3	0.5868	0.5868	1.15	5.1300	0.4510	0.1766	SuperCrit flow, Inlet end controls
SD-4	2.2598	1.5065	5.92	1.9300	0.9392	0.7947	Outlet Control
SD-5	1.9948	1.3299	4.26	1.7929	0.7918	0.6571	Outlet Control

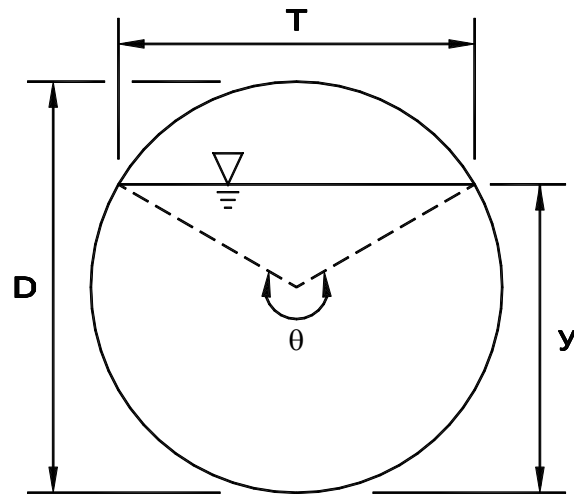
SD-6	1.0846	1.0846	2.60	1.2323	0.6913	0.5001	SuperCrit flow, Inlet end controls
SD-8	0.7582	0.7582	1.52	1.1796	0.5235	0.4506	SuperCrit flow, Inlet end controls
SD-9	1.1960	1.1960	1.08	1.1284	0.4364	0.3658	Outlet Control
SD-7	1.1849	1.1849	0.30	1.1796	0.2258	0.1931	Outlet Control
SD-2	4.5970	4.5970	4.56	3.4300	0.8908	0.6609	Outlet Control
SD-1	3.7349	3.7349	1.03	3.6869	0.4275	0.1919	Outlet Control
SD-3	0.5868	0.5868	1.15	5.1300	0.4510	0.1766	SuperCrit flow, Inlet end controls
SD-4	2.2598	1.5065	5.92	1.9300	0.9392	0.7947	Outlet Control
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SD-6	1.0846	1.0846	2.60	1.2323	0.6913	0.5001	SuperCrit flow, Inlet end controls
SD-8	0.7582	0.7582	1.52	1.1796	0.5235	0.4506	SuperCrit flow, Inlet end controls
SD-9	1.1960	1.1960	1.08	1.1284	0.4364	0.3658	Outlet Control
SD-7	1.1849	1.1849	0.30	1.1796	0.2258	0.1931	Outlet Control
SD-2	4.5970	4.5970	4.56	3.4300	0.8908	0.6609	Outlet Control
SD-1	3.7349	3.7349	1.03	3.6869	0.4275	0.1919	Outlet Control
SD-3	0.5868	0.5868	1.15	5.1300	0.4510	0.1766	SuperCrit flow, Inlet end controls
SD-4	2.2598	1.5065	5.92	1.9300	0.9392	0.7947	Outlet Control
SD-5	1.9948	1.3299	4.26	1.7929	0.7918	0.6571	Outlet Control
SD-6	1.0846	1.0846	2.60	1.2323	0.6913	0.5001	SuperCrit flow, Inlet end controls
SD-8	0.7582	0.7582	1.52	1.1796	0.5235	0.4506	SuperCrit flow, Inlet end controls
SD-9	1.1960	1.1960	1.08	1.1284	0.4364	0.3658	Outlet Control
SD-7	1.1849	1.1849	0.30	1.1796	0.2258	0.1931	Outlet Control



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

Project Name: Alderwood South Apartments Project No.: 17-166  
Description: Detention Discharge Pipe Date: 7/18/2018  
Calc. By: KKE

Pipe Diameter (D) = 18 in  
Pipe Slope (S) = 0.54 %  
Flow Depth (y) = 0.87 ft  
Flowrate (Q) = 7.13 cfs  
Mannings Coeff. (n) = 0.009  
Theta Angle ( $\theta$ ) = 3.46 rad  
Wetted Area (A) = 1.06 ft<sup>2</sup>  
Wet. Perimeter (P) = 2.60 ft  
Hydraulic Radius (R) = 0.41 ft  
Top Width (T) = 1.48 ft  
Flow Velocity = 6.71 fps



Solve

Reset Form

#### Formulas:

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

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

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

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

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

Top Width (T):  $T = \sin\left(\frac{\theta}{2}\right)d$

## **SECTION 6.0: OPERATIONS AND MAINTENANCE MANUAL**

The proposed storm drainage system consists of buried pipes, catch basins, a detention pipe system and a flow control riser. These facilities will require periodic maintenance and inspection. Inspection and maintenance procedures are contained on the following pages and have been taken from the 2016 KCSWDM.

### NO. 3 - CLOSED DETENTION SYSTEMS (PIPES/TANKS)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
Storage Area	Plugged Air Vents	One-half of the cross section of a vent is blocked at any point with debris and sediment	Vents free of debris and sediment
	Debris and Sediment	Accumulated sediment depth exceeds 10% of the diameter of the storage area for ½ length of storage vault or any point depth exceeds 15% of diameter. Example: 72-inch storage tank would require cleaning when sediment reaches depth of 7 inches for more than ½ length of tank.	All sediment and debris removed from storage area.
	Joints Between Tank/Pipe Section	Any crack allowing material to be transported into facility	All joint between tank /pipe sections are sealed
	Tank Pipe Bent Out of Shape	Any part of tank/pipe is bent out of shape more than 10% of it's design shape	Tank/ pipe repaired or replaced to design.
Manhole	Cover Not in Place	Cover is missing or only partially in place. Any open manhole requires maintenance.	Manhole is closed.
	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than ½ inch of thread (may not apply to self-locking lids.)	Mechanism opens with proper tools.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying 80lbs of lift. Intent is to keep cover from sealing off access to maintenance.	Cover can be removed and reinstalled by one maintenance person.
	Ladder Rungs Unsafe	King County Safety Office and/or maintenance person judges that ladder is unsafe due to missing rungs, misalignment, rust, or cracks.	Ladder meets design standards allows maintenance person safe access.
Catch Basins		See "Catch Basins" Standards No. 5	See "Catch Basins" Standards No. 5

### NO. 4 - CONTROL STRUCTURE/FLOW RESTRICTOR

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash and Debris (Includes Sediment)	Distance between debris build-up and bottom of orifice plate is less than 1-1/2 feet.	All trash and debris removed.
	Structural Damage	Structure is not securely attached to manhole wall and outlet pipe structure should support at least 1,000 lbs of up or down pressure.	Structure securely attached to wall and outlet pipe.
		Structure is not in upright position (allow up to 10% from plumb).	Structure in correct position.
		Connections to outlet pipe are not watertight and show signs of rust.	Connections to outlet pipe are water tight; structure repaired or replaced and works as designed.
		Any holes--other than designed holes--in the structure.	Structure has no holes other than designed holes.
Cleanout Gate	Damaged or Missing	Cleanout gate is not watertight or is missing.	Gate is watertight and works as designed.
		Gate cannot be moved up and down by one maintenance person.	Gate moves up and down easily and is watertight.
		Chain leading to gate is missing or damaged.	Chain is in place and works as designed.
		Gate is rusted over 50% of its surface area.	Gate is repaired or replaced to meet design standards..
Orifice Plate	Damaged or Missing	Control device is not working properly due to missing, out of place, or bent orifice plate.	Plate is in place and works as designed.
	Obstructions	Any trash, debris, sediment, or vegetation blocking the plate.	Plate is free of all obstructions and works as designed.
Overflow Pipe	Obstructions	Any trash or debris blocking (or having the potential of blocking) the overflow pipe.	Pipe is free of all obstructions and works as designed.
Manhole		See "Closed Detention Systems" Standards No. 3	See "Closed Detention Systems" Standards No. 3
Catch Basin		See "Catch Basins" Standards No. 5	See "Catch Basins" Standards No. 5

## NO. 5 - CATCH BASINS

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
General	Trash & Debris (Includes Sediment)	Trash or debris of more than 1/2 cubic foot which is located immediately in front of the catch basin opening or is blocking capacity of the basin by more than 10%	No Trash or debris located immediately in front of catch basin opening.
		Trash or debris (in the basin) that exceeds 1/3 the depth from the bottom of basin to invert the lowest pipe into or out of the basin.	No trash or debris in the catch basin.
		Trash or debris in any inlet or outlet pipe blocking more than 1/3 of its height.	Inlet and outlet pipes free of trash or debris.
		Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane).	No dead animals or vegetation present within the catch basin.
		Deposits of garbage exceeding 1 cubic foot in volume	No condition present which would attract or support the breeding of insects or rodents.
	Structure Damage to Frame and/or Top Slab	Corner of frame extends more than 3/4 inch past curb face into the street (If applicable).	Frame is even with curb.
		Top slab has holes larger than 2 square inches or cracks wider than 1/4 inch (intent is to make sure all material is running into basin).	Top slab is free of holes and cracks.
		Frame not sitting flush on top slab, i.e., separation of more than 3/4 inch of the frame from the top slab.	Frame is sitting flush on top slab.
	Cracks in Basin Walls/ Bottom	Cracks wider than 1/2 inch and longer than 3 feet, any evidence of soil particles entering catch basin through cracks, or maintenance person judges that structure is unsound.	Basin replaced or repaired to design standards.
		Cracks wider than 1/2 inch and longer than 1 foot at the joint of any inlet/ outlet pipe or any evidence of soil particles entering catch basin through cracks.	No cracks more than 1/4 inch wide at the joint of inlet/outlet pipe.
	Sediment/ Misalignment	Basin has settled more than 1 inch or has rotated more than 2 inches out of alignment.	Basin replaced or repaired to design standards.
	Fire Hazard	Presence of chemicals such as natural gas, oil and gasoline.	No flammable chemicals present.
	Vegetation	Vegetation growing across and blocking more than 10% of the basin opening.	No vegetation blocking opening to basin.
		Vegetation growing in inlet/outlet pipe joints that is more than six inches tall and less than six inches apart.	No vegetation or root growth present.
	Pollution	Nonflammable chemicals of more than 1/2 cubic foot per three feet of basin length.	No pollution present other than surface film.
Catch Basin Cover	Cover Not in Place	Cover is missing or only partially in place. Any open catch basin requires maintenance.	Catch basin cover is closed
	Locking Mechanism Not Working	Mechanism cannot be opened by on maintenance person with proper tools. Bolts into frame have less than 1/2 inch of thread.	Mechanism opens with proper tools.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying 80 lbs. of lift; intent is keep cover from sealing off access to maintenance.	Cover can be removed by one maintenance person.
Ladder	Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, misalignment, rust, cracks, or sharp edges.	Ladder meets design standards and allows maintenance person safe access.
Metal Grates (If Applicable)		Grate with opening wider than 7/8 inch.	Grate opening meets design standards.
	Trash and Debris	Trash and debris that is blocking more than 20% of grate surface.	Grate free of trash and debris.
	Damaged or Missing.	Grate missing or broken member(s) of the grate.	Grate is in place and meets design standards.



## NO. 10 - CONVEYANCE SYSTEMS (PIPES & DITCHES)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
Pipes	Sediment & Debris	Accumulated sediment that exceeds 20% of the diameter of the pipe.	Pipe cleaned of all sediment and debris.
	Vegetation	Vegetation that reduces free movement of water through pipes.	All vegetation removed so water flows freely through pipes.
	Damaged	Protective coating is damaged; rust is causing more than 50% deterioration to any part of pipe.	Pipe repaired or replaced.
		Any dent that decreases the cross section area of pipe by more than 20%.	Pipe repaired or replaced.
Open Ditches	Trash & Debris	Trash and debris exceeds 1 cubic foot per 1,000 square feet of ditch and slopes.	Trash and debris cleared from ditches.
	Sediment	Accumulated sediment that exceeds 20 % of the design depth.	Ditch cleaned/ flushed of all sediment and debris so that it matches design.
	Vegetation	Vegetation that reduces free movement of water through ditches.	Water flows freely through ditches.
	Erosion Damage to Slopes	See "Ponds" Standard No. 1	See "Ponds" Standard No. 1
	Rock Lining Out of Place or Missing (If Applicable).	Maintenance person can see native soil beneath the rock lining.	Replace rocks to design standards.
Catch Basins		See "Catch Basins: Standard No. 5	See "Catch Basins" Standard No. 5
Debris Barriers (e.g., Trash Rack)		See "Debris Barriers" Standard No.6	See "Debris Barriers" Standard No. 6

## NO. 11 - GROUNDS (LANDSCAPING)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Weeds (Nonpoisonous)	Weeds growing in more than 20% of the landscaped area (trees and shrubs only).	Weeds present in less than 5% of the landscaped area.
	Safety Hazard	Any presence of poison ivy or other poisonous vegetation.	No poisonous vegetation present in landscaped area.
	Trash or Litter	Paper, cans, bottles, totaling more than 1 cubic foot within a landscaped area (trees and shrubs only) of 1,000 square feet.	Area clear of litter.
Trees and Shrubs	Damaged	Limbs or parts of trees or shrubs that are split or broken which affect more than 25% of the total foliage of the tree or shrub.	Trees and shrubs with less than 5% of total foliage with split or broken limbs.
		Trees or shrubs that have been blown down or knocked over.	Tree or shrub in place free of injury.
		Trees or shrubs which are not adequately supported or are leaning over, causing exposure of the roots.	Tree or shrub in place and adequately supported; remove any dead or diseased trees.

## **SECTION 7.0: SPECIAL REPORTS AND STUDIES**

The following reports are included under a separate cover:

- Engineering Geology Report, RH2, February 2017
- Revised Final Remedial Investigation Report, EHSI-International, Inc., August, 2016,  
Revised January and June, 2017