Land Surveying Civil Engineering Land Use Planning Landscape Architecture

City of Camas
Preliminary Drainage Analysis

Hood Street Subdivision

Modern Dwellings, LLC
Job # 10123.01.01

REVIEWED BY: Peter A. Tuck, P.E.

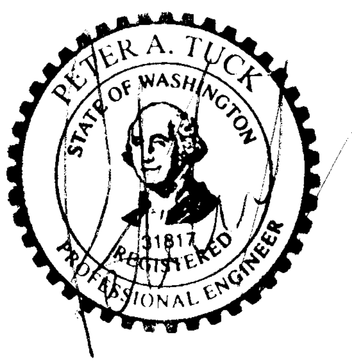
DESIGNED BY: Tyler Brinkman

Preliminary Drainage Analysis

Hood Street Subdivision

Modern Dwellings, Inc.

Project #10123.01.01



February 15, 2022

Designed by: Tyler Brinkman
Reviewed by: Peter Tuck, P.E.

Olson Engineering, Inc.
222 E. Evergreen Blvd
Vancouver, WA 98660
(360) 695-1385

REVISION	BY	DATE	COMMENTS

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Appendix J Development Plans:
- WWHM Pre-developed Catchment Plan
- WWHM Developed Catchment Plan
- Preliminary Utility and Stormwater Plan (C1.0)

Tables

General Location

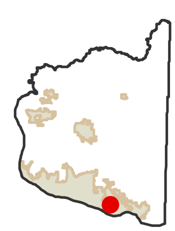
Printed on: August 07, 2020

Account: 127415000, 127440000
Owner: SAGE RAYMOND J
Address: 3206 NE 132ND AVE
C/S/Z: VANCOUVER, WA 98682

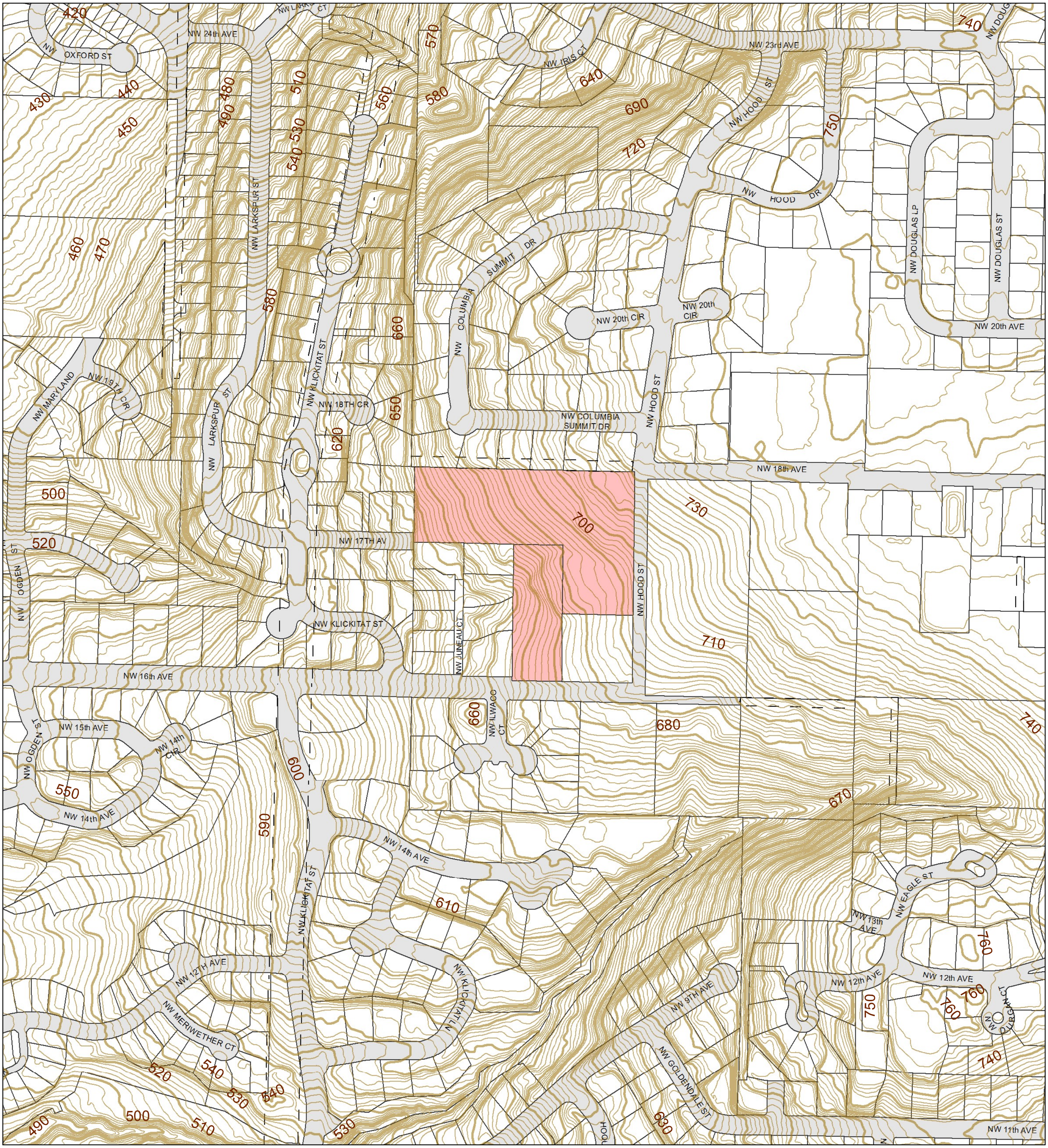
CLARK COUNTY, WASHINGTON
Geographic Information System

0 1,000 2,000
Feet

Location of Subject Property(s)



Information shown on this map was collected from several sources. Clark County accepts no responsibility for any inaccuracies that may be present.



Elevation Contours

Account: 127415000, 127440000
Owner: SAGE RAYMOND J
Address: 3206 NE 132ND AVE
C/S/Z: VANCOUVER, WA 98682

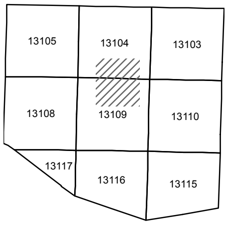
Subject Property(s)
Public Road
Transportation or Major Utility Easement
10' Elevation Contours
2' Elevation Contours

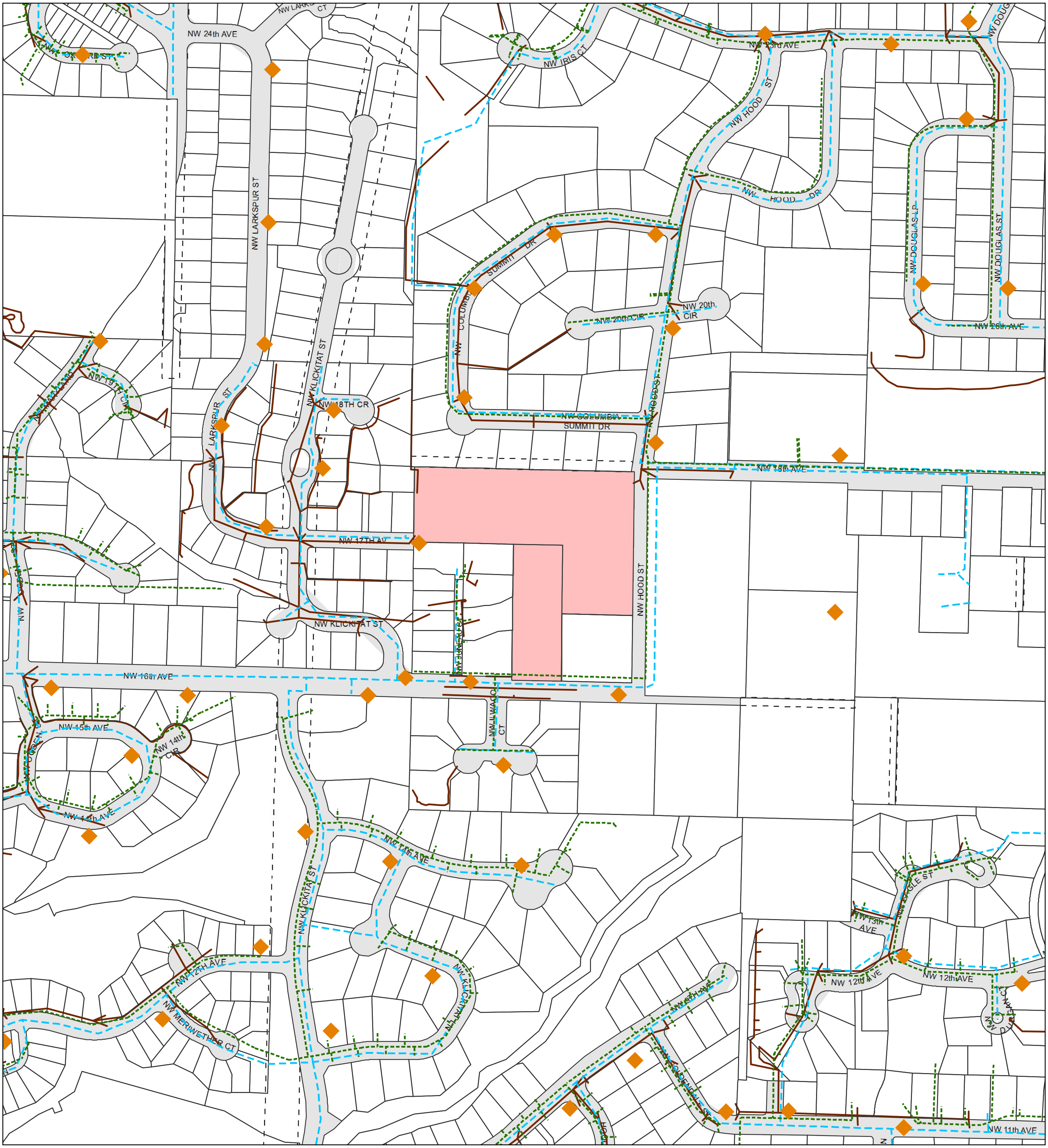
CLARK COUNTY, WASHINGTON
Geographic Information System

N

0 200 400
Feet

Printed on: August 07, 2020

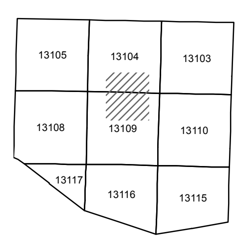




Water, Sewer, and Storm Systems

Printed on: August 07, 2020

Account: 127415000, 127440000
Owner: SAGE RAYMOND J
Address: 3206 NE 132ND AVE
C/S/Z: VANCOUVER, WA 98682

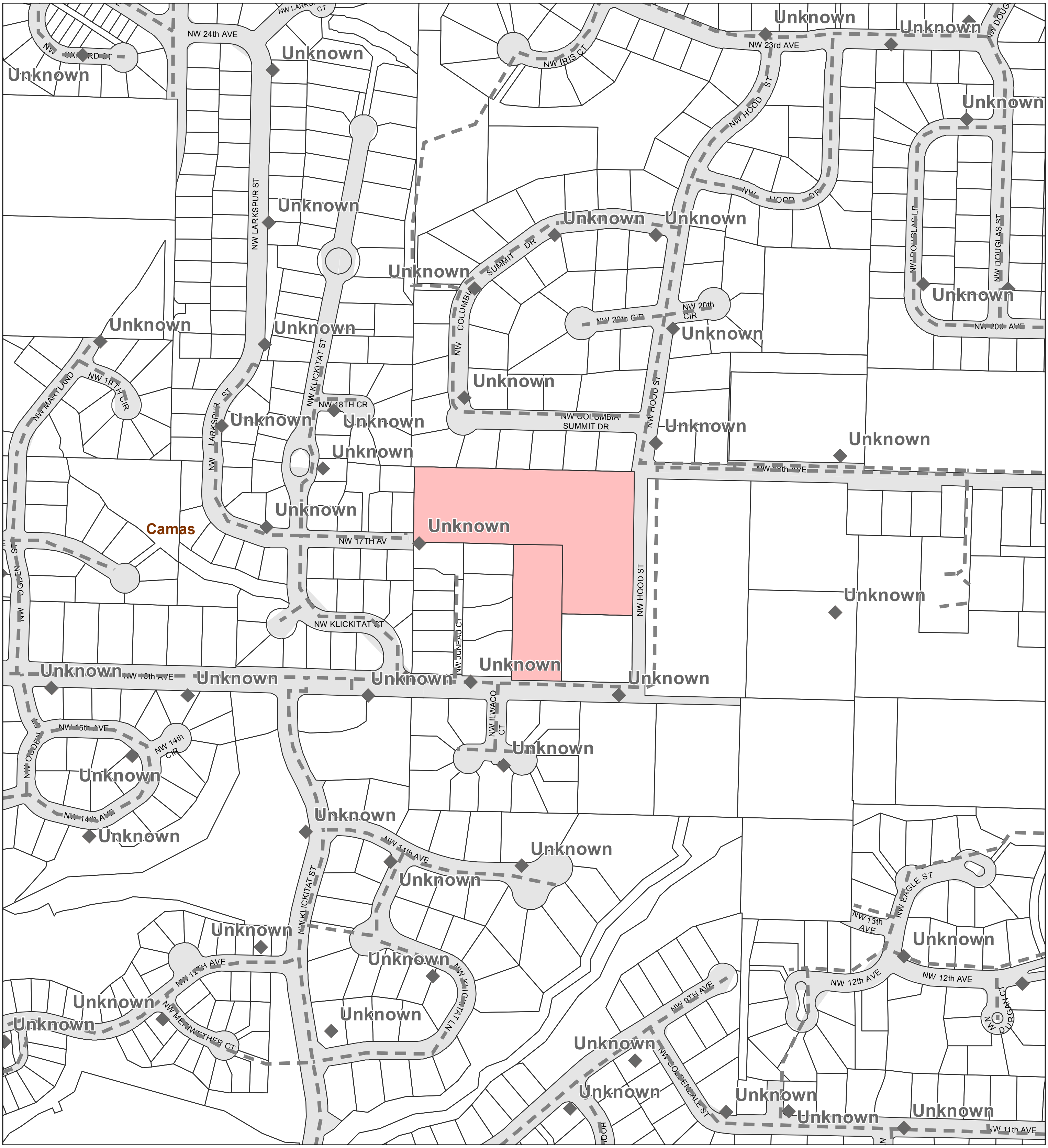


CLARK COUNTY, WASHINGTON
Geographic Information System

0 200 400
Feet

Legend	
Subject Property(s)	Storm Water Lines
Public Road	1-year Wellhead ZOC
Transportation or Major Utility Easement	5-year Wellhead ZOC
Water Lines	10-year Wellhead ZOC
Sewer Lines	Hydrants

Information shown on this map was collected from several sources. Clark County accepts no responsibility for any inaccuracies that may be present.



Printed on: August 07, 2020

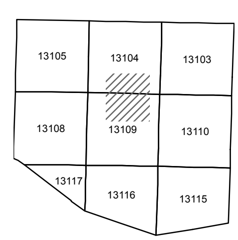
CLARK COUNTY, WASHINGTON
Geographic Information System

Water Systems

Account: 127415000, 127440000
Owner: SAGE RAYMOND J
Address: 3206 NE 132ND AVE
C/S/Z: VANCOUVER, WA 98682

0 200 400
Feet

Legend		
Subject Property(s)	10-20" Water Line	> 1000 - 1749 GPM at 20 PSI
Public Road	> 20" Water Line	> 1750 GPM at 20 PSI
Water District Boundary	No Flow Data Hydrant	Hydrant > 500' from parcel(s)
Unknown Size Water Line	0 - 499 GPM at 20 PSI	
< 10" Water LIne	500 - 999 GPM at 20 PSI	



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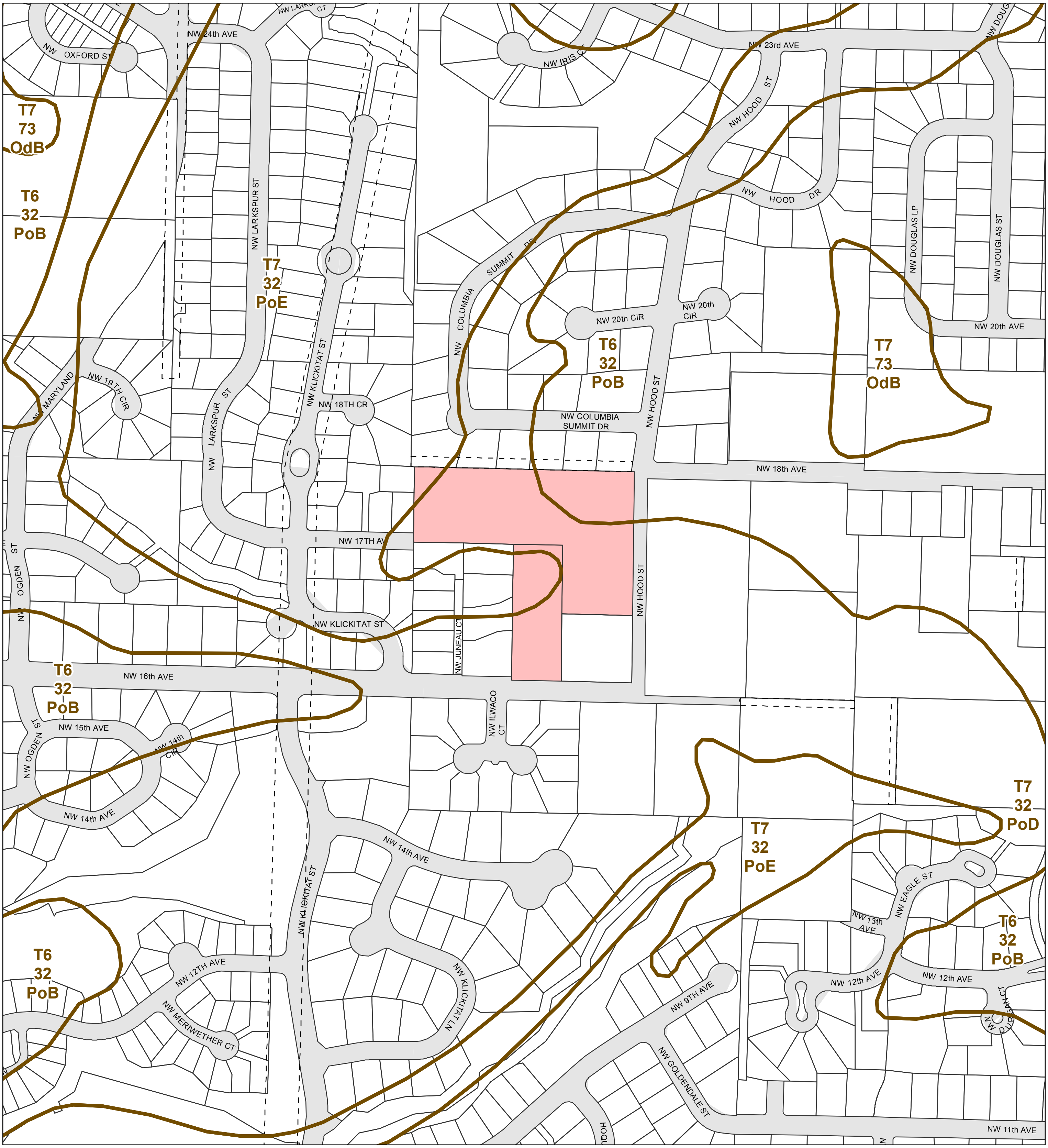


Soil Types

Printed on: August 07, 2020

Account: 127415000, 127440000
Owner: SAGE RAYMOND J
Address: 3206 NE 132ND AVE
C/S/Z: VANCOUVER, WA 98682

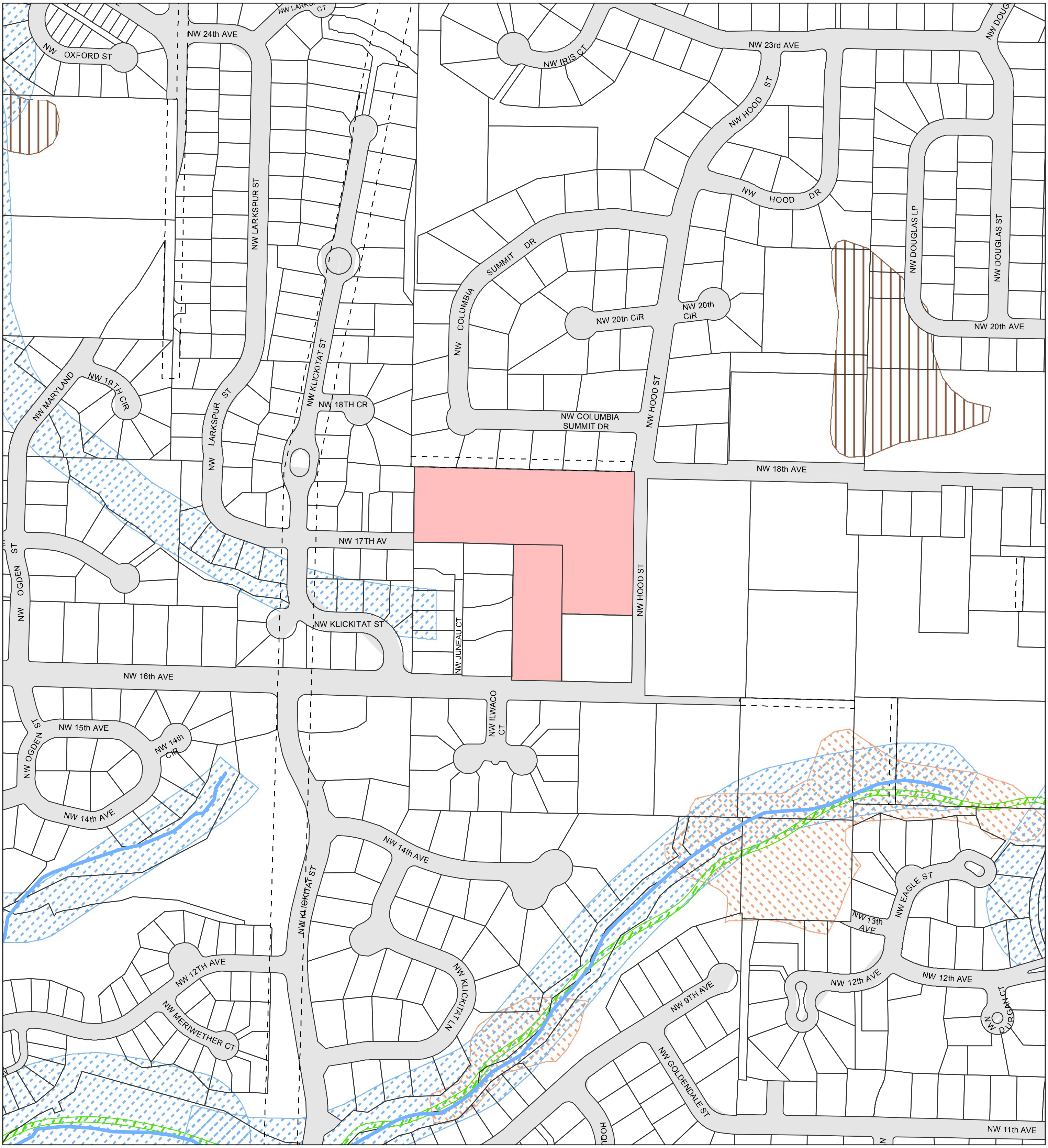
Subject Property(s)
Public Road
Transportation or Major Utility Easement
Soil Type Boundary

CLARK COUNTY, WASHINGTON
Geographic Information System

0 200 400 Feet

13105 13104 13103
13108 13109 13110
13117 13116 13115

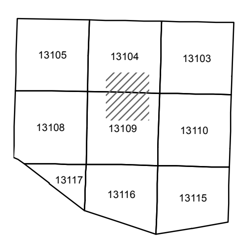
Information shown on this map was collected from several sources. Clark County accepts no responsibility for any inaccuracies that may be present.



Environmental Constraints I

Printed on: August 07, 2020

Account: 127415000, 127440000
Owner: SAGE RAYMOND J
Address: 3206 NE 132ND AVE
C/S/Z: VANCOUVER, WA 98682



CLARK COUNTY, WASHINGTON
Geographic Information System

0 200 400
Feet

- Subject Property(s)
- Public Road
- Transportation or Major Utility Easement
- Hydric Soils
- Wetland Inventory
- CARA Category 1
- Riparian Habitat or Species Area
- Non-Riparian Habitat or Species Area
- 100 year Floodplains
- Floodway
- Shorelines
- Stream

Information shown on this map was collected from several sources. Clark County accepts no responsibility for any inaccuracies that may be present.

Section A – Project Overview

1. **Describe the site location.**

   The proposed Hood Street Subdivision project site is approximately 6.1 acres in size and located on the west side of NW Hood Street and the north side of NW 16th Avenue in the city of Camas Washington. The development occupies parcels 127440-000 and 127415-000.

2. **Describe the topography, natural drainage patterns, vegetative ground cover, and presence of critical areas (CMC Title 16). Critical areas that receive runoff from the site shall be described to a minimum of ¼ mile away from the site boundary.**

   The site slopes generally from east to west with grades ranging from 10% to 25%. The steeper slopes reside at the center of the west side of the site. The site is predominantly covered with grass with trees and shrubs concentrated around existing structures. Stormwater runoff from the site drains across the site in the southwest direction to two different points along the west boundary. The southern release point drains to a natural channel that is eventually conveyed under NW Juneau Ct. by a culvert and then discharged to the existing channel to the west. The northern release point drains towards existing developments to the west of the site. Critical areas within the site include a wetland area.

3. **Identify and discuss existing onsite stormwater systems and their functions**

   There is an existing dispersion trench west of the newly constructed residence at the NE corner of the site. There are no other existing stormwater systems onsite. This dispersion trench will be removed and the existing flow will be directed into the proposed storm facility in Tract 'A'.

4. **Identify and discuss site parameters that influence stormwater system design.**

   According to the Geotechnical Site Investigation completed by Columbia West Engineering, Inc., the soils within the site were moist to wet and shallow groundwater was encountered at approximately 2 to 8 feet below the ground surface. As a result, underground stormwater cartridge treatment facilities are being proposed combined with underground detention pipes. Since the Geotechnical Site Investigation determined the soils onsite as having less than 0.06 inches per hour infiltration rate, all stormwater modeling in WWHM2012 assume saturated soil conditions with Soil Group 4 characteristics. This is described in greater detail in Section C "Soils Evaluation" of this report.

5. **Describe drainage to and from adjacent properties.**

   Stormwater runoff from the site generally drains across the site in the southwest direction to two different points along the west boundary. The southern release point drains to a natural channel that is eventually conveyed under NW Juneau Ct. by a culvert and then discharged to the existing channel to the west. The northern release point drains towards existing developments to the west of the site. The site receives offsite runoff from portions of parcel #127364-000 and #27439-000 located to the east and southern lots of Columbia Summit Estates II Phase 1 to the north.

6. Describe adjacent areas, including streams, lakes, wetland areas, residential areas, and roads that might be affected by the construction project.

The site is bordered on the north and west by existing residential developments. It is bordered on the east by NW Hood St and the south NW 16th Ave. Frontage improvements to these roads are proposed as part of this development. There is an existing wetland area located within the site area. There may be some grading along the outermost portions of the wetland area.

7. Generally describe proposed site construction, size of improvements, and proposed methods of mitigating stormwater runoff quantity and quality impacts.

The proposed development is approximately 6.1 acres in size and includes construction of a 17 lot residential subdivision. Site construction includes frontage improvements along the frontage on NW Hood Street and NW 16th Avenue in addition to new onsite roads, sidewalks, driveways, homes and landscape areas. Improvements include 1.08 acres of roof, 0.72 acres of roof, 0.25 acres of sidewalk, 0.38 acres of driveway and 3.72 acres of landscape and open space.

Stormwater runoff from the proposed development is to be captured and routed via pipe to one of two new underground stormwater facilities for detention and a corresponding cartridge treatment unit. One of the underground storage pipes is to be located Tract ‘A’ and conveyed via pipe to the existing storm main in 17th Ave. The other underground storage pipe is to be located at the northwest corner of Tracy ‘B’ along the west side of the site and conveyed via pipe to the existing low point wetland swale along the west side of the site. Each of the storage pipes will have a cartridge treatment unit upstream to meet City of Camas phosphorus control requirements. The roofs and landscaping areas in lots 1 – 3 will be captured via pipe and conveyed directly into the existing storm system in 17th Ave. The detention pipe in Tract ‘A’ will be oversized to compensate. The roofs and landscaping areas in lots 9 – 11 will be captured via pipe and conveyed directly into the existing low point along the west side of Tract ‘B’. The detention pipe in Tract ‘B’ will be oversized to compensate for the direct release.

Section B – Minimum Requirements

1. **Describe the land-disturbing activity and document the applicable minimum requirements for the project site. Include the following information in table form: a) amount of existing impervious surface, b) new impervious surface, c) replaced impervious surface, d) native vegetation converted to lawn or landscaping, e) native vegetation converted to pasture, and f) total amount of land-disturbing activity in table format.**

   The site is split between two Threshold Discharge Areas (TDA1) and (TDA2) and discharges at two different points on the west side of the site that get eventually get conveyed via pipe to the existing surface drain area southwest of NW Klickitat Street. Within (TDA1) the site has been divided into two separate catchment areas representing the areas of the TDA routed to one of the stormwater detention systems and the area of the TDA that is to be directly released without detention. These catchment areas are represented by catchment Basin A+B in the pre-developed model and Basin A and Basin B in the developed model. Within (TDA2) the site has been divided into two separate catchment areas representing the areas of the TDA routed to one of the stormwater detention systems and the area of the TDA that is to be directly released without detention. These catchment areas are represented by catchment Basin C+D in the pre-developed model and Basin C and Basin D in the developed model. New onsite land-disturbing activity for this proposal is approximately 6.1 acres of the 6.1 acre site.

   The site is predominantly covered with grass with trees and shrubs concentrated around existing structures. There is one small existing storage building within the site. The proposed development includes the addition of 1.08 acres of new roof, 0.72 acres of new asphalt pavement, 0.25 acre of new concrete sidewalks, and 0.38 acres of new concrete driveway that are all classified as “New Impervious Surface”. The proposed development also includes 3.72 acres of new landscaping that is classified as “Native Vegetation Converted to Lawn or Landscaping”.

   Per Figure 1.1 from the City of Camas Stormwater Design Standards Manual, the development needs to apply the Minimum Requirements as outlined in Figure 1.2. This was determined because the project site will discharge stormwater directly into a Municipal Separate Storm Sewer System owned and operated by the City of Camas and there will be more than 1 acre of disturbance. Per Figure 1.2, since the site has less than 35% of existing impervious surface and the development will add more than 5,000 SF of new impervious surface, Minimum Requirements #1 through #9 will apply to the new impervious surfaces and the converted pervious surfaces.

   Refer to Fig. 1.1 and 1.2, included in Appendix C.

The following table summarizes the proposed site changes:

	TDA 1	TDA 2
Existing Impervious Surface (Acres)	0.00	0.00
New Impervious Surface (Acres)	1.74	0.68
Replaced Impervious Surface (Acres)	0.00	0.00
Existing Impervious Surface to Remain (Acres)	0.00	0.00
Native vegetation converted to lawn or landscaping (Acres)	2.76	0.96
Native vegetation converted to pasture (Acres)	0.00	0.00
Total land-disturbing activity (Acres)	4.50	1.64

Table B1: Site Improvement Summary

2. **Provide a statement that confirms the minimum requirements that will apply to the development activity. For land-disturbing activities where minimum requirements 1 through 10 must be met include the following: a) Provide the amount of effective impervious area in each TDA, and document through an approved continuous runoff simulation model the increase in the 100-year flood frequency from pre-developed to developed conditions for each TDA, b) list the TDAs that must meet the runoff control requirements listed in Minimum Requirement 6, c) list the TDAs that must meet the flow control requirements listed in Minimum Requirement 7, and d) list the TDAs that must meet the wetlands protection requirements listed in Minimum Requirement 8.**

   The 0.72 acres of new asphalt pavement, 0.25 acre of new sidewalk, and 0.38 acres of new driveway are classified as "Effective Pollution Generating Impervious Surface" (PGIS). The 3.72 acres of landscaping is classified as "Effective Pollution Generating Pervious Surface" (PGPS). The following table summarizes the additional characteristics that determine compliance with Minimum Requirements 6, 7, and 8:

	TDA 1	TDA 2
Effective Pollution Generating Impervious Surface (PGIS) (Acres)	0.81	0.29
Effective Pollution Generating Pervious Surface (PGPS) (Acres)	2.76	0.96
Does the Large Water Body Exemption apply to this project?	No	No
Does the 100-year runoff increase by more than 0.1 cfs?	Yes	Yes
Does the project discharge directly or indirectly (through a conveyance system) into a wetland?	Yes	No

Table B2: Additional Compliance Characteristics

As a result of these surface cover characteristics, the following Minimum Requirements are triggered for this project per the City of Camas Stormwater Design Standards Manual:

	TDA1	TDA 2
Minimum Requirement 2 (Construction Stormwater Pollution Prevention)	Yes	Yes
Minimum Requirements 1, 3, 4, and 5 (Stormwater Site Plans, Source Control, Preservation of Natural Drainage Systems & Outfalls, Onsite Stormwater Management)	Yes	Yes
Minimum Requirement 6 (Runoff Treatment)	Yes	Yes
Minimum Requirement 7 (Flow Control)	Yes	Yes
Minimum Requirement 8 (Wetlands Protection)	Yes	Yes

Table B3: Applicable Minimum Requirements

Section C – Soils Evaluation

1. **Describe the site's suitability for stormwater infiltration for flow control, runoff treatment, and low impact development (LID) measures.**

   Columbia West Engineering, Inc. has completed a Geotechnical Site Investigation for this development (see Appendix F). Test pits were excavated on site and it was determined that the soil was moist to wet and groundwater seepage was encountered at depths of 2 to 8 feet. The report included infiltration testing that showed rates of less than 0.06 inches per hour of infiltration. As a result, infiltration is not being considered as a viable option for flow control or treatment on this project.

2. **Identify water table elevations, flow directions (where available), and data on seasonal water table fluctuations with minimum and maximum water table elevations where these may affect stormwater facilities.**

   Columbia West Engineering, Inc. has completed a Geotechnical Site Investigation for this development (see Appendix F). Eight test pits were excavated on site. Soil moisture conditions were moist to wet and groundwater seeps and springs were encountered in test pits TP-3 through TP-8 at depths of 2 to 8 feet. With the proposed closed underground detention system, groundwater elevations shouldn't impact the stormwater facilities.

3. **Identify and describe soil parameters and design methods for use in hydrologic and hydraulic design of proposed facilities.**

   The Soil Survey of Clark County by the Soil Conservation Service shows the soil onsite is primarily Powell Silt Loam (PoD), (PoB) and (PoE). (See Vicinity Maps section and Appendix A of this report for the Soils Map). The soil properties are as follows:

   Powell Silt Loam (PoD)(PoB)(PoE)

   Classification: Hydrologic Group D / SG4

   Permeability: 0-24 in. depth, < 0.06 in/hr

Curve Numbers:	Meadow/Pasture	CN=89
	Grass/Landscape:	CN=90
	Pavement/Sidewalk:	CN=98
	Roof:	CN=98

A detailed list of the runoff curve numbers used in conveyance design is included in Appendix B. According to the Geotechnical Site Investigation by Columbia West Engineering, Inc. (See Appendix F), soil mottling, the presence of clay soils, and the prevalent groundwater seepage indicates that the soils onsite will likely accept little runoff and would be expected to behave more as a Hydrologic Soil Group 4 soil rather than Soil Group 3. As a result, onsite soils have been modeled as a Hydrologic Soil Group 4 for purposes of the stormwater calculations.

Conveyance design for the development is to be completed at time of final design. Runoff for conveyance design is to be estimated using the Santa Barbara Urban Hydrograph (SBUH) methodology. The following design storms are to be used in the hydrologic analysis:

2-year, 24-hour storm	2.8 inches of rainfall
10-year, 24-hour storm	3.8 inches of rainfall
100-year, 24-hour storm	5.0 inches of rainfall
Water Quality Storm (0.70 x 2-year storm)	1.96 inches of rainfall

Isopluvial maps for the 2-year, 10-year, and 100-year storms are included in Appendix B.

4. Report findings of testing and analysis used to determine the infiltration rate.

Due to the high observed groundwater elevations and poor permeability of the existing soil, infiltration is not being proposed for this development.

5. Where unstable or complex soil conditions exist that may significantly affect the design of stormwater facilities, the responsible official may require a preliminary soils report that addresses stormwater design considerations arising from soil conditions. The preliminary soils report shall be prepared by a registered professional engineer proficient in geotechnical investigation and engineering or a registered soil scientist. The preliminary soils report shall include a soils map developed using the criteria set in the *NRCS National Soil Survey Handbook* (NRCS 2007) and the *SCS Soil Survey Manual* (SCS 1993), at a minimum scale of 1:5,000 (12.7 inch/mile).

A Geotechnical Site Investigation Report has been prepared by Columbia West Engineering, Inc. (see Appendix F). Additional information will be provided, if required.

Section D – Source Control

1. **If the development activity includes any of the activities listed in Section 2.2 of Volume IV of the *Stormwater Management Manual for Western Washington* (SMMWW), identify the source control BMPs to be used with the land-disturbing activity.**

The following Source Control BMPs apply to this project:

- BMPs for Landscaping and Lawn/Vegetation Management
    - Install engineered soil/landscape systems to improve the infiltration and regulation of stormwater in landscaped areas.
    - Do not dispose of collected vegetation into waterways or storm drainage systems.

- BMPs for Maintenance of Stormwater Drainage and Treatment Systems
    - Inspect and clean dispersion trench, conveyance system, and catch basins as needed, and determine whether improvements in O & M are needed.
    - Promptly repair any deterioration threatening the structural integrity of the facilities. These include replacement of clean-out gates, catch basin lids, and rock in dispersion trench.
    - Ensure that storm sewer capacities are not exceeded and that heavy sediment discharges to the sewer system are prevented.
    - Regularly remove debris and sludge from BMPs used for peak-rate control, treatment, etc. and discharge to sanitary sewer if approved by the sewer authority, or truck to a local or state government approved disposal site.
    - Clean catch basins when the depth of deposits reaches 60 percent of the sump depth as measured from the bottom of basin to invert of lowest pipe into or out of the basin. However, in no case should there be less than six inches clearance from the debris surface to the invert of the lowest pipe.
    - Clean woody debris in catch basins as frequently as needed to ensure proper operation of the catch basin.
    - Post warning signs; “Dump No Waste – Drains to Ground Water,” “Streams,” “Lakes,” or emboss on or adjacent to all storm drain inlets where practical.
    - Disposal of sediments and liquids must comply with “Recommendations for Management of Street Wastes” described in Appendix IV-G of Volume IV of the Stormwater Manual.

- BMPs for Urban Streets
    - For maximum Stormwater pollutant reductions on curbed streets and high volume parking lots use efficient vacuum sweepers.
    - For moderate stormwater pollutant reductions on curbed streets use regenerative air sweepers or tandem sweeping operations.
    - For minimal stormwater pollutant reductions on curbed streets use mechanical sweepers.
    - Conduct sweeping at optimal frequencies. Optimal frequencies are those scheduled sweeping intervals that produce the most cost-effective annual reduction of pollutants normally found in stormwater and can vary depending on land use, traffic volume and rainfall patterns.

- Disposal of street sweeping solids must comply with "Recommendations for Management of Street Wastes" described in Appendix IV-G of Volume IV of the Stormwater Manual.
- Inform citizens about eliminating yard debris, oil and other wastes in street gutters to reduce street pollutant sources.
-

Additional recommended BMPs can be found in Section 2.2 of Volume IV of the Stormwater Manual.

Section E – Onsite Stormwater Management BMPs

1. **On the preliminary development plan or other maps, show the site areas where on-site stormwater management BMPs will be effectively implemented. The plan must show the areas of retained native vegetation and required flow lengths and vegetated flow paths, as required for proper implementation of each onsite stormwater BMP. Arrows must show the stormwater flow path to each BMP.**

   All stormwater runoff from the proposed development is to be captured and routed via pipe to one of two new stormwater facilities for treatment and detention. One facility is to be located at the west side of the site in Tract 'A'. The other facility is to be located along the west side of the site in the northwest corner of Tract 'B'. Each of the facilities is to be comprised of an Underground Detention and Cartridge Treatment System. Contech "Phosphosorb" media filter cartridges are being proposed to meet City of Camas phosphorus control requirements for developments within the LaCamas watershed. The facility in Tract 'A' will discharge via pipe to the stormwater system in 17th Avenue to the west of the site. The facility in Tract 'B' will discharge via pipe to an existing low point wetland swale along the western side of the site. (Refer to Preliminary Utility Plan in Appendix J for stormwater facility locations).

2. **Identify and describe geotechnical studies or other information used to complete the analysis and design of each on-site stormwater BMP.**

   Columbia West Engineering, Inc. has completed a Geotechnical Site Investigation for this development (see Appendix F). Test pits were excavated on site and it was determined that the soil was moist to wet and groundwater seepage was encountered at depths of 2 to 8 feet. The report included infiltration testing that showed rates of less than 0.06 inches per hour of infiltration. As a result, infiltration is not being considered as a viable option for flow control or treatment on this project.

3. **Identify the criteria (and their source) used to complete analyses for each on-site stormwater BMP.**

   The facility has been designed to provide treatment for the water quality storm (91% of the 24-hour continuous runoff volume) in accordance with City of Camas Stormwater Design Standards Manual Section 5.03 and Volume V of the Stormwater Management Manual for Western Washington (SMMWW) and detention for the continuous storm in accordance with the requirements of the City of Camas Stormwater Design Standards Manual Section 4.02 and Volume III of the SMMWW. WWHM2012 has been used for the continuous simulation model for this development.

4. Describe how design criteria will be met for each proposed on-site stormwater management BMP.

Two separate Combined Detention and Stormwater Cartridge Treatment Facilities are proposed in order to meet treatment and flow control requirements. Stormwater treatment will be met with the Manufactured Media Cartridge Filter System and flow-control requirements will be met with the underground detention pipe and control structure. Since the development is located within the LaCamas watershed, phosphorus control is required per Section 5.04 of the City of Camas Stormwater Design Standards Manual. Contech “Phosphosorb” media filter cartridges were selected to meet these requirements from the Phosphorus Treatment Menu in Section 3.3 of Volume V of the SMMWW. Flow control structures with an orifice and weir will be utilized in order to control stormwater flows from each facility. (Refer to Appendix J for Preliminary Utility Plan).

5. Describe any on-site application of LID measures planned for the project. Provide a plan that shows the proposed location and approximate size of each LID facility.

Due to the relatively high existing ground water elevation and saturated soil conditions, infiltration LID measures are not applicable to this project. In addition, due to the onsite slopes and lot sizes, none of the dispersion BMP’s are feasible for this site.

6. Identify and describe any assumptions used to complete the analysis.

Groundwater elevation was assumed to be below the detention volume for purposes of designing the stormwater detention facilities. The detention volume in each storage pipe was assumed to be dry at the beginning of the modeled storm event.

7. Describe site suitability, including hydrologic soil groups, slopes, areas of native vegetation, and adequate location of each BMP.

The Soil Survey of Clark County by the Soil Conservation Service shows the soil onsite is primarily Powell Silt Loam (PoB), (PoD) and (PoE). According to the Geotechnical Site Investigation by Columbia West Engineering, Inc. (See Appendix F), soil mottling, the presence of clay soils, and the prevalent groundwater seeps indicates that the soils onsite will likely accept little runoff and would be expected to behave more as a Hydrologic Soil Group 4 soil rather than Soil Group 3. As a result, infiltration is not proposed and onsite soils have been modeled as a Hydrologic Soil Group 4 for purposes of the stormwater calculations.

The proposed stormwater facilities have been located within the relative low areas of the site in order to provide for the most efficient drainage for the developed site.

Section F – Runoff Treatment Analysis and Design

1. **Document the level of treatment required (basic, enhanced, phosphorus, oil/water separation) based on procedures in Vol. V, Chapter 2 of the SMMWW.**

   Since the development is located within the LaCamas watershed, phosphorus control is required per Section 5.04 of the City of Camas Stormwater Design Standards Manual. According to the procedures outlined in Vol. V, Ch. 2 of the Stormwater Manual, the project requires phosphorus treatment. (See Treatment Facility Selection Flow Chart in Appendix C).

2. **Provide background and description to support the selection of the treatment BMP being proposed. Include an analysis of initial implementation costs and long-term maitenance costs.**

   Due to the relatively high existing ground water elevation and saturated soil conditions, it was determined that Combined Underground Detention and Media Cartridge Filter Systems would be the most viable treatment option for the site. A cost analysis has not been prepared, but could be provided if deemed to be necessary.

3. **Identify geotechnical or soils studies or other information used to complete the analysis and design.**

   Columbia West Engineering, Inc. has completed a Geotechnical Site Investigation for this development (see Appendix F). Test pits were excavated on site and it was determined that the soil was moist to wet and groundwater seepage was encountered at depths of 2 to 8 feet. The report included infiltration testing that showed rates of less than 0.06 inches per hour of infiltration. As a result, infiltration is not being considered as a viable option for flow control or treatment on this project.

4. **Identify the BMPs used in the design, and their sources.**

   Two separate Combined Detention and Stormwater Cartridge Treatment Facilities are proposed in order to meet treatment and flow control requirements. Stormwater treatment will be met with the Manufactured Media Cartridge Filter System and flow-control requirements will be met with the underground detention pipe and control structure. Since the development is located within the LaCamas watershed, phosphorus control is required per Section 5.04 of the City of Camas Stormwater Design Standards Manual. Contech "Phosphosorb" media filter cartidges were selected to meet these requirements from the Phosphorus Treatment Menu in Section 3.3 of Volume V of the SMMWW. Flow control structures with an orifice and weir will be utilized in order to control stormwater flows from each facility. (Refer to Appendix J for Preliminary Utility Plan).

5. **Summarize the results of the runoff treatment design, and describe how the proposed design meets the requirements of CMC Chapter 14.02 and the Stormwater Manual.**

   The site is divided into two individual catchment areas. Runoff from the new impervious areas (road, curb and sidewalk, and driveways) and landscape areas will be collected and routed to the Contech Stormfilter manhole for treatment. Upstream of the treatment manhole, the storm flow will be split to route the required water quality flow to the treatment BMP. A tabulation of water quality treatment flow rates according to the WWHM model is below. These represent the flow rate at or above 91% of the runoff volume (in accordance with City of Camas Stormwater Design Standards Manual Section 5.03 and Volume V of the SMMWW), as estimated by an approved continuous runoff model, required to be treated. Contech "Phosphosorb" media filter cartidges were selected to meet these requirements from the Phosphorus Treatment Menu in Section 3.3 of Volume V of the SMMWW. The cartridge configuration required to treat each flow rate is included in the table below. Each 27" cartridge with "Phosphosorb" treats18.8 gmp (0.0416 cfs) of flow.

Treatment System	Required WQ Flowrate (Offline)	Contech Stormfilter Sizing	Allowable WQ Flowrate
Tract 'A'	0.1413 cfs	(4) 27" Cartridges	0.1676 cfs
Lot 1	0.0462 cfs	(2) 27" Cartridges	0.0838 cfs

Table F1: Water Quality Flow Rate and Cartridge Filter Selection

   Refer to Appendix D for screen shots of the WWHM model.

6. **Provide a table that lists the amount of Pollution-Generating Pervious Surfaces (PGPS) and Pollution-Generating Impervious Surfaces (PGIS) for each Threshold Discharge Area (TDA).**

   The following table lists the areas of Pollution-Generating Pervious Surfaces (PGPS) and Pollution-Generating Impervious Surfaces (PGIS) for each Threshold Discharge Area (TDA):

	TDA 1	TDA 2
Effective Pollution Generating Impervious Surface (PGIS) (Acres)	0.977	0.364
Effective Pollution Generating Pervious Surface (PGPS) (Acres)	2.756	0.962

Table F2: Effective Pollution Generating Surface Summary

Section G – Flow Control Analysis and Design

1. **Identify the site's suitability for stormwater infiltration for flow control, including tested infiltration rates, logs of soil borings, and other information.**

   Columbia West Engineering, Inc. has completed a Geotechnical Site Investigation for this development (see Appendix F). Test pits were excavated on site and it was determined that the soil was moist to wet and groundwater seeps were encountered at depths of 2 to 8 feet. The report concluded that soil mottling, the presence of clay soils, and the prevalence of ground water seeps indicates that the soil will likely accept little runoff. As a result, infiltration is not being considered as a viable option for flow control or treatment on this project.

2. **Identify and describe geotechnical or other studies used to complete the analysis and design.**

   Columbia West Engineering, Inc. has completed a Geotechnical Site Investigation for this development (see Appendix F). Test pit logs in the vicinity of the proposed stormwater facilities (TP-1 and TP-2), show infiltration at these sites to be <0.06 inches per hour. Due to these infiltration rates and the slope of the ground surface of the site, underground detention and media cartridge filter system are being proposed for stormwater treatment.

3. **If infiltration cannot be utilized for flow control, provide the following additional information:**

   a. **Identify areas where flow control credits can be obtained for dispersion, LID, or other measures, per the requirements in the Stormwater Manual.**

   Due to the relatively high existing ground water elevation and saturated soil conditions, infiltration LID measures are not applicable to this project.

   b. **Provide the approximate sizing and location of flow control facilities for each TDA, per Volume III of the Stormwater Manual.**

   All stormwater runoff from the proposed development is to be captured and routed via pipe to one of two new stormwater facilities for treatment and detention. One facility is to be located at the west side of the site in Tract 'A'. The other facility is to be located along the west side of the site in the northwest corner of Tract 'B'. Each of the facilities is to be comprised of an Underground Detention and Cartridge Treatment System. Contech "Phosphosorb" media filter cartridges are being proposed to meet City of Camas phosphorus control requirements for developments within the LaCamas watershed. The facility in Tract 'A' will discharge via pipe to the stormwater system in 17th Avenue to the west of the site. The facility in Tract 'B' will discharge via pipe to an existing low point wetland swale along the western side of the site. The Tract 'B' facility will consist of a 60" Contech Stormfilter Manhole and a 4' x 40' underground detention pipe. The Tract 'A' facility will consist of a 48" Contech Stormfilter Manhole and a 4' x 40' underground detention pipe. (Refer to Preliminary Utility Plan in Appendix J for stormwater facility locations).

c. Identify the criteria (and their sources) used to complete the analysis, including pre-developed and post-developed land use characteristics.

The storm facilities have been designed to provide detention for the continuous storm in accordance with the requirements of the City of Camas Stormwater Design Standards Manual Section 4.02 and Volume III of the SMMWW. WWHM2012 has been used for the continuous simulation model for this development. According to the Geotechnical Site Investigation by Columbia West Engineering, Inc. (See Appendix F), soil mottling, the presence of clay soils, and the prevalent groundwater seeps indicates that the soils onsite will likely accept little runoff and would be expected to behave more as a Hydrologic Soil Group 4 soil rather than Soil Group 3. As a result, onsite soils have been modeled as a Hydrologic Soil Group 4 for purposes of the stormwater calculations.

The pre-developed TDA 1 includes Catchments Basin A+B, and the pre-developed TDA 2 includes Catchments Basin C+D. The developed TDA 1 includes Catchments Basin A and Basin B; and the developed TDA 2 includes Catchments Basin C and Basin D (see Catchment Plans in Appendix J for location). Catchments Basin A+B, Basin A and Basin B represent the southeast portion of the development and were used to size the Tract ‘B’ stormwater facility. Catchments Basin C+D, Basin C and Basin D represent the northwest portion of the development and were used to size the Tract ‘A’ stormwater facility. A summary of the pre-developed and developed catchment data are shown in the tables below:

Pre-developed catchment areas:

Catchment	Storm Facility	Description	Area (acres)
Basin A+B	Tract ‘B’	SG4, Forest, Steep	4.496
Basin C+D	Tract ‘A’	SG4, Forest, Steep	1.642

Table G1: Hydrologic parameters used in pre-developed catchment analysis

Developed catchment areas:

Catchment	Storm Facility	Description	Area (acres)
Basin A	Tract 'B'	Roads Steep Roof Tops Flat Driveways Steep Sidewalks Steep SG3, Lawn, Steep	0.109 0.158 0.034 0.032 0.469
Basin B	Tract 'B'	Roads Steep Roof Tops Flat Driveways Steep Sidewalks Steep SG3, Lawn, Steep	0.387 0.605 0.275 0.140 2.287
Basin C	Tract 'A'	Roads Steep Roof Tops Flat Driveways Steep Sidewalks Steep SG3, Lawn, Steep	0.223 0.158 0.034 0.073 0.631
Basin D	Tract 'A'	Roof Tops Flat Driveways Steep SG3, Lawn, Steep	0.158 0.034 0.331

Table G2: Hydrologic parameters used in developed catchment analysis

4. **For sites considered to be historical prairie, submit a project site report prepared by a wetland scientist or horticulturist experienced in identifying soils, plans, and other evidence associated with historic prairies to demonstrate the existence of historic prairie on the project site. Areas within Camas that were historically prairie include Fern and Lacamas prairies. Contact City staff for a map showing potential prairie locations.**

This section does not apply.

5. Complete a hydrologic analysis for existing and developed site conditions, in accordance with the requirements of Chapter 4 of this manual and Chapter 2, Volume III of the Stormwater Manual, using an approved continuous runoff simulation model. Compute existing and developed flow duration for all subbasins. Provide an output table from the continuous flow model.

<u>Tract 'B' Facility:</u>

A summary of the pre-developed and developed flows for the Tract 'B' Facility (Catchments Basin A+B, Basin A, Basin B) from the WWHM2012 calculations is shown in the table below:

Return Period	Pre-developed Flow (cfs)	Developed Flow (cfs)
2-Year	1.35	1.24
10-Year	2.43	2.09
50-Year	3.04	2.96
100-Year	3.23	3.36

Table G3: Pre-developed and developed flows for Tract 'B' Facility.

A summary of the developed flows and stormwater facility storage volumes and stage elevations for the Tract 'B' Facility from the WWHM2012 calculations is shown in the table below:

Return Period	Developed Flow (cfs)	Detention Volume (ac-ft)	Detention Stage Elevation (ft)
2-Year	1.24	0.009	3.06
10-Year	2.09	0.009	3.17
50-Year	2.96	0.010	3.25
100-Year	3.36	0.010	3.29

Table G4: Developed flows and stormwater facility storage volumes / stage elevations for Tract 'B' Facility

From the tables above, it can be seen that the proposed design meets the flow-control requirements, as specified in the City of Camas Stormwater Design Standards Manual Section 4.02 and Volume III of the SMMWW. It can also be seen that the proposed detention volume is sufficient to detain the stormwater from the developed catchment areas Basin A and Basin B.

<u>Tract 'A' Facility:</u>

A summary of the pre-developed and developed flows for the Tract 'A' Facility (Catchments Basin C+D, Basin C, and Basin D) from the WWHM2012 calculations is shown in the table below:

Return Period	Pre-developed Flow (cfs)	Developed Flow (cfs)
2-Year	0.49	0.37
10-Year	0.89	0.67
50-Year	1.11	1.01
100-Year	1.18	1.19

Table G5: Pre-developed and developed flows for Tract 'A' Facility.

A summary of the developed flows and stormwater facility storage volumes and stage elevations for the Tract ‘A’ Facility from the WWHM2012 calculations is shown in the table below:

Return Period	Developed Flow (cfs)	Detention Volume (ac-ft)	Detention Stage Elevation (ft)
2-Year	0.37	0.009	2.99
10-Year	0.67	0.009	3.07
50-Year	1.01	0.009	3.12
100-Year	1.19	0.009	3.14

Table G6: Developed flows and stormwater facility storage volumes / stage elevations for Tract ‘A’ Facility

From the tables above, it can be seen that the proposed design meets the flow-control requirements, as specified in the City of Camas Stormwater Design Standards Manual Section 4.02 and Volume III of the SMMWW. It can also be seen that the proposed detention volume is sufficient to detain the stormwater from the developed catchment areas Basin C and Basin D.

6. Include and reference all hydrologic computations, equations, graphs, and any other aids necessary to clearly show the methodology and results.

Refer to Appendix E for a detailed WWHM2012 hydraulic analysis of the pre-developed and developed site during the 2-, 10-, 50-, and 100-yr. continuous storm events.

7. Include all maps, exhibits, graphics, and references used to determine existing and developed site hydrology.

Refer to the Catchment Plans in Appendix J for catchment area locations and the specific locations of the stormwater facilities.

Refer to the Maps section of this report.

Section H – Wetlands Protection

Refer to the Wetland Delineation and Assessment prepared by Olson Environmental LLC. in Appendix G.

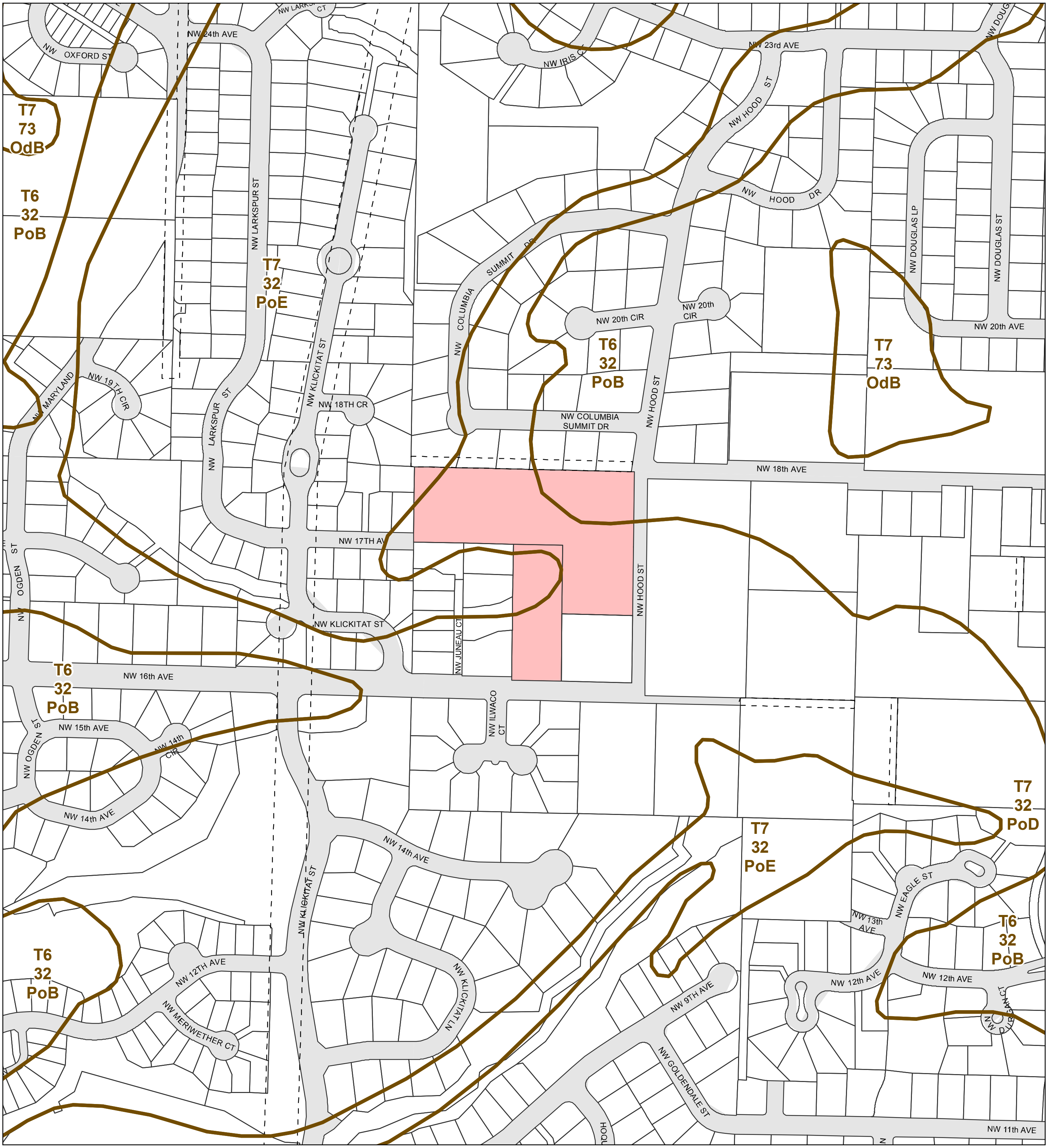
Appendix Index

Map Symbol	Soil Name	Hydrologic Group	Clark County WWHM Soils Group
NbA	NEWBERG	B	2
NbB	NEWBERG	B	2
OdB	ODNE	D	4
OeD	OLEQUA	B	3
OeE	OLEQUA	B	3
OeF	OLEQUA	B	3
OhD	OLEQUA VARIANT	C	4
OhF	OLEQUA VARIANT	C	4
OlB	OLYMPIC	B	3
OlD	OLYMPIC	B	3
OlE	OLYMPIC	B	3
OlF	OLYMPIC	B	3
OmE	OLYMPIC	B	3
OmF	OLYMPIC	B	3
OpC	OLYMPIC VARIANT	C	3
OpE	OLYMPIC VARIANT	C	3
OpG	OLYMPIC VARIANT	C	3
OrC	OLYMPIC VARIANT	C	3
PhB	PILCHUCK	C	2
PoB	POWELL	C	3
PoD	POWELL	C	3
PoE	POWELL	C	3
PuA	PUYALLUP	B	2
Ra	RIVERWASH	D	N/A
Rc	RIVERWASH	D	N/A
Rk	ROCK LAND	D	N/A
Ro	ROUGH BROKEN LAND	A	1
SaC	SALKUM	B	2
SlB	SARA	D	4
SlD	SARA	D	4
SlF	SARA	D	4
SmA	SAUVIE	B	3
SmB	SAUVIE	B	3
SnA	SAUVIE	D	3
SpB	SAUVIE	B	3

TABLE 7.—*Estimated physical and chemical properties of the soils*—Continued

Soil series and map symbols	Depth from surface	Classification: Dominant USDA texture	Classification: Unified	Classification: AASHO	Percentage passing sieve—: No. 4 (4.76 mm.) [1]	Percentage passing sieve—: No. 10 (2.0 mm.)	Percentage passing sieve—: No. 200 (0.074 mm.)	Permeability	Available water capacity	Reaction
	Inches							*Inches per hour*	*Inches per inch of soil*	*pH*
Minniece: MnA, MnD.	0–48	Silty clay and clay	CH	A–7	90–95	85–95	65–75	<0. 06	0. 06–0. 08	6. 1–7.
	48	Basalt bedrock.								
MoA.	0–12	Silt loam	ML	A–4	100	95–100	65–75	0. 63–2. 0	0. 19–0. 21	6. 1–6.
	12–22	Silty clay	CH	A–7	95–100	95–100	80–90	0. 06–0. 2	0. 12–0. 14	6. 1–6.
	22–60	Very gravelly clay loam (weakly cemented).	GC	A–2	35–50	30–50	20–35	<0. 06	0. 03–0. 05	5. 6–6.
Mossyrock: MsB.	0–23	Silt loam	OL or OH	A–5	95–100	95–100	50–60	0. 63–2. 0	0. 19–0. 21	6. 1–6.
	23–60	Silt loam	ML	A–5	100	95–100	55–65	0. 63–2. 0	0. 19–0. 21	6. 6–7.
	60–74	Loam	ML	A–4	100	95–100	70–80	0. 63–2. 0	0. 16–0. 18	6. 1–7.
Newberg: NbA, NbB.	0–7	Silt loam	ML	A–4	--------	100	70–80	0. 63–2. 0	0. 19–0. 21	5. 6–6.
	7–52	Fine sandy loam and sandy loam.	SM or ML	A–4	--------	100	40–55	2. 0–6. 3	0. 13–0. 15	6. 1–7.
	52–72	Sand	SM	A–1	--------	100	5–15	0. 63–20. 0	0. 05–0. 07	6. 6–7.
Odne: OdB.	0–50	Silt loam, silty clay loam, clay loam, and loam.	CL	A–4 or A–6	--------	100	75–85	<0. 06	0. 10–0. 12	5. 0–6.
Olequa: OeD, OeE, OeF.	0–17	Silt loam	ML	A–7	--------	100	75–85	0. 63–2. 0	0. 19–0. 21	6. 1–6.
	17–90	Heavy silt loam and silty clay loam.	CL	A–7	--------	100	80–90	0. 2–0. 63	0. 19–0. 21	4. 5–6.
OhD, OhF.	0–32	Silty clay loam	CL	A–7	95–100	90–95	85–95	0. 2–0. 63	0. 19–0. 21	[illegible]–6.
	32–82	Silty clay and clay	CH	A–7	95–100	90–95	85–95	<0. 06	0. 06–0. 08	[illegible]. 1–6.
Olympic: OlB, OlD, OlE, OlF, OmE, OmF.	0–44	Clay loam and silty clay loam.	ML or CL	A–7	90–100	90–100	75–85	0. 2–0. 63	0. 19–0. 21	5. 1–6.
	44–59	Gravelly clay loam.	GC	A–4	75–90	70–85	35–50	0. 2–0. 63	0. 10–0. 12	4. 5–5.
	59	Fractured basalt.								
OpC, OpE, OpG, OrC.	0–30	Heavy clay loam and heavy silty clay loam.	ML or CL	A–7	90–95	90–95	75–85	0. 2–0. 63	0. 19–0. 21	5. 1–6.
	30	Fractured basalt.								
Pilchuck: PhB.	0–60	Fine sand	SM	A–3	95–100	90–100	5–10	6. 3–20. 0	0. 05–0. 07	6. 1–7.
Powell: PoB, PoD, PoE.	0–23	Silt loam	ML	A–4	--------	100	80–90	0. 63–0. 20	0. 18–0. 20	5. 1–6.
	23–63	Slit loam (fragipan).	ML	A–4	--------	100	80–90	0. 06–0. 20	0. 06–0. 08	5. 1–6.
Puyallup: PuA.	0–27	Stratified fine sandy loam, loam, and loamy sand.	SM	A–4	100	95–100	35–50	2. 0–6. 3	0. 10–0. 12	5. 6–6.
	27–60	Gravelly sand	SP or SW	A–1	70–90	65–85	0–5	6. 3–20. 0	0. 04–0. 06	6. 6–7.
Riverwash, sandy: Ra.	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Riverwash, cobbly: Rc.	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Rock land: Rk.	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Rough broken land: Ro.	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)

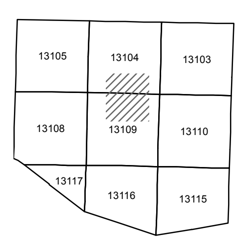
See footnotes at end of table.



Soil Types

Printed on: August 07, 2020

Account: 127415000, 127440000
Owner: SAGE RAYMOND J
Address: 3206 NE 132ND AVE
C/S/Z: VANCOUVER, WA 98682



CLARK COUNTY, WASHINGTON
Geographic Information System

0 200 400
Feet

- Subject Property(s)
- Public Road
- Transportation or Major Utility Easement
- Soil Type Boundary

Information shown on this map was collected from several sources. Clark County accepts no responsibility for any inaccuracies that may be present.

Table III-1.3 SCS Western Washington Runoff Curve Numbers (Published by SCS in 1982) Runoff curve numbers for selected agricultural, suburban and urban land use for Type 1A rainfall distribution, 24-hour storm duration.

LAND USE DESCRIPTION		CURVE NUMBERS BY HYDROLOGIC SOIL GROUP A	B	C	D
Cultivated land(1):	winter condition	86	91	94	95
Mountain open areas:	low growing brush & grasslands	74	82	89	92
Meadow or pasture:		65	78	85	89
Wood or forest land:	undisturbed	42	64	76	81
Wood or forest land:	young second growth or brush	55	72	81	86
Orchard:	with cover crop	81	88	92	94
Open spaces, lawns, parks, golf courses, cemeteries, landscaping.					
Good condition:	grass cover on ≥75% of the area	68	80	86	90
Fair condition:	grass cover on 50-75% of the area	77	85	90	92
Gravel roads & parking lots:		76	85	89	91
Dirt roads & parking lots:		72	82	87	89
Impervious surfaces, pavement, roofs etc.		98	98	98	98
Open water bodies:	lakes, wetlands, ponds etc.	100	100	100	100
Single family residential(2):		Separate curve number shall be selected for pervious & impervious portions of the site or basin			
Dwelling Unit/Gross Acre	%Impervious(3)				
1.0 DU/GA	15				
1.5 DU/GA	20				
2.0 DU/GA	25				
2.5 DU/GA	30				
3.0 DU/GA	34				
3.5 DU/GA	38				
4.0 DU/GA	42				
4.5 DU/GA	46				
5.0 DU/GA	48				
5.5 DU/GA	50				
6.0 DU/GA	52				
6.5 DU/GA	54				
7.0 DU/GA	56				
PUD's, condos, apartments, commercial businesses & industrial areas	%impervious must be computed				

(1) For a more detailed description of agricultural land use curve numbers refer to National Engineering Handbook, Sec. 4, Hydrology, Chapter 9, August 1972.
(2) Assumes roof and driveway runoff is directed into street/storm system.
(3) The remaining pervious areas (lawn) are considered to be in good condition for these curve numbers.

Table III-1.4 "n" AND "k" Values Used in Time Calculations for Hydrographs

"n_s" Sheet Flow Equation Manning's Values (for the initial 300 ft. of travel)	n_s
Smooth surfaces (concrete, asphalt, gravel, or bare hand packed soil) 0.011	
Fallow fields or loose soil surface (no residue)	0.05
Cultivated soil with residue cover ($s \leq 0.20$ ft/ft)	0.06
Cultivated soil with residue cover ($s > 0.20$ ft/ft)	0.17
Short prairie grass and lawns	0.15
Dense grasses	0.24
Bermuda grass	0.41
Range (natural)	0.13
Woods or forest with light underbrush	0.40
Woods or forest with dense underbrush	0.80

*Manning values for sheet flow only, from Overton and Meadows 1976 (See TR-55, 1986)

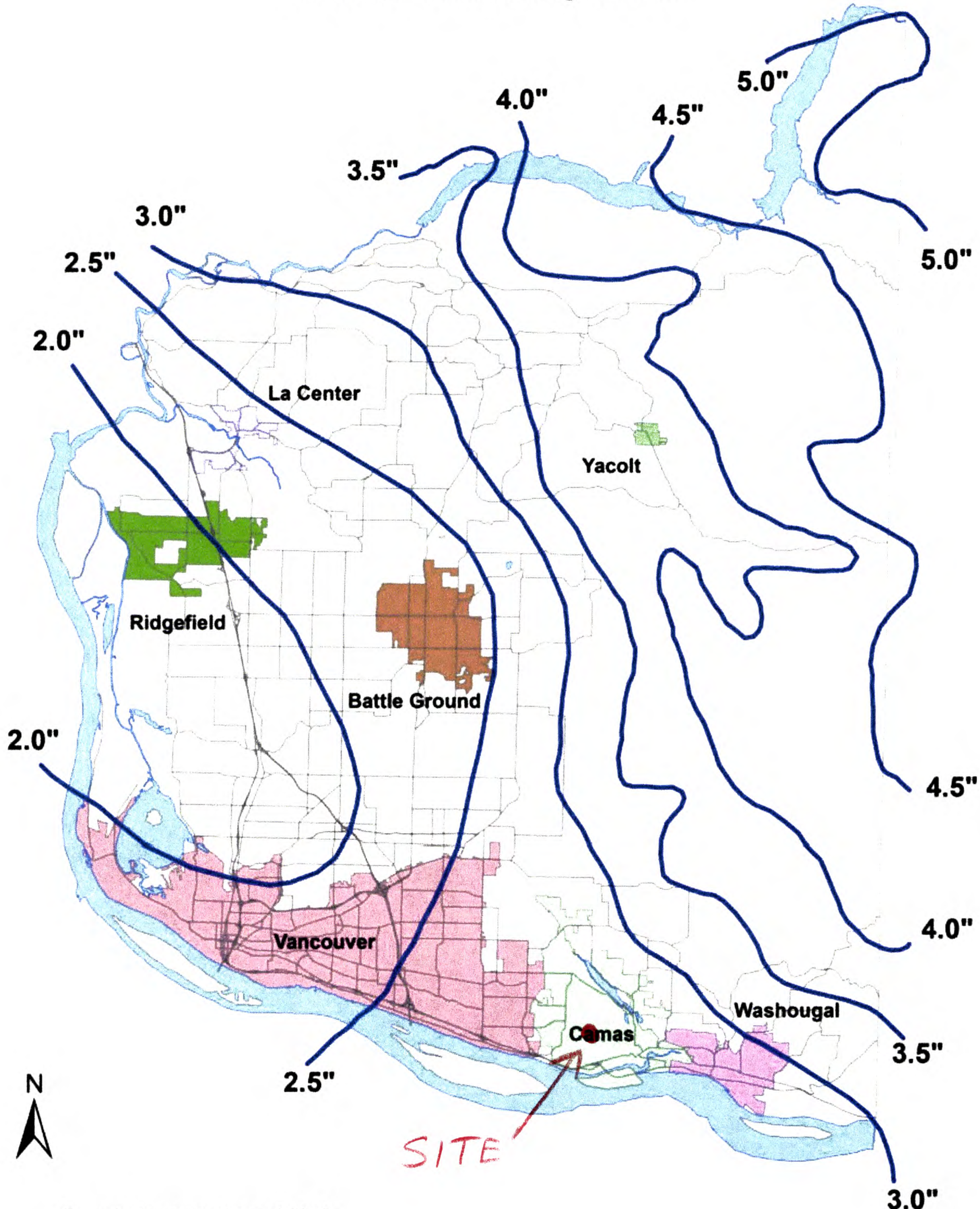
"k" Values Used in Travel Time/Time of Concentration Calculations

Shallow Concentrated Flow (After the initial 300 ft. of sheet flow, R = 0.1)	k_s
1. Forest with heavy ground litter and meadows (n = 0.10)	3
2. Brushy ground with some trees (n = 0.060)	5
3. Fallow or minimum tillage cultivation (n = 0.040)	8
4. High grass (n = 0.035)	9
5. Short grass, pasture and lawns (n = 0.030)	11
6. Nearly bare ground (n = 0.25)	13
7. Paved and gravel areas (n = 0.012)	27

Channel Flow (intermittent) (At the beginning of visible channels R = 0.2)	k_c
1. Forested swale with heavy ground litter (n = 0.10)	5
2. Forested drainage course/ravine with defined channel bed (n = 0.050)	10
3. Rock-lined waterway (n = 0.035)	15
4. Grassed waterway (n = 0.030)	17
5. Earth-lined waterway (n = 0.025)	20
6. CMP pipe (n = 0.024)	21
7. Concrete pipe (0.012)	42
8. Other waterways and pipe 0.508/n	

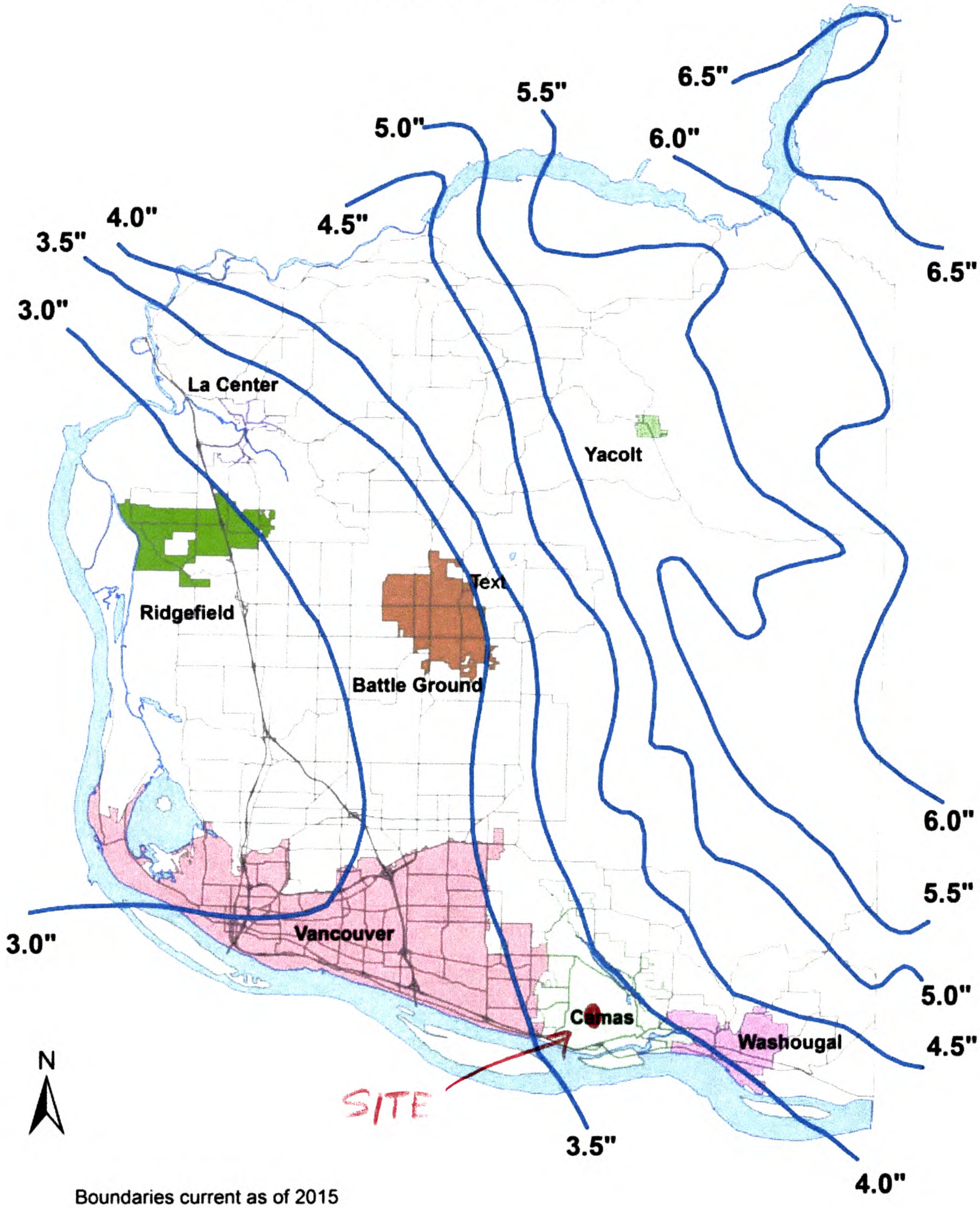
Channel Flow (Continuous stream, R = 0.4)	k_c
9. Meandering stream with some pools (n = 0.040)	20
10. Rock-lined stream (n = 0.035)	23
11. Grass-lined stream (n = 0.030)	27
12. Other streams, man-made channels and pipe 0.807/n**	

Isopluvial Map for Clark County
2-Year, 24-Hour Design Storm



Boundaries current as of 2015

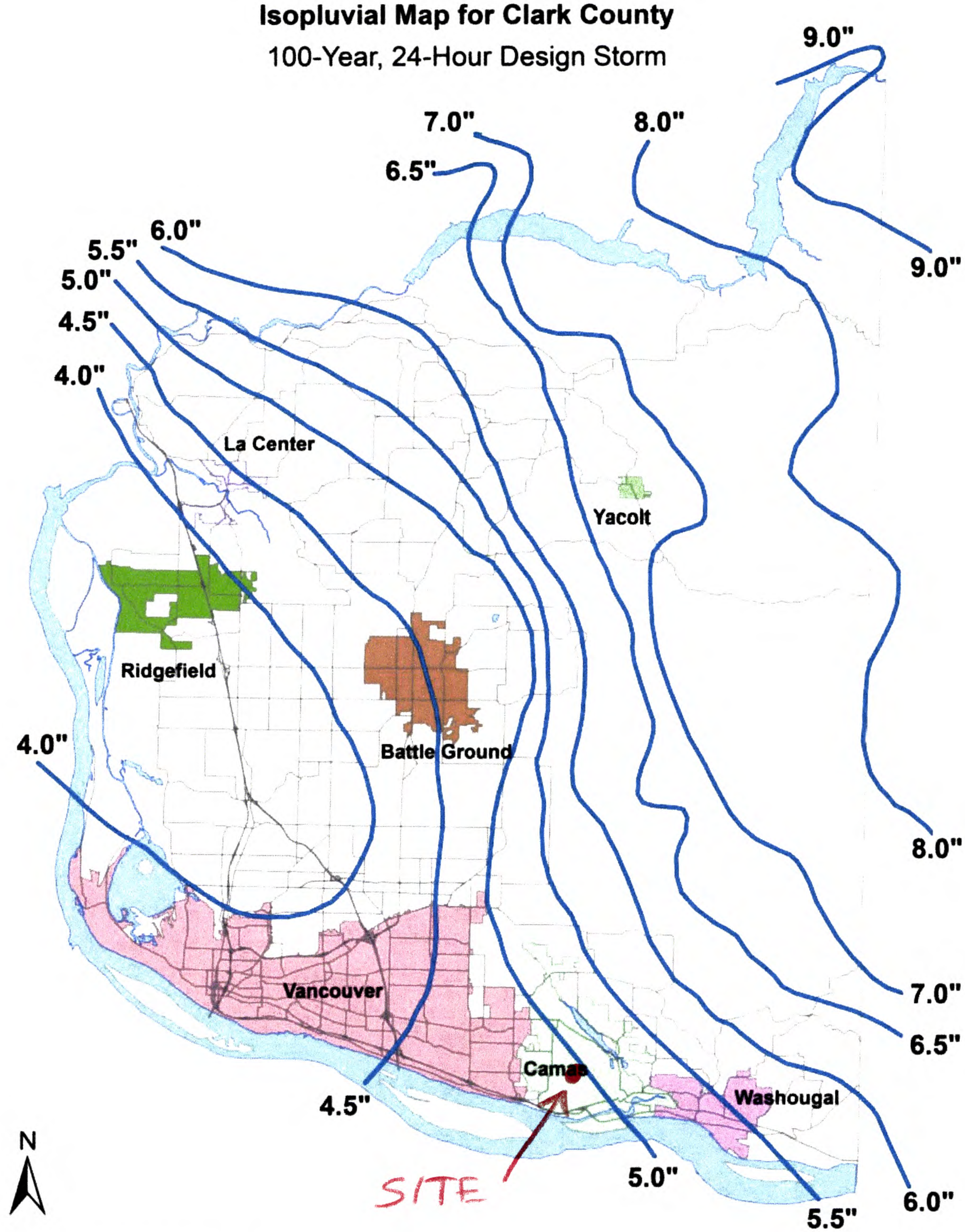
Isopluvial Map for Clark County
10-Year, 24-Hour Design Storm



Boundaries current as of 2015

Isopluvial Map for Clark County

100-Year, 24-Hour Design Storm



Boundaries current as of 2015.

Chapter 1: General Requirements

Continued

Figure 1.1: Flow Chart for Determining Stormwater Requirements

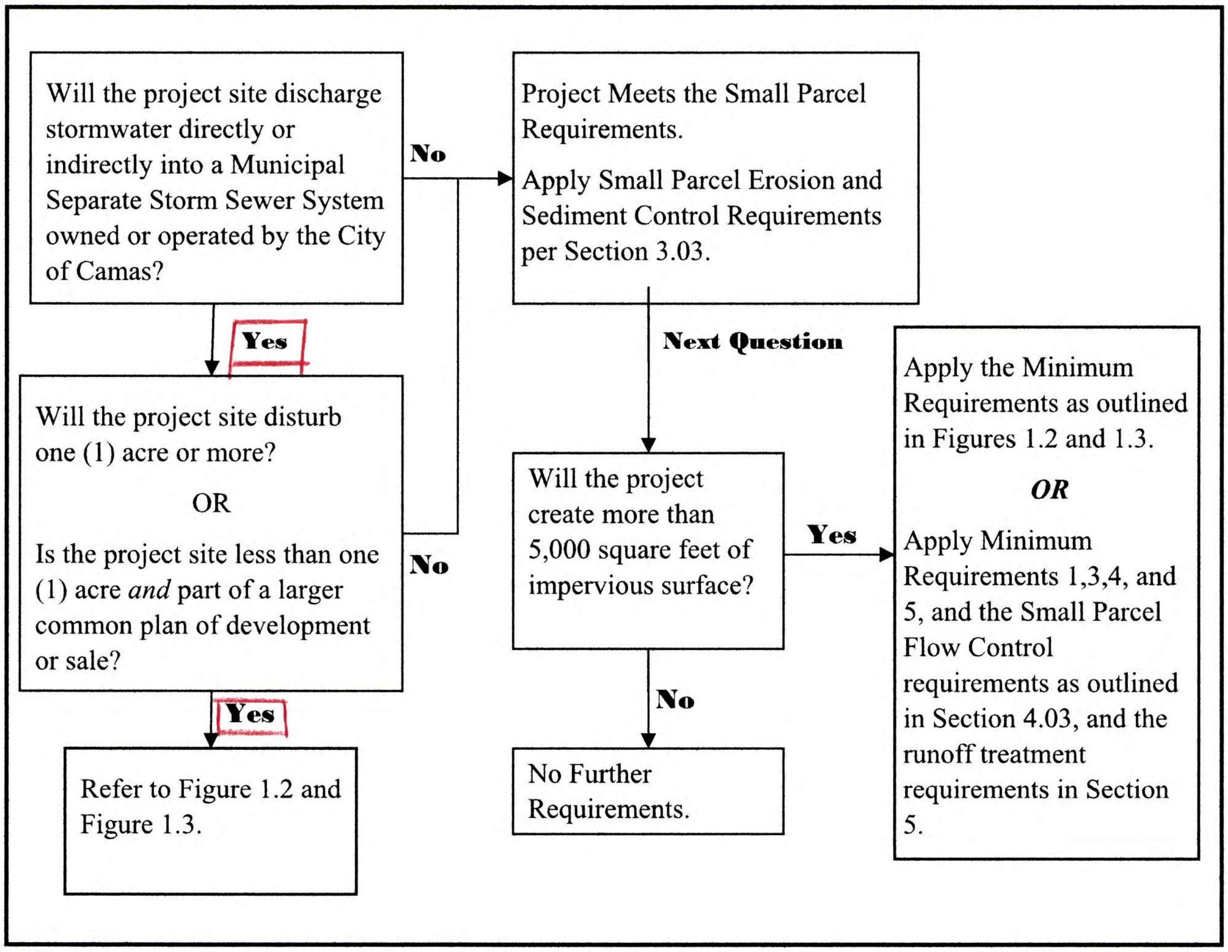
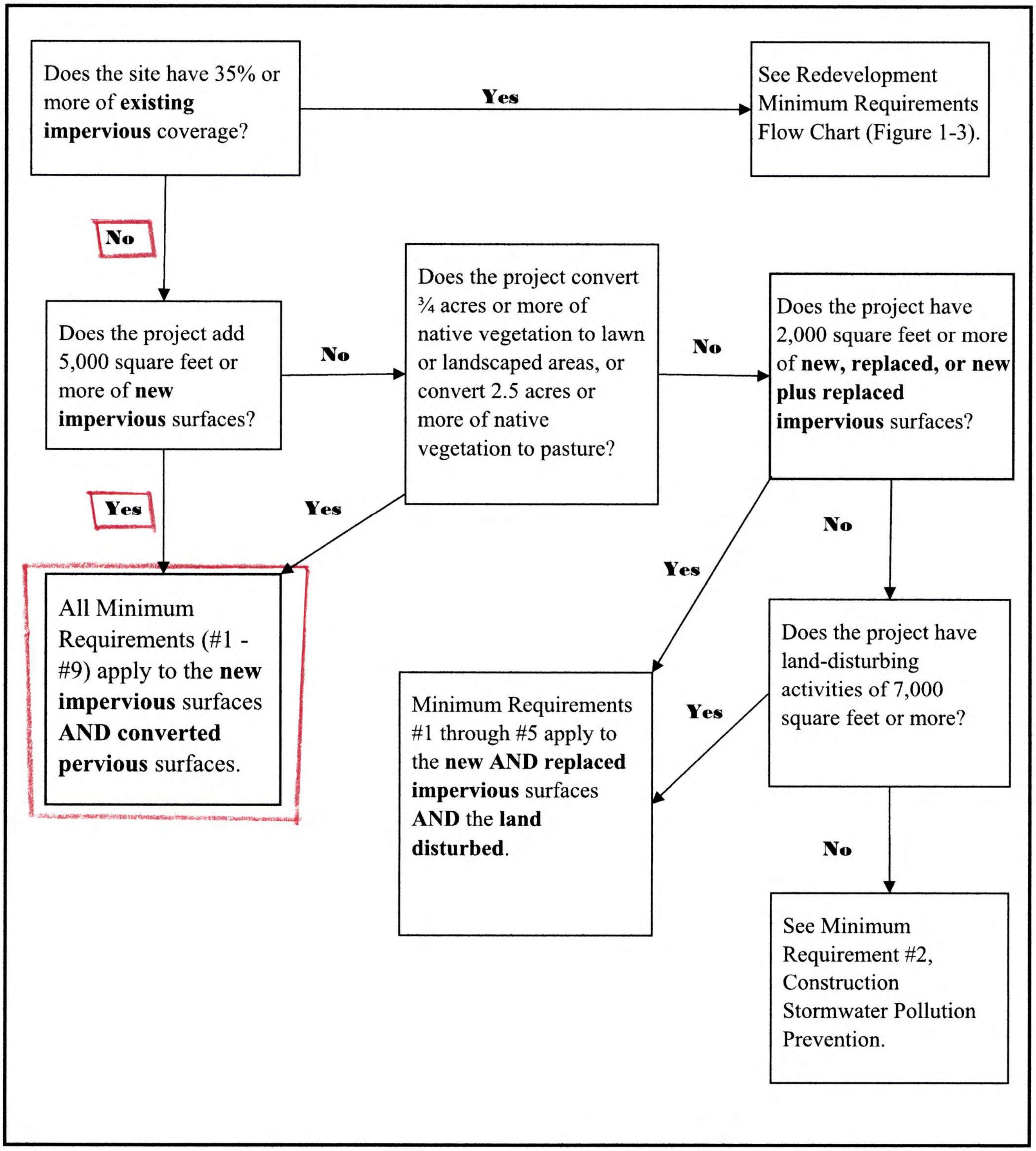
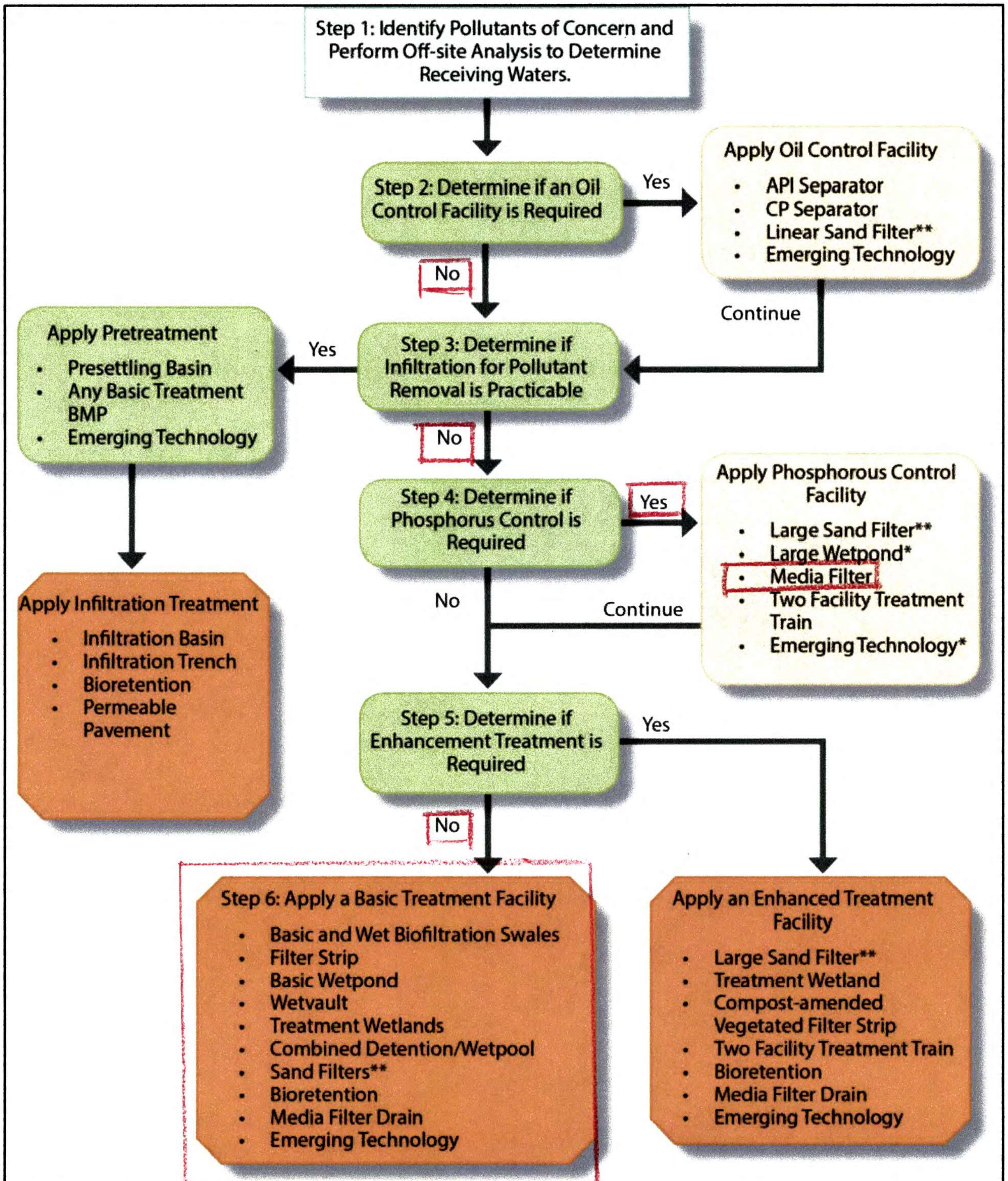


Figure 1.2: New Development Minimum Requirements Flow Chart





* When Phosphorous Control and Enhanced Treatment are required, the Large Wetpond and certain types of emerging technologies will not meet both types of treatment requirements. A different or an additional treatment facility will be required to meet Enhanced Treatment.
** When a Sand Filter BMP is selected, pretreatment for debris and TSS is also required.

Figure 3.1: Treatment Facility Selection Flow Chart

I-3 Minimum Requirements for New Development and Redevelopment

I-3.1 Introduction to the Minimum Requirements

This chapter describes the Minimum Requirements for stormwater management at new development and redevelopment sites. I-3.3 Applicability of the Minimum Requirements should be consulted to determine which of the Minimum Requirements apply to any given project. Figure I-3.1: Flow Chart for Determining Requirements for New Development and Figure I-3.2: Flow Chart for Determining Requirements for Redevelopment should be consulted to determine whether the Minimum Requirements apply to new surfaces, replaced surfaces, or new and replaced surfaces. Volumes II through V of this manual present Best Management Practices (BMPs) for use in meeting the Minimum Requirements.

The text in this box originates from one or more of the following Permits:
Appendix 1 of the Phase I / Phase II Municipal Stormwater Permits
Construction Stormwater General Permit

Depending on the type and size of the proposed project, different combinations of the Minimum Requirements or UIC Program regulations apply. See I-4 UIC Program for information on the UIC Program regulations.

In general, small projects are required to control erosion and sedimentation from construction activities and to apply simpler approaches to runoff treatment and flow control of stormwater runoff from the developed site. Controlling flows from small projects is important because the cumulative effect of uncontrolled flows from many small projects can be as damaging as those from a single large project.

Large projects must provide erosion and sedimentation control during construction, permanent control of stormwater runoff from the developed site through selection of appropriate BMPs, and other measures to reduce and control the on-site and off-site impacts of the project.

Sites being redeveloped must generally meet the same Minimum Requirements as new development for the new hard surfaces and converted vegetation areas. Redevelopment sites must also provide erosion control, source control, and on-site stormwater management for the portion of the site being redeveloped. In addition, if the redevelopment meets certain cost or space (as applied to roads) thresholds, updated stormwater management for the redeveloped pervious and hard surfaces must be provided. There may also be situations in which additional controls are required for sites, regardless of type or size, as a result of basin plans or special water quality concerns.

I-3.2 Exemptions

Unless otherwise indicated in this section, the practices described in this section are exempt from the Minimum Requirements, even if such practices meet the definition of new development or redevelopment.

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Forest Practices

Forest practices regulated under Title 222 WAC, except for Class IV-General forest practices that are conversions from timberland to other uses, are exempt from the provisions of the Minimum Requirements.

The text in this box originates from one or more of the following Permits:
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Commercial Agriculture

Commercial agriculture practices involving working the land for production are generally exempt. However, the conversion from timberland to agriculture, and the construction of impervious surfaces are not exempt.

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Oil and Gas Field Activities or Operations

Construction of drilling sites, waste management pits, and access roads, as well as construction of transportation and treatment infrastructure such as pipelines, natural gas treatment plants, natural gas pipeline compressor stations, and crude oil pumping stations are exempt. Operators are encouraged to implement and maintain Best Management Practices to minimize erosion and control sediment during and after construction activities to help ensure protection of surface water quality during storm events.

The text in this box originates from one or more of the following Permits:
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Pavement Maintenance

The following pavement maintenance practices are exempt:

- pothole and square cut patching,
- overlaying existing asphalt or concrete pavement with asphalt or concrete without expanding the area of coverage,
- shoulder grading,
- reshaping/regrading drainage systems,
- crack sealing,
- resurfacing with in-kind material without expanding the road prism,
- pavement preservation activities that do not expand the road prism, and
- vegetation maintenance.

The following pavement maintenance practices are not categorically exempt, and are subject to the Minimum Requirements that are triggered when the thresholds identified for new or redevelopment projects are met per I-3.3 Applicability of the Minimum Requirements.

- Removing and replacing an asphalt or concrete pavement to base course or lower, or repairing the pavement base: These are considered replaced hard surfaces.
- Extending the pavement edge without increasing the size of the road prism, or paving graveled shoulders: These are considered new hard surfaces.
- Resurfacing by upgrading from dirt to gravel, a bituminous surface treatment ("chip seal"), asphalt, or concrete; upgrading from gravel to chip seal, asphalt, or concrete; or upgrading from chip seal to asphalt or concrete: These are considered new impervious surfaces.

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Underground Utility Projects

Underground utility projects that replace the ground surface with in-kind material or materials with similar runoff characteristics are only subject to I-3.4.2 MR2: Construction Stormwater Pollution Prevention Plan (SWPPP).

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I-3.3 Applicability of the Minimum Requirements

Minimum Requirement Thresholds

Follow the steps below to ensure the project complies with the applicable Minimum Requirements:

1. First, determine if all runoff is infiltrating into a UIC well (i.e. approved continuous runoff modeling methods indicate that the entire runoff file is infiltrated). If it is, refer to I-4 UIC Program. If not, continue with the steps below.
2. Determine the Minimum Requirements that apply to the entire project using the Project Thresholds for new development and redevelopment listed below.
3. Delineate the Threshold Discharge Areas (TDAs) within the Site. See the definition of TDA in the Glossary for guidance on how to delineate a TDA.
4. For each Minimum Requirement that is applicable to the project (per step 2), use the TDA Thresholds to determine which, if any, BMP(s) must be constructed within each TDA to satisfy that Minimum Requirement. The TDA Thresholds are given within the text of each Minimum Requirement.

   Minimum Requirements #1, #2, #3, #4, #5, and #9 do not have separate TDA Thresholds, and must be applied to the entire project if they are applicable to the project. Minimum Requirements #6, #7, and #8 have TDA Thresholds that describe when and/or what type(s) of BMP (s) must be constructed within each TDA, if they are applicable to the project.

   It is possible for a project to require Minimum Requirements #6, #7, and #8 per the Project Thresholds, but then not require construction of BMPs in individual TDAs to comply with Minimum Requirement #6, #7, and/or #8. By documenting that the TDA Thresholds that would require construction of a BMP have not been triggered for an individual TDA, the project proponent is in compliance with that Minimum Requirement for that TDA.

Not all of the Minimum Requirements apply to every new development or redevelopment project. The applicability varies depending on the project type and size. This section identifies thresholds that determine the applicability of the Minimum Requirements to projects. Use the flow charts in Figure I-3.1: Flow Chart for Determining Requirements for New Development and Figure I-3.2: Flow Chart for Determining Requirements for Redevelopment to determine which of the Minimum Requirements apply. The Minimum Requirements themselves are presented in I-3.4 Minimum Requirements (MRs).

Use the thresholds in Figure I-3.1: Flow Chart for Determining Requirements for New Development and Figure I-3.2: Flow Chart for Determining Requirements for Redevelopment at the time of application for a subdivision, plat, short plat, building permit, or other construction permit. The plat or short plat approval shall identify all stormwater BMPs that are required for each lot. For projects involving only land disturbing activities, (e.g., clearing or grading), the thresholds apply at the time of application for the permit allowing or authorizing that activity. Note the exemption in I-3.2 Exemptions for forest practices other than Class IV General.

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Figure I-3.1: Flow Chart for Determining Requirements for New Development

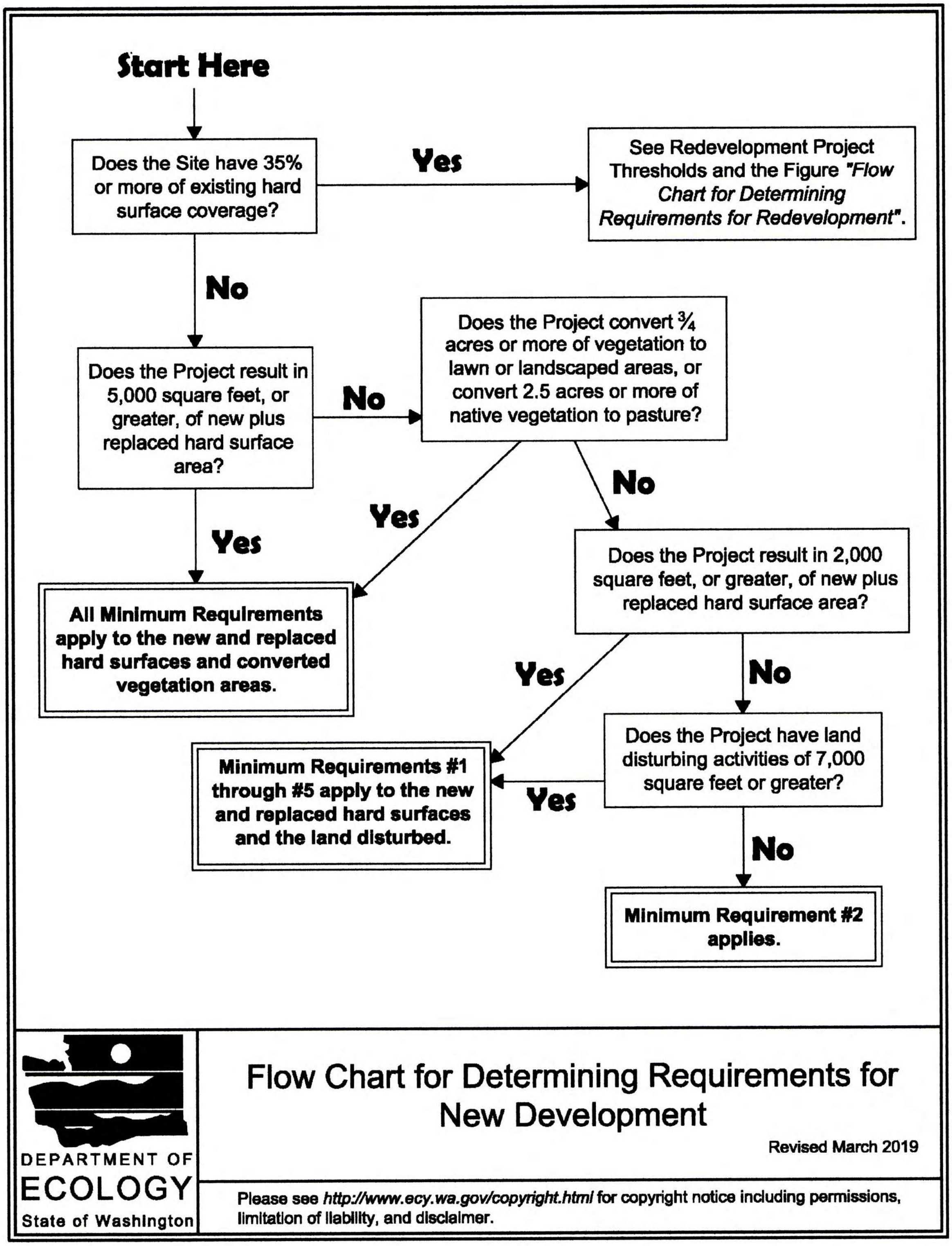
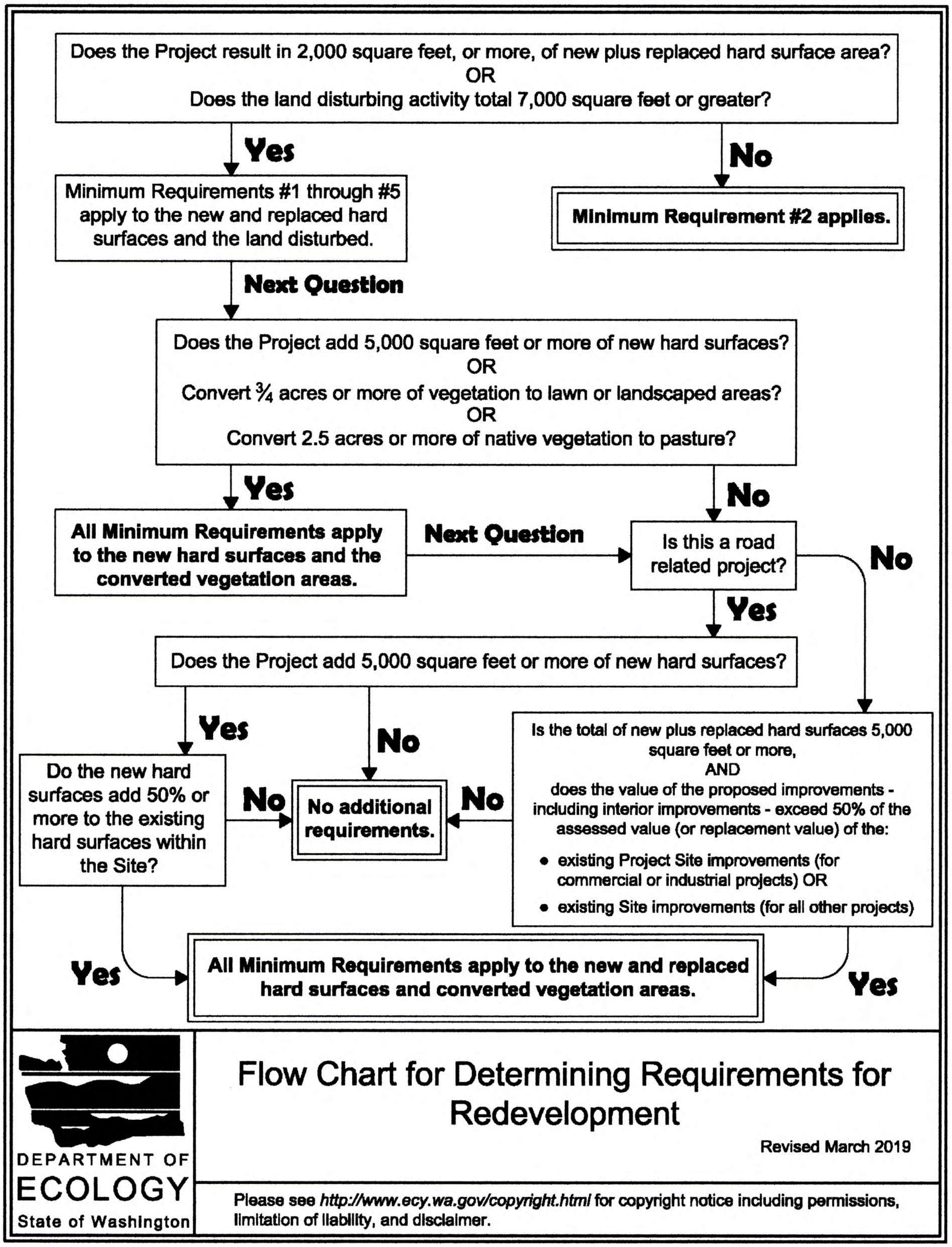


Figure I-3.2: Flow Chart for Determining Requirements for Redevelopment



New Development Project Thresholds

All new development shall be required to comply with Minimum Requirement #2.

The following new development shall comply with Minimum Requirements #1 through #5 for the new and replaced hard surfaces and the land disturbed:

- Results in 2,000 square feet, or greater, of new plus replaced hard surface area, or
- Has land disturbing activity of 7,000 square feet or greater.

The following new development shall comply with Minimum Requirements #1 through #9 for the new and replaced hard surfaces and the converted vegetation areas:

- Results in 5,000 square feet, or greater, of new plus replaced hard surface area, or
- Converts ¾ acres, or more, of vegetation to lawn or landscaped areas, or
- Converts 2.5 acres, or more, of native vegetation to pasture.

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Redevelopment Project Thresholds

All redevelopment shall be required to comply with Minimum Requirement #2.

The following redevelopment shall comply with Minimum Requirements #1 through #5 for the new and replaced hard surfaces and the land disturbed:

- Results in 2,000 square feet or more, of new plus replaced hard surface area, or
- Has land disturbing activity of 7,000 square feet or greater.

The following redevelopment shall comply with Minimum Requirements #1 through #9 for the new hard surfaces and converted vegetation areas:

- Adds 5,000 square feet or more of new hard surfaces or,
- Converts ¾ acres, or more, of vegetation to lawn or landscaped areas, or
- Converts 2.5 acres, or more, of native vegetation to pasture.

The local government may allow the Minimum Requirements to be met for an equivalent (flow and pollution characteristics) area. The equivalent area may be within the same TDA. If the equivalent area is outside the TDA, or off-site, the equivalent area must drain to the same receiving water and the guidance for equivalent facilities using in-basin transfers must be followed (see I-D.6 Regional Facility Area Transfers). The jurisdiction is responsible for maintaining tracking records for all area transfers approved by the jurisdiction.

Additional Requirements for Redevelopment

Road-related projects shall comply with all the Minimum Requirements for the new and replaced hard surfaces (including pavement, shoulders, curbs, and sidewalks) and the converted vegetation areas if the new hard surfaces total 5,000 square feet or more and total 50% or more of the existing hard surfaces within the Site.

Other types of redevelopment projects shall comply with all the Minimum Requirements for the new and replaced hard surfaces and the converted vegetation areas if:

- the total of new plus replaced hard surfaces is 5,000 square feet or more, and
- For commercial or industrial projects: the valuation of the proposed improvements, including interior improvements, exceeds 50% of the assessed value of the existing Project Site improvements.
- For all other projects: the valuation of the proposed improvements, including interior improvements, exceeds 50% of the assessed value of the existing Site improvements.

The local government may exempt or institute a stop-loss provision for redevelopment projects from compliance with Minimum Requirement #5, #6, #7, and/or #8 as applied to the replaced hard surfaces if the local government has adopted a plan and a schedule that fulfills those requirements in regional facilities.

The local government may grant a variance/exception to the application of Minimum Requirement #7 to replaced impervious surfaces if such application imposes a severe economic hardship. See I-3.6.2 Exceptions/Variances to the MRs.

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Objective

Redevelopment projects have the same requirements as new development projects in order to minimize the impacts from new surfaces. To not discourage redevelopment projects, replaced surfaces aren't required to be brought up to new stormwater standards unless the cost or space thresholds identified above are exceeded. As long as the replaced surfaces have similar pollution-generating potential to the surfaces that they are replacing, the amount of pollutants discharged shouldn't be significantly different from the existing site conditions. However, if the redevelopment project scope is sufficiently large that the cost or space thresholds identified above are exceeded, it is reasonable to require the replaced surfaces to be brought up to current stormwater standards. This is consistent with other utility standards. When a structure or a property undergoes significant remodeling, local governments often require the site to be brought up to new building code requirements (e.g., on-site sewage disposal systems, fire systems).

Supplemental Guidelines

For purposes of applying the above thresholds to a proposed single family residential subdivision (i.e., a plat or short plat project), assume 4,000 sq. ft. of hard surface (8,000 sq. ft. on lots of 5 acres or more) for each newly created lot, unless the project proponent has otherwise formally declared other values for each lot in the corresponding complete land division application. Where local land use regulations restrict maximum hard (or impervious) surfaces to smaller amounts, those maxima may be used.

The local government may allow the Minimum Requirements to be met for an equivalent (flow and pollution characteristics) area for new development projects as well as redevelopment projects. The equivalent area may be within the same TDA. If the equivalent area is outside the TDA, or off-site, the equivalent area must drain to the same receiving water and the guidance for equivalent facilities using in-basin transfers must be followed (see I-D.6 Regional Facility Area Transfers). The jurisdiction is responsible for maintaining tracking records for all area transfers approved by the jurisdiction.

Options for Local Governments

Local governments may select from various methods for identifying projects that must comply with all the Minimum Requirements for the new and replaced hard surfaces and the converted vegetation areas on the project site (See Additional Requirements for Redevelopment, above). Examples of methods that may vary between jurisdictions include:

- Identifying the valuation of the proposed improvements by various methods such as:
  - The designer's estimate of the proposed project,
  - The anticipated future (post-project) assessed value for the improvements on the Site (not including the property value), minus the current year, pre-project assessor's data for the improvements on the Site (not including the property value),
  - The anticipated future (post-project) appraisal value for the improvements on the Site (not including the property value), minus the current (within a year or other pre-determined period of time), pre-project appraisal value of the improvements on the Site (not including the property value),
- Identifying the assessed value of the existing Site improvements by various methods such as:
  - Current year, pre-project assessor's data for the improvements on the Site (not including the property value),
  - Current (within a year or other predetermined period of time), pre-project appraisal value of the improvements on the Site (not including the property value),
  - The estimated cost to replace the existing improvements on the Site, as determined by the Marshall Value System, or a similar valuation system.
- Providing an alternate method that does not rely on the direct comparison of existing and proposed Site improvements, such as:

- Exceeding a certain dollar value of improvements, as determined by a predetermined method, such as the designer's estimate of the proposed project,
- Exceeding a certain ratio of the new hard surfaces to the total of replaced plus new hard surfaces

A local government's thresholds for the application of the Minimum Requirements to replaced hard surfaces must be at least as stringent as Ecology's thresholds. Local governments should be prepared to demonstrate that by comparing the number and types of historical projects that would have been regulated using Ecology's thresholds versus the local government's thresholds.

Local governments are allowed to institute a stop-loss provision on the application of the Minimum Requirements to replaced hard surfaces. A stop-loss provision is an upper limit on the extent to which a Minimum Requirement is applied. For instance, there could be a maximum percentage of the estimated total project costs that are dedicated to meeting stormwater requirements. A project would not have to incur additional stormwater costs above that maximum, even though the standard redevelopment requirements will not be fully achieved. The allowance for a stop-loss provision pertains to the extent that Minimum Requirements #6, #7, and #8 are imposed on replaced hard surfaces. It does not apply to meeting Minimum Requirements for new hard surfaces.

Local governments can also establish criteria for allowing redevelopment projects to pay a fee in lieu of constructing Runoff Treatment or Flow Control BMPs on a redeveloped site. At a minimum, the fee should be the equivalent of an engineering estimate of the cost of meeting all applicable Minimum Requirements for the project. The local government should use such funds for the implementation of stormwater control projects that would have similar benefits to the same receiving water as if the project had constructed its required improvements. Expenditure of such funds is subject to other state statutory requirements.

Ecology cautions local governments about the potential long-term consequences of allowing a fee-in-lieu of stormwater facilities. Sites that are allowed to pay a fee continue to discharge stormwater without stormwater controls. If it is determined, through future basin planning for instance, that controls on such sites are necessary to achieve water quality goals or legal requirements, the public may bear the costs for providing those controls.

Local governments are also encouraged to review all road projects for changes in elevations or drainage flowpaths that could cause flooding, upland or stream erosion, or changes to discharges to wetlands. For example, adding curbs will result in redirecting flows and possibly causing new downstream impacts. The local government should set project-specific requirements to avoid or mitigate those impacts.

Local governments may use regional facilities as an alternative method to meet Minimum Requirements #5, #6, #7, and/or #8. The local government must retain an engineering report that details how the regional facility meets the Minimum Requirements for the sites that drain to it. See Appendix I-D: Regional Facilities for details.

Local governments may use a Basin Plan to modify Minimum Requirements #5, #6, #7, and/or #8. See Appendix I-B: Basin Plans for details.

I-3.4 Minimum Requirements (MRs)

I-3.4.1 MR1: Preparation of Stormwater Site Plans

All projects meeting the thresholds in I-3.3 Applicability of the Minimum Requirements shall prepare a Stormwater Site Plan for local government review. Stormwater Site Plans shall use site-appropriate development principles, as required and encouraged by local development codes, to retain native vegetation and minimize impervious surfaces to the extent feasible. Stormwater Site Plans shall be prepared in accordance with III-3 Stormwater Site Plans.

The text in this box originates from one or more of the following Permits:
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Objective

The 2,000 square foot threshold for hard surfaces and 7,000 square foot threshold for land disturbance, as detailed in I-3.3 Applicability of the Minimum Requirements, are chosen to capture most single family home construction and their equivalent. The scope of the stormwater site plan only covers compliance with Minimum Requirements #2 through #5 if the thresholds of 5,000 square feet of hard surface or conversion of ¾ acre of vegetation to lawn or landscape, or conversion of 2.5 acres of vegetation to pasture are not exceeded.

Supplemental Guidelines

Projects proposed by departments and agencies within the local government with jurisdiction must comply with this requirement. The local government shall determine the process for ensuring proper project review, inspection, and compliance by its own departments and agencies.

I-3.4.2 MR2: Construction Stormwater Pollution Prevention Plan (SWPPP)

Project Thresholds

All new development and redevelopment projects are responsible for preventing erosion and discharge of sediment and other pollutants into receiving waters.

Projects which result in 2,000 square feet or more of new plus replaced hard surface area, or which disturb 7,000 square feet or more of land must prepare a Construction Stormwater Pollution Prevention Plan (SWPPP) as part of the Stormwater Site Plan (see I-3.4.1 MR1: Preparation of Stormwater Site Plans).

Projects below those thresholds (listed above) are not required to prepare a Construction SWPPP, but must consider all of the Construction SWPPP Elements (listed below) and develop controls for all Construction SWPPP Elements that pertain to the project site.

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General Requirements

The Construction SWPPP shall include a narrative and drawings. All BMPs shall be clearly referenced in the narrative and marked on the drawings. The Construction SWPPP narrative shall include documentation to explain and justify the pollution prevention decisions made for the project. Each of the 13 Construction SWPPP Elements (listed below) must be considered and included in the Construction SWPPP unless site conditions render the Element unnecessary and the exemption from that Element is clearly justified in the narrative of the SWPPP.

Clearing and grading activities for developments shall be permitted only if conducted pursuant to an approved site development plan (e.g., subdivision approval) that establishes permitted areas of clearing, grading, cutting, and filling. These permitted clearing and grading areas and any other areas required to preserve critical or sensitive areas, buffers, native growth protection easements, or tree retention areas, shall be delineated on the site plans and the development site.

The Construction SWPPP shall be implemented beginning with initial land disturbance and until final stabilization. Sediment and Erosion control BMPs shall be consistent with the BMPs contained in II-3 Construction Stormwater BMPs.

Seasonal Work Limitations: From October 1 through April 30, clearing, grading, and other soil disturbing activities shall only be permitted if shown to the satisfaction of the local permitting authority that silt-laden runoff will be prevented from leaving the site through a combination of the following:

1. Site conditions including existing vegetative coverage, slope, soil type and proximity to receiving waters; and
2. Limitations on activities and the extent of disturbed areas; and
3. Proposed erosion and sediment control measures.

The following activities are exempt from the seasonal clearing and grading limitations:

1. Routine maintenance and necessary repair of erosion and sediment control BMPs,
2. Routine maintenance of public facilities or existing utility structures that do not expose the soil or result in the removal of the vegetative cover to soil, and
3. Activities where there is one hundred percent infiltration of surface water runoff within the site in approved and installed erosion and sediment control facilities.

The text in this box originates from one or more of the following Permits:
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Objective

To control erosion and prevent sediment and other pollutants from leaving the site during the construction phase of a project. To have fully functional stormwater BMPs for the developed site upon completion of construction.

Supplemental Guidelines

If a Construction SWPPP is found to be inadequate (with respect to erosion and sediment control requirements), then the Plan Approval Authority within the Local Government shall require that other Construction Stormwater BMPs be implemented, as appropriate.

The Plan Approval Authority may allow development of generic Construction SWPPP's that apply to commonly conducted public road activities, such as road surface replacement, that trigger this minimum requirement. They may also develop an abbreviated Construction SWPPP format for project sites that will disturb less than 1 acre.

Based on the information provided and/or local weather conditions, the local permitting authority may expand or restrict the seasonal limitation on site disturbance. The local permitting authority shall take enforcement action - such as a notice of violation, administrative order, penalty, or stop-work order under the following circumstances:

- If, during the course of any construction activity or soil disturbance during the seasonal limitation period, sediment leaves the construction site causing a violation of the surface water quality standard; or
- If clearing and grading limits or erosion and sediment control measures shown in the approved plan are not maintained.

The primary project proponent shall coordinate with utilities and other contractors. The primary project proponent shall evaluate, with input from utilities and other contractors, the stormwater management requirements for the entire project, including the utilities, when preparing the Construction SWPPP.

Construction SWPPP Elements

Element 1: Preserve Vegetation / Mark Clearing Limits

a. Before beginning land disturbing activities, including clearing and grading, clearly mark all clearing limits, sensitive areas and their buffers, and trees that are to be preserved within the construction area.

b. Retain the duff layer, native top soil, and natural vegetation in an undisturbed state to the maximum degree practicable.

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Additional Guidance for Element 1

- Plastic, metal, fabric fence, or other physical barriers may be used to mark the clearing limits. Note the difference between the practical use and proper installation of BMP C233: Silt Fence and the proper use and installation of BMP C103: High-Visibility Fence.
- If it is not practical to retain the duff layer in place, then stockpile it on site, cover it to prevent erosion, and replace it immediately when you finish disturbing the site.

Suggested BMPs for Element 1

- BMP C101: Preserving Natural Vegetation
- BMP C102: Buffer Zones
- BMP C103: High-Visibility Fence
- BMP C233: Silt Fence

Element 2: Establish Construction Access

a. Limit construction vehicle access and exit to one route, if possible.

b. Stabilize access points with a pad of quarry spalls, crushed rock, or other equivalent BMPs, to minimize tracking of sediment onto public roads.

c. Locate wheel wash or tire baths on site, if the stabilized construction entrance is not effective in preventing tracking sediment onto roads.

d. If sediment is tracked off site, clean the affected roadway(s) thoroughly at the end of each day, or more frequently as necessary (for example, during wet weather). Remove sediment from roads by shoveling, sweeping, or picking up and transporting the sediment to a controlled sediment disposal area.

e. Conduct street washing only after sediment is removed in accordance with 2.d (above).

f. Control street wash wastewater by pumping back on site, or otherwise prevent it from discharging into systems tributary to waters of the State.

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Additional Guidance for Element 2

Minimize construction site access points along linear projects, such as roadways. Street washing may require local jurisdiction approval.

Suggested BMPs for Element 2

- BMP C105: Stabilized Construction Access
- BMP C106: Wheel Wash
- BMP C107: Construction Road / Parking Area Stabilization

Element 3: Control Flow Rates

a. Protect properties and waterways downstream of development sites from erosion and the associated discharge of turbid waters due to increases in the velocity and peak volumetric flow rate of stormwater runoff from the project site.

b. Where necessary to comply with 3.a (above), construct stormwater infiltration or detention BMPs as one of the first steps in grading. Assure that detention BMPs function properly before constructing site improvements (e.g., impervious surfaces).

c. If permanent infiltration BMPs are used for temporary flow control during construction, protect these BMPs from siltation during the construction phase.

The text in this box originates from one or more of the following Permits:
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Additional Guidance for Element 3

- Conduct a downstream analysis if changes in flows could impair or alter conveyance systems, streambanks, bed sediment, or aquatic habitat. See III-3.2 Preparing a Stormwater Site Plan for off-site analysis guidelines.
- Even gently sloped areas need flow controls such as BMP C235: Wattles or other energy dissipation / filtration structures. Place dissipation facilities closer together on steeper slopes. These methods prevent water from building higher velocities as it flows downstream within the construction site.
- Control structures designed for permanent detention BMPs are not appropriate for use during construction without modification. If used during construction, modify the control structure to allow for long-term storage of runoff and enable sediment to settle. Verify that the BMP is sized appropriately for this purpose. Restore BMPs to their original design dimensions, remove sediment, and install a final control structure at completion of the project.
- Erosion has the potential to occur because of increases in the volume, velocity, and peak flow rate of stormwater runoff from the project site. The local permitting agency may require infiltration or detention BMP designs that provide additional or different stormwater flow control than the designs detailed in this manual. These requirements may be necessary to address local conditions or to protect properties and waterways downstream.
- Velocity of water leaving the site should not exceed 3 feet/second, if the discharge is to a stream or ditch. Install velocity dissipation, such as BMP C207: Check Dams or BMP C202: Riprap Channel Lining to ensure reduction of the flow velocity to a non-erosive level.
- If the discharge from a project site is to a municipal storm drainage system, the allowable discharge rate may be limited by the capacity of the public system. It may be necessary to clean the municipal storm drainage system prior to the start of the discharge to prevent scouring solids from the drainage system. Obtain permission from the owner of the collection system before discharging to it. Ensure that no downstream pipes are surcharged as a result of increased flows from the project site.

- If the discharge from a project site is directly to a flow control exempt receiving water listed in Appendix I-A: Flow Control Exempt Receiving Waters or to an infiltration system, there is no discharge flow limit.

Suggested BMPs for Element 3

- BMP C203: Water Bars
- BMP C207: Check Dams
- BMP C209: Outlet Protection
- BMP C235: Wattles
- BMP C240: Sediment Trap
- BMP C241: Sediment Pond (Temporary)
- See also V-12 Detention BMPs

Element 4: Install Sediment Controls

Design, install, and maintain effective erosion controls and sediment controls to minimize the discharge of pollutants.

a. Construct sediment control BMPs (sediment ponds, traps, filters, etc.) as one of the first steps in grading. These BMPs must be functional before other land disturbing activities take place.

b. Minimize sediment discharges from the site. The design, installation and maintenance of erosion and sediment controls must address factors such as the amount, frequency, intensity and duration of precipitation, the nature of resulting stormwater runoff, and soil characteristics, including the range of soil particle sizes expected to be present on the site.

c. Direct stormwater runoff from disturbed areas through BMP C241: Sediment Pond (Temporary) or other appropriate sediment removal BMP, before the runoff leaves a construction site or before discharge to an infiltration facility. Runoff from fully stabilized areas may be discharged without a sediment removal BMP, but must control flow rates per Element 3: Control Flow Rates.

d. Locate BMPs intended to trap sediment on site in a manner to avoid interference with the movement of juvenile salmonids attempting to enter off-channel areas or drainages.

e. Provide and maintain natural buffers around surface waters, direct stormwater to vegetated areas to increase sediment removal and maximize stormwater infiltration, unless infeasible.

f. Where feasible, design outlet structures that withdraw impounded stormwater from the surface to avoid discharging sediment that is still suspended lower in the water column.

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Additional Guidance for Element 4

- Outlet structures that withdraw impounded stormwater from the surface to avoid discharging sediment that is still suspended lower in the water column are for the construction period only. If installing a floating pump structure, include a stopper to prevent the pump basket from hitting the bottom of the pond.
- If a sediment trapping BMP utilizes a control structure that will also be used in a permanent detention BMP application, the control structure construction must be finalized for the permanent BMP application upon project completion.
- Install sediment controls in a manner that protects the sensitive areas and their buffers marked in accordance with Element 1: Preserve Vegetation / Mark Clearing Limits.
- Where feasible, direct stormwater to vegetated areas to increase sediment removal and maximize stormwater infiltration.
- Seed and mulch earthen structures such as dams, dikes, and diversions according to the timing indicated in Element 5: Stabilize Soils.
- Full stabilization includes concrete or asphalt paving; quarry spalls used as ditch lining; or the use of rolled erosion products, a bonded fiber matrix product, or vegetative cover in a manner that will fully prevent soil erosion.
- The Local Permitting Authority may inspect and approve areas fully stabilized by means other than pavement or quarry spalls.

Suggested BMPs for Element 4

- BMP C231: Brush Barrier
- BMP C232: Gravel Filter Berm
- BMP C233: Silt Fence
- BMP C234: Vegetated Strip
- BMP C235: Wattles
- BMP C240: Sediment Trap
- BMP C241: Sediment Pond (Temporary)
- BMP C250: Construction Stormwater Chemical Treatment
- BMP C251: Construction Stormwater Filtration

Element 5: Stabilize Soils

a. Stabilize exposed and unworked soils by application of effective BMPs that prevent erosion. Applicable BMPs include, but are not limited to: temporary and permanent seeding, sodding, mulching, plastic covering, erosion control fabrics and matting, soil application of polyacrylamide (PAM), the early application of gravel base on areas to be paved, and dust control.

b. Control stormwater volume and velocity within the site to minimize soil erosion.

c. Control stormwater discharges, including both peak flow rates and total stormwater volume, to minimize erosion at outlets and to minimize downstream channel and stream bank erosion.

d. Soils must not remain exposed and unworked for more than the time periods set forth below to prevent erosion:

   - During the dry season (May 1 - September 30): 7 days
   - During the wet season (October 1 - April 30): 2 days

e. Stabilize soils at the end of the shift before a holiday or weekend if needed based on the weather forecast.

f. Stabilize soil stockpiles from erosion, protect with sediment trapping measures, and where possible, locate away from storm drain inlets, waterways and drainage channels.

g. Minimize the amount of soil exposed during construction activity.

h. Minimize the disturbance of steep slopes.

i. Minimize soil compaction and, unless infeasible, preserve topsoil.

The text in this box originates from one or more of the following Permits:
Appendix 1 of the Phase I / Phase II Municipal Stormwater Permits
Construction Stormwater General Permit

Additional Guidance for Element 5

- Soil stabilization BMPs should be appropriate for the time of year, site conditions, estimated duration of use, and potential water quality impacts that stabilization agents may have on downstream waters or ground water.
- Ensure that gravel base used for stabilization is clean and does not contain fines or sediment.

Suggested BMPs for Element 5

- BMP C120: Temporary and Permanent Seeding
- BMP C121: Mulching
- BMP C122: Nets and Blankets
- BMP C123: Plastic Covering

- BMP C124: Sodding
- BMP C125: Topsoiling / Composting
- BMP C126: Polyacrylamide (PAM) for Soil Erosion Protection
- BMP C130: Surface Roughening
- BMP C131: Gradient Terraces
- BMP C140: Dust Control

Element 6: Protect Slopes

a. Design and construct cut-and-fill slopes in a manner to minimize erosion. Applicable practices include, but are not limited to, reducing continuous length of slope with terracing and diversions, reducing slope steepness, and roughening slope surfaces (for example, track walking).

b. Divert off-site stormwater (run-on) or ground water away from slopes and disturbed areas with interceptor dikes, pipes and/or swales. Off-site stormwater should be managed separately from stormwater generated on site.

c. At the top of slopes, collect drainage in pipe slope drains or protected channels to prevent erosion. Temporary pipe slope drains must be sized to convey the flow rate calculated by one of the following methods:

   - Single Event Hydrograph Method: The peak volumetric flow rate calculated using a 10-minute time step from a Type 1A, 10-year, 24-hour frequency storm.

     OR

   - Continuous Simulation Method: The 10-year peak flow rate, as determined by an approved continuous runoff model with a 15-minute time step.

   The hydrologic analysis must use the existing land cover condition for predicting flow rates from tributary areas outside the project limits. For tributary areas on the project site, the analysis must use the temporary or permanent project land cover condition, whichever will produce the highest flow rates. If using the Western Washington Hydrology Model (WWHM) to predict flows, bare soil areas should be modeled as "landscaped" area.

d. Place excavated material on the uphill side of trenches, consistent with safety and space considerations.

e. Place check dams at regular intervals within constructed channels that are cut down a slope.

The text in this box originates from one or more of the following Permits:
Appendix 1 of the Phase I / Phase II Municipal Stormwater Permits
Construction Stormwater General Permit

Additional Guidance for Element 6

- Consider soil type and its potential for erosion.
- Stabilize soils on slopes, as specified in Element 5: Stabilize Soils.
- BMP combinations are the most effective method of protecting slopes with disturbed soils. For example, use both BMP C121: Mulching and BMP C122: Nets and Blankets in combination.

Suggested BMPs for Element 6

- BMP C120: Temporary and Permanent Seeding
- BMP C121: Mulching
- BMP C122: Nets and Blankets
- BMP C123: Plastic Covering
- BMP C124: Sodding
- BMP C130: Surface Roughening
- BMP C131: Gradient Terraces
- BMP C200: Interceptor Dike and Swale
- BMP C201: Grass-Lined Channels
- BMP C203: Water Bars
- BMP C204: Pipe Slope Drains
- BMP C205: Subsurface Drains
- BMP C206: Level Spreader
- BMP C207: Check Dams
- BMP C208: Triangular Silt Dike (TSD)

Element 7: Protect Drain Inlets

a. Protect all storm drain inlets made operable during construction so that stormwater runoff does not enter the conveyance system without first being filtered or treated to remove sediment.

b. Clean or remove and replace inlet protection devices when sediment has filled one-third of the available storage (unless a different standard is specified by the product manufacturer).

The text in this box originates from one or more of the following Permits:
Appendix 1 of the Phase I / Phase II Municipal Stormwater Permits
Construction Stormwater General Permit

Additional Guidance for Element 7

- Protect all existing storm drain inlets so that stormwater runoff does not enter the conveyance system without first being filtered or treated to remove sediment.
- Keep all approach roads clean. Do not allow sediment and street wash water to enter storm drains without prior and adequate treatment (as defined above) unless treatment is provided before the storm drain discharges to waters of the State.
- Inlets should be inspected weekly at a minimum and daily during storm events.

Suggested BMPs for Element 7

- BMP C220: Inlet Protection

Element 8: Stabilize Channels and Outlets

a. Design, construct, and stabilize all on-site conveyance channels to prevent erosion from the flow rate calculated by one of the following methods:

   - Single Event Hydrograph Method: The peak volumetric flow rate calculated using a 10-minute time step from a Type 1A, 10-year, 24-hour frequency storm.

     OR

   - Continuous Simulation Method: The 10-year peak flow rate, as determined by an approved continuous runoff model with a 15-minute time step.

   The hydrologic analysis must use the existing land cover condition for predicting flow rates from tributary areas outside the project limits. For tributary areas on the project site, the analysis must use the temporary or permanent project land cover condition, whichever will produce the highest flow rates. If using the Western Washington Hydrology Model (WWHM) to predict flows, bare soil areas should be modeled as "landscaped" area.

b. Provide stabilization, including armoring material, adequate to prevent erosion of outlets, adjacent stream banks, slopes and downstream reaches at the outlets of all conveyance systems.

The text in this box originates from one or more of the following Permits:
Appendix 1 of the Phase I / Phase II Municipal Stormwater Permits
Construction Stormwater General Permit

Additional Guidance for Element 8

The best method for stabilizing channels is to completely line the channel with BMP C122: Nets and Blankets first, then add BMP C207: Check Dams as necessary to function as an anchor and to slow the flow of water.

Suggested BMPs for Element 8

- BMP C122: Nets and Blankets
- BMP C202: Riprap Channel Lining

- BMP C207: Check Dams
- BMP C209: Outlet Protection

Element 9: Control Pollutants

Design, install, implement and maintain effective pollution prevention measures to minimize the discharge of pollutants. The project proponent must:

a. Handle and dispose of all pollutants, including waste materials and demolition debris that occur on site in a manner that does not cause contamination of stormwater.

b. Provide cover, containment, and protection from vandalism for all chemicals, liquid products, petroleum products, and other materials that have the potential to pose a threat to human health or the environment. On-site fueling tanks must include secondary containment. Secondary containment means placing tanks or containers within an impervious structure capable of containing 110% of the volume contained in the largest tank within the containment structure. Double-walled tanks do not require additional secondary containment.

c. Conduct maintenance, fueling, and repair of heavy equipment and vehicles using spill prevention and control measures. Clean contaminated surfaces immediately following any spill incident.

d. Discharge wheel wash or tire bath wastewater to a separate on-site treatment system that prevents discharge to surface water, or to the sanitary sewer, with local sewer district approval.

e. Apply fertilizers and pesticides in a manner and at application rates that will not result in loss of chemical to stormwater runoff. Follow manufacturers' label requirements for application rates and procedures.

f. Use BMPs to prevent contamination of stormwater runoff by pH-modifying sources. The sources for this contamination include, but are not limited to: recycled concrete stockpiles, bulk cement, cement kiln dust, fly ash, new concrete washing and curing waters, waste streams generated from concrete grinding and sawing, exposed aggregate processes, dewatering concrete vaults, concrete pumping and mixer washout waters.

g. Adjust the pH of stormwater if necessary to prevent violations of water quality standards.

h. Assure that washout of concrete trucks is performed off site or in designated concrete washout areas only. Do not wash out concrete truck drums or concrete handling equipment onto the ground, or into storm drains, open ditches, streets, or streams. Washout of small concrete handling equipment may be disposed of in a formed area awaiting concrete where it will not contaminate surface or ground water. Do not dump excess concrete on site, except in designated concrete washout areas. Concrete spillage or concrete discharge directly to ground water or surface waters of the State is prohibited. Do not wash out to formed areas awaiting infiltration BMPs.

i. Obtain written approval from Ecology before using chemical treatment other than CO_2, dry ice, or food grade vinegar to adjust pH.

j. Uncontaminated water from water-only based shaft drilling for construction of building, road, and bridge foundations may be infiltrated provided the wastewater is managed in a way that prohibits discharge to surface waters. Prior to infiltration, water from water-only based shaft drilling that comes into contact with curing concrete must be neutralized until pH is in the range of 6.5 to 8.5 (su).

The text in this box originates from one or more of the following Permits:
Appendix 1 of the Phase I / Phase II Municipal Stormwater Permits
Construction Stormwater General Permit

Additional Guidance for Element 9

- Wheel wash and/or tire bath wastewater can be combined with wastewater from concrete washout areas if the wastewaters will be properly disposed of at an offsite location or treatment facility.
- Do not use upland land applications for discharging wastewater from concrete washout areas.
- Woody debris may be chopped and spread on site.
- Conduct oil changes, hydraulic system drain down, solvent and degreasing cleaning operations, fuel tank drain down and removal, and other activities which may result in discharge or spillage of pollutants to the ground or into stormwater runoff using spill prevention measures, such as drip pans.
- Clean contaminated surfaces immediately following any discharge or spill incident. Emergency repairs may be performed on-site using temporary plastic placed beneath and, if raining, over the vehicle.

Suggested BMPs for Element 9

- BMP C151: Concrete Handling
- BMP C152: Sawcutting and Surfacing Pollution Prevention
- BMP C153: Material Delivery, Storage, and Containment
- BMP C154: Concrete Washout Area
- BMP C250: Construction Stormwater Chemical Treatment
- BMP C251: Construction Stormwater Filtration
- BMP C252: Treating and Disposing of High pH Water
- Also see the Source Control BMPs detailed in Volume IV

Element 10: Control Dewatering

a. Discharge foundation, vault, and trench dewatering water, which have similar characteristics to stormwater runoff at the site, into a controlled conveyance system before discharge to BMP C240: Sediment Trap or BMP C241: Sediment Pond (Temporary).

b. Discharge clean, non-turbid dewatering water, such as well-point ground water, to systems tributary to, or directly into surface waters of the State, as specified in Element 8: Stabilize Channels and Outlets, provided the dewatering flow does not cause erosion or flooding of receiving waters. Do not route clean dewatering water through stormwater sediment BMPs. Note that "surface waters of the State" may exist on a construction site as well as off site; for example, a creek running through a site.

c. Handle highly turbid or otherwise contaminated dewatering water separately from stormwater.

d. Other dewatering treatment or disposal options may include:

   i. Infiltration.

   ii. Transport off site in a vehicle, such as a vacuum flush truck, for legal disposal in a manner that does not pollute state waters.

   iii. Ecology-approved on-site chemical treatment or other suitable treatment technologies.

   iv. Sanitary or combined sewer discharge with local sewer district approval, if there is no other option.

   v. Use of a sedimentation bag that discharges to a ditch or swale for small volumes of localized dewatering.

The text in this box originates from one or more of the following Permits:
Appendix 1 of the Phase I / Phase II Municipal Stormwater Permits
Construction Stormwater General Permit

Additional Guidance for Element 10

- Channels must be stabilized, as specified in Element 8: Stabilize Channels and Outlets.
- Construction equipment operation, clamshell digging, concrete tremie pour, or work inside a cofferdam can create highly turbid or contaminated dewatering water.
- Discharging sediment-laden (muddy) water into waters of the State likely constitutes violation of water quality standards for turbidity. The easiest way to avoid discharging muddy water is through infiltration and preserving vegetation.
- Dewatering water from contaminated sites must be handled separately from stormwater. Direct contaminated stormwater to a sanitary sewer where allowed by the local sewer authority, or to other approved treatment.

Suggested BMPs for Element 10

- BMP C203: Water Bars
- BMP C236: Vegetative Filtration

Element 11: Maintain BMPs

a. Maintain and repair all temporary and permanent erosion and sediment control BMPs as needed to assure continued performance of their intended function in accordance with BMP specifications.

b. Remove all temporary erosion and sediment control BMPs within 30 days after achieving final site stabilization or after the temporary BMPs are no longer needed.

The text in this box originates from one or more of the following Permits:
Appendix 1 of the Phase I / Phase II Municipal Stormwater Permits
Construction Stormwater General Permit

Additional Guidance for Element 11

- Some temporary erosion and sediment control BMPs are biodegradable and designed to remain in place following construction. BMP C122: Nets and Blankets is an example of a BMP with biodegradable options.
- Provide protection to all BMPs installed for the permanent control of stormwater from sediment and compaction. All BMPs that are to remain in place following completion of construction shall be examined and placed in full operating conditions. If sediment enters the BMPs during construction, it shall be removed and the facility shall be returned to the conditions specified in the construction documents.
- Remove or stabilize trapped sediment on site. Permanently stabilize disturbed soil resulting from removal of BMPs or vegetation.

Suggested BMPs for Element 11

- BMP C150: Materials on Hand
- BMP C160: Certified Erosion and Sediment Control Lead

Element 12: Manage the Project

a. Phase development projects to the maximum degree practicable and take into account seasonal work limitations.

b. Inspect, maintain and repair all BMPs as needed to assure continued performance of their intended function. Projects regulated under the Construction Stormwater General Permit (CSWGP) must conduct site inspections and monitoring in accordance with Special Condition S4 of the CSWGP.

c. Maintain, update, and implement the Construction SWPPP.

d. Projects that disturb one or more acres must have site inspections conducted by a Certified Erosion and Sediment Control Lead (CESCL). Project sites disturbing less than one acre may have a CESCL or a person without CESCL certification conduct inspections. By the initiation of construction, the Construction SWPPP must identify the CESCL or inspector, who must be present on site or on-call at all times.

The text in this box originates from one or more of the following Permits:
Appendix 1 of the Phase I / Phase II Municipal Stormwater Permits
Construction Stormwater General Permit

Additional Guidance for Element 12

The project manager must ensure that the project is built in such a way to comply with all Construction SWPPP Elements, as detailed in this section. Considerations for the project manager include, but are not limited to:

- construction phasing
- seasonal work limitations
- coordination with utilities and other contractors
- inspection
- monitoring
- maintaining an updated construction SWPPP

Phasing of Construction

Phase development projects where feasible in order to prevent soil erosion and transporting of sediment from the site during construction. Revegetate exposed areas and maintain that vegetation as an integral part of the clearing activities for any phase.

Clearing and grading activities for developments shall be permitted only if conducted using an approved site development plan (e.g., subdivision approval) that establishes permitted areas of clearing, grading, cutting, and filling. Minimize removing trees and disturbing or compacting native soils when establishing permitted clearing and grading areas. Show on the site plans and the development site permitted clearing and grading areas and any other areas required to preserve critical or sensitive areas, buffers, native growth protection easements, or tree retention areas as may be required by local jurisdictions.

Inspection

All BMPs must be inspected, maintained, and repaired as needed to assure continued performance of their intended function. Site inspections must be conducted by a person knowledgeable in the principles and practices of erosion and sediment control. The person must have the skills to 1) assess the site conditions and construction activities that could impact the quality of stormwater, and 2) assess the effectiveness of erosion and sediment control measures used to control the quality of stormwater discharges.

For construction sites one acre or larger that discharge stormwater to surface waters of the state, a CESCL must be identified in the construction SWPPP; this person must be on-site or on-call at all times. Certification must be obtained through an approved training program that meets the erosion and sediment control training standards established by Ecology. See BMP C160: Certified Erosion and Sediment Control Lead.

Appropriate BMPs or design changes shall be implemented as soon as possible whenever inspection and/or monitoring reveals that the BMPs identified in the Construction SWPPP are inadequate, due to the actual discharge of /or potential to discharge a significant amount of any pollutant.

The CESCL or inspector must examine stormwater visually for the presence of suspended sediment, turbidity, discoloration, and oil sheen. They must evaluate the effectiveness of BMPs and determine if it is necessary to install, maintain, or repair BMPs to improve the quality of stormwater discharges.

Based on the results of the inspection, construction site operators must correct the problems identified by:

- Reviewing the Construction SWPPP for compliance with the 13 elements and making appropriate revisions within 7 days of the inspection.
- Immediately beginning the process of fully implementing and maintaining appropriate source control and/or treatment BMPs as soon as possible, addressing the problems no later than within 10 days of the inspection. If installation of necessary treatment BMPs is not feasible within 10 days, the construction site operator may request an extension within the initial 10-day response period.
- Documenting BMP implementation and maintenance in the site log book (applies only to sites that have coverage under the Construction Stormwater General Permit).

The CESCL or inspector must inspect all areas disturbed by construction activities, all BMPs, and all stormwater discharge points at least once every calendar week and within 24 hours of any discharge from the site. (For purposes of this condition, individual discharge events that last more than one day do not require daily inspections. For example, if a stormwater pond discharges continuously over the course of a week, only one inspection is required that week.) The CESCL or inspector may reduce the inspection frequency for temporary stabilized, inactive sites to once every calendar month

Maintaining an Updated Construction SWPPP

Retain the Construction SWPPP on-site or within reasonable access to the site.

Modify the Construction SWPPP whenever there is a change in the design, construction, operation, or maintenance at the construction site that has, or could have, a significant effect on the discharge of pollutants to waters of the state.

The Construction SWPPP must be modified if, during inspections or investigations conducted by the owner/operator, or the applicable local or state regulatory authority, it is determined that the Construction SWPPP is ineffective in eliminating or significantly minimizing pollutants in stormwater discharges from the site. Modify the Construction SWPPP as necessary to include additional or modified BMPs designed to correct problems identified. Complete revisions to the Construction SWPPP within seven (7) days following the inspection.

Suggested BMPs for Element 12

- BMP C150: Materials on Hand
- BMP C160: Certified Erosion and Sediment Control Lead
- BMP C162: Scheduling

Element 13: Protect Low Impact Development BMPs

The primary purpose of On-Site Stormwater Management is to reduce the disruption of the natural site hydrology through infiltration. BMPs used to meet I-3.4.5 MR5: On-Site Stormwater Management (often called LID BMPs) are permanent facilities.

a. Protect all LID BMPs (including, but not limited to BMP T7.30: Bioretention, BMP T5.14: Rain Gardens, and BMP T5.15: Permeable Pavements) from sedimentation through installation and maintenance of erosion and sediment control BMPs on portions of the site that drain into the LID BMPs. Restore the BMPs to their fully functioning condition if they accumulate sediment during construction. Restoring the BMP must include removal of sediment and any sediment-laden Bioretention/Rain Garden soils, and replacing the removed soils with soils meeting the design specification.

b. Maintain the infiltration capabilities of LID BMPs by protecting against compaction by construction equipment and foot traffic. Protect completed lawn and landscaped areas from compaction due to construction equipment.

c. Control erosion and avoid introducing sediment from surrounding land uses onto BMP T5.15: Permeable Pavements. Do not allow muddy construction equipment on the base material or pavement. Do not allow sediment-laden runoff onto permeable pavements or base materials.

d. Permeable pavement fouled with sediments or no longer passing an initial infiltration test must be cleaned using procedures in accordance with this manual or the manufacturer's procedures.

e. Keep all heavy equipment off existing soils under LID BMPs that have been excavated to final grade to retain the infiltration rate of the soils.

The text in this box originates from one or more of the following Permits:
Appendix 1 of the Phase I / Phase II Municipal Stormwater Permits
Construction Stormwater General Permit

Additional Guidance for Element 13

See Chapter 5: Precision Site Preparation, Construction & Inspection of LID Facilities in the *LID Technical Guidance Manual for Puget Sound* (Hinman and Wulkan, 2012) for more detail on protecting LID integrated management practices.

Note that the *LID Technical Guidance Manual for Puget Sound* (Hinman and Wulkan, 2012) is for additional informational purposes only. You must follow the guidance within this manual if there are any discrepancies between this manual and the *LID Technical Guidance Manual for Puget Sound* (Hinman and Wulkan, 2012).

Suggested BMPs for Element 13

- BMP C102: Buffer Zones
- BMP C103: High-Visibility Fence
- BMP C200: Interceptor Dike and Swale
- BMP C201: Grass-Lined Channels
- BMP C207: Check Dams
- BMP C208: Triangular Silt Dike (TSD)
- BMP C231: Brush Barrier
- BMP C233: Silt Fence
- BMP C234: Vegetated Strip

I-3.4.3 MR3: Source Control of Pollution

All known, available and reasonable Source Control BMPs must be applied to all projects. Source Control BMPs must be selected, designed, and maintained in accordance with this manual.

The text in this box originates from one or more of the following Permits:
Appendix 1 of the Phase I / Phase II Municipal Stormwater Permits
Construction Stormwater General Permit

Objective

The intent of Source Control BMPs is to prevent stormwater from coming in contact with pollutants. They are a cost-effective means of reducing pollutants in stormwater and should be a first consideration in all projects.

Supplemental Guidelines

Source Control BMPs include Operational BMPs and Structural Source Control BMPs. See Volume IV for design details of these BMPs. For construction sites, see II-3.2 Construction Source Control BMPs.

Structural Source Control BMPs should be identified in the stormwater site plan and should be shown on all applicable plans submitted for local government review and approval.

An adopted and implemented Basin Plan (see Appendix I-B: Basin Plans) or Total Maximum Daily Load (see I-2.13 Total Maximum Daily Loads (TMDLs)) may be used to develop more stringent source control requirements that are tailored to a specific basin.

Identifying Source Control Strategies in a Basin Plan

Basin Plans can identify potential sources of pollution within the basin and develop strategies to eliminate or control these sources to protect beneficial uses.

A Basin Plan can include the following Source Control strategies:

1. Detection and correction of illicit discharges to storm sewer systems, including the use of dry weather sampling and dye-tracing techniques;
2. Identification of existing businesses, industries, utilities, and other activities that may store materials susceptible to spillage or leakage of pollutants into the storm sewer system or to the ground via wells, drains, or sumps;
3. Elimination or control of pollutant sources identified in (2);
4. Identification and control of future businesses, industries, utilities, and other activities which may store materials susceptible to spillage or leakage of pollutants into the storm sewer system; and
5. Training and public education

A Basin Plan that incorporates the standard requirements from this section as well as more stringent requirements does not require Ecology approval.

I-3.4.4 MR4: Preservation of Natural Drainage Systems and Outfalls

Natural drainage patterns shall be maintained, and discharges from the Project Site shall occur at the natural location, to the maximum extent practicable. The manner by which runoff is discharged from the Project Site must not cause a significant adverse impact to downstream receiving waters and downgradient properties. All outfalls require energy dissipation.

The text in this box originates from one or more of the following Permits:
Appendix 1 of the Phase I / Phase II Municipal Stormwater Permits
Construction Stormwater General Permit

Objective

To preserve and utilize natural drainage systems to the fullest extent because of the multiple stormwater benefits these systems provide; and to prevent erosion at and downstream of the discharge location.

Supplemental Guidelines

Creating new drainage patterns results in more site disturbance and more potential for erosion and sedimentation during and after construction. Creating new discharge points can create significant stream channel erosion problems as the receiving water body typically must adjust to the new flows.

Diversions can cause greater impacts than would otherwise occur by discharging runoff at the natural location.

Where no conveyance system exists at the adjacent downgradient property line and the discharge was previously unconcentrated flow or significantly lower concentrated flow, then measures must be taken to prevent downgradient impacts. Drainage easements from downstream property owners may be needed and should be obtained prior to approval of engineering plans.

The following discharge requirement is recommended:

Where no conveyance system exists at the abutting downstream property line and the natural (existing) discharge is unconcentrated, any runoff concentrated by the proposed project must be discharged as follows:

a. If the 100-year peak discharge, as estimated using an approved continuous runoff model using 15-minute time steps, is less than or equal to 0.3 cfs under existing conditions and will remain less than or equal to 0.3 cfs under developed conditions, then the concentrated runoff may be discharged onto outlet protection with riprap, such as those described in V-1.4.3 Outfall Systems, or to any other system that serves to disperse flows.

b. If the 100-year peak discharge, as estimated using an approved continuous runoff model using 15-minute time steps, is less than or equal to 0.75 cfs under existing conditions and will remain less than or equal to 0.75 cfs under developed conditions, then the concentrated runoff may be discharged through a dispersal trench, such as those described in V-1.4.3 Outfall Systems, or other dispersal system, provided the applicant can demonstrate that there will be no significant adverse impact to downhill properties or drainage systems.

c. If the 100-year peak discharge, as estimated using an approved continuous runoff model using 15-minute time steps, is greater than 0.75 cfs for either existing or developed conditions, or if a significant adverse impact to downgradient properties or drainage systems is likely, then a conveyance system must be provided to convey the concentrated runoff across the downstream properties to an acceptable discharge point (i.e., an enclosed drainage system or open drainage feature where concentrated runoff can be discharged without significant adverse impact).

Stormwater control or treatment structures should not be located within the expected 25-year water level elevations for salmonid-bearing waters. Such areas may provide off-channel habitat for juvenile salmonids and salmonid fry. Designs for outfall systems to protect against adverse impacts from concentrated runoff are included in V-1.4.3 Outfall Systems.

I-3.4.5 MR5: On-Site Stormwater Management

Projects shall employ Stormwater Management BMPs in accordance with the following thresholds, standards, and lists to infiltrate, disperse, and retain stormwater runoff on site to the extent feasible without causing flooding or erosion impacts.

The text in this box originates from one or more of the following Permits:
Appendix 1 of the Phase I / Phase II Municipal Stormwater Permits
Construction Stormwater General Permit

Compliance Options by Project Type

All projects that require Minimum Requirement #5 (as detailed in I-3.3 Applicability of the Minimum Requirements) must employ Stormwater Management BMPs as detailed below. The compliance options for the project depend on the amount of improvements proposed, the location of the project, the size of the parcel the project is on, and whether or not the project is Flow Control exempt.

Note that the site may contain multiple parcels. The designer may choose different compliance methods for different parcels, depending on the proposed design and the options for each parcel as detailed below.

Projects that Trigger Only Minimum Requirements #1 - #5

Projects that are not Flow Control exempt that trigger only Minimum Requirements #1 through #5 (per I-3.3 Applicability of the Minimum Requirements) shall either:

- Use the LID BMPs from List #1 for all surfaces within each type of surface in List #1;

  or

- Use any Flow Control BMP(s) desired to achieve the LID Performance Standard, and apply BMP T5.13: Post-Construction Soil Quality and Depth.

Projects that Trigger Minimum Requirements #1 - #9

Projects that are not Flow Control exempt that trigger Minimum Requirements #1 through #9 (per I-3.3 Applicability of the Minimum Requirements) have the compliance options shown in Table I-3.1: Minimum Requirement #5 Compliance Options for Projects Triggering Minimum Requirements #1 - #9.

Table I-3.1: Minimum Requirement #5 Compliance Options for Projects Triggering Minimum Requirements #1 - #9

<table>
<tr><th>Project Location and Parcel Size</th><th>Minimum Requirement #5 Compliance Options</th></tr>
<tr><td>Projects inside the UGA, on any size parcel</td><td rowspan="2">Use the LID BMPs from List #2 for all surfaces within each type of surface in List #2;
or
Use any Flow Control BMPs desired to achieve the LID Performance Standard, and apply BMP T5.13: Post-Construction Soil Quality and Depth.</td></tr>
<tr><td>Projects outside the UGA, on a parcel smaller than 5 acres</td></tr>
<tr><td>Projects outside the UGA, on a parcel 5 acres or larger</td><td>Use any Flow Control BMPs desired to achieve the LID Performance Standard, and apply BMP T5.13: Post-Construction Soil Quality and Depth.</td></tr>
<tr><td colspan="2">Note: This text refers to the Urban Growth Area (UGA) as designated under the Growth Management Act (GMA) (Chapter 36.70A RCW) of the State of Washington. If the project is located in a county that is not subject to planning under the GMA, the city limits shall be used instead.</td></tr>
</table>

Flow Control Exempt Projects

Projects qualifying as Flow Control exempt in accordance with the TDA Exemption in I-3.4.7 MR7: Flow Control shall either:

- Use the LID BMPs from List #3 for all surfaces within each type of surface in List #3;

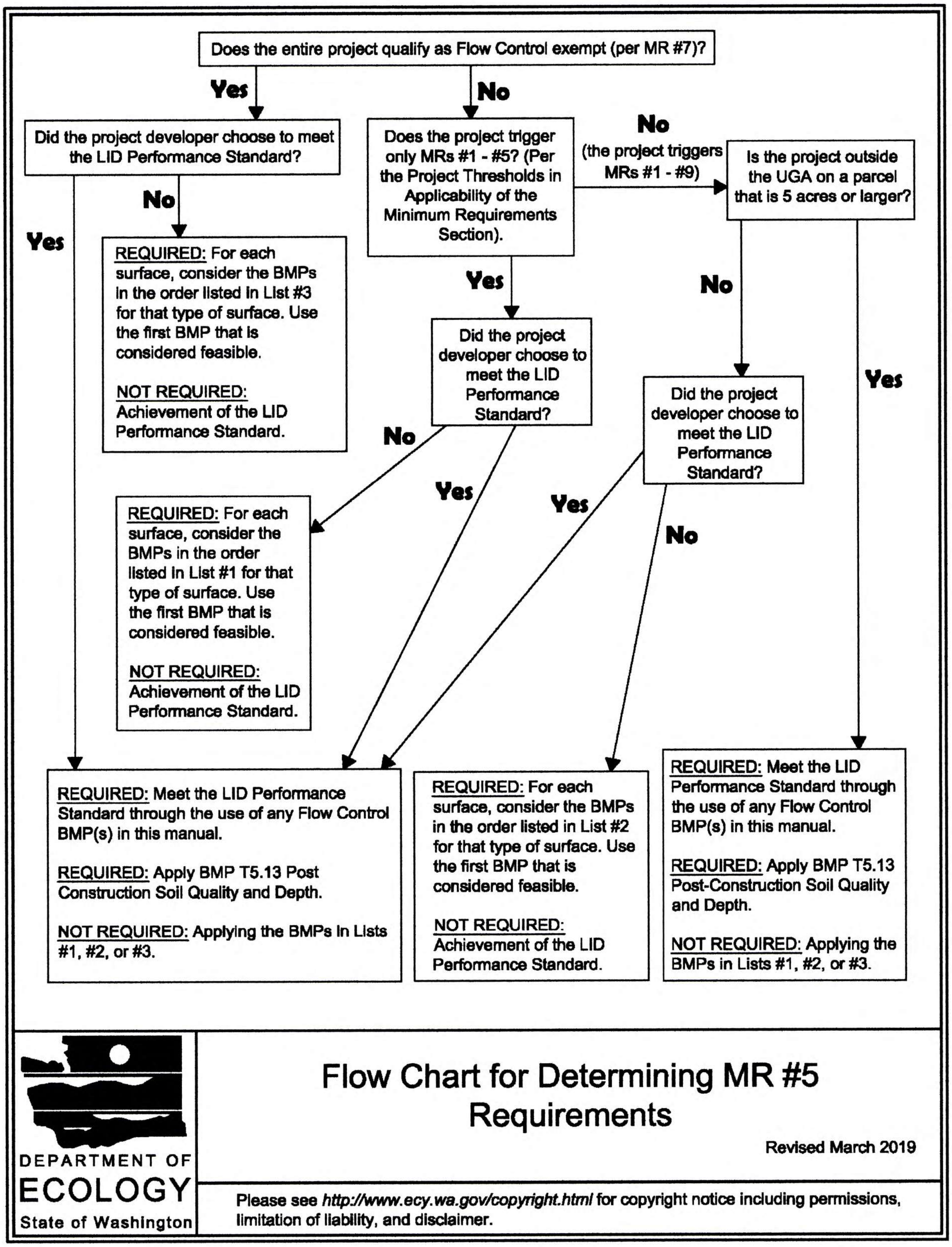
  or

- Use any Flow Control BMP(s) desired to achieve the LID Performance Standard, and apply BMP T5.13: Post-Construction Soil Quality and Depth.

If the project has multiple TDAs, all TDAs must be Flow Control exempt per the TDA Exemption in I-3.4.7 MR7: Flow Control for the project to use the options listed here.

The text in this box originates from one or more of the following Permits:
Appendix 1 of the Phase I / Phase II Municipal Stormwater Permits
Construction Stormwater General Permit

Figure I-3.3: Flow Chart for Determining MR #5 Requirements



Compliance Methods

LID Performance Standard

The LID Performance Standard compliance method for Minimum Requirement #5 requires modeling the proposed Flow Control BMPs to demonstrate the flow reduction as described below. Note that in order to meet the LID Performance Standard, the chosen Flow Control BMPs will most likely need to include infiltration.

Stormwater discharges shall match developed discharge durations to pre-developed durations for the range of pre-developed discharge rates from 8% of the 2-year peak flow to 50% of the 2-year peak flow. Refer to the Flow Control Performance Standard section in I-3.4.7 MR7: Flow Control for information about the assignment of the pre-developed condition. Project sites that must also meet I-3.4.7 MR7: Flow Control must match flow durations between 8% of the 2-year flow through the full 50-year flow.

Designers selecting this option cannot use BMP T5.14: Rain Gardens to achieve the LID Performance Standard. They may choose to use BMP T7.30: Bioretention to achieve the LID Performance Standard.

The text in this box originates from one or more of the following Permits:
Appendix 1 of the Phase I / Phase II Municipal Stormwater Permits
Construction Stormwater General Permit

The List Approach

The List Approach compliance method for Minimum Requirement #5 requires evaluating the BMPs in Table I-3.2: The List Approach for MR5 Compliance.

For each surface, evaluate the feasibility of the BMPs in the order listed, and use the first BMP that is considered feasible. The designer must document the site conditions and infeasibility criteria used to deem BMPs infeasible. Once a BMP is deemed feasible and used for a surface, no other BMP from the list is necessary for that surface.

If all BMPs in the list are infeasible, then the designer must document the site conditions and infeasibility criteria used to deem each BMP infeasible. This documentation will demonstrate compliance with Minimum Requirement #5.

Feasibility shall be determined by evaluation against:

- Design criteria, limitations, and infeasibility criteria identified for each BMP in this manual; and
- Competing Needs Criteria as listed below.

The text in this box originates from one or more of the following Permits:
Appendix 1 of the Phase I / Phase II Municipal Stormwater Permits
Construction Stormwater General Permit

Table I-3.2: The List Approach for MR5 Compliance

List #1 (For MR #1 - #5 Projects That Are Not Flow Control Exempt)	List #2 (For MR #1 - #9 Projects That Are Not Flow Control Exempt)	List #3 (For Flow Control Exempt Projects)
Surface Type: Lawn and Landscaped Areas		
BMP T5.13: Post-Construction Soil Quality and Depth	BMP T5.13: Post-Construction Soil Quality and Depth	BMP T5.13: Post-Construction Soil Quality and Depth
Surface Type: Roofs		
1. BMP T5.30: Full Dispersion or BMP T5.10A: Downspout Full Infiltration	1. BMP T5.30: Full Dispersion or BMP T5.10A: Downspout Full Infiltration	1. BMP T5.10A: Downspout Full Infiltration
2. BMP T5.14: Rain Gardens or BMP T7.30: Bioretention	2. BMP T7.30: Bioretention	2. BMP T5.10B: Downspout Dispersion Systems
3. BMP T5.10B: Downspout Dispersion Systems	3. BMP T5.10B: Downspout Dispersion Systems	3. BMP T5.10C: Perforated Stub-out Connections
4. BMP T5.10C: Perforated Stub-out Connections	4. BMP T5.10C: Perforated Stub-out Connections	
Surface Type: Other Hard Surfaces		
1. BMP T5.30: Full Dispersion	1. BMP T5.30: Full Dispersion	BMP T5.12: Sheet Flow Dispersion or BMP T5.11: Concentrated Flow Dispersion
2. BMP T5.15: Permeable Pavements or BMP T5.14: Rain Gardens or BMP T7.30: Bioretention	2. BMP T5.15: Permeable Pavements	
3. BMP T5.12: Sheet Flow Dispersion or BMP T5.11: Concentrated Flow Dispersion	3. BMP T7.30: Bioretention 4. BMP T5.12: Sheet Flow Dispersion or BMP T5.11: Concentrated Flow Dispersion	
Notes for using the List Approach: 1. Size BMP T5.14: Rain Gardens and BMP T7.30: Bioretention used in the List Approach to have a minimum horizontal projected surface area below the overflow which is at least 5% of the area drain-		

Table I-3.2: The List Approach for MR5 Compliance (continued)

List #1 (For MR #1 - #5 Projects That Are Not Flow Control Exempt)	List #2 (For MR #1 - #9 Projects That Are Not Flow Control Exempt)	List #3 (For Flow Control Exempt Projects)
ing to it. 2. When the designer encounters BMP T5.15: Permeable Pavements in the List Approach, it is not a requirement to pave these surfaces. Where pavement is proposed, it must be permeable to the extent feasible unless BMP T5.30: Full Dispersion is employed.		

Objective

The objective of On-Site Stormwater Management is to use practices distributed across a development that reduce the amount of disruption of the natural hydrologic characteristics of the site.

Competing Needs Criteria

LID BMPs can be superseded or restricted where they are in conflict with:

- Requirements of the following federal or state laws, rules, and standards:
  - Historic Preservation Laws and Archaeology Laws as listed at https://dahp.wa.gov/project-review/preservation-laws,
  - Federal Superfund or Washington State Model Toxics Control Act,
  - Federal Aviation Administration requirements for airports,
  - Americans with Disabilities Act.
- When an LID requirement has been found to be in conflict with special zoning district design criteria adopted and being implemented pursuant to a community planning process. The existing local codes may supersede or reduce the LID requirement.
- Public health and safety standards (e.g. active zone of a skate park, bike park, or sport court where permeable pavement violates safety standards).
- Transportation regulations to maintain the option for future expansion or multi-modal use of public rights-of-way.
- A local Critical Area Ordinance that provides protection of tree species.
- A local code or rule adopted as part of a Wellhead Protection Program established under the Federal Safe Drinking Water Act; or adopted to protect a Critical Aquifer Recharge Area established under the State Growth Management Act.

Supplemental Guidelines

In order to meet the LID Performance Standard, designers may use any Flow Control BMP in the SWMMWW. There are no specific Flow Control BMPs that must be used to meet the LID Performance Standard.

"Flooding or erosion impacts" include flooding of septic systems, crawl spaces, living areas, outbuildings, etc.; increased ice or algal growth on sidewalks/roadways; earth movement/settlement; erosion and other potential damage.

Recent research indicates that traditional development techniques in residential, commercial, and industrial land development cause gross disruption of the natural hydrologic cycle with severe impacts to water and water-related natural resources. Based upon gross level applications of continuous runoff modeling and assumptions concerning minimum flows needed to maintain beneficial uses, watersheds must retain the majority of their natural vegetation cover and soils, and developments must minimize their disruption of the natural hydrologic cycle in order to avoid significant natural resource degradation in lowland streams.

The BMPs listed in this section are likely insufficient by themselves to prevent significant hydrologic disruptions and impacts to streams and their natural resources. Therefore, local governments should look for opportunities to change their local development codes to minimize impervious surfaces and retain native vegetation in all development situations. Most importantly, to maintain the beneficial uses of our lowland freshwater systems will require land use planning that targets retention of a majority of a creek's watershed in its natural condition, and retains most of the benefits of headwater areas, connected wetlands, riparian, and floodplain areas.

I-3.4.6 MR6: Runoff Treatment

Projects shall employ Runoff Treatment BMPs in accordance with the following thresholds, standards, and requirements to remove pollutants from stormwater runoff.

The text in this box originates from one or more of the following Permits:
Appendix 1 of the Phase I / Phase II Municipal Stormwater Permits
Construction Stormwater General Permit

TDA Thresholds

Each TDA within a project that requires Minimum Requirement #6 (as detailed in I-3.3 Applicability of the Minimum Requirements) must be reviewed to determine if Runoff Treatment BMPs are required for the TDA to be in compliance with Minimum Requirement #6.

Note that it is possible for a project that requires Minimum Requirement #6 with multiple TDAs to not need Runoff Treatment BMP(s) in one or more individual TDAs. If a TDA does not trigger the TDA threshold for Runoff Treatment BMPs, then the designer must document the areas within the TDA used to determine that the TDA threshold was not met. This documentation will demonstrate compliance with Minimum Requirement #6 for the TDA.

When assessing a TDA against the following thresholds, only consider the types of surfaces (e.g. new hard surfaces, replaced hard surfaces, converted vegetation areas) that are subject to Minimum Requirement #6, per the Project Thresholds in I-3.3 Applicability of the Minimum Requirements.

The following TDAs require construction of Runoff Treatment BMPs. If a TDA meets any of the following thresholds, Runoff Treatment BMPs are required. The project proponent must demonstrate that the TDA does not meet either of the following thresholds for Runoff Treatment BMPs to not be required for that TDA.

- TDAs that have a total of 5,000 square feet or more of pollution-generating hard surface (PGHS), or
- TDAs that have a total of 3/4 of an acre or more of pollution-generating pervious surfaces (PGPS) – not including permeable pavements, and from which there will be a surface discharge in a natural or man-made conveyance system from the site.

The text in this box originates from one or more of the following Permits:
Appendix 1 of the Phase I / Phase II Municipal Stormwater Permits
Construction Stormwater General Permit

Runoff Treatment BMP Sizing

Size Runoff Treatment BMPs to treat the Water Quality Design Flow Rate or Water Quality Design Storm Volume, as detailed in III-2.6 Sizing Your Runoff Treatment BMPs.

The text in this box originates from one or more of the following Permits:
Appendix 1 of the Phase I / Phase II Municipal Stormwater Permits
Construction Stormwater General Permit

Runoff Treatment BMP Selection, Design, and Maintenance

Runoff Treatment BMPs shall be:

- Selected in accordance with the process identified in III-1.2 Choosing Your Runoff Treatment BMPs,
- Designed in accordance with the design criteria in Volume V, and
- Maintained in accordance with the maintenance criteria in Volume V.

The text in this box originates from one or more of the following Permits:
Appendix 1 of the Phase I / Phase II Municipal Stormwater Permits
Construction Stormwater General Permit

Additional Requirements

The (direct or indirect) discharge of untreated stormwater from pollution-generating hard surfaces to ground water must not be authorized by the local government, except for infiltration or dispersion of runoff through LID BMPs per The List Approach in I-3.4.5 MR5: On-Site Stormwater Management.

The text in this box originates from one or more of the following Permits:
Appendix 1 of the Phase I / Phase II Municipal Stormwater Permits
Construction Stormwater General Permit

The direct discharge of untreated stormwater from pollution-generating hard surfaces to ground water is prohibited, except for infiltration or dispersion of runoff through LID BMPs per The List Approach in I-3.4.5 MR5: On-Site Stormwater Management.

Objective

The purpose of Runoff Treatment is to reduce pollutant loads and concentrations in stormwater run-off using physical, biological, and chemical removal mechanisms so that beneficial uses of receiving waters are maintained and, where applicable, restored. When site conditions are appropriate, infilt-ration can potentially be the most effective BMP for Runoff Treatment.

Supplemental Guidelines

See III-1.2 Choosing Your Runoff Treatment BMPs for determining the appropriate Runoff Treat-ment Performance Goal for the site, and a list of BMPs that may be used to meet that performance goal using the presumptive approach.

See Volume V for detailed guidance on design and maintenance of Runoff Treatment BMPs.

An adopted and implemented basin plan, or a Total Maximum Daily Load (TMDL - also known as a Water Clean-up Plan) may be used to develop Runoff Treatment requirements that are tailored to a specific basin. However, Runoff Treatment requirements shall meet, at a minimum, the Basic Treat-ment Performance Goal (as detailed in III-1.2 Choosing Your Runoff Treatment BMPs).

Runoff from surfaces that are not pollution-generating do not need to be treated and may bypass the Runoff Treatment BMP(s), if it is not mingled with runoff from pollution-generating surfaces.

Drainage from areas in native vegetation should not be mixed with untreated runoff from streets and driveways, if possible. It is best to infiltrate or disperse this relatively clean runoff to maximize recharge to shallow ground water, wetlands, and streams.

Revising MR6 through a Basin Plan

Basin Plans (see Appendix I-B: Basin Plans) can develop different requirements and performance standards than those detailed above to reduce pollutant concentrations or loads based on an eval-uation of the beneficial uses to be protected within or downstream of the basin. Consideration must be given to the antidegradation provisions of the Clean Water Act and implementing state water qual-ity standards. The evaluation should include an analysis of existing and future conditions. Basin spe-cific requirements and performance standards can be developed based on an evaluation of pollutant loads and modeling of receiving water conditions.

Basic Treatment (as described in III-1.2 Choosing Your Runoff Treatment BMPs) is a minimum standard that must be applied regardless of the quality of the receiving water(s). Additional levels of Runoff Treatment beyond Basic Treatment may be justified in order to control the impacts of future development.

Runoff Treatment requirements and performance standards developed from a Basin Plan should apply to individual development sites within the basin. Regional Runoff Treatment BMPs can be considered an acceptable substitute for on-site Runoff Treatment BMPs if they can meet the Runoff Treatment requirements and performance standards identified in the Basin Plan. A limitation to the use of regional Runoff Treatment BMPs is that the conveyances used to transport the stormwater to the Regional BMP must not include waters of the state that have existing or attainable beneficial uses other than drainage.

The above text describes how Basin Plans can influence Runoff Treatment requirements and performance standards for new and redevelopment. Basin Plans can also be used to identify structural retrofit Runoff Treatment requirements for reducing the effects of existing development on the aquatic resources.

I-3.4.7 MR7: Flow Control

Projects shall employ Flow Control BMPs in accordance with the following thresholds, standards, and requirements to reduce the impacts of stormwater runoff from hard surfaces and land cover conversions.

The text in this box originates from one or more of the following Permits:
Appendix 1 of the Phase I / Phase II Municipal Stormwater Permits
Construction Stormwater General Permit

TDA Exemption

Flow Control is not required for TDAs that discharge directly to, or indirectly through an MS4 to a water listed in Appendix I-A: Flow Control Exempt Receiving Waters, subject to all of the following restrictions:

- Direct discharge to the exempt receiving water does not result in the diversion of drainage from any perennial stream classified as Types 1, 2, 3, or 4 in the State of Washington Interim Water Typing System, or Types "S", "F", or "Np" in the Permanent Water Typing System, or from any category I, II, or III wetland.
- If flow splitters or conveyance elements are applied to route natural runoff volumes from the TDA to any downstream Type 5 stream or category IV wetland, then:
  - Design of the flow splitters or conveyance elements must be based on approved continuous simulation modeling analysis. The design must assure that flows delivered to Type 5 stream reaches will approximate, but in no case exceed, durations ranging from 50% of the 2-year to the 50-year peak flow.
  - Flow splitters or conveyance elements that deliver flow to category IV wetlands must also be designed using approved continuous simulation modeling to preserve pre-project wetland hydrologic conditions unless specifically waived or exempted by regulatory agencies with permitting jurisdiction.

- The TDA must be drained by a conveyance system that is comprised entirely of man-made conveyance elements (e.g., pipes, ditches, outfall protection) and extends to the ordinary high water line of the exempt receiving water.
- The conveyance system between the TDA and the exempt receiving water shall have sufficient hydraulic capacity to convey discharges from future build-out conditions (under current zoning) from contributing areas of the Site, and the existing condition from contributing off-site areas.
- Any erodible elements of the manmade conveyance system must be adequately stabilized to prevent erosion under the conditions noted above.

Local governments may petition Ecology to exempt projects in additional areas. A petition must justify the proposed exemption based upon a hydrologic analysis that demonstrates that the potential stormwater runoff from the exempted area will not significantly increase the erosion forces on the stream channel nor have near field impacts. See Appendix I-A: Flow Control Exempt Receiving Waters for details

The text in this box originates from one or more of the following Permits:
Appendix 1 of the Phase I / Phase II Municipal Stormwater Permits
Construction Stormwater General Permit

TDA Thresholds

Each TDA within a project that requires Minimum Requirement #7 (as detailed in I-3.3 Applicability of the Minimum Requirements) must be reviewed to determine if Flow Control BMPs are required for the TDA to be in compliance with Minimum Requirement #7.

Note that it is possible for a project that requires Minimum Requirement #7 with multiple TDAs to not need Flow Control BMP(s) in one or more individual TDAs. If a TDA does not trigger the TDA thresholds for Flow Control BMPs, then the designer must document the areas within the TDA used to determine that the TDA thresholds were not met. This documentation will demonstrate compliance with Minimum Requirement #7 for the TDA.

When assessing a TDA against the following thresholds, only consider the types of surfaces (e.g. new hard surfaces, replaced hard surfaces, converted vegetation areas) that are subject to Minimum Requirement #7, per the Project Thresholds in I-3.3 Applicability of the Minimum Requirements.

The following TDAs require construction of Flow Control BMPs to achieve the Flow Control Performance Standard. If a TDA meets any of the following thresholds, Flow Control BMPs are required. The project proponent must demonstrate that the TDA does not meet any of the following thresholds for Flow Control BMPs to not be required for that TDA.

- TDAs that have a total of 10,000 square feet or more of effective impervious surfaces, or
- TDAs that convert ¾ acres or more of native vegetation, pasture, scrub/shrub, or unmaintained non-native vegetation to lawn or landscape, or convert 2.5 acres or more of native

vegetation to pasture, and from which there is a surface discharge in a natural or man-made conveyance system from the TDA, or

- TDAs that through a combination of effective hard surfaces and converted vegetation areas cause a 0.15 cubic feet per second (cfs) or greater increase in the 100-year flow frequency as estimated using an approved continuous simulation model and 15-minute time steps.

The 0.15 cfs increase should be a comparison of the post project runoff to the existing condition runoff. For the purpose of applying this threshold, the existing condition is either the pre-project land cover, or the land cover that existed at the site as of a date when the local jurisdiction first adopted Flow Control requirements into code or rules.

The text in this box originates from one or more of the following Permits:
Appendix 1 of the Phase I / Phase II Municipal Stormwater Permits
Construction Stormwater General Permit

Flow Control Performance Standard

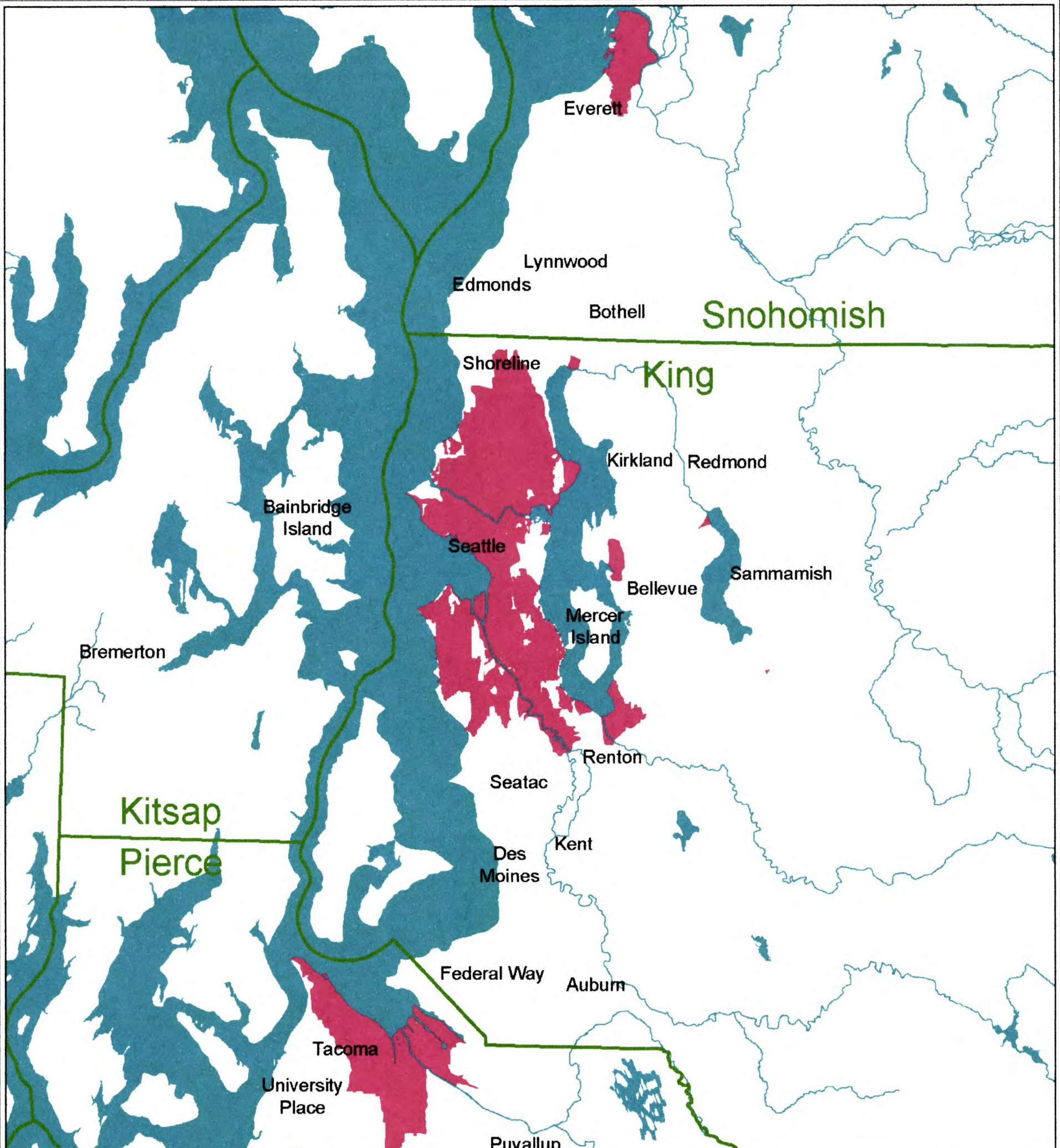
Stormwater discharges shall match developed discharge durations to pre-developed durations for the range of pre-developed discharge rates from 50% of the 2-year peak flow up to the full 50-year peak flow. The pre-developed condition to be matched shall be a forested land cover unless:

- Reasonable, historic information is provided that indicates the site was prairie prior to settlement (modeled as pasture in the approved continuous simulation model); or,

- The drainage area of the immediate stream and all subsequent downstream basins have had at least 40% total impervious area (TIA) since 1985. In this case, the pre-developed condition to be matched shall be the existing land cover condition. Figure I-3.4: Basins with 40% Total Impervious Area as of 1985 depicts those areas which meet this criterion. Where basin-specific studies determine a stream channel to be unstable, even though the above criterion is met, the pre-developed condition assumption shall be the "historic" land cover condition, or a land cover condition commensurate with achieving a target flow regime identified by an approved basin study.

The text in this box originates from one or more of the following Permits:
Appendix 1 of the Phase I / Phase II Municipal Stormwater Permits
Construction Stormwater General Permit

Figure I-3.4: Basins with 40% Total Impervious Area as of 1985



DEPARTMENT OF ECOLOGY
State of Washington

Basins with 40% Total Impervious Area
as of 1985

Revised June 2016

Alternative Flow Control Performance Standard

An alternative Flow Control Performance Standard may be established through application of watershed-scale hydrologic modeling and supporting field observations. Possible reasons for an alternative Flow Control Performance Standard include:

- Establishment of a stream–specific threshold of significant bedload movement other than the assumed 50% of the 2-year peak flow;
- Zoning and Land Clearing Ordinance restrictions that, in combination with an alternative Flow Control Performance Standard, maintain or reduce the naturally occurring erosive forces on the stream channel; or
- A duration control standard is not necessary for protection, maintenance, or restoration of designated and existing beneficial uses or Clean Water Act compliance.

The text in this box originates from one or more of the following Permits:
Appendix 1 of the Phase I / Phase II Municipal Stormwater Permits
Construction Stormwater General Permit

Additional Requirement

Flow Control BMPs shall be selected, designed, and maintained in accordance with this manual.

The text in this box originates from one or more of the following Permits:
Appendix 1 of the Phase I / Phase II Municipal Stormwater Permits
Construction Stormwater General Permit

Objective

The objective of this Minimum Requirement is to prevent increases in the stream channel erosion rates that are characteristic of natural conditions (i.e., prior to disturbance by European settlement). The Flow Control Performance Standard intends to maintain the total amount of time that a receiving stream exceeds an erosion-causing threshold based upon historic rainfall and natural land cover conditions. That threshold is assumed to be 50% of the 2-year peak flow. Maintaining the naturally occurring erosion rates within streams is vital, though by itself insufficient, to protect fish habitat and production.

Supplemental Guidelines

The 1992 Ecology manual (Ecology, 1992) focused primarily on controlling the peak flow release rates for recurrence intervals of concern – the 2, 10, and 100-year rates. This level of control did not adequately address the increased duration at which those high flows occur because of the increased volume of water from the developed condition as compared to the pre-developed conditions.

To protect stream channels from increased erosion, it is necessary to control the durations over which a stream channel experiences geomorphically significant flows such that the energy imparted to the stream channel does not increase significantly. Geomorphically significant flows are those that are capable of moving sediments. This target will translate into lower release rates and significantly larger Flow Control BMPs than the standard from the 1992 Ecology manual. The size of Flow Control BMPs can be reduced by changing the extent to which the site is disturbed.

Reduction of flows through infiltration decreases stream channel erosion and helps to maintain base flow throughout the summer months. Infiltration should follow the guidance in this manual to reduce the chance of threatening ground water quality.

Using LID BMPs reduces the predicted runoff rates and volumes, and thus also reduces the size of required Flow Control BMPs.

Application of certain LID and/or infiltration BMPs can result in reducing the effective impervious area and the converted vegetation areas such that the TDA Thresholds are not triggered, and a Flow Control BMP is not required. See the definition of Effective Impervious Surface in the Glossary for details. Application of BMP T5.30: Full Dispersion also results in eliminating the requirement for a Flow Control BMP for those areas that are "fully dispersed."

Diversion of flow from perennial streams and from wetlands can be considered if significant existing (i.e., pre-project) flooding, stream stability, water quality, or aquatic habitat problems would be solved or significantly mitigated by bypassing stormwater runoff rather than providing stormwater detention and discharge to natural drainage features. Bypassing should not be considered as an alternative to applicable Flow Control or Runoff Treatment if the flooding, stream stability, water quality or habitat problem to be solved would be caused by the project. In addition, the proposal should not exacerbate other water quality/quantity problems such as inadequate low flows or inadequate wetland water elevations. The existing problems and their solution or mitigation as a result of the direct discharge should be documented by a stormwater engineer or scientist after review of any available drainage reports, basin plans, or other relevant literature. The restrictions in this Minimum Requirement on conveyance systems that transfer water to an exempt receiving water are also applicable in these situations. Approvals by all regulatory authorities with relevant permits applicable to the project are necessary.

How to Determine an Alternative Flow Control Performance Standard

A Basin Plan (see Appendix I-B: Basin Plans) may be used to identify an Alternative Flow Control Performance Standard. The Basin Plan must contain an analyses to determine the measures necessary to protect a stream channel from accelerated erosion.

Ecology's default Flow Control Performance Standard is based upon a generalization that the threshold of significant bedload movement in Western Washington streams occurs at 50% of the 2-year return stream flow. Through field observations and measurements, a local government may estimate a more appropriate threshold – higher or lower- for a specific stream. The alternative threshold can become the lower limit for the range of flows over which the duration standard applies. For instance, if the threshold is established at 70% of a 2-year return flow, the Alternative Flow Control Performance Standard would be to match the discharge durations of flows from the developed site to the range of pre-developed discharge rates from 70% of the 2-year peak flow up to the full 50-year peak flow.

An Alternative Flow Control Performance Standard must be compatible with maintaining and restoring the designated beneficial uses for that stream. If the existing stream condition is not compatible with the beneficial uses, it should not be used to determine an Alternative Flow Control Performance Standard.

Basin Plans that intend to identify an Alternative Flow Control Performance Standard will require the use of computer models and field work to verify and support the models. Permit holders considering the use of Basin Plans to identify an Alternative Flow Control Performance Standard are encouraged to contact their regional permit specialist during the planning stage.

Ecology cautions local governments seeking to determine a threshold of bed load movement for a stream whose channel has been significantly altered from its historic condition by stormwater flows. An Alternative Flow Control Performance Standard must be compatible with the restoration and maintenance of the designated beneficial uses of the stream. If the current threshold of bed load movement is not compatible with creating and sustaining channel conditions for the beneficial uses, it is not an acceptable regulatory target.

How did Ecology Determine Which Areas Meet the 40% TIA Since 1985 Criterion?

Figure I-3.4: Basins with 40% Total Impervious Area as of 1985 shows those basins that qualify for use of a Flow Control Performance Standard that would require matching high flow durations of a project to the durations produced by the existing land cover condition. To qualify, a basin must have been at or above 40 percent total impervious area (TIA) since 1985. Figure I-3.4: Basins with 40% Total Impervious Area as of 1985 depicts basins that exceeded 40 percent total impervious area as of 1986. The Department of Ecology has used 1986 land covers as estimated from satellite images as the best available information upon which to make these designations.

Ecology contracted with Sanborn, Inc. to provide land cover data for Western Washington for 1991, and an analysis of change in land cover, impervious surface, and forest canopy for all of Western Washington between 1991 and 2001. The project built upon land cover data classified under the NOAA Coastal Change Analysis Program (C-CAP) for 1996 and 2001.

The resulting report is titled *Western Washington Land Cover Change Analysis: Final Report* (Fiorella, 2005).

Ecology used one of the report's outputs, total impervious area by basin in 1991, to create and publish a map of areas that potentially qualified for use of the existing land cover condition as the flow control target for new and re-development projects. Now that 1986 land cover data using similar estimating techniques has been made available by NOAA, Ecology has produced Figure I-3.4: Basins with 40% Total Impervious Area as of 1985 that supersedes the previous map.

The analysis involved the following steps:

- Determine the basin scale upon which to do the analysis. Some streams have only one basin designated for their drainage area. Other streams have multiple sub-basins for which the TIA and area data are available. The analysis begins just above those points at which a Flow Control standard does not apply. Usually that is a stream's discharge to Puget Sound or a large lake system that is exempt from flow control, e.g., Lake Washington/Lake Union/Ship Canal area.
- Using the 1986 data, compute an area-weighted TIA using data for all sub-basins within the

larger basin.

- If the basin does not exceed the 40% TIA criterion, none of the sub-basins potentially qualify unless a sub-basin discharges very near to the bottom of the basin drainage. If the basin exceeds 40% TIA at least some area within the basin potentially qualifies. To determine that area, proceed upstream and compute areal weighted %TIA for smaller drainages within the subject basin. A drainage area of an identifiable side-stream or an upper area draining to the main stream channel does not qualify if the respective areal-weighted %TIA of its sub-basins does not exceed the 40% criterion.

- Remove designation of basins which met the 40% criterion, but for which:
  - a basin-specific study suggests the stream channel to be unstable;
  - an approved basin study identified a target flow regime intended to achieve acceptable natural resource objectives (e.g. Des Moines Creek).

Ecology's *Discussion Paper: Proposed Flow Control Standard for Highly Urbanized Drainage Basins* (Ecology, 2004c) explains the basis for the less stringent Flow Control standard for basins meeting the criteria. The implementation section at the end of the paper no longer applies to the updated (2010) map, but the background and rationale for the exemption does.

The map in GIS format and all associated metadata are available to local governments from Ecology's GIS web site at the following address:

https://ecology.wa.gov/Research-Data/Data-resources/Geographic-Information-Systems-GIS/GIS-data#l

Permit holders interested in using alternative data or methods to demonstrate that a basin meets this criterion for a highly urbanized basin prior to 1985 should contact their Regional Permit Specialist prior to beginning such a study.

Revising MR7 through a Basin Plan

Basin Plans (see Appendix I-B: Basin Plans) are well-suited to control stream channel erosion for both existing and future conditions. Flow Control standards developed from a Basin Plan may be used to alter the default standards described above, and can include a combination of on-site, regional, and stream protection and rehabilitation measures, and retrofitting opportunities.

- On-site standards are usually the primary mechanism to protect streams from the impacts of increased high flows in future conditions.

- Regional Flow Control facilities are used primarily to correct existing stream erosion problems.

- In-stream protection and rehabilitation measures may be applied where stream channel erosion problems exist that will not be corrected by on-site or regional facilities. However, caution is urged in the application of such measures. If the causes of the stream channel erosion problems still exist, repairs to the physical expression of those problems may be short-lived. In some instances, it may be prudent to apply in-stream measures to reduce impacts until the basin hydrology is improved. This does not alleviate the jurisdiction from needing to ensure that existing and beneficial uses are restored to the receiving water. In stream work cannot be used to satisfy the Minimum Requirements under the permit.

- Retrofitting opportunities may include modified outlets for, and expansion of existing Detention BMPs.

Basin Plans may be used to:

- develop an Alternative Flow Control Performance Standard, as described above.
- identify additional receiving waters as Flow Control Exempt, as described in Appendix I-A: Flow Control Exempt Receiving Waters.
- identify basins that have had at least 40% total impervious area since 1985, as described above.

I-3.4.8 MR8: Wetlands Protection

Projects shall employ Stormwater Management BMPs in accordance with the following thresholds, standards, and requirements to reduce the impacts of stormwater runoff to wetlands.

The text in this box originates from one or more of the following Permits:
Appendix 1 of the Phase I / Phase II Municipal Stormwater Permits
Construction Stormwater General Permit

TDA Thresholds

This Minimum Requirement applies only to TDAs whose stormwater discharges into a wetland, either directly or indirectly through a conveyance system.

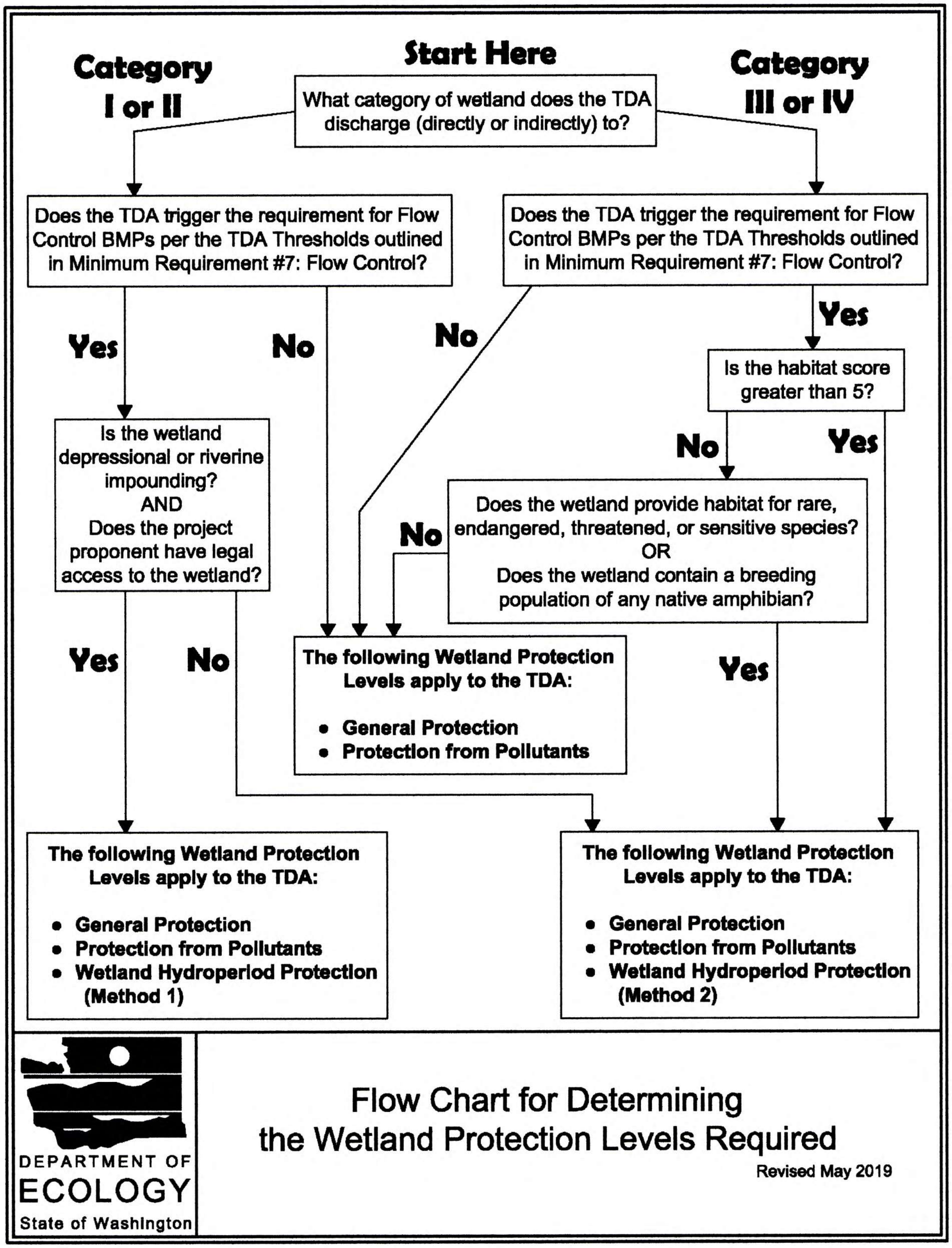
Each TDA within a project that requires Minimum Requirement #8 (as detailed in I-3.3 Applicability of the Minimum Requirements) must be reviewed to determine what Level(s) of Wetland Protection must be applied to the TDA to comply with Minimum Requirement #8. The Level(s) of Wetland Protection that must be applied are dependent upon:

- The category of wetland that the TDA is discharging to,
- Whether or not the TDA triggers the requirement for Flow Control BMPs per the TDA Thresholds in I-3.4.7 MR7: Flow Control,
- Whether or not the wetland is a depressional or impounded wetland,
- Whether or not the project proponent has legal access to the wetland,
- The wetland habitat score,
- Whether or not the wetland provides habitat for rare, endangered, threatened, and/or sensitive species, and
- Presence of a breeding population of native amphibians.

Refer to Figure I-3.5: Flow Chart for Determining Wetland Protection Level Requirements to determine what Level(s) of Wetland Protection must be applied to comply with Minimum Requirement #8.

The text in this box originates from one or more of the following Permits:
Appendix 1 of the Phase I / Phase II Municipal Stormwater Permits
Construction Stormwater General Permit

Figure I-3.5: Flow Chart for Determining Wetland Protection Level Requirements



Levels of Wetland Protection

The following Levels of Wetland Protection are further explained in Appendix I-C: Wetland Protection Guidelines.

General Protection

General Protection includes general practices that benefit wetlands of all types. See I-C.2 General Protection for details.

Protection from Pollutants

Protection from Pollutants includes measures to protect the wetland from pollutants in stormwater runoff. Measures of protection include Construction Stormwater BMPs, Source Control BMPs, LID practices and principles, and Runoff Treatment BMPs. See I-C.3 Protection from Pollutants for details.

Wetland Hydroperiod Protection

Wetland Hydroperiod Protection includes measures to avoid excessive hydrologic alteration of existing wetlands from development. There are two methods within Wetland Hydroperiod Protection:

- Method 1: Monitoring and Wetland Stage Modeling

  This method requires data collection specific to the wetland, as well as continuous simulation modeling to demonstrate that the proposed project will not negatively alter the wetland hydrology.

- Method 2: Site Discharge Modeling

  This method requires continuous simulation modeling of the runoff from the TDA to demonstrate that the changes in total discharge volume to the wetland will remain similar to the pre-development condition.

See I-C.4 Wetland Hydroperiod Protection for details on both methods.

The text in this box originates from one or more of the following Permits:
Appendix 1 of the Phase I / Phase II Municipal Stormwater Permits
Construction Stormwater General Permit

Additional Requirements

Stormwater Management BMPs shall not be built within a wetland or its buffer, except for:

- Necessary conveyance systems as approved by the local government; or
- As allowed in I-C.6 Compensatory Mitigation of Wetlands.

> ***The text in this box originates from one or more of the following Permits:***
> *Appendix 1 of the Phase I / Phase II Municipal Stormwater Permits*
> *Construction Stormwater General Permit*

Objective

The objective of this Minimum Requirement is to ensure that wetlands receive the same level of protection as any other water of the state. Wetlands are extremely important natural resources that provide multiple functions and values, including ground water recharge, flood control, and stream channel erosion protection. They are easily impacted by development unless careful planning and management are conducted. Wetlands can be severely degraded by stormwater discharges from urban development due to pollutants in the runoff and also due to disruption of the natural hydrologic pattern of the wetland.

Supplemental Guidelines

Appendix I-C: Wetland Protection Guidelines shall be used for discharges to natural wetlands and mitigated wetlands.

How Do I Reconcile the Flow Control Performance Standard from MR7 with MR8?

In most cases, if Wetland Hydroperiod Protection is required per I-3.4.8 MR8: Wetlands Protection, then the Flow Control Performance Standard is also required per I-3.4.7 MR7: Flow Control. In these cases, the designer must attempt to meet the requirements for both MRs. This may prove to be feasible in many situations because I-3.4.7 MR7: Flow Control will seek to adjust the flow in small time intervals and I-3.4.8 MR8: Wetlands Protection looks to maintain daily flow volumes.

If the designer is unable to meet both requirements, then the requirement to maintain the hydroperiod of the wetland becomes the overriding concern and the designer must show compliance with I-3.4.8 MR8: Wetlands Protection. If this is the case, the designer must also provide documentation detailing why they are unable to meet both requirements.

Revising MR8 through a Basin Plan

Basin Plans (see Appendix I-B: Basin Plans) can be used to develop alternative protection standards for wetlands and other sensitive areas, such as landslide hazard areas, wellhead protection areas, and ground water quality management areas. These standards can include Source Control, Runoff Treatment, Flow Control, stage levels, and frequency and duration of inundations.

I-3.4.9 MR9: Operation and Maintenance

> An operation and maintenance manual that is consistent with the provisions in Volume V shall be provided for proposed Runoff Treatment and Flow Control BMPs. The party (or parties) responsible for maintenance and operation shall be identified in the operation and maintenance manual. At private facilities, a copy of the operation and maintenance manual shall be retained

on site or within reasonable access to the site, and shall be transferred with the property to the new owner. For public facilities, a copy of the operation and maintenance manual shall be retained in the appropriate department. A log of maintenance activity that indicates what actions were taken shall be kept and be available for inspection by the local government.

The text in this box originates from one or more of the following Permits:
Appendix 1 of the Phase I / Phase II Municipal Stormwater Permits
Construction Stormwater General Permit

Objective

The objective of this Minimum Requirement is to ensure that Stormwater Management BMPs are properly maintained and operated.

Supplemental Guidelines

Inadequate maintenance is a common cause of failure for Stormwater Management BMPs. See the maintenance section within each BMP, as well as the tables in Appendix V-A: BMP Maintenance Tables. Local governments should consider more detailed requirements for maintenance logs, such as a record of where wastes were disposed.

I-3.5 Additional Protective Measures (Optional)

I-3.5.1 What Are Additional Protective Measures (APMs)?

Additional Protective Measures (APMs) are measures above and beyond the Minimum Requirements (MRs) that Ecology recommends for local governments to consider in their stormwater program. Ecology considers their use to be in the best interest of the general public and the environment, but will not make their implementation a requirement for manual equivalency or permit compliance.

I-3.5.2 APM1: Financial Liability

Ecology recommends that local governments require performance bonding or other appropriate financial guarantees for all projects to ensure construction of Stormwater Management BMPs in compliance with these standards. In addition, Ecology recommends that local governments require a project applicant post a minimum two-year financial guarantee of the satisfactory performance and maintenance of any Stormwater Management BMPs that are scheduled to be assumed by the local government for operation and maintenance.

Local governments may choose to require longer performance bonds for certain project types, such as those that use the demonstrative approach (see I-1.6 Presumptive versus Demonstrative Approaches to Protecting Water Quality).

Objective

The objective of this APM is to ensure that development projects have adequate financial resources to fully implement their stormwater management requirements and that liability is not unduly incurred by local governments.

Supplemental Guidelines

The type of financial instrument required is less important than ensuring that there are adequate funds available in the event that non-compliance occurs.

I-3.5.3 APM2: Off-Site Analysis Report

Ecology recommends that local governments require development projects that discharge stormwater off-site to submit an off-site analysis report that assesses the potential off-site water quality, erosion, slope stability, and drainage impacts associated with the project, and proposes appropriate mitigation for those impacts. The report should also assess the amount of off-site run-on from upstream off-site areas that may affect the site design.

The initial qualitative analysis shall extend along the flow path from the project site to the receiving water, for a distance up to one mile. If the receiving water is within one-quarter mile from the project site, the analysis shall extend within the receiving water to one-quarter mile from the project site. The analysis shall extend one-quarter mile beyond any improvements proposed as mitigation. The analysis must extend upstream from the project site to a point where there are no backwater effects created by the project, and the designer can determine all areas contributing run-on to the project.

The existing or potential impacts to be evaluated and mitigated should include:

- Conveyance system capacity problems;
- Localized flooding;
- Erosion, including landslide hazards and erosion along streambanks and at the outfall location;
- Violations of surface water quality standards as identified in a Basin Plan or a TMDL; or violations of ground water quality standards in a wellhead protection area.

Objective

The objective of the off-site analysis report is to identify, evaluate, and determine measures to prevent off-site water quality, erosion, slope stability, and drainage impacts that may be caused or aggravated by a proposed project. "Aggravated" shall mean increasing the frequency of occurrence and/or severity of a problem.

Supplemental Guidelines

Some of the most common and potentially destructive impacts of land development are erosion of downgradient properties, localized flooding, and slope failures. These are caused by increased surface water volumes and changed runoff patterns. Because these problems frequently do not have a related water quality impact, Ecology is not listing off-site analysis as a Minimum Requirement. However, taking the precautions of off-site analysis could prevent substantial property damage and public safety risks.

Projects should be required to initially submit, with the permit application, a qualitative off-site analysis report of each downstream system leaving a site. Upon review of the qualitative analysis, the local project reviewer may require that a quantitative analysis be performed. A quantitative off-site analysis report should contain the following:

1. **Define and map the study area**

   The off-site analysis report should include a map of the study area to show:

   - the study area's boundaries;
   - the study area's topography (at a minimum a USGS 1:24000 Quadrangle Topographic map);
   - the site's property lines;
   - the boundaries of proposed land disturbance;
   - the downstream flow path(s);
   - the tributary drainage areas to the downstream flow path(s); and
   - existing and/or potential problems.

2. **Review all available information on the study area**

   The designer should review, and the off-site analysis report should summarize all available basin plans, ground water management area plans, drainage studies, floodplain/floodway FEMA maps, wetlands inventory maps, Critical Areas maps, stream habitat reports, salmon distribution reports, etc. within the study area.

3. **Field inspect the study area**

   The designer should physically inspect the existing on- and off-site drainage systems within the study area for existing or potential problems and drainage features. An initial inspection and investigation should include:

   - Investigate problems reported or observed during the resource review;
   - Locate existing/potential constrictions or capacity deficiencies in the drainage system;
   - Identify existing/potential flooding problems;
   - Identify existing/potential overtopping, scouring, bank sloughing, or sedimentation;
   - Identify significant destruction of aquatic habitat (e.g., siltation, stream incision);
   - Collect qualitative data on features such as land use, impervious surface, topography, soils, presence of streams and/or wetlands;

- Collect information on pipe sizes, channel characteristics, drainage structures;
- Verify tributary drainage areas identified in the mapped study area;
- Contact the local government office with drainage review authority, neighboring property owners, and residents about drainage problems;
- Note date and weather at time of inspection.

The results of this inspection should be detailed in the off-site analysis report.

4. Describe the drainage system, and its existing and predicted problems

For each drainage system component (e.g., pipe, culvert, bridges, outfalls, ponds, vaults) the following should be covered in the off-site analysis report: location, physical description, problems, and field observations.

All existing or potential problems (e.g., ponding water, erosion) identified from the field inspection and information review should be described. The descriptions should be used to determine whether adequate mitigation can be identified, or whether a more detailed analysis is necessary. The following information should be provided for each existing or potential problem:

- Magnitude of or damage caused by the problem
- General frequency and duration
- Return frequency of storm or flow when the problem occurs
- Water elevation when the problem occurs
- Names and concerns of parties involved
- Current mitigation of the problem
- Possible cause of the problem
- Whether the project is likely to aggravate the problem or create a new one.

Upon review of the off-site analysis report, the local government may require mitigation measures deemed adequate for the problems depending upon the presence of existing or predicted flooding, erosion, or water quality problems, and on the proposed design of the Stormwater Management BMPs.

I-3.6 Adjustments and Exceptions/Variances to the MRs

I-3.6.1 Adjustments to the MRs

Adjustments to the Minimum Requirements may be granted prior to permit approval and construction. The jurisdiction may grant an adjustment provided that written findings of fact are prepared that address the following:

- The adjustment provides substantially equivalent environmental protection.
- Based on sound Engineering practices, the objectives of safety, function, environmental protection, and facility maintenance are met.

The text in this box originates from one or more of the following Permits:
Appendix 1 of the Phase I / Phase II Municipal Stormwater Permits
Construction Stormwater General Permit

I-3.6.2 Exceptions/Variances to the MRs

Exceptions/variances (exceptions) to the Minimum Requirements may be granted prior to permit approval and construction. The jurisdiction may grant an exception following legal public notice of an application for an exception or variance, legal public notice of the jurisdiction's decision on the application, and written findings of fact that document the jurisdiction's determination to grant an exception.

The jurisdiction may grant an exception to the Minimum Requirements if such application imposes a severe and unexpected economic hardship. To determine whether the application imposes a severe and unexpected economic hardship on the project applicant, the jurisdiction must consider and document, with written findings of fact, the following:

- The current (pre-project) use of the Site, and
- How the application of the Minimum Requirement(s) restricts the proposed use of the Site compared to the restrictions that existed prior to the adoption of the Minimum Requirements; and
- The possible remaining uses of the Site if the exception were not granted; and
- The uses of the Site that would have been allowed prior to the adoption of the Minimum Requirements; and
- A comparison of the estimated amount and percentage of value loss as a result of the Minimum Requirements versus the estimated amount and percentage of value loss as a result of requirements that existed prior to adoption of the Minimum Requirements; and
- The feasibility for the owner to alter the project to apply the Minimum Requirements.

In addition, any exception must meet the following criteria:

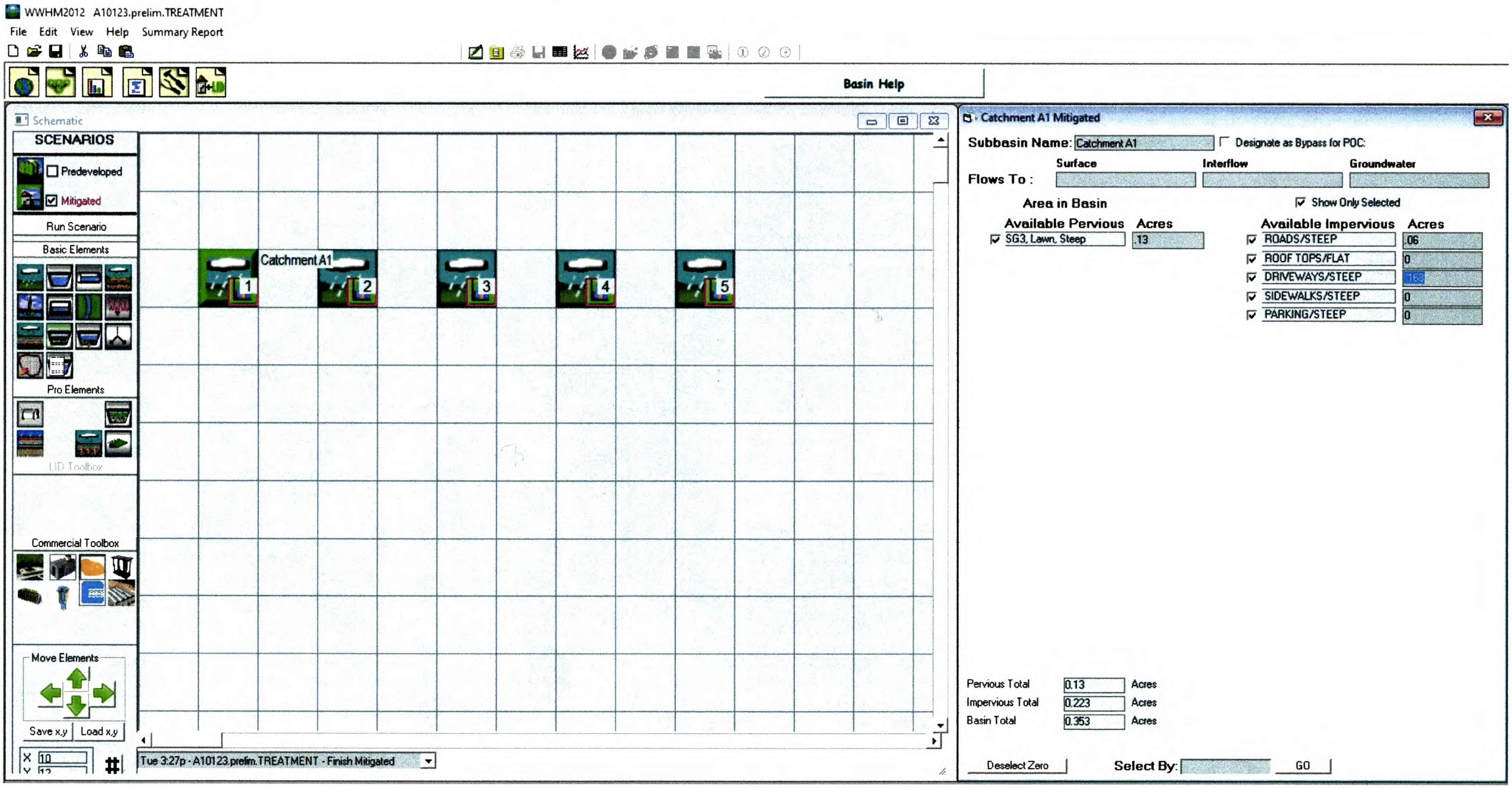
- The exception will not increase risk to the public health and welfare, nor be injurious to other properties in the vicinity and/or downstream, and to the quality of waters of the state; and

- The exception is the least possible exception that could be granted to comply with the intent of the Minimum Requirements.

The text in this box originates from one or more of the following Permits:
Appendix 1 of the Phase I / Phase II Municipal Stormwater Permits
Construction Stormwater General Permit

Supplemental Guidelines

The adjustment (see I-3.6.1 Adjustments to the MRs) and exception provisions are an important element of the plan review and enforcement programs. They are intended to maintain a necessary flexible working relationship between local officials and applicants. Plan Approval Authorities should consider these requests judiciously, keeping in mind both the need of the applicant to maximize cost-effectiveness and the need to protect off-site properties and resources from damage.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Basin Help
Schematic
SCENARIOS
Predeveloped
Mitigated
Run Scenario
Basic Elements
Pro Elements
LID Toolbox
Commercial Toolbox
Move Elements
Save x,y
Load x,y
X 10
Catchment A1
1
2
3
4
5
Tue 3:27p - A10123.prelim.TREATMENT - Finish Mitigated
Catchment A1 Mitigated
Subbasin Name: Catchment A1
Designate as Bypass for POC:
Surface
Interflow
Groundwater
Flows To :
Area in Basin
Show Only Selected
Available Pervious
Acres
SG3, Lawn, Steep
.13
Available Impervious
Acres
ROADS/STEEP
.06
ROOF TOPS/FLAT
0
DRIVEWAYS/STEEP
SIDEWALKS/STEEP
0
PARKING/STEEP
0
Pervious Total 0.13 Acres
Impervious Total 0.223 Acres
Basin Total 0.353 Acres
Deselect Zero
Select By:
GO

Analysis

Run Analysis

Water Quality

On-Line BMP	
24 hour Volume (ac-ft)	0.0375
Standard Flow Rate (cfs)	0.0548

Off-Line BMP	
Standard Flow Rate (cfs)	0.0304

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

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

Analyze datasets Compact WDM Delete Selected Monthly FF

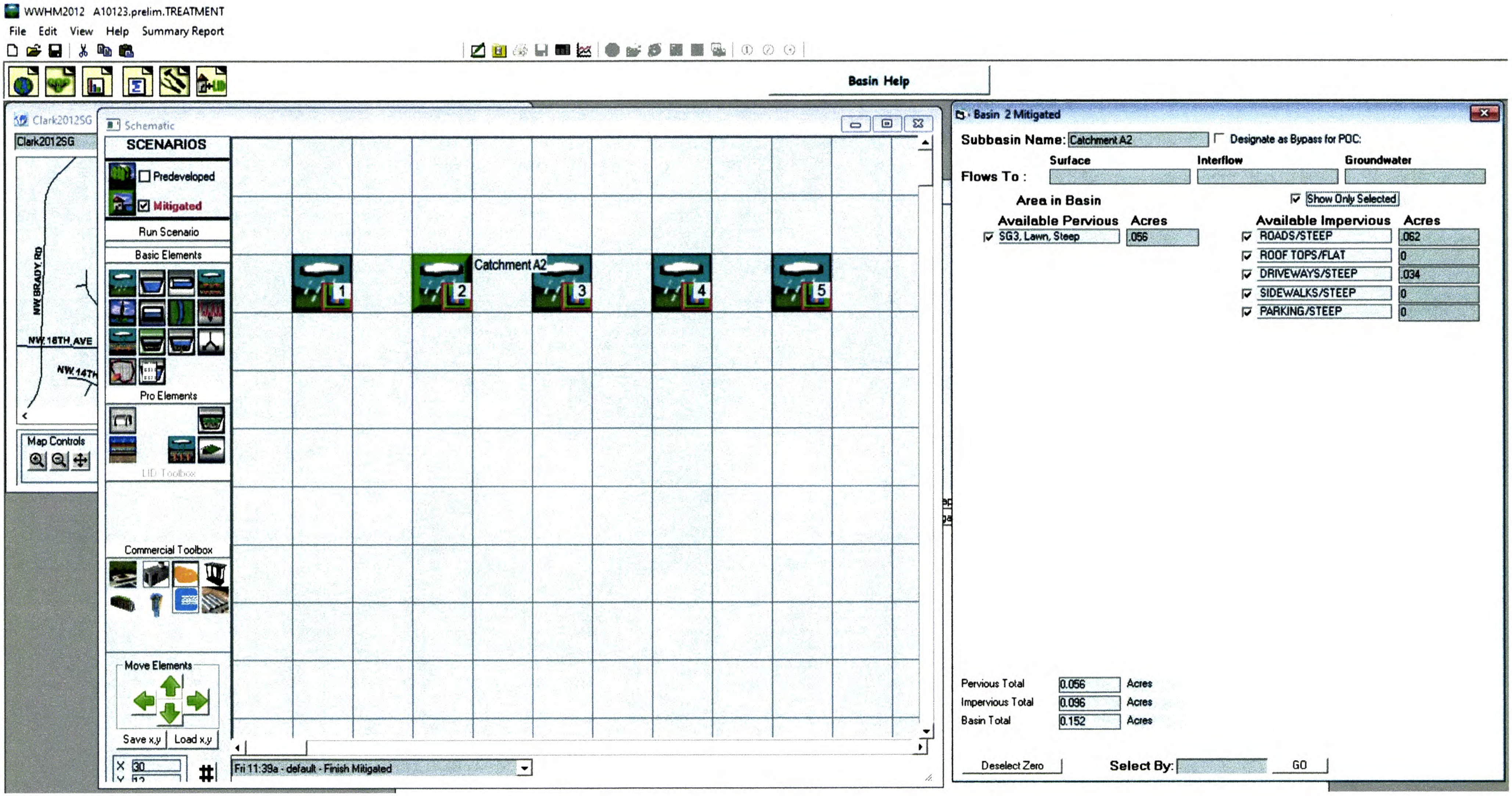
801 POC 1 Mitigated flow

POC 1 | POC 2 | POC 3 | POC 4 | POC 5

All Datasets | Flow | Stage | Precip | Evap

Flood Frequency Method

- (•) Log Pearson Type III 17B
- ( ) Weibull
- ( ) Cunnane
- ( ) Gringorten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Basin Help
Clark2012SG
Schematic
SCENARIOS
Predeveloped
Mitigated
Run Scenario
Basic Elements
Pro Elements
LID Toolbox
Commercial Toolbox
Move Elements
Save x,y
Load x,y
X 30
NW BRADY RD
NW 16TH AVE
NW 14TH
Map Controls
Catchment A2
1
2
3
4
5
Fri 11:39a - default - Finish Mitigated
Basin 2 Mitigated
Subbasin Name: Catchment A2
Designate as Bypass for POC:
Surface
Interflow
Groundwater
Flows To :
Area in Basin
Show Only Selected
Available Pervious
Acres
SG3, Lawn, Steep
.056
Available Impervious
Acres
ROADS/STEEP
.062
ROOF TOPS/FLAT
0
DRIVEWAYS/STEEP
.034
SIDEWALKS/STEEP
0
PARKING/STEEP
0
Pervious Total 0.056 Acres
Impervious Total 0.096 Acres
Basin Total 0.152 Acres
Deselect Zero
Select By:
GO

Analysis

Water Quality

Run Analysis

On-Line BMP	
24 hour Volume (ac-ft)	0.0161
Standard Flow Rate (cfs)	0.0236

Off-Line BMP	
Standard Flow Rate (cfs)	0.0130

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

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

Analyze datasets Compact WDM Delete Selected

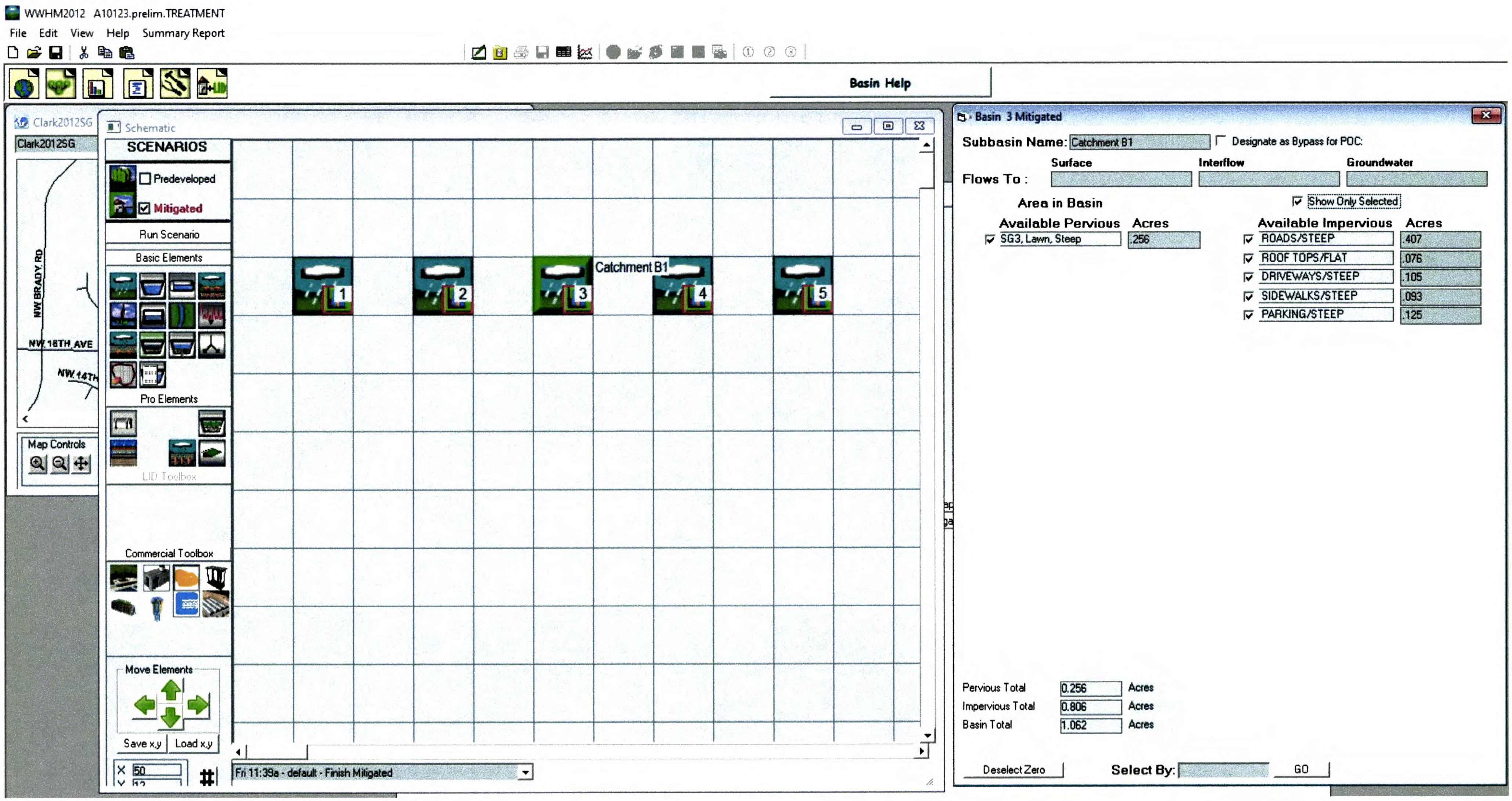
Monthly FF

1 NORTH WILLAMETTE EVAPORATION, STA NO. 6151
2 Lacamas
701 Inflow to POC 1 Mitigated
801 POC 1 Mitigated flow
802 POC 2 Mitigated flow
803 POC 3 Mitigated flow
804 POC 4 Mitigated flow
805 POC 5 Mitigated flow

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

Flood Frequency Method

- Log Pearson Type III 17B
- Weibull
- Cunnane
- Gringorten



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Basin Help
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Basic Elements
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Move Elements
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NW BRADY RD
NW 18TH AVE
NW 14TH
Map Controls
Catchment B1
1
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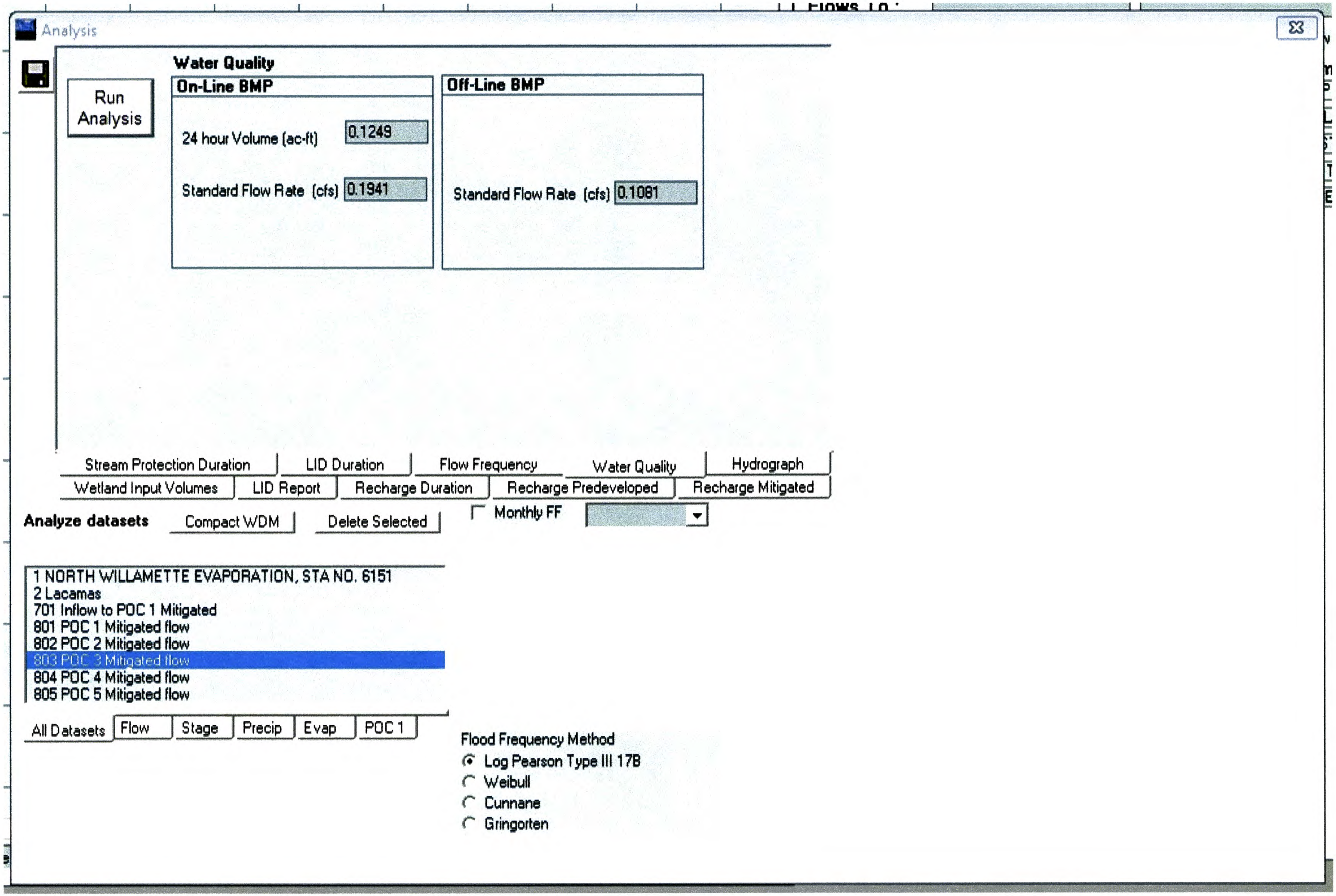
Fri 11:39a - default - Finish Mitigated
Basin 3 Mitigated
Subbasin Name: Catchment B1
Designate as Bypass for POC:
Surface
Interflow
Groundwater
Flows To :
Area in Basin
Show Only Selected
Available Pervious Acres
SG3, Lawn, Steep .256
Available Impervious Acres
ROADS/STEEP .407
ROOF TOPS/FLAT .076
DRIVEWAYS/STEEP .105
SIDEWALKS/STEEP .093
PARKING/STEEP .125
Pervious Total 0.256 Acres
Impervious Total 0.806 Acres
Basin Total 1.062 Acres
Deselect Zero
Select By:
GO


Analysis
Water Quality
Run Analysis
On-Line BMP
24 hour Volume (ac-ft) 0.1249
Standard Flow Rate (cfs) 0.1941
Off-Line BMP
Standard Flow Rate (cfs) 0.1081
Stream Protection Duration
LID Duration
Flow Frequency
Water Quality
Hydrograph
Wetland Input Volumes
LID Report
Recharge Duration
Recharge Predeveloped
Recharge Mitigated
Analyze datasets
Compact WDM
Delete Selected
Monthly FF
1 NORTH WILLAMETTE EVAPORATION, STA NO. 6151
2 Lacamas
701 Inflow to POC 1 Mitigated
801 POC 1 Mitigated flow
802 POC 2 Mitigated flow
803 POC 3 Mitigated flow
804 POC 4 Mitigated flow
805 POC 5 Mitigated flow
All Datasets
Flow
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Precip
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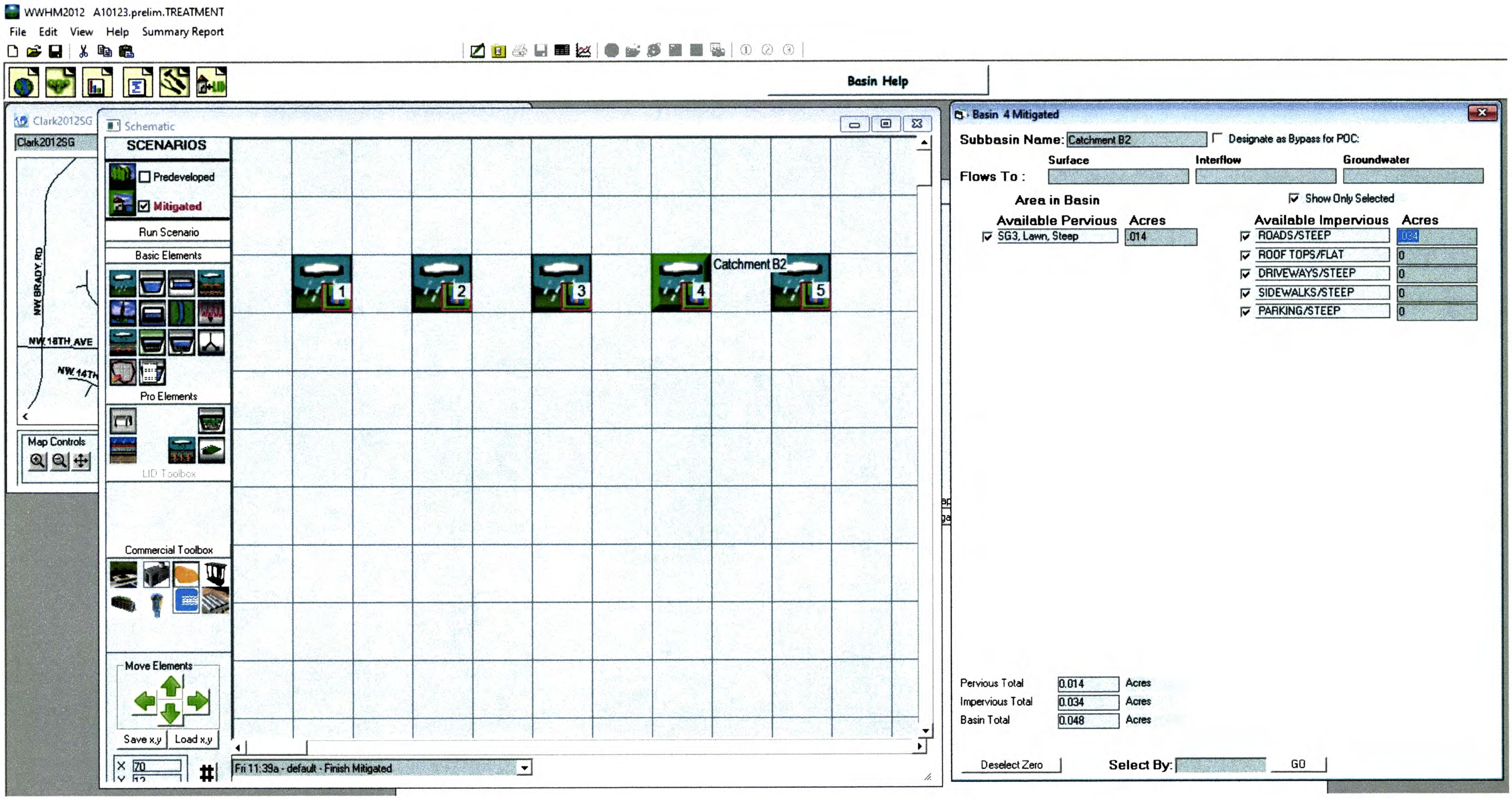
POC 1
Flood Frequency Method
Log Pearson Type III 17B
Weibull
Cunnane
Gringorten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Catchment B2
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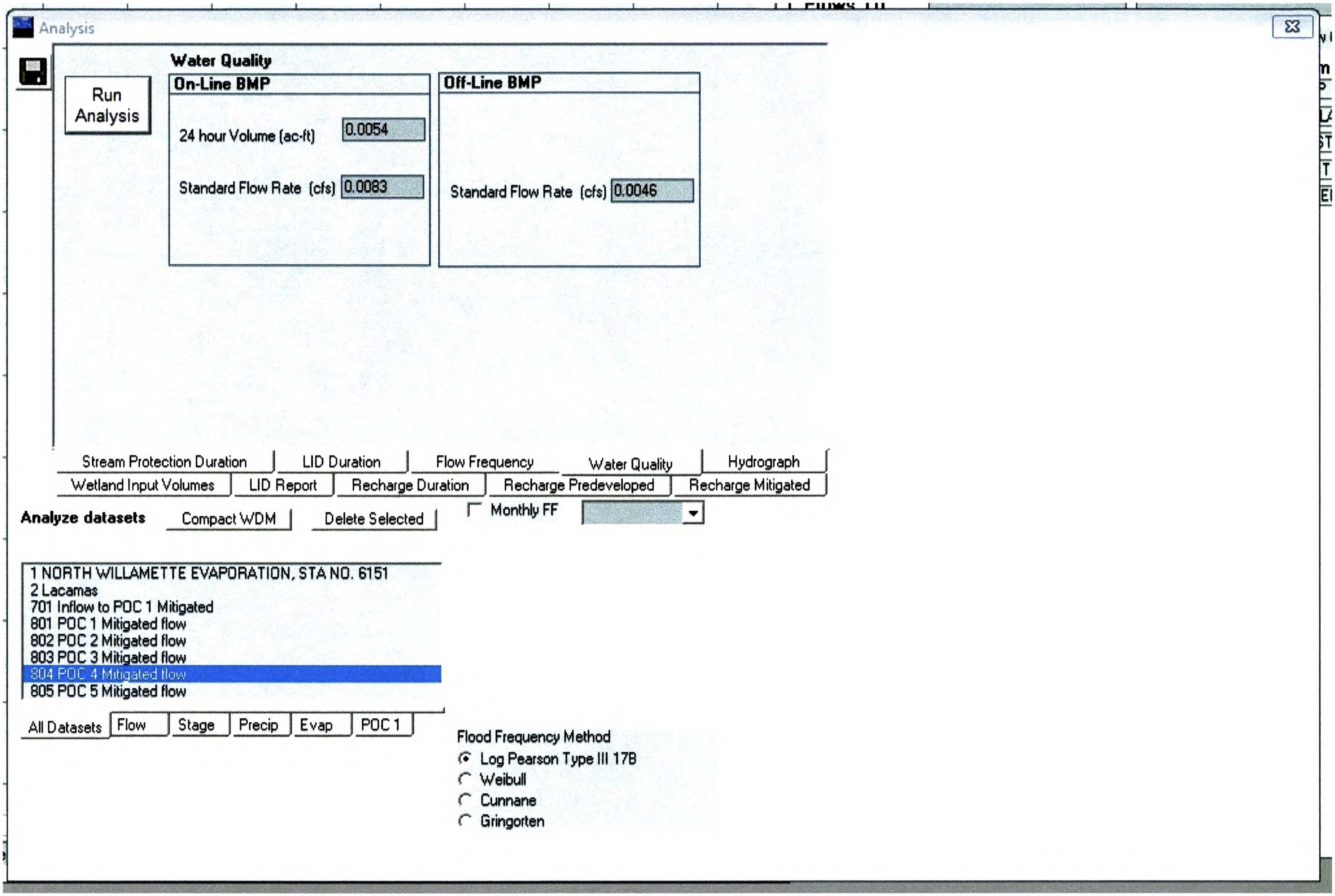
Fri 11:39a - default - Finish Mitigated
Basin 4 Mitigated
Subbasin Name: Catchment B2
Designate as Bypass for POC:
Surface
Interflow
Groundwater
Flows To :
Area in Basin
Show Only Selected
Available Pervious
Acres
SG3, Lawn, Steep
.014
Available Impervious
Acres
ROADS/STEEP
.034
ROOF TOPS/FLAT
0
DRIVEWAYS/STEEP
0
SIDEWALKS/STEEP
0
PARKING/STEEP
0
Pervious Total 0.014 Acres
Impervious Total 0.034 Acres
Basin Total 0.048 Acres
Deselect Zero
Select By:
GO


Analysis
Water Quality
Run Analysis
On-Line BMP
24 hour Volume (ac-ft) 0.0054
Standard Flow Rate (cfs) 0.0083
Off-Line BMP
Standard Flow Rate (cfs) 0.0046
Stream Protection Duration
LID Duration
Flow Frequency
Water Quality
Hydrograph
Wetland Input Volumes
LID Report
Recharge Duration
Recharge Predeveloped
Recharge Mitigated
Analyze datasets
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Delete Selected
Monthly FF
1 NORTH WILLAMETTE EVAPORATION, STA NO. 6151
2 Lacamas
701 Inflow to POC 1 Mitigated
801 POC 1 Mitigated flow
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804 POC 4 Mitigated flow
805 POC 5 Mitigated flow
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Flood Frequency Method
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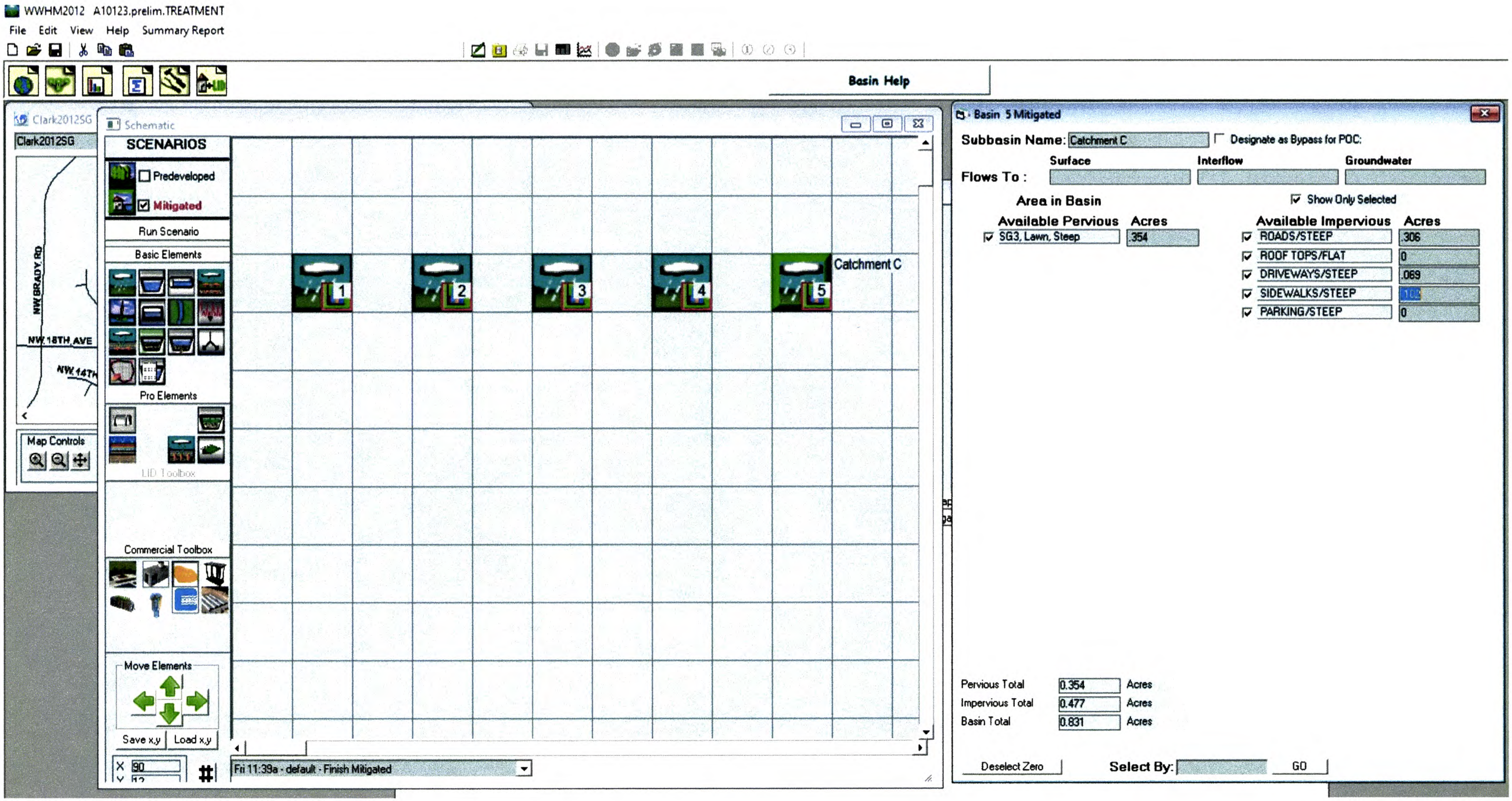
Cunnane
Gringorten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Pro Elements
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Commercial Toolbox
Move Elements
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Map Controls
NW BRADY RD
NW 18TH AVE
Catchment C
1
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3
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5
Fri 11:39a - default - Finish Mitigated
Basin 5 Mitigated
Subbasin Name: Catchment C
Designate as Bypass for POC:
Surface
Interflow
Groundwater
Flows To :
Area in Basin
Show Only Selected
Available Pervious Acres
SG3, Lawn, Steep .354
Available Impervious Acres
ROADS/STEEP .306
ROOF TOPS/FLAT 0
DRIVEWAYS/STEEP .069
SIDEWALKS/STEEP
PARKING/STEEP 0
Pervious Total 0.354 Acres
Impervious Total 0.477 Acres
Basin Total 0.831 Acres
Deselect Zero
Select By:
GO

Flows To :

Analysis

Water Quality

Run Analysis

On-Line BMP

24 hour Volume (ac-ft) 0.0833

Standard Flow Rate (cfs) 0.1174

Off-Line BMP

Standard Flow Rate (cfs) 0.0649

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

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

Analyze datasets Compact WDM Delete Selected

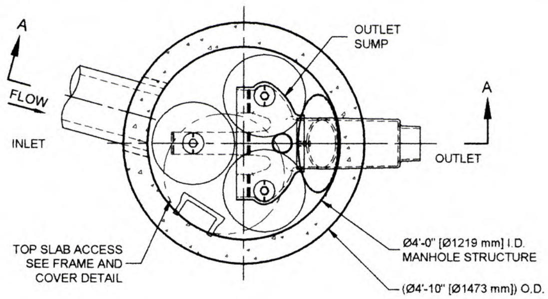
Monthly FF

1 NORTH WILLAMETTE EVAPORATION, STA NO. 6151
2 Lacamas
701 Inflow to POC 1 Mitigated
801 POC 1 Mitigated flow
802 POC 2 Mitigated flow
803 POC 3 Mitigated flow
804 POC 4 Mitigated flow
805 POC 5 Mitigated flow

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

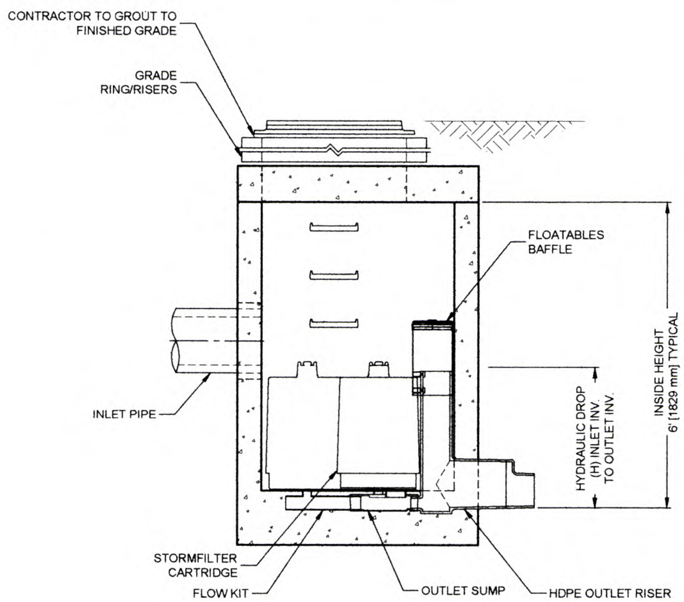
Flood Frequency Method

- Log Pearson Type III 17B
- Weibull
- Cunnane
- Gringorten



PLAN VIEW

STANDARD OUTLET RISER
FLOWKIT: 40A



SECTION A-A

The Stormwater Management StormFilter®

THIS PRODUCT MAY BE PROTECTED BY ONE OR MORE OF THE FOLLOWING U.S. PATENTS: 5,322,629; 5,524,576; 5,707,527; 5,985,157; 6,027,639; 6,649,048; RELATED FOREIGN PATENTS, OR OTHER PATENTS PENDING

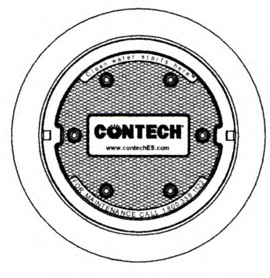
STORMFILTER DESIGN NOTES

STORMFILTER TREATMENT CAPACITY IS A FUNCTION OF THE CARTRIDGE SELECTION AND THE NUMBER OF CARTRIDGES. THE STANDARD MANHOLE STYLE IS SHOWN WITH THE MAXIMUM NUMBER OF CARTRIDGES (3). VOLUME SYSTEM IS ALSO AVAILABLE WITH MAXIMUM 3 CARTRIDGES.
Ø4 [1219 mm] MANHOLE STORMFILTER PEAK HYDRAULIC CAPACITY IS 1.0 CFS [28.3 L/s] . IF THE SITE CONDITIONS EXCEED 1.0 CFS [28.3 L/s] AN UPSTREAM BYPASS STRUCTURE IS REQUIRED.

CARTRIDGE SELECTION

CARTRIDGE HEIGHT	27" [686 mm]			18" [458 mm]			LOW DROP		
RECOMMENDED HYDRAULIC DROP (H)	3.05' [930 mm]			2.3' [700 mm]			1.8' [550 mm]		
SPECIFIC FLOW RATE (gpm/sf) [L/s/m^2]	2 [1.30]	1.67* [1.08]	1 [0.65]	2 [1.30]	1.67* [1.08]	1 [0.65]	2 [1.30]	1.67* [1.08]	1 [0.65]
CARTRIDGE FLOW RATE (gpm) [L/s]	22.5 [1.42]	18.79 [1.19]	11.25 [0.71]	15 [0.95]	12.53 [0.79]	7.5 [0.44]	10 [0.63]	8.35 [0.54]	5 [0.32]

* 1.67 gpm/sf [1.08 L/s/m^2] SPECIFIC FLOW RATE IS APPROVED WITH PHOSPHOSORB® (PSORB) MEDIA ONLY



FRAME AND COVER

(DIAMETER VARIES)
N.T.S.

SITE SPECIFIC DATA REQUIREMENTS

STRUCTURE ID	*
WATER QUALITY FLOW RATE (cfs) [L/s]	*
PEAK FLOW RATE (cfs) [L/s]	*
RETURN PERIOD OF PEAK FLOW (yrs)	*
CARTRIDGE HEIGHT (SEE TABLE ABOVE)	*
NUMBER OF CARTRIDGES REQUIRED	*
CARTRIDGE FLOW RATE	*
MEDIA TYPE (PERLITE, ZPG, PSORB)	*

PIPE DATA:	I.E.	MATERIAL	DIAMETER
INLET PIPE #1	*	*	*
INLET PIPE #2	*	*	*
OUTLET PIPE	*	*	*

RIM ELEVATION	*

ANTI-FLOTATION BALLAST	WIDTH	HEIGHT
	*	*

NOTES/SPECIAL REQUIREMENTS:

* PER ENGINEER OF RECORD

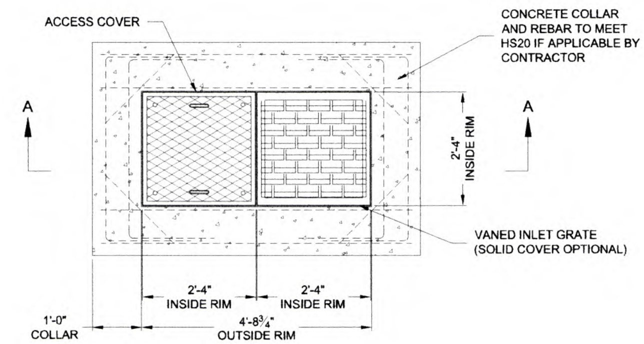
GENERAL NOTES
1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. DIMENSIONS MARKED WITH ( ) ARE REFERENCE DIMENSIONS. ACTUAL DIMENSIONS MAY VARY.
3. FOR SITE SPECIFIC DRAWINGS WITH DETAILED VAULT DIMENSIONS AND WEIGHTS, PLEASE CONTACT YOUR CONTECH ENGINEERED SOLUTIONS LLC REPRESENTATIVE. www.ContechES.com
4. STORMFILTER WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING.
5. STRUCTURE SHALL MEET AASHTO HS-20 LOAD RATING, ASSUMING EARTH COVER OF 0' - 5' [1524 mm] AND GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION. CASTINGS SHALL MEET AASHTO M306 AND BE CAST WITH THE CONTECH LOGO.
6. FILTER CARTRIDGES SHALL BE MEDIA-FILLED, PASSIVE, SIPHON ACTUATED, RADIAL FLOW, AND SELF CLEANING. RADIAL MEDIA DEPTH SHALL BE 7-INCHES [178 mm]. FILTER MEDIA CONTACT TIME SHALL BE AT LEAST 38 SECONDS.
7. SPECIFIC FLOW RATE IS EQUAL TO THE FILTER TREATMENT CAPACITY (gpm) [L/s] DIVIDED BY THE FILTER CONTACT SURFACE AREA (sq ft)[m^2].
8. STORMFILTER STRUCTURE SHALL BE PRECAST CONCRETE CONFORMING TO ASTM C-478 AND AASHTO LOAD FACTOR DESIGN METHOD.

INSTALLATION NOTES
A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE STORMFILTER STRUCTURE.
C. CONTRACTOR TO INSTALL JOINT SEALANT BETWEEN ALL STRUCTURE SECTIONS AND ASSEMBLE STRUCTURE.
D. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT INLET PIPE(S).
E. CONTRACTOR TO PROVIDE AND INSTALL CONNECTOR TO THE OUTLET RISER STUB. STORMFILTER EQUIPPED WITH A DUAL DIAMETER HDPE OUTLET STUB AND SAND COLLAR. IF OUTLET PIPE IS LARGER THAN 8 INCHES [200 mm], CONTRACTOR TO REMOVE THE 8 INCH [200 mm] OUTLET STUB AT MOLDED-IN CUT LINE. COUPLING BY FERNCO OR EQUAL AND PROVIDED BY CONTRACTOR.
F. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO PROTECT CARTRIDGES FROM CONSTRUCTION-RELATED EROSION RUNOFF.

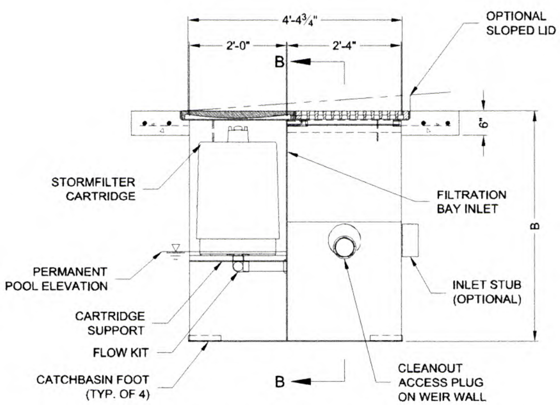
CONTECH® ENGINEERED SOLUTIONS LLC
www.contechES.com
9025 Centre Pointe Dr., Suite 400, West Chester, OH 45069
800-338-1122 513-645-7000 513-645-7993 FAX

SFMH48
STORMFILTER
STANDARD DETAIL

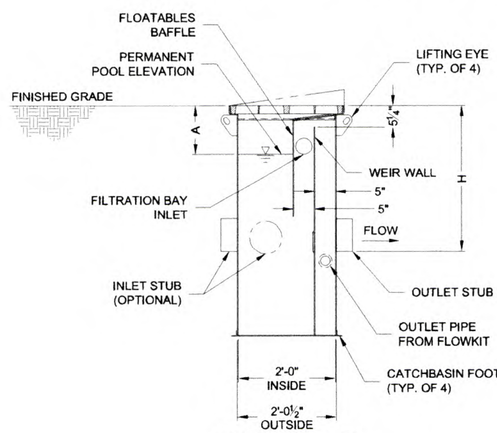
I:\STORMWATER\COMMOPS\10 STORMFILTER\40 STANDARD DRAWINGS\MANHOLE\SFMH48-DTL.DWG 4/5/2019 10:54 AM



PLAN VIEW



SECTION A-A



SECTION B-B

STORMFILTER STEEL CATCHBASIN DESIGN NOTES

STORMFILTER TREATMENT CAPACITY IS A FUNCTION OF THE CARTRIDGE SELECTION AND THE NUMBER OF CARTRIDGES. 1 CARTRIDGE CATCHBASIN HAS A MAXIMUM OF ONE CARTRIDGE. SYSTEM IS SHOWN WITH A 27" CARTRIDGE, AND IS ALSO AVAILABLE WITH AN 18" CARTRIDGE. STORMFILTER CATCHBASIN CONFIGURATIONS ARE AVAILABLE WITH A DRY INLET BAY FOR VECTOR CONTROL.
PEAK HYDRAULIC CAPACITY PER TABLE BELOW. IF THE SITE CONDITIONS EXCEED PEAK HYDRAULIC CAPACITY, AN UPSTREAM BYPASS STRUCTURE IS REQUIRED.

CARTRIDGE SELECTION

CARTRIDGE HEIGHT	27"			18"			18" DEEP		
RECOMMENDED HYDRAULIC DROP (H)	3.05'			2.3'			3.3'		
SPECIFIC FLOW RATE (gpm/sf)	2 gpm/sf	1.67* gpm/sf	1 gpm/sf	2 gpm/sf	1.67* gpm/sf	1 gpm/sf	2 gpm/sf	1.67* gpm/sf	1 gpm/sf
CARTRIDGE FLOW RATE (gpm)	22.5	18.79	11.25	15	12.53	7.5	15	12.53	7.5
PEAK HYDRAULIC CAPACITY	1.0			1.0			1.8		
INLET PERMANENT POOL LEVEL (A)	1'-0"			1'-0"			2'-0"		
OVERALL STRUCTURE HEIGHT (B)	4'-9"			3'-9"			4'-9"		

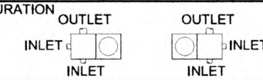
* 1.67 gpm/sf SPECIFIC FLOW RATE IS APPROVED WITH PHOSPHOSORB® (PSORB) MEDIA ONLY

GENERAL NOTES
1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. FOR SITE SPECIFIC DRAWINGS WITH DETAILED STORMFILTER CATCHBASIN STRUCTURE DIMENSIONS AND WEIGHTS, PLEASE CONTACT YOUR CONTECH ENGINEERED SOLUTIONS LLC REPRESENTATIVE. www.contechES.com
3. STORMFILTER CATCHBASIN WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING.
4. INLET SHOULD NOT BE LOWER THAN OUTLET. INLET (IF APPLICABLE) AND OUTLET PIPING TO BE SPECIFIED BY ENGINEER AND PROVIDED BY CONTRACTOR.
5. MANUFACTURER TO APPLY A SURFACE BEAD WELD IN THE SHAPE OF THE LETTER "O" ABOVE THE OUTLET PIPE STUB ON THE EXTERIOR SURFACE OF THE STEEL SFCB.
6. STORMFILTER CATCHBASIN EQUIPPED WITH 4 INCH (APPROXIMATE) LONG STUBS FOR INLET (IF APPLICABLE) AND OUTLET PIPING. STANDARD OUTLET STUB IS 8 INCHES IN DIAMETER. MAXIMUM OUTLET STUB IS 15 INCHES IN DIAMETER. CONNECTION TO COLLECTION PIPING CAN BE MADE USING FLEXIBLE COUPLING BY CONTRACTOR.
7. STEEL STRUCTURE TO BE MANUFACTURED OF 1/4 INCH STEEL PLATE. CASTINGS SHALL MEET AASHTO M306 LOAD RATING. TO MEET HS20 LOAD RATING ON STRUCTURE, A CONCRETE COLLAR IS REQUIRED. WHEN REQUIRED, CONCRETE COLLAR WITH #4 REINFORCING BARS TO BE PROVIDED BY CONTRACTOR.
8. FILTER CARTRIDGES SHALL BE MEDIA-FILLED, PASSIVE, SIPHON ACTUATED, RADIAL FLOW, AND SELF CLEANING. RADIAL MEDIA DEPTH SHALL BE 7-INCHES. FILTER MEDIA CONTACT TIME SHALL BE AT LEAST 38 SECONDS.
9. SPECIFIC FLOW RATE IS EQUAL TO THE FILTER TREATMENT CAPACITY (gpm) DIVIDED BY THE FILTER CONTACT SURFACE AREA (sq ft).

INSTALLATION NOTES
A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE CATCHBASIN (LIFTING CLUTCHES PROVIDED).
C. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO PROTECT CARTRIDGES FROM CONSTRUCTION-RELATED EROSION RUNOFF.

1-CARTRIDGE CATCHBASIN STORMFILTER DATA

STRUCTURE ID		XXX
WATER QUALITY FLOW RATE (cfs)		X.XX
PEAK FLOW RATE (<1 cfs)		X.XX
RETURN PERIOD OF PEAK FLOW (yrs)		XXX
CARTRIDGE HEIGHT (27", 18", 18" DEEP)		XX
CARTRIDGE FLOW RATE (gpm)		XX
MEDIA TYPE (PERLITE, ZPG, PSORB)		XXXXX
RIM ELEVATION		XXX.XX'
PIPE DATA:	I.E.	DIAMETER
INLET STUB	XXX.XX'	XX"
OUTLET STUB	XXX.XX'	XX"
CONFIGURATION		
SLOPED LID		YES\NO
SOLID COVER		YES\NO
NOTES/SPECIAL REQUIREMENTS:		



The Stormwater Management StormFilter®

CONTECH® ENGINEERED SOLUTIONS LLC
www.contechES.com
9025 Centre Pointe Dr., Suite 400, West Chester, OH 45069
800-526-3999 513-645-7000 513-645-7993 FAX

1 CARTRIDGE CATCHBASIN STORMFILTER STANDARD DETAIL

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WWHM2012

PROJECT REPORT

General Model Information

Project Name:	A10123.prelim.DETENTION.SITE(new)
Site Name:	
Site Address:	
City:	
Report Date:	2/14/2022
Gage:	Lacamas
Data Start:	1948/10/01
Data End:	2008/09/30
Timestep:	15 Minute
Precip Scale:	1.300
Version Date:	2021/08/18
Version:	4.2.18

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
Low Flow Threshold for POC3:	50 Percent of the 2 Year
High Flow Threshold for POC3:	50 Year

Landuse Basin Data
Predeveloped Land Use

Offsite

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
SG3, Lawn, Steep	0.849
Pervious Total	0.849
Impervious Land Use	acre
ROADS STEEP	0.06
ROOF TOPS FLAT	0.151
DRIVEWAYS STEEP	0.163
Impervious Total	0.374
Basin Total	1.223

Element Flows To:

Surface	Interflow	Groundwater

Basin A

Bypass:	No	
GroundWater:	No	
Pervious Land Use	acre	
SG4, Forest, Steep	0.93	
Pervious Total	0.93	
Impervious Land Use	acre	
Impervious Total	0	
Basin Total	0.93	

Element Flows To:

Surface	Interflow	Groundwater

Basin B

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
SG4, Forest, Steep	2.595
Pervious Total	2.595
Impervious Land Use	acre
Impervious Total	0
Basin Total	2.595

Element Flows To:

Surface	Interflow	Groundwater

Basin C+D

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
SG4, Forest, Steep	2.916
Pervious Total	2.916
Impervious Land Use	acre
Impervious Total	0
Basin Total	2.916

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Offsite

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
SG3, Lawn, Steep	0.849
Pervious Total	0.849
Impervious Land Use	acre
ROADS STEEP	0.06
ROOF TOPS FLAT	0.151
DRIVEWAYS STEEP	0.163
Impervious Total	0.374
Basin Total	1.223

Element Flows To:

Surface	Interflow	Groundwater
Tank A	Tank A	

Basin A

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
SG3, Lawn, Steep	0.494
Pervious Total	0.494
Impervious Land Use	acre
ROADS STEEP	0.122
ROOF TOPS FLAT	0.106
DRIVEWAYS STEEP	0.197
SIDEWALKS STEEP	0.008
Impervious Total	0.433
Basin Total	0.927

Element Flows To:

Surface	Interflow	Groundwater
Tank A	Tank A	

Basin B

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
SG3, Lawn, Steep	1.32
Pervious Total	1.32
Impervious Land Use	acre
ROADS STEEP	0.434
ROOF TOPS FLAT	0.514
DRIVEWAYS STEEP	0.23
SIDEWALKS STEEP	0.097
Impervious Total	1.275
Basin Total	2.595

Element Flows To:

Surface	Interflow	Groundwater
Tank B	Tank B	

Basin C

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
SG3, Lawn, Steep	1.501
Pervious Total	1.501
Impervious Land Use	acre
ROADS STEEP	0.33
ROOF TOPS FLAT	0.317
DRIVEWAYS STEEP	0.092
SIDEWALKS STEEP	0.113
Impervious Total	0.852
Basin Total	2.353

Element Flows To:

Surface	Interflow	Groundwater
Tank C	Tank C	

Basin D

Bypass:	No	
GroundWater:	No	
Pervious Land Use	acre	
SG3, Lawn, Steep	0.34	
Pervious Total	0.34	
Impervious Land Use	acre	
ROOF TOPS FLAT	0.158	
SIDEWALKS STEEP	0.012	
Impervious Total	0.17	
Basin Total	0.51	

Element Flows To:

Surface	Interflow	Groundwater
Tank C	Tank C	

Lot 9 Roof

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
Pervious Total	0
Impervious Land Use	acre
ROOF TOPS FLAT	0.053
Impervious Total	0.053
Basin Total	0.053

Element Flows To:

Surface	Interflow	Groundwater
Tank C	Tank C	

Routing Elements
Predeveloped Routing

Mitigated Routing

TRACT H

Tank A

Dimensions
Depth: 4 ft.
Tank Type: Circular
Diameter: 4 ft.
Length: 48.6351098072829 ft.
Discharge Structure
Riser Height: 3 ft.
Riser Diameter: 18 in.
Notch Type: Rectangular
Notch Width: 0.150 ft.
Notch Height: 1.318 ft.
Orifice 1 Diameter: 2.863 in. Elevation:0 ft.
Element Flows To:
Outlet 1 Outlet 2

Tank Hydraulic Table

Stage(feet)	**Area(ac.)**	**Volume(ac-ft.)**	**Discharge(cfs)**	**Infilt(cfs)**
0.0000	0.000000	0.000000	0.000	0.000
0.0444	0.000936	0.000028	0.046	0.000
0.0889	0.001317	0.000078	0.066	0.000
0.1333	0.001603	0.000143	0.081	0.000
0.1778	0.001841	0.000220	0.093	0.000
0.2222	0.002046	0.000307	0.104	0.000
0.2667	0.002228	0.000402	0.114	0.000
0.3111	0.002392	0.000504	0.124	0.000
0.3556	0.002542	0.000614	0.132	0.000
0.4000	0.002680	0.000730	0.140	0.000
0.4444	0.002807	0.000852	0.148	0.000
0.4889	0.002926	0.000980	0.155	0.000
0.5333	0.003036	0.001112	0.162	0.000
0.5778	0.003140	0.001249	0.169	0.000
0.6222	0.003237	0.001391	0.175	0.000
0.6667	0.003329	0.001537	0.181	0.000
0.7111	0.003415	0.001687	0.187	0.000
0.7556	0.003496	0.001841	0.193	0.000
0.8000	0.003573	0.001998	0.199	0.000
0.8444	0.003645	0.002158	0.204	0.000
0.8889	0.003713	0.002322	0.209	0.000
0.9333	0.003778	0.002488	0.214	0.000
0.9778	0.003839	0.002657	0.219	0.000
1.0222	0.003896	0.002829	0.224	0.000
1.0667	0.003950	0.003004	0.229	0.000
1.1111	0.004001	0.003180	0.234	0.000
1.1556	0.004048	0.003359	0.239	0.000
1.2000	0.004093	0.003540	0.243	0.000
1.2444	0.004135	0.003723	0.248	0.000
1.2889	0.004174	0.003908	0.252	0.000
1.3333	0.004211	0.004094	0.256	0.000
1.3778	0.004244	0.004282	0.261	0.000
1.4222	0.004276	0.004471	0.265	0.000
1.4667	0.004304	0.004662	0.269	0.000
1.5111	0.004331	0.004854	0.273	0.000

1.5556		0.004354	0.005047		0.277		0.000	
1.6000		0.004376	0.005241		0.281		0.000	
1.6444		0.004395	0.005436		0.285		0.000	
1.6889		0.004412	0.005631		0.289		0.000	
1.7333		0.004426	0.005828		0.298		0.000	
1.7778		0.004438	0.006025		0.311		0.000	
1.8222		0.004448	0.006222		0.325		0.000	
1.8667		0.004456	0.006420		0.342		0.000	
1.9111		0.004462	0.006618		0.359		0.000	
1.9556		0.004465	0.006817		0.378		0.000	
2.0000		0.004466	0.007015		0.398		0.000	
2.0444		0.004465	0.007214		0.419		0.000	
2.0889		0.004462	0.007412		0.440		0.000	
2.1333		0.004456	0.007610		0.462		0.000	
2.1778		0.004448	0.007808		0.485		0.000	
2.2222		0.004438	0.008006		0.508		0.000	
2.2667	2.282	0.004426	0.008203	.00827	0.532	0.54	0.000	2 YEAR
2.3111		0.004412	0.008399		0.556		0.000	
2.3556		0.004395	0.008595		0.580		0.000	
2.4000		0.004376	0.008790		0.605		0.000	
2.4444		0.004354	0.008984		0.629		0.000	
2.4889		0.004331	0.009177		0.654		0.000	
2.5333		0.004304	0.009369		0.679		0.000	
2.5778		0.004276	0.009559		0.705		0.000	
2.6222		0.004244	0.009749		0.730		0.000	
2.6667		0.004211	0.009936		0.755		0.000	
2.7111		0.004174	0.010123		0.783		0.000	
2.7556		0.004135	0.010307		0.814		0.000	
2.8000		0.004093	0.010490		0.844		0.000	
2.8444		0.004048	0.010671		0.876		0.000	
2.8889	2.906	0.004001	0.010850	.0109	0.908	0.92	0.000	10
2.9333		0.003950	0.011027		0.940		0.000	
2.9778		0.003896	0.011201		0.973		0.000	
3.0222		0.003839	0.011373		1.044		0.000	
3.0667	3.068	0.003778	0.011542	.0115	1.268	1.28	0.000	50
3.1111	3.092	0.003713	0.011709	.0116	1.585	1.45	0.000	100
3.1556		0.003645	0.011872		1.970		0.000	
3.2000		0.003573	0.012033		2.407		0.000	
3.2444		0.003496	0.012190		2.882		0.000	
3.2889		0.003415	0.012344		3.383		0.000	
3.3333		0.003329	0.012493		3.893		0.000	
3.3778		0.003237	0.012639		4.400		0.000	
3.4222		0.003140	0.012781		4.888		0.000	
3.4667		0.003036	0.012918		5.345		0.000	
3.5111		0.002926	0.013051		5.759		0.000	
3.5556		0.002807	0.013178		6.121		0.000	
3.6000		0.002680	0.013300		6.428		0.000	
3.6444		0.002542	0.013416		6.679		0.000	
3.6889		0.002392	0.013526		6.881		0.000	
3.7333		0.002228	0.013629		7.048		0.000	
3.7778		0.002046	0.013724		7.287		0.000	
3.8222		0.001841	0.013810		7.465		0.000	
3.8667		0.001603	0.013887		7.639		0.000	
3.9111		0.001317	0.013952		7.809		0.000	
3.9556		0.000936	0.014003		7.974		0.000	
4.0000		0.000000	0.014030		8.136		0.000	
4.0444		0.000000	0.000000		8.294		0.000	

TRACT B

Tank B

Dimensions
Depth: 4 ft.
Tank Type: Circular
Diameter: 4 ft.
Length: 100.010880682032 ft.
Discharge Structure
Riser Height: 3 ft.
Riser Diameter: 18 in.
Notch Type: Rectangular
Notch Width: 0.372 ft.
Notch Height: 1.325 ft.
Orifice 1 Diameter: 3.286 in. Elevation:0 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
0.0444	0.001	0.000	0.061	0.000
0.0889	0.002	0.000	0.087	0.000
0.1333	0.003	0.000	0.107	0.000
0.1778	0.003	0.000	0.123	0.000
0.2222	0.004	0.000	0.138	0.000
0.2667	0.004	0.000	0.151	0.000
0.3111	0.004	0.001	0.163	0.000
0.3556	0.005	0.001	0.174	0.000
0.4000	0.005	0.001	0.185	0.000
0.4444	0.005	0.001	0.195	0.000
0.4889	0.006	0.002	0.204	0.000
0.5333	0.006	0.002	0.214	0.000
0.5778	0.006	0.002	0.222	0.000
0.6222	0.006	0.002	0.231	0.000
0.6667	0.006	0.003	0.239	0.000
0.7111	0.007	0.003	0.247	0.000
0.7556	0.007	0.003	0.254	0.000
0.8000	0.007	0.004	0.262	0.000
0.8444	0.007	0.004	0.269	0.000
0.8889	0.007	0.004	0.276	0.000
0.9333	0.007	0.005	0.283	0.000
0.9778	0.007	0.005	0.289	0.000
1.0222	0.008	0.005	0.296	0.000
1.0667	0.008	0.006	0.302	0.000
1.1111	0.008	0.006	0.308	0.000
1.1556	0.008	0.006	0.315	0.000
1.2000	0.008	0.007	0.321	0.000
1.2444	0.008	0.007	0.326	0.000
1.2889	0.008	0.008	0.332	0.000
1.3333	0.008	0.008	0.338	0.000
1.3778	0.008	0.008	0.343	0.000
1.4222	0.008	0.009	0.349	0.000
1.4667	0.008	0.009	0.354	0.000
1.5111	0.008	0.010	0.360	0.000
1.5556	0.009	0.010	0.365	0.000
1.6000	0.009	0.010	0.370	0.000

1.6444		0.009	0.011		0.375		0.000	
1.6889		0.009	0.011		0.382		0.000	
1.7333		0.009	0.012		0.402		0.000	
1.7778		0.009	0.012		0.430		0.000	
1.8222		0.009	0.012		0.463		0.000	
1.8667		0.009	0.013		0.500		0.000	
1.9111		0.009	0.013		0.540		0.000	
1.9556		0.009	0.014		0.583		0.000	
2.0000		0.009	0.014		0.628		0.000	
2.0444		0.009	0.014		0.676		0.000	
2.0889	2.102	0.009	0.015	0.015	0.725	0.74	0.000	2 YEAR
2.1333		0.009	0.015		0.776		0.000	
2.1778		0.009	0.016		0.829		0.000	
2.2222		0.009	0.016		0.883		0.000	
2.2667		0.009	0.016		0.937		0.000	
2.3111		0.009	0.017		0.993		0.000	
2.3556		0.009	0.017		1.050		0.000	
2.4000		0.009	0.018		1.107		0.000	
2.4444		0.009	0.018		1.165		0.000	
2.4889 ✓		0.008	0.018 ✓		1.223	1.22	0.000	10
2.5333		0.008	0.019		1.282		0.000	
2.5778		0.008	0.019		1.340		0.000	
2.6222		0.008	0.020		1.399		0.000	
2.6667		0.008	0.020		1.458		0.000	
2.7111		0.008	0.020		1.527		0.000	
2.7556		0.008	0.021		1.599		0.000	
2.8000	2.817	0.008	0.021		1.672	1.70	0.000	50
2.8444		0.008	0.021		1.747		0.000	
2.8889		0.008	0.022		1.822		0.000	
2.9333	2.939	0.008	0.022		1.900	1.91	0.000	100
2.9778		0.008	0.023		1.978		0.000	
3.0222		0.007	0.023		2.073		0.000	
3.0667		0.007	0.023		2.297		0.000	
3.1111		0.007	0.024		2.615		0.000	
3.1556		0.007	0.024		3.001		0.000	
3.2000		0.007	0.024		3.439		0.000	
3.2444		0.007	0.025		3.916		0.000	
3.2889		0.007	0.025		4.417		0.000	
3.3333		0.006	0.025		4.928		0.000	
3.3778		0.006	0.026		5.435		0.000	
3.4222		0.006	0.026		5.924		0.000	
3.4667		0.006	0.026		6.382		0.000	
3.5111		0.006	0.026		6.797		0.000	
3.5556		0.005	0.027		7.160		0.000	
3.6000		0.005	0.027		7.468		0.000	
3.6444		0.005	0.027		7.719		0.000	
3.6889		0.004	0.027		7.922		0.000	
3.7333		0.004	0.028		8.091		0.000	
3.7778		0.004	0.028		8.330		0.000	
3.8222		0.003	0.028		8.509		0.000	
3.8667		0.003	0.028		8.684		0.000	
3.9111		0.002	0.028		8.854		0.000	
3.9556		0.001	0.028		9.021		0.000	
4.0000		0.000	0.028		9.183		0.000	
4.0444		0.000	0.000		9.342		0.000	

TRACT A

Tank C

Dimensions
Depth: 3 ft.
Tank Type: Circular
Diameter: 3 ft.
Length: 35.2167028983782 ft.
Discharge Structure
Riser Height: 2 ft.
Riser Diameter: 18 in.
Notch Type: Rectangular
Notch Width: 0.310 ft.
Notch Height: 0.914 ft.
Orifice 1 Diameter: 4.349990B83648060rft.
Element Flows To:
Outlet 1 Outlet 2

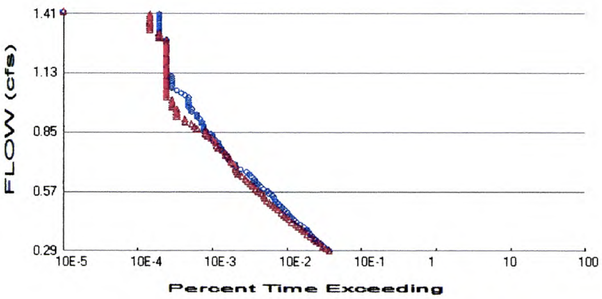
Tank Hydraulic Table

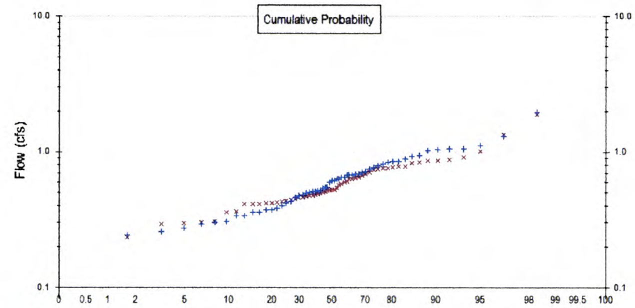
Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.000000	0.000000	0.000	0.000
0.0333	0.000508	0.000011	0.093	0.000
0.0667	0.000715	0.000032	0.132	0.000
0.1000	0.000871	0.000058	0.162	0.000
0.1333	0.001000	0.000090	0.187	0.000
0.1667	0.001111	0.000125	0.209	0.000
0.2000	0.001210	0.000164	0.229	0.000
0.2333	0.001299	0.000205	0.248	0.000
0.2667	0.001380	0.000250	0.265	0.000
0.3000	0.001455	0.000297	0.281	0.000
0.3333	0.001524	0.000347	0.296	0.000
0.3667	0.001589	0.000399	0.310	0.000
0.4000	0.001649	0.000453	0.324	0.000
0.4333	0.001705	0.000509	0.338	0.000
0.4667	0.001758	0.000567	0.350	0.000
0.5000	0.001808	0.000626	0.363	0.000
0.5333	0.001855	0.000687	0.375	0.000
0.5667	0.001899	0.000750	0.386	0.000
0.6000	0.001940	0.000814	0.397	0.000
0.6333	0.001980	0.000879	0.408	0.000
0.6667	0.002017	0.000946	0.419	0.000
0.7000	0.002052	0.001013	0.429	0.000
0.7333	0.002085	0.001082	0.439	0.000
0.7667	0.002116	0.001152	0.449	0.000
0.8000	0.002145	0.001223	0.459	0.000
0.8333	0.002173	0.001295	0.468	0.000
0.8667	0.002199	0.001368	0.478	0.000
0.9000	0.002223	0.001442	0.487	0.000
0.9333	0.002246	0.001516	0.496	0.000
0.9667	0.002267	0.001592	0.504	0.000
1.0000	0.002287	0.001667	0.513	0.000
1.0333	0.002305	0.001744	0.522	0.000
1.0667	0.002322	0.001821	0.530	0.000
1.1000	0.002338	0.001899	0.540	0.000
1.1333	0.002352	0.001977	0.557	0.000
1.1667	0.002365	0.002056	0.577	0.000
1.2000	0.002376	0.002135	0.601	0.000

1.2333		0.002387	0.002214		0.626		0.000	
1.2667		0.002396	0.002294		0.654		0.000	
1.3000		0.002404	0.002374		0.683		0.000	
1.3333		0.002410	0.002454		0.713		0.000	
1.3667		0.002416	0.002534		0.744		0.000	
1.4000		0.002420	0.002615		0.777		0.000	
1.4333	1.4520	0.002423	0.002696	.002740	0.811	.83	0.000	2 YEAR
1.4667		0.002425	0.002777		0.845		0.000	
1.5000		0.002425	0.002857		0.880		0.000	
1.5333		0.002425	0.002938		0.916		0.000	
1.5667		0.002423	0.003019		0.953		0.000	
1.6000		0.002420	0.003100		0.990		0.000	
1.6333		0.002416	0.003180		1.028		0.000	
1.6667		0.002410	0.003261		1.066		0.000	
1.7000		0.002404	0.003341		1.104		0.000	
1.7333		0.002396	0.003421		1.143		0.000	
1.7667		0.002387	0.003501		1.183		0.000	
1.8000		0.002376	0.003580		1.222		0.000	
1.8333		0.002365	0.003659		1.262		0.000	
1.8667		0.002352	0.003738		1.302		0.000	
1.9000	1.907	0.002338	0.003816	.003832	1.342	1.35	0.000	10
1.9333		0.002322	0.003894		1.382		0.000	
1.9667		0.002305	0.003971		1.422		0.000	
2.0000		0.002287	0.004047		1.463		0.000	
2.0333		0.002267	0.004123		1.565		0.000	
2.0667	2.08	0.002246	0.004198	.0042	1.748	1.84	0.000	50
2.1000	2.11	0.002223	0.004273	.0043	1.983	2.07	0.000	100
2.1333		0.002199	0.004346		2.258		0.000	
2.1667		0.002173	0.004419		2.566		0.000	
2.2000		0.002145	0.004491		2.902		0.000	
2.2333		0.002116	0.004562		3.260		0.000	
2.2667		0.002085	0.004632		3.633		0.000	
2.3000		0.002052	0.004701		4.016		0.000	
2.3333		0.002017	0.004769		4.403		0.000	
2.3667		0.001980	0.004836		4.788		0.000	
2.4000		0.001940	0.004901		5.164		0.000	
2.4333		0.001899	0.004965		5.526		0.000	
2.4667		0.001855	0.005028		5.869		0.000	
2.5000		0.001808	0.005089		6.187		0.000	
2.5333		0.001758	0.005148		6.478		0.000	
2.5667		0.001705	0.005206		6.738		0.000	
2.6000		0.001649	0.005262		6.966		0.000	
2.6333		0.001589	0.005316		7.162		0.000	
2.6667		0.001524	0.005368		7.329		0.000	
2.7000		0.001455	0.005417		7.473		0.000	
2.7333		0.001380	0.005465		7.599		0.000	
2.7667		0.001299	0.005509		7.796		0.000	
2.8000		0.001210	0.005551		7.934		0.000	
2.8333		0.001111	0.005590		8.070		0.000	
2.8667		0.001000	0.005625		8.203		0.000	
2.9000		0.000871	0.005656		8.334		0.000	
2.9333		0.000715	0.005683		8.462		0.000	
2.9667		0.000508	0.005703		8.588		0.000	
3.0000		0.000000	0.005715		8.712		0.000	
3.0333		0.000000	0.000000		8.834		0.000	

Analysis Results

POC 1





+ Predeveloped   x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 1.779
Total Impervious Area: 0.374

Mitigated Landuse Totals for POC #1
Total Pervious Area: 1.343
Total Impervious Area: 0.807

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.576886
5 year	0.846103
10 year	1.024721
25 year	1.248852
50 year	1.414126
100 year	1.577724

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0.543908
5 year	0.763135
10 year	0.917784
25 year	1.123817
50 year	1.284986
100 year	1.452724

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1949	0.431	0.691
1950	0.499	0.410
1951	0.794	0.663
1952	0.536	0.522
1953	0.594	0.571
1954	1.057	0.779
1955	0.462	0.414
1956	0.839	0.708
1957	0.853	0.633
1958	0.849	0.760

1959	0.360	0.308
1960	0.356	0.300
1961	0.720	0.641
1962	0.546	0.460
1963	0.611	0.597
1964	0.519	0.446
1965	0.550	0.473
1966	0.645	0.526
1967	0.630	0.486
1968	0.691	0.825
1969	0.818	0.856
1970	1.962	1.894
1971	0.301	0.416
1972	0.481	0.523
1973	0.509	0.444
1974	0.706	0.646
1975	0.383	0.292
1976	0.675	0.504
1977	0.145	0.232
1978	1.032	0.757
1979	0.773	0.777
1980	0.371	0.359
1981	0.882	0.774
1982	0.684	0.539
1983	1.118	0.859
1984	0.337	0.303
1985	0.307	0.424
1986	0.401	0.580
1987	0.633	0.514
1988	0.338	0.432
1989	0.472	0.508
1990	0.275	0.417
1991	0.680	0.733
1992	0.673	0.609
1993	0.923	0.750
1994	0.517	0.465
1995	0.418	0.414
1996	1.027	1.013
1997	1.294	1.331
1998	1.046	0.918
1999	0.613	0.472
2000	0.512	0.363
2001	0.244	0.232
2002	0.945	0.839
2003	0.749	0.628
2004	0.257	0.439
2005	0.294	0.499
2006	0.503	0.479
2007	0.371	0.472
2008	0.653	0.876

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	1.9622	1.8936
2	1.2941	1.3310
3	1.1183	1.0127
4	1.0573	0.9177

5	1.0458	0.8760
6	1.0320	0.8594
7	1.0267	0.8560
8	0.9448	0.8389
9	0.9229	0.8251
10	0.8825	0.7789
11	0.8528	0.7768
12	0.8495	0.7741
13	0.8386	0.7604
14	0.8185	0.7567
15	0.7944	0.7500
16	0.7727	0.7335
17	0.7485	0.7076
18	0.7198	0.6913
19	0.7064	0.6629
20	0.6913	0.6462
21	0.6845	0.6411
22	0.6803	0.6331
23	0.6747	0.6278
24	0.6730	0.6087
25	0.6529	0.5965
26	0.6455	0.5796
27	0.6330	0.5711
28	0.6295	0.5393
29	0.6131	0.5262
30	0.6112	0.5230
31	0.5939	0.5224
32	0.5496	0.5143
33	0.5458	0.5084
34	0.5361	0.5043
35	0.5192	0.4987
36	0.5166	0.4855
37	0.5122	0.4789
38	0.5090	0.4730
39	0.5034	0.4722
40	0.4991	0.4716
41	0.4806	0.4648
42	0.4717	0.4600
43	0.4620	0.4458
44	0.4315	0.4439
45	0.4184	0.4391
46	0.4012	0.4323
47	0.3833	0.4239
48	0.3713	0.4173
49	0.3706	0.4164
50	0.3601	0.4139
51	0.3556	0.4138
52	0.3380	0.4097
53	0.3373	0.3632
54	0.3069	0.3591
55	0.3014	0.3081
56	0.2938	0.3033
57	0.2749	0.2996
58	0.2567	0.2923
59	0.2442	0.2324
60	0.1446	0.2317

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.2884	774	775	100	Pass
0.2998	711	698	98	Pass
0.3112	647	630	97	Pass
0.3226	590	572	96	Pass
0.3339	534	524	98	Pass
0.3453	487	479	98	Pass
0.3567	459	429	93	Pass
0.3680	430	389	90	Pass
0.3794	404	359	88	Pass
0.3908	384	329	85	Pass
0.4021	350	299	85	Pass
0.4135	315	274	86	Pass
0.4249	286	243	84	Pass
0.4363	260	222	85	Pass
0.4476	238	204	85	Pass
0.4590	222	190	85	Pass
0.4704	212	174	82	Pass
0.4817	195	157	80	Pass
0.4931	182	145	79	Pass
0.5045	168	135	80	Pass
0.5159	159	124	77	Pass
0.5272	149	112	75	Pass
0.5386	141	105	74	Pass
0.5500	134	102	76	Pass
0.5613	120	95	79	Pass
0.5727	115	86	74	Pass
0.5841	101	79	78	Pass
0.5954	92	72	78	Pass
0.6068	86	67	77	Pass
0.6182	78	62	79	Pass
0.6296	76	58	76	Pass
0.6409	69	52	75	Pass
0.6523	66	46	69	Pass
0.6637	60	45	75	Pass
0.6750	50	43	86	Pass
0.6864	44	43	97	Pass
0.6978	42	40	95	Pass
0.7092	37	38	102	Pass
0.7205	35	37	105	Pass
0.7319	33	35	106	Pass
0.7433	32	32	100	Pass
0.7546	30	31	103	Pass
0.7660	28	28	100	Pass
0.7774	27	25	92	Pass
0.7887	26	24	92	Pass
0.8001	25	23	92	Pass
0.8115	23	22	95	Pass
0.8229	21	20	95	Pass
0.8342	21	18	85	Pass
0.8456	20	17	85	Pass
0.8570	17	17	100	Pass
0.8683	16	13	81	Pass
0.8797	16	12	75	Pass

0.8911	15	11	73	Pass
0.9025	15	9	60	Pass
0.9138	14	9	64	Pass
0.9252	13	7	53	Pass
0.9366	13	7	53	Pass
0.9479	11	7	63	Pass
0.9593	11	7	63	Pass
0.9707	10	6	60	Pass
0.9820	10	6	60	Pass
0.9934	10	6	60	Pass
1.0048	10	6	60	Pass
1.0162	10	5	50	Pass
1.0275	9	5	55	Pass
1.0389	8	5	62	Pass
1.0503	7	5	71	Pass
1.0616	6	5	83	Pass
1.0730	6	5	83	Pass
1.0844	6	5	83	Pass
1.0958	6	5	83	Pass
1.1071	6	5	83	Pass
1.1185	6	5	83	Pass
1.1299	5	5	100	Pass
1.1412	5	5	100	Pass
1.1526	5	5	100	Pass
1.1640	5	5	100	Pass
1.1753	5	5	100	Pass
1.1867	5	5	100	Pass
1.1981	5	5	100	Pass
1.2095	5	5	100	Pass
1.2208	5	5	100	Pass
1.2322	5	5	100	Pass
1.2436	5	5	100	Pass
1.2549	5	5	100	Pass
1.2663	5	5	100	Pass
1.2777	5	5	100	Pass
1.2891	5	5	100	Pass
1.3004	4	4	100	Pass
1.3118	4	4	100	Pass
1.3232	4	4	100	Pass
1.3345	4	3	75	Pass
1.3459	4	3	75	Pass
1.3573	4	3	75	Pass
1.3686	4	3	75	Pass
1.3800	4	3	75	Pass
1.3914	4	3	75	Pass
1.4028	4	3	75	Pass
1.4141	4	3	75	Pass

Water Quality

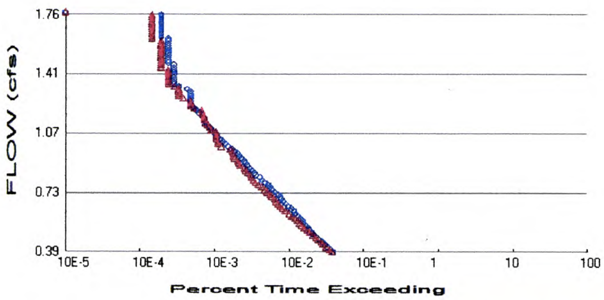
Water Quality BMP Flow and Volume for POC #1

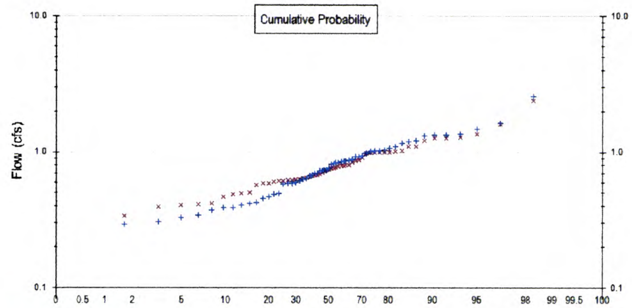
On-line facility volume:	0 acre-feet
On-line facility target flow:	0 cfs.
Adjusted for 15 min:	0 cfs.
Off-line facility target flow:	0 cfs.
Adjusted for 15 min:	0 cfs.

LID Report

LID Technique	Used for 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
Tank APOC	☐	**234.43**			☐	**0.00**			
Total Volume Infiltrated		**234.43**	**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





+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #2
Total Pervious Area: 2.595
Total Impervious Area: 0

Mitigated Landuse Totals for POC #2
Total Pervious Area: 1.32
Total Impervious Area: 1.275

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #2

Return Period	**Flow(cfs)**
2 year	0.777318
5 year	1.185671
10 year	1.404639
25 year	1.625879
50 year	1.756701
100 year	1.863934

Flow Frequency Return Periods for Mitigated. POC #2

Return Period	**Flow(cfs)**
2 year	0.736714
5 year	1.023623
10 year	1.224535
25 year	1.490712
50 year	1.697933
100 year	1.912806

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #2

Year	**Predeveloped**	**Mitigated**
1949	0.587	1.092
1950	0.724	0.499
1951	1.021	0.800
1952	0.639	0.761
1953	0.820	0.756
1954	1.332	0.996
1955	0.633	0.503
1956	1.163	0.917
1957	1.073	0.806
1958	0.838	0.992
1959	0.489	0.413

1960	0.456	0.488
1961	1.031	0.839
1962	0.734	0.651
1963	0.820	0.773
1964	0.756	0.605
1965	0.677	0.637
1966	0.919	0.725
1967	0.852	0.624
1968	0.977	1.275
1969	1.010	1.266
1970	2.583	2.382
1971	0.418	0.631
1972	0.666	0.749
1973	0.701	0.623
1974	1.017	0.864
1975	0.589	0.418
1976	0.919	0.679
1977	0.030	0.316
1978	1.352	1.002
1979	0.858	0.993
1980	0.494	0.469
1981	1.191	0.984
1982	0.833	0.780
1983	1.471	1.025
1984	0.469	0.393
1985	0.326	0.611
1986	0.406	0.873
1987	0.725	0.589
1988	0.390	0.681
1989	0.424	0.702
1990	0.342	0.589
1991	0.862	0.987
1992	0.869	0.794
1993	1.101	0.993
1994	0.739	0.612
1995	0.599	0.660
1996	1.318	1.353
1997	1.628	1.611
1998	1.334	1.267
1999	0.885	0.575
2000	0.577	0.404
2001	0.305	0.336
2002	1.204	1.101
2003	0.943	0.786
2004	0.292	0.628
2005	0.371	0.737
2006	0.697	0.665
2007	0.391	0.690
2008	0.612	1.219

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #2

Rank	Predeveloped	Mitigated
1	2.5826	2.3817
2	1.6277	1.6110
3	1.4705	1.3534
4	1.3522	1.2748
5	1.3336	1.2674

6	1.3318	1.2659
7	1.3175	1.2195
8	1.2040	1.1007
9	1.1913	1.0922
10	1.1632	1.0252
11	1.1011	1.0015
12	1.0727	0.9961
13	1.0314	0.9934
14	1.0212	0.9931
15	1.0170	0.9925
16	1.0097	0.9869
17	0.9773	0.9840
18	0.9426	0.9169
19	0.9195	0.8726
20	0.9195	0.8641
21	0.8851	0.8394
22	0.8692	0.8056
23	0.8622	0.7997
24	0.8583	0.7939
25	0.8516	0.7865
26	0.8385	0.7801
27	0.8326	0.7729
28	0.8200	0.7607
29	0.8199	0.7560
30	0.7565	0.7489
31	0.7395	0.7373
32	0.7339	0.7248
33	0.7246	0.7019
34	0.7241	0.6903
35	0.7008	0.6810
36	0.6966	0.6788
37	0.6774	0.6648
38	0.6661	0.6604
39	0.6389	0.6511
40	0.6334	0.6367
41	0.6122	0.6312
42	0.5986	0.6277
43	0.5886	0.6243
44	0.5869	0.6231
45	0.5769	0.6121
46	0.4936	0.6110
47	0.4885	0.6045
48	0.4687	0.5895
49	0.4560	0.5891
50	0.4239	0.5751
51	0.4179	0.5031
52	0.4064	0.4990
53	0.3910	0.4883
54	0.3901	0.4687
55	0.3712	0.4176
56	0.3423	0.4134
57	0.3262	0.4043
58	0.3047	0.3933
59	0.2921	0.3364
60	0.0300	0.3158

Duration Flows

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.3887	817	790	96	Pass
0.4025	750	729	97	Pass
0.4163	689	668	96	Pass
0.4301	630	603	95	Pass
0.4439	586	566	96	Pass
0.4578	541	511	94	Pass
0.4716	499	476	95	Pass
0.4854	466	438	93	Pass
0.4992	424	398	93	Pass
0.5130	390	368	94	Pass
0.5268	372	333	89	Pass
0.5407	353	311	88	Pass
0.5545	330	292	88	Pass
0.5683	313	267	85	Pass
0.5821	293	249	84	Pass
0.5959	276	226	81	Pass
0.6098	258	207	80	Pass
0.6236	243	186	76	Pass
0.6374	223	170	76	Pass
0.6512	205	158	77	Pass
0.6650	190	149	78	Pass
0.6788	176	141	80	Pass
0.6927	165	134	81	Pass
0.7065	158	120	75	Pass
0.7203	150	118	78	Pass
0.7341	135	107	79	Pass
0.7479	122	99	81	Pass
0.7618	116	90	77	Pass
0.7756	110	81	73	Pass
0.7894	100	74	74	Pass
0.8032	92	69	75	Pass
0.8170	85	66	77	Pass
0.8309	75	64	85	Pass
0.8447	71	58	81	Pass
0.8585	67	55	82	Pass
0.8723	62	52	83	Pass
0.8861	57	46	80	Pass
0.8999	55	44	80	Pass
0.9138	52	43	82	Pass
0.9276	48	39	81	Pass
0.9414	45	38	84	Pass
0.9552	43	37	86	Pass
0.9690	39	36	92	Pass
0.9829	36	34	94	Pass
0.9967	32	26	81	Pass
1.0105	29	23	79	Pass
1.0243	27	23	85	Pass
1.0381	25	22	88	Pass
1.0520	23	22	95	Pass
1.0658	22	22	100	Pass
1.0796	20	22	110	Pass
1.0934	19	19	100	Pass
1.1072	18	18	100	Pass
1.1210	17	17	100	Pass

1.1349	16	16	100	Pass
1.1487	15	15	100	Pass
1.1625	15	15	100	Pass
1.1763	14	15	107	Pass
1.1901	13	14	107	Pass
1.2040	12	14	116	Fail
1.2178	11	11	100	Pass
1.2316	10	10	100	Pass
1.2454	10	10	100	Pass
1.2592	10	10	100	Pass
1.2730	10	8	80	Pass
1.2869	10	7	70	Pass
1.3007	10	7	70	Pass
1.3145	10	7	70	Pass
1.3283	9	7	77	Pass
1.3421	7	6	85	Pass
1.3560	6	5	83	Pass
1.3698	6	5	83	Pass
1.3836	6	5	83	Pass
1.3974	6	5	83	Pass
1.4112	6	5	83	Pass
1.4251	6	5	83	Pass
1.4389	6	5	83	Pass
1.4527	6	4	66	Pass
1.4665	6	4	66	Pass
1.4803	5	4	80	Pass
1.4941	5	4	80	Pass
1.5080	5	4	80	Pass
1.5218	5	4	80	Pass
1.5356	5	4	80	Pass
1.5494	5	4	80	Pass
1.5632	5	4	80	Pass
1.5771	5	4	80	Pass
1.5909	5	4	80	Pass
1.6047	5	4	80	Pass
1.6185	5	3	60	Pass
1.6323	4	3	75	Pass
1.6462	4	3	75	Pass
1.6600	4	3	75	Pass
1.6738	4	3	75	Pass
1.6876	4	3	75	Pass
1.7014	4	3	75	Pass
1.7152	4	3	75	Pass
1.7291	4	3	75	Pass
1.7429	4	3	75	Pass
1.7567	4	3	75	Pass

The development has an increase in flow durations from 1/2 Predeveloped 2 year flow to the 2 year flow or more than a 10% increase from the 2 year to the 50 year flow.

Water Quality

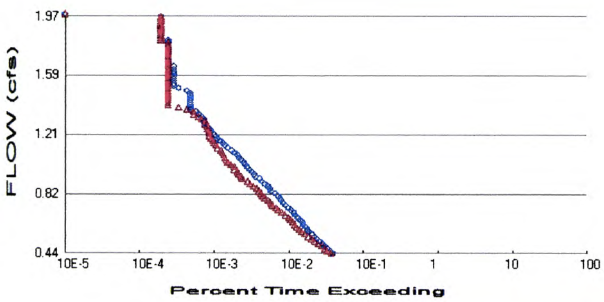
Water Quality BMP Flow and Volume for POC #2

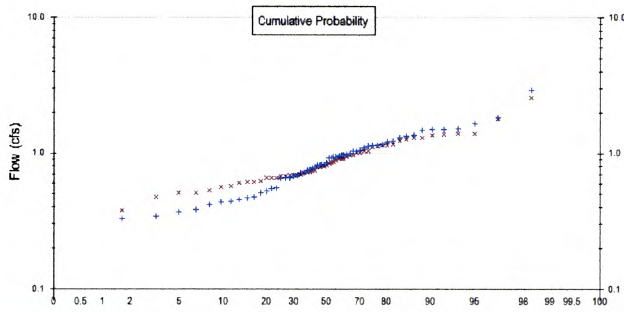
On-line facility volume:	0 acre-feet
On-line facility target flow:	0 cfs.
Adjusted for 15 min:	0 cfs.
Off-line facility target flow:	0 cfs.
Adjusted for 15 min:	0 cfs.

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
Tank B POC	☐	318.90			☐	0.00			
Total Volume Infiltrated		318.90	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 3





+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #3
Total Pervious Area: 2.916
Total Impervious Area: 0

Mitigated Landuse Totals for POC #3
Total Pervious Area: 1.841
Total Impervious Area: 1.075

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #3

Return Period	**Flow(cfs)**
2 year	0.873472
5 year	1.332337
10 year	1.578391
25 year	1.826998
50 year	1.974003
100 year	2.0945

Flow Frequency Return Periods for Mitigated. POC #3

Return Period	**Flow(cfs)**
2 year	0.829574
5 year	1.136119
10 year	1.348459
25 year	1.627456
50 year	1.843122
100 year	2.065532

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #3

Year	**Predeveloped**	**Mitigated**
1949	0.659	1.002
1950	0.814	0.715
1951	1.148	1.031
1952	0.718	0.742
1953	0.921	0.798
1954	1.497	1.299
1955	0.712	0.655
1956	1.307	1.010
1957	1.205	1.036
1958	0.942	1.167
1959	0.549	0.530

1960	0.512	0.506
1961	1.159	0.969
1962	0.825	0.680
1963	0.921	0.883
1964	0.850	0.619
1965	0.761	0.684
1966	1.033	0.787
1967	0.957	0.819
1968	1.098	1.152
1969	1.135	1.306
1970	2.902	2.571
1971	0.470	0.567
1972	0.749	0.850
1973	0.787	0.693
1974	1.143	0.866
1975	0.661	0.474
1976	1.033	0.723
1977	0.034	0.371
1978	1.520	1.147
1979	0.964	1.233
1980	0.555	0.563
1981	1.339	1.124
1982	0.936	0.941
1983	1.652	1.399
1984	0.527	0.513
1985	0.367	0.607
1986	0.457	0.907
1987	0.814	0.807
1988	0.438	0.611
1989	0.476	0.835
1990	0.385	0.731
1991	0.969	0.968
1992	0.977	0.911
1993	1.237	1.117
1994	0.831	0.658
1995	0.673	0.656
1996	1.481	1.378
1997	1.829	1.811
1998	1.499	1.393
1999	0.995	0.750
2000	0.648	0.609
2001	0.342	0.381
2002	1.353	1.262
2003	1.059	0.909
2004	0.328	0.688
2005	0.417	0.790
2006	0.783	0.686
2007	0.439	0.681
2008	0.688	1.359

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #3

Rank	**Predeveloped**	**Mitigated**
1	2.9021	2.5712
2	1.8290	1.8112
3	1.6524	1.3986
4	1.5195	1.3928
5	1.4986	1.3783

6	1.4966	1.3593
7	1.4805	1.3061
8	1.3530	1.2992
9	1.3387	1.2621
10	1.3071	1.2331
11	1.2373	1.1666
12	1.2054	1.1516
13	1.1590	1.1465
14	1.1476	1.1240
15	1.1427	1.1168
16	1.1345	1.0357
17	1.0982	1.0313
18	1.0592	1.0098
19	1.0332	1.0019
20	1.0332	0.9685
21	0.9946	0.9684
22	0.9767	0.9411
23	0.9689	0.9111
24	0.9645	0.9091
25	0.9570	0.9073
26	0.9422	0.8827
27	0.9356	0.8664
28	0.9214	0.8497
29	0.9213	0.8352
30	0.8501	0.8188
31	0.8309	0.8071
32	0.8247	0.7982
33	0.8142	0.7897
34	0.8136	0.7874
35	0.7874	0.7502
36	0.7827	0.7421
37	0.7611	0.7309
38	0.7485	0.7226
39	0.7179	0.7150
40	0.7117	0.6927
41	0.6880	0.6877
42	0.6726	0.6859
43	0.6614	0.6836
44	0.6595	0.6808
45	0.6482	0.6797
46	0.5547	0.6582
47	0.5489	0.6558
48	0.5267	0.6547
49	0.5124	0.6195
50	0.4763	0.6107
51	0.4696	0.6091
52	0.4567	0.6066
53	0.4393	0.5671
54	0.4384	0.5627
55	0.4171	0.5303
56	0.3846	0.5127
57	0.3665	0.5065
58	0.3424	0.4738
59	0.3283	0.3808
60	0.0337	0.3713

Duration Flows
The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.4367	817	777	95	Pass
0.4523	747	691	92	Pass
0.4678	692	632	91	Pass
0.4833	630	580	92	Pass
0.4988	585	514	87	Pass
0.5144	540	461	85	Pass
0.5299	500	422	84	Pass
0.5454	466	381	81	Pass
0.5610	425	340	80	Pass
0.5765	391	309	79	Pass
0.5920	371	286	77	Pass
0.6075	353	265	75	Pass
0.6231	330	251	76	Pass
0.6386	313	233	74	Pass
0.6541	293	221	75	Pass
0.6697	276	207	75	Pass
0.6852	258	188	72	Pass
0.7007	243	168	69	Pass
0.7162	222	151	68	Pass
0.7318	205	141	68	Pass
0.7473	190	126	66	Pass
0.7628	176	119	67	Pass
0.7784	165	110	66	Pass
0.7939	158	100	63	Pass
0.8094	150	93	62	Pass
0.8249	136	89	65	Pass
0.8405	121	84	69	Pass
0.8560	116	77	66	Pass
0.8715	110	70	63	Pass
0.8870	100	63	63	Pass
0.9026	92	59	64	Pass
0.9181	85	49	57	Pass
0.9336	75	48	64	Pass
0.9492	71	44	61	Pass
0.9647	67	43	64	Pass
0.9802	62	39	62	Pass
0.9957	57	39	68	Pass
1.0113	55	35	63	Pass
1.0268	52	32	61	Pass
1.0423	48	30	62	Pass
1.0579	45	29	64	Pass
1.0734	43	28	65	Pass
1.0889	39	27	69	Pass
1.1044	36	26	72	Pass
1.1200	32	23	71	Pass
1.1355	29	22	75	Pass
1.1510	27	21	77	Pass
1.1665	25	20	80	Pass
1.1821	23	19	82	Pass
1.1976	22	18	81	Pass
1.2131	20	18	90	Pass
1.2287	19	18	94	Pass
1.2442	18	17	94	Pass

1.2597	17	17	100	Pass
1.2752	16	16	100	Pass
1.2908	15	16	106	Pass
1.3063	15	14	93	Pass
1.3218	14	13	92	Pass
1.3374	13	11	84	Pass
1.3529	12	11	91	Pass
1.3684	10	9	90	Pass
1.3839	10	7	70	Pass
1.3995	10	5	50	Pass
1.4150	10	5	50	Pass
1.4305	10	5	50	Pass
1.4461	10	5	50	Pass
1.4616	10	5	50	Pass
1.4771	10	5	50	Pass
1.4926	9	5	55	Pass
1.5082	7	5	71	Pass
1.5237	6	5	83	Pass
1.5392	6	5	83	Pass
1.5547	6	5	83	Pass
1.5703	6	5	83	Pass
1.5858	6	5	83	Pass
1.6013	6	5	83	Pass
1.6169	6	5	83	Pass
1.6324	6	5	83	Pass
1.6479	6	5	83	Pass
1.6634	5	5	100	Pass
1.6790	5	5	100	Pass
1.6945	5	5	100	Pass
1.7100	5	5	100	Pass
1.7256	5	5	100	Pass
1.7411	5	5	100	Pass
1.7566	5	5	100	Pass
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1.7877	5	5	100	Pass
1.8032	5	5	100	Pass
1.8187	5	4	80	Pass
1.8343	4	4	100	Pass
1.8498	4	4	100	Pass
1.8653	4	4	100	Pass
1.8808	4	4	100	Pass
1.8964	4	4	100	Pass
1.9119	4	4	100	Pass
1.9274	4	4	100	Pass
1.9429	4	4	100	Pass
1.9585	4	4	100	Pass
1.9740	4	4	100	Pass

Water Quality

Water Quality BMP Flow and Volume for POC #3

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 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
Tank C POC	☐	**314.19**			☐	**0.00**			
Total Volume Infiltrated		**314.19**	**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.

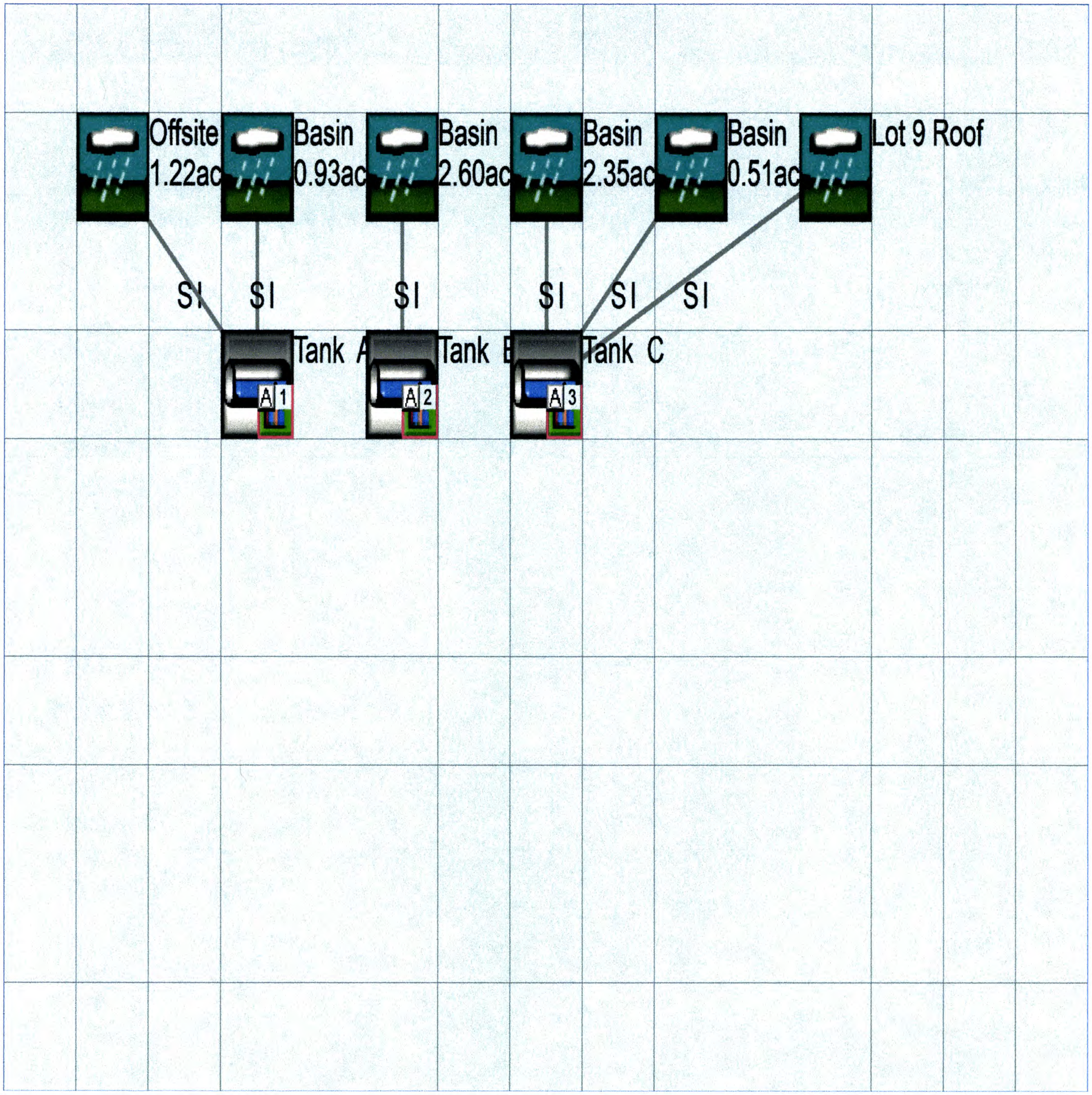
IMPLND Changes

No IMPLND changes have been made.

Appendix

Predeveloped Schematic

Mitigated Schematic



Predeveloped UCI File

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END GLOBAL

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           27   PreA10123.prelim.DETENTION.SITE(new).L61
           28   PreA10123.prelim.DETENTION.SITE(new).L62
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           31   POCA10123.prelim.DETENTION.SITE(new)2.dat
           32   POCA10123.prelim.DETENTION.SITE(new)3.dat
END FILES

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      IMPLND       3
      IMPLND       4
      IMPLND       7
      PERLND      30
      COPY       501
      COPY       502
      COPY       503
      DISPLY       1
      DISPLY       2
      DISPLY       3
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END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
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    1       Offsite                     MAX                    1    2   30    9
    2       Basin B                     MAX                    1    2   31    9
    3       Basin  C+D                  MAX                    1    2   32    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  502         1    1
  503         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #        K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                         in  out          ***
   27      SG3, Lawn, Steep        1    1    1    1   27    0
   30      SG4, Forest, Steep      1    1    1    1   27    0
```

```
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   27         0    0    1    0    0    0    0    0    0    0    0    0
   30         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ***************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
   27         0    0    4    0    0    0    0    0    0    0    0    0    1    9
   30         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   27         0    0    0    0    0    0    0    0    0    0    0
   30         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   27              0         9      0.05       400      0.15         0      0.96
   30              0         6      0.04       400      0.15         0      0.96
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   27              0         0       2.5         2         0         0         0
   30              0         0         3         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                               ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   27            0.1       0.8      0.25         4       0.4      0.25
   30            0.2       0.4      0.35         2       0.4       0.7
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
              ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
   27              0         0         0         0         3         1         0
   30              0         0         0         0       2.5         1         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name-------->   Unit-systems   Printer ***
    # -  #                      User  t-series Engl Metr ***
                                        in  out          ***
    3       ROADS/STEEP            1     1    1   27    0
    4       ROOF TOPS/FLAT         1     1    1   27    0
    7       DRIVEWAYS/STEEP        1     1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    3         0    0    1    0    0    0
    4         0    0    1    0    0    0
```

```
    7           0     0     1     0     0     0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    3           0     0     4     0     0     0     1     9
    4           0     0     4     0     0     0     1     9
    7           0     0     4     0     0     0     1     9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI      ***
    3           0     0     0     0     0
    4           0     0     0     0     0
    7           0     0     0     0     0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    3            400       0.1       0.1      0.05
    4            400      0.01       0.1       0.1
    7            400       0.1       0.1      0.05
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    3              0         0
    4              0         0
    7              0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    3              0         0
    4              0         0
    7              0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->  MBLK   ***
<Name>   #                  <-factor->     <Name>   #  Tbl#   ***
Offsite***
PERLND  27                       0.849     COPY   501     12
PERLND  27                       0.849     COPY   501     13
IMPLND   3                        0.06     COPY   501     15
IMPLND   4                       0.151     COPY   501     15
IMPLND   7                       0.163     COPY   501     15
Basin A***
PERLND  30                        0.93     COPY   501     12
PERLND  30                        0.93     COPY   501     13
Basin B***
PERLND  30                       2.595     COPY   502     12
PERLND  30                       2.595     COPY   502     13
Basin  C+D***
PERLND  30                       2.916     COPY   503     12
PERLND  30                       2.916     COPY   503     13

******Routing******
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
```

```
COPY    501 OUTPUT MEAN   1 1   48.4        DISPLY   1      INPUT  TIMSER 1
COPY    502 OUTPUT MEAN   1 1   48.4        DISPLY   2      INPUT  TIMSER 1
COPY    503 OUTPUT MEAN   1 1   48.4        DISPLY   3      INPUT  TIMSER 1


<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                 ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG            ***
                                         in  out                             ***
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ****************** PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                      ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *       *  *  *  *  *          ***
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                         ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit        for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1.3            PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1.3            IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.8            PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.8            IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
COPY    501 OUTPUT MEAN   1 1      48.4    WDM     501 FLOW     ENGL      REPL
COPY    502 OUTPUT MEAN   1 1      48.4    WDM     502 FLOW     ENGL      REPL
COPY    503 OUTPUT MEAN   1 1      48.4    WDM     503 FLOW     ENGL      REPL
END EXT TARGETS
```

```
MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13

  MASS-LINK       15
IMPLND     IWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   15

END MASS-LINK

END RUN
```

Mitigated UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1948 10 01        END    2008 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME      0 RUN      1                 UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                             ***
WDM        26   A10123.prelim.DETENTION.SITE(new).wdm
MESSU      25   MitA10123.prelim.DETENTION.SITE(new).MES
           27   MitA10123.prelim.DETENTION.SITE(new).L61
           28   MitA10123.prelim.DETENTION.SITE(new).L62
           31   POCA10123.prelim.DETENTION.SITE(new)2.dat
           30   POCA10123.prelim.DETENTION.SITE(new)1.dat
           32   POCA10123.prelim.DETENTION.SITE(new)3.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      27
      IMPLND       3
      IMPLND       4
      IMPLND       7
      IMPLND      10
      RCHRES       1
      RCHRES       2
      RCHRES       3
      COPY         2
      COPY       502
      COPY         1
      COPY       501
      COPY         3
      COPY       503
      DISPLY       2
      DISPLY       1
      DISPLY       3
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    2        Tank  B                     MAX                    1    2   31    9
    1        Tank  A                     MAX                    1    2   30    9
    3        Tank  C                     MAX                    1    2   32    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
    2         1    1
  502         1    1
  501         1    1
    3         1    1
  503         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
```

```
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # - #                          User  t-series Engl Metr ***
                                         in  out           ***
   27     SG3, Lawn, Steep        1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # - # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   27         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ***************************** PIVL  PYR
    # - # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
   27         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # - # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   27         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # - # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   27              0         9      0.05       400      0.15         0      0.96
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # - # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   27              0         0       2.5         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                               ***
    # - #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   27           0.1       0.8      0.25         4       0.4      0.25
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
              ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # - # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
   27              0         0         0         0         3         1         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # - #                     User  t-series Engl Metr ***
                                      in  out          ***
    3      ROADS/STEEP           1    1    1   27    0
    4      ROOF TOPS/FLAT        1    1    1   27    0
    7      DRIVEWAYS/STEEP       1    1    1   27    0
   10      SIDEWALKS/STEEP       1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # - # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    3         0    0    1    0    0    0
```

```
    4          0    0    1    0    0    0
    7          0    0    1    0    0    0
   10          0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    3          0    0    4    0    0    0    1    9
    4          0    0    4    0    0    0    1    9
    7          0    0    4    0    0    0    1    9
   10          0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
    3          0    0    0    0    0
    4          0    0    0    0    0
    7          0    0    0    0    0
   10          0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    3            400       0.1       0.1      0.05
    4            400      0.01       0.1       0.1
    7            400       0.1       0.1      0.05
   10            400       0.1       0.1      0.05
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    3              0         0
    4              0         0
    7              0         0
   10              0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    3              0         0
    4              0         0
    7              0         0
   10              0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Offsite***
PERLND  27                       0.849     RCHRES   2      2
PERLND  27                       0.849     RCHRES   2      3
IMPLND   3                        0.06     RCHRES   2      5
IMPLND   4                       0.151     RCHRES   2      5
IMPLND   7                       0.163     RCHRES   2      5
Basin  A***
PERLND  27                       0.494     RCHRES   2      2
PERLND  27                       0.494     RCHRES   2      3
IMPLND   3                       0.122     RCHRES   2      5
IMPLND   4                       0.106     RCHRES   2      5
IMPLND   7                       0.197     RCHRES   2      5
IMPLND  10                       0.008     RCHRES   2      5
Basin  B***
PERLND  27                        1.32     RCHRES   1      2
```

```
PERLND  27                           1.32     RCHRES   1       3
IMPLND   3                          0.434     RCHRES   1       5
IMPLND   4                          0.514     RCHRES   1       5
IMPLND   7                           0.23     RCHRES   1       5
IMPLND  10                          0.097     RCHRES   1       5
Basin  C***
PERLND  27                          1.501     RCHRES   3       2
PERLND  27                          1.501     RCHRES   3       3
IMPLND   3                           0.33     RCHRES   3       5
IMPLND   4                          0.317     RCHRES   3       5
IMPLND   7                          0.092     RCHRES   3       5
IMPLND  10                          0.113     RCHRES   3       5
Basin  D***
PERLND  27                           0.34     RCHRES   3       2
PERLND  27                           0.34     RCHRES   3       3
IMPLND   4                          0.158     RCHRES   3       5
IMPLND  10                          0.012     RCHRES   3       5
Lot 9 Roof***
IMPLND   4                          0.053     RCHRES   3       5

******Routing******
PERLND  27                          0.849     COPY     1      12
IMPLND   3                           0.06     COPY     1      15
IMPLND   4                          0.151     COPY     1      15
IMPLND   7                          0.163     COPY     1      15
PERLND  27                          0.849     COPY     1      13
PERLND  27                          0.494     COPY     1      12
IMPLND   3                          0.122     COPY     1      15
IMPLND   4                          0.106     COPY     1      15
IMPLND   7                          0.197     COPY     1      15
IMPLND  10                          0.008     COPY     1      15
PERLND  27                          0.494     COPY     1      13
RCHRES   2                              1     COPY   501      16
RCHRES   1                              1     COPY   502      16
RCHRES   1                              1     COPY   602      16
RCHRES   3                              1     COPY   503      16
RCHRES   3                              1     COPY   603      16
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   502 OUTPUT MEAN   1 1   48.4        DISPLY   2     INPUT  TIMSER 1
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1
COPY   503 OUTPUT MEAN   1 1   48.4        DISPLY   3     INPUT  TIMSER 1


<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                 ***
    # -   #<------------------><---> User T-series  Engl Metr LKFG           ***
                                            in  out                          ***
    1      Tank  B               1    1    1    1    28    0    1
    2      Tank  A               1    1    1    1    28    0    1
    3      Tank  C               1    1    1    1    28    0    1
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
    1        1    0    0    0    0    0    0    0    0    0
    2        1    0    0    0    0    0    0    0    0    0
    3        1    0    0    0    0    0    0    0    0    0
  END ACTIVITY
```

```
  PRINT-INFO
    <PLS > ***************** Print-flags ****************** PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
    1         4    0    0    0    0    0    0    0    0    0    1    9
    2         4    0    0    0    0    0    0    0    0    0    1    9
    3         4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                         ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *       *  *  *  *  *        ***
    1        0  1  0  0    4  0  0  0  0       0  0  0  0  0       2  2  2  2  2
    2        0  1  0  0    4  0  0  0  0       0  0  0  0  0       2  2  2  2  2
    3        0  1  0  0    4  0  0  0  0       0  0  0  0  0       2  2  2  2  2
  END HYDR-PARM1

  HYDR-PARM2
    # -  #     FTABNO        LEN      DELTH      STCOR         KS       DB50        ***
  <------><--------><--------><--------><--------><--------><-------->        ***
    1              1       0.02        0.0        0.0        0.5        0.0
    2              2       0.01        0.0        0.0        0.5        0.0
    3              3       0.01        0.0        0.0        0.5        0.0
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                            ***
    # -  # ***    VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
         *** ac-ft     for each possible exit        for each possible exit
  <------><-------->      <---><---><---><---><---> *** <---><---><---><---><--->
    1           0          4.0  0.0  0.0  0.0  0.0        0.0  0.0  0.0  0.0  0.0
    2           0          4.0  0.0  0.0  0.0  0.0        0.0  0.0  0.0  0.0  0.0
    3           0          4.0  0.0  0.0  0.0  0.0        0.0  0.0  0.0  0.0  0.0
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
  FTABLE       2
   91    4
     Depth       Area     Volume  Outflow1 Velocity  Travel Time***
      (ft)    (acres) (acre-ft)    (cfs)   (ft/sec)     (Minutes)***
  0.000000  0.000000  0.000000  0.000000
  0.044444  0.000936  0.000028  0.046893
  0.088889  0.001317  0.000078  0.066317
  0.133333  0.001603  0.000143  0.081221
  0.177778  0.001841  0.000220  0.093786
  0.222222  0.002046  0.000307  0.104856
  0.266667  0.002228  0.000402  0.114864
  0.311111  0.002392  0.000504  0.124068
  0.355556  0.002542  0.000614  0.132634
  0.400000  0.002680  0.000730  0.140680
  0.444444  0.002807  0.000852  0.148289
  0.488889  0.002926  0.000980  0.155527
  0.533333  0.003036  0.001112  0.162443
  0.577778  0.003140  0.001249  0.169076
  0.622222  0.003237  0.001391  0.175458
  0.666667  0.003329  0.001537  0.181617
  0.711111  0.003415  0.001687  0.187573
  0.755556  0.003496  0.001841  0.193346
  0.800000  0.003573  0.001998  0.198951
  0.844444  0.003645  0.002158  0.204403
  0.888889  0.003713  0.002322  0.209713
  0.933333  0.003778  0.002488  0.214892
  0.977778  0.003839  0.002657  0.219949
  1.022222  0.003896  0.002829  0.224892
  1.066667  0.003950  0.003004  0.229729
  1.111111  0.004001  0.003180  0.234466
```

1.155556	0.004048	0.003359	0.239110
1.200000	0.004093	0.003540	0.243664
1.244444	0.004135	0.003723	0.248136
1.288889	0.004174	0.003908	0.252528
1.333333	0.004211	0.004094	0.256845
1.377778	0.004244	0.004282	0.261090
1.422222	0.004276	0.004471	0.265268
1.466667	0.004304	0.004662	0.269381
1.511111	0.004331	0.004854	0.273432
1.555556	0.004354	0.005047	0.277424
1.600000	0.004376	0.005241	0.281359
1.644444	0.004395	0.005436	0.285240
1.688889	0.004412	0.005631	0.289382
1.733333	0.004426	0.005828	0.298672
1.777778	0.004438	0.006025	0.311201
1.822222	0.004448	0.006222	0.325874
1.866667	0.004456	0.006420	0.342212
1.911111	0.004462	0.006618	0.359914
1.955556	0.004465	0.006817	0.378769
2.000000	0.004466	0.007015	0.398613
2.044444	0.004465	0.007214	0.419314
2.088889	0.004462	0.007412	0.440760
2.133333	0.004456	0.007610	0.462859
2.177778	0.004448	0.007808	0.485526
2.222222	0.004438	0.008006	0.508690
2.266667	0.004426	0.008203	0.532283
2.311111	0.004412	0.008399	0.556245
2.355556	0.004395	0.008595	0.580522
2.400000	0.004376	0.008790	0.605063
2.444444	0.004354	0.008984	0.629820
2.488889	0.004331	0.009177	0.654750
2.533333	0.004304	0.009369	0.679810
2.577778	0.004276	0.009559	0.704963
2.622222	0.004244	0.009749	0.730170
2.666667	0.004211	0.009936	0.755397
2.711111	0.004174	0.010123	0.783694
2.755556	0.004135	0.010307	0.814004
2.800000	0.004093	0.010490	0.844861
2.844444	0.004048	0.010671	0.876255
2.888889	0.004001	0.010850	0.908176
2.933333	0.003950	0.011027	0.940612
2.977778	0.003896	0.011201	0.973556
3.022222	0.003839	0.011373	1.044377
3.066667	0.003778	0.011542	1.268168
3.111111	0.003713	0.011709	1.585090
3.155556	0.003645	0.011872	1.970078
3.200000	0.003573	0.012033	2.407314
3.244444	0.003496	0.012190	2.882914
3.288889	0.003415	0.012344	3.383063
3.333333	0.003329	0.012493	3.893575
3.377778	0.003237	0.012639	4.400037
3.422222	0.003140	0.012781	4.888291
3.466667	0.003036	0.012918	5.345124
3.511111	0.002926	0.013051	5.759136
3.555556	0.002807	0.013178	6.121728
3.600000	0.002680	0.013300	6.428208
3.644444	0.002542	0.013416	6.679004
3.688889	0.002392	0.013526	6.880960
3.733333	0.002228	0.013629	7.048721
3.777778	0.002046	0.013724	7.287136
3.822222	0.001841	0.013810	7.465758
3.866667	0.001603	0.013887	7.639668
3.911111	0.001317	0.013952	7.809222
3.955556	0.000936	0.014003	7.974734
4.000000	0.001000	0.014030	8.136484

END FTABLE 2
FTABLE 1
91 4

Depth (ft)	Area (acres)	Volume (acre-ft)	Outflow1 (cfs)	Velocity (ft/sec)	Travel Time*** (Minutes)***

0.000000	0.000000	0.000000	0.000000
0.044444	0.001925	0.000057	0.061774
0.088889	0.002707	0.000161	0.087361
0.133333	0.003297	0.000295	0.106995
0.177778	0.003785	0.000453	0.123547
0.222222	0.004207	0.000631	0.138130
0.266667	0.004582	0.000826	0.151314
0.311111	0.004919	0.001037	0.163437
0.355556	0.005227	0.001263	0.174722
0.400000	0.005510	0.001502	0.185321
0.444444	0.005772	0.001752	0.195345
0.488889	0.006016	0.002014	0.204880
0.533333	0.006244	0.002287	0.213990
0.577778	0.006457	0.002569	0.222728
0.622222	0.006657	0.002861	0.231135
0.666667	0.006845	0.003161	0.239248
0.711111	0.007022	0.003469	0.247094
0.755556	0.007189	0.003785	0.254699
0.800000	0.007347	0.004108	0.262083
0.844444	0.007496	0.004438	0.269265
0.888889	0.007636	0.004774	0.276260
0.933333	0.007769	0.005116	0.283082
0.977778	0.007894	0.005464	0.289744
1.022222	0.008011	0.005818	0.296256
1.066667	0.008122	0.006176	0.302627
1.111111	0.008227	0.006540	0.308868
1.155556	0.008325	0.006908	0.314985
1.200000	0.008417	0.007280	0.320985
1.244444	0.008503	0.007656	0.326875
1.288889	0.008584	0.008035	0.332661
1.333333	0.008659	0.008419	0.338348
1.377778	0.008728	0.008805	0.343941
1.422222	0.008792	0.009194	0.349444
1.466667	0.008851	0.009586	0.354862
1.511111	0.008905	0.009981	0.360199
1.555556	0.008954	0.010378	0.365457
1.600000	0.008998	0.010777	0.370641
1.644444	0.009037	0.011178	0.375754
1.688889	0.009072	0.011580	0.382741
1.733333	0.009102	0.011984	0.402865
1.777778	0.009127	0.012389	0.430460
1.822222	0.009147	0.012795	0.463216
1.866667	0.009163	0.013202	0.500028
1.911111	0.009175	0.013610	0.540192
1.955556	0.009181	0.014018	0.583200
2.000000	0.009184	0.014426	0.628657
2.044444	0.009181	0.014834	0.676242
2.088889	0.009175	0.015242	0.725686
2.133333	0.009163	0.015649	0.776759
2.177778	0.009147	0.016056	0.829258
2.222222	0.009127	0.016462	0.883001
2.266667	0.009102	0.016867	0.937826
2.311111	0.009072	0.017271	0.993586
2.355556	0.009037	0.017674	1.050143
2.400000	0.008998	0.018075	1.107373
2.444444	0.008954	0.018474	1.165159
2.488889	0.008905	0.018870	1.223390
2.533333	0.008851	0.019265	1.281965
2.577778	0.008792	0.019657	1.340785
2.622222	0.008728	0.020047	1.399759
2.666667	0.008659	0.020433	1.458800
2.711111	0.008584	0.020816	1.527160
2.755556	0.008503	0.021196	1.599057
2.800000	0.008417	0.021572	1.672336
2.844444	0.008325	0.021944	1.746968
2.888889	0.008227	0.022312	1.822929
2.933333	0.008122	0.022675	1.900193
2.977778	0.008011	0.023034	1.978737
3.022222	0.007894	0.023387	2.073096
3.066667	0.007769	0.023735	2.297786

3.111111	0.007636	0.024078	2.615601
3.155556	0.007496	0.024414	3.001474
3.200000	0.007347	0.024744	3.439591
3.244444	0.007189	0.025067	3.916064
3.288889	0.007022	0.025383	4.417081
3.333333	0.006845	0.025691	4.928455
3.377778	0.006657	0.025991	5.435774
3.422222	0.006457	0.026282	5.924878
3.466667	0.006244	0.026565	6.382557
3.511111	0.006016	0.026837	6.797408
3.555556	0.005772	0.027099	7.160834
3.600000	0.005510	0.027350	7.468143
3.644444	0.005227	0.027589	7.719764
3.688889	0.004919	0.027814	7.922539
3.733333	0.004582	0.028026	8.091114
3.777778	0.004207	0.028221	8.330338
3.822222	0.003785	0.028399	8.509765
3.866667	0.003297	0.028556	8.684475
3.911111	0.002707	0.028690	8.854824
3.955556	0.001925	0.028794	9.021128
4.000000	0.001000	0.028852	9.183664

END FTABLE 1
FTABLE 3
91 4

Depth (ft)	Area (acres)	Volume (acre-ft)	Outflow1 (cfs)	Velocity (ft/sec)	Travel Time*** (Minutes)***
0.000000	0.000000	0.000000	0.000000		
0.033333	0.000508	0.000011	0.093751		
0.066667	0.000715	0.000032	0.132584		
0.100000	0.000871	0.000058	0.162381		
0.133333	0.001000	0.000090	0.187502		
0.166667	0.001111	0.000125	0.209633		
0.200000	0.001210	0.000164	0.229642		
0.233333	0.001299	0.000205	0.248041		
0.266667	0.001380	0.000250	0.265167		
0.300000	0.001455	0.000297	0.281252		
0.333333	0.001524	0.000347	0.296466		
0.366667	0.001589	0.000399	0.310936		
0.400000	0.001649	0.000453	0.324762		
0.433333	0.001705	0.000509	0.338023		
0.466667	0.001758	0.000567	0.350783		
0.500000	0.001808	0.000626	0.363095		
0.533333	0.001855	0.000687	0.375003		
0.566667	0.001899	0.000750	0.386544		
0.600000	0.001940	0.000814	0.397751		
0.633333	0.001980	0.000879	0.408650		
0.666667	0.002017	0.000946	0.419266		
0.700000	0.002052	0.001013	0.429620		
0.733333	0.002085	0.001082	0.439730		
0.766667	0.002116	0.001152	0.449613		
0.800000	0.002145	0.001223	0.459283		
0.833333	0.002173	0.001295	0.468754		
0.866667	0.002199	0.001368	0.478037		
0.900000	0.002223	0.001442	0.487143		
0.933333	0.002246	0.001516	0.496082		
0.966667	0.002267	0.001592	0.504863		
1.000000	0.002287	0.001667	0.513494		
1.033333	0.002305	0.001744	0.521982		
1.066667	0.002322	0.001821	0.530334		
1.100000	0.002338	0.001899	0.540201		
1.133333	0.002352	0.001977	0.557074		
1.166667	0.002365	0.002056	0.577762		
1.200000	0.002376	0.002135	0.601163		
1.233333	0.002387	0.002214	0.626732		
1.266667	0.002396	0.002294	0.654118		
1.300000	0.002404	0.002374	0.683069		
1.333333	0.002410	0.002454	0.713391		
1.366667	0.002416	0.002534	0.744925		
1.400000	0.002420	0.002615	0.777541		
1.433333	0.002423	0.002696	0.811126		

```
   1.466667  0.002425  0.002777  0.845583
   1.500000  0.002425  0.002857  0.880824
   1.533333  0.002425  0.002938  0.916773
   1.566667  0.002423  0.003019  0.953358
   1.600000  0.002420  0.003100  0.990517
   1.633333  0.002416  0.003180  1.028188
   1.666667  0.002410  0.003261  1.066319
   1.700000  0.002404  0.003341  1.104858
   1.733333  0.002396  0.003421  1.143757
   1.766667  0.002387  0.003501  1.182971
   1.800000  0.002376  0.003580  1.222458
   1.833333  0.002365  0.003659  1.262177
   1.866667  0.002352  0.003738  1.302092
   1.900000  0.002338  0.003816  1.342164
   1.933333  0.002322  0.003894  1.382359
   1.966667  0.002305  0.003971  1.422645
   2.000000  0.002287  0.004047  1.462989
   2.033333  0.002267  0.004123  1.565868
   2.066667  0.002246  0.004198  1.748688
   2.100000  0.002223  0.004273  1.983100
   2.133333  0.002199  0.004346  2.258270
   2.166667  0.002173  0.004419  2.566911
   2.200000  0.002145  0.004491  2.902897
   2.233333  0.002116  0.004562  3.260431
   2.266667  0.002085  0.004632  3.633711
   2.300000  0.002052  0.004701  4.016812
   2.333333  0.002017  0.004769  4.403693
   2.366667  0.001980  0.004836  4.788261
   2.400000  0.001940  0.004901  5.164501
   2.433333  0.001899  0.004965  5.526632
   2.466667  0.001855  0.005028  5.869300
   2.500000  0.001808  0.005089  6.187796
   2.533333  0.001758  0.005148  6.478296
   2.566667  0.001705  0.005206  6.738118
   2.600000  0.001649  0.005262  6.966003
   2.633333  0.001589  0.005316  7.162410
   2.666667  0.001524  0.005368  7.329825
   2.700000  0.001455  0.005417  7.473089
   2.733333  0.001380  0.005465  7.599737
   2.766667  0.001299  0.005509  7.795960
   2.800000  0.001210  0.005551  7.934547
   2.833333  0.001111  0.005590  8.070351
   2.866667  0.001000  0.005625  8.203536
   2.900000  0.000871  0.005656  8.334251
   2.933333  0.000715  0.005683  8.462630
   2.966667  0.000508  0.005703  8.588797
   3.000000  0.001000  0.005715  8.712864
  END FTABLE  3
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1.3             PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1.3             IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.8             PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.8             IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
RCHRES   2 HYDR   RO      1 1        1     WDM   1000 FLOW     ENGL      REPL
RCHRES   2 HYDR   STAGE   1 1        1     WDM   1001 STAG     ENGL      REPL
COPY     1 OUTPUT MEAN    1 1     48.4     WDM    701 FLOW     ENGL      REPL
COPY   501 OUTPUT MEAN    1 1     48.4     WDM    801 FLOW     ENGL      REPL
RCHRES   1 HYDR   RO      1 1        1     WDM   1002 FLOW     ENGL      REPL
RCHRES   1 HYDR   STAGE   1 1        1     WDM   1003 STAG     ENGL      REPL
COPY     2 OUTPUT MEAN    1 1     48.4     WDM    702 FLOW     ENGL      REPL
```

```
COPY    502 OUTPUT MEAN   1 1      48.4      WDM    802 FLOW      ENGL      REPL
RCHRES    3 HYDR   RO     1 1         1      WDM   1004 FLOW      ENGL      REPL
RCHRES    3 HYDR   STAGE  1 1         1      WDM   1005 STAG      ENGL      REPL
COPY      3 OUTPUT MEAN   1 1      48.4      WDM    703 FLOW      ENGL      REPL
COPY    503 OUTPUT MEAN   1 1      48.4      WDM    803 FLOW      ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->      <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->      <Name>                <Name> # #***
  MASS-LINK       2
PERLND     PWATER SURO       0.083333       RCHRES         INFLOW IVOL
  END MASS-LINK   2

  MASS-LINK       3
PERLND     PWATER IFWO       0.083333       RCHRES         INFLOW IVOL
  END MASS-LINK   3

  MASS-LINK       5
IMPLND     IWATER SURO       0.083333       RCHRES         INFLOW IVOL
  END MASS-LINK   5

  MASS-LINK       12
PERLND     PWATER SURO       0.083333       COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333       COPY           INPUT  MEAN
  END MASS-LINK   13

  MASS-LINK       15
IMPLND     IWATER SURO       0.083333       COPY           INPUT  MEAN
  END MASS-LINK   15

  MASS-LINK       16
RCHRES     ROFLOW                           COPY           INPUT  MEAN
  END MASS-LINK   16


END MASS-LINK

END RUN
```

Predeveloped HSPF Message File

Mitigated HSPF Message File

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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

Geotechnical Site Investigation

Sage Property

Camas, Washington

January 4, 2021

Geotechnical ■ Environmental ■ Special Inspections

Columbia West

Engineering, Inc

11917 NE 95th Street
Vancouver, Washington
98682
Phone: 360-823-2900
Fax: 360-823-2901

www.columbiawestengineering.com

Geotechnical ▪ Environmental ▪ Special Inspections
Columbia West
Engineering, Inc

GEOTECHNICAL SITE INVESTIGATION
SAGE PROPERTY
CAMAS, WASHINGTON

Prepared For:	**Mr. Sergey Marandyuk** **Modern NW, Inc.** **8101 NE Glisan Street** **Portland, Oregon 97213**
Site Location:	**1811 NW Hood Street** **Parcel Nos. 127415000, 127440000** **Camas, Washington**
Prepared By:	**Columbia West Engineering, Inc.** **11917 NE 95th Street** **Vancouver, Washington 98682** **Phone: 360-823-2900** **Fax: 360-823-2901**
Date Prepared:	**January 4, 2021**

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GEOTECHNICAL SITE INVESTIGATION
SAGE PROPERTY
CAMAS, WASHINGTON

1.0 INTRODUCTION

Columbia West Engineering, Inc. (Columbia West) was retained by Modern NW, Inc. to conduct a geotechnical site investigation for the proposed Sage Property single-family residential project located in Camas, Washington. The purpose of the investigation was to observe and assess subsurface soil conditions at specific locations and provide geotechnical engineering analyses, planning, and design recommendations for proposed development. This report also addresses potential geologic hazard areas in accordance with *Camas Municipal Code, Section 16.59, Geologically Hazardous Areas*. The specific scope of services was outlined in a proposal contract dated August 13, 2020. This report summarizes the investigation and provides field assessment documentation and laboratory analytical test reports. This report is subject to the limitations expressed in Section 7.0, *Conclusion and Limitations*, and Appendix E.

1.1 General Site Information

As indicated on Figures 1 and 2, the subject site is located at 1811 NW Hood Street in Camas, Washington. The site is comprised of tax parcels 127415000 and 127440000 totaling approximately 6.08 acres. The approximate latitude and longitude are N 45° 35' 30" and W 122° 26' 37", and the legal description is a portion of the NE ¼ of Section 09, T1N, R3E, Willamette Meridian. The regulatory jurisdictional agency is the City of Camas, Washington.

1.2 Proposed Development

Correspondence with the client indicates that proposed development includes construction of a single-family residential subdivision with approximately 15 building lots, paved public roadways, underground utilities, and stormwater management facilities. The preliminary site plan is indicated on Figure 2A. Columbia West has not reviewed preliminary grading plans but understands that cut and fill will likely be proposed at the subject site. This report is based upon proposed development as described above and may not be applicable if modified.

2.0 REGIONAL GEOLOGY AND SOIL CONDITIONS

The subject site lies within the Willamette Valley/Puget Sound Lowland, a wide physiographic depression flanked by the mountainous Coast Range on the west and the Cascade Range on the east. Inclined or uplifted structural zones within the Willamette Valley/Puget Sound Lowland constitute highland areas and depressed structural zones form sediment-filled basins. The site is located in the eastern portion of the Portland/Vancouver Basin, an open, somewhat elliptical, northwest-trending syncline approximately 60 miles wide.

According to the *Geologic Map of the Camas Quadrangle, Clark County, Washington, and Multnomah County, Oregon* (Russell C. Evarts, USGS Geological Survey, 2008), near-surface soils on the eastern portion of the subject site are expected to consist of Holocene-aged, unconsolidated loess deposits of silt and fine sand (Qlo). Mapped QTc exposures on the western portion of the property indicate that loess deposits may be underlain by Pleistocene- to Pliocene-aged, unconsolidated to cemented, pebble- to boulder-sized sedimentary conglomerate.

The *Web Soil Survey* (United States Department of Agriculture, Natural Resource Conservation Service [USDA NRCS], 2020 Website) identifies surface soils as Powell silt loam. Powell series soils are generally fine-textured clays and silts with low permeability, moderate water capacity, and low shear strength. Powell soils are generally moisture sensitive, somewhat compressible, and described as having low shrink-swell potential. The erosion hazard is slight primarily based upon slope grade.

3.0 REGIONAL SEISMOLOGY

Recent research and subsurface mapping investigations within the Pacific Northwest appear to suggest the historic potential risk for a large earthquake event with strong localized ground movement may be underestimated. Past earthquakes in the Pacific Northwest appear to have caused landslides and ground subsidence, in addition to severe flooding near coastal areas. Earthquakes may also induce soil liquefaction, which occurs when elevated horizontal ground acceleration and velocity cause soil particles to interact as a fluid as opposed to a solid. Liquefaction of soil can result in lateral spreading and temporary loss of bearing capacity and shear strength.

There are at least four major known fault zones in the vicinity of the site that may be capable of generating potentially destructive horizontal accelerations. These fault zones are described briefly in the following text.

<u>Portland Hills Fault Zone</u>

The Portland Hills Fault Zone consists of several northwest-trending faults located along the northeastern margin of the Tualatin Mountains, also known as the Portland Hills, and the southwest margin of the Portland Basin. The fault zone is approximately 25 to 30 miles in length and is located approximately 18 miles west of the site. According to *Seismic Design Mapping, State of Oregon* (Geomatrix Consultants, 1995), there is no definitive consensus among geologists as to the zone fault type. Several alternate interpretations have been suggested.

According to the *USGS Earthquake Hazards Program*, the fault was originally mapped as a down-to-the-northeast normal fault but has also been mapped as part of a regional-scale zone of right-lateral, oblique slip faults, and as a steep escarpment caused by asymmetrical folding above a south-west dipping, blind thrust fault. The Portland Hills fault offsets Miocene Columbia River Basalts, and Miocene to Pliocene sedimentary rocks of the Troutdale Formation. No fault scarps on surficial Quaternary deposits have been described along the fault trace, and the fault is mapped as buried by the Pleistocene-aged Missoula flood deposits.

However, evidence suggests that fault movement has impacted shallow Holocene deposits and deeper Pleistocene sediments. Seismologists recorded a M3.2 earthquake thought to be associated with the fault zone near Kelly Point Park in November 2012, a M3.9 earthquake thought to be associated with the fault zone near Kelly Point Park in April 2003, and a M3.5 earthquake possibly associated with the fault zone approximately 1.3 miles east of the fault in 1991. Therefore, the Portland Hills Fault Zone is generally thought to be potentially active and capable of producing possible damaging earthquakes.

Gales Creek-Newberg-Mt. Angel Fault Zone

Located approximately 32 miles southwest of the site, the northwest-striking, approximately 50-mile long Gales Creek-Newberg-Mt. Angel Structural Zone forms the northwestern boundary between the Oregon Coast Range and the Willamette Valley, and consists of a series of discontinuous northwest-trending faults. The southern end of the fault zone forms the southwest margin of the Tualatin basin. Possible late-Quaternary geomorphic surface deformation may exist along the structural zone (Geomatrix Consultants, 1995).

According to the *USGS Earthquake Hazards Program*, the Mount Angel fault is mapped as a high-angle, reverse-oblique fault, which offsets Miocene rocks of the Columbia River Basalts, and Miocene and Pliocene sedimentary rocks. The fault appears to have controlled emplacement of the Frenchman Spring Member of the Wanapum Basalts, and thus must have a history that predates the Miocene age of these rocks. No unequivocal evidence of deformation of Quaternary deposits has been described as a thick sequence of sediments deposited by the Missoula floods covers much of the southern part of the fault trace.

Although no definitive evidence of impacts to Holocene sediments have clearly been identified, the Mount Angel fault appears to have been the location of minor earthquake swarms in 1990 near Woodburn, Oregon, and a M5.6 earthquake in March 1993 near Scotts Mills, approximately four miles south of the mapped extent of the Mt. Angel fault. It is unclear if the earthquake occurred along the fault zone or a parallel structure. Therefore, the Gales Creek-Newberg-Mt. Angel Structural Zone is considered potentially active.

Lacamas Lake-Sandy River Fault Zone

The northwest-trending Lacamas Lake Fault and northeast-trending Sandy River Fault intersect north of Camas, Washington approximately two miles east of the site, and form part of the northeastern margin of the Portland basin. According to *Geology and Groundwater Conditions of Clark County Washington* (USGS Water Supply Paper 1600, Mundorff, 1964) and the *Geologic Map of the Lake Oswego Quadrangle* (Oregon DOGAMI Series GMS-59, 1989), the Lacamas Lake fault zone consists of shear contact between the Troutdale Formation and underlying Oligocene andesite-basalt bedrock. Secondary shear contact associated with the fault zone may have produced a series of prominent northwest-southeast geomorphic lineaments in proximity to the site.

According to the *USGS Earthquake Hazards Program* the fault has been mapped as a normal fault with down-to-the-southwest displacement and has also been described as a steeply northeast or southwest-dipping, oblique, right-lateral, slip-fault. The trace of the Lacamas Lake fault is marked by the very linear lower reach of Lacamas Creek. No fault scarps on Quaternary surficial deposits have been described. The Lacamas Lake fault offsets Pliocene-aged sedimentary conglomerates generally identified as the Troutdale formation, and Pliocene- to Pleistocene-aged basalts generally identified as the Boring Lava formation.

Recent seismic reflection data across the probable trace of the fault under the Columbia River yielded no unequivocal evidence of displacement underlying the Missoula flood deposits, however, recorded mild seismic activity during the recent past indicates this area may be potentially seismogenic.

Cascadia Subduction Zone

The Cascadia Subduction Zone has recently been recognized as a potential source of strong earthquake activity in the Portland/Vancouver Basin. This phenomenon is the result of the earth's large tectonic plate movement. Geologic evidence indicates that volcanic ocean floor activity along the Juan de Fuca ridge in the Pacific Ocean causes the Juan de Fuca Plate to perpetually move east and subduct under the North American Continental Plate. The subduction zone results in historic volcanic and potential earthquake activity in proximity to the plate interface, believed to lie approximately 20 to 50 miles west of the general location of the Oregon and Washington coast (Geomatrix Consultants, 1995).

4.0 GEOTECHNICAL AND GEOLOGIC FIELD INVESTIGATION

A geotechnical field investigation consisting of visual reconnaissance, eight test pits (TP-1 through TP-8), and three infiltration tests was conducted at the site on November 20, 2020. Test pits were explored with a track-mounted excavator. Subsurface soil profiles were logged in accordance with Unified Soil Classification System (USCS) specifications. Disturbed soil samples were collected from relevant soil horizons and submitted for laboratory analysis. Analytical laboratory test results are presented in Appendix A. Exploration locations are indicated on Figure 2. Subsurface exploration logs are presented in Appendix B. Soil descriptions and classification information are provided in Appendix C. A photo log is presented in Appendix D.

4.1 Surface Investigation and Site Description

The approximate 6.08-acre subject site consists of two tax parcels located at 1811 NW Hood Street in Camas, Washington. The site is bounded by residential development to the north and west, NW 16th Avenue to the south, and NW Hood Street to the east. Observed site structures included an existing single-family home and an agricultural outbuilding located along the eastern property boundary. Site vegetation primarily consisted of grass in open areas with trees and shrubs concentrated around existing structures. Site elevations range from approximately 642 to 730 feet above mean sea level (amsl) respectively between the east and west site boundaries.

Field reconnaissance and review of site topographic mapping indicate rolling to gently sloped terrain with grades of 10 to 15 percent characterizing the site. Slope grades exceed 15 percent in localized areas and are identified as potential landslide hazards according to *Clark County Maps Online*. Discussion related to slope geometry, geomorphic features, and stability are discussed later in Section 5.0, *Geologically Hazardous Areas*.

4.2 Subsurface Exploration and Investigation

Test pits were explored to a maximum depth of 14 feet below ground surface (bgs). Exploration locations were selected to observe subsurface soil characteristics in proximity to proposed development areas and are indicated on Figure 2.

4.2.1 Soil Type Description

The field investigation indicated the presence of approximately 12 to 16 inches of sod and topsoil in the observed locations. Underlying the topsoil layer, subsurface soils resembling native USDA Powell soil series descriptions were encountered. Subsurface lithology was reasonably consistent at explored locations and may generally be described by soil types identified in the following text. Detailed field logs and observed stratigraphy for the encountered materials are presented in Appendix B, *Subsurface Exploration Logs*.

Soil Type 1 – Existing FILL

Soil Type 1 represents existing fill and was observed to consist of tan to dark brown, moist to wet, medium stiff silt. Soil Type 1 was observed below the topsoil layer in test pit TP-5 and extended to an observed depth of 5 feet bgs. Additional discussion and recommendations pertaining to Soil Type 1 are discussed in Section 6.1.1, *Existing Fill.*

Soil Type 2 – Lean CLAY

Soil Type 2 was observed to primarily consist of tan to brown moist to wet, medium stiff to stiff lean CLAY. Soil Type 2 was observed below Soil Type 1 in test pit TP-5 and below the topsoil layer in all other test pits. Soil Type 2 extended to observed depths of 6.5 to 13 feet bgs where it was typically underlain by Soil Type 3.

Analytical laboratory testing conducted upon representative soil samples obtained from test pits TP-1, TP-3, and TP-6 indicated approximately 85 to 87 percent by weight passing the No. 200 sieve and in situ moisture contents ranging from 25 to 30 percent. Atterberg Limits analysis conducted on tested samples of Soil Type 2 indicated liquid limits ranging from 31 to 41 percent and plasticity indices ranging from 11 to 21 percent. The laboratory tested samples of Soil Type 2 are classified CL according to USCS specifications and A-6(8), A-6(16), and A-7-6(18) according to AASHTO specifications.

Soil Type 3 – Sandy Elastic SILT

Soil Type 3 was observed to primarily consist of brown to orange/red-brown, moist to wet, medium stiff to stiff sandy elastic SILT. Portions of the soil type contained trace to some subrounded gravels, cobbles, and boulders which may represent initial transition from unconsolidated regolith to mapped sedimentary conglomerate (Evarts, 2008). With the exception of TP-3, Soil Type 3 was observed below Soil Type 2 in all test pit explorations and extended to the maximum depth of exploration.

Analytical laboratory testing conducted upon a representative soil sample obtained from test pit TP-7 indicated approximately 53 percent by weight passing the No. 200 sieve and an in situ moisture content of approximately 42 percent. Atterberg Limits analysis indicated a liquid limit of 58 percent and a plasticity index of 25 percent. The laboratory tested sample of Soil

Type 3 is classified MH according to USCS specifications and A-7-5(11) according to AASHTO specifications.

4.2.2 Groundwater

Groundwater seeps and springs were observed within test pit explorations TP-3 through TP-8 at depths ranging from 2 to 8 feet bgs. Review of nearby well logs obtained from the State of Washington Department of Ecology indicates that static groundwater levels in the area may vary significantly. Variations in ground water elevations likely reflect the screened interval depth of these wells, changes in ground surface elevation, and the presence of multiple aquifers and confining units. Mitigation of shallow groundwater within proposed development areas is discussed in greater detail in Section 6.8, *Dewatering* and Section 6.12, *Drainage*.

Groundwater levels are often subject to seasonal variance and may rise during extended periods of increased precipitation or flooding. Perched groundwater may also be present in localized areas. Seeps and springs may become evident during site grading, primarily along slopes or in areas cut below existing grade. Structures, roads, and drainage design should be planned accordingly.

5.0 GEOLOGICALLY HAZARDOUS AREAS

Camas Municipal Code, Section 16.59 defines geologic hazard requirements for proposed development in areas subject to City of Camas jurisdiction. Three potential geologic hazards are identified: (1) erosion hazard areas, (2) landslide hazard areas, and (3) seismic hazard areas. As previously indicated, hazard mapping obtained from *Clark County Maps Online* indicates potential landslide hazard areas (slopes greater than 15 percent) within portions of the property.

Columbia West conducted a geologic hazard review to assess whether these hazards are present at the subject property proposed for development, and if so, to provide mitigation recommendations. The geologic hazard review was based upon physical and visual reconnaissance, subsurface exploration, laboratory analysis of collected soil samples, and review of maps and other published technical literature. The results of the geologic hazard review are discussed in the following sections.

5.1 Erosion Hazards

Camas Municipal Code, Section 16.59.020.A defines an erosion hazard as areas where slope grades meet or exceed 40 percent. Based upon review of slope grade mapping published by *Clark County Maps Online,* maximum slope grades of 15 to 25 percent are mapped in the central and western portions of the site. Therefore, site slopes do not meet the definition of an erosion hazard according to *Camas Municipal Code*.

5.2 Landslide Hazards

Columbia West conducted a review of available mapping, *Clark County GIS* data, and site reconnaissance to evaluate the potential presence of a landslide hazard on or near the subject site.

5.2.1 Geologic Literature Review

Columbia West reviewed *Slope Stability, Clark County, Washington* (Fiksdal, 1975) to assess site slope characteristics. The Fiksdal report identifies four levels of potential instability within Clark County: (1) stable areas – no slides or unstable slopes, (2) areas of potential instability because of underlying geologic conditions and physical characteristics associated with steepness, (3) areas of historical or still active landslides, and (4) older landslide debris. The site is mapped as (1) stable – no slides or unstable slopes.

Columbia West also reviewed the *Geologic Map of the Camas Quadrangle, Clark County, Washington, and Multnomah County, Oregon* (Russell C. Evarts, USGS Geological Survey, 2008) and the *Landslide Inventory Map of the Northwest Quarter of the Camas Quadrangle, Multnomah County, Oregon, and Clark County, Washington* (William Burns, et al., 2012) which indicates that no active landslides or historic landslide deposits are mapped at the subject site or in the surrounding vicinity.

5.2.2 Slope Reconnaissance and Slope Stability Assessment

To observe geomorphic conditions, Columbia West personnel conducted visual and physical reconnaissance of slopes on the property. Test pits TP-1 through TP-8 were explored in sloped areas. Subsurface native soils at the locations tested generally consisted of medium stiff to stiff lean clay and sandy elastic silt with trace to some gravels, cobbles, and boulders. Soil horizons appeared firm and well developed.

Review of topographic mapping published by *Clark County Maps Online* indicates that the subject site is located in an area that slopes regionally downgradient from east to west with no apparent toe or crest observed on the property or adjacent parcels. The maximum grade change between the east and west property boundaries is approximately 88 feet. Slope grades of 10 to 15 percent characterize the property with localized areas approaching 15 to 25 percent. Slopes appear planar with no observed evidence of instability. There was no observed direct evidence of large-scale, mass slope movements or historic landslides. No landslide debris was observed within explored site soils and groundwater seeps or springs within the face of the slopes were not observed.

Camas Municipal Code defines a landslide hazard as slopes mapped by Fiksdal as ‘areas of potential instability’ or areas meeting all three of the following characteristics: 1) slopes steeper than 15 percent; 2) hillsides intersecting geologic contacts with permeable sediment overlying low permeability sediment or bedrock, and; 3) any springs or groundwater seepage. The above-mentioned criteria were not observed during our field investigation or site research. Based upon the results of slope reconnaissance, subsurface exploration, and site research, slopes on the subject site do not appear to meet the definition of a landslide hazard according to *Camas Municipal Code.*

5.3 Seismic Hazard Areas

Seismic hazards include areas subject to severe risk of earthquake-induced damage. Damage may occur due to soil liquefaction, dynamic settlement, ground shaking amplification, or surface faulting rupture. These seismic hazards are discussed below.

5.3.1 Soil Liquefaction and Dynamic Settlement

According to *the Liquefaction Susceptibility Map of Clark County, Washington* (Washington State Department of Natural Resources, 2004), the site is mapped as very low susceptibility for liquefaction. Liquefaction, defined as the transformation of the behavior of a granular material from a solid to a liquid due to increased pore-water pressure and reduced effective stress, may occur when granular materials quickly compact under cyclic stresses caused by a seismic event. The effects of liquefaction may include immediate ground settlement, lateral spreading, and differential compaction.

Soils most susceptible to liquefaction are recent geologic deposits, such as river and floodplain sediments. These soils are generally saturated, cohesionless, loose to medium dense sands within 50 feet of ground surface. Potentially liquefiable soils located above the existing, historic, or expected ground water levels do not generally pose a liquefaction hazard. It is important to note that changes in perched ground water elevation may occur due to project development or other factors not observed at the time of investigation.

Based upon the results of subsurface exploration, literature review, and laboratory analysis, the above-mentioned criteria were not observed during the geotechnical site investigation. Therefore, the potential for soil liquefaction is considered to be very low.

5.3.2 Ground Shaking Amplification

Review of the *Site Class Map of Clark County, Washington* (Washington State Department of Natural Resources, 2004), indicates that site soils may be represented by Site Class C as defined in *2015 IBC Section 1613.3.2*. A designation of Site Class C indicates that minor amplification of seismic energy may occur during a seismic event due to subsurface conditions. However, this is typical for many areas within Clark County, does not represent a geologic hazard in Columbia West's opinion, and will not prohibit development if properly accounted for during the design process. Additional seismic information is presented in Section 6.10, *Seismic Design Considerations*.

5.3.3 Fault Rupture

Because there are no known geologic seismic faults within the site boundaries, fault rupture is unlikely.

6.0 DESIGN RECOMMENDATIONS

The geotechnical site investigation suggests the proposed development is generally compatible with surface and subsurface soils, provided the recommendations presented in this report are utilized and incorporated into the design and construction processes. The primary geotechnical concerns associated with the site are existing fill, drainage, shallow groundwater, and fine-textured soil. Design recommendations are presented in the following text sections.

6.1 Site Preparation and Grading

Vegetation, organic material, unsuitable fill, and deleterious material that may be encountered should be cleared from areas identified for structures and site grading. Vegetation, other organic material, and debris should be removed from the site. Stripped topsoil should also be removed or used only as landscape fill in nonstructural areas with slopes less than 25 percent. The stripping depth for sod and highly organic topsoil is anticipated to vary between approximately 12 and 16 inches. The required stripping depth may increase in areas of existing fill, heavy organics, or previously existing structures. Actual stripping depths should be determined based upon visual observations made during construction when soil conditions are exposed. The post-construction maximum depth of landscape fill placed or spread at any location onsite should not exceed one foot.

Previously disturbed soil, debris, or unconsolidated fill encountered during grading or construction activities should be removed completely and thoroughly from structural areas. This includes old foundations, basement walls, utilities, associated soft soils, and debris. Excavation areas should be backfilled with engineered structural fill.

Test pits excavated during site exploration were backfilled loosely with onsite soils. These test pits should be located and properly backfilled with structural fill during site improvements construction. Trees, stumps, and associated roots should also be removed from structural areas, individually and carefully. Resulting cavities and excavation areas should be backfilled with engineered structural fill.

Site grading activities should be performed in accordance with requirements specified in the *2015 International Building Code* (IBC), Chapter 18 and Appendix J, with exceptions noted in the text herein. Site preparation, soil stripping, and grading activities should be observed and documented by Columbia West.

6.1.1 Existing Fill

As previously discussed and indicated on Figure 2, existing fill was observed within test pit TP-5 and extended to an observed depth of 5 feet bgs. Observed fill material generally consisted of tan to dark brown, moist to wet, medium stiff silt. As presented in Appendix D, *Photo Log*, review of 1998 aerial imagery published by *Clark County Maps Online* indicates previous site disturbance and potential earthwork activity in the vicinity of test pit TP-5.

Existing fill and other previously disturbed soils or debris are not suitable for bearing structures in their current state and should be removed completely and thoroughly from structural areas. In some areas, existing fill may directly overlie vegetation and the original topsoil layer. This material should also be removed completely. Upon removal of existing fill, Columbia West should observe the exposed subgrade to verify adequate support conditions.

Based upon Columbia West's investigation, existing fill soils as described appear to be acceptable for reuse as structural fill, provided materials are observed to exhibit index properties similar to those observed during this investigation and that construction adheres to the specifications presented in this report. Portions of existing fill found to contain highly organic soils, debris, or other deleterious material should be removed. Note that the limited scope of exploration conducted for this investigation cannot wholly eliminate uncertainty regarding the presence of unsuitable soils in areas not explored. Final recommendations regarding the suitability of reusing existing fill soils as structural fill material should be provided in the field by Columbia West during construction.

6.2 Engineered Structural Fill

Areas proposed for fill placement should be appropriately prepared as described in the preceding text. Surface soils should then be scarified and compacted prior to additional fill placement. Engineered structural fill should be placed in loose lifts not exceeding 12 inches in depth and compacted using standard conventional compaction equipment. The soil moisture content should be within two percentage points of optimum conditions. A field density at least equal to 95 percent of the maximum dry density, obtained from the standard Proctor moisture-density relationship test (ASTM D698), is recommended for structural fill placement. Engineered structural fill placed on sloped grades should be benched to provide a horizontal surface for compaction.

Compaction of engineered structural fill should be verified by nuclear gauge field compaction testing performed in accordance with ASTM D6938. Field compaction testing should be performed for each vertical foot of engineered fill placed. Engineered fill placement should be observed by Columbia West.

Engineered structural fill placement activities should be performed during dry summer months if possible. Most clean native soils (Soil Types 2 and 3) may be suitable for use as structural fill if adequately dried or moisture-conditioned to achieve recommended compaction specifications. Native soils with a plasticity index greater than 25, if encountered, should be evaluated and approved by Columbia West prior to use as structural fill. Boulders and large cobbles exceeding approximately six inches in diameter should be removed from proposed native fill soils prior to placement. Native soils may require addition of moisture during periods of dry weather. Compacted fill soils should be covered shortly after placement.

Because they are moisture-sensitive, fine-textured soils are often difficult to excavate and compact during wet weather conditions. If adequate compaction is not achievable with clean native soils, import structural fill consisting of granular fill meeting WSDOT specifications for *Gravel Borrow 9-03.14(1)* is recommended.

Representative samples of proposed engineered structural fill should be submitted for laboratory analysis and approval by Columbia West prior to placement. Laboratory analyses should include particle-size gradation and standard Proctor moisture-density analysis.

6.3 Cut and Fill Slopes

Fill placed on existing grades steeper than 5H:1V should be horizontally benched at least 10 feet into the slope. Fill slopes greater than six feet in height should be vertically keyed into existing subsurface soil. A typical fill slope cross-section is shown in Figure 3. Drainage implementations, including subdrains or perforated drain pipe trenches, may also be necessary in proximity to cut and fill slopes if seeps or springs are encountered. Drainage design may be performed on a case-by-case basis. Extent, depth, and location of drainage may be determined in the field by Columbia West during construction when soil conditions are exposed. Failure to provide adequate drainage may result in soil sloughing, settlement, or erosion.

Final cut or fill slopes at the site should not exceed 2H:1V or 20 feet in height without individual slope stability analysis. The values above assume a minimum horizontal setback for loads of 10 feet from top of cut or fill slope face or overall slope height divided by three (H/3), whichever is greater. A minimum slope setback detail for structures is presented in Figure 4.

Concentrated drainage or water flow over the face of slopes should be prohibited, and adequate protection against erosion is required. Fill slopes should be constructed by placing fill material in maximum 12-inch level lifts, compacting as described in Section 6.2, *Engineered Structural Fill* and horizontally benching where appropriate. Fill slopes should be overbuilt, compacted, and trimmed at least two feet horizontally to provide adequate compaction of the outer slope face. Proper cut and fill slope construction is critical to overall project stability and should be observed and documented by Columbia West.

6.4 Foundations

Residential foundations are anticipated to consist of shallow continuous perimeter or column spread footings. Typical building loads are not expected to exceed approximately 3 kips per foot for perimeter footings or 10 kips per column. If actual loading exceeds anticipated loading, additional analysis should be conducted for the specific load conditions and proposed footing dimensions. Footings should be designed by a licensed structural engineer and conform to the recommendations below.

The existing ground surface should be prepared as described in Section 6.1, *Site Preparation and Grading*, and Section 6.2, *Engineered Structural Fill*. Foundations should bear upon firm native soil (Soil Types 2 or 3) or engineered structural fill.

To evaluate bearing capacity for proposed structures, serviceability and reliability of shear resistance for subsurface soils was considered. Allowable bearing capacity is typically a function of footing dimension and subsurface soil properties, including settlement and shear resistance. Based upon in situ field testing and laboratory analysis, the estimated allowable bearing capacity for well-drained foundations prepared as described above is 1,500 psf. Bearing capacity may be increased by one-third for transient lateral forces such as seismic or wind. The estimated coefficient of friction between in situ compacted native soil or engineered structural fill and in-place poured concrete is 0.35. Lateral forces may also be resisted by an assumed passive soil equivalent fluid pressure of 250 psf/f against embedded footings. The upper six inches of soil should be neglected in passive pressure calculations.

Footings should extend to a depth at least 18 inches below lowest adjacent grade to provide adequate bearing capacity and protection against frost heave. Foundations constructed during wet weather conditions will require over-excavation of saturated subgrade soils and granular structural backfill prior to concrete placement. Over-excavation recommendations should be provided by Columbia West during foundation excavation and construction. Excavations adjacent to foundations should not extend within a 2H:1V angle projected down from the outside bottom footing edge without additional geotechnical analysis.

Foundations should not be permitted to bear upon existing fill or disturbed soil (Soil Type 1). Columbia West should observe foundation excavations prior to placing forms or reinforcing bar to verify subgrade support conditions are as anticipated in this report.

6.5 Slabs on Grade

Proposed residential structures may have slab-on-grade floors. Slabs should be supported on firm, competent, in situ soil (Soil Types 2 or 3) or engineered structural fill. Disturbed soils and unsuitable fills in proposed slab locations should be removed and replaced with structural fill.

Preparation and compaction beneath slabs should be performed in accordance with the recommendations presented in Section 6.1, *Site Preparation and Grading* and Section 6.2, *Engineered Structural Fill*. Slabs should be underlain by at least 6 inches of 1 ¼"-0 crushed aggregate meeting WSDOT 9-03.9(3). Geotextile filter fabric conforming to *WSDOT 2010 Standard Specification M 41-10, 9-33.2(1), Geotextile Properties, Table 3: Geotextile for Separation or Soil Stabilization* may be used below the crushed aggregate to increase subgrade support. For lightly loaded slabs not exceeding 200 psf, the modulus of subgrade reaction is estimated to be 100 psi/inch. Columbia West should be contacted for additional analysis if slab loading exceeds 200 psf. If desired, a moisture barrier may be constructed beneath the slabs. Slabs should be appropriately waterproofed in accordance with the desired type of finished flooring. Slab thickness and reinforcement should be designed by an experienced structural engineer in accordance with anticipated loads.

6.6 Static Settlement

Total long-term static footing displacement for shallow foundations constructed as described in this report is not anticipated to exceed approximately 1 inch. Differential settlement between comparably loaded footing elements is not expected to exceed approximately ½ inch over a span of 50 feet. The resulting vertical displacement after loading may be due to elastic distortion, dissipation of excess pore pressure, or soil creep.

6.7 Excavation

Soils at the site were explored to a maximum depth of 14 feet using a track-mounted excavator. Explosive blasting is not anticipated, however, difficult excavation conditions associated with bouldery or cemented soils will require appropriately-sized equipment and potential specialized excavation techniques to construct site improvements.

Groundwater seeps and springs were encountered within test pit explorations TP-3 through TP-8 at depths ranging from 2 to 8 feet below ground surface. Recommendations as presented in Section 6.8, *Dewatering* should be considered where below-grade construction intersects the shallow groundwater table.

Based upon laboratory analysis and field testing, near-surface soils may be Washington State Industrial Safety and Health Administration (WISHA) Type C. For temporary open-cut excavations deeper than four feet, but less than 20 feet in soils of these types, the maximum allowable slope is 1.5H:1V. WISHA soil type should be confirmed during field construction activities by the contractor. Soil is often anisotropic and heterogeneous, and it is possible that WISHA soil types determined in the field may differ from those described above.

Site-specific shoring design may be required if open-cut excavations are infeasible or if excavations are proposed adjacent to existing infrastructure. Typical methods for stabilizing excavations consist of soldier piles and timber lagging, sheet pile walls, tiebacks and shotcrete, or pre-fabricated hydraulic shoring. Because lateral earth pressure distributions acting on below-grade structures are dependent upon the type of shoring system used, Columbia West should be contacted to conduct additional analysis when shoring type, excavation depths, and locations are known.

The contractor should be held responsible for site safety, sloping, and shoring. Columbia West is not responsible for contractor activities and in no case should excavation be conducted in excess of all applicable local, state, and federal laws.

6.8 Dewatering

Groundwater elevation and hydrostatic pressure should be carefully considered during design of utilities, retaining walls, or other structures that require below-grade excavation. Utility trenches in shallow groundwater areas or excavations and cuts that remain open for even short periods of time may undermine or collapse due to groundwater effects. Placement of layers of riprap or quarry spalls in localized areas on shallow excavation side slopes may be required to limit instability. Over-excavation and stabilization of pipe trenches or other excavations with imported crushed aggregate or gabion rock may also be necessary to provide adequate subgrade support.

Significant pumping and dewatering may be required to temporarily reduce the groundwater elevation to allow construction of proposed below-grade structures, installation of utilities, or placement of structural fills. Dewatering via a sump within excavation zones may be insufficient to control groundwater and provide excavation side slope stability. Dewatering may be more feasibly conducted by installing a system of temporary well points and pumps around proposed excavation areas or utility trenches. Depending on proposed utility depths, a site-specific dewatering plan may be necessary. Well pumps should remain functioning at all times during the excavation and construction period. Suitable back-up pumps and power supplies should be available to prevent unanticipated shut-down of dewatering equipment. Failure to operate pumps full-time may result in flooding of the excavation zones, resulting in damage to forms, slopes, or equipment.

6.9 Lateral Earth Pressure

If retaining walls are proposed, lateral earth pressures should be carefully considered in the design process. Hydrostatic pressure and additional surcharge loading should also be considered. Retained material may include engineered structural backfill or undisturbed native soil. Structural wall backfill should consist of imported granular material meeting *Section 9-03.12(2)* of *WSDOT Standard Specifications*. Backfill should be prepared and compacted to at least 95 percent of maximum dry density as determined by the modified Proctor test (ASTM D1557). Recommended parameters for lateral earth pressures for retained soils and engineered structural backfill consisting of imported granular fill meeting WSDOT specifications for *Gravel Backfill for Walls 9-03.12(2)* are presented in Table 1.

Table 1. Lateral Earth Pressure Parameters for Level Backfill

Retained Soil	Equivalent Fluid Pressure for Level Backfill			Wet Density	Drained Internal Angle of Friction
	At-rest	Active	Passive		
Undisturbed native Lean CLAY (Soil Type 2)	61 pcf	42 pcf	319 pcf	115 pcf	28°
Undisturbed native Sandy Elastic SILT (Soil Type 3)	62 pcf	42 pcf	346 pcf	120 pcf	29°
Approved Structural Backfill Material WSDOT 9-03.12(2) compacted aggregate backfill	52 pcf	32 pcf	568 pcf	135 pcf	38°

**The upper 6 inches of soil should be neglected in passive pressure calculations. If exterior grade from top or toe of retaining wall is sloped, Columbia West should be contacted to provide location-specific lateral earth pressures.*

The design parameters presented in Table 1 are valid for static loading cases only and are based upon in situ undisturbed native soils or compacted granular fill. The recommended earth pressures do not include surcharge loads, dynamic loading, hydrostatic pressure, or seismic design. If sloped backfill conditions are proposed for the site, Columbia West should be contacted for additional analysis and associated recommendations.

If seismic design is required for unrestrained walls, seismic forces may be calculated by superimposing a uniform lateral force of $10H^2$ pounds per lineal foot of wall, where H is the total wall height in feet. If seismic design is required for restrained walls, seismic forces may be calculated by superimposing a uniform lateral force of $25H^2$ pounds per lineal foot of wall. The resultant force should be applied at 0.6H from the base of the wall.

A continuous one-foot-thick zone of free-draining, washed, open-graded 1-inch by 2-inch drain rock and a 4-inch perforated gravity drain pipe is assumed behind retaining walls. Geotextile filter fabric should be placed between the drain rock and backfill soil. Specifications for drainpipe design are presented in Section 6.12, *Drainage*. If walls cannot be gravity drained, saturated base conditions and/or applicable hydrostatic pressures should be assumed.

Final retaining wall design should be reviewed and approved by Columbia West. Retaining wall subgrade and backfill activities should also be observed and tested for compliance with recommended specifications by Columbia West during construction.

6.10 Seismic Design Considerations

According to the *ASCE 7 Hazard Tool,* the anticipated peak ground and maximum considered earthquake spectral response accelerations resulting from seismic activity for the subject site are summarized in Table 2.

Table 2. Approximate Probabilistic Ground Motion Values for 'firm rock' sites based on subject property longitude and latitude

	2% Probability of Exceedance in 50 yrs
Peak Ground Acceleration	0.397 g
0.2 sec Spectral Acceleration	0.922 g
1.0 sec Spectral Acceleration	0.382 g

The listed probabilistic ground motion values are based upon "firm rock" sites with an assumed shear wave velocity of 2,500 ft/s in the upper 100 feet of soil profile. These values should be adjusted for site class effects by applying site coefficients Fa, Fv, F_{PGA} as defined in *ASCE 7-10, Tables 11.4-1, 11.4-2, and 11.8-1.* The site coefficients are intended to more accurately characterize estimated peak ground and respective earthquake spectral response accelerations by considering site-specific soil characteristics and index properties. Seismic site class was discussed previously in Section 5.3, *Seismic Hazard Areas*.

Localized peak ground accelerations exceeding the adjusted values may occur in some areas in direct proximity to an earthquake's origin. This may be a result of amplification of seismic energy due to depth to competent bedrock, compression and shear wave velocity of bedrock, presence and thickness of loose, unconsolidated alluvial deposits, soil plasticity, grain size, and other factors.

Identification of specific seismic response spectra is beyond the scope of this investigation. If site structures are designed in accordance with recommendations specified in the *2015 IBC*, the potential for peak ground accelerations in excess of the adjusted and amplified values should be understood.

6.11 Infiltration Testing Results and Hydrologic Soil Group Classification

To facilitate design of stormwater management infrastructure and classify tested soils into a representative hydrologic soil group, Columbia West conducted in situ infiltration testing within test pits TP-1 through TP-3 at a depth of approximately two feet bgs. Results of in situ infiltration testing are presented in Table 3. Infiltration rates are presented as a coefficient of permeability (k) and have been reported without application of a factor of safety.

Table 3. Infiltration Test Results and Hydrologic Soil Group Classifications

Test Number	Location	Approximate Test Depth (feet bgs)	Approximate Depth to Groundwater on 11-20-20 (feet bgs)	USCS Soil Type (*Indicates Visual Classification)	Clark County WWHM Soil Group**	Passing No. 200 Sieve (%)	Infiltration Rate (Coefficient of Permeability, k) (inches/hour)
IT-1.1	TP-1	2.0	Not observed to 11.0	CL, Lean CLAY	4	86.8	**< 0.06**
IT-2.1	TP-2	2.0	Not observed to 13.0	CL, Lean CLAY*	4	--	**< 0.06**
IT-3.1	TP-3	2.0	2.0	CL, Lean CLAY	4	86.1	**< 0.06**

** WWHM classifications are based upon subsurface investigation and infiltration testing conducted at the locations indicated.

Single-ring, falling head infiltration tests were performed by inserting standpipes into the soil at the noted depths, filling the pipes with water, and measuring time relative to changes in hydraulic head. Using Darcy's Law for saturated flow in homogenous media, the coefficient of permeability (k) was then calculated. Soils in the tested locations were observed and sampled where appropriate to adequately characterize the subsurface profile. Tested native soils are classified as lean CLAY (CL) according to USCS specifications.

Columbia West classified tested near-surface soils within test pits TP-1 through TP-3 into representative soil groups based upon site-specific infiltration test results and review of published literature. As indicated in Table 3, observed near-surface infiltration rates were less than 0.06 inches per hour in the tested locations. Based upon review of USDA hydrologic soil group criteria (USDA, 2007), Appendix 2-A of the *2015 Clark County Stormwater Manual,* and the *Clark County WWHM Soil Groupings Memorandum* (Otak, 2010), measured infiltration rates generally meet the criteria for WWHM Soil Group 4. Therefore, based upon site-specific infiltration testing and review of published literature, tested near-surface soils in the locations of TP-1 through TP-3 may be appropriately classified as presented in Table 3.

Due to the presence of shallow groundwater and fine-textured, low permeability soils at the site, subsurface disposal of concentrated stormwater is likely infeasible and is not recommended without further study.

6.12 Drainage

At a minimum, site drainage should include surface water collection and conveyance to properly designed stormwater management structures and facilities. Drainage design in general should conform to City of Camas regulations. Finished site grading should be conducted with positive drainage away from structures. Depressions or shallow areas that may retain ponding water should be avoided. Roof drains, low-point drains, and perimeter foundation drains are recommended for structures. Drains should consist of separate systems and gravity flow with a minimum two-percent slope away from foundations into an approved discharge location.

Perimeter foundation drains should consist of 3-inch perforated PVC pipe surrounded by a minimum of 1 ft^3 of clean, washed drain rock per linear foot of pipe and wrapped with geotextile filter fabric. Open-graded drain rock with a maximum particle size of 3 inches and less than 2 percent passing the No. 200 sieve is recommended. Geotextile filter fabric should consist of Mirafi 140N or approved equivalent, with AOS between No. 70 and No. 100 sieve. The water permittivity should be greater than 1.5/sec. Figure 5 presents a typical foundation drain. Perimeter drains may limit increased hydrostatic pressure beneath footings and assist in reducing potential perched moisture areas.

Subdrains should also be considered if portions of the site are cut below surrounding grades. Shallow groundwater, springs, or seeps should be conveyed via drainage channel or perforated pipe into an approved discharge. Recommendations for design and installation of perforated drainage pipe may be performed on a case-by-case basis by Columbia West during construction. Failure to provide adequate surface and sub-surface drainage may result in soil slumping or unanticipated settlement of structures exceeding tolerable limits. A typical perforated drain pipe trench detail is presented in Figure 6.

Site improvements construction in some areas may occur at or near the shallow groundwater table, particularly if work is conducted during wet-weather conditions. Dewatering may be necessary, and a drainage mat may be required to achieve sufficient elevation for fill placement. A typical drainage mat is shown on Figure 7. Columbia West should determine drainage mat location, extent, and thickness when subsurface conditions are exposed. Drainage mats may need to be constructed in conjunction with subdrains to convey captured water to an approved discharge location.

Drains should be closely monitored after construction to assess their effectiveness. If additional surface or shallow subsurface seeps become evident, the drainage provisions may require modification or additional drains. Columbia West should be consulted to provide appropriate recommendations.

6.13 Bituminous Asphalt and Portland Cement Concrete

Review of Figure 2A indicates that proposed development will include new asphalt-paved public roadways. Unless a site-specific pavement design is conducted, Columbia West recommends adherence to City of Camas paving guidelines for roadway improvements in the public right-of-way.

For dry weather construction, pavement surface sections should bear upon competent subgrade consisting of scarified and compacted native soil or engineered structural fill. Wet weather pavement construction is discussed in Section 6.14, *Wet Weather Construction Methods and Techniques*. Subgrade conditions should be evaluated and tested by Columbia West prior to placement of crushed aggregate base. Subgrade evaluation should include nuclear gauge density testing and wheel proof-roll observations conducted with a loaded 12-cubic yard, double-axle dump truck or equivalent. Nuclear gauge density testing should be conducted at 150-foot intervals or as determined by the onsite geotechnical engineer. Subgrade soil should be compacted to at least 95 percent of the modified Proctor dry density, as determined by ASTM D1557. Areas of observed deflection or rutting during proof-roll evaluation should be excavated to a firm surface and replaced with compacted crushed aggregate.

Crushed aggregate base should be compacted and tested in accordance with the specifications outlined above. Asphalt concrete pavement should be compacted to at least 91 percent of maximum Rice density. Nuclear gauge density testing should be conducted to verify adherence to recommended specifications. Testing frequency should be in accordance with Washington Department of Transportation and City of Camas specifications.

Portland cement concrete curbs and sidewalks should be installed in accordance with City of Camas specifications. Curb and sidewalk aggregate base should be observed and proof-rolled by Columbia West. Soft areas that deflect or rut should be stabilized prior to pouring concrete. Concrete should be tested during installation in accordance with ASTM C171, C138, C231, C143, C1064, and C31. This includes casting of cylinder specimen at a frequency of four cylinders per 100 cubic yards of poured concrete. Recommended field concrete testing includes slump, air entrainment, temperature, and unit weight.

6.14 Wet Weather Construction Methods and Techniques

Wet weather construction often results in significant shear strength reduction and soft areas that may rut or deflect. Installation of granular working layers may be necessary to provide a firm support base and sustain construction equipment. Granular layers should consist of all-weather gravel, 2x4-inch gabion, or other similar material (six-inch maximum size with less than five percent passing the No. 200 sieve).

Construction equipment traffic across exposed soil should be minimized. Equipment traffic induces dynamic loading, which may result in weak areas and significant reduction in shear strength for wet soils. Wet weather construction may also result in generation of significant excess quantities of soft wet soil. This material should be removed from the site or stockpiled in a designated area.

Construction during wet weather conditions may require increased base thickness. Over-excavation of subgrade soils or subgrade amendment with lime and/or cement may be necessary to provide a firm base upon which to place crushed aggregate. Geotextile filter fabric is also recommended. If soil amendment with lime or cement is considered, Columbia West should be contacted to provide appropriate recommendations based upon observed field conditions and desired performance criteria.

Crushed aggregate base should be installed in a single lift with trucks end-dumping from an advancing pad of granular fill. During extended wet periods, stripping activities may also need to be conducted from an advancing pad of granular fill. Once installed, the crushed aggregate base should be compacted with several passes from a static drum roller. A vibratory compactor is not recommended because it may further disturb the subgrade. Subdrains may also be necessary to provide subgrade drainage and maintain structural integrity.

Crushed aggregate base should be compacted to at least 95 percent of maximum dry density according to the modified Proctor density test (ASTM D1557). Compaction should be verified by nuclear gauge density testing. Observation of a proof-roll with a loaded dump truck is also recommended as an indication of the compacted aggregate's performance.

It should be understood that wet weather construction is risky and costly. Columbia West should observe and document wet weather construction activities. Proper construction methods and techniques are critical to overall project integrity.

6.15 Erosion Control Measures

As indicated previously in Section 5.1, *Erosion Hazards*, the erosion hazard for site soils in flat to shallow-gradient portions of the property is likely to be low. The potential for erosion generally increases in sloped areas. Therefore, disturbance to vegetation in sloped areas should be minimized during construction activities. Soil is also prone to erosion if unprotected and unvegetated during periods of increases precipitation. Erosion can be minimized by performing construction activities during dry summer months.

Site-specific erosion control measures should be implemented to address the maintenance of exposed areas. This may include silt fence, biofilter bags, straw wattles, or other suitable methods. During construction activities, exposed areas should be well-compacted and protected from erosion with visqueen, surface tackifier, or other means, as appropriate. Temporary slopes or exposed areas may be covered with straw, crushed aggregate, or riprap in localized areas to minimize erosion. Erosion and water runoff during wet weather conditions may be controlled by application of strategically placed channels and small detention depressions with overflow pipes.

After grading, exposed surfaces should be vegetated as soon as possible with erosion-resistant native vegetation. Jute mesh or straw may be applied to enhance vegetation. Once established, vegetation should be properly maintained. Disturbance to existing native vegetation and surrounding organic soil should also be minimized during construction activities.

6.16 Soil Shrink/Swell Potential

Based upon laboratory analysis, tested near-surface soils contain as much as 87 percent by weight passing the No. 200 sieve and exhibit a plasticity index ranging from 11 to 25 percent. This indicates the potential for soil shrinking or swelling and underscores the importance of proper moisture conditioning during fill placement. Medium to high plasticity soils, if approved for use as structural fill, should be placed and compacted at a moisture content approximately two percent above optimum as determined by laboratory analysis.

6.17 Utility Installation

Utility installation may require subsurface excavation and trenching. Excavation, trenching and shoring should conform to federal (Occupational Safety and Health Administration) (OSHA) (29 CFR, Part 1926) and *WISHA* (WAC, Chapter 296-155) regulations. Site soils may slough when cut vertically and sudden precipitation events or perched groundwater may result in accumulation of water within excavation zones and trenches.

Utilities should be installed in general accordance with manufacturer's recommendations. Utility trench backfill should consist of *WSDOT 9-03.19 Bank Run Gravel for Trench Backfill* or *WSDOT 9-03.14(2) Select Borrow* with a maximum particle size of 2 ½-inches. Trench backfill material within 18 inches of the top of utility pipes should be hand compacted (i.e., no heavy compaction equipment). The remaining backfill should be compacted to at least 95 percent of maximum dry density as determined by the standard Proctor moisture-density test (ASTM D698). Clean, free-draining, fine bedding sand is recommended for use in the pipe zone. With exception of the pipe zone, backfill should be placed in loose lifts not exceeding 12 inches in thickness.

Compaction of utility trench backfill material should be verified by nuclear gauge field compaction testing performed in accordance with ASTM D6938. Field compaction testing should be performed at 200-foot intervals along the utility trench centerline at the surface and midpoint depth of the trench. Compaction frequency and specifications may be modified for non-structural areas in accordance with recommendations of the site geotechnical engineer.

7.0 CONCLUSION AND LIMITATIONS

This geotechnical site investigation report was prepared in accordance with accepted standard conventional principles and practices of geotechnical engineering. This investigation pertains only to material tested and observed as of the date of this report and is based upon proposed site development as described in the text herein. This report is a professional opinion containing recommendations established by engineering interpretations of subsurface soils based upon conditions observed during site exploration. Soil conditions may differ between tested locations or over time. Slight variations may produce impacts to the performance of structural facilities if not adequately addressed. This underscores the importance of diligent QA/QC construction observation and testing to verify soil conditions are as anticipated in this report.

Therefore, this report contains several recommendations for field observation and testing by Columbia West personnel during construction activities. Columbia West cannot accept responsibility for deviations from recommendations described in this report. Future performance of structural facilities is often related to the degree of construction observation by qualified personnel. These services should be performed to the full extent recommended.

This report is not an environmental assessment and should not be construed as a representative warranty of site subsurface conditions. The discovery of adverse environmental conditions, or subsurface soils that deviate from those described in this report, should immediately prompt further investigation. The above statements are in lieu of all other statements expressed or implied.

This report was prepared solely for the client and is not to be reproduced without prior authorization from Columbia West. Final engineering plans and specifications for the project should be reviewed and approved by Columbia West as they relate to geotechnical and grading issues prior to final design approval. Columbia West is not responsible for independent conclusions or recommendations made by other parties based upon information presented in this report. Unless a particular service was expressly included in the scope, it was not performed and there should be no assumptions based upon services not provided. Additional report limitations and important information about this document are presented in Appendix E. This information should be carefully read and understood by the client and other parties reviewing this document.

Sincerely,

COLUMBIA WEST ENGINEERING, Inc.

Lance V. Lehto, PE, GE
President

LANCE V. LEHTO
STATE OF WASHINGTON
36301
REGISTERED
PROFESSIONAL ENGINEER

1-4-21

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FIGURES

Geotechnical • Environmental • Special Inspections Columbia West Engineering, Inc	Job No: 20287 Date: 12/21/20 Drawn: GLW Checked: LVL	SITE LOCATION MAP SAGE PROPERTY CAMAS, WASHINGTON	FIGURE 1

Infiltration Test Results

Test Number	Location	Approximate Test Depth (feet bgs)	Groundwater Depth on 11-20-20 (feet bgs)	USCS Soil Type (*Visual Classification)	Clark County WWHM Soil Group	Passing No. 200 Sieve (%)	Infiltration Rate (Coefficient of Permeability, k) (inches/hour)
IT-1.1	TP-1	2.0	Not observed to 11.0	CL, Lean CLAY	4	86.8	< 0.06
IT-2.1	TP-2	2.0	Not observed to 13.0	CL, Lean CLAY*	4	-	< 0.06
IT-3.1	TP-3	2.0	2.0	CL, Lean CLAY	4	86.1	< 0.06

APPROXIMATE LOCATION OF TEST PIT EXPLORATION

APPROXIMATE LOCATION OF INFILTRATION TEST

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Columbia West
Engineering, Inc

Job No: 20287
Date: 12/21/20
Drawn: GLW
Checked: LVL

EXPLORATION LOCATION MAP
SAGE PROPERTY

NOTES:
1. SITE LOCATION: 1811 NW HOOD STREET, CAMAS, WASHINGTON.
2. SITE CONSISTS OF TAX PARCELS 127415000 AND 127440000 TOTALING APPROXIMATELY 6.08 ACRES.
3. AERIAL PHOTO SOURCED FROM CLARK COUNTY GIS, 2020.
4. EXPLORATION LOCATIONS ARE APPROXIMATE AND NOT SURVEYED.
5. TEST PIT EXPLORATIONS BACKFILLED LOOSELY WITH ONSITE SOILS ON NOVEMBER 20, 2020.

FIGURE 2

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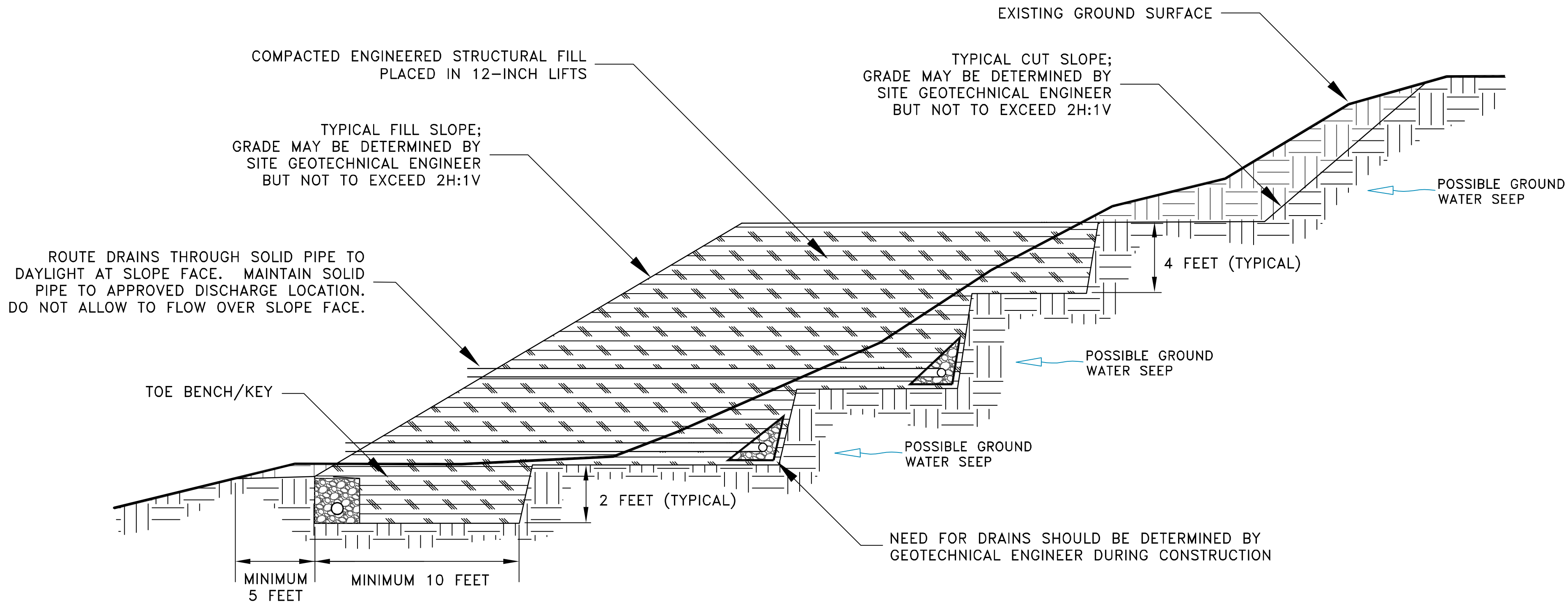
Columbia West Engineering, Inc

Job No: 20287
Date: 12/21/20
Drawn: GLW
Checked: LVL

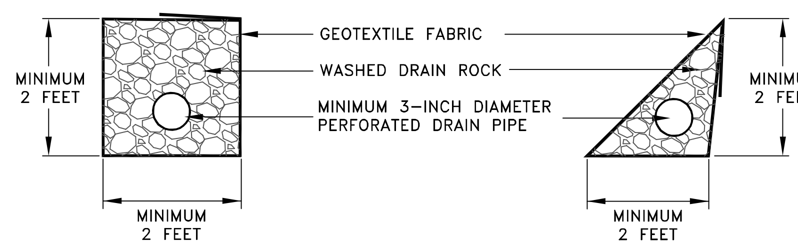
PRELIMINARY SITE PLAN
SAGE PROPERTY

NOTES:
1. SITE PLAN PROVIDED BY OLSON ENGINEERING, INC.

FIGURE
2A



TYPICAL DRAIN SECTION DETAIL



DRAIN SPECIFICATIONS

GEOTEXTILE FABRIC SHALL CONSIST OF MIRAFI 140N OR APPROVED EQUIVALENT WITH AOS BETWEEN No. 70 AND No. 100 SIEVE.

WASHED DRAIN ROCK SHALL BE OPEN-GRADED ANGULAR DRAIN ROCK WITH LESS THAN 2 PERCENT PASSING THE No. 200 SIEVE AND A MAXIMUM PARTICLE SIZE OF 3 INCHES.

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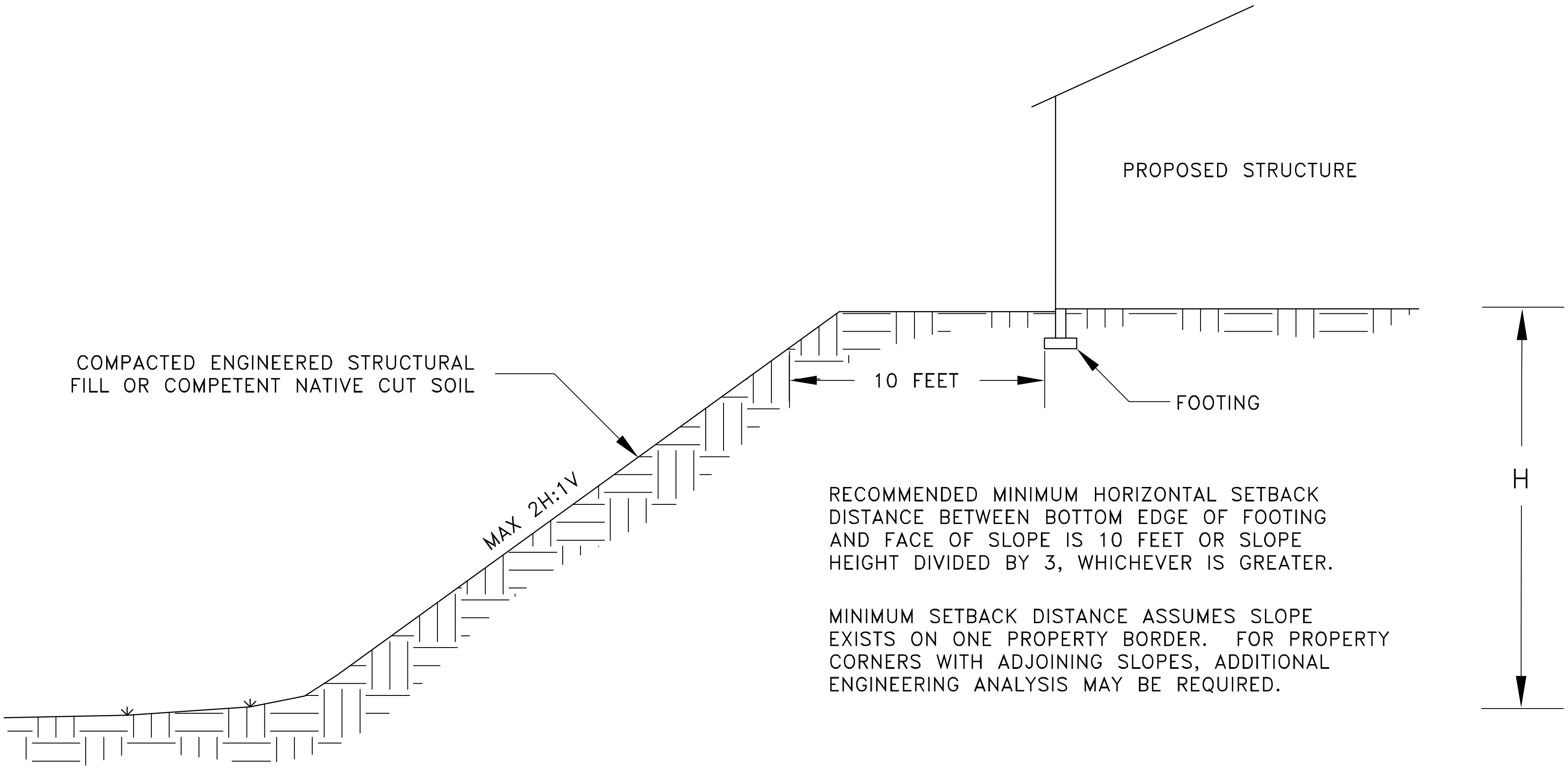
TYPICAL CUT AND FILL SLOPE CROSS SECTION

NOTES:
1. DRAWING IS NOT TO SCALE.
2. DRAWING REPRESENTS TYPICAL CUT AND FILL SLOPE CROSS SECTION AND MAY NOT BE SITE-SPECIFIC.

FIGURE 3



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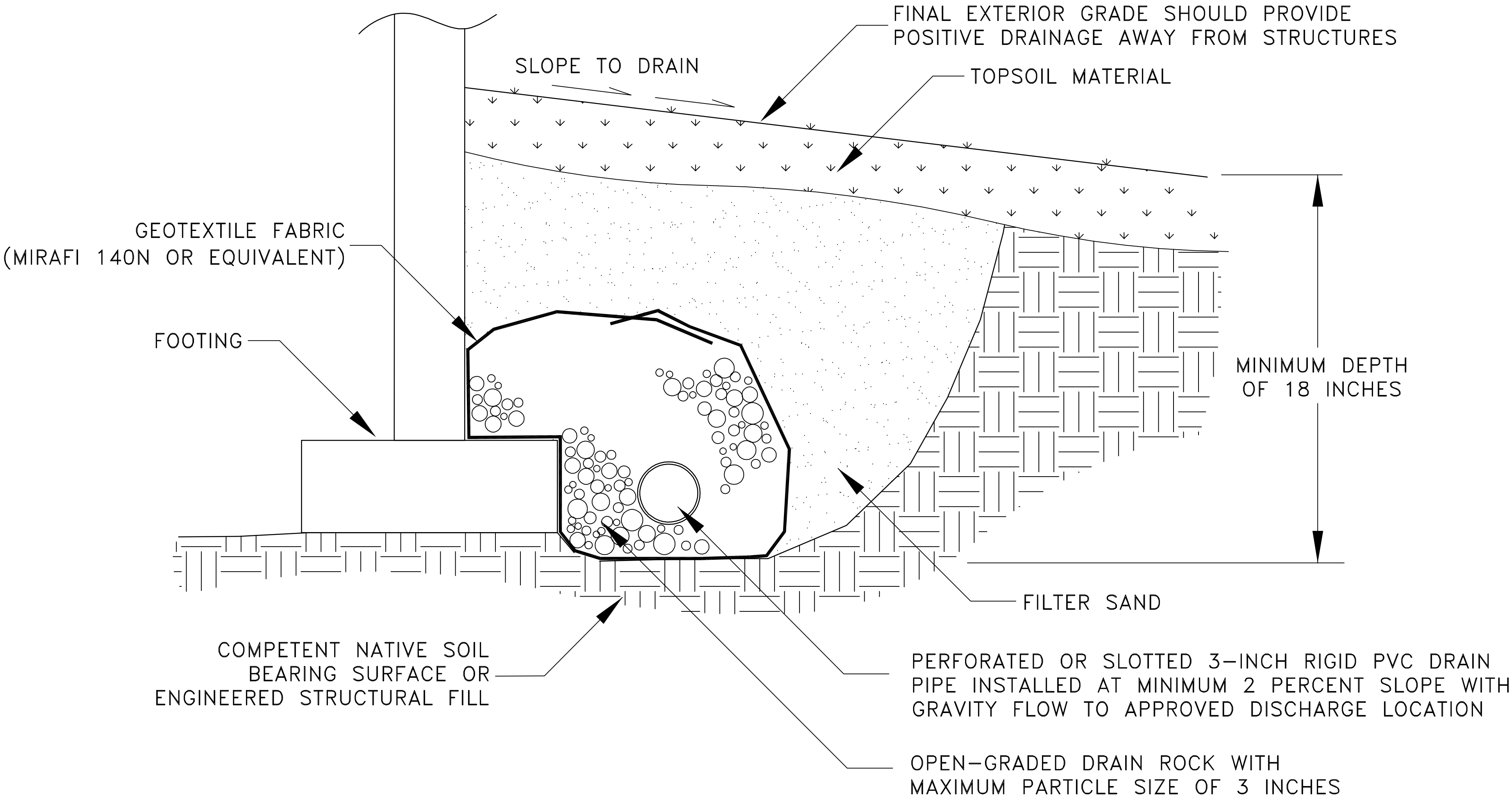
TYPICAL MINIMUM FOUNDATION
SLOPE SETBACK DETAIL

NOTES:
1. DRAWING IS NOT TO SCALE.
2. SLOPES AND PROFILES SHOWN ARE APPROXIMATE.
3. DRAWING REPRESENTS TYPICAL FOUNDATION SETBACK DETAIL AND MAY NOT BE SITE-SPECIFIC.

FIGURE
4



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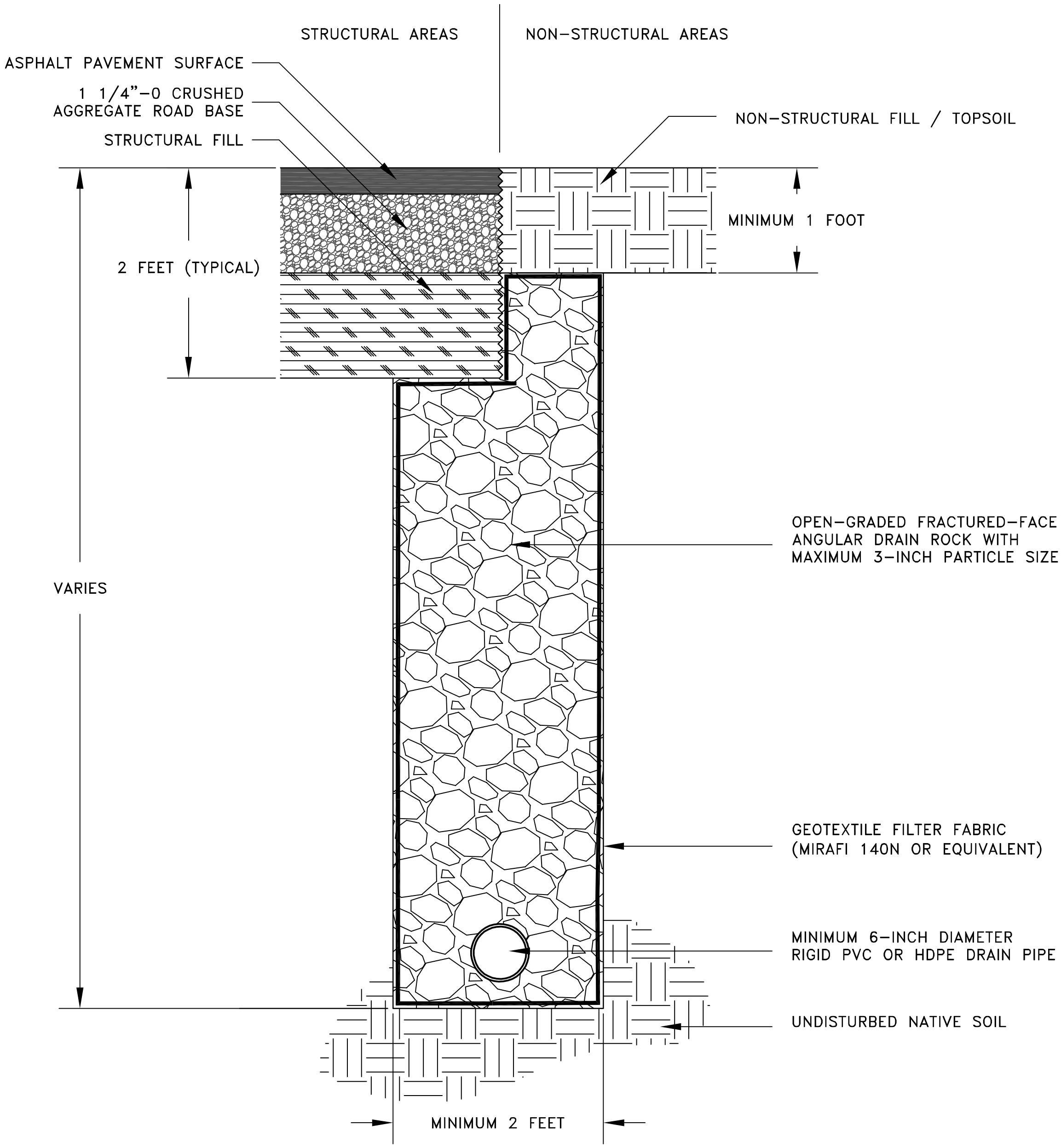
TYPICAL PERIMETER FOOTING DRAIN DETAIL

NOTES:
1. DRAWING IS NOT TO SCALE.
2. DRAWING REPRESENTS TYPICAL PERIMETER FOOTING DRAIN DETAIL AND MAY NOT BE SITE-SPECIFIC.

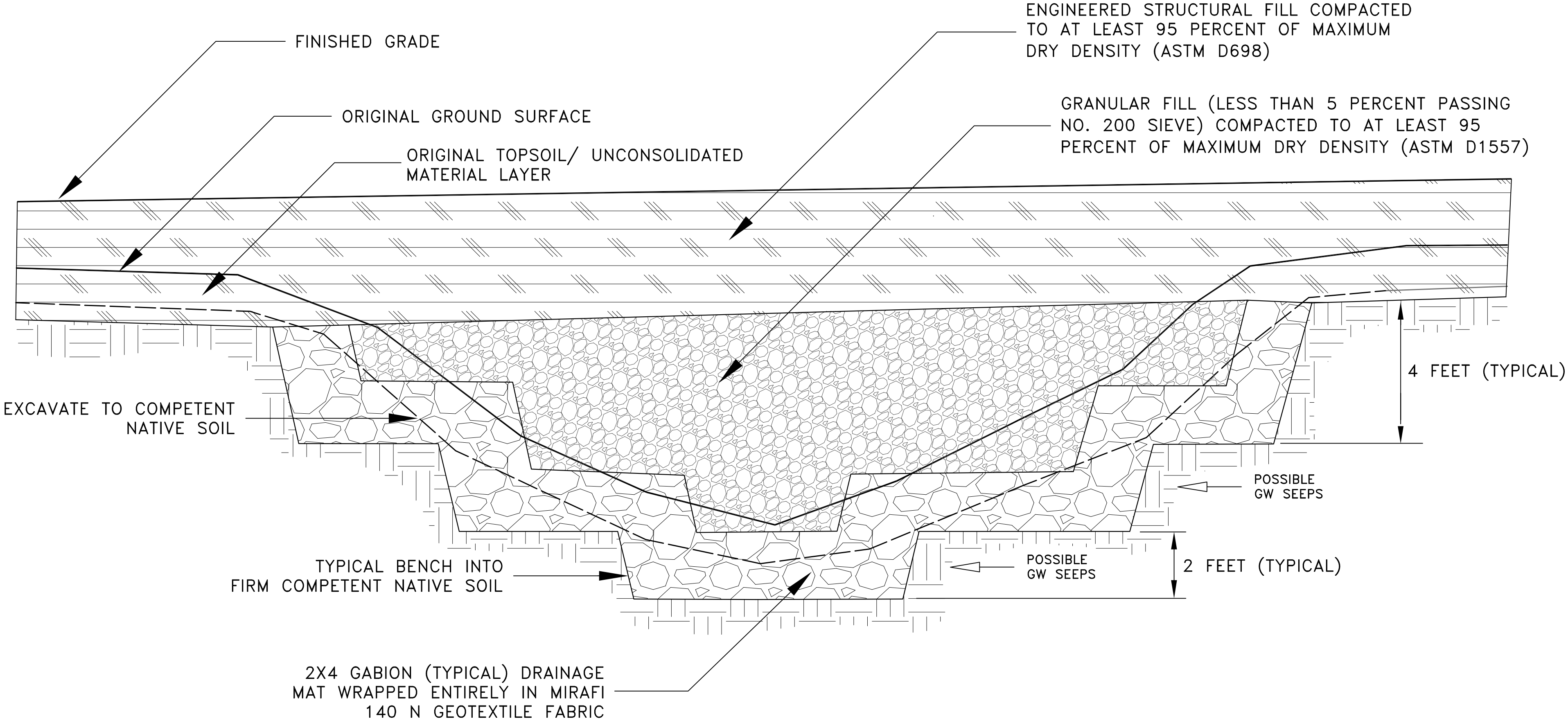
FIGURE 5



NOTE: LOCATION, INVERT ELEVATION, DEPTH OF TRENCH, AND EXTENT OF PERFORATED PIPE REQUIRED MAY BE MODIFIED BY THE GEOTECHNICAL ENGINEER DURING CONSTRUCTION BASED UPON FIELD OBSERVATION AND SITE-SPECIFIC SOIL CONDITIONS.

Geotechnical ▪ Environmental ▪ Special Inspections Columbia West Engineering, Inc	TYPICAL PERFORATED DRAIN PIPE TRENCH DETAIL	NOTES: 1. DRAWING IS NOT TO SCALE. 2. DRAWING REPRESENTS TYPICAL PERFORATED DRAIN PIPE TRENCH DETAIL AND MAY NOT BE SITE-SPECIFIC.	FIGURE 6

TYPICAL DRAINAGE MAT CROSS-SECTION



Geotechnical ▪ Environmental ▪ Special Inspections Columbia West Engineering, Inc	TYPICAL DRAINAGE MAT CROSS SECTION	NOTES: 1. DRAWING IS NOT TO SCALE. 2. DRAWING REPRESENTS TYPICAL DRAINAGE MAT SECTION AND MAY NOT BE SITE–SPECIFIC.	FIGURE 7

APPENDIX A
LABORATORY TEST RESULTS

11917 NE 95th Street, Vancouver, Washington 98682
Phone: 360-823-2900, Fax: 360-823-2901
www.columbiawestengineering.com

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PARTICLE-SIZE ANALYSIS REPORT

PROJECT	CLIENT	PROJECT NO.	LAB ID
Sage Property Camas, Washington	Modern NW, Inc. 8101 NE Glisan Street Portland, Oregon 97213	20287	S20-1663
		REPORT DATE: 12/08/20	FIELD ID: TP1.1
		DATE SAMPLED: 11/20/20	SAMPLED BY: MCK

MATERIAL DATA

MATERIAL SAMPLED	MATERIAL SOURCE	USCS SOIL TYPE
Lean CLAY	Test Pit TP-01 depth = 2 feet	CL, Lean Clay

SPECIFICATIONS	AASHTO CLASSIFICATION
none	A-6(16)

LABORATORY TEST DATA

LABORATORY EQUIPMENT	TEST PROCEDURE
Rainhart "Mary Ann" Sifter, moist prep, hand washed, 12" single sieve-set	ASTM D6913, Method A

ADDITIONAL DATA

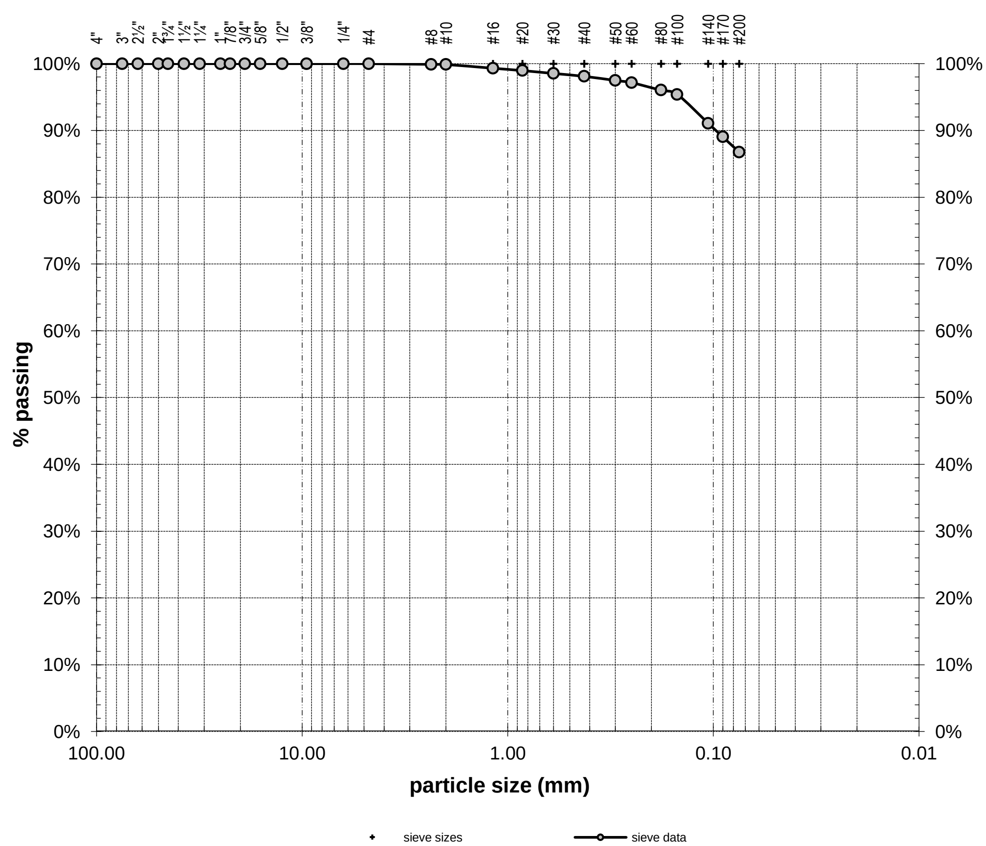
initial dry mass (g) =	138.17		
as-received moisture content =	24.0%	coefficient of curvature, C_C =	n/a
liquid limit =	38	coefficient of uniformity, C_U =	n/a
plastic limit =	20	effective size, $D_{(10)}$ =	n/a
plasticity index =	18	$D_{(30)}$ =	n/a
fineness modulus =	n/a	$D_{(60)}$ =	n/a

SIEVE DATA

% gravel = 0.0%
% sand = 13.2%
% silt and clay = 86.8%

	SIEVE SIZE US	SIEVE SIZE mm	PERCENT PASSING SIEVE act.	PERCENT PASSING SIEVE interp.	SPECS max	SPECS min
GRAVEL	6.00"	150.0		100%		
	4.00"	100.0		100%		
	3.00"	75.0		100%		
	2.50"	63.0		100%		
	2.00"	50.0		100%		
	1.75"	45.0		100%		
	1.50"	37.5		100%		
	1.25"	31.5		100%		
	1.00"	25.0		100%		
	7/8"	22.4		100%		
	3/4"	19.0		100%		
	5/8"	16.0		100%		
	1/2"	12.5		100%		
	3/8"	9.50		100%		
	1/4"	6.30		100%		
	#4	4.75	100%			
SAND	#8	2.36		100%		
	#10	2.00	100%			
	#16	1.18		99%		
	#20	0.850	99%			
	#30	0.600		99%		
	#40	0.425	98%			
	#50	0.300		97%		
	#60	0.250	97%			
	#80	0.180		96%		
	#100	0.150	95%			
	#140	0.106		91%		
	#170	0.090		89%		
	#200	0.075	87%			

GRAIN SIZE DISTRIBUTION



DATE TESTED	TESTED BY
11/30/20	BTT

COLUMBIA WEST ENGINEERING, INC. authorized signature

11917 NE 95th Street, Vancouver, Washington 98682
Phone: 360-823-2900, Fax: 360-823-2901
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Columbia West Engineering, Inc

ATTERBERG LIMITS REPORT

PROJECT	CLIENT	PROJECT NO.	LAB ID
Sage Property Camas, Washington	Modern NW, Inc. 8101 NE Glisan Street Portland, Oregon 97213	20287	S20-1663
		REPORT DATE: 12/08/20	FIELD ID: TP1.1
		DATE SAMPLED: 11/20/20	SAMPLED BY: MCK

MATERIAL DATA

MATERIAL SAMPLED	MATERIAL SOURCE	USCS SOIL TYPE
Lean CLAY	Test Pit TP-01 depth = 2 feet	CL, Lean Clay

LABORATORY TEST DATA

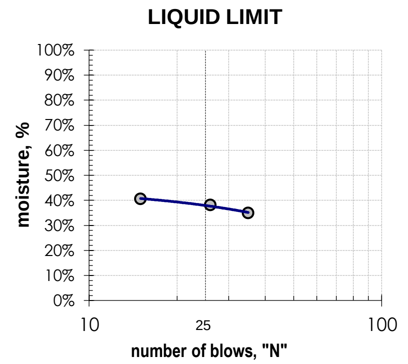
LABORATORY EQUIPMENT	TEST PROCEDURE
Liquid Limit Machine, Hand Rolled	ASTM D4318

ATTERBERG LIMITS

liquid limit = 38
plastic limit = 20
plasticity index = 18

LIQUID LIMIT DETERMINATION

	❶	❷	❸	❹
wet soil + pan weight, g =	30.58	32.22	33.02	
dry soil + pan weight, g =	28.08	29.09	29.55	
pan weight, g =	20.91	20.89	20.98	
N (blows) =	35	26	15	
moisture, % =	34.9 %	38.2 %	40.5 %	

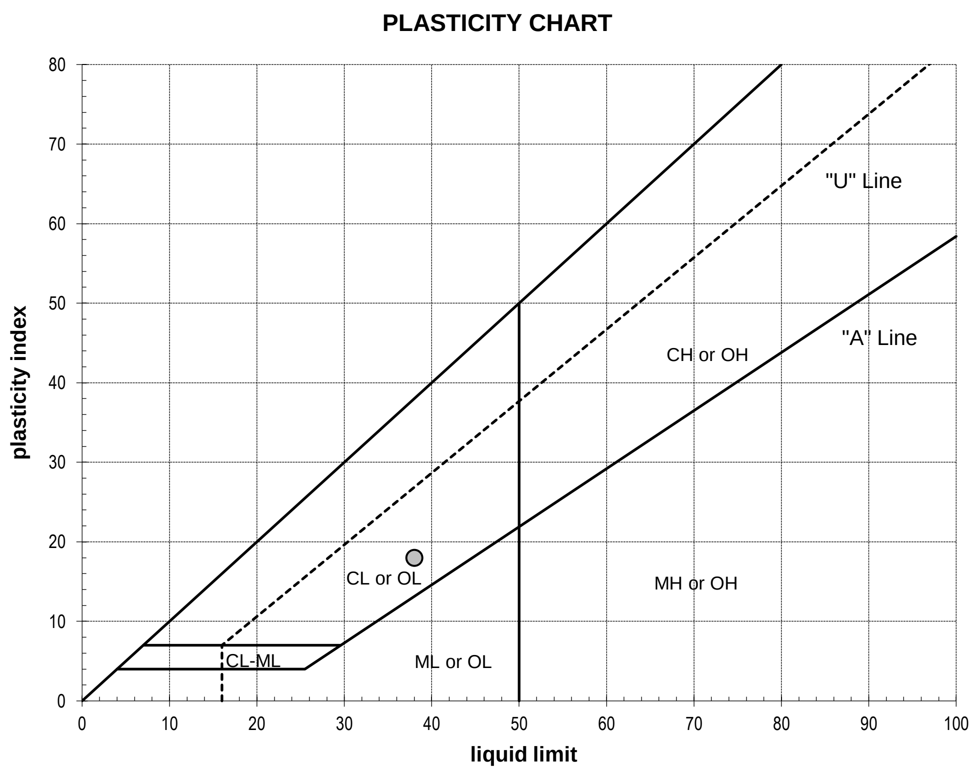


SHRINKAGE

shrinkage limit = n/a
shrinkage ratio = n/a

PLASTIC LIMIT DETERMINATION

	❶	❷	❸	❹
wet soil + pan weight, g =	27.42	27.27		
dry soil + pan weight, g =	26.31	26.17		
pan weight, g =	20.93	20.74		
moisture, % =	20.6 %	20.3 %		



ADDITIONAL DATA

% gravel =	0.0%
% sand =	13.2%
% silt and clay =	86.8%
% silt =	n/a
% clay =	n/a
moisture content =	24.0%

DATE TESTED	TESTED BY
11/30/20	RTT

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PARTICLE-SIZE ANALYSIS REPORT

PROJECT	CLIENT	PROJECT NO.	LAB ID
Sage Property Camas, Washington	Modern NW, Inc. 8101 NE Glisan Street Portland, Oregon 97213	20287	S20-1664
		REPORT DATE: 12/08/20	FIELD ID: TP3.1
		DATE SAMPLED: 11/20/20	SAMPLED BY: MCK

MATERIAL DATA

MATERIAL SAMPLED	MATERIAL SOURCE	USCS SOIL TYPE
Lean CLAY	Test Pit TP-03 depth = 2 feet	CL, Lean Clay

SPECIFICATIONS	AASHTO CLASSIFICATION
none	A-7-6(18)

LABORATORY TEST DATA

LABORATORY EQUIPMENT	TEST PROCEDURE
Rainhart "Mary Ann" Sifter, moist prep, hand washed, 12" single sieve-set	ASTM D6913, Method A

ADDITIONAL DATA

initial dry mass (g) =	143.87		
as-received moisture content =	29.7%	coefficient of curvature, C_C =	n/a
liquid limit =	41	coefficient of uniformity, C_U =	n/a
plastic limit =	20	effective size, $D_{(10)}$ =	n/a
plasticity index =	21	$D_{(30)}$ =	n/a
fineness modulus =	n/a	$D_{(60)}$ =	n/a

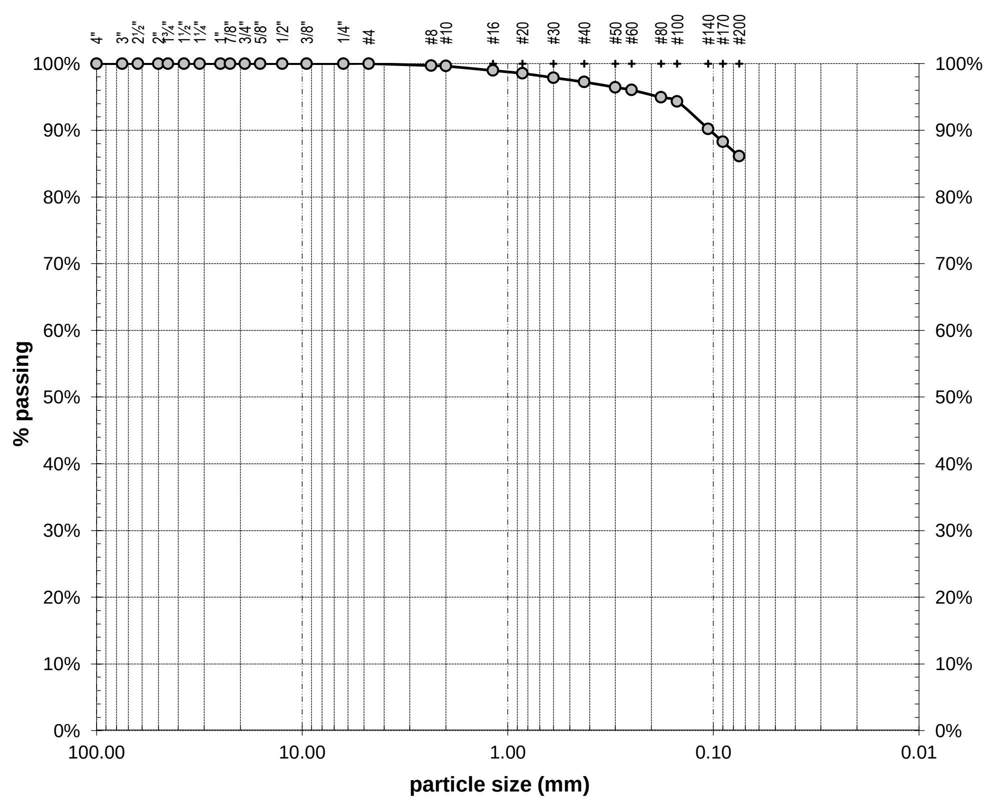
SIEVE DATA

% gravel = 0.0%
% sand = 13.9%
% silt and clay = 86.1%

	SIEVE SIZE US	SIEVE SIZE mm	PERCENT PASSING SIEVE act.	PERCENT PASSING SIEVE interp.	SPECS max	SPECS min
GRAVEL	6.00"	150.0		100%		
	4.00"	100.0		100%		
	3.00"	75.0		100%		
	2.50"	63.0		100%		
	2.00"	50.0		100%		
	1.75"	45.0		100%		
	1.50"	37.5		100%		
	1.25"	31.5		100%		
	1.00"	25.0		100%		
	7/8"	22.4		100%		
	3/4"	19.0		100%		
	5/8"	16.0		100%		
	1/2"	12.5		100%		
	3/8"	9.50		100%		
	1/4"	6.30		100%		
	#4	4.75	100%			
SAND	#8	2.36		100%		
	#10	2.00	100%			
	#16	1.18		99%		
	#20	0.850	99%			
	#30	0.600		98%		
	#40	0.425	97%			
	#50	0.300		96%		
	#60	0.250	96%			
	#80	0.180		95%		
	#100	0.150	94%			
	#140	0.106		90%		
	#170	0.090		88%		
	#200	0.075	86%			

DATE TESTED	TESTED BY
11/30/20	BTT

GRAIN SIZE DISTRIBUTION



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ATTERBERG LIMITS REPORT

PROJECT	CLIENT	PROJECT NO.	LAB ID
Sage Property Camas, Washington	Modern NW, Inc. 8101 NE Glisan Street Portland, Oregon 97213	20287	S20-1664
		REPORT DATE: 12/08/20	FIELD ID: TP3.1
		DATE SAMPLED: 11/20/20	SAMPLED BY: MCK

MATERIAL DATA

MATERIAL SAMPLED	MATERIAL SOURCE	USCS SOIL TYPE
Lean CLAY	Test Pit TP-03 depth = 2 feet	CL, Lean Clay

LABORATORY TEST DATA

LABORATORY EQUIPMENT	TEST PROCEDURE
Liquid Limit Machine, Hand Rolled	ASTM D4318

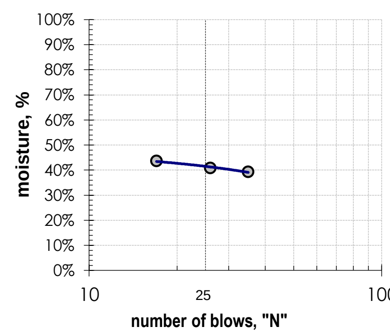
ATTERBERG LIMITS

liquid limit =	41
plastic limit =	20
plasticity index =	21

LIQUID LIMIT DETERMINATION

	❶	❷	❸	❹
wet soil + pan weight, g =	31.32	31.24	31.63	
dry soil + pan weight, g =	28.38	28.24	28.44	
pan weight, g =	20.90	20.89	21.13	
N (blows) =	35	26	17	
moisture, % =	39.3 %	40.8 %	43.6 %	

LIQUID LIMIT



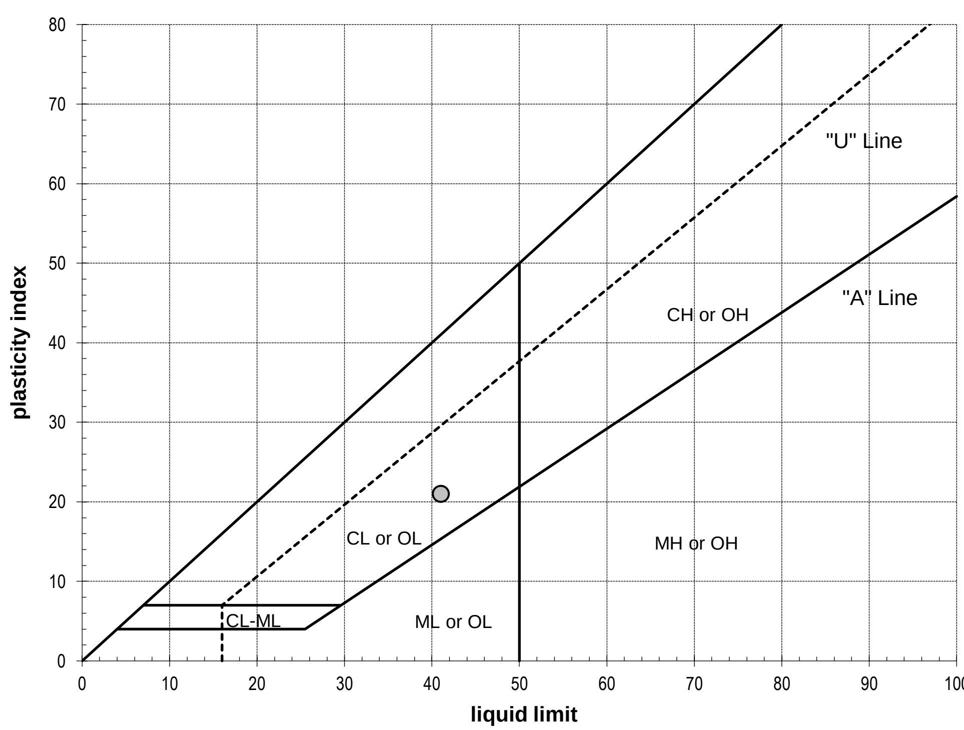
SHRINKAGE

shrinkage limit =	n/a
shrinkage ratio =	n/a

PLASTIC LIMIT DETERMINATION

	❶	❷	❸	❹
wet soil + pan weight, g =	27.12	27.46		
dry soil + pan weight, g =	26.02	26.33		
pan weight, g =	20.61	20.80		
moisture, % =	20.3 %	20.4 %		

PLASTICITY CHART



ADDITIONAL DATA

% gravel =	0.0%
% sand =	13.9%
% silt and clay =	86.1%
% silt =	n/a
% clay =	n/a
moisture content =	29.7%

DATE TESTED	TESTED BY
11/30/20	RTT

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PARTICLE-SIZE ANALYSIS REPORT

PROJECT	CLIENT	PROJECT NO.	LAB ID
Sage Property Camas, Washington	Modern NW, Inc. 8101 NE Glisan Street Portland, Oregon 97213	20287	S20-1665
		REPORT DATE: 12/08/20	FIELD ID: TP6.1
		DATE SAMPLED: 11/20/20	SAMPLED BY: MCK

MATERIAL DATA

MATERIAL SAMPLED	MATERIAL SOURCE	USCS SOIL TYPE
Lean CLAY	Test Pit TP-06 depth = 5 feet	CL, Lean Clay

SPECIFICATIONS	AASHTO CLASSIFICATION
none	A-6(8)

LABORATORY TEST DATA

LABORATORY EQUIPMENT	TEST PROCEDURE
Rainhart "Mary Ann" Sifter, moist prep, hand washed, 12" single sieve-set	ASTM D6913, Method A

ADDITIONAL DATA

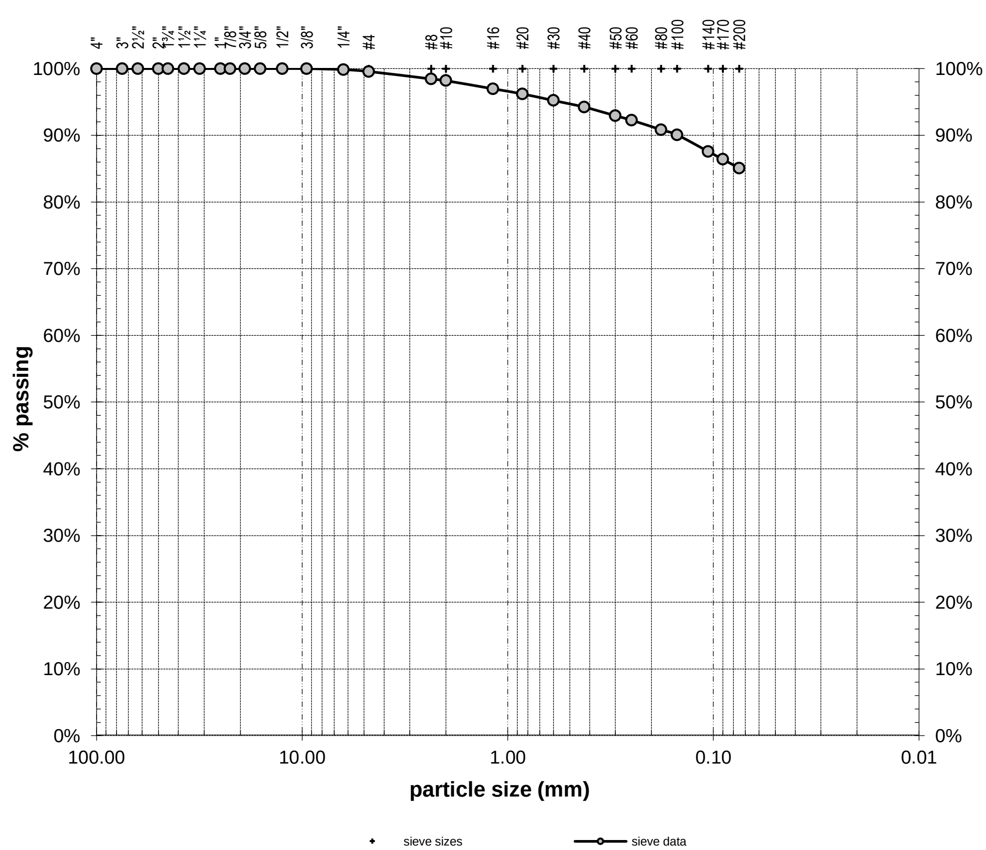
initial dry mass (g) =	163.31		
as-received moisture content =	25.3%	coefficient of curvature, C_C =	n/a
liquid limit =	31	coefficient of uniformity, C_U =	n/a
plastic limit =	20	effective size, $D_{(10)}$ =	n/a
plasticity index =	11	$D_{(30)}$ =	n/a
fineness modulus =	n/a	$D_{(60)}$ =	n/a

SIEVE DATA

% gravel = 0.4%
% sand = 14.5%
% silt and clay = 85.1%

	SIEVE SIZE US	SIEVE SIZE mm	PERCENT PASSING SIEVE act.	PERCENT PASSING SIEVE interp.	SPECS max	SPECS min
GRAVEL	6.00"	150.0		100%		
	4.00"	100.0		100%		
	3.00"	75.0		100%		
	2.50"	63.0		100%		
	2.00"	50.0		100%		
	1.75"	45.0		100%		
	1.50"	37.5		100%		
	1.25"	31.5		100%		
	1.00"	25.0		100%		
	7/8"	22.4		100%		
	3/4"	19.0		100%		
	5/8"	16.0		100%		
	1/2"	12.5		100%		
	3/8"	9.50	100%			
	1/4"	6.30	100%			
	#4	4.75	100%			
SAND	#8	2.36		98%		
	#10	2.00	98%			
	#16	1.18		97%		
	#20	0.850	96%			
	#30	0.600		95%		
	#40	0.425	94%			
	#50	0.300		93%		
	#60	0.250	92%			
	#80	0.180		91%		
	#100	0.150	90%			
	#140	0.106		88%		
	#170	0.090		86%		
	#200	0.075	85%			

GRAIN SIZE DISTRIBUTION



DATE TESTED	TESTED BY
11/30/20	BTT

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ATTERBERG LIMITS REPORT

PROJECT	CLIENT	PROJECT NO.	LAB ID
Sage Property Camas, Washington	Modern NW, Inc. 8101 NE Glisan Street Portland, Oregon 97213	20287	S20-1665
		REPORT DATE: 12/08/20	FIELD ID: TP6.1
		DATE SAMPLED: 11/20/20	SAMPLED BY: MCK

MATERIAL DATA

MATERIAL SAMPLED	MATERIAL SOURCE	USCS SOIL TYPE
Lean CLAY	Test Pit TP-06 depth = 5 feet	CL, Lean Clay

LABORATORY TEST DATA

LABORATORY EQUIPMENT	TEST PROCEDURE
Liquid Limit Machine, Hand Rolled	ASTM D4318

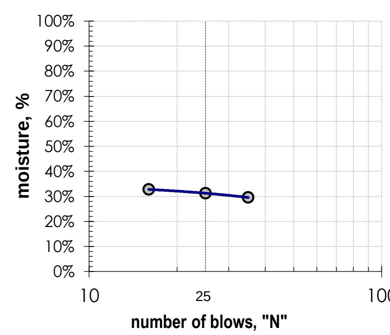
ATTERBERG LIMITS

liquid limit =	31
plastic limit =	20
plasticity index =	11

LIQUID LIMIT DETERMINATION

	❶	❷	❸	❹
wet soil + pan weight, g =	35.61	33.97	31.62	
dry soil + pan weight, g =	32.29	30.83	28.90	
pan weight, g =	21.05	20.79	20.60	
N (blows) =	35	25	16	
moisture, % =	29.5 %	31.3 %	32.8 %	

LIQUID LIMIT



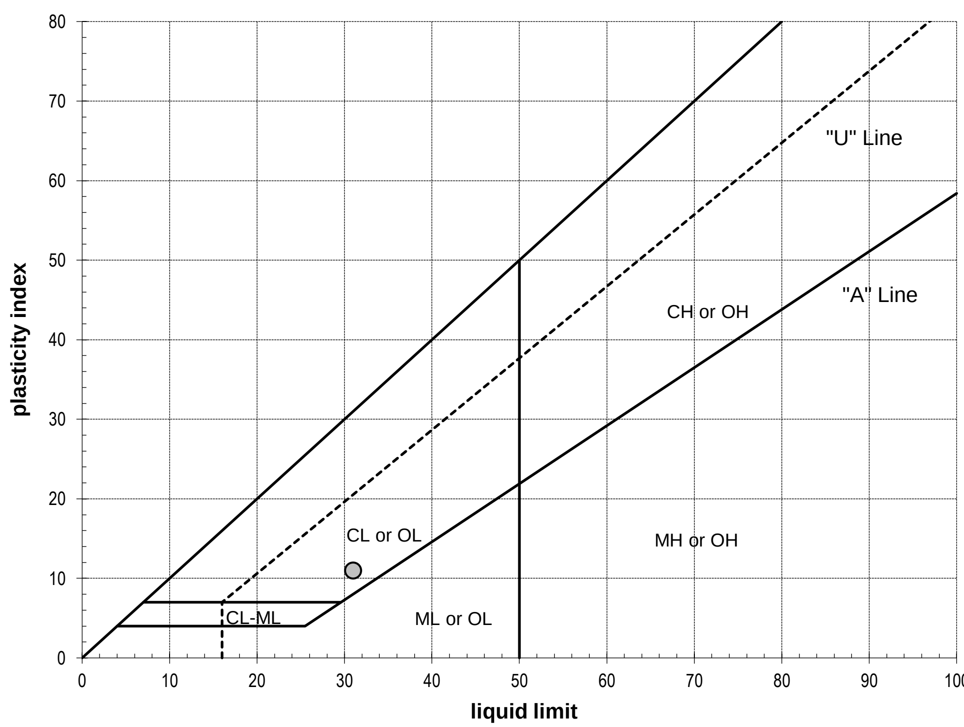
SHRINKAGE

shrinkage limit =	n/a
shrinkage ratio =	n/a

PLASTIC LIMIT DETERMINATION

	❶	❷	❸	❹
wet soil + pan weight, g =	27.54	27.85		
dry soil + pan weight, g =	26.41	26.65		
pan weight, g =	20.79	20.75		
moisture, % =	20.1 %	20.3 %		

PLASTICITY CHART



ADDITIONAL DATA

% gravel =	0.4%
% sand =	14.5%
% silt and clay =	85.1%
% silt =	n/a
% clay =	n/a
moisture content =	25.3%

DATE TESTED	TESTED BY
11/30/20	RTT

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PARTICLE-SIZE ANALYSIS REPORT

PROJECT	CLIENT	PROJECT NO.	LAB ID
Sage Property Camas, Washington	Modern NW, Inc. 8101 NE Glisan Street Portland, Oregon 97213	20287	S20-1666
		REPORT DATE: 12/08/20	FIELD ID: TP7.1
		DATE SAMPLED: 11/20/20	SAMPLED BY: MCK

MATERIAL DATA

MATERIAL SAMPLED	MATERIAL SOURCE	USCS SOIL TYPE
Sandy Elastic SILT	Test Pit TP-07 depth = 12 feet	MH, Sandy Elastic Silt
SPECIFICATIONS: none		AASHTO CLASSIFICATION: A-7-5(11)

LABORATORY TEST DATA

LABORATORY EQUIPMENT	TEST PROCEDURE
Rainhart "Mary Ann" Sifter, air-dried prep, hand washed, composite sieve - #4 split	ASTM D6913, Method A

ADDITIONAL DATA

initial dry mass (g) =	14552.7		
as-received moisture content =	42.2%	coefficient of curvature, C_C =	n/a
liquid limit =	58	coefficient of uniformity, C_U =	n/a
plastic limit =	33	effective size, $D_{(10)}$ =	n/a
plasticity index =	25	$D_{(30)}$ =	n/a
fineness modulus =	n/a	$D_{(60)}$ =	0.127 mm

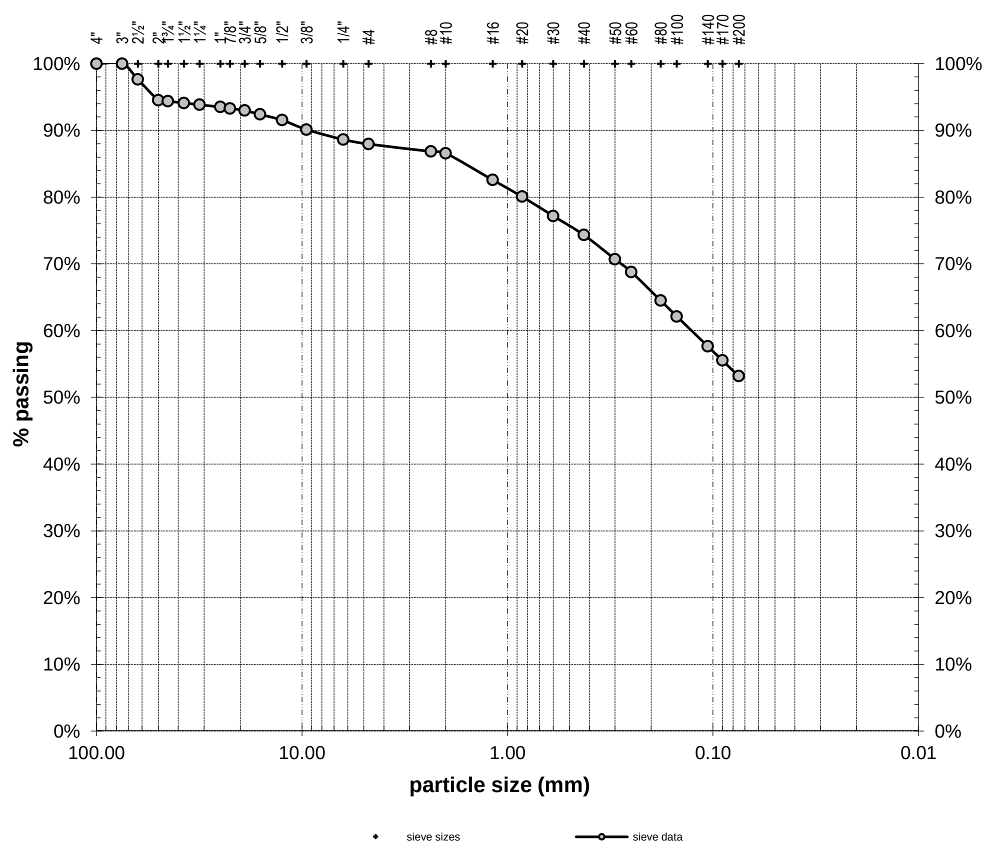
NOTE: Entire sample used for analysis; did not meet minimum size required.

SIEVE DATA

% gravel = 12.0%
% sand = 34.8%
% silt and clay = 53.2%

	SIEVE SIZE US	SIEVE SIZE mm	PERCENT PASSING SIEVE act.	PERCENT PASSING SIEVE interp.	SPECS max	SPECS min
GRAVEL	6.00"	150.0		100%		
	4.00"	100.0		100%		
	3.00"	75.0	100%			
	2.50"	63.0		98%		
	2.00"	50.0	95%			
	1.75"	45.0		94%		
	1.50"	37.5		94%		
	1.25"	31.5		94%		
	1.00"	25.0	93%			
	7/8"	22.4		93%		
	3/4"	19.0	93%			
	5/8"	16.0		92%		
	1/2"	12.5	92%			
	3/8"	9.50	90%			
	1/4"	6.30	89%			
	#4	4.75	88%			
SAND	#8	2.36		87%		
	#10	2.00	87%			
	#16	1.18		83%		
	#20	0.850	80%			
	#30	0.600		77%		
	#40	0.425	74%			
	#50	0.300		71%		
	#60	0.250	69%			
	#80	0.180		65%		
	#100	0.150	62%			
	#140	0.106		58%		
	#170	0.090		56%		
	#200	0.075	53%			

GRAIN SIZE DISTRIBUTION



DATE TESTED	TESTED BY
12/03/20	RTT

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ATTERBERG LIMITS REPORT

PROJECT	CLIENT	PROJECT NO.	LAB ID
Sage Property Camas, Washington	Modern NW, Inc. 8101 NE Glisan Street Portland, Oregon 97213	20287	S20-1666
		REPORT DATE: 12/08/20	FIELD ID: TP7.1
		DATE SAMPLED: 11/20/20	SAMPLED BY: MCK

MATERIAL DATA

MATERIAL SAMPLED	MATERIAL SOURCE	USCS SOIL TYPE
Sandy Elastic SILT	Test Pit TP-07 depth = 12 feet	MH, Sandy Elastic Silt

LABORATORY TEST DATA

LABORATORY EQUIPMENT	TEST PROCEDURE
Liquid Limit Machine, Hand Rolled	ASTM D4318

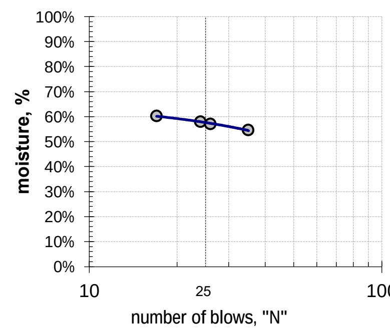
ATTERBERG LIMITS

liquid limit =	58
plastic limit =	33
plasticity index =	25

LIQUID LIMIT DETERMINATION

	❶	❷	❸	❹
wet soil + pan weight, g =	32.79	33.00	32.50	33.14
dry soil + pan weight, g =	28.59	28.60	28.22	28.58
pan weight, g =	20.89	20.89	20.84	21.01
N (blows) =	35	26	24	17
moisture, % =	54.6 %	57.1 %	58.0 %	60.2 %

LIQUID LIMIT



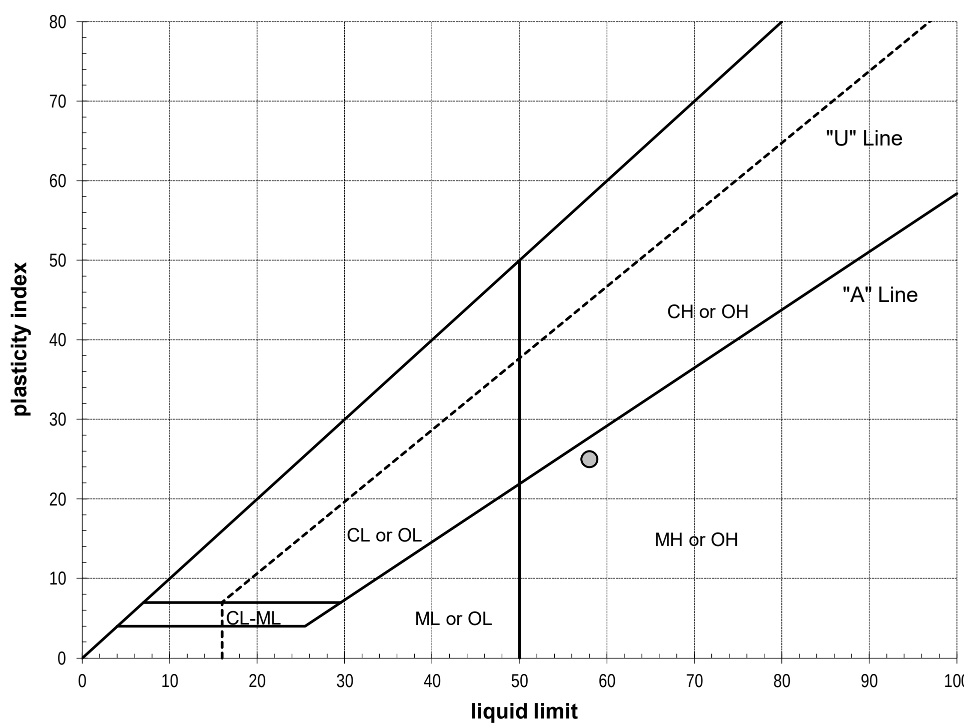
SHRINKAGE

shrinkage limit =	n/a
shrinkage ratio =	n/a

PLASTIC LIMIT DETERMINATION

	❶	❷	❸	❹
wet soil + pan weight, g =	28.49	27.31		
dry soil + pan weight, g =	26.59	25.74		
pan weight, g =	20.77	20.98		
moisture, % =	32.7 %	33.0 %		

PLASTICITY CHART



ADDITIONAL DATA

% gravel =	12.0%
% sand =	34.8%
% silt and clay =	53.2%
% silt =	n/a
% clay =	n/a
moisture content =	42.2%

DATE TESTED	TESTED BY
12/04/20	KMS

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APPENDIX B
SUBSURFACE EXPLORATION LOGS

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TEST PIT LOG

PROJECT NAME	CLIENT		PROJECT NO.	TEST PIT NO.
Sage Property	Modern NW, Inc.		20287	TP-1
PROJECT LOCATION	CONTRACTOR	EQUIPMENT	TECHNICIAN	DATE
Camas, Washington	L&S Contractors	Excavator	MCK	11/20/20
TEST PIT LOCATION	APPROX. SURFACE ELEVATION	GROUNDWATER DEPTH	START TIME	FINISH TIME
See Figure 2	650 ft amsl	Not Observed	0819	1230

Depth (feet)	Sample Field ID	SCS Soil Survey Description	AASHTO Soil Type	USCS Soil Type	Graphic Log	LITHOLOGIC DESCRIPTION AND REMARKS	Moisture Content (%)	Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Infiltration Testing
0						Approximately 12 inches of grass and topsoil					
		Powell silt loam		CL		Tan to brown, moist, medium stiff to stiff lean CLAY. [Soil Type 2]					IT1.1
	TP1.1		A-6(16)				24.0	86.8	38	18	D = 2.0-ft k < 0.06 in/hr
5											
			A-7	MH		Tan to orange-brown, weathered, moist, medium stiff to stiff sandy elastic SILT. [Soil Type 3]					
10						Rounded to subrounded cobbles and boulders observed at approximately 10 feet bgs.					
						Bottom of test pit at 11.0 feet bgs. Groundwater not observed to 11.0 feet bgs on 11/20/20.					
15											

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TEST PIT LOG

PROJECT NAME	CLIENT		PROJECT NO.	TEST PIT NO.
Sage Property	Modern NW, Inc.		20287	TP-2
PROJECT LOCATION	CONTRACTOR	EQUIPMENT	TECHNICIAN	DATE
Camas, Washington	L&S Contractors	Excavator	MCK	11/20/20
TEST PIT LOCATION	APPROX. SURFACE ELEVATION	GROUNDWATER DEPTH	START TIME	FINISH TIME
See Figure 2	694 ft amsl	Not Observed	0853	1245

Depth (feet)	Sample Field ID	SCS Soil Survey Description	AASHTO Soil Type	USCS Soil Type	Graphic Log	LITHOLOGIC DESCRIPTION AND REMARKS	Moisture Content (%)	Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Infiltration Testing
0						Approximately 12 inches of grass and topsoil					
		Powell silt loam	A-6	CL		Brown to tan, moist, medium stiff lean CLAY. [Soil Type 2]					IT2.1 D = 2.0-ft k < 0.06 in/hr
5											
			A-7	MH		Red-brown, weathered, moist, medium stiff to stiff sandy elastic SILT. [Soil Type 3]					
10						Rounded to subrounded cobbles and boulders observed at approximately 12 feet bgs.					
						Bottom of test pit at 13.0 feet bgs. Groundwater not observed to 13.0 feet bgs on 11/20/20.					
15											

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TEST PIT LOG

PROJECT NAME	CLIENT		PROJECT NO.	TEST PIT NO.
Sage Property	Modern NW, Inc.		20287	TP-3
PROJECT LOCATION	CONTRACTOR	EQUIPMENT	TECHNICIAN	DATE
Camas, Washington	L&S Contractors	Excavator	MCK	11/20/20
TEST PIT LOCATION	APPROX. SURFACE ELEVATION	GROUNDWATER DEPTH	START TIME	FINISH TIME
See Figure 2	670 ft amsl	2.0 feet bgs	0930	1300

Depth (feet)	Sample Field ID	SCS Soil Survey Description	AASHTO Soil Type	USCS Soil Type	Graphic Log	LITHOLOGIC DESCRIPTION AND REMARKS	Moisture Content (%)	Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Infiltration Testing
0						Approximately 12 inches of grass and topsoil					
		Powell silt loam		CL		Brown to tan, mottled, moist to wet, medium stiff lean CLAY. [Soil Type 2]					
▼ (2.0)	TP3.1		A-7-6(18)				29.7	86.1	41	21	IT3.1 D = 2.0-ft k < 0.06 in/hr
5											
10											
						Bottom of test pit at 13.0 feet bgs. Groundwater observed at approximately 2.0 feet bgs on 11/20/20.					
15											

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TEST PIT LOG

PROJECT NAME	CLIENT		PROJECT NO.	TEST PIT NO.
Sage Property	Modern NW, Inc.		20287	TP-4
PROJECT LOCATION	CONTRACTOR	EQUIPMENT	TECHNICIAN	DATE
Camas, Washington	L&S Contractors	Excavator	MCK	11/20/20
TEST PIT LOCATION	APPROX. SURFACE ELEVATION	GROUNDWATER DEPTH	START TIME	FINISH TIME
See Figure 2	676 ft amsl	2.0 feet bgs	1005	1028

Depth (feet)	Sample Field ID	SCS Soil Survey Description	AASHTO Soil Type	USCS Soil Type	Graphic Log	LITHOLOGIC DESCRIPTION AND REMARKS	Moisture Content (%)	Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Infiltration Testing
0						Approximately 12 inches of grass and topsoil.					
		Powell silt loam	A-6	CL		Brown to tan, moist to wet, medium stiff lean CLAY. [Soil Type 2]					
			A-7	MH		Tan to orange-brown, weathered, wet, medium stiff to stiff sandy elastic SILT with trace to some subrounded gravel. [Soil Type 3]					
						Bottom of test pit at 13.0 feet bgs. Groundwater observed at approximately 2.0 feet bgs on 11/20/20.					

Depth scale: 0, 5, 10, 15

11917 NE 95TH Street, Vancouver, Washington 98682
Phone: 360-823-2900, Fax: 360-823-2901
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TEST PIT LOG

PROJECT NAME	CLIENT		PROJECT NO.	TEST PIT NO.
Sage Property	Modern NW, Inc.		20287	TP-5
PROJECT LOCATION	CONTRACTOR	EQUIPMENT	TECHNICIAN	DATE
Camas, Washington	L&S Contractors	Excavator	MCK	11/20/20
TEST PIT LOCATION	APPROX. SURFACE ELEVATION	GROUNDWATER DEPTH	START TIME	FINISH TIME
See Figure 2	700 ft amsl	2.0 feet bgs	1030	1059

Depth (feet)	Sample Field ID	SCS Soil Survey Description	AASHTO Soil Type	USCS Soil Type	Graphic Log	LITHOLOGIC DESCRIPTION AND REMARKS	Moisture Content (%)	Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Infiltration Testing
0						Approximately 12 inches of grass and topsoil.					
						FILL. Tan to dark brown, moist to wet, medium stiff silt. [Soil Type 1]					
5		Powell silt loam	A-6	CL		Tan, mottled, wet, medium stiff lean CLAY. [Soil Type 2]					
10											
			A-7	MH		Tan to orange-brown, weathered, wet, stiff sandy elastic SILT with trace to some subrounded gravel. [Soil Type 3]					
15						Bottom of test pit at 14.0 feet bgs. Groundwater observed at approximately 2.0 feet bgs on 11/20/20.					

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TEST PIT LOG

PROJECT NAME	CLIENT		PROJECT NO.	TEST PIT NO.
Sage Property	Modern NW, Inc.		20287	TP-6
PROJECT LOCATION	**CONTRACTOR**	**EQUIPMENT**	**TECHNICIAN**	**DATE**
Camas, Washington	L&S Contractors	Excavator	MCK	11/20/20
TEST PIT LOCATION	**APPROX. SURFACE ELEVATION**	**GROUNDWATER DEPTH**	**START TIME**	**FINISH TIME**
See Figure 2	702 ft amsl	8.0 feet bgs	1100	1122

Depth (feet)	Sample Field ID	SCS Soil Survey Description	AASHTO Soil Type	USCS Soil Type	Graphic Log	LITHOLOGIC DESCRIPTION AND REMARKS	Moisture Content (%)	Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Infiltration Testing
0						Approximately 12 inches of grass and topsoil.					
		Powell silt loam		CL		Brown to tan, moist, medium stiff lean CLAY. [Soil Type 2]					
5	TP6.1		A-6(8)				25.3	85.1	31	11	
			A-7	MH		Brown to red-brown, weathered, wet, stiff sandy elastic SILT. [Soil Type 3]					
10											
						Rounded to subrounded cobbles and boulders at approximately 13 feet bgs.					
15						Bottom of test pit at 14.0 feet bgs. Groundwater observed at approximately 8.0 feet bgs on 11/20/20.					

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TEST PIT LOG

PROJECT NAME	CLIENT		PROJECT NO.	TEST PIT NO.
Sage Property	Modern NW, Inc.		20287	TP-7
PROJECT LOCATION	CONTRACTOR	EQUIPMENT	TECHNICIAN	DATE
Camas, Washington	L&S Contractors	Excavator	MCK	11/20/20
TEST PIT LOCATION	APPROX. SURFACE ELEVATION	GROUNDWATER DEPTH	START TIME	FINISH TIME
See Figure 2	696 ft amsl	6.5 feet bgs	1124	1150

Depth (feet)	Sample Field ID	SCS Soil Survey Description	AASHTO Soil Type	USCS Soil Type	Graphic Log	LITHOLOGIC DESCRIPTION AND REMARKS	Moisture Content (%)	Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Infiltration Testing
0						Approximately 14 to 16 inches of grass and topsoil.					
		Powell silt loam	A-6	CL		Brown to tan, mottled, moist to wet, medium stiff lean CLAY. [Soil Type 2]					
5											
				MH		Red-brown to orange-brown, weathered, wet, medium stiff to stiff sandy elastic SILT. [Soil Type 3]					
10											
	TP7.1		A-7-5(11)				42.2	53.2	58	25	
						Bottom of test pit at 13.0 feet bgs. Groundwater observed at approximately 6.5 feet bgs on 11/20/20.					
15											

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TEST PIT LOG

PROJECT NAME	CLIENT		PROJECT NO.	TEST PIT NO.
Sage Property	Modern NW, Inc.		20287	TP-8
PROJECT LOCATION	CONTRACTOR	EQUIPMENT	TECHNICIAN	DATE
Camas, Washington	L&S Contractors	Excavator	MCK	11/20/20
TEST PIT LOCATION	APPROX. SURFACE ELEVATION	GROUNDWATER DEPTH	START TIME	FINISH TIME
See Figure 2	674 ft amsl	3.0 feet bgs	1153	1225

Depth (feet)	Sample Field ID	SCS Soil Survey Description	AASHTO Soil Type	USCS Soil Type	Graphic Log	LITHOLOGIC DESCRIPTION AND REMARKS	Moisture Content (%)	Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Infiltration Testing
0						Approximately 12 inches of grass and topsoil					
		Powell silt loam	A-6	CL		Brown to tan, moist to wet, medium stiff lean CLAY. [Soil Type 2]					
5											
			A-7	MH		Brown to red-brown, weathered, wet, medium stiff to stiff sandy elastic SILT. [Soil Type 3]					
10											
						Bottom of test pit at 12.0 feet bgs. Groundwater observed at approximately 3.0 feet bgs on 11/20/20.					
15											

APPENDIX C
SOIL CLASSIFICATION INFORMATION

SOIL DESCRIPTION AND CLASSIFICATION GUIDELINES

Particle-Size Classification

COMPONENT	ASTM/USCS		AASHTO	
	size range	sieve size range	size range	sieve size range
Cobbles	> 75 mm	greater than 3 inches	> 75 mm	greater than 3 inches
Gravel	75 mm – 4.75 mm	3 inches to No. 4 sieve	75 mm – 2.00 mm	3 inches to No. 10 sieve
Coarse	75 mm – 19.0 mm	3 inches to 3/4-inch sieve	-	-
Fine	19.0 mm – 4.75 mm	3/4-inch to No. 4 sieve	-	-
Sand	4.75 mm – 0.075 mm	No. 4 to No. 200 sieve	2.00 mm – 0.075 mm	No. 10 to No. 200 sieve
Coarse	4.75 mm – 2.00 mm	No. 4 to No. 10 sieve	2.00 mm – 0.425 mm	No. 10 to No. 40 sieve
Medium	2.00 mm – 0.425 mm	No. 10 to No. 40 sieve	-	-
Fine	0.425 mm – 0.075 mm	No. 40 to No. 200 sieve	0.425 mm – 0.075 mm	No. 40 to No. 200 sieve
Fines (Silt and Clay)	< 0.075 mm	Passing No. 200 sieve	< 0.075 mm	Passing No. 200 sieve

Consistency for Cohesive Soil

CONSISTENCY	SPT N-VALUE (BLOWS PER FOOT)	POCKET PENETROMETER (UNCONFINED COMPRESSIVE STRENGTH, tsf)
Very Soft	2	less than 0.25
Soft	2 to 4	0.25 to 0.50
Medium Stiff	4 to 8	0.50 to 1.0
Stiff	8 to 15	1.0 to 2.0
Very Stiff	15 to 30	2.0 to 4.0
Hard	30 to 60	greater than 4.0
Very Hard	greater than 60	-

Relative Density for Granular Soil

RELATIVE DENSITY	SPT N-VALUE (BLOWS PER FOOT)
Very Loose	0 to 4
Loose	4 to 10
Medium Dense	10 to 30
Dense	30 to 50
Very Dense	more than 50

Moisture Designations

TERM	FIELD IDENTIFICATION
Dry	No moisture. Dusty or dry.
Damp	Some moisture. Cohesive soils are usually below plastic limit and are moldable.
Moist	Grains appear darkened, but no visible water is present. Cohesive soils will clump. Sand will bulk. Soils are often at or near plastic limit.
Wet	Visible water on larger grains. Sand and silt exhibit dilatancy. Cohesive soil can be readily remolded. Soil leaves wetness on the hand when squeezed. Soil is much wetter than optimum moisture content and is above plastic limit.

AASHTO SOIL CLASSIFICATION SYSTEM

TABLE 1. Classification of Soils and Soil-Aggregate Mixtures

General Classification	Granular Materials (35 Percent or Less Passing .075 mm)			Silt-Clay Materials (More than 35 Percent Passing 0.075)			
Group Classification	A-1	A-3	A-2	A-4	A-5	A-6	A-7
Sieve analysis, percent passing:							
2.00 mm (No. 10)	-	-	-				
0.425 mm (No. 40)	50 max	51 min	-	-	-	-	-
0.075 mm (No. 200)	25 max	10 max	35 max	36 min	36 min	36 min	36 min
Characteristics of fraction passing 0.425 mm (No. 40)							
Liquid limit				40 max	41 min	40 max	41 min
Plasticity index	6 max	N.P.		10 max	10 max	11 min	11 min
General rating as subgrade	Excellent to good			Fair to poor			

Note: The placing of A-3 before A-2 is necessary in the "left to right elimination process" and does not indicate superiority of A-3 over A-2.

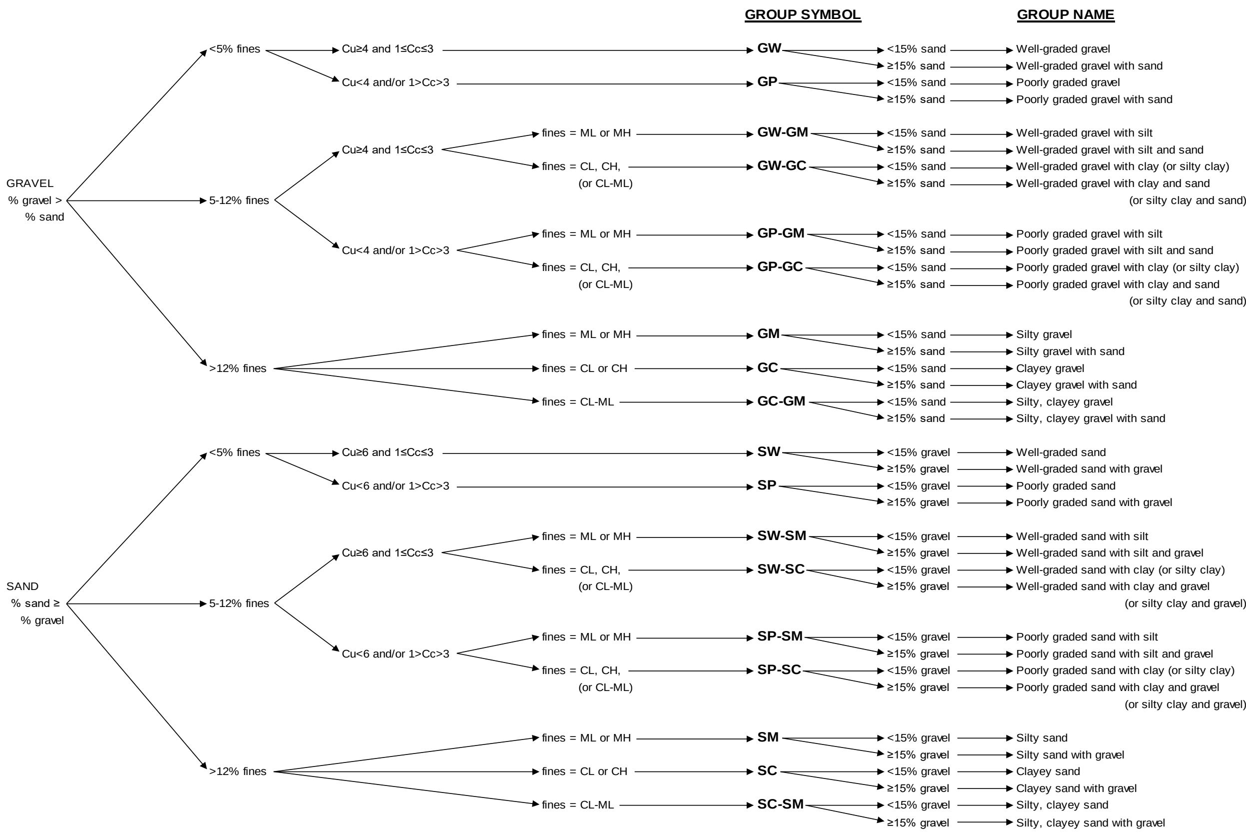
TABLE 2. Classification of Soils and Soil-Aggregate Mixtures

General Classification	Granular Materials (35 Percent or Less Passing 0.075 mm)							Silt-Clay Materials (More than 35 Percent Passing 0.075 mm)			
	A-1			A-2							A-7
Group Classification	A-1-a	A-1-b	A-3	A-2-4	A-2-5	A-2-6	A-2-7	A-4	A-5	A-6	A-7-5, A-7-6
Sieve analysis, percent passing:											
2.00 mm (No. 10)	50 max	-	-	-	-	-	-	-	-	-	-
0.425 mm (No. 40)	30 max	50 max	51 min	-	-	-	-	-	-	-	-
0.075 mm (No. 200)	15 max	25 max	10 max	35 max	35 max	35 max	35 max	36 min	36 min	36 min	36 min
Characteristics of fraction passing 0.425 mm (No. 40)											
Liquid limit				40 max	41 min	40 max	41 min	40 max	41 min	40 max	41 min
Plasticity index	6 max		N.P.	10 max	10 max	11 min	11 min	10 max	10 max	11 min	11min
Usual types of significant constituent materials	Stone fragments, gravel and sand		Fine sand	Silty or clayey gravel and sand				Silty soils		Clayey soils	
General ratings as subgrade	Excellent to Good							Fair to poor			

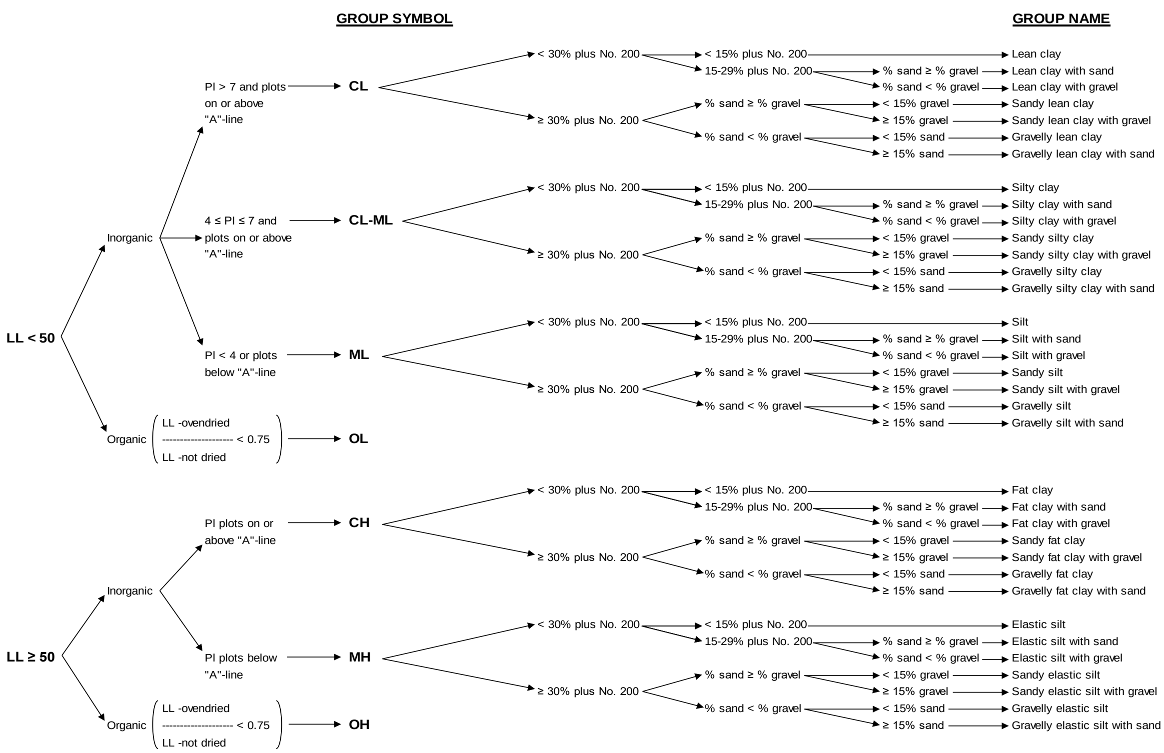
Note: Plasticity index of A-7-5 subgroup is equal to or less than LL minus 30. Plasticity index of A-7-6 subgroup is greater than LL minus 30 (see Figure 2).

AASHTO = American Association of State Highway and Transportation Officials

USCS SOIL CLASSIFICATION SYSTEM



Flow Chart for Classifying Coarse-Grained Soils (More Than 50% Retained on No. 200 Sieve)



Flow Chart for Classifying Fine-Grained Soil (50% or More Passes No. 200 Sieve)

APPENDIX D
PHOTO LOG

Sage Property

November, 2020

Camas, Washington

Northern Site Area, Facing East from TP-8

Sage Property

November, 2020

Camas, Washington

Central Site Area, Facing West from TP-5

Sage Property

November, 2020

Camas, Washington

Typical Test Pit Profile, TP-1

Sage Property

November, 2020

Camas, Washington

Typical Test Pit Profile, TP-4

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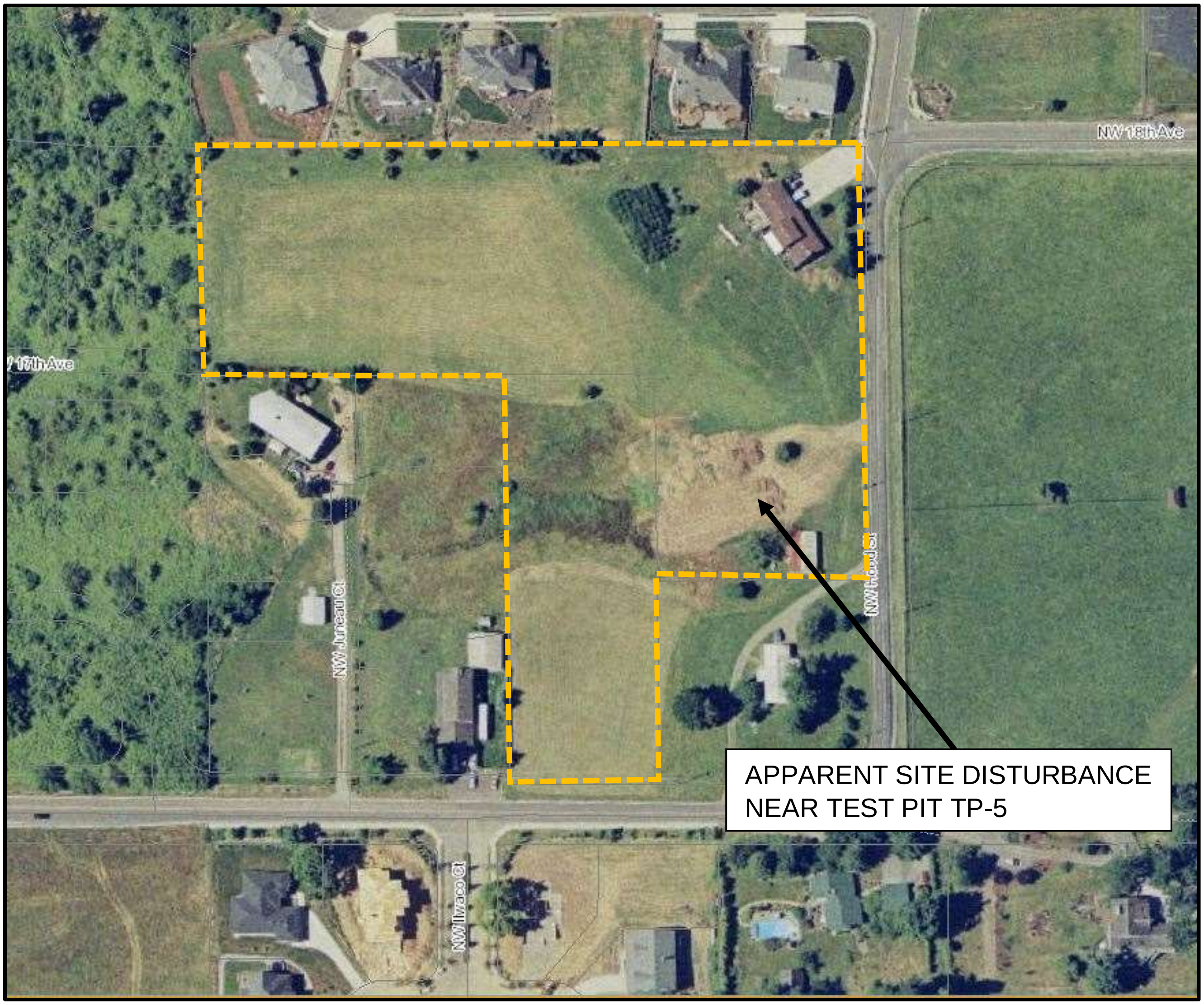
Sage Property

November, 2020

Camas, Washington



1998 Aerial Photography

(Clark County Maps Online, Accessed December, 2020)

APPENDIX E
REPORT LIMITATIONS AND IMPORTANT INFORMATION

Date: January 4, 2021
Project: Sage Property
Camas, Washington

Geotechnical and Environmental Report Limitations and Important Information

Report Purpose, Use, and Standard of Care

This report has been prepared in accordance with standard fundamental principles and practices of geotechnical engineering and/or environmental consulting, and in a manner consistent with the level of care and skill typical of currently practicing local engineers and consultants. This report has been prepared to meet the specific needs of specific individuals for the indicated site. It may not be adequate for use by other consultants, contractors, or engineers, or if change in project ownership has occurred. It should not be used for any other reason than its stated purpose without prior consultation with Columbia West Engineering, Inc. (Columbia West). It is a unique report and not applicable for any other site or project. If site conditions are altered, or if modifications to the project description or proposed plans are made after the date of this report, it may not be valid. Columbia West cannot accept responsibility for use of this report by other individuals for unauthorized purposes, or if problems occur resulting from changes in site conditions for which Columbia West was not aware or informed.

Report Conclusions and Preliminary Nature

This geotechnical or environmental report should be considered preliminary and summary in nature. The recommendations contained herein have been established by engineering interpretations of subsurface soils based upon conditions observed during site exploration. The exploration and associated laboratory analysis of collected representative samples identifies soil conditions at specific discreet locations. It is assumed that these conditions are indicative of actual conditions throughout the subject property. However, soil conditions may differ between tested locations at different seasonal times of the year, either by natural causes or human activity. Distinction between soil types may be more abrupt or gradual than indicated on the soil logs. This report is not intended to stand alone without understanding of concomitant instructions, correspondence, communication, or potential supplemental reports that may have been provided to the client.

Because this report is based upon observations obtained at the time of exploration, its adequacy may be compromised with time. This is particularly relevant in the case of natural disasters, earthquakes, floods, or other significant events. Report conclusions or interpretations may also be subject to revision if significant development or other manmade impacts occur within or in proximity to the subject property. Groundwater conditions, if presented in this report, reflect observed conditions at the time of investigation. These conditions may change annually, seasonally or as a result of adjacent development.

Additional Investigation and Construction QA/QC

Columbia West should be consulted prior to construction to assess whether additional investigation above and beyond that presented in this report is necessary. Even slight variations in soil or site conditions may produce impacts to the performance of structural facilities if not adequately addressed. This underscores the importance of diligent QA/QC construction observation and testing to verify soil conditions do not differ materially or significantly from the interpreted conditions utilized for preparation of this report.

Therefore, this report contains several recommendations for field observation and testing by Columbia West personnel during construction activities. Actual subsurface conditions are more readily observed and discerned during the earthwork phase of construction when soils are exposed. Columbia West cannot accept responsibility for deviations from recommendations described in this report or future performance of structural facilities if another consultant is retained during the construction phase or Columbia West is not engaged to provide construction observation to the full extent recommended.

Collected Samples

Uncontaminated samples of soil or rock collected in connection with this report will be retained for thirty days. Retention of such samples beyond thirty days will occur only at client's request and in return for payment of storage charges incurred. All contaminated or environmentally impacted materials or samples are the sole property of the client. Client maintains responsibility for proper disposal.

Report Contents

This geotechnical or environmental report should not be copied or duplicated unless in full, and even then only under prior written consent by Columbia West, as indicated in further detail in the following text section entitled *Report Ownership*. The recommendations, interpretations, and suggestions presented in this report are only understandable in context of reference to the whole report. Under no circumstances should the soil boring or test pit excavation logs, monitor well logs, or laboratory analytical reports be separated from the remainder of the report. The logs or reports should not be redrawn or summarized by other entities for inclusion in architectural or civil drawings, or other relevant applications.

Report Limitations for Contractors

Geotechnical or environmental reports, unless otherwise specifically noted, are not prepared for the purpose of developing cost estimates or bids by contractors. The extent of exploration or investigation conducted as part of this report is usually less than that necessary for contractor's needs. Contractors should be advised of these report limitations, particularly as they relate to development of cost estimates. Contractors may gain valuable information from this report, but should rely upon their own interpretations as to how subsurface conditions may affect cost, feasibility, accessibility and other components of the project work. If believed necessary or relevant, contractors should conduct additional exploratory investigation to obtain satisfactory data for the purposes of developing adequate cost estimates. Clients or developers cannot insulate themselves from attendant liability by disclaiming accuracy for subsurface ground conditions without advising contractors appropriately and providing the best information possible to limit potential for cost overruns, construction problems, or misunderstandings.

Report Ownership

Columbia West retains the ownership and copyright property rights to this entire report and its contents, which may include, but may not be limited to, figures, text, logs, electronic media, drawings, laboratory reports, and appendices. This report was prepared solely for the client, and other relevant approved users or parties, and its distribution must be contingent upon prior express written consent by Columbia West. Furthermore, client or approved users may not use, lend, sell, copy, or distribute this document without express written consent by Columbia West. Client does not own nor have rights to electronic media files that constitute this report, and under no circumstances should said electronic files be distributed or copied. Electronic media is susceptible to unauthorized manipulation or modification, and may not be reliable.

Consultant Responsibility

Geotechnical and environmental engineering and consulting is much less exact than other scientific or engineering disciplines, and relies heavily upon experience, judgment, interpretation, and opinion often based upon media (soils) that are variable, anisotropic, and non-homogenous. This often results in unrealistic expectations, unwarranted claims, and uninformed disputes against a geotechnical or environmental consultant. To reduce potential for these problems and assist relevant parties in better understanding of risk, liability, and responsibility, geotechnical and environmental reports often provide definitive statements or clauses defining and outlining consultant responsibility. The client is encouraged to read these statements carefully and request additional information from Columbia West if necessary.

1811 NW Hood Street
Wetland Delineation and Assessment
Camas, Washington

Prepared For:
Modern NW
1801 NE Glisan Street
Portland, OR 97213

Prepared By:
Olson Environmental LLC
222 E. Evergreen Blvd
Vancouver, WA 98660
(360) 693-4555

June 14, 2021

OLSON ENVIRONMENTAL LLC
ENVIRONMENTAL SERVICES • GIS • HABITAT RESTORATION

TABLE OF CONTENTS

FIGURES

APPENDICIES

WETLAND DELINEATION AND ASSESSMENT

Project:	**1811 Hood Street**
Applicant:	**Modern NW**
Location:	**1811 Hood Street, Camas, Washington**
Legal Description:	**NE & NW ¼ of Section 09,T1N, R3E W. M., Clark County**
Serial Number(s):	**127415-000 (4.67 ac.) and 127440-000 (1.41 ac.)**
Study Area Size:	**6.08 acres**
Jurisdiction:	**Camas**
Watershed:	**Lacamas Creek/Dwyer Creek (10)**
WRIA	**Salmon – Washougal (28)**
Zoning:	**R-7.5**
ComPlan:	**SFM (Single Family Medium)**
Assessment by:	**Kevin Terlep and Garrett Jordan**
Site Visit:	**6/11/2021 and 6/14/2021**
Report Date:	**06/14/2021**

1.0 INTRODUCTION

This report details the results of a wetland delineation and assessment conducted for Modern NW, by Olson Environmental, LLC. (OE). The study area is located at 1811 Hood Street, Camas, Washington (Fig. 1). This report identifies the extent of any wetlands and associated buffers found within the study area as defined and regulated by the US Army Corps of Engineers (USACE) and the Washington Department of Ecology (Ecology) under sections 401 and 404 of the Clean Water Act, and locally by the City of Camas under Camas Municipal Code (CMC) 16.53.

The 6.08-acre properties include parcel 127415-000 (4.67 acres) and 127440-000 (1.41 acres). The study area includes the entirety of both parcels for a proposed 14-unit single family residential development and associated roads.

The majority of the study area is open grassland, it moderately slopes from the northeast to the southwest (Fig. 2). One existing house is located on the adjacent parcel to southeast. The eastern property line is immediately parallel to Northwest Hood Street and NW Columbia Summit Drive and NW Klickitat Street are to the north and west, respectively. The property is located within the Dwyer Creek sub-watershed of the Lacamas Creek watershed (WRIA 28). Through the course of the assessment one (1) wetland was identified along the western property line of the southern parcel (127440-000).

2.0 WETLAND DELINEATION AND ASSESSMENT METHODS

The wetland delineation was conducted according to the Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys and Coast Region (USACE, 2010.) hereafter, referred to as the manual. According to the manual, jurisdictional wetlands are defined as:

> *Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.*

Prior to the on-site investigations, a review of existing information related to determination of the wetland boundaries was conducted. This review included the Clark County topographic data (Fig. 2), Clark County Soil Survey data (Fig. 3), and Clark County Wetland Inventory (LWI) & National Wetland Inventory (NWI) data (Fig. 4).

The manual uses three parameters in making wetland determinations: hydrophytic vegetation, hydric soils, and wetland hydrology. Except in certain situations defined in the manual, evidence of a minimum of one positive indicator from each parameter (hydrology, soil, and vegetation) must be found in order to make a positive wetland determination.

<u>Hydrophytic vegetation</u> are plants that due to morphological, physiological, and/or reproductive adaptations, have the ability to grow, effectively compete, reproduce, and/or persist in anaerobic soil conditions. Individual plant species within a single plant community are characterized with a wetland indicator status according to the most current National Wetland Plant List (Lichvar et al. 2016). Wetland indicator status ratings and their ordinal rating categories, based on ecological descriptions, are as follows:

Indicator Status* (abbreviation):
Obligate (OBL) - Almost always is a hydrophyte, rarely in uplands
Facultative Wetland (FACW) - Usually is a hydrophyte but occasionally found in uplands
Facultative (FAC) - Commonly occurs as either a hydrophyte or non-hydrophyte
Facultative Upland (FACU) - Occasionally is a hydrophyte, but usually occurs in uplands
Upland (UPL) - Rarely is a hydrophyte, almost always in uplands
*Source: Lichvar and Gillrich (2011)

Hydrophytic vegetation is present when more than 50 percent of the dominant species have an indicator status of OBL, FACW, and/or FAC.

<u>Hydric soils</u> are soils that are saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions that favor the growth and regeneration of hydrophytic vegetation. The presence or absence of hydric soils is determined in the field by digging soil pits to a depth of 16 inches and examining the soil for hydric soil

indicators. Organic soils such as peats and mucks are considered hydric soils. Mineral hydric soils are generally either gleyed or have redox concentrations and/or low matrix chroma immediately below the A-horizon or 10 inches (whichever is shallower). Soil colors are determined using the Munsell Soil Color Chart (Munsell Color System 2009).

Wetland hydrology is present when an area is inundated or saturated to the surface for at least 5 percent of the growing season. The growing season is defined as the portion of the year when soil temperature at 19.7 inches below the soil surface is greater than biological zero (5 degrees C). The site was examined for standing water and/or saturated soils, which serve as primary indicators of wetland hydrology. The area was also checked for other wetland hydrologic characteristics such as watermarks, drift lines, wetland drainage patterns, and morphological plant adaptations.

3.0 SITE SPECIFIC METHODS

OE conducted the onsite wetland delineation and assessment on June 11 and 14, 2021 using the methodology found in the Regional Supplement to the Manual (USACE 2010). In addition, applicable guidance and any supporting technical guidance documents issued by the USACE, Ecology, and Clark County were also utilized.

The entire site was first traversed by foot to observe any visible wetland conditions. Once the general location of the wetland boundaries were identified, paired data plots were taken in areas that represented the conditions of the uplands and wetlands, respectively. One and ten meter radius plots were chosen in a uniform topographic position that was representative of a single plant community. The paired plots were located approximately 5 - 10 feet apart to minimize the margin of error. Soils at each sample plot were typically inspected to a depth of 16 inches (or more) to determine the presence or absence of hydric soil characteristics and/or wetland hydrology. Data sheets for the sample plots are attached in Appendix A.

The wetland boundary was determined based on the presence of hydric soils, the presence of wetland hydrology (i.e. oxidized rhizospheres along living roots, soil saturation), and a dominance of hydrophytic vegetation. It should be noted that only paired plots were recorded in the field, however, numerous unrecorded plots were dug to confirm wetland boundaries. The on-site wetlands were classified according the USFWS classification system (Cowardin et al. 1979) and the Hydrogeomorphic (HGM) Classification system (Adamus et al. 2001).

4.0 RESULTS AND DISCUSSION

The Clark County GIS Maps Online and the LWI Map, Figure 4, indicate that wetlands do not occur within the study area. The US Fish and Wildlife Service’s National Wetland Inventory map (NWI) was also consulted and likewise, no NWI wetlands occur within the study area. It is noted that Figure 4 and the County GIS maps are derived from NWI and LWI data, aerial photographs, NRCS Maps, previous delineations, and topographic map interpretation. They are not intended to represent the extent of jurisdictional wetlands. There may be unmapped wetland and waters subject to regulation and all wetlands and waters boundary mapping is approximate. In all cases, actual field conditions determine the presence, absence, and boundaries of wetlands and waters.

The following Map Unit Symbols are mapped (Fig. 3) on this site:

> ***Powell silt loam, 20 to 30 percent slopes (PoE)***. The Powell series consists of moderately drained soils formed in old alluvial silt and underlain by a layer of fragipan at 23-36 inches. These soils are moderately permeable, surface run-off is medium, and the erosion hazard is moderate to severe if left uncovered (McGee 1972). They are classified as **non-hydric** soils according to the Clark County hydric soils list.
>
> ***Powell silt loam, 8 to 20 percent slopes (PoD)***. The Powell series consists of moderately drained soils formed in old alluvial silt and underlain by a layer of fragipan at 23-36 inches. These soils are moderately permeable, surface run-off is medium, and the erosion hazard is moderate (McGee 1972). They are classified as **non-hydric** soils according to the Clark County hydric soils list.

4.1 WETLANDS

<u>Wetland A (11, 480 sq. ft)</u>

During the onsite assessment, one (1) wetland was identified along the west property line (Fig. 5) in the area indicated by the previous wetland study. This wetland appears to remnant of a larger wetland that extended to the northeast and continues onto the property to the west. Vegetation within the wetland is dominated by soft rush (*Juncus effusus* -FACW), teasel (*Dipsacus fullonum* -FAC), velvet grass (*Holcus lanatus* -FAC) and reed canary grass (*Phalaris arundinacea* -FACW). Soils within the wetland are characterized by dark brown to very dark grayish brown matrixes (7.5-10YR 3/1) from 0-16 inches and 2-5% strong brown (7.5YR4-6) redox concentrations from 6-16 inches occurring within the matrix. The hydric soil indicator for these soils was redox dark surface (F6). The wetland hydrology indicators were geomorphic position (D2), oxidational within the rhizosphere of living roots (C3), and passing the FAC-neutral test (D5).

4.2 NON-WETLANDS

The majority of the non-wetlands throughout the site are dominated by open grassland. At the time of the site visit there were no indications that it is mowed on a regular basis. Dominant species within the pasture include velvet grass, red fescue (*Festuca rubra* -FAC), reed canary grass, and meadow foxtail (*Alopecurus pratensis* -FAC). Very few trees occur within the study area but several big-leaf maples (*Acer macrophyllum* -FAC) were observed within the study area. A tree line is also formed by the backyards of adjacent parcels to the west. Some of the species there include Douglas-fir (*Pseudotsuga* *menziesii* -FACU), western red cedar (*Thuja occidentalis* -FAC), and Oregon ash (*Fraxinus latifolia* -FACW).

5.0 WETLAND FUNCTIONAL ASSESSMENT

The delineated wetlands were assessed using the Washington State Wetland Rating System for Western Washington (Hruby Update 2014). The system was designed to differentiate between wetlands based on their sensitivity to disturbance, their significance, their rarity, our ability to replace them, and the functions they provide.

Through a series of questions, the wetland rating system generates a number for water quality functions, hydrologic functions, and habitat function, which creates a total score for functions. Based on the total score, the wetland is categorized as a Category I, II, III, or IV wetland. Table 1 below summarizes the wetland type, total score for functions, and category of wetlands identified within the study area.

Table 1. Wetland Function Rating

Wetland	Wetland Type	Water Quality Functions	Hydrologic Functions	Habitat Functions	Total Score	Wetland Category
A	Slope	4	4	3	11	IV

6.0 REGULATORY ISSUES

Through the course of the wetland one (1) wetland was identified within the study area as shown in Figure 5. CMC 16.53.040 provides for the protection of wetlands within Camas's jurisdiction. The ordinance establishes protective buffers associated with wetlands and specifies that certain permits or approvals be obtained for projects containing wetlands or their respective buffers. As shown in Table 1, Wetland A was rated to be a Category IV wetland with a habitat score of 3. CMC requires that Category IV wetlands with habitat function scores of 3 to be protected with a 50-foot high-intensity land use buffer (Fig. 6, CMC Table 16.53.040-1).

In addition to CMC 16.53, jurisdictional wetlands are also regulated at the federal and state levels by the USACE and Ecology under Sections 401 and 404 of the Clean Water Act, respectively. Any impacts to the wetlands may require notification and approval from the USACE and Ecology. It is recommended that the USACE and Ecology be contacted regarding current permit requirements before proceeding with any development activities that would impact wetlands on this site.

The wetland boundaries and classifications shown in this report have been determined using the most appropriate field techniques and best professional judgment of the environmental scientist. It should be noted that USACE and Camas have the final authority in determining the wetland boundaries and categories under their respective jurisdictions. It is recommended that this delineation report

be submitted to these agencies for concurrence prior to purchasing a property, starting any development or planning activities that would affect wetlands or buffers on this site.

7.0 LITERATURE CITED

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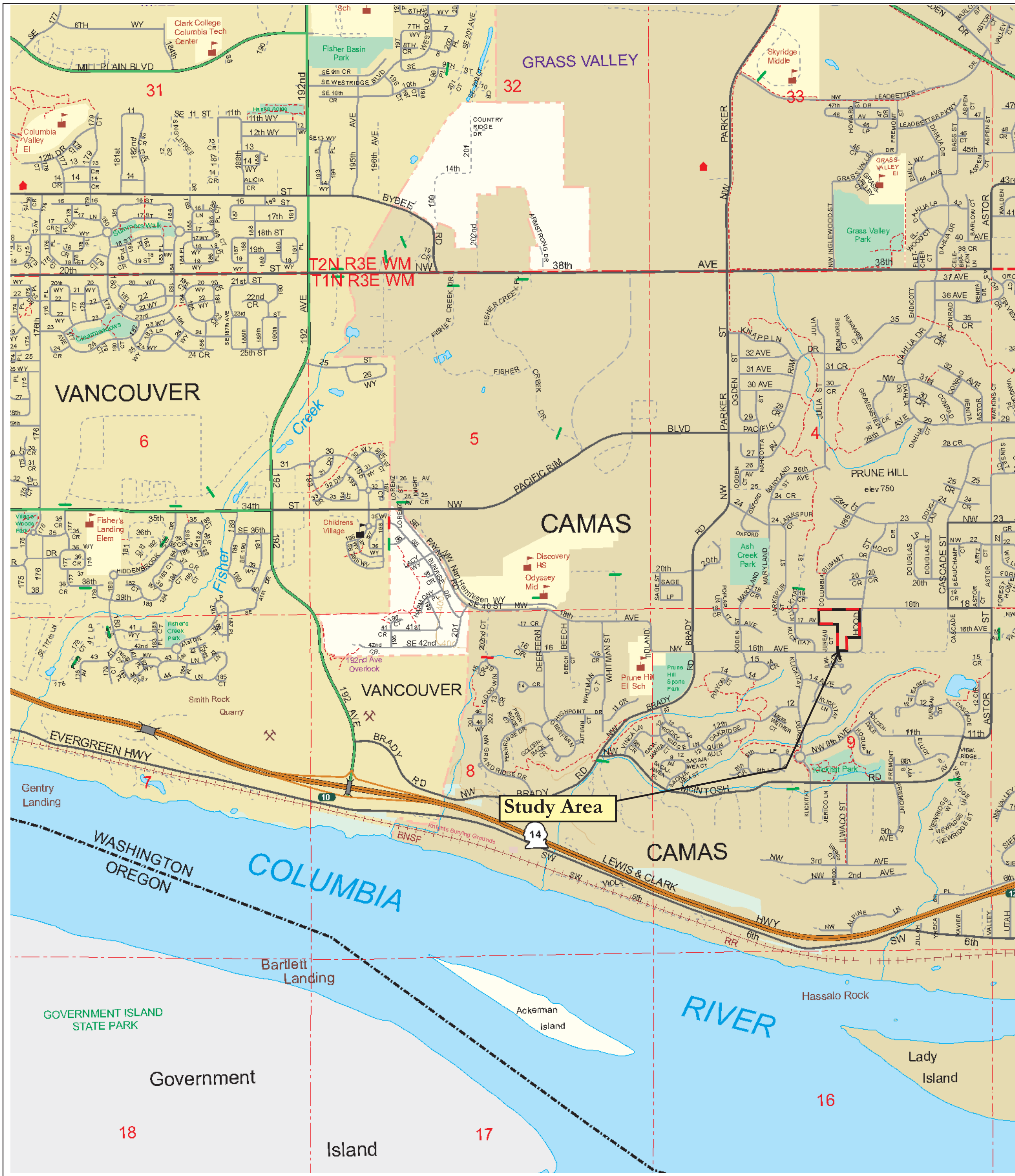
FIGURES

APPENDICIES



APPLICANT:
Modern NW
8101 NW Glisan
Portland, OR 97213

PURPOSE:
Wetland Delineation

Project Location
1811 NW Hood Street
Camas, Washington

OLSON ENVIRONMENTAL LLC
222 E. Evergreen Blvd., Vancouver, WA 98660 ph: 360-693-4555 fax: 360-699-6242

PROPOSED ACTIVITIES IN:
Lacamas Creek Watershed
LEGAL: NE & NW 1/4 of S09, T1N, R3E W. M.
NEAR: Camas, Washington
COUNTY: Clark County
DATE: 06/16/2021

Figure 1

APPLICANT:
Modern NW
8101 NW Glisan
Portland, OR 97213

PURPOSE:
Wetland Delineation

Topographic Map [Clark County GIS]

1811 NW Hood Street
Camas, Washington

OLSON ENVIRONMENTAL LLC
ENVIRONMENTAL SERVICES • GIS • HABITAT RESTORATION
222 E. Evergreen Blvd., Vancouver, WA 98660 ph: 360-693-4555 fax: 360-699-6242

PROPOSED ACTIVITIES IN:
Lacamas Creek Watershed
LEGAL: NE & NW 1/4 of S09, T1N, R3E W. M.
NEAR: Camas, Washington
COUNTY: Clark County
DATE: 06/16/2021

Figure 2

APPLICANT: Modern NW 8101 NW Glisan Portland, OR 97213 **PURPOSE:** Wetland Delineation	**Clark County Soil Survey [NRCS]** 1811 NW Hood Street Camas, Washington OLSON ENVIRONMENTAL LLC ENVIRONMENTAL SERVICES • GIS • HABITAT RESTORATION 222 E. Evergreen Blvd., Vancouver, WA 98660 ph: 360-693-4555 fax: 360-699-6242	**PROPOSED ACTIVITIES IN:** Lacamas Creek Watershed **LEGAL:** NE & NW 1/4 of S09, T1N, R3E W. M. **NEAR:** Camas, Washington **COUNTY:** Clark County **DATE:** 06/16/2021 **Figure 3**

APPLICANT:
Modern NW
8101 NW Glisan
Portland, OR 97213

PURPOSE:
Wetland Delineation

Clark County GIS Wetland Inventory [LWI/NWI]
1811 NW Hood Street
Camas, Washington

OLSON ENVIRONMENTAL LLC
ENVIRONMENTAL SERVICES • GIS • HABITAT RESTORATION
222 E. Evergreen Blvd., Vancouver, WA 98660 ph: 360-693-4555 fax: 360-699-6242

PROPOSED ACTIVITIES IN:
Lacamas Creek Watershed
LEGAL: NE & NW 1/4 of S09, T1N, R3E W. M.
NEAR: Camas, Washington
COUNTY: Clark County
DATE: 06/16/2021

Figure 4

APPLICANT:
Modern NW
8101 NW Glisan
Portland, OR 97213

PURPOSE:
Wetland Delineation

Delineated Wetland Boundary and Sample Plots
1811 NW Hood Street
Camas, Washington

OLSON ENVIRONMENTAL LLC
ENVIRONMENTAL SERVICES • GIS • HABITAT RESTORATION
222 E. Evergreen Blvd., Vancouver, WA 98660 ph: 360-693-4555 fax: 360-699-6242

PROPOSED ACTIVITIES IN:
Lacamas Creek Watershed
LEGAL: NE & NW 1/4 of S09, T1N, R3E W. M.
NEAR: Camas, Washington
COUNTY: Clark County
DATE: 06/16/2021

Figure 5

APPLICANT:
Modern NW
8101 NW Glisan
Portland, OR 97213

PURPOSE:
Wetland Delineation

Wetland Buffers - High LUI
1811 NW Hood Street
Camas, Washington

OLSON ENVIRONMENTAL LLC
222 E. Evergreen Blvd., Vancouver, WA 98660 ph: 360-693-4555 fax: 360-699-6242

PROPOSED ACTIVITIES IN:
Lacamas Creek Watershed
LEGAL: NE & NW 1/4 of S09, T1N, R3E W. M.
NEAR: Camas, Washington
COUNTY: Clark County
DATE: 06/16/2021

Figure 6


Wetland Finger Facing East


Top of Wetland Facing West


Wetland Finger Facing West


Maples Along Northern Property boundary


Bottom of Wetland Facing South


Western Property Boundary Facing 16th Ave

APPLICANT:
Modern NW
8101 NW Glisan
Portland, OR 97213

PURPOSE:
Wetland Delineation

Photo Sheet 1
1811 NW Hood Street
Camas, Washington

OLSON ENVIRONMENTAL LLC
ENVIRONMENTAL SERVICES • GIS • HABITAT RESTORATION
222 E. Evergreen Blvd., Vancouver, WA 98660 ph: 360-693-4555 fax: 360-699-6242

PROPOSED ACTIVITIES IN:
Lacamas Creek Watershed
LEGAL: NE & NW 1/4 of S09, T1N, R3E W. M.
NEAR: Camas, Washington
COUNTY: Clark County
DATE: 06/16/2021

Photo-Sheet 1

APPENDIX B

WETLAND RATING SYSTEM FOR WESTERN WASHINGTON
WETLAND RATING FORMS

WETLAND A –SLOPE HGM CLASS

Wetland name or number A___

RATING SUMMARY – Western Washington

Name of wetland (or ID #): Hood St____________________________ Date of site visit: 06/11/2021

Rated by Kevin Terlep________________ Trained by Ecology?__ Yes X No Date of training______

HGM Class used for rating Slope_____________ Wetland has multiple HGM classes?___Y x N

NOTE: Form is not complete without the figures requested *(figures can be combined)*.
Source of base aerial photo/map ESRI ArcMap Aerial Imagery basemap

OVERALL WETLAND CATEGORY IV___ (based on functions___ or special characteristics___)

1. Category of wetland based on FUNCTIONS

_______**Category I** – Total score = 23 - 27

_______**Category II** – Total score = 20 - 22

_______**Category III** – Total score = 16 - 19

x______**Category IV** – Total score = 9 - 15

FUNCTION	Improving Water Quality	Hydrologic	Habitat	
			Circle the appropriate ratings	
Site Potential	H M L	H M L	H M L	
Landscape Potential	H M L	H M L	H M L	
Value	H M L	H M L	H M L	**TOTAL**
Score Based on Ratings	4	4	3	11

Score for each function based on three ratings *(order of ratings is not important)*

9 = H,H,H
8 = H,H,M
7 = H,H,L
7 = H,M,M
6 = H,M,L
6 = M,M,M
5 = H,L,L
5 = M,M,L
4 = M,L,L
3 = L,L,L

2. Category based on SPECIAL CHARACTERISTICS of wetland

CHARACTERISTIC	CATEGORY
Estuarine	I II
Wetland of High Conservation Value	I
Bog	I
Mature Forest	I
Old Growth Forest	I
Coastal Lagoon	I II
Interdunal	I II III IV
None of the above	X

Wetland name or number A

Maps and figures required to answer questions correctly for Western Washington

Depressional Wetlands

Map of:	To answer questions:	Figure #
Cowardin plant classes	D 1.3, H 1.1, H 1.4	
Hydroperiods	D 1.4, H 1.2	
Location of outlet *(can be added to map of hydroperiods)*	D 1.1, D 4.1	
Boundary of area within 150 ft of the wetland *(can be added to another figure)*	D 2.2, D 5.2	
Map of the contributing basin	D 4.3, D 5.3	
1 km Polygon: Area that extends 1 km from entire wetland edge - including polygons for accessible habitat and undisturbed habitat	H 2.1, H 2.2, H 2.3	
Screen capture of map of 303(d) listed waters in basin (from Ecology website)	D 3.1, D 3.2	
Screen capture of list of TMDLs for WRIA in which unit is found (from web)	D 3.3	

Riverine Wetlands

Map of:	To answer questions:	Figure #
Cowardin plant classes	H 1.1, H 1.4	
Hydroperiods	H 1.2	
Ponded depressions	R 1.1	
Boundary of area within 150 ft of the wetland *(can be added to another figure)*	R 2.4	
Plant cover of trees, shrubs, and herbaceous plants	R 1.2, R 4.2	
Width of unit vs. width of stream *(can be added to another figure)*	R 4.1	
Map of the contributing basin	R 2.2, R 2.3, R 5.2	
1 km Polygon: Area that extends 1 km from entire wetland edge - including polygons for accessible habitat and undisturbed habitat	H 2.1, H 2.2, H 2.3	
Screen capture of map of 303(d) listed waters in basin (from Ecology website)	R 3.1	
Screen capture of list of TMDLs for WRIA in which unit is found (from web)	R 3.2, R 3.3	

Lake Fringe Wetlands

Map of:	To answer questions:	Figure #
Cowardin plant classes	L 1.1, L 4.1, H 1.1, H 1.4	
Plant cover of trees, shrubs, and herbaceous plants	L 1.2	
Boundary of area within 150 ft of the wetland *(can be added to another figure)*	L 2.2	
1 km Polygon: Area that extends 1 km from entire wetland edge - including polygons for accessible habitat and undisturbed habitat	H 2.1, H 2.2, H 2.3	
Screen capture of map of 303(d) listed waters in basin (from Ecology website)	L 3.1, L 3.2	
Screen capture of list of TMDLs for WRIA in which unit is found (from web)	L 3.3	

Slope Wetlands

Map of:	To answer questions:	Figure #
Cowardin plant classes	H 1.1, H 1.4	B1
Hydroperiods	H 1.2	B3
Plant cover of **dense** trees, shrubs, and herbaceous plants	S 1.3	B2
Plant cover of **dense, rigid** trees, shrubs, and herbaceous plants *(can be added to figure above)*	S 4.1	B2
Boundary of 150 ft buffer (can be added to another figure)	S 2.1, S 5.1	B1
1 km Polygon: Area that extends 1 km from entire wetland edge - including polygons for accessible habitat and undisturbed habitat	H 2.1, H 2.2, H 2.3	B4
Screen capture of map of 303(d) listed waters in basin (from Ecology website)	S 3.1, S 3.2	B5
Screen capture of list of TMDLs for WRIA in which unit is found (from web)	S 3.3	B6

Wetland name or number A

HGM Classification of Wetlands in Western Washington

For questions 1-7, the criteria described must apply to the entire unit being rated.

If the hydrologic criteria listed in each question do not apply to the entire unit being rated, you probably have a unit with multiple HGM classes. In this case, identify which hydrologic criteria in questions 1-7 apply, and go to Question 8.

1. Are the water levels in the entire unit usually controlled by tides except during floods?

NO – go to 2 **YES** – the wetland class is **Tidal Fringe** – go to 1.1

1.1 Is the salinity of the water during periods of annual low flow below 0.5 ppt (parts per thousand)?

NO – Saltwater Tidal Fringe (Estuarine) **YES – Freshwater Tidal Fringe**

If your wetland can be classified as a Freshwater Tidal Fringe use the forms for ***Riverine*** *wetlands. If it is Saltwater Tidal Fringe it is an* ***Estuarine*** *wetland and is not scored. This method* ***cannot*** *be used to score functions for estuarine wetlands.*

2. The entire wetland unit is flat and precipitation is the only source (>90%) of water to it. Groundwater and surface water runoff are NOT sources of water to the unit.

NO – go to 3 **YES** – The wetland class is **Flats**

If your wetland can be classified as a Flats wetland, use the form for ***Depressional*** *wetlands.*

3. Does the entire wetland unit **meet all** of the following criteria?

__The vegetated part of the wetland is on the shores of a body of permanent open water (without any plants on the surface at any time of the year) at least 20 ac (8 ha) in size;

__At least 30% of the open water area is deeper than 6.6 ft (2 m).

NO – go to 4 **YES –** The wetland class is **Lake Fringe** (Lacustrine Fringe)

4. Does the entire wetland unit **meet all** of the following criteria?

✓ The wetland is on a slope (*slope can be very gradual*),

✓ The water flows through the wetland in one direction (unidirectional) and usually comes from seeps. It may flow subsurface, as sheetflow, or in a swale without distinct banks,

✓ The water leaves the wetland **without being impounded**.

NO – go to 5 **YES** – The wetland class is **Slope**

NOTE: Surface water does not pond in these type of wetlands except occasionally in very small and shallow depressions or behind hummocks (depressions are usually <3 ft diameter and less than 1 ft deep).

5. Does the entire wetland unit **meet all** of the following criteria?

___The unit is in a valley, or stream channel, where it gets inundated by overbank flooding from that stream or river,

___The overbank flooding occurs at least once every 2 years.

Wetland name or number A

NO – go to 6 **YES** – The wetland class is **Riverine**

NOTE: The Riverine unit can contain depressions that are filled with water when the river is not flooding

6. Is the entire wetland unit in a topographic depression in which water ponds, or is saturated to the surface, at some time during the year? *This means that any outlet, if present, is higher than the interior of the wetland.*

NO – go to 7 **YES** – The wetland class is **Depressional**

7. Is the entire wetland unit located in a very flat area with no obvious depression and no overbank flooding? The unit does not pond surface water more than a few inches. The unit seems to be maintained by high groundwater in the area. The wetland may be ditched, but has no obvious natural outlet.

NO – go to 8 **YES** – The wetland class is **Depressional**

8. Your wetland unit seems to be difficult to classify and probably contains several different HGM classes. For example, seeps at the base of a slope may grade into a riverine floodplain, or a small stream within a Depressional wetland has a zone of flooding along its sides. GO BACK AND IDENTIFY WHICH OF THE HYDROLOGIC REGIMES DESCRIBED IN QUESTIONS 1-7 APPLY TO DIFFERENT AREAS IN THE UNIT (make a rough sketch to help you decide). Use the following table to identify the appropriate class to use for the rating system if you have several HGM classes present within the wetland unit being scored.

NOTE: Use this table only if the class that is recommended in the second column represents 10% or more of the total area of the wetland unit being rated. If the area of the HGM class listed in column 2 is less than 10% of the unit; classify the wetland using the class that represents more than 90% of the total area.

HGM classes within the wetland unit being rated	HGM class to use in rating
Slope + Riverine	Riverine
Slope + Depressional	Depressional
Slope + Lake Fringe	Lake Fringe
Depressional + Riverine along stream within boundary of depression	Depressional
Depressional + Lake Fringe	Depressional
Riverine + Lake Fringe	Riverine
Salt Water Tidal Fringe and any other class of freshwater wetland	Treat as ESTUARINE

If you are still unable to determine which of the above criteria apply to your wetland, or if you have ***more than 2 HGM classes*** *within a wetland boundary, classify the wetland as Depressional for the rating.*

Wetland name or number A

SLOPE WETLANDS **Water Quality Functions** - Indicators that the site functions to improve water quality	
S 1.0. Does the site have the potential to improve water quality?	
S 1.1. Characteristics of the average slope of the wetland: *(a 1% slope has a 1 ft vertical drop in elevation for every 100 ft of horizontal distance)* Slope is 1% or less — points = 3 Slope is > 1%-2% — points = 2 Slope is > 2%-5% — points = 1 Slope is greater than 5% — points = 0	0
S 1.2. The soil 2 in below the surface (or duff layer) is true clay or true organic *(use NRCS definitions)*: Yes = 3 No = 0	0
S 1.3. Characteristics of the plants in the wetland that trap sediments and pollutants: Choose the points appropriate for the description that best fits the plants in the wetland. *Dense means you have trouble seeing the soil surface (>75% cover), and uncut means not grazed or mowed and plants are higher than 6 in.* Dense, uncut, herbaceous plants > 90% of the wetland area — points = 6 Dense, uncut, herbaceous plants > ½ of area — points = 3 Dense, woody, plants > ½ of area — points = 2 Dense, uncut, herbaceous plants > ¼ of area — points = 1 Does not meet any of the criteria above for plants — points = 0	0
Total for S 1 — Add the points in the boxes above	0

Rating of Site Potential If score is:___**12 = H** ___**6-11 = M** _X_**0-5 = L** *Record the rating on the first page*

S 2.0. Does the landscape have the potential to support the water quality function of the site?	
S 2.1. Is > 10% of the area within 150 ft on the uphill side of the wetland in land uses that generate pollutants? Heavy metals and oil from road Yes = 1 No = 0	1
S 2.2. Are there other sources of pollutants coming into the wetland that are not listed in question S 2.1? Other sources fertilizers and herbicides from yards Yes = 1 No = 0	1
Total for S 2 — Add the points in the boxes above	2

Rating of Landscape Potential If score is:_X_**1-2 = M** ___**0 = L** *Record the rating on the first page*

S 3.0. Is the water quality improvement provided by the site valuable to society?	
S 3.1. Does the wetland discharge directly (i.e., within 1 mi) to a stream, river, lake, or marine water that is on the 303(d) list? Yes = 1 No = 0	0
S 3.2. Is the wetland in a basin or sub-basin where water quality is an issue? *At least one aquatic resource in the basin is on the 303(d) list.* Yes = 1 No = 0	0
S 3.3. Has the site been identified in a watershed or local plan as important for maintaining water quality? *Answer YES if there is a TMDL for the basin in which unit is found.* Yes = 2 No = 0	0
Total for S 3 — Add the points in the boxes above	0

Rating of Value If score is:___**2-4 = H** ___**1 = M** _X_**0 = L** *Record the rating on the first page*

Wetland name or number A

SLOPE WETLANDS

Hydrologic Functions - Indicators that the site functions to reduce flooding and stream erosion

S 4.0. Does the site have the potential to reduce flooding and stream erosion?	
S 4.1. Characteristics of plants that reduce the velocity of surface flows during storms: Choose the points appropriate for the description that best fits conditions in the wetland. *Stems of plants should be thick enough (usually > 1/8 in), or dense enough, to remain erect during surface flows.* Dense, uncut, **rigid** plants cover > 90% of the area of the wetland points = 1 All other conditions points = 0	0

Rating of Site Potential If score is: ___1 = M X 0 = L *Record the rating on the first page*

S 5.0. Does the landscape have the potential to support the hydrologic functions of the site?	
S 5.1. Is more than 25% of the area within 150 ft upslope of wetland in land uses or cover that generate excess surface runoff? Yes = 1 No = 0	1

Rating of Landscape Potential If score is: X 1 = M ___0 = L *Record the rating on the first page*

S 6.0. Are the hydrologic functions provided by the site valuable to society?	
S 6.1. Distance to the nearest areas downstream that have flooding problems: The sub-basin immediately down-gradient of site has flooding problems that result in damage to human or natural resources (e.g., houses or salmon redds) points = 2 Surface flooding problems are in a sub-basin farther down-gradient points = 1 No flooding problems anywhere downstream points = 0	0
S 6.2. Has the site been identified as important for flood storage or flood conveyance in a regional flood control plan? Yes = 2 No = 0	0
Total for S 6 Add the points in the boxes above	0

Rating of Value If score is: ___2-4 = H ___1 = M X 0 = L *Record the rating on the first page*

NOTES and FIELD OBSERVATIONS:

Wetland name or number A

These questions apply to wetlands of all HGM classes.

HABITAT FUNCTIONS - Indicators that site functions to provide important habitat

H 1.0. Does the site have the potential to provide habitat?

H 1.1. Structure of plant community: *Indicators are Cowardin classes and strata within the Forested class.* Check the Cowardin plant classes in the wetland. *Up to 10 patches may be combined for each class to meet the threshold of ¼ ac or more than 10% of the unit if it is smaller than 2.5 ac. Add the number of structures checked.*

____Aquatic bed	4 structures or more: points = 4	1
X Emergent	3 structures: points = 2	
X Scrub-shrub (areas where shrubs have > 30% cover)	2 structures: points = 1	
____Forested (areas where trees have > 30% cover)	1 structure: points = 0	

If the unit has a Forested class, check if:

____The Forested class has 3 out of 5 strata (canopy, sub-canopy, shrubs, herbaceous, moss/ground-cover) that each cover 20% within the Forested polygon

H 1.2. Hydroperiods

Check the types of water regimes (hydroperiods) present within the wetland. The water regime has to cover more than 10% of the wetland or ¼ ac to count (*see text for descriptions of hydroperiods*).

____Permanently flooded or inundated	4 or more types present: points = 3	2
X Seasonally flooded or inundated	3 types present: points = 2	
X Occasionally flooded or inundated	2 types present: points = 1	
X Saturated only	1 type present: points = 0	
____Permanently flowing stream or river in, or adjacent to, the wetland		
____Seasonally flowing stream in, or adjacent to, the wetland		
____**Lake Fringe wetland**	**2 points**	
____**Freshwater tidal wetland**	**2 points**	

H 1.3. Richness of plant species

Count the number of plant species in the wetland that cover at least 10 ft^2.

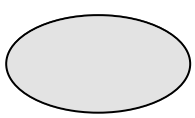
Different patches of the same species can be combined to meet the size threshold and you do not have to name the species. ***Do not include Eurasian milfoil, reed canarygrass, purple loosestrife, Canadian thistle***

If you counted: > 19 species	points = 2	1
5 - 19 species	points = 1	
< 5 species	points = 0	

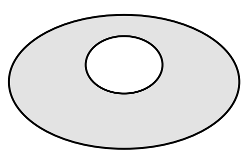
H 1.4. Interspersion of habitats

Decide from the diagrams below whether interspersion among Cowardin plants classes (described in H 1.1), or the classes and unvegetated areas (can include open water or mudflats) is high, moderate, low, or none. *If you have four or more plant classes or three classes and open water, the rating is always high.*

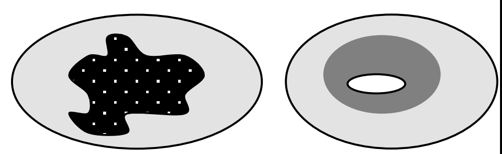
Score: 1



None = 0 points

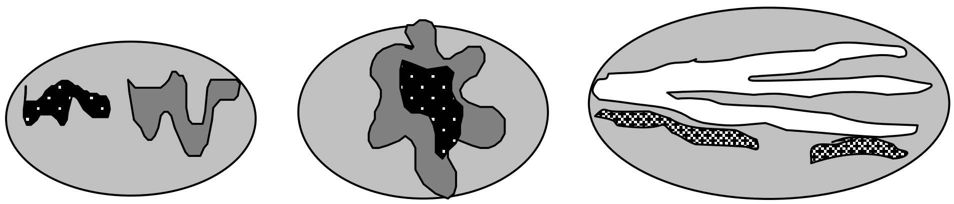


Low = 1 point



Moderate = 2 points

All three diagrams in this row are **HIGH** = 3points



Wetland name or number A____

H 1.5. Special habitat features: Check the habitat features that are present in the wetland. *The number of checks is the number of points.* ____Large, downed, woody debris within the wetland (> 4 in diameter and 6 ft long). ____Standing snags (dbh > 4 in) within the wetland ____Undercut banks are present for at least 6.6 ft (2 m) **and/or** overhanging plants extends at least 3.3 ft (1 m) over a stream (or ditch) in, or contiguous with the wetland, for at least 33 ft (10 m) ____Stable steep banks of fine material that might be used by beaver or muskrat for denning (> 30 degree slope) OR signs of recent beaver activity are present *(cut shrubs or trees that have not yet weathered where wood is exposed)* ____At least ¼ ac of thin-stemmed persistent plants or woody branches are present in areas that are permanently or seasonally inundated *(structures for egg-laying by amphibians)* ____Invasive plants cover less than 25% of the wetland area in every stratum of plants (*see H 1.1 for list of strata*)	0
Total for H 1 — Add the points in the boxes above	5

Rating of Site Potential If score is:____**15-18 = H** ____**7-14 = M** __X__**0-6 = L** *Record the rating on the first page*

H 2.0. Does the landscape have the potential to support the habitat functions of the site?	
H 2.1. Accessible habitat (include *only habitat that directly abuts wetland unit*). *Calculate:* % undisturbed habitat __0__ + [(% moderate and low intensity land uses)/2] __0.5__ = __0.5__ % If total accessible habitat is: > $^1/_3$ (33.3%) of 1 km Polygon — points = 3 20-33% of 1 km Polygon — points = 2 10-19% of 1 km Polygon — points = 1 < 10% of 1 km Polygon — points = 0	0
H 2.2. Undisturbed habitat in 1 km Polygon around the wetland. *Calculate:* % undisturbed habitat __21__ + [(% moderate and low intensity land uses)/2] __6__ = __27__ % Undisturbed habitat > 50% of Polygon — points = 3 Undisturbed habitat 10-50% and in 1-3 patches — points = 2 Undisturbed habitat 10-50% and > 3 patches — points = 1 Undisturbed habitat < 10% of 1 km Polygon — points = 0	1
H 2.3. Land use intensity in 1 km Polygon: If > 50% of 1 km Polygon is high intensity land use — points = (- 2) ≤ 50% of 1 km Polygon is high intensity — points = 0	-2
Total for H 2 — Add the points in the boxes above	-1

Rating of Landscape Potential If score is:____**4-6 = H** ____**1-3 = M** __X__**< 1 = L** *Record the rating on the first page*

H 3.0. Is the habitat provided by the site valuable to society?	
H 3.1. Does the site provide habitat for species valued in laws, regulations, or policies? *Choose only the highest score that applies to the wetland being rated.* Site meets ANY of the following criteria: — points = 2 — It has 3 or more priority habitats within 100 m (see next page) — It provides habitat for Threatened or Endangered species (any plant or animal on the state or federal lists) — It is mapped as a location for an individual WDFW priority species — It is a Wetland of High Conservation Value as determined by the Department of Natural Resources — It has been categorized as an important habitat site in a local or regional comprehensive plan, in a Shoreline Master Plan, or in a watershed plan Site has 1 or 2 priority habitats (listed on next page) within 100 m — points = 1 Site does not meet any of the criteria above — points = 0	0

Rating of Value If score is:____**2 = H** ____**1 = M** __X__**0 = L** *Record the rating on the first page*

Wetland name or number A

WDFW Priority Habitats

Priority habitats listed by WDFW (see complete descriptions of WDFW priority habitats, and the counties in which they can be found, in: Washington Department of Fish and Wildlife. 2008. Priority Habitat and Species List. Olympia, Washington. 177 pp. http://wdfw.wa.gov/publications/00165/wdfw00165.pdf or access the list from here: http://wdfw.wa.gov/conservation/phs/list/)

Count how many of the following priority habitats are within 330 ft (100 m) of the wetland unit: ***NOTE:*** *This question is independent of the land use between the wetland unit and the priority habitat.*

— **Aspen Stands:** Pure or mixed stands of aspen greater than 1 ac (0.4 ha).

— **Biodiversity Areas and Corridors**: Areas of habitat that are relatively important to various species of native fish and wildlife (*full descriptions in WDFW PHS report*).

— **Herbaceous Balds:** Variable size patches of grass and forbs on shallow soils over bedrock.

— **Old-growth/Mature forests:** Old-growth west of Cascade crest – Stands of at least 2 tree species, forming a multi-layered canopy with occasional small openings; with at least 8 trees/ac (20 trees/ha) > 32 in (81 cm) dbh or > 200 years of age. Mature forests – Stands with average diameters exceeding 21 in (53 cm) dbh; crown cover may be less than 100%; decay, decadence, numbers of snags, and quantity of large downed material is generally less than that found in old-growth; 80-200 years old west of the Cascade crest.

— **Oregon White Oak:** Woodland stands of pure oak or oak/conifer associations where canopy coverage of the oak component is important (*full descriptions in WDFW PHS report p. 158 – see web link above*).

— **Riparian**: The area adjacent to aquatic systems with flowing water that contains elements of both aquatic and terrestrial ecosystems which mutually influence each other.

— **Westside Prairies:** Herbaceous, non-forested plant communities that can either take the form of a dry prairie or a wet prairie (*full descriptions in WDFW PHS report p. 161 – see web link above*).

— **Instream:** The combination of physical, biological, and chemical processes and conditions that interact to provide functional life history requirements for instream fish and wildlife resources.

— **Nearshore**: Relatively undisturbed nearshore habitats. These include Coastal Nearshore, Open Coast Nearshore, and Puget Sound Nearshore. (*full descriptions of habitats and the definition of relatively undisturbed are in WDFW report – see web link on previous page).*

— **Caves:** A naturally occurring cavity, recess, void, or system of interconnected passages under the earth in soils, rock, ice, or other geological formations and is large enough to contain a human.

— **Cliffs:** Greater than 25 ft (7.6 m) high and occurring below 5000 ft elevation.

— **Talus:** Homogenous areas of rock rubble ranging in average size 0.5 - 6.5 ft (0.15 - 2.0 m), composed of basalt, andesite, and/or sedimentary rock, including riprap slides and mine tailings. May be associated with cliffs.

— **Snags and Logs:** Trees are considered snags if they are dead or dying and exhibit sufficient decay characteristics to enable cavity excavation/use by wildlife. Priority snags have a diameter at breast height of > 20 in (51 cm) in western Washington and are > 6.5 ft (2 m) in height. Priority logs are > 12 in (30 cm) in diameter at the largest end, and > 20 ft (6 m) long.

Note: All vegetated wetlands are by definition a priority habitat but are not included in this list because they are addressed elsewhere.

Wetland name or number A

CATEGORIZATION BASED ON SPECIAL CHARACTERISTICS

Wetland Type *Check off any criteria that apply to the wetland. Circle the category when the appropriate criteria are met.*	**Category**
SC 1.0. Estuarine wetlands Does the wetland meet the following criteria for Estuarine wetlands? — The dominant water regime is tidal, — Vegetated, and — With a salinity greater than 0.5 ppt Yes –Go to **SC 1.1** No= **Not an estuarine wetland**	
SC 1.1. Is the wetland within a National Wildlife Refuge, National Park, National Estuary Reserve, Natural Area Preserve, State Park or Educational, Environmental, or Scientific Reserve designated under WAC 332-30-151? Yes = **Category I** No - Go to **SC 1.2**	**Cat. I**
SC 1.2. Is the wetland unit at least 1 ac in size and meets at least two of the following three conditions? — The wetland is relatively undisturbed (has no diking, ditching, filling, cultivation, grazing, and has less than 10% cover of non-native plant species. (If non-native species are *Spartina*, see page 25) — At least ¾ of the landward edge of the wetland has a 100 ft buffer of shrub, forest, or un-grazed or un-mowed grassland. — The wetland has at least two of the following features: tidal channels, depressions with open water, or contiguous freshwater wetlands. Yes = **Category I** No = **Category II**	**Cat. I** **Cat. II**
SC 2.0. Wetlands of High Conservation Value (WHCV) SC 2.1. Has the WA Department of Natural Resources updated their website to include the list of Wetlands of High Conservation Value? Yes **–** Go to **SC 2.2** No **–** Go to **SC 2.3** SC 2.2. Is the wetland listed on the WDNR database as a Wetland of High Conservation Value? Yes **= Category I** No **= Not a WHCV** SC 2.3. Is the wetland in a Section/Township/Range that contains a Natural Heritage wetland? http://www1.dnr.wa.gov/nhp/refdesk/datasearch/wnhpwetlands.pdf Yes **– Contact WNHP/WDNR and go to SC 2.4** No **= Not a WHCV** SC 2.4. Has WDNR identified the wetland within the S/T/R as a Wetland of High Conservation Value and listed it on their website? Yes **= Category I** No **= Not a WHCV**	**Cat. I**
SC 3.0. Bogs Does the wetland (or any part of the unit) meet both the criteria for soils and vegetation in bogs? *Use the key below.* ***If you answer YES you will still need to rate the wetland based on its functions.*** SC 3.1. Does an area within the wetland unit have organic soil horizons, either peats or mucks, that compose 16 in or more of the first 32 in of the soil profile? Yes – Go to **SC 3.3** No – Go to **SC 3.2** SC 3.2. Does an area within the wetland unit have organic soils, either peats or mucks, that are less than 16 in deep over bedrock, or an impermeable hardpan such as clay or volcanic ash, or that are floating on top of a lake or pond? Yes – Go to **SC 3.3** No = **Is not a bog** SC 3.3. Does an area with peats or mucks have more than 70% cover of mosses at ground level, AND at least a 30% cover of plant species listed in Table 4? Yes = **Is a Category I bog** No – Go to **SC 3.4** **NOTE:** If you are uncertain about the extent of mosses in the understory, you may substitute that criterion by measuring the pH of the water that seeps into a hole dug at least 16 in deep. If the pH is less than 5.0 and the plant species in Table 4 are present, the wetland is a bog. SC 3.4. Is an area with peats or mucks forested (> 30% cover) with Sitka spruce, subalpine fir, western red cedar, western hemlock, lodgepole pine, quaking aspen, Engelmann spruce, or western white pine, AND any of the species (or combination of species) listed in Table 4 provide more than 30% of the cover under the canopy? Yes = **Is a Category I bog** No **= Is not a bog**	**Cat. I**

Wetland name or number A

SC 4.0. Forested Wetlands Does the wetland have at least 1 contiguous acre of forest that meets one of these criteria for the WA Department of Fish and Wildlife's forests as priority habitats? ***If you answer YES you will still need to rate the wetland based on its functions.*** — **Old-growth forests** (west of Cascade crest): Stands of at least two tree species, forming a multi-layered canopy with occasional small openings; with at least 8 trees/ac (20 trees/ha) that are at least 200 years of age OR have a diameter at breast height (dbh) of 32 in (81 cm) or more. — **Mature forests** (west of the Cascade Crest): Stands where the largest trees are 80- 200 years old OR the species that make up the canopy have an average diameter (dbh) exceeding 21 in (53 cm). Yes = **Category I** No = **Not a forested wetland for this section**	**Cat. I**
SC 5.0. Wetlands in Coastal Lagoons Does the wetland meet all of the following criteria of a wetland in a coastal lagoon? — The wetland lies in a depression adjacent to marine waters that is wholly or partially separated from marine waters by sandbanks, gravel banks, shingle, or, less frequently, rocks — The lagoon in which the wetland is located contains ponded water that is saline or brackish (> 0.5 ppt) during most of the year in at least a portion of the lagoon *(needs to be measured near the bottom)* Yes – Go to **SC 5.1** No = **Not a wetland in a coastal lagoon** SC 5.1. Does the wetland meet all of the following three conditions? — The wetland is relatively undisturbed (has no diking, ditching, filling, cultivation, grazing), and has less than 20% cover of aggressive, opportunistic plant species (see list of species on p. 100). — At least ¾ of the landward edge of the wetland has a 100 ft buffer of shrub, forest, or un-grazed or un-mowed grassland. — The wetland is larger than $^{1}/_{10}$ ac (4350 ft^2) Yes = **Category I** No = **Category II**	**Cat. I** **Cat. II**
SC 6.0. Interdunal Wetlands Is the wetland west of the 1889 line (also called the Western Boundary of Upland Ownership or WBUO)? ***If you answer yes you will still need to rate the wetland based on its habitat functions.*** In practical terms that means the following geographic areas: — Long Beach Peninsula: Lands west of SR 103 — Grayland-Westport: Lands west of SR 105 — Ocean Shores-Copalis: Lands west of SR 115 and SR 109 Yes – Go to **SC 6.1** No = **not an interdunal wetland for rating** SC 6.1. Is the wetland 1 ac or larger and scores an 8 or 9 for the habitat functions on the form (rates H,H,H or H,H,M for the three aspects of function)? Yes = **Category I** No – Go to **SC 6.2** SC 6.2. Is the wetland 1 ac or larger, or is it in a mosaic of wetlands that is 1 ac or larger? Yes = **Category II** No – Go to **SC 6.3** SC 6.3. Is the unit between 0.1 and 1 ac, or is it in a mosaic of wetlands that is between 0.1 and 1 ac? Yes = **Category III** No = **Category IV**	**Cat I** **Cat. II** **Cat. III** **Cat. IV**
Category of wetland based on Special Characteristics If you answered No for all types, enter "Not Applicable" on Summary Form	Not Applicable

APPLICANT: Modern NW 8101 NW Glisan Portland, OR 97213 PURPOSE: Wetland Rating Graphics	**Cowardin Vegetation Types and 150' Buffer** 1811 NW Hood Street Camas, Washington OLSON ENVIRONMENTAL LLC 222 E. Evergreen Blvd., Vancouver, WA 98660 ph: 360-693-4555 fax: 360-699-6242	**PROPOSED ACTIVITIES IN:** Lacamas Creek Watershed **LEGAL:** NE & NW 1/4 of S09, T1N, R3E W. M. **NEAR:** Camas, Washington **COUNTY:** Clark County **DATE:** 06/16/2021 **Appendix B1**

APPLICANT: Modern NW 8101 NW Glisan Portland, OR 97213 **PURPOSE:** Wetland Rating Graphics	**Plant Cover** 1811 NW Hood Street Camas, Washington OLSON ENVIRONMENTAL LLC 222 E. Evergreen Blvd., Vancouver, WA 98660 ph: 360-693-4555 fax: 360-699-6242	**PROPOSED ACTIVITIES IN:** Lacamas Creek Watershed **LEGAL:** NE & NW 1/4 of S09, T1N, R3E W. M. **NEAR:** Camas, Washington **COUNTY:** Clark County **DATE:** 06/16/2021 Appendix B2

APPLICANT:
Modern NW
8101 NW Glisan
Portland, OR 97213

PURPOSE:
Wetland Rating Graphics

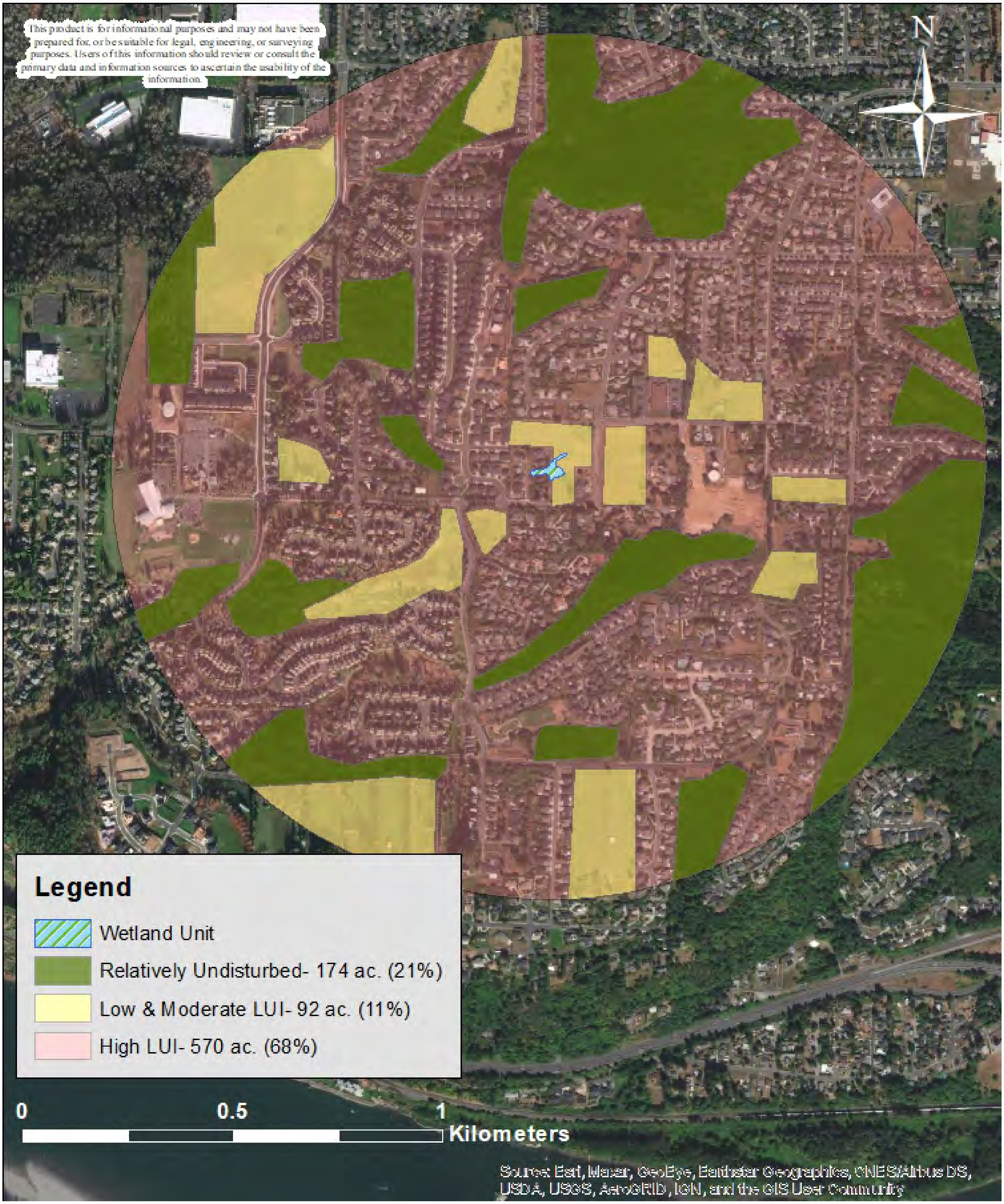
Hydroperiods
1811 NW Hood Street
Camas, Washington

OLSON ENVIRONMENTAL LLC

222 E. Evergreen Blvd., Vancouver, WA 98660 ph: 360-693-4555 fax: 360-699-6242

PROPOSED ACTIVITIES IN:
Lacamas Creek Watershed
LEGAL: NE & NW 1/4 of S09, T1N, R3E W. M.
NEAR: Camas, Washington
COUNTY: Clark County
DATE: 06/16/2021

Appendix B3



APPLICANT:
Modern NW
8101 NW Glisan
Portland, OR 97213

PURPOSE:
Wetland Rating Graphics

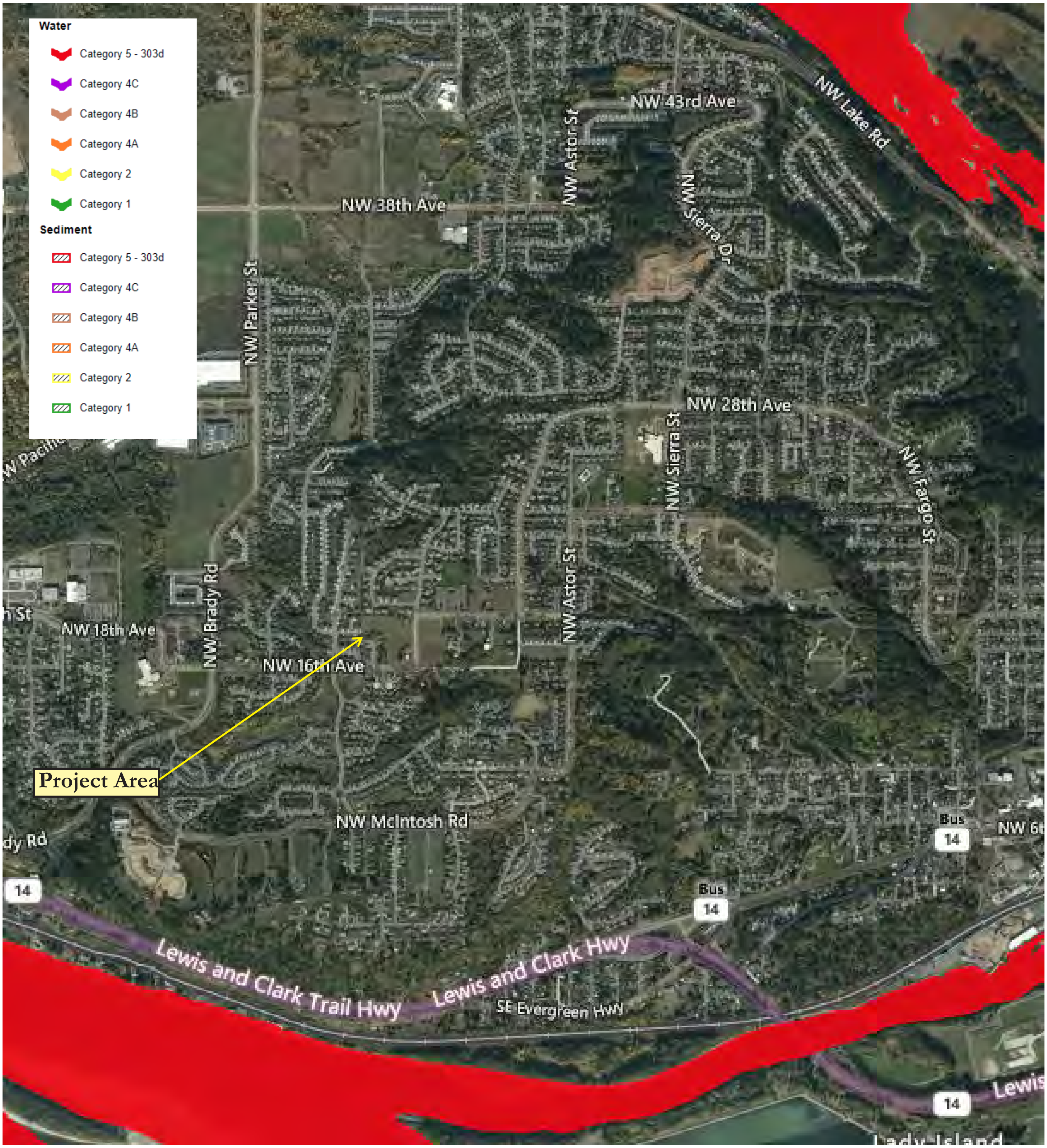
Land Use Intensity

1811 NW Hood Street
Camas, Washington

OLSON ENVIRONMENTAL LLC
222 E. Evergreen Blvd., Vancouver, WA 98660 ph: 360-693-4555 fax: 360-699-6242

PROPOSED ACTIVITIES IN:
Lacamas Creek Watershed
LEGAL: NE & NW 1/4 of S09, T1N, R3E W. M.
NEAR: Camas, Washington
COUNTY: Clark County
DATE: 06/16/2021

Appendix B4



APPLICANT:
Modern NW
8101 NW Glisan
Portland, OR 97213

PURPOSE:
Wetland Rating Graphics

Water Quality Assessment Map (Ecology)
1811 NW Hood Street
Camas, Washington

OLSON ENVIRONMENTAL LLC
222 E. Evergreen Blvd., Vancouver, WA 98660 ph: 360-693-4555 fax: 360-699-6242

PROPOSED ACTIVITIES IN:
Lacamas Creek Watershed
LEGAL: NE & NW 1/4 of S09, T1N, R3E W. M.
NEAR: Camas, Washington
COUNTY: Clark County
DATE: 06/16/2021

Appendix B5

DEPARTMENT OF ECOLOGY State of Washington

Washington State Water Quality Assessment
303(d)/305(b) List

Approved WQ Assessment Contact Us WQ Atlas

Category 3 listings contain data insufficient in determining water quality, therefore are removed from your results.
Include these 13 omitted listings.

New Search | Modify Search | Export

Search Results - 21 Matched Listings

	ListingID	AU ID	Medium	Parameter	Category	Waterbody Name	WRIA	WQ Improvement Project	WQ Atlas Map Link
View	7893	17080001001821	Water	Temperature	2	DWYER CREEK	28 - Salmon-Washougal		7893
View	7894	17080001001821	Water	Dissolved Oxygen	5	DWYER CREEK	28 - Salmon-Washougal		7894
View	7895	17080001001821	Water	pH	2	DWYER CREEK	28 - Salmon-Washougal		7895
View	7910	17080001000301	Water	pH	2	LACAMAS CREEK	28 - Salmon-Washougal		7910
View	7912	17080001000301	Water	Dissolved Oxygen	5	LACAMAS CREEK	28 - Salmon-Washougal		7912
View	7913	17080001000301	Water	Bacteria	5	LACAMAS CREEK	28 - Salmon-Washougal		7913
View	7914	17080001000299	Water	Temperature	5	LACAMAS CREEK	28 - Salmon-Washougal		7914
View	7915	17080001000299	Water	Dissolved Oxygen	5	LACAMAS CREEK	28 - Salmon-Washougal		7915
View	7916	17080001000299	Water	pH	5	LACAMAS CREEK	28 - Salmon-Washougal		7916
View	7917	17080001000301	Water	Temperature	5	LACAMAS CREEK	28 - Salmon-Washougal		7917
View	7920	17080001000305	Water	Temperature	5	LACAMAS CREEK	28 - Salmon-Washougal		7920
View	7921	17080001000305	Water	Dissolved Oxygen	5	LACAMAS CREEK	28 - Salmon-Washougal		7921
View	7922	17080001000305	Water	pH	2	LACAMAS CREEK	28 - Salmon-Washougal		7922
View	7923	17080001000306	Water	Temperature	5	LACAMAS CREEK	28 - Salmon-Washougal		7923
View	7924	17080001000306	Water	Dissolved Oxygen	5	LACAMAS CREEK	28 - Salmon-Washougal		7924
View	7925	17080001000306	Water	pH	2	LACAMAS CREEK	28 - Salmon-Washougal		7925
View	7927	17080001000305	Water	Bacteria	2	LACAMAS CREEK	28 - Salmon-Washougal		7927
View	71669	17080001000301	Water	Ammonia-N	1	LACAMAS CREEK	28 - Salmon-Washougal		71669
View	71671	17080001002259	Water	Ammonia-N	1	LACAMAS CREEK	28 - Salmon-Washougal		71671
View	72473	17080001002259	Water	Bacteria	1	LACAMAS CREEK	28 - Salmon-Washougal		72473
View	73862	17080001002259	Water	Temperature	2	LACAMAS CREEK	28 - Salmon-Washougal		73862

New Search | Modify Search | Export

APPLICANT:
Modern NW
8101 NW Glisan
Portland, OR 97213

PURPOSE:
Wetland Rating Graphics

TMDLs for Project Watershed (Ecology)
1811 NW Hood Street
Camas, Washington

OLSON ENVIRONMENTAL LLC
ENVIRONMENTAL SERVICES • GIS • HABITAT RESTORATION
222 E. Evergreen Blvd., Vancouver, WA 98660 ph: 360-693-4555 fax: 360-699-6242

PROPOSED ACTIVITIES IN:
Lacamas Creek Watershed
LEGAL: NE & NW 1/4 of S09, T1N, R3E W. M.
NEAR: Camas, Washington
COUNTY: Clark County
DATE: 06/16/2021

Appendix B6

City of Camas

Storm Sewer Systems

Operation & Maintenance Manual

Public & Private Systems

September 2009

City of Camas

Storm Sewer Systems

Operation & Maintenance Manual

Public & Private Systems

September 2009

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TABLE OF CONTENTS

Operation & Maintenance Manual

Introduction

Public & Private Systems

September 2009

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Background

Everything, whether it be public or privately owned, roads, parking lots, residential developments, commercial or industrial developments, or school facilities have various components that make up a storm sewer system. These components consist of conveyance pipes, catch basins, manholes, roadside ditches, stormwater facilities (such as drywells, bioswales, detention ponds, wet ponds, oil/water separators), landscaping (both hardscape and softscape), and any other structure that collects, conveys, controls, and/or treats stormwater. Regardless of the component, all storm sewer systems eventually discharge into 'waters of the state' which are our streams, rivers, lakes, wetlands, and groundwater.

Under the Federal Clean Water Act (FCWA) and in compliance with the Department of Ecology's NPDES Phase II Permit 'waters of the state' are to be protected from contamination. This in turn protects threatened and endangered species under the Federal Endangered Species Act (FESA).

One way to protect 'waters of the state' is to provide the proper maintenance of all storm sewer system components. It is the responsibility of the City of Camas to ensure that all components of the storm sewer system are properly maintained and operated. The City is responsible for those components that are located within the City's right-of-way, such as the conveyance pipes, manholes, catch basins, and roadside ditches. There are also a few specific stormwater ponds that are the responsibility of the City. However, the majority of the storm facilities are owned and maintained by the property owners as private facilities. These property owners include, but are not limited to, Homeowners Associations (HOA's), property manager companies, school districts, and commercial/industrial site owners.

Purpose of the Manual

This manual is intended to help, both public and private operators, meet the requirements for proper maintenance and operation of the various storm sewer system components. Proper maintenance will help to assure that:

- Storm sewer facilities operate as they were designed;
- Storm sewer systems are cleaned of the pollutants that they trap, such as sediment and oils, so that storm sewer systems are not overwhelmed and in so doing become pollutant sources;
- Pollutant sources are removed, or minimized, prior to entering the storm sewer system.

Along with keeping a site from flooding, properly maintained storm sewers can help reduce surface water and groundwater pollution. Most sites have some type of stormwater control component designed to limit the environmental and flooding damage caused by stormwater runoff. These components require more labor intensive maintenance than a system of pipes and catch basins.

It is the intent of the City to conduct yearly inspections of storm sewer facilities, preferably late spring/early summer to allow maintenance to occur late summer, prior to the fall rainy season. See Appendix A for an example of a *Storm Sewer System Maintenance Notification* form.

Manual Layout

The manual breaks out the various storm sewer system components and the general maintenance activities required for said component. For each component or activity this manual will:

- Briefly describe the component type, e.g. facility or activity.
- List the water quality and non-water quality result of each facility or activity.
- List the *Best Management Practices (BMP's)* needed to meet the water quality and general maintenance requirements.

Additional information may be found in other manuals, such as the Washington Department of Ecology's *2005 Stormwater Management Manual for Western Washington, Vols. IV and V*, or site specific Operation and Maintenance (O&M) Manuals.

Maintenance is performed as a means to obtain specific results. The maintenance results, as listed below, are specified for each drainage feature or activity. They include maintaining performance and appearance of the facility, and the need to prevent maintenance work itself from becoming a pollutant source or damaging habitat.

Maintenance Results (R1-R10)

Water Quality Results:

R1 Avoid or minimize sediment and pollutant discharges from the work area.
R2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
R3 Avoid or minimize vegetation removal.
R4 Preserve native vegetation.

Infrastructure Maintenance Results:

R5 Protect public safety and health.
R6 Prevent catastrophique infrastructure failures.
R7 Maintain and/or restore the intended infrastructure function.
R8 Prevent and/or reduce flooding.
R9 Protect infrastructure.
R10 Meet public expectations for aesthetics.

Storm sewer facility refers to specific drainage features, such as catch basins, pipes, ditches, ponds, biofiltration swales, and infiltration systems. Activities refer to maintenance tasks associated with operating and maintaining stormwater facilities such as vegetation management and small repair projects. Depending on the extent of the maintenance, some property owners may be able to handle storm sewer maintenance themselves. Often, however, depending on the type of maintenance, the property owners will contract out the work. Landscapers are often employed to maintain vegetated facilities, such as swales and pond areas.

Heavier work, like cleaning catch basins, ditch inlets, outlet structures, or drywells often requires special equipment, such as trucks that can vacuum out sediment. When located within the city right-of-way, maintenance is typically the responsibility of the City. For those located on private property a contractor would need to be contacted to perform this work. Check phone book listings, such as sewer and cleaning contractors, tank cleaning, and environmental and ecological services. Check with the contractor to ensure that all materials are disposed of according to solid waste and hazardous materials regulations. *Ultimately, the generator of the waste or hazardous material is responsible for proper disposal.*

Special Facilities:
Manufactured storm sewer facilities, such as leaf compost filters and oil/water separators often have maintenance requirements and manuals specified or written by the manufacturer. Also, larger or more complex storm sewer facilities may include specifications for maintenance and vegetation management that provide specific detail above and beyond this manual. Where the *Public Works Director* determines that these manuals or plans provide an equal or greater level of maintenance and water quality protection, then these procedures shall be followed by the owner. The Public Works Director must approve these individual maintenance plans, specifications, or manuals.

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Operation & Maintenance Procedures

Vegetated Facilities

Public & Private Systems

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Biofiltration Swales

Biofiltration swales use grass or other dense vegetation to filter sediment and oily materials out of stormwater. Usually they look like flat-bottomed channels with grass growing in them. Swales are stormwater treatment devices that must be properly maintained to sustain pollutant removal capacity.

Maintenance Results

- R1 Avoid or minimize sediment and pollutant discharges from the surrounding area.
- R2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
- R7 Maintain or restore the intended infrastructure function.
- R10 Meet public expectations for aesthetics.

Procedures

Inspection

Swales are easy to inspect and need to be well maintained to treat stormwater. Make frequent visual inspections, at least once every 6 months and after storm events of >0.50 inch rainfall/24 hours, for problems such as channeling flow, rills, bare ground, sediment accumulation, oily material, and debris. Maintain adequate grass growth and eliminate bare spots.

Identify and remove pollutant sources that are discharging to the swale.

Maintain access to inlet and outlet structures for pollutant removal, and to grass swale for mowing and noxious weed removal.

Cleaning

Remove leaves, litter, sediment, oily materials, and grass cuttings when mowing or at any time that it is observed in the swale as this can cause blockage of inlets and outlets.

Clear inlets, outlets, curb cuts, and level spreaders of debris to prevent blockage of stormwater flow.

Use a rake and shovel to remove, by hand, sediment accumulations greater than 2-inches thick that cover grass areas; avoid vegetation removal. Reseed bare areas.

Vegetation Management

Mow to keep grass at the maximum height (9-inches). Mow to no less then 4-inches in height and a minimum of four cuttings per year. Remove clippings from the swale.

If a swale has an underdrain system, vehicular traffic (other then grass mowing equipment) on the swale bottom is to be avoided to prevent damage to the underdrain pipes.

Preserve healthy vegetation or reestablish vegetation where needed. Seed bare spots.

Blackberry removal is required and should be done 2-3 times a year. Pesticide use is **not** allowed. After cutting down of blackberries, vines are to be bagged and removed from the area.

Use appropriate BMP's to cover bare soils. BMP's include hydroseeding or mulches.

Trees and shrubbery are not allowed to grow within the biofiltration swale as they interfere with the facility's function and maintenance activities. Any cut trees should be salvaged for habitat enhancement or converted to mulch or firewood.

Storm sewer facilities are, in effect, water body buffers where pesticides and fertilizers are not to be used. See Vegetation Management in Storm Sewer Systems for more information.

Repairs
Often swales have problems due to flooding or erosion. Where possible, correct the underlying problem before trying to repair the symptom.

Level spreaders must be in proper working order for swales to function properly. Where level spreaders are damaged, sunken, or bypassed by erosion, repair them to design standards.

If there is a problem with grass dying due to the swale being flooded during the wet season, there are two options: convert the swale vegetation to a plant variety that can stand being flooded or find a way to fix the swale so it drains better.

Call the Public Works Department at 817-7231 for information on approved plants. **Design modifications to any storm sewer facility cannot be made without prior approval from the City of Camas.**

Filter Strips

Filter strips are linear strips of grass that remove sediment and oils from stormwater by filtering it. Stormwater is treated as it runs across the filter. Usually, filter strips are placed along the edge of linear paved areas, such as parking lots and roads. Where designed filter strips are installed; road shoulders should only be graded to maintain level flow off the road.

Maintenance Results

- R1 Avoid or minimize sediment and pollutant discharges from the area.
- R2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
- R7 Maintain or restore the intended infrastructure function.
- R10 Meet public expectations for aesthetics.

Procedures

Inspection

Filter strips are easy to inspect and need to be well maintained to treat stormwater. Make frequent visual inspections for problems such as channeling flow, rills, bare ground, oily material, and debris.

Identify and remove pollutant sources.

Cleaning

Clear inlets and outlets to prevent blockage.

Remove litter when mowing or litter accumulates.

Use a rake and/or shovel to remove sediment and debris accumulations greater than 2-inches thick that cover grass areas; avoid vegetation removal. Remove sediment and re-level the slope to an even surface so that water spreads and does not form channels. Reseed bare areas.

Vegetation Management

Mow to keep grass at the optimum height (6-inches). Mow to no less then 4-inches in height and a minimum of four cutting per year.

Remove clippings from the treatment area. They may be spread elsewhere on site where they will not reenter the stormwater facility.

Preserve healthy vegetation or reestablish vegetation where needed. Seed bare spots.

Use appropriate BMP's to cover bare soils. BMP's include hydroseeding or mulches.

Storm sewer facilities are, in effect, water body buffers where pesticides and fertilizers are not to be used. See Vegetation Management in Storm Sewer Systems for more information.

Repairs
Where possible, correct the underlying problem before trying to repair the symptom.

The flow spreader must be level and spread flow evenly across the filter strip. Immediately repair any defects in the flow spreader.

If ruts develop, fill them with coarse soil, level the surface and reseed.

Detention Ponds/Facility

Detention pond facilities are designed to hold and slowly release stormwater by use of a pond and a specially designed control structure. Styles vary greatly from well manicured to natural appearing. Generally, native vegetation is preferred for reduced maintenance and enhance wildlife habitat. Some facilities are designed to appear as natural water bodies or are in a park-like setting.

Maintenance Results

- R1 Avoid or minimize sediment and pollutant discharges from the work area.
- R2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
- R3 Avoid or minimize vegetation removal.
- R7 Maintain or restore the intended infrastructure function.
- R8 Prevent or reduce flooding.
- R10 Meet public expectations for aesthetics.

Procedures

Inspection
Facilities should be inspected, at a minimum, once a year. Inspect the facility for litter, dead vegetation, invasion of trees and noxious weeds, accumulated sediment, oil and other pollutants. Identify pollutant sources to the facility.

Cleaning
Remove litter when litter accumulates.

Remove any pollutants greater in volume then a surface sheen.

Remove trees and noxious weeds that are growing within the pond, on side slopes/berms, or within the emergency overflow area.

Remove sediment when it accumulates to 10 percent of the designed pond depth (plans can be obtained for Public Works Department). Sediment removal should be undertaken during the summer months (drier time of the year). Ponds are not to be altered from the original approved design without prior permission from the City of Camas.

Material Handling
Disposal of waste, e.g. sediment or standing water, from the maintenance of these facilities shall be conducted in accordance with federal, state, and local regulations, including the Minimum Functional Standards for Solid Waste handling Chapter 173-304 WAC; guidelines for disposal of waste materials; and where appropriate, Dangerous Waste Regulations, Chapter 173-303 WAC.

Vegetation Management
Where a facility has a natural area (open space/buffer/wetlands), vegetation management should be timed to avoid or minimize impacts on wildlife. An example is a facility used by breeding birds such as red-winged black birds.

Mow, or rotary weed trim, vegetation to match surrounding area or sustain any other intended use of the facility, such as wildlife habitat or recreation area.

Use mechanical methods to control weeds. Pesticides, herbicides and fertilizers are not to be used in stormwater control facilities. See Vegetation Management in Storm Sewer Systems for more information.

If plants need replacing, please contact the City for a list of native plants.

Trees are not allowed to grow in the pond, on emergency overflows, or on berms. Trees can block flows and roots can lead to berm failure.

Trees and shrubbery may be allowed to grow around the perimeter of the pond unless growth interferes with the facility function or maintenance activities.

Blackberry removal is required and should be done 2-3 times a year. Pesticide use is **not** allowed around water. After cutting down of blackberries, vines are to be bagged and removed from the area.

Repairs
Repair and seed bare areas. Repair eroded slopes when rills form. Use cover BMP's on exposed soils.

Rodent holes in a dam or berm can serve as a means of piping water out of the pond. Remove the rodents, preferably by trapping, and repair the dam or berm. Check with the Washington Department of Fish and Wildlife before removing a game animal or fur-bearer, for example muskrat, beaver, and nutria.

Where applicable, repair the pond liner if it is visible and repair or replace where there are more than three holes greater than ¼-inch diameter.

If berms or dams show signs of settlement or sinkholes, serious problems may be occurring. Consult a licensed professional engineer to determine the cause of the settlement or sinkhole. Spillway areas should be completely covered by minimum of 12-inches of rock. **Design modifications to any storm sewer facility cannot be made without prior approval from the City of Camas.**

Infiltration Facilities (Basins/Ponds/Trenches)

Infiltration facilities dispose of water by holding it in an area where it can soak into the ground. These are open facilities that may either drain rapidly and have grass bases, or have perpetual ponds where water levels rise and fall with stormwater flows. Infiltration facilities may be designed to handle all of the runoff from an area or they may overflow and bypass larger storms.

Since the facility is designed to pass water into the ground, generally after passing through a sediment trap/manhole, anything that can cause the base to clog will reduce the performance and is a large concern. Generally, infiltration basins are managed like detention ponds, but with greater emphasis on maintaining the capacity to infiltrate stormwater.

Maintenance Results

- R1 Avoid or minimize sediment and pollutant discharges from the area.
- R2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
- R3 Avoid or minimize vegetation removal.
- R7 Maintain or restore the intended infrastructure function.
- R8 Prevent or reduce flooding.
- R10 Meet public expectations for aesthetics.

Procedures

Inspection

During the first year after construction, the sediment trap shall be monitored after every large storm (>1-inch per 24 hours) and monthly from October 1 through May 31 to ensure the facility is draining as intended.

Check once per year after a rainstorm to see if the facility is draining as intended. Inspect all features of the facility annually.

A thorough inspection of the observation points should be made if there is a decrease in retention basin capacity. Inspection points can include monitoring ports built into the base of the facility and water table depth monitoring wells. Water levels in these inspection points can provide information about the performance of the facility. It will probably require a licensed professional engineer or other professional trained in hydraulics to interpret the information.

Identify and remove pollutant sources to the facility. Inspect the facility for oil and other pollutants and remove any pollutants greater in volume than a surface sheen.

Cleaning

Trash is to be removed as it accumulates.

Remove sediment when it accumulates to 2-inches or if the facility does not drain between storms or meet 90 percent of design capabilities.

If the facility has a sediment trap/manhole, clean out the sediment when one-half foot accumulates.

Materials Handling
Disposal of waste from maintenance of drainage facilities shall be conducted in accordance with federal, state, and local regulations, including the Minimum Functional Standards for Solid Waste handling Chapter 173-304 WAC; guidelines for disposal of waste materials; and where appropriate, Dangerous Waste Regulations, Chapter 173-303 WAC.

Vegetation Management
Where a facility has a natural area (open space/buffer/wetlands), vegetation management should be timed to avoid or minimize impacts on wildlife. An example is a facility used by breeding birds such as red-winged black birds.

Mow, or rotary weed trim, vegetation to match surrounding area or sustain any other intended use of the facility, such as wildlife habitat or recreation area.

Use mechanical methods to control weeds. Pesticides, herbicides and fertilizers are not to be used in stormwater control facilities. See Vegetation Management in Storm Sewer Systems for more information.

If plants need replacing, please contact the City for a list of native plants.

Trees should not be allowed to grow in the pond, over the trench, on emergency overflows, or on berms that are greater than 4-feet in height. Trees can block flows and roots can lead to berm failure. Remove any trees growing on emergency overflows, berms greater than 4-feet in height, or within the pond.

Trees and shrubbery should be allowed to grow around the perimeter of the facility unless growth interferes with the facility function or maintenance activities. Any cut trees should be salvaged for habitat enhancement or converted to mulch or firewood.

Repairs
If the facility is overflowing for a storm that is it was designed to infiltrate, it needs to be repaired. This may require removing accumulated sediment and cleaning or rebuilding the system so that it works according to design.

Repair and seed bare areas. Repair eroded slopes when rills form. Use cover BMP's on exposed soils.

Rodent holes on a dam or berm can serve as a means of piping water out of the pond. Remove the rodents, preferably by trapping, and repair the dam or berm. Check with the Washington Department of Fish and Wildlife before removing a game animal or fur-bearer, for example muskrat, beaver, and nutria.

Spillway areas should be completely covered with more a minimum of 12-inches of rock.

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Wet Biofiltration Ponds, Swales, and Treatment Wetlands

Wet biofiltration swales and treatment wetlands use dense wetland vegetation and settling to filter sediment and oily materials out of stormwater. These stormwater treatment devices must be properly maintained to sustain pollutant removal capacity. In some cases, biofiltration swales that were designed to drain between storms remain wet and need to be rebuilt or converted to wetland swales. A designed wet biofiltration swale uses wetland plants instead of grass.

Maintenance Results

- R1 Avoid or minimize sediment and pollutant discharges from the area.
- R2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
- R7 Maintain or restore the intended infrastructure function.
- R10 Meet public expectations for aesthetics.

Procedures

Inspection

Swales are easy to inspect and need to be well maintained to treat stormwater. Make frequent visual inspections for problems such as bare ground, sediment and oily material.

Identify and remove sources of pollutants to the swale.

Cleaning

Clear inlets and outlets of debris in order to prevent blockage.

Remove litter and trash when it collects.

Where possible, use a rake and/or shovel to remove sediment accumulations greater than 2-inches thick in 10 percent of the treatment area.

Vegetation Management

Sparse vegetation or dense clumps of cattail do not properly treat stormwater. Try to find the cause of the problem and fix it to ensure dense vegetation. Cut back excessive cattail shoots. Normally, wetland vegetation does not need to be harvested unless there is an excessive die back that causes water quality problems.

If there is a problem with grass dying due to the swale being flooded during the wet season, there are two options: plant varieties that can stand being flooded or find a way to fix the swale so it drains better. Call the Public Works Department at 817-7231 for information on plants and possible swale modifications.

Outside of the treatment area, preserve healthy vegetation or reestablish vegetation where needed. Seed bare spots. Use cover BMP's on bare soils.

Trees and shrubbery should be allowed to grow unless they interfere with facility function or maintenance activities. Any cut trees should be salvaged for habitat enhancement or converted to mulch or firewood.

Stormwater control facilities are, in effect, water body buffers in which pesticides and fertilizer are not used. See Vegetation Management in Stormwater Control Facilities for more information.

Repairs

Often swales have problems due to flooding or erosion. Where possible, correct the underlying problem before trying to repair the symptom.

Repair any defect that causes the wet swale to dry out during the wet season.

Replace stormwater facility signs that are broken, damaged, or stolen.

Drainage Ditches

Ditches are often manmade open-channels that carry only stormwater. These ditches are maintained to prevent localized flooding by draining stormwater. Maintenance includes removing sediment, debris, litter, and overgrown vegetation.

Many manmade drainage ditches carry water when it is not raining. This water comes from groundwater seepage and wetlands. These ditches can be recognized by the presence of wetland plants, such as cattails. Any work that disturbs these channels is probably subject to a variety of environmental regulations and may require an HPA permit from the Washington Department of Fish and Wildlife. Contact the Washington Department of Fish and Wildlife and the City of Camas Public Words Department before beginning any work.

Maintenance Results

R1 Avoid or minimize sediment and pollutant discharges from the area.
R2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
R3 Avoid or minimize vegetation removal.
R4 Preserve natives plants.
R7 Maintain or restore the intended infrastructure function.
R8 Prevent or reduce flooding.
R9 Protect infrastructure.

Procedures

Inspection

Inspect ditches during routine site maintenance or at least once per year.

Cleaning

Land disturbing activities that remove vegetation or disturb soil are subject to erosion/sediment control requirements per CMC 15.32. A good time to clean drainage ditches is during the growing season, when it's easiest to reestablish vegetation.

Cleaning or excavating within seasonally dry or ditched watercourses may require an HPA from WDFW. Consult the official state DNR water type maps or contact the City of Camas for assistance in determining whether watercourses are typed streams (e.g. type 1, 2, 3, 4 or 5) that are regulated by WDFW. *Contact VTDFW Region Five office for additional information on whether specific watercourses are regulated under the State Hydraulic Code, or if unmapped streams are encountered.*

If feasible, remove small amounts of sediment by hand when performing routine site maintenance.

Vegetation should only be removed when it reduces free movement of water through the ditch. Never remove more vegetation than is absolutely needed.

Only remove sediment when it reaches 20 percent of the ditch depth or affects the historic or designed hydraulic capacity.

Alternate cleaning areas with undisturbed areas, leaving undisturbed sections to act as sediment trapping filters between worked areas.

Trap sediment that is generated by ditch maintenance to keep it from entering water bodies. Use sediment-trapping BMP's such as bio-filter bags at the lower end of each excavated area.

Prevent sediment from eroding when ditch work is performed. Perform work during dry weather unless there is an emergency, such as property or road flooding.

Vegetate bare soils by hydroseeding or cover bare soils with an approved BMP. Hand seed for smaller areas.

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Operation & Maintenance Procedures

Stormwater Structures

Public & Private Systems

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Catch Basins and Curb Inlets

Catch basins and curb inlets trap sediment and some oils that are washed off the road surface during a storm event. This sediment and the oils if not removed from the basins and inlets have the potential to pollute water bodies. They need to be inspected and cleaned at a minimum annually, more often if necessary; to remove accumulated sediment, fluids, and trash.

Maintenance Results

- R1 Avoid or minimize sediment and pollutant discharges from the work area.
- R2 Prevent parking areas, roads, drainage systems, facilities, and property from becoming pollutant sources.
- R7 Maintain or restore the intended infrastructure function
- R8 Prevent or reduce flooding.
- R9 Protect infrastructure.

Procedures

Inspection

Inspect catch basins and curb inlets at least once per year, more often if necessary.

Periodically inspect the catch basin or curb inlets and surrounding areas for pollutants, such as leaks from dumpsters, minor spills, and oil dumping. Act to have the pollutant source removed. Ensure that grass clippings and leave debris is not being blown into the streets.

Cleaning

Clean catch basins and curb inlets when they become one third full in order to maintain sediment-trapping capacity. Catch basin, curb inlet, and manhole cleaning should be performed in a manner that keeps removed sediment and contaminated water from being discharged back into the storm sewer.

Clean putrid materials from the catch basins and curb inlets when discovered or reported.

Keep the inlet grates cleared of debris and litter.

Safety

Work inside underground structures (e.g. manholes) requires special OSHA-required confined space equipment and procedures. The most practical option may be to contract with a sewer-cleaning contractor for this work.

Materials Handling

Disposal of waste from maintenance of drainage facilities shall be conducted in accordance with federal, state, and local regulations, including the Minimum Functional Standards for Solid Waste handling Chapter 173-304 WAC; guidelines for disposal of waste materials; and where appropriate, Dangerous Waste Regulations, Chapter 173-303 WAC.

Removed sediment must be disposed of in the garbage as solid waste. Contaminated water should be disposed of in a sanitary sewer after oils are removed using oil absorbent materials or other mechanical means. Used oil absorbents should be recycled or disposed according to the manufacture's instructions.

Repairs
Repair any damages that prevent the catch basin or curb inlet from functioning as designed. An example is a broken or missing outlet elbow.

Follow the Procedures described under the Activity: Installation, Repair and Replacement of Enclosed Drainage Systems.

Debris Barriers/Trash Racks

Debris barriers and trash racks are barred covers to pipe openings. They prevent large objects from entering pipes and keeps pets and people out of the pipes as well. In cases where there is fish migration, maintaining unblocked trash racks allows fish passage.

Maintenance Results

- R1 Avoid or minimize sediment and pollutant discharges from the work area.
- R2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
- R5 Protect public safety and health.
- R6 Prevent catastrophique infrastructure failures.
- R7 Maintain or restore the intended infrastructure function.
- R8 Prevent or reduce flooding.
- R9 Protect infrastructure.

Procedures

Inspection

Inspect debris barriers and trash racks at least once per year in the fall.

Cleaning

Clean debris barriers and trash racks when debris is plugging more then 20 percent of the openings or when obstruction to fish passages are created. Consult the Washington Department of Wildlife is in a fish-bearing waterway.

Repairs

Immediately replace missing racks and bars.

Replace bars that are deteriorated to the point where they may be easily removed.

Straighten bent bars back into position.

Follow the Procedures described in the Activity: Installation, Repair and Replacement of Enclosed Drainage Systems.

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Energy Dissipaters

Energy dissipaters are critical for preventing erosion at storm drain outfalls. There are a variety of designs, including wire gabion baskets, rock splash pads, trenches, and specially designed pools or manholes.

Maintenance Results

- R1 Avoid or minimize sediment and pollutant discharges from the work area.
- R2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
- R7 Maintain or restore the intended infrastructure function.
- R8 Prevent or reduce flooding.
- R9 Protect infrastructure.

Procedures

Inspection

Inspect at least once per year.

Cleaning

Remove any accumulated litter.
Dispersion trenches: remove sediment from pipe when it reaches 20 percent of the pipe diameter.

Repairs

Rock splash pads: replace missing or moved rocks to cover exposed soil and meet design standards.

Dispersion trenches: repair conditions that cause concentrated flow along the trench. Clean pipe perforations when one-half of them are plugged or if flows bypass or overflow the trench.

Manhole/Chamber: when the structure deteriorates to one-half its original size or it becomes structurally unsound, replace it to the design standards.

Follow the practice described under the Activity: Installation, Repair and Replacement of Enclosed Drainage Systems.

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Manholes

Manholes are large cylindrical vaults usually set at storm sewer pipe connections. Unless you have OSHA approved training and equipment, never enter a manhole. There is a considerable risk of poisonous gas and injury.

Maintenance Results

R1 Avoid or minimize sediment and pollutant discharges from the work area.
R2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
R7 Maintain or restore the intended infrastructure function.
R8 Prevent or reduce flooding.
R9 Protect infrastructure.

Procedures

Inspection

Inspect the manhole once per year. Check frame and lid for cracks and wear, such as rocking lids or lids move by traffic.

Periodically inspect the manhole and surrounding areas for pollutants such as leaks from dumpsters, minor spills, and oil dumping. Take action to have the pollutant source removed.

Cleaning

Clean manholes when there is a blockage of the stormwater channel. Cleaning should be performed in a way that ensures removed sediment and water is not discharged back into the storm sewer.

Safety

Never enter a confined space without proper training and safety gear. Work inside underground structures requires special OSHA-required confined space equipment and procedures. The most practical option may be to contract with a sewer-cleaning contractor.

Materials Handling

Disposal of waste from maintenance of drainage facilities shall be conducted in accordance with federal, state, and local regulations, including the Minimum Functional Standards for Solid Waste handling Chapter 173-304 WAC; guidelines for disposal of waste materials; and where appropriate, Dangerous Waste Regulations, Chapter 173-303 WAC.

Removed sediment must be disposed of in the garbage as solid waste. Contaminated water should be disposed of in a sanitary sewer after oils are removed using oil absorbent materials or other mechanical means. Used oil absorbents should be recycled or disposed according to the manufacture's instructions.

Repairs

Repair all security and access features so they are fully functional. This includes locking lids, cover, and ladder rungs.

Replace broken parts or lids that rock or are moved by traffic.

Follow the practice described under the Activity: Installation, Repair and Replacement of Enclosed Drainage Systems.

Oil/Water Separators and Buried Wet Vaults

An oil/water separator is an underground vault that treats stormwater by mechanically separating oil from water. The oil rises to the surface and floats on the water and sediment settles to the bottom. Buried wet vaults are similar to oil/water separators in that they are sub-surface vaults that separate sediment and floating materials from stormwater.

These facilities have special problems for maintenance and should be serviced by contractors. The main issues are working in confined spaces and properly handling any sludge and oil cleaned from vaults or oil/water separators. Manufacturer's recommendations for maintenance should be followed at a minimum.

Maintenance Results

- R1 Avoid or minimize sediment and pollutant discharges from the work area.
- R2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
- R7 Maintain or restore the intended infrastructure function.
- R9 Protect infrastructure.

Procedures

Inspection

Periodically check stormwater flow out of the facility. It should be clear and not have a thick visible oil sheen.

Annually check for cracks large enough to let soil enter the vault, broken or defective plates and baffles, and crushed or damaged pipes.

Periodically inspect the surrounding areas for pollutants, such as leaks from dumpsters, minor spills, and oil dumping. Take action to the pollutant source removed.

Cleaning

Remove trash and litter from the vault, inlet, and piping.

Remove oil when it reaches one-inch thickness.

Remove sediment when it accumulates to 6-inches in depth.

Safety

Work inside underground structures requires special OSHA-required confined space equipment and procedures. The most practical option may be to contract with a sewer-cleaning contractor.

Materials Handling

Disposal of waste from maintenance of drainage facilities shall be conducted in accordance with federal, state, and local regulations, including the Minimum Functional Standards for Solid

Waste handling Chapter 173-304 WAC; guidelines for disposal of waste materials; and where appropriate, Dangerous Waste Regulations, Chapter 173-303 WAC.

Removed sediment must be disposed of in the garbage as solid waste. Contaminated water should be disposed of in a sanitary sewer after oils are removed using oil absorbent materials or other mechanical means. Used oil absorbents should be recycled or disposed according to the manufacture's instructions.

Repairs

Repair any cracked or defective plates or baffles. Cracks are repaired so that no cracks greater than ¼-inch are present. Repair any leaks that allow water levels to drop and cause oil to be washed from the unit.

Repair all security and access features so they are fully functional. This includes locking lids, covers, and ladder rungs.

Follow the practice described under the Activity: Installation, Repair and Replacement of Enclosed Drainage Systems.

Flow Control Structures/Flow Restrictors

Flow control structures and flow restrictors direct or restrict flow in or out of a facility. Outflow controls on detention facilities are a common example where flow control structures slowly release stormwater at a specific rate. If these flow controls are damaged, plugged, bypassed, or not working properly, the facility could overtop or be releasing water at too high of a rate. This would likely damage streams habitat and property. Site plans should have detailed drawings showing how the flow control structures should appear. Consult a licensed professional engineer or the City of Camas Public Works Department for assistance.

Maintenance Results

- R2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
- R7 Maintain or restore the intended infrastructure function.
- R9 Protect infrastructure.

Procedures

Inspection
Inspect at least once per year for all features listed under Cleaning and Repairs, or when a facility does not drain properly or other problems occur.

Cleaning
Remove sediment within 18-inches of the bottom of an orifice plate.

Remove trash and debris that may block the orifice plate.

Remove any trash or debris that may bloc an overflow pipe.

Safety
Work inside underground structures requires special OSHA-required confined space equipment and procedures. The most practical option may be to contract with a sewer-cleaning contractor.

Materials Handling
Disposal of waste from maintenance of drainage facilities shall be conducted in accordance with federal, state, and local regulations, including the Minimum Functional Standards for Solid Waste handling Chapter 173-304 WAC; guidelines for disposal of waste materials; and where appropriate, Dangerous Waste Regulations, Chapter 173-303 WAC.

Removed sediment must be disposed of in the garbage as solid waste. Contaminated water should be disposed of in a sanitary sewer after oils are removed using oil absorbent materials or other mechanical means. Used oil absorbents should be recycled or disposed according to the manufacture’s instructions.

Repairs

Repair or replace to original design specification any outlet orifice that is enlarged, bypassed, or damaged.

Make certain that overflow outlets are not blocked.

Structures should be securely in place and within 10 percent of vertical.

Repair outlet pipe structures that have leaking connections or holes not specified by the design.

Repair or replace a non-functional or damaged cleanout gate.

Repair or replace damaged orifice plates to original design specification.

No outflow controls can be modified with approval of the City of Camas Public Works Department engineer.

Follow the practice described under the Activity: Installation, Repair and Replacement of Enclosed Drainage Systems.

Storm Sewer/Drain Pipe

Storm sewer pipes convey stormwater. Storm pipes are constructed of many different types of materials and are sometimes perforated to allow groundwater to be collected by the storm system. Storm pipes are cleaned to remove sediment or blockages when problems are identified. Storm pipes must be clear of obstructions and breaks to prevent localized flooding.

Maintenance Results

O1 Avoid or minimize sediment and pollutant discharges from the work area.
O2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
O7 Maintain or restore the intended infrastructure function.
O8 Prevent or reduce flooding.
O9 Protect infrastructure.

Procedures

Inspection

Pipes are difficult to inspect requiring special equipment and training. Usually, if a problem occurs the owner needs to call a sewer of plumbing contractor to inspect, repair, or clean pipelines.

Cleaning

Clean pipes when sediment depth is greater than 20 percent of pipe diameter. When cleaning a pipe, minimize sediment and debris discharges from pipes to the storm sewer. Install downstream debris traps (where applicable) before cleaning and then remove material.

Generally, use mechanical methods to remove root obstructions from inside storm sewer pipes. Do not put root-dissolving chemicals in storm sewer pipes. If there is a problem, remove the vegetation over the line.

Safety

Work inside underground structures requires special OSHA-required confined space equipment and procedures. The most practical option may be to contract with a sewer-cleaning contractor.

Materials Handling

Sediment and debris from pipes should be disposed in the garbage as solid waste. Pick out any rocks first.

Repairs

Repair or replace pipes when a dent or break closes more than 20 percent of the pipe diameter.

Repair or replace pipes damaged by rust or deterioration.

Follow the practice described under the Activity: Installation, Repair, and Replacement of Enclosed Drainage Systems.

Underground Detention Systems

Some detention systems consist of underground tanks or vaults that are usually placed under paved areas. They hold and slowly release stormwater runoff from roofs and pavement.

Tanks and vaults are confined spaces where work requires special OSHA-required training and equipment.

Maintenance Results

- R1 Avoid or minimize sediment and pollutant discharges from the work area.
- R2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
- R7 Maintain or restore the intended infrastructure function.
- R9 Protect infrastructure.

Procedures

Inspection

Inspect annually for the features listed under Cleaning and Repairs.

Periodically inspect the manhole and surrounding areas for pollutants such as leaks from dumpsters, minor spills, and oil dumping. Take action to have the pollutant source removed.

Cleaning

Remove trash and litter from the vault, inlet, and piping.

Clean air vents that have one-half of their area plugged.

Remove sediment when it accumulates to $1/10^{th}$ the depth of a rectangular vault or $1/10^{th}$ the diameter of a round tank or pipe.

Safety

Work inside underground structures requires special OSHA-required confined space equipment and procedures. The most practical option may be to contract with a sewer-cleaning contractor.

Materials Handling

Disposal of waste from maintenance of drainage facilities shall be conducted in accordance with federal, state, and local regulations, including the Minimum Functional Standards for Solid Waste handling Chapter 173-304 WAC; guidelines for disposal of waste materials; and where appropriate, Dangerous Waste Regulations, Chapter 173-303 WAC.

Removed sediment must be disposed of in the garbage as solid waste. Contaminated water should be disposed of in a sanitary sewer after oils are removed using oil absorbent materials or other mechanical means. Used oil absorbents should be recycled or disposed according to the manufacture's instructions.

Repairs
Repair any cracked or defective plates or baffles. Cracks are repaired so that no cracks greater than ¼-inch are present.

Any part of a tank or pipe that is bent out of shape more than 10 percent of its design shape must be replaced or repaired.

Repair any joints that are cracked and allow soil into the facility.

Repair all security and access features so they are fully functional. This includes locking lids, covers, and ladder rungs.

Follow the practice described under the Activity: Installation, Repair and Replacement of Enclosed Drainage Systems.

Operation & Maintenance Procedures

Special Facilities

Public & Private Systems

September 2009

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Drywells

Drywells are perforated, open-bottomed manholes used to infiltrate stormwater into the ground. While not the intended use, drywells trap sediment and some of the oil pollutants in stormwater runoff. Drywells are more likely to fill with oily sediment in areas that lack swales or other treatment facilities. Fine oil sediment can clog drywells and lead to localized street flooding. Also, pollutants discharged into drywells can migrate into groundwater. Drywells were often installed in closed topographic depressions, areas with will-drained soils, or areas having inadequate storm sewers. Often, drywells contain groundwater.

Maintenance Results

- R1 Avoid or minimize sediment and pollutant discharges from the work area.
- R2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
- R7 Maintain or restore the intended infrastructure function.
- R8 Prevent or reduce flooding.
- R9 Protect infrastructure.

Procedures

Inspection

Drywells should be inspected at least once a year and no less than once every five years.

Periodically inspect the manhole and surrounding areas for pollutants such as leaks from dumpsters, minor spills, and oil dumping. Take action to have the pollutant source removed.

If a problem with flooding or slow drainage occurs, observe or inspect the drywell for infiltration rate and observe water level depths if monitoring wells are installed.

Cleaning

Clean out drywells when sediment depth is greater than 1/3 of the distance between the vase and inlet pipe.

Drywell cleaning should be performed in a way that makes certain removed sediment and water is not discharged back into the storm sewer.

Safety

Work inside underground structures requires special OSHA-required confined space equipment and procedures. The most practical option may be to contract with a sewer-cleaning contractor.

Materials Handling

Disposal of waste from maintenance of drainage facilities shall be conducted in accordance with federal, state, and local regulations, including the Minimum Functional Standards for Solid Waste handling Chapter 173-304 WAC; guidelines for disposal of waste materials; and where appropriate, Dangerous Waste Regulations, Chapter 173-303 WAC.

Removed sediment must be disposed of in the garbage as solid waste. Contaminated water should be disposed of in a sanitary sewer after oils are removed using oil absorbent materials or other mechanical means. Used oil absorbents should be recycled or disposed according to the manufacture's instructions.

Repairs
If the drywell does not dissipate stormwater, it should be replaced or repaired.

It is possible to restore some drywell capacity by water-jetting clogged openings.

Another option is installing a new drywell or drainage trench, and converting the clogged drywell into a sediment trap. This has the advantage of providing a sediment trap and some amount of spill trapping. The sediment trap conversion requires grouting the holes, covering the base with concrete, and adding piping. Alterations to any storm facility **cannot** be done without approval from the City of Camas.

If there is standing water in a drywell, it probably is into the water table. Drywells in the water table should be rebuilt to prevent stormwater from going directly into groundwater.

Repair all security and access features so they are fully functional. This includes locking lids, covers, and ladder rungs.

Follow the practice described under the Activity: Installation, Repair, and Replacement of Enclosed Drainage Systems.

StormFilter™ (Leaf Compost Filter)

The StormFilter is a patented system for treating stormwater. The systems have evolved during the last 10 years from very simple above ground filter beds to a variety of vault devices containing cylindrical filters filled with leaf compost pellets. StormFilter facilities consist of cartridges filled with one or a combination of media. Media can be selected to target pollutants specific to a particular site. The cartridges are housed in pre-cast or cast in-place concrete vaults or in a steel catch basin configuration. Each configuration uses baffles to promote settling of solids and separation of oils and other floatable materials. The majority of pollutants are captured by the media and held in the cartridges. Some additional settling will occur in the inlet and cartridge bays of each vault.

Maintenance Results

- R1 Avoid or minimize sediment and pollutant discharges from the work area.
- R2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
- R7 Maintain or restore the intended infrastructure function.
- R9 Protect infrastructure.

Procedures

Inspection

Inspect the StormFilter every six months. The inspection should determine sediment depth and the specific maintenance and repairs needed.

Inspect annually for cracks large enough to let soil enter the vault, broken or defective plates and baffles, and crushed or damaged pipes.

Periodically inspect the manhole and surrounding areas for pollutants such as leaks from dumpsters, minor spills, and oil dumping. Take action to have the pollutant source removed.

Cleaning

Remove trash and litter from the vault, inlet, and piping.

Remove sediment when it accumulates to 6-inches in depth in settling chambers.

Remove sediment when it accumulates on filter media.

Replace media cartridges per manufacture's recommendation.

Safety

Work inside underground structures requires special OSHA-required confined space equipment and procedures. The most practical option may be to contract with a sewer-cleaning contractor.

Materials Handling

Disposal of waste from maintenance of drainage facilities shall be conducted in accordance with federal, state, and local regulations, including the Minimum Functional Standards for Solid

Waste handling Chapter 173-304 WAC; guidelines for disposal of waste materials; and where appropriate, Dangerous Waste Regulations, Chapter 173-303 WAC.

Removed sediment must be disposed of in the garbage as solid waste. Contaminated water should be disposed of in a sanitary sewer after oils are removed using oil absorbent materials or other mechanical means. Used oil absorbents should be recycled or disposed according to the manufacture's instructions.

Repairs

Repair any cracked or defective plates or baffles. Cracks are repaired so that no cracks greater than ¼-inch are found.

Replace media cartridges if it takes longer than an hour for water to empty through media or if water frequently overflows the treatment chamber. Replace defective cartridges.

Repair all security and access features so they are fully functional. This includes locking lids, covers, and ladder rungs.

Follow the practice described under the Activity: Installation, Repair, and Replacement of Enclosed Drainage Systems.

Infiltration Systems (work in-progress)

Due to the dominance of clay soils within the City of Camas, infiltrations systems are not allowed, except on a case-by-case basis.

Maintenance Results

- R1 Avoid or minimize sediment and pollutant discharges from the work area.
- R2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
- R7 Maintain or restore the intended infrastructure function.
- R10 Meet public expectations for aesthetics

Procedures

Inspection

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Operation & Maintenance Procedures

Miscellaneous Activities

Public & Private Systems

September 2009

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Fences, Gates, and Water Quality Signs

Fences are installed around the perimeter of storm sewer facilities as a means of protecting the public, as they restrict entrance to the facility. Gates are installed to allow for maintenance access. Gates will be secured shut, typically with a double lock system that allows access to the City and to the property owner's maintenance crew.

Water Quality Signs are installed on the fences, or on sign poles, within public view as a means of educating the public as to the presence of a storm sewer facility. These signs also have a number located in the upper right hand corner that is cross referenced, at the City, to an address and maintenance responsibility.

Maintenance Results

R5 Protect public safety and health.
R7 Maintain or restore the intended infrastructure function.
R9 Protect infrastructure.

Procedures

Inspection

Inspect fences, gates, and water quality signs during facility maintenance.

Repairs

Repair any opening that allows entry into the facility, including access beneath the fence.

Replace any missing gates.

Repair broken gate hinges or gates which do not close and lock properly.

Replace any missing signs or signs that have more than a 20 percent unreadable surface.

Repair sign posts that lean more than 8-inches off vertical.

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Access Roads and Easements

Most stormwater facilities have access roads to bring in heavy equipment for facility maintenance. These roads should be maintained for inspection access and ease of equipment access.

Maintenance Results

- R1 Avoid or minimize sediment and pollutant discharges from the work area.
- R2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
- R7 Maintain or restore the intended infrastructure function.
- R10 Meet public expectations for aesthetics.

Procedures

Inspection

Inspect once a year or when facilities are maintained.

Cleaning

Remove litter when mowing or when there is any accumulation.

Remove any debris that blocks roads or may damage tires.

Vegetation Management

Manage vegetation as for the rest of the facility. Trees and shrubs may be removed from access roads and easements if they block access for necessary maintenance or will prevent or harm intended stormwater facility function. Use of pesticides is prohibited unless prior approval is received from the City.

Repairs

Correct any bare or eroded soils by seeding or a cover BMP.

Repair road surfaces when they may lead to erosion or limit equipment access.

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Pavement Sweeping

Pavement sweeping is performed as a means of removing sand, dirt, and litter from streets and curb gutters. Sweeping also reduces dust during dry weather. Pavement sweeping is also part of storm sewer maintenance procedure because it limits the amount of sediment washed into the storm sewer facilities. The water quality procedure for street sweeping focuses on sediment removal and disposal. Reducing the amount of sediment washed into catch basins, curb inlets, detention facilities, drywells, and other facilities can save money because sweeping is generally cheaper that removing sediment from facilities. Sweeping also helps protect facilities from clogging with sediment.

Maintenance Results

- R2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
- R5 Protect public safety and health.
- R10 Meet public expectations for aesthetics.

Procedures

Inspection

Inspect on a weekly basis, depending on traffic volumes.

Cleaning

Sweep the site to help keep sediment from entering storm sewer systems and water bodies.

Sweeping is especially useful for cleaning up work areas.

Sweeping can be as easy as using a couple of push brooms or as involved as using mechanical methods.

Materials Handling

Disposal of waste from maintenance of drainage facilities shall be conducted in accordance with federal, state, and local regulations, including the Minimum Functional Standards for Solid Waste handling Chapter 173-304 WAC; guidelines for disposal of waste materials; and where appropriate, Dangerous Waste Regulations, Chapter 173-303 WAC.

Sweepings should be disposed of as solid waste or under a program permitted by the Southwest Washington Health District.

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Operation & Maintenance Procedures

Enclosed Storm Sewers System

Public & Private Systems

September 2009

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Installation, Repair, and Replacement of Enclosed Drainage Systems

This chapter includes tasks such as repair and replacement of pipe, catch basins, drywells, and manholes. It also includes drainage projects that add new pipes, catch basins, or infiltration structures. New drainage projects are subject to regulations under CMC 15.36 Erosion/Sediment Control Plans.

Maintenance Results

- R1 Avoid or minimize sediment and pollutant discharges from the work area.
- R2 Prevent parking areas, roads, drainage systems, and drainage facilities from becoming pollutant sources.
- R7 Maintain or restore the intended infrastructure function.
- R8 Prevent or reduce flooding.

Procedures

Cleaning

Avoid or minimize vegetation removal. If work is near a stream or wetland, there are regulatory requirements to must be met.

Prevent debris, oils, cleaning agents, and sediment from entering waterways.

Avoid or minimize work in wet weather. This will reduce the problems of containing sediment.

Carry spill control kit on-site to contain and clean up possible small spills in the work area, e.g. oil spills.

Protect our storm systems:

- Install sediment traps around curb inlets and catch basins, e.g. biobags or gravel filled pillows.
- Install catch basin inserts.
- Sweep or vacuum dust and debris from the repair job. Do not wash materials into storm sewers.
- Place stockpiles away from drainage ways, wetlands, and natural wetland and habitat buffers. Cover stockpiles or contain them with berms or other containment devices.
- At stream crossings, trap material using screens or another approved form of containment. Use containment BMP's to protect roadside ditches during wet weather.

Ensure that along with the approved erosion/sediment control measures that are in-place prior to construction, that there is an emergency sediment control kit for unexpected problems; e.g. trench dewatering. This should include:

- Sediment bag,
- Additional biobags and catch basin inserts,
- Push brooms and flat edge shovels.

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Minor Culvert Repair (not in a natural stream)

This activity is for the replacement or repair of culverts and inlets. It applies only to structures that are in ditches that are specifically for storm drainage. These are ditches that do not carry water during dry weather. If there is any question about whether the ditch is a storm drain or a stream, consult with the Washington Department of Fish and Wildlife and the City of Camas Public Works Department.

Maintenance Results

R1 Avoid or minimize sediment and pollutant discharges from the work area.
R3 Avoid or minimize vegetation removal.
R7 Maintain or restore the intended infrastructure function.
R8 Prevent or reduce flooding.
R9 Protect infrastructure.

Procedures

Comply with erosion/sediment control requirements in CMC 15.32.

Avoid or minimize vegetation removal. If work is near a stream or wetland, there are likely to be regulatory requirements.

Other than to address a threat to public safety or property due to flooding, perform work during the dry season.

Minimize soil disturbance.

Use sediment controls to trap any sediment and prevent sediment from entering the storm sewer and water bodies. Sediment trapping BMP's are to be used to the extent practical during emergencies. An emergency sediment control kit is highly recommended.

Use cover BMP's to prevent erosion of bare soil. Vegetate bare soils.

Major Culvert Repair (at a Stream Crossing)

This activity is the replacement or repair of culverts and inlets bridging a stream or ditch with flowing water during dry weather. If there is any question about whether the ditch is a storm drain or a stream, consult the Washington Department of Fish and Wildlife and the City of Camas Public Works Department.

These projects must meet all regulatory requirements.

- SEPA
- Shoreline
- HPA Permit
- Flood Plain

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Operation & Maintenance Procedures

Vegetation Management

Public & Private Systems

April 2009

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General Goals and Philosophy

The City of Camas recognizes the special importance of the rivers, streams, wetlands, ponds, and stormwater control and treatment facilities. The sensitive nature of such habitat, their plant and animal communities, and their direct link with other waterways require that we establish specific policies to ensure their health. All landscape management decisions for controlling unwanted vegetation, diseases, and pests should follow Integrated Pest Management (IPM) principles and decision-making rationale. These are as follows:

- Proper planning and management decisions begin the IPM process.
- Cultural methods of vegetation and pest control are preferred and are first employed.
- Mechanical means of vegetation and pest control are next in line of preference, and are utilized where feasible.
- Biological methods of vegetation and pest control are considered before chemical means, where they are feasible.
- Botanical and synthetic pesticides are used only when no other feasible methods exist.

General Procedures

Use Only Appropriate Plants

The City of Camas has adopted a list of approved plants for use in development projects, and to assist homeowners in choosing appropriate plantings. The list also has prohibited undesirable plants. Only plants approved for use on the City of Camas Plant List are allowed for use within the City's right-of-way, storm sewer facilities, and wetland buffers.

Mulching

Mulches and other ground coverings are useful during the installation and restoration of landscapes as well as their ongoing maintenance. Mulches meet a variety of needs. They suppress weeds, help to retain moisture around plants, reduce possible erosion, and provide visual enhancement.

Always consider the possible impacts when using mulches, which may include:

- Inadvertent introduction of non-native plants and diseases to the site.
- Leaching of substances such as tannins from the mulch into nearby waterways.
- Migration of mulch material in waterways.
- Nutrient leaching into waterways.

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Vegetation and Pest Management in Storm Sewer Facilities

Storm sewer facilities include biofiltration treatment swales, treatment wetlands, treatment ponds, detention ponds, open channels, and infiltration basins. Stormwater control facilities discharge to surface water or groundwater directly or through pipes or ditches. Facilities are built to remove pollutants and to control the discharge rate of stormwater.

Generally, vegetation should be maintained to blend into surrounding areas. Storm sewer facilities can also provide habitat for birds, amphibians, and other aquatic life. Promoting native vegetation, where feasible, improves habitat. Swales often blend into intensively managed landscapes. Pond perimeters can include native vegetation.

The use of pesticides, and in most cases fertilizer, is not compatible with the task of pollutant removal or where there is a direct discharge of stormwater to streams and groundwater.

Features of Storm Sewer Facilities:
- There is a mix of native and non-native plants.
- Generally not used by the public.
- Include areas managed to promote design function, such as turf in swales.
- Managed landscapes may be nearby.
- May be used by fish and wildlife.

Objectives for Storm Sewer Facilities:
- Maintain healthy plant communities.
- Avoid or minimize need for chemical intervention.
- Control invasive plants where feasible.
- No bare soil areas are allowed.
- Tolerance for natural appearance and weeds.

Procedures
The vegetation management focus is in establishing and maintaining healthy low-maintenance native plantings and sustaining the design function of vegetated filters, such as biofiltration swales. This includes controlling invasive plants where feasible, and planting cover on bare soils.

Only use plants on the City of Camas approved plant list.

In some cases, the original plantings may not be appropriate for the actual conditions at a facility. One example is a frequently flooded swale that cannot support normal turf. In cases like this, replace turf with appropriate wetland plants if the underlying drainage problem cannot be fixed.

Consider the use of soil amendments, such as compost before using fertilizer.

Limit mulch use to covering bare soil while establishing plantings.

Chemical use should be avoided within 25 feet of any area that holds or conveys surface water or stormwater. This includes the base of a biofiltration swale.

Trees or shrubs that hinder accessibility to access roads may be trimmed (or removed if within the access road) when access is required for maintenance by heavy equipment.

Trees that pose a risk to stormwater structures due to root growth should be removed and replaced by smaller shrubs.

Vegetation and Pest Management in Wetland Areas

Constructed wetlands are built to treat stormwater. As water bodies, treatment wetlands connect to streams and groundwater. Constructed wetlands also play host to insects, fish, amphibian, and birds that are sensitive to horticultural chemicals. Because of this, chemical use should be avoided or minimized in wetland buffers. Wetland management has a low tolerance for invasive or non-native plants.

Procedures listed here apply only to those parts of a constructed wetland that are not subject to inundation or saturation during the growing season.

Features of Constructed Wetlands:

- Limited public access.
- Plants may or may not be well established, depending on age and condition.
- May provide fish and wildlife habitat.

Objectives for Constructed Wetlands:

- Maintain health plant communities.
- Avoid or minimize need for chemical intervention.
- Low tolerance of invasive and non-native plants.
- Bare soil areas are not allowed.

Procedures

There should be a plan for establishing and maintaining vegetation in a newly constructed wetland facility. If there is a plan, follow it. If there is not a plan, follow these Procedures. Maintenance focuses on establishing and sustaining healthy native plantings. This includes more vigorously controlling invasive plants. It also includes covering for bare soil.

Only use plants on the City of Camas approved plant list.

Consider the use of soil amendments such as compost before using fertilizer.

Limit mulch use to covering bare soil while establishing plantings.

Chemical intervention is to be minimized and is to be avoided, whenever possible, within 25 feet of areas subject to inundation during the growing season.

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Operation & Maintenance Procedures

Example "Storm Sewer System Maintenance Notification"

Public & Private Systems

April 2009

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CITY OF CAMAS
STORM SEWER SYSTEM MAINTENANCE NOTIFICATION

Date Inspected: ______________________

Facility Name (subdivision/commercial/industrial): ______________________

Address or Location: ______________________

Contact Information: ______________________

Complete Maintenance by: ______________________ Re-inspected on: ____________

TYPE OF FACILITY:

Detention Pond: Wet _______ Extended Dry ________ Other ______________________

Water Quality Swale: Yes No Wetlands in Vicinity: Yes No Possible

Other Comments: ______________________

GENERAL LOCATION SKETCH: Show approximate dimensions, north arrow, structure locations, access location, name of nearest road, etc. As-Builts Available: Yes No

Facility Check List:

Item	Yes	No
Located Access		
Located Inlet		
Located Outlet		
Located Orifice		
Slopes (Note Excess)		
Fenced / Gated		
Needs a Lock		
1-3 Photos Taken		
Outlet Type: Standpipe, Grated, Pipe, Open Channel, Other		
Other Comments:		

GENERAL MAINTENANCE NEEDS:

Mowing Ability: ________% Weed Eater Ability (due to fence/steep slopes): _______%

Remove the following: Blackberries Scotch broom Thistle Trees in Pond/Swale Cattails

Silt Removal Needed: Yes No If Yes, From: Inlet / Outlet Structure Pond / Swale

Inlet Protection: Adequate / Inadequate Outlet Protection: Adequate / Inadequate

Overflow Protection: Adequate / Inadequate Protection Needs: additional rock / vegetation removal

Trash Debris and/or Vegetation Removal Needed: Yes No

Erosion Damage: Severe Minor None Recommended Repairs: ______________________

____

Vegetation: Dense Average Sparse Needs: Replacement Additional Seeding

Additional Work Needed After Initial Vegetation Removal: yes / no

Description: ______________________

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PRE-APPLICATION MEETING NOTES
Hood St. Subdivision
PA21-52

Thursday, November 4, 2021
3:30pm, City Hall (meeting via zoom)
616 NE 4th Ave. Camas, WA. 98607

Applicant:	Modern Dwellings, LLC
City of Camas:	Lauren Hollenbeck, Senior Planner Anita Ashton, Engineering Ahmed Yanka, Engineering Brian Smith, Building Official Ron Schumacher, Fire Dept.
Location:	1811 NW Hood Street Camas, WA 98607 Parcel Numbers: 127415000, 127440000
Zoning:	R-7.5 (Single-Family Residential)
Description:	The applicant is proposing to subdivide 6.05-acres into 17 single-family residential lots

NOTICE: Notwithstanding any representation by City staff at a pre-application conference, staff is not authorized to waive any requirement of the City Code. Any omission or failure by staff to recite to an applicant all relevant applicable code requirements shall not constitute a waiver by the City of any standard or requirement. [CMC 18.55.060 (C)] This pre-application conference shall be valid for a period of 180 days from the date it is held. If no application is filed within 180 days of the conference or meeting, the applicant must schedule and attend another conference before the City will accept a permit application. [CMC 18.55.060 (D)] Any changes to the code or other applicable laws, which take effect between the pre-application conference and submittal of an application, shall be applicable. [CMC 18.55.060 (D)]. A link to the Camas Municipal Code (CMC) can be found on the City of Camas website, http://www.cityofcamas.us/ on the main page under “Business and Development”.

PLANNING DIVISION **LAUREN HOLLENBECK (360) 817-7253**

An application for a subdivision is considered a Type III permit. Applicable codes for this proposal include Title 16 Environment, Title 17 Land Development and Title 18 Zoning of the Camas Municipal Code (CMC), which can be found on the city website. Please note it remains the **applicant’s responsibility** to review the CMC and address all applicable provisions. The following pre-application notes are based on application materials and site plan submitted to the City on October 11, 2021:

Application Requirements

Your proposal will need to comply with the general application requirements per **CMC Section 18.55.110** in addition to the specific applicable application requirements outlined in **CMC Section 17.11.030.B** for a preliminary subdivision plat. The following is an excerpt from the requirements of CMC Section17.11.030.B (see code section for full text):

1. A completed city application form and required fee(s);

Fees will be based on the adopted fees at the time of land use application submittal. The current fees include the following:

1. Preliminary Plat	$7,175 + $250 per lot
2. SEPA	$810.00
3. Critical Areas Review *(for each type)*	$775.00
4. Archaeological Review	$137.00
5. Fire Department Review	$354.00
6. Building Permit and Plan Review	based on the valuation of the project
7. Engineering Review	3% of estimated construction costs

2. A completed and signed SEPA checklist;
3. Complete applications for other required land use proposals applicable to the proposal;
4. A vicinity map showing location of the site;
5. A survey of existing significant trees as required under CMC Section 18.13.045;
6. All existing conditions shall be delineated on the site plan per CMC Section 17.11.030.B.6(a-p);
7. A preliminary grading plan as slopes are greater than ten percent;
8. Preliminary stormwater plan and report;
9. A geotechnical report consistent with CMC Chapter 16.59 as development is proposed on slopes greater than ten percent
10. A copy of the Clark County assessor's map which show the location of each property within 300 feet of the subdivision;
11. One set of mailing labels for all property owners as provided in CMC Section 18.55.110;
12. A traffic study
13. A narrative addressing ownership and maintenance of open spaces, stormwater facilities, public trails and critical areas, and the applicable approval criteria (CMC Section 17.11.030.D) and standards of the Camas Municipal Code. It should also address any proposed building conditions or restrictions.
14. A development sign must be posted on site per CMC Section 18.55.110.H (1-5).
15. Necessary drawings and reports- three sets and an electronic copy (send as a PDF by email or on a disc). All documents and reports must be submitted as separate pdf copies.

Preliminary Plat

The following comments are based on the site plan materials submitted with this Pre Application:

1. The preliminary plat drawings must meet the density and dimensional standards for lots in a Single-Family Residential (R-7.5) zone, and infrastructure improvements (i.e. roads, easements, etc.).
    a. Lots 3 and 5 require a minimum 30-foot wide lot frontage on the cul-de-sac/curve per CMC 18.09.040 Table 2- *Building Setbacks for Single-Family Residential Zones*.
2. Per CMC 18.09.040 Table 1 Note 3, "For parcels with an existing dwelling, a one-time exception may be allowed to partition from the parent parcel a lot that exceeds the maximum lot size

permitted in the underlying zone. Any further partitioning of the parent parcel or the oversized lot must comply with the lot size requirements of the underlying zone." This criterion can be used to create the proposed lot size for the existing residential home. Staff would not support a boundary line adjustment.

3. Per CMC 18.09.080.B, the lots adjacent to the adjacent R-12 zoned properties shall be the maximum lot size allowed for the proposed development and may utilize the density transfer provisions, which is 9,000 square feet. If density transfer provisions are used, CMC 18.09.040.B Table 1 R-7.5 density and dimensional standards is applicable.
    a. Lots 3-7, 9 and 10 shall have a maximum lot size of 9,000 square feet.
4. Density calculation is based on development/net acreage which is defined as the total land use development exclusive of open space and critical areas. Developed/net acreage includes infrastructure, storm drainage facilities and lots and access easements.
5. Building setback requirements are found at CMC 18.09.040-Table 2, which includes the requirement for setbacks to be drawn on the plat. Per Note 2, *"Garage setback is five feet behind the front of the dwelling."*
6. Building envelopes (setbacks) shall be shown on the preliminary and final plats. Per CMC Section 17.19.030.D.3.a, a 40ft. by 40ft. square dwelling should be able to fit within the building envelope.
7. Each dwelling unit within a new development shall be landscaped with at least one tree per CMC 17.19.030.F.
8. Per CMC 17.19.040.B.1.c, if the average lot size is less than 7,500 square feet, one additional off-street parking space is required for every 5 units and shall be located within a common tract.
9. Per CMC 17.19.040.B.10.a, a Circulation plan is required at application that includes the subject site and properties within six hundred feet showing topography, critical areas and existing and proposed streets, trails, etc. Streets shall extend to and connect with neighboring properties per CMC 17.19.040.B.6.a.
10. A direct pedestrian or bicycle connection shall be provided to the neatest street or pedestrian use from a cul-de-sac or dead-end street per CMC 17.19.040.B.10.b.ii. As such, a pedestrian connection shall be provided from the cul-de-sac to NW 17th Avenue and from the dead-end street to NW 16th Avenue.
11. The storm drainage facility shall include a 10-foot L2 landscape buffer per CMC 17.19.030.F.6.
12. The location and height of any retaining walls shall be shown on the grading plan. Retaining wall height requirements are found in CMC 18.17.060.

Landscaping Regulations and Tree Retention
Landscaping standards shall apply to all new land divisions per CMC 18.13.020.B.1. A Landscape, Tree and Vegetation plan must be submitted pursuant to CMC 18.13.040.A. If trees are proposed for removal, a Tree Survey is required per CMC 18.13.040.B and must be prepared by a certified arborist or professional forester pursuant to the requirements outlined in CMC 18.13.045. A minimum 20-unit tree density per net acre is required and needs to be incorporated in the overall landscape plan per CMC 18.13.051.A.

SEPA
The proposed development is not categorically exempt from the requirements of the State Environmental Policy Act (SEPA) per CMC Section 16.07.020.A as the proposed is more than ten residential units and contains environmentally sensitive areas per CMC 16.07.025.C. The current SEPA environmental checklist is on the website.

Critical Areas Review
Clark County GIS mapping identifies geologically hazardous areas (i.e. steep slopes and landslide hazards) and a critical areas assessment was prepared on the subject property that identified a wetland, which both are designated as critical areas per CMC Section 16.51.070. As such, a critical areas report is required if a proposed development is within or adjacent to a critical area per CMC Section 16.51.130. The general requirements for a critical areas report are found in CMC Section 16.51.140. The City's code contains additional requirements for each type of critical area.

- The critical areas report requirements for Wetlands are found in CMC 16.53.030. If impacts to wetland are anticipated, then an analysis of alternative designed must be included as a demonstration of the effort to avoid impacts per CMC Section 16.53.050.D.
- The critical areas report requirements for Geologically Hazardous Areas are found in CMC 16.59.060 and 16.59.070.

Archaeological Review
The site is located in an area of moderate-high probability for the presence of archaeological objects. There is a known archaeological object within a ¼ mile of the site, and as such an archaeological predetermination will be required per CMC Section 16.31.070.B. Submit proof of mailing or emailing the tribes per CMC 16.31.160.

ENGINEERING DIVISION **ANITA ASHTON (360) 817-7231 aashton@cityofcamas.us**

General Requirements:

1. Civil site construction plans shall be prepared by a licensed Washington State Engineer in accordance with the *Camas Design Standards Manual (CDSM)* and CMC 17.19.040.
2. The Community Development Engineering Dept. is responsible for plan review (PR) and construction inspection (CI).
3. A 3% PR&CI fee is collected by engineering for all infrastructure improvements.
    a. A stamped preliminary engineer's estimate shall be submitted to the CDEV Engineering Dept prior to or with submittal of plans for first review.
        i. The first review submittal shall consist of three (3) full size sets and one (1) half size set of the engineering plans, and one (1) hard copy of the revised TIR.
    b. Payment of the 1% plan review (PR) fee shall be due prior to start of first review.
    c. Payment of the 2% construction inspection (CI) fee shall be due prior to construction plan approval and release of approved plans to the applicant's consultant.
    d. Under no circumstances will the applicant be allowed to begin construction prior to construction plan approval.
4. *Engineering site improvements plans are not to be submitted until after land-use decision is issued.*
5. *Building applications will not be accepted until after Final Acceptance of all infrastructure improvements have been completed.*
6. *Final acceptance is issued by the Community Development Engineering Dept.*
7. Any existing wells, septic tanks, and septic drain fields shall be decommissioned in accordance with State and County guidelines per CMC 17.19.020 (A3).
8. The applicant will be required to purchase all permanent traffic control signs, street name signs, street lighting, and traffic control markings for the proposed development.
9. Regulations for installation of public improvements, improvement agreements, bonding, final platting, and final acceptance can be found at CMC 17.21.
10. The applicant will be responsible for ensuring that private utilities; underground power, telephone, gas, CATV, interior street/parking lighting, and associated appurtenances are installed.

Traffic/Transportation:

1. A transportation impact study (TIA) is not required as the proposed development will not result in 200 vehicle trips per day (VPD) or more.
2. A traffic engineer is to analyze the following:
    a. Site distance access (es) at NW Hood Street, NW 18th Avenue and NW 16th Avenue.
    b. A traffic circulation plan showing ingress and egress, per CMC 17.19.040 (B.10.a).
    c. Address movement conflicts with nearby intersections, left-turn pocket analysis on NW Hood Street at the proposed access location, and applicable private driveways.
    d. Provide AM and PM Peak trip distribution to and from the site.

Streets:

1. The proposed development fronts NW Hood Street and NW 16th Avenue. Both roads are classified as existing 2 lane arterials per the City's 2016 Transportation Comp Plan.
2. Per CMC 17.19.040.B.5, the applicant will be required to dedicate sufficient right-of-way for full half-width street improvements along the proposed frontage.
    a. The existing right-of-way (ROW) along the frontage of the proposed development is 40-feet in width. The applicant will be required to dedicate sufficient ROW to provide for 37-foot wide ROW width from the centerline of NW Hood Street and the centerline NW 16th Avenue.
    b. ROW dedication is to extend from the northernmost limit of the proposed development, which includes the frontage along the SFR.
3. Per CMC 17.19.040. B.1, the applicant will be required to construct full half-width street improvements along the frontages on NW Hood Street and NW 16th Avenue.
    a. This includes the section of frontage on NW Hood Street adjacent to the new SFR being built Parcel No. 127415-000.
    b. Additionally, the driveway access off NW Hood Street to the new SFR is to be eliminated. The new SFR will be required to take access from the proposed interior private road.
4. CMC 17.19.040.B.6. requires a vehicular connection from NW Hood Street to NW 17th Avenue.
    a. The applicant should provide a narrative with ample reasoning for why the vehicular connection is not practicable and why a deviation from the design standards should be supported by the city engineer.
5. Per CDSM, Access Spacing Standards Table 3: The minimum access spacing on an arterial is 660-feet with a maximum of 1,000-feet.
    a. The proposed access off NW Hood Street is approximately 283-feet south of the intersection of NW Hood Street and NW 18th Avenue; and approximately 340-feet north of the intersection of NW Hood Street and NW 16th Avenue.
    b. The proposed location does not meet the minimum access spacing requirements of 660-feet on an arterial.
6. Per CMC 17.19.040.B Table 17.19.040-1 Minimum Private Street Standards D:
    a. Access to five or more dwelling units and greater than 300-feet in length requires a 48-foot wide tract, 28-feet of paved surface, 5-foot wide sidewalks and planter strips on both sides of the road, and no parking on one side of the road.
7. The applicant has proposed to construct a private road in accordance with Minimum Private Street Standards D.
8. Per CMC 17.19.040.B Table 17.19.040-1 Minimum Private Street Standards A:
    a. Access to four or less dwelling units requires a 20-feet wide tract, 12-feet of paved surface, optional 5-foot sidewalk, no planter strip, and no parking on either side.
    b. The applicant has proposed a dead-end access road to proposed Lots 9, 10, and 11, which meets these standards.

   c. However, as the access road is greater that 150-feet in length, a dead-end turnaround will be required.

9. Per CMC 17.19.040.B.10.b.ii Cul-de-sacs and permanent dead-end streets over three hundred feet in length may be denied unless topographic or other physical constraints prohibit achieving this standard. When cul-de-sacs or dead-end streets are permitted, a direct pedestrian or bicycle connection shall be provided to the nearest available street or pedestrian oriented use.
   a. The proposed private road is approximately 725-feet in length and dead-ends at a 35-foot radii cul-de-sac.
   b. If approved, the applicant will be required to provide a pedestrian/bicycle connection to NW 17th Avenue. Additionally, the pedestrian access is to meet ADA accessibility requirements, per CDSM.
10. The applicant is proposing a gated access off NW Hood Street. Gate permits are issued by the Fire Marshall's Office.
    a. Civil plans are to show the location of the gate and controller, to provide a minimum 25-foot radius turnaround area and be offset sufficiently from NW Hood Street to limit vehicular backups onto NW Hood Street.
11. The applicant will be required to provide a 5-foot wide hard surface ADA path along NW 16th Avenue from the west end of the proposed frontage improvements to the existing sidewalk on NW 16th Avenue at NW Juneau Court, for a distance of approximately 140-feet. See the plat for Master Key short plat.
12. Street tree planting is required in accordance with CMC 17.19.030 (F).
13. LED street lighting is to be installed along all street frontages within and adjacent to the proposed development, in accordance with CDSM.
14. Private streets, with street lighting, are to have separate meters and the maintenance of all lights and power will be the responsibility of the Owner/Homeowner's Association.

<u>Stormwater:</u>

1. The site of proposed development is approximately 6.08 acres.
2. The applicant shall provide a preliminary stormwater report, using the most current edition of Ecology's *Stormwater Management Manual for Western Washington (latest edition 2019 SWMMWW*).
3. Per CMC 14.02 Stormwater Control, stormwater treatment and detention shall be designed in accordance with the latest edition of Ecology's *SWMMWW*.
4. Refer to Ecology's *Figure I-3.1 Flow Chart for Determining Requirements for New Development (Vol. I, Chapter 3)*.
   a. All development projects shall comply with Minimum Requirement (MR) #2 – Submittal of a Stormwater Pollution Prevent Plan (SWPPP).
   b. As the project results in 5,000 sf, or greater, of new plus replaced hard surface area; than Minimum Requirements (MR) #1- #9 will apply.
5. Stormwater facilities are to be placed in a Tract, with right-of-entry to the City for inspection purposes.
6. Ownership and maintenance of onsite stormwater facilities will be the responsibility of the Owner/HOA, per CMC 17.19.040 (C3).
7. Public and private storm easements, if required, are to be shown on the construction drawings.
8. Provisions are to be provided for roof downspout controls. Stormwater from downspouts is not to be directed onto adjoining parcels. Reference Ecology's latest edition of the SWMMWW for roof downspout controls and CMC 14.02 and 17.19.040.C.
9. A designated concrete washout area (BMP C154, Vol. II, Chap. 3, pgs. 320-326) is to be shown on the site plans. The washout area is to be removed prior to issuance of final occupancy.

10. There are known stormwater issues from the adjacent Summit @ Columbia Vista subdivision that may impact the proposed Lots 1-3, that will need to be addressed.

Erosion Control

1. The site of proposed development is approximately 6.08 acres.
2. As the land-disturbing activities are greater than one acre, the applicant will be required to obtain an *NPDES Construction Stormwater General Permit* from Ecology, which includes the *Stormwater Pollution Prevention Plan (SWPPP)*. Copies of both are to be submitted to Engineering prior to any land-disturbing activities.
3. The applicant will be responsible for all erosion and sediment control measures to ensure that sediment laden water does not leave the site or impact adjacent parcels.
4. Per CMC 17.21.030.B an erosion and sediment control (ESC) bond, in the amount 200% of the engineer's estimate for ESC measures, is to be submitted prior to any land-disturbing activities.
5. Mud tracking onto the road surface is discouraged and any mud tracking is to be cleaned up immediately.

Water

1. There is an existing 12-inch ductile iron water main located in NW Hood Street.
2. The applicant will be required to design and construct a minimum 8-inch ductile iron water main from NW Hood Street throughout the proposed development.
3. The applicant will be required to provide a looped water system from NW Hood Street and through to the existing 8-inch blowoff at the eastern end of NW 17th Avenue.
4. The applicant shall provide a separate 1-inch water service and install the water meter box to each of the lots located within this development.
5. Trenching, backfill, and surface restoration on NW Hood Street will be required, per CDSM Detail G2 and G2A.
6. An onsite water sampling station will be required.
7. Applicant shall demonstrate that there are adequate fire flows available for the development.
8. A 10-foot separation shall be maintained between water and sanitary sewer lines.

Sanitary Sewer:

1. There is an existing 4-inch pressure (STEP) sewer line located in NW Hood Street.
2. The Applicant will be required to design and construct a new sewer main to serve the development, with 1-inch laterals provided to each lot.
3. Trenching, backfill, and surface restoration on NW Hood Street will be required, per CDSM Detail G2 and G2A.
4. Home builders will be required to provide a sewer STEP tanks for each lot.
5. The STEP tanks are to be per CDSM STEP Tank Details.
6. The STEP tanks are to be installed by a certified Roth tank installer.
7. The tap on the existing sanitary sewer main is to be performed by a tapping Contractor approved by the City's Water/Sewer Dept. Approved list provided below.
8. A 10-foot separation shall be maintained between water and sanitary sewer lines.

City Approved Tapping Contractors:

1. A&A Drilling Services, Inc (water & pressure sewer):
   16734 SE Kens Ct. #B, Milwaukie, OR 97267, 800-548-3827,
   http://www.aadrilling.com

Parks/Trails:

1. Not applicable

Impact Fees & System Development Charges (SDCs):

1. The proposed development is in the South District.
2. Impact Fees and SDCs are collected at time of building permit issuance.

3. Impact fees and SDCs are adjusted on January 1st of each year.

Impact Fees for 2021:

1. Single Family Detached:
    a. Traffic Impact Fees - $3,555.00
    b. School Impact Fees (SIF) (Camas) – $5,371.00
    c. Park/Open Space Impact Fees (PIF) – $4,782.00
    d. Fire Impact Fees (FIF) - $0.20 sf

System Development Charges (SDCs) for 2021:

1. Water
    a. 3/4” meter - $7,398.00 + $401.00 connection fee
2. Sewer
    a. Residential - $2,493.00

BUILDING DIVISION **BRIAN SMITH (360) 817-7243**

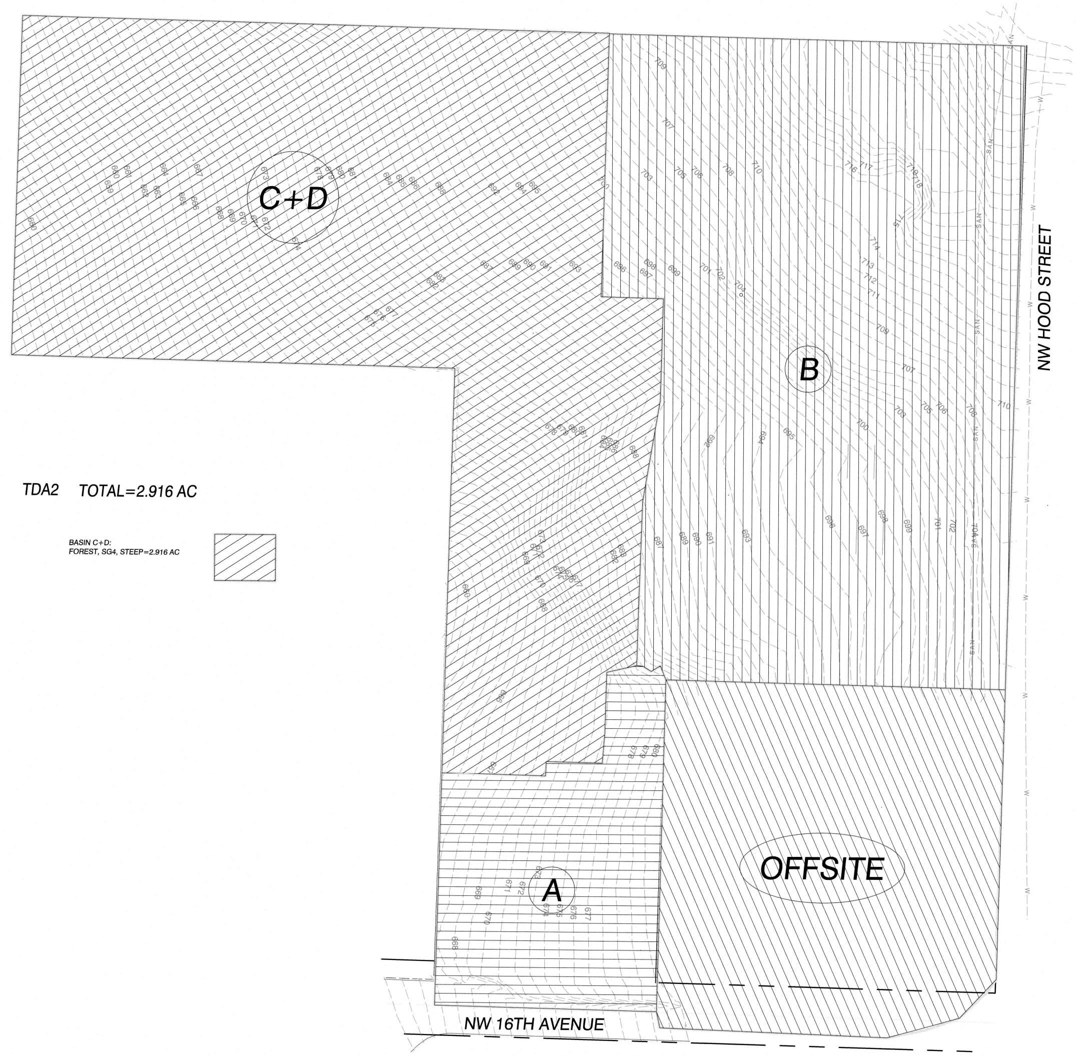
1. Existing structures to be removed will need an asbestos survey and demolition permit.
2. Decommissioning of septic tanks and drain fields through Clark County Department of Health
3. Property corners shall be established by a licensed surveyor.
4. The structures will be reviewed under the most current building codes as adopted by The State of Washington.
5. The structural drawings and calculations shall be prepared and stamped by a Professional Engineer licensed by the State of Washington.
6. The placement of buildings and structures on or adjacent to slopes steeper than one unit vertical in three units horizontal shall conform to Sections R403.1.7.1 through R403.1.7.4. A geotechnical report may be required
7. The required fire distance between buildings and property line shall be in accordance with the International Residential Code.
8. The required fire suppression system shall be in accordance with IBC and other applicable codes standards and shall be reviewed by the Camas Fire Marshal’s office.
9. Storm water from adjacent properties and existing developments should be taken into consideration.
10. Storm sewer disposal and connections shall be identified on the approved plans.
11. All lots shall be provided a storm drain lateral at the lowest practical location.
12. Developer shall provide a designated concrete wash out area.
13. An approved monument sign for posting addresses shall be provided at all Flag lots, the monument sign, location and design a shall be noted on the Plat.
14. Impact fees and System Development charges shall be applicable
15. Estimated review for building plan review is currently 4 – 6 weeks

FIRE DEPARTMENT **RON SCHUMACHER (360) 834-6191**

No building or structure regulated by the building and/or fire code shall be erected, constructed, enlarged, altered, repaired, moved, converted or demolished unless a separate permit for each building or structure has first been obtained from the CWFMO Camas Municipal Code 15.04.030.D.12.a

Any inadvertent omission or failure to site or include any applicable codes or code language by the Fire Marshal’s office or the City shall not be considered a waiver by the applicant.

1. Low Flow Life Safety Residential Fire Sprinklers (NFPA 13D) required in all new dwellings
2. Two hydrants shall be installed; one at the entrance to the subdivision, the other at the start of the cul-de-sac bulb.
3. An approved address sign, in accordance with the Camas Municipal Code, must be posted for each residence where the access road or flag lot leaves the public road or access tract. This sign shall be of permanence in its design/installation and shall be approved prior to installation. Contact the FMO for approval. CMC 17.19.030.D.5.d
4. If existing or discovered, Underground oil tank removal requires a permit with the fire marshal's office following IFC (International Fire Code) 3404.2.14
5. Private Streets require a plan for access obstruction per CMC, 17.19.040.A.9
6. Witnessed Hydrant Flushing required contact the FMO to schedule.
7. Water line size installation from the meter into the house shall be determined with the fire sprinkler contractor and not the underground or plumbing contractor. If the Fire Sprinkler Contractor is not consulted then a minimum 2 inch supply line is required.
8. If Installed CMC 12.36 Privacy Gate Permit required with the fire marshal's office and the public works department.
9. No parking signs required per city and fire codes.
10. Fire department turn-around required at the end of the private-street shown on your submittal, when dead end distances exceed 150 ft.
11. An approved plan for mitigating obstructed emergency vehicle access on the private street is required. e.g. "Emergency Vehicle Access Do Not Block Unauthorized Vehicles Towed At Vehicle Owners Expense". An additional sign on the address monument may be required. Sign approval required prior to installation.
12. For questions or to request inspections contact the Fire Marshal's Office via Camas Connect. Otherwise please call our inspection line at 360-891-6191 x1. or email at FMO@cityofcamas.us



TDA1 TOTAL=2.595 AC

BASIN B:
FOREST, SG4, STEEP=2.595 AC

TDA2 TOTAL=2.916 AC

BASIN C+D:
FOREST, SG4, STEEP=2.916 AC

TDA3 TOTAL=2.513 AC

BASIN A:
FOREST, SG4, STEEP=0.930 AC

OFFSITE:
ROOFS=0.151 AC
ROADS=0.060 AC
DRIVEWAYS=0.163 AC
FOREST, SG4, STEEP=0.849 AC

SCALE: 1"=40'

-40' 0 40' 80'

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CLIENT:
MODERN NW INC
8101 NE GLISAN
PORTLAND, OR 97213

PH: (971) 322-3318
CONTACT: Sergey Marandyuk
EMAIL: sergey@modernnw.com

PRE-DEVELOPED CATCHMENT PLAN FOR:

HOOD STREET SUBDIVISION

OLSON ENGINEERING INC.
LAND SURVEYORS
ENGINEERS
360-695-1385
503-289-9936
222 E. EVERGREEN, VANCOUVER, WA 98660

PETER A. TUCK
STATE OF WASHINGTON
PROFESSIONAL ENGINEER

2/15/22

CHANGES / REVISIONS

DESCRIPTION:	DATE:

DESIGNED: TJB

DRAWN: TJB

CHECKED: PAT

DATE: JULY 2021

SCALE: H: 1"=40'
V:

HOOD STREET SUBDIVISION

JOB NO.: A10123.01.01

SHEET

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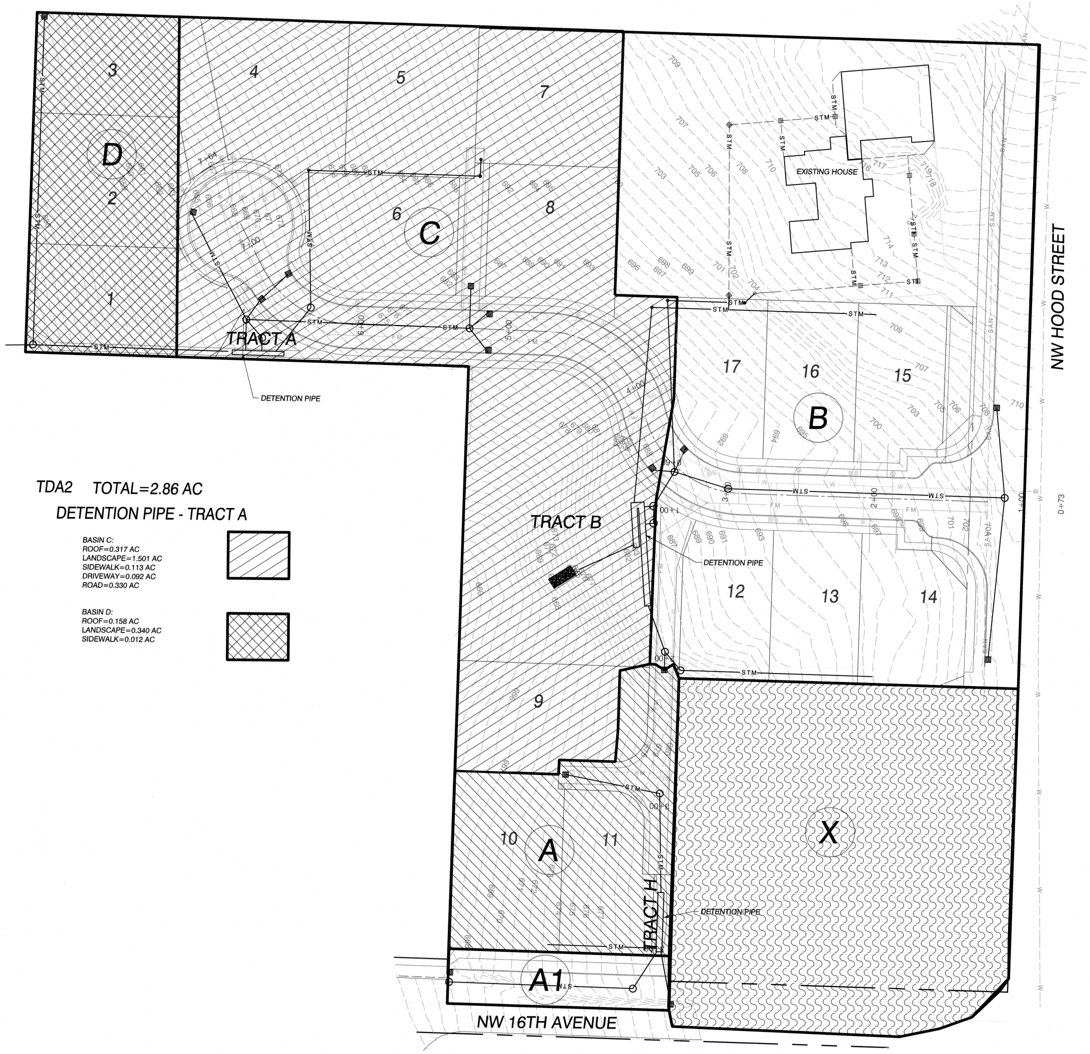

TDA1 TOTAL=2.60 AC

DETENTION PIPE - TRACT B

BASIN B:
ROOF=0.514 AC
LANDSCAPE=1.320 AC
SIDEWALK=0.097 AC
DRIVEWAY=0.230 AC
ROAD=0.434 AC

TDA2 TOTAL=2.86 AC

DETENTION PIPE - TRACT A

BASIN C:
ROOF=0.317 AC
LANDSCAPE=1.501 AC
SIDEWALK=0.113 AC
DRIVEWAY=0.092 AC
ROAD=0.330 AC

BASIN D:
ROOF=0.158 AC
LANDSCAPE=0.340 AC
SIDEWALK=0.012 AC

TDA3 TOTAL=1.83 AC

DETENTION PIPE - TRACT H

BASIN A:
ROOF=0.106 AC
LANDSCAPE=0.494 AC
SIDEWALK=0.008 AC
DRIVEWAY=0.197 AC
ROAD=0.122 AC

BASIN X:
ROOF=0.151 AC
LANDSCAPE=0.849 AC
DRIVEWAY=0.163 AC
ROAD=0.060 AC

RELEASED WITHOUT DETENTION

BASIN A1:
LANDSCAPE=0.025 AC
SIDEWALK=0.021 AC
ROAD=0.079 AC

SCALE: 1"=40'

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CLIENT:
MODERN NW INC
8101 NE GLISAN
PORTLAND, OR 97213
PH: (971) 322-3318
CONTACT: Sergey Marandyuk
EMAIL: sergey@modernnw.com

DEVELOPED CATCHMENT PLAN FOR:

HOOD STREET SUBDIVISION

OLSON ENGINEERING INC.
LAND SURVEYORS
ENGINEERS
360-695-1385
503-289-9936
222 E. EVERGREEN, VANCOUVER, WA 98660

PETER A. TUCK
STATE OF WASHINGTON
31817
REGISTERED
PROFESSIONAL ENGINEER

2/15/22

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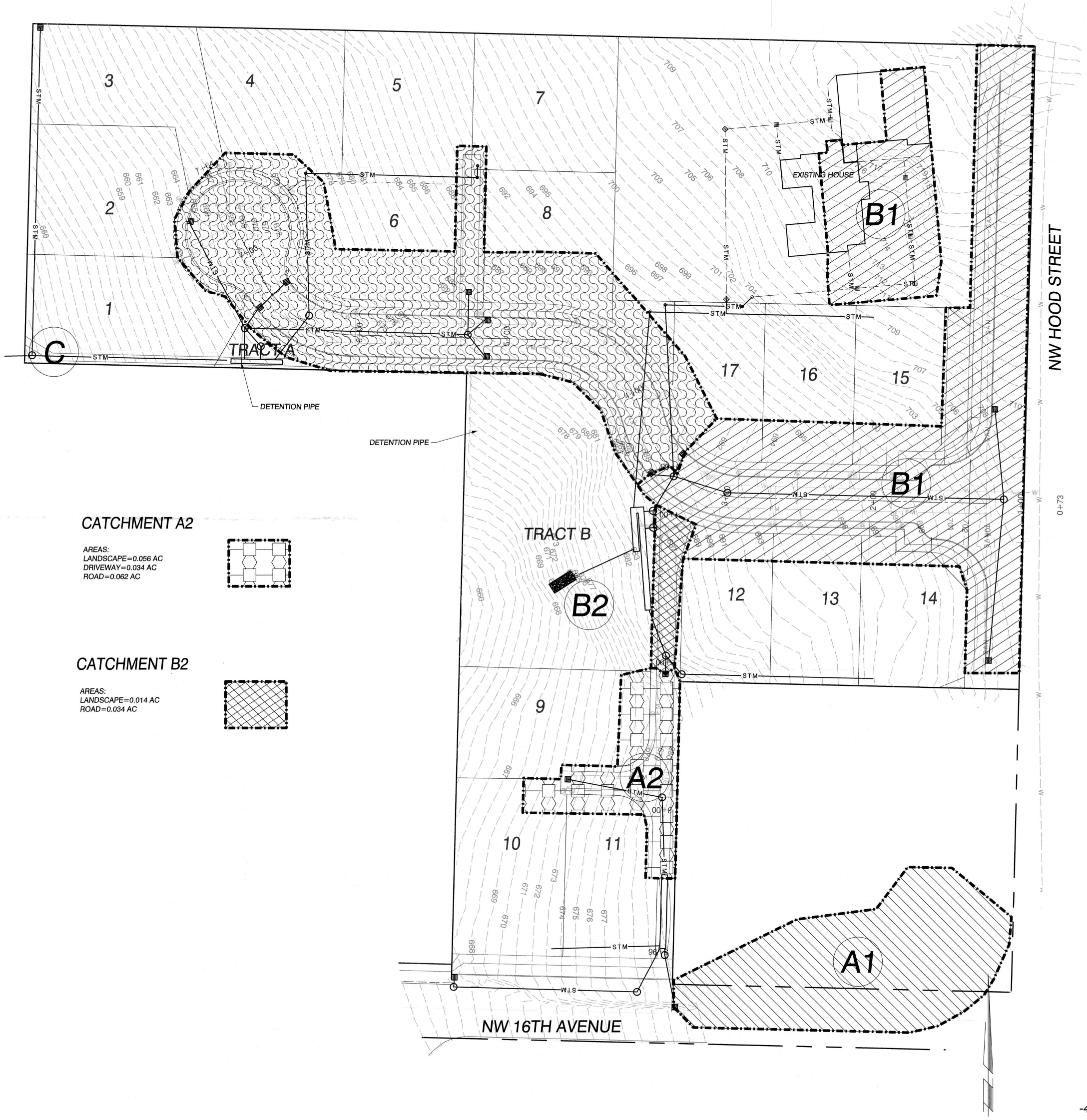

CATCHMENT A1

AREAS:
LANDSCAPE=0.13 AC
DRIVEWAY=0.163 AC
ROAD=0.060 AC

CATCHMENT A2

AREAS:
LANDSCAPE=0.056 AC
DRIVEWAY=0.034 AC
ROAD=0.062 AC

CATCHMENT B1

AREAS:
ROOF=0.076 AC
LANDSCAPE=0.256 AC
SIDEWALK=0.093 AC
DRIVEWAY=0.230 AC
ROAD=0.407 AC

CATCHMENT B2

AREAS:
LANDSCAPE=0.014 AC
ROAD=0.034 AC

CATCHMENT C

AREAS:
LANDSCAPE=0.354 AC
SIDEWALK=0.102 AC
DRIVEWAY=0.069 AC
ROAD=0.306 AC

SCALE: 1"=40'

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CLIENT:

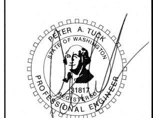
MODERN NW INC
8101 NE GLISAN
PORTLAND, OR 97213

PH: (971) 322-3318
CONTACT: Sergey Marandyuk
EMAIL: sergey@modernnw.com

DEVELOPED TREATMENT CATCHMENT PLAN FOR:

HOOD STREET SUBDIVISION

OLSON ENGINEERING INC.
LAND SURVEYORS
ENGINEERS
222 E. EVERGREEN, VANCOUVER, WA 98660
360-695-1385
503-289-9936



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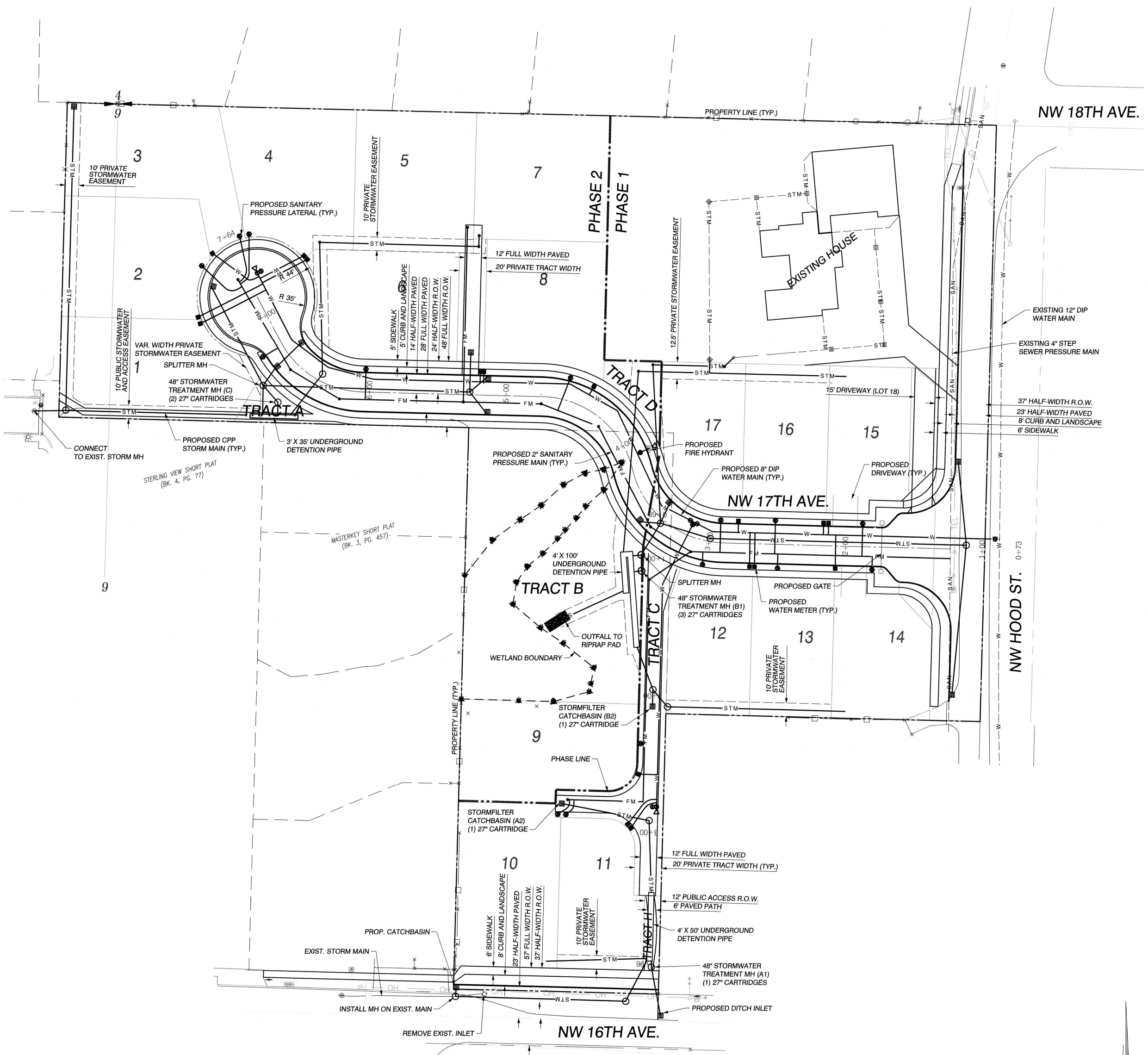

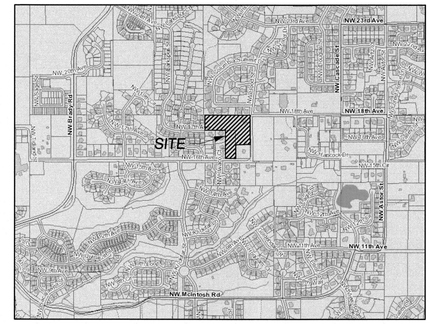

VICINITY MAP

NOT TO SCALE

SANITARY:

1) THERE IS AN EXISTING 4" SANITARY PRESSURE (STEP) MAIN IN NE HOOD STREET.

2) A NEW PRESSURE MAIN WILL BE EXTENDED INTO THE DEVELOPMENT TO SERVE LOTS 1 THROUGH 17.

3) ALL PROPOSED LOTS WILL BE SERVED WITH A PRESSURE SERVICE LATERAL.

WATER:

1) THERE IS AN EXISTING 12" WATER MAIN IN NW HOOD ST, NW 16TH AVE AND NW 17TH AVE.

2) A WATER MAIN WILL BE CONSTRUCTED THAT EXTENDS THE EXISTING MAIN IN NE HOOD ST. INTO THE SITE.

3) ALL PROPOSED LOTS WILL INCLUDE AN INDIVIDUAL METER.

4) PROPOSED FIRE HYDRANTS WILL BE ADDED THROUGH THE SITE TO MEET FIRE CONTROL REQUIREMENTS AND WILL BE LOCATED AS REQUIRED BY THE FIRE MARSHALL.

STORMWATER:

1) ALL STORMWATER SYSTEMS WILL BE DESIGNED IN CONFORMANCE WITH CITY OF CAMAS STANDARDS AND THE STORMWATER MANAGEMENT MANUAL FOR WESTERN WASHINGTON.

2) ALL STORMWATER FACILITIES WILL BE PRIVATELY OWNED AND MAINTAINED BY THE HOA WITH RIGHT-0F-ENTRY TO THE CITY OF CAMAS FOR INSPECTION PURPOSES.

3) NATIVE SOILS ON THE SITE ARE CONSIDERED TO BE WWHM GROUP 4 (USDA GROUP C).

4) STORMWATER RUNOFF FROM THE ON SITE PAVEMENT, SIDEWALKS, DRIVEWAYS, AND LANDSCAPE AREAS WILL BE COLLECTED IN CATCH BASINS AND ROUTED TO BIORETENTION CELLS (CONTECH STORMFILTER OR SIMILAR) FOR TREATMENT. ROOF DOWNSPOUTS AND LOW POINT CRAWL SPACE DRAINS WILL BE ROUTED VIA INDIVIDUAL LATERAL CONNECTIONS DIRECTLY TO AN UNDERGROUND DETENTION PIPE. QUANTITY CONTROL REQUIREMENTS WILL BE MET WITH AN UNDERGROUND DETENTION PIPE. RELEASE OF STORMWATER WILL BE AT OR BELOW PREDEVELOPED RATES.

SCALE: 1"=40'

-40' 0 40' 80'

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CLIENT:

MODERN NW INC
8101 NE GLISAN
PORTLAND, OR 97213

PH: (971) 322-3318
CONTACT: Sergey Marandyuk
EMAIL: sergey@modernnw.com

PRELIMINARY UTILITY AND STORMWATER PLAN FOR:

HOOD STREET SUBDIVISION

OLSON ENGINEERING INC.
LAND SURVEYORS
ENGINEERS
222 E. EVERGREEN, VANCOUVER, WA 98660
360-695-1385
503-289-9936

PETER A. TUCK
STATE OF WASHINGTON
31817
REGISTERED
PROFESSIONAL ENGINEER
2/15/22

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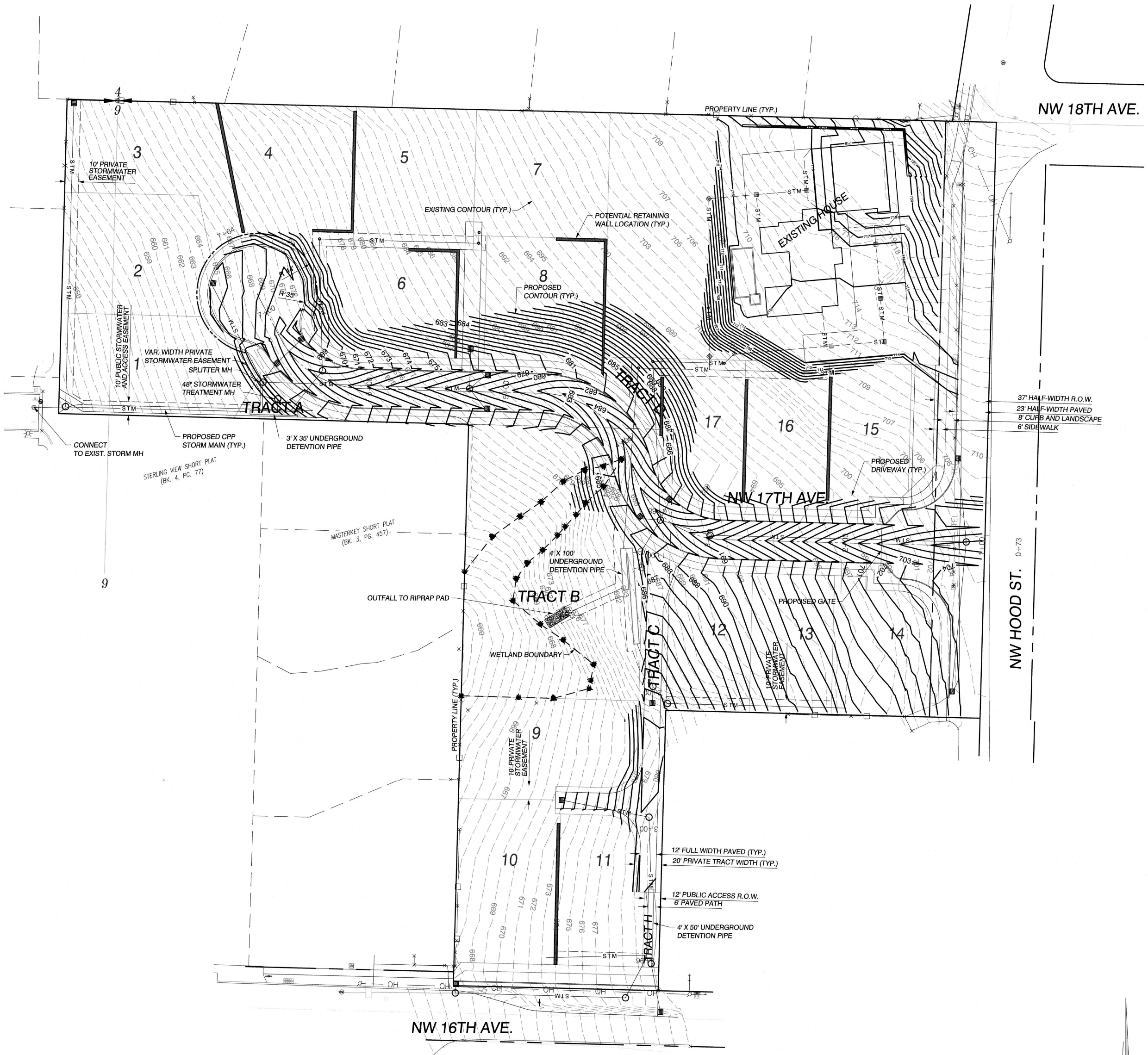

APPROXIMATE EARTHWORK VOLUMES

CUT .... 4,500 C.Y.

FILL .... 2,000 C.Y.

NOTE:
THE CUT AND FILL FIGURES ABOVE REPRESENT APPROXIMATE QUANTITIES CALCULATED FROM THE EXISTING SURFACE TO FINISHED GRADE AND DO NOT INCLUDE STRIPPINGS, ROAD EXCAVATION, TRENCH SPOILS, OVER EXCAVATION, SHRINKAGE, AND SWELL ETC. CONTRACTORS ARE SOLELY RESPONSIBLE FOR QUANTITY ESTIMATES FOR BIDDING PURPOSES.

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8101 NE GLISAN
PORTLAND, OR 97213

PH: (971) 322-3318
CONTACT: Sergey Marandyuk
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PRELIMINARY GRADING PLAN FOR:

HOOD STREET SUBDIVISION

OLSON ENGINEERING INC.
LAND SURVEYORS
ENGINEERS
222 E. EVERGREEN, VANCOUVER, WA 98660

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