EXHIBIT 45

OLSON
engineering

Civil Engineering

Surveying

Planning

Landscape Design

Forestry

CITY OF CAMAS

PRELIMINARY DRAINAGE ANALYSIS

GREEN MOUNTAIN MIXED USE PRD PHASE 1

CITY OF CAMAS

DESIGNED BY: RICHARD PROUSE, P.E.
REVIEWED BY: PETER TUCK, P.E.

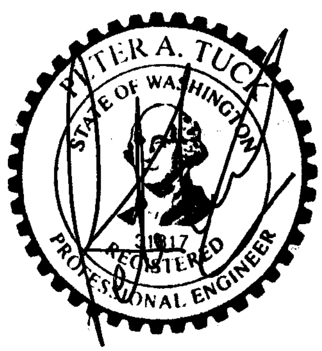
OLSON
ENGINEERING INC.
Practical expertise. Exceptional results.

Preliminary Drainage Analysis

Green Mountain Mixed Use PRD Phase 1

City of Camas

PROJECT NO. 8938.01.02



12/31/14

December 31, 2014

Designed by: Richard Prouse, P.E.

Reviewed by: Peter A. Tuck, P.E.

Olson Engineering, Inc.
1111 Broadway
Vancouver, WA 98660
(360) 695-1385

REVISION	BY	DATE	COMMENTS

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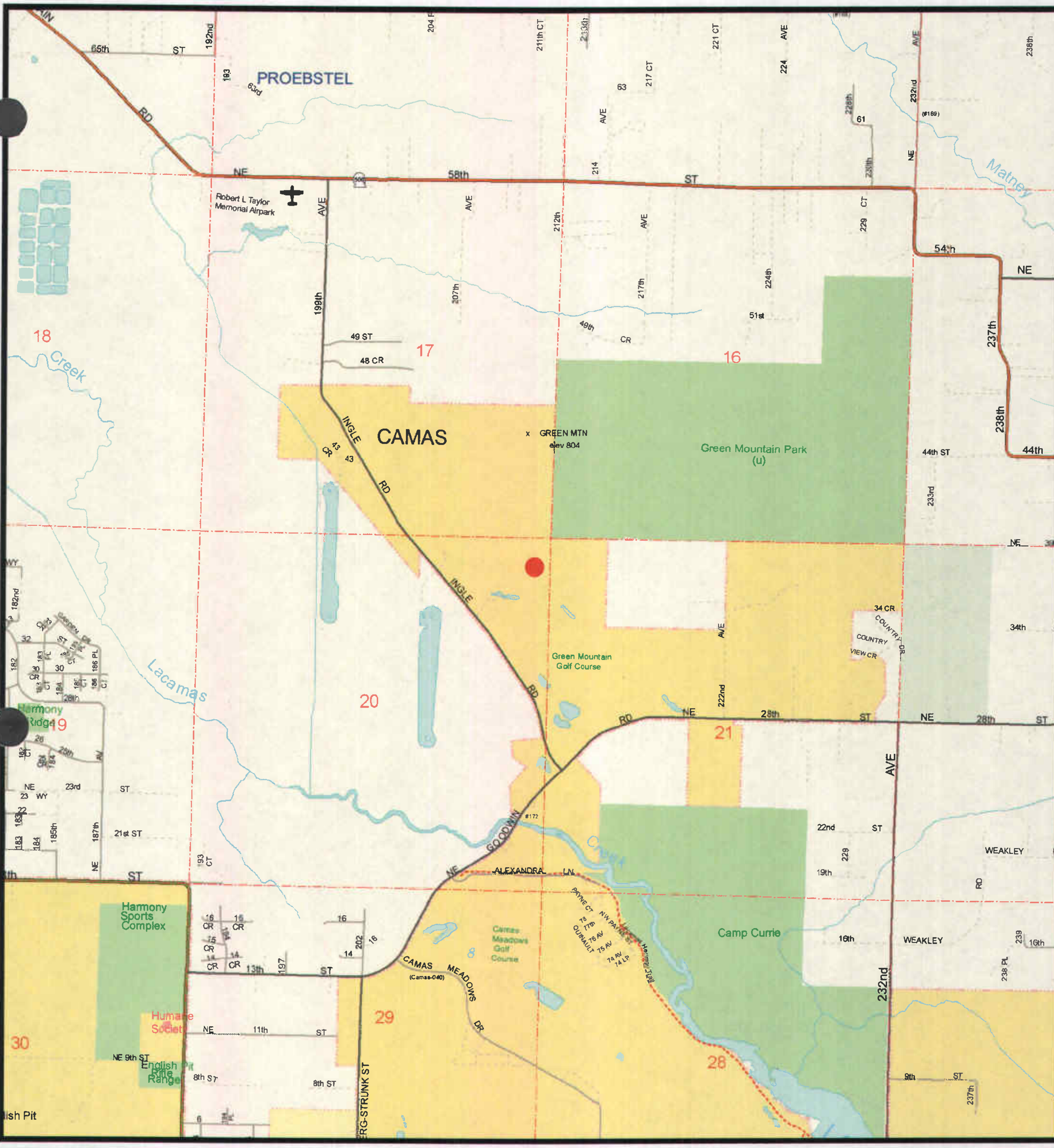


General Location Map

Account No: 171727000, 172341000, 171704000, 172555000
Owner: GREEN MOUNTAIN LAND LLC
Address: 5300 MEADOWS STE 400
C/S/Z: LAKE OSWEGO, OR 97035

CLARK COUNTY, WASHINGTON
Geographic Information System

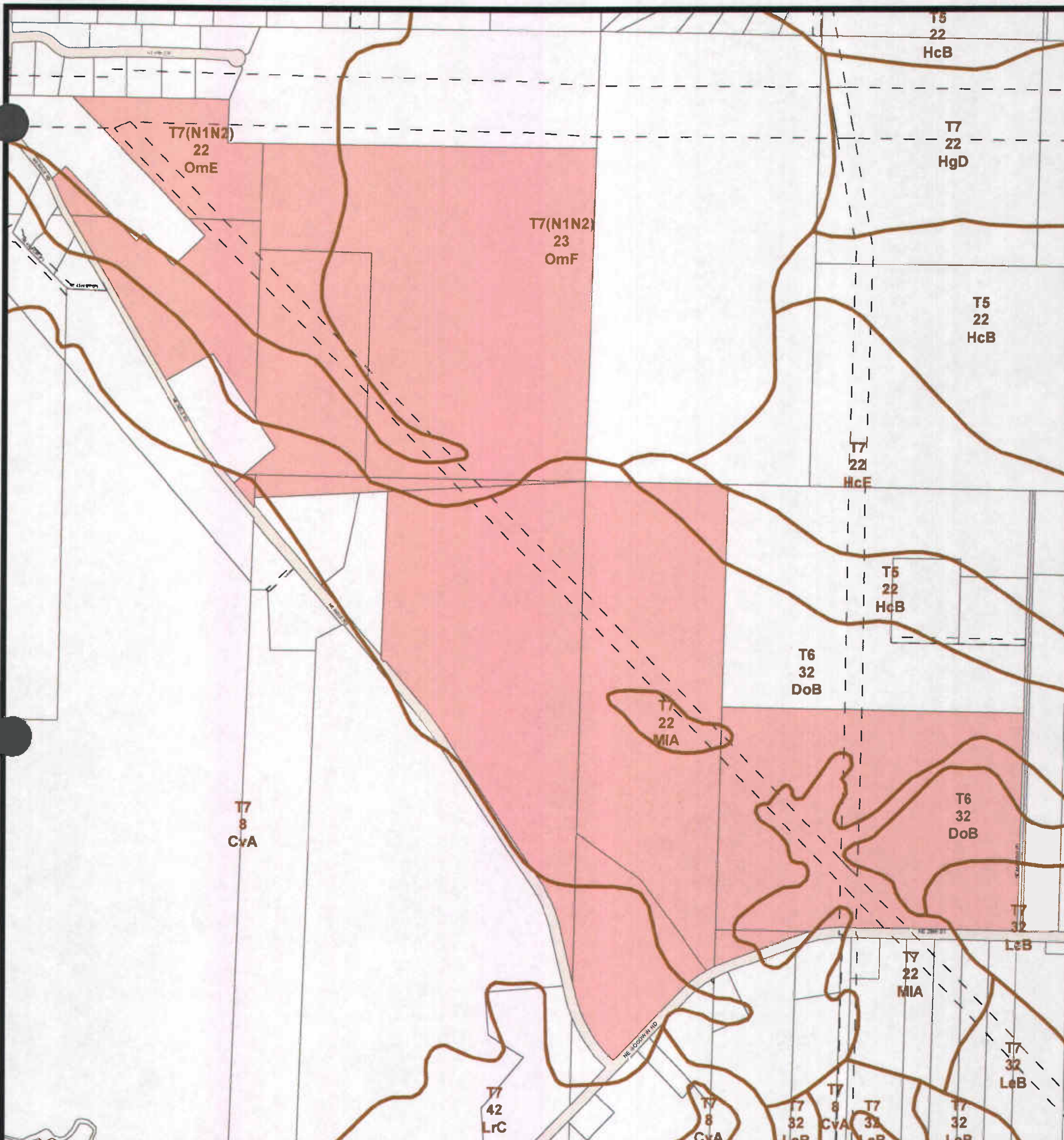
1:24,000

0 0.1 0.2 0.3 0.4 0.5 Miles

Subject Property Location

Printed on: January 28, 2014

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



CLARK COUNTY, WASHINGTON

Geographic Information System

1:9,600

390 780 1,170 Feet

Soil Types

Account No: 171727000, 172341000, 171704000, 172555000

Owner: GREEN MOUNTAIN LAND LLC

Address: 5300 MEADOWS STE 400

C/S/Z: LAKE OSWEGO, OR 97035

Subject Parcel

Public Road

Transportation or Major Utility Easement

Soil Type Boundary

Printed on: January 28, 2014

23118	23117	23116
23119	23120	23121
23130	23129	23128

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

Water Sewer and Storm Systems

Account No: 171727000, 172341000, 171704000, 172555000
Owner: GREEN MOUNTAIN LAND LLC
Address: 5300 MEADOWS STE 400
C/S/Z: LAKE OSWEGO, OR 97035

CLARK COUNTY, WASHINGTON
Geographic Information System

1:9,600

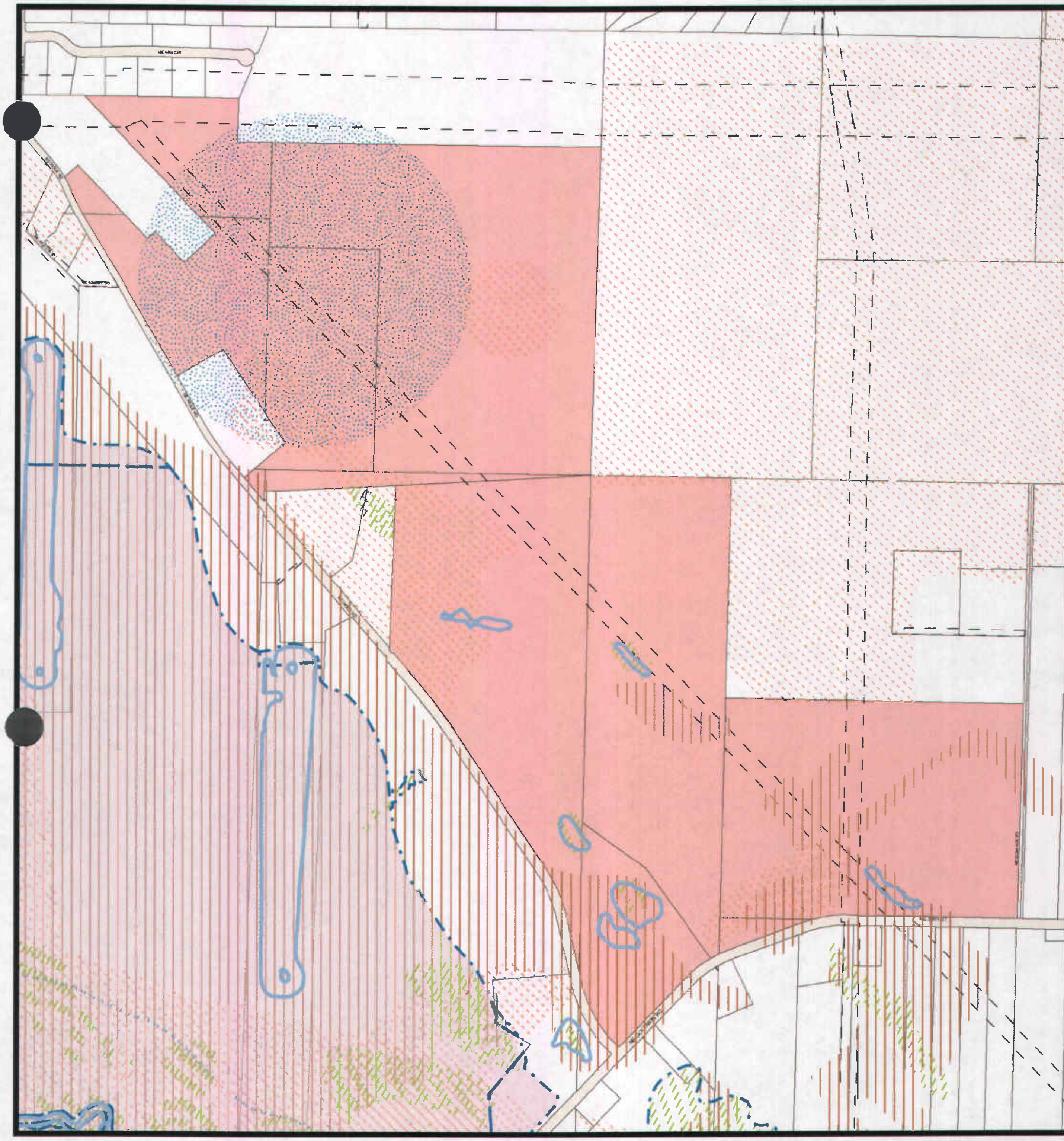
0 390 780 1,170 Feet

- Subject Parcel
- Public Road
- Transportation or Major Utility Easement
- Storm Water Lines
- Water Lines
- Sewer Lines
- 1-year Wellhead ZOC
- 5-year Wellhead ZOC
- 10-year Wellhead ZOC
- Hydrants

Printed on: January 28, 2014

23118	23117	23116
23119	23120	23121
23130	23129	23128

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

Account No: 171727000, 172341000, 171704000, 172555000

Owner: GREEN MOUNTAIN LAND LLC

Address: 5300 MEADOWS STE 400

C/S/Z: LAKE OSWEGO, OR 97035

CLARK COUNTY, WASHINGTON

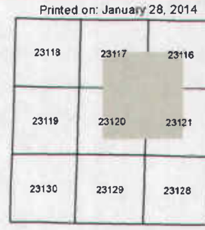
Geographic Information System

1:9,600

0 390 780 1,170 Feet

- Subject Parcel
- Public Road
- Transportation or Major Utility Easement
- Hydric Soils
- Wetland Inventory
- Non-riparian Habitat or Species Area
- CARA Category 1
- 100 year Floodplains
- Floodway
- Shorelines
- Stream

Printed on: January 28, 2014



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

Geographic Information System

1:9,600

0 390 780 1,170 Feet

Environmental Constraints II

Account No: 171727000, 172341000, 171704000, 172555000

Owner: GREEN MOUNTAIN LAND LLC

Address: 5300 MEADOWS STE 400

C/S/Z: LAKE OSWEGO, OR 97035

- Subject Parcel
- Public Road
- Transportation or Major Utility Easement
- Slopes > 15%
- Potentially Unstable Slope
- Historic or Active Landslide
- Severe Erosion Hazard Areas
- CCHR Historic Site
- NRHP Historic Site
- INV Historic Site

Printed on: January 28, 2014

23118	23117	23116
23119	23120	23121
23130	23129	23128

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 No: 171727000, 172341000, 171704000, 172555000

Owner: GREEN MOUNTAIN LAND LLC

Address: 5300 MEADOWS STE 400

C/S/Z: LAKE OSWEGO, OR 97035

Printed on: January 28, 2014

CLARK COUNTY, WASHINGTON

Geographic Information System

N

1:9,600

0 390 780 1,170 Feet

Proposed Development Area

Public Road

Transportation or Major Utility Easement

2' Elevation Contour

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

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Section A – Project Overview

1. **Describe the site location.**

   The proposed Green Mountain project site is approximately 281.6 acres in size and located on the north side of NE Goodwin Road and the east side of NE Ingle Road in the city of Camas Washington. Phase 1 of the development is 51.2 acres in size and occupies portions of parcels 172557-000, 172553-000, and 173178-000 within the existing Green Mountain Golf Course.

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 northeast to southwest with grades ranging from 5% to 20%. The steeper slopes reside at the north end of the site, which is covered with trees and a dense understory. The remainder of the phase 1 site is predominantly covered with grass associated with the golf course fairways and greens, areas of trees and brush between the fairways, manmade ponds, and some wetland areas. Stormwater runoff from the site drains across the site in the southwest direction to NE Ingle Road where it is conveyed under the road by several culverts and then discharged to the existing wetland area west of the road. Critical areas within the site include a stream and wetland areas.

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

   The golf course includes culverts, ponds, and streams that serve to convey stormwater through the site to the ditch along the northeast side of NE Ingle road. There are several culverts along this ditch that convey stormwater flows beneath NE Ingle Road to the existing wetland area located southwest of the road.

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

   According to the Preliminary Geotechnical Engineering Report completed by GeoPacific Engineering, Inc., the soils within the site were moist to wet and perched groundwater was encountered at approximately 2 to 8.5 feet below the ground surface. As a result, wetpond treatment facilities are being proposed combined with shallow detention ponds above the wetpool elevation. Since the Geotechnical Engineering Report described the soils onsite as being saturated with perched groundwater, all stormwater modeling in WWHM2012 assume saturated soil conditions with Soil Group 4 characterisitics. This is described in greater detail in Section C "Soils Evaluation" of this report.

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

   All runoff from within the site drains generally in the southwest direction to the existing conveyance ditch located along the northeast side of NE Ingles Road. This stormwater is then conveyed beneath NE Ingles Road via several culverts to the existing wetland area southwest of the road. The site receives offsite runoff from portions of parcel #171493-000 and #173159 located 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 southwest by NE Ingle Road. Frontage improvements to this road are proposed as part of this development. There is an existing stream, several manmade ponds, and wetland areas located within the phase 1 site area. No impacts to the existing stream, wetland, or associated buffers are anticipated.

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

The proposed development for phase 1 is approximately 51.2 acres in size and includes construction of a 201 lot residential subdivision. Site construction includes frontage improvements along the phase 1 frontage on NE Ingle Road in addition to new onsite roads, sidewalks, driveways, homes, landscape, and park areas. Improvements include 12.34 acres of roof, 8.90 acres of pavement, 2.53 acres of sidewalk, 2.47 acres of driveway, 4.95 acres of pond, 19.59 acres of landscape, and 5.22 acres of open space and park area.

All stormwater runoff from the proposed development is to be captured and routed via pipe to one of three new wetpond stormwater facilities for treatment and detention. Two of the wetponds are to be located at the southwest end of the site along NE Ingle Road in Tracts 'A' and 'H'. A third is to be located at the east end of the site north of the existing wetland area in Tract 'R'. Each of the wetponds is to be comprised of a "large" two-cell pond with detention volume above the wet pool surface elevation. "Large" wet ponds are required in order to meet City of Camas phosphorus control requirements for developments within the LaCamas watershed. The two stormwater facilities next to NE Ingle Road will discharge via pipe to the existing wetland area west of the road and the third facility will discharge to the existing Wetland 'G' next to the facility. Stormwater from this wetland will then be captured in a ditch inlet at the downstream end and conveyed via pipe to the wetland west of NE Ingles Road. All offsite runoff from the north of the site will be captured in a ditch inlet and conveyed via pipe to NE Ingle Road, where it will also be discharged to the existing wetland.

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 entire site lies within the same Threshold Discharge Area (TDA1) and ultimately discharges to the existing wetland southwest of NE Ingle Road. Within the (TDA1) the site has been divided into three separate catchments areas representing the areas of the site routed to each of the three stormwater facilities. These catchment areas are represented by catchments 1P, 2P, and 3P in the pre-developed model and 1D, 2D, and 3D in the developed model. New onsite land-disturbing activity for this proposal is approximately 50.8 acres of the 51.2 acre site. The remaining 0.4 acres is comprised of wetland and park area that are to remain undisturbed and bypass the stormwater facilities.

   The north end of the site is covered with trees and a dense understory and the remainder of the is predominantly covered with grass associated with the golf course fairways and greens, areas of trees and brush between the fairways, manmade ponds, and some wetland areas. There is approximately 3.26 acre of existing impervious roads and buildings within the site. The proposed development includes the addition of 12.34 acres of new roof, 8.90 acres of new asphalt pavement, 2.53 acre of new concrete and asphalt sidewalks, 2.47 acres of new concrete driveway, and 4.95 acres of new stormwater facility that are all classified as "New Impervious Surface". The proposed development also includes 19.59 acres of new landscaping that is classified as "Native Vegetation Converted to Lawn or Landscaping". The remaining 0.40 acre is to remain as undisturbed grass pasture.

   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
Existing Impervious Surface (Acres)	3.256
New Impervious Surface (Acres)	31.190
Replaced Impervious Surface (Acres)	0.000
Existing Impervious Surface to Remain (Acres)	0.000
Native vegetation converted to lawn or landscaping (Acres)	19.590
Native vegetation converted to pasture (Acres)	0.000
Total land-disturbing activity (Acres)	50.780

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 8.90 acres of new asphalt pavement, 2.53 acre of new sidewalk, and 2.47 acres of new driveway are classified as "Effective Pollution Generating Impervious Surface" (PGIS). The 19.59 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
Effective Pollution Generating Impervious Surface (PGIS) (Acres)	13.900
Effective Pollution Generating Pervious Surface (PGPS) (Acres)	19.590
Does the Large Water Body Exemption apply to this project?	No
Does the 100-year runoff increase by more than 0.1 cfs?	Yes
Does the project discharge directly or indirectly (through a conveyance system) into a wetland?	Yes

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

   GeoPacific Engineering, Inc. has completed a Preliminary Geotechnical Engineering Report for this development (see Appendix G). Test pits were excavated on site and it was determined that the soil was moist to wet and perched groundwater seepage was encountered at depths of 2 to 8.5 feet. The report concluded that soil mottling, the presence of clay soils, and the prevalence of ground water seepage 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 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.**

   GeoPacific Engineering, Inc. has completed a Preliminary Geotechnical Engineering Report for this development (see Appendix G). Test pits were excavated on site and orange and gray mottling was observed in near surface soils in all explorations. Soil moisture conditions were moist to wet and perched groundwater seepage was encountered in test pits TP-2, TP-5 through TP-9, TP-13, TP-1 (2013), TP-13 (2013), TP-15 (2013), and TP-16 (2013) at depths of 2 to 8.5 feet. Static groundwater was measured at a depth of 2 feet below the ground surface in test pit TP-1 (2013). As a result of these shallow ground water elevations, the wetpond detention facilities have been proposed with only 3 ft. of detention above the permanent wet pool surface elevation. According to the test pit logs in the vicinity of the proposed stormwater facilities (TP-2, TP-3, and TP-10 (2013)), ground water was observed at elevations lower than 6 feet from ground surface. As a result, the groundwater should not impact the detention volume within the 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 Dollar Loam (DoB) with some areas of Hesson Clay Loam (HcB) and Olympic Clay Loam (OmF). The Hesson Clay Loam and Olympic Clay Loam reside primarily along the north boundary of the phase 1 site (see Vicinity Maps section and Appendix A of this report for the Soils Map). The soil properties are as follows:

   <u>Dollar Loam</u> (DoB)

   Classification: Hydrologic Group C / SG3

   Permeability: 0-32 in. depth, 0.63 to 2.0 in/hr
32-60 in. depth, < 0.06 in/hr

Curve Numbers:	Meadow/Pasture	CN=85
	Grass/Landscape:	CN=86
	Pavement/Sidewalk:	CN=98
	Roof:	CN=98

Hesson Clay Loam (HcB)

Classification: Hydrologic Group C / SG3

Permeability: 0-22 in. depth, 0.63 to 2.0 in/hr
22-91 in. depth, 0.2 to 0.63 in/hr

Curve Numbers:	Meadow/Pasture	CN=85
	Grass/Landscape:	CN=86
	Pavement/Sidewalk:	CN=98
	Roof:	CN=98

Olympic Clay Loam (OmF)

Classification: Hydrologic Group B / SG3

Permeability: 0-44 in. depth, 0.2 to 0.63 in/hr
44-59 in. depth, 0.2 to 0.63 in/hr

Curve Numbers:	Meadow/Pasture	CN=78
	Grass/Landscape:	CN=80
	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 Preliminary Geotechnical Engineering Report by GeoPacific Engineering, Inc. (see Appendix G), 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	3.9 inches of rainfall
100-year, 24-hour storm	5.2 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 Preliminary Geotechnical Engineering Report has been prepared by GeoPacific Engineering, Inc. (see Appendix G). 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 three new stormwater facilities for treatment and detention. Two of the facilities are to be located at the southwest end of the site along NE Ingle Road in Tracts 'A' and 'H'. A third is to be located at the east end of the site north of the existing wetland area in Tract 'R'. Each of the facilities is to be comprised of a Combined Detention and Wetpool Facility (BMP T10.40). More specifically, these will be "large" two-cell ponds with detention volume above the wet pool surface elevation. "Large" wet ponds are required in order to meet City of Camas phosphorus control requirements for developments within the LaCamas watershed. The two facilities next to NE Ingle Road will discharge via pipe to the existing wetland area west of the road and the third facility will discharge to the existing Wetland 'G' next to the facility. Stormwater from this wetland will then be captured in a ditch inlet at the downstream end and conveyed via pipe to the wetland west of NE Ingles Road. All offsite runoff from the north of the site will be captured in a ditch inlet and conveyed via pipe to NE Ingle Road, where it will also be discharged to the existing wetland. Refer to Preliminary Utility Plans and Developed Catchment 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.**

   GeoPacific Engineering, Inc. has completed a Preliminary Geotechnical Engineering Report for this development (see Appendix G). According to the test pit logs in the vicinity of the proposed stormwater facilities (TP-2, TP-3, and TP-10 (2013)), ground water was observed at elevations lower than 6 feet from ground surface. Due to these shallow ground water elevations, the wetpond detention facilities have been proposed with only 3 ft. of detention above the permanent wet pool surface elevation. As a result, the groundwater should not impact the detention volume within the facilities.

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.**

   Three separate Combined Detention and Stormwater Wetpool Facilities (BMP T10.40) are proposed in order to meet treatment and flow control requirements. Stormwater treatment will be met with the two-cell wetpond and flow-control requirements will be met with the 3 ft. of detention above the proposed wetpond permanent pool surface elevation in each of the facilities. The wetpool portion of each facility has been designed per the guidelines set forth in Volume V, Chapter 10 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. "Large" wetponds were selected to meet these requirements from the Phosphorus Treatment Menu in Section 3.3 of Volume V of the SMMWW. Per Section 10.3 of Volume V of the SMMWW, a large wetpond requires a wet pool volume at least 1.5 times larger than the required basic wet pool volume. The detention portion of each facility has been designed in accordance with the guidelines set forth in Volume III, Section 3.2 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 I for Stormwater Facility Plans and Details).

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.

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 pond 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 Dollar Loam (DoB) with some areas of Hesson Clay Loam (HcB) and Olympic Clay Loam (OmF). According to the Preliminary Geotechnical Engineering Report by GeoPacific Engineering, Inc. (see Appendix G), 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, 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 Detention and Stormwater Wetpool Facilities (BMP T10.40) 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.**

   GeoPacific Engineering, Inc. has completed a Preliminary Geotechnical Engineering Report for this development (see Appendix G). Test pits were excavated on site and orange and gray mottling was observed in near surface soils in all explorations. Soil moisture conditions were moist to wet and perched groundwater seepage was encountered in test pits TP-2, TP-5 through TP-9, TP-13, TP-1 (2013), TP-13 (2013), TP-15 (2013), and TP-16 (2013) at depths of 2 to 8.5 feet. Static groundwater was measured at a depth of 2 feet below the ground surface in test pit TP-1 (2013). As a result of these shallow ground water elevations, the wetpond detention facilities have been proposed with only 3 ft. of detention above the permanent wet pool surface elevation. According to the test pit logs in the vicinity of the proposed stormwater facilities (TP-2, TP-3, and TP-10 (2013)), ground water was observed at elevations lower than 6 feet from ground surface. As a result, the groundwater should not impact the detention volume within the facilities.

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

   Three separate Combined Detention and Stormwater Wetpool Facilities (BMP T10.40) are proposed in order to meet treatment and flow control requirements. Stormwater treatment will be met with the two-cell wetpond and flow-control requirements will be met with the 3 ft. of detention above the proposed wetpond permanent pool surface elevation in each of the facilities. The wetpool portion of each facility has been designed per the guidelines set forth in Volume V, Chapter 10 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. "Large" wetponds were selected to meet these requirements from the Phosphorus Treatment Menu in Section 3.3 of Volume V of the SMMWW. Per Section 10.3 of Volume V of the SMMWW, a large wetpond requires a wet pool volume at least 1.5 times larger than the required basic wet pool volume. (Refer to Appendix F for Stormwater Facility Plans and Details).

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.**

   As required under BMP T10.40, the wetpool portion of the facilities were designed according to the procedure for Wetponds – Basic and Large (BMP T10.10) in Volume V, Chapter 10 of the SMMWW. A general summary of the design criteria is as follows:

   - The facility consists of two cells, a presettling cell (Cell #1) and a secondary cell (Cell #2).
   - The presettling cell contains approximately 25% to 35% of the total wetpool volume. Refer to the summary of the wetpool surface area calculations below.
   - One foot of sediment storage is provided in the presettling cell below the permanent pool base elevation.
   - The depth of the presettling cell (Cell#1) is 4 ft, excluding the 1 ft. of sediment storage.
   - The depth of the secondary cell (Cell #2) is 4 ft.
   - A 5 ft. wide berm extends across the full width of the wetpool and ties into the side slopes and base of the pond.
   - All pond side slopes within the wetpool and detention volume are no steeper than 3H:1V.
   - The top of the berm is set 1 foot below the WQ design water surface elevation with side slopes no steeper than 3H:1V.
   - All inlets have been designed to enter the first cell. Inlets and outlet have been located to maximize the flowpath through the facility. The ratio of the flowpath length to width from the inlet to the outlet is at least 3:1.
   - The inlets and the outlets are submerged below the wetpool surface elevation with the inlet inverts a minimum of 2 ft. from the pond bottom, excluding the 1 ft. of sediment storage.

   Each of the facilities 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 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. "Large" wetponds were selected to meet these requirements from the Phosphorus Treatment Menu in Section 3.3 of Volume V of the SMMWW. Per Section 10.3 of Volume V of the SMMWW, a large wetpond requires a wet pool volume at least 1.5 times larger than the required basic wet pool volume. WWHM2012 has been used for the continuous simulation model for this development (see Appendix D). As required, this volume was used with the sizing procedure described in Volume V, Chapter 10 of the SMMWW in order to size the minimum required wet pool volume for the wetpools. The results of this water quality design are as follows:

Identify required wetpool volume using the wetpond sizing procedure.

Wetpool	WWHM2012 WQ Storm Volume (acre-ft)	WWHM2012 Required WQ Volume for Large Wetpool (cf)
Tract 'A' Wetpool	2.0201	131,994
Tract 'H' Wetpool	0.9776	63,876
Tract 'R' Wetpool	2.5745	168,218

Table F1: Water quality required wetpool volume from WWHM2012

A screen shot from the WWHM3 water quality volume calculation is included in Appendix D of this report.

Calculate the minimum required surface area of the total stormwater wetpool.

Wetpool	Required Wetpool Surface Area (sf)	Design Wetpool Surface Area (sf)
Tract 'A' Wetpool	37,636	43,103
Tract 'H' Wetpool	19,321	20,664
Tract 'R' Wetpool	47,089	48,550

Table F2: Minimum required total wetpool surface area

Detailed wetpool surface area calculations are included in Appendix D.

The wetpool design for each of the three facilities is detailed as follows:

Tract 'A' Wetpool:
The stormwater facility design provides a total wetpool surface area of 43,103 SF at an elevation of 190.0 ft. The presettling cell (Cell #1) has a wetpool base area of 10,026 SF at an elevation of 186.0 ft. and a wetpool surface area of 14,905 SF at an elevation of 190.0 ft. with a total Cell #1 wetpool volume of 49,862 CF. There is 1 ft. of sediment storage under Cell #1 between the elevations of 185.0 ft. and 186.0 ft. The secondary cell (Cell #2) has a base area of 20,539 SF at an elevation of 186.0 ft. and a surface area of 28,198 SF at an elevation of 190.0 ft with a total Cell #2 wetpool volume of 97,474 CF. As required, the wetpool volume of Cell #1 is approximately 34% of the total 147,336 CF wetpool volume. The top of the 5 foot berm between the cells is at an elevation 1 foot below the wetpool surface at 189.0 ft. The side slopes of both cells are 3H:1V with the exception of the pond access which is 5H:1V.

Tract 'H' Wetpool:
The stormwater facility design provides a total wetpool surface area of 20,664 SF at an elevation of 199.0 ft. The presettling cell (Cell #1) has a wetpool base area of 4,573 SF at an elevation of 195.0 ft. and a wetpool surface area of 8,310 SF at an elevation of 199.0 ft. with a total Cell #1 wetpool volume of 25,766 CF. There is 1 ft. of sediment storage under Cell #1 between the elevations of 194.0 ft. and 195.0 ft. The secondary cell (Cell #2) has a base area of 7,567 SF at an elevation of 195.0 ft. and a surface area of 12,354 SF at an elevation of 199.0 ft with a total Cell #2 wetpool volume of 39,842 CF. As required, the wetpool volume of Cell #1 is approximately 35% of the total 65,608 CF wetpool volume. The top of the 5 foot berm between the cells is at an elevation 1 foot below the wetpool surface at 198.0 ft. The side slopes of both cells are 3H:1V with the exception of the pond access which is 5H:1V.

Tract 'R' Wetpool:
The stormwater facility design provides a total wetpool surface area of 48,550 SF at an elevation of 248.0 ft. The presettling cell (Cell #1) has a wetpool base area of 9,654 SF at an elevation of 244.0 ft. and a wetpool surface area of 16,536 SF at an elevation of 248.0 ft. with a total Cell #1 wetpool volume of 52,380 CF. There is 1 ft. of sediment storage under Cell #1 between the elevations of 243.0 ft. and 244.0 ft. The secondary cell (Cell #2) has a base area of 23,565 SF at an elevation of 244.0 ft. and a surface area of 32,015 SF at an elevation of 248.0 ft with a total Cell #2 wetpool volume of 111,160 CF. As required, the wetpool volume of Cell #1 is approximately 32% of the total 163,540 CF wetpool volume. The top of the 5 foot berm between the cells is at an elevation 1 foot below the wetpool surface at 247.0 ft. The side slopes of both cells are 3H:1V with the exception of the pond access which is 5H:1V.

Refer to Appendix D for water quality calculations and stormwater treatment wetpool sizing calculations.

Refer to Appendix F for stormwater facility plans, details, and volume calculations.

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
Effective Pollution Generating Impervious Surface (PGIS) (Acres)	13.900
Effective Pollution Generating Pervious Surface (PGPS) (Acres)	19.590

Table F3: 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.**

   GeoPacific Engineering, Inc. has completed a Preliminary Geotechnical Engineering Report for this development (see Appendix G). Test pits were excavated on site and it was determined that the soil was moist to wet and perched groundwater seepage was encountered at depths of 2 to 8.5 feet. The report concluded that soil mottling, the presence of clay soils, and the prevalence of ground water seepage 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.**

   GeoPacific Engineering, Inc. has completed a Preliminary Geotechnical Engineering Report for this development (see Appendix G). According to the test pit logs in the vicinity of the proposed stormwater facilities (TP-2, TP-3, and TP-10 (2013)), ground water was observed at elevations lower than 6 feet from ground surface. Due to these shallow ground water elevations, the wetpond detention facilities have been proposed with only 3 ft. of detention above the permanent wet pool surface elevation. As a result, the groundwater should not impact the detention volume within the facilities.

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 TDA1 is to be captured and routed via pipe to one of three new stormwater facilities for treatment and detention. Two of the facilities are to be located at the southwest end of the site along NE Ingle Road in Tracts 'A' and 'H'. A third is to be located at the east end of the site north of the existing wetland area in Tract 'R'. Each of the facilities is to be comprised of a Combined Detention and Wetpool Facility (BMP T10.40). More specifically, these will be "large" two-cell ponds with detention volume above the wet pool surface elevation. "Large" wet ponds are required in order to meet City of Camas phosphorus control requirements for developments within the LaCamas watershed. The detention volume in each facility will be 3 ft. with 1 additional ft. of freeboard. The Tract 'A' wetpool has a total detention volume of 196,838 CF, the Tract 'H' wetpool has a detention volume of 99,804 CF, and the Tract 'R' wetpool has a detention volume of 220,586 CF.

The two facilities next to NE Ingle Road will discharge via pipe to the existing wetland area west of the road and the third facility will discharge to the existing Wetland 'G' next to the facility. Stormwater from this wetland will then be captured in a ditch inlet at the downstream end and conveyed via pipe to the wetland west of NE Ingles Road. All offsite runoff from the north of the site will be captured in a ditch inlet and conveyed via pipe to NE Ingle Road, where it will also be discharged to the existing wetland. (Refer to Preliminary Utility Plan in Appendix M 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 facility has 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 Preliminary Geotechnical Engineering Report by GeoPacific Engineering, Inc. (See Appendix G), 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.

The pre-developed TDA 1 includes Catchments 1P, 2P, and 3P. The developed TDA 1 includes Catchments 1Da, 1Db, 2D, and 3D (see Catchment Plans in Appendix J for location). Catchments 1P, 1Da and 1Db represent the southwest portion of the development and were used to size the Tract 'H' stormwater facility. Catchments 2P and 2D represent the southeast portion of the development and were used to size the Tract 'A' stormwater facility. Catchments 3P and 3D represent the north portion of the site and were used to size the Tract 'R' stormwater facility. All of the stormwater facilities discharge to the existing wetland area to the southwest of NE Ingle Road. 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)
1P	Tract 'H'	SG4, Forest, Mod.	8.612
2P	Tract 'A'	SG4, Forest, Mod.	17.491
3P	Tract 'R'	SG4, Forest, Mod.	26.540

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

Developed catchment areas:

Catchment	Storm Facility	Description	Area (acres)
1Da	Tract 'H'	Roads Mod. Roof Tops Flat Driveways Mod. Sidewalks Mod. Pond SG3, Lawn, Mod.	0.965 2.066 0.413 0.318 0.921 2.053
1Db	Tract 'H'	Roads Mod. Roof Tops Flat Driveways Mod. Sidewalks Mod. SG3, Lawn, Mod.	0.319 0.675 0.131 0.094 0.656
2D	Tract 'A'	Roads Mod. Roof Tops Flat Driveways Mod. Sidewalks Mod. Pond SG3, Lawn, Mod.	4.440 4.075 0.815 1.147 2.029 4.985
3D	Tract 'R'	Roads Mod. Roof Tops Flat Driveways Mod. Sidewalks Mod. Pond SG3, Lawn, Mod.	3.491 6.198 1.240 1.063 2.000 12.548

Table G2: Hydrologic parameters used in developed catchment analysis

A summary of the pre-developed and developed TDA 1 land use areas are shown in the tables below:

Pre-developed TDA 1:

Land Use	Description	Area (ac)
Pervious	SG4, Forest, Mod.	52.643
Impervious	N/A	0.000

Table G3: Land use areas for pre-developed TDA 1

Developed TDA 1:

Land Use	Description	Area (ac)
Pervious	SG3, Lawn, Mod.	20.243
Impervious	Roads Mod. Roof Tops Flat Driveways Mod. Sidewalks Mod. Pond	9.215 13.014 2.599 2.622 4.950

Table G4: Land use areas for developed TDA 1

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.**

   The detention portion of each facility has been designed in accordance with the guidelines set forth in Volume III, Section 3.2 of the SMMWW. A summary of the design criteria is as follows:

   1) The detention has been designed as a flow-through system, maximizing the distance between the inlet and the outlet.

   2) Interior side slopes within the detention zone of the pond have been designed at 3H:1V.

   3) The stormwater facility includes an emergency overflow weir that discharges directly to the existing roadside ditch in the event that the capacity of the facility is exceeded.

   4) A 15 ft. wide gravel access road provides access into the first cell with a maximum slope of 5H:1V.

   5) The entire facility is surrounded with a 6 ft. high chain-link fence.

   The detention volume design for each of the three facilities is detailed as follows:

   <u>Tract 'A' Facility:</u>
   The stormwater facility was designed to provide detention above the wetpool surface elevation of 190.0 ft. Due to the high ground water elevations, the detention zone was kept above the measured groundwater elevation and held to a relatively shallow 3 ft depth, with an additional 1 ft. of freeboard above. The base of the detention zone within the stormwater facility has an area of 43,103 SF at an elevation of 190.0 ft. and the top of the detention zone has an area of 55,316 SF at an elevation of 194.0 ft. The resulting total detention volume is approximately 196,838 CF. Stormwater is to be detained in the detention zone between the elevations of 190.0 ft. and 193.0 ft. Since the top of the pond is at an elevation of 194.0 ft., a freeboard of 1 ft. is provided. Refer to the Stormwater Facility Plan, Details, and Volume Calculations in Appendix F.

   A summary of the pre-developed and developed flows for the Tract 'A' Facility (Catchments 2P and 2D) from the WWHM2012 calculations is shown in the table below:

Return Period	Pre-developed Flow (cfs)	Developed Flow (cfs)
2-Year	4.92	3.15
10-Year	9.01	5.40
50-Year	11.33	7.97
100-Year	12.03	9.26

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	3.15	1.33	1.47 / 191.47
10-Year	5.40	1.71	1.87 / 191.87
50-Year	7.97	2.07	2.23 / 192.23
100-Year	9.26	2.17	2.33 / 192.33

Table G6: Developed flows and 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 area 2D and maintain at least 1 ft. of freeboard from the top of pond elevation of 194.0 ft.

Tract 'H' Facility:
The stormwater facility was designed to provide detention above the wetpool surface elevation of 199.0 ft. Due to the high ground water elevations, the detention zone was kept above the measured groundwater elevation and held to a relatively shallow 3 ft depth, with an additional 1 ft. of freeboard above. The base of the detention zone within the stormwater facility has an area of 20,664 SF at an elevation of 199.0 ft. and the top of the detention zone has an area of 29,238 SF at an elevation of 203.0 ft. The resulting total detention volume is approximately 99,804 CF. Stormwater is to be detained in the detention zone between the elevations of 199.0 ft. and 202.0 ft. Since the top of the pond is at an elevation of 203.0 ft., a freeboard of 1 ft. is provided. Refer to the Stormwater Facility Plan, Details, and Volume Calculations in Appendix F.

A summary of the pre-developed and developed flows for the Tract 'H' Facility (Catchments 1P, 1Da, and 1Db) from the WWHM2012 calculations is shown in the table below:

Return Period	Pre-developed Flow (cfs)	Developed Flow (cfs)
2-Year	2.42	1.60
10-Year	4.44	2.77
50-Year	5.58	4.13
100-Year	5.93	4.81

Table G7: Pre-developed and developed flows for Tract 'H' Facility.

A summary of the developed flows and stormwater facility storage volumes and stage elevations for the Tract 'H' 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	1.60	0.61	1.30 / 200.30
10-Year	2.77	0.78	1.63 / 200.63
50-Year	4.13	0.93	1.93 / 200.93
100-Year	4.81	1.00	2.07 / 201.07

Table G8: Developed flows and facility storage volumes / stage elevations for Tract 'H' 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 1Da and 1Db and maintain at least 1 ft. of freeboard from the top of pond elevation of 203.0 ft.

Tract 'R' Facility:
The stormwater facility was designed to provide detention above the wetpool surface elevation of 248.0 ft. Due to the high ground water elevations, the detention zone was kept above the measured groundwater elevation and held to a relatively shallow 3 ft depth, with an additional 1 ft. of freeboard above. The base of the detention zone within the stormwater facility has an area of 48,550 SF at an elevation of 248.0 ft. and the top of the detention zone has an area of 61,743 SF at an elevation of 252.0 ft. The resulting total detention volume is approximately 220,586 CF. Stormwater is to be detained in the detention zone between the elevations of 248.0 ft. and 251.0 ft. Since the top of the pond is at an elevation of 252.0 ft., a freeboard of 1 ft. is provided. Refer to the Stormwater Facility Plan, Details, and Volume Calculations in Appendix F.

A summary of the pre-developed and developed flows for the Tract 'R' Facility (Catchments 3P and 3D) from the WWHM2012 calculations is shown in the table below:

Return Period	Pre-developed Flow (cfs)	Developed Flow (cfs)
2-Year	7.47	5.40
10-Year	13.67	9.09
50-Year	17.19	13.25
100-Year	18.26	15.31

Table G9: Pre-developed and developed flows for Tract 'R' Facility.

A summary of the developed flows and stormwater facility storage volumes and stage elevations for the Tract 'R' 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	5.40	1.65	1.47 / 249.47
10-Year	9.09	2.24	1.97 / 249.97
50-Year	13.25	2.77	2.40 / 250.40
100-Year	15.31	2.93	2.53 / 250.53

Table G10: Developed flows and facility storage volumes / stage elevations for Tract 'R' 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 3D and maintain at least 1 ft. of freeboard from the top of pond elevation of 252.0 ft.

Refer to the stormwater facility plans, details, and volume calculations in Appendix F.

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 Utility Plans and Developed 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 mitigation plan prepared by Ecological Land Services, Inc.

APPENDIX

I. APPENDICES

Appendix Index

Appendix A Hydrologic Soil Groups
Table 7 – Estimated Physical and Chemical Properties of Soils
Soils Map

Appendix B Table III-1.3 SCS Western Washington Runoff Curve Numbers
Table III-1.4 "n" and "k" Values Used in Time Calculations for Hydrographs
Isopluvial Maps for Design Storms

Appendix C Figure 1.1: Flow Chart for Determining Stormwater Requirements.
Section 1.2 "Minimum Requirements" from Vol. I of the SMMWW.
Figure 2.1: Treatment Facility Selection Flow Chart
Section 2.5 "Minimum Requirements" from Vol. I of the SMMWW.

Appendix D WWHM2012 Analysis – 91% Continuous Storm (Water Quality)
Stormwater Treatment Wetland Sizing Calculations

Appendix E WWHM2012 Analysis – Continuous Storm (Flow Control)

Appendix F Stormwater Facility Plans, Details, and Specifications:
- Stormwater Facility Plan, Profile, and Sections.
- Stormwater Facility Volume Calculations

Appendix G Preliminary Geotechnical Engineering Report for Green Mountain Phase 1, by GeoPacific Engineering, Inc. dated December 03, 2014.

Appendix H Stormwater Facility Maintenance Manual
(By Clark County Public Works Dept.)

Appendix I City of Camas Pre-Application Conference Notes

Appendix J Development Plans
- Pre-developed Catchment Plan
- Developed Catchment Plan
- Preliminary Offsite Utility Plan
- Preliminary Utility Plan (South)
- Preliminary Utility Plan (North)
- Preliminary Storm Facility Plan & Sections

A

Exhibit B

Hydrologic Soil Groups for Soils in Clark County

U.S. Department of Agriculture
Soil Conservation Service

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9/17/91

WATER FEATURES

Survey Area—CLARK COUNTY, WASHINGTON

Map symbol and soil name		Hydro-logic group	Flooding			High water table		
			Freq	Duration	Months	Depth (Ft)	Kind	Months
BpB	BEAR PRAIRIE	B	NONE		—	6.0—6.0		—
BpC	BEAR PRAIRIE	B	NONE		—	6.0—6.0		—
CnB	CINEBAR	B	NONE		—	6.0—6.0		—
CnD	CINEBAR	B	NONE		—	6.0—6.0		—
CnE	CINEBAR	B	NONE		—	6.0—6.0		—
CnG	CINEBAR	B	NONE		—	6.0—6.0		—
CrE	CINEBAR	B	NONE		—	6.0—6.0		—
CrG	CINEBAR	B	NONE		—	6.0—6.0		—
CsF	CISPUS	B	NONE		—	6.0—6.0		—
CtA	CLOQUATO	B	OCCA		NOV—MAR	6.0—6.0		—
CvA	COVE	D	OCCA		DEC—APR	0—1.0	PERCH	DEC—JUN
CwA	COVE	D	OCCA		DEC—APR	0—1.0	PERCH	DEC—JUN
DoB	DOLLAR	C	NONE		—	1.5—3.0	PERCH	NOV—APR
Fn	FILL LAND		NONE		—	2.0—2.0		—
GeB	GEE	C	NONE		—	2.0—4.0	PERCH	NOV—APR
GeD	GEE	C	NONE		—	2.0—4.0	PERCH	NOV—APR
GeE	GEE	C	NONE		—	2.0—4.0	PERCH	NOV—APR
GeF	GEE	C	NONE		—	2.0—4.0	PERCH	NOV—APR
GuB	GUMBOOT	D	NONE		—	0—1.5	APPAR	DEC—APR
HcB	HESSON	C	NONE		—	6.0—6.0		—
HcD	HESSON	C	NONE		—	6.0—6.0		—
HcE	HESSON	C	NONE		—	6.0—6.0		—
HcF	HESSON	C	NONE		—	6.0—6.0		—
HgB	HESSON	C	NONE		—	6.0—6.0		—
HgD	HESSON	C	NONE		—	6.0—6.0		—
HhE	HESSON	C	NONE		—	6.0—6.0		—
HiA	HILLSBORO	B	NONE		—	6.0—6.0		—
HiB	HILLSBORO	B	NONE		—	6.0—6.0		—
HiC	HILLSBORO	B	NONE		—	6.0—6.0		—
HiD	HILLSBORO	B	NONE		—	6.0—6.0		—
HiE	HILLSBORO	B	NONE		—	6.0—6.0		—
HiF	HILLSBORO	B	NONE		—	6.0—6.0		—
HoA	HILLSBORO	B	NONE		—	6.0—6.0		—
HoB	HILLSBORO	B	NONE		—	6.0—6.0		—
HoC	HILLSBORO	B	NONE		—	6.0—6.0		—
HoD	HILLSBORO	B	NONE		—	6.0—6.0		—
HoE	HILLSBORO	B	NONE		—	6.0—6.0		—
HoG	HILLSBORO	B	NONE		—	6.0—6.0		—
HsB	HILLSBORO	B	NONE		—	6.0—6.0		—
HtA	HOCKINSON	D	NONE		—	0.5—1.5	APPAR	NOV—APR
HuB	HOCKINSON	D	NONE		—	0.5—1.5	APPAR	NOV—APR
HvA	HOCKINSON	D	NONE		—	0.5—1.5	APPAR	NOV—APR
	DOLLAR	C	NONE		—	1.5—3.0	PERCH	NOV—APR

WATER FEATURES

Survey Area—CLARK COUNTY, WASHINGTON

Map symbol and soil name		Hydro-logic group	Flooding			High water table		
			Freq	Duration	Months	Depth (Ft)	Kind	Months
KeC	KINNEY	B	NONE		—	6.0—6.0		—
KeE	KINNEY	B	NONE		—	6.0—6.0		—
KeF	KINNEY	B	NONE		—	6.0—6.0		—
KnF	KINNEY	B	NONE		—	6.0—6.0		—
LaE	LARCHMOUNT	B	NONE		—	6.0—6.0		—
LaG	LARCHMOUNT	B	NONE		—	6.0—6.0		—
LcG	LARCHMOUNT	B	NONE		—	6.0—6.0		—
LeB	LAUREN	B	NONE		—	6.0—6.0		—
LgB	LAUREN	B	NONE		—	6.0—6.0		—
LgD	LAUREN	B	NONE		—	6.0—6.0		—
LgF	LAUREN	B	NONE		—	6.0—6.0		—
LiB	LAUREN	B	NONE		—	6.0—6.0		—
LrC	LAUREN	C	NONE		—	1.5—3.0	PERCH	DEC—MAR
LrF	LAUREN	C	NONE		—	1.5—3.0	PERCH	DEC—MAR
McB	McBEE	C	FREQ		NOV—MAY	2.0—3.0	APPAR	NOV—APR
McB	McBEE	C	OCCA		NOV—MAY	2.0—3.0	APPAR	NOV—APR
MeA	McBEE	C	FREQ		NOV—MAY	2.0—3.0	APPAR	NOV—APR
MfA	McBEE VARIANT	D	RARE		—	—	APPAR	—
MnA	MINNIECE	D	NONE		—	0—2.0	PERCH	NOV—MAY
MnD	MINNIECE	D	NONE		—	0—2.0	PERCH	NOV—MAY
MoA	MINNIECE VARIANT	D	NONE		—	0—2.0	PERCH	NOV—MAY
MsB	MOSSYROCK	B	NONE		—	6.0—6.0		—
NbA	NEWBERG	B	OCCA		DEC—MAR	6.0—6.0		—
NbB	NEWBERG	B	OCCA		DEC—MAR	6.0—6.0		—
OdB	ODNE	D	NONE		—	0—1.5	APPAR	OCT—APR
OeD	OLEQUA	B	NONE		—	6.0—6.0		—
OeE	OLEQUA	B	NONE		—	6.0—6.0		—
OeF	OLEQUA	B	NONE		—	6.0—6.0		—
OhD	OLEQUA VARIANT	C	NONE		—	2.0—3.0	APPAR	NOV—MAY
OhF	OLEQUA VARIANT	C	NONE		—	2.0—3.0	APPAR	NOV—MAY
OiB	OLYMPIC	B	NONE		—	6.0—6.0		—
OiD	OLYMPIC	B	NONE		—	6.0—6.0		—
OiE	OLYMPIC	B	NONE		—	6.0—6.0		—
OiF	OLYMPIC	B	NONE		—	6.0—6.0		—
OmE	OLYMPIC	B	NONE		—	6.0—6.0		—
OmF	OLMPIC	B	NONE		—	6.0—6.0		—
OpC	OLYMPIC VARIANT	C	NONE		—	6.0—6.0		—
OpE	OLYMPIC VARIANT	C	NONE		—	6.0—6.0		—
OpG	OLYMPIC VARIANT	C	NONE		—	6.0—6.0		—
OrC	OLYMPIC VARIANT	C	NONE		—	6.0—6.0		—
PhB	PILCHUCK	C	OCCA		NOV—APR	2.0—4.0	APPAR	NOV—APR
PoB	POWELL	C	NONE		—	1.5—2.0	PERCH	DEC—APR
PoD	POWELL	C	NONE		—	1.5—2.0	PERCH	DEC—APR
PoE	POWELL	C	NONE		—	1.5—2.0	PERCH	DEC—APR

Map Symbol	Soil Name	HSG	SCS Permeability (in/hr)	Dominant USDA Texture	Depth from surface
				SG 3	
DoB	DOLLAR	C	<0.06	Loam	32-60 inches
HcB	HESSON	C	0.2 - 0.63	Clay	22-91 inches
HcD	HESSON	C	0.2 - 0.63	Clay	22-91 inches
HcE	HESSON	C	0.2 - 0.63	Clay	22-91 inches
HcF	HESSON	C	0.2 - 0.63	Clay	22-91 inches
HgB	HESSON	C	0.2 - 0.63	Gravelly Clay	22-91 inches
HgD	HESSON	C	0.2 - 0.63	Gravelly Clay	22-91 inches
HhE	HESSON	C	0.2 - 0.63	Gravelly Clay	22-91 inches
HoA	HILLSBORO	B	0.63 - 2.0	Silt Loam	0-86 inches
HoB	HILLSBORO	B	0.63 - 2.0	Silt Loam	0-86 inches
HoC	HILLSBORO	B	0.63 - 2.0	Silt Loam	0-86 inches
HoD	HILLSBORO	B	0.63 - 2.0	Silt Loam	0-86 inches
HoE	HILLSBORO	B	0.63 - 2.0	Silt Loam	0-86 inches
HoG	HILLSBORO	B	0.63 - 2.0	Silt Loam	0-86 inches
HsB	HILLSBORO	B	0.63 - 2.0	Silt Loam	0-86 inches
McB	McBEE	C	0.63 - 2.0	Silty Clay Loam, Clay	0-65 inches
McA	McBEE	C	0.63 - 2.0	Silty Clay Loam, Clay	0-65 inches
MIA	McBEE	C	0.63 - 2.0 (>20 deeper than 44in)	Gravelly Fine Sandy Loam	19-44 inches
OcD	OLEQUA	B	0.2 - 0.63	Heavy Silt Loam and Silty Clay Loam	17-90 inches
OcE	OLEQUA	B	0.2 - 0.63	Heavy Silt Loam and Silty Clay Loam	17-90 inches
OcF	OLEQUA	B	0.2 - 0.63	Heavy Silt Loam and Silty Clay Loam	17-90 inches
OlB	OLYMPIC	B	0.2 - 0.63	Gravelly Clay Loam	44-59 inches
OlD	OLYMPIC	B	0.2 - 0.63	Gravelly Clay Loam	44-59 inches
OlE	OLYMPIC	B	0.2 - 0.63	Gravelly Clay Loam	44-59 inches
OlF	OLYMPIC	B	0.2 - 0.63	Gravelly Clay Loam	44-59 inches
OmE	OLYMPIC	B	0.2 - 0.63	Gravelly Clay Loam	44-59 inches
OmF	OLYMPIC	B	0.2 - 0.63	Gravelly Clay Loam	44-59 inches
OpC	OLYMPIC VARIANT	C	0.2 - 0.63	Heavy Clay Loam and Heavy silty Clay Loam	0-33 inches
OpE	OLYMPIC VARIANT	C	0.2 - 0.63	Fractured Basalt	0-33 inches
OpG	OLYMPIC VARIANT	C	0.2 - 0.63	Fractured Basalt	0-33 inches
OrC	OLYMPIC VARIANT	C	0.2 - 0.63	Fractured Basalt	0-33 inches
PoB	POWELL	C	0.06 - 0.20	Silt Loam	23 63 inches
PoD	POWELL	C	0.06 - 0.20	Silt Loam	23-63 inches
PoE	POWELL	C	0 06 - 0.20	Silt Loam	23-63 inches
SmA	SAUVIE	B	0.2 - 0.63	Silty Clay Loam and Silt Loam	0-63 inches
SmB	SAUVIE	B	0.2 - 0.63	Silty Clay Loam and Silt Loam	0-63 inches
SnA	SAUVIE	D	2.0 - 6.3	Fine Sandy Loam	36-63 inches
SpB	SAUVIE	B	0.2 - 0.63	Silty Clay Loam and Silt Loam	0-63 inches
				SG 4	
CvA	COVE	D	0.06 - 0.20	Gravelly Silty Clay Loam	21-60 inches
CwA	COVE	D	0.06 - 0.20	Silt Loam	21-60 inches
GeB	GEE	C	<0.06	Silty Clay Loam	22-72 inches
GeD	GEE	C	<0.06	Silty Clay Loam	22-72 inches
GeE	GEE	C	<0.06	Silty Clay Loam	22-72 inches
GeF	GEE	C	<0.06	Silty Clay Loam	22-72 inches
GuB	GUMBOOT	D	0.06 - 0.2	Gravelly Silty Clay Loam, Clay Loam	12-50 inches
HtA	HOCKINSON	D	0.06 - 0.2	Fine Sandy Loam and Loam	23-51 inches
HuB	HOCKINSON	D	0.06 - 0.2	Fine Sandy Loam and Loam	23-51 inches
HvA	HOCKINSON	D	0.06 - 0.2	Fine Sandy Loam and Loam	23-51 inches
LrC	LAUREN	C	<0.06	Very Gravelly Clay Loam	14-60 inches
LrF	LAUREN	C	<0.06	Very Gravelly Clay Loam	14-60 inches
MnA	MINNIECE	D	<0.06	Silty Clay and Clay Basalt Bedrock	0-48 inches
MnD	MINNIECE	D	<0.06	Silty Clay and Clay Basalt Bedrock	0 48 inches
MoA	MINNIECE VARIANT	D	<0.06	Very Gravelly Clay Loam	22-60 inches
OdB	ODNE	D	<0.06	Silt Loam, silty Clay Loam, Clay Loam, and Loam	0-50 inches
OhD	OLEQUA VARIANT	C	<0.06	Silty Clay and Clay	32-82 inches
OhF	OLEQUA VARIANT	C	<0.06	Silty Clay and Clay	32-82 inches
SlB	SARA	D	<0.06	Heavy Silty Clay Loam and Silty Clay	10-70 inches
SlD	SARA	D	<0.06	Heavy Silty Clay Loam and Silty Clay	10-70 inches
SlF	SARA	D	<0.06	Heavy Silty Clay Loam and Silty Clay	10-70 inches
				SG 5	
Sr	SEMIAHMOO	C	0.63 - 2.0	Muck	0-40 inches
Su	SEMIAHMOO VARIANT	D	0.63 - 2.0	Muck	0-30 inches
ThA	TISCH	D	0.2 - 0.63	Muck	31-45 inches

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

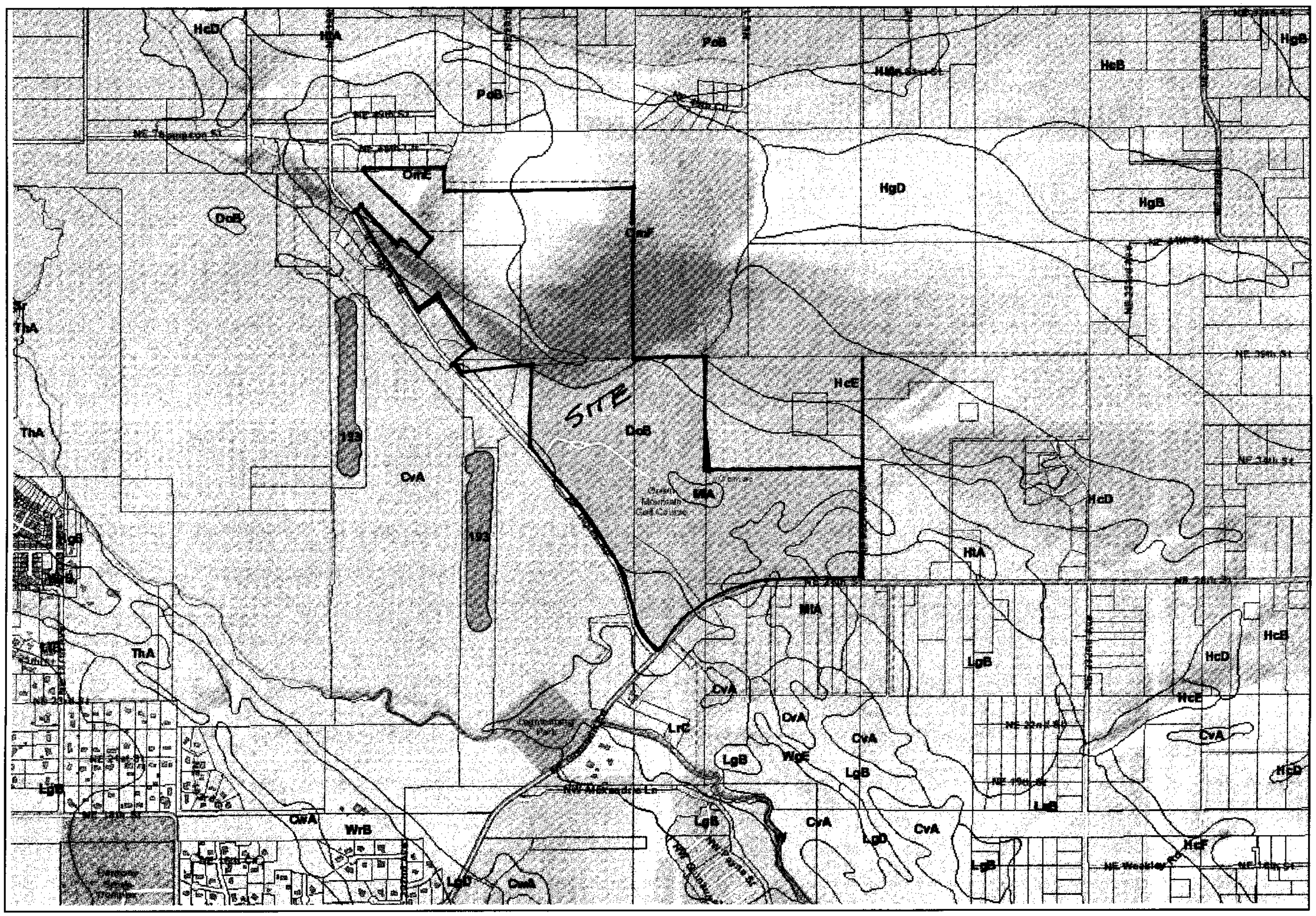
Soil series and map symbols	Depth from surface	Classification			Percentage passing sieve—			Permeability	Available water capacity	Reaction
		Dominant USDA texture	Unified	AASHO	No. 4 (4.76 mm.) [1]	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)			
	Inches							*Inches per hour*	*Inches per inch of soil*	*pH*
Bear Prairie: BpB, BpC.	0–51	Silt loam	CL	A-6	90–100	85–95	75–85	0.63–2.0	0.19–0.21	4.6–5.5
	51–75	Gravelly loam	ML	A-4	70–80	65–75	50–60	0.63–2.0	0.14–0.16	5.1–6.0
Cinebar:										
CnB, CnD, CnE, CnG.	0–65	Silt loam and loam.	ML	A-4	90–100	85–95	60–70	0.63–2.0	0.19–0.21	5.1–6.5
CrE, CrG.	0–60	Silt loam	CL	A-4	70–80	60–80	50–70	0.63–2.0	0.12–0.14	5.1–6.5
Cispus: CsF.	0–24	Gravelly sandy loam.	SM	A-2	70–80	65–75	20–30	2.0–6.3	0.08–0.10	5.6–6.5
	24–53	Very cobbly sand	SM	A-1	35–50	30–50	5–10	>20.0	0.03–0.05	5.6–6.5
Cloquato: CtA.	0–40	Silt loam	ML	A-4	--------	100	70–80	0.63–0.20	0.19–0.21	5.6–7.3
	40–72	Sandy loam and sand.	SM	A-2	100	95–100	15–30	>6.3	0.08–0.10	5.6–7.3
Cove: CvA.	0–36	Clay	CH	A-7	--------	100	70–80	<0.06	0.14–0.16	5.6–7.3
	36–54	Gravelly silty clay loam.	CL	A-7	65–75	60–70	50–60	0.06–0.20	0.15–0.17	5.6–7.3
Cove, thin solum: CwA.	0–14	Silty clay loam	CL	A-7	--------	100	85–95	0.06–0.20	0.19–0.21	4.5–6.0
	14–21	Clay	CH	A-7	--------	100	70–80	<0.06	0.14–0.16	5.6–7.3
	21–60	Silt loam	ML or CL	A-4 or A-6.	--------	100	65–75	0.06–0.20	0.19–0.21	6.6–7.3
Dollar: DoB.	0–32	Loam	ML	A-4	100	90–95	60–70	0.63–2.0	0.16–0.18	4.5–6.0
	32–60	Loam (fragipan)	ML or CL	A-4	100	95–100	60–70	<0.06	0.06–0.08	6.0
Fill land: Fn.	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Gee: GeB, GeD, GeE, GeF.	0–22	Silt loam	ML or CL	A-6	--------	100	70–85	0.63–2.0	0.19–0.21	5.1–6.0
	22–72	Silty clay loam	CL	A-6	--------	100	70–80	<0.06	0.06–0.08	5.1–6.0
Gumboot: GuB.	0–12	Silt loam	OL	A-7	90–95	85–95	75–85	0.63–2.0	0.19–0.21	4.5–7.
	12–50	Gravelly silty clay loam, clay loam.	CL	A-6	90–100	85–95	65–75	0.06–0.2	0.19–0.21	6.1–7.
	50–60	Very gravelly silty clay.	GC	A-7	40–50	35–50	25–35	<0.06	0.06–0.08	6.1–7.
Hesson:										
HcB, HcD, HcE, HcF.	0–22	Clay loam	CL	A-7	85–95	85–95	65–75	0.63–2.0	0.19–0.21	4.5–6.
	22–91	Clay	CH	A-7	85–90	85–90	75–85	0.2–0.63	0.14–0.16	4.5–6.
HgB, HgD, HhE.	0–22	Gravelly clay loam.	SC	A-6	75–85	70–80	40–50	0.63–2.0	0.14–0.16	4.5–6.
	22–91	Gravelly clay	CH	A-7	75–85	70–80	60–70	0.2–0.63	0.11–0.13	4.5–6.
Hillsboro:										
HlA, HlB, HlC, HlD, HlE, HlF.	0–36	Loam	ML	A-4	--------	100	55–65	0.63–2.0	0.16–0.18	5.1–6.
	36–62	Sandy loam and sand.	SM	A-1	95–100	95–100	15–25	2.0–6.3	0.10–0.12	5.6–7.
HoA, HoB, HoC, HoD, HoE, HoG, HsB.	0–86	Silt loam (boulders on surface of HsB).	ML	A-4	--------	100	80–90	0.63–2.0	0.19–0.21	5.0–6.

See footnotes at end of table.

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]	No. 10 (2.0 mm.)	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.


SITE
DoB
CvA
HgD
HgB
HcB
HcD
HcE
PoB
LgB
ThA
WrB

B

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

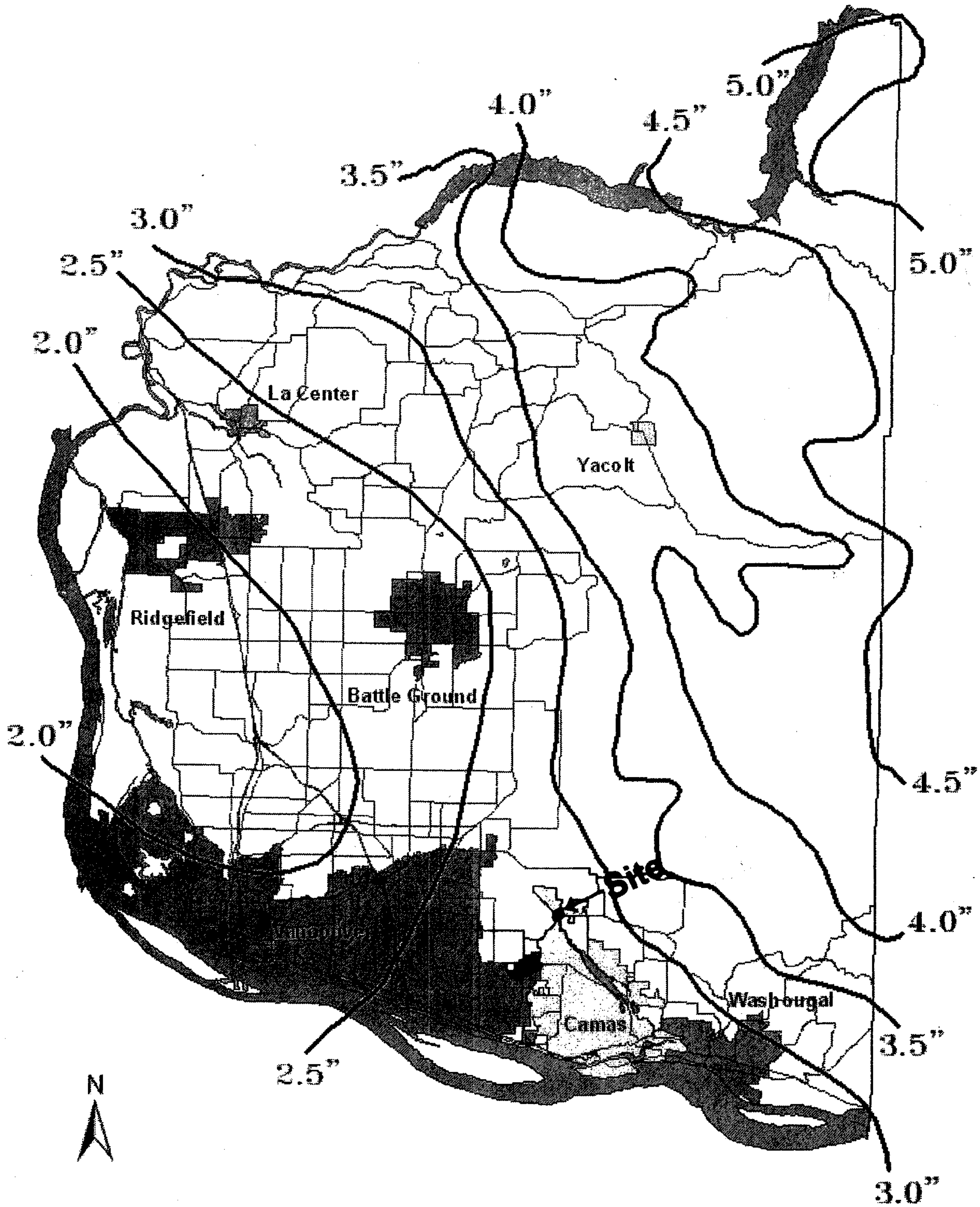
Shallow Concentrated Flow (After the initial 300 ft. of sheet flow, R = 0.1)	k_s
1. Forest with heavy ground litter and meadows (n = 0.10)	3
2. Brushy ground with some trees (n = 0.060)	5
3. Fallow or minimum tillage cultivation (n = 0.040)	8
4. High grass (n = 0.035)	9
5. Short grass, pasture and lawns (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**	

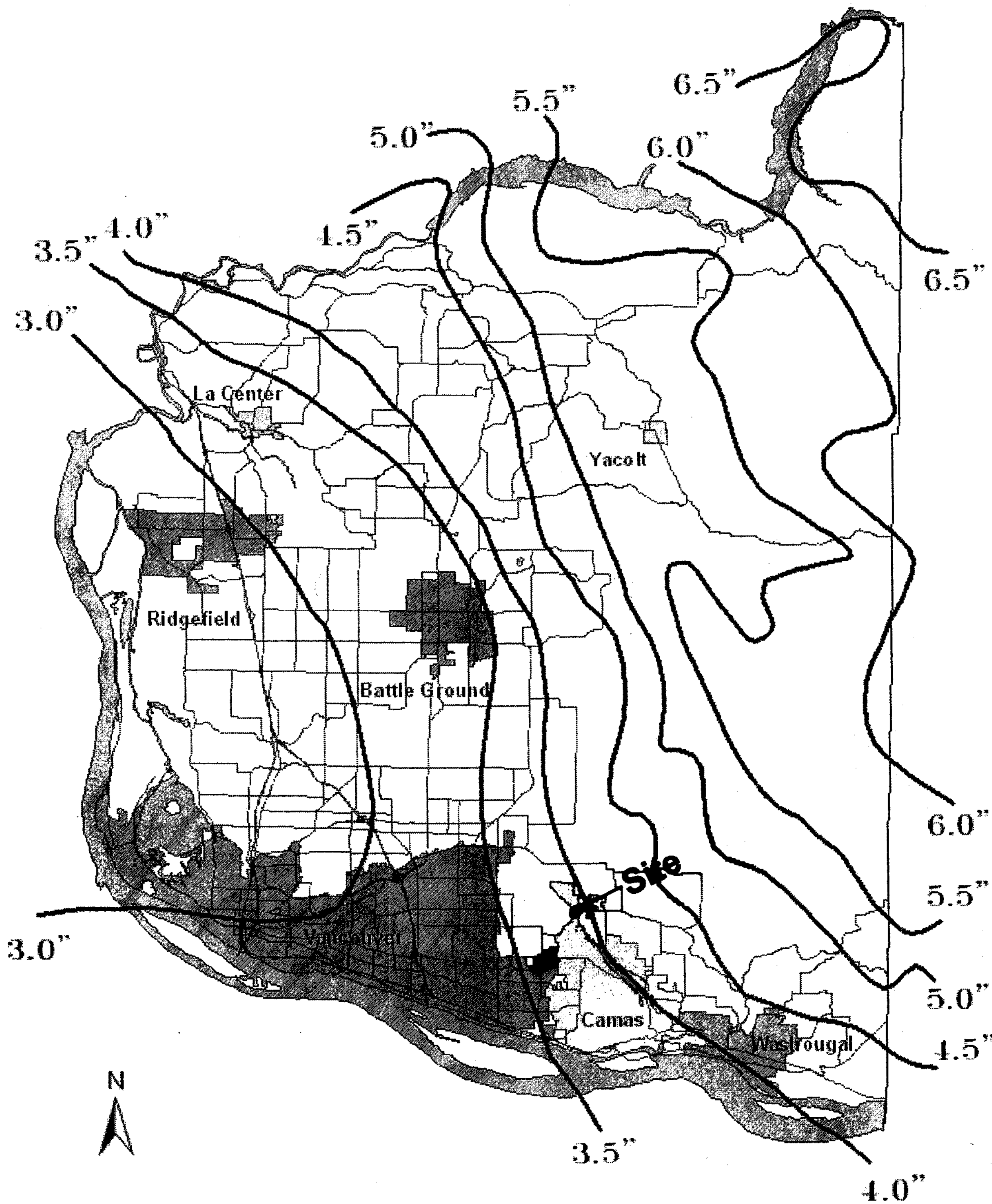
2-YR STORM = 2.8"

Figure A-2: 2-Year, 24-Hour Clark County Isopluvial Map



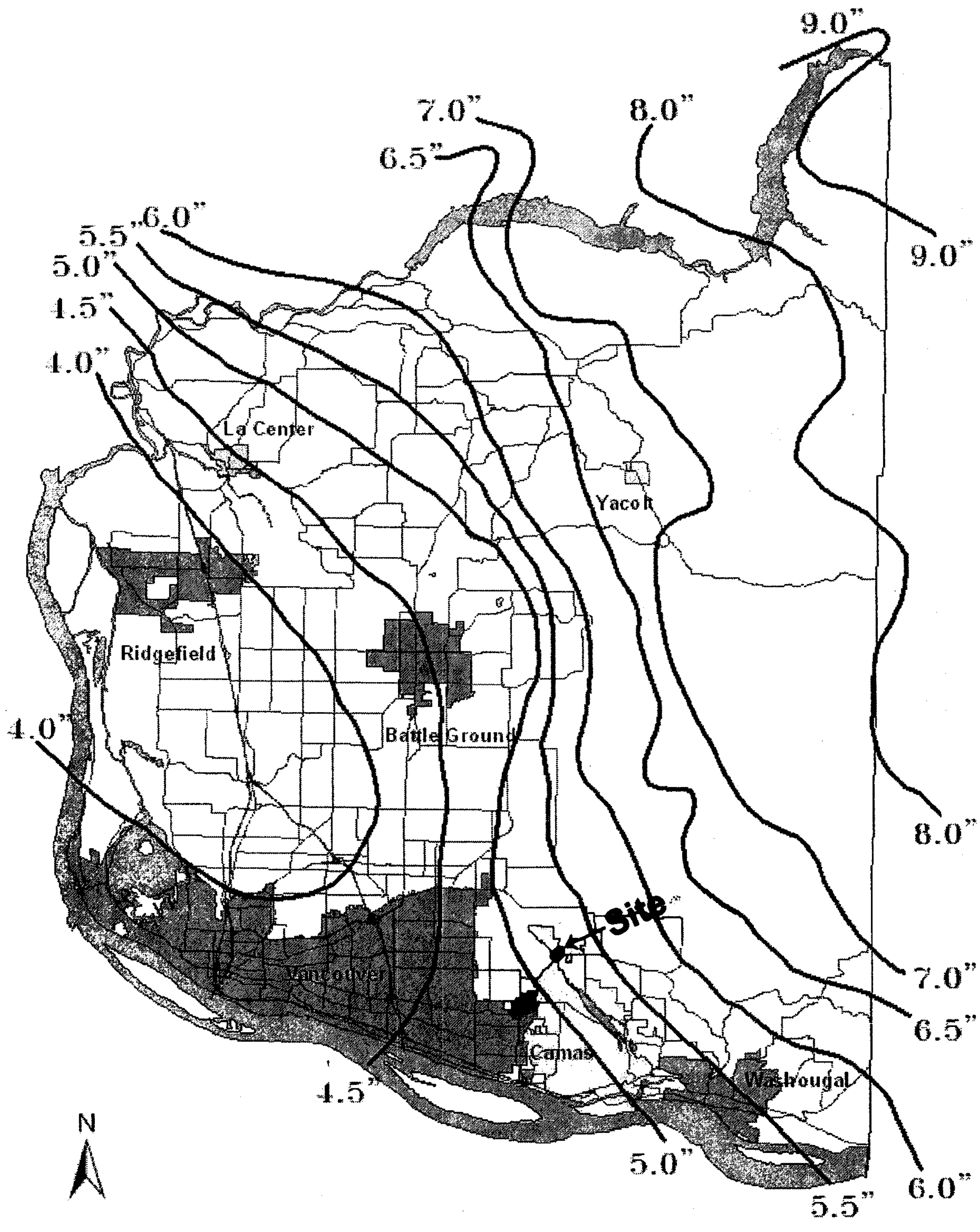
10-YR STORM = 3.9"

Figure A-3: 10-Year, 24-Hour Clark County Isopluvial Map



100-YR STORM = 5.2"

Figure A-5: 100-Year, 24-Hour Clark County Isopluvial Map



C

Figure 1.1: Flow Chart for Determining Stormwater Requirements

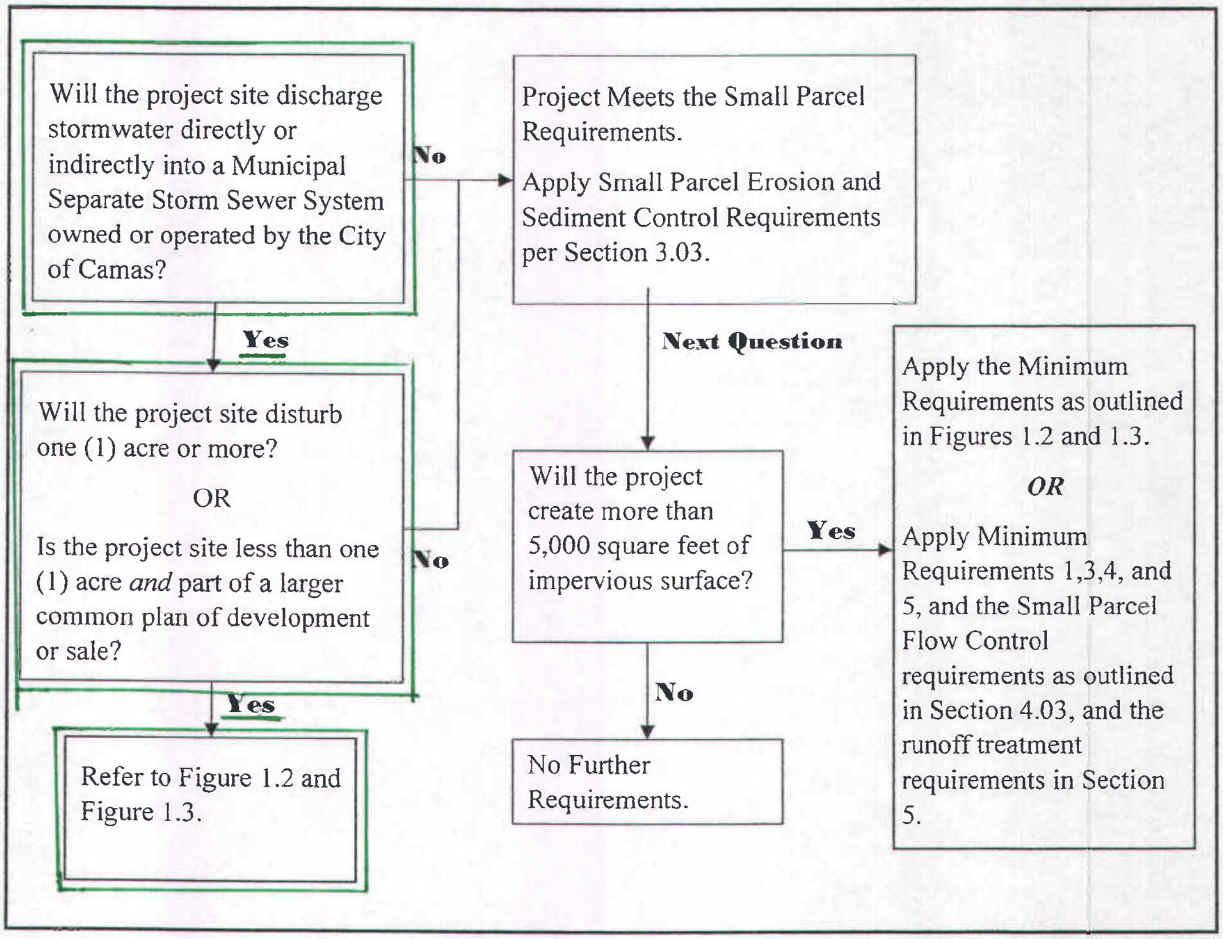
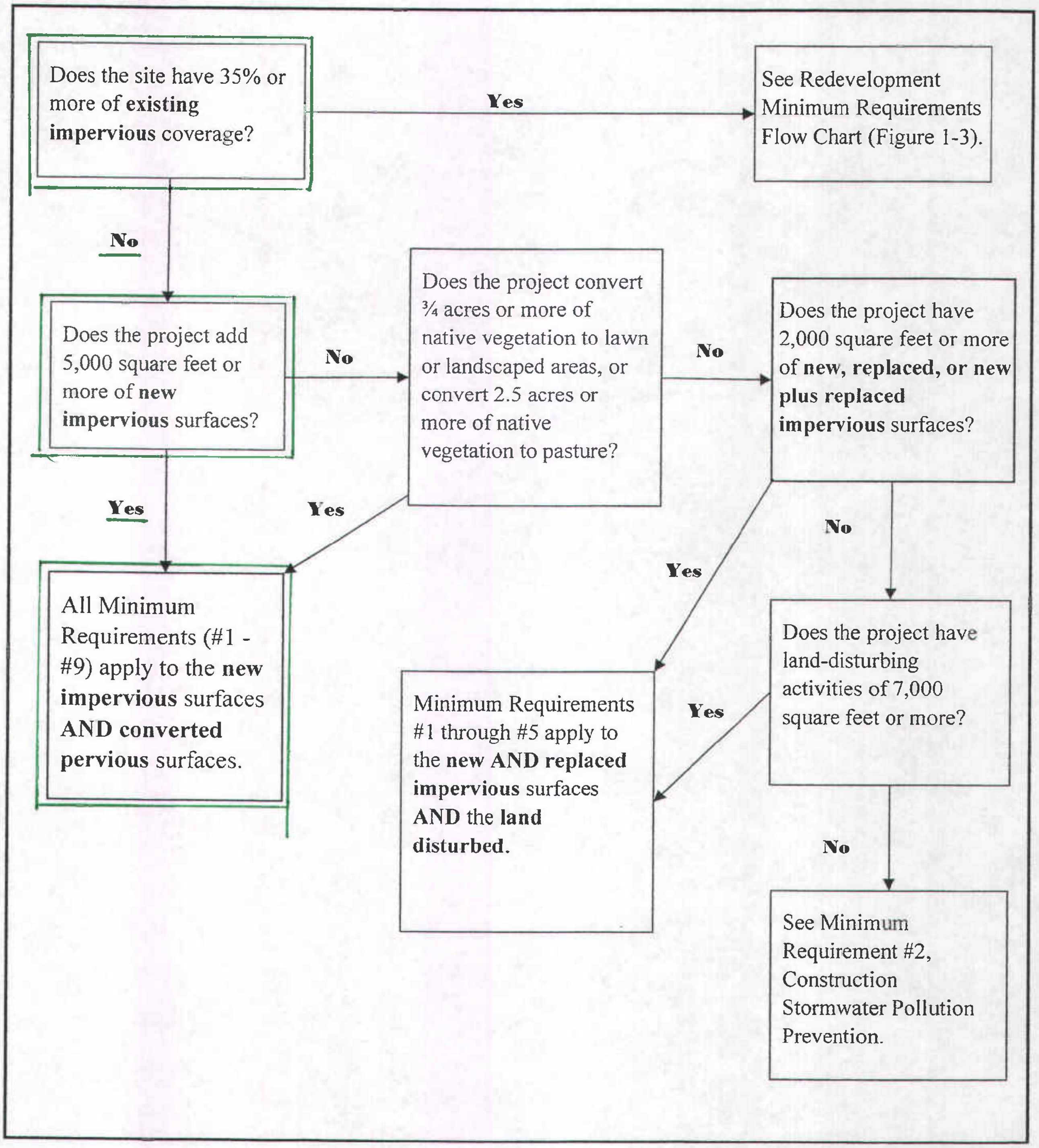
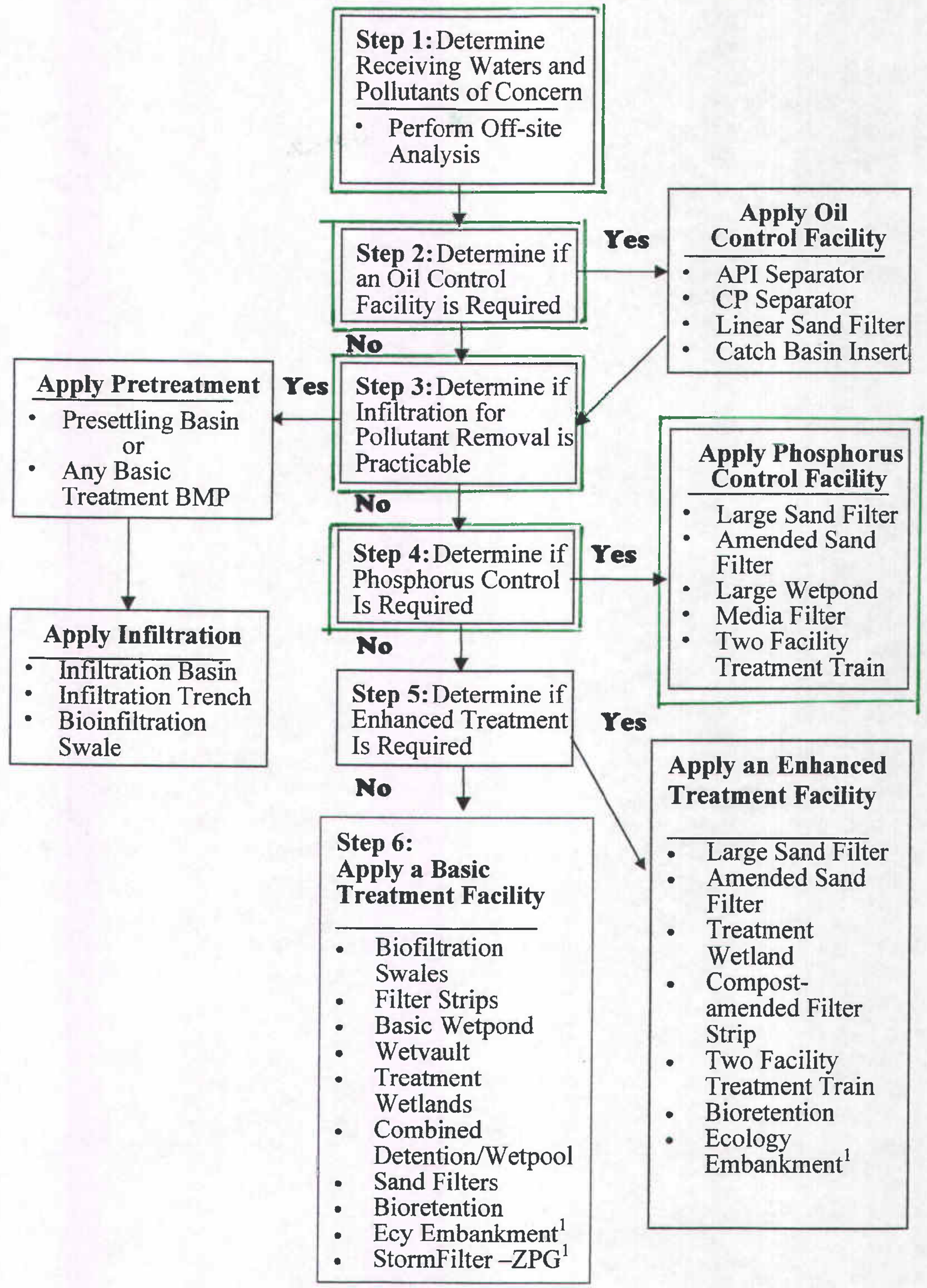


Figure 1.2: New Development Minimum Requirements Flow Chart





[1] See Section 3.5, Chapter 3 of Volume V for more information

Figure 2.1 – Treatment Facility Selection Flow Chart

2.5 Minimum Requirements

This section describes the minimum requirements for stormwater management at development and redevelopment sites. Section 2.4 should be consulted to determine which requirements apply to any given project. Figures 2.4.1 and 2.4.2 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.

Throughout this chapter, requirements are written in bold and supplemental guidelines that serve as advice and other materials are not in bold.

2.5.1 Minimum Requirement #1: Preparation of Stormwater Site Plans

All projects meeting the thresholds in Section 2.4 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 Chapter 3 of this volume.

Objective

The 2,000 square feet threshold for hard surfaces and 7,000 square foot threshold for land disturbance are chosen to capture most single family home construction and their equivalent. Note that 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.

2.5.2 Minimum Requirement #2: Construction Stormwater Pollution Prevention (SWPP)

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 SWPP Plan (SWPPP) as part of the Stormwater Site Plan (see Section 2.5.1).

Projects that result in less than 2,000 square feet of new plus replaced hard surface area, or disturb less than 7,000 square feet of land are not required to prepare a Construction SWPPP, but must consider all of the 13 Elements of Construction Stormwater Pollution Prevention and develop controls for all elements that pertain to the project site.

General Requirements

The SWPPP shall include a narrative and drawings. All BMPs shall be clearly referenced in the narrative and marked on the drawings. The SWPPP narrative shall include documentation to explain and justify the pollution prevention decisions made for the project. Each of the 13 elements 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 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 chapters 3 and 4 of Volume II.

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.**

2. **Limitations on activities and the extent of disturbed areas.**
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.**
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.**

Project Requirements - Construction SWPPP Elements

Element 1: Preserve Vegetation/Mark Clearing Limits

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

Element 2: Establish Construction Access

- **Limit construction vehicle access and exit to one route, if possible.**
- **Stabilize access points with a pad of quarry spalls, crushed rock, or other equivalent BMPs, to minimize tracking of sediment onto public roads.**
- **Locate wheel wash or tire baths on site, if the stabilized construction entrance is not effective in preventing tracking sediment onto roads.**
- **If sediment is tracked off site, clean the affected roadway 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 pick up and transport the sediment to a controlled sediment disposal area.**
- **Conduct street washing only after sediment is removed in accordance with the above bullet.**

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

Element 3: Control Flow Rates

- **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.**
- **Where necessary to comply with the bullet above, construct stormwater retention or detention facilities as one of the first steps in grading. Assure that detention facilities function properly before constructing site improvements (e.g. impervious surfaces).**
- **If permanent infiltration ponds are used for flow control during construction, protect these facilities from siltation during the construction phase.**

Element 4: Install Sediment Controls

- **Design, install, and maintain effective erosion controls and sediment controls to minimize the discharge of pollutants.**
- **Construct sediment control BMPs (sediment ponds, traps, filters, etc.) as one of the first steps in grading. These BMPs shall be functional before other land disturbing activities take place.**
- **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.**
- **Direct stormwater runoff from disturbed areas through a sediment pond 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 meet the flow control performance standard in Element #3, bullet #1.**
- **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.**
- **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.**

Element 5: Stabilize Soils

- **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 early on areas to be paved, and dust control.**
- **Control stormwater volume and velocity within the site to minimize soil erosion.**
- **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.**
- **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 - Sept. 30): 7 days**
  - **During the wet season (October 1 - April 30): 2 days**
- **Stabilize soils at the end of the shift before a holiday or weekend if needed based on the weather forecast.**
- **Stabilize soil stockpiles from erosion, protected with sediment trapping measures, and where possible, be located away from storm drain inlets, waterways and drainage channels.**
- **Minimize the amount of soil exposed during construction activity.**
- **Minimize the disturbance of steep slopes.**
- **Minimize soil compaction and, unless infeasible, preserve topsoil.**

Element 6: Protect Slopes

- **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).**
- **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 the site.**
- **At the top of slopes, collect drainage in pipe slope drains or protected channels to prevent erosion.**
  - **Temporary pipe slope drains must handle the peak 10-minute velocity of flow from a Type 1A, 10-year, 24-hour frequency**

storm for the developed condition. Alternatively, the 10-year and 1-hour flow rate predicted by an approved continuous runoff model, increased by a factor of 1.6, may be used. 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.

- Place excavated material on the uphill side of trenches, consistent with safety and space considerations.
- Place check dams at regular intervals within constructed channels that are cut down a slope.

Element 7: Protect Drain Inlets

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

Element 8: Stabilize Channels and Outlets

- Design, construct, and stabilize all on-site conveyance channels to prevent erosion from the following expected peak flows:
    - Channels must handle the peak 10-minute velocity of flow from a Type 1A, 10- year, 24-hour frequency storm for the developed condition. Alternatively, the 10-year, 1-hour flow rate indicated by an approved continuous runoff model, increased by a factor of 1.6, may be used. 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.
- 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.

Element 9: Control Pollutants

- **Design, install, implement and maintain effective pollution prevention measures to minimize the discharge of pollutants.**
- **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.**
- **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 take within the containment structure. Double-walled tanks do not require additional secondary containment.**
- **Conduct maintenance, fueling, and repair of heavy equipment and vehicles using spill prevention and control measures. Clean contaminated surfaces immediately following any spill incident.**
- **Discharge wheel wash or tire bath wastewater to a separate on-site treatment system that prevents discharge to surface water, such as closed-loop recirculation or upland application, or to the sanitary sewer, with local sewer district approval.**
- **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.**
- **Use BMPs to prevent contamination of stormwater runoff by pH modifying sources. The sources for this contamination include, but are not limited to: 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.**
- **Adjust the pH of stormwater if necessary to prevent violations of water quality standards.**
- **Assure that washout of concrete trucks is performed off-site or in designated concrete washout areas only. Do not wash out concrete trucks onto the ground, or into storm drains, open ditches, streets, or streams. Do not dump excess concrete on-site, except in designated concrete washout areas. Concrete spillage or concrete discharge to surface waters of the State is prohibited.**

- **Obtain written approval from Ecology before using chemical treatment other than CO_2 or dry ice to adjust pH.**

Element 10: Control De-Watering

- **Discharge foundation, vault, and trench de-watering water, which has similar characteristics to stormwater runoff at the site, into a controlled conveyance system before discharge to a sediment trap or sediment pond.**
- **Discharge clean, non-turbid de-watering water, such as well-point ground water, to systems tributary to, or directly into surface waters of the State, as specified in Element #8, provided the de-watering flow does not cause erosion or flooding of receiving waters. Do not route clean dewatering water through stormwater sediment ponds. 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.**
- **Handle highly turbid or otherwise contaminated dewatering water separately from stormwater.**
- **Other treatment or disposal options may include:**
  1. **Infiltration.**
  2. **Transport off-site in a vehicle, such as a vacuum flush truck, for legal disposal in a manner that does not pollute state waters.**
  3. **Ecology-approved on-site chemical treatment or other suitable treatment technologies.**
  4. **Sanitary or combined sewer discharge with local sewer district approval, if there is no other option.**
  5. **Use of a sedimentation bag with outfall to a ditch or swale for small volumes of localized dewatering.**

Element 11: Maintain BMPs

- **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.**
- **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.**

Element 12: Manage The Project

- **Phase development projects to the maximum degree practicable and take into account seasonal work limitations.**
- **Inspection and monitoring – Inspect, maintain and repair all BMPs as needed to assure continued performance of their intended function. Projects regulated under the Construction Stormwater General Permit must conduct site inspections and monitoring in accordance with Special Condition S4 of the Construction Stormwater General Permit.**
- **Maintaining an updated construction SWPPP – Maintain, update, and implement the SWPPP.**
- **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 SWPPP must identify the CESCL or inspector, who must be present on-site or on-call at all times.**
- The CESCL or inspector (project sites less than one acre) must have the skills to assess the:
    - Site conditions and construction activities that could impact the quality of stormwater.
    - Effectiveness of erosion and sediment control measures used to control the quality of stormwater discharges.
- 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 SWPPP for compliance with the 13 construction SWPPP 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 not 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 (sites larger than 1 acre).

- 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.

Element 13: Protect Low Impact Development BMPs

- **Protect all Bioretention and Rain Garden BMPs from sedimentation through installation and maintenance of erosion and sediment control BMPs on portions of the site that drain into the Bioretention and/or Rain Garden 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.**
- **Prevent compacting Bioretention and rain garden BMPs by excluding construction equipment and foot traffic. Protect completed lawn and landscaped areas from compaction due to construction equipment.**
- **Control erosion and avoid introducing sediment from surrounding land uses onto 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.**
- **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.**
- **Keep all heavy equipment off existing soils under LID facilities that have been excavated to final grade to retain the infiltration rate of the soils.**

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 facilities and BMP's 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[1] within the Local Government should require that other 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 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.

Coordination 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.

Element #13, Protect Low Impact Development BMPs, is not yet included as a permit condition in the NPDES Construction Stormwater General Permit. That permit is not scheduled for reissuance until December, 2015. Until that permit is reissued with element #13 added as a permit condition, the element may be enforceable only through the requirements of local stormwater codes that may have been updated to include it. Municipal Stormwater Permittees must incorporate this element into local requirements per the timelines in their Municipal Stormwater Permit.

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[1] The Plan Approval Authority is defined as that department within a local government that has been delegated authority to approve stormwater site plans.

2.5.3 Minimum Requirement #3: 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 according to this manual.

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, therefore, should be a first consideration in all projects.

Supplemental Guidelines

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 more stringent source control requirements that are tailored to a specific basin.

Source Control BMPs include Operational BMPs and Structural Source Control BMPs. See Volume IV for design details of these BMPs. For construction sites, see Volume II, Chapter 4.

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.

2.5.4 Minimum Requirement #4: Preservation of Natural Drainage Systems and Outfalls

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

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 is less than or equal to 0.2 cfs (0.3 cfs using 15 minute time steps) under existing conditions and will remain less than or equal to 0.2 cfs under developed conditions, then the concentrated runoff may be discharged onto a rock pad or to any other system that serves to disperse flows.

b) If the 100-year peak discharge is less than or equal to 0.5 cfs (0.75 cfs using 15 minute time steps) under existing conditions and will remain less than or equal to 0.5 cfs under developed conditions, then the concentrated runoff may be discharged through a dispersal trench 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 is greater than 0.5 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 Volume V, Chapter 4.

2.5.5 Minimum Requirement #5: On-site Stormwater Management

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

Projects qualifying as flow control exempt in accordance with Section 2.5.7 of this chapter do not have to achieve the LID performance standard, nor consider bioretention, rain gardens, permeable pavement, and full dispersion if using List #1 or List #2. However, those projects must implement BMP T5.13; BMPs T5.10A, B, or C; and BMP T5.11or T5.12, if feasible.

Project Thresholds

Projects triggering only Minimum Requirements #1 through #5 shall either:

a. **Use On-site Stormwater Management BMPs from List #1 for all surfaces within each type of surface in List #1; or**

b. **Demonstrate compliance with the LID Performance Standard. Projects selecting this option cannot use Rain Gardens. They may choose to use Bioretention BMPs as described in Chapter 7 of Volume V to achieve the LID Performance Standard.**

Projects triggering Minimum Requirements #1 through #9, must meet the requirements in Table 2.5.1.

Table 2.5.1 On-site Stormwater Management Requirements for Projects Triggering Minimum Requirements #1 - #9

Project Type and Location	Requirement
New development on any parcel inside the UGA, or new development outside the UGA on a parcel less than 5 acres	Low Impact Development Performance Standard and BMP T5.13; or List #2 (applicant option).
New development outside the UGA on a parcel of 5 acres or larger	Low Impact Development Performance Standard and BMP T5.13.
Redevelopment on any parcel inside the UGA, or redevelopment outside the UGA on a parcel less than 5 acres	Low Impact Development Performance Standard and BMP T5.13; or List #2 (applicant option).
Redevelopment outside the UGA on a parcel of 5 acres or larger	Low Impact Development Performance Standard and BMP T5.13.

NOTE: This table 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 Permittee is located in a county that is not subject to planning under the GMA, the city limits shall be used instead.

Low Impact Development Performance Standard

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 Standard Flow Control Requirement section in Minimum Requirement #7 for information about the assignment of the pre-developed condition. Project sites that must also meet minimum requirement #7 – flow control - must match flow durations between 8% of the 2-year flow through the full 50-year flow.

List #1: On-site Stormwater Management BMPs for Projects Triggering Minimum Requirements #1 through #5

For each surface, consider the BMP's in the order listed for that type of surface. Use the first BMP that is considered feasible. No other On-site Stormwater Management BMP is necessary for that surface. Feasibility shall be determined by evaluation against:

1. **Design criteria, limitations, and infeasibility criteria identified for each BMP in this manual; and**
2. **Competing Needs Criteria listed in Chapter 5 of Volume V of this manual.**

Lawn and landscaped areas:

- **Post-Construction Soil Quality and Depth in accordance with BMP T5.13 in Chapter 5 of Volume V**

Roofs:

1. **Full Dispersion in accordance with BMP T5.30 in Chapter 5 of Volume V, or Downspout Full Infiltration Systems in accordance with BMP T5.10A in Section 3.1.1 in Chapter 3 of Volume III**
2. **Rain Gardens in accordance with BMP T5.14 in Chapter 5 of Volume V, or Bioretention in accordance with Chapter 7 of Volume V. The rain garden or bioretention facility must have a minimum horizontal projected surface area below the overflow which is at least 5% of the area draining to it.**
3. **Downspout Dispersion Systems in accordance with BMP T5.10B in Section 3.1.2 in Chapter 3 of Volume III**
4. **Perforated Stub-out Connections in accordance with BMP T5.10C in Section 3.1.3 in Chapter 3 of Volume III**

Other Hard Surfaces:

1. **Full Dispersion in accordance with BMP T5.30 in Chapter 5 of Volume V**

2. **Permeable pavement[1] in accordance with BMP T5.15 in Chapter 5 of Volume V, or Rain Gardens in accordance with BMP T5.14 in Chapter 5 of Volume V, or Bioretention in accordance with Chapter 7 of of Volume V. The rain garden or bioretention facility must have a minimum horizontal projected surface area below the overflow which is at least 5% of the area draining to it.**

3. **Sheet Flow Dispersion in accordance with BMP T5.12, or Concentrated Flow Dispersion in accordance with BMP T5.11 in Chapter 5 of Volume V.**

List #2: On-site Stormwater Management BMPs for Projects Triggering Minimum Requirements #1 through #9

For each surface, consider the BMPs in the order listed for that type of surface. Use the first BMP that is considered feasible. No other On-site Stormwater Management BMP is necessary for that surface. Feasibility shall be determined by evaluation against:

1. **Design criteria, limitations, and infeasibility criteria identified for each BMP in this manual; and**

2. **Competing Needs Criteria listed in Chapter 5 of Volume V of this manual.**

Lawn and landscaped areas:

- **Post-Construction Soil Quality and Depth in accordance with BMP T5.13 in Chapter 5 of Volume V.**

Roofs:

1. **Full Dispersion in accordance with BMP T5.30 in Chapter 5 of Volume V, or Downspout Full Infiltration Systems in accordance with BMP T5.10A in Section 3.1.1 in Chapter 3 of Volume III**

2. **Bioretention (See Chapter 7 of Volume V) facilities that have a minimum horizontally projected surface area below the overflow which is at least 5% of the total surface area draining to it.**

3. **Downspout Dispersion Systems in accordance with BMP T5.10B in Section 3.1.2 in Chapter 3 of Volume III**

4. **Perforated Stub-out Connections in accordance with BMP T5.10C in Section 3.1.3 in Chapter 3 of Volume III**

Other Hard Surfaces:

1. **Full Dispersion in accordance with BMP T5.30 in Chapter 5 of Volume V**

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[1] This is not a requirement to pave these surfaces. Where pavement is proposed, it must be permeable to the extent feasible unless full dispersion is employed.

2. **Permeable pavement[1] in accordance with BMP T5.15 in chapter 5 of Volume V**
3. **Bioretention BMP's (See Chapter 7, Volume V of the SMMWW) that have a minimum horizontally projected surface area below the overflow which is at least 5% of the total surface area draining to it.**
4. **Sheet Flow Dispersion in accordance with BMP T5.12, or Concentrated Flow Dispersion in accordance with BMP T5.11 in Chapter 5 of Volume V.**

Objective

To use practices distributed across a development that reduce the amount of disruption of the natural hydrologic characteristics of the site.

Supplemental Guidelines

"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 described in Section 3.1 of Volume III, and Section 5.3.1 of Volume V 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.

2.5.6 Minimum Requirement #6: Runoff Treatment

Thresholds

When assessing a project against the following thresholds, only consider those hard and pervious surfaces that are subject to this minimum requirement as determined in Section 2.4 of this chapter.

The following require construction of stormwater treatment facilities:

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

Treatment Facility Sizing

Size stormwater treatment facilities for the entire area that drains to them, even if some of those areas are not pollution-generating, or were not included in the project site threshold decisions (Section 2.4 of this chapter) or the treatment threshold decisions of this minimum requirement.

Water Quality Design Storm Volume:

- **The volume of runoff predicted from a 24-hour storm with a 6-month return frequency (a.k.a., 6-month, 24-hour storm). Wetpool facilities are sized based upon the volume of runoff predicted through use of the Natural Resource Conservation Service curve number equations in Chapter 2 of Volume III, for the 6-month, 24-hour storm. Alternatively, when using an approved continuous runoff model, the water quality design storm volume shall be equal to the simulated daily volume that represents the upper limit of the range of daily volumes that accounts for 91% of the entire runoff volume over a multi-decade period of record.**

Water Quality Design Flow Rate:

- **Preceding Detention Facilities or when Detention Facilities are not required: The flow rate at or below which 91% of the runoff volume, as estimated by an approved continuous runoff model, will be treated. Design criteria for treatment facilities are assigned to achieve the applicable performance goal (e.g., 80% TSS removal) at the water quality design flow rate . At a minimum, 91% of the total runoff volume, as estimated by an approved continuous runoff model, must pass through the treatment**

facility(ies) at or below the approved hydraulic loading rate for the facility(ies).

- **Downstream of Detention Facilities: The water quality design flow rate must be the full 2-year release rate from the detention facility.**

Treatment Facility Selection, Design, and Maintenance

Stormwater treatment facilities shall be:

- Selected in accordance with the process identified in Chapter 4 of Volume I, and Chapter 2 of Volume V,
- Designed in accordance with the design criteria in Volume V, and
- Maintained in accordance with the maintenance schedule in Volume V.

Additional Requirements

Direct discharge of untreated stormwater from pollution-generating hard surfaces to ground water is prohibited, except for the discharge achieved by infiltration or dispersion of runoff through use of On-site Stormwater Management BMPs, in accordance with Chapter 5, Volume V and Chapter 7, Volume V; or by infiltration through soils meeting the soil suitability criteria in Chapter 3 of Volume III.

Objective

The purpose of runoff treatment is to reduce pollutant loads and concentrations in stormwater runoff 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, infiltration can potentially be the most effective BMP for runoff treatment.

Supplemental Guidelines

See Volume V for more detailed guidance on selection, design, and maintenance of treatment facilities. The water quality design storm volume and flow rates are intended to capture and effectively treat about 90-95% of the annual runoff volume in western Washington. See Appendix I-B for background on their derivation.

Volume V includes performance goals for Basic, Enhanced, Phosphorus, and Oil Control treatment, and a menu of facility options for each treatment type. Treatment facilities that are selected from the appropriate menu and designed in accordance with their design criteria are presumed to meet the applicable performance goals.

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, treatment requirements shall not be less than that achieved by facilities in the Basic Treatment Menu (see Volume V, Chapter 3).

Treatment facilities applied consistent with this manual are presumed to meet the requirement of state law to provide all known available and reasonable methods of treatment (RCW 90.52.040, RCW 90.48.010). This technology-based treatment requirement does not excuse any discharge from the obligation to apply whatever technology is necessary to comply with state water quality standards, Chapter 173-201A WAC; state ground water quality standards, Chapter 173-200 WAC; state sediment management standards, Chapter 173-204 WAC; and the underground injection control program, Chapter 173-218 WAC. Additional treatment to meet those standards may be required by federal, state, or local governments.

Infiltration through use of On-site Stormwater Management BMPs can provide both treatment of stormwater, through the ability of certain soils to remove pollutants, and volume control of stormwater, by decreasing the amount of water that runs off to surface water. Infiltration through engineered treatment facilities that utilize the natural soil profile can also be very effective at treating stormwater runoff, but pretreatment must be applied and soil conditions must be appropriate to achieve effective treatment while not impacting ground water resources. See Chapter 6 of Volume V for pretreatment design details.

Discharge of pollution-generating surfaces into a dry well, after pretreatment for solids reduction, can be acceptable if the soil conditions provide sufficient treatment capacity. Dry wells into gravelly soils are not likely to have sufficient treatment capability. They must be preceded by at least a basic treatment BMP. See Volume V, Chapters 2 and 7 for details.

Impervious surfaces that are "fully dispersed" in accordance with BMP T5.30 in Volume V are not considered effective impervious surfaces. Impervious surfaces that are "dispersed" in accordance with BMPs T5.10B, T5.11, and T5.12 in Section 5.3.1 of Volume V are still considered effective surfaces though they may be modeled as pervious surfaces if flow path lengths meet the specified minima. See Volume III, Appendix III-C for a more complete description of hydrologic representation of On-site Stormwater Management BMPs.

2.5.7 Minimum Requirement #7: Flow Control

Applicability

Projects must provide flow control to reduce the impacts of stormwater runoff from hard surfaces and land cover conversions. The requirement below applies to projects that discharge stormwater directly, or indirectly through a conveyance system, into a fresh waterbody.

Flow Control is not required for projects that discharge directly to, or indirectly to a water listed in Appendix I-E - Flow Control-Exempt Receiving Waters subject to 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; and**
- **Flow splitting devices or drainage BMP's are applied to route natural runoff volumes from the project site to any downstream Type 5 stream or category IV wetland:**
  - **Design of flow splitting devices or drainage BMP's will be based on continuous hydrologic modeling analysis. The design will 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 splitting devices or drainage BMP's that deliver flow to category IV wetlands will also be designed using continuous hydrologic modeling to preserve pre-project wetland hydrologic conditions unless specifically waived or exempted by regulatory agencies with permitting jurisdiction; and**
- **The project site must be drained by a conveyance system that is comprised entirely of manmade conveyance elements (e.g., pipes, ditches, outfall protection, etc.) and extends to the ordinary high water line of the exempt receiving water; and**
- **The conveyance system between the project site and the exempt receiving water shall have sufficient hydraulic capacity to convey discharges from future build-out conditions (under current zoning) of the site, and the existing condition from non-project areas from which runoff is or will be collected; and**
- **Any erodible elements of the manmade conveyance system must be adequately stabilized to prevent erosion under the conditions noted above.**

If the discharge is to a stream that leads to a wetland, or to a wetland that has an outflow to a stream, both this requirement and Minimum Requirement #8 apply.

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.

Thresholds

When assessing a project against the following thresholds, consider only those impervious, hard, and pervious surfaces that are subject to this minimum requirement as determined in Section 2.4 of this chapter.

The following circumstances require achievement of the standard flow control requirement for western Washington:

- **Projects in which the total of effective impervious surfaces is 10,000 square feet or more in a threshold discharge area, or**
- **Projects that convert ¾ acres or more of vegetation to lawn or landscape, or convert 2.5 acres or more of native vegetation to pasture in a threshold discharge area, and from which there is a surface discharge in a natural or man-made conveyance system from the site, or**
- **Projects that through a combination of effective hard surfaces and converted vegetation areas cause a 0.10 cubic feet per second increase in the 100-year flow frequency from a threshold discharge area as estimated using the Western Washington Hydrology Model or other approved model and one-hour time steps (or a 0.15 cfs increase using 15-minute time steps).** [2]

Standard Flow Control Requirement

The following requirement applies to the the following counties:

Clallam	Jefferson	Pacific	Snohomish
Clark	King	Pierce	Thurston
Cowlitz	Kitsap	San Juan	Wahkiakum
Grays Harbor	Lewis	Skagit	Whatcom
Island	Mason	Skamania	

[2] The 0.10 cfs (one-hour time steps) or 0.15 cfs (15-minute time steps) 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.

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 Western Washington Hydrology Model); or,**
- **The drainage area of the immediate stream and all subsequent downstream basins have had at least 40% total impervious area since 1985. In this case, the pre-developed condition to be matched shall be the existing land cover condition. The map in Appendix I-F 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.**

This standard requirement is waived for sites that will reliably infiltrate all the runoff from hard surfaces and converted vegetation areas.

Western Washington Alternative Requirement

An alternative requirement may be established through application of watershed-scale hydrological modeling and supporting field observations. Possible reasons for an alternative flow control requirement 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 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.**

Additional Requirement

Flow Control BMPs shall be selected, designed, and maintained according to Volume III or a local government manual deemed equivalent to this manual.

Objective

To prevent increases in the stream channel erosion rates that are characteristic of natural conditions (i.e., prior to disturbance by European settlement). The 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

Reduction of flows through infiltration decreases stream channel erosion and helps to maintain base flow throughout the summer months. However, infiltration should follow the guidance in this manual to reduce the chance that ground water quality is threatened by such discharges.

Volume III includes a description of the Western Washington Hydrology Model. The model provides ways to represent On-site Stormwater Management BMPs described in Volumes III and V. Using those BMPs reduces the predicted runoff rates and volumes and thus also reduces the size of the required flow control facilities.

Application of sufficient types of On-site Stormwater Management BMPs can result in reducing the effective impervious area and the converted vegetation areas such that a flow control facility is not required. Application of "Full Dispersion", BMP T5.30, also results in eliminating the flow control facility requirement for those areas that are "fully dispersed."

See the guidelines in Appendix I-D for Minimum Requirement #8, and directions concerning use of the Western Washington Hydrology Model for information about the approach for protecting wetland hydrologic conditions.

Diversions 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 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 applicable in these situations. Approvals by all regulatory authorities with relevant permits applicable to the project are necessary.

Ecology hopes to publish guidance concerning basin studies to develop basin-specific flow control strategies intended to stabilize stream channels and provide flows intended to protect and restore beneficial uses such as fish resources. The recommendations made in basin plans should be consistent with the requirements and intent of the federal Clean Water Act, the State Water Pollution Control Act, and any other applicable natural resources statutes, such as the Federal Endangered Species Act.

2.5.8 Minimum Requirement #8: Wetlands Protection

Applicability

The requirements below apply only to projects whose stormwater discharges into a wetland, either directly or indirectly through a conveyance system.

Thresholds

The thresholds identified in Minimum Requirement #6 – Runoff Treatment, and Minimum Requirement #7 – Flow Control shall also be applied to determine the applicability of this requirement to discharges to wetlands.

Standard Requirement

Projects shall comply with Guide Sheets #1 through #3 in Appendix I-D. The hydrologic analysis shall use the existing land cover condition to determine the existing hydrologic conditions unless directed otherwise by a regulatory agency with jurisdiction.

Additional Requirements

Stormwater treatment and flow control facilities shall not be built within a natural vegetated buffer, except for:

- **Necessary conveyance systems as approved by the local government; or**
- **As allowed in wetlands approved for hydrologic modification and/or treatment in accordance with Guide Sheet 2 in Appendix I-D.**

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 requirements for wetlands that are tailored to a specific basin.

Objective

To ensure that wetlands receive the same level of protection as any other waters of the state. Wetlands are extremely important natural resources which provide multiple stormwater benefits, 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 natural hydrologic functioning of the wetland system. Changes in water levels and the frequency and duration of inundations are of particular concern.

Supplemental Guidelines

Appendix I-D Guidelines for Wetlands when Managing Stormwater shall be used for discharges to natural wetlands and wetlands constructed as mitigation. While it is always necessary to pre-treat stormwater prior to discharge to a wetland, there are limited circumstances where wetlands may be used for additional treatment and detention of stormwater. These situations are considered in Guide Sheet 2 of Appendix I-D.

Note that if selective runoff bypass is an alternative being considered to maintain the hydroperiod, the hydrologic analysis must consider the impacts of the bypassed flow. For instance, if the bypassed flow is eventually directed to a stream, the flow duration standard, Minimum Requirement #7, applies to the bypass.

2.5.9 Minimum Requirement #9: Operation and Maintenance

An operation and maintenance manual that is consistent with the provisions in Volume V shall be provided for proposed stormwater facilities and BMPs, and the party (or parties) responsible for maintenance and operation shall be identified. 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.

Objective

To ensure that stormwater control facilities are adequately maintained and operated properly.

Supplemental Guidelines

Inadequate maintenance is a common cause of failure for stormwater control facilities. The description of each BMP in Volumes II, III, and V includes a section on maintenance. Chapter 4 of Volume V includes a schedule of maintenance standards for drainage facilities. Local

D

TRACT 'A' FACILITY

WWHM2012

PROJECT REPORT

General Model Information

Project Name:	8938.e.Green Mtn Ph1-Prelim-Tract A Pond
Site Name:	Green Mountain
Site Address:	NE Goodwin Road
City:	Camas, WA.
Report Date:	12/23/2014
Gage:	Lacamas
Data Start:	1948/10/01
Data End:	2008/09/30
Timestep:	15 Minute
Precip Scale:	1.30
Version:	2014/09/12

POC Thresholds

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

Landuse Basin Data

Predeveloped Land Use

Basin 2P

Bypass:	No
GroundWater:	No
Pervious Land Use	Acres
SG4, Forest, Mod	17.491
Pervious Total	17.491
Impervious Land Use	Acres
Impervious Total	0
Basin Total	17.491

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Basin 2D

Bypass:	No
GroundWater:	No
Pervious Land Use	Acres
SG3, Lawn, Mod	4.985
Pervious Total	4.985
Impervious Land Use	Acres
ROADS MOD	4.44
ROOF TOPS FLAT	4.075
DRIVEWAYS MOD	0.815
SIDEWALKS MOD	1.147
POND	2.029
Impervious Total	12.506
Basin Total	17.491

Element Flows To:

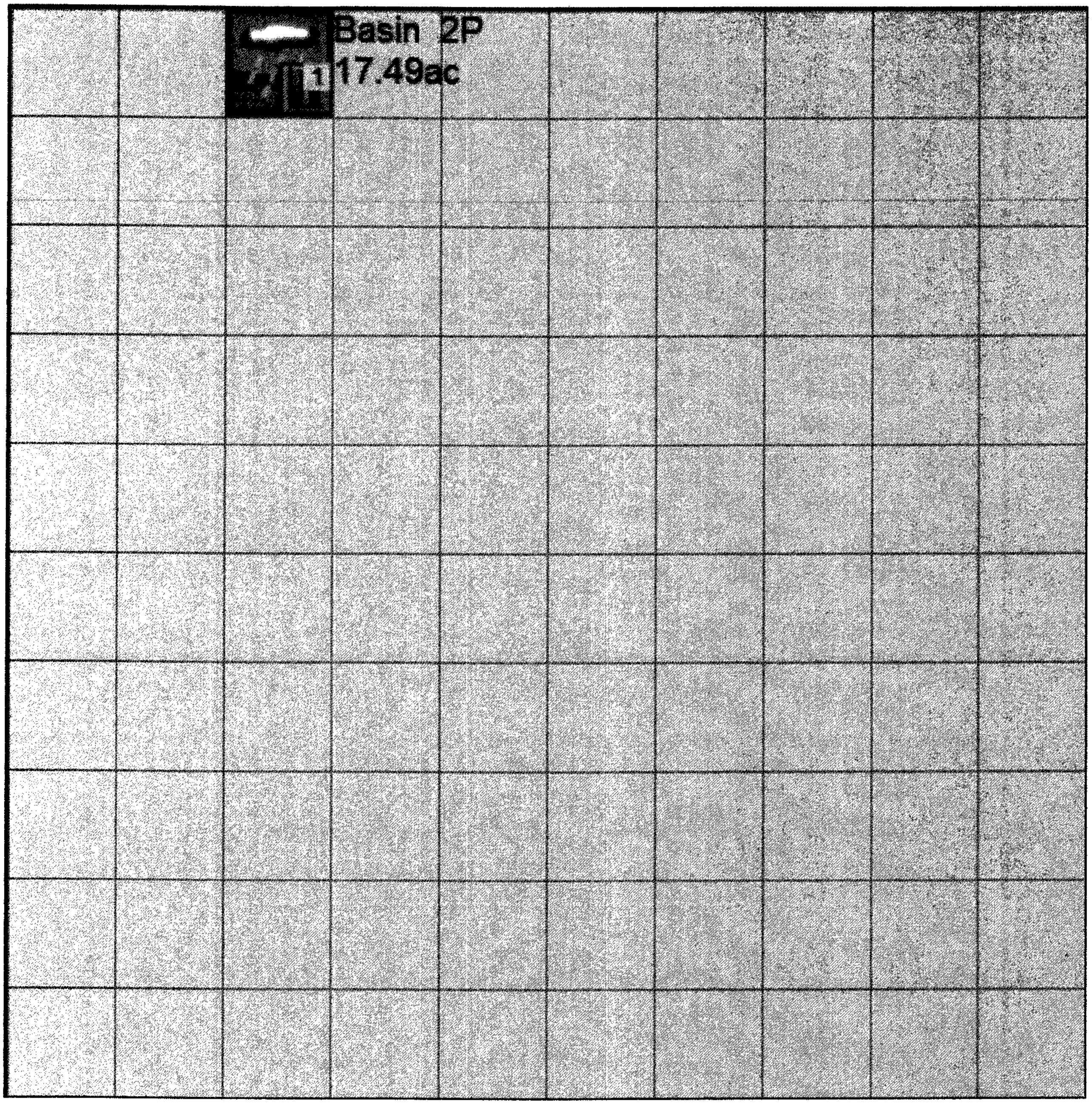
Surface	Interflow	Groundwater
Trapezoidal Pond 1	Trapezoidal Pond 1	

Water Quality

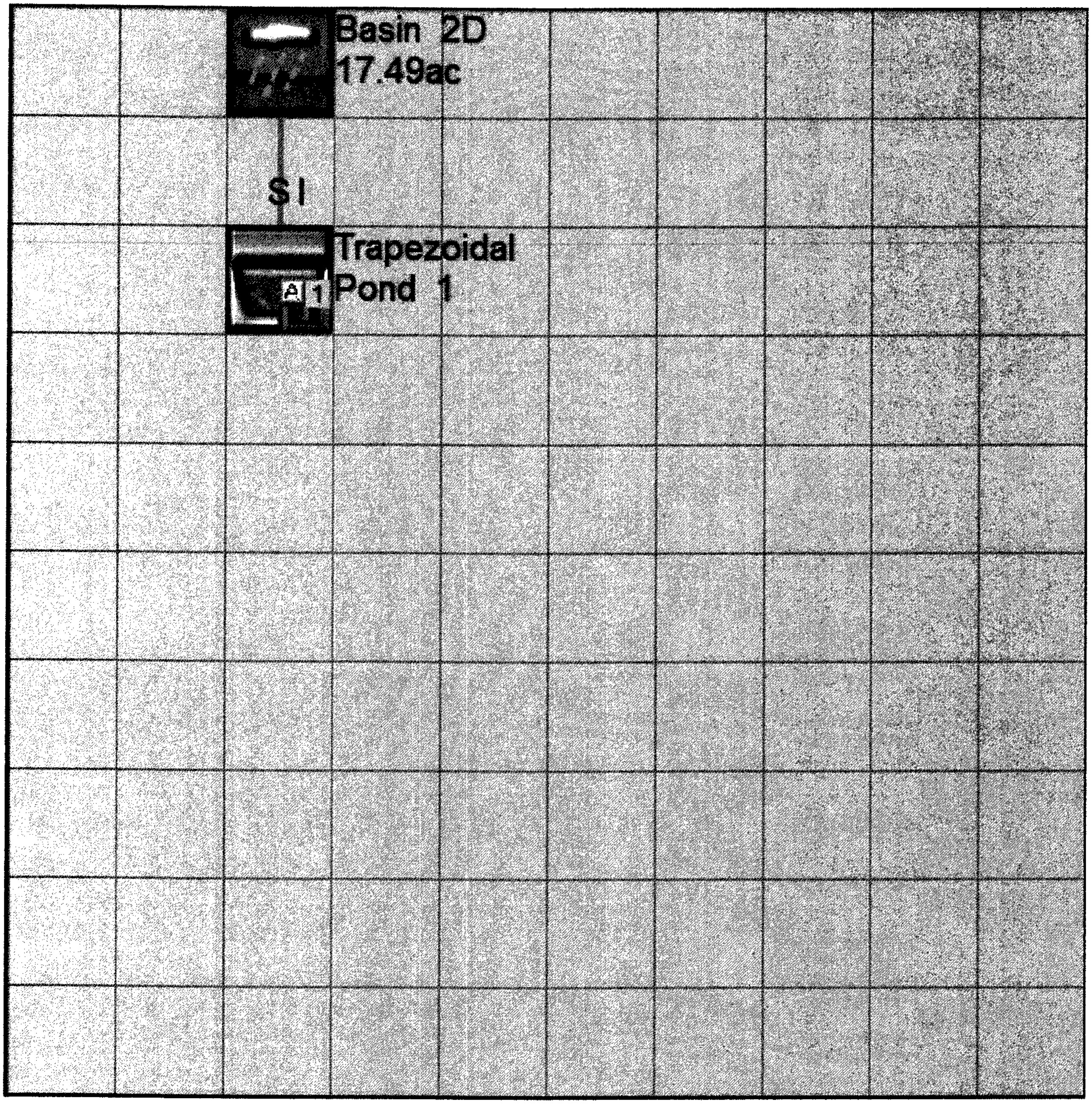
Water Quality BMP Flow and Volume for POC #1

On-line facility volume:	2.0201 acre-feet
On-line facility target flow:	2.7556 cfs.
Adjusted for 15 min:	2.7556 cfs.
Off-line facility target flow:	1.5386 cfs.
Adjusted for 15 min:	1.5386 cfs.

Appendix
Predeveloped Schematic



Mitigated Schematic



TRACT 'H' FACILITY

WWHM2012

PROJECT REPORT

General Model Information

Project Name:	8938.e.Green Mtn Ph1-Prelim-Tract H Pond
Site Name:	Green Mountain
Site Address:	NE Goodwin Road
City:	Camas, WA.
Report Date:	12/23/2014
Gage:	Lacamas
Data Start:	1948/10/01
Data End:	2008/09/30
Timestep:	15 Minute
Precip Scale:	1.30
Version:	2014/09/12

POC Thresholds

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

Landuse Basin Data
Predeveloped Land Use

Basin 1P

Bypass:	No
GroundWater:	No
Pervious Land Use	Acres
SG4, Forest, Mod	8.612
Pervious Total	8.612
Impervious Land Use	Acres
Impervious Total	0
Basin Total	8.612

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Basin 1Da

Bypass:	No
GroundWater:	No
Pervious Land Use	Acres
SG3, Lawn, Mod	2.053
Pervious Total	2.053
Impervious Land Use	Acres
ROADS MOD	0.965
ROOF TOPS FLAT	2.066
DRIVEWAYS MOD	0.413
SIDEWALKS MOD	0.318
POND	0.921
Impervious Total	4.683
Basin Total	6.736

Element Flows To:

Surface	Interflow	Groundwater
Trapezoidal Pond 1	Trapezoidal Pond 1	

Basin 1Db (Future Lots)

Bypass:	No
GroundWater:	No
Pervious Land Use	Acres
SG3, Lawn, Mod	0.656
Pervious Total	0.656
Impervious Land Use	Acres
ROADS MOD	0.319
ROOF TOPS FLAT	0.675
DRIVEWAYS MOD	0.131
SIDEWALKS MOD	0.094
Impervious Total	1.219
Basin Total	1.875

Element Flows To:

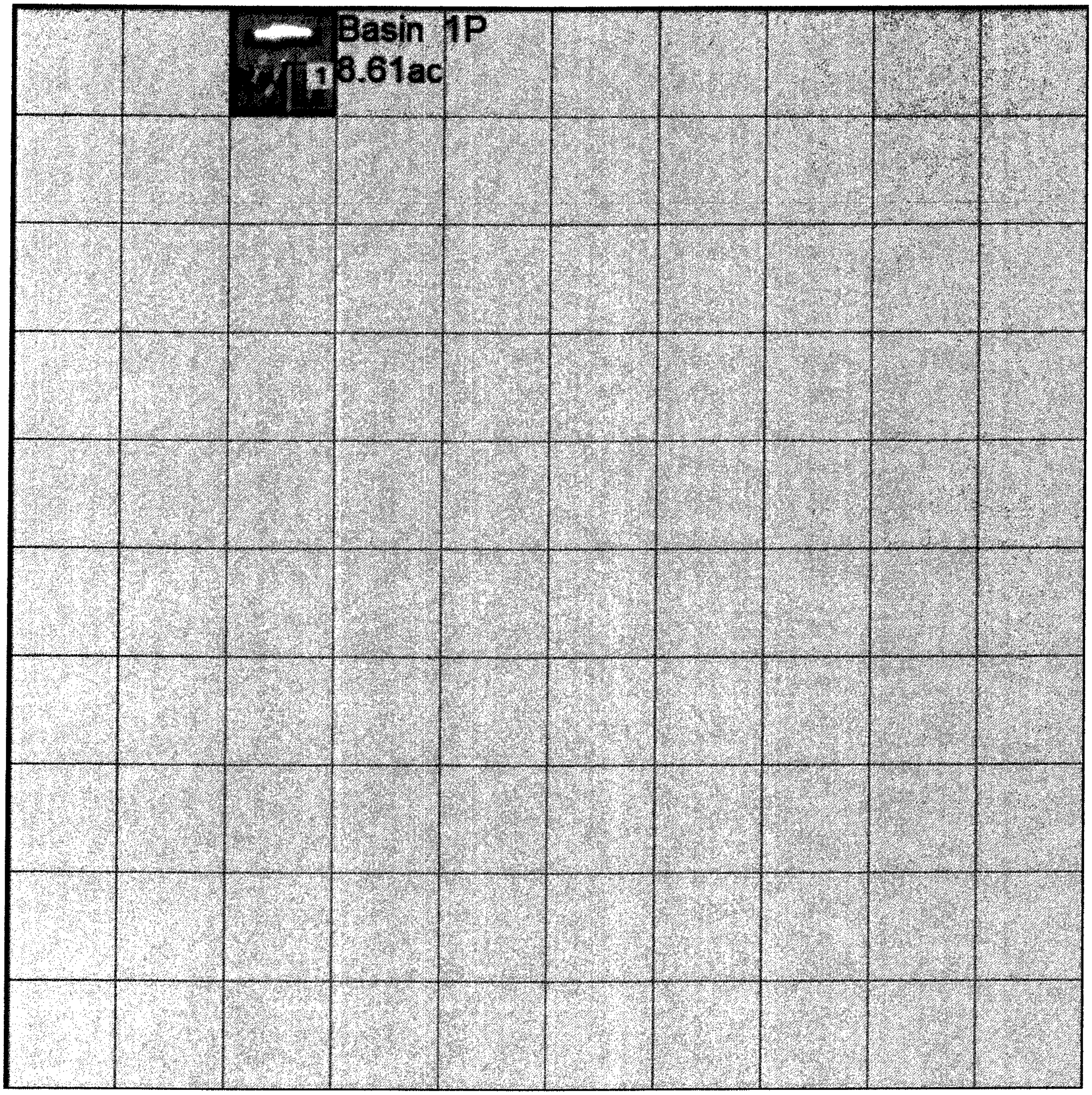
Surface	Interflow	Groundwater
Trapezoidal Pond 1	Trapezoidal Pond 1	

Water Quality

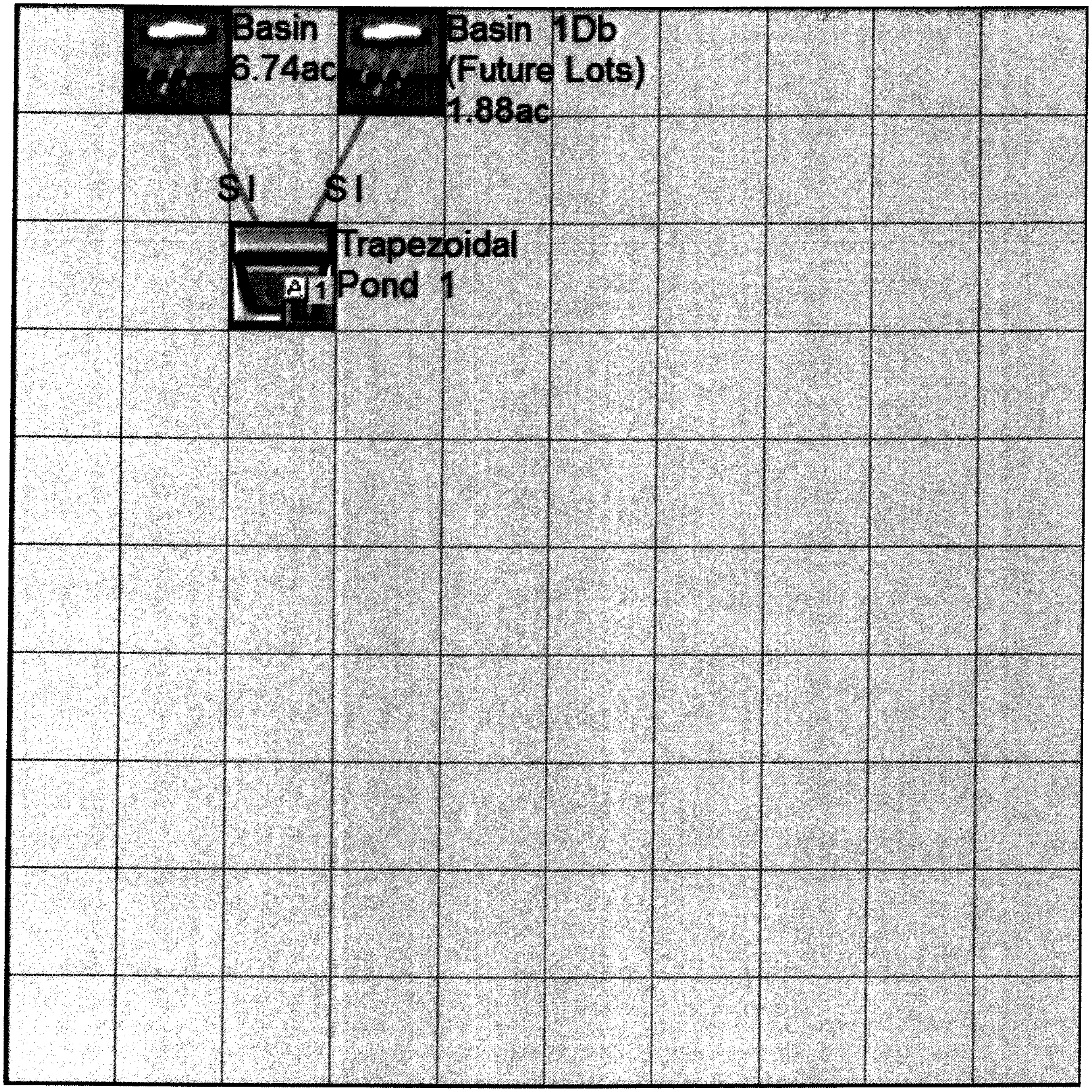
Water Quality BMP Flow and Volume for POC #1

On-line facility volume:	0.9776 acre-feet
On-line facility target flow:	1.284 cfs.
Adjusted for 15 min:	1.284 cfs.
Off-line facility target flow:	0.7159 cfs.
Adjusted for 15 min:	0.7159 cfs.

Appendix
Predeveloped Schematic



Mitigated Schematic



TRACT 'R' FACILITY

WWHM2012

PROJECT REPORT

General Model Information

Project Name:	8938.e.Green Mtn Ph1-Prelim-Tract R Pond-W
Site Name:	Green Mountain
Site Address:	NE Goodwin Road
City:	Camas, WA.
Report Date:	12/23/2014
Gage:	Lacamas
Data Start:	1948/10/01
Data End:	2008/09/30
Timestep:	15 Minute
Precip Scale:	1.30
Version:	2014/09/12

POC Thresholds

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

Landuse Basin Data
Predeveloped Land Use

Basin 4P & 5P

Bypass:	No
GroundWater:	No
Pervious Land Use	Acres
SG4, Forest, Mod	26.54
Pervious Total	26.54
Impervious Land Use	Acres
Impervious Total	0
Basin Total	26.54

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Basin 4D

Bypass:	No
GroundWater:	No
Pervious Land Use	Acres
SG3, Lawn, Mod	12.548
Pervious Total	12.548
Impervious Land Use	Acres
ROADS MOD	3.491
ROOF TOPS FLAT	6.198
DRIVEWAYS MOD	1.24
SIDEWALKS MOD	1.063
POND	2
Impervious Total	13.992
Basin Total	26.54

Element Flows To:

Surface	Interflow	Groundwater
Trapezoidal Pond 1	Trapezoidal Pond 1	

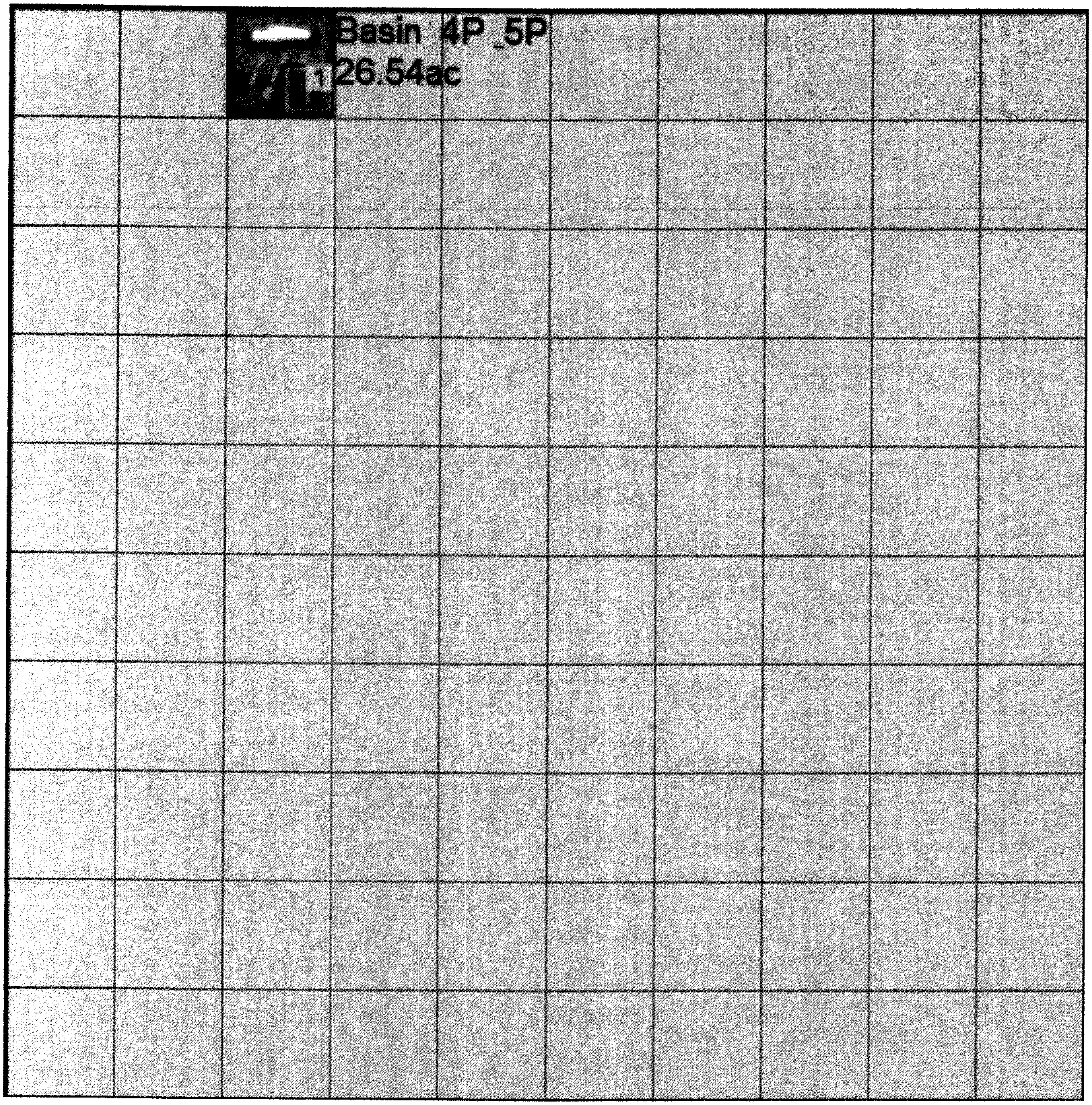
Water Quality

Water Quality BMP Flow and Volume for POC #1

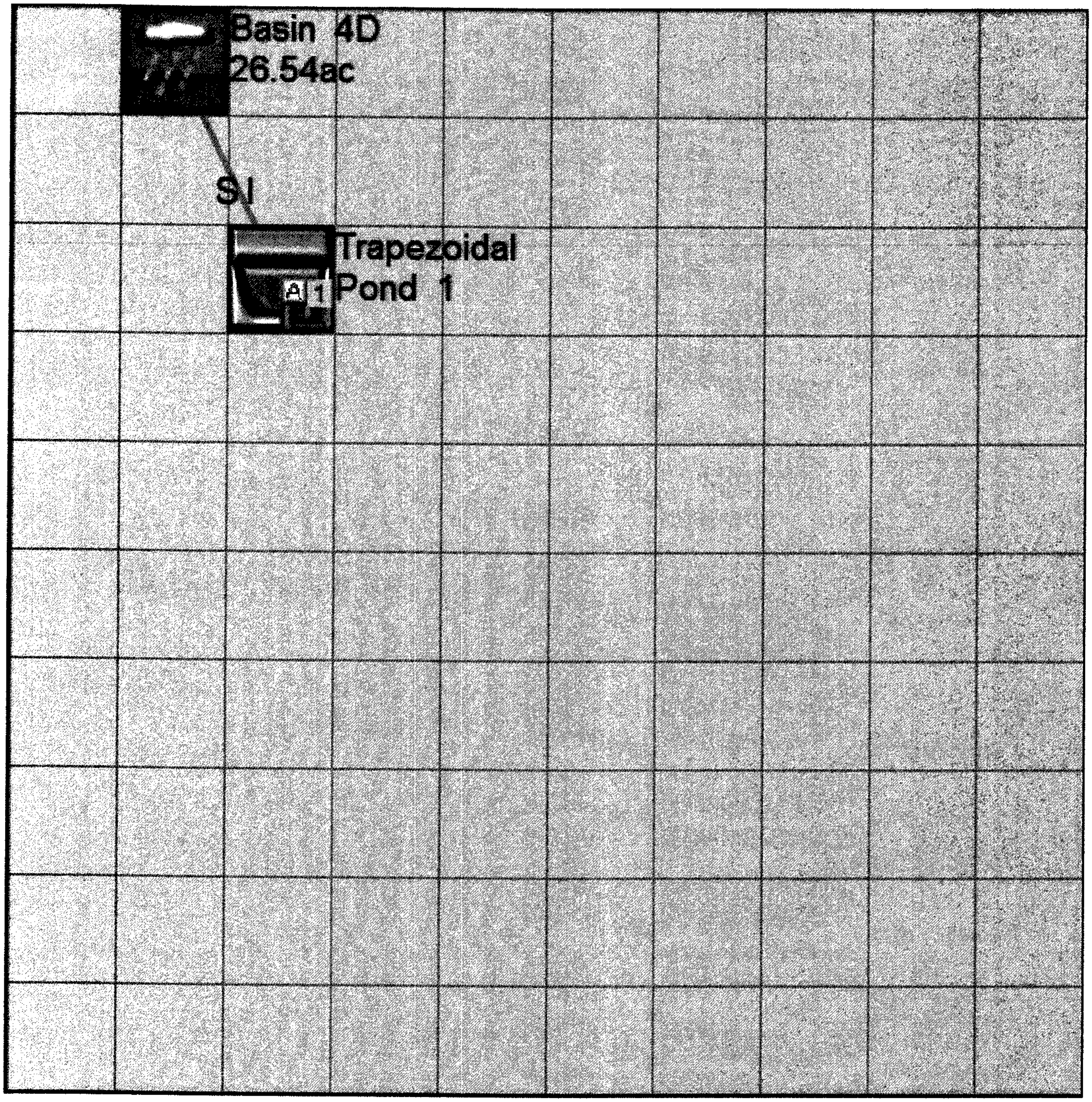
On-line facility volume:	2.5745 acre-feet
On-line facility target flow:	3.1011 cfs.
Adjusted for 15 min:	3.1011 cfs.
Off-line facility target flow:	1.7175 cfs.
Adjusted for 15 min:	1.7175 cfs.

Appendix

Predeveloped Schematic



Mitigated Schematic



Project: Green Mountain
Subject: Wetpool Calculations
Date: December 23, 2014

Wetpool Design Calculations

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

<u>Step 1:</u> Identify required wetpool volume using the sizing procedure.

The 91st percentile, 24-hour runoff volume, estimated by WWHM2012 continuous runoff model (refer to WWHM2012 report):

24-hour volume = 2.0201 ac-ft
(2.0201 ac-ft)*(43,560.17 sf/ac) = **<u>87,996 cf</u>**

<u>Step 2:</u> Multiply the required wetpool volume by a factor of 1.5 to calculate the "large" wetpool volume required for phosphorus control.

(87,996 cf)*(1.5) = **<u>131,994 cf</u>**

<u>Step 3:</u> Calculate the surface area of the stormwater wetpool. Calculate the surface area of the stormwater wetpool by using the volume from Step 1 and dividing by the average water depth (use 4 ft.).

$V_{Total} = h(A_1 + A_2)/2$ where: V_{Total} = total wetpool volume (cf)
h = wetpool average depth (ft)
A_1 = water quality design surface area of wetpool (sf)
A_2 = bottom area of wetpool (sf)
= $(L_1 - 24 \text{ ft})*(W_1 - 24 \text{ ft})$

131,994 cf = (4 ft)*(A_1 + A_2)/2

131,994 cf / 4 ft = 32,999 sf @ 2.0 ft. depth (mid. depth)

32,999 sf = 181.7 ft Length x 181.7 ft Width

A_1 = Top = (182 ft + 12 ft)*(182 ft + 12 ft) = (194 ft)*(194 ft) = 37,636 sf

A_2 = Bottom = (182 ft - 12 ft)*(182 ft - 12 ft) = (170 ft)*(170 ft) = 28,900 sf

Check: (4ft)*(28,900 sf + 37,636 sf)/2 = 133,072 cf => O.K.

A_1 = Top = 37,636 sf A_2 = Bottom = 28,900 sf

⇨ Minimum required for surface area of wetpond = **<u>37,636 sf</u>** **(Design provides 43,103 sf)**

<u>Tract 'H' Wetpool:</u>

<u>Step 1:</u> Identify required wetpool volume using the sizing procedure.

The 91st percentile, 24-hour runoff volume, estimated by WWHM2012 continuous runoff model (refer to WWHM2012 report):

24-hour volume = 0.9776 ac-ft
(0.9776 ac-ft)*(43,560.17 sf/ac) = **<u>42,584 cf</u>**

<u>Step 2:</u> Multiply the required wetpool volume by a factor of 1.5 to calculate the "large" wetpool volume required for phosphorus control.

(42,584 cf)*(1.5) = **<u>63,876 cf</u>**

<u>Step 3:</u> Calculate the surface area of the stormwater wetpool. Calculate the surface area of the stormwater wetpool by using the volume from Step 1 and dividing by the average water depth (use 4 ft.).

$V_{Total} = h(A_1 + A_2)/2$

where: V_{Total} = total wetpool volume (cf)
h = wetpool average depth (ft)
A_1 = water quality design surface area of wetpool (sf)
A_2 = bottom area of wetpool (sf)
= $(L_1 - 24\text{ ft})*(W_1 - 24\text{ ft})$

63,876 cf = (4 ft)*($A_1 + A_2$)/2

63,876 cf / 4 ft = 15,969 sf @ 2.0 ft. depth (mid. depth)

15,969 sf = 126.4 ft Length x 126.4 ft Width

A_1 = Top = (127 ft + 12 ft)*(127 ft + 12 ft) = (139 ft)*(139 ft) = 19,321 sf

A_2 = Bottom = (127 ft - 12 ft)*(127 ft - 12 ft) = (115 ft)*(115 ft) = 13,225 sf

Check: (4ft)*(13,225 sf + 19,321 sf)/2 = 65,092 cf => O.K.

A_1 = Top = 19,321 sf A_2 = Bottom = 13,225 sf

⇨ Minimum required for surface area of wetpond = **<u>19,321 sf</u>** **(Design provides 20,664 sf)**

Tract 'R' Wetpool:

Step 1: Identify required wetpool volume using the sizing procedure.

The 91st percentile, 24-hour runoff volume, estimated by WWHM2012 continuous runoff model (refer to WWHM2012 report):

24-hour volume = 2.5745 ac-ft
(2.5745 ac-ft)*(43,560.17 sf/ac) = **112,145 cf**

Step 2: Multiply the required wetpool volume by a factor of 1.5 to calculate the "large" wetpool volume required for phosphorus control.

(112,145 cf)*(1.5) = **168,218 cf**

Step 3: Calculate the surface area of the stormwater wetpool. Calculate the surface area of the stormwater wetpool by using the volume from Step 1 and dividing by the average water depth (use 4 ft.).

$V_{Total} = h(A_1 + A_2)/2$

where: V_{Total} = total wetpool volume (cf)
h = wetpool average depth (ft)
A_1 = water quality design surface area of wetpool (sf)
A_2 = bottom area of wetpool (sf)
= $(L_1 - 24\ ft)*(W_1 - 24\ ft)$

168,218 cf = (4 ft)*($A_1 + A_2$)/2

168,218 cf / 4 ft = 42,055 sf @ 2.0 ft. depth (mid. depth)

42,055 sf = 205.1 ft Length x 205.1 ft Width

A_1 = Top = (205 ft + 12 ft)*(205 ft + 12 ft) = (217 ft)*(217 ft) = 47,089 sf

A_2 = Bottom = (205 ft - 12 ft)*(205 ft - 12 ft) = (193 ft)*(193 ft) = 37,249 sf

Check: (4ft)*(37,249 sf + 47,089 sf)/2 = 168,676 cf => O.K.

A_1 = Top = 47,089 sf A_2 = Bottom = 37,249 sf

⇨ Minimum required for surface area of wetpond = **47,089 sf** **(Design provides 48,550 sf)**

E

TRACT 'A' FACILITY

WWHM2012

PROJECT REPORT

General Model Information

Project Name:	8938.e.Green Mtn Ph1-Prelim-Tract A Pond
Site Name:	Green Mountain
Site Address:	NE Goodwin Road
City:	Camas, WA.
Report Date:	12/23/2014
Gage:	Lacamas
Data Start:	1948/10/01
Data End:	2008/09/30
Timestep:	15 Minute
Precip Scale:	1.30
Version:	2014/09/12

POC Thresholds

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

Landuse Basin Data
Predeveloped Land Use

Basin 2P

Bypass:	No
GroundWater:	No
Pervious Land Use	Acres
SG4, Forest, Mod	17.491
Pervious Total	17.491
Impervious Land Use	Acres
Impervious Total	0
Basin Total	17.491

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Basin 2D

Bypass:	No
GroundWater:	No
Pervious Land Use	Acres
SG3, Lawn, Mod	4.985
Pervious Total	4.985
Impervious Land Use	Acres
ROADS MOD	4.44
ROOF TOPS FLAT	4.075
DRIVEWAYS MOD	0.815
SIDEWALKS MOD	1.147
POND	2.029
Impervious Total	12.506
Basin Total	17.491

Element Flows To:

Surface	Interflow	Groundwater
Trapezoidal Pond 1	Trapezoidal Pond 1	

Routing Elements
Predeveloped Routing

Mitigated Routing

Trapezoidal Pond 1

Bottom Length:	194.00 ft.
Bottom Width:	194.00 ft.
Depth:	3 ft.
Volume at riser head:	1.8371 acre-ft.
Side slope 1:	3 To 1
Side slope 2:	3 To 1
Side slope 3:	3 To 1
Side slope 4:	3 To 1
Discharge Structure	
Riser Height:	2 ft.
Riser Diameter:	18 in.
Notch Type:	Rectangular
Notch Width:	1.500 ft.
Notch Height:	0.734 ft.
Orifice 1 Diameter:	9.123 in. Elevation:0 ft.
Element Flows To:	
Outlet 1	Outlet 2

Pond Hydraulic Table

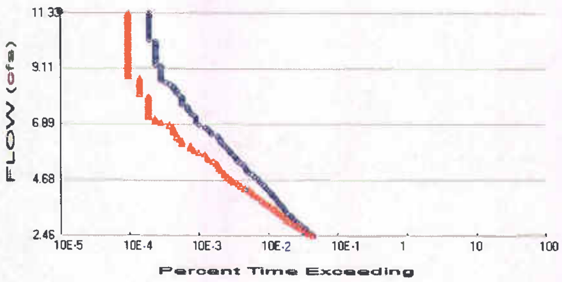
Stage(ft)	Area(ac)	Volume(ac-ft)	Discharge(cfs)	Infilt(cfs)
0.0000	0.864	0.000	0.000	0.000
0.0333	0.865	0.028	0.399	0.000
0.0667	0.867	0.057	0.564	0.000
0.1000	0.869	0.086	0.691	0.000
0.1333	0.871	0.115	0.798	0.000
0.1667	0.872	0.144	0.892	0.000
0.2000	0.874	0.173	0.977	0.000
0.2333	0.876	0.203	1.055	0.000
0.2667	0.878	0.232	1.128	0.000
0.3000	0.880	0.261	1.197	0.000
0.3333	0.881	0.291	1.262	0.000
0.3667	0.883	0.320	1.323	0.000
0.4000	0.885	0.349	1.382	0.000
0.4333	0.887	0.379	1.438	0.000
0.4667	0.889	0.409	1.493	0.000
0.5000	0.890	0.438	1.545	0.000
0.5333	0.892	0.468	1.596	0.000
0.5667	0.894	0.498	1.645	0.000
0.6000	0.896	0.528	1.693	0.000
0.6333	0.898	0.558	1.739	0.000
0.6667	0.900	0.588	1.784	0.000
0.7000	0.901	0.618	1.828	0.000
0.7333	0.903	0.648	1.871	0.000
0.7667	0.905	0.678	1.914	0.000
0.8000	0.907	0.708	1.955	0.000
0.8333	0.909	0.738	1.995	0.000
0.8667	0.910	0.769	2.035	0.000
0.9000	0.912	0.799	2.073	0.000
0.9333	0.914	0.829	2.111	0.000
0.9667	0.916	0.860	2.149	0.000
1.0000	0.918	0.891	2.185	0.000
1.0333	0.920	0.921	2.222	0.000

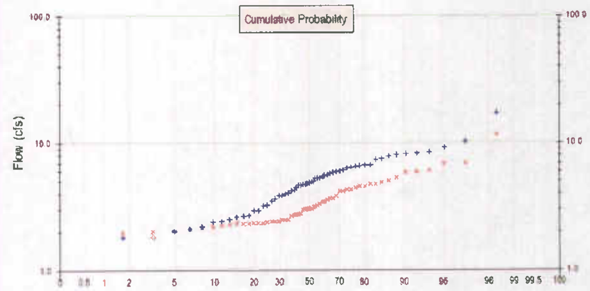
1.0667	0.922	0.952	2.257	0.000
1.1000	0.923	0.983	2.292	0.000
1.1333	0.925	1.013	2.327	0.000
1.1667	0.927	1.044	2.361	0.000
1.2000	0.929	1.075	2.394	0.000
1.2333	0.931	1.106	2.427	0.000
1.2667	0.933	1.137	2.460	0.000
1.3000	0.934	1.169	2.523	0.000
1.3333	0.936	1.200	2.611	0.000
1.3667	0.938	1.231	2.714	0.000
1.4000	0.940	1.262	2.831	0.000
1.4333	0.942	1.294	2.958	0.000
1.4667	0.944	1.325	3.095	0.000
1.5000	0.946	1.357	3.242	0.000
1.5333	0.947	1.388	3.396	0.000
1.5667	0.949	1.420	3.558	0.000
1.6000	0.951	1.451	3.728	0.000
1.6333	0.953	1.483	3.905	0.000
1.6667	0.955	1.515	4.088	0.000
1.7000	0.957	1.547	4.277	0.000
1.7333	0.959	1.579	4.472	0.000
1.7667	0.961	1.611	4.674	0.000
1.8000	0.962	1.643	4.881	0.000
1.8333	0.964	1.675	5.093	0.000
1.8667	0.966	1.707	5.310	0.000
1.9000	0.968	1.740	5.533	0.000
1.9333	0.970	1.772	5.761	0.000
1.9667	0.972	1.804	5.994	0.000
2.0000	0.974	1.837	6.231	0.000
2.0333	0.976	1.869	6.345	0.000
2.0667	0.978	1.902	6.533	0.000
2.1000	0.979	1.934	6.769	0.000
2.1333	0.981	1.967	7.044	0.000
2.1667	0.983	2.000	7.351	0.000
2.2000	0.985	2.033	7.688	0.000
2.2333	0.987	2.066	8.053	0.000
2.2667	0.989	2.098	8.442	0.000
2.3000	0.991	2.131	8.855	0.000
2.3333	0.993	2.165	9.290	0.000
2.3667	0.995	2.198	9.746	0.000
2.4000	0.997	2.231	10.22	0.000
2.4333	0.998	2.264	10.71	0.000
2.4667	1.000	2.297	11.23	0.000
2.5000	1.002	2.331	11.76	0.000
2.5333	1.004	2.364	12.30	0.000
2.5667	1.006	2.398	12.87	0.000
2.6000	1.008	2.431	13.45	0.000
2.6333	1.010	2.465	14.05	0.000
2.6667	1.012	2.499	14.66	0.000
2.7000	1.014	2.533	15.28	0.000
2.7333	1.016	2.566	15.92	0.000
2.7667	1.018	2.600	16.58	0.000
2.8000	1.020	2.634	17.25	0.000
2.8333	1.022	2.668	17.93	0.000
2.8667	1.024	2.702	18.62	0.000
2.9000	1.025	2.737	19.33	0.000
2.9333	1.027	2.771	20.05	0.000
2.9667	1.029	2.805	20.78	0.000

3.0000	1.031	2.839	21.53	0.000
3.0333	1.033	2.874	22.29	0.000

Analysis Results

POC 1





+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 17.491
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 4.985
Total Impervious Area: 12.506

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	4.920127
5 year	7.5772
10 year	9.011185
25 year	10.465236
50 year	11.327199
100 year	12.034828

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	3.149125
5 year	4.422885
10 year	5.401487
25 year	6.802812
50 year	7.97383
100 year	9.260231

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1949	3.699	3.000
1950	4.770	2.697
1951	6.466	2.389
1952	3.882	4.165
1953	5.289	2.354
1954	8.092	2.784
1955	4.064	2.117
1956	7.458	6.078
1957	6.594	3.058
1958	4.894	5.341

1959	2.959	2.049
1960	2.719	3.048
1961	6.803	3.692
1962	4.757	2.759
1963	5.324	2.525
1964	4.940	2.456
1965	4.236	3.139
1966	5.925	3.024
1967	5.354	2.433
1968	6.406	4.747
1969	6.132	7.011
1970	16.965	11.540
1971	2.708	2.224
1972	4.326	2.338
1973	4.500	3.559
1974	6.812	5.858
1975	3.874	2.370
1976	5.849	3.327
1977	0.174	1.969
1978	8.518	4.286
1979	5.556	4.574
1980	3.218	2.199
1981	7.629	4.410
1982	5.046	4.870
1983	9.227	4.285
1984	2.978	2.167
1985	2.145	2.794
1986	2.658	3.233
1987	4.692	2.524
1988	2.241	2.317
1989	2.423	2.435
1990	2.063	2.357
1991	5.448	2.517
1992	5.635	2.322
1993	6.689	4.993
1994	4.828	3.466
1995	3.986	4.537
1996	8.386	6.885
1997	10.221	5.769
1998	8.260	3.814
1999	5.761	3.493
2000	3.296	1.952
2001	1.819	2.021
2002	7.947	3.051
2003	6.051	3.673
2004	1.848	3.207
2005	2.460	2.341
2006	4.663	2.731
2007	2.541	4.173
2008	3.511	4.750

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	**Predeveloped**	**Mitigated**
1	16.9652	11.5396
2	10.2213	7.0112
3	9.2270	6.8852
4	8.5178	6.0777

5	8.3862	5.8579
6	8.2596	5.7687
7	8.0919	5.3408
8	7.9468	4.9929
9	7.6288	4.8701
10	7.4583	4.7502
11	6.8121	4.7473
12	6.8032	4.5739
13	6.6891	4.5369
14	6.5941	4.4103
15	6.4660	4.2860
16	6.4063	4.2851
17	6.1323	4.1726
18	6.0510	4.1647
19	5.9253	3.8136
20	5.8487	3.6916
21	5.7606	3.6733
22	5.6350	3.5592
23	5.5560	3.4931
24	5.4482	3.4661
25	5.3543	3.3270
26	5.3236	3.2325
27	5.2891	3.2072
28	5.0462	3.1388
29	4.9397	3.0580
30	4.8939	3.0507
31	4.8279	3.0483
32	4.7705	3.0239
33	4.7570	3.0003
34	4.6919	2.7938
35	4.6629	2.7841
36	4.4998	2.7590
37	4.3257	2.7313
38	4.2357	2.6975
39	4.0643	2.5250
40	3.9863	2.5238
41	3.8824	2.5174
42	3.8740	2.4555
43	3.6989	2.4350
44	3.5108	2.4327
45	3.2958	2.3889
46	3.2175	2.3700
47	2.9777	2.3572
48	2.9594	2.3543
49	2.7186	2.3408
50	2.7080	2.3377
51	2.6577	2.3220
52	2.5405	2.3175
53	2.4601	2.2245
54	2.4231	2.1991
55	2.2410	2.1672
56	2.1455	2.1167
57	2.0632	2.0487
58	1.8482	2.0207
59	1.8188	1.9685
60	0.1745	1.9521

Duration Flows
The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
2.4601	894	893	99	Pass
2.5496	823	762	92	Pass
2.6392	755	674	89	Pass
2.7288	687	589	85	Pass
2.8183	626	527	84	Pass
2.9079	576	476	82	Pass
2.9975	535	429	80	Pass
3.0870	490	379	77	Pass
3.1766	456	348	76	Pass
3.2662	430	320	74	Pass
3.3557	392	296	75	Pass
3.4453	363	275	75	Pass
3.5349	346	251	72	Pass
3.6244	324	222	68	Pass
3.7140	304	201	66	Pass
3.8036	287	181	63	Pass
3.8931	271	163	60	Pass
3.9827	253	143	56	Pass
4.0723	237	127	53	Pass
4.1618	226	123	54	Pass
4.2514	211	109	51	Pass
4.3410	193	96	49	Pass
4.4305	182	84	46	Pass
4.5201	165	76	46	Pass
4.6097	152	66	43	Pass
4.6992	145	61	42	Pass
4.7888	131	55	41	Pass
4.8784	120	50	41	Pass
4.9679	107	49	45	Pass
5.0575	100	44	44	Pass
5.1471	96	42	43	Pass
5.2366	91	40	43	Pass
5.3262	83	38	45	Pass
5.4158	75	34	45	Pass
5.5053	71	29	40	Pass
5.5949	69	28	40	Pass
5.6845	62	26	41	Pass
5.7740	59	21	35	Pass
5.8636	56	18	32	Pass
5.9532	52	16	30	Pass
6.0427	49	16	32	Pass
6.1323	44	12	27	Pass
6.2219	43	12	27	Pass
6.3114	41	11	26	Pass
6.4010	39	10	25	Pass
6.4906	32	10	31	Pass
6.5801	30	9	30	Pass
6.6697	28	9	32	Pass
6.7593	26	9	34	Pass
6.8488	21	8	38	Pass
6.9384	19	6	31	Pass
7.0280	19	5	26	Pass
7.1175	19	5	26	Pass

7.2071	18	4	22	Pass
7.2967	16	4	25	Pass
7.3862	15	4	26	Pass
7.4758	14	4	28	Pass
7.5654	14	4	28	Pass
7.6550	12	4	33	Pass
7.7445	12	4	33	Pass
7.8341	12	4	33	Pass
7.9237	12	4	33	Pass
8.0132	11	4	36	Pass
8.1028	10	3	30	Pass
8.1924	10	3	30	Pass
8.2819	9	3	33	Pass
8.3715	9	3	33	Pass
8.4611	8	3	37	Pass
8.5506	7	3	42	Pass
8.6402	6	3	50	Pass
8.7298	6	3	50	Pass
8.8193	6	2	33	Pass
8.9089	6	2	33	Pass
8.9985	6	2	33	Pass
9.0880	6	2	33	Pass
9.1776	6	2	33	Pass
9.2672	5	2	40	Pass
9.3567	5	2	40	Pass
9.4463	5	2	40	Pass
9.5359	5	2	40	Pass
9.6254	5	2	40	Pass
9.7150	5	2	40	Pass
9.8046	5	2	40	Pass
9.8941	5	2	40	Pass
9.9837	5	2	40	Pass
10.0733	5	2	40	Pass
10.1628	5	2	40	Pass
10.2524	4	2	50	Pass
10.3420	4	2	50	Pass
10.4315	4	2	50	Pass
10.5211	4	2	50	Pass
10.6107	4	2	50	Pass
10.7002	4	2	50	Pass
10.7898	4	2	50	Pass
10.8794	4	2	50	Pass
10.9689	4	2	50	Pass
11.0585	4	2	50	Pass
11.1481	4	2	50	Pass
11.2376	4	2	50	Pass
11.3272	4	2	50	Pass

Water Quality

Water Quality BMP Flow and Volume for POC #1

On-line facility volume:	2.0201 acre-feet
On-line facility target flow:	2.7556 cfs.
Adjusted for 15 min:	2.7556 cfs.
Off-line facility target flow:	1.5386 cfs.
Adjusted for 15 min:	1.5386 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
Trapezoidal Pond 1 POC	☐	2608.81			☐	0.00			
Total Volume Infiltrated		2608.81	0.00	0.00		0.00	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50-yr									Duration Analysis Result = Failed

Model Default Modifications

Total of 0 changes have been made.

PERLND Changes

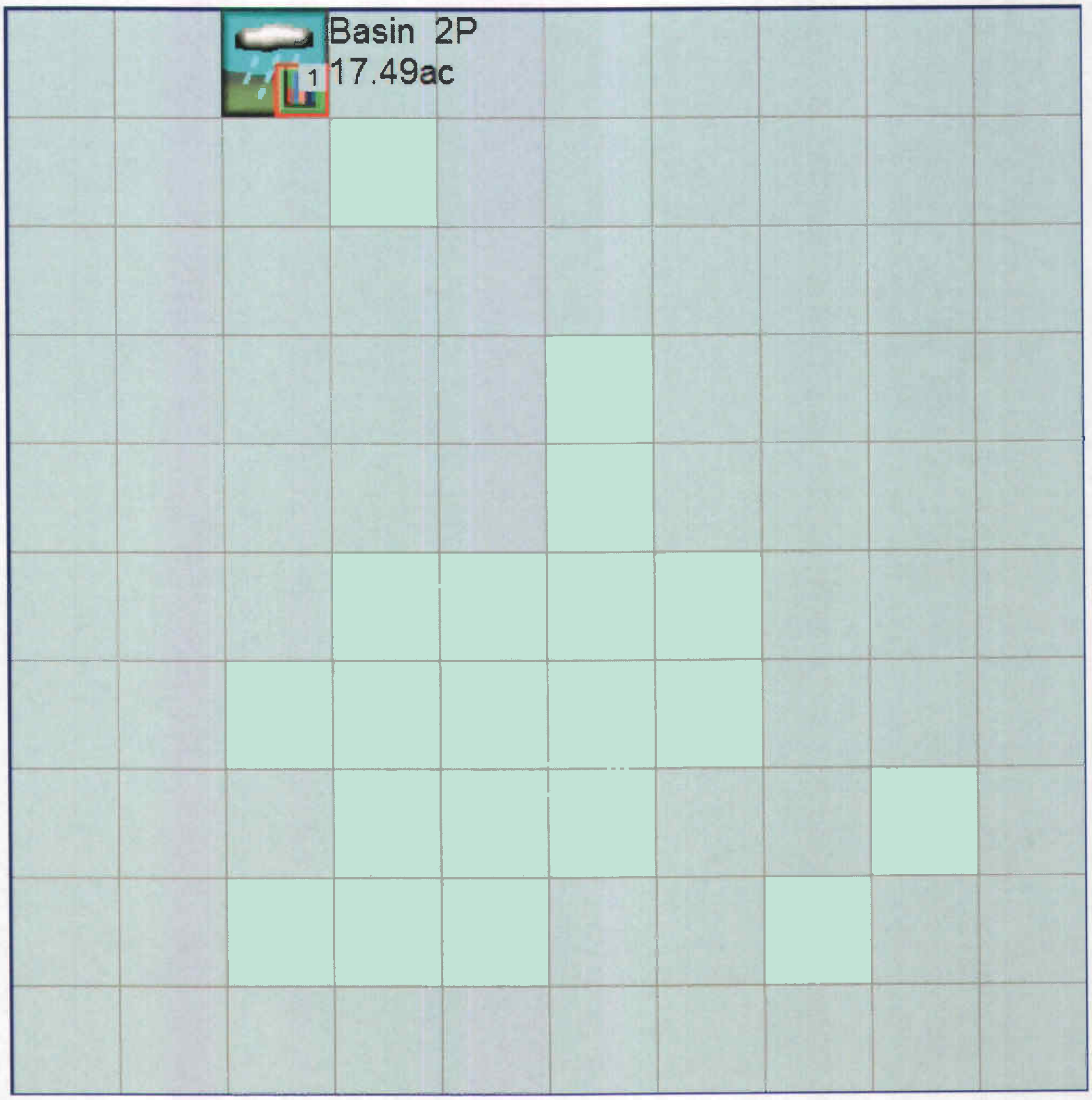
No PERLND changes have been made.

IMPLND Changes

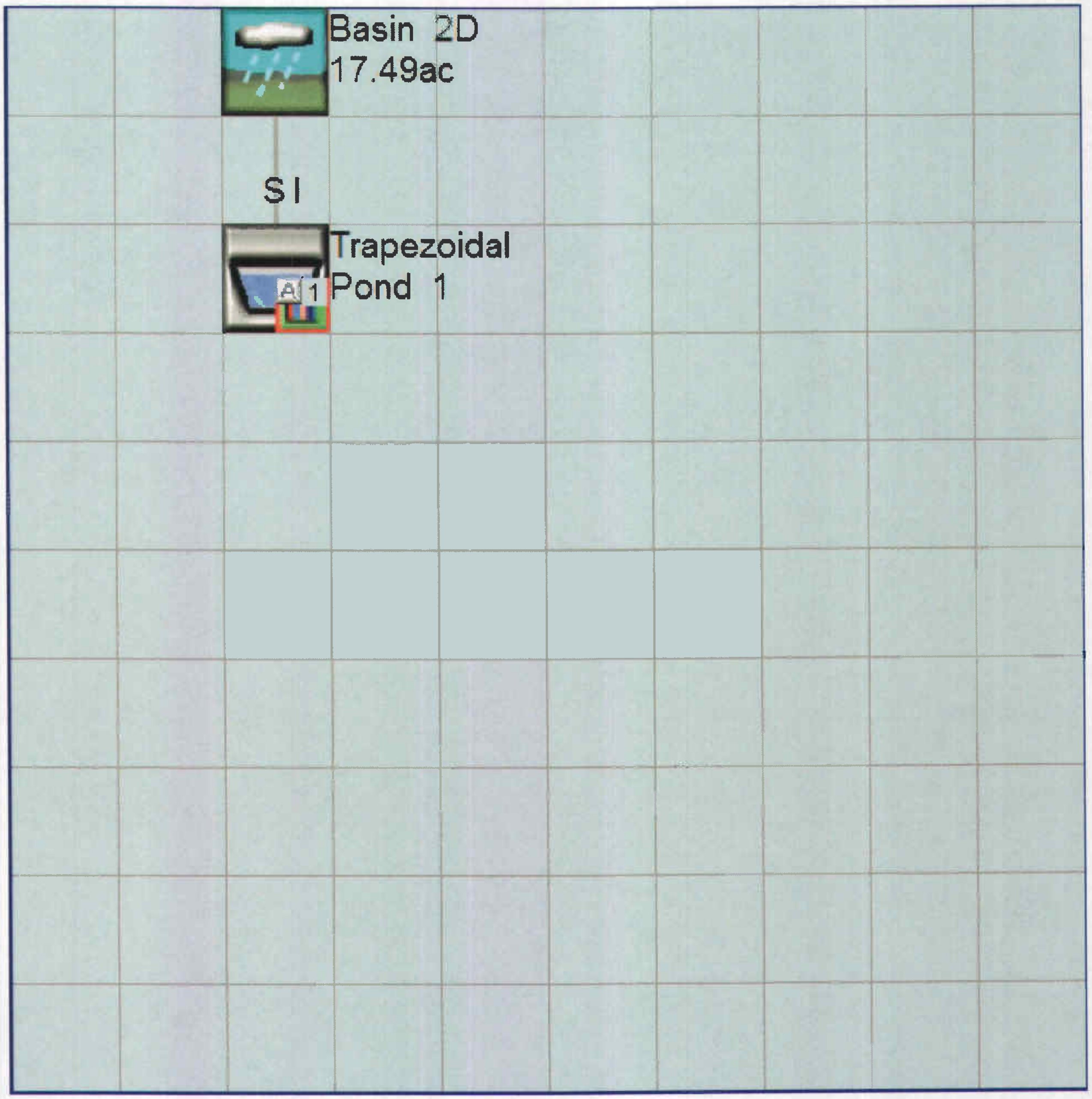
No IMPLND changes have been made.

Appendix

Predeveloped Schematic



Mitigated Schematic



Predeveloped UCI File

```
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   8938.e.Green Mtn Ph1-Prelim-Tract K Pond.wdm
MESSU      25   Pre8938.e.Green Mtn Ph1-Prelim-Tract K Pond.MES
           27   Pre8938.e.Green Mtn Ph1-Prelim-Tract K Pond.L61
           28   Pre8938.e.Green Mtn Ph1-Prelim-Tract K Pond.L62
           30   POC8938.e.Green Mtn Ph1-Prelim-Tract K Pond1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      29
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Basin  2P                   MAX                   1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         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            ***
   29      SG4, Forest, Mod        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 ***
   29         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  *********
   29         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 ***
   29       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
   29           0           6      0.04       400       0.1         0      0.96
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   29           0           0         3         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                               ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   29            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
   29           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           ***
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
  END PRINT-INFO

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

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
  END IWAT-PARM2

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

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
  END IWAT-STATE1
```

```
END IMPLND

SCHEMATIC
<-Source->                    <--Area-->     <-Target->    MBLK    ***
<Name>    #                   <-factor->     <Name>    #   Tbl#    ***
Basin  2P***
PERLND  29                       17.491      COPY    501     12
PERLND  29                       17.491      COPY    501     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


<-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
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

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   8938.e.Green Mtn Ph1-Prelim-Tract K Pond.wdm
MESSU      25   Mit8938.e.Green Mtn Ph1-Prelim-Tract K Pond.MES
           27   Mit8938.e.Green Mtn Ph1-Prelim-Tract K Pond.L61
           28   Mit8938.e.Green Mtn Ph1-Prelim-Tract K Pond.L62
           30   POC8938.e.Green Mtn Ph1-Prelim-Tract K Pond1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      26
      IMPLND       2
      IMPLND       4
      IMPLND       6
      IMPLND       9
      IMPLND      14
      RCHRES       1
      COPY         1
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Trapezoidal Pond  1         MAX                    1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         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           ***
   26      SG3, Lawn, Mod          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 ***
   26         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  *********
 26         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 ***
 26         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
 26              0         6      0.05       400       0.1         0      0.96
END PWAT-PARM2

PWAT-PARM3
  <PLS >      PWATER input info: Part 3         ***
  # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
 26              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 ***
 26            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
 26              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           ***
    2      ROADS/MOD                1     1    1   27    0
    4      ROOF TOPS/FLAT           1     1    1   27    0
    6      DRIVEWAYS/MOD            1     1    1   27    0
    9      SIDEWALKS/MOD            1     1    1   27    0
   14      POND                     1     1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    2         0    0    1    0    0    0
    4         0    0    1    0    0    0
    6         0    0    1    0    0    0
    9         0    0    1    0    0    0
   14         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   *********
    2         0    0    4    0    0    0    1    9
    4         0    0    4    0    0    0    1    9
    6         0    0    4    0    0    0    1    9
    9         0    0    4    0    0    0    1    9
   14         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      ***
  2          0    0    0    0    0
  4          0    0    0    0    0
  6          0    0    0    0    0
  9          0    0    0    0    0
 14          0    0    0    0    0
END IWAT-PARM1

IWAT-PARM2
  <PLS >       IWATER input info: Part 2         ***
  # -  # ***  LSUR      SLSUR       NSUR      RETSC
  2            400       0.05        0.1       0.08
  4            400       0.01        0.1        0.1
  6            400       0.05        0.1       0.08
  9            400       0.05        0.1       0.08
 14            400       0.01        0.1        0.1
END IWAT-PARM2

IWAT-PARM3
  <PLS >       IWATER input info: Part 3         ***
  # -  # ***PETMAX    PETMIN
  2              0         0
  4              0         0
  6              0         0
  9              0         0
 14              0         0
END IWAT-PARM3

IWAT-STATE1
  <PLS > *** Initial conditions at start of simulation
  # -  # ***  RETS      SURS
  2              0         0
  4              0         0
  6              0         0
  9              0         0
 14              0         0
END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                   <--Area-->     <-Target->   MBLK    ***
<Name>   #                   <-factor->     <Name>   #   Tbl#    ***
Basin  2D***
PERLND  26                        4.985     RCHRES   1      2
PERLND  26                        4.985     RCHRES   1      3
IMPLND   2                         4.44     RCHRES   1      5
IMPLND   4                        4.075     RCHRES   1      5
IMPLND   6                        0.815     RCHRES   1      5
IMPLND   9                        1.147     RCHRES   1      5
IMPLND  14                        2.029     RCHRES   1      5

******Routing******
PERLND  26                        4.985     COPY     1     12
IMPLND   2                         4.44     COPY     1     15
IMPLND   4                        4.075     COPY     1     15
IMPLND   6                        0.815     COPY     1     15
IMPLND   9                        1.147     COPY     1     15
IMPLND  14                        2.029     COPY     1     15
PERLND  26                        4.985     COPY     1     13
RCHRES   1                            1     COPY   501     16
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


<-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     Trapezoidal Pond-009    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
  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
  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
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH      STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
    1            1      0.02       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
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
  FTABLE      1
   91    4
     Depth       Area     Volume  Outflow1 Velocity  Travel Time***
      (ft)    (acres) (acre-ft)    (cfs)   (ft/sec)    (Minutes)***
  0.000000  0.350487  0.000000  0.000000
  0.033333  0.351622  0.011702  0.399093
  0.066667  0.352760  0.023442  0.564402
  0.100000  0.353899  0.035219  0.691249
  0.133333  0.355040  0.047035  0.798185
  0.166667  0.356183  0.058889  0.892398
  0.200000  0.357328  0.070780  0.977573
  0.233333  0.358474  0.082710  1.055900
  0.266667  0.359622  0.094679  1.128805
  0.300000  0.360773  0.106685  1.197278
  0.333333  0.361925  0.118730  1.262042
  0.366667  0.363079  0.130814  1.323641
```

0.400000	0.364234	0.142935	1.382498
0.433333	0.365392	0.155096	1.438949
0.466667	0.366551	0.167295	1.493268
0.500000	0.367713	0.179533	1.545679
0.533333	0.368876	0.191809	1.596371
0.566667	0.370041	0.204124	1.645501
0.600000	0.371207	0.216479	1.693207
0.633333	0.372376	0.228872	1.739605
0.666667	0.373546	0.241304	1.784797
0.700000	0.374719	0.253775	1.828872
0.733333	0.375893	0.266285	1.871911
0.766667	0.377069	0.278834	1.913981
0.800000	0.378247	0.291423	1.955147
0.833333	0.379426	0.304051	1.995463
0.866667	0.380608	0.316718	2.034981
0.900000	0.381791	0.329425	2.073746
0.933333	0.382976	0.342171	2.111800
0.966667	0.384163	0.354956	2.149180
1.000000	0.385352	0.367782	2.185921
1.033333	0.386542	0.380647	2.222054
1.066667	0.387735	0.393551	2.257609
1.100000	0.388929	0.406496	2.292613
1.133333	0.390125	0.419480	2.327090
1.166667	0.391323	0.432504	2.361064
1.200000	0.392523	0.445568	2.394556
1.233333	0.393725	0.458672	2.427586
1.266667	0.394928	0.471816	2.460229
1.300000	0.396134	0.485001	2.523421
1.333333	0.397341	0.498225	2.611037
1.366667	0.398550	0.511490	2.714587
1.400000	0.399761	0.524795	2.830980
1.433333	0.400973	0.538141	2.958429
1.466667	0.402188	0.551527	3.095731
1.500000	0.403404	0.564954	3.242003
1.533333	0.404622	0.578421	3.396564
1.566667	0.405842	0.591928	3.558865
1.600000	0.407064	0.605477	3.728456
1.633333	0.408288	0.619066	3.904956
1.666667	0.409514	0.632696	4.088038
1.700000	0.410741	0.646367	4.277417
1.733333	0.411970	0.660079	4.472845
1.766667	0.413201	0.673832	4.674098
1.800000	0.414434	0.687626	4.880979
1.833333	0.415669	0.701461	5.093306
1.866667	0.416905	0.715337	5.310917
1.900000	0.418144	0.729254	5.533662
1.933333	0.419384	0.743213	5.761405
1.966667	0.420626	0.757213	5.994019
2.000000	0.421870	0.771255	6.231386
2.033333	0.423116	0.785338	6.345946
2.066667	0.424363	0.799463	6.533947
2.100000	0.425613	0.813629	6.769689
2.133333	0.426864	0.827837	7.044005
2.166667	0.428117	0.842087	7.351598
2.200000	0.429372	0.856378	7.688896
2.233333	0.430629	0.870711	8.053277
2.266667	0.431887	0.885087	8.442710
2.300000	0.433148	0.899504	8.855562
2.333333	0.434410	0.913963	9.290484
2.366667	0.435674	0.928465	9.746334
2.400000	0.436940	0.943008	10.22213
2.433333	0.438208	0.957594	10.71702
2.466667	0.439477	0.972222	11.23026
2.500000	0.440749	0.986893	11.76116
2.533333	0.442022	1.001605	12.30913
2.566667	0.443297	1.016361	12.87362
2.600000	0.444574	1.031159	13.45414
2.633333	0.445853	1.045999	14.05023
2.666667	0.447134	1.060882	14.66148
2.700000	0.448416	1.075808	15.28751

```
  2.733333  0.449700  1.090777  15.92795
  2.766667  0.450986  1.105788  16.58247
  2.800000  0.452274  1.120842  17.25076
  2.833333  0.453564  1.135940  17.93254
  2.866667  0.454856  1.151080  18.62753
  2.900000  0.456149  1.166263  19.33547
  2.933333  0.457445  1.181490  20.05612
  2.966667  0.458742  1.196760  20.78926
  3.000000  0.460041  1.212073  21.53465
  END FTABLE  1
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   1 HYDR   RO     1 1        1      WDM   1004 FLOW     ENGL      REPL
RCHRES   1 HYDR   STAGE  1 1        1      WDM   1005 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
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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TRACT 'H' FACILITY

WWHM2012

PROJECT REPORT

General Model Information

Project Name:	8938.e.Green Mtn Ph1-Prelim-Tract H Pond
Site Name:	Green Mountain
Site Address:	NE Goodwin Road
City:	Camas, WA.
Report Date:	12/23/2014
Gage:	Lacamas
Data Start:	1948/10/01
Data End:	2008/09/30
Timestep:	15 Minute
Precip Scale:	1.30
Version:	2014/09/12

POC Thresholds

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

Landuse Basin Data
Predeveloped Land Use

Basin 1P

Bypass:	No
GroundWater:	No
Pervious Land Use	Acres
SG4, Forest, Mod	8.612
Pervious Total	8.612
Impervious Land Use	Acres
Impervious Total	0
Basin Total	8.612

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Basin 1Da

Bypass:	No
GroundWater:	No
Pervious Land Use	Acres
SG3, Lawn, Mod	2.053
Pervious Total	2.053
Impervious Land Use	Acres
ROADS MOD	0.965
ROOF TOPS FLAT	2.066
DRIVEWAYS MOD	0.413
SIDEWALKS MOD	0.318
POND	0.921
Impervious Total	4.683
Basin Total	6.736

Element Flows To:

Surface	Interflow	Groundwater
Trapezoidal Pond 1	Trapezoidal Pond 1	

Basin 1Db (Future Lots)

Bypass:	No
GroundWater:	No
Pervious Land Use	Acres
SG3, Lawn, Mod	0.656
Pervious Total	0.656
Impervious Land Use	Acres
ROADS MOD	0.319
ROOF TOPS FLAT	0.675
DRIVEWAYS MOD	0.131
SIDEWALKS MOD	0.094
Impervious Total	1.219
Basin Total	1.875

Element Flows To:

Surface	Interflow	Groundwater
Trapezoidal Pond 1	Trapezoidal Pond 1	

Routing Elements
Predeveloped Routing

Mitigated Routing

Trapezoidal Pond 1

Bottom Length:	139.00 ft.
Bottom Width:	139.00 ft.
Depth:	3 ft.
Volume at riser head:	0.9659 acre-ft.
Side slope 1:	3 To 1
Side slope 2:	3 To 1
Side slope 3:	3 To 1
Side slope 4:	3 To 1
Discharge Structure	
Riser Height:	2 ft.
Riser Diameter:	18 in.
Notch Type:	Rectangular
Notch Width:	1.000 ft.
Notch Height:	0.900 ft.
Orifice 1 Diameter:	6.631 in. Elevation:0 ft.
Element Flows To:	
Outlet 1	Outlet 2

Pond Hydraulic Table

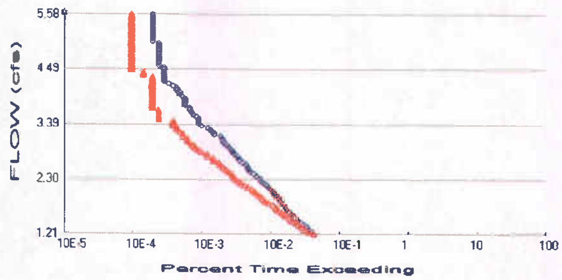
Stage(ft)	Area(ac)	Volume(ac-ft)	Discharge(cfs)	Infilt(cfs)
0.0000	0.443	0.000	0.000	0.000
0.0333	0.444	0.014	0.210	0.000
0.0667	0.446	0.029	0.298	0.000
0.1000	0.447	0.044	0.365	0.000
0.1333	0.448	0.059	0.421	0.000
0.1667	0.450	0.074	0.471	0.000
0.2000	0.451	0.089	0.516	0.000
0.2333	0.452	0.104	0.557	0.000
0.2667	0.453	0.119	0.596	0.000
0.3000	0.455	0.134	0.632	0.000
0.3333	0.456	0.150	0.666	0.000
0.3667	0.457	0.165	0.699	0.000
0.4000	0.459	0.180	0.730	0.000
0.4333	0.460	0.195	0.760	0.000
0.4667	0.461	0.211	0.788	0.000
0.5000	0.462	0.226	0.816	0.000
0.5333	0.464	0.242	0.843	0.000
0.5667	0.465	0.257	0.869	0.000
0.6000	0.466	0.273	0.894	0.000
0.6333	0.468	0.288	0.919	0.000
0.6667	0.469	0.304	0.942	0.000
0.7000	0.470	0.320	0.966	0.000
0.7333	0.472	0.335	0.988	0.000
0.7667	0.473	0.351	1.011	0.000
0.8000	0.474	0.367	1.032	0.000
0.8333	0.476	0.383	1.054	0.000
0.8667	0.477	0.399	1.075	0.000
0.9000	0.478	0.414	1.095	0.000
0.9333	0.480	0.430	1.115	0.000
0.9667	0.481	0.446	1.135	0.000
1.0000	0.482	0.463	1.154	0.000
1.0333	0.484	0.479	1.173	0.000

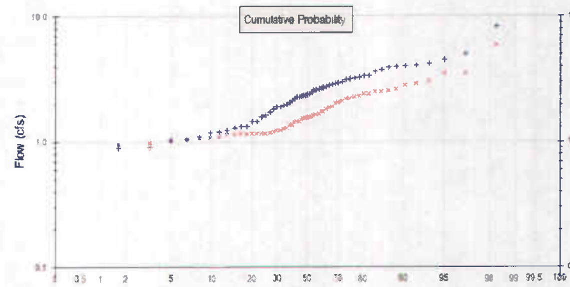
1.0667	0.485	0.495	1.192	0.000
1.1000	0.486	0.511	1.211	0.000
1.1333	0.488	0.527	1.249	0.000
1.1667	0.489	0.544	1.304	0.000
1.2000	0.490	0.560	1.370	0.000
1.2333	0.492	0.576	1.444	0.000
1.2667	0.493	0.593	1.526	0.000
1.3000	0.494	0.609	1.614	0.000
1.3333	0.496	0.626	1.708	0.000
1.3667	0.497	0.642	1.808	0.000
1.4000	0.498	0.659	1.913	0.000
1.4333	0.500	0.675	2.023	0.000
1.4667	0.501	0.692	2.137	0.000
1.5000	0.502	0.709	2.256	0.000
1.5333	0.504	0.726	2.379	0.000
1.5667	0.505	0.742	2.507	0.000
1.6000	0.506	0.759	2.638	0.000
1.6333	0.508	0.776	2.772	0.000
1.6667	0.509	0.793	2.911	0.000
1.7000	0.511	0.810	3.053	0.000
1.7333	0.512	0.827	3.198	0.000
1.7667	0.513	0.844	3.347	0.000
1.8000	0.515	0.862	3.499	0.000
1.8333	0.516	0.879	3.654	0.000
1.8667	0.517	0.896	3.813	0.000
1.9000	0.519	0.913	3.974	0.000
1.9333	0.520	0.931	4.138	0.000
1.9667	0.522	0.948	4.306	0.000
2.0000	0.523	0.965	4.476	0.000
2.0333	0.524	0.983	4.578	0.000
2.0667	0.526	1.000	4.754	0.000
2.1000	0.527	1.018	4.978	0.000
2.1333	0.529	1.036	5.241	0.000
2.1667	0.530	1.053	5.537	0.000
2.2000	0.531	1.071	5.862	0.000
2.2333	0.533	1.089	6.215	0.000
2.2667	0.534	1.107	6.593	0.000
2.3000	0.536	1.124	6.995	0.000
2.3333	0.537	1.142	7.418	0.000
2.3667	0.538	1.160	7.863	0.000
2.4000	0.540	1.178	8.327	0.000
2.4333	0.541	1.196	8.811	0.000
2.4667	0.543	1.214	9.314	0.000
2.5000	0.544	1.232	9.834	0.000
2.5333	0.545	1.251	10.37	0.000
2.5667	0.547	1.269	10.92	0.000
2.6000	0.548	1.287	11.49	0.000
2.6333	0.550	1.305	12.08	0.000
2.6667	0.551	1.324	12.68	0.000
2.7000	0.553	1.342	13.29	0.000
2.7333	0.554	1.361	13.92	0.000
2.7667	0.555	1.379	14.57	0.000
2.8000	0.557	1.398	15.22	0.000
2.8333	0.558	1.416	15.90	0.000
2.8667	0.560	1.435	16.58	0.000
2.9000	0.561	1.454	17.28	0.000
2.9333	0.563	1.472	17.99	0.000
2.9667	0.564	1.491	18.71	0.000

3.0000	0.565	1.510	19.45	0.000
3.0333	0.567	1.529	20.19	0.000

Analysis Results

POC 1





+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 8.612
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 2.709
Total Impervious Area: 5.902

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	2.422511
5 year	3.730766
10 year	4.436813
25 year	5.15274
50 year	5.577142
100 year	5.925555

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	Flow(cfs)
2 year	1.596139
5 year	2.259723
10 year	2.772708
25 year	3.511033
50 year	4.130813
100 year	4.814129

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	Predeveloped	Mitigated
1949	1.821	1.575
1950	2.349	1.379
1951	3.184	1.175
1952	1.912	2.147
1953	2.604	1.186
1954	3.984	1.450
1955	2.001	1.057
1956	3.672	3.038
1957	3.247	1.589
1958	2.410	2.658

1959	1.457	1.017
1960	1.339	1.531
1961	3.350	1.913
1962	2.342	1.455
1963	2.621	1.309
1964	2.432	1.243
1965	2.086	1.552
1966	2.917	1.567
1967	2.636	1.195
1968	3.154	2.556
1969	3.019	3.487
1970	8.353	5.971
1971	1.333	1.102
1972	2.130	1.162
1973	2.216	1.822
1974	3.354	2.905
1975	1.907	1.180
1976	2.880	1.684
1977	0.086	0.972
1978	4.194	2.239
1979	2.736	2.423
1980	1.584	1.088
1981	3.756	2.336
1982	2.485	2.428
1983	4.543	2.295
1984	1.466	1.078
1985	1.056	1.384
1986	1.309	1.648
1987	2.310	1.242
1988	1.103	1.151
1989	1.193	1.207
1990	1.016	1.169
1991	2.683	1.288
1992	2.774	1.171
1993	3.294	2.540
1994	2.377	1.759
1995	1.963	2.229
1996	4.129	3.503
1997	5.033	2.840
1998	4.067	2.059
1999	2.836	1.740
2000	1.623	0.969
2001	0.896	0.998
2002	3.913	1.593
2003	2.979	1.892
2004	0.910	1.643
2005	1.211	1.151
2006	2.296	1.436
2007	1.251	2.070
2008	1.729	2.524

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	8.3531	5.9714
2	5.0326	3.5031
3	4.5431	3.4870
4	4.1939	3.0383

5	4.1291	2.9053
6	4.0668	2.8403
7	3.9842	2.6583
8	3.9128	2.5562
9	3.7562	2.5399
10	3.6722	2.5243
11	3.3541	2.4281
12	3.3497	2.4228
13	3.2935	2.3360
14	3.2467	2.2951
15	3.1836	2.2385
16	3.1543	2.2293
17	3.0193	2.1474
18	2.9793	2.0703
19	2.9174	2.0588
20	2.8797	1.9131
21	2.8364	1.8923
22	2.7745	1.8219
23	2.7356	1.7593
24	2.6825	1.7405
25	2.6363	1.6839
26	2.6212	1.6483
27	2.6042	1.6426
28	2.4846	1.5932
29	2.4321	1.5886
30	2.4096	1.5748
31	2.3771	1.5671
32	2.3488	1.5517
33	2.3422	1.5306
34	2.3102	1.4552
35	2.2959	1.4503
36	2.2155	1.4362
37	2.1299	1.3835
38	2.0855	1.3785
39	2.0011	1.3091
40	1.9627	1.2883
41	1.9116	1.2432
42	1.9074	1.2421
43	1.8212	1.2070
44	1.7286	1.1947
45	1.6228	1.1859
46	1.5842	1.1800
47	1.4661	1.1749
48	1.4571	1.1708
49	1.3385	1.1686
50	1.3333	1.1617
51	1.3085	1.1507
52	1.2509	1.1506
53	1.2113	1.1018
54	1.1931	1.0876
55	1.1034	1.0776
56	1.0564	1.0572
57	1.0158	1.0171
58	0.9100	0.9979
59	0.8955	0.9715
60	0.0859	0.9692

Duration Flows
The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
1.2113	895	891	99	Pass
1.2554	823	764	92	Pass
1.2995	755	664	87	Pass
1.3436	687	591	86	Pass
1.3877	626	528	84	Pass
1.4318	576	493	85	Pass
1.4759	536	442	82	Pass
1.5200	494	399	80	Pass
1.5641	455	353	77	Pass
1.6082	430	327	76	Pass
1.6523	392	300	76	Pass
1.6964	364	271	74	Pass
1.7405	346	249	71	Pass
1.7846	324	227	70	Pass
1.8287	305	197	64	Pass
1.8728	287	176	61	Pass
1.9169	271	161	59	Pass
1.9610	253	147	58	Pass
2.0051	237	133	56	Pass
2.0492	226	124	54	Pass
2.0933	211	113	53	Pass
2.1374	193	98	50	Pass
2.1815	182	88	48	Pass
2.2256	165	77	46	Pass
2.2697	152	71	46	Pass
2.3138	145	64	44	Pass
2.3579	131	60	45	Pass
2.4020	120	57	47	Pass
2.4461	107	52	48	Pass
2.4902	100	48	48	Pass
2.5343	96	43	44	Pass
2.5784	91	39	42	Pass
2.6225	83	37	44	Pass
2.6666	75	32	42	Pass
2.7107	71	31	43	Pass
2.7548	69	26	37	Pass
2.7989	62	25	40	Pass
2.8430	59	21	35	Pass
2.8871	56	19	33	Pass
2.9312	52	17	32	Pass
2.9753	49	16	32	Pass
3.0193	44	14	31	Pass
3.0634	43	13	30	Pass
3.1075	41	13	31	Pass
3.1516	39	11	28	Pass
3.1957	32	11	34	Pass
3.2398	30	10	33	Pass
3.2839	28	9	32	Pass
3.3280	26	9	34	Pass
3.3721	21	8	38	Pass
3.4162	19	8	42	Pass
3.4603	19	8	42	Pass
3.5044	19	5	26	Pass

3.5485	18	5	27	Pass
3.5926	16	5	31	Pass
3.6367	15	5	33	Pass
3.6808	14	5	35	Pass
3.7249	14	4	28	Pass
3.7690	12	4	33	Pass
3.8131	12	4	33	Pass
3.8572	12	4	33	Pass
3.9013	12	4	33	Pass
3.9454	11	4	36	Pass
3.9895	10	4	40	Pass
4.0336	10	4	40	Pass
4.0777	9	4	44	Pass
4.1218	9	4	44	Pass
4.1659	8	4	50	Pass
4.2100	7	4	57	Pass
4.2541	6	4	66	Pass
4.2982	6	4	66	Pass
4.3423	6	4	66	Pass
4.3864	6	3	50	Pass
4.4305	6	3	50	Pass
4.4746	6	2	33	Pass
4.5187	6	2	33	Pass
4.5628	5	2	40	Pass
4.6069	5	2	40	Pass
4.6510	5	2	40	Pass
4.6951	5	2	40	Pass
4.7392	5	2	40	Pass
4.7833	5	2	40	Pass
4.8274	5	2	40	Pass
4.8715	5	2	40	Pass
4.9156	5	2	40	Pass
4.9597	5	2	40	Pass
5.0038	5	2	40	Pass
5.0479	4	2	50	Pass
5.0920	4	2	50	Pass
5.1361	4	2	50	Pass
5.1802	4	2	50	Pass
5.2243	4	2	50	Pass
5.2684	4	2	50	Pass
5.3125	4	2	50	Pass
5.3566	4	2	50	Pass
5.4007	4	2	50	Pass
5.4448	4	2	50	Pass
5.4889	4	2	50	Pass
5.5330	4	2	50	Pass
5.5771	4	2	50	Pass

Water Quality

Water Quality BMP Flow and Volume for POC #1

On-line facility volume:	0.9776 acre-feet
On-line facility target flow:	1.284 cfs.
Adjusted for 15 min:	1.284 cfs.
Off-line facility target flow:	0.7159 cfs.
Adjusted for 15 min:	0.7159 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
Trapezoidal Pond 1 POC	☐	1253.39			☐	0.00			
Total Volume Infiltrated		1253.39	0.00	0.00		0.00	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50-yr									Duration Analysis Result = Failed

Model Default Modifications

Total of 0 changes have been made.

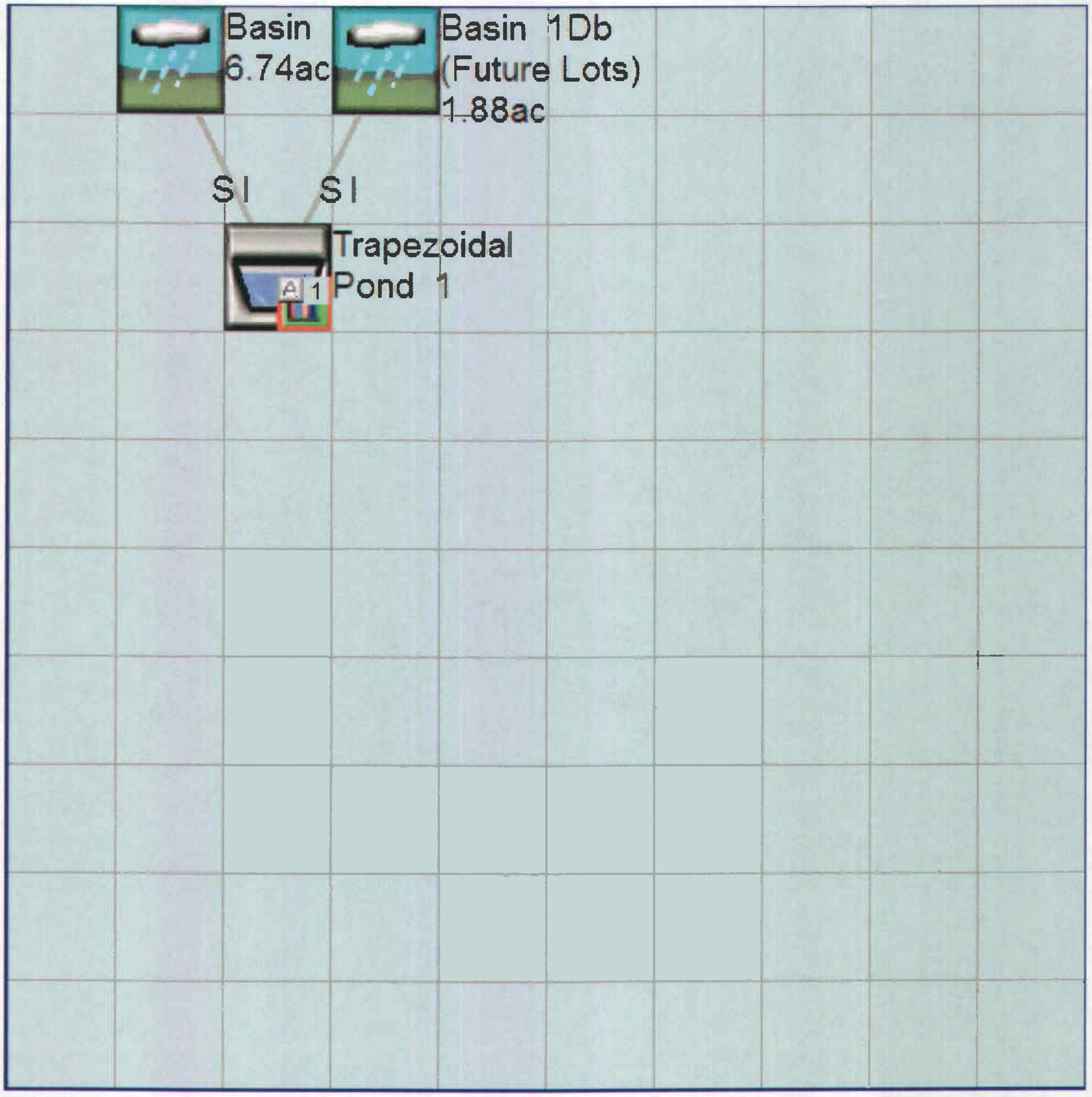
PERLND Changes
No PERLND changes have been made.

IMPLND Changes
No IMPLND changes have been made.

Appendix

Predeveloped Schematic

Mitigated Schematic



Predeveloped UCI File

```
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   8938.e.Green Mtn Ph1-Prelim-Tract F Pond.wdm
MESSU      25   Pre8938.e.Green Mtn Ph1-Prelim-Tract F Pond.MES
           27   Pre8938.e.Green Mtn Ph1-Prelim-Tract F Pond.L61
           28   Pre8938.e.Green Mtn Ph1-Prelim-Tract F Pond.L62
           30   POC8938.e.Green Mtn Ph1-Prelim-Tract F Pond1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      29
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Basin  1P                   MAX                    1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         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           ***
   29      SG4, Forest, Mod        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 ***
   29         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  *********
   29         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 ***
   29        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
   29             0         6      0.04       400       0.1         0      0.96
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   29             0         0         3         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                                  ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   29            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
   29             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           ***
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    ***
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
  END PRINT-INFO

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

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
  END IWAT-PARM2

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

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
  END IWAT-STATE1
```

```
END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->    MBLK    ***
<Name>   #                  <-factor->     <Name>   #    Tbl#    ***
Basin  1P***
PERLND  29                       8.612     COPY   501      12
PERLND  29                       8.612     COPY   501      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



<-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
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

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   8938.e.Green Mtn Ph1-Prelim-Tract F Pond.wdm
MESSU      25   Mit8938.e.Green Mtn Ph1-Prelim-Tract F Pond.MES
           27   Mit8938.e.Green Mtn Ph1-Prelim-Tract F Pond.L61
           28   Mit8938.e.Green Mtn Ph1-Prelim-Tract F Pond.L62
           30   POC8938.e.Green Mtn Ph1-Prelim-Tract F Pond1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      26
      IMPLND       2
      IMPLND       4
      IMPLND       6
      IMPLND       9
      IMPLND      14
      RCHRES       1
      COPY         1
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Trapezoidal Pond  1          MAX                   1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         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            ***
   26      SG3, Lawn, Mod          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 ***
   26         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  *********
   26         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 ***
   26         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
   26            0         6      0.05       400       0.1         0      0.96
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3          ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   26            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 ***
   26            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
   26            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            ***
    2      ROADS/MOD              1    1    1   27    0
    4      ROOF TOPS/FLAT         1    1    1   27    0
    6      DRIVEWAYS/MOD          1    1    1   27    0
    9      SIDEWALKS/MOD          1    1    1   27    0
   14      POND                   1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    2         0    0    1    0    0    0
    4         0    0    1    0    0    0
    6         0    0    1    0    0    0
    9         0    0    1    0    0    0
   14         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   *********
    2         0    0    4    0    0    0    1    9
    4         0    0    4    0    0    0    1    9
    6         0    0    4    0    0    0    1    9
    9         0    0    4    0    0    0    1    9
   14         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     ***
    2          0    0    0    0    0
    4          0    0    0    0    0
    6          0    0    0    0    0
    9          0    0    0    0    0
   14          0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2          ***
    # -  # ***  LSUR      SLSUR       NSUR      RETSC
    2            400       0.05        0.1       0.08
    4            400       0.01        0.1        0.1
    6            400       0.05        0.1       0.08
    9            400       0.05        0.1       0.08
   14            400       0.01        0.1        0.1
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3          ***
    # -  # ***PETMAX    PETMIN
    2              0         0
    4              0         0
    6              0         0
    9              0         0
   14              0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    2              0         0
    4              0         0
    6              0         0
    9              0         0
   14              0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->    <-Target->    MBLK   ***
<Name>   #                  <-factor->    <Name>   #    Tbl#   ***
Basin  1Da***
PERLND  26                       2.053    RCHRES   1       2
PERLND  26                       2.053    RCHRES   1       3
IMPLND   2                       0.965    RCHRES   1       5
IMPLND   4                       2.066    RCHRES   1       5
IMPLND   6                       0.413    RCHRES   1       5
IMPLND   9                       0.318    RCHRES   1       5
IMPLND  14                       0.921    RCHRES   1       5
Basin  1Db (Future Lots)***
PERLND  26                       0.656    RCHRES   1       2
PERLND  26                       0.656    RCHRES   1       3
IMPLND   2                       0.319    RCHRES   1       5
IMPLND   4                       0.675    RCHRES   1       5
IMPLND   6                       0.131    RCHRES   1       5
IMPLND   9                       0.094    RCHRES   1       5

******Routing******
PERLND  26                       2.053    COPY     1      12
IMPLND   2                       0.965    COPY     1      15
IMPLND   4                       2.066    COPY     1      15
IMPLND   6                       0.413    COPY     1      15
IMPLND   9                       0.318    COPY     1      15
IMPLND  14                       0.921    COPY     1      15
```

```
PERLND  26                        2.053     COPY     1      13
PERLND  26                        0.656     COPY     1      12
IMPLND   2                        0.319     COPY     1      15
IMPLND   4                        0.675     COPY     1      15
IMPLND   6                        0.131     COPY     1      15
IMPLND   9                        0.094     COPY     1      15
PERLND  26                        0.656     COPY     1      13
RCHRES   1                            1     COPY   501      16
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


<-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     Trapezoidal Pond-009   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
  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
  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
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN      DELTH      STCOR        KS       DB50        ***
  <------><--------><--------><--------><--------><--------><-------->        ***
    1             1      0.02        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
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
  FTABLE       1
   91    4
     Depth      Area     Volume  Outflow1 Velocity  Travel Time***
```

(ft)	(acres)	(acre-ft)	(cfs)	(ft/sec)	(Minutes)***
0.000000	0.170873	0.000000	0.000000		
0.033333	0.171666	0.005709	0.210842		
0.066667	0.172461	0.011444	0.298175		
0.100000	0.173258	0.017206	0.365188		
0.133333	0.174056	0.022995	0.421683		
0.166667	0.174857	0.028810	0.471456		
0.200000	0.175659	0.034652	0.516455		
0.233333	0.176463	0.040521	0.557835		
0.266667	0.177269	0.046416	0.596350		
0.300000	0.178077	0.052339	0.632525		
0.333333	0.178887	0.058288	0.666740		
0.366667	0.179698	0.064265	0.699283		
0.400000	0.180512	0.070268	0.730377		
0.433333	0.181327	0.076299	0.760200		
0.466667	0.182144	0.082357	0.788897		
0.500000	0.182963	0.088442	0.816586		
0.533333	0.183783	0.094554	0.843367		
0.566667	0.184606	0.100694	0.869323		
0.600000	0.185430	0.106861	0.894525		
0.633333	0.186256	0.113056	0.919038		
0.666667	0.187085	0.119278	0.942913		
0.700000	0.187914	0.125528	0.966198		
0.733333	0.188746	0.131806	0.988935		
0.766667	0.189580	0.138111	1.011161		
0.800000	0.190415	0.144445	1.032909		
0.833333	0.191252	0.150806	1.054208		
0.866667	0.192091	0.157195	1.075086		
0.900000	0.192932	0.163612	1.095565		
0.933333	0.193775	0.170057	1.115669		
0.966667	0.194620	0.176530	1.135417		
1.000000	0.195466	0.183032	1.154827		
1.033333	0.196314	0.189561	1.173917		
1.066667	0.197164	0.196119	1.192701		
1.100000	0.198016	0.202706	1.211193		
1.133333	0.198870	0.209320	1.249673		
1.166667	0.199726	0.215964	1.304676		
1.200000	0.200583	0.222636	1.370354		
1.233333	0.201442	0.229336	1.444626		
1.266667	0.202303	0.236065	1.526293		
1.300000	0.203166	0.242823	1.614550		
1.333333	0.204031	0.249609	1.708807		
1.366667	0.204898	0.256425	1.808607		
1.400000	0.205766	0.263269	1.913585		
1.433333	0.206636	0.270143	2.023440		
1.466667	0.207509	0.277045	2.137918		
1.500000	0.208383	0.283977	2.256800		
1.533333	0.209258	0.290937	2.379897		
1.566667	0.210136	0.297927	2.507042		
1.600000	0.211015	0.304946	2.638087		
1.633333	0.211897	0.311995	2.772899		
1.666667	0.212780	0.319073	2.911358		
1.700000	0.213665	0.326180	3.053355		
1.733333	0.214552	0.333317	3.198790		
1.766667	0.215440	0.340484	3.347573		
1.800000	0.216331	0.347680	3.499618		
1.833333	0.217223	0.354906	3.654848		
1.866667	0.218117	0.362162	3.813189		
1.900000	0.219013	0.369447	3.974574		
1.933333	0.219911	0.376762	4.138939		
1.966667	0.220811	0.384108	4.306225		
2.000000	0.221712	0.391483	4.476376		
2.033333	0.222616	0.398889	4.578834		
2.066667	0.223521	0.406324	4.754833		
2.100000	0.224428	0.413790	4.978669		
2.133333	0.225337	0.421286	5.241173		
2.166667	0.226247	0.428813	5.537046		
2.200000	0.227160	0.436369	5.862714		
2.233333	0.228074	0.443957	6.215552		
2.266667	0.228990	0.451574	6.593528		

```
    2.300000  0.229908  0.459223  6.995008
    2.333333  0.230828  0.466902  7.418639
    2.366667  0.231750  0.474611  7.863279
    2.400000  0.232674  0.482352  8.327945
    2.433333  0.233599  0.490123  8.811782
    2.466667  0.234526  0.497925  9.314035
    2.500000  0.235455  0.505758  9.834031
    2.533333  0.236386  0.513622  10.37117
    2.566667  0.237319  0.521517  10.92490
    2.600000  0.238253  0.529443  11.49472
    2.633333  0.239190  0.537401  12.08019
    2.666667  0.240128  0.545389  12.68089
    2.700000  0.241068  0.553409  13.29642
    2.733333  0.242010  0.561461  13.92644
    2.766667  0.242954  0.569543  14.57060
    2.800000  0.243899  0.577657  15.22859
    2.833333  0.244847  0.585803  15.90013
    2.866667  0.245796  0.593981  16.58494
    2.900000  0.246747  0.602190  17.28276
    2.933333  0.247700  0.610430  17.99335
    2.966667  0.248655  0.618703  18.71648
    3.000000  0.249611  0.627007  19.45192
  END FTABLE  1
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   1 HYDR   RO     1 1         1     WDM   1004 FLOW     ENGL      REPL
RCHRES   1 HYDR   STAGE  1 1         1     WDM   1005 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
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

Disclaimer

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Olympia, WA. 98501
Toll Free 1(866)943-0304
Local (360)943-0304

www.clearcreeksolutions.com

Tract 'R' Facility

WWHM2012

PROJECT REPORT

General Model Information

Project Name:	8938.e.Green Mtn Ph1-Prelim-Tract R Pond-W
Site Name:	Green Mountain
Site Address:	NE Goodwin Road
City:	Camas, WA.
Report Date:	12/23/2014
Gage:	Lacamas
Data Start:	1948/10/01
Data End:	2008/09/30
Timestep:	15 Minute
Precip Scale:	1.30
Version:	2014/09/12

POC Thresholds

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

Landuse Basin Data
Predeveloped Land Use

Basin 4P & 5P

Bypass:	No
GroundWater:	No
Pervious Land Use	Acres
SG4, Forest, Mod	26.54
Pervious Total	26.54
Impervious Land Use	Acres
Impervious Total	0
Basin Total	26.54

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Basin 4D

Bypass:	No
GroundWater:	No
Pervious Land Use	Acres
SG3, Lawn, Mod	12.548
Pervious Total	12.548
Impervious Land Use	Acres
ROADS MOD	3.491
ROOF TOPS FLAT	6.198
DRIVEWAYS MOD	1.24
SIDEWALKS MOD	1.063
POND	2
Impervious Total	13.992
Basin Total	26.54

Element Flows To:

Surface	Interflow	Groundwater
Trapezoidal Pond 1	Trapezoidal Pond 1	

Routing Elements
Predeveloped Routing

Mitigated Routing

Trapezoidal Pond 1

Bottom Length:	217.00 ft.
Bottom Width:	217.00 ft.
Depth:	3 ft.
Volume at riser head:	2.2838 acre-ft.
Side slope 1:	3 To 1
Side slope 2:	3 To 1
Side slope 3:	3 To 1
Side slope 4:	3 To 1
Discharge Structure	
Riser Height:	2 ft.
Riser Diameter:	18 in.
Notch Type:	Rectangular
Notch Width:	1.500 ft.
Notch Height:	0.900 ft.
Orifice 1 Diameter:	11.641 inElevation:0 ft.
Element Flows To:	
Outlet 1	Outlet 2

Pond Hydraulic Table

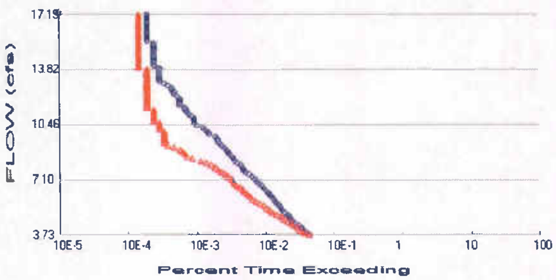
Stage(ft)	**Area(ac)**	**Volume(ac-ft)**	**Discharge(cfs)**	**Infilt(cfs)**
0.0000	1.081	0.000	0.000	0.000
0.0333	1.083	0.036	0.649	0.000
0.0667	1.085	0.072	0.919	0.000
0.1000	1.087	0.108	1.125	0.000
0.1333	1.089	0.144	1.299	0.000
0.1667	1.091	0.181	1.453	0.000
0.2000	1.093	0.217	1.591	0.000
0.2333	1.095	0.253	1.719	0.000
0.2667	1.097	0.290	1.837	0.000
0.3000	1.099	0.327	1.949	0.000
0.3333	1.101	0.363	2.054	0.000
0.3667	1.103	0.400	2.155	0.000
0.4000	1.105	0.437	2.251	0.000
0.4333	1.107	0.474	2.342	0.000
0.4667	1.109	0.511	2.431	0.000
0.5000	1.111	0.548	2.516	0.000
0.5333	1.113	0.585	2.599	0.000
0.5667	1.115	0.622	2.679	0.000
0.6000	1.117	0.659	2.756	0.000
0.6333	1.119	0.696	2.832	0.000
0.6667	1.121	0.734	2.906	0.000
0.7000	1.123	0.771	2.977	0.000
0.7333	1.125	0.808	3.047	0.000
0.7667	1.127	0.846	3.116	0.000
0.8000	1.129	0.884	3.183	0.000
0.8333	1.131	0.921	3.249	0.000
0.8667	1.133	0.959	3.313	0.000
0.9000	1.135	0.997	3.376	0.000
0.9333	1.137	1.035	3.438	0.000
0.9667	1.139	1.073	3.499	0.000
1.0000	1.141	1.111	3.559	0.000
1.0333	1.143	1.149	3.617	0.000

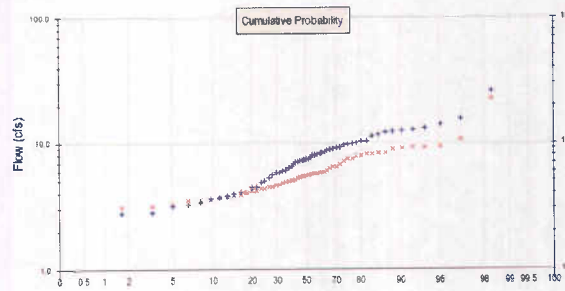
1.0667	1.145	1.187	3.675	0.000
1.1000	1.147	1.225	3.732	0.000
1.1333	1.149	1.263	3.819	0.000
1.1667	1.151	1.302	3.930	0.000
1.2000	1.153	1.340	4.056	0.000
1.2333	1.156	1.379	4.195	0.000
1.2667	1.158	1.417	4.345	0.000
1.3000	1.160	1.456	4.504	0.000
1.3333	1.162	1.495	4.672	0.000
1.3667	1.164	1.533	4.848	0.000
1.4000	1.166	1.572	5.031	0.000
1.4333	1.168	1.611	5.222	0.000
1.4667	1.170	1.650	5.419	0.000
1.5000	1.172	1.689	5.622	0.000
1.5333	1.174	1.728	5.832	0.000
1.5667	1.176	1.768	6.047	0.000
1.6000	1.178	1.807	6.267	0.000
1.6333	1.180	1.846	6.494	0.000
1.6667	1.182	1.886	6.725	0.000
1.7000	1.185	1.925	6.962	0.000
1.7333	1.187	1.965	7.203	0.000
1.7667	1.189	2.004	7.449	0.000
1.8000	1.191	2.044	7.700	0.000
1.8333	1.193	2.084	7.955	0.000
1.8667	1.195	2.123	8.215	0.000
1.9000	1.197	2.163	8.480	0.000
1.9333	1.199	2.203	8.748	0.000
1.9667	1.201	2.243	9.021	0.000
2.0000	1.203	2.283	9.298	0.000
2.0333	1.206	2.324	9.428	0.000
2.0667	1.208	2.364	9.632	0.000
2.1000	1.210	2.404	9.884	0.000
2.1333	1.212	2.444	10.17	0.000
2.1667	1.214	2.485	10.49	0.000
2.2000	1.216	2.525	10.85	0.000
2.2333	1.218	2.566	11.23	0.000
2.2667	1.220	2.607	11.63	0.000
2.3000	1.222	2.647	12.06	0.000
2.3333	1.225	2.688	12.51	0.000
2.3667	1.227	2.729	12.98	0.000
2.4000	1.229	2.770	13.47	0.000
2.4333	1.231	2.811	13.98	0.000
2.4667	1.233	2.852	14.51	0.000
2.5000	1.235	2.893	15.05	0.000
2.5333	1.237	2.934	15.62	0.000
2.5667	1.239	2.976	16.19	0.000
2.6000	1.242	3.017	16.79	0.000
2.6333	1.244	3.059	17.40	0.000
2.6667	1.246	3.100	18.02	0.000
2.7000	1.248	3.142	18.66	0.000
2.7333	1.250	3.183	19.32	0.000
2.7667	1.252	3.225	19.99	0.000
2.8000	1.254	3.267	20.67	0.000
2.8333	1.257	3.309	21.36	0.000
2.8667	1.259	3.351	22.07	0.000
2.9000	1.261	3.393	22.79	0.000
2.9333	1.263	3.435	23.53	0.000
2.9667	1.265	3.477	24.27	0.000

3.0000	1.267	3.519	25.03	0.000
3.0333	1.270	3.561	25.80	0.000

Analysis Results

POC 1





+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1

Total Pervious Area:	26.54
Total Impervious Area:	0

Mitigated Landuse Totals for POC #1

Total Pervious Area:	12.548
Total Impervious Area:	13.992

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	7.465561
5 year	11.497273
10 year	13.67313
25 year	15.879434
50 year	17.187334
100 year	18.261055

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	5.397394
5 year	7.495243
10 year	9.092886
25 year	11.364225
50 year	13.250141
100 year	15.311281

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1949	5.613	6.815
1950	7.239	4.848
1951	9.811	5.008
1952	5.891	6.307
1953	8.025	4.870
1954	12.278	6.009
1955	6.167	3.578
1956	11.317	9.013
1957	10.006	5.687
1958	7.426	7.431

1959	4.490	3.251
1960	4.125	4.459
1961	10.323	6.489
1962	7.218	5.718
1963	8.078	5.425
1964	7.495	4.690
1965	6.427	4.512
1966	8.991	5.644
1967	8.124	4.352
1968	9.721	9.159
1969	9.305	9.095
1970	25.742	22.162
1971	4.109	4.043
1972	6.564	4.175
1973	6.828	5.575
1974	10.336	8.316
1975	5.878	3.762
1976	8.875	5.509
1977	0.265	2.936
1978	12.925	8.109
1979	8.430	8.223
1980	4.882	3.600
1981	11.576	7.816
1982	7.657	6.485
1983	14.001	7.969
1984	4.518	3.533
1985	3.255	4.632
1986	4.033	5.719
1987	7.119	3.876
1988	3.400	4.368
1989	3.677	3.892
1990	3.131	3.718
1991	8.267	5.840
1992	8.550	5.112
1993	10.150	7.471
1994	7.326	5.228
1995	6.049	5.805
1996	12.725	10.630
1997	15.509	9.197
1998	12.533	8.176
1999	8.741	4.943
2000	5.001	3.135
2001	2.760	3.125
2002	12.058	7.216
2003	9.181	5.849
2004	2.804	4.997
2005	3.733	4.198
2006	7.075	5.342
2007	3.855	5.588
2008	5.327	8.835

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	25.7421	22.1621
2	15.5093	10.6302
3	14.0006	9.1967
4	12.9245	9.1589

5	12.7248	9.0950
6	12.5327	9.0125
7	12.2782	8.8354
8	12.0581	8.3162
9	11.5756	8.2235
10	11.3168	8.1759
11	10.3363	8.1090
12	10.3228	7.9691
13	10.1497	7.8156
14	10.0055	7.4706
15	9.8112	7.4314
16	9.7206	7.2162
17	9.3048	6.8154
18	9.1814	6.4886
19	8.9907	6.4845
20	8.8746	6.3072
21	8.7409	6.0092
22	8.5503	5.8485
23	8.4304	5.8396
24	8.2668	5.8049
25	8.1244	5.7192
26	8.0778	5.7179
27	8.0254	5.6870
28	7.6569	5.6444
29	7.4952	5.5880
30	7.4258	5.5747
31	7.3256	5.5085
32	7.2385	5.4251
33	7.2181	5.3417
34	7.1193	5.2279
35	7.0753	5.1115
36	6.8277	5.0084
37	6.5637	4.9974
38	6.4271	4.9435
39	6.1670	4.8700
40	6.0486	4.8481
41	5.8909	4.6903
42	5.8782	4.6322
43	5.6125	4.5119
44	5.3271	4.4589
45	5.0009	4.3682
46	4.8821	4.3518
47	4.5182	4.1983
48	4.4905	4.1746
49	4.1250	4.0432
50	4.1089	3.8916
51	4.0326	3.8762
52	3.8549	3.7623
53	3.7328	3.7183
54	3.6768	3.5997
55	3.4004	3.5776
56	3.2554	3.5332
57	3.1305	3.2506
58	2.8043	3.1347
59	2.7598	3.1247
60	0.2648	2.9355

Duration Flows
The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
3.7328	895	895	100	Pass
3.8687	823	768	93	Pass
4.0046	755	667	88	Pass
4.1405	687	597	86	Pass
4.2764	626	530	84	Pass
4.4123	576	481	83	Pass
4.5482	535	430	80	Pass
4.6841	490	380	77	Pass
4.8200	455	342	75	Pass
4.9559	430	302	70	Pass
5.0918	392	262	66	Pass
5.2277	363	238	65	Pass
5.3636	346	213	61	Pass
5.4995	324	193	59	Pass
5.6354	305	170	55	Pass
5.7713	287	147	51	Pass
5.9073	271	133	49	Pass
6.0432	253	122	48	Pass
6.1791	237	113	47	Pass
6.3150	226	103	45	Pass
6.4509	211	98	46	Pass
6.5868	193	89	46	Pass
6.7227	182	79	43	Pass
6.8586	165	73	44	Pass
6.9945	152	71	46	Pass
7.1304	145	67	46	Pass
7.2663	131	60	45	Pass
7.4022	120	54	45	Pass
7.5381	107	48	44	Pass
7.6740	100	43	43	Pass
7.8099	96	39	40	Pass
7.9458	91	34	37	Pass
8.0817	83	29	34	Pass
8.2176	75	24	32	Pass
8.3535	71	18	25	Pass
8.4894	69	15	21	Pass
8.6253	62	14	22	Pass
8.7612	59	13	22	Pass
8.8972	56	12	21	Pass
9.0331	52	10	19	Pass
9.1690	49	8	16	Pass
9.3049	44	7	15	Pass
9.4408	43	7	16	Pass
9.5767	41	7	17	Pass
9.7126	39	7	17	Pass
9.8485	32	7	21	Pass
9.9844	30	7	23	Pass
10.1203	28	6	21	Pass
10.2562	26	6	23	Pass
10.3921	21	6	28	Pass
10.5280	19	6	31	Pass
10.6639	19	5	26	Pass
10.7998	19	5	26	Pass

10.9357	18	5	27	Pass
11.0716	16	5	31	Pass
11.2075	15	5	33	Pass
11.3434	14	5	35	Pass
11.4793	14	4	28	Pass
11.6152	12	4	33	Pass
11.7512	12	4	33	Pass
11.8871	12	4	33	Pass
12.0230	12	4	33	Pass
12.1589	11	4	36	Pass
12.2948	10	4	40	Pass
12.4307	10	4	40	Pass
12.5666	9	4	44	Pass
12.7025	9	4	44	Pass
12.8384	8	4	50	Pass
12.9743	7	4	57	Pass
13.1102	6	4	66	Pass
13.2461	6	4	66	Pass
13.3820	6	4	66	Pass
13.5179	6	4	66	Pass
13.6538	6	4	66	Pass
13.7897	6	4	66	Pass
13.9256	6	3	50	Pass
14.0615	5	3	60	Pass
14.1974	5	3	60	Pass
14.3333	5	3	60	Pass
14.4692	5	3	60	Pass
14.6051	5	3	60	Pass
14.7411	5	3	60	Pass
14.8770	5	3	60	Pass
15.0129	5	3	60	Pass
15.1488	5	3	60	Pass
15.2847	5	3	60	Pass
15.4206	5	3	60	Pass
15.5565	4	3	75	Pass
15.6924	4	3	75	Pass
15.8283	4	3	75	Pass
15.9642	4	3	75	Pass
16.1001	4	3	75	Pass
16.2360	4	3	75	Pass
16.3719	4	3	75	Pass
16.5078	4	3	75	Pass
16.6437	4	3	75	Pass
16.7796	4	3	75	Pass
16.9155	4	3	75	Pass
17.0514	4	3	75	Pass
17.1873	4	3	75	Pass

Water Quality

Water Quality BMP Flow and Volume for POC #1

On-line facility volume:	2.5745 acre-feet
On-line facility target flow:	3.1011 cfs.
Adjusted for 15 min:	3.1011 cfs.
Off-line facility target flow:	1.7175 cfs.
Adjusted for 15 min:	1.7175 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
Trapezoidal Pond 1 POC	☐	3391.62			☐	0.00			
Total Volume Infiltrated		3391.62	0.00	0.00		0.00	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50-yr									Duration Analysis Result = Failed

Model Default Modifications

Total of 0 changes have been made.

PERLND Changes

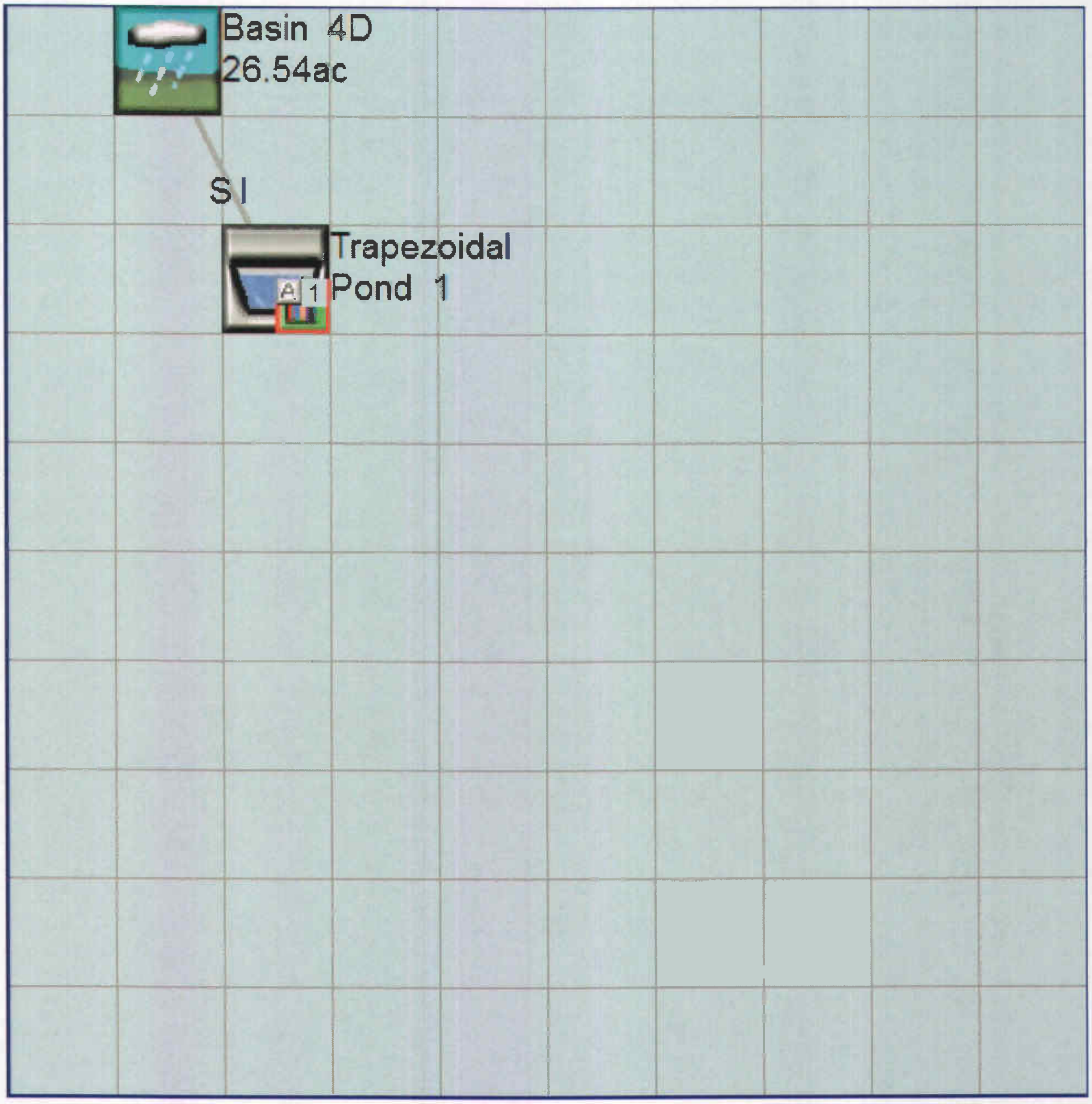
No PERLND changes have been made.

IMPLND Changes

No IMPLND changes have been made.

Appendix
Predeveloped Schematic

Mitigated Schematic



Predeveloped UCI File

```
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   8938.e.Green Mtn Ph1-Prelim-Tract R Pond-W.wdm
MESSU      25   Pre8938.e.Green Mtn Ph1-Prelim-Tract R Pond-W.MES
           27   Pre8938.e.Green Mtn Ph1-Prelim-Tract R Pond-W.L61
           28   Pre8938.e.Green Mtn Ph1-Prelim-Tract R Pond-W.L62
           30   POC8938.e.Green Mtn Ph1-Prelim-Tract R Pond-W1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      29
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Basin  4P & 5P              MAX                    1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         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           ***
   29      SG4, Forest, Mod        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 ***
   29         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  *********
   29         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 ***
   29         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
   29             0          6      0.04       400       0.1         0      0.96
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   29             0          0         3         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                                     ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   29            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
   29             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           ***
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    ***
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL     *********
  END PRINT-INFO

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

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
  END IWAT-PARM2

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

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
  END IWAT-STATE1
```

```
END IMPLND

SCHEMATIC
<-Source->                  <--Area-->      <-Target->    MBLK   ***
<Name>    #                 <-factor->      <Name>   #    Tbl#   ***
Basin  4P & 5P***
PERLND  29                      26.54       COPY   501     12
PERLND  29                      26.54       COPY   501     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


<-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
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

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   8938.e.Green Mtn Ph1-Prelim-Tract R Pond-W.wdm
MESSU      25   Mit8938.e.Green Mtn Ph1-Prelim-Tract R Pond-W.MES
           27   Mit8938.e.Green Mtn Ph1-Prelim-Tract R Pond-W.L61
           28   Mit8938.e.Green Mtn Ph1-Prelim-Tract R Pond-W.L62
           30   POC8938.e.Green Mtn Ph1-Prelim-Tract R Pond-W1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      26
      IMPLND       2
      IMPLND       4
      IMPLND       6
      IMPLND       9
      IMPLND      14
      RCHRES       1
      COPY         1
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Trapezoidal Pond  1         MAX                    1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         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           ***
   26      SG3, Lawn, Mod          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 ***
   26         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  *********
   26       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 ***
   26       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
   26            0           6      0.05       400       0.1         0      0.96
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3          ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   26            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 ***
   26            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
   26            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           ***
    2      ROADS/MOD              1    1    1   27    0
    4      ROOF TOPS/FLAT         1    1    1   27    0
    6      DRIVEWAYS/MOD          1    1    1   27    0
    9      SIDEWALKS/MOD          1    1    1   27    0
   14      POND                   1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    2         0    0    1    0    0    0
    4         0    0    1    0    0    0
    6         0    0    1    0    0    0
    9         0    0    1    0    0    0
   14         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    2         0    0    4    0    0    0    1    9
    4         0    0    4    0    0    0    1    9
    6         0    0    4    0    0    0    1    9
    9         0    0    4    0    0    0    1    9
   14         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       ***
  2         0    0    0    0    0
  4         0    0    0    0    0
  6         0    0    0    0    0
  9         0    0    0    0    0
 14         0    0    0    0    0
END IWAT-PARM1

IWAT-PARM2
  <PLS >      IWATER input info: Part 2          ***
  # -  # ***  LSUR     SLSUR      NSUR      RETSC
  2            400      0.05       0.1       0.08
  4            400      0.01       0.1        0.1
  6            400      0.05       0.1       0.08
  9            400      0.05       0.1       0.08
 14            400      0.01       0.1        0.1
END IWAT-PARM2

IWAT-PARM3
  <PLS >      IWATER input info: Part 3          ***
  # -  # ***PETMAX    PETMIN
  2              0         0
  4              0         0
  6              0         0
  9              0         0
 14              0         0
END IWAT-PARM3

IWAT-STATE1
  <PLS > *** Initial conditions at start of simulation
  # -  # ***  RETS      SURS
  2              0         0
  4              0         0
  6              0         0
  9              0         0
 14              0         0
END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->    MBLK    ***
<Name>   #                  <-factor->     <Name>   #    Tbl#    ***
Basin  4D***
PERLND  26                      12.548     RCHRES   1       2
PERLND  26                      12.548     RCHRES   1       3
IMPLND   2                       3.491     RCHRES   1       5
IMPLND   4                       6.198     RCHRES   1       5
IMPLND   6                        1.24     RCHRES   1       5
IMPLND   9                       1.063     RCHRES   1       5
IMPLND  14                           2     RCHRES   1       5

******Routing******
PERLND  26                      12.548     COPY     1      12
IMPLND   2                       3.491     COPY     1      15
IMPLND   4                       6.198     COPY     1      15
IMPLND   6                        1.24     COPY     1      15
IMPLND   9                       1.063     COPY     1      15
IMPLND  14                           2     COPY     1      15
PERLND  26                      12.548     COPY     1      13
RCHRES   1                           1     COPY   501      16
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


<-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     Trapezoidal Pond-009    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
  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
  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
  END HYDR-PARM1

  HYDR-PARM2
    # -  #     FTABNO       LEN     DELTH     STCOR        KS      DB50        ***
  <------><--------><--------><--------><--------><--------><-------->        ***
    1            1      0.02       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
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
  FTABLE      1
   91    4
     Depth      Area     Volume  Outflow1 Velocity  Travel Time***
      (ft)    (acres)  (acre-ft)   (cfs)   (ft/sec)    (Minutes)***
  0.000000  0.220488  0.000000  0.000000
  0.033333  0.221389  0.007365  0.649799
  0.066667  0.222292  0.014759  0.918954
  0.100000  0.223196  0.022184  1.125485
  0.133333  0.224103  0.029639  1.299598
  0.166667  0.225011  0.037124  1.452995
  0.200000  0.225921  0.044640  1.591676
  0.233333  0.226833  0.052186  1.719206
  0.266667  0.227746  0.059762  1.837909
  0.300000  0.228662  0.067369  1.949397
  0.333333  0.229579  0.075006  2.054845
  0.366667  0.230499  0.082674  2.155139
```

0.400000	0.231420	0.090373	2.250969
0.433333	0.232342	0.098102	2.342883
0.466667	0.233267	0.105862	2.431325
0.500000	0.234194	0.113653	2.516660
0.533333	0.235122	0.121475	2.599196
0.566667	0.236052	0.129328	2.679190
0.600000	0.236984	0.137212	2.756863
0.633333	0.237918	0.145127	2.832408
0.666667	0.238854	0.153073	2.905989
0.700000	0.239792	0.161051	2.977753
0.733333	0.240731	0.169060	3.047827
0.766667	0.241672	0.177100	3.116326
0.800000	0.242615	0.185171	3.183352
0.833333	0.243560	0.193274	3.248995
0.866667	0.244507	0.201408	3.313337
0.900000	0.245456	0.209574	3.376454
0.933333	0.246406	0.217772	3.438413
0.966667	0.247358	0.226002	3.499274
1.000000	0.248313	0.234263	3.559095
1.033333	0.249268	0.242556	3.617927
1.066667	0.250226	0.250881	3.675818
1.100000	0.251186	0.259238	3.732811
1.133333	0.252147	0.267626	3.819345
1.166667	0.253111	0.276047	3.930242
1.200000	0.254076	0.284501	4.056749
1.233333	0.255043	0.292986	4.195761
1.266667	0.256012	0.301503	4.345496
1.300000	0.256982	0.310053	4.504759
1.333333	0.257955	0.318636	4.672679
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1.600000	0.265801	0.388467	6.267938
1.633333	0.266790	0.397344	6.494103
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1.700000	0.268773	0.415196	6.961959
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END FTABLES

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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
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RCHRES   1 HYDR   STAGE  1 1        1      WDM   1005 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
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  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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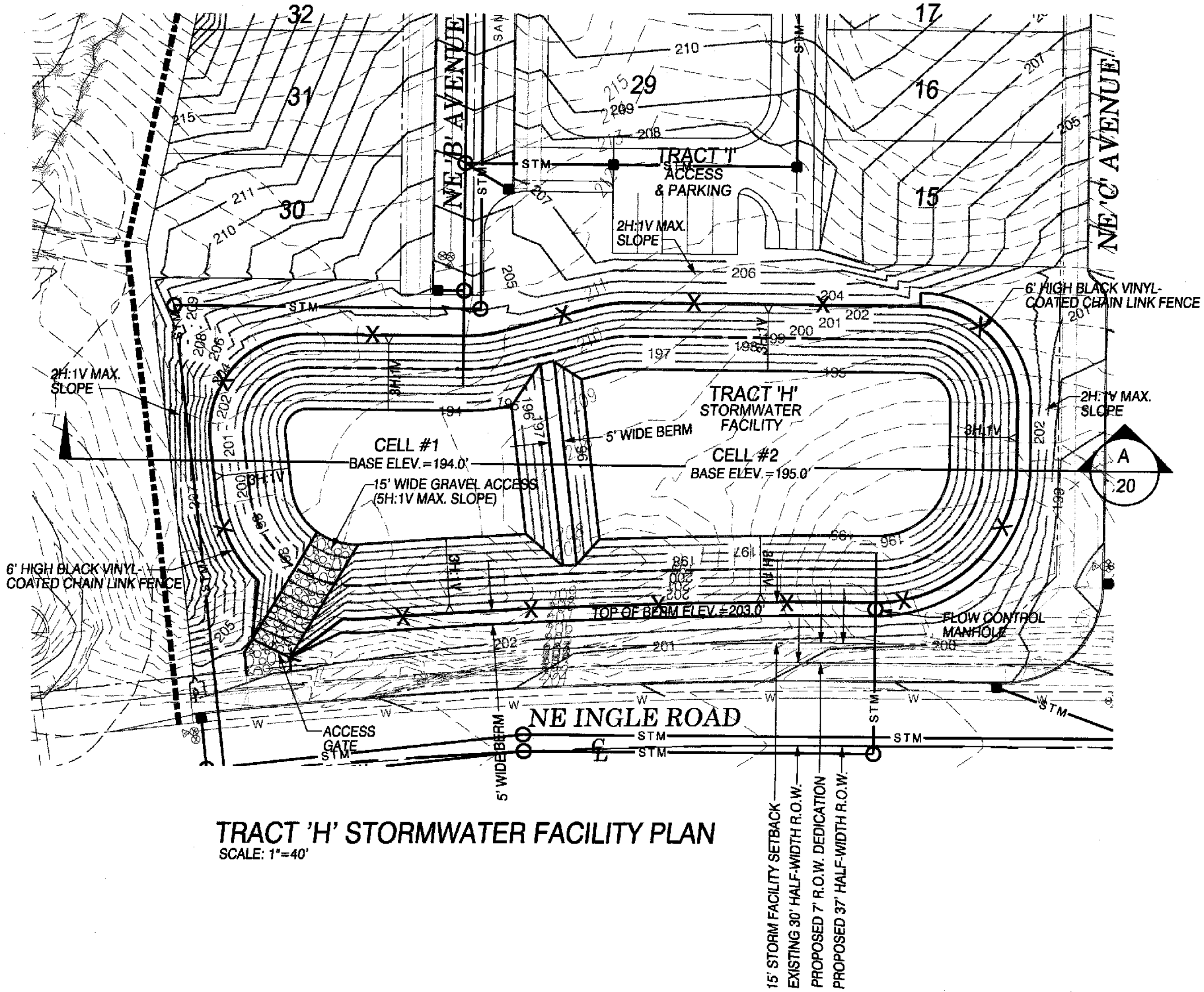
F



TRACT 'H' STORMWATER FACILITY PLAN

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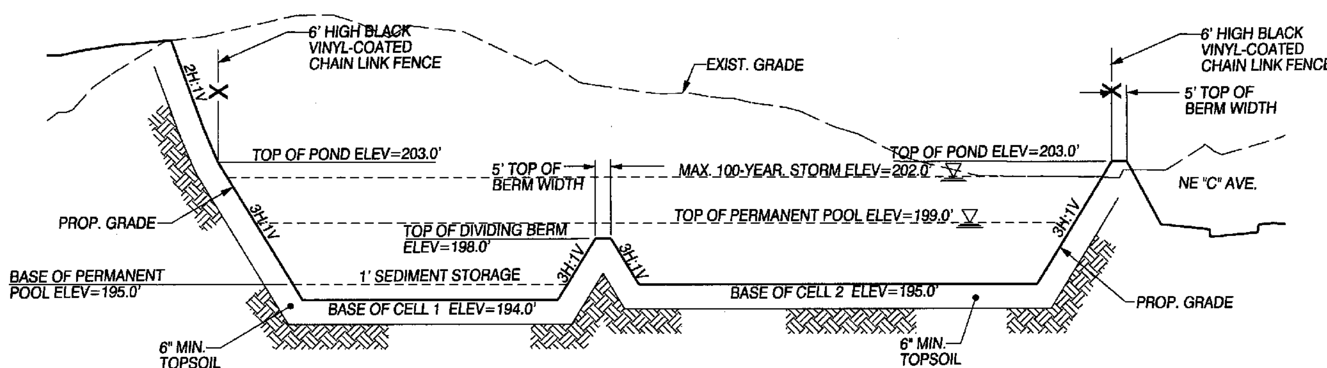
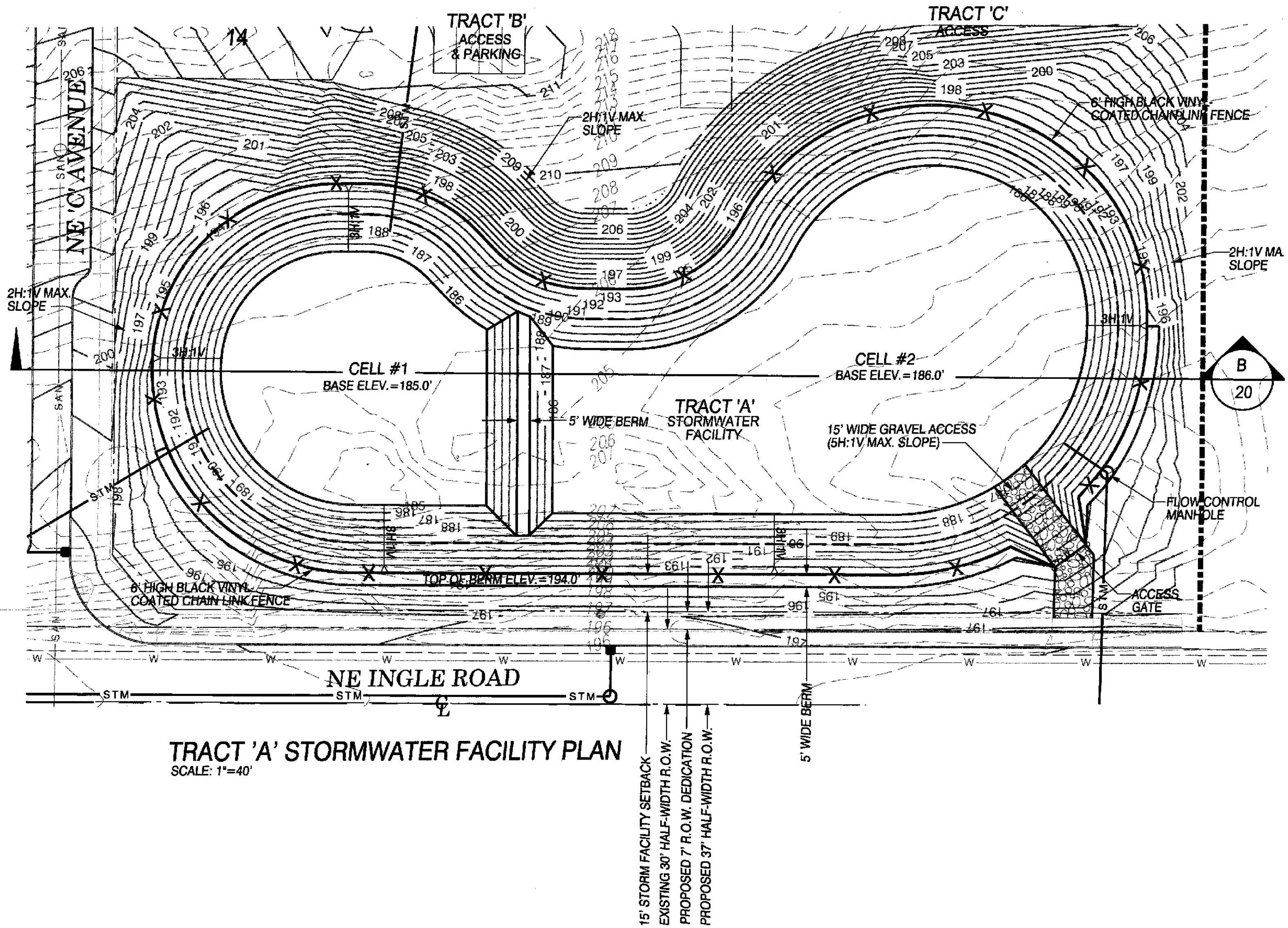


TRACT 'H' STORMWATER FACILITY SECTION

A
20

NTS



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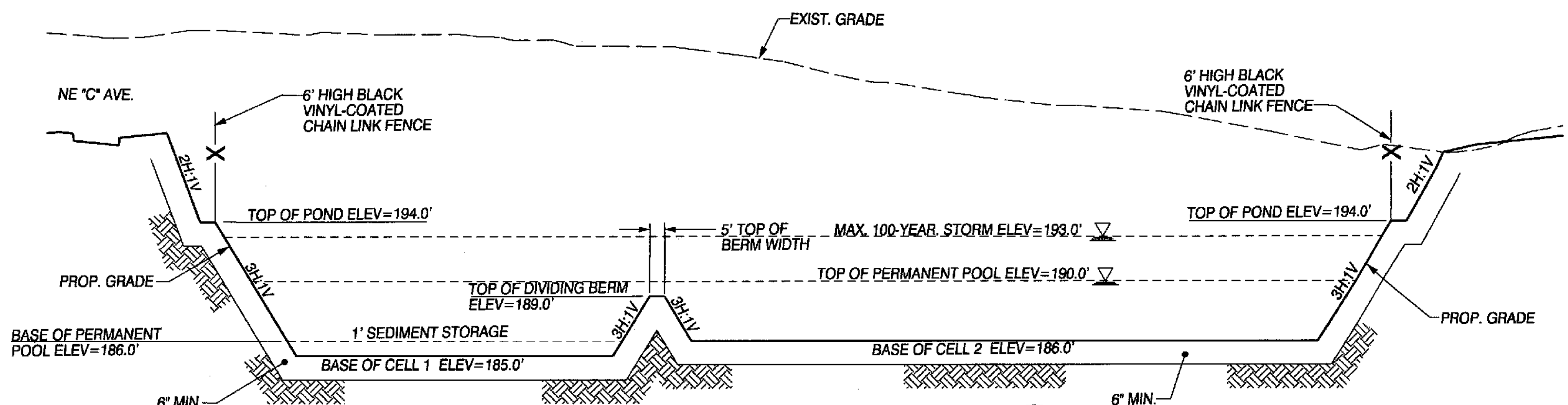

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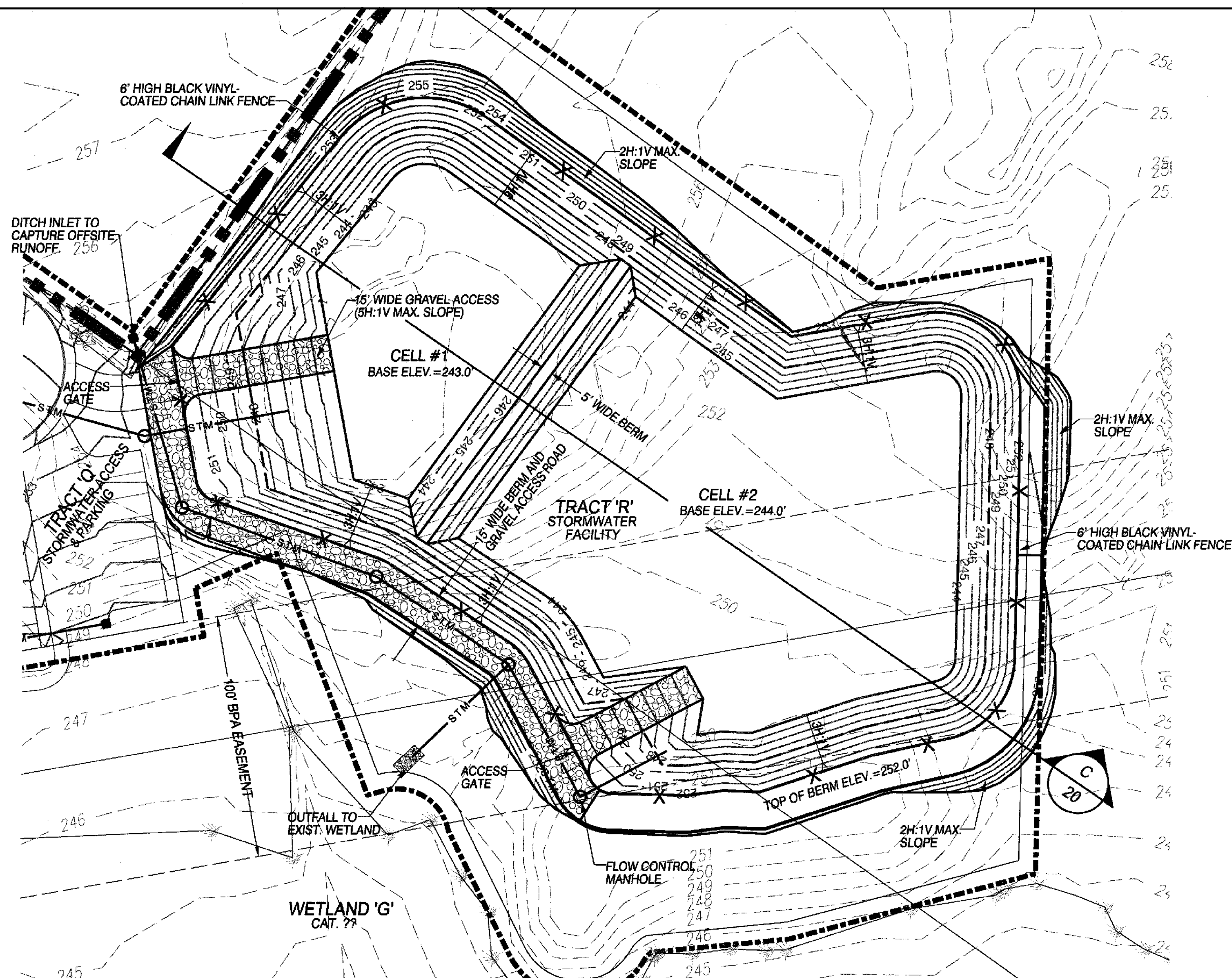
NTS

B
20



TRACT 'R' STORMWATER FACILITY PLAN

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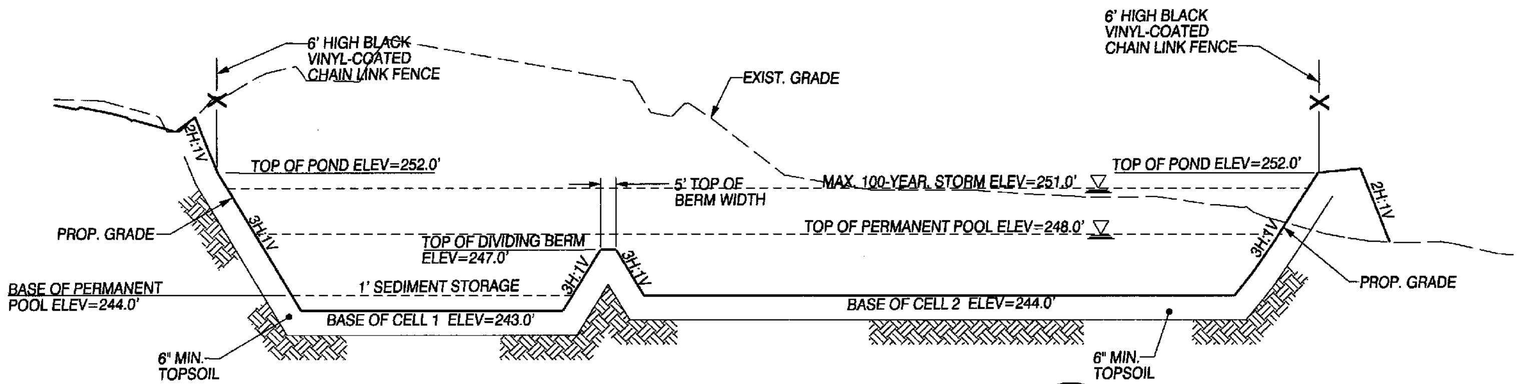

TRACT 'R' STORMWATER FACILITY SECTION

NTS

C
20

G

Real-World Geotechnical Solutions
Investigation • Design • Construction Support

Revised December 3, 2014
Project No. 13-3186

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Beaverton, Oregon 97006

SUBJECT: PRELIMINARY GEOTECHNICAL ENGINEERING REPORT
GREEN MOUNTAIN - PHASE 1
NE INGLE ROAD & NE 28TH STREET
CAMAS, WASHINGTON

This report presents the results of a geotechnical engineering study conducted by GeoPacific Engineering, Inc. (GeoPacific) for the above-referenced project. The purpose of our investigation was to evaluate subsurface conditions at the site and to provide geotechnical recommendations for site development. This geotechnical study was performed in accordance with GeoPacific Proposal No. P-4836, dated April 30, 2014, and your subsequent authorization of our proposal and *General Conditions for Geotechnical Services*. This report is considered Preliminary because a final grading plan has not been developed.

SITE DESCRIPTION AND PROPOSED DEVELOPMENT

The Green Mountain site is located on the north side of NE Goodwin Road and east of NE Ingle Road in the City of Camas, Clark County, Washington. The property includes several tax lots that total approximately 281.6 acres. Topography on the southern portion of the site is flat to gently sloping with grades of about 5 to 10 percent. Steeper slopes (up to 35 percent grade) are present on Green Mountain, which is a basalt cinder cone, located in the northern portion of the site. Near vertical slopes are present at the base of Green Mountain where basalt bedrock is exposed.

Phase 1 is approximately 51 acres and located in the southern portion of the site, which is part of the Green Mountain Golf Course. Topography is flat to gently sloping with grades generally about 5 to 20 percent. Improvements include several structures, parking areas and driveways, cart tracks, manmade ponds, and fairways. Vegetation consists of short grasses and sparse trees.

It is our understanding that the proposed development will consist of a subdivision for single family homes, new streets, and associated underground utilities. A grading plan has not been provided for our review; however, we anticipate maximum cuts and fills will be on the order of about 12 feet due to the sloping topography and filling of existing ponds.

REGIONAL AND LOCAL GEOLOGIC SETTING

Regionally, the subject site lies within the Willamette Valley/Puget Sound lowland, a broad structural depression situated between the Coast Range on the west and the Cascade Range on the east. A series of discontinuous faults subdivide the Willamette Valley into a mosaic of fault-bounded, structural blocks (Yeats et al., 1996). Uplifted structural blocks form bedrock highlands, while down-warped structural blocks form sedimentary basins.

The low-lying portion of the site is underlain by the Quaternary aged (last 1.6 million years) Willamette Formation, a catastrophic flood deposits associated with repeated glacial outburst flooding of the Willamette Valley (Trimble, 1963; Yeats et al., 1996; Phillips, 1987). The last of these outburst floods occurred about 10,000 years ago. These deposits typically consist of horizontally layered, micaceous, silty sand with gravel that is underlain by medium dense to dense gravel.

The Willamette Formation is underlain by a gravel conglomerate interbedded with siltstone and sandstone. Evarts (2006) indicates the age of the conglomerate is poorly constrained but is likely Pliocene to Pleistocene in age (10,000 to 5.3 million years ago). The conglomerate is partially cemented with the upper portion moderately weathered.

The northern portion of the Green Mountain site is underlain by Basaltic Andesite of Green Mountain (Evarts, 2006). The gray basaltic andesite lava flows erupted from a cinder cone on Green Mountain during the Pleistocene (2.6 to 5.3 million years ago). The basalt contains weathered ash, trace quartzite pebbles, and fine grained xenoliths (Evarts, 2006).

A portion of the site is underlain by Miocene to Pleistocene age (16 to 0.5 million years ago) terrigenous sedimentary rocks belonging to the Troutdale Formation (Evarts, 2006). The Troutdale Formation is informally divided into an upper and lower member. Lithologies in the upper member include lenticular layers of volcaniclastic (vitric) sand, quartzite-bearing gravel, fine-grained sand, silt and clay, micaceous quartz-rich sand, and conglomerate with a cumulative average thickness of 100 to 150 feet. The lower member consists primarily of laminated silty clay and sand with reported thicknesses in water well logs of up to 800 feet. These sediments vary from weakly-consolidated to well-indurated.

REGIONAL SEISMIC SETTING

At least four potential source zones capable of generating damaging earthquakes are thought to exist in the region. These include the Lacamas Creek-Sandy River Fault, Portland Hills Fault Zone, Gales Creek-Newberg-Mt. Angel Structural Zone, and the Cascadia Subduction Zone, as discussed below.

Lacamas Creek-Sandy River Fault

The Lacamas Creek Fault is recognized based on a fault shear contact between Oligocene (30 million years old) volcanic rocks and the Troutdale Formation, and a series of prominent geomorphic lineaments with a cumulative length of 24 miles (Mundorff, 1964; Beeson et al., 1989). The Sandy River Fault, interpreted from gravity and borehole data, forms a possible right stepping, 7-mile-long extension of the Lacamas Creek Fault that vertically displaces the Columbia River Basalt by 1,300 feet (Beeson et al., 1989; Geomatrix Consultants, 1995). A 1989, M3.9 earthquake in the vicinity may have occurred on the Lacamas Creek Fault. A comprehensive seismic hazard study commissioned by the Oregon Department of Transportation concluded that the Lacamas Creek-Sandy River Fault Zone is potentially active with a possible rupture length of greater than 25 miles. The Lacamas Creek Fault is mapped as being ½ mile southwest of the subject site (Figure 1).

Portland Hills Fault Zone

The Portland Hills Fault Zone is a series of NW-trending faults that include the central Portland Hills Fault, the western Oatfield Fault, and the eastern East Bank Fault. These faults occur in a northwest-trending zone that varies in width between 3.5 and 5.0 miles. The combined three faults vertically displace the Columbia River Basalt by 1,130 feet and appear to control thickness changes in late Pleistocene (approx. 780,000 years) sediment (Madin, 1990). The Portland Hills Fault occurs along the Willamette River at the base of the Portland Hills, and is about 13 miles southwest of the site. The Oatfield Fault occurs along the western side of the Portland Hills, and is about 16 miles southwest of the site. The accuracy of the fault mapping is stated to be within 500 meters (Wong, et al., 2000). No historical seismicity is correlated with the mapped portion of the Portland Hills Fault Zone, but in 1991 a M3.5 earthquake occurred on a NW-trending shear plane located 1.3 miles east of the fault (Yelin, 1992). Although there is no definitive evidence of recent activity, the Portland Hills Fault Zone is assumed to be potentially active (Geomatrix Consultants, 1995).

Gales Creek-Newberg-Mt. Angel Structural Zone

The Gales Creek-Newberg-Mt. Angel Structural Zone is a 50-mile-long zone of discontinuous, NW-trending faults that lies about 36 miles southwest of the subject site. These faults are recognized in the subsurface by vertical separation of the Columbia River Basalt and offset seismic reflectors in the overlying basin sediment (Yeats et al., 1996; Werner et al., 1992). A geologic reconnaissance and photogeologic analysis study conducted for the Scoggins Dam site in the Tualatin Basin revealed no evidence of deformed geomorphic surfaces along the structural zone (Unruh et al., 1994). No seismicity has been recorded on the Gales Creek Fault or Newberg Fault; however, these faults are considered to be potentially active because they may connect with the seismically active Mount Angel Fault and the rupture plane of the 1993 M5.6 Scotts Mills earthquake (Werner et al. 1992; Geomatrix Consultants, 1995).

Cascadia Subduction Zone

The Cascadia Subduction Zone is a 680-mile-long zone of active tectonic convergence where oceanic crust of the Juan de Fuca Plate is subducting beneath the North American continent at a rate of 4 cm per year (Goldfinger et al., 1996). A growing body of geologic evidence suggests that prehistoric subduction zone earthquakes have occurred (Atwater, 1992; Carver, 1992; Peterson et al., 1993; Geomatrix Consultants, 1995). This evidence includes: (1) buried tidal marshes recording episodic, sudden subsidence along the coast of northern California, Oregon, and Washington, (2) burial of subsided tidal marshes by tsunami wave deposits, (3) paleoliquefaction features, and (4) geodetic uplift patterns on the Oregon coast. Radiocarbon dates on buried tidal marshes indicate a recurrence interval for major subduction zone earthquakes of 250 to 650 years with the last event occurring 300 years ago (Atwater, 1992; Carver, 1992; Peterson et al., 1993; Geomatrix Consultants, 1995). The inferred seismogenic portion of the plate interface lies approximately 50 miles west of the Portland Basin at depths of between 20 and 40 kilometers below the surface.

FIELD EXPLORATION

Our site-specific exploration for Phase 1 was conducted on May 23rd, 2014. A total of 13 exploratory test pits were excavated with a medium sized trackhoe to depths ranging between 5 and 9 feet at the approximate locations shown on Figure 2. Test pits TP-1 and TP-12 are outside of the Phase 1 boundary due to a reconfiguration of the layout and are not presented. The previous investigation for the entire Green Mountain site consisted of 25 exploratory test pits excavated November 5th through 7th, 2013. Five test pits from the previous investigation are located within Phase 1 – test pits TP-1, TP-10, TP-13, TP-15, and TP-16. Test pits from the 2013 investigation for the entire Green Mountain site will be referred to as TP-1 (2013), TP-10 (2013), TP-13 (2013), TP-15 (2013), and TP-16 (2013). It should be noted that exploration locations were located in the field by pacing or taping distances from apparent property corners and other site features shown on the plans provided. As such, the locations of the explorations should be considered approximate.

A GeoPacific geologist continuously monitored the field exploration program and logged the borings. Soils observed in the explorations were classified in general accordance with the Unified Soil Classification System. During exploration, our geologist also noted geotechnical conditions such as soil consistency, moisture and groundwater conditions. Logs of test pits are attached to this report. The following report sections are based on the exploration program and summarize subsurface conditions encountered at the site.

Undocumented Fill – Undocumented fill was encountered directly at the ground surface in test pits TP-2, TP-3, TP-4, TP-7, TP-8, TP-10, TP-11, and TP-13. The fill generally consisted of brown, medium stiff to stiff, silt (ML) with gravel, clay, and sand and medium dense, silty sand (SM). The fill extended to a depth of 1.5 to 3.5 feet. It is likely that other areas of undocumented fill exist in the vicinity of the existing structures, driveways, and the throughout the golf course.

Topsoil Horizon – The ground surface in test pits TP-5, TP-6, TP-9, TP-1 (2013), TP-10 (2013), TP-13 (2013), TP-15 (2013), and TP-16 (2013) was directly underlain by a low to highly organic topsoil horizon. The dark brown silt (OL-ML) contained trace amounts of sand and contained fine roots throughout. The topsoil horizon was loose and extended to a depth of 6 to 18 inches.

Colluvial Soil – Colluvial soil, formed by downward migration of material under gravitational forces, was encountered beneath the topsoil horizon in test pit TP-15. These soils generally consisted of stiff to very stiff, silty clay (CL) to clayey silt (ML) with weathered basalt that displayed strong orange and gray mottling. In explorations, the colluvial soil extended to a depth of 3 feet in test pit TP-15.

Buried Topsoil Horizon – A low organic, buried topsoil horizon was encountered beneath the fill in test pit TP-8. The buried topsoil horizon was on the order of 6 inches in thickness - extending to a depth of 3 feet.

Fine Grained Catastrophic Flood Deposits (Willamette Formation) – Underlying the topsoil horizon in test pits TP-5, TP-6, TP-9, TP-1 (2013), TP-10 (2013), and TP-13 (2013); the buried topsoil horizon in test pit TP-8; and the fill in test pits TP-2, TP-4, TP-7, TP-10, and TP-13 was fine grained catastrophic flood deposits. These soils generally consisted of stiff to very stiff, light brown, clayey silt (ML) with trace sand that displayed subtle to strong orange and gray mottling. Where encountered, the flood deposits generally extended to a depth of 3 to 7 feet and beyond the maximum depth of exploration in test pits TP-4, TP-7, TP-8, and TP-1 (2013) excavated to a maximum depth of 8.5 feet.

Conglomerate – Underlying the topsoil horizon in test pits TP-15 (2013) and TP-16 (2013); the fill in test pit TP-3, and the fine grained catastrophic flood deposits in test pits TP-2, TP-5, TP-6, TP-9, TP-10, TP-13, TP-10 (2013), and TP-13 (2013) was dense to very dense subrounded gravel (GM) with sandy, clayey silt matrix; dense, silty sand (SM); and stiff silt (ML) with subrounded gravel. The conglomerate was partially cemented and extended beyond the maximum depth of exploration (6 to 10.5 feet).

Soil Moisture and Groundwater

On May 23, 2014 and November 5 through 7, 2013, soils encountered in test pits were moist to wet. Groundwater seepage was encountered in test pits TP-2, TP-5 through TP-9, TP-13, TP-1 (2013), TP-13 (2013), TP-15 (2013) and TP-16 (2013) at depths of 2 to 8.5 feet. Discharge was visually estimated at ¼ to 2 gallons per minute. In test pit TP-1 (2013), the static groundwater level rose to a depth of 2 feet after the test pit had been left open for a time period of several hours. Experience has shown that temporary perched storm-related groundwater conditions often occur within the surface soils over fine-grained native deposits such as those beneath the site, particularly during the wet season. It is anticipated that groundwater conditions will vary depending on the season, local subsurface conditions, changes in site utilization, and other factors.

SLOPE STABILITY

For the purpose of evaluating slope stability, we: (1) reviewed regional 1:24,000 scale topography by the U.S. Geological Survey and published geologic mapping, (2) reviewed 1:150 scale topographic survey mapping of the site by Olson Engineering, Inc., (3) performed a geological reconnaissance of the site, and (4) evaluated subsurface soil conditions in exploratory test pits. Regional slope stability mapping of Clark County, Washington published by the Washington Department of Natural Resources Division of Geology identifies an area of potential instability on the southwest side of Green Mountain (Fiksdal, 1975). This area roughly correlates with the near vertical rock exposures at the base of Green Mountain that is north of the Phase 1 area. No mapped landslides are indicated in the Phase 1 study area on more recent geologic mapping conducted by Evarts (2006).

Based on the data review, field reconnaissance and site exploration, the slope instability hazard for the Phase 1 portion of the Green Mountain property is considered to be low. Slopes in the Phase 1 area are on the order of 5 to 20 percent. Slope geomorphology at the site is generally smooth and uniform - consistent with relative stability. Subsurface explorations indicate the site is generally underlain by stiff to very-stiff, clayey silt (ML) loess underlain by dense to very dense, silty gravel (GM). These materials are generally characterized by moderate to high shear strength and a relatively high resistance to slope instability on gentle slopes. The Phase 1 area is considered generally suitable for development.

PRELIMINARY CONCLUSIONS AND RECOMMENDATIONS

Our investigation indicates that the proposed development is geotechnically feasible, provided that the recommendations of this report are incorporated into the design and construction phases of the project. The primary geotechnical constraint to development is the presence of fill throughout the site. Up to 5 feet of fill was encountered in the exploratory test pits. It is anticipated that fill is prevalent throughout the fairway areas of the golf course where sand traps, ponds, and sculpted topography have been created.

Stormwater Disposal

Soil conditions at the site generally consist of fine grained flood deposits (consisting of clayey silt with sand) underlain by coarse grained, partially cemented conglomerate consisting of subrounded gravel with a clayey silt matrix and trace sand. Orange and gray mottling was observed in near surface soils in all explorations. Soil moisture conditions were moist to wet and perched groundwater seepage was encountered in test pits TP-2, TP-5 through TP-9, TP-13, TP-1 (2013), TP-13 (2013), TP-15 (2013) and TP-16 (2013) at depths of 2 to 8.5 feet. Static groundwater was measured at a depth of 2 feet below the ground surface in test pit TP-1 (2013). Soil mottling, the presence of clay soils, and the prevalent groundwater seepage indicates the soils will likely accept little runoff – if any. Soils with moderate permeability are already saturated with perched groundwater. We would expect soil conditions to behave more as Soil Group 4 soils than Soil Group 3 soils outlined in the Western Washington Continuous Simulation Hydrology Model.

Site Preparation

Due to the presence of fill through the site, areas of proposed construction and areas to receive fill should be cleared of vegetation and existing fill soils should then be removed to stiff or dense native soils. Organic soils are likely present at the bottom of the ponds and should be removed to stiff, native soils. Inorganic debris and organic materials from clearing should be removed from the site. It is likely that the existing fill may be reused as engineered fill provided that they are properly moisture conditioned and free of organic or inorganic debris. Organic-rich root zones should then be stripped from construction areas of the site or where engineered fill is to be placed. Depth of stripping is estimated to average 8+ inches. The final depth of soil removal will be determined on the basis of a site inspection after the stripping/ excavation has been performed. Stripped topsoil should preferably be removed from the site. Any remaining topsoil should be stockpiled only in designated areas and stripping operations should be observed and documented by the geotechnical engineer or his representative.

Remaining undocumented fills and any subsurface structures (dry wells, basements, driveway and landscaping fill, old utility lines, septic leach fields, etc.) should be removed and the excavations backfilled with engineered fill. Fill in excess of 5 feet was encountered directly at the ground surface in test pits for this investigation. Sculpted topography in the vicinity of the fairways indicates the presence of fill. We anticipate that other areas of fill may exist in the vicinity of the existing structures, parking lots, and driveways.

Engineered Fill

All grading for the proposed construction should be performed as engineered grading in accordance with the applicable building code at time of construction with the exceptions and additions noted herein. Proper test frequency and earthwork documentation usually requires daily observation and testing during stripping, rough grading, and placement of engineered fill. Imported fill material must be approved by the geotechnical engineer prior to being imported to the site. Oversize material greater than 6 inches in size should not be used within 3 feet of foundation footings, and material greater than 12 inches in diameter should not be used in engineered fill.

Engineered fill should be compacted in horizontal lifts not exceeding 8 inches using standard compaction equipment. We recommend that engineered fill be compacted to at least 90% of the maximum dry density determined by ASTM D1557 (Modified Proctor) or equivalent. Field density testing should conform to ASTM D2922 and D3017, or D1556. All engineered fill should be observed and tested by the project geotechnical engineer or his representative. Typically, one density test is performed for at least every 2 vertical feet of fill placed or every 500 yd^3, whichever requires more testing. Because testing is performed on an on-call basis, we recommend that the earthwork contractor be held contractually responsible for test scheduling and frequency.

Site earthwork will be impacted by soil moisture and shallow groundwater conditions. Earthwork in wet weather would likely require extensive use of cement or lime treatment, or other special measures, at considerable additional cost compared to earthwork performed under dry-weather conditions.

Excavating Conditions and Utility Trenches

We anticipate that on-site soils can be excavated using conventional heavy equipment such as trackhoes to a depth of 9 feet. All temporary cuts in excess of 4 feet in height should be sloped in accordance with U.S. Occupational Safety and Health Administration (OSHA) regulations (29 CFR Part 1926), or be shored. The existing native soil is classified as Type B Soil and temporary excavation side slope inclinations as steep as 1H:1V may be assumed for planning purposes. This cut slope inclination is applicable to excavations above the water table only. Maintenance of safe working conditions, including temporary excavation stability, is the responsibility of the contractor. Actual slope inclinations at the time of construction should be determined based on safety requirements and actual soil and groundwater conditions.

Soft, saturated soils and groundwater may be encountered in utility trenches, particularly during the wet season. We anticipate that dewatering systems consisting of ditches, sumps and pumps would be adequate for control of perched groundwater. Regardless of the dewatering system used, it should be installed and operated such that in-place soils are prevented from being removed along with the groundwater. Trench bottom stabilization, such as one to two feet of compacted crushed aggregate base, may be necessary in deeper trenches.

Vibrations created by traffic and construction equipment may cause some caving and raveling of excavation walls. In such an event, lateral support for the excavation walls should be provided by the contractor to prevent loss of ground support and possible distress to existing or previously constructed structural improvements.

PVC pipe should be installed in accordance with the procedures specified in ASTM D2321. We recommend that trench backfill be compacted to at least 95% of the maximum dry density obtained by Modified Proctor ASTM D1557 or equivalent. Initial backfill lift thickness for a ¾"-0 crushed aggregate base may need to be as great as 4 feet to reduce the risk of flattening underlying flexible pipe. Subsequent lift thickness should not exceed 1 foot. If imported granular fill material is used, then the lifts for large vibrating plate-compaction equipment (e.g. hoe compactor attachments) may be up to 2 feet, provided that proper compaction is being achieved and each lift is tested. Use of large vibrating compaction equipment should be carefully monitored near existing structures and improvements due to the potential for vibration-induced damage.

Adequate density testing should be performed during construction to verify that the recommended relative compaction is achieved. Typically, one density test is taken for every 4 vertical feet of backfill on each 200-lineal-foot section of trench.

Erosion Control Considerations

During our field exploration program, we did not observe soil types that would be considered highly susceptible to erosion, except in areas of steeply sloping topography. In our opinion, the primary concern regarding erosion potential will occur during construction, in areas that have been stripped of vegetation. Erosion at the site during construction can be minimized by implementing the project erosion control plan, which should include judicious use of straw bales and silt fences. If used, these erosion control devices should be in place and remain in place throughout site preparation and construction.

Erosion and sedimentation of exposed soils can also be minimized by quickly re-vegetating exposed areas of soil, and by staging construction such that large areas of the project site are not denuded and exposed at the same time. Areas of exposed soil requiring immediate and/or temporary protection against exposure should be covered with either mulch or erosion control netting/blankets. Areas of exposed soil requiring permanent stabilization should be seeded with an approved grass seed mixture, or hydroseeded with an approved seed-mulch-fertilizer mixture.

Wet Weather Earthwork

Soils underlying the site are likely to be moisture sensitive and may be difficult to handle or traverse with construction equipment during periods of wet weather. Earthwork is typically most economical when performed under dry weather conditions. Earthwork performed during the wet-weather season will probably require expensive measures such as cement treatment or imported granular material to compact fill to the recommended engineering specifications. If earthwork is to be performed or fill is to be placed in wet weather or under wet conditions when soil moisture content is difficult to control, the following recommendations should be incorporated into the contract specifications.

- Earthwork should be performed in small areas to minimize exposure to wet weather. Excavation or the removal of unsuitable soils should be followed promptly by the placement and compaction of clean engineered fill. The size and type of construction equipment used may have to be limited to prevent soil disturbance. Under some circumstances, it may be necessary to excavate soils with a backhoe to minimize subgrade disturbance caused by equipment traffic;
- The ground surface within the construction area should be graded to promote run-off of surface water and to prevent the ponding of water;
- Material used as engineered fill should consist of clean, granular soil containing less than 5 percent fines. The fines should be non-plastic. Alternatively, cement treatment of on-site soils may be performed to facilitate wet weather placement;
- The ground surface within the construction area should be sealed by a smooth drum vibratory roller, or equivalent, and under no circumstances should be left uncompacted and exposed to moisture. Soils which become too wet for compaction should be removed and replaced with clean granular materials;
- Excavation and placement of fill should be observed by the geotechnical engineer to verify that all unsuitable materials are removed and suitable compaction and site drainage is achieved; and
- Bales of straw and/or geotextile silt fences should be strategically located to control erosion.

If cement or lime treatment is used to facilitate wet weather construction, GeoPacific should be contacted to provide additional recommendations and field monitoring.

Anticipated Foundations

The proposed residential structures may be supported on shallow foundations bearing on competent undisturbed, native soils and/or engineered fill, appropriately designed and constructed as recommended in this report. Foundation design, construction, and setback requirements should conform to the applicable building code at the time of construction. For maximization of bearing strength and protection against frost heave, spread footings should be embedded at a minimum depth of 18 inches below exterior grade. The recommended minimum widths for continuous footings supporting wood-framed walls without masonry are 12 inches for single-story, 15 inches for two-story, and 18 inches for three-story structures. Minimum foundation reinforcement should consist of a No. 4 bar at the top of the stem walls, and a No. 4 bar at the bottom of the footings. Concrete slab-on-grade reinforcement should consist of No. 4 bars placed on 24-inch centers in a grid pattern.

The anticipated allowable soil bearing pressure is 1,500 lbs/ft^2 for footings bearing on competent, native soil and/or engineered fill. A maximum chimney and column load of 30 kips is recommended for the site. The recommended maximum allowable bearing pressure may be increased by 1/3 for short-term transient conditions such as wind and seismic loading. For heavier loads, the geotechnical engineer should be consulted. The coefficient of friction between on-site soil and poured-in-place concrete may be taken as 0.40, which includes no factor of safety. The maximum anticipated total and differential footing movements (generally from soil expansion and/or settlement) are 1 inch and ¾ inch over a span of 20 feet, respectively. We anticipate that the majority of the estimated settlement will occur during construction, as loads are applied. Excavations near structural footings should not extend within a 1H:1V plane projected downward from the bottom edge of footings.

Footing excavations should penetrate through topsoil and any loose soil to competent subgrade that is suitable for bearing support. All footing excavations should be trimmed neat, and all loose or softened soil should be removed from the excavation bottom prior to placing reinforcing steel bars. Due to the moisture sensitivity of on-site native soils, foundations constructed during the wet weather season may require overexcavation of footings and backfill with compacted, crushed aggregate.

Our recommendations are for house construction incorporating raised wood floors and conventional spread footing foundations. If living space of the structures will incorporate basements, a geotechnical engineer should be consulted to make additional recommendations for retaining walls, water-proofing, underslab drainage and wall subdrains. After site development, a Final Soil Engineer's Report should either confirm or modify the above recommendations.

Pavement Design

For design purposes, we used an estimated resilient modulus of 9,000 for compacted native soil. Table 1 presents our recommended minimum pavement section for dry weather construction.

Table 1. Recommended Minimum Dry-Weather Pavement Section

Material Layer	Light-duty Public Streets	Compaction Standard
Asphaltic Concrete (AC)	3 in.	92%/ 92% of Rice Density AASHTO T-209
Crushed Aggregate Base ¾"-0 (leveling course)	2 in.	95% of Modified Proctor AASHTO T-180
Crushed Aggregate Base 1½"-0	8 in.	95% of Modified Proctor AASHTO T-180
Subgrade	12 in.	95% of Modified Proctor AASHTO T-180 or equivalent

Any pockets of organic debris or loose fill encountered during ripping or tilling should be removed and replaced with engineered fill (see *Site Preparation* Section). In order to verify subgrade strength, we recommend proof-rolling directly on subgrade with a loaded dump truck during dry weather and on top of base course in wet weather. Soft areas that pump, rut, or weave should be stabilized prior to paving. If pavement areas are to be constructed during wet weather, the subgrade and construction plan should be reviewed by the project geotechnical engineer at the time of construction so that condition specific recommendations can be provided. The moisture sensitive subgrade soils make the site a difficult wet weather construction project.

During placement of pavement section materials, density testing should be performed to verify compliance with project specifications. Generally, one subgrade, one base course, and one asphalt compaction test is performed for every 100 to 200 linear feet of paving.

Seismic Design

Structures should be designed to resist earthquake loading in accordance with the methodology described in the 2010 ASCE-7 Standard. We recommend Site Class D be used for design. Design values determined for the site using the USGS (United States Geological Survey) *U.S. Seismic Design Maps* tool (Version 3.1.0) are summarized in Table 2, presented on the following page.

Table 2. Recommended Earthquake Ground Motion Parameters (2010 ASCE-7)

Parameter	Value
Location (Lat, Long), degrees	45.646, -122.457
Mapped Spectral Acceleration Values (MCE):	
Peak Ground Acceleration	0.374
Short Period, S_s	0.880 g
1.0 Sec Period, S_1	0.375 g
Soil Factors for Site Class D:	
F_a	1.148
F_v	1.650
Residential Site Value = 2/3 x F_a x S_s	0.673 g
Residential Seismic Design Category	D_0

Soil liquefaction is a phenomenon wherein saturated soil deposits temporarily lose strength and behave as a liquid in response to earthquake shaking. Soil liquefaction is generally limited to loose, granular soils located below the water table. Following development, on-site soils will consist predominantly of engineered fill or native fine-grained soils above the water table, which are not considered susceptible to liquefaction. Therefore, it is our opinion that special design or construction measures are not required to mitigate the effects of liquefaction.

Drainage

The upslope side of retaining walls and perimeter footings should be provided with a drainage system consisting of 3-inch diameter, slotted, flexible plastic pipe embedded in a minimum of 1 ft^3 per lineal foot of clean, free-draining gravel or 1 1/2" - 3/4" drain rock. The drain pipe and surrounding drain rock should be wrapped in non-woven geotextile (Mirafi 140N, or approved equivalent) to minimize the potential for clogging and/or ground loss due to piping. Water collected from the footing drains should be directed into the local storm drain system or other suitable outlet. A minimum 0.5 percent fall should be maintained throughout the drain and non-perforated pipe outlet. Down spouts and roof drains should not be connected to the foundation drains in order to reduce the potential for clogging. The footing drains should include clean-outs to allow periodic maintenance and inspection. Grades around the proposed structure should be sloped such that surface water drains away from the building. Footing drains are recommended to prevent detrimental effects of groundwater on foundations, and should not be expected to eliminate all potential sources of water entering a crawlspace or beneath a slab-on-grade. An adequate grade to a low point outlet drain in any crawlspace areas is required by code. Underslab drains are sometimes added beneath the slab when placed over soils of low permeability and shallow, perched groundwater.

UNCERTAINTIES AND LIMITATIONS

We have prepared this report for the owner and their consultants for use in design of this project only. This report should be provided in its entirety to prospective contractors for bidding and estimating purposes; however, the conclusions and interpretations presented in this report should not be construed as a warranty of the subsurface conditions. Experience has shown that soil and groundwater conditions can vary significantly over small distances. Inconsistent conditions can occur between explorations that may not be detected by a geotechnical study. If, during future site operations, subsurface conditions are encountered which vary appreciably from those described herein, GeoPacific should be notified for review of the recommendations of this report, and revision of such if necessary.

Sufficient geotechnical monitoring, testing and consultation should be provided during construction to confirm that the conditions encountered are consistent with those indicated by explorations. The checklist attached to this report outlines recommended geotechnical observations and testing for the project. Recommendations for design changes will be provided should conditions revealed during construction differ from those anticipated, and to verify that the geotechnical aspects of construction comply with the contract plans and specifications.

Within the limitations of scope, schedule and budget, GeoPacific attempted to execute these services in accordance with generally accepted professional principles and practices in the fields of geotechnical engineering and engineering geology at the time the report was prepared. No warranty, expressed or implied, is made. The scope of our work did not include environmental assessments or evaluations regarding the presence or absence of wetlands or hazardous or toxic substances in the soil, surface water, or groundwater at this site.

We appreciate this opportunity to be of service.

Sincerely,

GEOPACIFIC ENGINEERING, INC.

JAMES D. IMBRIE
STATE OF WASHINGTON
27177
REGISTERED
PROFESSIONAL ENGINEER

Exp 3-31-16

Beth K. Rapp
Senior Geotechnical Staff

James D. Imbrie, P.E.
Principal Geotechnical Engineer

Attachments: References
Figure 1 – Vicinity Map
Figure 2 – Site and Exploration Plan
Test Pit Logs – TP-2 through TP-11, & TP-13
Test Pit Logs from Previous Study – TP-1 (2013), TP-10 (2013), TP-13 (2013), TP-15 (2013) & TP-16 (2013)

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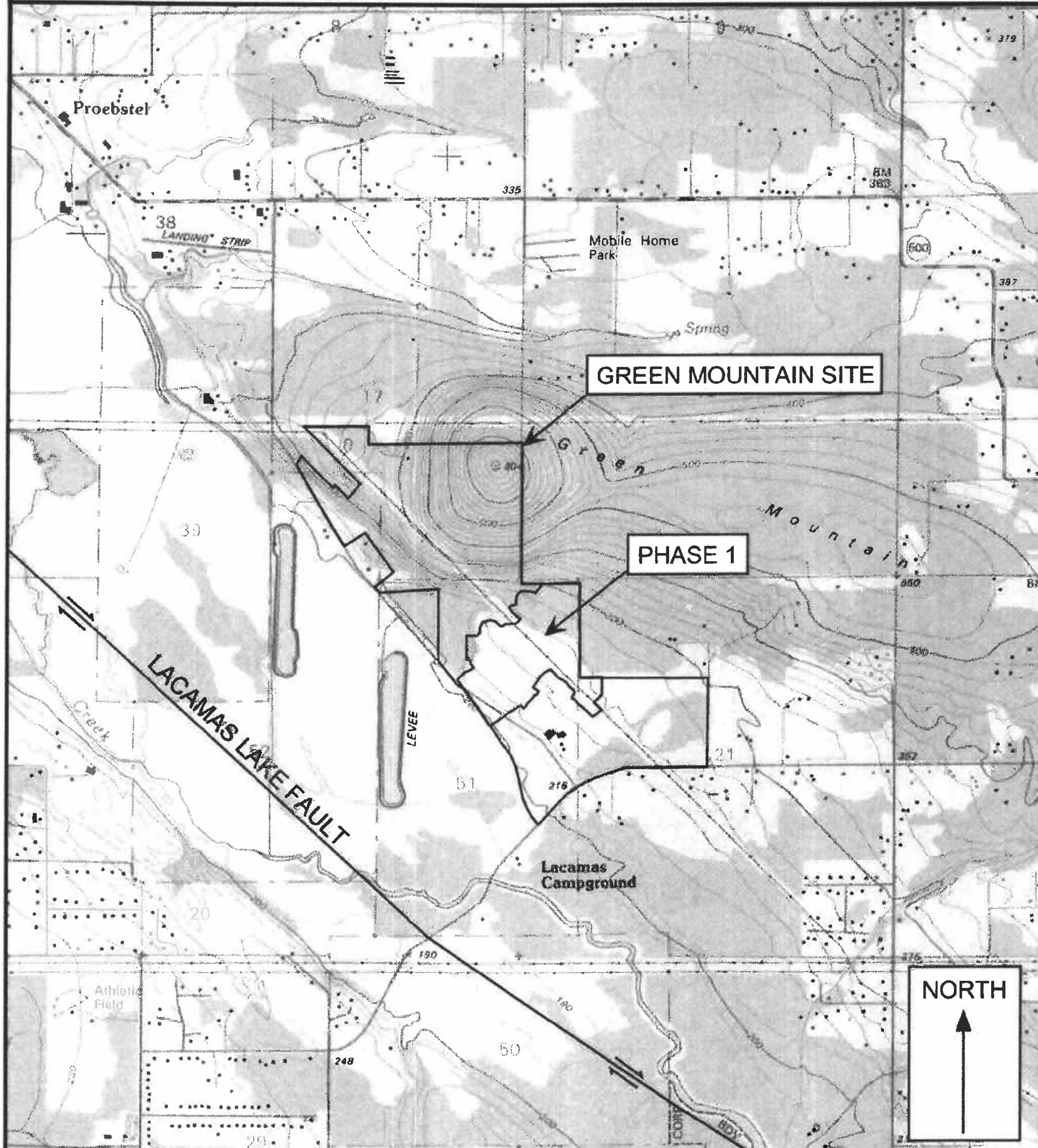
VICINITY MAP



Legend

Approximate Scale 1 in = 2,000 ft

Date: 11/25/2014
Drawn by: EKR

Base map: U.S. Geological Survey 7.5 minute Topographic Map Series, Lacamas Creek, Washington Quadrangle, 1990.

Project: Green Mountain Phase 1 Camas, Washington	Project No. 13-3186	FIGURE 1

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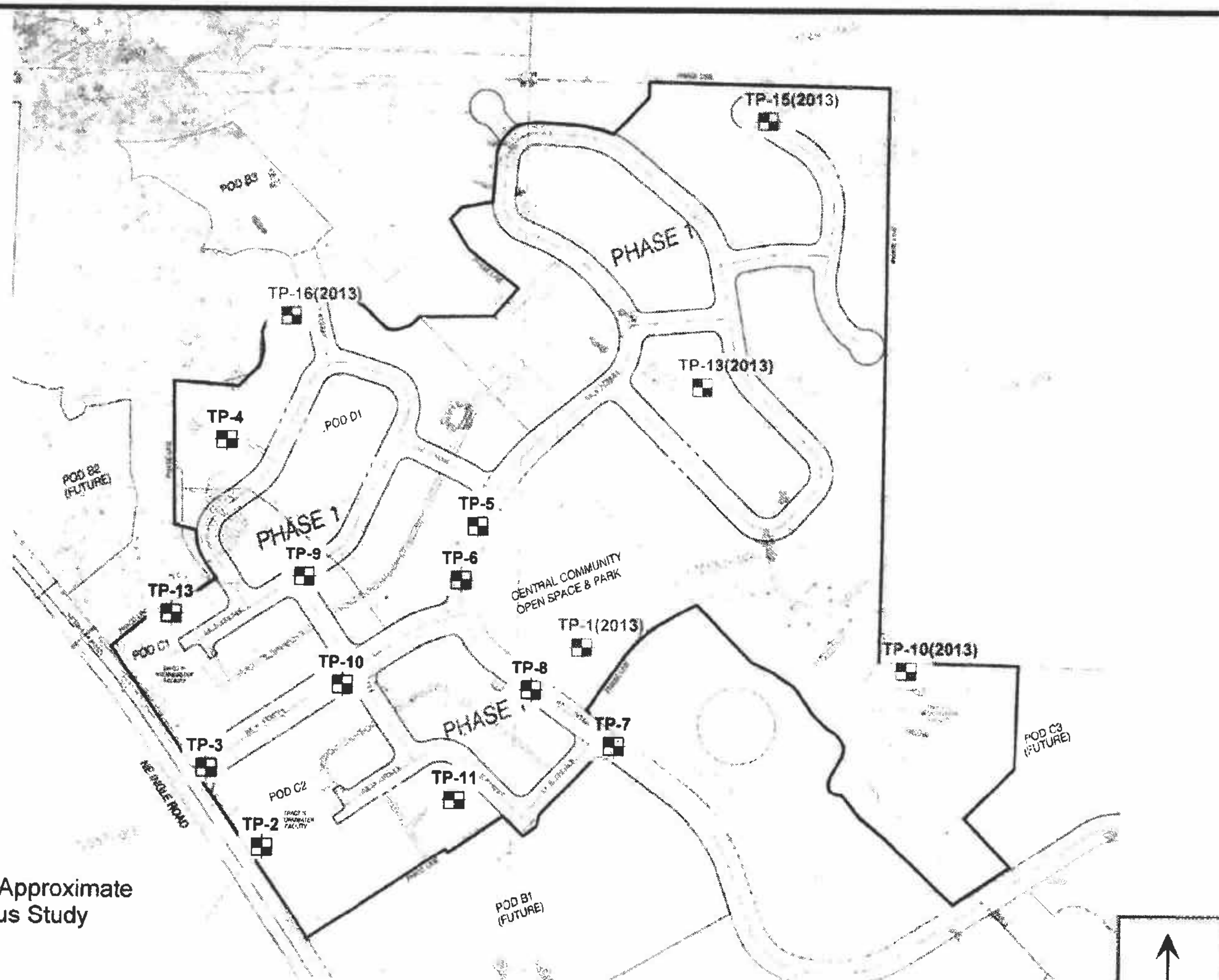
SITE PLAN AND EXPLORATION LOCATIONS



Legend

TP-2 Test Pit Designation and Approximate Location

TP-16(2013) Test Pit Designation and Approximate Location-from Previous Study

0 400'

APPROXIMATE SCALE 1"=400'

Base map provided by Olson Engineering Dated November 2014.

Project: Green Mountain Phase 1 Camas, Washington	Project No. 13-3186	Date: 10/2/2014 Drawn by: EKR	FIGURE 2

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TEST PIT LOG

Project: Green Mountain Phase 1
Camas, Washington

Project No. 13-3186

Test Pit No. **TP-2**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
1	3.0					Stiff to very stiff, SILT (ML), trace sand, brown, moderately organic, trace roots throughout, 6 inch topsoil developed at surface, strong orange and gray mottling, trace black staining, moist (Fill)
2	1.5					
3	4.5					Stiff to very stiff, clayey SILT (ML), trace sand, brown, micaceous, subtle orange and gray mottling, trace black staining, moist (Fine Grained Catastrophic Flood Deposits)
4	3.5					
5						
6						
7					Seepage	Dense, subrounded GRAVEL (GM), trace clayey silt matrix, trace sand, brown to gray, trace black staining, partially cemented, strong orange and gray mottling, gravel is up to 9 inches in diameter, well graded, moist to wet (Conglomerate)
8					Seepage	
9						Test Pit Terminated at 8.5 Feet.
10						Note: Groundwater seepage encountered at 7 - 8 feet. Discharge visually estimated at 1/2 gallon per minute.
11						
12						

LEGEND

Bag Sample (100 to 1,000 g) · Bucket Sample (5 Gal Bucket) · Shelby Tube Sample · Seepage · Water Bearing Zone · Water Level at Abandonment

Date Excavated: 5/23/2014
Logged By: B. Rapp
Surface Elevation:

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TEST PIT LOG

Project: Green Mountain Phase 1, Camas, Washington	Project No. 13-3186	Test Pit No. TP-3

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
1	4.5					Stiff to very stiff, SILT (ML), trace subrounded gravel, brown, with inorganic debris (asphalt), trace roots throughout, 6 inch thick topsoil developed at surface, strong orange and gray mottling, trace black staining, moist (Fill)
2	4.5					
3	4.5					
4	3.5					Stiff to very stiff, sandy SILT (ML), trace subrounded gravel, brown, micaceous, subtle to strong orange and gray mottling, trace black staining, moist (Conglomerate)
5						
6						
7						Dense, subrounded GRAVEL (GM), trace clayey silt matrix, trace sand, brown to gray, trace black staining, partially cemented, strong orange and gray mottling, gravel is up to 9 inches in diameter, well graded, moist to wet (Conglomerate)
8						
9						Test Pit Terminated at 8.5 Feet.
10						Note: No seepage or groundwater encountered.
11						
12						

LEGEND

Bag Sample (100 to 1,000 g) — Bucket Sample (5 Gal. Bucket) — Shelby Tube Sample — Seepage — Water Bearing Zone — Water Level at Abandonment

Date Excavated: 5/23/2014
Logged By: B. Rapp
Surface Elevation:

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TEST PIT LOG

Project: Green Mountain Phase 1, Camas, Washington	Project No. 13-3186	Test Pit No. TP-4

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
1	4.5					Stiff to very stiff, sandy SILT (ML), trace subrounded gravel, gray, trace organic debris, trace roots throughout, 6 inch thick topsoil developed at surface, subtle to strong orange and gray mottling, trace black staining, moist (Fill)
2	4.0					
3	3.5					Stiff to very stiff, sandy SILT (ML), light brown, micaceous, strong orange and gray mottling, trace black staining, moist (Fine Grained Catastrophic Flood Deposits)
4	3.0					
5						
6						
7						
8						Test Pit Terminated at 8 Feet.
9						
10						Note: No seepage or groundwater encountered.
11						
12						

LEGEND

Bag Sample (100 to 1,000 g) · Bucket Sample (5 Gal. Bucket) · Shelby Tube Sample · Seepage · Water Bearing Zone · Water Level at Abandonment

Date Excavated: 5/23/2014
Logged By: B. Rapp
Surface Elevation:

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TEST PIT LOG

Project: Green Mountain Phase 1
Camas, Washington

Project No. 13-3186

Test Pit No. **TP-5**

Depth (ft)	Pocket Penetrometer (tons/ft^2)	Sample Type	In-Situ Dry Density (lb/ft^3)	Moisture Content (%)	Water Bearing Zone	Material Description
0–1						Low to moderately organic, SILT (OL-ML), dark brown, fine roots throughout, loose, moist (Topsoil)
1	4.5					Stiff to very stiff, sandy SILT (ML), light brown, micaceous, subtle to strong orange and gray mottling, trace black staining, moist (Fine Grained Catastrophic Flood Deposits)
2	2.0					
3	2.5					
4	2.5					
5						
6						Medium dense to dense, silty SAND (SM), brown to blue gray below 8.5 feet, subtle to strong orange and gray mottling, sand is fine to medium grained, partially lithified, trace black staining, moist (Conglomerate)
7					Seepage (7.5 ft)	
8						
9						Test Pit Terminated at 9 Feet.
10						
11						Note: Groundwater seepage encountered at 7.5 feet. Discharge visually estimated at 1/4 gallon per minute.
12						

LEGEND

Bag Sample (100 to 1,000 g) · Bucket Sample (5 Gal. Bucket) · Shelby Tube Sample · Seepage · Water Bearing Zone · Water Level at Abandonment

Date Excavated: 5/23/2014
Logged By: B. Rapp
Surface Elevation:

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TEST PIT LOG

Project: Green Mountain Phase 1, Camas, Washington	Project No. 13-3186	Test Pit No. TP-6

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
0–0.5						Low organic, SILT (OL-ML), dark brown, roots throughout, loose, moist (Topsoil)
1	2.5					
2	4.5					
3	3.5					Stiff to very stiff, sandy SILT (ML), light brown, micaceous, subtle to strong orange and gray mottling, trace black staining, moist (Fine Grained Catastrophic Flood Deposits)
4	4.0					
4.5					Seepage	
5						
6						
7						Medium dense to dense, silty SAND (SM), trace subrounded gravel, brown, strong orange and gray mottling, sand is fine to medium grained, partially lithified, trace black staining, moist (Conglomerate)
8						
9						Test Pit Terminated at 8.5 Feet.
10						Note: Groundwater seepage encountered at 4.5 feet. Discharge visually estimated at 1/4 gallon per minute.
11						
12						

LEGEND

100 to 1,000 g — Bag Sample; 5 Gal Bucket — Bucket Sample; Shelby Tube Sample; Seepage; Water Bearing Zone; Water Level at Abandonment

Date Excavated: 5/23/2014
Logged By: B. Rapp
Surface Elevation:

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TEST PIT LOG

Project: Green Mountain Phase 1, Camas, Washington	Project No. 13-3186	Test Pit No. TP-7

Depth (ft)	Pocket Penetrometer (tons/ft^2)	Sample Type	In-Situ Dry Density (lb/ft^3)	Moisture Content (%)	Water Bearing Zone	Material Description
1	4.0					Stiff to very stiff, sandy SILT (ML), trace subrounded gravel, light brown, trace roots throughout, 6 inch thick topsoil developed at surface, strong orange and gray mottling, trace black staining, moist (Fill)
2	4.0					
3	2.0					
4	2.5					Stiff to very stiff, sandy SILT (ML), light brown, micaceous, strong orange and gray mottling, trace black staining, moist (Fine Grained Catastrophic Flood Deposits)
5						
6					Seepage	
7						
8						
9						Test Pit Terminated at 8.5 Feet.
10						Note: Groundwater seepage encountered at 5.5 - 6.5 feet. Discharge visually estimated at 1/4 gallon per minute.
11						
12						

LEGEND

Bag Sample (100 to 1,000 g) | Bucket Sample (5 Gal Bucket) | Shelby Tube Sample | Seepage | Water Bearing Zone | Water Level at Abandonment

Date Excavated: 5/23/2014
Logged By: B. Rapp
Surface Elevation:

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TEST PIT LOG

Project: Green Mountain Phase 1 Camas, Washington	Project No. 13-3186	Test Pit No. **TP-8**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
1	2.0					Stiff to very stiff, sandy SILT (ML), light brown, trace roots throughout, 6 inch thick topsoil developed at surface, strong orange and gray mottling, moist (Fill)
2	2.5					Low organic, SILT (OL-ML), gray, trace fine roots throughout, loose, moist (Buried Topsoil)
3	2.0					Stiff to very stiff, sandy SILT (ML), light brown, micaceous, strong orange and gray mottling, trace black staining, moist (Fine Grained Catastrophic Flood Deposits)
4	1.5					
5						
6					Seepage	
7					Seepage	
8					Seepage	
9						Test Pit Terminated at 8.5 Feet.
10						Note: Groundwater seepage encountered at 5.5 - 7.5 feet. Discharge visually estimated at 1/2 gallon per minute.
11						
12						

LEGEND

100 to 1,000 g — Bag Sample
5 Gal Bucket — Bucket Sample
Shelby Tube Sample
Seepage
Water Bearing Zone
Water Level at Abandonment

Date Excavated: 5/23/2014
Logged By: B. Rapp
Surface Elevation:

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TEST PIT LOG

Project: Green Mountain Phase 1, Camas, Washington	Project No. 13-3186	Test Pit No. TP-9

Depth (ft)	Pocket Penetrometer (tons/ft^2)	Sample Type	In-Situ Dry Density (lb/ft^3)	Moisture Content (%)	Water Bearing Zone	Material Description
0–0.75						Moderately organic, SILT (OL-ML), trace gravel fill, dark brown, fine roots throughout, loose, moist (Topsoil)
1	4.0					Stiff to very stiff, clayey SILT (ML), trace sand, brown, micaceous, subtle orange and gray mottling, trace roots to 3 feet, trace black staining, moist (Fine Grained Catastrophic Flood Deposits)
2	3.5					
3	4.5					
4	4.5					
5						
6						
7					Seepage	Dense, subrounded GRAVEL (GM), trace clayey silt matrix, trace sand, brown to gray, trace black staining, partially cemented, strong orange and gray mottling, moist to wet (Conglomerate)
8						
9						Test Pit Terminated at 8.5 Feet.
10						Note: Groundwater seepage encountered at 7.5 feet. Discharge visually estimated at 1/4 gallon per minute.
11						
12						

LEGEND

Bag Sample (100 to 1,000 g) | Bucket Sample (5 Gal Bucket) | Shelby Tube Sample | Seepage | Water Bearing Zone | Water Level at Abandonment

Date Excavated: 5/23/2014
Logged By: B. Rapp
Surface Elevation:

GeoPacific Engineering, Inc
14835 SW 72nd Avenue
Portland, Oregon 97224
Tel: (503) 598-8445 Fax: (503) 941-9281

TEST PIT LOG

Project: Green Mountain Phase 1, Camas, Washington	Project No. 13-3186	Test Pit No. **TP-10**

Depth (ft)	Pocket Penetrometer (tons/ft^2)	Sample Type	In-Situ Dry Density (lb/ft^3)	Moisture Content (%)	Water Bearing Zone	Material Description
1	4.0					Stiff to very stiff, SILT (ML), trace sand, brown, trace inorganic debris, trace roots throughout, 6 inch topsoil developed at surface, strong orange and gray mottling, moist (Fill)
2	4.0					
3	4.5					Stiff to very stiff, sandy SILT (ML), trace clay, light brown, micaceous, subtle to strong orange and gray mottling, trace black staining, moist (Fine Grained Catastrophic Flood Deposits)
4	4.5					
5						
6						
7						Dense to very dense, subrounded GRAVEL (GM), trace clayey silt matrix, trace sand, brown to gray, trace black staining, partially cemented, strong orange and gray mottling, gravel is up to 6 inches in diameter, well graded, moist (Conglomerate)
8						
9						Test Pit Terminated at 8.5 Feet.
10						Note: No seepage or groundwater encountered.
11						
12						

LEGEND

100 to 1,000 g — Bag Sample; 5 Gal. Bucket — Bucket Sample; Shelby Tube Sample; Seepage; Water Bearing Zone; Water Level at Abandonment

Date Excavated: 5/23/2014
Logged By: B. Rapp
Surface Elevation:

GeoPacific Engineering, Inc.
14835 SW 72nd Avenue
Portland, Oregon 97224
Tel: (503) 598-8445 Fax: (503) 941-9281

TEST PIT LOG

Project: Green Mountain Phase 1
Camas, Washington

Project No. 13-3186

Test Pit No. **TP-11**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
1	2.5					Stiff to very stiff, sandy SILT (ML), trace gravel, light brown, trace fine roots throughout, 6 inch thick topsoil developed at surface, moist (Fill)
2	4.5					Low to moderately organic, SILT (OL-ML), brown, trace fine roots throughout, moist (Buried Topsoil)
3	3.5					Stiff to very stiff, sandy SILT (ML), light brown, subtle to strong orange and gray mottling, moist (Fill)
4	3.0					
5						Test Pit Terminated at 5 Feet due to Buried Water Line Tape.
6						Note: No groundwater or seepage encountered.
7						
8						
9						
10						
11						
12						

LEGEND

100 to 1,000 g — Bag Sample
5 Gal Bucket — Bucket Sample
Shelby Tube Sample
Seepage
Water Bearing Zone
Water Level at Abandonment

Date Excavated: 5/23/2014
Logged By: B. Rapp
Surface Elevation:

GeoPacific Engineering, Inc.
14835 SW 72nd Avenue
Portland, Oregon 97224
Tel: (503) 598-8445 Fax: (503) 941-9281

TEST PIT LOG

Project: Green Mountain Phase 1, Camas, Washington	Project No. 13-3186	Test Pit No. **TP-13**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
1	1.5					Stiff, sandy SILT (ML), trace clay, light brown, trace roots throughout, 6 inch thick topsoil developed at surface, strong orange and gray mottling, moist (Fill)
2	2.0					
3	2.5					
4	4.0					Stiff to very stiff, sandy SILT (ML), light brown, micaceous, strong orange and gray mottling, trace black staining, moist (Fine Grained Catastrophic Flood Deposits)
5						
6						
7						Dense to very dense, subrounded GRAVEL (GM), trace silty sand matrix, brown to gray, trace black staining, strong orange and gray mottling, gravel is up to 12 inches in diameter, moist (Conglomerate)
8						
9						Test Pit Terminated at 8.5 Feet.
10						Note: Groundwater seepage encountered at 8.5 feet. Discharge visually estimated at 1/4 gallon per minute.
11						
12						

LEGEND

Bag Sample (100 to 1,000 g) | Bucket Sample (5 Gal. Bucket) | Shelby Tube Sample | Seepage | Water Bearing Zone | Water Level at Abandonment

Date Excavated: 5/23/2014
Logged By: B. Rapp
Surface Elevation:

GeoPacific Engineering, Inc.
14835 SW 72nd Avenue
Portland, Oregon 97224
Tel: (503) 598-8445 Fax: (503) 941-9281

TEST PIT LOG

Project: Green Mountain, Camas, Washington	Project No. 13-3186	Test Pit No. TP-1 (2013)

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
1	0.5					Moderately organic, sandy SILT (OL-ML), dark brown, roots throughout, loose, moist (Topsoil)
2	1.0					Medium stiff, sandy SILT (ML), brown, micaceous, strong orange and gray mottling, moist to wet (Fine Grained Catastrophic Flood Deposits)
3	1.0					
4	0.5					
5						Test Pit Terminated at 4 Feet for Infiltration Testing.
6						Note: Groundwater seepage encountered at 3 feet. Discharge visually estimated at less than 1 gallon per minute. Static groundwater at 2 Feet at Completion of Infiltration Testing.
7						
8						
9						
10						
11						
12						

LEGEND

100 to 1,000 g — Bag Sample; 5 Gal. Bucket — Bucket Sample; Shelby Tube Sample; Seepage; Water Bearing Zone; Water Level at Abandonment

Date Excavated: 11/5-7/2013
Logged By: B. Rapp
Surface Elevation:

GeoPacific Engineering, Inc.
14835 SW 72nd Avenue
Portland, Oregon 97224
Tel: (503) 598-8445 Fax: (503) 941-9281

TEST PIT LOG

Project: Green Mountain, Camas, Washington	Project No. 13-3186	Test Pit No. TP-10 (2013)

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
0–0.7						Moderately organic, SILT (OL-ML), dark brown, fine roots throughout, loose, moist (Topsoil)
1	2.0					Stiff to very stiff, sandy SILT (ML), trace clay, light brown, micaceous, strong orange and gray mottling, trace black staining, moist (Fine Grained Catastrophic Flood Deposits)
2	2.0					
3	1.5					
4	3.5					Dense, subrounded GRAVEL (GM), trace sandy silt matrix, light brown to gray, trace black staining, strong orange and gray mottling, micaceous, moist (Conglomerate)
5						
6						Test Pit Terminated at 6 Feet.
7						
8						Note: No seepage or groundwater encountered.
9						
10						
11						
12						

LEGEND

100 to 1,000 g — Bag Sample; 5 Gal Bucket — Bucket Sample; Shelby Tube Sample; Seepage; Water Bearing Zone; Water Level at Abandonment

Date Excavated: 11/5-7/2013
Logged By: B. Rapp
Surface Elevation:

GeoPacific Engineering, Inc.
14835 SW 72nd Avenue
Portland, Oregon 97224
Tel: (503) 598-8445 Fax: (503) 941-9281

TEST PIT LOG

Project: Green Mountain Phase 1 Camas, Washington	Project No. 13-3186	Test Pit No. TP-13 (2013)

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
0–1						Moderately organic, SILT (OL-ML), brown, fine roots throughout, loose, moist (Topsoil)
1–3	1.5 (at 2), 3.0 (at 3)					Medium stiff to very stiff, sandy SILT (ML), trace clay, light brown, micaceous, strong orange and gray mottling, trace black staining, moist (Fine Grained Catastrophic Flood Deposits)
3–9					Seepage (at 8)	Dense, subrounded GRAVEL (GM), trace sandy silt matrix, trace clay, light brown to gray, trace black staining, well graded, strong orange and gray mottling, micaceous, moist (Conglomerate)
9–12						Test Pit Terminated at 9 Feet. Note: Groundwater seepage encountered at 8 feet. Discharge visually estimated at 1 gallon per minute.

LEGEND

Bag Sample (100 to 1,000 g) | Bucket Sample (5 Gal Bucket) | Shelby Tube Sample | Seepage | Water Bearing Zone | Water Level at Abandonment

Date Excavated: 11/5-7/2013
Logged By: B. Rapp
Surface Elevation:

GeoPacific Engineering Inc.
14835 SW 72nd Avenue
Portland, Oregon 97224
Tel: (503) 598-8445 Fax: (503) 941-9281

TEST PIT LOG

Project: Green Mountain Phase 1, Camas, Washington	Project No. 13-3186	Test Pit No. TP-15 (2013)

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
0–0.7						Moderately organic, SILT (OL-ML), with basalt fragments, dark brown, fine roots throughout, loose, moist (Topsoil)
1	1.5					Stiff to very stiff, silty CLAY (CL) to clayey SILT (ML), with gray weathered basalt, light reddish-brown, trace fine roots throughout, strong orange and gray mottling, black staining, moist (Colluvial Soil)
2	3.5				Seepage	
3–10.5						Medium dense, silty SAND (SM) with interbeds of stiff, sandy SILT (ML), light brown, micaceous, sand is fine to medium grained, strong orange and gray mottling, trace black staining, moist (Conglomerate)
11–12						Test Pit Terminated at 10.5 Feet. Note: Groundwater seepage encountered at 2 feet. Discharge visually estimated at 1 gallon per minute.

LEGEND

100 to 1,000 g — Bag Sample; 5 Gal. Bucket — Bucket Sample; Shelby Tube Sample; Seepage; Water Bearing Zone; Water Level at Abandonment

Date Excavated: 11/5-7/2013
Logged By: B. Rapp
Surface Elevation:

GeoPacific Engineering, Inc.
14835 SW 72nd Avenue
Portland, Oregon 97224
Tel: (503) 598-8445 Fax: (503) 941-9281

TEST PIT LOG

Project: Green Mountain Camas, Washington	Project No. 13-3186	Test Pit No. TP-16 (2013)

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
0–1	0.5 (at 1)					Moderately organic, SILT (OL-ML), dark brown, fine roots throughout, loose, moist (Topsoil)
1–9	2.0 (at 2); 3.5 (at 3); 2.0 (at 4)				Seepage (3.5–6.5)	Medium dense, silty SAND (SM) with interbeds of stiff, sandy SILT (ML), light brown to gray, micaceous, sand is coarse to medium grained, strong orange and gray mottling, trace black staining, moist to wet (Conglomerate)
9–12						Test Pit Terminated at 9 Feet. Note: Groundwater seepage encountered at 3.5 to 6.5 feet. Discharge visually estimated at 2 gallons per minute.

LEGEND

Bag Sample (100 to 1,000 g) | Bucket Sample (5 Gal. Bucket) | Shelby Tube Sample | Seepage | Water Bearing Zone | Water Level at Abandonment

Date Excavated: 11/5-7/2013
Logged By: B. Rapp
Surface Elevation:

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STORMWATER FACILITY MAINTENANCE MANUAL

Clark County Public Works Department
Clean Water Program

January 2009

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Table of Contents

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Introduction

Background

All businesses and government agencies have some form of stormwater drainage facilities. Stormwater facilities or storm sewers on private sites drain to roadside ditches, county storm sewer pipes, streams, or to groundwater from infiltration facilities. Storm sewers include pipes, catch basins, manholes, grassy treatment swales, ditches, drywells, ponds, oil/water separators, and any other structures that collect, convey, control, or treat stormwater.

Requirements from the federal Clean Water Act and compliance with rules to protect threatened salmon under the federal Endangered Species Act also require that all storm drainage facilities be properly operated and maintained

In November 1998, Clark County adopted the Water Quality Ordinance (as Chapter 13.26A CCC). The Water Quality Ordinance requires businesses and public agencies to use water quality protection practices, referred to as best management practices or BMPs, to eliminate or reduce pollution from their outdoor activities. The Water Quality Ordinance was amended in July 2000 to include minimum standards for maintaining drainage facilities. The water quality ordinance will be amended in 2008 to meet state standards for preventing pollutants from business and government operations from reaching the storm sewer. Development under Chapter 40.380 CCC is also required to maintain storm sewers. Chapter 40.380 CCC will be amended in 2008 to meet the 2007 NPDES Permit requirements to follow state guidelines for controlling stormwater and erosion on development and construction sites. New facilities are either transferred to county ownership and maintenance or maintained by the owner as private facilities.

Purpose

This manual is intended to meet all storm sewer systems operation and maintenance requirements under Clark County Code Chapter 13.26A Water Quality, Chapter 40.380 Stormwater Controls, and the Stormwater Management Manual for Western Washington: Volume II (Washington Department of Ecology, April, 2005). It applies to county operations, as well as public or privately owned and operated systems in unincorporated areas of Clark County.

Drainage systems are often in or near areas that are also fish and wildlife habitat. This manual helps make sure that storm sewer owners perform their maintenance in a way that conforms to regulations protecting fish and wildlife.

Why Maintain Storm Sewer Facilities?

Along with keeping the site from flooding, properly maintained storm sewers can help reduce surface water and groundwater pollution. Many newer sites have stormwater control facilities designed to limit the environment damage and flooding damage by stormwater runoff. These systems cost many thousands of dollars to install and require more maintenance than a system of pipes and catch basins.

Storm sewer maintenance is necessary to protect streams, lakes, wetlands, and groundwater. Proper maintenance helps assure that:

- Storm sewers operate as they were designed;
- Storm sewers are cleaned of the pollutants that they trap, such as sediment and oils, so that the site's storm sewers are not overwhelmed and become pollutant sources;
- Sources of pollutants to storm sewers (such as leaky dumpsters) are removed.

What You Should Be Doing

This manual describes the steps you can take to assure that your storm sewers meet water quality requirements. If your site was approved for construction under county stormwater requirements adopted in 1994, the storm sewer system should have an approved plan for maintenance. This manual will help facility owners follow those requirements.

Look for electronic copies of the manual on the Clark County web site:
http://www.clark.wa.gov/water-resources/techassist/business.html

Method for Creating this Manual
Stormwater Management Manual for Western Washington: Volume V

This manual draws on other maintenance manuals to create an updated Stormwater Facility Maintenance Manual for Clark County.

Along with documenting current county standards and practices, this manual includes maintenance practices from the Stormwater Management Manual for Western Washington: Volume ~~II~~V (Washington Department of Ecology, April, 2005), the Pierce County Stormwater Maintenance Manual for Private Facilities (2005), and the Clark County Stormwater Facility Maintenance Manual (July, 2000). The main sources are:

- Washington Department of Ecology (April, 2005) Stormwater Management Manual for Western Washington: Volume V.
- Pierce County (2005) Stormwater Maintenance Manual for Private Facilities.

Emergent Treatment Technologies

Volume V, Chapter 12 of the SWMMWW addresses emerging treatment technologies. Since emerging technologies are rapidly evolving and it is not practical to update the SWMMWW every time a new device comes out, the Technology Assessment Protocol - Ecology (TAPE) was created as guidance for evaluating emerging stormwater treatment technologies. The TAPE can be found online at http://www.ecy.wa.gov/biblio/0210037.html.

Ecology assigns a General Use Level Designation (GULD) on emergent technologies that may be used Washington.

Maintenance standards in General Use Level Designation approvals for emergent technologies not found in the Clark County Stormwater Facility Maintenance Manual are adopted by reference and can be found at http://www.ecy.wa.gov/programs/wq/stormwater/newtech/technologies.html.

Mosquito Control

Mosquitoes can be annoying and sometimes pose a serious risk to public health. In certain areas of the United States, mosquitoes can transmit diseases such as West Nile Virus and equine encephalitis. To combat mosquitoes and the public health hazards they present, Clark County has established mosquito control program. Information on the the Clark County Mosquito Control District can be accessed on line at http://www.clark.wa.gov/mosquito/.

Mosquito control programs place a high priority on trying to prevent a large population of adult mosquitoes from developing so that additional controls may not be necessary. Since mosquitoes must have water to breed, methods of prevention may include identifying stormwater infrastructure such as catch basins, retention/detention systems, and other water holding areas that may harbor mosquitoes.

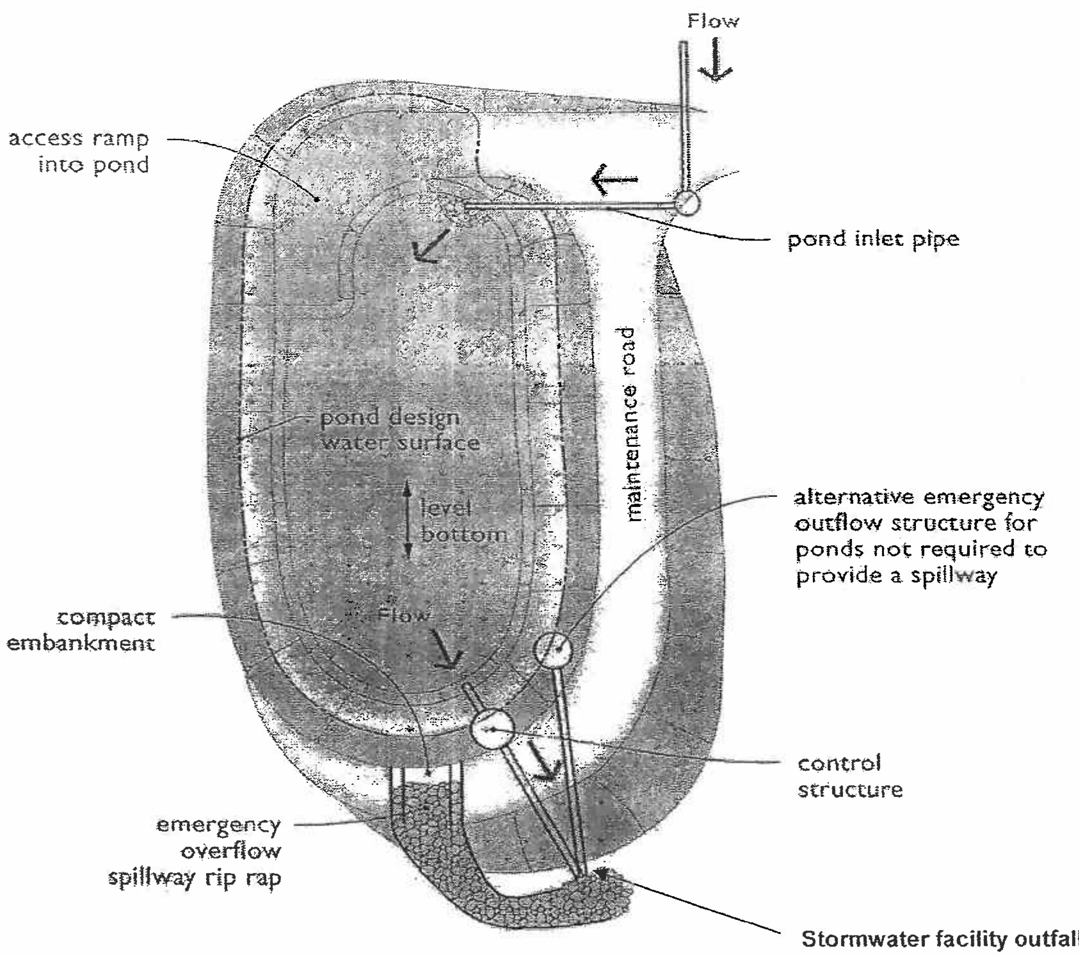
If mosquitoes are identified during stormwater facility maintenance or inspection activities and are a concern, a request to the Clark County Mosquito Control District for service or information regarding mosquito control can be made through either the 24-hour service request line, (360) 397-8430.

Detention Pond

A stormwater detention pond is an open basin built by excavating below existing ground or by constructing above-ground berms (embankments). The detention pond temporarily stores stormwater runoff during rain events and slowly releases it through an outlet (control structure). Detention ponds are typically designed to completely drain within 24 hours after the completion of a storm event. Styles vary greatly from well manicured to natural appearing. Generally, more natural-appearing vegetation is preferred for reduced maintenance and enhanced wildlife habitat. Some facilities are designed to appear as natural water bodies or are in park-like areas.

Facility objects that are typically associated with a detention pond include:

- access road or easement
- fence, gate, and water quality sign
- control structure/flow restrictor
- energy dissipaters
- conveyance stormwater pipe



Detention Pond

Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed Or Not Needed
General	Trash and Debris	Any trash and debris which exceed 5 cubic feet per 1,000 square feet (this is about equal to the amount of trash it would take to fill up one standard size garbage can). In general, there should be no visual evidence of dumping. If less than threshold all trash and debris will be removed as part of next scheduled maintenance.	Trash and debris cleared from site.
	Poisonous Vegetation and noxious weeds	Any poisonous or nuisance vegetation which may constitute a hazard to maintenance personnel or the public. Any evidence of noxious weeds as defined by State or local regulations. (Apply requirements of adopted IPM policies for the use of herbicides).	No danger of poisonous vegetation where maintenance personnel or the public might normally be. (Coordinate with Clark County Weed Management department) Complete eradication of noxious weeds may not be possible. Compliance with State or local eradication policies required
	Contaminants and Pollution	Any evidence of oil, gasoline, contaminants or other pollutants (Coordinate removal/cleanup with local water quality response agency).	No contaminants or pollutants present.
	Rodent Holes	Any evidence of rodent holes if facility is acting as a dam or berm, or any evidence of water piping through dam or berm via rodent holes.	Rodents destroyed and dam or berm repaired. (Coordinate with Clark County Maintenance and Operations department; coordinate with Ecology Dam Safety Office if pond exceeds 10 acre-feet.)
	Beaver Dams	Dam results in change or function of the facility.	Facility is returned to design function. (Coordinate trapping of beavers and removal of dams with appropriate permitting agencies)
	Insects	When insects such as wasps and hornets interfere with maintenance activities.	Insects destroyed or removed from site. Apply insecticides in compliance with adopted Clark County Maintenance and Operations policies.
	Tree Growth and Hazard Trees	Tree growth does not allow maintenance access or interferes with maintenance activity (i.e., slope mowing, silt removal, vactoring, or equipment movements). If trees are not interfering with access or maintenance, do not remove. If dead, diseased, or dying trees are identified (Use a certified Arborist to determine health of tree or removal requirements)	Trees do not hinder maintenance activities. Harvested trees should be recycled into mulch or other beneficial uses (e.g., alders for firewood). Remove hazard Trees
Side Slopes of Pond	Erosion	Eroded damage over 2 inches deep where cause of damage is still present or where there is potential for continued erosion. Any erosion observed on a compacted berm embankment.	Slopes should be stabilized using appropriate erosion control measure(s); e.g., rock reinforcement, planting of grass, compaction. If erosion is occurring on compacted berms a licensed civil engineer should be consulted to resolve source of erosion.

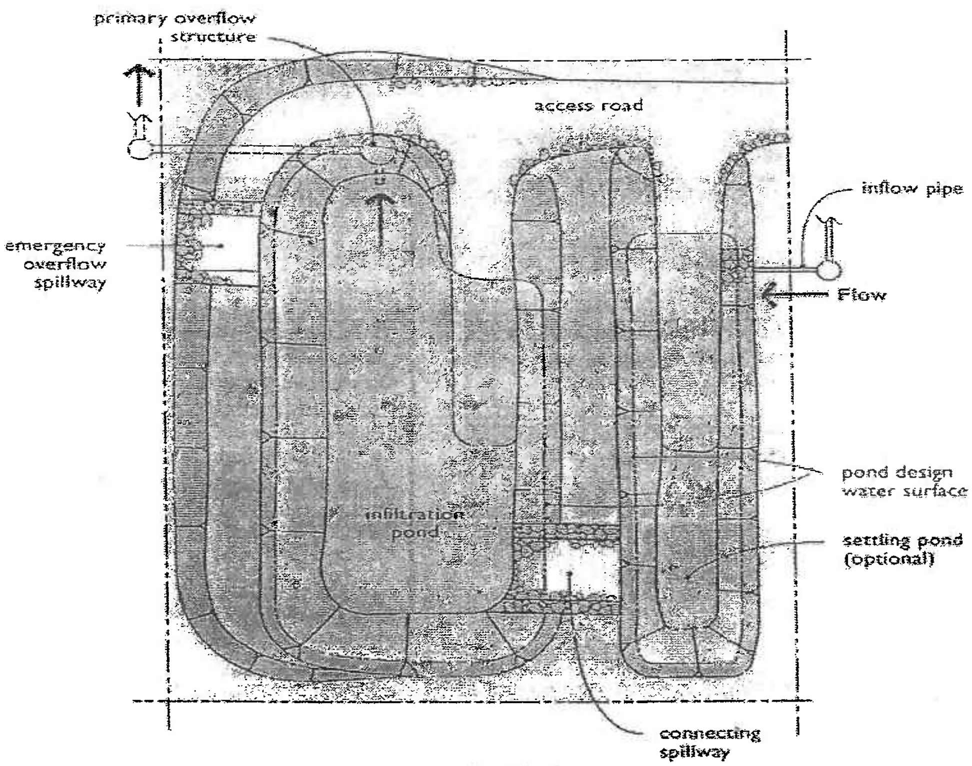
Detention Pond (Continued)			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed Or Not Needed**
Storage Area	Sediment	Accumulated sediment that exceeds 10% of the designed pond depth unless otherwise specified or affects inletting or outletting condition of the facility.	Sediment cleaned out to designed pond shape and depth; pond reseeded if necessary to control erosion.
	Liner (If Applicable)	Liner is visible and has more than three 1/4-inch holes in it.	Liner repaired or replaced. Liner is fully covered.
Pond Berms (Dikes)	Settlements	Any part of berm which has settled 4 inches lower than the design elevation. If settlement is apparent, measure berm to determine amount of settlement. Settling can be an indication of more severe problems with the berm or outlet works. A licensed civil engineer should be consulted to determine the source of the settlement.	Dike is built back to the design elevation.
	Piping	Discernable water flow through pond berm. Ongoing erosion with potential for erosion to continue. (Recommend a Geotechnical engineer be called in to inspect and evaluate condition and recommend repair of condition.	Piping eliminated. Erosion potential resolved.
Emergency Overflow/ Spillway and Berms Over 4 Feet in Height.	Tree Growth	Tree growth on emergency spillways creates blockage problems and may cause failure of the berm due to uncontrolled overtopping. Tree growth on berms over 4 feet in height may lead to piping through the berm which could lead to failure of the berm.	Trees should be removed. If root system is small (base less than 4 inches) the root system may be left in place. Otherwise the roots should be removed and the berm restored. A licensed civil engineer should be consulted for proper berm/spillway restoration.
	Piping	Discernable water flow through pond berm. Ongoing erosion with potential for erosion to continue. (Recommend a Geotechnical engineer be called in to inspect and evaluate condition and recommend repair of condition.	Piping eliminated. Erosion potential resolved.
Emergency Overflow/ Spillway	Rock Missing	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil at the top of out flow path of spillway. (Rip-rap on inside slopes need not be replaced.)	Rocks and pad depth are restored to design standards.
	Erosion	Eroded damage over 2 inches deep where cause of damage is still present or where there is potential for continued erosion. Any erosion observed on a compacted berm embankment.	Slopes should be stabilized using appropriate erosion control measure(s); e.g., rock reinforcement, planting of grass, compaction. If erosion is occurring on compacted berms a licensed civil engineer should be consulted to resolve source of erosion.

Infiltration Basin

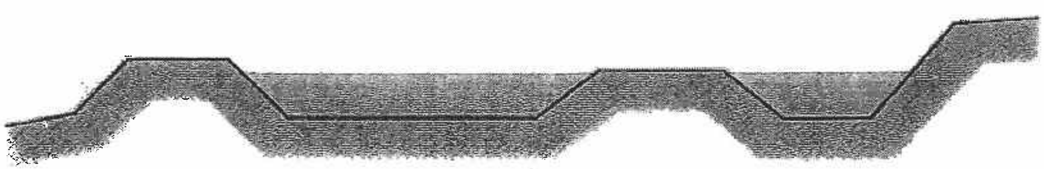
A stormwater infiltration open basin disposes of water by holding it in an area where it can soak into the ground. These are open facilities that may either drain rapidly and have grass bases, or have perpetual ponds where water levels rise and fall with stormwater flows. Infiltration facilities may be designed to handle all of the runoff from an area or they may overflow and bypass larger storms. Since the facility is design to pass water into the ground, anything that can cause the base to clog will reduce 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.

Facility objects that are typically associated with an infiltration facility include:

- access road or easement
- fence, gate, and water quality sign
- energy dissipaters
- conveyance stormwater pipe



BIRD'S-EYE VIEW



SIDE PROFILE

Infiltration Basin			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed Or Not Needed**
General	Trash and Debris	Any trash and debris which exceed 5 cubic feet per 1,000 square feet (this is about equal to the amount of trash it would take to fill up one standard size garbage can). In general, there should be no visual evidence of dumping. If less than threshold all trash and debris will be removed as part of next scheduled maintenance.	Trash and debris cleared from site.
	Poisonous Vegetation and Noxious Weeds	Any poisonous or nuisance vegetation which may constitute a hazard to maintenance personnel or the public. Any evidence of noxious weeds as defined by State or local regulations. (Apply requirements of adopted IPM policies for the use of herbicides).	No danger of poisonous vegetation where maintenance personnel or the public might normally be. (Coordinate with Clark County Weed Management department) Complete eradication of noxious weeds may not be possible. Compliance with State or local eradication policies required
	Contaminants and Pollution	Any evidence of oil, gasoline, contaminants or other pollutants. (Coordinate removal/cleanup with local water quality response agency).	No contaminants or pollutants present.
	Rodent Holes	Any evidence of rodent holes if facility is acting as a dam or berm, or any evidence of water piping through dam or berm via rodent holes.	Rodents destroyed and dam or berm repaired. (Coordinate with Clark County Maintenance and Operations department; coordinate with Ecology Dam Safety Office if pond exceeds 10 acre-feet.)
	Beaver Dams	Dam results in change or function of the facility.	Facility is returned to design function. (Coordinate trapping of beavers and removal of dams with appropriate permitting agencies)
	Insects	When insects such as wasps and hornets interfere with maintenance activities.	Insects destroyed or removed from site. Apply insecticides in compliance with adopted Clark County Maintenance and Operations policies.
Storage Area	Sediment	Water ponding in infiltration pond after rainfall ceases and appropriate time allowed for infiltration. (A percolation test pit or test of facility indicates facility is only working at 90% of its designed capabilities. If two inches or more sediment is present, remove).	Sediment is removed and/or facility is cleaned so that infiltration system works according to design.
Filter Bags (If Applicable)	Filled with Sediment and Debris	Sediment and debris fill bag more than 1/2 full.	Filter bag is replaced or system is redesigned.
Rock Filters	Sediment and Debris	By visual inspection, little or no water flows through filter during heavy rain storms.	Gravel in rock filter is replaced.

Infiltration Basin (Continued)			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed Or Not Needed**
Side Slopes of Pond	Erosion	Eroded damage over 2 inches deep where cause of damage is still present or where there is potential for continued erosion. Any erosion observed on a compacted berm embankment	Slopes should be stabilized using appropriate erosion control measure(s); e.g., rock reinforcement, planting of grass, compaction. If erosion is occurring on compacted berms a licensed civil engineer should be consulted to resolve source of erosion.
Pond Berms (Dikes)	Settlements	Any part of berm which has settled 4 inches lower than the design elevation. If settlement is apparent, measure berm to determine amount of settlement. Settling can be an indication of more severe problems with the berm or outlet works. A licensed civil engineer should be consulted to determine the source of the settlement.	Dike is built back to the design elevation.
Emergency Overflow/ Spillway and Berms Over 4 Feet in Height.	Tree Growth	Tree growth on emergency spillways creates blockage problems and may cause failure of the berm due to uncontrolled overtopping. Tree growth on berms over 4 feet in height may lead to piping through the berm which could lead to failure of the berm.	Trees should be removed. If root system is small (base less than 4 inches) the root system may be left in place. Otherwise the roots should be removed and the berm restored. A licensed civil engineer should be consulted for proper berm/spillway restoration.
	Piping	Discernable water flow through pond berm. Ongoing erosion with potential for erosion to continue. (Recommend a Geotechnical engineer be called in to inspect and evaluate condition and recommend repair of condition.	Piping eliminated. Erosion potential resolved.
Emergency Overflow/ Spillway	Rock Missing	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil at the top of out flow path of spillway. (Rip-rap on inside slopes need not be replaced.)	Rocks and pad depth are restored to design standards.
Emergency Overflow/ Spillway	Erosion	Eroded damage over 2 inches deep where cause of damage is still present or where there is potential for continued erosion. Any erosion observed on a compacted berm embankment.	Slopes should be stabilized using appropriate erosion control measure(s); e.g., rock reinforcement, planting of grass, compaction. If erosion is occurring on compacted berms a licensed civil engineer should be consulted to resolve source of erosion.
Pre-settling Ponds and Vaults	Facility or Sump Filled With Sediment and/or Debris	6" or designed sediment trap depth of sediment.	Sediment is removed.

Catch Basin

A catch basin is an underground concrete structure typically fitted with a slotted grate to collect stormwater runoff and route it through underground pipes. Catch basins can also be used as a junction in a pipe system and may have a solid lid. There are two types.

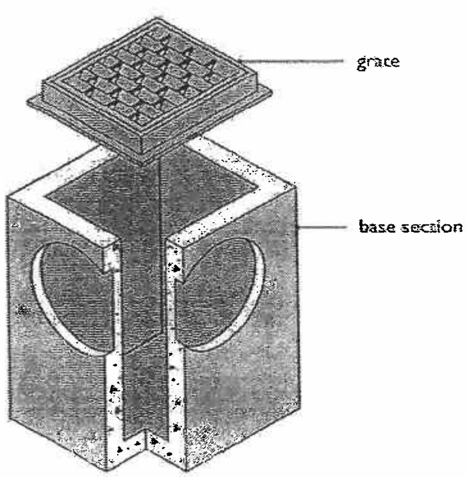
A Type 1 catch basin is a rectangular box with approximate dimensions of 3'x2'x5'. Type 1 catch basins are utilized when the connected conveyance pipes are less than 18 inches in diameter and the depth from the gate to the bottom of the pipe is less than 5 feet.

Type 2 catch basins, also commonly referred to as storm manholes, are round concrete structures ranging in diameter from 4 feet to 8 feet. Type 2 catch basins are used when the connecting conveyance pipe is 18 inches or greater or the depth from grate to pipe bottom exceeds 5 feet. Type 2 catch basins typically have manhole steps mounted on the side of the structure to allow access.

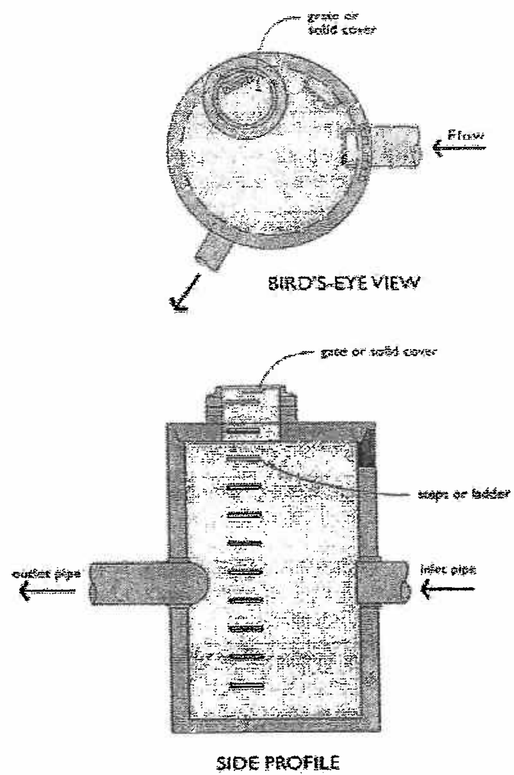
Both types typically provide a storage volume (sump) below the outlet pipe to allow sediments and debris to settle out of the stormwater runoff. Some catch basins are also fitted with a spill control device (inverted elbow on outlet pipe) intended to contain large quantities of grease or oils.

The most common tool for cleaning catch basins is a truck with a tank and vacuum hose (vactor truck) to remove sediment and debris from the sump. A catch basin may be an enclosed space where harmful chemicals and vapors can accumulate. Therefore, if the inspection and maintenance requires entering a catch basin, it should be conducted by an individual trained and certified to work in hazardous confined spaces.

Catch basins are typically associated with all stormwater facilities.



Type 1



Type 2

Catch Basins			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed Or Not Needed**
General	Trash and Debris	Trash or debris which is located immediately in front of the catch basin opening or is blocking inletting capacity of the basin by more than 10%.	No Trash or debris located immediately in front of catch basin or on grate opening.
		Trash or debris (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of six inches clearance from the debris surface to the invert of the lowest pipe.	No trash or debris in the catch basin.
		Trash or debris in any inlet or outlet pipe blocking more than 1/3 of its height.	Inlet and outlet pipes free of trash or debris.
		Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane).	No dead animals or vegetation present within the catch basin.
	Sediment	Sediment (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of 6 inches clearance from the sediment surface to the invert of the lowest pipe.	No sediment in the catch basin
	Structure Damage to Frame and/or Top Slab	Top slab has holes larger than 2 square inches or cracks wider than 1/4 inch (Intent is to make sure no material is running into basin).	Top slab is free of holes and cracks.
		Frame not sitting flush on top slab, i.e., separation of more than 3/4 inch of the frame from the top slab. Frame not securely attached	Frame is sitting flush on the riser rings or top slab and firmly attached.
	Fractures or Cracks in Basin Walls/ Bottom	Maintenance person judges that structure is unsound.	Basin replaced or repaired to design standards.
		Grout fillet has separated or cracked wider than 1/2 inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering catch basin through cracks.	Pipe is regrouted and secure at basin wall.
	Settlement/ Misalignment	If failure of basin has created a safety, function, or design problem.	Basin replaced or repaired to design standards.
	Vegetation	Vegetation growing across and blocking more than 10% of the basin opening.	No vegetation blocking opening to basin.
		Vegetation growing in inlet/outlet pipe joints that is more than six inches tall and less than six inches apart.	No vegetation or root growth present.
	Contaminants and Pollution	Any evidence of oil, gasoline, contaminants or other pollutants (Coordinate removal/cleanup with local water quality response agency).	No contaminants or pollutants present.

Catch Basins (Continued)			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed Or Not Needed**
Catch Basin Cover	Cover Not in Place	Cover is missing or only partially in place. Any open catch basin requires maintenance.	Catch basin cover is closed
	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 1/2 inch of thread.	Mechanism opens with proper tools.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure (Intent is to keep cover from sealing off access to maintenance).	Cover can be removed by one maintenance person.
Ladder	Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, not securely attached to basin wall, misalignment, rust, cracks, or sharp edges.	Ladder meets design standards and allows maintenance person safe access.
Metal Grates (If Applicable)	Grate opening Unsafe	Grate with opening wider than 7/8 inch.	Grate opening meets design standards.
	Trash and Debris	Trash and debris that is blocking more than 20% of grate surface inletting capacity.	Grate free of trash and debris.
	Damaged or Missing.	Grate missing or broken member(s) of the grate.	Grate is in place and meets design standards.

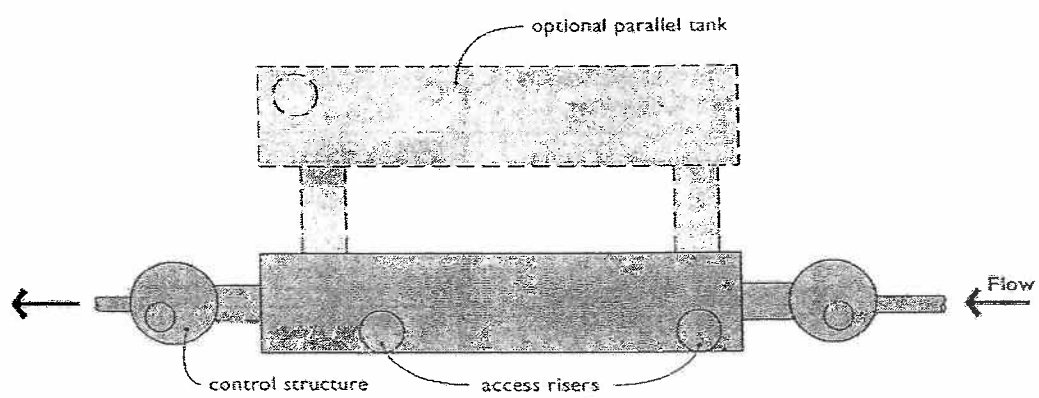
Closed Detention System (Tanks/Vault)

A closed detention system functions similarly to a detention pond with the temporary storage volume provided by an underground structure to regulate the storm discharge rate from the site. The structure is typically constructed of large diameter pipe (48" diameter or greater) or a concrete box (vault). These systems are typically utilized for sites that do not have space available for an above-ground system and are more commonly associated with commercial sites.

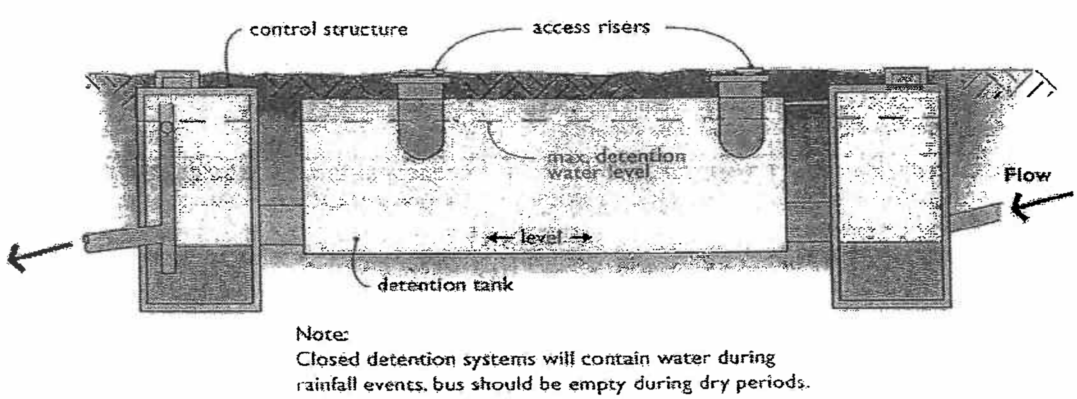
Underground detention systems are enclosed spaces where harmful chemicals and vapors can accumulate. Therefore, the inspection and maintenance of these facilities should be conducted by an individual trained and certified to work in hazardous confined spaces.

Facility objects that are typically associated with a closed detention system include:

- access road or easement
- fence, gate, and water quality sign
- control structure/flow restrictor
- conveyance stormwater pipe



BIRD'S-EYE VIEW



SIDE PROFILE

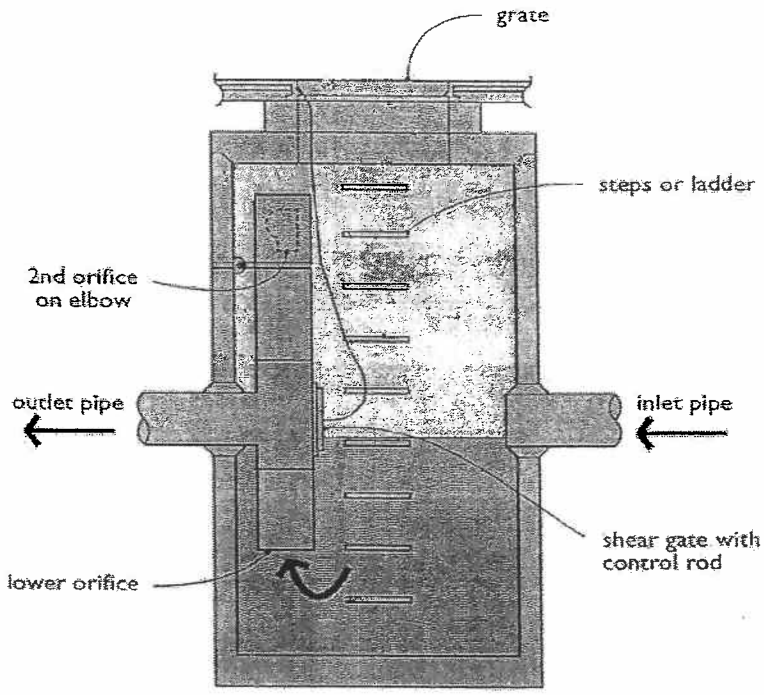
Closed Detention Systems (Tanks/Vaults)			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed Or Not Needed**
Storage Area	Plugged Air Vents	One-half of the cross section of a vent is blocked at any point or the vent is damaged.	Vents open and functioning.
	Debris and Sediment	Accumulated sediment depth exceeds 10% of the diameter of the storage area for 1/2 length of storage vault or any point depth exceeds 15% of diameter. (Example: 72-inch storage tank would require cleaning when sediment reaches depth of 7 inches for more than 1/2 length of tank.)	All sediment and debris removed from storage area.
	Joints Between Tank/Pipe Section	Any openings or voids allowing material to be transported into facility (Will require engineering analysis to determine structural stability).	All joint between tank/pipe sections are sealed.
	Tank Pipe Bent Out of Shape	Any part of tank/pipe is bent out of shape more than 10% of its design shape. (Review required by engineer to determine structural stability).	Tank/pipe repaired or replaced to design.
	Vault Structure Includes Cracks in Wall, Bottom, Damage to Frame and/or Top Slab	Cracks wider than 1/2-inch and any evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determines that the vault is not structurally sound.	Vault replaced or repaired to design specifications and is structurally sound.
		Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or any evidence of soil particles entering the vault through the walls.	No cracks more than 1/4-inch wide at the joint of the inlet/outlet pipe.
Manhole	Cover Not in Place	Cover is missing or only partially in place. Any open manhole requires maintenance.	Manhole is closed.
	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 1/2 inch of thread (may not apply to self-locking lids).	Mechanism opens with proper tools.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure. Intent is to keep cover from sealing off access to maintenance.	Cover can be removed and reinstalled by one maintenance person.
	Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, misalignment, not securely attached to structure wall, rust, or cracks.	Ladder meets design standards. Allows maintenance person safe access.
Catch Basins	All Potential Defects	**See Catch Basins on pages 13 – 15**	

Control Structure/Flow Restrictor

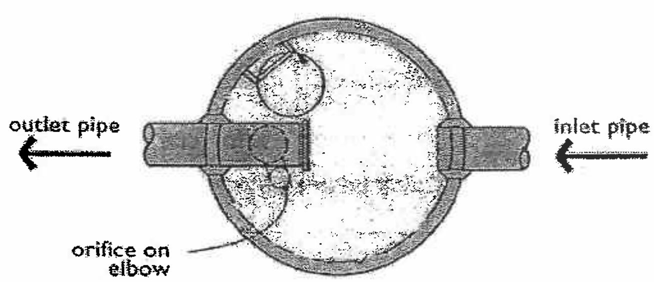
Flow control structures and flow restrictors direct or restrict flow in or out of facility components. Outflow controls on detention facilities are a common example where flow control structures slowly release stormwater at a specific rate. The flow is regulated by a combination of orifices (holes with specifically sized diameters) and weirs (plates with rectangular or "V" shaped notch). Lack of maintenance of the control structure can result in the plugging of an orifice. If these flow controls are damaged, plugged, bypassed, or not working properly, the facility could overtop or release water too quickly. This will likely damage streams, habitat, and property.

Facility objects that are typically associated with a control structure/flow restrictor include:

- detention ponds
- CONTECH® StormFilter
- closed detention system
- conveyance stormwater pipe



BIRD'S-EYE VIEW



SECTION PROFILE

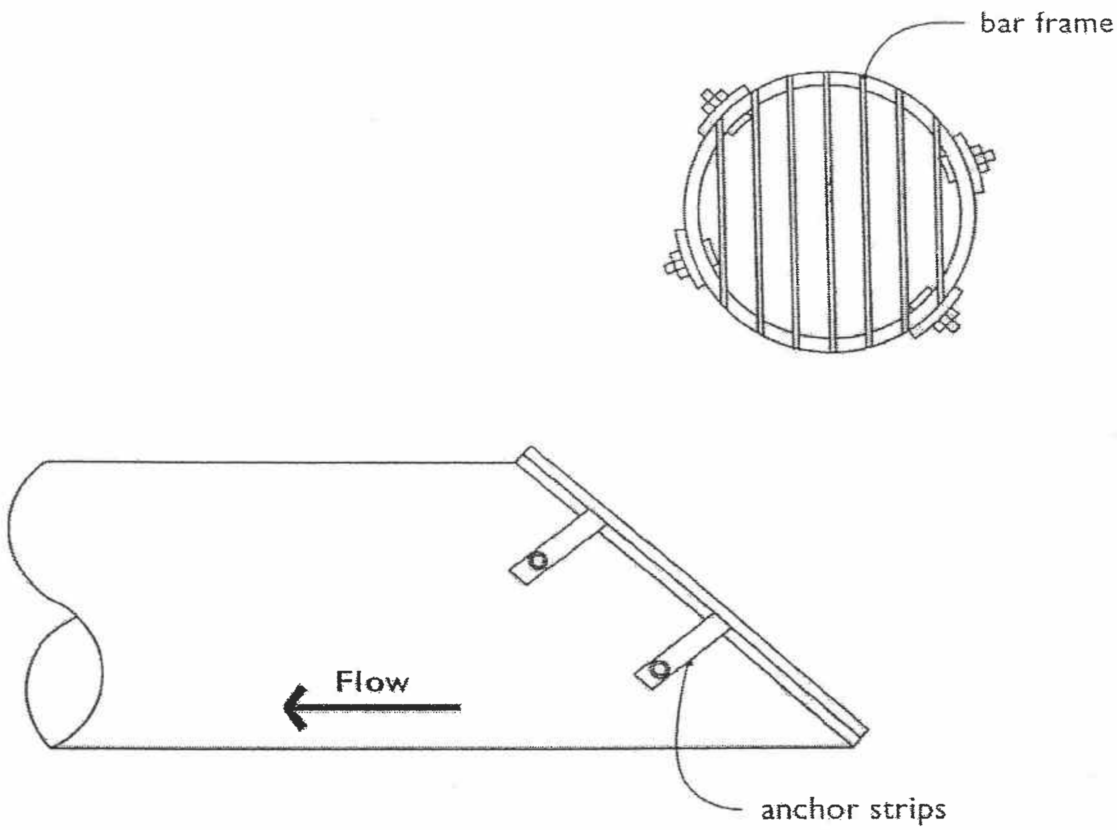
Control Structure/Flow Restrictor

Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed Or Not Needed
General	Trash and Debris (Includes Sediment)	Material exceeds 25% of sump depth or 1 foot below orifice plate.	Control structure orifice is not blocked. All trash and debris removed.
	Structural Damage	Structure is not securely attached to manhole wall.	Structure securely attached to wall and outlet pipe.
		Structure is not in upright position (allow up to 10% from plumb).	Structure in correct position.
		Connections to outlet pipe are not watertight and show signs of rust.	Connections to outlet pipe are water tight; structure repaired or replaced and works as designed.
		Any holes--other than designed holes--in the structure.	Structure has no holes other than designed holes.
Cleanout Gate	Damaged or Missing	Cleanout gate is not watertight or is missing.	Gate is watertight and works as designed.
		Gate cannot be moved up and down by one maintenance person.	Gate moves up and down easily and is watertight.
		Chain/rod leading to gate is missing or damaged.	Chain is in place and works as designed.
		Gate is rusted over 50% of its surface area.	Gate is repaired or replaced to meet design standards.
Orifice Plate	Damaged or Missing	Control device is not working properly due to missing, out of place, or bent orifice plate.	Plate is in place and works as designed.
	Obstructions	Any trash, debris, sediment, or vegetation blocking the plate.	Plate is free of all obstructions and works as designed.
Overflow Pipe	Obstructions	Any trash or debris blocking (or having the potential of blocking) the overflow pipe.	Pipe is free of all obstructions and works as designed.
Manhole	Cover Not in Place	Cover is missing or only partially in place. Any open manhole requires maintenance.	Manhole is closed.
	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 1/2 inch of thread (may not apply to self-locking lids).	Mechanism opens with proper tools.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure. Intent is to keep cover from sealing off access to maintenance.	Cover can be removed and reinstalled by one maintenance person.
	Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, misalignment, not securely attached to structure wall, rust, or cracks.	Ladder meets design standards. Allows maintenance person safe access.
Catch Basins	All Potential Defects	**See Catch Basins on pages 10 - 12**	

Debris Barrier & Access Barrier (e.g. Trash Rack)

A debris barrier is a bar grate over the open end of a culvert or stormwater conveyance pipe. The intent of a debris barrier is to prevent large materials from entering a closed pipe system. Debris barriers are typically located on the outlet pipe from a detention pond to the control structure. If a debris barrier is not located on the outlet pipe, one should be installed to prevent plugging of the control structure and possible flooding.

An access barrier is similar to a debris barrier but is installed on all pipe ends that exceed 18 inches in diameter. Their function is to prevent debris and unauthorized access into the storm conveyance pipe. Only qualified personnel should attempt to maintain or remove debris from the barrier when water is flowing through the conveyance pipe.



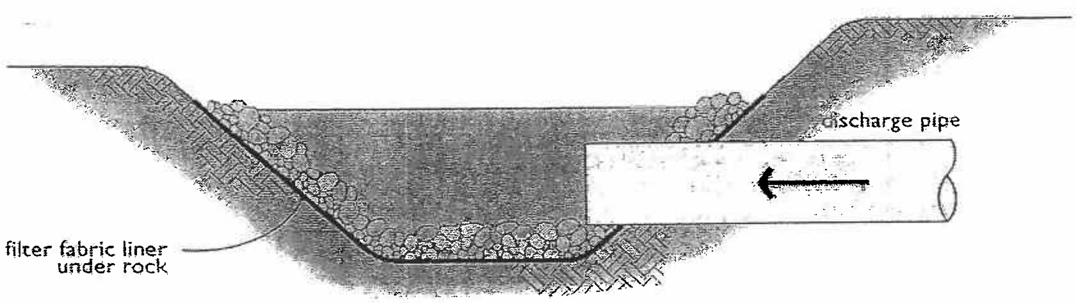
Debris Barriers			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed Or Not Needed**
General	Trash and Debris	Trash or debris that is plugging more than 20% of the openings in the barrier.	Barrier cleared to design flow capacity.
	Damaged/ Missing Bars.	Bars are bent out of shape more than 3 inches.	Bars in place with no bends more than 3/4 inch.
		Bars are missing or entire barrier missing.	Bars in place according to design.
		Bars are loose and rust is causing 50% deterioration to any part of barrier.	Barrier replaced or repaired to design standards.
	Inlet/Outlet Pipe	Debris barrier missing or not attached to pipe	Barrier firmly attached to pipe

Energy Dissipater

An energy dissipater is installed on or near the inlet or outlet to a closed pipe system to prevent erosion at these locations. There are a variety of designs, including wire gabion baskets, rock splash pads, trenches, and specially designed pools or manholes. The rock splash pad is typically constructed of 4- to 12-inch diameter rocks a minimum of 12 inches thick and is often lined with filter fabric. The rock pad should extend above the top of the pipe a minimum of 1 foot.

Facility objects that are typically associated with a energy dissipaters include:

- detention ponds
- infiltration basin
- wetponds
- treatment wetlands



Energy Dissipaters			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed Or Not Needed**
External:			
Rock Pad	Missing or Moved Rock	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil.	Rock pad replaced to design standards.
	Erosion	Soil erosion in or adjacent to rock pad.	Rock pad replaced to design standards.
Dispersion Trench	Pipe Plugged with Sediment	Accumulated sediment that exceeds 20% of the design depth.	Pipe cleaned/flushed so that it matches design.
	Not Discharging Water Properly	Visual evidence of water discharging at concentrated points along trench (normal condition is a "sheet flow" of water along trench). Intent is to prevent erosion damage.	Trench redesigned or rebuilt to standards.
	Perforations Plugged.	Over 1/2 of perforations in pipe are plugged with debris and sediment.	Perforated pipe cleaned or replaced.
	Water Flows Out Top of "Distributor" Catch Basin.	Maintenance person observes or receives credible report of water flowing out during any storm less than the design storm or its causing or appears likely to cause damage.	Facility rebuilt or redesigned to standards.
	Receiving Area Over-Saturated	Water in receiving area is causing or has potential of causing landslide problems.	No danger of landslides.
Internal:			
Manhole/ Chamber	Worn or Damaged Post, Baffles, Side of Chamber	Structure dissipating flow deteriorates to 1/2 of original size or any concentrated worn spot exceeding one square foot which would make structure unsound.	Structure replaced to design standards.
Catch Basins	All Potential Defects	See Catch Basins on pages 13 - 15	

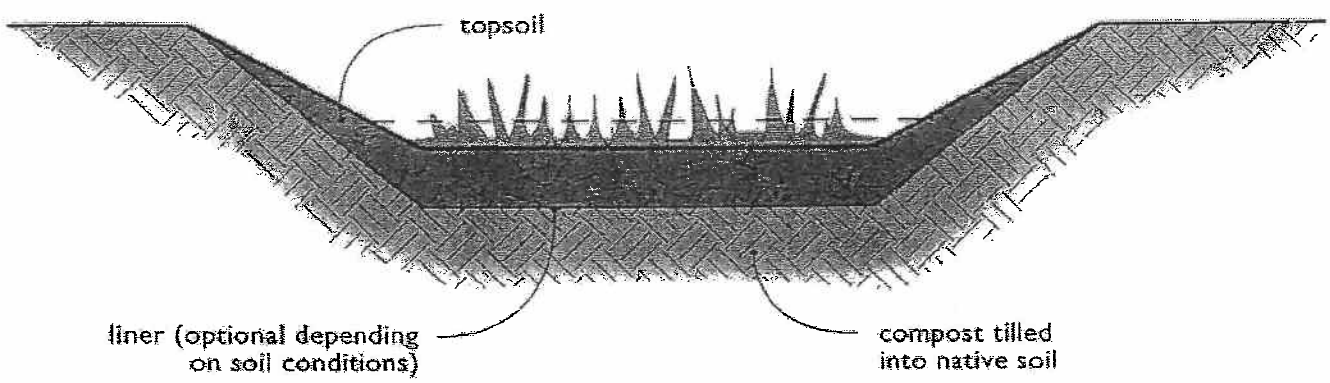
Typical Biofiltration Swale

A biofiltration swale uses 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. Biofiltration uses vegetation in conjunction with slow and shallow-depth flow for runoff treatment. As runoff passes through the vegetation, pollutants are removed through the combined effects of filtration, infiltration, and settling. These effects are aided by the reduction of the velocity of stormwater as it passes through the biofilter.

Biofiltration swales provide stormwater quality control (treatment), but do not provide stormwater quantity control (detention/retention). Swales are stormwater treatment devices that must be properly maintained to sustain pollutant removal capacity.

Facility objects that are often associated with a typical biofiltration swale include:

- access road or easement
- fence, gate, and water quality sign
- energy dissipaters
- debris barrier (e.g. trash rack)
- catch basins/field inlets
- drywell
- infiltration trench
- sediment trap



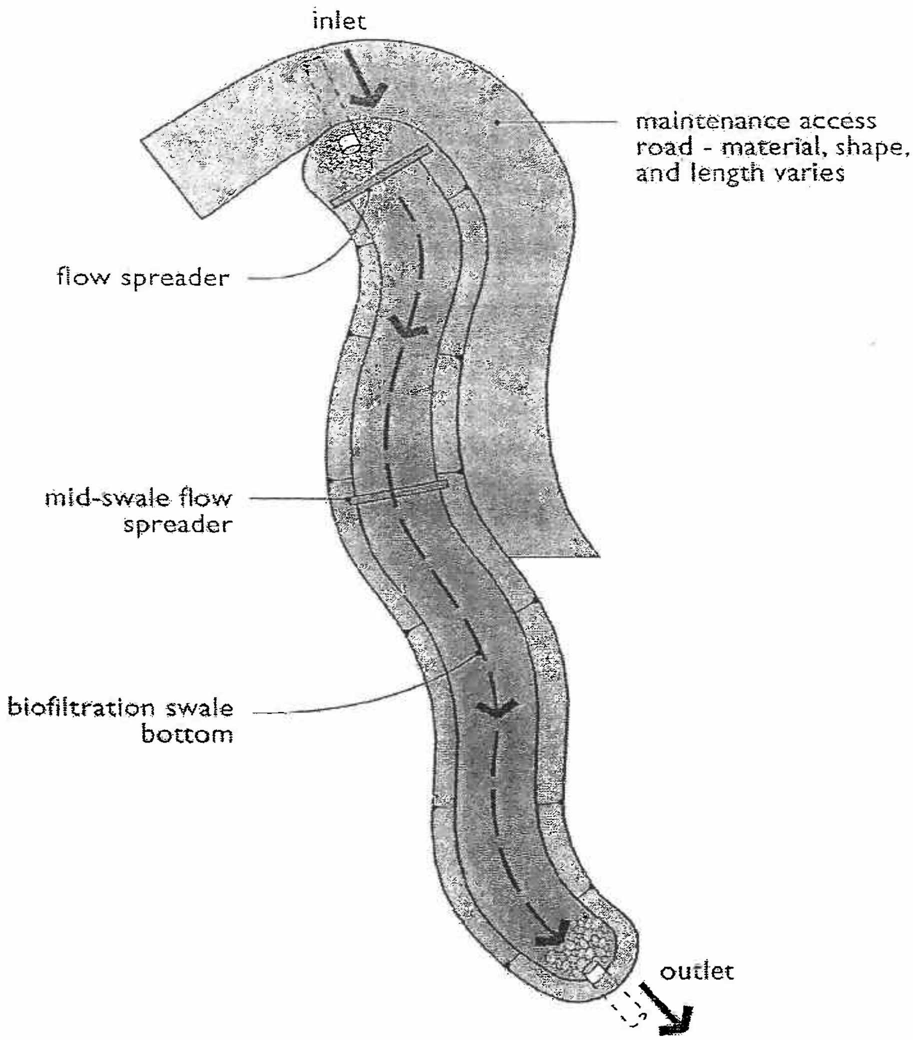
Typical Biofiltration Swale			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed Or Not Needed**
General	Sediment Accumulation on Grass	Sediment depth exceeds 2 inches.	Remove sediment deposits on grass treatment area of the bio-swale. When finished, swale should be level from side to side and drain freely toward outlet. There should be no areas of standing water once inflow has ceased.
	Standing Water	When water stands in the swale between storms and does not drain freely.	Any of the following may apply: remove sediment or trash blockages, improve grade from head to foot of swale, remove clogged check dams, add underdrains or convert to a wet biofiltration swale.
	Flow spreader	Flow spreader uneven or clogged so that flows are not uniformly distributed through entire swale width.	Level the spreader and clean so that flows are spread evenly over entire swale width.
	Constant Baseflow	When small quantities of water continually flow through the swale, even when it has been dry for weeks, and an eroded, muddy channel has formed in the swale bottom.	Add a low-flow pea-gravel drain the length of the swale or by-pass the baseflow around the swale.
	Poor Vegetation Coverage	When grass is sparse or bare or eroded patches occur in more than 10% of the swale bottom.	Determine why grass growth is poor and correct that condition. Re-plant with plugs of grass from the upper slope: plant in the swale bottom at 8-inch intervals. Or re-seed into loosened, fertile soil.
	Vegetation	When the grass becomes excessively tall (greater than 10-inches); when nuisance weeds and other vegetation starts to take over.	Mow vegetation or remove nuisance vegetation so that flow not impeded. Grass should be mowed to a height of 3 to 4 inches. Remove grass clippings.
	Excessive Shading	Grass growth is poor because sunlight does not reach swale.	If possible, trim back over-hanging limbs and remove brushy vegetation on adjacent slopes.
	Inlet/Outlet	Inlet/outlet areas clogged with sediment and/or debris.	Remove material so that there is no clogging or blockage in the inlet and outlet area.
	Trash and Debris Accumulation	Trash and debris accumulated in the bio-swale.	Remove trash and debris from bioswale.
	Erosion/Scouring	Eroded or scoured swale bottom due to flow channelization, or higher flows.	For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with crushed gravel. If bare areas are large, generally greater than 12 inches wide, the swale should be re-graded and re-seeded. For smaller bare areas, over seed when bare spots are evident, or take plugs of grass from the upper slope and plant in the swale bottom at 8-inch intervals.

Wet Biofiltration Swale

A wet biofiltration swale is a variation of a basic biofiltration swale for use where the centerline slope is slight, groundwater tables are high, or a continuous low base flow is likely to result in wet soil conditions for long periods of time. Where continuously wet soil conditions exceeds about 2 weeks, typical grasses will die. Thus, vegetation specifically adapted to wet soil conditions is needed. Different vegetation, in turn, requires modification of several of the design and maintenance requirements from the basic biofiltration swale.

Facility objects that are often associated with a wet biofiltration swale include:

- access road or easement
- fence, gate, and water quality sign
- energy dissipaters (flow spreaders)
- debris barrier (e.g. trash rack)
- catch basins/field inlets



Wet Biofiltration Swale			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed Or Not Needed**
General	Sediment Accumulation	Sediment depth exceeds 2-inches in 10% of the swale treatment area.	Remove sediment deposits in treatment area.
	Water Depth	Water not retained to a depth of about 4 inches during the wet season.	Build up or repair outlet berm so that water is retained in the wet swale.
	Wetland Vegetation	Vegetation becomes sparse and does not provide adequate filtration, OR vegetation is crowded out by very dense clumps of cattail, which do not allow water to flow through the clumps.	Determine cause of lack of vigor of vegetation and correct. Replant as needed. For excessive cattail growth, cut cattail shoots back and compost off-site. Note: normally wetland vegetation does not need to be harvested unless die-back is causing oxygen depletion in downstream waters.
	Inlet/Outlet	Inlet/outlet area clogged with sediment and/or debris.	Remove clogging or blockage in the inlet and outlet areas.
	Trash and Debris Accumulation	Any trash and debris which exceed 5 cubic feet per 1,000 square feet (this is about equal to the amount of trash it would take to fill up one standard size garbage can). In general, there should be no visual evidence of dumping. If less than threshold all trash and debris will be removed as part of next scheduled maintenance.	Remove trash and debris from wet swale.
	Erosion/Scouring	Swale has eroded or scoured due to flow channelization, or higher flows.	Check design flows to assure swale is large enough to handle flows. By-pass excess flows or enlarge swale. Replant eroded areas with fibrous-rooted plants such as Juncus effusus (soft rush) in wet areas or snowberry (Symphoricarpos albus) in dryer areas.

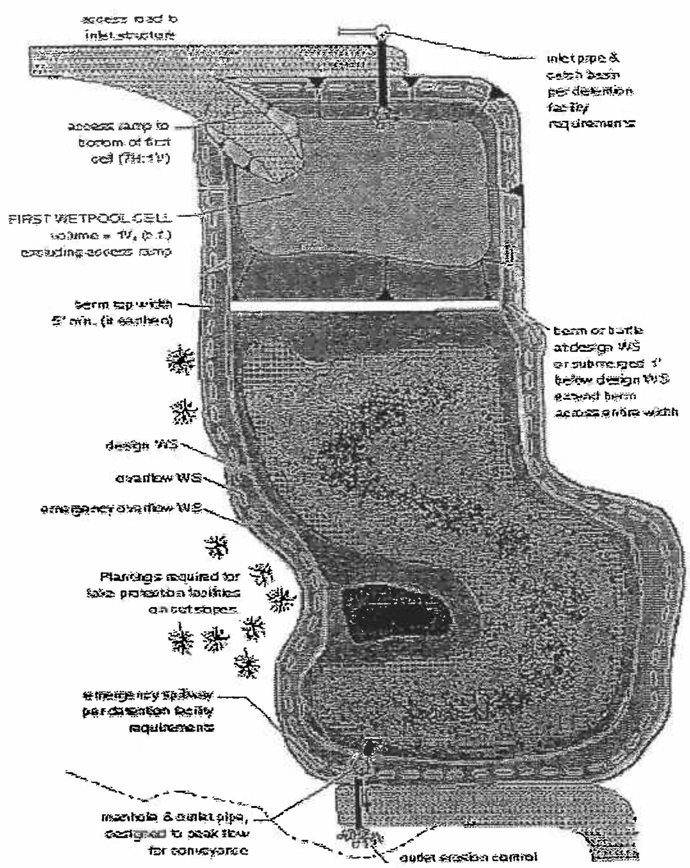
Treatment Wetland

A stormwater treatment wetland is a shallow man-made pond that is designed to treat stormwater through the biological processes associated with emergent aquatic plants. These facilities use dense wetland vegetation and settling to filter sediment and oily materials out of stormwater.

Stormwater treatment wetlands are used to capture pollutants in a managed environment so that they will not reach natural wetlands and other ecologically important habitats. Vegetation must occasionally be harvested and sediment dredged in stormwater treatment wetlands. In general, stormwater wetlands perform well to remove sediment, metals, and pollutants that bind to humic or organic acids.

Facility objects that are often associated with a treatment wetland include:

- access road or easement
- fence, gate, and water quality sign
- energy dissipaters (flow spreaders)
- conveyance stormwater pipe



Treatment Wetland

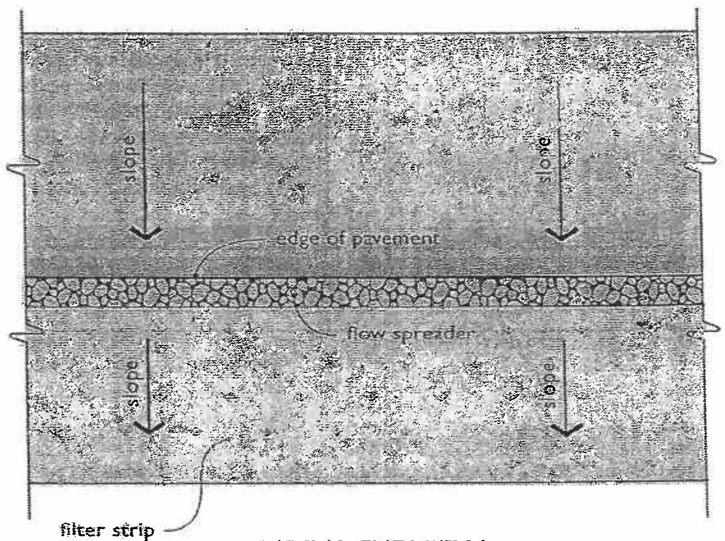
Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed Or Not Needed
General	Sediment Accumulation	Sediment accumulation exceeds design standards in presettling cell.	Remove sediment deposits in presettling cell.
	Water Depth	Water not retained to a depth of about 18 inches during the wet season.	Repair outlet so that water is retained in the wet swale.
	Wetland Vegetation	Vegetation becomes sparse and does not provide adequate filtration.	Determine cause of lack of vigor of vegetation and correct. Replant as needed.
		Nuisance plant species becomes abundant.	Nuisance plant species should be removed and desirable species should be planted.
	Trash and Debris Accumulation	Any trash and debris which exceed 5 cubic feet per 1,000 square feet (this is about equal to the amount of trash it would take to fill up one standard size garbage can). In general, there should be no visual evidence of dumping. If less than threshold all trash and debris will be removed as part of next scheduled maintenance.	Remove trash and debris from wetland area.

Filter Strip

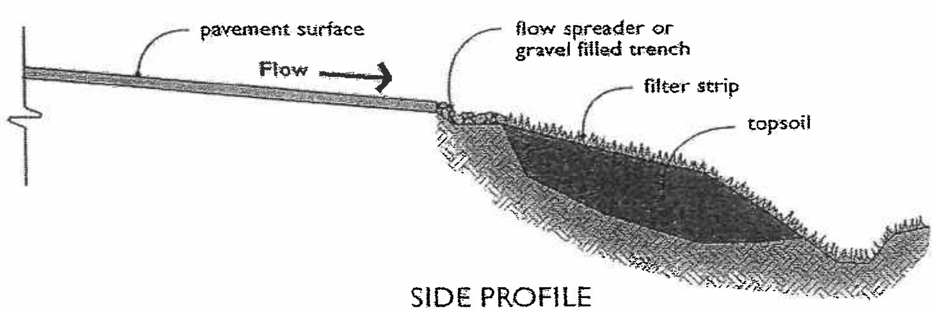
A filter strip is a linear strip of grass that removes sediment and oils from stormwater by filtering it. Stormwater is treated as it runs across the filter. Usually, filter strips are placed along the edge of linear paved areas such as parking lots and roads. Where designed filter strips are installed, road shoulders should only be graded to maintain level flow off the road.

Facility objects that are often associated with a filter strip include:

- access road or easement
- fence, gate, and water quality sign
- energy dissipaters (flow spreaders)



BIRD'S-EYE VIEW



SIDE PROFILE

Filter Strip

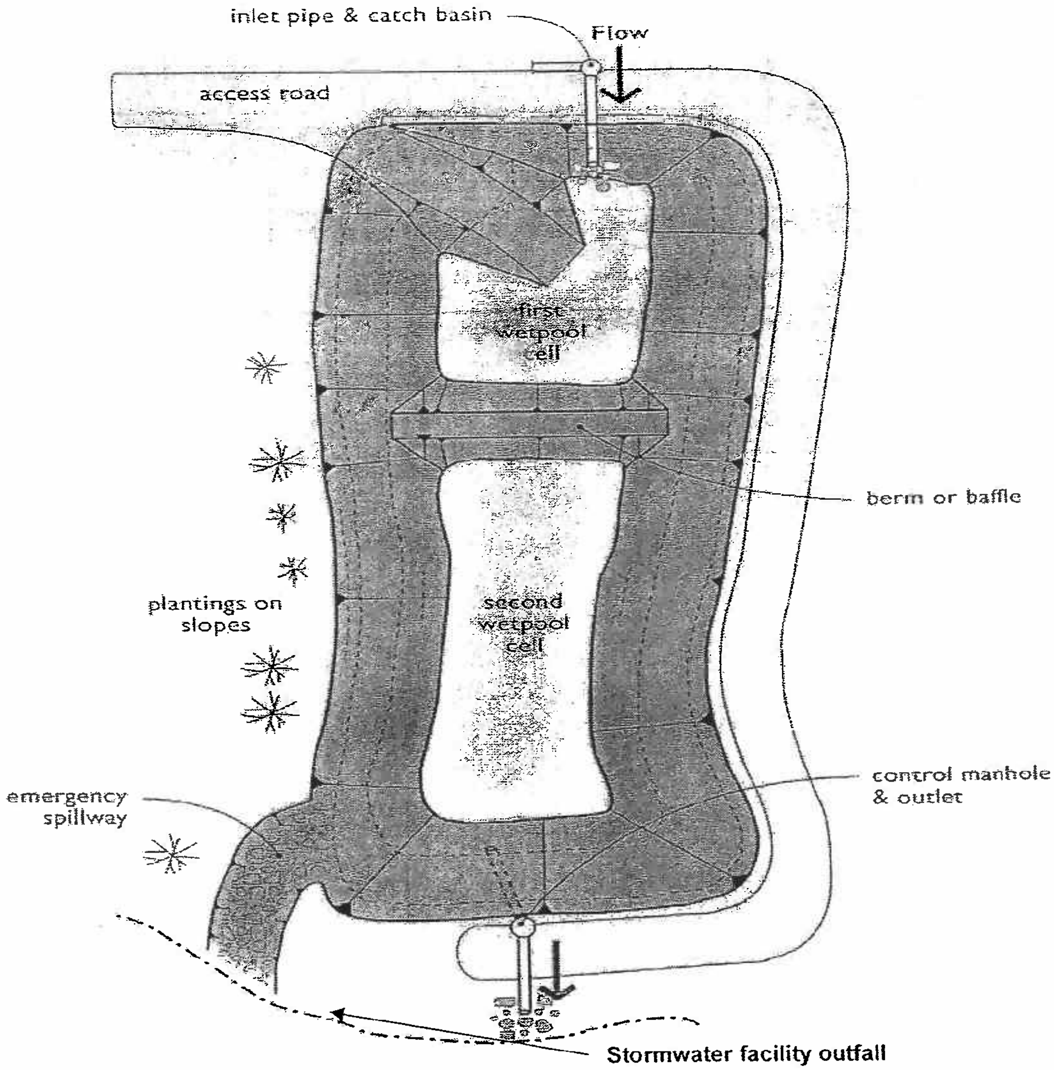
Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed Or Not Needed
General	Sediment Accumulation on Grass	Sediment depth exceeds 2 inches.	Remove sediment deposits, re-level so slope is even and flows pass evenly through strip.
	Vegetation	When the grass becomes excessively tall (greater than 10-inches); when nuisance weeds and other vegetation starts to take over.	Mow grass, control nuisance vegetation, such that flow not impeded. Grass should be mowed to a height between 3-4 inches.
	Trash and Debris Accumulation	Trash and debris accumulated on the filter strip.	Remove trash and Debris from filter.
	Erosion/Scouring	Eroded or scoured areas due to flow channelization, or higher flows.	For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with crushed gravel. The grass will creep in over the rock in time. If bare areas are large, generally greater than 12 inches wide, the filter strip should be re-graded and re-seeded. For smaller bare areas, over seed when bare spots are evident.
	Flow spreader	Flow spreader uneven or clogged so that flows are not uniformly distributed through entire filter width.	Level the spreader and clean so that flows are spread evenly over entire filter width.

Wetpond

A wetpond is an open basin that retains a permanent pool of water (wetpool) year round or only during the wet season. The volume of the wetpond allows sediment and other pollutants to settle out of the runoff. Wetland vegetation is typically planted within the wetpond to provide additional treatment through nutrient (i.e. nitrogen) removal. Detention quantity control can be provided with additional temporary storage volume above the permanent pool elevation.

Facility objects that are typically associated with a wetpond include:

- access road or easement
- fence, gate, and water quality sign
- detention pond
- control structure/flow restrictor
- energy dissipaters
- debris barrier (e.g. trash rack)
- conveyance stormwater pipe



Wetponds

Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed Or Not Needed
General	Water level	First cell is empty, doesn't hold water.	Line the first cell to maintain at least 4 feet of water. Although the second cell may drain, the first cell must remain full to control turbulence of the incoming flow and reduce sediment resuspension.
	Trash and Debris	Accumulation that exceeds 1 CF per 1000-SF of pond area.	Trash and debris removed from pond.
	Sediment Accumulation in Pond Bottom	Sediment accumulations in pond bottom that exceeds the depth of sediment zone plus 6-inches, usually in the first cell.	Sediment removed from pond bottom.
	Oil Sheen on Water	Prevalent and visible oil sheen.	Oil removed from water using oil-absorbent pads or vactor truck. Source of oil located and corrected. If chronic low levels of oil persist, plant wetland plants such as Juncus effusus (soft rush) which can uptake small concentrations of oil.
	Erosion	Erosion of the pond's side slopes and/or scouring of the pond bottom, that exceeds 6-inches, or where continued erosion is prevalent.	Slopes stabilized using proper erosion control measures and repair methods.
	Settlement of Pond Dike/Berm	Any part of these components that has settled 4-inches or lower than the design elevation, or inspector determines dike/berm is unsound.	Dike/berm is repaired to specifications.
	Internal Berm	Berm dividing cells should be level.	Berm surface is leveled so that water flows evenly over entire length of berm.
	Overflow Spillway	Rock is missing and soil is exposed at top of spillway or outside slope.	Rocks replaced to specifications.

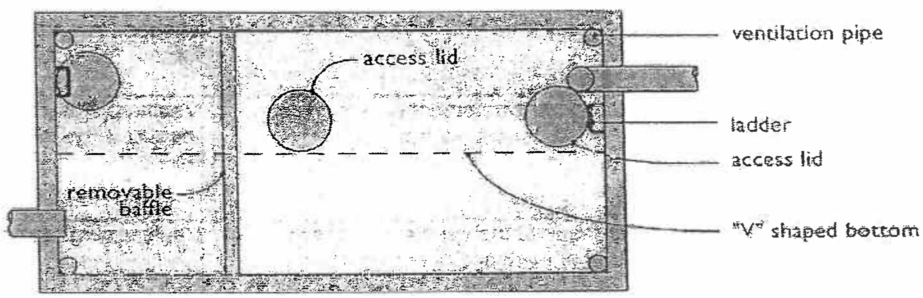
Wet Vault

A wet vault is an underground structure similar in appearance to a detention vault, except that a wet vault has a permanent pool of water (wetpool) which dissipates energy and improves the settling of sediment and other pollutants. Being underground, the wet vault lacks the nutrient removal ability of vegetation.

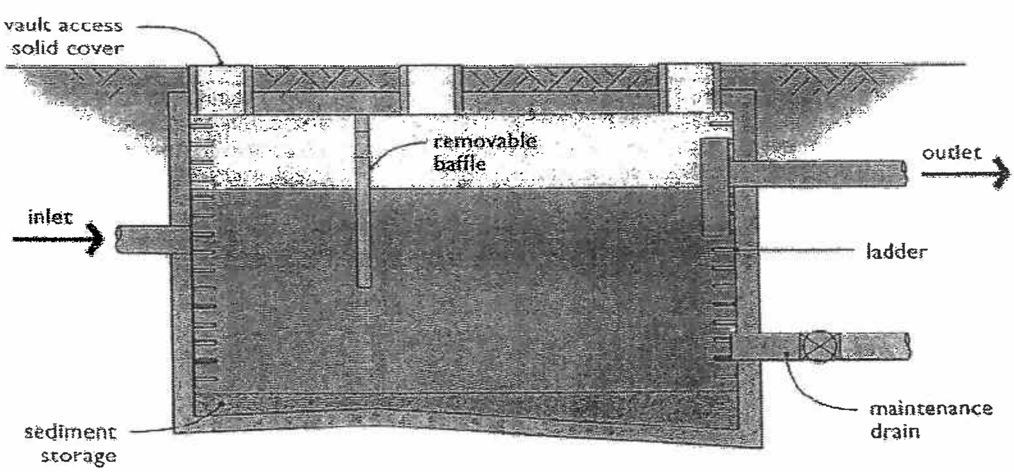
As discussed in the underground detention systems, wet vaults are a closed space where harmful chemicals and gasses can accumulate. Therefore, the inspection and maintenance of these facilities should be conducted by an individual trained and certified to work in hazardous confined spaces.

Facility objects that are typically associated with a wet vault include:

- access road or easement
- fence, gate, and water quality sign
- conveyance stormwater pipe



BIRD'S-EYE VIEW



SECTION PROFILE

Wet Vault

Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed Or Not Needed
General	Trash/Debris Accumulation	Trash and debris accumulated in vault, pipe or inlet/outlet (includes floatables and non-floatables).	Remove trash and debris from vault.
	Sediment Accumulation in Vault	Sediment accumulation in vault bottom exceeds the depth of the sediment zone plus 6-inches.	Remove sediment from vault.
	Damaged Pipes	Inlet/outlet piping damaged or broken and in need of repair.	Pipe repaired and/or replaced.
	Access Cover Damaged/Not Working	Cover cannot be opened or removed, especially by one person.	Pipe repaired or replaced to proper working specifications.
	Ventilation	Ventilation area blocked or plugged.	Blocking material removed or cleared from ventilation area. A specified % of the vault surface area must provide ventilation to the vault interior (see design specifications).
	Damage - Includes Cracks in Walls Bottom, Damage to Frame and/or Top Slab	Maintenance/inspection personnel determine that the vault is not structurally sound.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound.
		Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the inlet/outlet pipe.
	Baffles	Baffles corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection staff.	Baffles repaired or replaced to specifications.
Ladder	Access Ladder Damage	Ladder is corroded or deteriorated, not functioning properly, not attached to structure wall, missing rungs, has cracks and/or misaligned. Confined space warning sign missing.	Ladder replaced or repaired to specifications, and is safe to use as determined by inspection personnel. Replace sign warning of confined space entry requirements. Ladder and entry notification complies with OSHA standards.

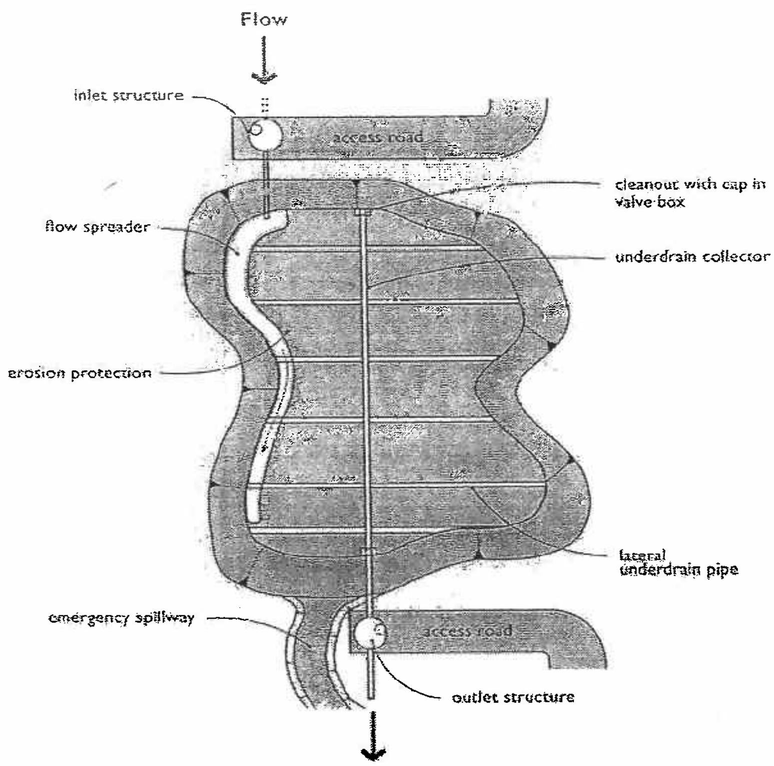
Sand Filter (Above Ground/Open)

A sand filter functions by filtering stormwater runoff through a sand bed typically 18 inches in depth. The treated runoff is collected in the underdrain system and routed to a detention/retention facility or a downstream conveyance system. A typical sand filtration system consists of a pretreatment system for removing larger sediment and debris from the runoff, a flow spreader, a sand bed, and an underdrain piping. The sand filter bed typically includes a woven (geotextile) fabric between the sand bed and the underdrain system.

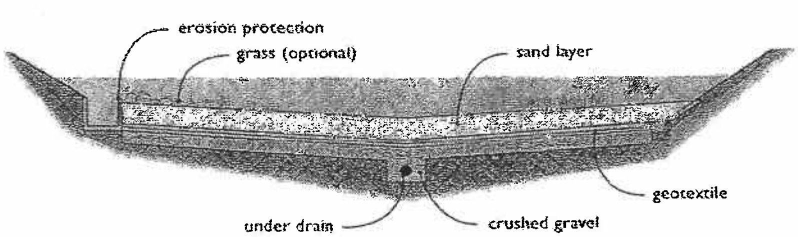
An above ground sand filters looks similar to a detention pond with a sand-lined bottom.

Facility objects that are typically associated with an open sand filter include:

- access road or easement
- fence, gate, and water quality sign
- control structure/flow restrictor
- energy dissipaters
- conveyance stormwater pipe



BIRD'S-EYE VIEW



SIDE PROFILE

Sand Filter (Open)

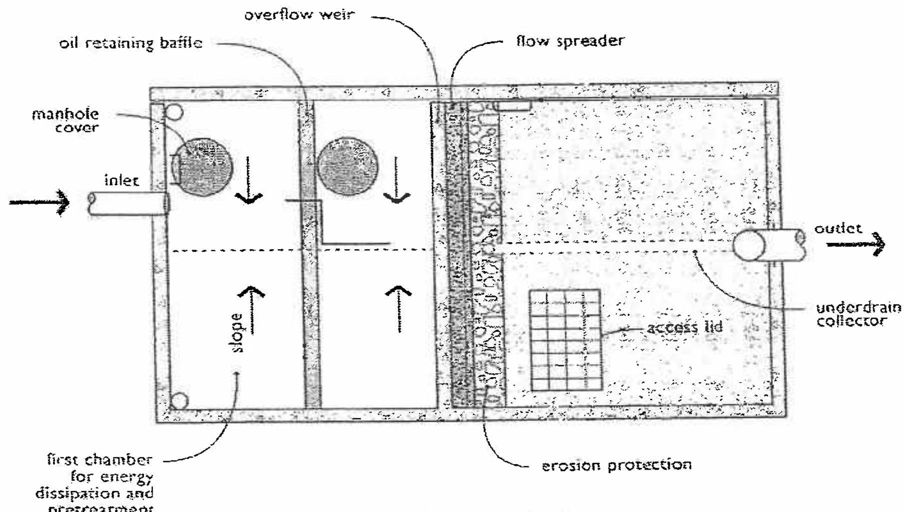
Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed Or Not Needed
Above Ground (open sand filter)	Sediment Accumulation on Top Layer	Sediment depth exceeds 1/2-inch.	No sediment deposit on grass layer of sand filter that would impede permeability of the filter section.
	Trash and Debris Accumulations	Trash and debris accumulated on sand filter bed.	Trash and debris removed from sand filter bed.
	Sediment/ Debris in Clean-Outs	When the clean-outs become full or partially plugged with sediment and/or debris.	Sediment removed from clean-outs.
	Sand Filter Media	Drawdown of water through the sand filter media takes longer than 24-hours, and/or flow through the overflow pipes occurs frequently.	Top several inches of sand are scraped. May require replacement of entire sand filter depth depending on extent of plugging (a sieve analysis is helpful to determine if the lower sand has too high a proportion of fine material).
	Prolonged Flows	Sand is saturated for prolonged periods of time (several weeks) and does not dry out between storms due to continuous base flow or prolonged flows from detention facilities.	Low, continuous flows are limited to a small portion of the facility by using a low wooden divider or slightly depressed sand surface.
	Short Circuiting	When flows become concentrated over one section of the sand filter rather than dispersed.	Flow and percolation of water through sand filter is uniform and dispersed across the entire filter area.
	Erosion Damage to Slopes	Erosion over 2-inches deep where cause of damage is prevalent or potential for continued erosion is evident.	Slopes stabilized using proper erosion control measures.
	Rock Pad Missing or Out of Place	Soil beneath the rock is visible.	Rock pad replaced or rebuilt to design specifications.
	Flow Spreader	Flow spreader uneven or clogged so that flows are not uniformly distributed across sand filter.	Spreader leveled and cleaned so that flows are spread evenly over sand filter.
	Damaged Pipes	Any part of the piping that is crushed or deformed more than 20% or any other failure to the piping.	Pipe repaired or replaced.

Sand Filter (Below Ground/Enclosed)

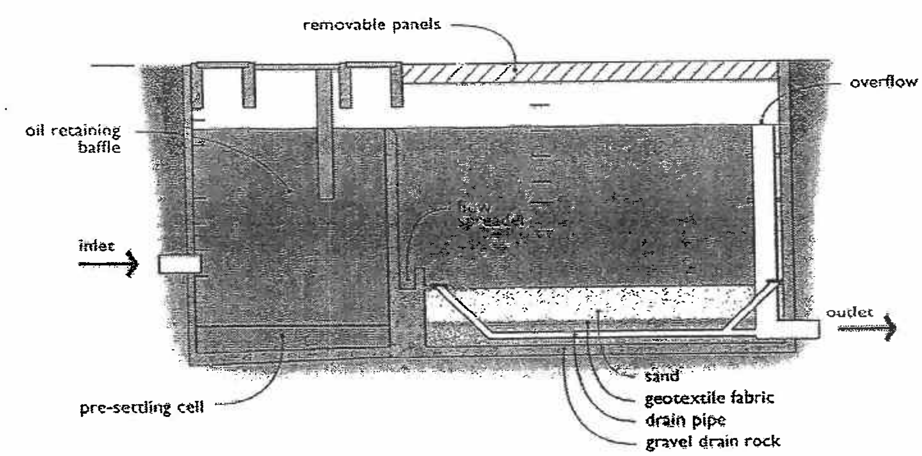
A sand filter vault is similar to an open sand filter except that the sand layer and underdrains are installed below ground in a vault. It consists of presettling and sand filtration cells and functions by filtering stormwater runoff through a sand bed. Treated runoff is collected in the underdrain system and routed to a detention/retention facility or a downstream conveyance system.

Facility objects that are typically associated with a below ground sand filter include:

- access road or easement
- fence, gate, and water quality sign
- conveyance stormwater pipe



BIRD'S-EYE VIEW



SIDE PROFILE

Sand Filter (Below Ground/Enclosed)			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed Or Not Needed**
Below Ground Vault.	Sediment Accumulation on Sand Media Section	Sediment depth exceeds 1/2-inch.	No sediment deposits on sand filter section that which would impede permeability of the filter section.
	Sediment Accumulation in Pre-Settling Portion of Vault	Sediment accumulation in vault bottom exceeds the depth of the sediment zone plus 6-inches.	No sediment deposits in first chamber of vault.
	Trash/Debris Accumulation	Trash and debris accumulated in vault, or pipe inlet/outlet, floatables and non-floatables.	Trash and debris removed from vault and inlet/outlet piping.
	Sediment in Drain Pipes/Cleanouts	When drain pipes, cleanouts become full with sediment and/or debris.	Sediment and debris removed.
	Short Circuiting	When seepage/flow occurs along the vault walls and corners. Sand eroding near inflow area.	Sand filter media section re-laid and compacted along perimeter of vault to form a semi-seal. Erosion protection added to dissipate force of incoming flow and curtail erosion.
	Damaged Pipes	Inlet or outlet piping damaged or broken and in need of repair.	Pipe repaired and/or replaced.
	Access Cover Damaged/Not Working	Cover cannot be opened, corrosion/deformation of cover. Maintenance person cannot remove cover using normal lifting pressure.	Cover repaired to proper working specifications or replaced.
	Ventilation	Ventilation area blocked or plugged	Blocking material removed or cleared from ventilation area. A specified % of the vault surface area must provide ventilation to the vault interior (see design specifications).
	Vault Structure Damaged; Includes Cracks in Walls, Bottom, Damage to Frame and/or Top Slab.	Cracks wider than 1/2-inch or evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not structurally sound.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound.
		Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the inlet/outlet pipe.
	Baffles/Internal Walls	Baffles or walls corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to specifications.
	Access Ladder Damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Ladder replaced or repaired to specifications, and is safe to use as determined by inspection personnel.

Stormwater Management StormFilter®

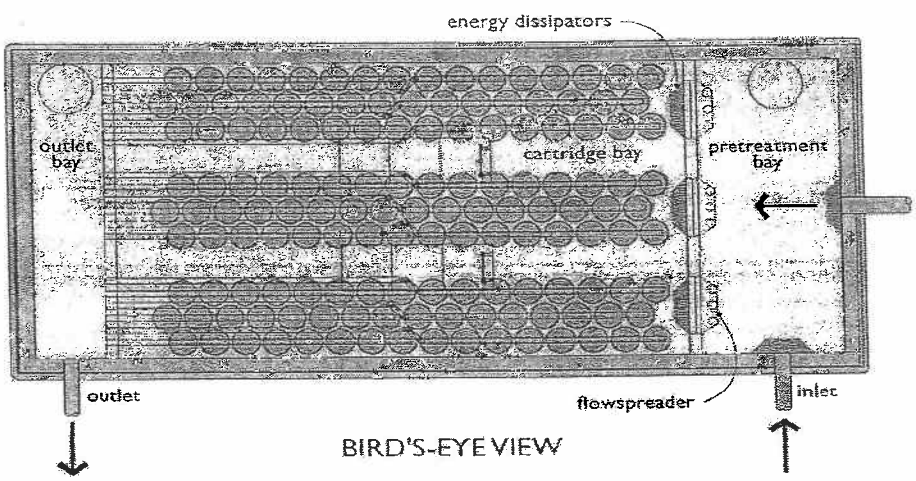
The Stormwater Management StormFilter® is a passive, flow-through, stormwater filtration system. The system is comprised of one or more vaults that house rechargeable, media-filled filter cartridges. The StormFilter works by passing stormwater through the filtering medium, which traps particulates and/or adsorb pollutants such as dissolved metals and hydrocarbons. Once filtered through the media, the treated stormwater is directed to a collection pipe or discharged into an open channel drainage way.

The filter media can be housed in cartridge filters enclosed in concrete vaults or catch basin-like structures. Various types of filter media are available from the manufacturer.

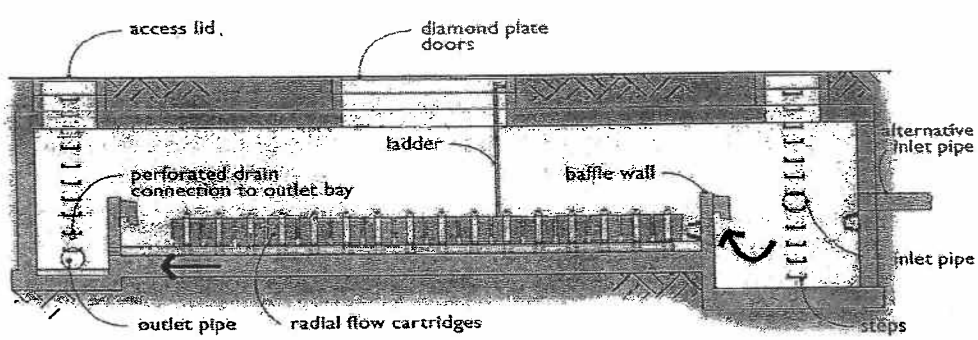
StormFilter units are a proprietary manufactured system. See manufacturer's publications for additional maintenance information.

Facility objects that are typically associated with a StormFilter® system include:

- access road or easement
- control structure/flow restrictor
- conveyance stormwater pipe



BIRD'S-EYE VIEW



SIDE PROFILE

StormFilter® (leaf compost filter)

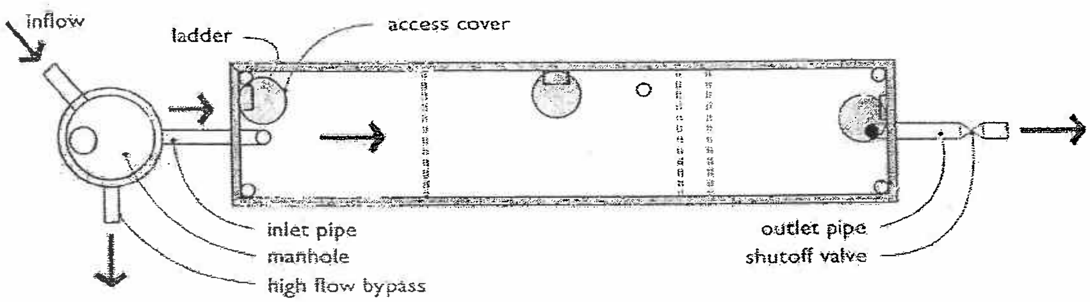
Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed Or Not Needed
Fore bay	Sediment Accumulation	Sediment accumulation exceeds 6 inches or 1/3 of available sump.	Sediment accumulation less than 6 inches.
Media Filter Vault	Sediment Accumulation on Top of Filter Cartridges.	Sediment depth exceeds 0.25-inches on top of filter cartridges.	No sediment deposits on top of cartridges. Sediment on cartridges likely indicates that cartridges are plugged and require maintenance. No sediment deposits which would impede permeability of the compost media.
	Sediment Accumulation in Vault	Sediment depth exceeds 4 inches in first chamber. Look for other indicators of clogged cartridges or overflow.	Sediment in vault should be removed. Cartridges should be checked and replaced or serviced as needed. No sediment deposits in vault bottom of first chamber.
	Trash and Floatable Debris Accumulation	Trash and floatable debris accumulated in vault.	No trash or floatable debris in filter vault.
	Sediment in Drain Pipes/Clean-Outs	When drain pipes, clean-outs, become full with sediment and/or debris.	Sediment and debris removed.
	Damaged Pipes	Any part of the pipes that are crushed or damaged due to corrosion and/or settlement.	Pipe repaired and/or replaced.
	Access Cover Damaged/Not Working	Cover cannot be opened; one person cannot open the cover using normal lifting pressure, corrosion/deformation of cover.	Cover repaired to proper working specifications or replaced.
	Vault Structure Includes Cracks in Wall, Bottom, Damage to Frame and/or Top Slab	Cracks wider than 1/2-inch or evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not structurally sound.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound.
		Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the inlet/outlet pipe.
	Baffles	Baffles corroding, cracking warping, and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to specifications.
	Access Ladder Damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Ladder replaced or repaired and meets specifications, and is safe to use as determined by inspection personnel.
Below Ground Cartridge Type	Compost Media	Drawdown of water through the media takes longer than 1 hour, and/or overflow occurs frequently.	Media cartridges replaced.
	Short Circuiting	Flows do not properly enter filter cartridges.	Filter cartridges replaced.
	Filter cartridges Submerged.	Filter vault does not drain within 24 hours following storm. Look for evidence of submergence due to backwater or excessive hydrocarbon loading.	Filter media checked and replaced if needed. If cartridges are plugged with oil, additional treatment or source control BMP may be needed.

Oil/Water Separator (API Type)

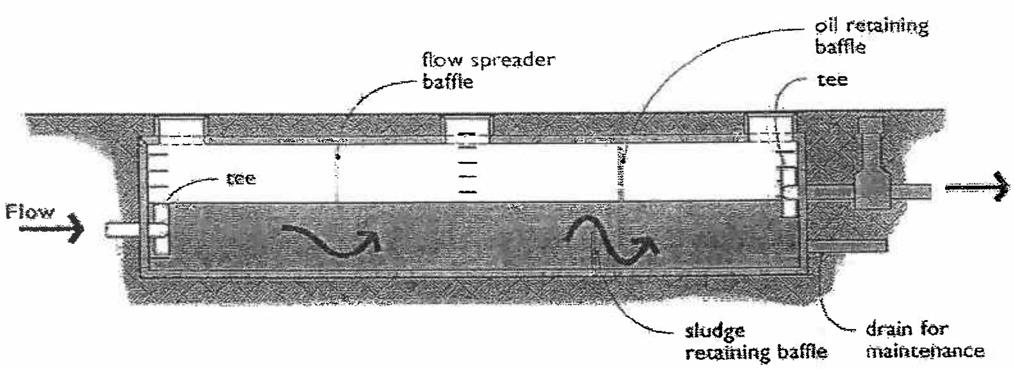
An oil/water separator is an underground vault that treats stormwater by mechanically separating oil from water. The oil rises to the surface and floats on the water and sediment settles to the bottom. Oil/water separators are typically utilized in locations where high oil concentrations in the stormwater runoff are anticipated (e.g. service and fuel stations). Oil/water separators are most commonly used as the first pre-treatment facility in a series of stormwater management facilities.

Facility objects that are typically associated with an oil/water separator include:

- access road or easement
- control structure/flow restrictor



BIRD'S-EYE VIEW



SIDE PROFILE

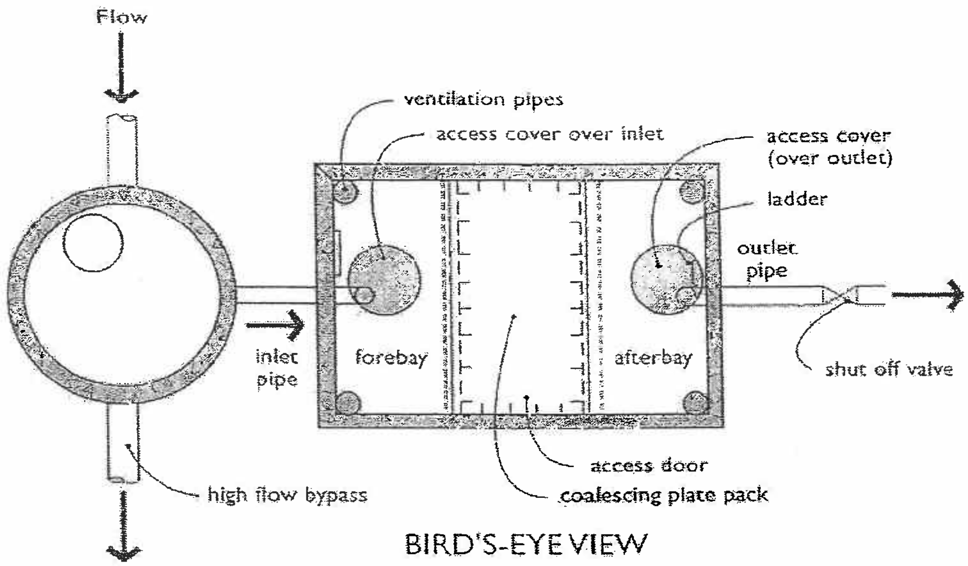
Baffle Oil/Water Separator (API Type)			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed Or Not Needed**
General	Monitoring	Inspection of discharge water for obvious signs of poor water quality (i.e. obvious oil or other contaminants present)	Effluent discharge from vault should be clear with out thick visible sheen.
	Sediment Accumulation	Sediment depth in bottom of vault exceeds 6-inches in depth.	No sediment deposits on vault bottom that would impede flow through the vault and reduce separation efficiency.
	Trash and Debris Accumulation	Trash and debris accumulation in vault, or pipe inlet/outlet, floatables and non-floatables.	Trash and debris removed from vault, and inlet/outlet piping.
	Oil Accumulation	Oil accumulations that exceed 1-inch, at the surface of the water.	Extract oil from vault by vactoring. Disposal in accordance with state and local rules and regulations.
	Damaged Pipes	Inlet or outlet piping damaged or broken and in need of repair.	Pipe repaired or replaced.
	Access Cover Damaged/Not Working	Cover cannot be opened, corrosion/deformation of cover.	Cover repaired to proper working specifications or replaced.
	Vault Structure Damage - Includes Cracks in Walls Bottom, Damage to Frame and/or Top Slab	Top slab has holes larger than 2 square inches or cracks wider than 1/4 inch. (Intent is to make sure no material is running into basin).	Top slab is free of holes and cracks.
		Frame not sitting flush on top slab, i.e., separation of more than 3/4 inch of the frame from the top slab. Frame not securely attached	Frame is sitting flush on the riser rings or top slab and firmly attached.
		Maintenance person judges that structure is unsound.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound.
		Grout fillet has separated or cracked wider than 1/2 inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering catch basin through cracks.	Pipe is regrouted and secure at basin wall.
		Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the inlet/outlet pipe.
	Baffles	Baffles corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to specifications.
	Access Ladder Damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Ladder replaced or repaired and meets specifications, and is safe to use as determined by inspection personnel.

Coalescing Plate Oil/Water Separator

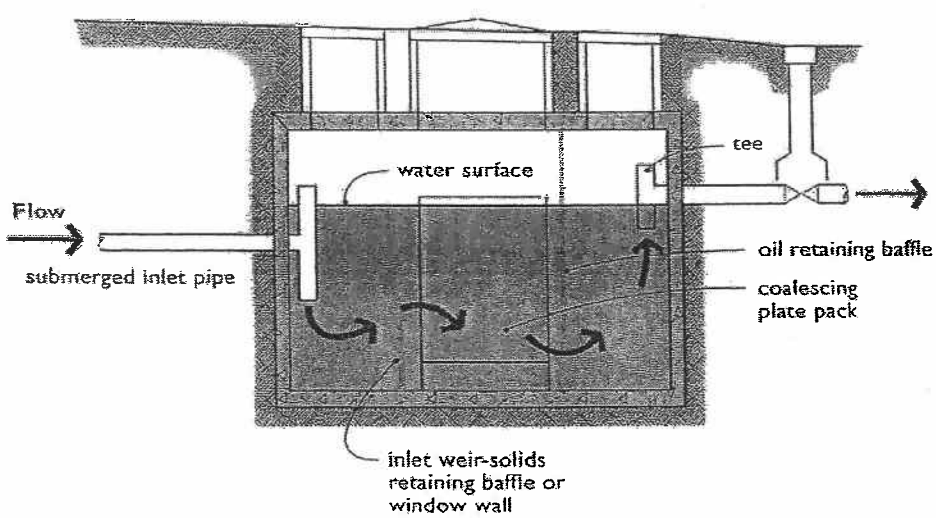
A coalescing plate oil/water separator is generally the same as the API type. The main difference is that coalescing plate separators include a series of parallel plates in the separation bay (2nd bay) that increase the oil removal efficiency of the separator.

Facility objects associated with a coalescing plate oil/water separator may include:

- access road or easement
- control structure/flow restrictor
- conveyance stormwater pipe



BIRD'S-EYE VIEW



SIDE PROFILE

Coalescing Plate Oil/Water Separator

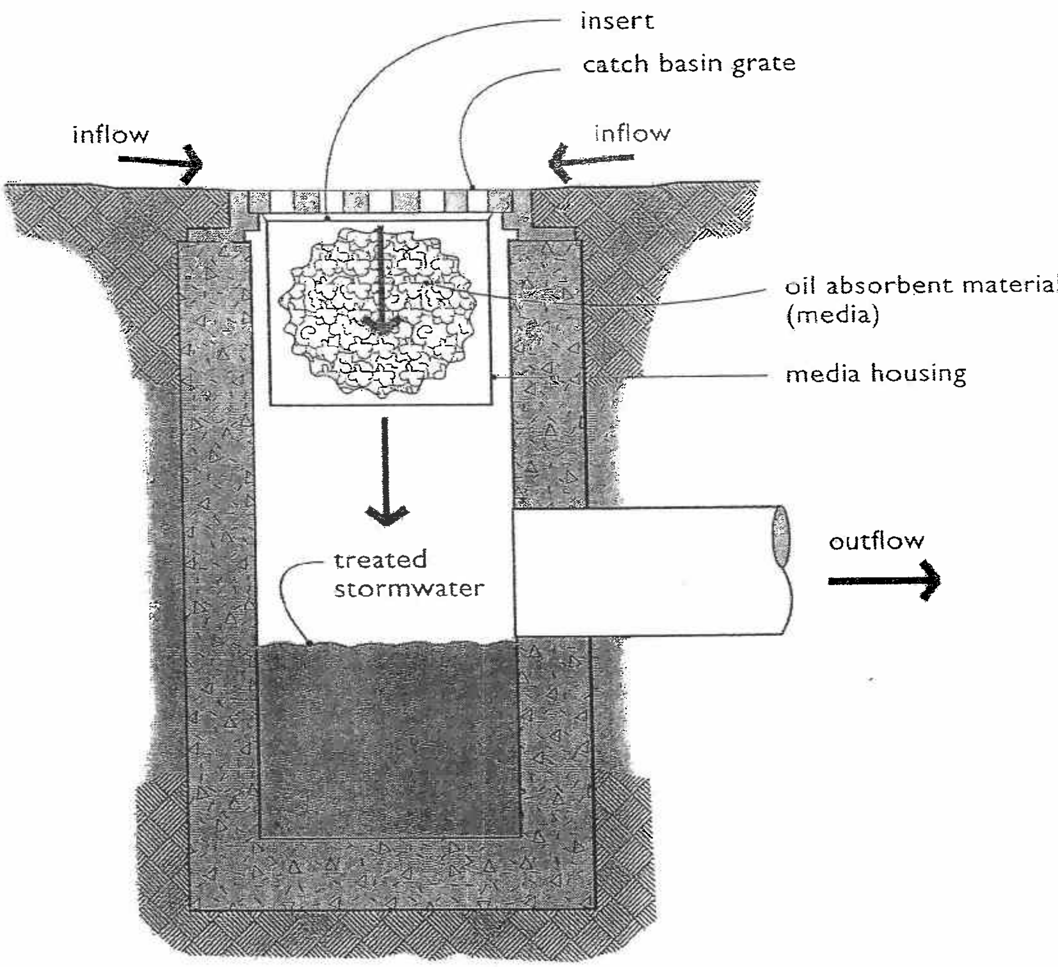
Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed Or Not Needed
General	Monitoring	Inspection of discharge water for obvious signs of poor water quality (i.e. obvious oil or other contaminants present)	Effluent discharge from vault should be clear with no thick visible sheen.
	Sediment Accumulation	Sediment depth in bottom of vault exceeds 6-inches in depth and/or visible signs of sediment on plates.	No sediment deposits on vault bottom and plate media, which would impede flow through the vault and reduce separation efficiency.
	Trash and Debris Accumulation	Trash and debris accumulated in vault, or pipe inlet/outlet, floatables and non-floatables.	Trash and debris removed from vault, and inlet/outlet piping.
	Oil Accumulation	Oil accumulation that exceeds 1-inch at the water surface.	Oil is extracted from vault using vactoring methods. Coalescing plates are cleaned by thoroughly rinsing and flushing. Should be no visible oil depth on water.
	Damaged Coalescing Plates	Plate media broken, deformed, cracked and/or showing signs of failure.	A portion of the media pack or the entire plate pack is replaced depending on severity of failure.
	Damaged Pipes	Inlet or outlet piping damaged or broken and in need of repair.	Pipe repaired and or replaced.
	Baffles	Baffles corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to specifications.
	Vault Structure Damage - Includes Cracks in Walls, Bottom, Damage to Frame and/or Top Slab	Cracks wider than 1/2-inch or evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not structurally sound.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound.
		Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the inlet/outlet pipe.
	Access Ladder Damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Ladder replaced or repaired and meets specifications, and is safe to use as determined by inspection personnel.

Catch Basin Insert

Catch basin inserts are becoming more widely used to trap sediment and oil entering catch basins. Most involve some type of filter media and oil-absorbent pads. Filters avoid flooding by overflowing when they become clogged or when there are high storm flows.

Catch basin inserts typically consist of the following components:

- A structure (screened box, brackets, etc.) which contains a pollutant removal medium
- A means of suspending the structure in a catch basin
- A filter medium such as sand, carbon, fabric, etc.
- A primary inlet and outlet for the stormwater
- A secondary outlet for bypassing flows that exceed design flow



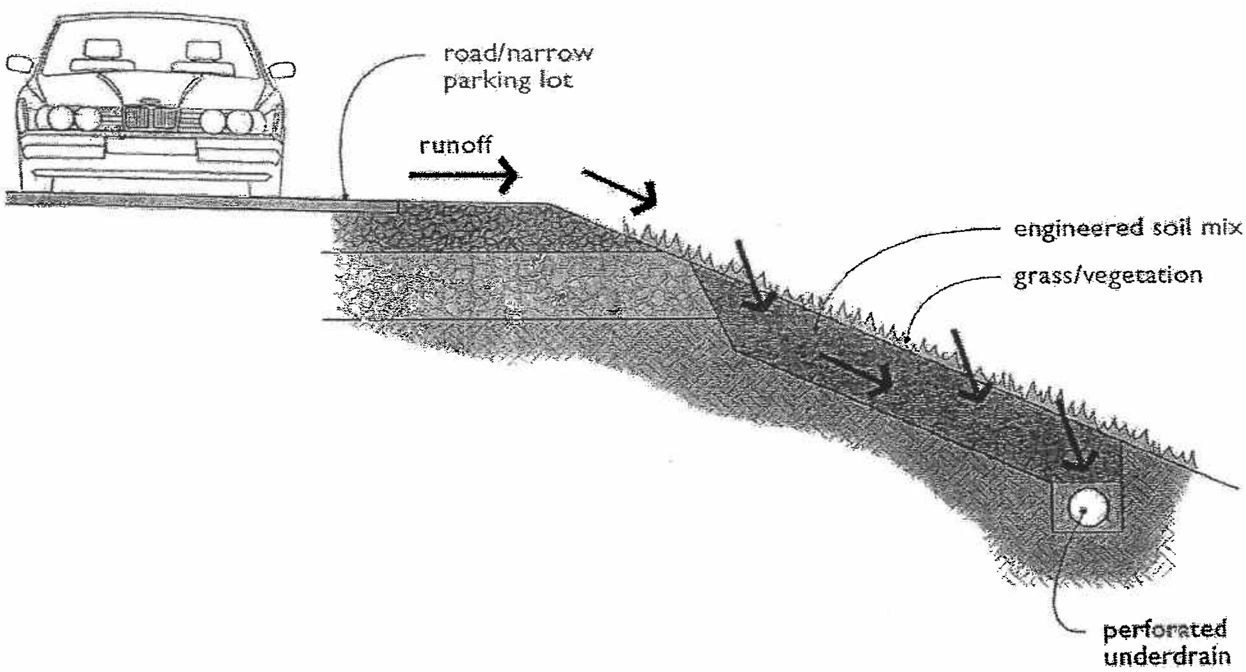
Catch Basin Insert			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed Or Not Needed**
General	Sediment Accumulation	When sediment forms a cap over the insert media of the insert and/or unit.	No sediment cap on the insert media and its unit.
	Trash and Debris Accumulation	Trash and debris accumulates on insert unit creating a blockage/restriction.	Trash and debris removed from insert unit. Runoff freely flows into catch basin.
–	Media Insert Not Removing Oil	Effluent water from media insert has a visible sheen.	Effluent water from media insert is free of oils and has no visible sheen.
	Media Insert Water Saturated	Catch basin insert is saturated with water and no longer has the capacity to absorb.	Remove and replace media insert
	Media Insert-Oil Saturated	Media oil saturated due to petroleum spill that drains into catch basin.	Remove and replace media insert.
	Media Insert Use Beyond Normal Product Life	Media has been used beyond the typical average life of media insert product.	Remove and replace media at regular intervals, depending on insert product.

Media Filter Drain (previously referred to as the Ecology Embankment)

The media filter drain (MFD), previously referred to as the ecology embankment, is a linear flow-through stormwater runoff treatment device that can be sited along highway side slopes (conventional design) and medians (dual media filter drains), borrow ditches, or other linear depressions. The media filter drain can be used where available right of way is limited, sheet flow from the highway surface is feasible, and lateral gradients are generally less than 25% (4H:1V).

Facility objects that are often associated with an ecology embankment include:

- access road or easement
- fence, gate, and water quality sign



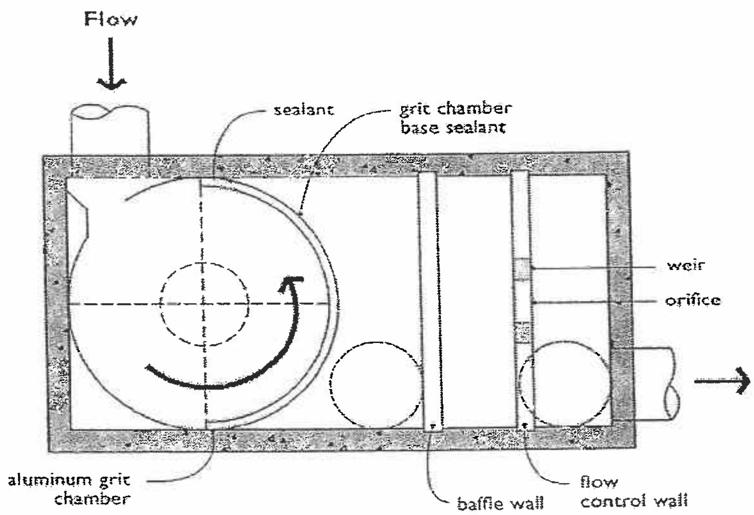
Media Filter Drain (previously referred to as the Ecology Embankment)			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed Or Not Needed**
General	Sediment accumulation on grass filter strip	Sediment depth exceeds 2 inches or creates uneven grading that interferes with sheet flow.	Remove sediment deposits on grass treatment area of the embankment. When finished, embankment should be level from side to side and drain freely toward the toe of the embankment slope. There should be no areas of standing water once inflow has ceased.
	No-vegetation zone/flow spreader	Flow spreader is uneven or clogged so that flows are not uniformly distributed over entire embankment width.	Level the spreader and clean so that flows are spread evenly over entire embankment width.
	Poor vegetation coverage	Grass is sparse or bare, or eroded patches are observed in more than 10% of the grass strip surface area.	Consult with roadside vegetation specialists to determine why grass growth is poor and correct the offending condition. Replant with plugs of grass from the upper slope or reseed into loosened, fertile soil or compost.
	Vegetation	Grass becomes excessively tall (greater than 10 inches); nuisance weeds and other vegetation start to take over.	Mow vegetation or remove nuisance vegetation so that flow is not impeded. Grass should be mowed to a height of 6 inches.
	Media filter drain mix replacement	Water is seen on the surface of the media filter drain mix from storms that are less than a 6-month, 24-hour precipitation event. Maintenance also needed on a 10-year cycle and during a preservation project.	Excavate and replace all of the media filter drain mix contained within the media filter drain.
	Excessive shading	Grass growth is poor because sunlight does not reach embankment.	If possible, trim back overhanging limbs and remove brushy vegetation on adjacent slopes.
	Trash and debris	Trash and debris have accumulated on embankment.	Remove trash and debris from embankment.

Vortechs® Stormwater Treatment System

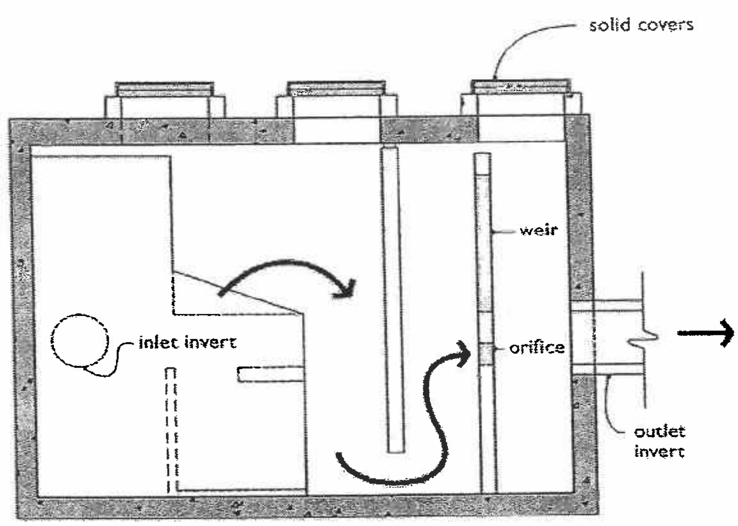
A vortex-enhanced sedimentation vault (Downstream Defenders) consists of a cylindrical vessel where the inlet flow spirals around the perimeter in a vortex-type action causing the heavier particles to settle out of the stormwater. It uses a vortex-enhanced settling mechanism (swirl-concentration) to capture settleable solids, floatables, and oil and grease.

Vortechs® treatment units are a proprietary manufactured system. See manufacturer's publications for additional maintenance information.

Facility objects that are often associated with a Vortechs® system include:
- access road or easement
- fence, gate, and water quality sign
- control structure/flow restrictor
- StormFilter
- conveyance stormwater pipe



BIRD'S-EYE VIEW



SIDE PROFILE

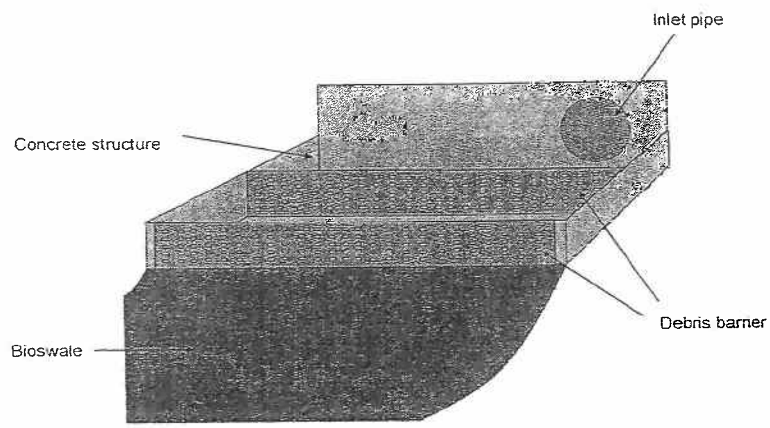
Vortechs® System			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed Or Not Needed**
General	Sediment Accumulation	Sediment depth is within 12 through 18" of dry weather water surface elevation.	Accumulated sediment should be removed.
	Trash and Debris Accumulation	Trash and debris accumulated in vault, or pipe inlet/outlet, floatables and non-floatables.	Trash and debris removed from vault, and inlet/outlet piping.
	Oil Accumulation	Oil accumulation that exceeds 1- inch at the water surface.	Oil is extracted from vault using vactoring methods. Coalescing plates are cleaned by thoroughly rinsing and flushing. Should be no visible oil depth on water.
	Damaged Pipes	Inlet or outlet piping damaged or broken and in need of repair.	Pipe repaired and or replaced.
	Baffles	Baffles corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to specifications.
	Vault Structure Damage - Includes Cracks in Walls, Bottom, Damage to Frame and/or Top Slab	Cracks wider than 1/2-inch or evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not structurally sound.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound.
		Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the inlet/outlet pipe.
	Sediment in Drain Pipes/Clean-Outs	When drain pipes, clean-outs, become full with sediment and/or debris.	Sediment and debris removed.
	Access Ladder Damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Ladder replaced or repaired and meets specifications, and is safe to use as determined by inspection personnel.

Sediment Trap

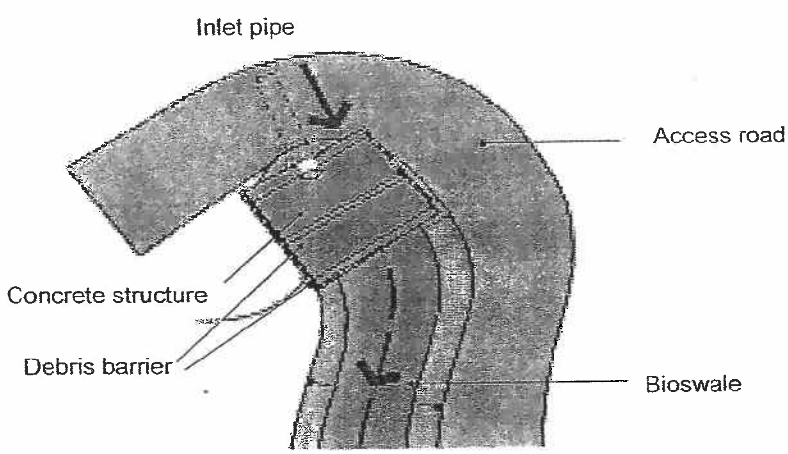
A sediment trap, (also known as a Bradley Weir or a facility sediment trap) is a concrete structure typically fitted with a slotted grate or multiple slotted grates (debris barriers). The concrete structure provides a storage volume (sump) below the outlet pipe to allow sediments and debris to settle out of the stormwater runoff. Some basins are also fitted with a spill control device (elbow on outlet pipe) intended to help direct and dissipate flow. The slotted grate (debris barrier) prevents larger debris from exiting the weir.

Facility objects that are often associated with a Bradley Weir include:

- access road or easement
- fence, gate, and water quality sign
- typical bioswale
- wet bioswale



Bird's-eye view



Sediment Trap

Drainage System Feature	Potential Defect	Maintenance Trigger	Results Expected When Maintenance Is Performed Or Not Needed
General	Trash and Debris	Trash or debris which is located immediately in front of the sediment trap opening or is blocking inletting capacity of the basin by more than 10%.	No Trash or debris located immediately in front of sediment trap or on grate opening.
		Trash or debris (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of six inches clearance from the debris surface to the	No trash or debris in the sediment trap.
		Trash or debris in any inlet or outlet pipe blocking more than 1/3 of its height.	Inlet and outlet pipes free of trash or debris.
		Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane).	No dead animals or vegetation present within the sediment trap.
	Sediment	Sediment (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of 6 inches clearance from the sediment surface to the invert.	No sediment in the sediment trap.
	Structure Damage to Frame and/or Top Slab	Slab has holes larger than 2 square inches or cracks wider than 1/4 inch (Intent is to make sure no material is running into basin.)	Structure is free of holes and cracks.
	Fractures or Cracks in Basin Walls/ Bottom	Maintenance person judges that structure is unsound.	Sediment trap replaced or repaired to design standards.
		Grout fillet has separated or cracked wider than 1/2 inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering catch basin through cracks.	Pipe is regrouted and secure at basin wall.
	Settlement/ Misalignment	If failure of basin has created a safety, function, or design problem.	Sediment trap replaced or repaired to design standards.
	Vegetation	Vegetation growing across and blocking more than 10% of the basin opening.	No vegetation blocking opening to sediment trap.
	Contaminants and Pollution	Any evidence of oil, gasoline, contaminants or other pollutants. (Coordinate removal/cleanup with local water quality response agency.)	No contaminants or pollutants present.
Debris barrier	Trash and Debris	Trash and debris that is blocking more than 20% of grate surface inletting capacity.	Grate free of trash and debris.
	Damaged or Missing.	Grate missing or broken member(s) of the grate.	Grate is in place and meets design standards.

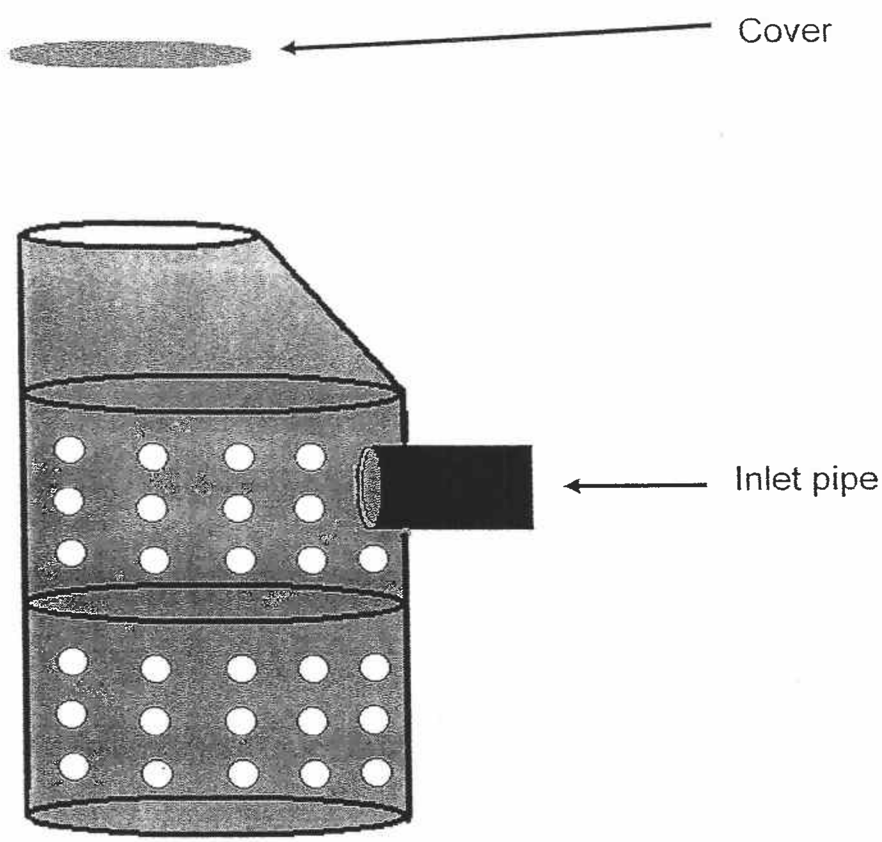
Drywell

A drywell is a perforated, open-bottomed manhole used to infiltrate stormwater into the ground. Drywells temporarily store stormwater runoff during rain events. Drywells do not discharge to a downstream conveyance system or nearby surface water. Instead, drywells rely on the ability of the site's soils to infiltrate the stormwater into the ground.

While not the intended use, drywells trap sediment and some of the oily pollutants in runoff. They are more likely to fill with oily sediment in areas that lack swales or other treatment facilities. Fine soil 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 well-drained soils, or areas having inadequate storm sewers. Often, drywells contain groundwater. Because drywells can be easily clogged and tend to concentrate pollutants in one place; pollution and sediment control practices should be used to protect them.

Facility objects that are typically associated with a drywell include:

- access road or easement
- fence, gate, and water quality sign
- field inlet
- bioswale
- StormFilter



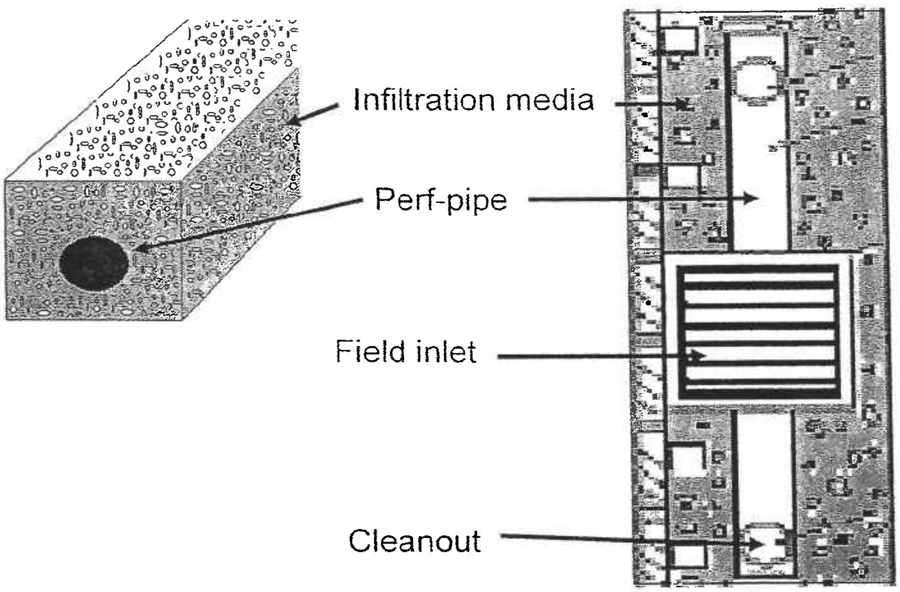
Drywell			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed Or Not Needed**
General	Does Not Dissipate Stormwater	Does not dissipate stormwater.	Replace or repair.
	Opening Clogged	Openings are clogged, reducing capacity.	Water-jet clogged openings. or Convert existing, clogged drywell to a sediment trap and install a new drywell or drainage trench. To convert to a sediment trap, required are grouting holes, covering the base with concrete, and adding piping.
	Standing Water	Standing water indicates the drywell is into the water table.	Rebuild drywell to prevent stormwater from going directly into groundwater.
	Trash and Debris	Trash, debris, or floatables that may exit through pipes	No trash or debris in drywell.
		Trash or debris in any inlet or outlet pipe.	Inlet and outlet pipes free of trash or debris.
	Sediment	Sediment in drywell exceeds 60 percent of the depth below the inlet pipe.	No sediment in drywell.
	Structure Damage	Maintenance person judges that structure is unsound.	Drywell replaced or repaired to design standards.
	Contaminants and Pollution	Any evidence of oil, gasoline, contaminants or other pollutants (Coordinate removal/cleanup with local water quality response agency). • Identify and remove source, AND • Report to Clark County Clean Water Program Illicit Discharge and Detection Elimination Program .	No contaminants or pollutants present.
Drywell Manhole	Cover Not in Place	Cover is missing or only partially in place. Any open catch basin requires maintenance.	Catch basin cover is closed
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure (Intent is to keep cover from sealing off access to maintenance).	Cover can be removed by one maintenance person.
Metal Grates (If Applicable)	Grate opening Unsafe	Grate with opening wider than 7/8 inch.	Grate opening meets design standards.
	Trash and Debris	Trash and debris that is blocking more than 20% of grate surface inletting capacity.	Grate free of trash and debris.
	Damaged or Missing.	Grate missing or broken member(s) of the grate.	Grate is in place and meets design standards.

Infiltration Trench

A stormwater infiltration trench is a closed basin built by excavating below existing ground. Infiltration trenches temporarily store stormwater runoff during rain events. Infiltration trenches do not discharge to a downstream conveyance system or nearby surface water. Instead, infiltration trenches rely on the ability of the site's soils to infiltrate the stormwater into the ground.

Facility objects that are typically associated with an infiltration trench include:

- access road or easement
- fence, gate, and water quality sign
- bioswale
- sediment trap
- field inlet



Infiltration Trench			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed Or Not Needed**
General	Contaminants and Pollution	Any evidence of oil, gasoline, contaminants or other pollutants in or around facility. • Identify and remove source, AND • Report to Clark County Clean Water Illicit Discharge and Detection Elimination Program .	No contaminants or pollutants present.
	Observation Well	Sediment depth greater than one foot above stone aggregate or the surface inlet.	No sediment in infiltration trench.
	Drainage Slow	Decreased capacity that indicates slow drainage.	Verify facility design rate. Clean perforated drain pipe. Do not allow removed sediment and water to discharge back into the storm sewer.

Field Inlet

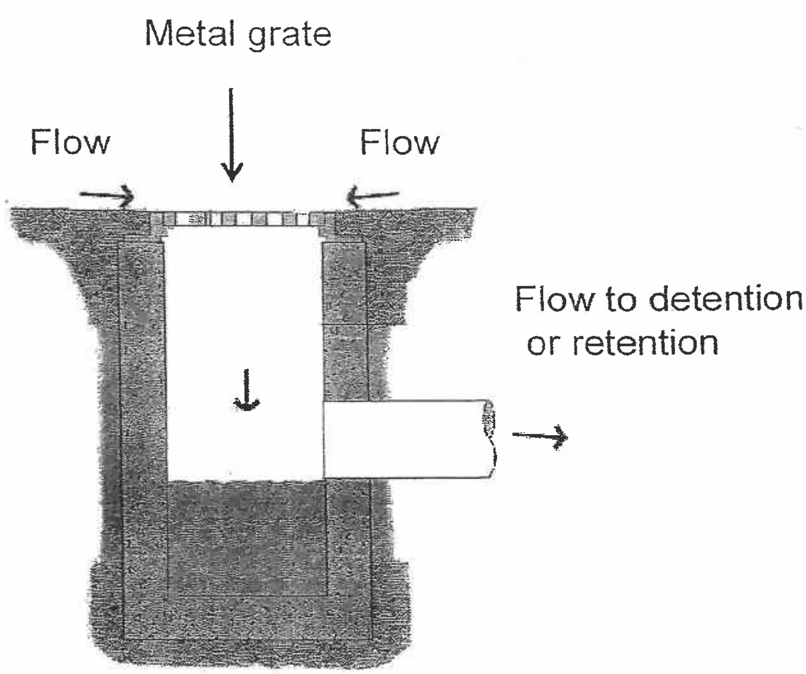
A field inlet is a concrete structure fitted with a slotted grate to collect stormwater runoff and route it through underground pipes.

Field inlets typically provide a storage volume (sump) below the outlet pipe to allow sediments and debris to settle out of the stormwater runoff. Some field inlets are fitted with a spill control device (inverted elbow on outlet pipe) intended to contain large quantities of grease or oils.

The most common tool for cleaning field inlets is a truck with a tank and vacuum hose (vactor truck) to remove sediment and debris from the sump.

Facility objects that are typically associated with a field inlet include:

- access road or easement
- control structure/flow restrictor
- bioswale
- detention pond
- infiltration basin control
- infiltration trench



Field Inlet

Drainage System Feature	Potential Problem	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed Or Not Needed
General	Trash and Debris	Trash or debris which is located immediately in front of the catch basin opening or is blocking inletting capacity of the field inlet by more than 10%.	No Trash or debris located immediately in front of field inlet or on grate opening.
		Trash or debris (in the field inlet) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of six inches clearance from the debris surface to the	No trash or debris in the field inlet.
		Trash or debris in any inlet or outlet pipe blocking more than 1/3 of its height.	Inlet and outlet pipes free of trash or debris.
		Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane).	No dead animals or vegetation present within the field inlet.
	Sediment	Sediment (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of 6 inches clearance from the sediment surface to the invert	No sediment in the field inlet.
	Structure Damage to Frame and/or Top Slab	Top slab has holes larger than 2 square inches or cracks wider than 1/4 inch (Intent is to make sure no material is running into basin).	Top slab is free of holes and cracks.
		Frame not sitting flush on top slab, i.e., separation of more than 3/4 inch of the frame from the top slab. Frame not securely attached	Frame is sitting flush on the riser rings or top slab and firmly attached.
	Fractures or Cracks in Basin Walls/ Bottom	Maintenance person judges that structure is unsound.	Basin replaced or repaired to design standards.
		Grout fillet has separated or cracked wider than 1/2 inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering field inlet through cracks.	Pipe is regrouted and secure at basin wall.
	Settlement/ Misalignment	If failure of basin has created a safety, function, or design problem.	Basin replaced or repaired to design standards.
	Vegetation	Vegetation growing across and blocking more than 10% of the basin opening.	No vegetation blocking opening to basin.
		Vegetation growing in inlet/outlet pipe joints that is more than six inches tall and less than six inches apart.	No vegetation or root growth present.
	Contaminants and Pollution	Any evidence of oil, gasoline, contaminants or other pollutants Sheen, obvious oil or other contaminants present. • Identify and remove source, AND • Report to Clark County Clean Water Program Illicit Discharge and Detection Elimination Program.	No contaminants or pollutants present.

Field Inlet (Continued)			
Drainage System Feature	**Potential Problem**	**Conditions When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed Or Not Needed**
Metal Grates	Grate Not in Place	Cover is missing or only partially in place. Any open field inlet requires maintenance.	Field inlet cover is closed
	Grate opening Unsafe	Grate with opening wider than 7/8 inch.	Grate opening meets design standards.
	Trash and Debris	Trash and debris that is blocking more than 20% of grate surface inletting capacity.	Grate free of trash and debris.
	Damaged or Missing.	Grate missing or broken member(s) of the grate.	Grate is in place and meets design standards.

Access Road and Easement

Many 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.

All facilities should allow access for the inspection process.

The easement area should be adequately landscaped. Landscaping is an essential component of stormwater management. Bare soil areas may generate higher levels of stormwater runoff and increase erosion and sedimentation in stormwater facilities. The following checklist gives some general guidance for management.

Access Road/Easement			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed Or Not Needed**
General	Erosion	Soils are bare or eroded.	Seed or use a covering BMP.
	Road Surface	Condition of road surface may lead to erosion of the facility or limit access.	Road repaired.
	Erosion of Ground Surface	Noticeable rills are seen in landscaped areas.	Causes of erosion are identified and steps taken to slow down/spread out the water. Eroded areas are filled, contoured, and seeded. If needed, regrade effected areas.
	Trash & Debris / Litter	Litter accumulation exceeds 1 cubic foot per 1,000 square feet.	No trash or debris present.
	Poisonous Vegetation and Noxious weeds	Any poisonous or nuisance vegetation which may constitute a hazard to maintenance personnel or the public.	No danger of poisonous vegetation where maintenance personnel or the public might normally be. (Coordinate with Clark County Weed Management department)
		Any evidence of noxious weeds as defined by State or local regulations.	Complete eradication of noxious weeds may not be possible. Compliance with State or local eradication policies required
		(Apply requirements of adopted Clark County Maintenance and Operations policies for the use of herbicides).	
	Tree Growth and Hazard Trees	Tree growth does not allow maintenance access or interferes with maintenance activity (i.e., slope mowing, silt removal, vactoring, or equipment movements). If trees are not interfering with access or maintenance, do not remove	Trees do not hinder maintenance activities. Harvested trees should be recycled into mulch or other beneficial uses (e.g., alders for firewood).
		If dead, diseased, or dying trees are identified	Remove hazard Trees
		(Use a certified Arborist to determine health of tree or removal requirements)	
		Trees or shrubs that have been blown down or knocked over.	Replant tree, inspecting for injury to stem or roots. Replace if severely damaged.

Access Road/Easement (Continued)			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed Or Not Needed**
General cont.	Vegetation	Any poisonous or nuisance vegetation which may constitute a hazard to maintenance personnel or the public. Any evidence of noxious weeds as defined by State or local regulations. (Apply requirements of adopted IPM policies for the use of herbicides).	No danger of poisonous vegetation where maintenance personnel or the public might normally be. (Coordinate with County Weed Management department.) Complete eradication of noxious weeds may not be possible. Compliance with State or local eradication policies is required.
	Weeds (Nonpoisonous)	Weeds growing in more than 20% of the landscaped area (trees and shrubs only).	Weeds present in less than 5% of the landscaped area.
	Insects	When insects such as wasps and hornets interfere with maintenance activities.	Insects destroyed or removed from site. Apply insecticides in compliance with adopted Clark County Maintenance and Operations policies

Fence, Gate, and/or Water Quality Sign

Stormwater facilities such as detention ponds or treatment wetlands often have fences to protect them from damage and keep children away from ponds or hazardous areas. Certain facilities such as biofiltration swales, approved under Chapter 13.29 CCC, are also required to have informational signs telling the public that the swale is a stormwater facility.

Fence, Gate and/or Water Quality Sign

Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed Or Not Needed
General	Gate or Fence Allows Unauthorized Entry	Openings in fence, missing gate, openings beneath fence allowing unauthorized access.	Gate and/or fence repaired to prevent unauthorized access
	Locking Mechanism	Mechanism cannot be opened by one maintenance person with proper tools.	Lock repaired/replaced.
		No lock on gate allows unauthorized entry.	Lock replaced.
	Damaged Parts	Posts out of plumb more than six inches.	Post plumb to within 1-1/2 inches of plumb
		Top rails of plumb more than six inches.	top rails free of bends greater than 1 inch.
	Erosion	Erosion has resulted in an opening under a fence that allows entry by people or pets.	Replace soil under fence so that no opening exceeds 4 inches in height.
	Water Quality Sign	Water quality sign is leaning more than 8 inches off vertical.	Sign reset to plumb.
		Water quality sign is missing or 20% of the surface is unreadable.	Sign replaced.

Conveyance Stormwater Pipe

Inlet and outlet stormwater pipes convey stormwater in, through, and out of stormwater facilities.

Storm sewer pipes convey stormwater. Pipes are built from many materials and are sometimes perforated to allow stormwater to infiltrate into the ground. Stormwater pipes are cleaned to remove sediment or blockages when problems are identified. Stormwater pipes must be clear of obstructions and breaks to prevent localized flooding. All stormwater pipes should be in proper working order and free of the possible defects listed below.

Conveyance Storm Pipe			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed Or Not Needed**
General	Obstructions, Including Roots	Root enters or deforms pipe, reducing flow.	Use mechanical methods to remove root. Do not put root-dissolving chemicals in storm sewer pipes. If necessary, remove the vegetation over the line.
	Pipe Dented or Broken	Inlet/outlet piping damaged or broken and in need of repair.	Pipe repaired and/or replaced.
	Pipe Rusted or Deteriorated	Any part of the piping that is crushed or deformed more than 20% or any other failure to the piping.	Pipe repaired and/or replaced.
	Sediment & Debris	Sediment depth is greater than 20% of pipe diameter.	Install upstream debris traps (where applicable) then clean pipe and remove material
	Debris barrier or Trash Rack Missing	Stormwater pipes > than 18 inches need debris barrier	Debris barrier present on all stormwater pipes 18 inches and greater

Stormwater Facility Discharge Points

Stormwater facility discharge points may convey stormwater from the stormwater facility into drainage trenches and receiving waters or other drainage areas. Stormwater facility discharge points need to be assessed to make sure stormwater is not causing any negative impacts to these drainage areas.

Facility Discharge Point			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed Or Not Needed**
Monitoring	Inspection of Discharge Water for Obvious Signs of Poor Water Quality.	Sheen, obvious oil or other contaminants present. • Identify and remove source, AND • Report to Clark County Clean Water Program Illicit Discharge and Detection Elimination Program .	Effluent discharge from facility should be clear.
	Receiving Area Saturated	Water in receiving area is causing substrate to become saturated and unstable. • Report to Clark County Clean Water Program for Engineer Evaluation.	Receiving area sound.
	Off Site Assessment	Erosion, scouring, or headcuts in ditch or stream banks due to flow channelization, or higher flows. • Report to Clark County Clean Water Program for Engineer Evaluation.	Ditch or stream banks stable.
General	Missing or Moved Rock	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil.	Rock pad replaced to design standards.
	Erosion	Soil erosion in or adjacent to rock pad.	Rock pad replaced to design standards.
	Obstructions, Including Roots	Roots or debris enters pipe or deforms pipe, reducing flow	Use mechanical methods to remove root. Do not put root-dissolving chemicals in storm sewer pipes. If necessary, remove the vegetation over the line.
	Pipe Rusted or Deteriorated	Any part of the pipe that is broken, crushed or deformed more than 20% or any other failure to the piping	Pipe repaired or replaced.
Internal (If Applicable)			
Energy Dissipater	All Potential Defects	**See Energy Dissipater on pages 23 – 24**	

Vegetation Management

The following practices are adapted, with minor modifications for format and local practices, from City of Portland Parks Pest Management Policy (April 1999).

General Goals and Philosophy

Clark County recognizes the special importance of rivers, streams, wetlands, ponds, and stormwater control and treatment facilities. The sensitive nature of such habitats, 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 principles and decision-making rationale. These are:

- 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 Practices

Use Only Appropriate Plants

Clark County has adopted a list of approved plants for use in development projects. The list also has prohibited undesirable plants. Only plants approved for use in the Clark County Plant List are allowed for use in plantings in unincorporated areas.

Vegetation and Pest Management in Stormwater Control Facilities

Stormwater control 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 either directly or through pipes or ditches. Many facilities are built to remove pollutants from stormwater.

Generally, vegetation should be maintained to blend into surrounding areas. Stormwater facilities can provide habitat for aquatic life and birds. Promoting natural vegetation where feasible improves habitat. Swales often blend into intensively managed landscapes. Pond perimeters can include natural vegetation.

The use of pesticides and, in most cases fertilizer, is not compatible with the task of pollutant removal or the direct connection of stormwater facilities to streams and groundwater.

Features of Stormwater 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 Stormwater 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

Practices

The vegetation management focus is 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 Vancouver plant list or the Clark County Plant List (Ordinance 1995-01-26).

In some cases, the original plantings may not be appropriate for the actual condition 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 block 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 may be removed and replaced by smaller shrubs.

City of Camas WASHINGTON

Pre-Application Meeting
Green Mountain PRD
Ingle Rd/Goodwin Rd
File PA14-07

Tuesday, February 25, 2014
2:00pm, Council Chambers
616 NE Fourth Avenue, Camas WA 98607

Applicant / Contact:	**Applicant**: Landerholm Law Firm Attn: Randy Printz 805 Broadway Suite 100 Vancouver WA 98660 Ph: (360) 696-3312 Email: randy.printz@landerholm.com	**Contact:** Same
Representing City of Camas:	Phil Bourquin, Community Development Director Robert Maul, Planning Manager Sarah Fox, Sr. Planner Bob Cunningham, Building Official Randy Miller, Fire Marshal Eric Levison, Public Works Director Jerry Acheson, Parks Manager Jim (Curleigh) Carothers, Engineering Manager Wes Heigh, Project Manager Norm Wurzer, Engineer	
Location:	Ingle Rd & Goodwin Rd (see application for tax parcels)	
Zoning:	R10, R6, MF & CC	
Description:	**The applicant proposes to develop a 283 acre site with a variety of lot sizes and densities that will include both single-family and multi-family components.**	

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 Department **Sarah Fox 817-7269**

The applicant has proposed several permits, some of which can be consolidated for a single decision issuance. The applicant is responsible for reviewing the code and addressing the applicable provisions.

1) The proposed preliminary master plan for a Planned Residential Development (PRD) application is TYPE III permit, which requires City Council approval, in accordance with the process described within CMC Chapter 18.23 and CMC Chapter 18.55. This underlying permit is typically consolidated with preliminary plat, critical areas, and SEPA reviews. The proposed zoning overlay requires legislative action.

2) Note that the city's development codes within Titles 16, 17, and 18 were amended last month, and are codified online. Also, the city's multi-family dimensional standards at CMC Chapter 18.09 Density and Dimensions were amended, however, at this time; the ordinance has not been codified online, and is therefore attached to these notes. The application will be subject to the codes adopted on the date of application.

3) PRD applications should address the criteria as found under CMC§18.23.100- Approval standards. The contents of an application are provided at CMC§18.23.070- Preliminary Master Plan Requirements. In addition the application should address:

   a) Proposed timing for validity of master plan and phasing.

   b) How the adopted dimensional standards must be modified. Please note, that a preliminary plat application can be approved in phases (See "Phasing" at CMC§17.11.040), and may be approved at a public hearing before the city's Hearings Examiner, rather than by city council as required for a PRD.

4) The proposed preliminary master plan should conform to the city's comprehensive plan for residential density, and the PRD standards at CMC§18.23.040 Density Standards. The current DA lists a total unit count of 1,379 dwelling units, but the proposed amount is closer to 1,643. As discussed in the pre-app, the applicant should address this issue in a revised DA and subsequent overall project application.

Notes on layout:

- All phases of the proposed development must be included at sufficient details to demonstrate compliance with applicable development codes.
- Double frontage lots if proposed, require additional lot depth per CMC 17.19.030 (D)(6). "*Residential lots which have street frontage along two opposite lot lines shall be avoided, except for lots which provide separation of a residential development from a traffic arterial or collector, in which case additional lot depth of at least twenty feet will be provided to act as a buffer strip, or* ***ten-foot landscape tract with ten-foot additional*** *lot depth, or a combination of both* ***to achieve twenty-foot additional depth*** *between the lot and the traffic arterial.*"
- Extra (off-street) parking areas are required to be located in a convenient location if average lot sizes are less than 7,400 square feet.
- The proposed lot layout may also contain "Restricted Corner Lots". These are corner that are restricted from access on side yard flanking street. The setbacks on these lots shall be treated as interior lots.

5) Critical area reports required.
   - General requirements for critical areas reports are found at CMC§16.51.140. The city's code contains additional requirements for each type of critical area (e.g. wetlands).
   - Wetland report requirements are found at CMC§16.53.030. The preliminary report and analysis must include efforts to avoid impacts. Alternative layouts to indicate feasibility should be provided.
   - Steep Slopes additional analysis in accordance with CMC16.59.060.
   - Archaeological Predetermination Report required in accordance with CMC§16.31.070, and must include proof of mailing notification to tribes.
   - Wildlife habitat reports must be submitted in accordance with chapter CMC§16.61.
   - Scenic views in accordance with CMC§16.33.010(B) should be illustrated on a site plan, identifying particular corridors.
6) Tree preservation efforts are required.
   - Tree survey must be conducted by biologist (include qualifications). The biologist will be required to review and coordinate tree preservation efforts with preliminary grading plans.
   - CMC 18.31 requires preservation of significant trees "to the extent practical", "healthy trees" and prefers "groups of significant trees". CMC§18.31.110 requires "mandatory preservation" in the form acceptable to the city. CMC§17.19.030 (A)(2) requires "every reasonable effort" to retain trees.
7) Sales office locations should be proposed with preliminary plans. If sales offices are proposed with the Type III application, then time frames for operation of the temporary use can be approved for longer than the limits of typical temporary uses (6 months) if requested.
8) **Zoning Overlay**: An application must include the current and proposed zoning drawing; along with a narrative to address how the change in zoning requested is in conformity with the adopted comprehensive plan, and the public interest. The proposed zone change must be compatible with the existing established development pattern of the surrounding area in terms of lot sizes, densities and uses
9) Fees will be based on the adopted fees at the time of application submittal. The current fees include the following (not all inclusive):

• Preliminary plat	$6,055 + $210 per lot
• PRD	$27 per unit + plat fees
• Zone change	$1,650
• SEPA	$685
• Critical areas	$650 (per type)
• Fire Department Review	$300

Engineering Department **Wes Heigh 817-7237**

1. Construction plans shall be prepared by a licensed Washington State engineer in accordance with City of Camas standards.
2. Per CMC 14.02 stormwater treatment and runoff control shall be designed in accordance with the 2005 Stormwater Management Manual for Western Washington and the City of Camas Stormwater Design Standards Manual.
3. This development is subject to the minimum improvement requirements identified in CMC 17.19.020.
4. Existing wells and septic tanks and septic drain fields shall be abandoned in accordance with state and county guide lines per CMC 17.19.020 (A3).

5. Proposed lots should have frontage on public streets, lot lines should be at right angles to the street or radial to curves per CMC 17.19.030 (D).
6. Flag lots shall meet the requirements of CMC 17.19.030 (D5).
7. Double frontage lots should be avoided per CMC 17.19.030 (D).
8. In accordance with CMC 17.19.030 (E) and per the 2007 Parks, Recreation and Open Space Comprehensive Plan provisions shall be made for Neighborhood Park (NP-16), Special Use Park (SU-14), Trails T-27, T-29 and T-30. The city is currently in the process of updating our Parks Plan. Application materials will need to address the requirements of the current plan at the time of submittal.
9. Street tree planting and landscaping of flag lots is required in accordance with CMC 17.19.030 (F).
10. Stormwater facilities shall be located and landscaped per CMC 17.19.030 (F6) and CMC 17.19.040 (C3a).
11. Maintenance of the storm water facilities will be the responsibility of the Homeowners Association per CMC 17.19.040 (C3).
12. The applicant will be responsible for all traffic control signs, street name signs, pavement markings and street lighting per CMC 17.19.030 (I) (J).
13. The applicant will be responsible for the design and submittal of the utility plan showing the locations for underground power, telephone, gas, CATV, street lights and associated appurtenances.
14. Private streets if proposed will need to meet the provisions of CMC 17.19.040 (A).
15. Public street requirements are found in CMC 17.19.040 (B). For street grades, centerline curve radii, and curb return radii requirements see CMC 17.19.040 (B12).
16. Half width street improvements and ROW dedication will be required along Goodwin Road and NE Ingle Road per CMC 17.19.040 (B2 & B5). Ingle half width ROW is 37' and Goodwin half width ROW at Ingle should be 50' tapering to 37' east of Ingle.
17. Streets should extend to the boundaries of the plat where appropriate to ensure access and circulation to neighboring properties per CMC 17.19.040 (B6a).
18. Where lot size average is under 7,400 SF additional off-street parking will be required in accordance with CMC 17.19.040 (B10c).
19. Any proposed phasing shall be consistent with the requirements of CMC 17.11.040.
20. The application narrative shall specifically address the approval criteria CMC 17.11.030 (D) and CMC 18.23.100.
21. A 3% plan review and inspection fee will be required per resolution number 1023. The fee will be based on an engineer's estimate or construction bid. The fee is due prior to approved construction drawings being released by the City.
22. An erosion control bond will be required for all land disturbing activities of an acre or more per CMC 17.21.030.
23. A NPDES permit will be required for this project per Washington Department of Ecology requirements if more than one acre of land will be disturbed.
24. A traffic study will be required for this project in accordance with the City's adopted Traffic Impact Study Guidelines. The study shall include speed surveys, traffic counts, site distance evaluation, AM and PM peak volumes, trip distribution and assignment, signal warrants, turn pocket analysis, with and without project analysis for the current year, build out year and the future 5 year and 20 year analysis. Evaluation of additional

off-site intersections will be required once trip generation and distribution information is determined, contact the City Engineer for specific intersections.

25. This project will generate more than 700 ADT and will be required to provide acceptable traffic calming measured in accordance with the Neighborhood Traffic Manual.
26. Intersection spacing and intersection setbacks shall meet the requirements of the 2012 TIF Plan.
27. Water and sewer system extensions to the site will need to be consistent with the adopted Water System Plan and the General Sewer Plan Amendment. The improvements will likely require the applicant to enter into agreements with the city for system upsizing and/or latecomer agreements.
28. Regulations for installation of public improvements, improvement agreements, bonding, final platting and final acceptance can be found at CMC 17.21.
29. Exception requests to the requirements of Title 17 shall meet the requirements of CMC 17.23.

Fire Department **Randy Miller 834-6191**

Please note, for current or future questions/issues, All review notes, plat notes and conclusions have been conducted based on the current codes at the time, specifically the International Fire Code (IFC), National Fire Code (NFC) & CMC.

1. Automatic fire sprinkler system designed and installed in accordance with NFPA 13D may be required in all new dwellings. IFC B 105, CMC 17.19 ** Besides the obvious life safety and property protection advantages, Fire Sprinklers provide flexibility for developers in subdivision single access points, long term phasing projects that create dead ends, potential for installation of fewer hydrants, narrower streets, steeper grades, waiver of third party Wildland Interface Studies and finally decreased Fire Impact Fee's.

2. Onsite fire hydrants required, contact fire department for locations. IFC Appendix C Sec. C 105

3. A separate permit with the Fire Marshal's office is required for any underground tank decommissioning, removal/disposal or abandoning in place. IFC 105.7.5, 3404.2.13.1.4

4. Provisions required to be made for the addressing of flag lots. Address numbers shall be plainly legible and clearly visible and must be posted for each residence where the flag lot access or easement leaves the public road. IFC 505.1, CMC 17.19.030-D-5-G

5. Witnessed hydrant flushing by the FMO required prior to final completion per NFPA guidelines in ALL new developments with hydrants.

6. Hydrant chains to be removed prior to final completion.

7. Hydrant pads to be poured below the break-away bolts and to be a minimum 4' by 4' pad.

8. Minimum 3 ft clearance required around all hydrants. No item such as plants, trees, rocks, signs, retaining walls, light poles, traffic signal poles, power/telephone poles, electrical service box, phone/cable box, gas service, driveways, etc. shall obstruct or be within 3 feet of a fire hydrant. Open sky shall exist above the hydrant. IFC 507.5.4.

9. Separate permit with the Fire Marshal's office required for any private access gates/barriers. IFC D 103.5, CMC 12.36.

10. Any structures on site may be evaluated for potential fire department training burns. Please contact the Fire Marshal's Office at 360-834-6191 for further information.

11. Any subdivision or new development where residential or commercial fire sprinklers are not installed requires a Separate Permit with the Fire Marshal's office submitted by a WA State Licensed Fire Sprinkler Contractor to establish actual GPM flow for each hydrant, NFPA 291.

Parks Department **Jerry Acheson 834-5307 x4490**

1. The Park, Recreation and Open Space Comprehensive Plan identifies a regional trail leading to a view point in the area. The applicant should clearly demonstrate how this development will complement and continue the natural environment of this trail corridor.
2. The Park, Recreation and Open Space Comprehensive Plan identifies the need for a neighborhood parks in the vicinity of this proposed subdivision. The application should address how this proposal complies with the comprehensive plan.
3. Park and Open Space impact fees may be creditable toward dedication and/or development of these community resources.

Camas Municipal Code (Ord. No. 2694)

18.05.020 Districts designated.

For the purposes of the Code, the city is divided into zoning districts designated as follows:

District	Symbol	Comprehensive Plan Designation
Residential 20,000	R-20	Single-family Low
Residential 15,000	R-15	Single-family Low
Residential 12,000	R-12	Single-family Medium
Residential 10,000	R-10	Single-family Medium
Residential 7,500	R-7.5	Single-family Medium
Residential 6,000	R-6	Single-family High
Residential 5,000	R-5	Single-family High
Multifamily-10	MF-10	Multifamily Low
Multifamily-18	MF-18	Multifamily High
Multifamily-24	MF-24	Multifamily High
Multifamily Cottage	MF-C	Overlay
Neighborhood Commercial	NC	Commercial
Community Commercial	CC	Commercial
Regional Commercial	RC	Commercial
Mixed Use	MX	Commercial
Downtown Commercial	DC	Commercial
Light Industrial	LI	Industrial
Heavy Industrial	HI	Industrial
Business Park	BP	Industrial
Light Industrial/Business Park	LI/BP	Light Industrial/Business Park
Neighborhood Park	NP	Park
Special Use Park	SU	Park
Open space/Green space	OS	Open space / Green space

18.05.040 Residential and multifamily zones

A. R-20 Residential-20,000. This zone is intended to ensure that the rural character of certain portions of the city is maintained. Residential development is expected to consist of large custom single-family dwellings on uniquely configured lots which are designed to be sensitive to topographic and environmental considerations. The average lot size is twenty thousand square feet at densities of one to two dwellings per acre.

B. R-15 Residential-15,000. This zone is intended for single-family dwellings with a minimum density of two to three dwellings per acre. This zone will permit the rural character of a number of existing neighborhoods to be maintained. The average lot size is fifteen thousand square feet.

C. R-12 Residential-12,000. This zone is intended for single-family dwellings with densities of three to four dwelling units per acre. This zone is designated for areas with steep topography for greater flexibility in site layout, and where potential hazards do not exist. The average lot size is twelve thousand square feet.

D. R-10 Residential-10,000. This zone is intended for single-family dwellings with densities of four to five dwellings per acre. This zone is intended to be zoned near low density residential districts, and where potential natural hazards do not exist. The average lot size is ten thousand square feet.

E. R-7.5 Residential-7,500. This zone is intended for single-family dwellings with densities of five to six dwellings per acre. This zone should have less slope than lower density zones, and be adjacent to existing high density residential districts. The average lot size is seven thousand five hundred square feet.

F. R-6 Residential-6,000. This zone is intended for single-family dwellings with densities of six to seven dwellings per acre. The slope of property is less than other lower density residential zones. This zone serves a transition to multifamily or commercial zones. The average lot size is six thousand square feet.

G. R-5 Residential-5,000. This zone is intended for single-family dwellings, either attached or detached, with densities of up to eight and one-half dwellings per acre. The slope of property is less than other medium density residential zones. Like the R-6 district, this zone serves as a transition to multifamily or commercial zones. The average lot size is five thousand square feet.

H. MF-10 Multifamily Residential. This zone provides for a diversity of dwellings such as duplexes, triplexes, fourplexes, rowhouses, and apartment complexes, with a density of up to ten units per acre. It is desirable for this zone to be adjacent to parks and multi-modal transportation systems. This zone can also serve as a transition between commercial and residential zones.

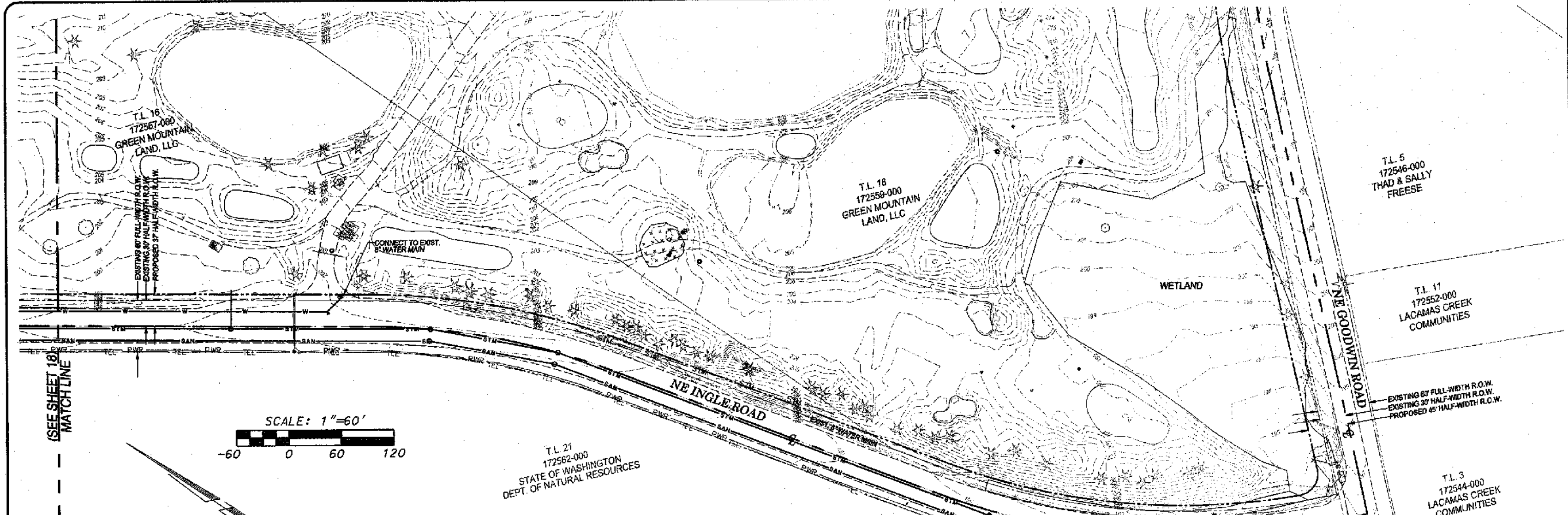
I. MF-18 and MF-24 Multifamily Residential. These zones are intended to provide for dwellings such as rowhouses and apartment complexes. It is desirable for these zones to be adjacent to parks and multi-modal transportation systems. These zones also serve as a transition between commercial and residential zones.

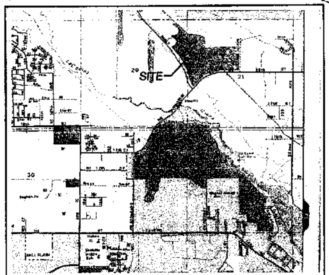
J. MF-C Cottage. This is an overlay zone, which is intended to increase the housing supply and style choices for smaller, single-level dwellings. It is desirable that cottages are designed to include unique architectural elements such as a front porch, steep-pitch gable roof, and a recessed garage; and to accommodate those with mobility impairments. This overlay zone may be utilized within multi-family zones only, and upon approval of a zoning district change.

18.09.050 Table 3—Density and dimensions for multifamily residential zones

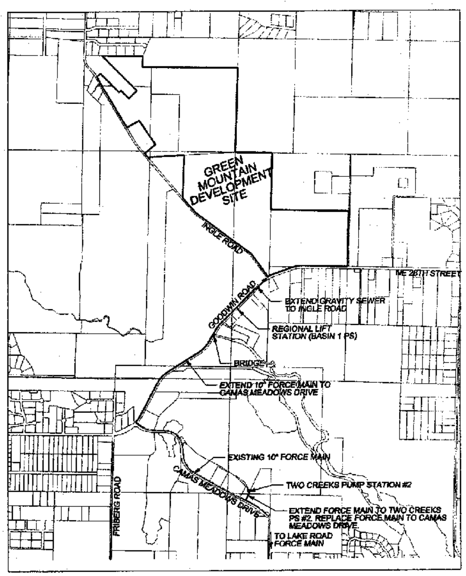
	MF-10	MF-18	MF-24	MF-C Overlay
Density				
Maximum density (dwelling units per gross acre)	10	18	24	18
Minimum density (dwelling units per gross acre)	6.0	6.0	6.0	6.0
Standard lots				
Minimum lot area (square feet)	3,000	2,100	1,800	None
Minimum lot width (feet)	30	20	20	0
Minimum lot depth (feet)	70	60	60	0
Maximum gross floor area (GFA) per dwelling unit (square feet)	No max	No max	No max	1,000 Note 4
Setbacks				
Minimum front yard/at garage front (feet)	15/18	10/18	10/18	0/18
Minimum side yard (feet)	3 Note 1	3 Note 1	3 Note 1	0
Minimum side yard, flanking a street (feet)	15	15	15	15
Minimum rear yard	10	10	10	0
Lot coverage				
Maximum building lot coverage	55%	65%	75%	Building coverage is limited by a minimum of 200 sq. ft. of useable yard adjacent to each dwelling unit.
Building height				
Maximum building height (feet)	35 Note 2	45 Note 2	45 Note 2	18 Note 3

Table 3 Notes:
1. The non-attached side of a dwelling unit shall be three feet, otherwise a zero-lot line is assumed.
2. Maximum building height: three stories and a basement but not to exceed height listed above.
3. Maximum building height: one story and a basement but not to exceed height listed above.
4. GFA in this instance does not include covered porches or assessory structures as defined per CMC18.17.040.





VICINITY MAP
NTS



SANITARY FORCE MAIN EXTENSION DETAIL (A/17)
NTS

LEGEND

	PERIMETER OF SITE
	RIGHT-OF-WAY LINE
	CENTERLINE OF ROAD
	FACE OF CURB
	LOT LINE
	POD BOUNDARY
	EASEMENT LINE
STM	STORM SEWER LINE
STM	EXIST STORM SEWER
SAN	SANITARY SEWER LINE
SAN	EXIST SANITARY SEWER
W	WATER SERVICE LINE
W	EXIST WATER LINE
MANHOLE	THRUST BLOCK
CLEAN OUT	WATER SERVICE ASSEMBLY
CATCH BASIN	BACKFLOW ASSEMBLY
FIRE HYDRANT ASSEMBLY	WATER VALVE AND BOX
	BLOW-OFF ASSEMBLY

PRELIMINARY UTILITY NOTES

STORM SEWER:

1) STORMWATER QUALITY AND QUANTITY CONTROL TO BE ACHIEVED USING WETPONDS WITH DETENTION ABOVE THE WETPOOL. STORMWATER FROM THE DEVELOPMENT TO BE DISCHARGED VIA OUTFALLS TO THE EXISTING WETLANDS/STREAM WEST OF NE INGLE ROAD.
2) WETPONDS HAVE BEEN SIZED TO MEET THE PHOSPHORUS CONTROL REQUIREMENTS FOR THE LACAMAS WATER SHED, AS SPECIFIED BY THE CITY OF CAMAS AND THE WASHINGTON STATE DEPARTMENT OF ECOLOGY.
3) THE PROPOSED STORMWATER FACILITIES WILL BE PRIVATELY OWNED AND MAINTAINED, WITH ACCESS AND INSPECTION EASEMENTS TO BE DEDICATED TO THE CITY OF CAMAS AS REQUIRED.

SANITARY:

1) SANITARY SEWER SERVICE WILL BE PROVIDED BY CITY OF CAMAS.
2) SANITARY SEWER WILL BE A GRAVITY SEWER. NEW SEWER MAIN WILL BE EXTENDED OFFSITE TO NEW PUMP STATION LOCATION ON NE GOODWIN RD.
3) SANITARY SEWER EASEMENTS WILL BE DEDICATED TO CITY OF CAMAS AS REQUIRED.

WATER:

1) WATER SERVICE WILL BE PROVIDED BY CITY OF CAMAS.
2) A NEW 8" DIP WATER MAIN WILL BE LOOPED THROUGH THE SITE TO PROVIDE WATER AND FIRE SERVICE TO THE PROPOSED DEVELOPMENT. CONNECTIONS WILL BE MADE TO THE EXISTING 8" DIP MAINS LOCATED IN NE INGLE RD. AND NE GOODWIN RD.
3) FIRE HYDRANTS WILL BE LOCATED AS SHOWN, OR AS DIRECTED BY THE FIRE MARSHAL.
4) WATER EASEMENTS WILL BE DEDICATED TO CITY OF CAMAS AS REQUIRED.

EROSION CONTROL:

1) EROSION CONTROL BMP'S WILL BE DESIGNED DURING FINAL DESIGN PER THE CITY OF CAMAS DESIGN STANDARDS MANUAL.

CLIENT:
GREEN MOUNTAIN LAND LLC.
17933 NW EVERGREEN PARKWAY
SUITE #300
BEAVERTON, OR 97006
ATTN: JOHN O'NEIL
PH: (503) 597-7100
EMAIL: johno@metlandgroup.com

PRELIMINARY OFFSITE UTILITY PLAN FOR:
GREEN MOUNTAIN MIXED USE PRD PHASE 1

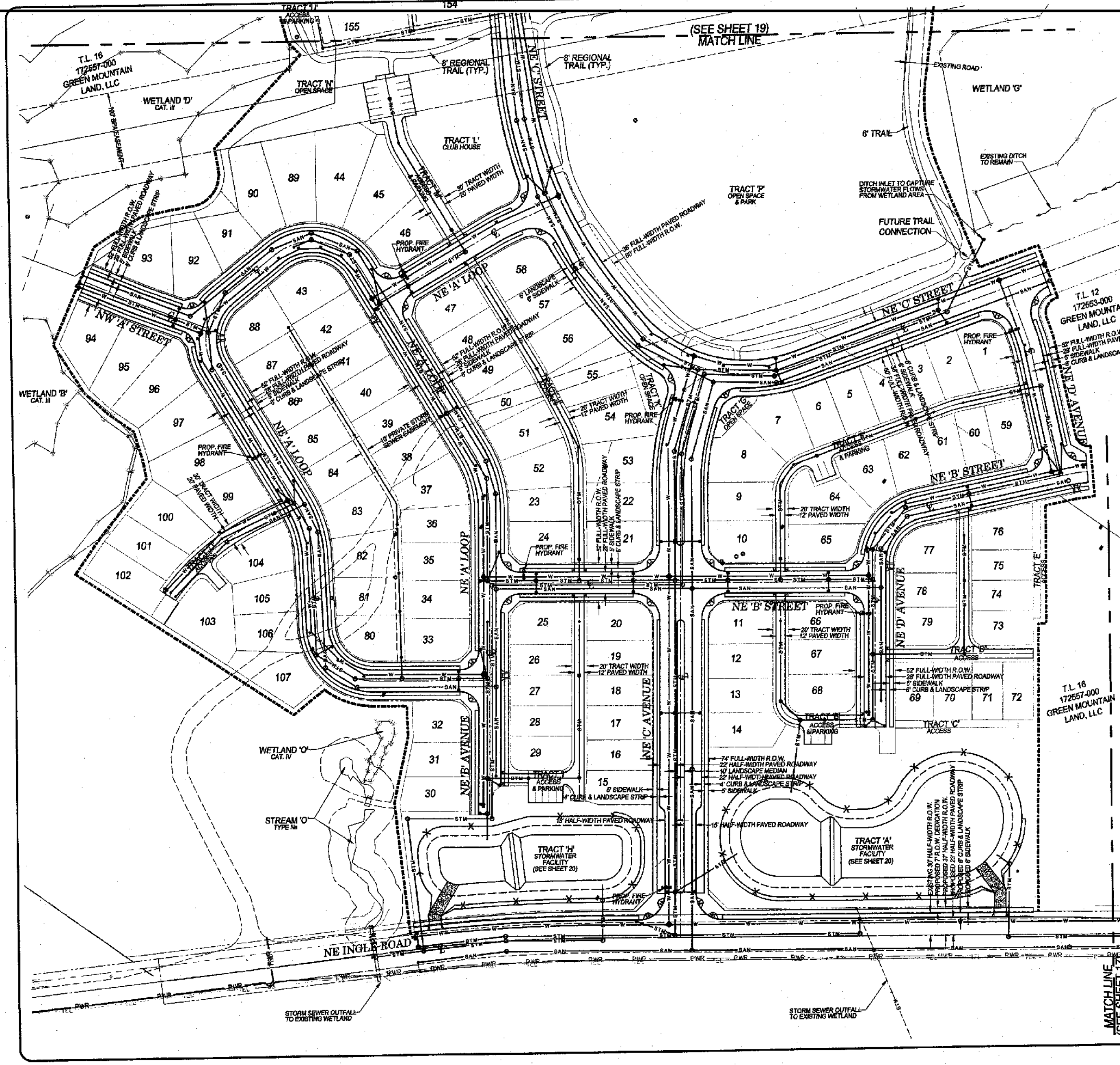
OLSON ENGINEERING INC. LAND SURVEYORS ENGINEERS 222 E. EVERGREEN BLVD., VANCOUVER, WA 98660

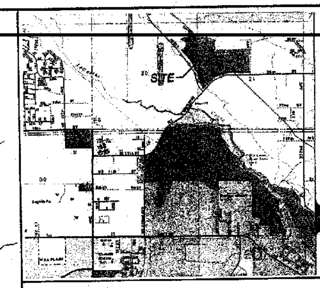
PETER A. TUCK — PROFESSIONAL ENGINEER
12/30/14

CHANGES / REVISIONS	
DESCRIPTION:	DATE:

DESIGNED: RWP
DRAWN: RWP
CHECKED: PAT
DATE: DECEMBER 2014
SCALE: H: 1" = 60' V: N/A

GREEN MOUNTAIN PHASE 1
JOB NO. 8938.01.02





VICINITY MAP
NTS

LEGEND

- PERIMETER OF SITE
- RIGHT-OF-WAY LINE
- CENTERLINE OF ROAD
- FACE OF CURB
- LOT LINE
- POD BOUNDARY
- EASEMENT LINE
- STM — STORM SEWER LINE
- STM — EXIST STORM SEWER
- SAN — SANITARY SEWER LINE
- SAN — EXIST SANITARY SEWER
- W — WATER SERVICE LINE
- W — EXIST WATER LINE
- MANHOLE
- CLEAN OUT
- CATCH BASIN
- FIRE HYDRANT ASSEMBLY
- THRUST BLOCK
- WATER SERVICE ASSEMBLY
- BACKFLOW ASSEMBLY
- WATER VALVE AND BOX
- BLOW-OFF ASSEMBLY

PRELIMINARY UTILITY NOTES

STORM SEWER:

1) STORMWATER QUALITY AND QUANTITY CONTROL TO BE ACHIEVED USING WETPONDS WITH DETENTION ABOVE THE WETPOOL. STORMWATER FROM THE DEVELOPMENT TO BE DISCHARGED VIA OUTFALLS TO THE EXISTING WETLANDS/STREAM WEST OF NE INGLE ROAD.
2) WETPONDS HAVE BEEN SIZED TO MEET THE PHOSPHORUS CONTROL REQUIREMENTS FOR THE LACAMAS WATER SHED, AS SPECIFIED BY THE CITY OF CAMAS AND THE WASHINGTON STATE DEPARTMENT OF ECOLOGY.
3) THE PROPOSED STORMWATER FACILITIES WILL BE PRIVATELY OWNED AND MAINTAINED, WITH ACCESS AND INSPECTION EASEMENTS TO BE DEDICATED TO THE CITY OF CAMAS AS REQUIRED.

SANITARY:

1) SANITARY SEWER SERVICE WILL BE PROVIDED BY CITY OF CAMAS.
2) SANITARY SEWER WILL BE A GRAVITY SEWER. NEW SEWER MAIN WILL BE EXTENDED OFFSITE TO NEW PUMP STATION LOCATION ON NE GOODWIN RD. (REFER TO SHEET 17)
3) SANITARY SEWER EASEMENTS WILL BE DEDICATED TO CITY OF CAMAS AS REQUIRED.

WATER:

1) WATER SERVICE WILL BE PROVIDED BY CITY OF CAMAS.
2) A NEW 8" DIP WATER MAIN WILL BE LOOPED THROUGH THE SITE TO PROVIDE WATER AND FIRE SERVICE TO THE PROPOSED DEVELOPMENT. CONNECTIONS WILL BE MADE TO THE EXISTING 8" DIP MAINS LOCATED IN NE INGLE RD. AND NE GOODWIN RD.
3) FIRE HYDRANTS WILL BE LOCATED AS SHOWN, OR AS DIRECTED BY THE FIRE MARSHAL.
4) WATER EASEMENTS WILL BE DEDICATED TO CITY OF CAMAS AS REQUIRED.

EROSION CONTROL:

1) EROSION CONTROL BMP'S WILL BE DESIGNED DURING FINAL DESIGN PER THE CITY OF CAMAS DESIGN STANDARDS MANUAL.

SCALE: 1"=60'
-60 0 60 120

CLIENT:
GREEN MOUNTAIN LAND LLC
17933 NW EVERGREEN PARKWAY
SUITE #300
BEAVERTON, OR 97006
ATTN: JOHN O'NEIL
PH: (503) 597-7100
EMAIL: johno@metlandgroup.com

PRELIMINARY UTILITY PLAN (SOUTH) FOR:
GREEN MOUNTAIN MIXED USE PRD PHASE 1

OLSON ENGINEERING INC. LAND SURVEYORS ENGINEERS
222 E. EVERGREEN BLVD., VANCOUVER, WA 98660
360-695-1385
503-289-9936

12/30/14

CHANGES / REVISIONS	
DESCRIPTION:	DATE:

DESIGNED: RWP
DRAWN: RWP
CHECKED: PAT
DATE: DECEMBER 2014
SCALE: H: 1" = 60' V: N/A

GREEN MOUNTAIN PHASE 1
JOB NO. 6938.01.02

SHEET
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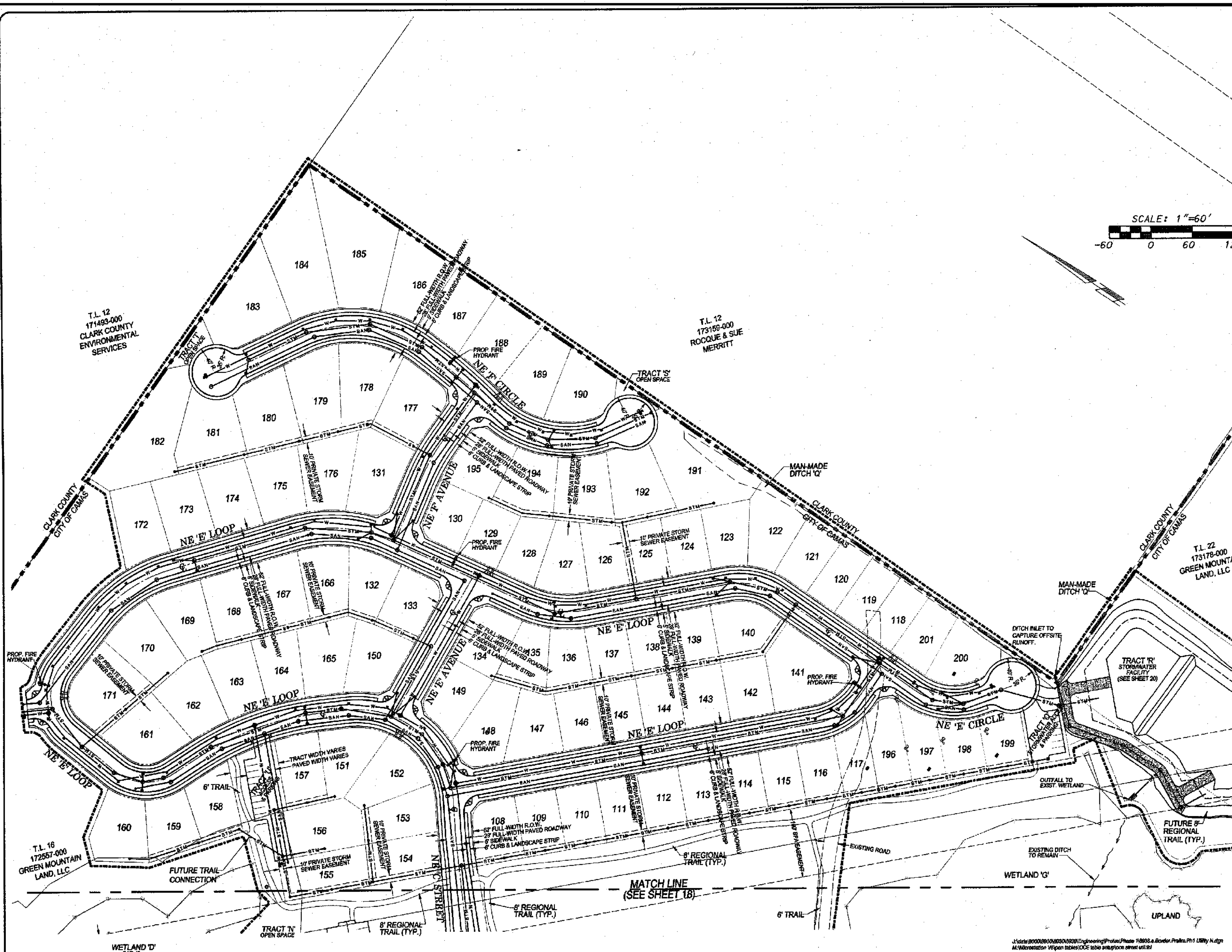


CLIENT:
GREEN MOUNTAIN LAND LLC
17933 NW EVERGREEN PARKWAY
SUITE #300
BEAVERTON, OR 97006

ATTN: JOHN O'NEIL
PH: (503) 597-7100
EMAIL: johno@metlandgroup.com

PRELIMINARY UTILITY PLAN (NORTH) FOR:

GREEN MOUNTAIN MIXED USE PRD
PHASE 1

OLSON ENGINEERING INC. LAND SURVEYORS ENGINEERS 360-695-1385 503-289-9936 222 E. EVERGREEN BLVD., VANCOUVER, WA 98660

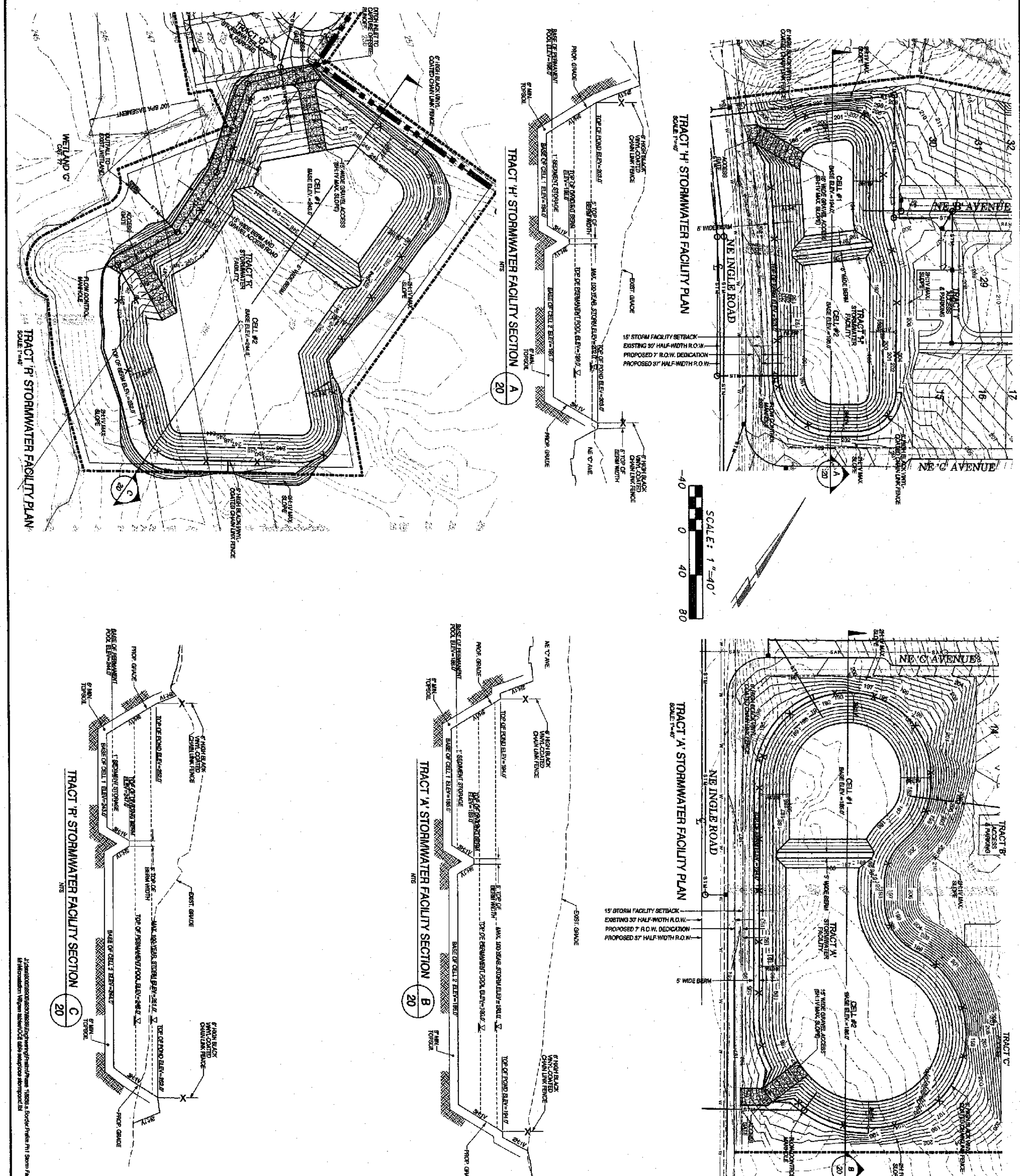
PETER A. TUCK STATE OF WASHINGTON REGISTERED PROFESSIONAL ENGINEER
12|30|14

CHANGES / REVISIONS	
DESCRIPTION:	DATE:

DESIGNED: RWP
DRAWN: RWP
CHECKED: PAT
DATE: DECEMBER 2014
SCALE: H: 1" = 60' V: N/A

GREEN MOUNTAIN PHASE 1
JOB NO. 8938.01.02

SHEET



PRELIMINARY STORM FACILITY PLAN AND SECTIONS FOR:

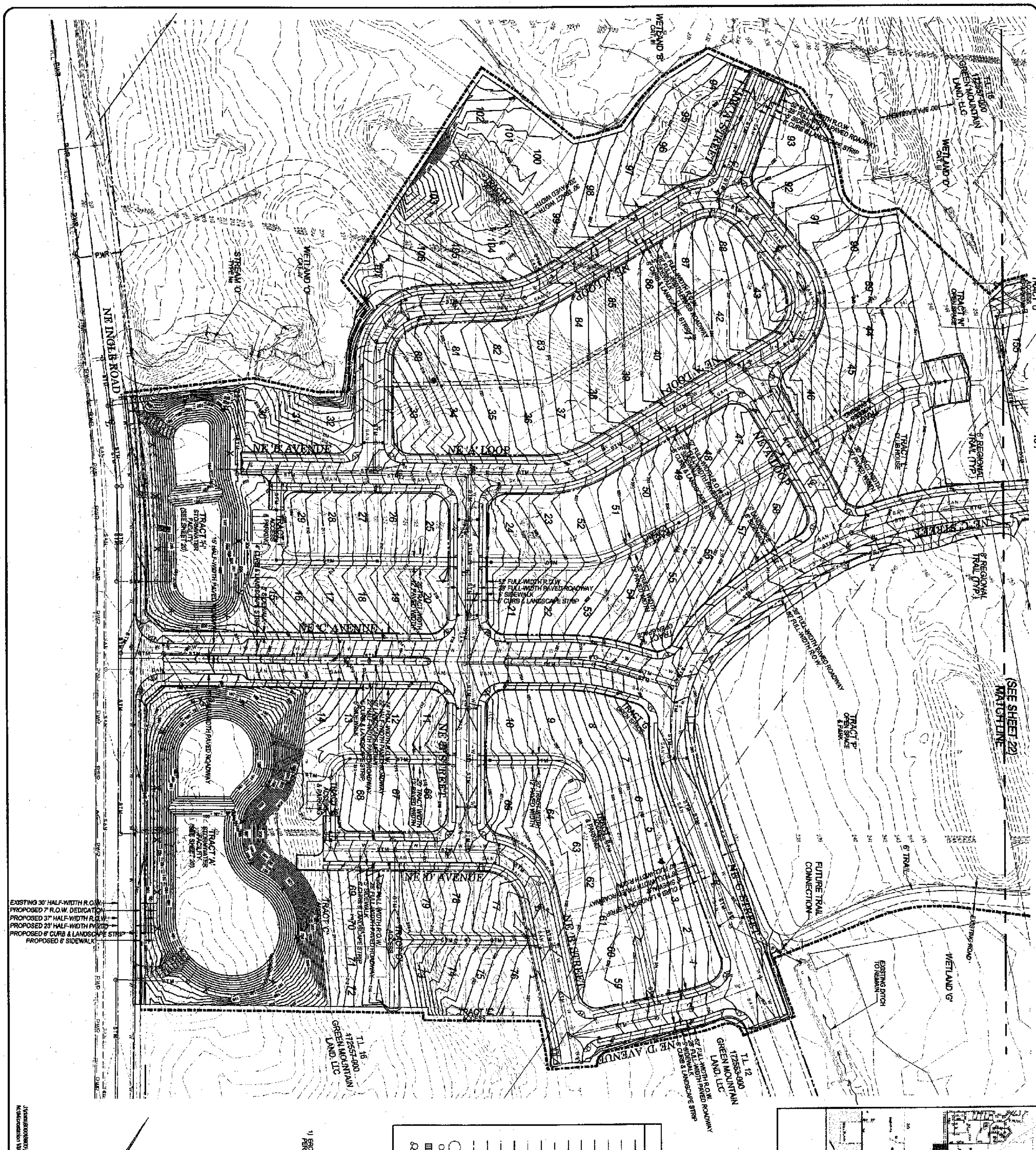
GREEN MOUNTAIN MIXED USE PRD
PHASE 1

OLSON ENGINEERING INC. LAND SURVEYORS ENGINEERS 222 E. EVERGREEN BLVD., VANCOUVER, WA 98660

CLIENT: GREEN MOUNTAIN LAND LLC

12/30/14

SHEET 20 of 25



PRELIMINARY GRADING PLAN (SOUTH) FOR:

GREEN MOUNTAIN MIXED USE PRD
PHASE 1

OLSON LAND SURVEYORS · ENGINEERS
ENGINEERING INC. 222 E. EVERGREEN BLVD., VANCOUVER, WA 98660

12/30/14

SHEET
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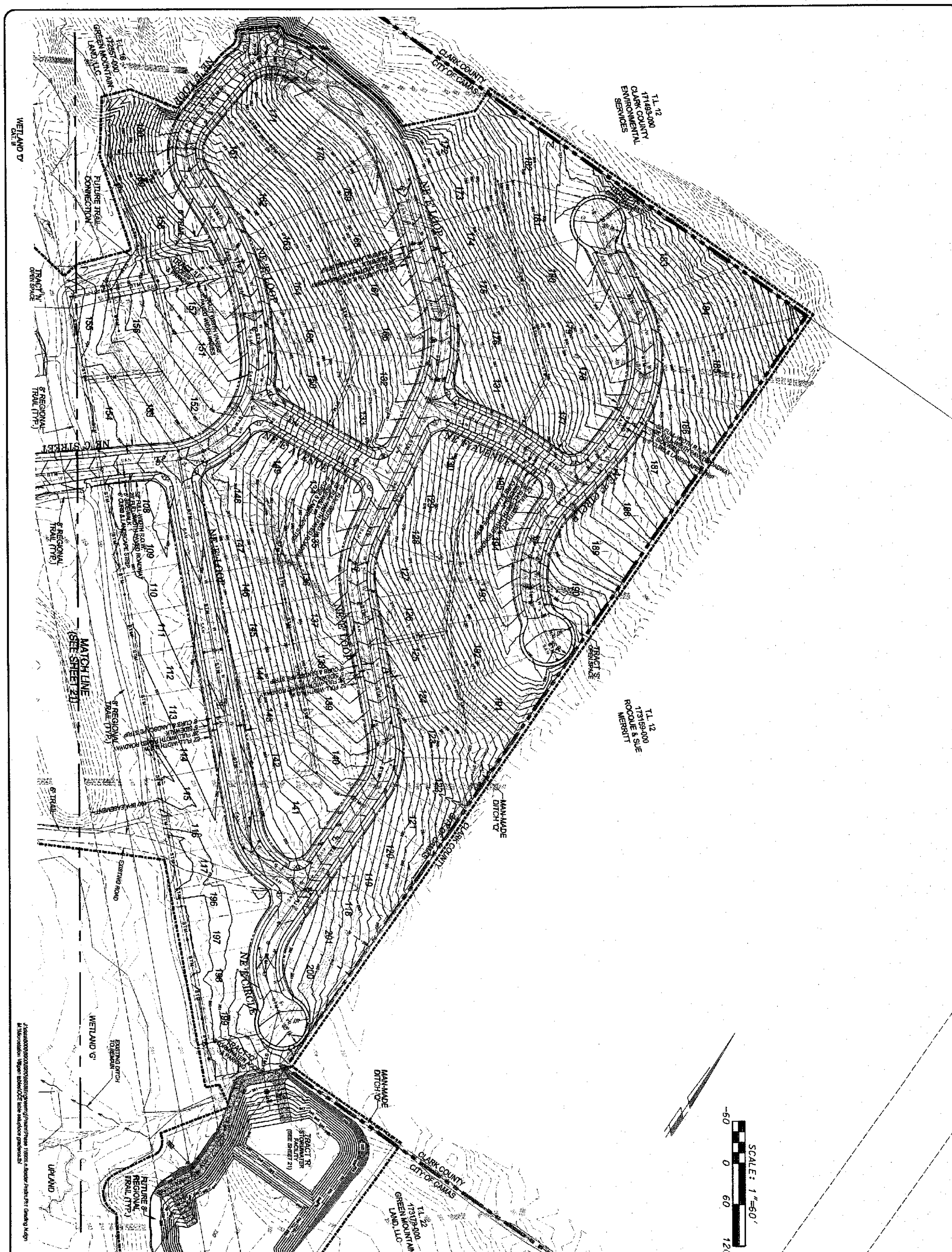

PRELIMINARY GRADING PLAN (NORTH) FOR:

GREEN MOUNTAIN MIXED USE PRD
PHASE 1

OLSON ENGINEERING INC. LAND SURVEYORS ENGINEERS
222 E. EVERGREEN BLVD., VANCOUVER, WA 98660

CLIENT:
GREEN MOUNTAIN LAND LLC.
BEAVERTON, OR 97005

12/30/14

CHANGES / REVISIONS	
DESCRIPTION:	DATE:

DESIGNED: RWP
DRAWN: RWP
CHECKED: PAT
DATE: DECEMBER 2014
SCALE: H: 1" = 60'
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GREEN MOUNTAIN PHASE 1

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