PRELIMINARY PLAT OF OAK SPRINGS

Drainage and Erosion Control Report/Construction SWPPP

Prepared for:

Conwell Investments, LLC
2415 Carpenter Road SE
Lacey, WA 98503

(360) 438-0525

October 14, 2013

Prepared by: Roland Blake Wilkerson, PE

Reviewed by: Steven D. Hatton, PE
HATTON GODAT PANTIER
3910 Martin Way E, Suite B
Olympia, WA 98506
(360) 943-1599

Project No: 13-046
Project Name: PRELIMINARY PLAT OF OAK SPRINGS
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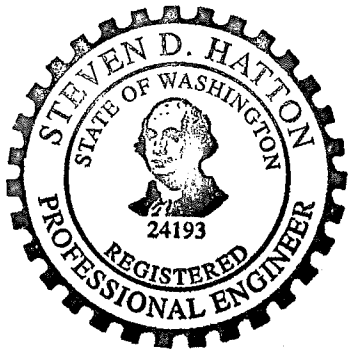
I hereby state that this Preliminary Drainage and Erosion Control Report/Construction SWPPP for PRELIMINARY PLAT OF OAK SPRINGS, Thurston County, Washington, has been prepared by me or under my supervision and meets the requirements of the Thurston County Drainage Design and Erosion Control Manual and the standard of care and expertise which is usual and customary in this community for professional engineers. I understand that Thurston County does not and will not assume liability for the sufficiency, suitability or performance of drainage facilities prepared by me.

Signature

10/17/13
Date



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I. THURSTON REGIONAL FACILITY SUMMARY FORM

Complete one for each facility (e.g., detention/retention, coalescing plate filter) on the project site. Attach 8 ½" by 11" sketch showing location of facility.

Proponent's facility name or identifier (e.g., Pond A): **Basin 1 Pond**

Name of road or street to access facility: **"C" Road**

Hearings Examiner case number: _____

Development Review Project No./Bldg. Permit No.: _____

Parcel Number(s): **11825240000**

To Be Completed By Utility Staff:

Utility facility number ..... _____

Parcel number status, (num, 1ch) ..... _____
0-Known; 1-Public; 2-Unknown; 3-Unassigned

Basin and sub-basin, (num, 6ch) ..... _____
2ch-Basin; 2ch-Sub-basin; 2ch-Future

Responsible jurisdiction, (alpha, 1ch) ..... _____
O-Olympia; C-County; T-Tumwater; L-Lacey

Part 1 – Project Name and Proponent

Project name: **PRELIMINARY PLAT OF OAK SPRINGS**

Project owner: **Conwell Investments, LLC**

Project contact: **Mark Conwell**

Address: **2415 Carpenter Road SE, Lacey, WA 98503**

Phone: **(360) 438-0525**

Project proponent (if different): _____

Address: _____

Phone: _____

Project engineer: **Steven D. Hatton, PE**
Firm: **HATTON GODAT PANTIER**
Phone number: **(360) 943-1599**

Part 2 – Project Location

Section	**25**
Township	**18N**
Range	**1W**

Names and addresses of adjacent property owners:

Evergreen Heights, LLC	1868 State Ave NE, Olympia, WA 98506
Walton, Kenneth E	3148 Marvin Road SE, Olympia, WA 98503
Oak Tree Preserve, LLC	15 Lake Bellevue DR #102, Bellevue, WA 98005

Part 3 – Type of Permit Application

Type of permit (e.g., commercial building): **Residential Plat**

Other permits (☒):

- ☐ DOF /W HPA
- ☐ COE Wetlands
- ☐ FEMA
- ☐ Shoreline Management
- ☒ Encroachment
- ☒ Other Utilities
- ☐ COE 404
- ☐ DOE Dam Safety
- ☐ Floodplain
- ☒ Rockery/Retaining Wall
- ☒ Grading

Other agencies (e.g., federal, state, local) that have reviewed or will review this Drainage and Erosion Control Plan: **NONE**

Part 4 – Proposed Project Description

What stream basin is the project in (e.g., Percival, Woodland)? **Woodland**

Zoning: ..... **LDR 3-6**

Onsite

Residential Subdivision:

Number of lots	**85**
Average lot size (acres)	**0.14**

Building Permit/Commercial Plat:

Building(s) (footprint, acres)	
Asphalt+ Concrete paving (acres)	
Gravel surface (acres)	
Pervious paving (acres)	
Public roads-including gravel shoulder (acres)	**2.88**
Private roads-including gravel shoulder (acres)	**0**
Onsite impervious surface total (acres)	**9.18**

Part 5 – Pre-Developed Project Site Characteristics

Stream through site (Y/N) **N**

Name ____

DNR Type ____

Type of feature this facility discharges to (e.g., lake, stream, intermittent stream, pothole, roadside ditch, sheet flow to adjacent property):

No Discharge

Swales (Y/N)	**N**
Steep slopes—steeper than 10% (Y/N)	**Y**
Erosion hazard (Y/N)	**Y**
100-year floodplain (Y/N)	**N**
Wetlands (Y/N)	**N**
Seeps/springs (Y/N)	**N**
High groundwater table (Y/N)	**N**
Other	

Part 6 – Facility Description

Total area tributary to facility including offsite (acres)	17.80
Total onsite area tributary to facility (acres)	17.80
Design impervious area tributary to facility (acres)	9.18
Design landscaped area tributary to facility (acres)	8.62
Design total tributary area to facility (acres)	17.80

Enter "1" for type of facility

Wet pond detention	
Wet pond water surface area (acres)	
Dry pond detention	
Underground Retention	
Infiltration pond	1
Drywell infiltration	
Coalescing plate separator	
Centrifuge separator	
Other .....Infiltration Treatment	1

Outlet type (enter "1" for each type present)

Filter	
Oil/water separator	
Single orifice	
Multiple orifices	
Weir	
Spillway	1
Pump(s)	
Other	

Part 7 – Release to Groundwater

Design percolation rate to groundwater (if applicable) **2.1 inches per hour**

Part 8 – Release to Surface Water (if applicable)

Jurisdiction MSL Elevation (Ft)	Percent Design Full	Volume (Cf)	Discharge To Surface Water (Cfs)
	0	0.00	0.00
	25		
	50		
	100		

THURSTON REGIONAL FACILITY SUMMARY FORM

Complete one for each facility (e.g., detention/retention, coalescing plate filter) on the project site. Attach 8 ½" by 11" sketch showing location of facility.

Proponent's facility name or identifier (e.g., Pond A): **Basin 2 Pond**

Name of road or street to access facility: **"C" Road**

Hearings Examiner case number: _____

Development Review Project No./Bldg. Permit No.: _____

Parcel Number(s): **11825240000**

To Be Completed By Utility Staff:

Utility facility number ..... _____

Parcel number status, (num, 1ch) ..... _____
0-Known; 1-Public; 2-Unknown; 3-Unassigned

Basin and sub-basin, (num, 6ch) ..... _____
2ch-Basin; 2ch-Sub-basin; 2ch-Future

Responsible jurisdiction, (alpha, 1ch) ..... _____
O-Olympia; C-County; T-Tumwater; L-Lacey

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Address: _____

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Range	**1W**

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Other permits (☒):

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- ☐ COE Wetlands
- ☐ FEMA
- ☐ Shoreline Management
- ☒ Encroachment
- ☒ Other Utilities
- ☐ COE 404
- ☐ DOE Dam Safety
- ☐ Floodplain
- ☒ Rockery/Retaining Wall
- ☒ Grading

Other agencies (e.g., federal, state, local) that have reviewed or will review this Drainage and Erosion Control Plan: **NONE**

Part 4 – Proposed Project Description

What stream basin is the project in (e.g., Percival, Woodland)? **Woodland**

Zoning: ..... **LDR 3-6**

Onsite

Residential Subdivision:

Number of lots	**4**
Average lot size (acres)	**0.14**

Building Permit/Commercial Plat:

Building(s) (footprint, acres)	
Asphalt+ Concrete paving (acres)	
Gravel surface (acres)	
Pervious paving (acres)	
Public roads-including gravel shoulder (acres)	**0.27**
Private roads-including gravel shoulder (acres)	**0**
Onsite impervious surface total (acres)	**1.37**

Part 5 – Pre-Developed Project Site Characteristics

Stream through site (Y/N) **N**

Name ____

DNR Type ____

Type of feature this facility discharges to (e.g., lake, stream, intermittent stream, pothole, roadside ditch, sheet flow to adjacent property):

No Discharge

Swales (Y/N)	**N**
Steep slopes—steeper than 10% (Y/N)	**Y**
Erosion hazard (Y/N)	**Y**
100-year floodplain (Y/N)	**N**
Wetlands (Y/N)	**N**
Seeps/springs (Y/N)	**N**
High groundwater table (Y/N)	**N**
Other	

Part 6 – Facility Description

Total area tributary to facility including offsite (acres)	2.21
Total onsite area tributary to facility (acres)	2.21
Design impervious area tributary to facility (acres)	1.37
Design landscaped area tributary to facility (acres)	0.84
Design total tributary area to facility (acres)	2.21

Enter "1" for type of facility

Wet pond detention	1
Wet pond water surface area (acres)	0.12
Dry pond detention	
Underground Retention	
Infiltration pond	1
Drywell infiltration	
Coalescing plate separator	
Centrifuge separator	
Other	

Outlet type (enter "1" for each type present)

Filter	
Oil/water separator	
Single orifice	
Multiple orifices	
Weir	
Spillway	1
Pump(s)	
Other	

Part 7 – Release to Groundwater

Design percolation rate to groundwater (if applicable) **6.5 inches per hour**

Part 8 – Release to Surface Water (if applicable)

Jurisdiction MSL Elevation (Ft)	Percent Design Full	Volume (Cf)	Discharge To Surface Water (Cfs)
	0	0.00	0.00
	25		
	50		
	100		

BOND QUANTITIES WORKSHEET

Satisfactory performance is required to be demonstrated by the stormwater handling facilities described in this Drainage and Erosion Control Report/Construction SWPPP and detailed in the Construction Plans and Specifications for this project. The probable construction cost to install these stormwater improvements, will be calculated during final construction design.

Bond Quantities Worksheet

II. DRAINAGE REPORT

Section 1 Project Description

This project proposes to sub-divide 20.02 acres into 89 single family lots. This project site is located in the Lacey Urban Growth Area of Thurston County, south of 28th Way SE off of Marvin Road SE. (See Vicinity Map in Appendix B.) This project is located on existing Tax Parcel Number 11825240000 in the northeast quarter of Section 25, Township 18 North, Range 1 West, Willamette Meridian, Olympia, Washington.

The project will construct 3 internal public roadways to serve the lots. Road improvements include 28-foot and 32-foot wide paved surfaces, crowned 2% each direction, with concrete curb and gutter, 6-foot planters, 5-foot sidewalks, street trees, and street lighting. Internal roadways within the plat will be constructed to City of Lacey standards.

Stormwater runoff from the project will be collected by catch basins and conveyed through piping to stormwater facilities located in Tract A. One of these facilities, "Basin 1 Pond", serving a majority of the plat, will be a retention pond with an infiltration treatment liner. The other facility, "Basin 2 Pond", will have a stormwater treatment wetland for treatment which overflows into a retention pond for infiltration. The facilities have been sized using the standards established in the 2009 Thurston County Drainage Design and Erosion Control Manual. It is anticipated that all stormwater runoff from roofs will be directed to the stormwater ponds due to the limited infiltration potential found in the upper portion of the site. Individual drywells may be provided in portions of the site as suitable soils will allow.

The lots will be served by City of Lacey sewer and water.

Section 2 Existing Conditions

Terrain at the site generally slopes down from north to south and west to east with an elevation difference of approximately 90 feet. The upper portion of the site is gently rolling to an area in the middle of the site that contains steeper slopes at approximately 30%. The lower portion of the site to the southeast contains more gradual slopes near the proposed stormwater ponds. There is no off-site contributing area since the properties north and west manage their own stormwater runoff, and the properties to the south and east are downgradient.

The vegetation onsite includes Scots broom, brush and shrubs, second-growth forest and oaks as identified on the site plan. There is an existing house, mobile home, garage, and barn located on the southwest corner of the site. The private well and septic systems will be decommissioned and abandoned per Thurston County and Washington State Department of Ecology standards.

Adjacent parcels to the north and west are currently developed as single family residential lots (Evergreen Heights Division 1 and 2). The parcel to the southwest is a single family home and the parcels south and east are currently undeveloped.

Portions of the site are located within the Well Head Protection Area for the City of Lacey's Well S27 and a Washington Water Service Co Well located at the intersection of Meridian Road and Yorkshire Drive. Enhanced water quality treatment and compost amended soils (with no biosolids or animal manure components) will be required for the site.

This project is located within the Woodland-Woodard Creek Drainage Basin which has an adopted drainage plan. No "problem areas" are identified downstream of this site in the adopted basin plan, but development of the site will comply with the recommendations of the basin plan including sizing conveyance to carry the 10 year storm at a minimum, ensuring emergency vehicle access to all residences during a 100-year storm, installing treatment facilities, complying with the critical areas ordinance and having no increase in the peak runoff discharges from the site.

The project is located within the "Woodland 4" watershed. Long Lake is also located within this watershed and phosphorous treatment will be required.

Section 3 Soils Report

The soil survey of Thurston County by the US Soil Conservation Service maps Alderwood gravelly sandy loam, of the Hydraulic Group C, on the northern two-thirds of the site, and Spanaway gravelly sandy loam, of the Hydraulic Group B, on the southern third of the site. The erosion potential for Alderwood and Spanaway soils are considered slight. Insight Geologic, Inc. conducted an evaluation of stormwater infiltration conditions, with three borings and six soil log pits drilled/dug at the site on June 12, 2013 and prepared a report of their findings dated July 30, 2013. The report indicates the soils found onsite are generally consistent with the soil survey mapping.

Insight Geologic utilized the "Detailed Method" (Massman Equations) outlined in Appendix III-A of the 2009 Thurston County Drainage Design and Erosion Control Manual (2009 DDECM) to determine a long-term design stormwater infiltration rate for the proposed stormwater facilities. However, during preliminary design of the stormwater facilities we found it necessary to place the bottom of the Basin 1 facility in a deeper soil stratum than assumed by Insight's calculations. Thurston County's "Drainage Scoping Report Response Letter" dated October 14, 2013 also indicated several adjustments to be made to Insight's tabulations. A Stormwater Maintenance Plan, included in Chapter IV of this document is required to be implemented by the Home Owner's Association ensuring an "average to high degree of maintenance will be performed on the facilities". Therefore the correction factor for siltation and biofouling was chosen to be 0.9.Using the lower soil stratum from Insight's borings and the above mentioned information, we've calculated a long term design infiltration rate for the Basin 1 facility of 3.5-inches per hour. No borings or soil logs were dug within the foot print of the Basin 2 facility, however, using the lower soil stratums from boring 2 we derived a long term design infiltration rate for the Basin 2 facility of 6.8-inches per hour.

Copies of the Soils Report and Thurston County Soil survey can be found in Appendix A.

Section 4 Wells and Septic Systems

Records at Thurston County and the Department of Ecology were searched in order to locate wells and septic systems that may be located within the setback distances from the stormwater pond or ponds. In addition, the Project Engineer, or someone under his direct supervision, has visited the site to verify the presence or absence of wells and septic systems as best can be done visually without trespassing onto other properties. All wells and septic systems found to be located within the setback distances from the stormwater pond or ponds have been shown on the plans.

Section 5 Fuel Tanks

Records at Thurston County and the Department of Ecology were searched in order to locate the presence of above and below ground fuel storage tanks that may be located within the setback distances from the stormwater pond or ponds. In addition, the Project Engineer, or someone under his direct supervision, has visited the site to verify the presence or absence of fuel tanks as best can be done visually without trespassing onto other properties. All fuel tanks found to be located within the setback distances from the stormwater pond or ponds have been shown on the plans.

Section 6 Analysis of 100-Year Flood

The Federal Emergency Management Agency prepares maps for all areas within Thurston County, including the incorporated cities therein. Panel #'s 530188 195 C depict the areas, if any, subjected to flooding in the vicinity of this proposal. By inspection of this map, this proposal appears to be located in Zone C, an area of minimal flooding. This area, therefore, is not located within the 100-year flood plain.

Section 7 Aesthetic Considerations

All above ground stormwater facilities will be hydroseeded upon completion. In addition, the water quality stormwater wetland will be planted with a variety of wetland species both in the permanent pool and along the fringes of the permanent water surface. Additional landscaping shall also be provided throughout the project in conformance with the approved landscaping plan, as applicable, and as otherwise required by the approving authority.

Section 8 Facility Sizing and Downstream Analysis

The following summarizes details regarding site areas:

- ❑ Total Basin Area: 20.02 acres
- ❑ Percent Impervious Area before Construction: 0% (0.00 ac)
- ❑ Percent Impervious Area after Construction: 52.7 % (10.55 ac)
- ❑ Disturbed Area during Construction: 20.02 acres
- ❑ Disturbed Area that is characterized as Impervious (i.e., access roads, staging, parking, pond water surface): 10.55 acres

Drainage Summary

2009 DDECM			
Pre-Developed Basin	**Basin 1**	**Basin 2**	**Total**
Forest (C)	12.70 ac	1.03 ac	13.73 ac
Forest (B)	5.10 ac	1.18 ac	6.28 ac
Total	17.80 ac	2.21 ac	20.02 ac (0% impervious)
100 -Year Flow Rate	3.11 cfs	0.28 cfs	3.39 cfs
Developed Basin			
Roads	1.98 ac	0.21 ac	2.19 ac
Driveways	1.30 ac	0.06 ac	1.36 ac
Sidewalk	0.90 ac	0.06 ac	0.96 ac
Roofs	3.90 ac	0.18 ac	4.08 ac
Pond	1.11 ac	0.86 ac	1.97 ac
Forest (C)	0.73 ac	0.00 ac	0.73 ac
Pasture (C)	0.52 ac	0.00 ac	0.52 ac
Pasture (B)	0.21 ac	0.00 ac	0.21 ac
Lawn (C)	5.08 ac	0.84 ac	5.92 ac
Lawn (B)	2.07 ac	0.00 ac	2.07 ac
Total	17.80 ac	2.21 ac	20.01 ac (52.7% impervious)
100 -Year Developed Flow	0.00 cfs (= 3.39 cfs net reduction in discharge vs. Pre-Developed)		

This project proposes to develop the site using standard development methods as specified by the 2009 Thurston County Drainage and Erosion Control Manual. Roadways, driveways and sidewalks are considered pollution-generating impervious surface (PGIS). Grease, oils and heavy metals from vehicles and sediment collect on roadways and driveways, and sediments collect on

sidewalks. Residential roofs are considered non-pollution generating impervious surfaces (NPGIS), but require treatment if runoff from the NPGIS combines with the PGIS runoff.

Table 3.1 Discharge/Area Summary

(All areas measured in acres)	Basin 1	Basin 2	Total
Total Non-Pollution Generating Impervious Surface (NPGIS)	5.01	1.04	6.05
Total Pollution Generating Impervious Surface (PGIS)	4.18	0.33	4.51
Total Pollution Generating Pervious Surface (PGPS)	0.00	0.00	0.00
Native Vegetation Converted to Lawn/Landscape	7.15	0.84	7.99
Native Vegetation Not Converted	1.46	0.00	1.46
Total Effective Impervious Surface (Impervious Draining to Facilities)	**9.19**	**1.37**	**10.56**
Increase (Decrease) in 100-year Storm Peak (cfs)	**(3.11)**	**(0.28)**	**(3.39)**
Discharge Point	No Discharge	No Discharge	No Discharge

The 2009 Thurston County Drainage and Erosion Control Manual summarize the requirements for providing treatment and flow control in decision charts. Based on these charts and the proposed conditions of the site, treatment and flow control are required for the site.

The project adds more than 10,000 square feet of impervious areas. All twelve minimum requirements for stormwater management within Thurston County apply.

The minimum requirements are:

1. Stormwater Site Planning
2. Construction Stormwater Pollution Prevention
3. Source Control of Pollution
4. Preservation of Natural Drainage Systems and Outfalls
5. Onsite Stormwater Management
6. Runoff Treatment
7. Flow Control
8. Wetlands Protection
9. Basin/Watershed Planning
10. Operation and Maintenance
11. Financial liability
12. Offsite Analysis and mitigation

Addressing these twelve requirements, it is anticipated that the proposed project will have little or no adverse effects on the downstream and surrounding hydrology. Each of the minimum requirements is discussed below.

Minimum Requirement #1: Stormwater Site Planning

The main components of Stormwater Site Planning are Construction Stormwater Pollution Prevention Planning and Permanent Stormwater Control Planning. This Drainage and Erosion Control Report/Construction SWPPP and the civil drawings and specifications are submitted as part of this project to meet this requirement.

Minimum Requirement #2: Construction Stormwater Pollution Prevention

A Construction Stormwater Pollution Prevention Plan (C-SWPPP) which addresses all twelve elements as required by the Department of Ecology will be developed for the site during final design. Section III of this Preliminary Drainage and Erosion Control Report provides an overview of the twelve elements required by the Department of Ecology.

Minimum Requirement #3: Source Control of Pollution

Permanent source control BMPs are used to prevent stormwater from coming in contact with pollutants and are used as a cost effective means of reducing pollutants in stormwater. The selection of permanent source control BMPs is based on the activities likely to occur on the site and the pollutants associated with those activities.

Based on a check of Volume IV, Chapter 6 of the 2009 Thurston County Drainage and Erosion Control Manual, the applicable activities with Source Control BMP's on this site are Automobile Washing, Automobile Maintenance, Storage of Solid Wastes and Food Wastes, Composting, Yard Maintenance and Gardening, Swimming Pool and Spa Cleaning and Maintenance, Household Hazardous Material Use, Storage and Disposal, Pet Waste Management and Maintenance of Stormwater Drainage and Treatment Facilities.

There are two types of source control BMPs: operational and structural. Operational source control BMPs are non-structural practices that prevent or reduce pollutants from entering stormwater. Structural source control BMP's are physical, structural or mechanical devices or facilities intended to prevent pollutants from entering stormwater. Section 1.6.1, Volume IV – Source Control of the Thurston County Drainage Design and Erosion Control Manual lists examples of these two types of source control BMP's.

EXAMPLES OF OPERATION SOURCE CONTROL BMPS

A. Form a Pollution Prevention Team that will be responsible for inspecting the stormwater systems and potential pollution sources, operation and maintenance of stormwater systems and enforcement of preventing pollution discharges into the stormwater systems. The team will also be the emergency response team.

B. Good housekeeping includes containing and cleaning up spills on any exposed soils, vegetation or paved areas; sweeping paved surfaces; cleaning pollutants and debris from all BMPs regularly; and making repairs to containment systems, leaks and other sources that could pollute the drainage system.

C. Preventative Maintenance

1. Provide recycling or post signs to recycle materials such as oils, solvents and wood waste to the maximum extent practicable.
2. Prevent the discharge of unpermitted liquids and solids into the storm drainage system.
3. Use drip pans to collect leaks and spills from vehicles and equipment.
4. Store liquids in steel or plastic containers that are rigid, durable, corrosion resistant, non-absorbent, water tight, rodent-proof and equipped with a close fitting cover.

D. Spill Prevention and Cleanup

1. Stencil warning signs at stormwater catch basins and drains – "Dump no waste".
2. Immediately stop, contain and clean up all spills.
3. Contact appropriate local agency (Fire Department, City of Olympia Public Works, Health Department or Department of Ecology) for assistance and guidance.
4. Keep spill containment and clean up kits readily accessible.

E. Employee training shall include identification of pollutant sources, understanding pollutant control measures, spill response procedures and acceptable material handling practices.

F. Inspections

1. Inspections should occur a minimum of twice a year, once during October 1 through April 30 and once during May 1 through September 30. Verify that BMPs are being implemented adequately and make note of any observations of floating materials, suspended solids, oil and grease, discoloration, turbidity or odor in stormwater discharges. Check pH as needed.
2. Determine whether there are unpermitted non-stormwater discharges to the drainage system and eliminate discharges.

Retain the following reports for at least three years:

i. Visual inspection reports.

ii. Reports on spills of oil or hazardous substances greater than Reportable Quantities that cause a violation of the State of Washington's Water Quality Standards. Contact Department of Ecology and ask for an oil spill operations or a hazardous waste specialist to determine if a spill is a substance of a Reportable Quantity. Southwest Region Dept. of Ecology: (360) 407-6300 or call 911.

EXAMPLES OF STRUCTURAL SOURCE CONTROL BMPS

A. Enclosing and/or covering pollutant sources, i.e., within a building or other enclosure, a roof over storage and working areas, a temporary tarpaulin, etc.

B. Physically segregating the pollutant source to prevent contact with uncontaminated stormwater that runs on the site from surrounding areas.

The owner will receive a copy of the Pollution Source Control Program as found in the Stormwater Maintenance Plan in Chapter IV below. The Source Control Program describes Best Management Practices (BMPs) for residential properties.

BMPs from Volume IV, Chapter 4, of the 2009 Thurston County Drainage and Erosion Control Manual for applicable activities are included in the above reference Pollution Source Control Program. The road ways proposed for this project are not high-use.

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

In the predeveloped condition, runoff from this site drains generally to the south, mixing with off site runoff as it crosses parcels to the south. Eventually, runoff from the project parcel and surrounding areas reaches Long Lake.

In the developed condition, runoff will drain to infiltration ponds located along the south eastern boundary. 100% of the developed runoff will be infiltrated onsite where it will recharge the underground aquifer which eventually feeds into Long Lake.

Minimum Requirement #5: Onsite Stormwater Management, Including Easements and Setbacks

This project uses infiltration BMP's to reduce stormwater runoff and recharge ground water aquifers and retain stormwater runoff onsite to the maximum extent possible. Stormwater runoff will be routed to one of two newly constructed infiltration ponds. Compost amended soil used in landscape areas will increase soil porosity and infiltrate a majority of precipitation falling on lawn and landscaped areas. Operation and maintenance requirements for the proposed stormwater management facilities are included in the Stormwater Maintenance Plan in Chapter IV below.

Easements will be provided for roof drain piping. The onsite catch basins and piping will be located within road rights-of-way. Infiltration facilities, access roads and piping within private tracts will be privately owned and maintained.

Facility sizing is provided under Minimum Requirement #6: Runoff Treatment and Minimum Requirement #7: Flow Control.

Minimum Requirement #6: Runoff Treatment

Table 2.1 from Volume 1, Chapter 2 of the Thurston County Drainage Design and Erosion Control Manual summarizes the requirements for treatment control. This project will add more than 5,000 sq ft of pollution generation impervious surface. Treatment is required.

Table 2.1 Treatment Requirements by Threshold Discharge Area

	< ¾ acres of PGPS	≥ ¾ acres of PGPS	< 5,000 ft² of PGIS	≥ 5,000 ft² of PGIS
Treatment Facilities		X		X
Onsite Stormwater BMPs	X	X	X	X

Treatment facilities must be sized to treat the 91st percentile, 24-hour runoff volume (Water Quality Volume (WQV)) as predicted using the most current version of WWHM with Thurston County Enhancements.

Portions of the site are located within the Well Head Protection Area for the City of Lacey's Well S27 and a Washington Water Service Co Well located at the intersection of Meridian Road and Yorkshire Drive. Enhanced water quality treatment and compost amended soils (with no biosolids or animal manure components) will be required for the site.

The project is located within the "Woodland 4" watershed. Long Lake is also located within this watershed and phosphorous treatment will be required.

The site is not a high use site and does not require treatment for oil control. The project is not one of the project types in the metal control menu and does not require treatment for metal.

Per Volume I, Sections 4.4.3 & 4.5.2, infiltration through soils meeting the requirements of Volume III, Section 2.3.1 and Volume V preceded by a presettling basin meets the phosphorous and enhanced treatment requirement. 24-inches of compost amended native soil or imported compost amended sandy loam, meeting the requirements of Volume III, Section 2.3.1 and Volume V, Appendix V-B of the 2009 Thurston County Drainage and Erosion Control Manual, placed in the Basin 1 facility up to the design water level, will be used to meet the enhanced and phosphorous treatment requirements. A presettling basin equal to 33% of the Water Quality Volume generated by WWHM will serve as pretreatment for this facility. An Excel spreadsheet showing presettling basin calculations for the Basin 1 facility is included in Appendix C.

Per Volume I, Sections 4.4.3 & 4.5.2 a large wet pond will satisfy the phosphorous treatment requirement and a stormwater treatment wetland will satisfy the enhanced treatment requirement. The Basin 2 facility will use a large stormwater treatment wetland to provide treatment. An Excel spreadsheet showing Stormwater Treatment Wetland volume calculations for the Basin 2 facility is included in Appendix C.

Appendix D contains WWHM analyses of each basin for the purpose of calculating the water quality treatment storm volume per the 2009 DDECM for Thurston County. Those volumes, as shown in the output files in Appendix D, are 1.57 ac-ft or 68,306 cf for Basin 1 and 0.23 ac-ft or 10,106 cf for Basin 2.

The required presettling basin volume required for Basin 1 is 33% of the WWHM volume or 22,541 cf. The bottom of the presettling basin has an area of 2,975 sf at an elevation of 218. The design water level (DWL) of the presettling basin has an area of 5,490 sf at an elevation of 224. The provided volume of 25,013 cf exceeds the required volume.

A large wet pond is defined as being 1.5 times the water quality treatment volume calculated by WWHM. For Basin 2 this equates to 0.35 ac-ft or 15,159 cf. To calculate the size of a stormwater treatment wetland this volume is divided by an assumed average depth of the pond of 3-feet. The required water surface area for the Basin 2 treatment pond is 5,053 sf. The design provides 5,104 sf exceeding the requirement. The stormwater treatment wetland is further broken down into two cells. The first cell is approximately 33% of the required volume or 4,548 cf. The bottom area of the first cell for Basin 2 is 585 sf at an elevation 210. The design water level (DWL) area of the first cell for Basin 2 is 1,816 sf at an elevation of 214. The provided volume of 4,577 cf exceeds the required volume. The second cell is split roughly as 20% of the surface area at 2 to 2.5 feet deep, 40% of

the surface area at 1.5 to 2 feet deep and the remaining 40% of the surface area at 1 to 1.5 feet deep.

Minimum Requirement #7: Flow Control

Table 2.2 from Volume 1, Chapter 2 of the Thurston County Drainage Design and Erosion Control Manual summarizes the requirements for treatment control. This project will add more than 10,000 sq ft of pollution generation impervious surface. Flow control is required.

Table 2.2 Flow Control Requirements by Threshold Discharge Area

	Flow Control Facilities	Onsite Stormwater Management BMPs
< ¾ acres conversion to lawn/landscape or < 2.5 acres to pasture.		X
≥ ¾ acres conversion to lawn/landscape or ≥ 2.5 acres to pasture.	X	X
< 10,000 ft^2 of effective impervious area.		X
≥ 10,000 ft^2 of effective impervious area.	X	X
≥ 0.1 cfs increase in the 100-year return frequency flow.	X	X

To meet the flow control requirements of the 2009 DDECM, developed discharge durations from the site shall match predeveloped discharge durations for the range of predeveloped discharge rates from 50% of the 2-year peak flow up to the full 50-year peak flow. Runoff and volume calculations shall be provided by the most current version of WWHM with Thurston County Enhancements. The predeveloped land cover used in the WWHM model shall be a forested condition unless historic information is provided indicating the site was prairie prior to settlement. Post developed land cover has been measured from the electronic drawings for the preliminary civil drawings. The land cover from this analysis has been recorded in an excel. The excel spreadsheet can be found in Appendix C of this document.

Post development stormwater runoff from Basins 1 & 2 will sheet flow over lawns and driveways and from road crowns to roadside curb and gutter, where it will be collected in catch basins and conveyed through piping to stormwater facilities where flow control requirements will be met. Flow control for the project will be met by infiltration. Excel spread sheets were developed to calculate the volume of the ponds provided. The excel spread sheets tabulate the measured area of each contour within the design ponds to calculate the volume of the ponds.

To determine the required WWHM volume for the Basin 1 Pond, the developed areas from Basin 1 were placed into WWHM and runoff from the developed area was connected to a hypothetical pond with a bottom area equivalent to the measured bottom area of the pond from the electronic drawing. The riser height was set so that the volume of the hypothetical pond matched the design volume from the excel spread sheet. The pond will use an amended treatment soil liner to provide treatment along with infiltration, as such a design infiltration rate of 2 in/hour was used for modeling the ponds. Infiltration rates of the native soils below the treatment liner are discussed below. A WWHM model was developed to route predicted runoff from Basin 1 through the hypothetical pond

and determine the amount of runoff infiltrated. The results of the WWHM model indicated that the Basin 1 Pond in Tract A infiltrated 100% of the WWHM predicted runoff.

A similar method was used to determine the required WWHM volume for the Basin 2 Pond using a long term design infiltration rate of 6.5 inches per hour.

Insight Geologic utilized the "Detailed Method" (Massman Equations) outlined in Appendix III-A of the 2009 Thurston County Drainage Design and Erosion Control Manual (2009 DDECM) to determine a long-term design stormwater infiltration rate for the proposed stormwater facilities. However, during preliminary design of the stormwater facilities we found it necessary to place the bottom of the Basin 1 facility in a deeper soil stratum than assumed by Insight's calculations. Thurston County's "Drainage Scoping Report Response Letter" dated October 14, 2013 also indicated several adjustments to be made to Insight's tabulations. A Stormwater Maintenance Plan, included in Chapter IV of this document is required to be implemented by the Home Owner's Association ensuring an "average to high degree of maintenance will be performed on the facilities". Therefore the correction factor for siltation and biofouling was chosen to be 0.9.Using the lower soil stratum from Insight's borings and the above mentioned information, we've calculated a long term design infiltration rate for the Basin 1 facility of 3.5-inches per hour. No borings or soil logs were dug within the foot print of the Basin 2 facility, however, using the lower soil stratums from boring 2 we derived a long term design infiltration rate for the Basin 2 facility of 6.8-inches per hour.

WWHM output files are included in Appendix D.

Minimum Requirement #8: Wetlands Protection

This project does not have wetlands on or near the site and does not discharge in the existing or proposed condition to a wetland.

Minimum Requirement #9: Basin/Watershed Planning

The project is located in the Woodland-Woodard Creek Basin east of Long Lake and Marvin Road. The Woodland-Woodard Creek Drainage Basin Plan does not indicate problem areas directly down stream of this site. However, as stormwater from this site will infiltrate to aquifers which feed Long Lake the stormwater design for the site will comply with the recommendations of the basin plan including sizing conveyance to carry the 10 year storm at a minimum, ensuring emergency vehicle access to all residences during a 100-year storm, installing treatment facilities, complying with the critical areas ordinance and having no increase in the peak runoff discharges from the site.

Installation of the infiltration BMP's proposed by this project will reduce runoff from the site. The proposed stormwater mitigation measures for this project meet the intent of the recommended solution provided in the Woodland-Woodard Creek Drainage Basin Plan.

Minimum Requirement #10: Operation and Maintenance

The Stormwater Maintenance Plan included in Chapter IV of this document includes a maintenance agreement, stormwater facility maintenance guide, a pollution source control program and an estimate of annual stormwater maintenance costs for the facilities. These documents are required to be implemented by the future Home Owner's Association to ensure the private drainage facilities are maintained.

In addition to the Stormwater Maintenance Plan, Thurston County requires verification of performance for infiltration facilities. Requirements are listed in Volume V, Section 3.1.5 of the 2009 Thurston County Drainage and Erosion Control Manual and summarized here.

1. Applicant will use an automated continuous water level monitor over a sufficient number of storms to provide an accurate "long-term" infiltration rate (minimum of 30 days) during which time two or more events exceed 30 percent of the facility volume. If atleast two events do not exceed 30 percent of the facility volume, monitoring will continue through one full wet season (November 1 to March 30).
2. Applicant will submit a facility monitoring and evaluation report, prepared and sealed by a licensed civil engineer, documenting the performance of the facility versus the facility design using the information obtained during the monitoring described above.

Ground water quality monitoring may also be required by Thurston County on a site by site basis to ensure ground water quality is being maintained. If required, at least one monitoring well must be installed geologically upstream and one downstream of the infiltration facility. At a minimum at least one sample will be collected from each well per year and analyzed for pollutants such as metals, nitrogen, phosphorous and dissolved solids.

Volume V, Section 3.1.6 of the Thurston County 2009 Drainage and Erosion Control Manual requires contingency planning for all projects using infiltration facilities. In the event that the verification of performance described above indicates that the infiltration facilities designed for this site aren't working as designed, this contingency plan will need to be instituted and verified as working prior to the release of any financial guarantees.

Alternative approaches for consideration as part of the contingency plan would include:

1. Installing gravel trenches under the treatment liner extending down to better soil stratum found deeper in Boring 3. (Boring 3 indicates a 5-foot layer of well graded gravel with sand the top of which is indicated about 5-feet below the proposed pond bottom.)
2. During final design of the facilities, the option of installing gravel trenches in Basin 2 Pond will also be investigated.

Implementation of these alternatives under a contingency plan would be required only if post construction monitoring indicates the facilities aren't working as designed. The project proponent, design engineer and Thurston County shall be consulted prior to the implementation of these alternatives. An estimate of costs to implement alternatives will be created by the design engineer and approved by Thurston County prior to beginning construction on any alternates, listed here or otherwise chosen. Financial guarantees for the additional costs of implementing contingencies will be provided based on the engineer's estimate of costs to ensure the contingency alternates will operate as designed.

Financial guarantees for the original project and any additional financial guarantees for contingency alternates will not be released until all infiltration facilities are shown, through testing, to work in accordance with the approved design and the requirements in the Thurston County 2009 Drainage Design and Erosion Control Manual.

Minimum Requirement #11: Financial Liability

Financial guarantees will be provided to insure that:

1 The project will operate according to the design approved by the project engineer, and

2 Operation of erosion control facilities will provide protection against siltation of surface water, erosion, and damage to adjacent properties.

Minimum Requirement #12: Offsite Analysis and Mitigation

This project is located within the Woodland Creek Watershed. According to the Woodland-Woodard Creek Drainage Basin Plan, these basins experience periodic flooding and fecal chloroform contamination. The project is located within the wellhead protection areas of two wells. The project is also located within a basin tributary to Long Lake, which is listed as phosphorous impacted.

This project is proposing to use low impact development techniques, infiltration BMP's, and post construction soil enhancements to decrease overall site runoff. The site will also implement treatment techniques to reduce phosphorous and provide enhanced treatment. Based on existing drainage paths from the site and the downstream system, it is expected that the improvements proposed by this project will improve conditions downstream from the site.

Volume V of the Thurston County 2009 Drainage Design and Erosion Control Manual requires the implementation of a safe path for overflow from infiltration facilities. The property down hill of the facilities proposed by this project are currently undeveloped forest and pasture land. In the future as these lands are developed the future developments will need to include measures to bypass potential overflow from the storm facilites.

Section 9 Covenants, Dedications and Easements

All stormwater facilities located on private property shall be owned, operated and maintained by the property owners, their heirs, successors and assigns. The property owners shall enter into an agreement with the governing body, a copy of which agreement is included in Chapter IV of this report. The agreement requires maintenance of the stormwater facilities in accordance with the maintenance plan provided and shall grant easement for access to the governing body to inspect the stormwater facilities. The agreement also makes provisions for the governing body to make repairs, after due notice is given to the owners, if repairs are necessary to ensure proper performance of the stormwater system and if the owners fail to make the necessary repairs. The cost of said repairs shall be borne by the property owners, their heirs, successors and assigns.

Section 10 Property Owners Association Articles of Incorporation

All residential subdivisions shall form a Homeowners' Association (HOA) for the purpose of assigning responsibility and liability for the operation and maintenance of stormwater facilities jointly serving lots within the subdivision. Articles of Incorporation shall be developed for the Association and submitted to the governing body prior to final project approval.

III. CONSTRUCTION STORMWATER POLLUTION PREVENTION PLAN (C-SWPPP)

Projects in which the new, replaced, or new plus replaced impervious surfaces total 2,000 square feet or more, or disturb 7,000 square feet or more of land must prepare a Construction Stormwater Pollution Prevention Plan (C-SWPPP). The C-SWPPP is a separate document and must address each of the twelve elements unless site conditions render the element unnecessary and the exemption from the element is clearly justified in the narrative of the C-SWPPP. A full C-SWPPP will be developed during final design prior to issuance of any permits for the project.

Section 1 Mark Clearing Limits

c. Prior to land disturbing activities, including clearing and grading, all clearing limits, sensitive areas and their buffers and trees that are to be preserved within the construction area shall be clearly marked, both in the field and on the plans, to prevent damage and offsite impacts.

d. Plastic, metal or stake wire fence may be used to mark the clearing limits.

e. The duff layer, native topsoil and natural vegetation shall be retained in an undisturbed state to the maximum extent practicable.

Section 2 Establish Construction Access

f. Construction vehicle access and exit shall be limited to one route, if possible.

g. Access points shall be stabilized with quarry spall or crushed rock to minimize the tracking of sediment onto public roads.

h. Wheel wash or tire baths may be used and should be located onsite.

i. Public roads shall be cleaned thoroughly as needed to protect stormwater infrastructure and downstream water resources. Sediment shall be removed from roads by shoveling or pickup sweeping and shall be transported to a controlled sediment disposal area. Street washing shall be allowed only after sediment is removed in this manner.

j. Street wash wastewater shall be controlled by pumping back onsite, or otherwise be prevented from discharging untreated into systems tributary to state surface waters.

Section 3 Control Flow Rates

k. Properties and waterways downstream from the site shall be protected from erosion due to increases in the volume, velocity and peak flow rate of stormwater runoff from the project site.

l. Downstream analysis is necessary if changes in flows could impair or alter conveyance systems, streambanks, bed sediment or aquatic habitat.

m. Comply with Minimum Requirement #7, stormwater retention/detention facilities shall be constructed as one of the first steps in grading. Detention facilities shall be functional prior to construction of site improvements (e.g. impervious surfaces).

n. The local permitting agency may require pond designs that provide additional or different stormwater flow control if necessary to address local conditions or to protect properties and waterways downstream from erosion due to increases in the volume, velocity and peak flow rate of stormwater runoff from the project site.

o. If permanent infiltration ponds are used for flow control during construction, these facilities shall be protected from siltation during the construction phase and plans made for restoration after construction.

Section 4 Install Sediment Controls

p. Prior to leaving a construction site, or prior to discharge to an infiltration facility, stormwater runoff from disturbed areas shall pass through a sediment pond or other appropriate sediment removal BMP. Runoff from fully stabilized areas may be discharged without a sediment removal BMP, but must meet the flow control performance standard of Element 3.a. Full stabilization means concrete or asphalt paving; quarry spalls used as ditch lining; or the use of rolled erosion products, a bonded fiber matrix product, or vegetation cover in a manner that will fully prevent soil erosion. The local permitting authority should inspect and approve areas stabilized by means other than pavement or quarry spalls.

q. Sediment ponds, vegetated buffer strips, sediment barriers or filters, dikes, and other BMPs intended to trap sediment onsite shall be constructed as one of the first steps in grading. These BMPs shall be functional before other land disturbing activities take place.

r. Earthen structures such as dams, dikes, and diversions shall be seeded and mulched according to the timing indicated in Element #5.

Section 5 Stabilize Soils

s. Soils shall be stabilized as outlined below, where downstream water resources or stormwater infrastructure may be negatively affected by sediments (i.e., runoff discharges off the development site).

t. From October 1 through April 30, no soils shall remain exposed and unworked for more than 2 days. From May 1 through September 30, no soils shall remain exposed and unworked for more than 7 days. From November 1 through February 28 soil disturbing activities shall be prohibited. No soil disturbing activities shall occur within Green Cove, Percival, Woodard, and Ellis Creek watersheds from October 1 through April 30. This condition applies to all onsite soils, whether at final grade or not.

u. Applicable practices include but are not limited to compost addition, temporary and permanent seeding, sodding, mulching, plastic covering, soil application of polyacrylamide (PAM), early application of gravel base on areas to be paved and dust control.

v. Soil stabilization measures selected should be appropriate for the time of year, site conditions, estimated duration of use and potential water quality impacts that stabilization agents may have on downstream waters or groundwater.

w. Soil stockpiles must be stabilized from erosion, protected with sediment-trapping measures, and located away from storm drains, waterways, or drainage channels.

x. Work on linear construction sites and activities, including right-of-way and easement clearing, roadway development, pipelines, and trenching for utilities, shall not exceed the capability of the individual contractor for his portion of the project to install the bedding materials, roadbeds, structures, pipelines, and/or utilities, and to re-stabilize the disturbed soils, in compliance with the applicable 2-day or 7-day criterion listed above.

Section 6 Protect Slopes

y. Cut and fill slopes shall be designed and constructed in a manner that will minimize erosion.

z. Consider soil type and its potential for erosion.

aa. Reduce slope runoff velocities by reducing the continuous length of slope with terracing and diversions, reduce slope steepness, and roughen slope surfaces.

bb. Offsite stormwater run-on shall be diverted away from slopes and disturbed areas with interceptor dikes and swales. Offsite stormwater should be managed separately from stormwater water generated onsite.

cc. To prevent erosion, at the top of the slopes collect drainage in pipe slope drains or protected channels. Temporary pipe slope drains shall handle the peak flow from a 10-year, 24-hour event; permanent slope drains shall be sized for a 25-year, 24-hour event. Check dams shall be used within channels that are cut down a slope.

dd. Provide drainage to remove groundwater intersecting the slope surface of exposed soil areas.

ee. Stabilize soils on slopes, as specified in Element #5.

Section 7 Protect Drain Inlets

ff. As needed to protect stormwater infrastructure and downstream water resources, all storm drain inlets made operable during construction shall be protected so that stormwater runoff shall not enter the conveyance system without first being filtered or treated to remove sediment.

gg. All approach roads shall be kept clean, and all sediment and street wash water shall not be allowed to enter storm drains without prior and adequate treatment, unless treatment is provided before the storm drain discharges to waters of the state.

Section 8 Stabilize Channels and Outlets

hh. All temporary onsite conveyance channels shall be designed, constructed and stabilized to prevent erosion from the peak 10-minute flow velocity from a Type 1A 10-year, 24-hour frequency storm for the developed condition.

ii. Stabilization, including armoring material, adequate to prevent erosion of outlets, adjacent streambanks, slopes and downstream reaches shall be provided at the outlets of all conveyance systems.

Section 9 Control Pollutants

jj. All pollutants, including waste materials and demolition debris, that occur onsite shall be handled and disposed of in a manner that does not cause contamination of stormwater.

kk. Cover, containment and protection from vandalism shall be provided for all chemicals, liquid products, petroleum products and non-inert wastes present on the site (see Chapter 173-304 WAC for the definition of inert waste). Onsite fueling tanks shall include secondary containment.

ll. Maintenance and repair of heavy equipment and vehicles involving oil changes, hydraulic system drain down, solvent and de-greasing cleaning operations, fuel tank drain down and removal, and other activities which may result in discharge or spillage of pollutants to the ground or into stormwater runoff must be conducted using spill prevention measures, such as drip pans. Contaminated surfaces shall be cleaned immediately following any discharge or spill incident. Report all spills to 911. Emergency repairs may be performed onsite using temporary plastic placed beneath, and if raining, over the vehicle.

mm. Wheel wash or tire bath wastewater shall be discharged to a separate onsite treatment system or to the sanitary sewer if allowed by the local wastewater authority.

nn. Application of agricultural chemicals, including fertilizers and pesticides, shall be conducted in a manner and at application rates that will not result in loss of chemical to stormwater runoff. Manufacturers' label recommendations shall be followed for application rates and procedures.

oo. Management of pH-modifying sources shall prevent contamination of runoff and stormwater collected on the site. These sources 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, and concrete pumping and mixer washout waters.

Section 10 Control De-Watering

pp. All foundation, vault, and trench de-watering water, which has similar characteristics to stormwater runoff at the site, shall be discharged into a controlled conveyance system, prior to discharge to a sediment trap or sediment pond. Channels must be stabilized, as specified in Element #8.

qq. Clean, non-turbid de-watering water, such as well-point groundwater, can be discharged to systems tributary to state surface waters, as specified in Element #8, provided the de-watering flow does not cause erosion or flooding of the receiving waters. These clean waters should not be routed through sediment ponds with water.

rr. Highly turbid or otherwise contaminated de-watering water, such as from construction equipment operation, clamshell digging, concrete tremie pour, or work inside a cofferdam, shall be handled separately from stormwater at the site.

ss. Other disposal options, depending on site constraints, may include:

Infiltration.

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

Onsite treatment using chemical treatment or other suitable treatment technologies.

Sanitary sewer discharge with local sewer district approval.

Section 11 Maintain BMPs

tt. All temporary and permanent erosion and sediment control BMPs shall be maintained and repaired as needed to assure continued performance of their intended function. All maintenance and repair shall be conducted in accordance with BMPs.

uu. Sediment control BMPs shall be inspected weekly or after a runoff-producing storm event during the dry season and daily during the wet season.

vv. All temporary erosion and sediment control BMPs shall be removed within 30 days after final site stabilization is achieved or after the temporary BMPs are no longer needed. Trapped sediment shall be removed or stabilized onsite. Disturbed soil areas resulting from removal of BMPs or vegetation shall be permanently stabilized.

Section 12 Manage the Project

ww. Phasing of Construction – Development projects shall be phased where feasible in order to prevent, to maximum extent practicable, the transport of sediment from the project site during construction. Re-vegetation of exposed areas and maintenance of that vegetation shall be an integral part of the clearing activities for any phase.

xx. Clearing and grading activities for developments shall be permitted only if conducted pursuant to an approved site development plan that establishes permitted areas of clearing, grading, cutting and filling. When establishing these permitted clearing and grading areas, consideration should be given to minimizing removal of existing trees and minimizing disturbance/compaction of native soils except as needed for building purposes. These permitted clearing and grading areas and any other areas required to preserve native growth protection easements or tree retention, as may be required by local jurisdictions, shall be delineated on the site plans and the development site.

yy. All plats shall include lot-specific grading plans, including information specified by the local permitting authority such as finished grades, finished floor elevations, buildable areas, and identified drainage outlets. This information would normally be submitted with the construction drawings, but may be required prior to preliminary plat approval.

zz. 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 construction site through a combination of the following:

Site condition including existing vegetative coverage, slope, soil type and proximity to receiving waters.

Limitations on activities and the extent of disturbed areas.

Proposed erosion and sediment control measures.

Based on the information provided, and/or local weather conditions, the local permitting authority may expand or restrict the seasonal limitation on site disturbance. If, during the course of any construction activity or soil disturbance during the seasonal limitation period, silt-laden runoff leaving the site causes a violation of the surface water quality standard or if clearing and grading limits or erosion and sediment control measures shown in the approved plan are not maintained, the local permitting authority may take enforcement action, including but not limited to, a notice of violation, administrative order, fine/penalty, stop-work order, or correction notice.

Local government may restrict clearing and grading activities where site conditions may present a significant risk of impact to property or critical areas. Contact the local permitting authority for information on specific site restrictions. In Olympia, except where approved chemical treatment, full dispersion or infiltration is practiced, clearing, grading and other soil disturbing activities are prohibited in all watersheds November through February, and in Green Cove, Percival, Woodard, and Ellis Creek watershed between October through April.

aaa. 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.

bbb. Inspection and Monitoring

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

Certified Erosion and Sediment Control Specialist (CESCS) – A CESCS shall be identified in the Construction SWPPP and shall be onsite or on-call at all times. Certification may be obtained an approved training program that meets the erosion and sediment control training program that meets the erosion and sediment training criteria established by Ecology. If a pre-construction meeting is held, this person shall attend.

Sampling and analysis of the stormwater discharges from a construction site may be necessary on a case-by-case basis to ensure compliance with standards. Monitoring and reporting requirements may be established by the local permitting authority when necessary. Sampling shall be per Volume I, Section 2.5.2 Element #12 of the City of Olympia Stormwater Manual.

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

ccc. Maintaining an Updated Construction SWPPP

The C-SWPPP shall be retained onsite or within reasonable access to the site.

The C-SWPPP shall be updated within 7 days to reflect any significant changes in the design, construction, operation, or maintenance at the construction site that have, or could have, a significant effect on the discharge of pollutants to waters of the state.

The C-SWPPP shall be updated within 7 days if during inspections or investigations by site staff or local or state officials, it is determined that the C-SWPPP is ineffective in controlling pollutants such that applicable discharge or surface water standards violations are apparent.

IV. STORMWATER MAINTENANCE PLAN

PRELIMINARY PLAT OF OAK SPRINGS

October 14, 2013

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RESIDENTIAL SUBDIVISION MAINTENANCE AGREEMENT

After recording return to:

Thurston County
2000 Lakeridge Drive SW
Olympia, WA 98502

Thurston County Project No._____

RESIDENTIAL SUBDIVISION
AGREEMENT TO MAINTAIN
STORMWATER FACILITIES AND TO IMPLEMENT A
POLLUTION SOURCE CONTROL PLAN

For purposes of this agreement and for indexing by the Auditor as required by R.C.W. Ch. 65.04, the parties of this agreement are Conwell Investments, LLC, **Owner**, and Thurston County.

LEGAL DESCRIPTION OF PROPERTY: (Abbreviated legal description if complete legal will not fit here and reference to where complete legal can be found.)

Preliminary Plat of Oak Springs

Assessor Parcel No.(s)

11825240000

(RESIDENTIAL SUBDIVISION VERSION)

AGREEMENT TO MAINTAIN STORMWATER FACILITIES AND TO IMPLEMENT A POLLUTION SOURCE CONTROL PLAN BY AND BETWEEN THURSTON COUNTY, AND Conwell Investments, LLC, AND ITS HEIRS, SUCCESSORS, OR ASSIGNS (HEREINAFTER "OWNER")

The upkeep and maintenance of stormwater facilities and the implementation of pollution source control best management practices (BMPs) are essential to the protection of water resources in Thurston County. All property owners are expected to conduct business in a manner that promotes environmental protection. This Agreement contains specific provisions with respect to maintenance of stormwater facilities and use of pollution source control BMPs. The authority to require maintenance and pollution source control is provided by Thurston County Code.

LEGAL DESCRIPTION:

Parcel "A"
The south half of the southeast quarter of the northwest quarter of Section 25, Township 18 North, Range 1West, W.M.;
Excepting therfrom that portion, if any lying in the right-of-way of county road known as Marvin Road, in Thurston County, Washington,
Parcel "B"
An easement for ingress, egress and utilities over, under, upon and through a 40 foot wide portion of land as described in insturment recorded December 3, 2007 under Recording No. 3980798 in Thurston County, Washington.

RECITALS

WHEREAS, OWNER is the owner of certain real property in Thurston County, Washington, described as set forth in the legal description contained herein and referred to in this agreement as the "Property".

and

WHEREAS, In connection with the OWNER'S proposed development of the Property, Thurston County has required and OWNER has agreed to construct stormwater facilities and to implement a pollution source control plan. The stormwater facilities and pollution source control plan were prepared by Hatton Godat Pantier, Inc for the OWNER'S property and is on file with Thurston County.

and

WHEREAS, OWNER has constructed improvements, including but not limited to, buildings, pavement, and stormwater facilities on the Property, in order to further the goals of Thurston County to ensure the protection and enhancement of Thurston County's water resources, THURSTON COUNTY

and OWNER hereby enter into this Agreement. The responsibilities of each party to this Agreement are identified below.

OWNER SHALL:

(1) Implement the stormwater facility maintenance program included herein as Attachment "A".

(2) Implement the pollution source control program included herein as Attachment "B".

(3) Maintain a record (in the form of a log book) of steps taken to implement the programs referenced in (1) and (2) above. The log book shall be available for inspection by THURSTON COUNTY at 2415 Carpenter Road SE, Lacey, WA 98503 during normal business hours. The log book shall catalog the action taken, who took it, when it was done, how it was done, and any problems encountered or follow-on actions recommended. Maintenance items ("problems") listed in Attachment "A" shall be inspected as specified in the attached instructions or more frequently if necessary. OWNER is encouraged to photocopy the individual checklists in Attachment "A" and use them to complete its monthly inspections. These completed checklists would then, in combination, comprise the log book.

(4) Submit an annual report to THURSTON COUNTY regarding implementation of the programs referenced in (1) and (2) above. The report must be submitted on or before August 31 of each calendar year and shall contain, at a minimum, the following:

(a) Name, address, and telephone number of the business, the person, or the firm responsible for plan implementation, and the person completing the report.

(b) Time period covered by the report.

(c) A chronological summary of activities conducted to implement the programs referenced in (1) and (2) above. A photocopy of the applicable sections of the log book, with any additional explanation needed, shall normally suffice. For any activities conducted by paid parties not affiliated with OWNER, include a copy of the invoice for services.

(d) An outline of planned activities for the next year.

(5) Prevent any unauthorized modifications to the drainage system and prevent it from being dismantled, revised, altered or removed except as necessary for maintenance, repair or replacement. Any such actions will be covered under item 4 above and shall be approved of by THURSTON COUNTY. Modifications to the stormwater quantity control and stormwater quality system must be approved in advance by THURSTON COUNTY and may require the submittal of revised design drawings, supporting calculations, modifications to maintenance requirements, and applications for permits.

THURSTON COUNTY WILL, AS RESOURCES ALLOW:

(1) Provide technical assistance to OWNER in support of its operation and maintenance activities conducted pursuant to its maintenance and source control programs. Said assistance shall be provided upon request, as County time and resources permit and at no charge to OWNER.

(2) Review the annual report and conduct occasional site visits to discuss performance and problems with OWNER.

(3) Review this agreement with OWNER and modify it as necessary.

REMEDIES:

(1) If THURSTON COUNTY determines that maintenance or repair work is required to be done to the stormwater facility existing on the OWNER'S property, THURSTON COUNTY shall give OWNER, and the person or agent in control of said property if different, written notice in accordance with the Notice Section of this Agreement, of the specific maintenance and/or repair required. THURSTON COUNTY shall set a reasonable time in which such work is to be completed by the persons who were given notice. If the above required maintenance and/or repair is not completed within the time set by THURSTON COUNTY, written notice will be sent to the persons who were given notice stating THURSTON COUNTY'S intention to perform such maintenance and bill the owner for all incurred expenses. THURSTON COUNTY may also adjust stormwater utility charges if required maintenance is not performed.

(2) If at any time THURSTON COUNTY determines that the existing system creates any imminent threat to public health, welfare or water quality THURSTON COUNTY may take immediate measures to remedy said threat. No notice to the persons listed in Remedies (1), above, shall be required under such circumstances, however, THURSTON COUNTY shall take reasonable steps to immediately notify OWNER of such imminent threat to the public health and welfare. All other responsibilities shall remain in effect.

(3) OWNER grants unrestricted authority to THURSTON COUNTY for access to any and all stormwater system features for the purpose of routine inspections and/or performing maintenance, repair and/or retrofit as may become necessary under Remedies (1) and/or (2).

(4) OWNER shall assume all responsibility for the cost of any maintenance and for repairs to the stormwater facility. Such responsibility shall include reimbursement to THURSTON COUNTY within 30 days of the receipt of the invoice for any such work performed. Overdue payments will require payment of interest at the current legal rate for liquidated judgments. If legal action ensues, any costs or fees incurred by THURSTON COUNTY will be borne by the parties responsible for said reimbursements.

(5) OWNER hereby grants to the THURSTON COUNTY a lien against the above-described property in an amount equal to the cost incurred by THURSTON COUNTY to perform the maintenance or repair work described herein.

NOTICE:

Whenever a party is required or permitted under this Agreement to provide the other party with any notice, request, demand, consent, or approval ("Notice"), such Notice will be given in writing and will be delivered to the other party at the address or facsimile number set forth below: (a) personally; (b) by a reputable overnight courier service; (c) by certified mail, postage prepaid, return receipt requested; or (d) by e-mail or facsimile transmission. A party may change its address for Notice by written notice to the other party delivered in the manner set forth above. Notice will be deemed to have been duly given: (i) on the date personally delivered; (ii) one (1) business day after delivery to an overnight courier service

with next-day service requested; (iii) on the third (3rd) business day after mailing, if mailed using certified mail; or (iv) on the date sent when delivered by facsimile or e-mail (so long as the sender sends such facsimile or email on a business day and receives electronic confirmation of receipt and a copy of the Notice is sent by one of the other means permitted hereunder on or before the next business day). The initial addresses for Notice are as follows:

IF TO OWNER:

Conwell Investments, LLC
2415 Carpenter Road SE
Lacey, WA 98503

Telephone: (360) 438-0525
Fax: _____
E-mail: user772574@aol.com

IF TO THURSTON COUNTY:

Thurston County
Storm and Surface Water Utility
929 Lakeridge Dr SW
Bldg. 4, Room 100
Olympia, WA 98502
Telephone: (360) 754-4681
Fax: (360) 754-4682
Web:
http://www.co.thurston.wa.us/stormwater/

This Agreement is intended to protect the value and desirability of the real property described above and to benefit all the citizens of the County. It shall run with the land and be binding on all parties having or acquiring from OWNER or their successors any right, title, or interest in the property or any part thereof, as well as their title, or interest in the property or any part thereof, as well as their heirs, successors, and assigns. They shall inure to the benefit of each present or future successor in interest of said property or any part thereof, or interest therein, and to the benefit of all citizens of THURSTON COUNTY.

Dated at _____, Washington, this _____ day of _____, _____.

OWNER

By: _____

_____
Title

STATE OF WASHINGTON)
) ss
COUNTY OF THURSTON)

On this day and year above personally appeared before me, _____

_____ known to be the _____ of _____

_____ , the company that executed the forgoing instrument, and acknowledged the said instrument to be the free and voluntary act and deed of said company, for the uses and purposes therein mentioned, and on oath stated that he is authorized to execute the said instrument.

Given under my hand and official seal this _____ day of _____, _____.

_____
Notary Public in and for the State of
Washington, residing in _____
My commission expires _____

Dated at _____, Washington, this _____ day of _____, _____

APPROVED as to form only May 11, 2011:

ACCEPTED BY:

_____
for THURSTON COUNTY

_____
Date

Attachment "A"
Stormwater Facilities Maintenance Program

II. STORMWATER FACILITY MAINTENANCE GUIDE

Introduction

What Is Stormwater Runoff?

When urban and suburban development covers the land with buildings, streets and parking lots, much of the native topsoil, duff, trees, shrubs and grass are replaced by asphalt and concrete. Rainfall that would have soaked directly into the ground instead stays on the surface as *stormwater runoff* making its way into storm drains (including man-made pipes, ditches or swale networks), stormwater ponds, surface and groundwater and, eventually, to Puget Sound.

What Is a Storm Drain System and How Does It Work?

The storm drain system for most developments includes measures to *carry, store, cleanse and release* the stormwater. Components work together to reduce the impacts of development on the environment. Impacts can include *flooding* that results in property damage and blocked emergency routes, *erosion* that can cause damage to salmon spawning habitat and *pollution* that harms fish and/or drinking water supplies.

The storm drain system provides a safe method to carry stormwater to the treatment and storage area. Swales and ponds filter pollutants from the stormwater by *physically* settling out particles, *chemically* binding pollutants to pond sediments and *biologically* converting pollutants to less harmful compounds. Ponds also store treated water, releasing it gradually to a nearby stream or to groundwater.

What Does Stormwater Runoff Have to Do With Water Quality?

Stormwater runoff must be treated because it carries litter, oil, gasoline, fertilizers, pesticides, pet wastes, sediments and anything else that can float, dissolve or be swept along by moving water. Left untreated, polluted stormwater can reach nearby waterways where it can harm and even kill aquatic life. It can also pollute groundwater to the extent that it requires treatment before it is suitable for drinking. Nationally, stormwater is recognized as a major threat to water quality. Remember to keep everything out of stormwater systems except the rainwater they are designed to collect.

Stormwater Facilities

Different types of ponds are designed for different purposes. For example, wet ponds primarily provide treatment of stormwater. Dry ponds or infiltration ponds are designed to provide storage for stormwater and allow for its gradual release downstream or into the ground.

Who Is Responsible for Maintaining Stormwater Facilities?

All stormwater facilities require maintenance. Regular maintenance ensures proper functioning and preserves visual appeal. This Stormwater Facility Maintenance Guide was designed to explain how stormwater facilities work and provide user-friendly, straightforward guidance on facility maintenance. You are responsible for regularly maintaining privately owned ponds, catch basins,

pipes and other drainage facilities on your property. Stormwater facilities located in public rights-of-way are maintained by local governments.

How to Use the Stormwater Facility Maintenance Guide

This Maintenance Guide includes a Site Plan specific to your development and a Facility Key that identifies the private stormwater facilities you are responsible for maintaining. A "Quick List" of maintenance activities has also been included to help you identify the more routine needs of your facility.

Included in This Guide

- Comprehensive Maintenance Checklists that provide specific details on required maintenance
- Pollution Prevention Tips that list ways to protect water quality and keep storm drain systems functioning smoothly
- Resources to provide more information and technical assistance

A Regional Approach to Stormwater Management

The Cities of Lacey, Olympia and Tumwater together with Thurston County are taking steps to educate and involve area residents in water quality issues and stormwater management. Stormwater runoff is a widespread cause of water quality impairment and stream degradation. The jurisdictions are working together with residents, businesses, community groups and schools to address this problem. This guide focuses on providing information on ways that you can reduce stormwater impacts through pollution prevention and proper facility maintenance.

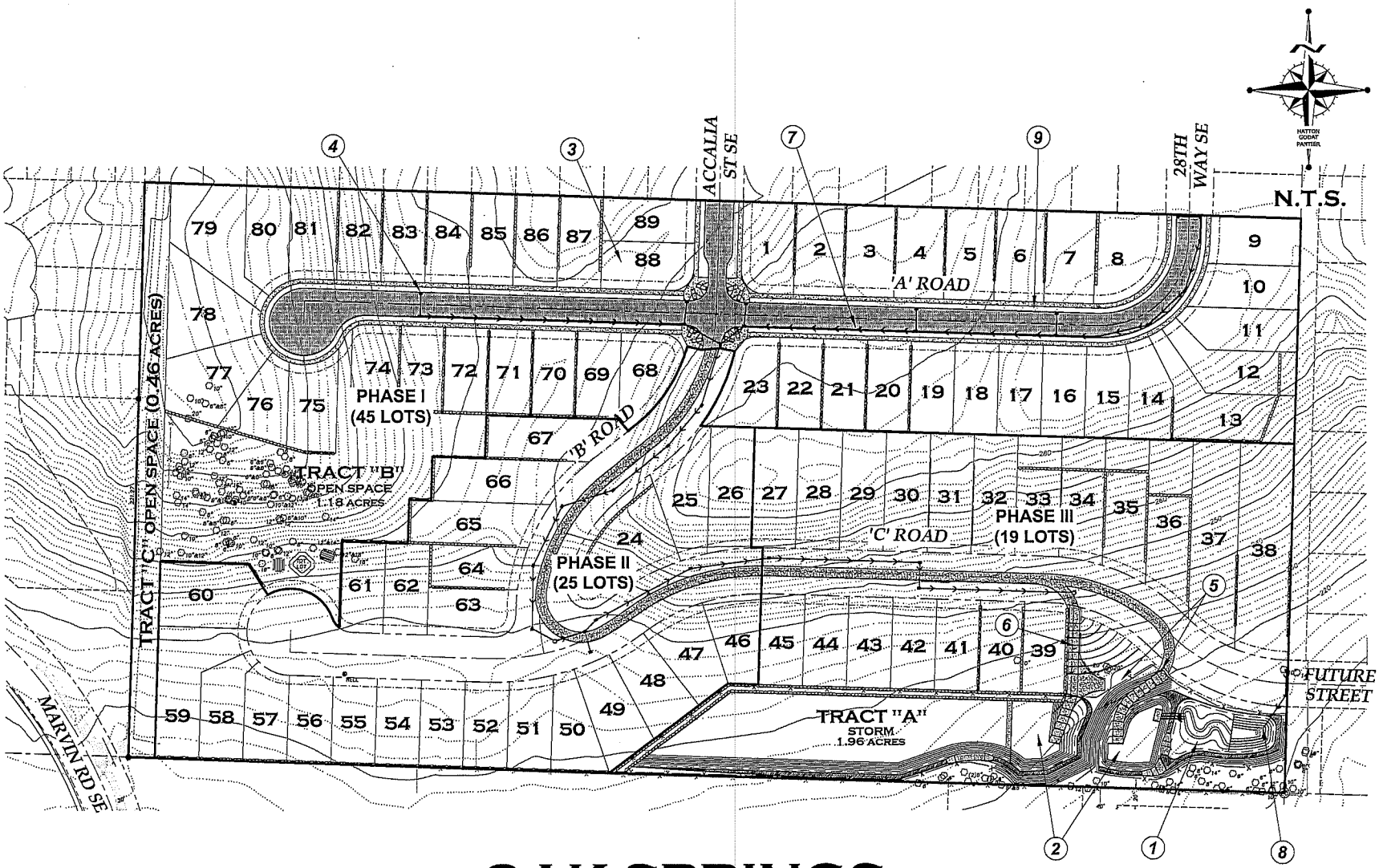
Your Stormwater Facilities

This section consists of two parts that are to be used together: the ***Facility Key*** and the ***Site Plan***. Review the site plan and identify the numbers denoting a feature of the system. Then check the facility key for the feature type and checklist name.

Facility Key

The stormwater facility in your neighborhood is comprised of the following elements:

Type of Feature and Checklist Name	Location on Site Plan
Stormwater Wetland (BMP WP.01)	1
Infiltration Basins (BMP IN.01)	2
Post Construction Soil Quality and Depth (LID.02)	3
Catch Basins and Inlets	4
Fencing and Gates	5
Access Roads and Easements	6
Conveyance Pipes and Ditches	7
Trash Racks	8
Grounds and Landscaping	9



OAK SPRINGS

FACILITY KEY

PHASE LINE

Quick List

The following is an abbreviated checklist of the most common types of maintenance required. Please go over this checklist after heavy rains. The list represents minimum maintenance to be performed and should be completed in conjunction with the other checklists for an effective maintenance program.

- ❑ Inspect catch basin grates to see that they are not clogged or broken. Remove twigs, leaves or other blockages. Contact the local jurisdiction to replace the grate if it is broken.
- ❑ Inspect inlet and outlet pipes for blockages. Clear all blockages.
- ❑ Inspect filter strip, swale and pond walls for erosion or caved in areas.
- ❑ Inspect riprap (rocks) at the inlets and outlets of culverts and other pipes. If they are silted in or eroded away, replace them.

Maintenance Checklists

The Maintenance Checklists in this packet are for your use when inspecting the stormwater facilities on your property. This packet has been customized so that only the checklists for your facilities are included. If you feel you are missing a checklist, or you have additional facilities not identified or addressed in this packet, please contact your local jurisdiction.

The checklists are in tabular format for ease of use. Each describes the area to inspect, inspection frequency, what to look for and what action to take. A log sheet is included toward the end of the chapter to help you track maintenance of your storm drainage system.

Although it is not intended for the maintenance survey to involve anything too difficult or strenuous, there are a few tools that will make the job easier and safer including:

- A flashlight
- A long pole or broom handle
- Some kind of pry bar or lifting tool for pulling manhole and grate covers
- Gloves

A resource list is included in the next chapter. There you will find the phone numbers of the agencies referenced in the tables, as well as the contractors and consultants who designed and constructed your facilities.

SAFETY WARNING: In keeping with OSHA regulations, you should never stick your head or any part of your body into a manhole or other type of confined space. When looking into a manhole or catch basin, stand above it and use the flashlight to help you see. Use a long pole or broom handle to check sediment depths in confined spaces. *NO PART OF YOUR BODY SHOULD BREAK THE PLANE OF* THE *OPEN HOLE.*

Table C-3B. Maintenance Checklist for Stormwater Wetland (BMP WP.01)

Frequency	Drainage Systems Feature	√	Problem	Conditions to Check For	Conditions that Shall Exist
M,S	General		Trash and Debris buildup in pond or wetland.	Dumping of yard wastes such as grass clippings and branches into basin. Unsightly accumulation of non-degradable materials such as glass, plastic, metal, foam, and coated paper.	Remove trash and debris and dispose as prescribed by Thurston County Department of Resource Stewardship.
M,S			Trash rack plugged or missing	Bar screen over outlet more than 25% covered by debris or missing.	Replace screen. Remove trash and debris and dispose as prescribed by City Waste Management Section.
M			Poisonous Vegetation	Any poisonous vegetation which may constitute a hazard to the public. Examples of poisonous vegetation include: tansy ragwort, poison oak, poison ivy, stinging nettles, devilsclub.	Remove poisonous vegetation. Do not spray chemicals on vegetation without obtaining guidance from the County. Contact Thurston County Noxious Weeds program.
M,S			Fire hazard or pollution	Presence of chemicals such as natural gas, oil, and gasoline, obnoxious color, odor, or sludge noted.	Find sources of pollution and eliminate them. Water is free from noticeable color, odor, or contamination.
M			Vegetation not growing or is overgrown	Plants are sparse or invasive species are present.	Hand-plant nursery-grown wetland plants in baser areas. Contact the Thurston County Noxious Weed program for direction on invasive species such as purple loosestrife and reed canary grass. Pond bottoms shall have uniform dense coverage of desired plant species.
M			Rodent Holes	If the facility is constructed with a dam or berm, look for rodent holes or any evidence of water piping through the dam or berm.	Rodents destroyed and dam or berm repaired. Contact the Thurston County Public Health and Social Services Department for guidance.
M			Insects	When insects such as wasps and hornets interfere with maintenance activities, or when mosquitoes become a nuisance.	Insects destroyed or removed from site. Contact Cooperative Extension Service for guidance.

Frequency	Drainage Systems Feature	√	Problem	Conditions to Check For	Conditions that Shall Exist
A			Tree Growth	Tree growth does not allow maintenance access or interferes with maintenance activity (i.e., slope mowing, silt removal, or equipment movements). If trees are not interfering with access, leave trees alone.	Trees do not hinder maintenance activities. Selectively cultivate trees such as alders for firewood. Remove species that are not part of recorded planting plan.
M	Side Slopes of Pond		Erosion on berms or at entrance/exit	Check around inlets and outlets for signs of erosion. Check berms for signs of sliding or settling. Action is needed where eroded damage over 2 inches deep and where there is potential for continued erosion.	Find causes of erosion and eliminate them. Then slopes should be stabilized by using appropriate erosion control measure(s); e.g., rock reinforcement, planting of grass, compaction.
A	Internal berm or embankment		Settlements	Any part of dike which has settled 4 inches lower than the design elevation.	Dike is built back to the design elevation.
			Irregular surface on internal berm	Top of berm not uniform and level.	Top of berm graded flat to design elevation.
A	Emergency Overflow/ Spillway		Rock Missing	Only one layer of rock exists above native soil in area 5 square feet or larger, or any exposure of native soil.	Replace rocks to design standards.
One time			Overflow Missing	Side of pond has no area with large rocks to handle emergency overflows.	Contact County for guidance.
A	Pond Areas		Sediment accumulation (first cell / forebay)	Sediment accumulations in pond bottom that exceeds the depth of sediment storage (1 foot) plus 6 inches.	Sediment storage contains no sediment.
A			Sediment accumulation (wetland cell)	Accumulated sediment that exceeds 10% of the designed pond depth.	Sediment cleaned out to designed pond shape and depth.
A			Liner damaged (if applicable)	Liner is visible or pond does not hold water as designed.	Liner repaired or replaced.
A			Water level (first cell / forebay)	Cell does not hold 3 feet of water year round.	3 feet of water retained year round.
A			Water level (wetland cell)	Cell does not retain water for at least 10 months of the year or wetland plants are not surviving.	Water retained at least 10 months of the year or wetland plants are surviving.

Frequency	Drainage Systems Feature	√	Problem	Conditions to Check For	Conditions that Shall Exist
A			Algae mats (first cell / forebay)	Algae mats develop over more than 10% of the water surface should be removed.	Algae mats removed (usually in the late summer before Fall rains.
A			Vegetation	Vegetation dead, dying, or overgrown (cattails) or not meeting original planting specifications.	Plants in wetland cell surviving and not interfering with wetland function.
A	Gravity Drain		Inoperable valve	Valve will not open and close	Valve opens and closes normally.
A			Valve won't seal	Valve does not seal completely.	Valve completely seals closed.
A	Inlet/Outlet pipe		Sediment accumulation	Sediment filling 20% or more of the pipe.	Inlet/outlet pipes clear of sediment.
A			Trash and debris	Trash and debris accumulated in inlet/outlet pipes (includes floatables and non-floatables).	No trash or debris in pipes.
A			Damaged	Cracks wider than ½ inch at the joint of the inlet / outlet pipe or any evidence of soil entering at the joints of the inlet / outlet pipes.	No cracks more than ¼ inch wide at the joint of the inlet/outlet pipe.

If you are unsure whether a problem exists, please contact Thurston County and ask for technical assistance.

Key:
A = Annual (March or April preferred)
M = Monthly (see schedule)
S = After major storms

Table C-4. Maintenance Checklist for Infiltration Basins (BMP IN.01), Infiltration Trenches (BMP IN.02), and Bioinfiltration Swale (BMP IN.03)

Frequency	Drainage Systems Feature	√	Problem	Conditions to Check For	Conditions that Shall Exist
M,S	General		Trash and Debris buildup in pond	Dumping of yard wastes such as grass clippings and branches into basin. Unsightly accumulation of non-degradable materials such as glass, plastic, metal, foam, and coated paper.	Remove trash and debris and dispose as prescribed by Thurston County Department of Resource Stewardship.
M			Poisonous Vegetation	Any poisonous vegetation which may constitute a hazard to the public. Examples of poisonous vegetation include: tansy ragwort, poison oak, stinging nettles, devilsclub.	Remove poisonous vegetation. Do not spray chemicals on vegetation without obtaining guidance from the County.
A			Tree Growth	Tree growth in pond or swale bottoms, side slopes and maintenance access areas.	Trees removed from facility bottom, side slopes and maintenance access areas. Remove species that are not part of recorded planting plan.
M,S			Fire Hazard or Pollution	Presence of chemicals such as natural gas, oil, and gasoline, obnoxious color, odor, or sludge noted.	Find sources of pollution and eliminate them. Water is free from noticeable color, odor, or contamination.
M			Vegetation not growing or is overgrown	Grass cover is sparse and weedy or is overgrown. Plants are sparse or invasive species are present.	Selectively thatch, aerate, and reseed ponds. Grass cutting unnecessary unless dictated by aesthetics. Contact the Thurston County Noxious Weed program for direction on invasive species such as purple loosestrife and reed canary grass. Pond bottoms shall have uniform dense coverage of desired plant species.
M			Rodent Holes	If the facility is constructed with a dam or berm, look for rodent holes or any evidence of water piping through the dam or berm.	Rodents destroyed and dam or berm repaired. Contact the Thurston County Public Health and Social Services Department for guidance.

Frequency	Drainage Systems Feature	√	Problem	Conditions to Check For	Conditions that Shall Exist
M			Insects	When insects such as wasps and hornets interfere with maintenance activities, or when mosquitoes become a nuisance.	Insects destroyed or removed from site. Contact Cooperative Extension Service for guidance.
A	Storage Area		Sediment buildup in system	A soil texture test indicates facility is not working at its designed capabilities or was incorrectly designed.	Sediment is removed and/or facility is cleaned so that infiltration system works according to design. A sediment trapping area is installed to reduce sediment transport into infiltration area.
A			Storage area drains slowly (more than 48 hours) or overflows	A soil texture test indicates facility is not working at its designed capabilities or was incorrectly designed.	Additional volume is added through excavation to provide needed storage. Soil is aerated and rototilled to improve drainage. Contact the County for information on its requirements regarding excavation.
M			Sediment trapping area	Any sediment and debris filling area to 10 percent of depth from sump bottom to bottom of outlet pipe or obstructing flow into the connector pipe.	Clean out sump to design depth.
One time			Sediment trapping area not present	Stormwater enters infiltration area directly without treatment.	Add a trapping area by constructing a sump for settling of solids. Segregate settling area from rest of facility. Contact County for more guidance.
M	Rock filters		Sediment and debris	By visual inspection little or no water flows through filter during heavy rain storms.	Replace gravel in rock filter.

If you are unsure whether a problem exists, please contact Thurston County and ask for technical assistance.

Key:
A = Annual (March or April preferred)
M = Monthly (see schedule)
S = After major storms

Table C-8. Maintenance Checklist for Compost Amended Soil for Post-Construction Soil Quality and Depth (BMP LID.02) and Compost-Amended Vegetated Filter Strip (BMP BF.06)

Frequency	Drainage Systems Feature	√	Problem	Conditions to Check For	Conditions that Shall Exist
A	General		Soil media (maintain high organic soil content	Vegetation not fully covering ground surface.	Re-mulch landscape beds with 2-3 inches of mulch until the vegetation fully closes over the ground surface
Ongoing				None. Preventative maintenance.	Return leaf fall and shredded woody materials from the landscape to the site as mulch.
Ongoing				None. Preventative maintenance.	On turf areas, "grasscycle" (mulch-mow or leave the clippings) to build turf health
Ongoing				None. Preventative maintenance.	Avoiding broadcast use of pesticides (bug and weed killers) like "weed & feed," which damage the soil life.
A				None. Preventative maintenance.	Where fertilization is needed (mainly turf and annual flower beds), a moderate fertilization program which relies on natural organic fertilizers (like compost) or slow release synthetic balanced fertilizers.
A			Compaction	Soils become waterlogged, do not appear to be infiltrating.	To remediate, aerate soil, till or further amend soil. If drainage is still slow, consider investigating alternative causes (e.g., high wet-season groundwater levels, low permeability soils). Also consider land use and protection from compacting activities. If areas are turf, aerate compacted areas and top dress them with 1/4 to 1/2 inch of compost to renovate them.

Frequency	Drainage Systems Feature	√	Problem	Conditions to Check For	Conditions that Shall Exist
A			Erosion/scouring	Areas of potential erosion are visible.	Take steps to repair or prevent erosion. Identify and address the causes of erosion.
A			Grass/vegetation	Less than 75% of planted vegetation is healthy with a generally good appearance.	Take appropriate maintenance actions (e.g., remove/replace plants)
M			Noxious weeds	Listed noxious vegetation is present. See Pierce County noxious weed list.	By law, noxious weeds must be removed and disposed immediately. It is strongly encouraged that herbicides and pesticides not be used in order to protect water quality.
Q			Weeds	Weeds are present.	Remove and dispose of weed material. It is strongly encouraged that herbicides and pesticides not be used in order to protect water quality.

If you are unsure whether a problem exists, please contact Thurston County and ask for technical assistance.

Key:
A = Annual (March or April preferred)
M = Monthly (see schedule)
S = After major storms.
Q = Quarterly

Table C-13. Maintenance Checklist for Catch Basins and Inlets

Frequency	Drainage Systems Feature	√	Problem	Conditions to Check For	Conditions that Shall Exist
M,S	General		Trash and Debris	Trash, debris, and sediment in or on basin	No trash or debris located immediately in front of catch basin opening. Grate is kept clean and allows water to enter.
M				Sediment or debris (in the basin) that exceeds 1/3 the depth (1-ft minimum storage remaining) from the bottom of basin to invert of the lowest pipe into or out of the basin.	No sediment or debris in the catch basin. Catch basin is dug out and clean.
M,S				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.
M			Structural Damage to Frame and/or Top Slab	Corner of frame extends more than 3/4 inch past curb face into the street (if applicable).	Frame is even with curb.
M				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.
M				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.
A			Cracks in Basin Walls/ Bottom	Cracks wider than 1/2 inch and longer than 3 feet, any evidence of soil particles entering catch basin through cracks, or maintenance person judges that structure is unsound.	Basin replaced or repaired to design standards. Contact a professional engineer for evaluation.
A				Cracks wider than 1/2 inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering catch basin through cracks.	No cracks more than 1/4 inch wide at the joint of inlet/outlet pipe.

Frequency	Drainage Systems Feature	√	Problem	Conditions to Check For	Conditions that Shall Exist
A			Settlement/ Misalignment	Basin has settled more than 1 inch or has rotated more than 2 inches out of alignment.	Basin replaced or repaired to design standards. Contact a professional engineer for evaluation.
A			Illicit discharges to Catch Basin	Look for connections from adjacent businesses, residences that are not part of drainage plan. If detected identify source of connection and notify Thurston County.	No connections to Catch Basins are allowed that are not part of the approved plans or authorized by permit from Thurston County.
M			Vegetation	Vegetation growing across and blocking more than 10 percent of the basin opening.	No vegetation blocking opening to basin.
M			Vegetation	Vegetation growing in inlet/outlet pipe joints that is more than 6 inches tall and less than 6 inches apart.	No vegetation or root growth present.

If you are unsure whether a problem exists, please contact Thurston County and ask for technical assistance.

Key:
A = Annual (March or April preferred)
M = Monthly (see schedule)
S = After major storms

Table C-15. Maintenance Checklist for Fencing

Frequency	Drainage Systems Feature	√	Problem	Conditions to Check For	Conditions that Shall Exist
M	General		Missing or broken parts/dead shrubbery	Any defect in the fence or screen that permits easy entry to a facility.	Fence is mended or shrubs replaced to form a solid barrier to entry.
M,S			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.
M			Unruly Vegetation	Shrubbery is growing out of control or is infested with weeds.	Shrubbery is trimmed and weeded to provide appealing aesthetics. Do not use chemicals to control weeds.
A	Wire Fences		Damaged Parts	Posts out of plumb more than 6 inches.	Posts plumb to within 1.5 inches of plumb.
A				Top rails bent more than 6 inches.	Top rail free of bends greater than 1 inch.
A				Any part of fence (including posts, top rails, and fabric) more than 1 foot out of design alignment.	Fence is aligned and meets design standards.
A				Missing or loose tension wire.	Tension wire in place and holding fabric.
A				Missing or loose barbed wire that is sagging more than 2.5 inches between posts.	Barbed wire in place with less than 3/4 inch sag between posts.
A				Extension arm missing, broken, or bent out of shape more than 1.5 inches.	Extension arm in place with no bends larger than 3/4 inch.
A			Deteriorated Paint or Protective Coating	Part or parts that have a rusting or scaling condition that has affected structural adequacy.	Structurally adequate posts or parts with a uniform protective coating.
M			Openings in Fabric	Openings in fabric are such that an 8-inch diameter ball could fit through.	No openings in fabric.

If you are unsure whether a problem exists, please contact Thurston County and ask for technical assistance.

Key:
A = Annual (March or April preferred)
M = Monthly (see schedule)
S = After major storms

Table C-16. Maintenance Checklist for Gates

Frequency	Drainage Systems Feature	√	Problem	Conditions to Check For	Conditions that Shall Exist
M	General		Damaged or Missing Components	Gate is broken, jammed, or missing.	Pond has a functioning gate to allow entry of people and maintenance equipment such as mowers and backhoe. If a lock is used, make sure the county field staff have a key.
M				Broken or missing hinges such that gate cannot be easily opened and closed by one maintenance person.	Hinges intact and lubed. Gate is working freely.
A				Gate is out of plumb more than 6 inches and more than 1 foot out of design alignment.	Gate is aligned and vertical.
A				Missing stretcher bar, stretcher bands, and ties.	Stretcher bar, bands, and ties in place.

If you are unsure whether a problem exists, please contact Thurston County and ask for technical assistance.

Key:
A = Annual (March or April preferred)
M = Monthly (see schedule)
S = After major storms

Table C-17. Maintenance Checklist for Access Roads/Easements

Frequency	Drainage Systems Feature	√	Problem	Conditions to Check For	Conditions that Shall Exist
One Time	General		No access road exists	If ponds or other drainage system features needing maintenance by motorized equipment are present, either an access road or access from public streets is required.	Determine whether an easement to drainage feature exists. If yes, obtain County permits and construct gravel (or equal) access road. If not report lack of easement to County attention.
M			Block roadway	Debris which could damage vehicle tires (glass or metal)	Roadway free of debris which could damage tires.
A				Any obstructions which reduce clearance above road surface to less than 14 feet.	Roadway overhead clear to 14 feet high.
A				Any obstructions restricting access to less than 15 feet width.	Obstruction removed to allow at least a 15 foot wide access.
A	Easement Markers		Easement Not Clearly Identified	Check that easement markers are in place identifying limits of easement	Easement markers installed at 100-ft intervals and changes in direction along easement lines.
A,S	Road surface		Settlement, potholes, mush spots, ruts	When any surface exceeds 6-inches in depth and 6 square feet in area. In general, any surface defect which hinders or prevents maintenance access.	Road surface uniformly smooth with no evidence of settlement, potholes, mush spots, or ruts. Occasionally application of additional gravel or pit run rock will be needed.
M			Vegetation in road surface	Woody growth that could block vehicular access. Excessive weed cover.	Remove woody growth at early stage to prevent blockage. Cut back weeds if they begin to encroach on road surface.
M,S	Shoulders and ditches		Erosion damage	Erosion within 1 foot of the roadway more than 8 inches wide and 6 inches deep	Shoulder free of erosion and matching the surrounding road.

If you are unsure whether a problem exists, please contact Thurston County and ask for technical assistance.

Key:
A = Annual (March or April preferred)
M = Monthly (see schedule)
S = After major storms

Table C-18. Conveyance Pipes and Ditches

Frequency	Drainage Systems Feature	√	Problem	Conditions to Check For	Conditions that Shall Exist
M,S	Pipes		Sediment & Debris	Accumulated sediment that exceeds 20% of the diameter of the pipe.	Pipe cleaned of all sediment and debris.
M			Vegetation	Vegetation that reduces free movement of water through pipes.	All vegetation removed so water flows freely through pipes.
A			Damaged (rusted, bent, or crushed)	Protective coating is damaged, rust is causing more than 50% deterioration to any part of pipe.	Pipe repaired or replaced.
M				Any dent that significantly impedes flow (i.e. decreases the cross section area of pipe by more than 20%)	Pipe repaired or replaced
M				Pipe has major cracks or tears allowing groundwater leakage.	Pipe repaired or replaced.
M,S	Open ditches		Trash & debris	Dumping of yard wastes such as grass clippings and branches into basin. Unsightly accumulation of non-degradable materials such as glass, plastic, metal, foam and coated paper.	Remove trash and debris and dispose as prescribed by solid waste regulations.
M			Sediment buildup	Accumulated sediment that exceeds 20% of the design depth.	Ditch cleared of all sediment and debris so that it matches design.
A			Vegetation	Vegetation (e.g. weedy shrubs or saplings) that reduces free movements of water through ditches.	Water flows freely through ditches. Grass vegetation should be left alone.
M			Erosion on	Check around inlets and outlets for signs of erosion. Check berms for signs of sliding or settling. Action is needed where eroded damage over 2 inches deep and where there is potential for continued erosion.	Find causes of erosion and eliminate them. Then slopes should be stabilized by using appropriate erosion control measure(s); e.g., rock reinforcement, planting of grass, compaction.
A			Rock lining out of place or missing (if applicable)	Maintenance person can see native soil beneath the rock lining.	Replace rocks to design standard.

If you are unsure whether a problem exists, please contact Thurston County and ask for technical assistance.

Key:
A = Annual (March or April preferred)
M = Monthly (see schedule)
S = After major storms

Table C-19. Debris Barriers (E.G. Trash Racks)

Frequency	Drainage Systems Feature	√	Problem	Conditions to Check For	Conditions that Shall Exist
M,S	Site		Trash and debris	Trash and debris plugging more than 20% of the area of the barrier.	Barrier clear to receive capacity flow.
A			Sediment accumulation	Sediment accumulation of greater than 20% of the area of the barrier	Barrier clear to receive capacity flow
A	Structure		Cracked, broken or loose	Structure with bars attached to is damaged – pipe is loose or cracked or concrete structure is cracked, broken or loose.	Structure barrier attached to is sound.
A	Bars		Bar spacing	Bar spacing exceeds 6-inches	Bars have at most 6-inches spacing
A			Damaged or missing bars	Bars are bent out of shape more than 3 inches.	Bars in place with no bends more than ¾ inch.
A				Bars are missing or entire barrier missing.	Bars in place according to design.
A				Bars are loose and rust is causing 50% deterioration to any part of barrier.	Repair or replace barrier to design standards.

If you are unsure whether a problem exists, please contact Thurston County and ask for technical assistance.

Key:
A = Annual (March or April preferred)
M = Monthly (see schedule)
S = After major storms

Table C-20. Maintenance Checklist for Grounds (Landscaping)

Frequency	Drainage Systems Feature	√	Problem	Conditions to Check For	Conditions that Shall Exist
M	General		Weeds (non poinsonous)	Weeds growing in more than 20% of the landscaped area (trees and shrubs only)	Weeds present in less than 5% of the landscaped area.
M			Safety hazard	Any presence of poison ivy, poison oak or other poisonous vegetation or insect nests.	No poisonous vegetation or inspect nests present in landscaped area.
M,S			Trash or litter	Trash/debris exceeds 5 cubic feet (this is about equal to the amount of trash in one standard garbage can) per 1,000 square feet. In general there should be no evidence of visual dumping.	Remove/dispose of waste in accordance with solid waste regulations.
M,S			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.
A	Trees and shrubs		Damage	Limbs or parts of trees or shrubs that are split or broken which affect more than 25% of the total foliage of the tree or shrub.	Trim trees/shrubs to restore shape. Replace trees/shrubs with severe damage.
M				Tree or shrubs that have been blown down or knocked over.	Replant tree, inspecting for injury to stem or roots. Replace if severely damaged.
A				Tree or shrubs which are not adequately supported or are leaning over, causing exposure of the roots.	Place stakes and rubber-coated ties around young trees/shrubs for support.
M,S	Shoulders and ditches		Erosion damage	Erosion within 1 foot of the roadway more than 8 inches wide and 6 inches deep	Shoulder free of erosion and matching the surrounding road.

If you are unsure whether a problem exists, please contact Thurston County and ask for technical assistance.

Key:
A = Annual (March or April preferred)
M = Monthly (see schedule)
S = After major storms

Resource Listing

If you suspect a problem exists, please contact your local jurisdiction at one of the numbers below and ask for Technical Assistance.

CONTACT NUMBERS

Thurston County (Storm & Surface Water)	(360) 754-4681
WSU Cooperative Extension	(360) 786-5445

DEVELOPER INFORMATION

Conwell Investments, LLC
2415 Carpenter Road SE
Lacey, WA 98503
(360) 438-0525

ENGINEER'S INFORMATION

HATTON GODAT PANTIER
3910 Martin Way E, Suite B
Olympia, WA 98506
(360) 943-1599

Log Sheet

Use log sheets to track maintenance checks and what items, if any, are repaired or altered. Make copies of this page; use a fresh copy for each inspection. The completed sheets will serve as a record of maintenance activity and will provide valuable information about how your facilities are operating. Log sheets should be kept in a dry, readily accessible place.

INSPECTION DATE: _____

PERFORMED BY: _____

PHONE NUMBER: _____ **ADDRESS:** _____

POSITION ON HOA: _____ **CITY, ST, ZIP:** _____

PART OF FACILITY INSPECTED	OBSERVATIONS (LIST REQUIRED MAINTENANCE ACTIVITIES)	ACTION TAKEN	DATE OF ACTION

Attachment "B"
Pollution Source Control Program

THURSTON COUNTY, WASHINGTON

RESIDENTIAL STORMWATER POLLUTION PREVENTION SOURCE CONTROL MANUAL

Grantor(s) (Last, First and Middle Initial)

_____ _____

Grantee(s) (Last, First and Middle Initial)

PUBLIC

_____ _____

Legal Description (abbreviated form: i.e. lot, block, plat or section, township, range, quarter/quarter)

_____

_____

Assessor's Property Tax Parcel/Account Number

_____ _____ _____

The Auditor/Recorder will rely on the information provided on this form. The staff will not read the document to verify the accuracy or completeness of the indexing information provided herein.

As-Built Drainage Plan Attached ? ☐ **Yes** ☐ **No**

Table of Contents

Introduction

ABOUT THIS MANUAL

Thurston County's water resources – its streams, lakes, wetlands, groundwater, and Puget Sound – play an important role in the quality of life we enjoy. They provide us with recreation and drinking water, support tourism and salmon and are used by industry. These waters, however, are vulnerable to pollution from a wide variety of human activities.

This manual applies to those residential properties and activities in unincorporated Thurston County that have the potential to contribute pollutants to stormwater runoff or directly to receiving waters. Stormwater runoff may seep into the ground, drain to a storm drain or a drainage ditch, or flow over the ground. Regardless of the way runoff leaves your site, it ends up in a stream river, lake, wetland, groundwater or Puget Sound.

Contaminated stormwater can negatively affect every water body it enters. Therefore, this manual provides detailed information on what you can do to reduce the contamination of surface water, groundwater, and stormwater from your property.

Many of our water pollution problems are due in large part to pollutants washed off the land by storms. The quality of "stormwater" from residential properties is an increasing concern nationwide. Many people believe that stormwater is "clean" and does not harm water quality. This perception is understandable since the amount of pollution from any one place is not usually significant by itself. But when all these small amounts are combined, they can cause significant pollution problems.

The federal Clean Water Act mandates that cities and counties control the quality of stormwater runoff. One way to achieve this is to implement pollution prevention measures on individual properties. By following the "Best Management Practices" described in this manual you can do your part to protect our streams, groundwater, and Puget Sound.

BEST MANAGEMENT PRACTICES ... WHAT ARE THEY?

Best Management Practices (BMPs) are a set of activities designed to reduce stormwater pollution. BMPs are separated into two broad categories: *source control* and *treatment.*

Source Control BMPs

***Source control* BMPs** prevent contaminants from entering stormwater runoff by controlling them at the source. Some source control BMPs are operational, such as checking regularly for leaks and drips from equipment and vehicles, covering materials that have potential to add pollutants to surface water if rainwater comes in contact with the materials, cleaning up pet waste, and minimizing use of pesticides, fertilizers, and insecticides. Other source control BMPs require use of a structure to prevent rainwater

from contacting materials that will contaminate stormwater runoff such as provide a covered area or berm to prevent clean stormwater from entering work or storage areas.

Source control BMPs prevent contaminants from entering stormwater by controlling them at the source.

Treatment BMPs

In contrast, ***treatments* BMPs** are structures that treat stormwater to remove contaminants. Treatment BMPs typically require elaborate planning, design and construction. A stormwater pond for your subdivision is an example of a *treatment BMP.* No treatment BMP is capable of removing 100 percent of the contaminants in stormwater and the less contaminants in the stormwater prior to the treatment BMP, the more effective the BMP is.

Also remember that, just because there is a stormwater collection system where you live, it does not necessarily mean that the stormwater is treated. Many developments were created prior to requirements to treat stormwater. The runoff from your property may go directly or indirectly to a stream or wetland without any treatment.

Keep in mind that runoff from your property may go directly or indirectly to a stream or wetland without any treatment.

This manual will focus on *source control* BMPs applicable to the routine practices of most owners of a single family residence..

WHAT'S IN THIS MANUAL?

This manual has been developed for the owners of single family residences. If you are trying to get a building permit to construct a new home you may be required to submit a copy of this manual, or its equivalent as part of your permit application and then record it with the Thurston County Auditor's office prior to receiving final approval of your project.

The manual is divided into three sections as follows:

- **Introduction**
- **General Principles of Pollution Prevention**
- **Best Management Practices for Single-Family Residences**

The general principles and best management practices described are based on the requirements of the ***Thurston County Drainage Design and Erosion Control Manual,*** Volume IV – *Source Control.*

General Principles of Pollution Prevention

There are 15 general principles of pollution prevention that every homeowner should consider.

This section describes simple pollution prevention principles that every homeowner should consider. Most of these are common sense, "housekeeping" types of solutions. With collective action by individuals throughout the county in implementing these principles, the improvement in water quality can be substantial. There are 15 general principles of pollution prevention.

1. Avoid the activity or reduce its occurrence

Avoid potentially polluting activity or do it less frequently, especially if it takes place outdoors. Apply lawn care chemicals following directions and only as needed. Do not apply herbicides right before it rains.

2. Move the activity indoors

Move a potentially polluting activity indoors out of the weather. This prevents runoff contamination and provides more control for a cleanup if a spill occurs. For example unload and store chemicals inside a garage area or shed instead of outside. Be safe and ensure any storage area is well ventilated and required building and fire code requirements are met.

3. Cleanup spills quickly

Promptly contain and cleanup solid and liquid pollutant leaks and spills on any exposed soil, vegetation, or paved area. Use readily available absorbents such as kitty litter to absorb spills and then sweep up the material and dispose of it in the garbage. Promptly repair or replace leaking connections, pipes, hoses, valves, etc. on vehicles and equipment you own.

4. Use less material

Don't buy or use more material than you really need. This not only helps keep potential disposal, storage and pollution problems to a minimum, but will probably save you money too.

5. Use the least toxic materials available

Investigate the use of materials that are less toxic. For example, replace a caustic-type detergent or solvent with a more environmentally friendly product. Even if you do switch to a biodegradable product, remember that only uncontaminated water is allowed to enter the stormwater drainage system.

Remember that only uncontaminated water is allowed to enter the stormwater drainage system.

6. Create and maintain vegetated areas near activity locations

Vegetation can filter pollutants out of stormwater. Route stormwater from parking and work areas through vegetated areas. Remember that wastewater other than stormwater runoff, such as wash water, must be discharged to a wastewater collection system (sewer or septic system), and may not be discharged to a storm drainage system.

7. Locate activities as far as possible from surface drainage paths

Activities located as far as possible from known drainage paths such as ditches, streams, other water bodies, and storm drains will be less likely to pollute, since it will take longer for material to reach the drainage features. This give more time to react to a spill, or if it is a "housekeeping" issue, may protect the local waters long enough for you to cleanup the area around the activity. Don't forget that groundwater protection is important throughout Thurston County, no matter where the activity is located, so the actions you take on a day-to-day basis area always important, even in dry weather.

Don't forget that groundwater protection is important throughout Thurston County.

8. Maintain stormwater drainage systems

Pollutants can concentrate over time in storm drainage facilities such as catch basins, ditches, and storm drains. When a large storm event occurs, turbulent runoff can mobilize these pollutants and carry them to receiving waters. By performing regular maintenance on stormwater facilities located on your property you can prevent this from occurring. Also repair or replace cracked or otherwise damaged pavement in parking areas and any other drainage areas that are subject to pollutant material leaks or spills.

9. Reduce, reuse, and recycle as much as possible

Look for ways to recycle instead of just disposing. This saves money and keeps hazardous and non-hazardous materials out of landfills. Contact the Thurston County Solid Waste Division at (360) 357-2491 for more information on recycling opportunities at the Thurston County Waste and Recover Center.

10. Be an advocate for stormwater pollution prevention

Help friends, neighbors, and business associates find ways to reduce stormwater pollution in their activities. Most people want clean water and do not pollute intentionally. Share your ideas and the BMPs in this manual to get them thinking about how their everyday activities affect water quality.

11. Report problems

We all must do our part to protect water, fish, wildlife, and our own health by implementing proper BMPs, and reporting water quality problems that we observe. In Thurston County, call the Water Resources Division of the Resource Stewardship Department at (360) 754-4681 to report dumping to storm drains or ditches.

12. Provide oversight and training

Talk to the members of your family, or if you are a landlord talk to your tenants, to ensure they understand the pollution prevention source control measures and BMPs described in this manual. If you are a landlord monitor the activities of your tenants to ensure that they are carrying out the principles of this manual.

13. Dust control

Sweep paved parking and storage areas regularly to collect and dispose of dust and debris that could contaminate stormwater. Do not hose down pollutants from any area to the ground, storm drain, conveyance ditch or any receiving water (stream, wetland, lake, etc.). Do not use used oils or other petroleum products for dust control. Volumes of water used for light watering for dust control of dirt driveways or gravel roads should be conducted to prevent any runoff of stormwater from the surface.

> *Do not hose down pollutants from any area to the ground, storm drain, conveyance ditch or any receiving water (stream, wetland, lake, etc.)*

14. Eliminate illicit connections

A common problem with the stormwater drainage system for most communities is the existence of illicit connections of wastewater to the storm drainage system. Many businesses and residences have internal building drains, sump overflows, sump pumps, garage and outdoor sinks and showers, and even sanitary sewer and septic system pipes that were inadvertently connected to the nearby storm drainage system in the past.

Examine the plumbing system for your home to determine if illicit connections exist. Any time it is found that toilets, sinks, appliances, showers and bathtubs, floor drains, industrial process waters, and/or other indoor activities are connected to the stormwater drainage system; these connections must be immediately rerouted to the sanitary or septic system, holding tanks, or process treatment system. For assistance in methods to detect and eliminate illicit connections contact the Water Resources Division at (360) 754-4681.

15. Dispose of waste properly

Every business and residence in Thurston County must dispose of solid and liquid wastes and contaminated stormwater properly. There are generally four options for disposal depending on the type of materials. These options include:

- Sanitary sewer and septic systems.
- Recycling facilities
- Municipal solid waste disposal facilities
- Hazardous waste treatment, storage and disposal facilities.

Every business and residence in Thurston County must dispose of solid and liquid wastes and contaminated stormwater properly.

Best Management Practices for Single Family Residences

Stormwater goes directly to our groundwater, lakes, streams and to Puget Sound. It does not go to the wastewater treatment plant.

The actions we take each day in and around our homes have a profound effect on surface water quality and fish habitat. Stormwater goes directly to our groundwater, lakes, streams, and to Puget Sound. It does not go to the wastewater treatment plant. Any pollutants that get into the stormwater go directly to surface or groundwater. Small amounts of pollution from many different sources can significantly affect our waterways. Stormwater BMPs discussed in this section are practical ways to keep stormwater from becoming polluted in the first place. It is recommended that all residents in Thurston County use these BMPs. **Please note that some of these procedures are required by various state, or county laws, and are noted as required BMPs.**

This section provides a general list of activities typically conducted by home owners and describes the BMPs that may be required or recommended to prevent stormwater pollution. The list includes brief information on applicability. More detailed information for the BMPs described in this section can be found in the Thurston County Drainage Design and Erosion Control Manual, Volume IV or by contacting the Thurston County Water Resources Division of the Resource Stewardship Department at (360) 754-4681. BMPs for the following activities are described in this section:

1. ***Automobile Washing***
2. ***Automobile Maintenance***
3. ***Storage of Solid Wastes and Food Wastes***
4. ***Composting***
5. ***Yard Maintenance and Gardening***
6. ***Swimming Pool and Spa Cleaning and Maintenance***
7. ***Household Hazardous Material use, Storage and Disposal***
8. ***Pet Waste Management***
9. ***On-Site Sewage Maintenance and Operation***
10. ***Activities in Wetlands and Wetlands Buffers***
11. ***Illicit Discharge Detection and Elimination***

1
Automobile Washing

Many residents wash their cars in the driveway or on the street. Wash waters typically flow to a storm drain or ditch, which discharges stormwater directly to the underlying groundwater or to the nearest stream, lake, or Puget Sound. Soaps and detergents, even the biodegradable ones, can have immediate and long-term effects on aquatic life in water bodies. The grime washed off the car also contains a variety of pollutants that can harm fish and wildlife.

Suggested BMPs

At Home:

- Wash your car directly over your lawn or make sure the wash water drains to a vegetated area. This allows the water and soap to soak into the ground instead of running off into a local water body.
- Ideally, no soaps or detergents should be used, but if you do use one, select one without phosphates.
- Commercial products are available that allow you to clean a vehicle without water. These were developed for areas where water is scarce, so a water saving benefit is realized, as well as reduced pollution.
- Use a hose nozzle with a shut-off valve to save water.
- Do not wash your car if rain is expected.
- Pour the bucket of soapy, dirty wash water down your sink. This way the water doesn't pollute surface water. Instead, it's treated at the wastewater treatment plant or by your septic system.

Away from Home:

- Consider not washing your car at home. Take it to a commercial car wash that has a recycle system and discharges wastewater to the sanitary sewer for treatment.

2
Automobile Maintenance

Many of us are "weekend mechanics". We enjoy the cost savings of changing our own oil and antifreeze, topping off the battery with water, and generally making our car perform its' best. There is a lot of potential for stormwater pollution associated with these activities; however, the following BMPs will help you minimize pollution while servicing your car, truck, van, or RV.

Required BMPs

- Recycle all oils, antifreeze, solvents, and batteries. Many local car parts dealers and gas stations accept used oil and oil filters. The Household Hazardous Waste facilities at the Thurston County Waste and Recovery Center accept oil, oil filters, antifreeze, and solvents.

- Never dump new or used automotive fluids or solvents on the ground, in a storm drain or street gutter, or in a water body. Eventually, it will make its way to local surface waters or groundwater, including the water we drink.

- Do not mix wastes. The chlorinated solvents in some carburetor cleaners can contaminate a huge tank of used oil, rendering it unsuitable for recycling. Always keep your wastes in separate containers which are properly labeled and store them out of the weather.

Never dump new or used automotive fluids or solvents on the ground, in a storm drain or street gutter...

Suggested BMPs

- Fix all leaks, to keep the leaky material off streets and out of surface water.

- To dispose of oil filters, punch a hole in the top and let drain for 24 hours. This is where a large funnel in the top of your oil storage container will come in handy. After draining, wrap in 2 layers of plastic and dispose of in your regular garbage or recycle by taking it to the Thurston County Waste and Waste and Recovery Center. Call the Thurston County Department of Public Works at (360) 754-4581 for up-to-date information on the appropriate disposal of consumer products.

- Use care in draining and collecting antifreeze to prevent accidental spills. Spilled antifreeze tastes sweet and can be deadly to animals that ingest it.

- Perform your service activities on concrete or asphalt or over a plastic tarpaulin to make spill cleanup easier. Keep a bag of kitty litter on hand to absorb spills. If there is a spill, sprinkle a good layer on the spill, let it absorb for a little while and then sweep it up. Place the

contaminated litter in a plastic bag, tie it up, and dispose of it in your regular garbage. Take care not to leave kitty litter out in the rain; it will form a sticky goop that is hard to clean up.

- If you are doing body work outside, be sure to use a tarpaulin to catch material resulting from grinding, sanding, and painting. Dispose of this waste by double bagging in plastic and placing in your garbage.

Spilled antifreeze tastes sweet and can be deadly to animals that ingest it.

3
Storage of Solid Wastes and Food Wastes

Improper storage of food and solid waste at residences can lead not only to water pollution problems, but problems with neighborhood pets and vermin as well. Following the BMPs listed below can help keep your property a clean and healthy place to live.

Suggested BMPs

- Recycle as much as you can. Most Thurston County residents have access to curbside pickup for yard waste and recyclable materials. Also, look under "recycling" in the phone book for firms which take other recyclables.

- All waste containers kept outside should have lids. If your lid is damaged, please call your local solid waste hauler to get the lid repaired or replaced. The Thurston County web site lists haulers for your neighborhood: www.co.thurston.wa.us/wwm/

- Leaking waste containers should be replaced. If your container is damaged, please call your local solid waste hauler.

- Store waste containers under cover if possible, or on grassy areas.

- Inspect the storage area regularly to pick up loose scraps of material and dispose of them properly.

- Purchase products which have the least amount of packaging materials.

- Compost biodegradable materials such as grass clippings and vegetable scraps instead of throwing them away. Your flowerbeds will love the finished compost, and you'll be helping to conserve limited landfill space. Call Thurston County Department of Public Works at (360) 754-4581 for more information on composting or information on yard waste collections. See the section on composting for BMPs relating to that activity.

- A fun alternative to traditional composting is worm composting. You can let worms do all the work for you by keeping a small vermiculture box just outside your kitchen. For more information on getting started with worms, call the number listed above.

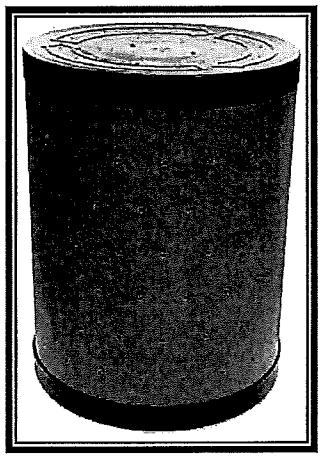
4
Composting

Composting is an earth-friendly activity as long as some common sense rules outlined below are followed. If you choose to compost, the following BMPs should be utilized. More information can be found on-line at: <www.co.thurston.wa.us/wwm/>

Suggested BMPs

- Compost piles must be located on an unpaved area where runoff can soak into the ground or be filtered by grass and other vegetation. Compost piles should be located in an area of your yard not prone to water ponding during storms, and should be kept well away from wetlands, streams, lakes, and other drainage paths.
- Compost piles must be maintained and turned over regularly to work properly. Large piles of unattended compost may create odor and vermin problems.
- Avoid putting hazardous, inorganic, plastics or metal waste in the pile.
- Cover the compost pile (See Figure) for two reasons:

    1. To keep stormwater from washing nutrients into waterways.
    2. To keep excess water from cooling the pile—this slows down the rate of decomposition.



(photo courtesy of Green Culture)

Figure: Covered Compost Bin.

- Build bins of wood, chicken wire, or fencing material to contain compost so it can't be washed away. You can purchase reduced price compost bins through Thurston County's web-site or find information on building your own bins. Call Thurston County Department of Public Works at (360) 754-4581 to get free composter designs and materials lists or see: <www.co.thurston.wa.us/wwm/>.

- Building a small earthen dike around your compost pile is an effective means of preventing nutrient-rich compost drainage from reaching stormwater paths.

Compost piles should be located in an area of your yard not prone to water ponding during storms, and should be kept well away from wetlands, streams, lakes and other drainage paths.

5
Yard Maintenance and Gardening

This section deals with the normal yard maintenance activities we all perform at our homes. Over watering, over fertilizing, improper herbicide application, and improper disposal of trimmings and clippings can all contribute to serious water pollution problems. Following the BMPs listed below will help alleviate pollutant runoff.

Required BMPs

- Follow the manufacturer's directions exactly for mixing and applying herbicides, fungicides, and pesticides, and use them sparingly. Never apply when it is windy or when rain is expected. Never apply over water, within 100 feet of a well-head, or adjacent to streams, wetlands, or other water bodies. Triple-rinse empty containers, using the rinsate for mixing your next batch of spray, and then double-bag and dispose of the empty container in your regular garbage. Never dispose of grass clippings or other vegetation in or near storm drains, streams, lakes, or Puget Sound.

Suggested BMPs

- Use natural, organic soil amendments when possible. The excellent soil conditioning properties of the organic matter aid water retention in lighter soils and help to break up and aerate heavier soils, so roots can grow better and less watering is needed. It contains both readily available and long term nitrogen and other nutrients commonly lacking in Northwest soils. The slow release of nitrogen better matches the needs of plants. Thus, there is much less potential for nitrates to leach into surface or groundwater due both to less "excess nitrogen" and less water use. Better vegetative growth can also reduce erosion and runoff.

Use natural, organic soil amendments when possible...The slow release of nitrogen better matches the needs of plants.

- Follow manufacturer's directions when applying fertilizers. More is not better, either for your lawn or for local water bodies. Never apply fertilizers over water or adjacent to ditches, streams, or other water bodies. Remember that organic fertilizers have a slow release of nitrogen, and less potential to pollute then synthetic fertilizers.

- Save water and prevent pollution problems by watering your lawn sensibly. Lawns and gardens typically need the equivalent of 1 inch of rainfall per week. You can check on how you're doing by putting a wide mouth jar out where you're sprinkling, and measure the water with a small plastic ruler. Overwatering to the point of runoff can carry polluting nutrients to the nearest water body.

Lawns and gardens typically need the equivalent of 1 inch of rainfall per week.... Put a wide mouth jar out when sprinkler, and measure the water with a small plastic ruler.

- Consider planting a vegetated buffer zone adjacent to streams or other water bodies on your property. Call the Thurston County Conservation District at (360) 754-3588 for advice and assistance in developing a planting plan. The Stream Team program (360) 754-4681 at the County may even be able to help you plant it!

- Reduce the need for pesticides and fertilizers on lawns by improving the health of the soil. Aerating, thatching, and topdressing with compost will improve soil health and help desired grasses compete with weeds and moss.

- Make sure all fertilizers and pesticides are stored in a covered location. Rain can wash the labels off of bottles and convert 50 pounds of boxed fertilizer into either a solid lump or a river of nutrients.

- Use a mulching mower and mow higher to improve soil/grass health and reduce or eliminate pesticide use.

- Compost all yard clippings, or use them as mulch to save water and keep down weeds in your garden. See Composting section for more information.

Aerating, thatching, and topdressing with compost will improve soil health and help desired grasses compete with weeds and moss.

- Practice organic gardening and virtually eliminate the need to use pesticides and fertilizers. Contact Thurston County Cooperative Extension at (360) 786-5445 for information and classes on earth-friendly gardening.

- Pull weeds instead of spraying and get some healthy exercise, too. If you must spray, use the least toxic formulations that will get the job done. The Master Gardener program listed above can help advise you on which spray to use.

- Work fertilizers into the soil instead of letting them lie on the ground surface exposed to the next rain storm.

- Plant native vegetation which is suited to Northwest conditions, they require less water and little to no fertilizers and pesticides.

- Contact your local waste disposal company for curbside pickup and recycling of yard waste.

6
Swimming Pool and Spa Cleaning and Maintenance

Despite the fact that we immerse ourselves in it, the water from pools and spas is far from chemically clean. Nutrients, pH, and chlorine can adversely affect fish and wildlife in water bodies. Following these BMPs will ensure the cleanliness of your pool and the environment.

Required BMPs

- Pool and spa water must be dechlorinated to 0.1 mg/L if it is to be emptied into a ditch or to the stormwater drainage system. Contact your pool chemical supplier to obtain the neutralizing chemicals you will need. The rate of flow into the ditch or drainage system must be regulated so that it does not cause problems such as erosion, surcharging, or flooding. Water discharged to the ground or a lawn must not cross property lines and must not produce runoff.

- If pool and spa water cannot be dechlorinated, it must be discharged to the sanitary sewer. Prior to draining, your local sewer provider must be notified to ensure they are aware of the volume of discharge and the potential effects of chlorine levels. A pool service company can help you determine the frequency of cleaning and backwash of filters.

- Diatomaceous earth used in pool filters cannot be disposed of in surface waters, on the ground, or into stormwater drainage systems or septic systems. Dry it out as much as possible, bag it in plastic, and dispose of at the landfill.

Suggested BMPs

Hire a professional pool service company to collect all pool water for proper disposal. Make sure to ask them where they will dispose of it and the kind of permits they hold to do so.

7
Household Hazardous Material use, Storage and Disposal

Once we really start looking around our houses, the amount of hazardous materials we have on site is a real eye-opener. Oil-based paints and stains, paint thinner, gasoline, charcoal starter fluid, cleaners, waxes, pesticides, fingernail polish remover, and wood preservatives are just a few hazardous materials that most of us have around the house.

When products such as these are dumped on the ground or in a storm drain, they can be washed directly to receiving waters where they can harm fish and wildlife. They can also infiltrate into the ground and contaminate drinking water supplies. The same problem can occur if they are disposed of with your regular garbage; the containers can leak at the landfill and contaminate groundwater. The same type of contamination can also occur if hazardous products are poured down a sink or toilet into a septic system. Don't pour them down the drain if you're on municipal sewers, either. Many compounds can "pass through" the wastewater treatment plant without treatment and contaminate receiving waters, or they can harm the biological process used at the treatment plant, reducing overall treatment efficiency.

With such a diversity of hazardous products present in all homes in Thurston County, a large potential for serious environmental harm exists if improper methods of storage, usage, and disposal are employed. Using the following BMPs will help keep these materials out of our soils, sediments, and waters.

Don't pour them down the drain... Many compounds can "pass through" the wastewater treatment plant without treatment and contaminate receiving waters.

Required BMPs

- Hazardous Materials must be used in accordance with the manufacturer recommendation or guidelines as shown on the label.

- Always store hazardous materials in properly labeled containers, never in food or beverage containers which could be misinterpreted by a child as something to eat or drink.

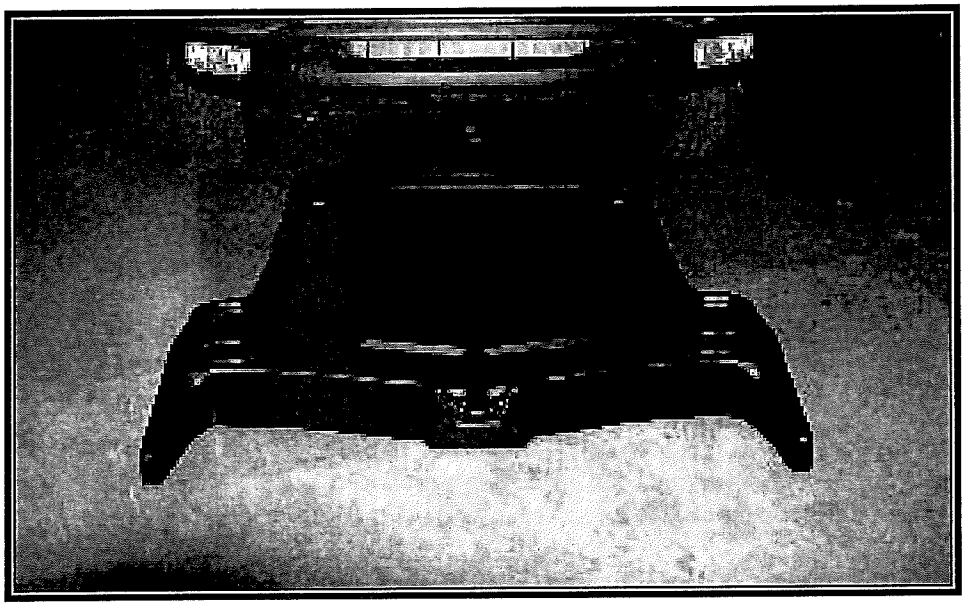
- Dispose of hazardous materials and their containers properly. Never dump products labeled as *poisonous*, *corrosive*, *caustic*, *flammable*, *inflammable*, *volatile*, *explosive danger*, *warning*, *caution*, or *dangerous* outdoors, in a storm drain, or into sinks, toilets or drains. Call the Thurston County Department of Public Works at (360) 754-4581 for information on disposal methods, collection events, and alternative products. Household hazardous wastes from Thurston County residents and non-residents are accepted at the HazoHouse, at the

Thurston County Waste and Recovery Center in Hawks Prairie at 2418 Hogum Bay Road NE.

Household hazardous wastes from Thurston County residents and non-residents are accepted at the HazoHouse, at the Thurston County Waste and Recovery Center in Hawks Prairie...

Suggested BMPs

- Check hazardous material containers frequently for signs of leakage. If a container is rusty and has the potential of leaking soon, place it in a secondary container before the leak occurs and prevent a cleanup problem.
- Hazardous materials should be stored out of the reach of children.
- Store hazardous materials containers under cover and off the ground. Keep them out of the weather to avoid rusting, freezing, cracking, labels being washed off, etc.
- Keep appropriate spill cleanup materials on hand. Kitty litter is good for many oil-based spills.
- Ground cloths and drip pans must be used under any work outdoors which involves hazardous materials such as oil-based paints, stains, rust removers, masonry cleaners, and others bearing label warnings as outlined above (See Figure).
- Latex paints are not a hazardous waste, but are not accepted in liquid form at the landfill. To dispose of, leave uncovered in a protected place until dry, then place in the garbage. If your can is at least half full, you can take it to the HazoHouse to be placed in Swap Shop area. If you wish to dry waste paint quickly, mix kitty litter or sawdust in the can to absorb the paint. Once paint is dry, leave the lid off when you place it in the garbage so your garbage collector can see that it is no longer liquid.
- Use less toxic products whenever possible. Ecology maintains a hotline at 1-800-RECYCLE, or see information online at https://fortress.wa.gov/ecy/recycle/
- If an activity involving the use of a hazardous material can be moved indoors out of the weather, then do so. Make sure you can provide proper ventilation, however.



Drip Pan for Capturing Spills and Drips During Engine Repair and Maintenance.

- Follow manufacturers' directions in the use of all materials. Over-application of yard chemicals, for instance, can result in the washing of these compounds into receiving water bodies. Never apply pesticides when rain is expected.

- When hazardous materials are in use, place the container inside a tub or bucket to minimize spills and store materials above the local base flood elevation (BFE).

Latex paints are not a hazardous waste... leave uncovered in a protected place until dry, then place in the garbage.

8
Pet Waste Management

Pet waste that washes into lakes, streams or Puget Sound begins to decay, using up oxygen and releasing ammonia. Low oxygen levels and ammonia combined with warm water can kill fish. Pet waste also contains nutrients that encourage weed and algae growth in waters we use for swimming, boating and fishing. Most importantly, in many urban areas, pet waste is the largest source of bacterial loading to streams. It can carry diseases that could make water unsafe for contact and lead to beach closures or affect shellfish harvest. These include:

- Campylobacteriosis—bacterial infection
- Salmonellosis—bacterial infection
- Toxocariasis—roundworm infection
- Toxoplasmosis—protozoan parasite infection
- Giardiasis—protozoan parasite infection
- Fecal Coliform—bacteria in feces, indicates contamination
- *E. coli*—bacteria in feces, may cause disease.

Pet waste is the largest source of bacterial loading in streams. It can carry diseases that could make water unsafe for contact and lead to beach closures or affect shellfish harvest.

Cleaning up after your pet can be as simple as taking a plastic bag or pooper scooper along on your next walk. Then choose one of the following:

Suggested BMPs

- **Bag it** – Put waste in a securely closed bag and deposit it in the trash. Do not put it in your yard waste container because pet waste may carry diseases, and yard waste treatment may not kill disease organisms.

- **Bury it** – Bury waste at least 1 foot deep and cover with soil in your yard or garden (not in food-growing areas).

- **Flush it** – Only flush pet wastes if your home is served by a sanitary sewer which goes to a sewage treatment plant. Water from your toilet goes through a treatment process that removes pollutants before it is discharged into the environment.

To prevent plumbing problems, don't flush debris or cat litter. Cat feces may be flushed, but used litter should be put in a securely closed bag in the trash. Septic systems are not designed to accommodate the high pollutant load of pet waste. To prevent premature failure or excessive maintenance costs do not flush pet wastes to your septic system.

To prevent premature failure or excessive maintenance costs do not flush pet wastes to your septic system.

- **Compost it** – waste from small animals **other than dogs and cats** (rabbits, rodents, etc.), can be put in your compost bin.

9
On-Site Sewage Maintenance and Operation

Thurston County is responsible for ensuring that stormwater discharged from stormwater management systems we operate does not harm or impair the use of the receiving waters (creeks, rivers, lakes, groundwater or Puget Sound). Sample tests of stormwater discharges and receiving water occasionally indicate high levels of fecal coliform bacteria.

One potential source of bacteria in surface water is malfunctioning onsite sewage systems (septic systems). Septic tank failures have been documented on private property in Thurston County.

Septic systems vary widely in their design and complexity. Owners of septic systems should contact the Thurston County Department of Public Health and Social Services (Environmental Health Division) at (360) 754-4111 to request an as-built of their system. As-built requests are also available at the Development Review counter at 2000 Lakeridge Drive SW, Olympia. More information is available at: <www.co.thurston.wa.us/permitting>.

In its simplest design the septic tank is the first stage of a private sewage disposal system. The septic tank is a water-tight tank below ground that is usually made of concrete but may be fiberglass, plastic or steel. Septic tanks have one or two access ports for inspection and maintenance which are usually buried a few inches below the ground.

The tank receives household wastewater through an inlet pipe at one end, settles out larger material to the bottom, breaks down waste material with bacteria present in the tank and delivers the partially treated wastewater out another pipe on the opposite end of the tank to the disposal field.

The disposal field is the second stage of the private sewage disposal system and completes the final breakdown of wastewater with organisms in the soil.

The disposal field consists of narrow trenches filled with gravel and perforated pipes that distribute the wastewater to the field. With proper maintenance, a well designed system can last a long time; however, disposal fields will clog if forced to handle large particles that should settle out in the bottom of the septic tank.

One potential source of bacteria in surface water is malfunctioning onsite sewage systems.

Required BMPs

Owners of septic systems must follow all of the requirements of the Thurston County Department of Public Health and Social Services, Environmental Health Division. They can be contacted at Thurston County Health Department at (360) 754-3355 extension 6518 for further information and specific requirements applicable to your system.

Suggested BMPs

- **Regular Inspection and Maintenance**
  Septic tanks require regular inspection and maintenance. Inspections should be done to measure accumulated sludge every 3 to 5 years. Pumping frequency can vary depending on tank size, family size and garbage disposal use. Failure to remove sludge periodically will result in reduced settling capacity and eventual overloading of the disposal field, which can be difficult and expensive to remedy. Maintenance is required on complex systems, those serving more than one single family residence, and commercial establishments.

- **Eliminate or Restrict Garbage Disposal Use**
  Eliminating or restricting garbage disposals can significantly reduce the loading of solids to the septic tank thus reducing the pumping frequency.

- **Reduce and Spread Water Use Out Over the Day**
  Septic tanks are limited in their ability to handle rapid large increases in the amount of water discharged into them. Excess wastewater flow can cause turbulence in the tank flushing accumulated solids into the disposal field. Over time this will impair the ability of the disposal field to function. Limit water using appliances to one at a time. Do one load of clothes a day rather than several in one day. Practice water conservation at home.

- **Chemical Use**
  Septic systems are to be used for the disposal of household wastewater only. Never dispose of excess or unwanted chemicals into the septic system. Occasional use of household cleaners in accordance with the manufacturers' recommendations should not harm your septic system. There is little evidence that products advertised for use as septic system cleaners and substitutes for pumping actually work as advertised.

  For additional information on proper operation of your septic system or to report a failing septic system in your neighborhood, contact Thurston County Environmental Health at (360) 786-5490 or at: <www.co.thurston.wa.us/health/ehoss/index.html>.

10
Activities in Wetlands and Wetlands Buffers

Wetlands and associated buffers are vegetated ecosystems through which water passes. These areas usually have a high water table and are often subject to periodic flooding. Wetlands can be very effective in removing sediments, nutrients and other pollutants from stormwater.

Wetlands can be very effective in removing sediments, nutrients and other pollutants from stormwater.

Maintaining wetlands and associated buffers helps to slow stormwater runoff, trap sediments and other pollutants and reduce the volume of runoff by allowing infiltration to occur. Reducing the velocity of runoff reduces soil erosion and increases contact time with soil and vegetation. Increasing contact of stormwater with soils and vegetation in a wetland or riparian area can be effective in removing sediments, nutrients and other pollutants from stormwater runoff.

Buffer areas are important to both the wetland and the upland areas as habitat for aquatic wetland-dependant wildlife and as buffers during extreme weather events. Other functions of buffer areas that contribute to water quality include shading, flood attenuation and shoreline stabilization.

Persons responsible for maintenance of wetland areas are encouraged to call Thurston County Development Services at (360)786-5490 prior to performing work in wetlands or their buffers.

Required BMPs

- Removal by hand of manmade litter and control of noxious weeds that are included on the state noxious weed list (Washington Administrative Code [WAC] 16-750) or invasive plant species as identified by Thurston County. Control may be conducted by clipping, pulling, over-shading with native tree and shrub species, or non-mechanized digging. Alternative methods such as mechanical excavation, barrier installation, or herbicide use may be allowed if acceptable to the Department of Resource Stewardship and acquisition of any necessary permits, per Thurston County Code Title 17 *Environment*, 17.15 - *Critical Areas.*

- Check with Thurston County Development Services and Planning on guidelines for vegetation and hazardous tree removal in critical areas.

Suggested BMPs

- To prevent possible contamination limit fertilizer and herbicide use around wetlands and their buffers.

- Limit access to wetlands and their buffers. To avoid compaction do not establish trails within the wetland areas

11
Illicit Discharge Detection and Elimination

A common problem with Thurston County's stormwater drainage system is illegal hook-ups to the system. Many businesses and residences hooked internal building drains, sump overflows, and even sanitary sewer and septic system pipes to the storm drain in the past, allowing a variety of pollutants to flow directly to receiving waters instead of the sanitary sewer or septic system. Frequently, these connections are unknown to the current owner, and do not appear on any plans for the site. Because of the pollution potential these connections represent, the Environmental Protection Agency, under the mandate of the NPDES stormwater permits, has made elimination of illegal connections a top priority.

All businesses and residences in Thurston County must examine their plumbing systems to determine if illegal connections exist. We recommend starting with site plans, to better understand what piping systems were initially installed, making piping that does not appear on the plan a priority for investigation. Wherever toilets, sinks, appliances, showers and bathtubs, floor drains, or other indoor activities are connected to the stormwater drainage system, immediately reroute them to the sanitary or septic system or holding tanks.

All businesses and residences in Thurston County must examine their plumbing systems to determine if illegal connections exist.

If sanitary facilities (such as toilets) are connected to the stormwater drainage system, you must obtain a permit from your local sewer utility and reroute them to the sanitary sewer. If sanitary service is not available, contact the Thurston County Public Health and Social Services Department at (360) 786-5581 for septic permits.

Dye Testing

Dye testing with a non-toxic dye is one way to determine where a pipe or structure drains if not obvious by observations or on plans. The dye is put into the structure and flushed with some water. Observations are then made at ends-of-pipes, drainage ditches, catch basins, and manholes to look for the color coming through. Contact Thurston County Department of Resource Stewardship, Water Resources Unit (360) 754-4681 if you need assistance in locating structures adjacent to your property.

Smoke Testing

Smoke testing can also help detect illegal connections and is best done by qualified personnel. To conduct smoke testing, shut off all indoor discharges, place a smoke bomb or other smoke-generating device in a storm drain manhole, and force air in after it. Station personnel at each suspect drain location to observe if smoke is coming out. Identify smoking drains for future rerouting.

Plugging or Rerouting Illicit Discharges

Drains which are found to connect to the stormwater drainage system must either be permanently plugged or disconnected and rerouted as soon as possible. Plug unused drains with concrete or similar permanent materials. If a drain pipe is to be rerouted and a sanitary sewer services the property, then the local sewer provider must be contacted. It is the responsibility of the property owner to follow through on rerouting illicit storm drainage connections to the sanitary sewer.

> *It is the responsibility of the property owner to follow through on rerouting illicit storm drainage connections to the sanitary sewer.*

If the property is not served by a sanitary sewer, alternate measures will be necessary. If the discharge is simply domestic waste, a septic system may be feasible. If it is necessary to install a septic system, the proper permits will need to be obtained from the Thurston County Public Health and Social Services Department at (360) 786-5581. If the discharge is anything other than domestic waste, then a holding tank or onsite treatment will be necessary. Contact LOTT Alliance Industrial Pretreatment Program at (360) 528-5708 or your local sewer service provider for specific directions for installation and disposal.

APPENDIX A – Reports

INSIGHT GEOLOGIC, INC.

Stormwater Evaluation Services

Proposed Conwell Plat Subdivision

Prepared For:

Hatton Godat Pantier

INSIGHT GEOLOGIC, INC.

July 30, 2013

Hatton Godat Pantier
3910 Martin Way East, Suite B
Olympia, Washington 98506
Attention: Steven Hatton, P.E.

Report
Stormwater Evaluation Services
Proposed Conwell Plat Subdivision
Olympia, Washington
Project No. 622-001-01

INTRODUCTION

Insight Geologic is pleased to provide our report of evaluation of stormwater infiltration conditions at the proposed Conwell residential subdivision located near the intersection of Marvin Road SE and Forest Drive SE in Thurston County, Washington. The location of the site relative to surrounding physical features is shown in the Vicinity Map, Figure 1.

The project site comprises approximately 20 acres and is currently undeveloped. Elevations on the property range from about 300 feet above mean sea level (MSL) in the northern portion of the property to about 200 feet MSL in the southern portion. Our project understanding is based on conversations with Hatton Godat Pantier (HGP) personnel and information provided. We understand that conceptual plans for the subdivision include 100 residential lots for single-family residences with appurtenant street areas.

SCOPE OF SERVICES

The objective of our services was to explore the groundwater conditions as a basis for developing on-site stormwater infiltration. Our specific scope of services included the following tasks:

1. Coordinate the location and clearance of underground utilities in the area of our proposed explorations. We contacted the "One Call" utility locating service to coordinate the clearance of publically owned utilities within right-of-ways.
2. Explore the subsurface site conditions using auger borings and backhoe-excavated test pits. Our borings were executed using a truck-mounted drill rig fitted with hollow-stem augers. Soil samples were collected at intervals of 5 feet or less for borings in the proposed stormwater infiltration area. Insight Geologic maintained a log of the conditions encountered. Test pits were excavated in several locations to evaluate the potential for stormwater disposal from the residences to dry wells.

3. Conduct grain-size distribution analyses (sieves) on as many as 13 soil samples from the borings. Additional sieves may be required if the soil profile is substantially heterogeneous, or if a more detailed infiltration analysis is required by Thurston County.
4. Utilizing the sieve results, provide design infiltration rates for each of the analyzed soil samples in general accordance with the "Detailed Method" as described in the Thurston County 2009 Stormwater Manual.
5. Prepare an initial geotechnical report that provides infiltration rate estimates and our preliminary estimates for depth to seasonal high groundwater.

Our scope of services deviated from the scope of services outlined in our proposal due to access restrictions in the northern portion of the property. We completed three borings in the lower southern portion of the site in the area of the proposed stormwater pond. The northern portion of the site was instead evaluated using backhoe excavated test pits which were not included in our original proposal. Also, we utilized the Detailed Method to evaluate design infiltration rates due to the variability of the soils encountered in the borings.

FINDINGS

General

Insight Geologic drilled three borings at the site on June 12, 2013. The borings were installed using a Diedrich D-120 drill rig configured with hollow stem augers, owned and operated by Holocene Drilling of Puyallup, Washington. Representative soil samples were collected at approximately 5-foot intervals during drilling using an 18-inch long split-barrel sampler. Blow counts, which provide a measure of the relative density of the soil were collected every 6 inches over the sampling interval. The blow counts over the final 12 inches of the sampling interval are presented on the boring logs. The recovered soil samples were classified in general accordance with ASTM D2487-06 and placed into plastic bags for subsequent gradation analysis. Two borings, B-1 and B-3 were drilled to depths of 25 feet below ground surface or about five times the proposed depth of the pond. Boring B-2 was drilled to a depth of 50 feet below ground surface to evaluate the depth of seasonal high groundwater. The locations of the borings are shown in the Site Plan, Figure 2.

Six exploratory test pits were excavated in the locations shown on Figure 2, using a small, truck-mounted excavator owned and operated by Hill Construction of Olympia, Washington. The test pits were excavated to depths of between about 4.5 and 5.5 feet below ground surface and generally were terminated in dense glacial sediments. Soils exposed in the test pits were logged in general accordance with ASTM D2487-06 methodology. The test pits were backfilled with excavated soil upon completion.

Soil

Soils exposed in the exploratory test pits consisted of a thin layer of organic-rich soil overlying loose, fine to medium sand with fine to medium gravel, which is interpreted as colluvium derived from weathered glacial till. Dense, fine to coarse sand with fine to coarse gravel and silt was encountered below the colluvial layer which we interpret as glacial till. Test pit logs are contained in Attachment A.

The borings encountered interbedded fine to coarse sand and fine to coarse gravel to the full depth explored. These materials are interpreted as glacial outwash and are in a loose to moderately dense condition. A thin silt layer was encountered in boring B-3 that appears to be laterally discontinuous, but could restrict the downward movement of infiltrated stormwater in this area. Boring logs are shown in Attachment A.

Groundwater

Groundwater was encountered in Boring B-2 at a depth of approximately 47 feet below ground surface. Groundwater was not encountered in the other borings or the exploratory test pits.

LABORATORY ANALYSES

Grain-size analysis was conducted on 13 soil samples collected from borings B-2 and B-3 in accordance with ASTM D422 methodology. The purpose of the analyses was to obtain grain-size data as the basis of calculating the design stormwater infiltration rate for the proposed stormwater pond at the site. The results of the grain-size data are contained in Attachment B.

STORMWATER INFILTRATION

Stormwater Pond

We completed a stormwater infiltration rate evaluation in general accordance with the Thurston County 2009 Stormwater Manual. The Manual provides a "Simple Method" to determine design infiltration rates based on the D_{10} value from ASTM gradation results. The Simple Method is appropriate for sites with little lateral and vertical variability of the infiltration receptor soils. Based on our gradation results and soil observations during drilling, it appeared that the vertical variability of soil types in the borings was not appropriate for utilization of the Simple Method.

We utilized the Detailed Method outlined in the Manual to derive a long-term design stormwater infiltration rate for the proposed stormwater pond. Laboratory-derived grain-size values for the various soil types encountered in boring B-2 for the full depth explored, along with a nominal stormwater pond dimensions and the measured depth to groundwater. The resulting design stormwater infiltration rate was calculated at 29.5 inches per hour. The Thurston County 2009 Stormwater Manual does not allow an infiltration rate greater than 20 inches per hour, therefore, the design infiltration rate for the Conwell plat in the area of boring B-2 is 20 inches per hour. Summary tables for the Detailed Method calculations are contained in Attachment C.

Roof Downspout Runoff Control

Based on our borings and test pits conducted at the site, the northern two thirds of the property appears to be underlain by dense glacial till with a thin mantle (less than 5 feet) of weathered till soils. These soils would classify as Class C and as such do not qualify for disposal of roof runoff into on-site dry wells based on Thurston County's Design Guide No. 5 Roof Downspout Runoff Controls.

Roof downspout dispersion may be used on sites where dry wells are not feasible. Two possible exceptions from the Design Guide that may limit the use of this method on the project site are lot size and slope. It may, therefore, be practical to allow runoff from roof downspouts to flow to the stormwater pond, particularly in light of the relatively high infiltration rate of the soils.

OPINION

We have performed an evaluation of soil conditions for the proposed Conwell plat project as they relate to the infiltration of stormwater at the site. Subsurface explorations were conducted on June 12 and 20 to evaluate soil conditions at the site. The explorations revealed soils in the area of the proposed stormwater pond in the southern portion of the site to consist of sand and gravel. Infiltration rate calculations using the Detailed Method as presented in the County's Stormwater Manual resulted in a design rate exceeding the County's maximum allowable design infiltration rate of 20 inches per hour.

LIMITATIONS

We have prepared this report for use by Hatton Godat Pantier and their authorized agents. This report may be made available to regulatory agencies.

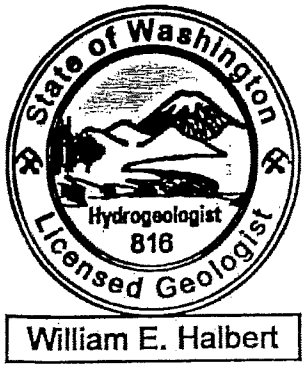
Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in this area at the time this report was prepared. No warranty or other conditions, express or implied, should be understood.

Please refer to the attachment titled "Report Limitations and Guidelines for Use" for additional information pertaining to use of this report.

We appreciate the opportunity to be of service to you on this project. Please contact us if you have questions or require additional information.

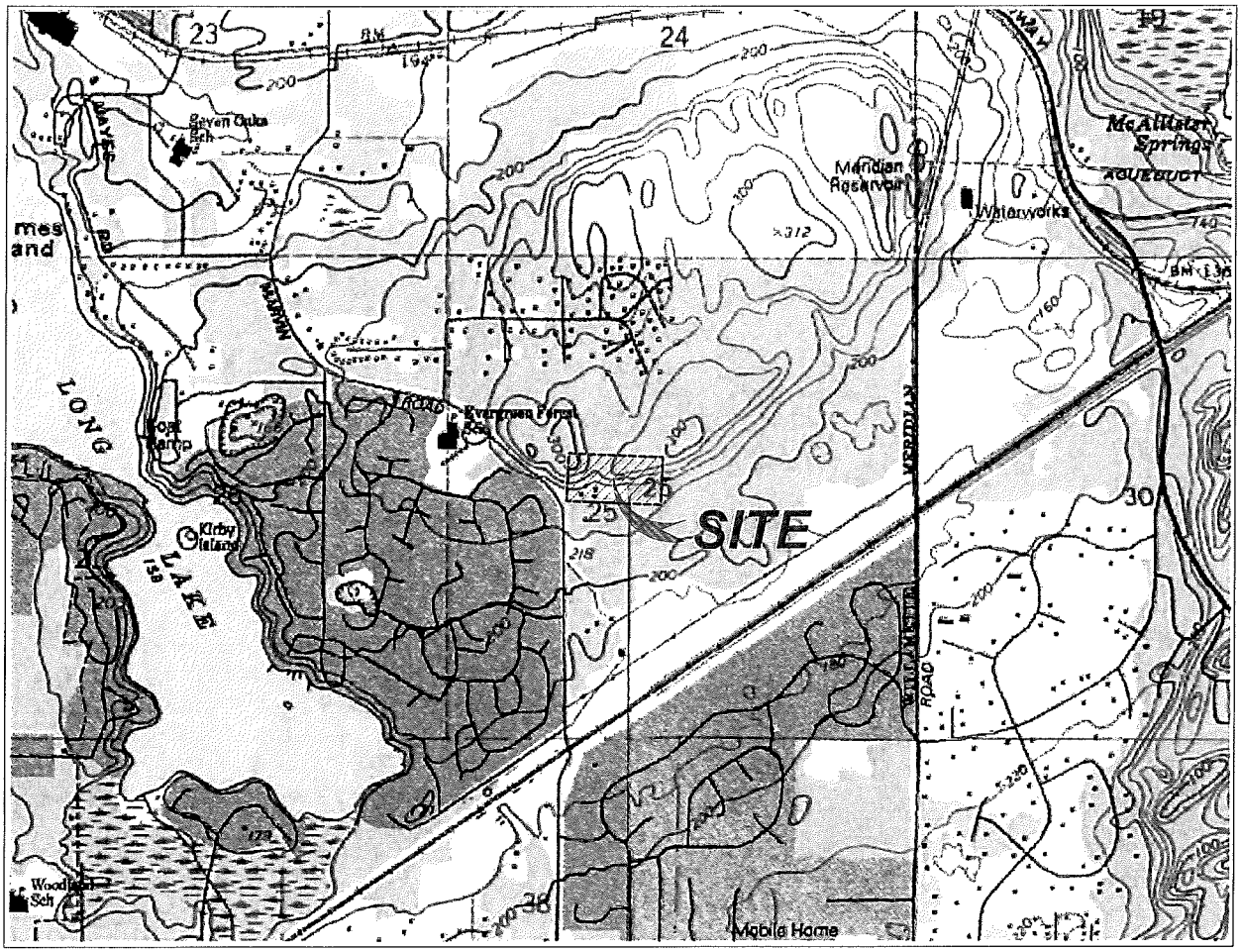
Respectfully Submitted,
INSIGHT GEOLOGIC, INC.

William E. Halbert, L.E.G., L.HG.
Principal



Attachments

FIGURES



Source: Maptech, Inc. (c) 1997

LACEY, WASHINGTON
7.5 MINUTE QUADRANGLE
Year Created 1959, Revised 1994

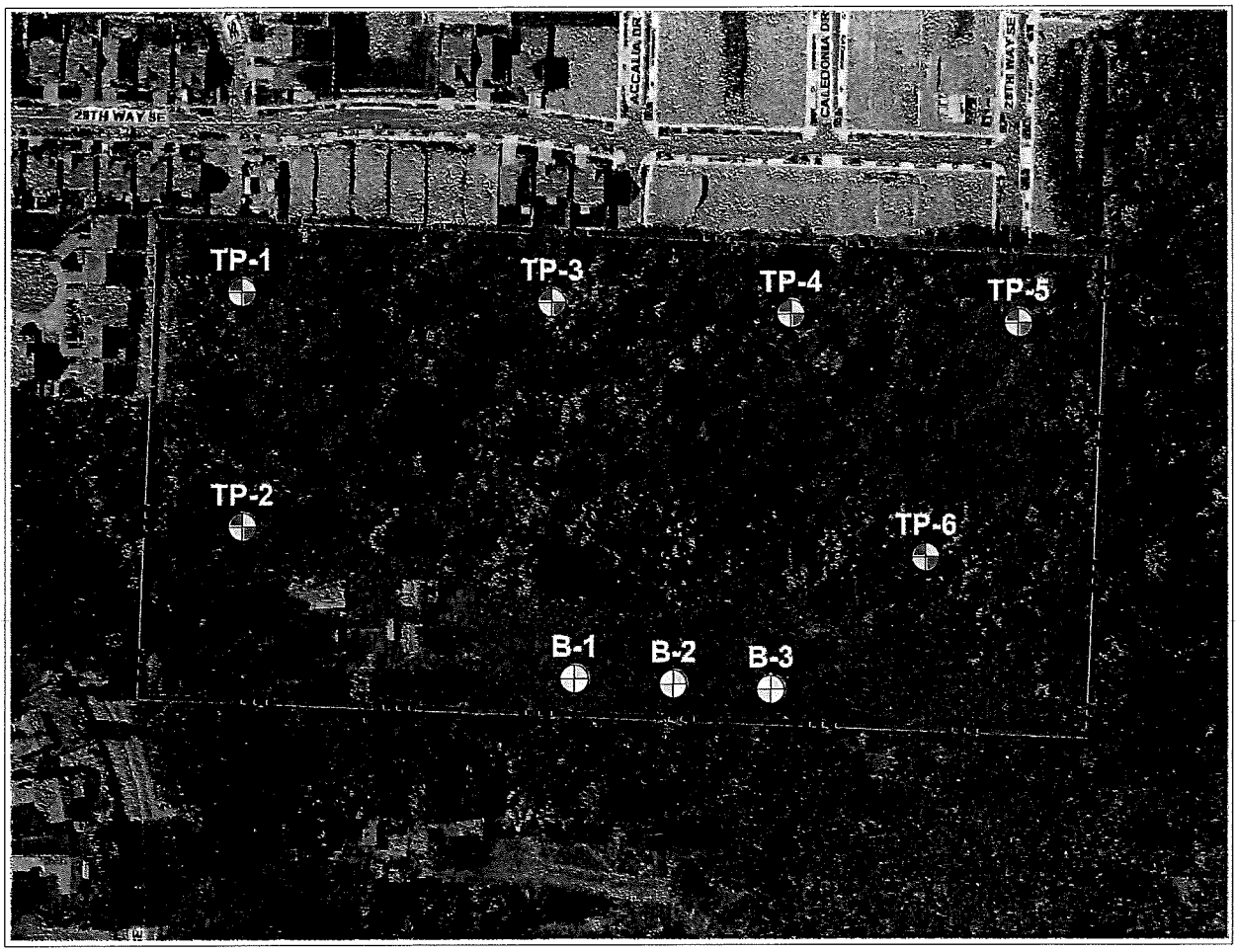
SCALE: 1: 24000

CONWELL PLAT

THURSTON COUNTY, WASHINGTON

INSIGHT GEOLOGIC, INC.

Figure 1
Vicinity Map



Source: Thurston County GeoData Center (C) image 2012

LEGEND:

B-1 ⊕ APPROXIMATE BORING LOCATION

TP-1 ◔ APPROXIMATE TEST PIT LOCATION

——··—— APPROXIMATE PROJECT BOUNDARY

0 125 150

SCALE: 1" = 250'

CONWELL PLAT

THURSTON COUNTY, WASHINGTON

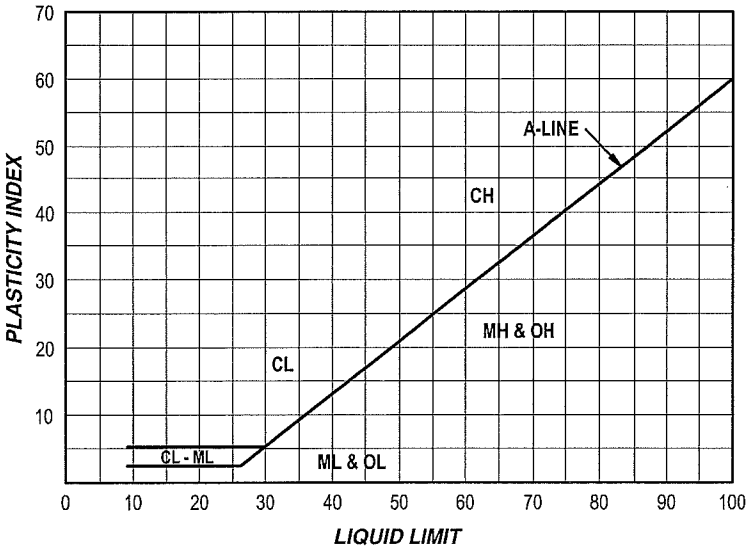
INSIGHT GEOLOGIC, INC.

Figure 2
Site Plan

ATTACHMENT A
EXPLORATION LOGS

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS		GROUP NAME
COARSE GRAINED SOILS MORE THAN 50% RETAINED ON NO. 200 SIEVE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVEL <5% FINES		GW	WELL-GRADED GRAVEL, FINE TO COARSE GRAVEL
				GP	POORLY GRADED GRAVEL
		GRAVEL WITH FINES >12% FINES		GM	SILTY GRAVEL
				GC	CLAYEY GRAVEL
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE	CLEAN SAND <5% FINES		SW	WELL-GRADED SAND, FINE TO COARSE SAND
				SP	POORLY GRADED SAND
		SAND WITH FINES >12% FINES		SM	SILTY SAND
				SC	CLAYEY SAND
FINE GRAINED SOILS MORE THAN 50% PASSING NO. 200 SIEVE	SILTS AND CLAYS LIQUID LIMIT LESS THAN 50	INORGANIC		ML	SILT
				CL	CLAY
		ORGANIC		OL	ORGANIC SILT, ORGANIC CLAY
	SILTS AND CLAYS LIQUID LIMIT 50 OR MORE	INORGANIC		MH	SILT OF HIGH PLASTICITY, ELASTIC SILT
				CH	CLAY OF HIGH PLASTICITY, FAT CLAY
		ORGANIC		OH	ORGANIC CLAY, ORGANIC SILT
HIGHLY ORGANIC SOILS				PT	PEAT



SOIL MOISTURE MODIFIERS:
DRY - ABSENCE OF MOISTURE, DUSTY, DRY TO THE TOUCH
MOIST - DAMP, BUT NO VISIBLE WATER
WET - VISIBLE FREE WATER OR SATURATED, USUALLY SOIL IS OBTAINED BELOW WATER TABLE

ADDITIONAL MATERIAL SYMBOLS

SYMBOLS		TYPICAL DESCRIPTION
	CC	CEMENT CONCRETE
	AC	ASPHALT CONCRETE
	CR	CRUSHED ROCK / QUARRY SPALLS
	TS	TOPSOIL/SOD/DUFF

GROUNDWATER EXPLORATION SYMBOLS

- MEASURED GROUNDWATER LEVEL IN EXPLORATION, WELL, OR PIEZOMETER
- GROUNDWATER OBSERVED AT TIME OF EXPLORATION
- PERCHED WATER OBSERVED AT TIME OF EXPLORATION
- MEASURED FREE PRODUCT IN WELL OR PIEZOMETER

STRATIGRAPHIC CONTACT

- APPROXIMATE CONTACT BETWEEN SOIL STRATA OR GEOLOGIC UNIT
- APPROXIMATE LOCATION OF SOIL STRATA CHANGE WITHIN GEOLOGIC SOIL UNIT
- APPROXIMATE GRADUAL CHANGE BETWEEN SOIL STRATA OR GEOLOGIC SOIL UNIT
- APPROXIMATE GRADUAL CHANGE OF SOIL STRATA WITHIN GEOLOGIC SOIL UNIT

LABORATORY / FIELD TEST CLASSIFICATIONS

- **%F** PERECENT FINES
- **AL** ATTERBERG LIMITS
- **CA** CHEMICAL ANALYSIS
- **CP** LABORATORY COMPACTION TEST
- **CS** CONSOLIDATION TEST
- **DS** DIRECT SHEAR
- **HA** HYDROMETER ANALYSIS
- **MC** MOISTURE CONTENT
- **MD** MOISTURE CONTENT AND DRY DENSITY
- **OC** ORGANIC COMPOUND
- **PM** PERMEABILITY OR HYDRAULIC CONDUCTIVITY
- **PP** POCKET PENETROMETER
- **SA** SIEVE ANALYSIS
- **TX** TRIAXIAL COMPRESSION
- **UC** UNCONFINED COMPRESSION
- **VS** VANE SHEAR

SAMPLER SYMBOLS

- 2.4 INCH I.D. SPLIT BARREL
- DIRECT-PUSH
- STANDARD PENETRATION TEST
- SHELBY TUBE
- PISTON
- BULK OR GRAB

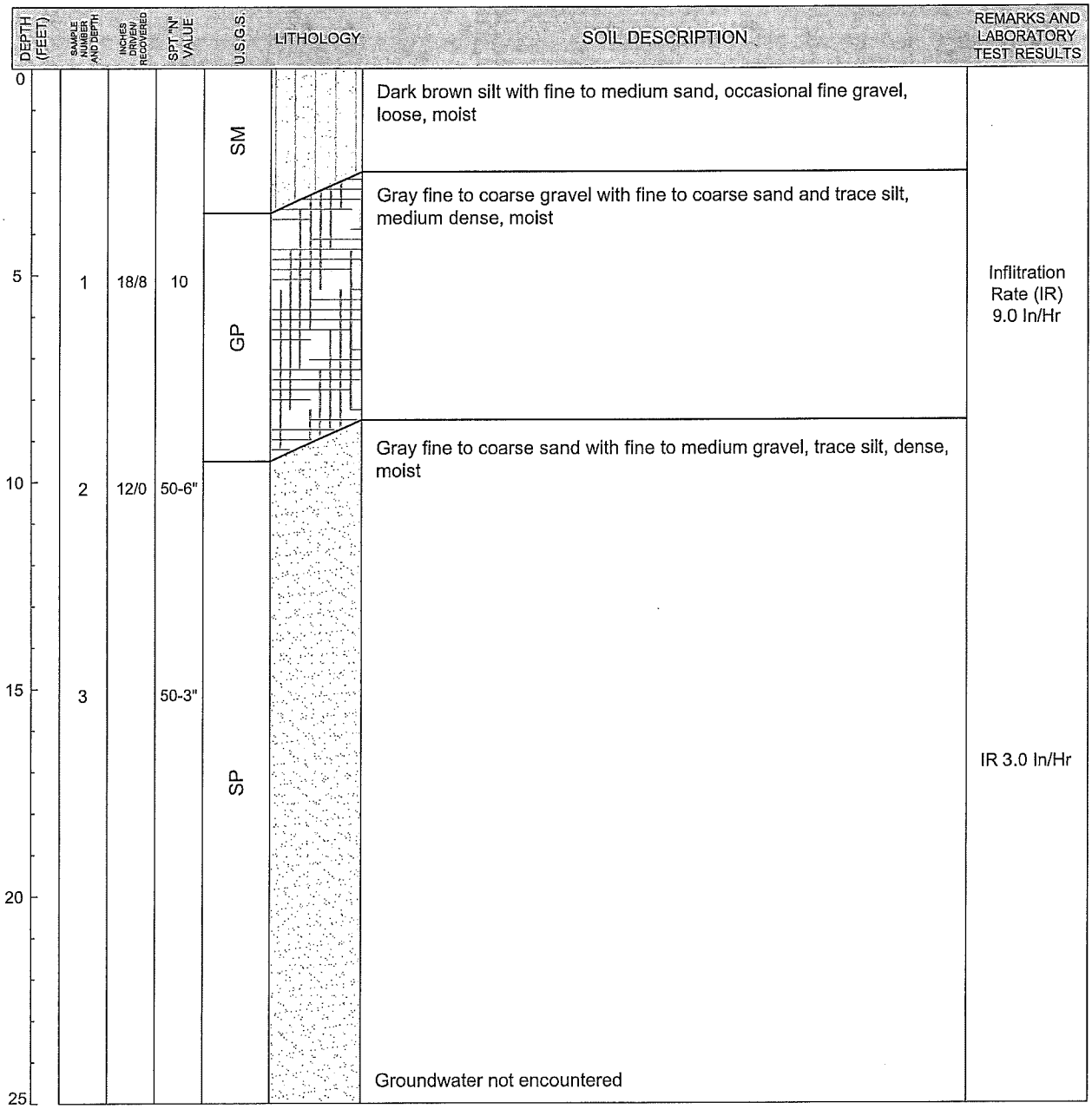
SHEEN CLASSIFICATIONS

- **NS** NO VISIBLE SHEEN
- **SS** SLIGHT SHEEN
- **MS** MODERATE SHEEN
- **HS** HEAVY SHEEN
- **NT** NOT TESTED

INSIGHT GEOLOGIC, INC.

Key to Exploration Logs

B-1



LEGEND:

PROJECT NO.: 622-001-01
DATE: JUNE 12, 2013
TOTAL DEPTH: 25 FEET
LOGGED BY: KEVIN VANDEHEY
DRILLING CONTRACTOR: HOLOCENE DRILLING
DRILLING EQUIPMENT: DIEDRICH D-120
DRILLING METHOD: HOLLOW STEM AUGER

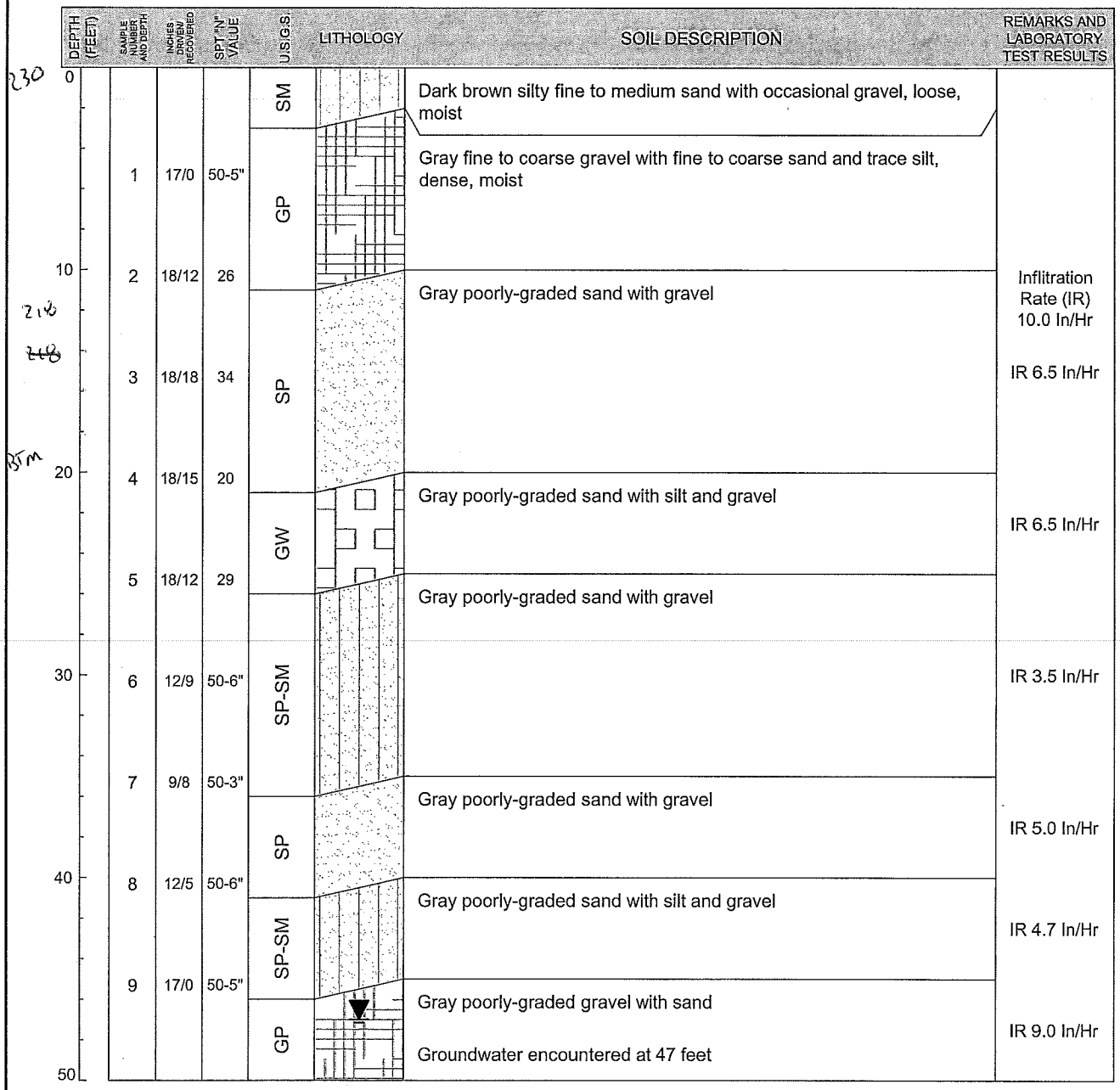
CONWELL PLAT

THURSTON COUNTY, WASHINGTON

INSIGHT GEOLOGIC, INC.

Exploration Log B-1

B-2



LEGEND:

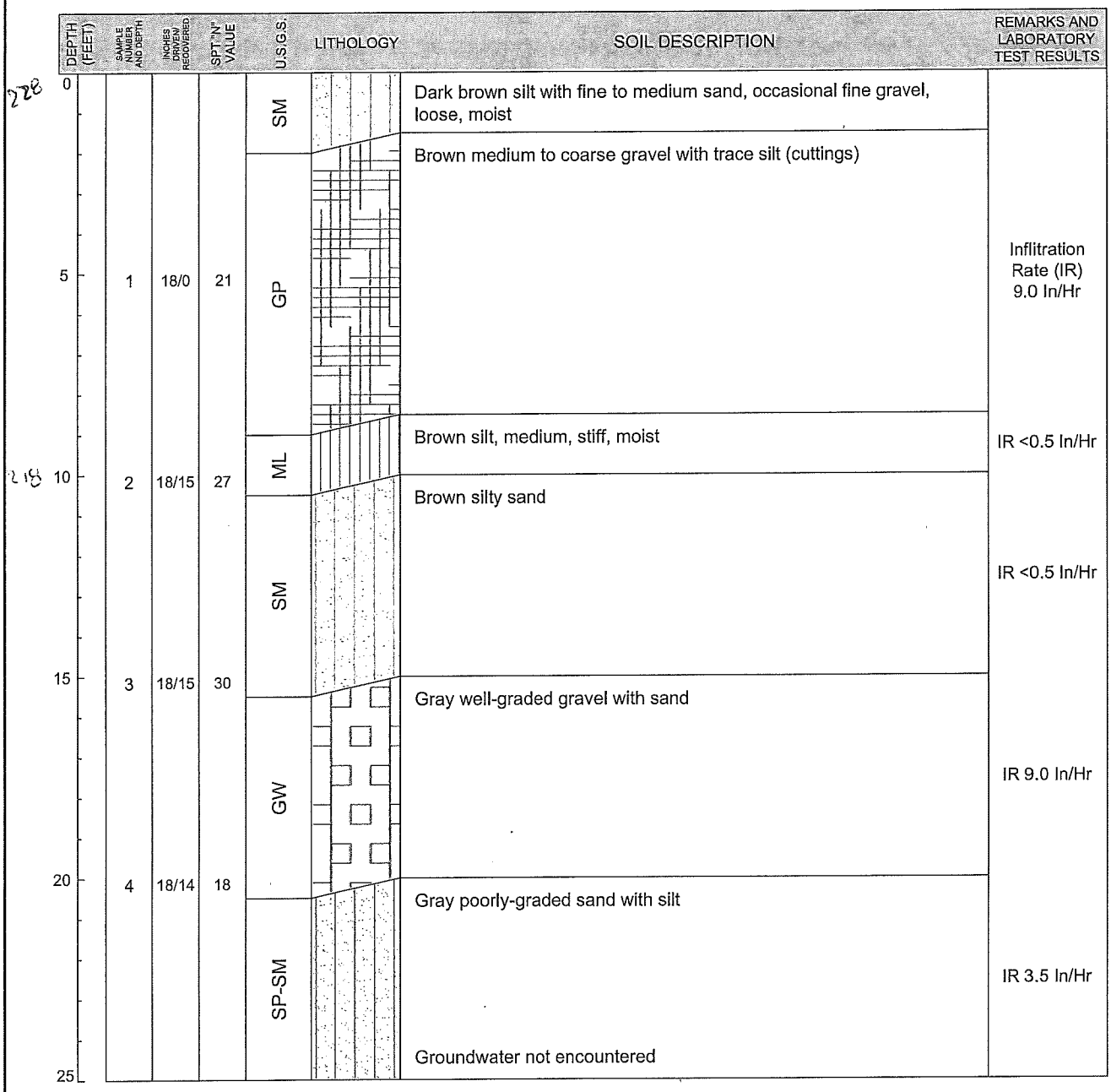
PROJECT NO.: 622-001-01
DATE: JUNE 12, 2013
TOTAL DEPTH: 50 FEET
LOGGED BY: KEVIN VANDEHEY
DRILLING CONTRACTOR: HOLOCENE DRILLING
DRILLING EQUIPMENT: DIEDRICH D-120
DRILLING METHOD: HOLLOW STEM AUGER

CONWELL PLAT
THURSTON COUNTY, WASHINGTON

INSIGHT GEOLOGIC, INC.

Exploration Log B-2

B-3



LEGEND:

PROJECT NO.: 622-001-01
DATE: JUNE 12, 2013
TOTAL DEPTH: 25 FEET
LOGGED BY: KEVIN VANDEHEY
DRILLING CONTRACTOR: HOLOCENE DRILLING
DRILLING EQUIPMENT: DIEDRICH D-120
DRILLING METHOD: HOLLOW STEM AUGER

CONWELL PLAT

THURSTON COUNTY, WASHINGTON

INSIGHT GEOLOGIC, INC.

Exploration Log B-3

TP-1

DEPTH (FT)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION	REMARKS AND LABORATORY TEST RESULTS
0	PT		Organic horizon	
1	SP-SM		Brown fine to medium sand with fine to medium gravel and silt, loose, moist (till)	
2				
3			Grades to light gray, very dense	
4			Groundwater not encountered	
5				
6				
7				
8				
9				
10				

LEGEND:

PROJECT NO.: 622-001-01
DATE: JUNE 20, 2013
TOTAL DEPTH: 3.5 FEET
LOGGED BY: KEVIN VANDEHEY
DRILLING EQUIPMENT: MINI EXCAVATOR

CONWELL PLAT

THURSTON COUNTY, WASHINGTON

INSIGHT GEOLOGIC, INC.

Exploration Log TP-1

TP-2

DEPTH (FT)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION	REMARKS AND LABORATORY TEST RESULTS
0	PT		Organic horizon	
1	SP-SM		Brown fine to medium sand with fine to medium gravel and silt, loose, moist	
2			Grades to light brown fine to coarse sand with fine to coarse gravel and silt, loose, moist	
3				
4	SP		Light gray fine to coarse sand with fine to coarse gravel, trace silt, very dense, moist (till)	
5				
6			Groundwater not encountered	
7				
8				
9				
10				

LEGEND:

PROJECT NO.: 622-001-01
DATE: JUNE 20, 2013
TOTAL DEPTH: 5.5 FEET
LOGGED BY: KEVIN VANDEHEY
DRILLING EQUIPMENT: MINI EXCAVATOR

CONWELL PLAT

THURSTON COUNTY, WASHINGTON

INSIGHT GEOLOGIC, INC.

Exploration Log TP-2

TP-3

DEPTH (FT)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION	REMARKS AND LABORATORY TEST RESULTS
0	PT		Organic horizon	
1	SP-SM		Dark brown fine to medium sand with fine to medium gravel and silt, loose, moist	
2			Grades to light brown fine to coarse sand with fine to coarse gravel and silt, loose, moist	
3				
4	SP		Light gray fine to coarse sand with fine to coarse gravel, trace silt, very dense, moist (till)	
5				
6			Groundwater not encountered	
7				
8				
9				
10				

LEGEND:

PROJECT NO.: 622-001-01
DATE: JUNE 20, 2013
TOTAL DEPTH: 5.5 FEET
LOGGED BY: KEVIN VANDEHEY
DRILLING EQUIPMENT: MINI EXCAVATOR

CONWELL PLAT

THURSTON COUNTY, WASHINGTON

INSIGHT GEOLOGIC, INC.

Exploration Log TP-3

TP-4

DEPTH (FT)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION	REMARKS AND LABORATORY TEST RESULTS
0	PT		Organic horizon	
1	SP-SM		Dark brown fine to medium sand with fine to medium gravel and silt, loose, moist	
2				
3			Grades to light brown fine to coarse sand with fine to coarse gravel and silt, loose, moist	
4			Grades to light gray, very dense, moist (till)	
5			Groundwater not encountered	
6				
7				
8				
9				
10				

LEGEND:

PROJECT NO.: 622-001-01
DATE: JUNE 20, 2013
TOTAL DEPTH: 4.5 FEET
LOGGED BY: KEVIN VANDEHEY
DRILLING EQUIPMENT: MINI EXCAVATOR

CONWELL PLAT

THURSTON COUNTY, WASHINGTON

INSIGHT GEOLOGIC, INC.

Exploration Log TP-4

TP-5

DEPTH (FT)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION	REMARKS AND LABORATORY TEST RESULTS
0	PT		Organic horizon	
1	SP-SM		Dark brown fine to medium sand with fine to medium gravel and silt, loose, moist	
2				
3			Grades to light gray fine to coarse sand with fine to coarse gravel and silt, very dense, moist (till)	
4				
5			Groundwater not encountered	
6				
7				
8				
9				
10				

LEGEND:

PROJECT NO.: 622-001-01
DATE: JUNE 20, 2013
TOTAL DEPTH: 4.5 FEET
LOGGED BY: KEVIN VANDEHEY
DRILLING EQUIPMENT: MINI EXCAVATOR

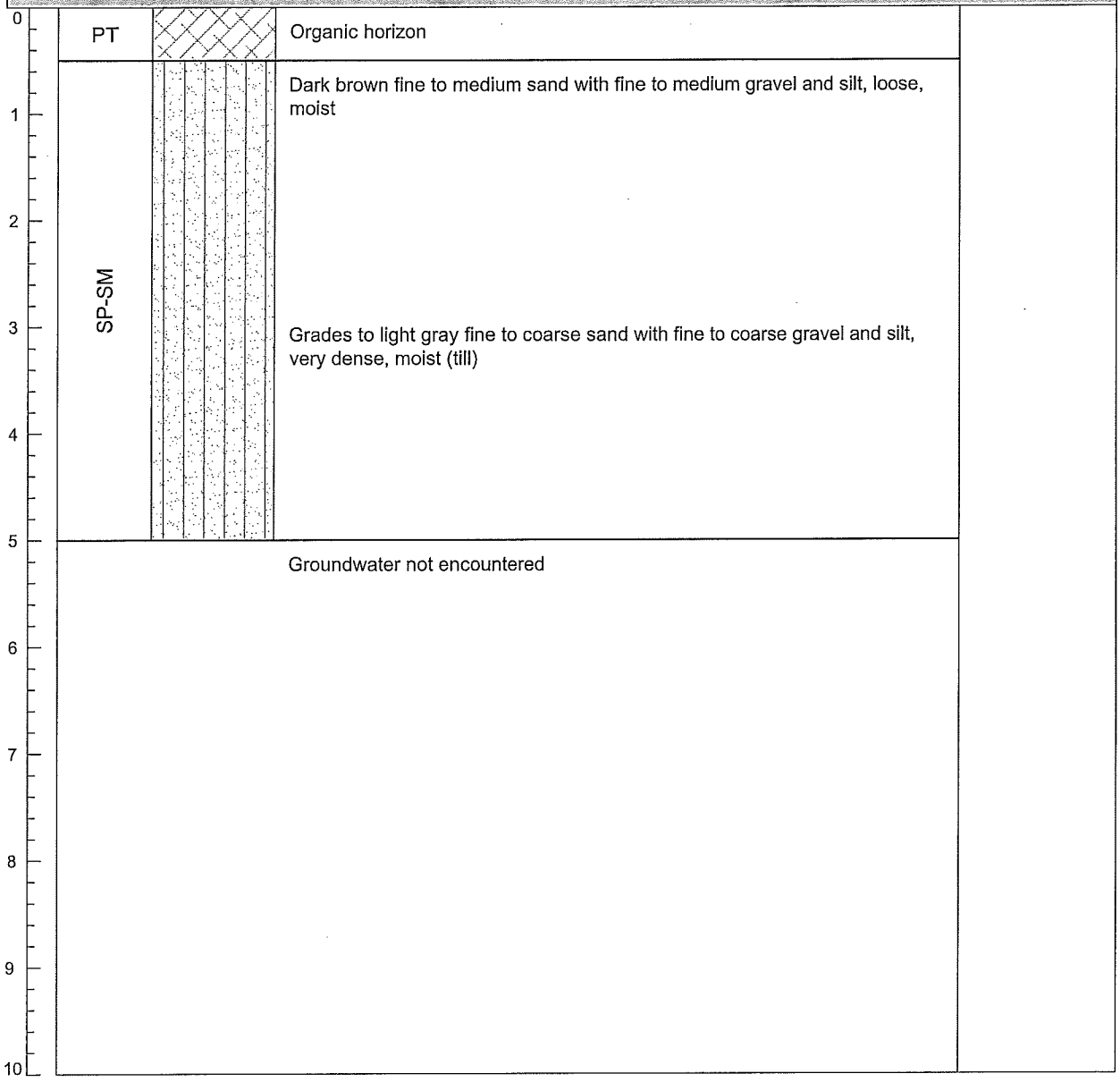
CONWELL PLAT

THURSTON COUNTY, WASHINGTON

INSIGHT GEOLOGIC, INC.

Exploration Log TP-5

TP-6



LEGEND:

PROJECT NO.: 622-001-01
DATE: JUNE 20, 2013
TOTAL DEPTH: 5 FEET
LOGGED BY: KEVIN VANDEHEY
DRILLING EQUIPMENT: MINI EXCAVATOR

CONWELL PLAT

THURSTON COUNTY, WASHINGTON

INSIGHT GEOLOGIC, INC.

Exploration Log TP-6

ATTACHMENT B

LABORATORY ANALYSES

Gradation Analysis Summary Data

Job Name: Conwell Plat
Job Number: 616-001-01
Date Tested: 6/24/13
Tested By: Kevin Vandehey

Sample Location: B-2
Sample Name: B-2 10.0'-11.0'
Depth: 10.0 - 11.0 Feet

Moisture Content (%) 3.1%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	96.1
3/8 in. (9.5-mm)	80.9
No. 4 (4.75-mm)	61.6
No. 10 (2.00-mm)	41.5
No. 20 (.850-mm)	23.8
No. 40 (.425-mm)	11.7
No. 60 (.250-mm)	6.4
No. 100 (.150-mm)	4.6
No. 200 (.075-mm)	3.7

Size Fraction	Percent by Weight
Coarse Gravel	3.9
Fine Gravel	34.5
Coarse Sand	20.1
Medium Sand	29.9
Fine Sand	8.0
Fines	3.7
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.35
D_{30}	0.87
D_{60}	3.60
D_{90}	16.00
Cc	0.60
Cu	10.29

ASTM Classification
Group Name: **Poorly-Graded Sand With Gravel**
Symbol: **SP**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: Conwell Plat
Job Number: 616-001-01
Date Tested: 6/24/13
Tested By: Kevin Vandehey

Sample Location: B-2
Sample Name: B-2 15.0'-16.0'
Depth: 15.0 - 16.0 Feet

Moisture Content (%) 3.7%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	100.0
3/8 in. (9.5-mm)	86.1
No. 4 (4.75-mm)	66.1
No. 10 (2.00-mm)	43.5
No. 20 (.850-mm)	25.6
No. 40 (.425-mm)	13.5
No. 60 (.250-mm)	8.3
No. 100 (.150-mm)	6.2
No. 200 (.075-mm)	4.7

Size Fraction	Percent by Weight
Coarse Gravel	0.0
Fine Gravel	33.9
Coarse Sand	22.6
Medium Sand	29.9
Fine Sand	8.8
Fines	4.7
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.30
D_{30}	0.85
D_{60}	3.90
D_{90}	12.00
Cc	0.6
Cu	13.0

ASTM Classification
Group Name: **Poorly-Graded Sand With Gravel**
Symbol: **SP**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: Conwell Plat
Job Number: 616-001-01
Date Tested: 6/24/13
Tested By: Kevin Vandehey

Sample Location: B-2
Sample Name: B-2 20.0'-21.0'
Depth: 20.0 - 21.0 Feet

Moisture Content (%) 1.7%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	89.8
3/8 in. (9.5-mm)	70.0
No. 4 (4.75-mm)	52.5
No. 10 (2.00-mm)	36.5
No. 20 (.850-mm)	23.0
No. 40 (.425-mm)	13.5
No. 60 (.250-mm)	8.5
No. 100 (.150-mm)	6.3
No. 200 (.075-mm)	4.9

Size Fraction	Percent by Weight
Coarse Gravel	10.2
Fine Gravel	37.3
Coarse Sand	16.0
Medium Sand	23.0
Fine Sand	8.6
Fines	4.9
Total	**100.0**

LL	--
PL	--
PI	--
D_{10}	0.30
D_{30}	1.50
D_{60}	6.60
D_{90}	19.00
Cc	1.14
Cu	22.00

ASTM Classification
Group Name: **Well-Graded Gravel with Sand**
Symbol: **GW**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: Conwell Plat
Job Number: 616-001-01
Date Tested: 6/24/13
Tested By: Kevin Vandehey

Sample Location: B-2
Sample Name: B-2 25.0'-26.0'
Depth: 25.0 - 26.0 Feet

Moisture Content (%) 2.1%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	84.7
3/8 in. (9.5-mm)	72.8
No. 4 (4.75-mm)	60.5
No. 10 (2.00-mm)	48.1
No. 20 (.850-mm)	36.9
No. 40 (.425-mm)	24.3
No. 60 (.250-mm)	13.4
No. 100 (.150-mm)	8.6
No. 200 (.075-mm)	5.9

Size Fraction	Percent by Weight
Coarse Gravel	15.3
Fine Gravel	24.2
Coarse Sand	12.4
Medium Sand	23.8
Fine Sand	18.4
Fines	5.9
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.20
D_{30}	0.59
D_{60}	4.60
D_{90}	25.00
Cc	0.38
Cu	23.00

ASTM Classification
Group Name: **Poorly-Graded Sand with Silt and Gravel**
Symbol: **SP-SM**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: Conwell Plat
Job Number: 616-001-01
Date Tested: 6/24/13
Tested By: Kevin Vandehey

Sample Location: B-2
Sample Name: B-2 30.0'-31.0'
Depth: 30.0 - 31.0 Feet

Moisture Content (%) 2.1%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	98.0
3/8 in. (9.5-mm)	90.9
No. 4 (4.75-mm)	80.6
No. 10 (2.00-mm)	69.9
No. 20 (.850-mm)	58.2
No. 40 (.425-mm)	32.1
No. 60 (.250-mm)	13.6
No. 100 (.150-mm)	8.6
No. 200 (.075-mm)	5.5

Size Fraction	Percent by Weight
Coarse Gravel	2.0
Fine Gravel	17.4
Coarse Sand	10.8
Medium Sand	37.7
Fine Sand	26.6
Fines	5.5
Total	**100.0**

LL	--
PL	--
PI	--
D_{10}	0.20
D_{30}	0.41
D_{60}	0.91
D_{90}	9.00
Cc	0.92
Cu	4.55

ASTM Classification
Group Name: **Poorly-Graded Sand with Silt and Gravel**
Symbol: **SP-SM**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: Conwell Plat
Job Number: 616-001-01
Date Tested: 6/24/13
Tested By: Kevin Vandehey

Sample Location: B-2
Sample Name: B-2 35.0'-36.0'
Depth: 35.0 - 36.0 Feet

Moisture Content (%) 3.2%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	84.3
3/8 in. (9.5-mm)	74.0
No. 4 (4.75-mm)	62.9
No. 10 (2.00-mm)	53.6
No. 20 (.850-mm)	41.6
No. 40 (.425-mm)	21.1
No. 60 (.250-mm)	10.7
No. 100 (.150-mm)	7.1
No. 200 (.075-mm)	4.8

Size Fraction	Percent by Weight
Coarse Gravel	15.7
Fine Gravel	21.4
Coarse Sand	9.3
Medium Sand	32.5
Fine Sand	16.2
Fines	4.8
Total	**100.0**

LL --
PL --
PI --

D_{10} 0.24
D_{30} 0.57
D_{60} 3.70
D_{90} 19.00

Cc 0.37
Cu 15.42

ASTM Classification
Group Name: **Poorly-Graded Sand With Gravel**
Symbol: **SP**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: Conwell Plat
Job Number: 616-001-01
Date Tested: 6/24/13
Tested By: Kevin Vandehey

Sample Location: B-2
Sample Name: B-2 40.0'-41.0'
Depth: 40.0 - 41.0 Feet

Moisture Content (%) 2.5%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	87.9
3/4 in. (19.0)	71.6
3/8 in. (9.5-mm)	64.6
No. 4 (4.75-mm)	55.8
No. 10 (2.00-mm)	46.8
No. 20 (.850-mm)	35.9
No. 40 (.425-mm)	19.5
No. 60 (.250-mm)	11.1
No. 100 (.150-mm)	7.6
No. 200 (.075-mm)	5.1

Size Fraction	Percent by Weight
Coarse Gravel	28.4
Fine Gravel	15.7
Coarse Sand	9.1
Medium Sand	27.3
Fine Sand	14.4
Fines	5.1
Total	**100.0**

LL	--
PL	--
PI	--
D_{10}	0.23
D_{30}	0.65
D_{60}	6.60
D_{90}	42.00
Cc	0.28
Cu	28.70

ASTM Classification
Group Name: **Poorly-Graded Sand with Silt and Gravel**
Symbol: **SP-SM**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: Conwell Plat
Job Number: 616-001-01
Date Tested: 6/24/13
Tested By: Kevin Vandehey

Sample Location: B-2
Sample Name: B-2 45.0'-46.0'
Depth: 45.0 - 46.0 Feet

Moisture Content (%) 7.8%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	54.7
3/8 in. (9.5-mm)	44.9
No. 4 (4.75-mm)	35.4
No. 10 (2.00-mm)	28.0
No. 20 (.850-mm)	20.5
No. 40 (.425-mm)	7.9
No. 60 (.250-mm)	4.2
No. 100 (.150-mm)	2.5
No. 200 (.075-mm)	1.4

Size Fraction	Percent by Weight
Coarse Gravel	45.3
Fine Gravel	19.3
Coarse Sand	7.5
Medium Sand	20.1
Fine Sand	6.6
Fines	1.4
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.39
D_{30}	2.60
D_{60}	22.00
D_{90}	34.00
Cc	0.79
Cu	56.41

ASTM Classification
Group Name: **Poorly Graded Gravel with Sand**
Symbol: **GP**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: Conwell Plat
Job Number: 616-001-01
Date Tested: 6/24/13
Tested By: Kevin Vandehey

Sample Location: B-3
Sample Name: B-3 10.0'-11.0'
Depth: 10.0 - 11.0 Feet

Moisture Content (%) 15.1%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	100.0
3/8 in. (9.5-mm)	100.0
No. 4 (4.75-mm)	99.9
No. 10 (2.00-mm)	99.4
No. 20 (.850-mm)	98.9
No. 40 (.425-mm)	98.0
No. 60 (.250-mm)	96.2
No. 100 (.150-mm)	91.0
No. 200 (.075-mm)	49.2

Size Fraction	Percent by Weight
Coarse Gravel	0.0
Fine Gravel	0.1
Coarse Sand	0.4
Medium Sand	1.5
Fine Sand	48.8
Fines	49.2
Total	**100.0**

LL --
PL --
PI --

D_{10} 0.00
D_{30} 0.00
D_{60} 0.09
D_{90} 0.16

Cc --
Cu --

ASTM Classification
Group Name: **Silty Sand**
Symbol: **SM**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: Conwell Plat
Job Number: 616-001-01
Date Tested: 6/24/13
Tested By: Kevin Vandehey

Sample Location: B-3
Sample Name: B-3 15.0'-16.0'
Depth: 15.0 - 16.0 Feet

Moisture Content (%) 3.1%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	81.1
3/8 in. (9.5-mm)	57.9
No. 4 (4.75-mm)	39.5
No. 10 (2.00-mm)	24.4
No. 20 (.850-mm)	16.2
No. 40 (.425-mm)	10.4
No. 60 (.250-mm)	5.7
No. 100 (.150-mm)	3.8
No. 200 (.075-mm)	2.3

Size Fraction	Percent by Weight
Coarse Gravel	18.9
Fine Gravel	41.6
Coarse Sand	15.1
Medium Sand	14.0
Fine Sand	8.1
Fines	2.3
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.4
D_{30}	2.9
D_{60}	11.0
D_{90}	26.0
Cc	1.8
Cu	25.6

ASTM Classification
Group Name: **Well-Graded Gravel with Sand**
Symbol: **GW**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: Conwell Plat
Job Number: 616-001-01
Date Tested: 6/24/13
Tested By: Kevin Vandehey

Sample Location: B-3
Sample Name: B-3 20.0'-21.0'
Depth: 20.0 - 21.0 Feet

Moisture Content (%) 6.8%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	93.8
3/8 in. (9.5-mm)	90.4
No. 4 (4.75-mm)	89.3
No. 10 (2.00-mm)	88.0
No. 20 (.850-mm)	85.7
No. 40 (.425-mm)	55.7
No. 60 (.250-mm)	19.3
No. 100 (.150-mm)	9.0
No. 200 (.075-mm)	5.6

Size Fraction	Percent by Weight
Coarse Gravel	6.2
Fine Gravel	4.4
Coarse Sand	1.4
Medium Sand	32.3
Fine Sand	50.0
Fines	5.6
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.17
D_{30}	0.30
D_{60}	0.47
D_{90}	9.00
Cc	1.13
Cu	2.76

ASTM Classification
Group Name: **Poorly-Graded Sand with Silt**
Symbol: **SP-SM**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: Conwell Plat
Job Number: 616-001-01
Date Tested: 6/24/13
Tested By: Kevin Vandehey

Sample Location: TP-3
Sample Name: TP-3 2.0'-3.5'
Depth: 2.0 - 3.5 Feet

Moisture Content (%) 10.2%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	89.0
3/4 in. (19.0)	74.1
3/8 in. (9.5-mm)	69.6
No. 4 (4.75-mm)	62.8
No. 10 (2.00-mm)	55.3
No. 20 (.850-mm)	49.7
No. 40 (.425-mm)	39.9
No. 60 (.250-mm)	23.9
No. 100 (.150-mm)	11.3
No. 200 (.075-mm)	5.8

Size Fraction	Percent by Weight
Coarse Gravel	25.9
Fine Gravel	11.3
Coarse Sand	7.5
Medium Sand	15.4
Fine Sand	34.2
Fines	5.8
Total	**100.0**

LL	--
PL	--
PI	--
D_{10}	0.16
D_{30}	0.30
D_{60}	3.50
D_{90}	40.00
Cc	0.16
Cu	21.88

ASTM Classification
Group Name: **Poorly-Graded Sand with Silt and Gravel**
Symbol: **SP-SM**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: Conwell Plat
Job Number: 616-001-01
Date Tested: 6/24/13
Tested By: Kevin Vandehey

Sample Location: TP-5
Sample Name: TP-5 0.4'- 3.0'
Depth: 0.4 - 3.0 Feet

Moisture Content (%) 14.1%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	91.7
3/8 in. (9.5-mm)	74.8
No. 4 (4.75-mm)	63.9
No. 10 (2.00-mm)	56.3
No. 20 (.850-mm)	49.8
No. 40 (.425-mm)	41.3
No. 60 (.250-mm)	31.6
No. 100 (.150-mm)	23.6
No. 200 (.075-mm)	13.3

Size Fraction	Percent by Weight
Coarse Gravel	8.3
Fine Gravel	27.9
Coarse Sand	7.6
Medium Sand	15.0
Fine Sand	28.0
Fines	13.3
Total	**100.0**

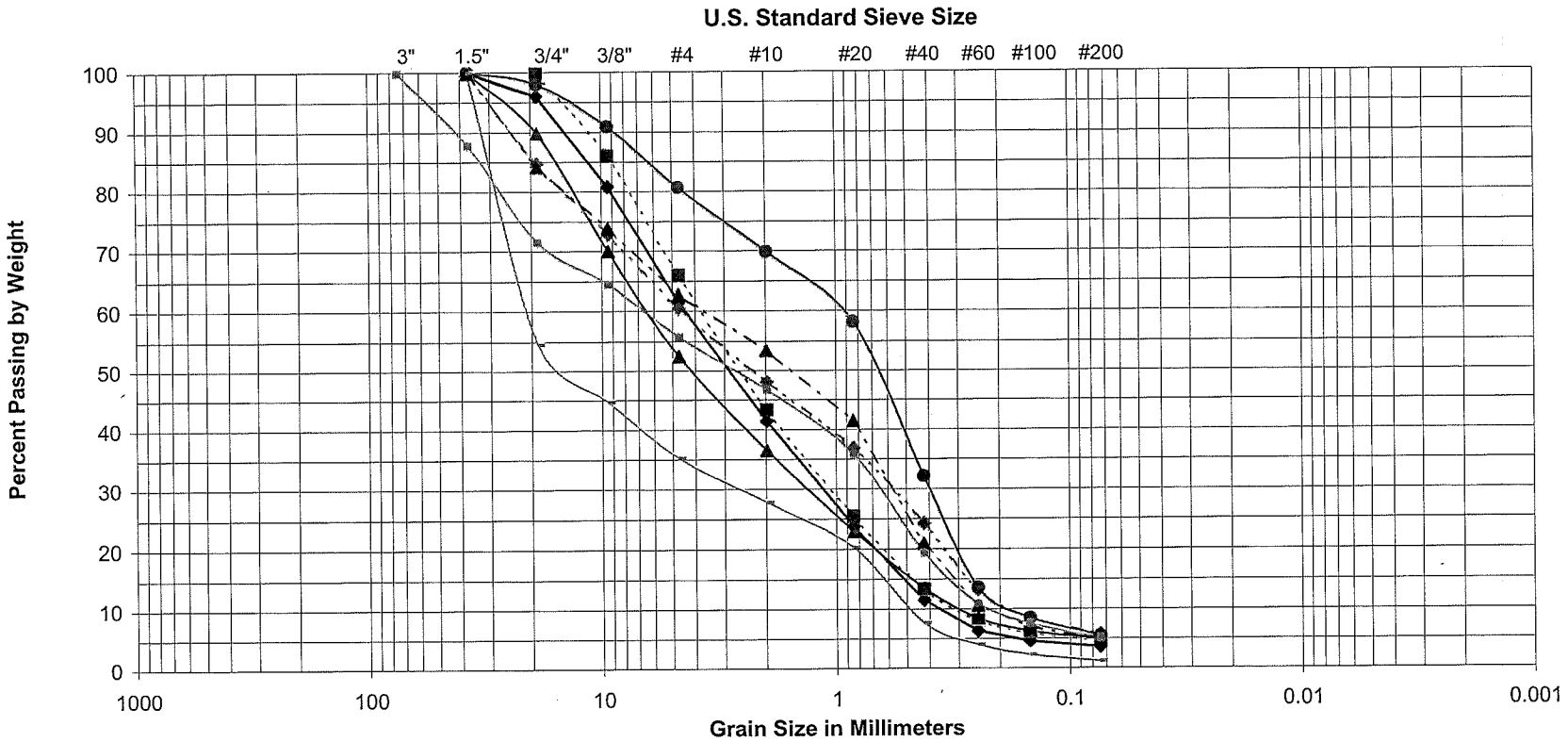
LL --
PL --
PI --

D_{10} 0.00
D_{30} 0.23
D_{60} 3.10
D_{90} 18.00

Cc --
Cu --

ASTM Classification
Group Name: **Poorly-Graded Sand with Silt and Gravel**
Symbol: **SP-SM**

INSIGHT GEOLOGIC, INC.



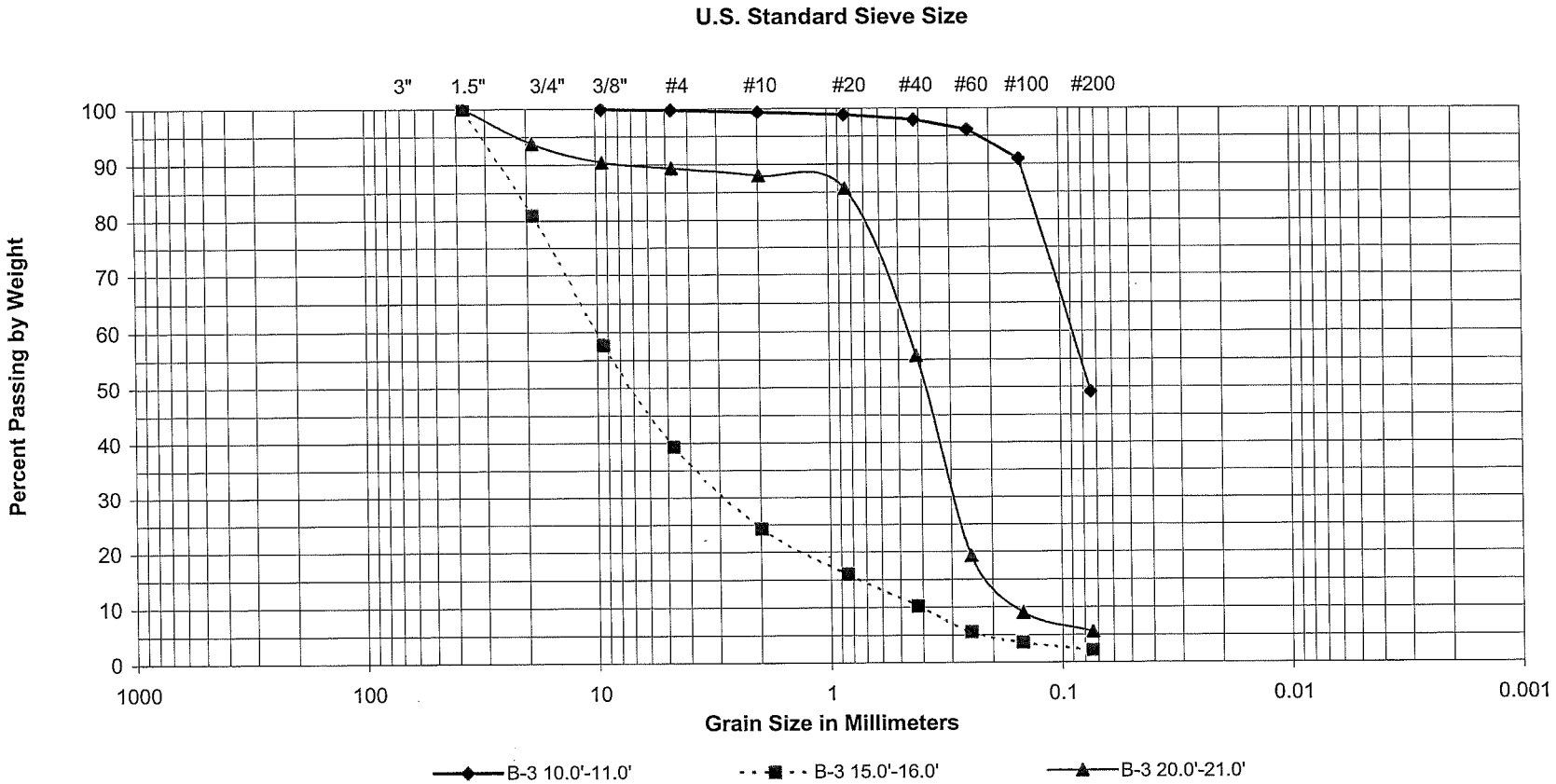
COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

CONWELL PLAT

THURSTON COUNTY, WASHINGTON

INSIGHT GEOLOGIC, INC.

Graph 1
Gradation Analysis Results



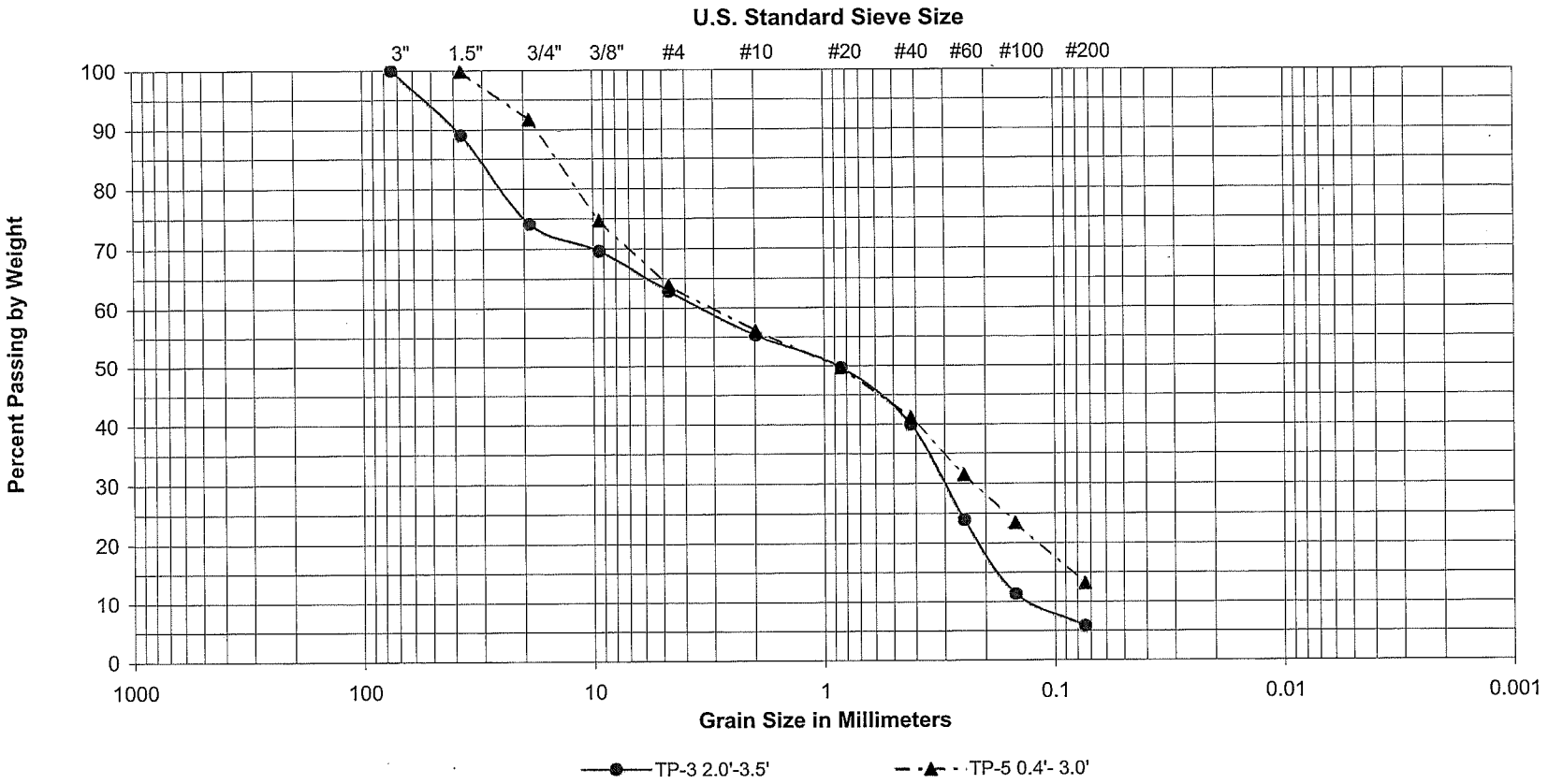
COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

CONWELL PLAT

THURSTON COUNTY, WASHINGTON

INSIGHT GEOLOGIC, INC.

Graph 2
Gradation Analysis Results



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

CONWELL PLAT

THURSTON COUNTY, WASHINGTON

INSIGHT GEOLOGIC, INC.

Graph 3
Gradation Analysis Results

ATTACHMENT C
DETAILED METHOD CALCULATIONS

Detailed Method for Determining Infiltration Rate
for
Proposed Conwell Plat
Thuston County, Washington
B-2

Equation 1 - Saturated Potential Hydraulic Conductivity						
Boring Number / Layer	Soil Classification	D_{10}	D_{60}	D_{90}	f_{fines}	K_{sat}
Layer 1	GP	0.39	22.00	34.00	0.01	303.7
Layer 2	SP	0.35	3.60	16.00	0.04	207.3
Layer 3	GW	0.30	6.60	19.00	0.01	192.2
Layer 4	SP-SM	0.20	4.60	25.00	5.90	0.0
Layer 5	SP	0.24	3.70	19.00	0.05	111.5
Layer 6	SP-SM	0.23	6.60	42.00	0.05	58.4
Layer 7	GP	0.39	22.00	34.00	0.01	303.7
Layer 8						
Layer 9						
Layer 10						
Ksat =	$2835*10^{(-1.57+1.90D10+0.015D60-0.013D90-2.08ffines)}$					
Where:						
Ksat:	Saturated Potential Hydraulic Conductivity, ft/day					
Dn:	Particle size for which "n" percent of particles by weight are smaller, mm.					
ffines:	Fraction of soil by weight passing the number 200 sieve, gm/gm.					

Equation 2 - Equivalent Potential Hydraulic Conductivity for Layers of Soils in One Hole				
d Hole Depth (below pond/trench bottom)	"dn" Layer Thickness	d_n/K_{sat}	SUM d_n/K_{sat}	K_{equiv}
540	72	0.2	1.8	303.7
	120	0.4		
	72	0.2		
	120	0.4		
	48	0.2		
	60	0.2		
	48	0.2		
Kequiv =	d / SUM(Dn/Kn)			
Where:				
d:	Total depth of soil column, in			
dn:	Thickness of layer "n" in soil column, in			
Kn:	Saturated potential hydraulic conductivity (Ksat) of layer "n", ft/day.			

Detailed Method for Determining Infiltration Rate
for
Conwell Plat
Thuston County, Washington
B-2

Equation 3b - Equivalent Potential Hydraulic Conductivity for Pond					
$D_{water\ table}$	D_{pond}	Cf_{size}	K_{equiv}	$K^{0.1}$	(i) (shallow)
47.0	5.00	1.00	303.69	1.771	0.191

$i = (D_{wt} + D_{pond}) * CF_{size} / (138.52 * K^{0.1})$

where:

Dwt: Depth to seasonal high water table, feet

Dpond: Depth of pond feet

K: Conductivity, ft / day

I: Hydraulic gradient, ft/ft

Equation 4 - Functional Saturated Hydraulic Conductivity		
K_{equiv}	(i) (shallow)	f
303.692	0.191	58.14

$f = K_{equiv} * I$

where:

Kequiv: Equivalent Potential Hydraulic Conductivity in ft/day

(i): Hydraulic gradient in ft/ft

Equation 5 - Facility Design Infiltration Rate				
f	CF_{aspect}	$CF_{silt/clo}$	f_{design} (ft/day)	f_{design} (in/hr)
58.14	1.02	1.00	59.068	29.534

$f_{design} = f * (CF_{aspect} * Cf_{silt/clo})$

where:

f: Functional Saturated Hydraulic Conductivity (ft/day)

Cf_{aspect}: Aspect ratio of pond (L/W)

$*Cf_{silt/clo}$: Degree of long-term maintenance and performance

Detailed Method for Determining Infiltration Rate
for
Proposed Conwell Plat
Thuston County, Washington
B-2

Equation 1 - Saturated Potential Hydraulic Conductivity						
Boring Number / Layer	Soil Classification	D_{10}	D_{60}	D_{90}	f_{fines}	K_{sat}
Layer 1	GP	0.39	22.00	34.00	0.01	303.7
Layer 2	SP	0.35	3.60	16.00	0.04	207.3
Layer 3	GW	0.30	6.60	19.00	0.01	192.2
Layer 4	SP-SM	0.20	4.60	25.00	5.90	0.0
Layer 5	SP	0.24	3.70	19.00	0.05	111.5
Layer 6	SP-SM	0.23	6.60	42.00	0.05	58.4
Layer 7	GP	0.39	22.00	34.00	0.01	303.7
Layer 8						
Layer 9						
Layer 10						

$Ksat = 2835*10^{(-1.57+1.90D10+0.015D60-0.013D90-2.08ffines)}$

Where:

Ksat: Saturated Potential Hydraulic Conductivity, ft/day

Dn: Particle size for which "n" percent of particles by weight are smaller, mm.

ffines: Fraction of soil by weight passing the number 200 sieve, gm/gm.

Equation 2 - Equivalent Potential Hydraulic Conductivity for Layers of Soils in One Hole				
d Hole Depth (below pond/trench bottom)	"dn" Layer Thickness	d_n/K_{sat}	SUM d_n/K_{sat}	K_{equiv}
540	72	0.2	1.8	303.7
	120	0.4		
	72	0.2		
	120	0.4		
	48	0.2		
	60	0.2		
	48	0.2		

Kequiv = d / SUM(Dn/Kn)

Where:

d: Total depth of soil column, in

dn: Thickness of layer "n" in soil column, in

Kn: Saturated potential hydraulic conductivity (Ksat) of layer "n", ft/day.

Detailed Method for Determining Infiltration Rate
for
Conwell Plat
Thuston County, Washington
B-2

Equation 3b - Equivalent Potential Hydraulic Conductivity for Pond					
$D_{water\ table}$	D_{pond}	Cf_{size}	K_{equiv}	$K^{0.1}$	(i) (shallow)
47.0	5.00	1.00	303.69	1.771	0.191

$i = (D_{wt} + D_{pond}) * CF_{size} / (138.62 * K^{0.1})$

where:

Dwt: Depth to seasonal high water table, feet
Dpond: Depth of pond feet
K: Conductivity, ft / day
i: Hydraulic gradient, ft/ft

Equation 4 - Functional Saturated Hydraulic Conductivity		
K_{equiv}	(i) (shallow)	f
303.692	0.191	58.14

$f = K_{equiv} * i$

where:

Kequiv: Equivalent Potential Hydraulic Conductivity in ft/day
(i): Hydraulic gradient in ft/ft

Equation 5 - Facility Design Infiltration Rate				
f	CF_{aspect}	$CF_{silt/bio}$	f_{design} (ft/day)	f_{design} (in/hr)
58.14	1.02	1.00	59.068	29.534

$f_{design} = f * (CF_{aspect} * Cf_{silt/bio})$

where:

f: Functional Saturated Hydraulic Conductivity (ft/day)
Cf_{aspect}: Aspect ratio of pond (L/W)
$*Cf_{silt/bio}$: Degree of long-term maintenance and performance

ATTACHMENT D

REPORT LIMITATIONS AND GUIDELINES FOR USE

ATTACHMENT D

REPORT LIMITATIONS AND GUIDELINES FOR USE[1]

This attachment provides information to help you manage your risks with respect to the use of this report.

HYDROGEOLOGIC SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES, PERSONS AND PROJECTS

This report has been prepared for the exclusive use of Hatton Godat Pantier (Client) and their authorized agents. This report may be made available to regulatory agencies for review. This report is not intended for use by others, and the information contained herein is not applicable to other sites.

Insight Geologic structures our services to meet the specific needs of our clients. For example, a hydrogeologic or geologic study conducted for a civil engineer or architect may not fulfill the needs of a construction contractor or even another civil engineer or architect that are involved in the same project. Because each hydrogeologic or geologic study is unique, each hydrogeologic or geologic report is unique, prepared solely for the specific client and project site. Our report is prepared for the exclusive use of our Client. No other party may rely on the product of our services unless we agree in advance to such reliance in writing. This is to provide our firm with reasonable protection against open-ended liability claims by third parties with whom there would otherwise be no contractual limits to their actions. Within the limitations of scope, schedule and budget, our services have been executed in accordance with our Agreement with the Client and generally accepted hydrogeologic practices in this area at the time this report was prepared. This report should not be applied for any purpose or project except the one originally contemplated.

A HYDROGEOLOGIC OR GEOLOGIC REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

Insight Geologic considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless Insight Geologic specifically indicates otherwise, do not rely on this report if it was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

If important changes are made after the date of this report, Insight Geologic should be given the opportunity to review our interpretations and recommendations and provide written modifications or confirmation, as appropriate.

SUBSURFACE CONDITIONS CAN CHANGE

This hydrogeologic or geologic report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by

[1] Developed based on material provided by ASFE, Professional Firms Practicing in the Geosciences; www.asfe.org .

manmade events such as construction on or adjacent to the site, or by natural events such as floods, earthquakes, slope instability or ground water fluctuations. Always contact Insight Geologic before applying a report to determine if it remains applicable.

MOST HYDROGEOLOGIC AND GEOLOGIC FINDINGS ARE PROFESSIONAL OPINIONS

Our interpretations of subsurface conditions are based on field observations from widely spaced sampling locations at the site. Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Insight Geologic reviewed field and laboratory data and then applied our professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ, sometimes significantly, from those indicated in this report. Our report, conclusions and interpretations should not be construed as a warranty of the subsurface conditions.

HYDROGEOLOGIC REPORT RECOMMENDATIONS ARE NOT FINAL

Do not over-rely on the preliminary recommendations included in this report. These recommendations are not final, because they were developed principally from Insight Geologic's professional judgment and opinion. Insight Geologic's recommendations can be finalized only by observing actual subsurface conditions revealed during construction.

A HYDROGEOLOGIC OR GEOLOGIC REPORT COULD BE SUBJECT TO MISINTERPRETATION

Misinterpretation of this report by other design team members can result in costly problems. You could lower that risk by having Insight Geologic confer with appropriate members of the design team after submitting the report. Also retain Insight Geologic to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a hydrogeologic engineering or geologic report. Reduce that risk by having Insight Geologic participate in pre-bid and preconstruction conferences, and by providing construction observation.

DO NOT REDRAW THE EXPLORATION LOGS

Hydrogeologic engineers and geologists prepare final boring and test pit logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a hydrogeologic engineering or geologic report should never be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, but recognize that separating logs from the report can elevate risk.

READ THESE PROVISIONS CLOSELY

Some clients, design professionals and contractors may not recognize that the geoscience practices (hydrogeologic engineering or geology) are far less exact than other engineering and natural science disciplines. This lack of understanding can create unrealistic expectations that could lead to disappointments, claims and disputes. Insight Geologic includes these explanatory "limitations" provisions in our reports to help reduce such risks. Please confer with Insight Geologic if you are unclear how these "Report Limitations and Guidelines for Use" apply to your project or site.

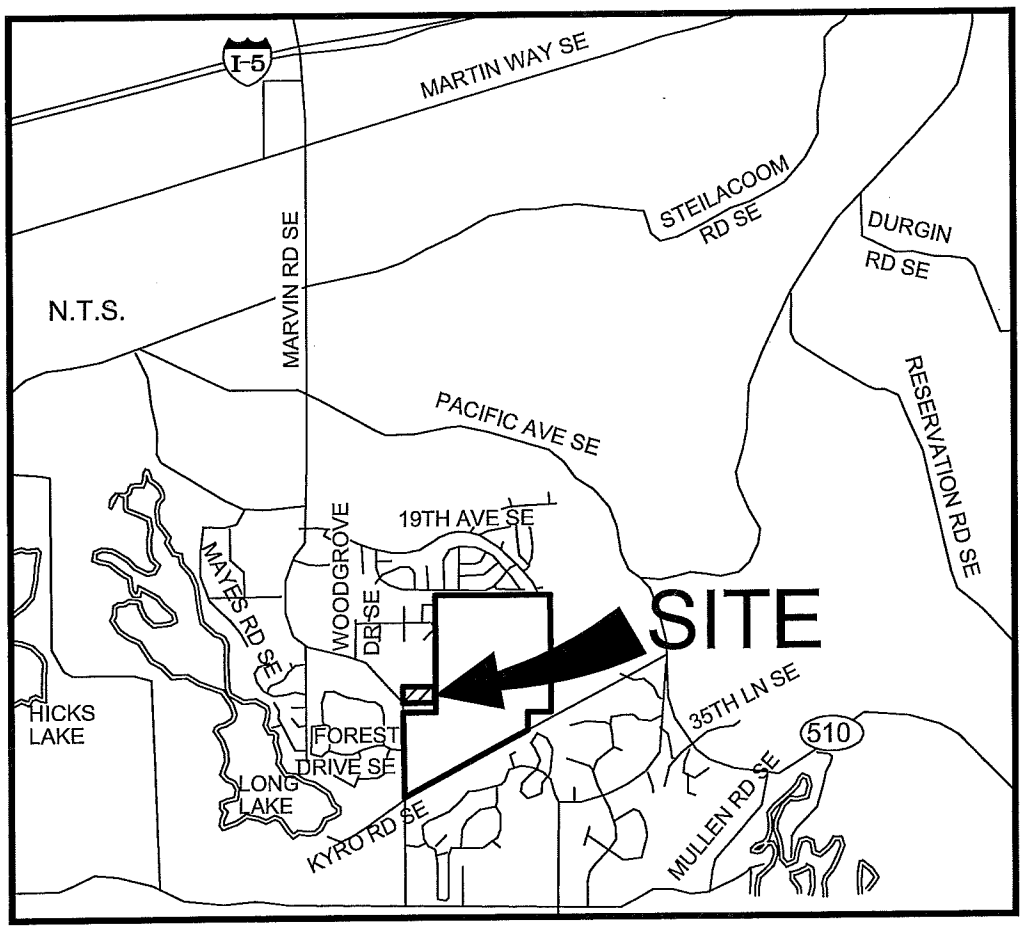
HYDROGEOLOGIC, GEOLOGIC AND ENVIRONMENTAL REPORTS SHOULD NOT BE INTERCHANGED

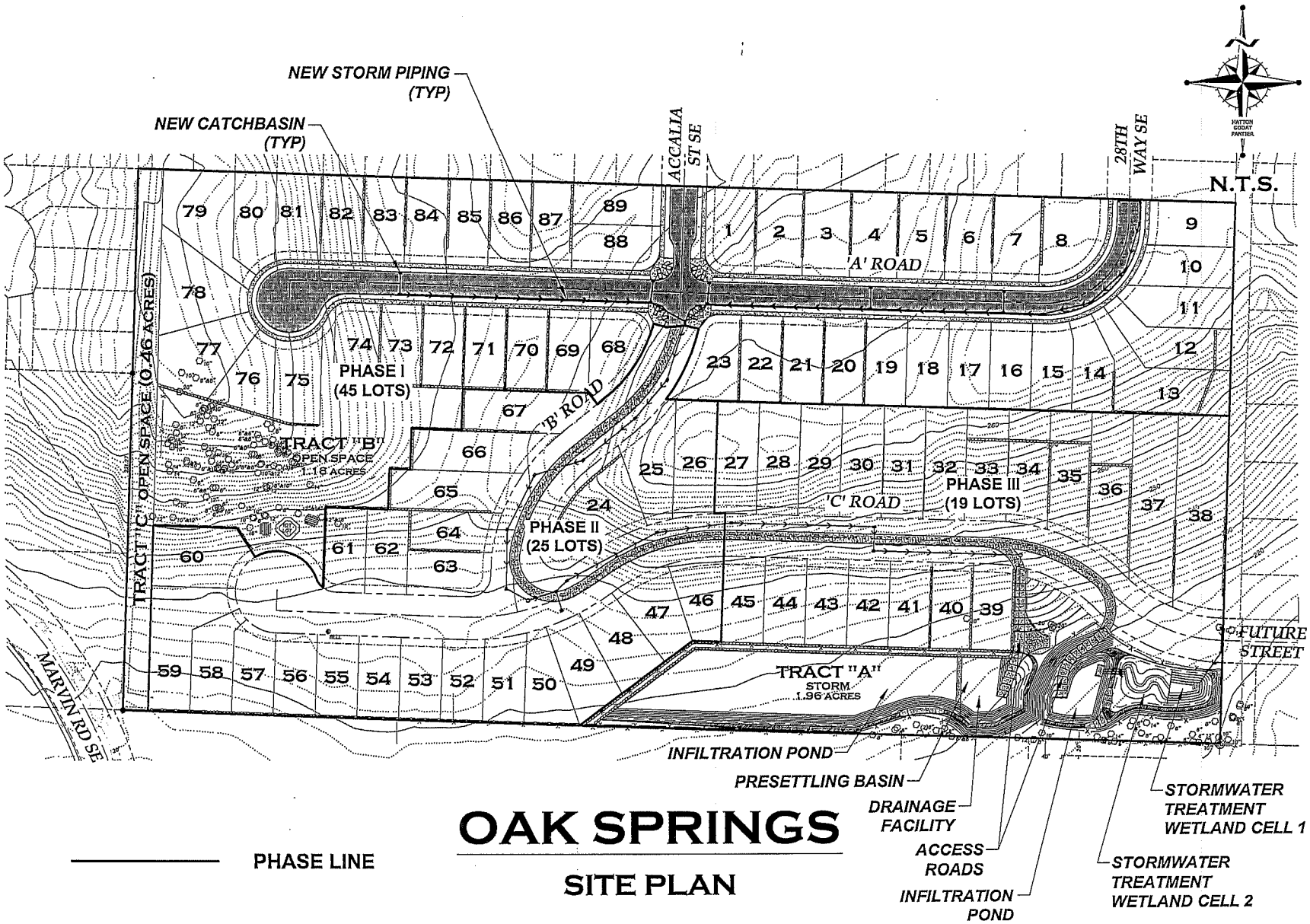
The equipment, techniques and personnel used to perform an environmental study differ significantly from those used to perform a hydrogeologic or geologic study and vice versa. For that reason, a hydrogeologic engineering or geologic report does not usually relate any environmental findings, conclusions or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. Similarly, environmental reports are not used to address hydrogeologic or geologic concerns regarding a specific project.

APPENDIX B – Maps

OAK SPRINGS

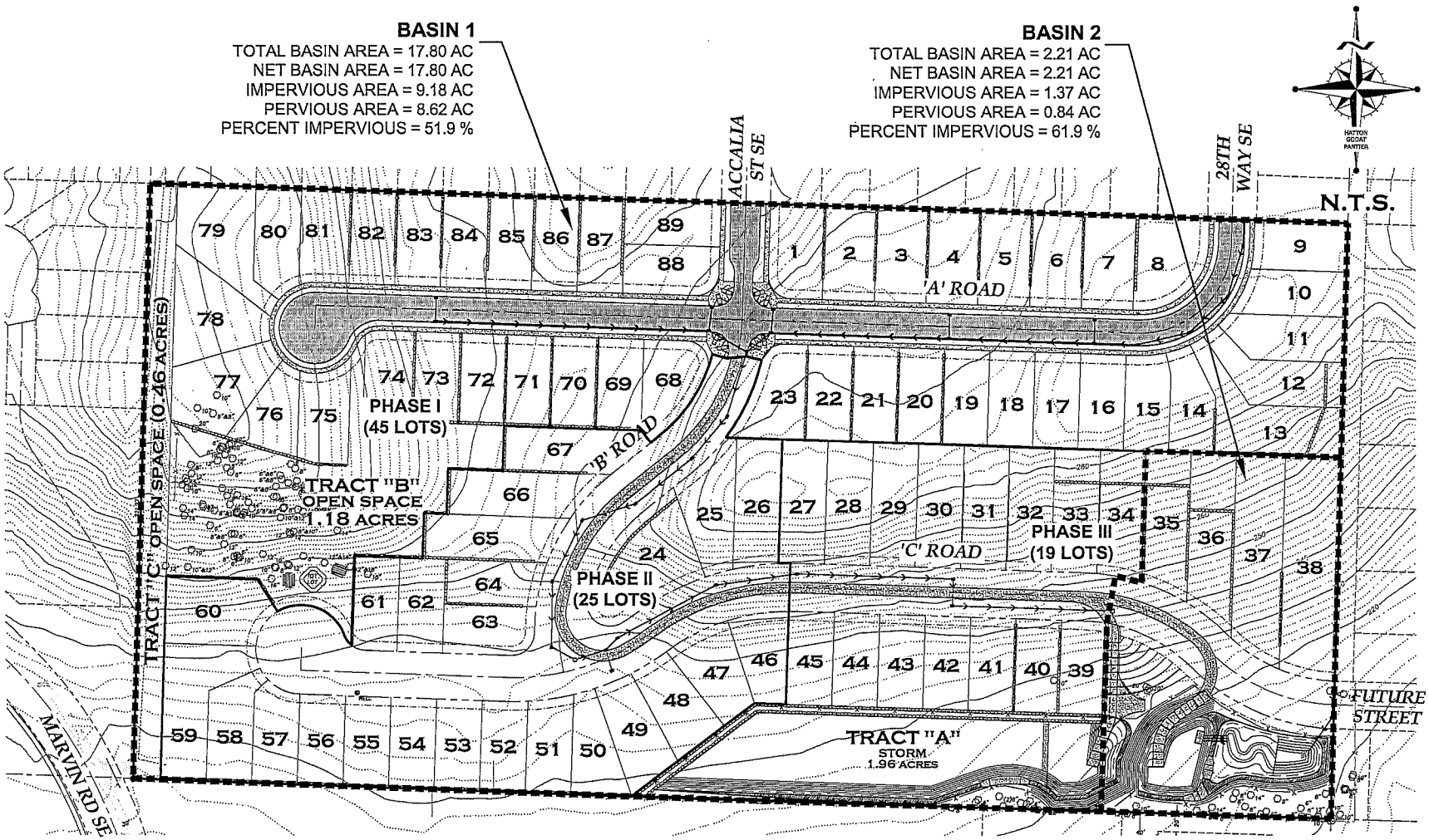
VICINITY MAP





OAK SPRINGS

SITE PLAN



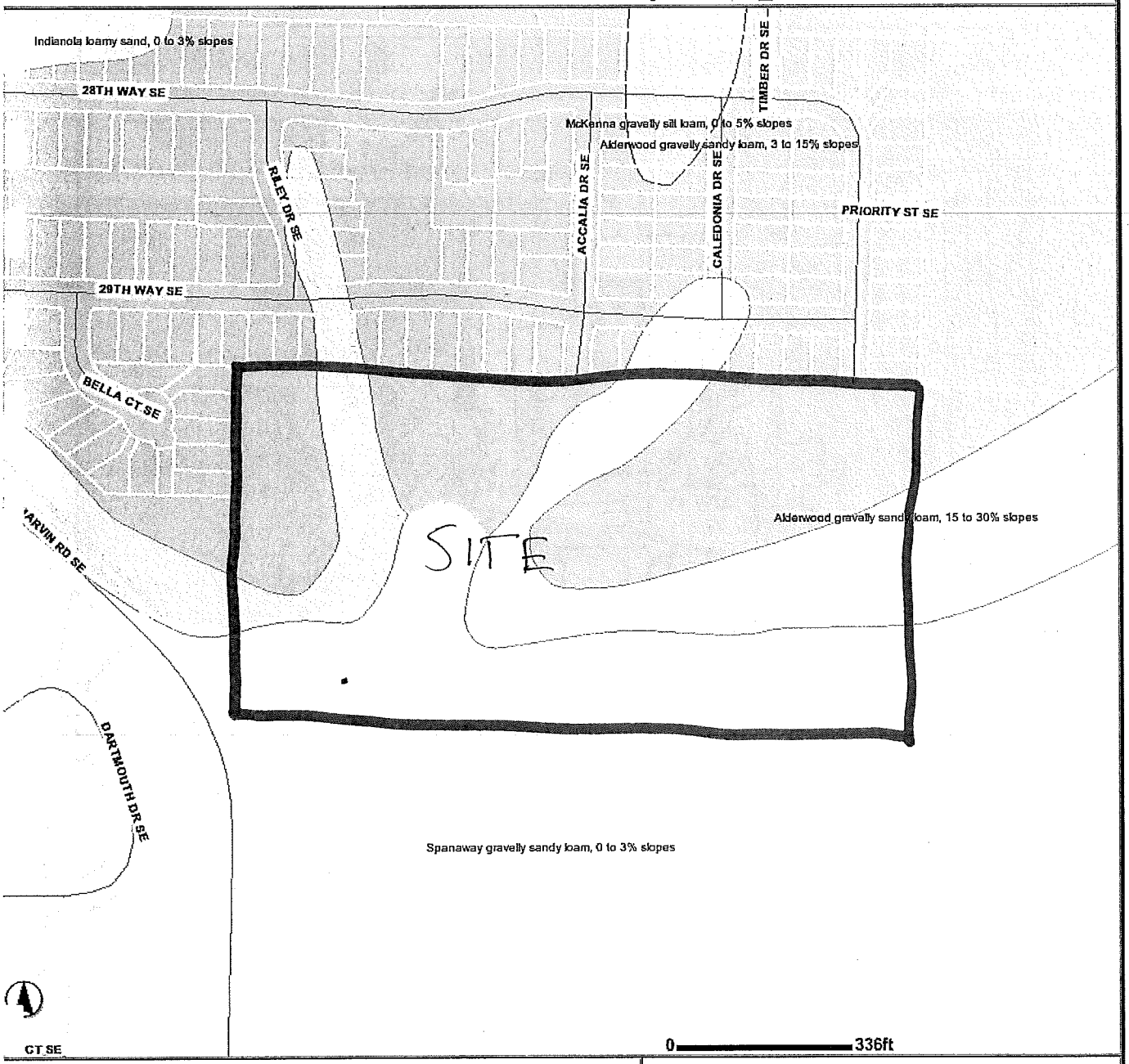
OAK SPRINGS

BASIN MAP

BASIN LINE

PHASE LINE

Thurston County Map

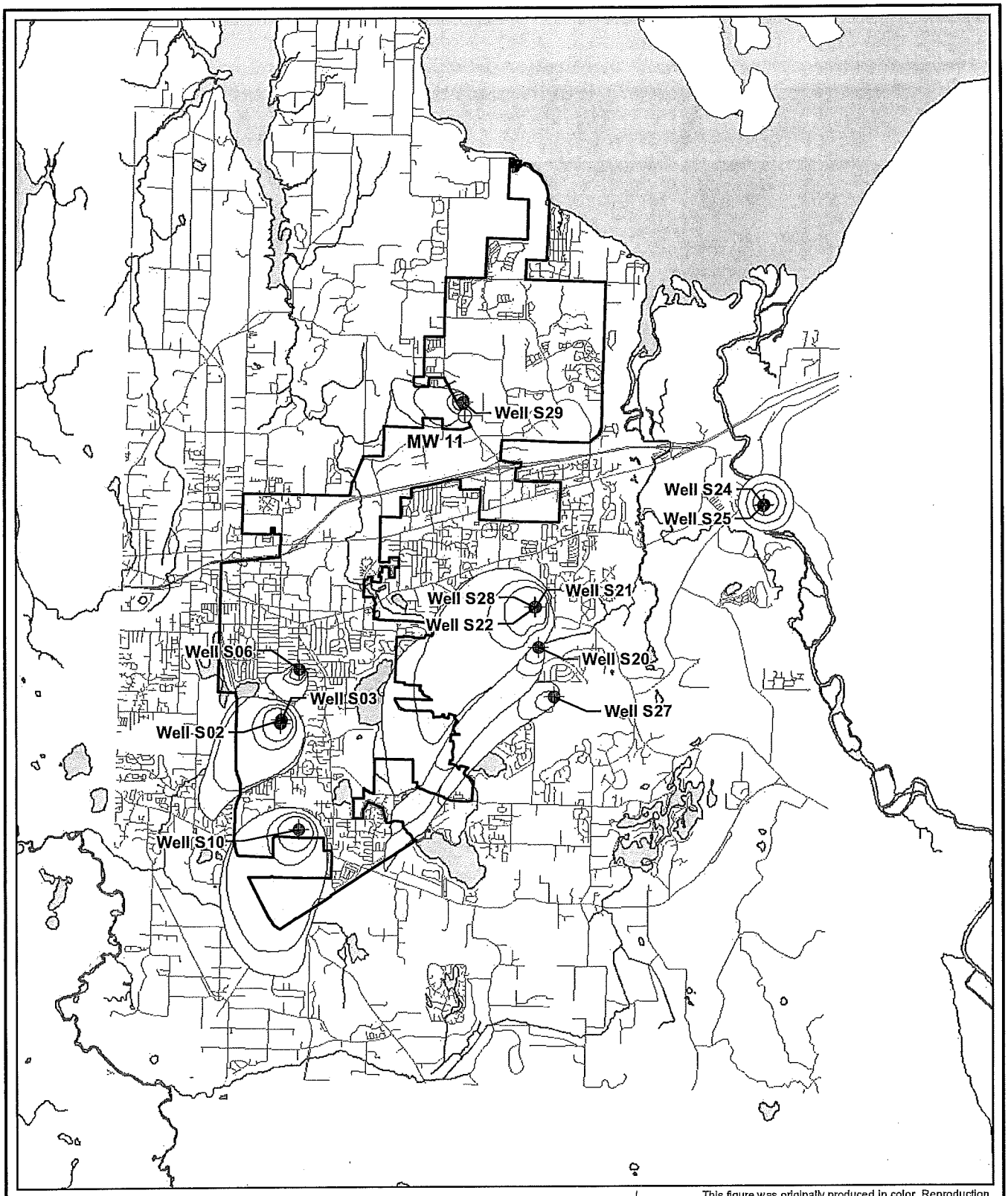


LEGEND

- Major Roads
- Roads
- Streams
- Contours
- Wetlands
- Wetland Buffers
- Flood Zones
- Water Bodies
- Zoning
- Cities
- Parcels

Thurston GeoData Center

929 Lakeridge Drive SW, Suite 216, 2nd Floor
Olympia, WA 98502-6031



LEGEND

- Production Well
- Recommended Monitoring Well
- Lacey City Limit

WHPAs

- 6 months
- 1 yr
- 5 yr
- 10 yr

0 6500

Scale in Feet

Map Projection:
Washington State Plane
South Zone NAD 1983

Source:
Carollo, WA DNR, USGS,
Golder Associates Inc.

N

This figure was originally produced in color. Reproduction in black and white may result in a loss of information.

FIGURE **6-3**

NEW WHPAs - EXISTING WELLS COMPLETED IN THE QPG AQUIFER

WELLHEAD PROTECTION WSP UPDATES/WA

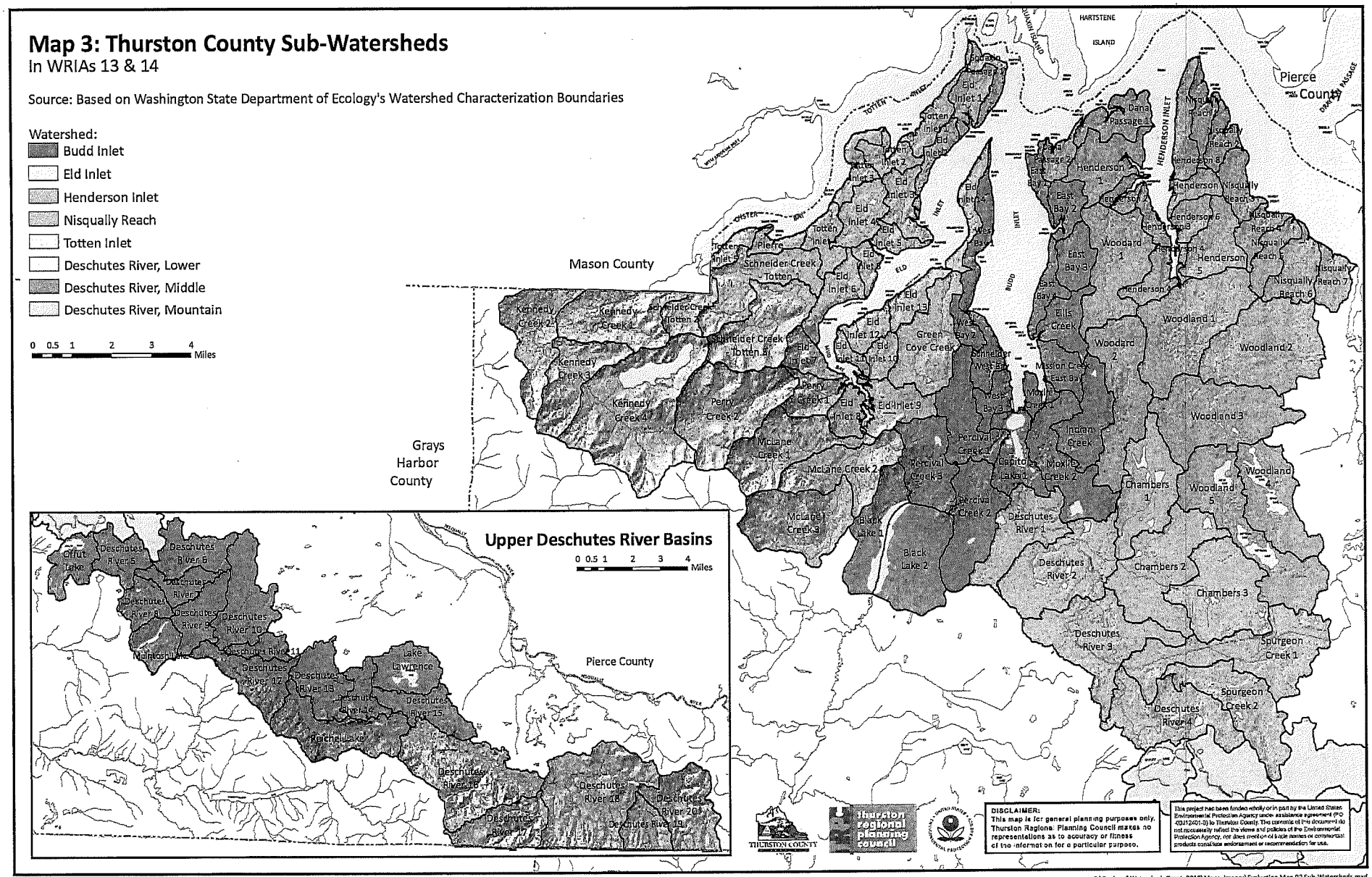
08393334F55_QPG_AquiferWHPAs.mxd | 3/19/2010| THAMMOND

Golder Associates

Map 3: Thurston County Sub-Watersheds

In WRIAs 13 & 14

Source: Based on Washington State Department of Ecology's Watershed Characterization Boundaries



February 1, 2011

P:\Regional\Watershed_Grant_2010\Maps_Images\Evaluation Map 03 Sub-Watersheds.mxd

APPENDIX C – Drainage Calculations

Oak Springs Preliminary Area Summary

Basin	C Soils Area (sq ft)	B Soils Area (sq ft)	Total Area (sq ft)	Total Area (acre)	Roof[1] Area (sq ft)	Roof to Pond Area (sq ft)	Road Area (sq ft)	Driveway[2] Area (sq ft)	Sidewalk Area (sq ft)	Forest Area (sq ft)	Pasture Area (sq ft)	Lawn Area (sq ft)	Pond Area (sq ft)	Net Area	Net Impervious	Net Pervious	Percent Impervious
Basin 1	553,256	222,329	775,585	17.80	170,000	170,000	86,244	56,474	39,221	31,757	32,151	311,582	48,155	17.80	9.18	8.62	51.6%
Basin 2	44,913	51,406	96,319	2.21	8,000	8,000	9,167	2,400	2,778	0	0	36,726	37,248	2.21	1.37	0.84	61.9%
Total	598,169	273,735	871,904	20.02	178,000	178,000	95,411	58,874	41,999	31,757	32,151	348,309	85,403	20.02	10.55	9.46	52.7%

(1) Roofs assumed to be 2000 sf
(2) Driveways assumed to be 600 sf

WWHM (areas in acres)	Basin 1 Existing	Basin 1 Proposed	Basin 2 Existing	Basin 2 Proposed
Forest, C	12.70	0.73	1.03	0.00
Forest, B	5.10	0.00	1.18	0.00
Pasture, C		0.52		0.00
Pasture, B		0.21		0.00
Lawn, C		5.08		0.84
Lawn, B		2.07		0.00
Roads		1.98		0.21
Roofs to Pond		3.90		0.18
Driveways		1.30		0.06
Sidewalks		0.90		0.06
Pond		1.11		0.86
Total	17.80	17.80	2.21	2.21
To Pond		17.80		2.21

Oak Springs
13-046

Basin 1 Pond

Trapezoidal Basin

Base elevation 218.0 ft

Infiltration Rate (f) 2.10 in/hr

Required Volume

Tributary Area	17.80 ac
WWHM Water Quality Volume:	68,306 cu-ft
WWHM Volume:	187,068 cu-ft

Basin 1 Pond

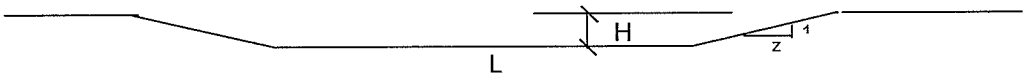
Elevation	Bottom Area	Water Surface Area	Volume	
218.00	28,125	28,125	0	
218.50	28,125	28,712	14,209	
219.00	28,125	29,298	28,710	
219.50	28,125	29,900	43,512	
220.00	28,125	30,501	58,610	
220.50	28,125	31,128	74,034	
221.00	28,125	31,754	89,763	
221.50	28,125	32,399	105,829	
222.00	28,125	33,044	122,206	
222.50	28,125	33,710	138,938	
223.00	28,125	34,375	155,989	
223.50	28,125	35,063	173,415	
224.00	28,125	35,750	191,168	DWL Exceeds WWHM Req'd Volume
224.50	28,125	36,467	209,336	
225.00	28,125	37,183	227,842	Top of pond

Presettling Basin Calculations

Water Quality Volume (WQV)	1.5681 ac-ft		68,306 cu-ft	
Presettling Basin Volume	WQV * 0.33	=	22,541 cu-ft	Minimum
Bottom	218.00	Area	2,975 sq ft	
DWL	224.00	Area	5,490 sq ft	
Designed Volume			25,013 cu-ft	Exceeds Req'd Presettling Volume

Basin 1 Overflow Spillway

Broad Crested Weir



For this weir $Q_{100} = C\sqrt{2g}(2/3LH^{3/2} + 8/15Tan\ \theta H^{5/2})$

(Page III-3-36 of the Stormwater Management Manual for the Puget Sound Basin)

C =	**0.6**	discharge coefficient
L =	**33.00'**	
z =	**10**	side slope
H =	**0.25'**	flow depth
Q =	14.04	cfs (100 Year Design Peak Inflow 13.81 cfs)
V =	1.58	fps

Oak Springs
13-046

Basin 2 Pond

Trapezoidal Basin

Base elevation 210.0 ft

Infiltration Rate (f) 6.50 in/hr

Required Volume

Tributary Area	2.21 ac
WWHM Water Quality Volume:	10,106 cu-ft
WQV*1.5	15,159 cu-ft
WWHM Volume:	13,861 cu-ft

Basin 2 Pond

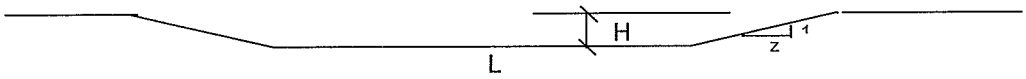
Elevation	Bottom Area	Water Surface Area	Volume	
210.00	2,481	2,481	0	
210.50	2,481	2,762	1,310	
211.00	2,481	3,042	2,757	
211.50	2,481	3,331	4,343	
212.00	2,481	3,620	6,065	
212.50	2,481	3,923	7,936	
213.00	2,481	4,226	9,945	
213.50	2,481	4,543	12,111	
214.00	2,481	4,859	14,416	DWL Exceeds WWHM Req'd Volume
214.50	2,481	5,199	16,907	
215.00	2,481	5,539	19,545	Top of pond

Stormwater Treatment Wetland Volumes

Water Quality Volume (WQV)	0.2320	ac-ft		10,106 cu-ft	
WQV*1.5	0.3480	ac-ft		15,159 cu-ft	
Water Quality Surface Area	15,159/3			5,053 sq ft	
Surface Area Provided				5,104 sq ft	Exceeds Req'd Surface Area
First Cell Volume	WQV * 0.33		=	4,548 cu-ft	Minimum
Bottom	210.00		Area	585 sq ft	
DWL	214.00		Area	1,816 sq ft	
Designed Volume				4,577 cu-ft	Exceeds Req'd First Cell Volume

Basin 2 Overflow Spillway

Broad Crested Weir



For this weir $Q_{100} = C\sqrt{2g}(2/3LH^{3/2} + 8/15Tan\ \theta H^{5/2})$

(Page III-3-36 of the Stormwater Management Manual for the Puget Sound Basin)

C =	**0.6**	discharge coefficient
L =	**6.00'**	
z =	**10**	side slope
H =	**0.25'**	flow depth
Q =	3.21	cfs (Basin 2 100 Year Design Peak Inflow 1.94 cfs)
V =	1.51	fps

Oak Springs Plat Stormwater
Pond Infiltration Rate Calculation
Massman Equation
October 11, 2013
Basin 1 Pond

				Grain Sizes (mm)				
Layer	**B-2- 10 ft**	**B-2-15 ft**	**B-2-20 ft**	**B-2-25 ft**	**B-3-10 ft**	**B-3-15 ft**	**B-3-20**	
D10	0.35	0.30	0.30	0.20	0.00	0.40	0.17	
D60	3.6	3.9	6.6	4.6	0.09	11	0.47	
D90	16	12	19	25	0.16	26	9	
Fines (%)	3.7	4.7	4.9	5.9	49.2	2.3	5.6	
Log10 (Ksat)	-1.14	-1.20	-1.25	-1.57	-2.59	-1.03	-1.47	
Ksat, cm/s	0.073	0.064	0.056	0.027	0.003	0.093	0.034	
Ksat, in/hr	103.64	90.41	79.72	38.26	3.61	132.02	47.65	
d, thickness (ft)	3.0	5.0	5.0	2.0	5.0	5.0	5.0	***Sum***
d, thickness (cm)	91.44	152.4	152.4	60.96	152.4	152.4	152.4	914 cm
								30 ft
d/K	1,251	2,389	2,710	2,258	59,851	1,636	4,533	74,628
Kequiv								0.012 cm/s
								17.4 in/hr
							K =	**34.7 ft/day**

Dwt = Depth from base of pond to water table: 35 ft
Dpond = Design Water Depth: 6.0 ft
CFsize=Correction factor for pond size:
CFsize = 0.73(Apond)^^-0.76 or 1.0, whichever is smaller
Apond=Pond bottom area in acres: 0.65 ac
CFsize= 1.01
CFsize= 1.0 **<--- Controls**

Gradient, i = (Dwt + Dpond)*CFsize/138.62(K^^0.1)

i = 0.207 ft/ft

Infiltration Rate, f = K*i

7.20 ft/day
3.60 in/hr

Biofouling and siltation reduction factor = 0.9
Aspect ratio reduction factor = 1.075 *=(0.02 x Aspect Ratio + 0.98)*

Infiltration Rate, f = **3.49 in/hr**

Oak Springs Plat Stormwater
Pond Infiltration Rate Calculation
Massman Equation
October 11, 2013
Basin 2 Pond

	Grain Sizes (mm)			
Layer	B-2- 20 ft	B-2-25 ft	B-2-30 ft	
D10	0.3	0.20	0.20	
D60	6.6	4.6	0.91	
D90	19	25	9	
Fines (%)	4.9	5.9	5.5	
Log10 (Ksat)	-1.25	-1.57	-1.41	
Ksat, cm/s	0.056	0.027	0.039	
Ksat, in/hr	79.72	38.26	55.43	
d, thickness (ft)	5.0	5.0	5.0	***Sum***
d, thickness (cm)	152.4	152.4	152.4	457 cm
				15 ft
d/K	2,710	5,646	3,897	12,252
Kequiv				0.037 cm/s
				52.9 in/hr
			K =	**105.8 ft/day**

Dwt = Depth from base of pond to water table: 27 ft
Dpond = Design Water Depth: 4.0 ft
CFsize=Correction factor for pond size:
CFsize = 0.73(Apond)^^-0.76 or 1.0, whichever is smaller
Apond=Pond bottom area in acres: 0.04 ac
CFsize= 8.43
CFsize= 1.0 **<--- Controls**

Gradient, i = (Dwt + Dpond)*CFsize/138.62(K^^0.1)

i = 0.140 ft/ft

Infiltration Rate, f = K*i

14.84 ft/day
7.42 in/hr

Biofouling and siltation reduction factor = 0.9
Aspect ratio reduction factor = 1.0222 *=(0.02 x Aspect Ratio + 0.98)*

Infiltration Rate, f = **6.83 in/hr**

APPENDIX D – WWHM

WWHM2012

PROJECT REPORT

General Model Information

Project Name:	13-046 Basin 1 preliminary
Site Name:	Oak Springs
Site Address:	3146 Marvin Road SE
City:	Olympia
Report Date:	10/15/2013
Gage:	Woodland Creek
Data Start:	1955/10/01
Data End:	2011/09/30
Timestep:	15 Minute
Precip Scale:	0.80
Version:	2013/06/10

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 1

Bypass:	No
GroundWater:	No

Pervious Land Use	Acres
A B, Forest, Mod	5.1
C, Forest, Mod	12.7
Pervious Total	17.8

Impervious Land Use	Acres
Impervious Total	0
Basin Total	17.8

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Basin 1

Bypass:	No
GroundWater:	No

Pervious Land Use	Acres
C, Forest, Mod	0.73
A B, Pasture, Mod	0.21
C, Pasture, Mod	0.52
C, Lawn, Flat	5.08
A B, Lawn, Flat	2.07
Pervious Total	8.61

Impervious Land Use	Acres
ROADS MOD	1.98
ROOF TOPS FLAT	3.9
DRIVEWAYS FLAT	1.3
SIDEWALKS MOD	0.9
POND	1.11
Impervious Total	9.19
Basin Total	17.8

Element Flows To:		
Surface	Interflow	Groundwater
Basin 1	Basin 1	

Routing Elements
Predeveloped Routing

Mitigated Routing

Basin 1

Bottom Length:	365.00 ft.
Bottom Width:	77.00 ft.
Depth:	7 ft.
Volume at riser head:	4.2945 acre-ft.
Infiltration On	
Infiltration rate:	2.1
Infiltration safety factor:	1
Side slope 1:	2 To 1
Side slope 2:	2 To 1
Side slope 3:	0 To 1
Side slope 4:	0 To 1
Discharge Structure	
Riser Height:	6 ft.
Riser Diameter:	100 in.
Element Flows To:	
Outlet 1	Outlet 2

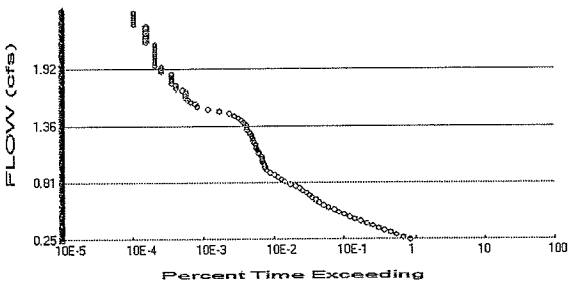
Pond Hydraulic Table

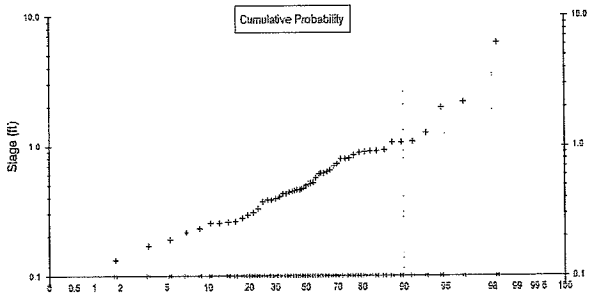
Stage(ft)	Area(ac)	Volume(ac-ft)	Discharge(cfs)	Infilt(cfs)
0.0000	0.645	0.000	0.000	0.000
0.0778	0.646	0.050	0.000	1.366
0.1556	0.648	0.100	0.000	1.366
0.2333	0.649	0.151	0.000	1.366
0.3111	0.651	0.201	0.000	1.366
0.3889	0.653	0.252	0.000	1.366
0.4667	0.654	0.303	0.000	1.366
0.5444	0.656	0.354	0.000	1.366
0.6222	0.657	0.405	0.000	1.366
0.7000	0.659	0.456	0.000	1.366
0.7778	0.661	0.508	0.000	1.366
0.8556	0.662	0.559	0.000	1.366
0.9333	0.664	0.611	0.000	1.366
1.0111	0.665	0.662	0.000	1.366
1.0889	0.667	0.714	0.000	1.366
1.1667	0.669	0.766	0.000	1.366
1.2444	0.670	0.818	0.000	1.366
1.3222	0.672	0.870	0.000	1.366
1.4000	0.673	0.923	0.000	1.366
1.4778	0.675	0.975	0.000	1.366
1.5556	0.677	1.028	0.000	1.366
1.6333	0.678	1.081	0.000	1.366
1.7111	0.680	1.133	0.000	1.366
1.7889	0.681	1.186	0.000	1.366
1.8667	0.683	1.239	0.000	1.366
1.9444	0.685	1.293	0.000	1.366
2.0222	0.686	1.346	0.000	1.366
2.1000	0.688	1.400	0.000	1.366
2.1778	0.689	1.453	0.000	1.366
2.2556	0.691	1.507	0.000	1.366
2.3333	0.693	1.561	0.000	1.366
2.4111	0.694	1.615	0.000	1.366
2.4889	0.696	1.669	0.000	1.366

2.5667	0.697	1.723	0.000	1.366
2.6444	0.699	1.777	0.000	1.366
2.7222	0.701	1.832	0.000	1.366
2.8000	0.702	1.886	0.000	1.366
2.8778	0.704	1.941	0.000	1.366
2.9556	0.706	1.996	0.000	1.366
3.0333	0.707	2.051	0.000	1.366
3.1111	0.709	2.106	0.000	1.366
3.1889	0.710	2.161	0.000	1.366
3.2667	0.712	2.217	0.000	1.366
3.3444	0.714	2.272	0.000	1.366
3.4222	0.715	2.328	0.000	1.366
3.5000	0.717	2.383	0.000	1.366
3.5778	0.719	2.439	0.000	1.366
3.6556	0.720	2.495	0.000	1.366
3.7333	0.722	2.551	0.000	1.366
3.8111	0.723	2.608	0.000	1.366
3.8889	0.725	2.664	0.000	1.366
3.9667	0.727	2.720	0.000	1.366
4.0444	0.728	2.777	0.000	1.366
4.1222	0.730	2.834	0.000	1.366
4.2000	0.732	2.891	0.000	1.366
4.2778	0.733	2.948	0.000	1.366
4.3556	0.735	3.005	0.000	1.366
4.4333	0.737	3.062	0.000	1.366
4.5111	0.738	3.119	0.000	1.366
4.5889	0.740	3.177	0.000	1.366
4.6667	0.741	3.235	0.000	1.366
4.7444	0.743	3.292	0.000	1.366
4.8222	0.745	3.350	0.000	1.366
4.9000	0.746	3.408	0.000	1.366
4.9778	0.748	3.466	0.000	1.366
5.0556	0.750	3.525	0.000	1.366
5.1333	0.751	3.583	0.000	1.366
5.2111	0.753	3.642	0.000	1.366
5.2889	0.755	3.700	0.000	1.366
5.3667	0.756	3.759	0.000	1.366
5.4444	0.758	3.818	0.000	1.366
5.5222	0.760	3.877	0.000	1.366
5.6000	0.761	3.936	0.000	1.366
5.6778	0.763	3.996	0.000	1.366
5.7556	0.765	4.055	0.000	1.366
5.8333	0.766	4.115	0.000	1.366
5.9111	0.768	4.174	0.000	1.366
5.9889	0.770	4.234	0.000	1.366
6.0667	0.771	4.294	1.397	1.366
6.1444	0.773	4.354	4.455	1.366
6.2222	0.775	4.414	8.501	1.366
6.3000	0.776	4.475	13.33	1.366
6.3778	0.778	4.535	18.84	1.366
6.4556	0.780	4.596	24.95	1.366
6.5333	0.781	4.657	31.61	1.366
6.6111	0.783	4.717	38.77	1.366
6.6889	0.785	4.778	46.40	1.366
6.7667	0.786	4.840	54.48	1.366
6.8444	0.788	4.901	62.97	1.366
6.9222	0.790	4.962	71.87	1.366
7.0000	0.791	5.024	81.15	1.366

7.0778	0.793	5.085	90.80	1.366

Analysis Results
POC 1





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 17.8
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 8.61
Total Impervious Area: 9.19

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.500804
5 year	0.939783
10 year	1.324271
25 year	1.929538
50 year	2.475316
100 year	3.109334

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0
5 year	0
10 year	0
25 year	0
50 year	0
100 year	0

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1956	0.560	0.000
1957	0.891	0.000
1958	0.253	0.000
1959	0.397	0.000
1960	0.610	0.000
1961	0.472	0.000
1962	0.172	0.000
1963	1.063	0.000
1964	0.797	0.000
1965	0.427	0.000

1966	0.257	0.000
1967	0.517	0.000
1968	0.375	0.000
1969	0.231	0.000
1970	0.427	0.000
1971	1.078	0.000
1972	0.846	0.000
1973	0.462	0.000
1974	0.442	0.000
1975	1.264	0.000
1976	0.606	0.000
1977	0.133	0.000
1978	0.895	0.000
1979	0.699	0.000
1980	0.447	0.000
1981	0.802	0.000
1982	0.523	0.000
1983	0.726	0.000
1984	0.505	0.000
1985	0.216	0.000
1986	1.068	0.000
1987	0.645	0.000
1988	0.293	0.000
1989	0.327	0.000
1990	0.907	0.000
1991	1.952	0.000
1992	6.201	0.000
1993	0.634	0.000
1994	0.260	0.000
1995	0.613	0.000
1996	0.914	0.000
1997	2.175	0.000
1998	0.924	0.000
1999	0.453	0.000
2000	0.253	0.000
2001	0.058	0.000
2002	0.513	0.000
2003	0.189	0.000
2004	0.278	0.000
2005	0.304	0.000
2006	0.460	0.000
2007	0.383	0.000
2008	0.474	0.000
2009	0.795	0.000
2010	0.386	0.000
2011	0.407	0.000

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	6.2011	0.0000
2	2.1752	0.0000
3	1.9521	0.0000
4	1.2635	0.0000
5	1.0781	0.0000
6	1.0676	0.0000
7	1.0632	0.0000
8	0.9241	0.0000

9	0.9140	0.0000
10	0.9073	0.0000
11	0.8947	0.0000
12	0.8913	0.0000
13	0.8456	0.0000
14	0.8017	0.0000
15	0.7966	0.0000
16	0.7953	0.0000
17	0.7262	0.0000
18	0.6985	0.0000
19	0.6449	0.0000
20	0.6336	0.0000
21	0.6132	0.0000
22	0.6097	0.0000
23	0.6058	0.0000
24	0.5602	0.0000
25	0.5233	0.0000
26	0.5165	0.0000
27	0.5133	0.0000
28	0.5052	0.0000
29	0.4738	0.0000
30	0.4716	0.0000
31	0.4616	0.0000
32	0.4598	0.0000
33	0.4533	0.0000
34	0.4471	0.0000
35	0.4422	0.0000
36	0.4274	0.0000
37	0.4274	0.0000
38	0.4069	0.0000
39	0.3971	0.0000
40	0.3858	0.0000
41	0.3832	0.0000
42	0.3749	0.0000
43	0.3269	0.0000
44	0.3040	0.0000
45	0.2928	0.0000
46	0.2782	0.0000
47	0.2602	0.0000
48	0.2573	0.0000
49	0.2532	0.0000
50	0.2532	0.0000
51	0.2312	0.0000
52	0.2159	0.0000
53	0.1893	0.0000
54	0.1716	0.0000
55	0.1328	0.0000
56	0.0576	0.0000

Duration Flows
The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.2504	16235	0	0	Pass
0.2729	12969	0	0	Pass
0.2953	10444	0	0	Pass
0.3178	8542	0	0	Pass
0.3403	7016	0	0	Pass
0.3628	5853	0	0	Pass
0.3852	4846	0	0	Pass
0.4077	4004	0	0	Pass
0.4302	3322	0	0	Pass
0.4527	2755	0	0	Pass
0.4751	2331	0	0	Pass
0.4976	1977	0	0	Pass
0.5201	1675	0	0	Pass
0.5426	1437	0	0	Pass
0.5650	1201	0	0	Pass
0.5875	1032	0	0	Pass
0.6100	885	0	0	Pass
0.6325	787	0	0	Pass
0.6549	708	0	0	Pass
0.6774	643	0	0	Pass
0.6999	577	0	0	Pass
0.7224	517	0	0	Pass
0.7448	468	0	0	Pass
0.7673	402	0	0	Pass
0.7898	338	0	0	Pass
0.8122	288	0	0	Pass
0.8347	259	0	0	Pass
0.8572	223	0	0	Pass
0.8797	203	0	0	Pass
0.9021	177	0	0	Pass
0.9246	158	0	0	Pass
0.9471	150	0	0	Pass
0.9696	145	0	0	Pass
0.9920	142	0	0	Pass
1.0145	139	0	0	Pass
1.0370	136	0	0	Pass
1.0595	133	0	0	Pass
1.0819	126	0	0	Pass
1.1044	121	0	0	Pass
1.1269	117	0	0	Pass
1.1494	112	0	0	Pass
1.1718	110	0	0	Pass
1.1943	106	0	0	Pass
1.2168	101	0	0	Pass
1.2393	99	0	0	Pass
1.2617	96	0	0	Pass
1.2842	91	0	0	Pass
1.3067	88	0	0	Pass
1.3291	83	0	0	Pass
1.3516	81	0	0	Pass
1.3741	79	0	0	Pass
1.3966	75	0	0	Pass
1.4190	69	0	0	Pass

1.4415	62	0	0	Pass
1.4640	54	0	0	Pass
1.4865	46	0	0	Pass
1.5089	33	0	0	Pass
1.5314	23	0	0	Pass
1.5539	16	0	0	Pass
1.5764	15	0	0	Pass
1.5988	13	0	0	Pass
1.6213	12	0	0	Pass
1.6438	11	0	0	Pass
1.6663	11	0	0	Pass
1.6887	11	0	0	Pass
1.7112	10	0	0	Pass
1.7337	8	0	0	Pass
1.7562	8	0	0	Pass
1.7786	7	0	0	Pass
1.8011	7	0	0	Pass
1.8236	7	0	0	Pass
1.8460	7	0	0	Pass
1.8685	7	0	0	Pass
1.8910	5	0	0	Pass
1.9135	5	0	0	Pass
1.9359	5	0	0	Pass
1.9584	4	0	0	Pass
1.9809	4	0	0	Pass
2.0034	4	0	0	Pass
2.0258	4	0	0	Pass
2.0483	4	0	0	Pass
2.0708	4	0	0	Pass
2.0933	4	0	0	Pass
2.1157	4	0	0	Pass
2.1382	4	0	0	Pass
2.1607	4	0	0	Pass
2.1832	3	0	0	Pass
2.2056	3	0	0	Pass
2.2281	3	0	0	Pass
2.2506	3	0	0	Pass
2.2731	3	0	0	Pass
2.2955	3	0	0	Pass
2.3180	3	0	0	Pass
2.3405	3	0	0	Pass
2.3629	2	0	0	Pass
2.3854	2	0	0	Pass
2.4079	2	0	0	Pass
2.4304	2	0	0	Pass
2.4528	2	0	0	Pass
2.4753	2	0	0	Pass

Water Quality

Water Quality BMP Flow and Volume for POC #1

On-line facility volume:	1.5681 acre-feet
On-line facility target flow:	1.5873 cfs.
Adjusted for 15 min:	1.5873 cfs.
Off-line facility target flow:	0.8891 cfs.
Adjusted for 15 min:	0.8891 cfs.

Model Default Modifications

Total of 0 changes have been made.

PERLND Changes

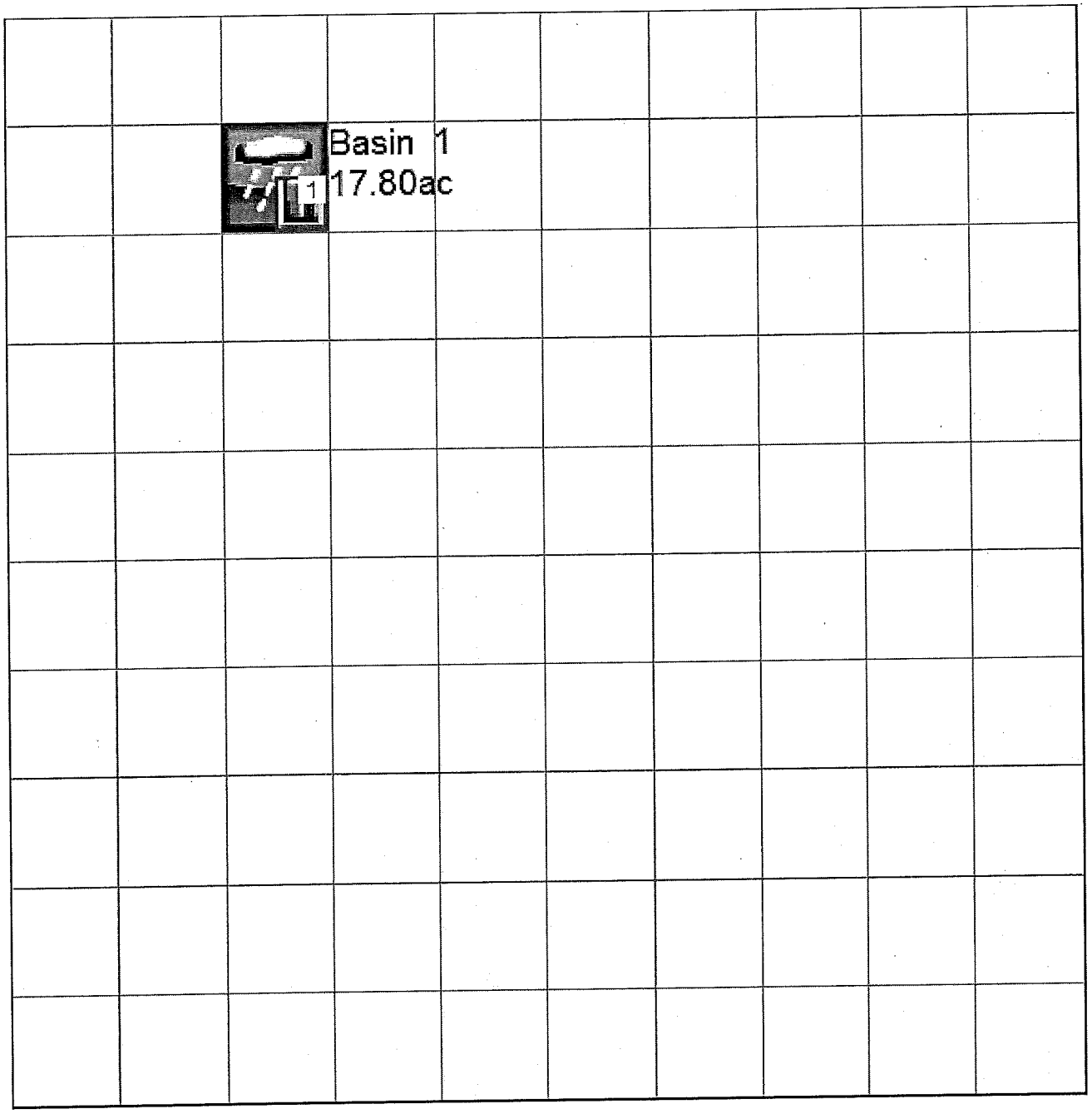
No PERLND changes have been made.

IMPLND Changes

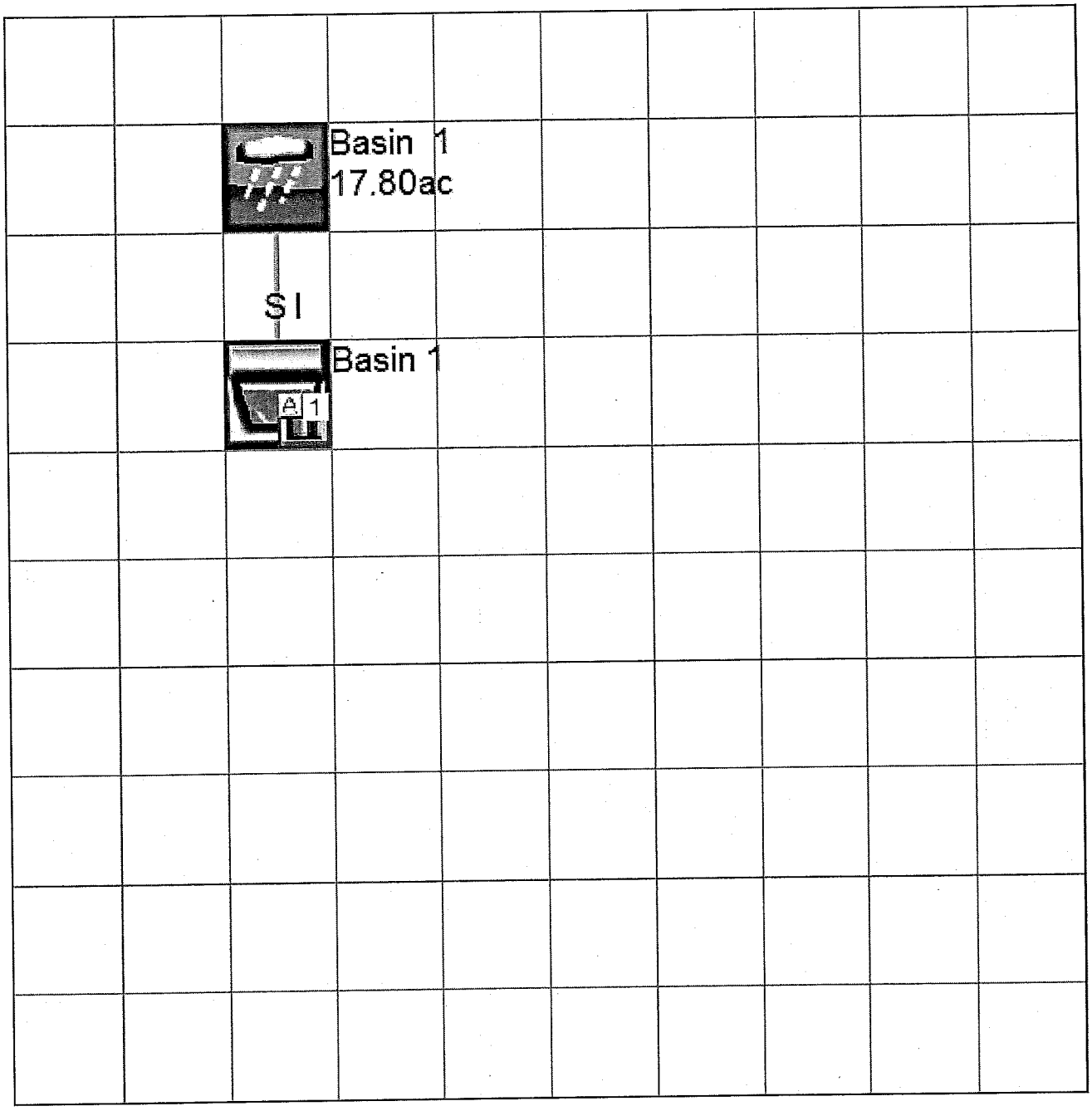
No IMPLND changes have been made.

Appendix

Predeveloped Schematic



Mitigated Schematic



Predeveloped UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1955 10 01         END    2011 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   13-046 Basin 1 preliminary.wdm
MESSU       25   Pre13-046 Basin 1 preliminary.MES
            27   Pre13-046 Basin 1 preliminary.L61
            28   Pre13-046 Basin 1 preliminary.L62
            30   POC13-046 Basin 1 preliminary1.dat
END FILES

OPN SEQUENCE
    INGRP               INDELT 00:15
      PERLND        2
      PERLND       11
      COPY        501
      DISPLY        1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title---------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Basin  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             ***
    2     A/B, Forest, Mod         1    1    1    1   27    0
   11     C, 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 ***
    2          0    0    1    0    0    0    0    0    0    0    0    0
   11          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  *********
```

```
  2          0    0    4    0    0    0    0    0    0    0    0    0    1    9
 11          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 ***
  2          0    0    0    0    0    0    0    0    0    0    0
 11          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
  2               0         5         2       400       0.1        0.3      0.996
 11               0       4.5      0.08       400       0.1        0.5      0.996
END PWAT-PARM2

PWAT-PARM3
  <PLS >      PWATER input info: Part 3          ***
  # -  # ***PETMAX     PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
  2               0         0         2         2         0         0         0
 11               0         0         2         2         0         0         0
END PWAT-PARM3
PWAT-PARM4
  <PLS >      PWATER input info: Part 4                                    ***
  # -  #      CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
  2            0.2       0.5      0.35         0       0.7       0.7
 11            0.2       0.5      0.35         6       0.5       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
  2               0         0         0         0         3         1         0
 11               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    1***
PERLND     2                        5.1      COPY    501      12
PERLND     2                        5.1      COPY    501      13
PERLND    11                       12.7      COPY    501      12
PERLND    11                       12.7      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    0.8             PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    0.8             IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.76            PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.76            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       1955 10 01         END    2011 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   13-046 Basin 1 preliminary.wdm
MESSU       25   Mit13-046 Basin 1 preliminary.MES
            27   Mit13-046 Basin 1 preliminary.L61
            28   Mit13-046 Basin 1 preliminary.L62
            30   POC13-046 Basin 1 preliminary1.dat
END FILES

OPN SEQUENCE
    INGRP               INDELT 00:15
      PERLND       11
      PERLND        5
      PERLND       14
      PERLND       16
      PERLND        7
      IMPLND        2
      IMPLND        4
      IMPLND        5
      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        Basin 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              ***
    11     C, Forest, Mod          1    1    1    1   27    0
     5     A/B, Pasture, Mod       1    1    1    1   27    0
    14     C, Pasture, Mod         1    1    1    1   27    0
    16     C, Lawn, Flat           1    1    1    1   27    0
     7     A/B, Lawn, Flat         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 ***
 11          0    0    1    0    0    0    0    0    0    0    0    0
  5          0    0    1    0    0    0    0    0    0    0    0    0
 14          0    0    1    0    0    0    0    0    0    0    0    0
 16          0    0    1    0    0    0    0    0    0    0    0    0
  7          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  *********
 11          0    0    4    0    0    0    0    0    0    0    0    0    1    9
  5          0    0    4    0    0    0    0    0    0    0    0    0    1    9
 14          0    0    4    0    0    0    0    0    0    0    0    0    1    9
 16          0    0    4    0    0    0    0    0    0    0    0    0    1    9
  7          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 ***
 11          0    0    0    0    0    0    0    0    0    0    0
  5          0    0    0    0    0    0    0    0    0    0    0
 14          0    0    0    0    0    0    0    0    0    0    0
 16          0    0    0    0    0    0    0    0    0    0    0
  7          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
 11               0       4.5       0.08       400        0.1        0.5      0.996
  5               0         5        1.5       400        0.1        0.3      0.996
 14               0       4.5       0.06       400        0.1        0.5      0.996
 16               0       4.5       0.03       400       0.05        0.5      0.996
  7               0         5        0.8       400       0.05        0.3      0.996
END PWAT-PARM2

PWAT-PARM3
  <PLS >       PWATER input info: Part 3          ***
  # -   # ***PETMAX     PETMIN     INFEXP     INFILD     DEEPFR     BASETP     AGWETP
 11               0          0          2          2          0          0          0
  5               0          0          2          2          0          0          0
 14               0          0          2          2          0          0          0
 16               0          0          2          2          0          0          0
  7               0          0          2          2          0          0          0
END PWAT-PARM3
PWAT-PARM4                                                                  ***
  <PLS >      PWATER input info: Part 4                                     ***
  # -   #      CEPSC      UZSN      NSUR      INTFW       IRC      LZETP ***
 11             0.2       0.5      0.35          6       0.5        0.7
  5            0.15       0.5       0.3          0       0.7        0.4
 14            0.15       0.4       0.3          6       0.5        0.4
 16             0.1      0.25      0.25          6       0.5       0.25
  7             0.1       0.5      0.25          0       0.7       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
 11               0         0         0          0       2.5          1          0
  5               0         0         0          0         3          1          0
 14               0         0         0          0       2.5          1          0
 16               0         0         0          0       2.5          1          0
```

```
    7              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
    5       DRIVEWAYS/FLAT        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
    5          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
    5          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
    5          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
    5           400      0.01       0.1        0.1
    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
    5              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
    5              0          0
    9              0          0
   14              0          0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                   <--Area-->     <-Target->   MBLK    ***
<Name>   #                   <-factor->     <Name>   #   Tbl#    ***
Basin  1***
PERLND  11                         0.73     RCHRES   1      2
PERLND  11                         0.73     RCHRES   1      3
PERLND   5                         0.21     RCHRES   1      2
PERLND   5                         0.21     RCHRES   1      3
PERLND  14                         0.52     RCHRES   1      2
PERLND  14                         0.52     RCHRES   1      3
PERLND  16                         5.08     RCHRES   1      2
PERLND  16                         5.08     RCHRES   1      3
PERLND   7                         2.07     RCHRES   1      2
PERLND   7                         2.07     RCHRES   1      3
IMPLND   2                         1.98     RCHRES   1      5
IMPLND   4                          3.9     RCHRES   1      5
IMPLND   5                          1.3     RCHRES   1      5
IMPLND   9                          0.9     RCHRES   1      5
IMPLND  14                         1.11     RCHRES   1      5

******Routing******
PERLND  11                         0.73     COPY     1     12
PERLND   5                         0.21     COPY     1     12
PERLND  14                         0.52     COPY     1     12
PERLND  16                         5.08     COPY     1     12
PERLND   7                         2.07     COPY     1     12
IMPLND   2                         1.98     COPY     1     15
IMPLND   4                          3.9     COPY     1     15
IMPLND   5                          1.3     COPY     1     15
IMPLND   9                          0.9     COPY     1     15
IMPLND  14                         1.11     COPY     1     15
PERLND  11                         0.73     COPY     1     13
PERLND   5                         0.21     COPY     1     13
PERLND  14                         0.52     COPY     1     13
PERLND  16                         5.08     COPY     1     13
PERLND   7                         2.07     COPY     1     13
RCHRES   1                            1     COPY   501     17
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     Basin 1                 2    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  5  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       0.07        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  5.0  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    5
     Depth      Area     Volume   Outflow1   Outflow2   Velocity  Travel Time***
      (ft)    (acres)  (acre-ft)    (cfs)      (cfs)    (ft/sec)    (Minutes)***
  0.000000  0.645202  0.000000  0.000000  0.000000
  0.077778  0.646781  0.050244  0.000000  1.366215
  0.155556  0.648361  0.100610  0.000000  1.366215
  0.233333  0.649942  0.151100  0.000000  1.366215
  0.311111  0.651525  0.201713  0.000000  1.366215
  0.388889  0.653108  0.252448  0.000000  1.366215
  0.466667  0.654692  0.303307  0.000000  1.366215
  0.544444  0.656278  0.354289  0.000000  1.366215
  0.622222  0.657865  0.405395  0.000000  1.366215
  0.700000  0.659453  0.456624  0.000000  1.366215
  0.777778  0.661042  0.507977  0.000000  1.366215
  0.855556  0.662632  0.559453  0.000000  1.366215
  0.933333  0.664223  0.611053  0.000000  1.366215
  1.011111  0.665815  0.662776  0.000000  1.366215
  1.088889  0.667409  0.714624  0.000000  1.366215
  1.166667  0.669003  0.766595  0.000000  1.366215
  1.244444  0.670599  0.818691  0.000000  1.366215
  1.322222  0.672196  0.870911  0.000000  1.366215
  1.400000  0.673793  0.923255  0.000000  1.366215
  1.477778  0.675392  0.975723  0.000000  1.366215
  1.555556  0.676992  1.028316  0.000000  1.366215
  1.633333  0.678594  1.081033  0.000000  1.366215
  1.711111  0.680196  1.133875  0.000000  1.366215
  1.788889  0.681799  1.186842  0.000000  1.366215
  1.866667  0.683404  1.239933  0.000000  1.366215
  1.944444  0.685009  1.293149  0.000000  1.366215
  2.022222  0.686616  1.346490  0.000000  1.366215
  2.100000  0.688224  1.399956  0.000000  1.366215
  2.177778  0.689833  1.453547  0.000000  1.366215
  2.255556  0.691443  1.507263  0.000000  1.366215
```

```
  2.333333  0.693054  1.561105  0.000000  1.366215
  2.411111  0.694667  1.615072  0.000000  1.366215
  2.488889  0.696280  1.669164  0.000000  1.366215
  2.566667  0.697895  1.723382  0.000000  1.366215
  2.644444  0.699510  1.777726  0.000000  1.366215
  2.722222  0.701127  1.832195  0.000000  1.366215
  2.800000  0.702745  1.886790  0.000000  1.366215
  2.877778  0.704364  1.941511  0.000000  1.366215
  2.955556  0.705984  1.996357  0.000000  1.366215
  3.033333  0.707605  2.051330  0.000000  1.366215
  3.111111  0.709227  2.106429  0.000000  1.366215
  3.188889  0.710851  2.161655  0.000000  1.366215
  3.266667  0.712475  2.217006  0.000000  1.366215
  3.344444  0.714101  2.272484  0.000000  1.366215
  3.422222  0.715728  2.328089  0.000000  1.366215
  3.500000  0.717355  2.383820  0.000000  1.366215
  3.577778  0.718984  2.439677  0.000000  1.366215
  3.655556  0.720614  2.495662  0.000000  1.366215
  3.733333  0.722246  2.551773  0.000000  1.366215
  3.811111  0.723878  2.608011  0.000000  1.366215
  3.888889  0.725511  2.664376  0.000000  1.366215
  3.966667  0.727146  2.720868  0.000000  1.366215
  4.044444  0.728781  2.777488  0.000000  1.366215
  4.122222  0.730418  2.834234  0.000000  1.366215
  4.200000  0.732056  2.891108  0.000000  1.366215
  4.277778  0.733695  2.948110  0.000000  1.366215
  4.355556  0.735335  3.005239  0.000000  1.366215
  4.433333  0.736976  3.062495  0.000000  1.366215
  4.511111  0.738619  3.119880  0.000000  1.366215
  4.588889  0.740262  3.177392  0.000000  1.366215
  4.666667  0.741906  3.235031  0.000000  1.366215
  4.744444  0.743552  3.292799  0.000000  1.366215
  4.822222  0.745199  3.350695  0.000000  1.366215
  4.900000  0.746847  3.408719  0.000000  1.366215
  4.977778  0.748496  3.466871  0.000000  1.366215
  5.055556  0.750146  3.525152  0.000000  1.366215
  5.133333  0.751797  3.583561  0.000000  1.366215
  5.211111  0.753449  3.642098  0.000000  1.366215
  5.288889  0.755103  3.700764  0.000000  1.366215
  5.366667  0.756757  3.759558  0.000000  1.366215
  5.444444  0.758413  3.818482  0.000000  1.366215
  5.522222  0.760069  3.877534  0.000000  1.366215
  5.600000  0.761727  3.936715  0.000000  1.366215
  5.677778  0.763386  3.996025  0.000000  1.366215
  5.755556  0.765046  4.055464  0.000000  1.366215
  5.833333  0.766707  4.115032  0.000000  1.366215
  5.911111  0.768370  4.174729  0.000000  1.366215
  5.988889  0.770033  4.234556  0.000000  1.366215
  6.066667  0.771698  4.294512  1.396999  1.366215
  6.144444  0.773363  4.354598  4.455376  1.366215
  6.222222  0.775030  4.414813  8.501868  1.366215
  6.300000  0.776698  4.475158  13.33567  1.366215
  6.377778  0.778367  4.535633  18.84464  1.366215
  6.455556  0.780037  4.596238  24.95429  1.366215
  6.533333  0.781708  4.656972  31.61049  1.366215
  6.611111  0.783380  4.717837  38.77157  1.366215
  6.688889  0.785054  4.778832  46.40416  1.366215
  6.766667  0.786728  4.839956  54.48074  1.366215
  6.844444  0.788404  4.901212  62.97813  1.366215
  6.922222  0.790081  4.962597  71.87643  1.366215
  7.000000  0.791758  5.024113  81.15833  1.366215
  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     0.8             PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL     0.8             IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL     0.76            PERLND   1 999 EXTNL  PETINP
```

```
WDM      1 EVAP     ENGL    0.76             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   1000 FLOW     ENGL       REPL
RCHRES   1 HYDR   O      1 1         1      WDM   1001 FLOW     ENGL       REPL
RCHRES   1 HYDR   O      2 1         1      WDM   1002 FLOW     ENGL       REPL
RCHRES   1 HYDR   STAGE  1 1         1      WDM   1003 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        17
RCHRES      OFLOW  OVOL   1                 COPY           INPUT  MEAN
  END MASS-LINK   17


END MASS-LINK

END RUN
```

Mitigated HSPF Message File

Disclaimer

Legal Notice

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

www.clearcreeksolutions.com

WWHM2012

PROJECT REPORT

General Model Information

Project Name:	13-046 Basin 2 preliminary
Site Name:	Oak Springs
Site Address:	3146 Marvin Road SE
City:	Olympia
Report Date:	10/15/2013
Gage:	Woodland Creek
Data Start:	1955/10/01
Data End:	2011/09/30
Timestep:	15 Minute
Precip Scale:	0.80
Version:	2013/06/10

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 2

Bypass:	No
GroundWater:	No

Pervious Land Use	Acres
A B, Forest, Mod	1.18
C, Forest, Mod	1.03
Pervious Total	2.21

Impervious Land Use	Acres
Impervious Total	0
Basin Total	2.21

Element Flows To:		
Surface	Interflow	Groundwater

Mitigated Land Use

Basin 2

Bypass:	No
GroundWater:	No

Pervious Land Use	Acres
C, Lawn, Flat	0.84
Pervious Total	0.84

Impervious Land Use	Acres
ROADS MOD	0.21
ROOF TOPS FLAT	0.18
DRIVEWAYS FLAT	0.06
SIDEWALKS MOD	0.06
POND	0.86
Impervious Total	1.37
Basin Total	2.21

Element Flows To:

Surface	Interflow	Groundwater
Trapezoidal Pond 2	Trapezoidal Pond 2	

Routing Elements
Predeveloped Routing

Mitigated Routing

Trapezoidal Pond 2

Bottom Length:	68.00 ft.
Bottom Width:	36.50 ft.
Depth:	5 ft.
Volume at riser head:	0.3182 acre-ft.
Infiltration On	
Infiltration rate:	6.5
Infiltration safety factor:	1
Side slope 1:	2 To 1
Side slope 2:	2 To 1
Side slope 3:	2 To 1
Side slope 4:	2 To 1
Discharge Structure	
Riser Height:	4 ft.
Riser Diameter:	100 in.
Element Flows To:	
Outlet 1	Outlet 2

Pond Hydraulic Table

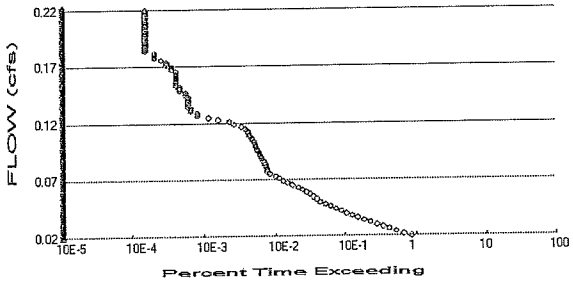
Stage(ft)	Area(ac)	Volume(ac-ft)	Discharge(cfs)	Infilt(cfs)
0.0000	0.057	0.000	0.000	0.000
0.0556	0.057	0.003	0.000	0.373
0.1111	0.058	0.006	0.000	0.373
0.1667	0.058	0.009	0.000	0.373
0.2222	0.059	0.012	0.000	0.373
0.2778	0.059	0.016	0.000	0.373
0.3333	0.060	0.019	0.000	0.373
0.3889	0.060	0.022	0.000	0.373
0.4444	0.061	0.026	0.000	0.373
0.5000	0.061	0.029	0.000	0.373
0.5556	0.062	0.033	0.000	0.373
0.6111	0.063	0.036	0.000	0.373
0.6667	0.063	0.040	0.000	0.373
0.7222	0.064	0.043	0.000	0.373
0.7778	0.064	0.047	0.000	0.373
0.8333	0.065	0.050	0.000	0.373
0.8889	0.065	0.054	0.000	0.373
0.9444	0.066	0.058	0.000	0.373
1.0000	0.066	0.061	0.000	0.373
1.0556	0.067	0.065	0.000	0.373
1.1111	0.068	0.069	0.000	0.373
1.1667	0.068	0.073	0.000	0.373
1.2222	0.069	0.077	0.000	0.373
1.2778	0.069	0.080	0.000	0.373
1.3333	0.070	0.084	0.000	0.373
1.3889	0.071	0.088	0.000	0.373
1.4444	0.071	0.092	0.000	0.373
1.5000	0.072	0.096	0.000	0.373
1.5556	0.072	0.100	0.000	0.373
1.6111	0.073	0.104	0.000	0.373
1.6667	0.074	0.108	0.000	0.373
1.7222	0.074	0.113	0.000	0.373
1.7778	0.075	0.117	0.000	0.373

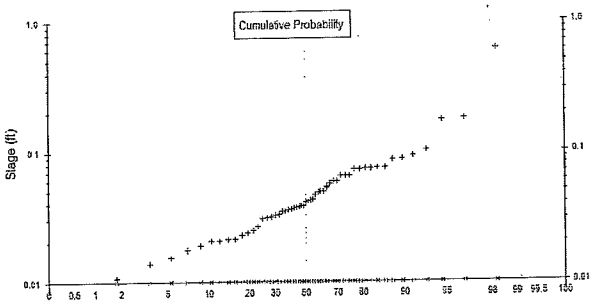
1.8333	0.075	0.121	0.000	0.373
1.8889	0.076	0.125	0.000	0.373
1.9444	0.077	0.129	0.000	0.373
2.0000	0.077	0.134	0.000	0.373
2.0556	0.078	0.138	0.000	0.373
2.1111	0.078	0.142	0.000	0.373
2.1667	0.079	0.147	0.000	0.373
2.2222	0.080	0.151	0.000	0.373
2.2778	0.080	0.156	0.000	0.373
2.3333	0.081	0.160	0.000	0.373
2.3889	0.082	0.165	0.000	0.373
2.4444	0.082	0.169	0.000	0.373
2.5000	0.083	0.174	0.000	0.373
2.5556	0.083	0.179	0.000	0.373
2.6111	0.084	0.183	0.000	0.373
2.6667	0.085	0.188	0.000	0.373
2.7222	0.085	0.193	0.000	0.373
2.7778	0.086	0.197	0.000	0.373
2.8333	0.087	0.202	0.000	0.373
2.8889	0.087	0.207	0.000	0.373
2.9444	0.088	0.212	0.000	0.373
3.0000	0.089	0.217	0.000	0.373
3.0556	0.089	0.222	0.000	0.373
3.1111	0.090	0.227	0.000	0.373
3.1667	0.091	0.232	0.000	0.373
3.2222	0.091	0.237	0.000	0.373
3.2778	0.092	0.242	0.000	0.373
3.3333	0.093	0.247	0.000	0.373
3.3889	0.093	0.253	0.000	0.373
3.4444	0.094	0.258	0.000	0.373
3.5000	0.095	0.263	0.000	0.373
3.5556	0.095	0.268	0.000	0.373
3.6111	0.096	0.274	0.000	0.373
3.6667	0.097	0.279	0.000	0.373
3.7222	0.097	0.284	0.000	0.373
3.7778	0.098	0.290	0.000	0.373
3.8333	0.099	0.295	0.000	0.373
3.8889	0.099	0.301	0.000	0.373
3.9444	0.100	0.306	0.000	0.373
4.0000	0.101	0.312	0.000	0.373
4.0556	0.101	0.318	1.062	0.373
4.1111	0.102	0.323	3.005	0.373
4.1667	0.103	0.329	5.522	0.373
4.2222	0.104	0.335	8.501	0.373
4.2778	0.104	0.341	11.88	0.373
4.3333	0.105	0.347	15.61	0.373
4.3889	0.106	0.352	19.68	0.373
4.4444	0.106	0.358	24.04	0.373
4.5000	0.107	0.364	28.69	0.373
4.5556	0.108	0.370	33.60	0.373
4.6111	0.109	0.376	38.77	0.373
4.6667	0.109	0.382	44.17	0.373
4.7222	0.110	0.389	49.81	0.373
4.7778	0.111	0.395	55.66	0.373
4.8333	0.111	0.401	61.73	0.373
4.8889	0.112	0.407	68.01	0.373
4.9444	0.113	0.413	74.49	0.373
5.0000	0.114	0.420	81.15	0.373

5.0556	0.114	0.426	88.01	0.373

Analysis Results

POC 1





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 2.21
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 0.84
Total Impervious Area: 1.37

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.040592
5 year	0.077964
10 year	0.112056
25 year	0.167754
50 year	0.219733
100 year	0.281879

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0
5 year	0
10 year	0
25 year	0
50 year	0
100 year	0

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1956	0.047	0.000
1957	0.072	0.000
1958	0.021	0.000
1959	0.032	0.000
1960	0.050	0.000
1961	0.039	0.000
1962	0.014	0.000
1963	0.086	0.000
1964	0.065	0.000
1965	0.035	0.000

1966	0.021	0.000
1967	0.042	0.000
1968	0.030	0.000
1969	0.019	0.000
1970	0.035	0.000
1971	0.093	0.000
1972	0.072	0.000
1973	0.038	0.000
1974	0.036	0.000
1975	0.103	0.000
1976	0.049	0.000
1977	0.011	0.000
1978	0.074	0.000
1979	0.057	0.000
1980	0.036	0.000
1981	0.065	0.000
1982	0.043	0.000
1983	0.059	0.000
1984	0.041	0.000
1985	0.018	0.000
1986	0.087	0.000
1987	0.054	0.000
1988	0.024	0.000
1989	0.027	0.000
1990	0.074	0.000
1991	0.173	0.000
1992	0.610	0.000
1993	0.058	0.000
1994	0.021	0.000
1995	0.050	0.000
1996	0.075	0.000
1997	0.177	0.000
1998	0.075	0.000
1999	0.037	0.000
2000	0.021	0.000
2001	0.005	0.000
2002	0.042	0.000
2003	0.015	0.000
2004	0.023	0.000
2005	0.025	0.000
2006	0.037	0.000
2007	0.031	0.000
2008	0.038	0.000
2009	0.065	0.000
2010	0.031	0.000
2011	0.033	0.000

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	0.6098	0.0000
2	0.1766	0.0000
3	0.1734	0.0000
4	0.1026	0.0000
5	0.0926	0.0000
6	0.0869	0.0000
7	0.0864	0.0000
8	0.0750	0.0000

9	0.0745	0.0000
10	0.0737	0.0000
11	0.0736	0.0000
12	0.0724	0.0000
13	0.0723	0.0000
14	0.0651	0.0000
15	0.0649	0.0000
16	0.0647	0.0000
17	0.0589	0.0000
18	0.0584	0.0000
19	0.0567	0.0000
20	0.0536	0.0000
21	0.0499	0.0000
22	0.0498	0.0000
23	0.0491	0.0000
24	0.0466	0.0000
25	0.0428	0.0000
26	0.0422	0.0000
27	0.0421	0.0000
28	0.0410	0.0000
29	0.0386	0.0000
30	0.0385	0.0000
31	0.0376	0.0000
32	0.0373	0.0000
33	0.0368	0.0000
34	0.0363	0.0000
35	0.0359	0.0000
36	0.0348	0.0000
37	0.0347	0.0000
38	0.0330	0.0000
39	0.0322	0.0000
40	0.0313	0.0000
41	0.0311	0.0000
42	0.0304	0.0000
43	0.0265	0.0000
44	0.0247	0.0000
45	0.0238	0.0000
46	0.0226	0.0000
47	0.0211	0.0000
48	0.0210	0.0000
49	0.0206	0.0000
50	0.0206	0.0000
51	0.0188	0.0000
52	0.0175	0.0000
53	0.0154	0.0000
54	0.0139	0.0000
55	0.0108	0.0000
56	0.0047	0.0000

Duration Flows
The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0203	16855	0	0	Pass
0.0223	13113	0	0	Pass
0.0243	10417	0	0	Pass
0.0263	8328	0	0	Pass
0.0284	6778	0	0	Pass
0.0304	5524	0	0	Pass
0.0324	4467	0	0	Pass
0.0344	3644	0	0	Pass
0.0364	2977	0	0	Pass
0.0384	2464	0	0	Pass
0.0404	2042	0	0	Pass
0.0425	1710	0	0	Pass
0.0445	1444	0	0	Pass
0.0465	1196	0	0	Pass
0.0485	1004	0	0	Pass
0.0505	852	0	0	Pass
0.0525	760	0	0	Pass
0.0545	674	0	0	Pass
0.0566	610	0	0	Pass
0.0586	539	0	0	Pass
0.0606	483	0	0	Pass
0.0626	414	0	0	Pass
0.0646	343	0	0	Pass
0.0666	289	0	0	Pass
0.0686	254	0	0	Pass
0.0707	220	0	0	Pass
0.0727	199	0	0	Pass
0.0747	164	0	0	Pass
0.0767	155	0	0	Pass
0.0787	150	0	0	Pass
0.0807	145	0	0	Pass
0.0827	142	0	0	Pass
0.0848	137	0	0	Pass
0.0868	133	0	0	Pass
0.0888	127	0	0	Pass
0.0908	122	0	0	Pass
0.0928	118	0	0	Pass
0.0948	112	0	0	Pass
0.0968	109	0	0	Pass
0.0989	105	0	0	Pass
0.1009	103	0	0	Pass
0.1029	99	0	0	Pass
0.1049	95	0	0	Pass
0.1069	92	0	0	Pass
0.1089	85	0	0	Pass
0.1109	82	0	0	Pass
0.1130	79	0	0	Pass
0.1150	75	0	0	Pass
0.1170	67	0	0	Pass
0.1190	53	0	0	Pass
0.1210	45	0	0	Pass
0.1230	31	0	0	Pass
0.1251	23	0	0	Pass

0.1271	16	0	0	Pass
0.1291	16	0	0	Pass
0.1311	13	0	0	Pass
0.1331	13	0	0	Pass
0.1351	12	0	0	Pass
0.1371	12	0	0	Pass
0.1392	12	0	0	Pass
0.1412	12	0	0	Pass
0.1432	12	0	0	Pass
0.1452	11	0	0	Pass
0.1472	11	0	0	Pass
0.1492	9	0	0	Pass
0.1512	9	0	0	Pass
0.1533	8	0	0	Pass
0.1553	8	0	0	Pass
0.1573	8	0	0	Pass
0.1593	8	0	0	Pass
0.1613	8	0	0	Pass
0.1633	8	0	0	Pass
0.1653	8	0	0	Pass
0.1674	7	0	0	Pass
0.1694	7	0	0	Pass
0.1714	6	0	0	Pass
0.1734	6	0	0	Pass
0.1754	5	0	0	Pass
0.1774	4	0	0	Pass
0.1794	4	0	0	Pass
0.1815	4	0	0	Pass
0.1835	3	0	0	Pass
0.1855	3	0	0	Pass
0.1875	3	0	0	Pass
0.1895	3	0	0	Pass
0.1915	3	0	0	Pass
0.1935	3	0	0	Pass
0.1956	3	0	0	Pass
0.1976	3	0	0	Pass
0.1996	3	0	0	Pass
0.2016	3	0	0	Pass
0.2036	3	0	0	Pass
0.2056	3	0	0	Pass
0.2076	3	0	0	Pass
0.2097	3	0	0	Pass
0.2117	3	0	0	Pass
0.2137	3	0	0	Pass
0.2157	3	0	0	Pass
0.2177	3	0	0	Pass
0.2197	3	0	0	Pass

Water Quality

Water Quality BMP Flow and Volume for POC #1

On-line facility volume:	0.232 acre-feet
On-line facility target flow:	0.2346 cfs.
Adjusted for 15 min:	0.2346 cfs.
Off-line facility target flow:	0.1312 cfs.
Adjusted for 15 min:	0.1312 cfs.

Model Default Modifications

Total of 0 changes have been made.

PERLND Changes

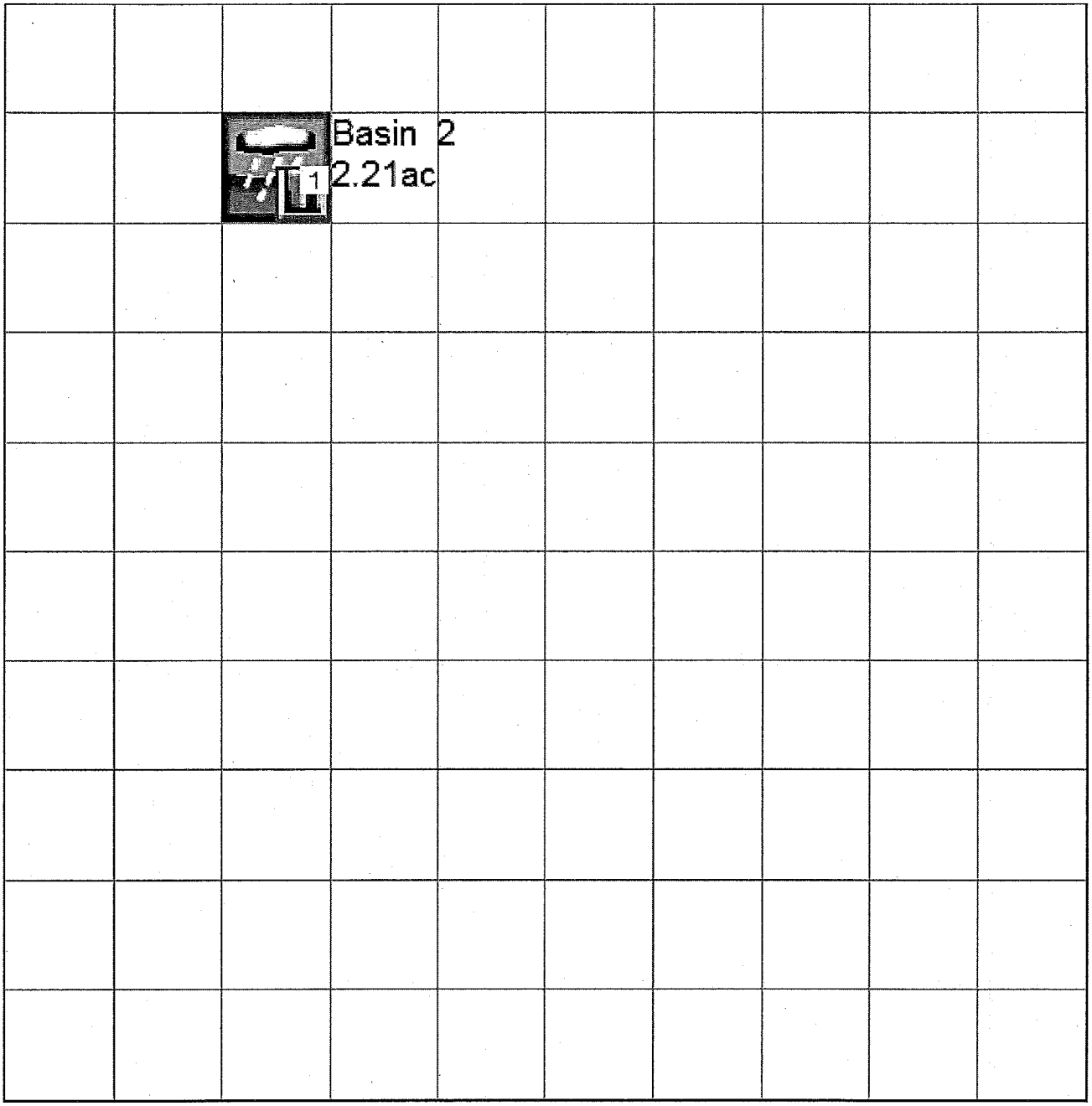
No PERLND changes have been made.

IMPLND Changes

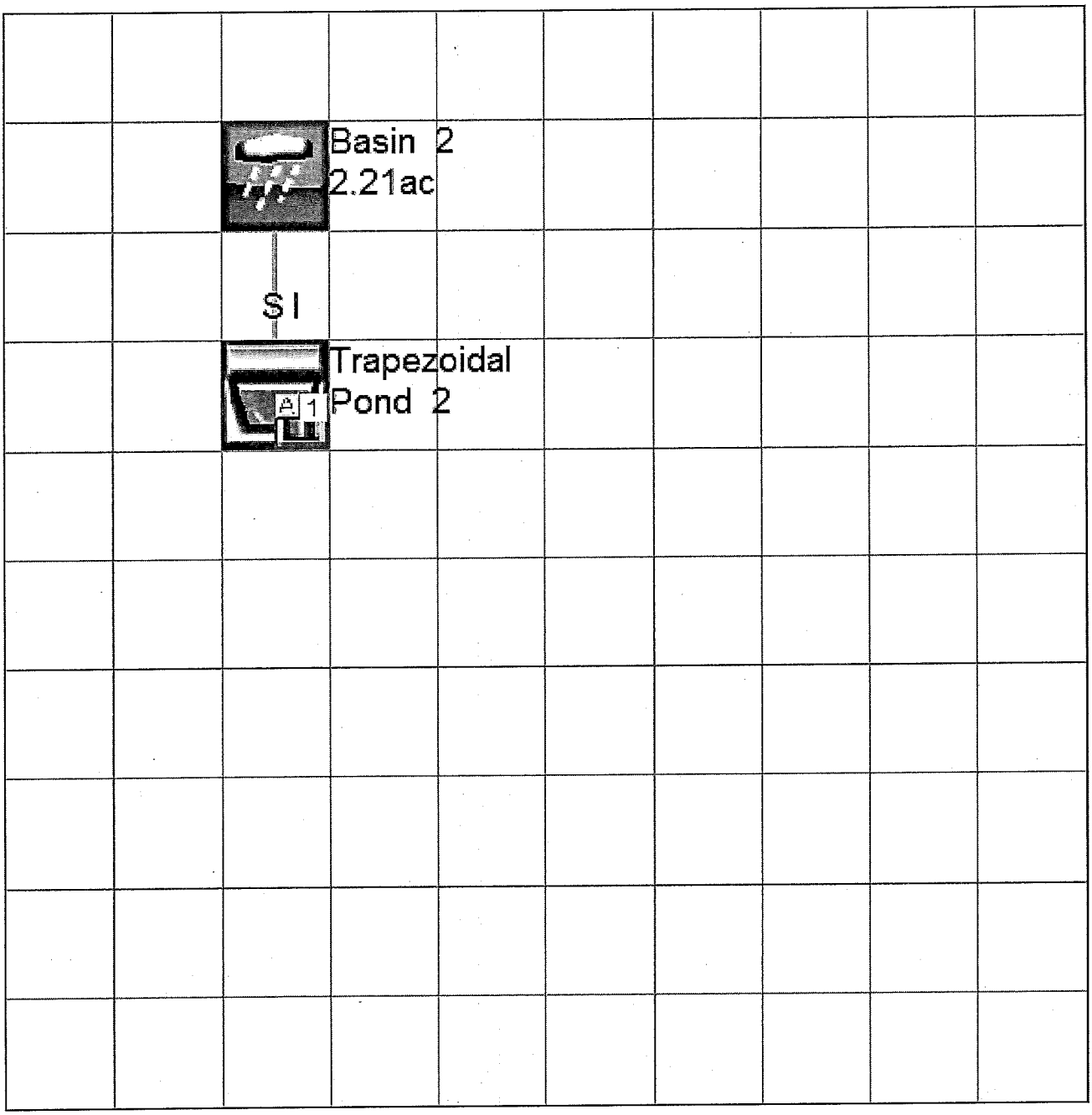
No IMPLND changes have been made.

Appendix

Predeveloped Schematic



Mitigated Schematic



Predeveloped UCI File

Mitigated UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1955 10 01         END    2011 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   13-046 Basin 2 preliminary.wdm
MESSU       25   Mit13-046 Basin 2 preliminary.MES
            27   Mit13-046 Basin 2 preliminary.L61
            28   Mit13-046 Basin 2 preliminary.L62
            30   POC13-046 Basin 2 preliminary1.dat
END FILES

OPN SEQUENCE
    INGRP               INDELT 00:15
      PERLND       16
      IMPLND        2
      IMPLND        4
      IMPLND        5
      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  2         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              ***
   16     C, Lawn, Flat            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 ***
   16         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  *********
   16         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 ***
   16         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
   16               0       4.5      0.03       400       0.05        0.5      0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3          ***
    # -   # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   16               0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                                  ***
    # -   #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   16          0.1      0.25      0.25         6       0.5      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
   16               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           ***
    2       ROADS/MOD             1    1    1   27    0
    4       ROOF TOPS/FLAT        1    1    1   27    0
    5       DRIVEWAYS/FLAT        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
    5         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
    5         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
    5          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
    5           400      0.01       0.1       0.1
    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
    5              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
    5              0         0
    9              0         0
   14              0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK    ***
<Name>   #                  <-factor->     <Name>   #   Tbl#    ***
Basin  2***
PERLND  16                       0.84     RCHRES   1      2
PERLND  16                       0.84     RCHRES   1      3
IMPLND   2                       0.21     RCHRES   1      5
IMPLND   4                       0.18     RCHRES   1      5
IMPLND   5                       0.06     RCHRES   1      5
IMPLND   9                       0.06     RCHRES   1      5
IMPLND  14                       0.86     RCHRES   1      5

******Routing******
PERLND  16                       0.84     COPY     1     12
IMPLND   2                       0.21     COPY     1     15
IMPLND   4                       0.18     COPY     1     15
IMPLND   5                       0.06     COPY     1     15
IMPLND   9                       0.06     COPY     1     15
IMPLND  14                       0.86     COPY     1     15
PERLND  16                       0.84     COPY     1     13
RCHRES   1                          1     COPY   501     17
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-005    2    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  5  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      0.01       0.0       0.0       0.5       0.0
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                     ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
           *** ac-ft     for each possible exit        for each possible exit
  <------><--------->     <---><---><---><---><---> *** <---><---><---><---><---->
    1         0           4.0  5.0  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    5
     Depth      Area     Volume  Outflow1  Outflow2  Velocity  Travel Time***
      (ft)    (acres) (acre-ft)   (cfs)     (cfs)   (ft/sec)    (Minutes)***
  0.000000  0.056979  0.000000  0.000000  0.000000
  0.055556  0.057513  0.003180  0.000000  0.373449
  0.111111  0.058050  0.006390  0.000000  0.373449
  0.166667  0.058588  0.009630  0.000000  0.373449
  0.222222  0.059129  0.012900  0.000000  0.373449
  0.277778  0.059673  0.016200  0.000000  0.373449
  0.333333  0.060218  0.019531  0.000000  0.373449
  0.388889  0.060766  0.022891  0.000000  0.373449
  0.444444  0.061316  0.026283  0.000000  0.373449
  0.500000  0.061869  0.029704  0.000000  0.373449
  0.555556  0.062423  0.033157  0.000000  0.373449
  0.611111  0.062980  0.036640  0.000000  0.373449
```

0.666667	0.063539	0.040155	0.000000	0.373449
0.722222	0.064101	0.043700	0.000000	0.373449
0.777778	0.064665	0.047277	0.000000	0.373449
0.833333	0.065231	0.050885	0.000000	0.373449
0.888889	0.065799	0.054525	0.000000	0.373449
0.944444	0.066369	0.058196	0.000000	0.373449
1.000000	0.066942	0.061899	0.000000	0.373449
1.055556	0.067517	0.065634	0.000000	0.373449
1.111111	0.068095	0.069401	0.000000	0.373449
1.166667	0.068674	0.073201	0.000000	0.373449
1.222222	0.069256	0.077032	0.000000	0.373449
1.277778	0.069840	0.080896	0.000000	0.373449
1.333333	0.070426	0.084792	0.000000	0.373449
1.388889	0.071015	0.088721	0.000000	0.373449
1.444444	0.071606	0.092683	0.000000	0.373449
1.500000	0.072199	0.096677	0.000000	0.373449
1.555556	0.072795	0.100705	0.000000	0.373449
1.611111	0.073392	0.104766	0.000000	0.373449
1.666667	0.073992	0.108860	0.000000	0.373449
1.722222	0.074595	0.112987	0.000000	0.373449
1.777778	0.075199	0.117148	0.000000	0.373449
1.833333	0.075806	0.121343	0.000000	0.373449
1.888889	0.076415	0.125571	0.000000	0.373449
1.944444	0.077026	0.129833	0.000000	0.373449
2.000000	0.077640	0.134130	0.000000	0.373449
2.055556	0.078256	0.138460	0.000000	0.373449
2.111111	0.078874	0.142825	0.000000	0.373449
2.166667	0.079494	0.147224	0.000000	0.373449
2.222222	0.080117	0.151657	0.000000	0.373449
2.277778	0.080742	0.156126	0.000000	0.373449
2.333333	0.081369	0.160629	0.000000	0.373449
2.388889	0.081999	0.165167	0.000000	0.373449
2.444444	0.082630	0.169740	0.000000	0.373449
2.500000	0.083264	0.174348	0.000000	0.373449
2.555556	0.083901	0.178992	0.000000	0.373449
2.611111	0.084539	0.183670	0.000000	0.373449
2.666667	0.085180	0.188385	0.000000	0.373449
2.722222	0.085823	0.193135	0.000000	0.373449
2.777778	0.086469	0.197921	0.000000	0.373449
2.833333	0.087116	0.202743	0.000000	0.373449
2.888889	0.087766	0.207601	0.000000	0.373449
2.944444	0.088418	0.212495	0.000000	0.373449
3.000000	0.089073	0.217425	0.000000	0.373449
3.055556	0.089729	0.222392	0.000000	0.373449
3.111111	0.090388	0.227395	0.000000	0.373449
3.166667	0.091049	0.232435	0.000000	0.373449
3.222222	0.091713	0.237511	0.000000	0.373449
3.277778	0.092379	0.242625	0.000000	0.373449
3.333333	0.093047	0.247776	0.000000	0.373449
3.388889	0.093717	0.252964	0.000000	0.373449
3.444444	0.094389	0.258189	0.000000	0.373449
3.500000	0.095064	0.263451	0.000000	0.373449
3.555556	0.095741	0.268752	0.000000	0.373449
3.611111	0.096421	0.274089	0.000000	0.373449
3.666667	0.097102	0.279465	0.000000	0.373449
3.722222	0.097786	0.284879	0.000000	0.373449
3.777778	0.098472	0.290330	0.000000	0.373449
3.833333	0.099161	0.295820	0.000000	0.373449
3.888889	0.099851	0.301348	0.000000	0.373449
3.944444	0.100544	0.306915	0.000000	0.373449
4.000000	0.101240	0.312520	0.000000	0.373449
4.055556	0.101937	0.318164	1.062733	0.373449
4.111111	0.102637	0.323846	3.005864	0.373449
4.166667	0.103339	0.329568	5.522125	0.373449
4.222222	0.104043	0.335328	8.501868	0.373449
4.277778	0.104750	0.341128	11.88172	0.373449
4.333333	0.105459	0.346967	15.61893	0.373449
4.388889	0.106170	0.352846	19.68210	0.373449
4.444444	0.106883	0.358764	24.04691	0.373449
4.500000	0.107599	0.364722	28.69380	0.373449

```
  4.555556  0.108317  0.370720  33.60658  0.373449
  4.611111  0.109037  0.376757  38.77157  0.373449
  4.666667  0.109759  0.382835  44.17700  0.373449
  4.722222  0.110484  0.388953  49.81262  0.373449
  4.777778  0.111211  0.395111  55.66938  0.373449
  4.833333  0.111940  0.401310  61.73924  0.373449
  4.888889  0.112672  0.407549  68.01494  0.373449
  4.944444  0.113405  0.413829  74.48996  0.373449
  5.000000  0.114141  0.420149  81.15833  0.373449
  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    0.8             PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    0.8             IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.76            PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.76            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   1000 FLOW     ENGL      REPL
RCHRES   1 HYDR   O      1 1         1      WDM   1001 FLOW     ENGL      REPL
RCHRES   1 HYDR   O      2 1         1      WDM   1002 FLOW     ENGL      REPL
RCHRES   1 HYDR   STAGE  1 1         1      WDM   1003 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        17
RCHRES     OFLOW  OVOL   1                 COPY           INPUT  MEAN
  END MASS-LINK    17


END MASS-LINK

END RUN
```

Predeveloped HSPF Message File

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