ENGINEERED DRAINAGE REPORT

of

5th Ave Townhomes Plat
585 5th Ave SW
Tumwater, WA 98512

for

ASH Holdings LLC
3425 Merryman Pl SE
Olympia, WA 98501
aholtze@gmail.com

by

THE LAND DEVELOPER'S
ENGINEERED SOLUTION
A Division of THE LAND DEVELOPER, Inc.

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January 22, 2026

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I. PROJECT OVERVIEW

This Engineered Drainage Plan was determined to be required as a result of proposing 11 unit townhome plat project proposing more than 10,000 sf of impervious coverage. The parcel is approximately 1.69 Acres in size. There does not appear to be any existing development on the site. The proposal includes the construction of a 11-lot townhome units. Onsite development includes the following:

LOT SIZE:	73,521 SF (1.69 AC)
FRONTAGE (S 5th Ave SW) COVERAGE:	
TOTAL AREA:	7,019 SF (0.16 AC)
NEW SIDEWALK:	1,543 SF (0.04 AC)
NEW + EX ASPH TO SWALE:	3,298 SF (0.08 AC)
NEW LANDSCAPED AREA:	2,178 SF (0.04 AC)
ONSITE COVERAGE:	
4 LOT 11 UNIT TOTAL AREA:	22,123 SF (0.51 AC)
NEW + REPLACED ASPHALT AREA:	1,716 SF (0.04 AC)
PATIO AREA:	792 SF (0.02 AC)
ROOF AREA:	12,312 SF (0.28 AC
BIORETENTION POND AREA:	7,062 SF (0.16 AC)
LANDSCAPED AREA:	9,241 SF (0.21 AC)
TOTAL ONSITE IMP COVERAGE:	14,820 SF (0.34 AC)
	OR 20% OK IF LESS THAN 60%

There are two bioretention ponds proposed for this project. One is intended to mitigate the onsite stormwater, and the other pond is intended to mitigate the frontage improvements.

The site address is 585 5th Ave SW, Tumwater, WA 98512. The parcel number is 33203200001. The legal description as shown on the Thurston County Assessor Website is as follows:

BLOCK 32 OF SUPPLEMENTAL PLAT OF BARNES ADDITION TO TUMWATER, AS PER PLAT RECORDED IN VOLUME 6 OF PLATS, PAGE 5, RECORDS OF THURSTON COUNTY, AUDITOR:

TOGETHER WITH THOSE PORTIONS OF VACATED "E" STREET ON THE NORTH OF SAID BLOCK 32, OF VACATED 5TH AVENUE ON THE WEST OF SAID BLOCK 32 AS VACATED BY ORDINANCE NO. 02005-027, RECORDED FEBRUARY 8, 2006 UNDER AUDITOR'S FILE NO. 3807120 AND RE-RECORDED UNDER AUDITOR'S FILE NO. 3624457;

EXCEPT THAT PORTION CONVEYED TO THE CITY OF TUMWATER BY DEED RECORDED FEBRUARY 1, 2007, UNDER AUDITOR' FILE NO. 3599306;

IN THURSTON COUNTY, WA.

TOGETHER WITH AND SUBJECT TO EASEMENTS, RESTRICTIONS, RESERVATIONS AND CONDITIONS OF RECORD, IF ANY. (NOT PART OF THIS SURVEY)

This project proposes to meet the LID performance standard through the use of BMP's listed in Figure 2.3 in the manual and utilizing WWHM analysis.

The Lawn and landscaped area will either preserve the native soil or amend the soil per manual requirements. This option was chosen for this project.

Roofs:

Roof downspouts are proposed to be collected and infiltrated into a bioretention pond.

Other Hard Surfaces:

Other hard surfaces are proposed to be collected and infiltrated into a bioretention pond.

See Appendix B for Basin Map and Site Plan.

II. EXISTING CONDITIONS

The existing site appears to be an undeveloped site. The property to the north drains onto the property from the peak of the regional hill. Stormwater then drains to the middle area of the lot and then drains offsite near the southwest corner of the property.

The attached soils report The upper 42” of soil has been designated as feasible for infiltration with LID elements. The recommended design infiltration rate listed is 1.28 in/hr for the frontage bioretention pond and 4.8 in/hr for the onsite bioretention pond. The property is currently vegetated with trees, grass and shrubs.

The existing tributary offsite Stormwater generally sheet flows onto the site on the northern portion of the property. The stormwater then drains through the property and discharges via sheet flow on the southwestern portion of the parcel. The project is located in an aquifer recharge area and is located in a wellhead protection area as defined by the Thurston County Health Department, the EPA or by the county. There are no known ravines, or wetlands located on the site. There are no known basin plans for the area. Refer to the attachments for applicable Soils Maps.

The USDA Soils Survey lists the onsite soils as Kapowsin silt loam.

There are no known ravines, or wetlands located on the site. There are no known basin plans for the area. Refer to appendix B for applicable Drainage Maps.

III. VICINITY ANALYSIS AND SUBBASIN DESCRIPTION

The regional drainage basin as shown in the attached. The hillside to the north of the subject parcel drains onto this parcel towards the middle area where the stormwater then drains offsite to the southwest of the parcel. A bypass drainage ditch is proposed to route offsite and onsite undeveloped open space area around the proposed bioretention ponds such that this stormwater will continue to discharge near the southwest corner of the parcel. Regional natural drainage system generally appears to be preserved.

IV. FLOW CONTROL AND WATER QUALITY FACILITY SIZING

STORMWATER MANAGEMENT MINIMUM REQUIREMENTS

There are eleven minimum requirements for stormwater management. The minimum requirements are:

1. Preparation of Stormwater Site Plan
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. Operation and Maintenance
10. Financial Liability
11. Offsite Analysis and Mitigation

Addressing these eleven 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: Preparation of Stormwater Site Plan

This Abbreviated Stormwater Site Plan is submitted as part of the 5th Ave Townhomes Binding Site Plan project to meet this requirement.

Minimum Requirement #2: Construction Stormwater Pollution Prevention

A Stormwater Pollution Prevention Plan (SWPPP) was developed to address erosion and sediment control anticipated during construction. The SWPPP will address all thirteen elements as required by the Department of Ecology. The SWPPP is attached in appendix F

Minimum Requirement #3: Source Control of Pollution

The homeowner will receive a copy of the Pollution Source Control Program as found in the Stormwater Maintenance Plan in Section VII below. The Source Control Program describes Best Management Practices (BMPs) for household products, automotive maintenance, pesticides, fertilizers and remodeling.

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

The offsite stormwater from the north sheet flows onsite and then will drain down to the middle area of the site where a bypass ditch is proposed to bypass the stormwater down to the southwest corner of the site where it will discharge in general consistency with existing drainage patterns. The proposed stormwater will infiltrate into the ground therefore it appears to maintain existing drainage patterns.

All natural drainage ways generally appear to be preserved.

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

List #2: On-Site Stormwater Management BMPs for Projects Triggering Minimum Requirements #1 through #11

For each surface, consider the BMPs in the order listed for that type of surface. Use the first BMP that is considered feasible. No other on-site stormwater management BMP is necessary for that surface.

Lawn and Landscaped Areas

1. Postconstruction soil quality and depth in Volume V, Chapter 6.

This option is chosen.

Roofs

1. Full dispersion in Volume V, Section 7.2, or downspout infiltration in Volume V, Section 15.3.

Full dispersion due to slopes over 15% near possible dispersion areas. Full infiltration is not feasible due to depth to groundwater.

2. Bioretention in Volume V, Chapter 9, that has a minimum horizontally projected surface area below the overflow, which is at least 5 percent of the total surface area draining to it.

Bioretention is chosen for this project. The design is provided below in this report.

3. Downspout dispersion in Volume V, Section 15.4. ***Not needed***
4. Perforated stub-out connections in Volume V, Section 15.5. ***Not needed***

Other Hard Surfaces

1. Full dispersion in Volume V, Section 7.2.

Full dispersion due to slopes over 15% near possible dispersion areas.

2. Permeable pavement 2 in Volume V, Chapter 11.

Not chosen

3. Bioretention in Volume V, Chapter 9, that has a minimum horizontally projected surface area below the overflow, which is at least 5 percent of the total surface area draining to it.

Bioretention is chosen for this project. The design is provided below in this report.

5. Sheet flow dispersion or concentrated flow dispersion BMPs in Volume V, Sections 7.3 and 7.4. ***Not needed***

All mitigated area stormwater will be infiltrated onsite via an infiltration bioretention ponds. Any stormwater not infiltrated will sheet flow offsite. No easements are required. All setback requirements are met with this project.

Minimum Requirement #6: Runoff Treatment

For sites with greater than 5,000 square feet of pollution generating impervious surface (PGIS), treatment facilities and onsite stormwater BMPs are required. This proposed project has more than 5,000 square feet of PGIS therefore treatment is required. Two bioretention ponds are proposed that meet treatment requirements for this project.

Onsite Bioretention Pond

Table 6.1 WWHM Pre-developed Land Use Summary for Treatment

WWHM Pre-developed Land Use (All Areas Measured in Acres)	Site
C, Forest, Flat	0.64
Saturated, Forest, Flat	0.00
C, Pasture, Flat	0.00
Roads Flat	0.00
Roofs Flat	0.00
Pond	0.00
Total Basin	**0.64**
Total % Impervious (all roofs, streets, sidewalks and ponds)	**0.00%**
100-year Storm Peak (cfs)	**0.0064**

Table 6.2 WWHM Developed Mitigated Land Use Summary for Treatment

WWHM Developed Land Use (All Areas Measured in Acres)	Total
A, Forest, Flat	0.00
A, Pasture, Mod (lawn/landscape)	0.21
Roads Flat	0.06
Roofs Flat	0.28
Pond	0.11
Total Basin	**0.64**

Frontage Bioretention Pond

Table 6.1 WWHM Pre-developed Land Use Summary for Treatment

WWHM Pre-developed Land Use (All Areas Measured in Acres)	Site
C, Forest, Flat	0.16
Saturated, Forest, Flat	0.00
C, Pasture, Flat	0.00
Roads Flat	0.00
Roofs Flat	0.00
Pond	0.00
Total Basin	**0.16**
Total % Impervious (all roofs, streets, sidewalks and ponds)	**0.00%**
100-year Storm Peak (cfs)	**0.0064**

Table 6.2 WWHM Developed Mitigated Land Use Summary for Treatment

WWHM Developed Land Use (All Areas Measured in Acres)	Total
A, Forest, Flat	0.00
A, Pasture, Mod (lawn/landscape)	0.04
Roads Flat	0.12
Roofs Flat	0.00
Pond	0.00
Total Basin	**0.16**

Minimum Requirement #7: Flow Control

This project is required to meet the LID performance standard through the use of BMP's listed in Figure 2.3 in the manual or meet the minimum LID hydraulic standards as shown in the manual utilizing WWHM analysis. For this project we have chosen to meet the LID requirements through analysis and implementing the desired BMP's listed below.

Lawn and landscaped area:

1. Lawn and landscaped area will either preserve the native soil or amend the soil per manual requirements. This option was chosen for this project.

Roofs:

1. Downspout Infiltration via bioretention pond was selected to mitigate the roof. The proposed roof is approximately 12,312 sf in size. The roof is proposed to be directed to large bioretention pond located to the west of the lots. Based upon the soils report the soils report the long-term infiltration rate is 4.8 inches per hour can be used for the onsite bioretention pond. However to provide a level of factor of safety a design infiltration rate of 3" per hour was used.

Other Hard Surfaces:

1. The proposal includes the construction of a 14,820 square feet (sf) driveway, concrete patios front and back yard. The above referenced bioretention pond was used to mitigate these hard surfaces. Based upon the soils report the soils report the long-term infiltration rate is 1.28 inches per hour can be used for the frontage bioretention pond.

   The area tributary to the onsite bioretention pond is as follows:

Table 7.1 WWHM Pre-developed Onsite Pond Land Use Summary

WWHM Pre-developed Land Use (All Areas Measured in Acres)	Site
C, Forest, Flat	0.41
Saturated, Forest, Flat	0.00
C, Pasture, Flat	0.00
Roads Flat	0.00
Roofs Flat	0.00
Pond	0.00
Total Basin	**0.41**
Total % Impervious (all roofs, streets, sidewalks and ponds)	**0.00%**
100-year Storm Peak (cfs)	**0.0064**

Table 7.2 WWHM Developed Mitigated Onsite Pond Land Use Summary

WWHM Developed Land Use (All Areas Measured in Acres)	Total
A, Forest, Flat	0.00
A, Pasture, Mod (lawn/landscape)	0.10
Roads Flat	0.15
Roofs Flat	0.16
Pond	0.00
Total Basin	**0.41**
Total % Impervious (all roofs, streets, sidewalks and ponds)	**77.0%**
Increase (Decrease) in 100-year Storm Peak (cfs)	**(0.01)**

Table 7.3 Onsite Pond Infiltration Trench Summary

	Pond A
Bottom Trench Elevation	272.50
Live Storage Elevation	273.50
Total Pond Bottom Area Req'd	4,200 sf

The required bottom area per WWHM is 2,200 sf, the actual area provided is 2,208 sf therefore the infiltration trench meets design criteria. This is the size specified in the plans therefore the bioretention pond meets design criteria.

The frontage improvements are designed to infiltrate into the second bioretention pond shown just south of the onsite pond. The following data was used to size this pond.

Table 7.4 WWHM Pre-developed Frontage Pond Land Use Summary

WWHM Pre-developed Land Use (All Areas Measured in Acres)	Site
C, Forest, Flat	0.16
Saturated, Forest, Flat	0.00
C, Pasture, Flat	0.00
Roads Flat	0.00
Roofs Flat	0.00
Pond	0.00
Total Basin	**0.16**
Total % Impervious (all roofs, streets, sidewalks and ponds)	**0.00%**
100-year Storm Peak (cfs)	**0.0064**

Table 7.5 WWHM Developed Mitigated Frontage Pond Land Use Summary

WWHM Developed Land Use (All Areas Measured in Acres)	Total
A, Forest, Flat	0.00
A, Pasture, Mod (lawn/landscape)	0.04
Roads Flat	0.12
Roofs Flat	0.00
Pond	0.00
Total Basin	**0.16**
Total % Impervious (all roofs, streets, sidewalks and ponds)	**77.0%**
Increase (Decrease) in 100-year Storm Peak (cfs)	**(0.01)**

Table 7.6 Frontage Pond Infiltration Trench Summary

	Pond A
Bottom Trench Elevation	272.50
Live Storage Elevation	273.50
Total Pond Bottom Area Req'd	1,950sf

The required bottom area per WWHM is 650 sf, the actual area provided is 848 sf therefore the infiltration trench meets design criteria. This is the size specified in the plans therefore the bioretention pond meets design criteria.

Minimum Requirement #8: Wetlands Protection

There are no identified wetlands on the site. Therefore, wetlands are protected based upon these projects compliance with the drainage manual.

Minimum Requirement #9: Operation and Maintenance

This project is a plat and a Declaration of Covenants, Conditions and Restrictions (CCR) and a stormwater maintenance plan are required to insure this project's stormwater mitigation continues to function as design. The property owner's will be responsible for maintaining the bioretention cells, stormwater conveyance systems and compost amended soil area. The Stormwater Maintenance Plan is contained in the appendix. The maintenance plan describes maintenance and operation of the Compost Amended Soils, bioretention facilities, catch basins, conveyance piping, and landscaping and how homeowners can minimize use of hazardous household products.

Minimum Requirement #10: Financial Liability

To insure compliance with these standards, performance bonding or other appropriate financial instruments shall be required for all projects.

In accordance with Tumwater Municipal Code 12.16.080, project applicants shall provide financial guarantees to ensure that:

- The project will operate according to the design approved by the project engineer, and
- Operation of erosion control facilities will provide protection against siltation of surface water, erosion, and damage to adjacent properties.

The applicant shall provide a financial guarantee to the administrator to ensure satisfactory maintenance of drainage facilities for a minimum of 2 years from final plat acceptance or acceptance of the project, whichever is later, in accordance with the maintenance plan submitted as part of the grading and erosion control plan.

A construction cost estimate will be provided at final approval of plan.

Minimum Requirement #11: Offsite Analysis and Mitigation

This project proposes to meet LID infiltration requirements. No increased offsite stormwater discharge is anticipated therefore not offsite analysis and mitigation are required.

V. AESTHETIC CONSIDERATIONS FOR FACILITIES

The bioretention ponds are proposed to be planted per the drainage design manual.

VI. CONVEYANCE SYSTEM ANALYSIS AND DESIGN

The roof conveyance pipe system includes the use of 6" diameter pvc. The attached capacity analysis shows that this pipe has capacity to convey the 25 year design stormwater event. The frontage roadway conveyance pipe system includes the use of 12" diameter pvc. The attached capacity analysis shows that this pipe has capacity to convey the 25 year design stormwater event. Reference appendix F for the analysis.

VII. COVENANTS, DEDICATIONS, EASEMENTS

Prior to final plat the applicable covenants, dedications and easements as shown on the preliminary plat and included in this report will be recorded against each parcel of this plat.

VIII. AGREEMENTS AND GUARANTEES

The performance and maintenance bonds as part of this project will be prepared as part of the construction drawing phase of this project.

IX. OTHER PERMITS OR CONDITIONS PLACED ON THE PROJECT

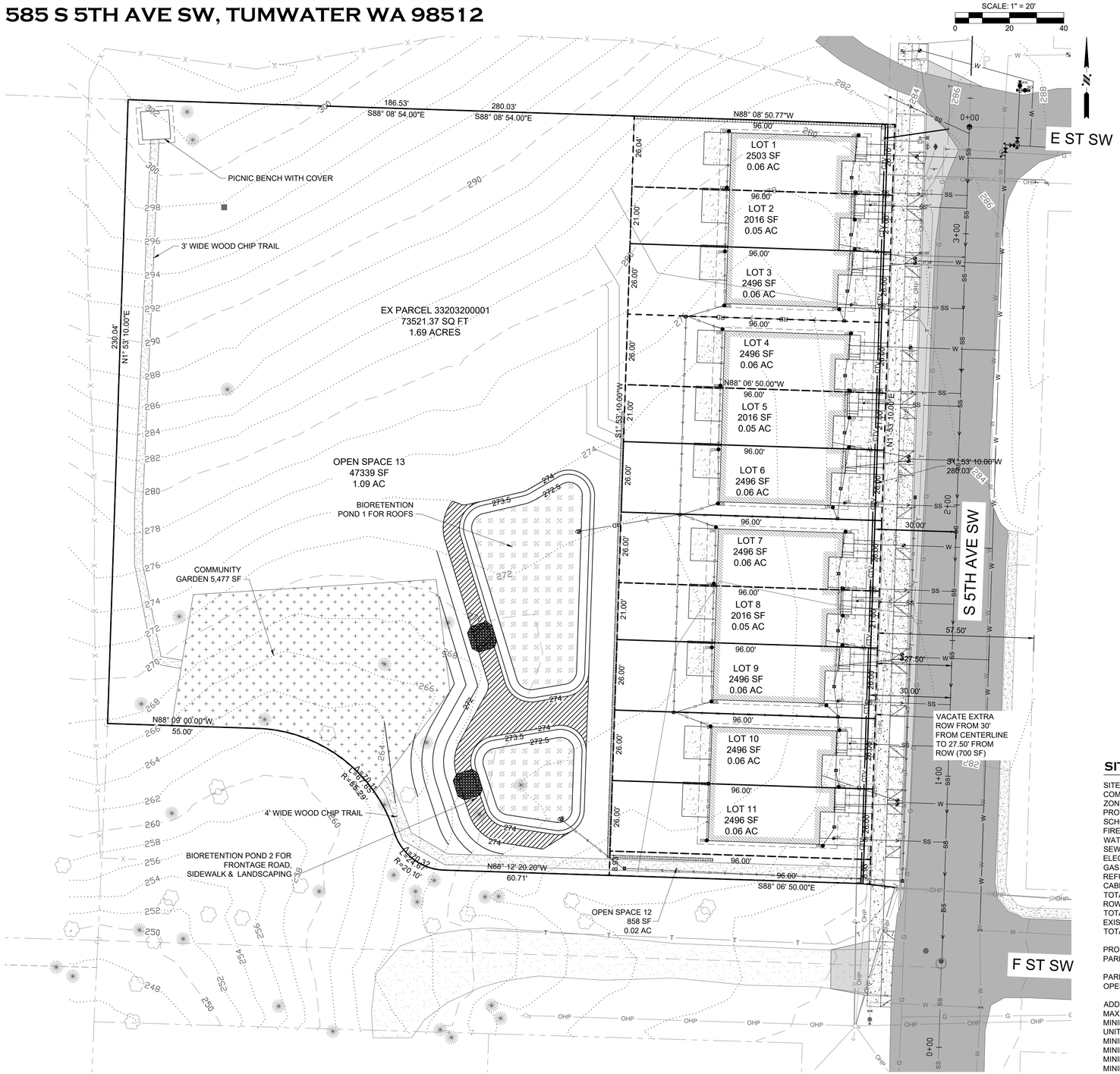
No other permit are anticipated to be required.

APPENDIX A –Drainage & Erosion Control Plans

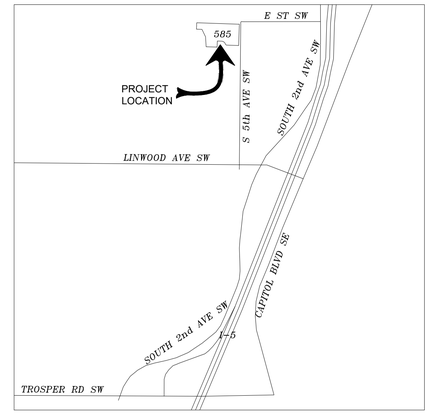
SE 1/4, SECTION 27, TOWNSHIP 18 N., RANGE 2 W., W.M.

5TH AVE TOWNHOMES PRELIMINARY PLAT SITE PLAN

585 S 5TH AVE SW, TUMWATER WA 98512



APPROXIMATE CUT/FILL GRADING QUANTITIES
CUT: 1,100 YARDS
FILL: 3,500 YARDS
FOR PERMITTING PURPOSED ONLY



VICINITY MAP

NTS

LEGEND

	EXISTING	PROPOSED
SUBJECT PROPERTY LINE		
ADJACENT LOT LINE		
HABITAT BUFFER LINE		
WETLAND BUFFER LINE		
EASEMENT LINE		
RIGHT-OF-WAY LINE		
CENTER LINE		
CONTOUR, MAJOR	160	160
CONTOUR, MINOR	158	158
CONIFEROUS TREE		
DECIDUOUS TREE		
STREET SIGN		
POWER LINE	UGP	UGP
OVERHEAD POWER LINE	OHP	OHP
POWER POLE		
GUY WIRE		
POWER VAULT	P	P
STREET LIGHT		
NATURAL GAS LINE	G	G
TELEPHONE LINE	T	T
TELEPHONE MANHOLE	T	T
TELEPHONE PEDESTAL	T	T
CABLE LINE	CTV	CTV
CABLE PEDESTAL	TV	TV
STORM MAIN LINE	SD	SD
FOOTING DRAIN LINE	FD	FD
ROOF DRAIN LINE	RD	RD
CATCH BASIN	CB	
TYPE I CATCH BASIN	D	
YARD DRAIN	YD	YD
DOWNSPOUT	DS	DS
WATER MAIN LINE	W	W
WATER METER	WM	
BLOWOFF VALVE FIRE HYDRANT	BO	BO
GATE VALVE		
SEWER MANHOLE	CO	CO
CLEANOUT	CO	
SEWER MAIN LINE	SS	SS
CONCRETE		
ASPHALT PAVEMENT		
POROUS ASPHALT		
LANDSCAPING		
GRAVEL		

PROJECT INFO

OWNER:
ASH HOLDINGS LLC
3425 MERRYMAN PL SE
OLYMPIA, WA 98501

LEGAL DESCRIPTION

BLOCK 32 OF SUPPLEMENTAL PLAT OF BARNES ADDITION TO TUMWATER, AS PER PLAT RECORDED IN VOLUME 6 OF PLATS, PAGE 5, RECORDS OF THURSTON COUNTY, AUDITOR:

TOGETHER WITH THOSE PORTIONS OF VACATED "E" STREET ON THE NORTH OF SAID BLOCK 32, OF VACATED 5TH AVENUE ON THE WEST OF SAID BLOCK 32 AS VACATED BY ORDINANCE NO. 02005-027, RECORDED FEBRUARY 8, 2006 UNDER AUDITOR'S FILE NO. 3807120 AND RE-RECORDED UNDER AUDITOR'S FILE NO. 3624457;

EXCEPT THAT PORTION CONVEYED TO THE CITY OF TUMWATER BY DEED RECORDED FEBRUARY 1, 2007, UNDER AUDITOR' FILE NO. 3599306;

IN THURSTON COUNTY, WA.

TOGETHER WITH AND SUBJECT TO EASEMENTS, RESTRICTIONS, RESERVATIONS AND CONDITIONS OF RECORD, IF ANY. (NOT PART OF THIS SURVEY)

BASIS OF BEARING

CITY OF TUMWATER COORDINATE SYSTEM AND BASED ON THURSTON COUNTY CONTROL POINT NO. ARC AND CENTERLINE BEARING ALONG 5TH AVE SW AND "E" ST. SW

VERTICAL DATUM

THURSTON COUNTY CONTROL POINT NO. ARC, FOUND WSDOT MONUMENT WITH 3" ALUMINUM CAP AT THE NW CORNER OF THE INTERSECTION OF LINWOOD AVE SW AND 2ND AVE SW, ELEVATION = 107.53'

PARCEL NUMBER

33203200001

SITE INFO

SITE ADDRESS:	585 S 5th Ave SW, Tumwater, WA 98512
COMPREHENSIVE PLAN DESIGNATION:	RESIDENTIAL
ZONING:	SFM
PROPOSED IBC CONSTRUCTION TYPE:	5V-B
SCHOOL DISTRICT:	TUMWATER SCHOOL DISTRICT
FIRE DISTRICT:	FIRE DISTRICT #03
WATER PROVIDER:	CITY OF TUMWATER
SEWER PROVIDER:	CITY OF TUMWATER
ELECTRICITY PROVIDER:	PSE
GAS PROVIDER:	PSE
REFUSE/RECYCLING PROVIDER:	LeMAY
CABLE/TV PROVIDER:	COMCAST
TOTAL SITE AREA:	1.69 AC OR 73,521 SF
ROW VACATION AREA:	0.02 AC OR 700 SF
TOTAL AREA AFTER VACATION:	1.70 AC OR 74,221 SF
EXISTING NUMBER OF UNITS:	VACANT
TOTAL EX RESIDENTIAL UNITS:	0
PROPOSED PROJECT:	TOWNHOME PLAT
PARKING SPACES REQUIRED RESIDENT:	2 SPACES / UNIT = 22 SPACES
PARKING SPACES PROP:	22 SPACES
OPEN SPACE REQUIRED:	15% OF SITE = 73,521 SF (0.15) = 11,028 SF
	50,257 SF PROVIDED

ADDITIONAL REGULATIONS:

MAXIMUM AVERAGE HOUSING DENSITY (units per acre)	(8) 1.70 AC = 14 UNITS
MINIMUM AVERAGE HOUSING DENSITY (units per acre)	(6) 1.70 AC = 11 UNITS
UNITS PROPOSED:	11 TOWN HOME UNITS
MINIMUM LOT SIZE	2,000 SF
MINIMUM FRONT YARD SETBACKS	10' or 20' @ GARAGE
MINIMUM REAR YARD SETBACKS	10'
MINIMUM SIDE YARD SETBACKS	5'
MAXIMUM BUILDING HEIGHT	35'
MAXIMUM IMPERVIOUS COVERAGE	70% (TOWNHOUSE) (1.69AC) = 1.18 AC

INDIVIDUAL LOT MAXIMUM COVERAGE CALCULATION:
WORST CASE LOT COVERAGE (LOT 2):

LOT SIZE:	2016 SF
MAX COVERAGE (70%):	1,411 SF
COVERAGE PROPOSED:	1,377 SF PROPOSED THEREFORE OK

SITE COVERAGE DATA

LOT SIZE: 73,521 SF (1.69 AC)

FRONTAGE (S 5TH AVE SW) COVERAGE:	
TOTAL AREA:	7,019 SF (0.16 AC)
NEW SIDEWALK:	1,543 SF (0.04 AC)
NEW + EX ASPH TO SWALE:	3,298 SF (0.08 AC)
NEW LANDSCAPED AREA:	2,178 SF (0.05 AC)
ONSITE AREA:	
11 LOT TOTAL AREA:	22,123 SF (0.51 AC)
NEW + REPLACED ASPHALT AREA:	1,716 SF (0.04 AC)
PATIO AREA:	792 SF (0.02 AC)
ROOF AREA:	12,312 SF (0.28 AC)
	< 0.56 AC THEREFORE OK)
LANDSCAPED AREA:	8,561 SF (0.20 AC)
TOTAL ONSITE IMP COVERAGE:	14,820 SF (0.34 AC)
	OR 20% OK IF LESS THAN 60%

THE LAND DEVELOPER'S ENGINEERED SOLUTION
a division of THE LAND DEVELOPER, INC.
5737 LINDERSON WAY SW,
TUMWATER, WA. 98501
PO BOX 4420, TUMWATER, WA. 98501
(360) 890-4806
E-MAIL: erik@thelanddeveloper.com

REVISIONS: DATE:

5TH AVE TOWNHOMES

COVER SHEET

PROJECT:
HOLTZE TOWNHOMES
S 585 S 5TH AVE SW
TUMWATER, WA 98512

CLIENT:
ASH HOLDINGS LLC
3425 MERRYMAN PL SE
OLYMPIA, WA 98501

DRAWN BY: EBA

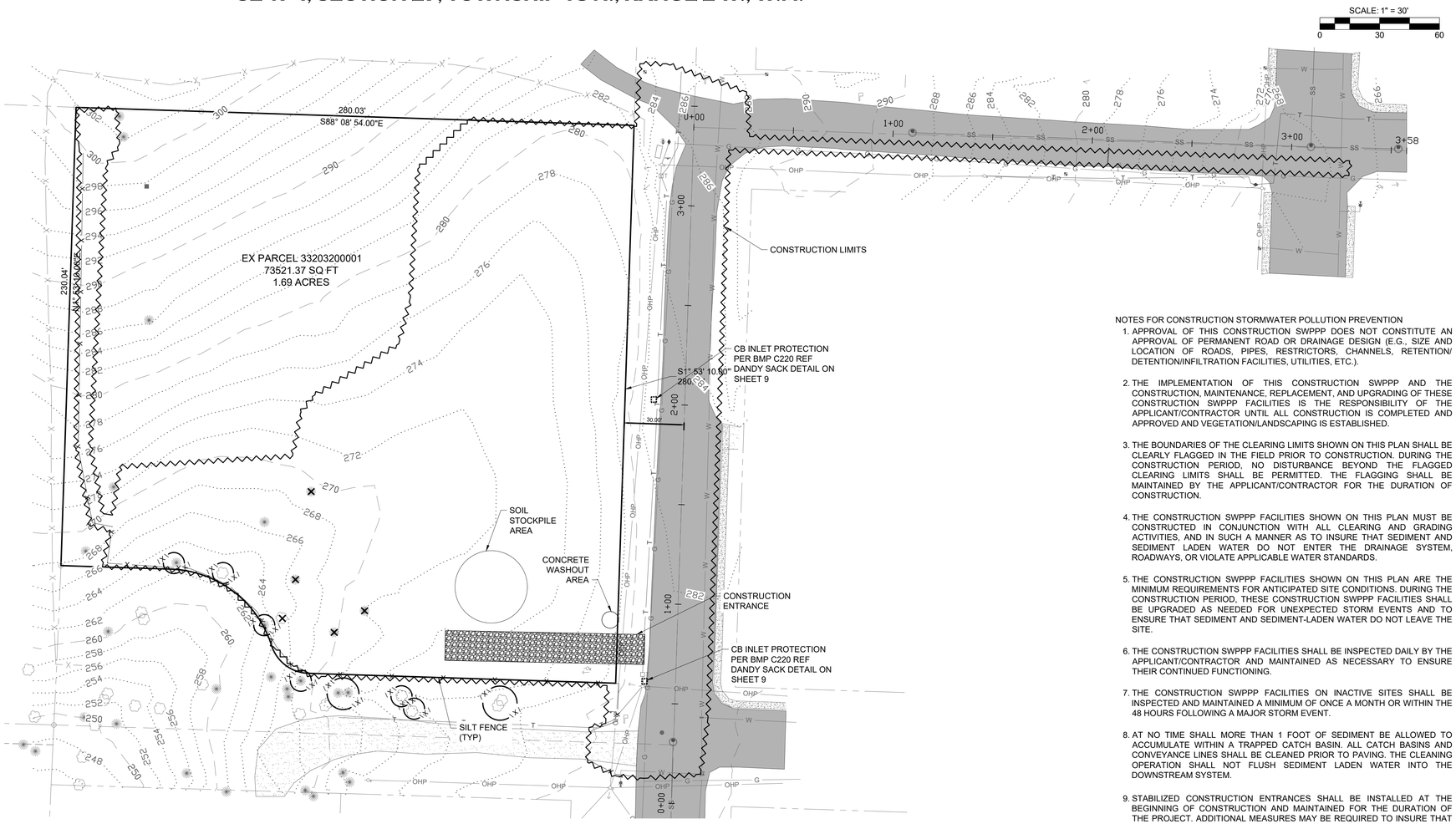
DATE: 9/24/25

AGENCY NO:

SHEET: 1 OF 4

JOB NO: 21-132

SE 1/4, SECTION 27, TOWNSHIP 18 N., RANGE 2 W., W.M.



NOTES FOR CONSTRUCTION STORMWATER POLLUTION PREVENTION

1. APPROVAL OF THIS CONSTRUCTION SWPPP DOES NOT CONSTITUTE AN APPROVAL OF PERMANENT ROAD OR DRAINAGE DESIGN (E.G., SIZE AND LOCATION OF ROADS, PIPES, RESTRICTORS, CHANNELS, RETENTION/ DETENTION/INFILTRATION FACILITIES, UTILITIES, ETC.).
2. THE IMPLEMENTATION OF THIS CONSTRUCTION SWPPP AND THE CONSTRUCTION, MAINTENANCE, REPLACEMENT, AND UPGRADING OF THESE CONSTRUCTION SWPPP FACILITIES IS THE RESPONSIBILITY OF THE APPLICANT/CONTRACTOR UNTIL ALL CONSTRUCTION IS COMPLETED AND APPROVED AND VEGETATION/LANDSCAPING IS ESTABLISHED.
3. THE BOUNDARIES OF THE CLEARING LIMITS SHOWN ON THIS PLAN SHALL BE CLEARLY FLAGGED IN THE FIELD PRIOR TO CONSTRUCTION. DURING THE CONSTRUCTION PERIOD, NO DISTURBANCE BEYOND THE FLAGGED CLEARING LIMITS SHALL BE PERMITTED. THE FLAGGING SHALL BE MAINTAINED BY THE APPLICANT/CONTRACTOR FOR THE DURATION OF CONSTRUCTION.
4. THE CONSTRUCTION SWPPP FACILITIES SHOWN ON THIS PLAN MUST BE CONSTRUCTED IN CONJUNCTION WITH ALL CLEARING AND GRADING ACTIVITIES, AND IN SUCH A MANNER AS TO INSURE THAT SEDIMENT AND SEDIMENT LADEN WATER DO NOT ENTER THE DRAINAGE SYSTEM, ROADWAYS, OR VIOLATE APPLICABLE WATER STANDARDS.
5. THE CONSTRUCTION SWPPP FACILITIES SHOWN ON THIS PLAN ARE THE MINIMUM REQUIREMENTS FOR ANTICIPATED SITE CONDITIONS. DURING THE CONSTRUCTION PERIOD, THESE CONSTRUCTION SWPPP FACILITIES SHALL BE UPGRADED AS NEEDED FOR UNEXPECTED STORM EVENTS AND TO ENSURE THAT SEDIMENT AND SEDIMENT-LADEN WATER DO NOT LEAVE THE SITE.
6. THE CONSTRUCTION SWPPP FACILITIES SHALL BE INSPECTED DAILY BY THE APPLICANT/CONTRACTOR AND MAINTAINED AS NECESSARY TO ENSURE THEIR CONTINUED FUNCTIONING.
7. THE CONSTRUCTION SWPPP FACILITIES ON INACTIVE SITES SHALL BE INSPECTED AND MAINTAINED A MINIMUM OF ONCE A MONTH OR WITHIN THE 48 HOURS FOLLOWING A MAJOR STORM EVENT.
8. AT NO TIME SHALL MORE THAN 1 FOOT OF SEDIMENT BE ALLOWED TO ACCUMULATE WITHIN A TRAPPED CATCH BASIN. ALL CATCH BASINS AND CONVEYANCE LINES SHALL BE CLEANED PRIOR TO PAVING. THE CLEANING OPERATION SHALL NOT FLUSH SEDIMENT LADEN WATER INTO THE DOWNSTREAM SYSTEM.
9. STABILIZED CONSTRUCTION ENTRANCES SHALL BE INSTALLED AT THE BEGINNING OF CONSTRUCTION AND MAINTAINED FOR THE DURATION OF THE PROJECT. ADDITIONAL MEASURES MAY BE REQUIRED TO INSURE THAT ALL PAVED AREAS ARE KEPT CLEAN FOR THE DURATION OF THE PROJECT.

TOPOGRAPHIC NOTE:

THE EXISTING TOPOGRAPHIC DATA SHOWN ON THESE DRAWINGS HAS BEEN PREPARED, IN PART, BASED UPON INFORMATION FURNISHED BY OTHERS. WHILE THIS INFORMATION IS BELIEVED TO BE RELIABLE, TLD, LLC CANNOT ENSURE ITS ACCURACY AND THUS IS NOT RESPONSIBLE FOR THE ACCURACY OF THAT INFORMATION OR FOR ANY ERRORS OR OMISSIONS WHICH MAY HAVE BEEN INCORPORATED INTO THESE DRAWINGS AS A RESULT.

SITE CONSTRUCTION NOTES:

1. DEMOLISH ALL EXISTING STRUCTURES WITHIN CLEARING LIMITS EXCEPT AS NOTED.
2. SEE SHEETS 3 & 4 FOR EROSION CONTROL DETAILS

X - INDICATES TREES TO BE REMOVED (TYP)

- INDICATES TREES TO BE PROTECTED W/ TREE PROTECTION FENCE INCLUDING A 4' TALL CHAIN LINK OR POLYETHYLENE LAMINAR SAFETY FENCING OR SIMILAR MATERIAL (TYP)

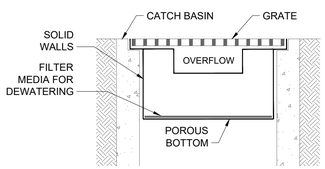
X — SILT FENCE

LIMITS OF DISTURBANCE

SURVEY MONUMENTS NOTES:

- EXISTING SURVEY MONUMENTS MUST BE SHOWN ON THE PLANS WITH NOTES TO PROTECT.
- DISTURBING EXISTING MONUMENTS REQUIRES A DNR PERMIT.
- NEW MONUMENTS TO BE INSTALLED PER CITY STANDARD PLANS

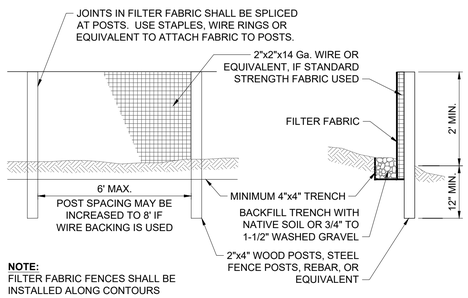
FIGURE D.2.1.5.F CATCH BASIN INSERT



NOTES:
THIS DETAIL IS ONLY SCHEMATIC. ANY INSERT IS ALLOWED THAT HAS:
- A MIN. 0.5 C.F. OF STORAGE,
- THE MEANS TO DEWATER THE STORED SEDIMENT,
- AN OVERFLOW, AND
- CAN BE EASILY MAINTAINED.

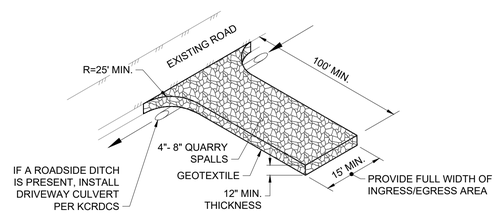
3 CB INLET PROTECTION
SCALE: NTS

FIGURE D.2.1.3.A SILT FENCE



NOTE:
FILTER FABRIC FENCES SHALL BE INSTALLED ALONG CONTOURS WHENEVER POSSIBLE

FIGURE D.2.1.4.A STABILIZED CONSTRUCTION ENTRANCE



NOTES:
- PER KING COUNTY ROAD DESIGN AND CONSTRUCTION STANDARDS (KCRDCS), DRIVEWAYS SHALL BE PAVED TO EDGE OF R-O-W PRIOR TO INSTALLATION OF THE CONSTRUCTION ENTRANCE TO AVOID DAMAGING OF THE ROADWAY.
- IT IS RECOMMENDED THAT THE ENTRANCE BE CROWNED SO THAT RUNOFF DRAINS OFF THE PAD.

THE LAND DEVELOPER'S ENGINEERED SOLUTION
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E-MAIL: erik@thelanddeveloper.com

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9/9/26

REVISIONS: DATE:

5TH AVE TOWNHOMES

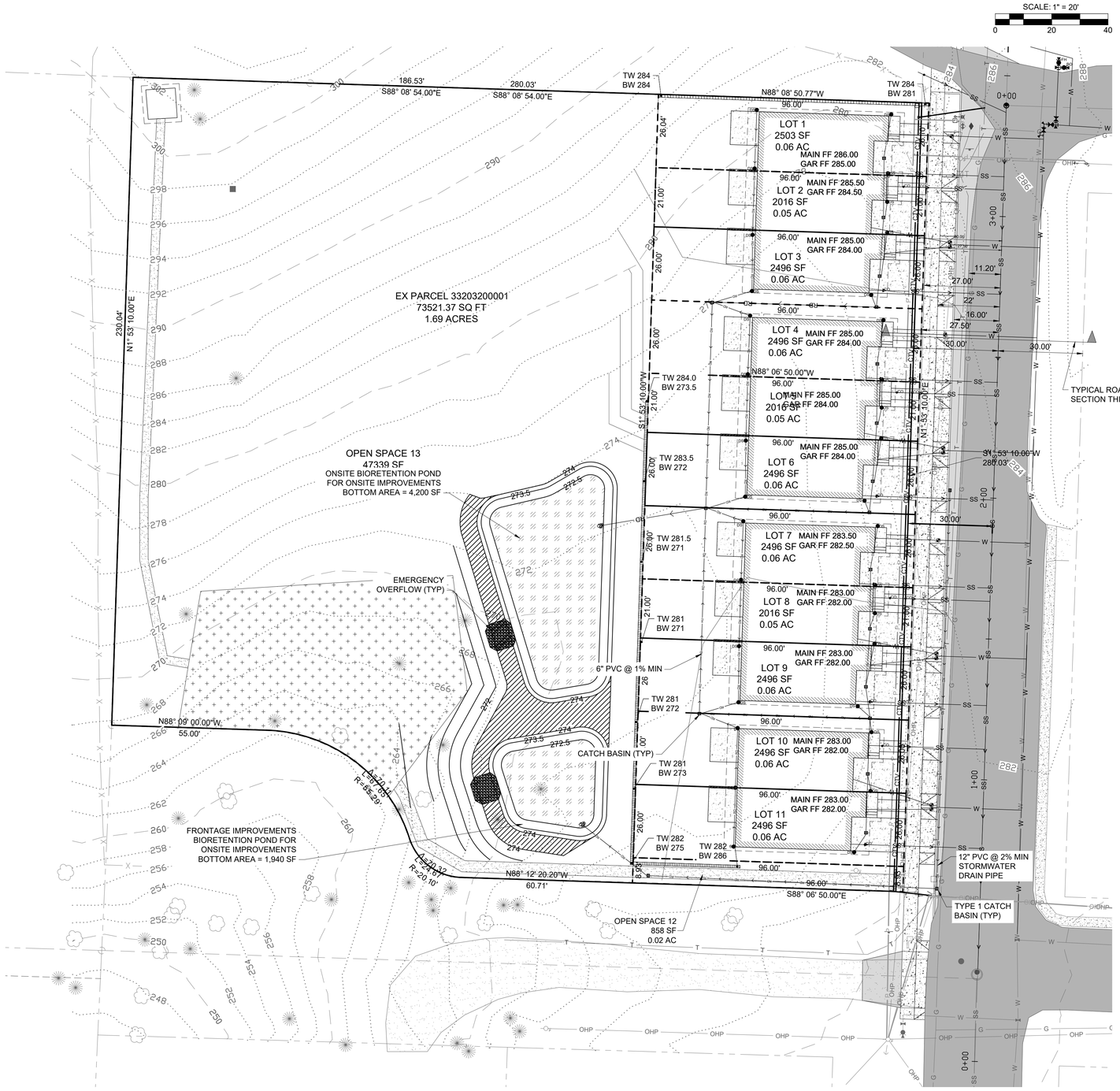
EROSION CONTROL PLAN

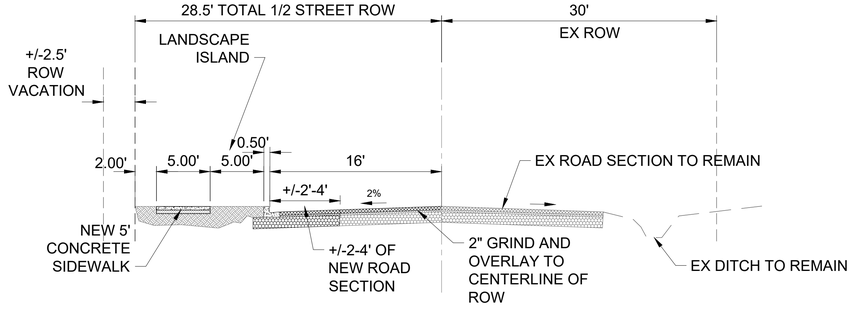
PROJECT:
HOLTZE TOWNHOMES
S 585 S 5TH AVE SW
TUMWATER, WA 98512

CLIENT:
ASH HOLDINGS LLC
3425 MERRYMAN PL SE
OLYMPIA, WA 98501

DRAWN BY: EBA
DATE: 9/24/25
AGENCY NO:
SHEET: 2 OF 4
JOB NO: 21-132

SE 1/4, SECTION 27, TOWNSHIP 18 N., RANGE 2 W., W.M.





B FRONTAGE STREET SECTION
N.T.S.

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11/9/26

REVISIONS: DATE:

5TH AVE TOWNHOMES

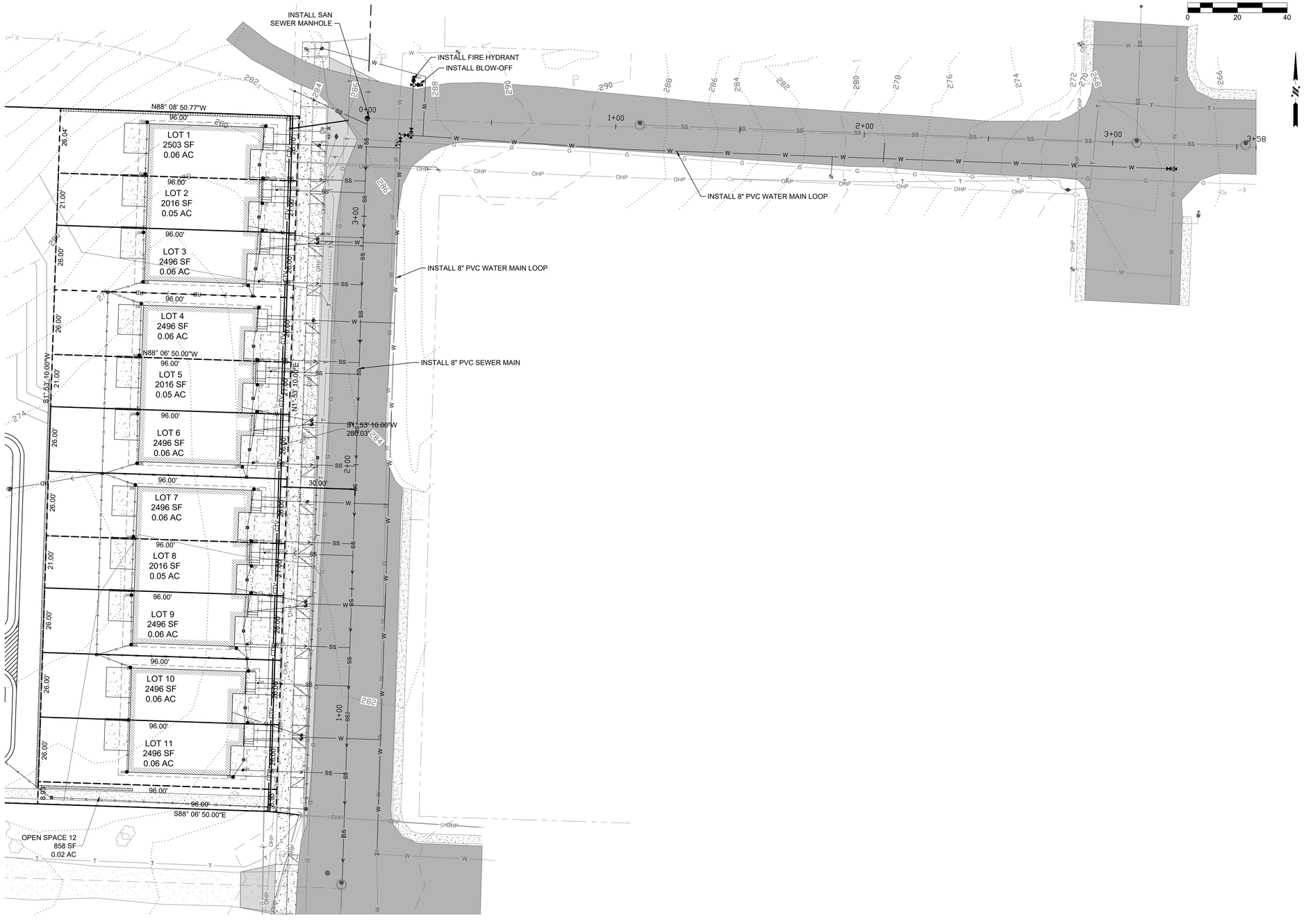
GRADING & DRAINAGE PLAN

PROJECT:
HOLTZE TOWNHOMES
S 585 S 5TH AVE SW
TUMWATER, WA 98512

CLIENT:
ASH HOLDINGS LLC
3425 MERRYMAN PL SE
OLYMPIA, WA 98501

DRAWN BY: EBA
DATE: 9/24/25
AGENCY NO:
SHEET: 3 OF 4
JOB NO: 21-132

SE 1/4, SECTION 27, TOWNSHIP 18 N., RANGE 2 W., W.M.



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11/9/26

REVISIONS: DATE:

5TH AVE TOWNHOMES

UTILITY PLAN

PROJECT:
HOLTZE TOWNHOMES
S 585 S 5TH AVE SW
TUMWATER, WA 98512

CLIENT:
ASH HOLDINGS LLC
3425 MERRYMAN PL SE
OLYMPIA, WA 98501

DRAWN BY: EBA

DATE: 9/24/25

AGENCY NO:

SHEET: 4 OF 4

JOB NO: 21-132

APPENDIX B – SWPPP

STORMWATER POLLUTION PREVENTION PLAN (SWPPP) (REQUIREMENT #2) REPORT

of

5th Ave Townhomes Binding Site Plan (BSP)
585 5th Ave SW
Tumwater, WA 98512

for

ASH Holdings LLC
3425 Merryman Pl SE
Olympia, WA 98501
aholtze@gmail.com

by

THE LAND DEVELOPER'S
ENGINEERED SOLUTION
A Division of THE LAND DEVELOPER, Inc.

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September 24, 2025

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Appendix A Erosion Control Best Management Practices (BMP)

I. SWPPP (REQUIREMENT 2) CONSTRUCTION STORMWATER POLLUTION PREVENTION PLAN (SWPPP)

Please reference Appendix A for construction plan sheets and Appendix B for applicable Erosion and Sediment Control Best Management Practices (BMP).

Element 1: Preserve vegetation/Mark Clearing Limits

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

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

• The duff layer, native top soil, and natural vegetation shall be retained in an undisturbed state to the maximum extent practicable. If it is not practicable to retain the duff layer in place, it should be stockpiled on site, covered to prevent erosion, and replaced immediately upon completion of the ground disturbing activities.

• Suggested BMPs:

- BMP C101: Preserving Natural Vegetation
- BMP C102: Buffer Zones
- BMP C103: High Visibility Plastic Fence.

Element 2: Establish Construction Access

• Construction vehicle access and exit shall be limited to one route, if possible, or two for linear projects such as roadways where more than one access is necessary for large equipment maneuvering.

• Access points shall be stabilized with a pad of quarry spalls, crushed rock, or equivalent BMP prior to traffic leaving the construction site to minimize the tracking of sediment onto all roads and accesses.

• Wheel wash or tire baths should be located on site, if the stabilized constructions entrance is not effective in preventing sediment from being tracked onto roads/accesses.

• If sediment is tracked off site, roads/accesses shall be cleaned thoroughly at the end of each day, or more frequently during wet weather, if necessary to prevent sediment from entering waters of the state. Sediment shall be removed from roads by shoveling or pickup sweeping and shall be transported to a controlled sediment disposal area. Street washing will be allowed only after sediment is removed in this manner.

• Street wash wastewater shall be controlled by pumping back on site to an approved infiltration facility, or otherwise must be prevented from discharging into systems tributary to state surface waters. Options include discharge to the sanitary sewer, or discharge to an approved offsite

treatment system. For discharges to the sanitary sewer, permits must be obtained from the County Industrial Pretreatment Program at (253) 798-3013.

• Suggested BMPs:
- BMP C105: Stabilized Construction Entrance
- BMP C107: Construction Road/Parking Area Stabilization.

Element 3: Control Flow Rates (Not required this project, threshold not met)

Element 4: Install Sediment Controls

• 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 (see Element #5 second bullet item) may be discharged without a sediment removal BMP, but must meet the flow control performance standard of Element #3 (first bullet item).

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

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

• BMPs intended to trap sediment on site must be located in a manner to avoid interference with the movement of juvenile salmonids attempting to enter off-channel areas or drainages, often during non-storm events, in response to rain event changes in stream elevation or wetted area.

• Suggested BMPs:
- BMP C233: Silt Fence
- BMP C234: Vegetated Strip
- BMP C235: Straw Wattles

Element 5: Stabilize Soils

• All exposed and unworked soils shall be stabilized by application of effective BMPs that protect the soil from the erosive forces of raindrop impact, flowing water, and wind.

• Full stabilization means all soil disturbing activities at the site have been completed and areas where the soil or natural vegetative cover has been disturbed have been properly covered and accepted to meet permanent erosion control. Permanent erosion control can include concrete or asphalt paving; quarry spalls used as ditch lining; application of thick layers of gravel or mulch; or vegetative cover in a manner that will fully prevent soil erosion. Where the term "fully established" is used to describe vegetative cover or plantings, it shall be understood to mean that healthy vegetation covers 90 percent of exposed bare soil. The application of hydroseeding, even in conjunction with a bonded fiber matrix (BFM) or rolled erosion product, will not be accepted as fully established permanent erosion control before the necessary development and ground cover requirements of the plantings are met. The strong root structures of well established

vegetation are an essential mechanism in controlling soil erosion. The county will inspect and must approve all areas as fully stabilized before the release of financial guarantees.

• Temporary erosion control measures shall remain in place until permanent measures are established.

• From October 1 through April 30, no soils shall remain exposed and unworked for more than 2 days. From May 1 to September 30, no soils shall remain exposed and unworked for more than 7 days. This condition applies to all soils on site, whether at final grade or not.

• Soils shall be stabilized at the end of the shift before a holiday or weekend if needed based on the weather forecast.

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

• Soil stabilization measures 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.

• Soil stockpiles must be stabilized from erosion, protected with sediment trapping measures, and when possible, be located away from storm drain inlets, waterways and drainage channels.

• Linear construction activities, including right-of-way and easement clearing, roadway development, pipelines, and trenching for utilities, shall be conducted to meet the soil stabilization requirement. Contractors shall install the bedding materials, roadbeds, structures, pipelines, or utilities and restabilize the disturbed soils so that:

- From October 1 through April 30 no soils shall remain exposed
- and unworked for more than 2 days, and
- From May 1 to September 30, no soils shall remain exposed
- and unworked for more than 7 days.

• Permanent site stability will be achieved by hydroseeding, mulch and placing beauty bark on disturbed areas. Coordinate with owner for location of each permanent BMP.

Suggested BMPs:

- BMP C120: Temporary and Permanent Seeding
- BMP C121: Mulching
- BMP C122: Nets and Blankets
- BMP C123: Plastic Covering
- BMP C124: Sodding
- BMP C125: Topsoiling
- BMP C130: Surface Roughening
- BMP C131: Gradient Terraces
- BMP C140: Dust Control.

Element 6: Protect Slopes

• Design and construct cut and fill slopes in a manner that will minimize erosion. Cover slopes with plastic covering BMP C123 as necessary to minimize erosion.

• Consider soil type and its potential for erosion.

• Reduce slope runoff velocities by reducing continuous length of slope with terracing and diversions, reduce slope steepness, and roughen slope surface.

• Offsite stormwater (run-on) shall be diverted away from slopes and disturbed areas with interceptor dikes and/or swales. Offsite stormwater must be managed separately from stormwater generated on the site.

• At the top of slopes, collect drainage in pipe slope drains or protected channels to prevent erosion. Temporary pipe slope drains shall handle the peak flow from a 10-year, 24-hour event assuming a Type 1A rainfall distribution. Alternatively, the 10-year, 1-hour time step flow rates indicated by an approved continuous runoff model, increased by a factor of 1.6, may be used. If a 15-minute (or less) time step is used, no correction factor is required. The hydrologic analysis shall use the existing land cover condition for predicting flow rates from tributary areas outside the project limits. For tributary areas on the project site, the analysis shall use the temporary or permanent project land cover condition, whichever will produce the highest flow rates.

• Permanent pipe slope drains shall be sized for the 100-year, 24-hour event.

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

• Excavated material shall be placed on the uphill side of trenches, consistent with safety and space considerations.

• Check dams shall be placed at regular intervals within channels that are cut down a slope.

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

• Suggested BMPs:
- BMP C120: Temporary and Permanent Seeding
- BMP C130: Surface Roughening
- BMP C131: Gradient Terraces

Element 7: Protect Drain Inlets

• All storm drain inlets made operable during construction shall be protected so that stormwater runoff does not enter the conveyance system without first being filtered or treated to remove sediment.

• All approach roads shall be kept clean. Sediment and street wash wastewater shall be controlled as specified above in Element #2.

• Inlets should be inspected weekly at a minimum and daily during storm events. Inlet protection devices should be cleaned or removed and replaced when sediment has filled one-third of the available storage (unless a different standard is specified by the product manufacturer).

• Suggested BMPs:
- BMP C220: Storm Drain Inlet Protection.

Element 8: Stabilize Channels and Outlets (Not applicable)

Element 9: Control Pollutants

• 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. Woody debris may be chopped and spread on site.

• Cover, containment, and protection from vandalism shall be provided for all chemicals, liquid products, petroleum products, and other materials that have the potential to pose a threat to human health or the environment. Onsite fueling tanks shall include secondary containment.

• 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. Emergency repairs may be performed on site using temporary plastic placed beneath and, if raining, over the vehicle.

• Wheel wash or tire bath wastewater shall be discharged to a separate onsite treatment system or to the sanitary sewer. • 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' recommendations for application rates and procedures shall be followed.

• BMPs shall be used to prevent or treat contamination of stormwater runoff by pH modifying sources. 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. Stormwater discharges shall not cause or contribute to a violation of the water quality standard for pH in the receiving water.

• Construction sites shall adjust the pH of stormwater if necessary to prevent violations of water quality standards. Projects must obtain written approval from the Department of Ecology prior to using chemical treatment other than CO_2 or dry ice to adjust pH.

• Suggested BMPs:
- BMP C151: Concrete Handling
- BMP C152: Sawcutting and Surfacing Pollution Prevention
- See Volume IV – Source Control BMPs.

Element 10: Control Dewatering (Not applicable)

• Foundation, vault, and trench dewatering water, which have 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.

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

• Highly turbid or contaminated dewatering water from construction equipment operation, clamshell digging, concrete tremie pour, or work inside a cofferdam, shall be handled separately from stormwater.

• Other disposal options, depending on site constraints, may include:

- Infiltration
- Transport offsite in a vehicle, such as a vacuum flush truck, for legal disposal in a manner that does not pollute state waters
- Ecology-approved onsite chemical treatment or other suitable treatment technologies
- Sanitary sewer discharge with local sewer district approval, if there is no other option
- Use of a sedimentation bag with outfall to a ditch or swale for small volumes of localized dewatering.

Element 11: Maintain BMPs

• All temporary and permanent ESC BMPs shall be maintained and repaired as needed to assure continued performance of their intended function. Maintenance and repair shall be conducted in accordance with BMP specifications.

• All temporary ESC 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 on site. Disturbed soil resulting from removal of BMPs
or vegetation shall be permanently stabilized.

Element 12: Manage the Project

Phasing of Construction

• Development projects shall be phased where feasible in order to prevent soil erosion and, to the maximum extent practicable, the transport of sediment from the site during construction. Revegetation of exposed areas and maintenance of that vegetation shall be an integral part of the clearing activities for any phase.

• Clearing and grading activities for developments shall be permitted only if conducted pursuant to an approved site development plan (e.g., subdivision approval) that establishes permitted areas of clearing, grading, cutting, and filling. 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 critical or sensitive areas,

buffers, native growth protection easements, or tree retention areas as may be required by local jurisdictions, shall be delineated on the site plans and the development site.

• 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 county that silt-laden runoff will be prevented from leaving the site through a combination of the following:

- Site conditions including existing vegetative coverage, slope, soil type, and proximity to receiving waters
- Limitations on activities and the extent of disturbed areas
- Proposed ESC measures.

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

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

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

- Routine maintenance and necessary repair of ESC BMPs
- Routine maintenance of public facilities or existing utility structures that do not expose the soil or result in the removal of the vegetative cover to soil
- Activities where there is 100 percent infiltration of surface water runoff within the site in approved and installed ESC facilities.

Coordination with Utilities and Other Contractors
• The primary project applicant 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.
• 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 ESC. The person must have the skills to: 1) assess the site conditions and construction activities that could impact the quality of stormwater and 2) assess the effectiveness of ESC measures used to control the quality of stormwater discharges.
- For construction sites that will disturb 1 acre or more and that discharge stormwater to surface waters of the state, a Certified Erosion and Sediment Control Lead (CESCL) shall be identified in the Construction SWPPP and shall be on site or on-call at all times. Certification may be obtained through an approved training program that meets the ESC training standards established by Ecology.
- Whenever inspection and/or monitoring reveals that the BMPs identified in the Construction SWPPP are inadequate, due to the actual discharge of or potential to discharge a significant amount of any pollutant, appropriate BMPs or design changes shall be implemented as soon as possible.

• Maintaining an updated Construction SWPPP:

- The Construction SWPPP shall be retained on site or within reasonable access to the site.
- The SWPPP shall be modified whenever there is a change in the design, construction, operation, or maintenance at the construction site that has, or could have, a significant effect on the discharge of pollutants to waters of the state.

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

Element 13: Protect Low Impact Development BMP's

Phasing of Construction

- Protect all Bioretention and Rain Garden BMPs from sedimentation through installation and maintenance of Construction SWPPP BMPs on portions of the site that drain into the Bioretention and/or Rain Garden BMPs. Restore the BMPs to their fully functioning condition if they accumulate sediment during construction. Restoring the BMP must include removal of sediment and any sediment-laden Bioretention/Rain Garden soils, and replacing the removed soils with soils meeting the design specification.

- Prevent compacting Bioretention and Rain Garden BMPs by excluding construction equipment and foot traffic. Protect completed lawn and landscaped areas from compaction due to construction equipment.

- Control erosion and avoid introducing sediment from surrounding land uses onto permeable pavements. Do not allow muddy construction equipment on the base material or pavement. Do not allow sediment-laden runoff onto permeable pavements, including permeable pavement subgrade, reservoir course, or wearing course.

- Pavements fouled with sediments or no longer passing an initial infiltration test must be cleaned using procedures shown in Volume III of this manual or the manufacturer's procedures.

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

- See Section 3.3 for more details on protecting LID BMPs.

- **Suggested BMPs:**
    - BMP C102: Buffer Zone
    - BMP C103: High Visibility Fence
    - BMP C200: Interceptor Dike and Swale
    - BMP C201: Grass-Lined Channels
    - BMP C207: Check Dams
    - BMP C208: Triangular Silt Dike (TSD) (Geotextile-Encased Check Dam)
    - BMP C231: Brush Barrier
    - BMP C233: Silt Fence
    - BMP C234: Vegetated Strip
    - BMP C235: Straw Wattles
    - BMP C236: Vegetated Filtration

II. CONSTRUCTION PHASING AND BMP IMPLEMENTATION

The BMP implementation schedule will be driven by the construction schedule. The following provides a sequential list of the proposed construction schedule milestones and the corresponding BMP implementation schedule. The list contains key milestones such as wet season construction.

The BMP implementation schedule listed below is keyed to proposed phases of construction project, and reflects differences in BMP installations and inspections that relate to wet season construction. The project site is located west of the Cascade Mountain Crest. As such, the dry season is considered to be from May 1 to September 30 and the wet season is considered to be from October 1 to April 30.

Estimated construction start date (during wet season): _____

Estimated construction end date: _____

Mobilize equipment on-site: _____

Mobilize and store all ESC and soil stabilization products _____

Install ESC measures: _____

Install stabilized construction entrance:	_____
Begin clearing and grading:	_____
Begin site grading:	_____
Site inspections and monitoring conducted weekly and for applicable rain events:	_____
Implement Element #12 BMP's and manage site to minimize soil disturbance during the wet season:	none
Final landscaping and planting begins:	_____
Permanent erosion control measures:	_____

III. SITE INSPECTION AND MONITORING

Monitoring includes visual inspection and monitoring for water quality parameters of concern, and documentation of the inspection and monitoring findings in a site log book. A site log book shall be maintained for all on-site construction activities and shall include:

1. A record of the implementation of the erosion control plan BMP's.
2. Site Inspections.

SITE INSPECTION

All BMP's shall be inspected, maintained, and repaired as needed to assure continued performance of their intended function.

Site inspection shall occur in all areas disturbed by construction activities and at all stormwater discharge points. The site inspection shall evaluate and document the effectiveness of the installed BMP's and determine if it is necessary to repair or replace any of the BMP's to improve the quality of stormwater discharges. All maintenance and repairs shall be documented in the site log book or forms provided in this document. All new BMP's or design changes shall be documented as soon as possible.

SITE INSPECTION FREQUENCY

Site inspections shall be conducted at least once a week and within 24 hours following any rainfall event which causes a discharge of stormwater from the site. For sites with temporary stabilization measures, the site inspection frequency can be reduce to once every month.

APPENDIX B – EROSION CONTROL BMP'S

BMP C101: Preserving Natural Vegetation

Purpose

The purpose of preserving natural vegetation is to reduce erosion wherever practicable. Limiting site disturbance is the single most effective method for reducing erosion. For example, conifers can hold up to about 50 percent of all rain that falls during a storm. Up to 20-30 percent of this rain may never reach the ground but is taken up by the tree or evaporates. Another benefit is that the rain held in the tree can be released slowly to the ground after the storm.

Conditions of Use

Natural vegetation should be preserved on steep slopes, near perennial and intermittent watercourses or swales, and on building sites in wooded areas.

- As required by local governments.
- Phase construction to preserve natural vegetation on the project site for as long as possible during the construction period.

Design and Installation Specifications

Natural vegetation can be preserved in natural clumps or as individual trees, shrubs and vines.

The preservation of individual plants is more difficult because heavy equipment is generally used to remove unwanted vegetation. The points to remember when attempting to save individual plants are:

- Is the plant worth saving? Consider the location, species, size, age, vigor, and the work involved. Local governments may also have ordinances to save natural vegetation and trees.
- Fence or clearly mark areas around trees that are to be saved. It is preferable to keep ground disturbance away from the trees at least as far out as the dripline.

  Plants need protection from three kinds of injuries:

- *Construction Equipment* - This injury can be above or below the ground level. Damage results from scarring, cutting of roots, and compaction of the soil. Placing a fenced buffer zone around plants to be saved prior to construction can prevent construction equipment injuries.
- *Grade Changes* - Changing the natural ground level will alter grades, which affects the plant's ability to obtain the necessary air, water, and minerals. Minor fills usually do not cause problems although sensitivity between species does vary and should be checked. Trees can typically tolerate fill of 6 inches or less. For shrubs and other plants, the fill should be less.

  When there are major changes in grade, it may become necessary to supply air to the roots of plants. This can be done by placing a layer of gravel and a tile system over the roots before the fill is made. A tile system protects a tree from a raised grade. The tile system should be

laid out on the original grade leading from a dry well around the tree trunk. The system should then be covered with small stones to allow air to circulate over the root area.

Lowering the natural ground level can seriously damage trees and shrubs. The highest percentage of the plant roots are in the upper 12 inches of the soil and cuts of only 2-3 inches can cause serious injury. To protect the roots it may be necessary to terrace the immediate area around the plants to be saved. If roots are exposed, construction of retaining walls may be needed to keep the soil in place. Plants can also be preserved by leaving them on an undisturbed, gently sloping mound. To increase the chances for survival, it is best to limit grade changes and other soil disturbances to areas outside the dripline of the plant.

- *Excavations* - Protect trees and other plants when excavating for drainfields, power, water, and sewer lines. Where possible, the trenches should be routed around trees and large shrubs. When this is not possible, it is best to tunnel under them. This can be done with hand tools or with power augers. If it is not possible to route the trench around plants to be saved, then the following should be observed:

  Cut as few roots as possible. When you have to cut, cut clean. Paint cut root ends with a wood dressing like asphalt base paint if roots will be exposed for more than 24-hours.

  Backfill the trench as soon as possible.

  Tunnel beneath root systems as close to the center of the main trunk to preserve most of the important feeder roots.

Some problems that can be encountered with a few specific trees are:

- Maple, Dogwood, Red alder, Western hemlock, Western red cedar, and Douglas fir do not readily adjust to changes in environment and special care should be taken to protect these trees.
- The windthrow hazard of Pacific silver fir and madrona is high, while that of Western hemlock is moderate. The danger of windthrow increases where dense stands have been thinned. Other species (unless they are on shallow, wet soils less than 20 inches deep) have a low windthrow hazard.
- Cottonwoods, maples, and willows have water-seeking roots. These can cause trouble in sewer lines and infiltration fields. On the other hand, they thrive in high moisture conditions that other trees would not.
- Thinning operations in pure or mixed stands of Grand fir, Pacific silver fir, Noble fir, Sitka spruce, Western red cedar, Western hemlock, Pacific dogwood, and Red alder can cause serious disease problems. Disease can become established through damaged limbs, trunks, roots,

and freshly cut stumps. Diseased and weakened trees are also susceptible to insect attack.

Maintenance Standards

Inspect flagged and/or fenced areas regularly to make sure flagging or fencing has not been removed or damaged. If the flagging or fencing has been damaged or visibility reduced, it shall be repaired or replaced immediately and visibility restored.

- If tree roots have been exposed or injured, "prune" cleanly with an appropriate pruning saw or lopers directly above the damaged roots and recover with native soils. Treatment of sap flowing trees (fir, hemlock, pine, soft maples) is not advised as sap forms a natural healing barrier.

BMP C102: Buffer Zones

Purpose

Creation of an undisturbed area or strip of natural vegetation or an established suitable planting that will provide a living filter to reduce soil erosion and runoff velocities.

Conditions of Use

Natural buffer zones are used along streams, wetlands and other bodies of water that need protection from erosion and sedimentation. Vegetative buffer zones can be used to protect natural swales and can be incorporated into the natural landscaping of an area.

Critical-areas buffer zones should not be used as sediment treatment areas. These areas shall remain completely undisturbed. The local permitting authority may expand the buffer widths temporarily to allow the use of the expanded area for removal of sediment.

Design and Installation Specifications

- Preserving natural vegetation or plantings in clumps, blocks, or strips is generally the easiest and most successful method.
- Leave all unstable steep slopes in natural vegetation.
- Mark clearing limits and keep all equipment and construction debris out of the natural areas and buffer zones. Steel construction fencing is the most effective method in protecting sensitive areas and buffers. Alternatively, wire-backed silt fence on steel posts is marginally effective. Flagging alone is typically not effective.
- Keep all excavations outside the dripline of trees and shrubs.
- Do not push debris or extra soil into the buffer zone area because it will cause damage from burying and smothering.
- Vegetative buffer zones for streams, lakes or other waterways shall be established by the local permitting authority or other state or federal permits or approvals.

Maintenance Standards

Inspect the area frequently to make sure flagging remains in place and the area remains undisturbed. Replace all damaged flagging immediately.

BMP C103: High Visibility Fence

Purpose

Fencing is intended to:

1. Restrict clearing to approved limits.
2. Prevent disturbance of sensitive areas, their buffers, and other areas required to be left undisturbed.
3. Limit construction traffic to designated construction entrances, exits, or internal roads.
4. Protect areas where marking with survey tape may not provide adequate protection.

Conditions of Use

To establish clearing limits plastic, fabric, or metal fence may be used:

- At the boundary of sensitive areas, their buffers, and other areas required to be left uncleared.
- As necessary to control vehicle access to and on the site.

Design and Installation Specifications

High visibility plastic fence shall be composed of a high-density polyethylene material and shall be at least four feet in height. Posts for the fencing shall be steel or wood and placed every 6 feet on center (maximum) or as needed to ensure rigidity. The fencing shall be fastened to the post every six inches with a polyethylene tie. On long continuous lengths of fencing, a tension wire or rope shall be used as a top stringer to prevent sagging between posts. The fence color shall be high visibility orange. The fence tensile strength shall be 360 lbs./ft. using the ASTM D4595 testing method.

If appropriate install fabric silt fence in accordance with BMP C233 to act as high visibility fence. Silt fence shall be at least 3 feet high and must be highly visible to meet the requirements of this BMP.

Metal fences shall be designed and installed according to the manufacturer's specifications.

Metal fences shall be at least 3 feet high and must be highly visible.

Fences shall not be wired or stapled to trees.

Maintenance Standards

If the fence has been damaged or visibility reduced, it shall be repaired or replaced immediately and visibility restored.

BMP C105: Stabilized Construction Entrance / Exit

Purpose

Stabilized Construction entrances are established to reduce the amount of sediment transported onto paved roads by vehicles or equipment. This is done by constructing a stabilized pad of quarry spalls at entrances and exits for construction sites.

Conditions of Use

Construction entrances shall be stabilized wherever traffic will be entering or leaving a construction site if paved roads or other paved areas are within 1,000 feet of the site.

For residential construction provide stabilized construction entrances for each residence, rather than only at the main subdivision entrance. Stabilized surfaces shall be of sufficient length/width to provide vehicle access/parking, based on lot size/configuration.

On large commercial, highway, and road projects, the designer should include enough extra materials in the contract to allow for additional stabilized entrances not shown in the initial Construction SWPPP. It is difficult to determine exactly where access to these projects will take place; additional materials will enable the contractor to install them where needed.

Design and Installation Specifications

See Figure 4.1.1 for details. Note: the 100' minimum length of the entrance shall be reduced to the maximum practicable size when the size or configuration of the site does not allow the full length (100').

Construct stabilized construction entrances with a 12-inch thick pad of 4-inch to 8-inch quarry spalls, a 4-inch course of asphalt treated base (ATB), or use existing pavement. Do not use crushed concrete, cement, or calcium chloride for construction entrance stabilization because these products raise pH levels in stormwater and concrete discharge to surface waters of the State is prohibited.

A separation geotextile shall be placed under the spalls to prevent fine sediment from pumping up into the rock pad. The geotextile shall meet the following standards:

Grab Tensile Strength (ASTM D4751)	200 psi min.
Grab Tensile Elongation (ASTM D4632)	30% max.
Mullen Burst Strength (ASTM D3786-80a)	400 psi min.
AOS (ASTM D4751)	20-45 (U.S. standard sieve size)

- Consider early installation of the first lift of asphalt in areas that will paved; this can be used as a stabilized entrance. Also consider the installation of excess concrete as a stabilized entrance. During large concrete pours, excess concrete is often available for this purpose.

- Fencing (see BMP C103) shall be installed as necessary to restrict traffic to the construction entrance.
- Whenever possible, the entrance shall be constructed on a firm, compacted subgrade. This can substantially increase the effectiveness of the pad and reduce the need for maintenance.
- Construction entrances should avoid crossing existing sidewalks and back of walk drains if at all possible. If a construction entrance must cross a sidewalk or back of walk drain, the full length of the sidewalk and back of walk drain must be covered and protected from sediment leaving the site.

Maintenance Standards

Quarry spalls shall be added if the pad is no longer in accordance with the specifications.

- If the entrance is not preventing sediment from being tracked onto pavement, then alternative measures to keep the streets free of sediment shall be used. This may include replacement/cleaning of the existing quarry spalls, street sweeping, an increase in the dimensions of the entrance, or the installation of a wheel wash.
- Any sediment that is tracked onto pavement shall be removed by shoveling or street sweeping. The sediment collected by sweeping shall be removed or stabilized on site. The pavement shall not be cleaned by washing down the street, except when high efficiency sweeping is ineffective and there is a threat to public safety. If it is necessary to wash the streets, the construction of a small sump to contain the wash water shall be considered. The sediment would then be washed into the sump where it can be controlled.
- Perform street sweeping by hand or with a high efficiency sweeper. Do not use a non-high efficiency mechanical sweeper because this creates dust and throws soils into storm systems or conveyance ditches.
- Any quarry spalls that are loosened from the pad, which end up on the roadway shall be removed immediately.
- If vehicles are entering or exiting the site at points other than the construction entrance(s), fencing (see BMP C103) shall be installed to control traffic.
- Upon project completion and site stabilization, all construction accesses intended as permanent access for maintenance shall be permanently stabilized.

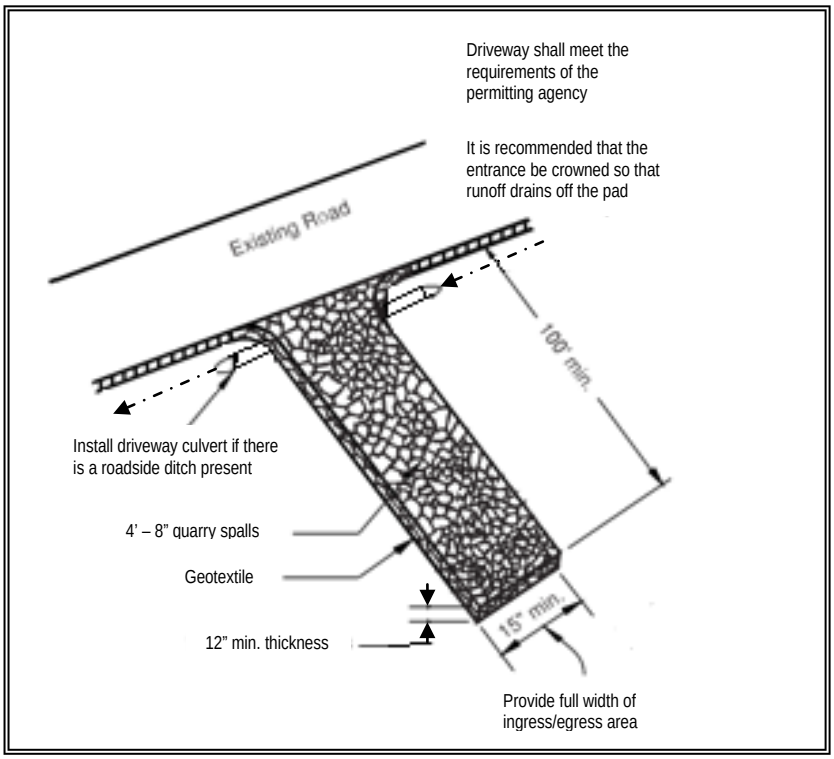


Figure 4.1.1 – Stabilized Construction Entrance

Approved as Equivalent

Ecology has approved products as able to meet the requirements of BMP C105. The products did not pass through the Technology Assessment Protocol – Ecology (TAPE) process. Local jurisdictions may choose not to accept this product approved as equivalent, or may require additional testing prior to consideration for local use. The products are available for review on Ecology's website at http://www.ecy.wa.gov/programs/wq/stormwater/newtech/equivalent.html

BMP C106: Wheel Wash

Purpose

Wheel washes reduce the amount of sediment transported onto paved roads by motor vehicles.

Conditions of Use

When a stabilized construction entrance (see BMP C105) is not preventing sediment from being tracked onto pavement.

- Wheel washing is generally an effective BMP when installed with careful attention to topography. For example, a wheel wash can be detrimental if installed at the top of a slope abutting a right-of-way where the water from the dripping truck can run unimpeded into the street.

- Pressure washing combined with an adequately sized and surfaced pad with direct drainage to a large 10-foot x 10-foot sump can be very effective.
- Discharge wheel wash or tire bath wastewater to a separate on-site treatment system that prevents discharge to surface water, such as closed-loop recirculation or upland land application, or to the sanitary sewer with local sewer district approval.
- Wheel wash or tire bath wastewater should not include wastewater from concrete washout areas.

Design and Installation Specifications

Suggested details are shown in Figure 4.1.2. The Local Permitting Authority may allow other designs. A minimum of 6 inches of asphalt treated base (ATB) over crushed base material or 8 inches over a good subgrade is recommended to pave the wheel wash.

Use a low clearance truck to test the wheel wash before paving. Either a belly dump or lowboy will work well to test clearance.

Keep the water level from 12 to 14 inches deep to avoid damage to truck hubs and filling the truck tongues with water.

Midpoint spray nozzles are only needed in extremely muddy conditions.

Wheel wash systems should be designed with a small grade change, 6- to 1-inches for a 10-foot-wide pond, to allow sediment to flow to the low side of pond to help prevent re-suspension of sediment. A drainpipe with a 2- to 3-foot riser should be installed on the low side of the pond to allow for easy cleaning and refilling. Polymers may be used to promote coagulation and flocculation in a closed-loop system. Polyacrylamide (PAM) added to the wheel wash water at a rate of 0.25 - 0.5 pounds per 1,000 gallons of water increases effectiveness and reduces cleanup time. If PAM is already being used for dust or erosion control and is being applied by a water truck, the same truck can be used to change the wash water.

Maintenance Standards

The wheel wash should start out the day with fresh water.

The wash water should be changed a minimum of once per day. On large earthwork jobs where more than 10-20 trucks per hour are expected, the wash water will need to be changed more often.

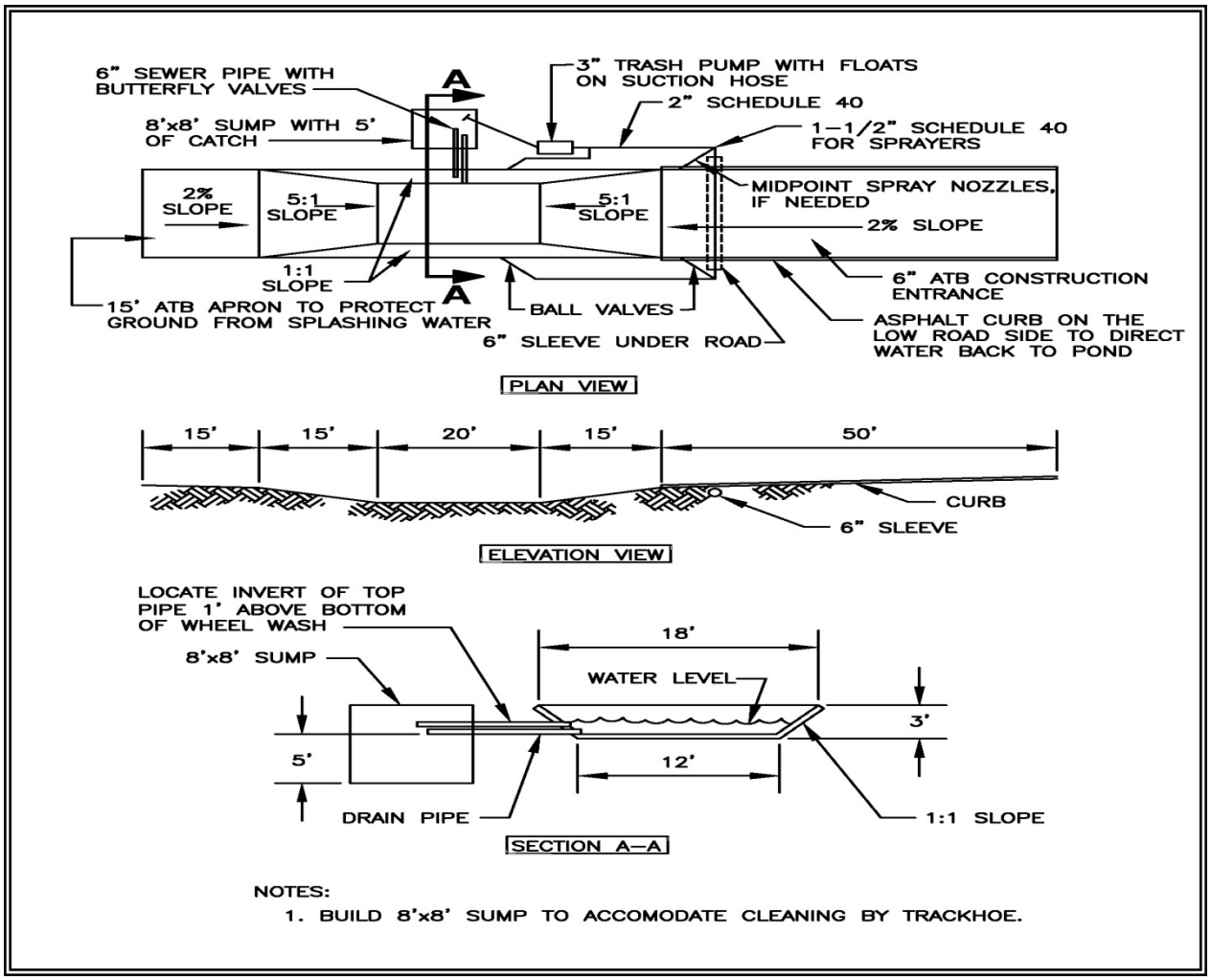


Figure 4.1.2 – Wheel Wash

Notes:

1. Asphalt construction entrance 6 in. asphalt treated base (ATB).
2. 3-inch trash pump with floats on the suction hose.
3. Midpoint spray nozzles, if needed.
4. 6-inch sewer pipe with butterfly valves. Bottom one is a drain. Locate top pipe's invert 1 foot above bottom of wheel wash.
5. 8 foot x 8 foot sump with 5 feet of catch. Build so the sump can be cleaned with a trackhoe.
6. Asphalt curb on the low road side to direct water back to pond.
7. 6-inch sleeve under road.
8. Ball valves.
9. 15 foot. ATB apron to protect ground from splashing water.

BMP C107: Construction Road/Parking Area Stabilization

Purpose

Stabilizing subdivision roads, parking areas, and other on-site vehicle transportation routes immediately after grading reduces erosion caused by construction traffic or runoff.

Conditions of Use

Roads or parking areas shall be stabilized wherever they are constructed, whether permanent or temporary, for use by construction traffic.

- High Visibility Fencing (see BMP C103) shall be installed, if necessary, to limit the access of vehicles to only those roads and parking areas that are stabilized.

Design and Installation Specifications

- On areas that will receive asphalt as part of the project, install the first lift as soon as possible.
- A 6-inch depth of 2- to 4-inch crushed rock, gravel base, or crushed surfacing base course shall be applied immediately after grading or utility installation. A 4-inch course of asphalt treated base (ATB) may also be used, or the road/parking area may be paved. It may also be possible to use cement or calcium chloride for soil stabilization. If cement or cement kiln dust is used for roadbase stabilization, pH monitoring and BMPs (BMPs C252 and C253) are necessary to evaluate and minimize the effects on stormwater. If the area will not be used for permanent roads, parking areas, or structures, a 6-inch depth of hog fuel may also be used, but this is likely to require more maintenance. Whenever possible, construction roads and parking areas shall be placed on a firm, compacted subgrade.
- Temporary road gradients shall not exceed 15 percent. Roadways shall be carefully graded to drain. Drainage ditches shall be provided on each side of the roadway in the case of a crowned section, or on one side in the case of a super-elevated section. Drainage ditches shall be directed to a sediment control BMP.
- Rather than relying on ditches, it may also be possible to grade the road so that runoff sheet-flows into a heavily vegetated area with a well-developed topsoil. Landscaped areas are not adequate. If this area has at least 50 feet of vegetation that water can flow through, then it is generally preferable to use the vegetation to treat runoff, rather than a sediment pond or trap. The 50 feet shall not include wetlands or their buffers. If runoff is allowed to sheetflow through adjacent vegetated areas, it is vital to design the roadways and parking areas so that no concentrated runoff is created.
- Storm drain inlets shall be protected to prevent sediment-laden water entering the storm drain system (see BMP C220).

Maintenance Standards

Inspect stabilized areas regularly, especially after large storm events.

Crushed rock, gravel base, etc. shall be added as required to maintain a

stable driving surface and to stabilize any areas that have eroded.

Following construction, these areas shall be restored to pre-construction condition or better to prevent future erosion.

Perform street cleaning at the end of each day or more often if necessary.

BMP C120: Temporary and Permanent Seeding

Purpose

Seeding reduces erosion by stabilizing exposed soils. A well-established vegetative cover is one of the most effective methods of reducing erosion.

Conditions of Use

Use seeding throughout the project on disturbed areas that have reached final grade or that will remain unworked for more than 30 days.

The optimum seeding windows for western Washington are April 1 through June 30 and September 1 through October 1.

Between July 1 and August 30 seeding requires irrigation until 75 percent grass cover is established.

Between October 1 and March 30 seeding requires a cover of mulch with straw or an erosion control blanket until 75 percent grass cover is established.

Review all disturbed areas in late August to early September and complete all seeding by the end of September. Otherwise, vegetation will not establish itself enough to provide more than average protection.

- Mulch is required at all times for seeding because it protects seeds from heat, moisture loss, and transport due to runoff. Mulch can be applied on top of the seed or simultaneously by hydroseeding. See BMP C121: Mulching for specifications.
- Seed and mulch, all disturbed areas not otherwise vegetated at final site stabilization. Final stabilization means the completion of all soil disturbing activities at the site and the establishment of a permanent vegetative cover, or equivalent permanent stabilization measures (such as pavement, riprap, gabions or geotextiles) which will prevent erosion.

Design and Installation Specifications

Seed retention/detention ponds as required.

Install channels intended for vegetation before starting major earthwork and hydroseed with a Bonded Fiber Matrix. For vegetated channels that will have high flows, install erosion control blankets over hydroseed. Before allowing water to flow in vegetated channels, establish 75 percent vegetation cover. If vegetated channels cannot be established by seed before water flow; install sod in the channel bottom—over hydromulch and erosion control blankets.

- Confirm the installation of all required surface water control measures to prevent seed from washing away.
- Hydroseed applications shall include a minimum of 1,500 pounds per acre of mulch with 3 percent tackifier. See BMP C121: Mulching for specifications.
- Areas that will have seeding only and not landscaping may need compost or meal-based mulch included in the hydroseed in order to establish vegetation. Re-install native topsoil on the disturbed soil surface before application.
- When installing seed via hydroseeding operations, only about 1/3 of the seed actually ends up in contact with the soil surface. This reduces the ability to establish a good stand of grass quickly. To overcome this, consider increasing seed quantities by up to 50 percent.
- Enhance vegetation establishment by dividing the hydromulch operation into two phases:

  1. Phase 1- Install all seed and fertilizer with 25-30 percent mulch and tackifier onto soil in the first lift.
  2. Phase 2- Install the rest of the mulch and tackifier over the first lift.

  Or, enhance vegetation by:

  1. Installing the mulch, seed, fertilizer, and tackifier in one lift.
  2. Spread or blow straw over the top of the hydromulch at a rate of 800-1000 pounds per acre.
  3. Hold straw in place with a standard tackifier.

  Both of these approaches will increase cost moderately but will greatly improve and enhance vegetative establishment. The increased cost may be offset by the reduced need for:

  - Irrigation.
  - Reapplication of mulch.
  - Repair of failed slope surfaces.

  This technique works with standard hydromulch (1,500 pounds per acre minimum) and BFM/MBFMs (3,000 pounds per acre minimum).
- Seed may be installed by hand if:
  - Temporary and covered by straw, mulch, or topsoil.
  - Permanent in small areas (usually less than 1 acre) and covered with mulch, topsoil, or erosion blankets.
- The seed mixes listed in the tables below include recommended mixes for both temporary and permanent seeding.

- Apply these mixes, with the exception of the wetland mix, at a rate of 120 pounds per acre. This rate can be reduced if soil amendments or slow-release fertilizers are used.
- Consult the local suppliers or the local conservation district for their recommendations because the appropriate mix depends on a variety of factors, including location, exposure, soil type, slope, and expected foot traffic. Alternative seed mixes approved by the local authority may be used.
- Other mixes may be appropriate, depending on the soil type and hydrology of the area.

- Table 4.1.2 lists the standard mix for areas requiring a temporary vegetative cover.

Table 4.1.2
Temporary Erosion Control Seed Mix

	% Weight	% Purity	% Germination
Chewings or annual blue grass *Festuca rubra var. commutata* or *Poa anna*	40	98	90
Perennial rye - *Lolium perenne*	50	98	90
Redtop or colonial bentgrass *Agrostis alba* or *Agrostis tenuis*	5	92	85
White dutch clover *Trifolium repens*	5	98	90

- Table 4.1.3 lists a recommended mix for landscaping seed.

Table 4.1.3
Landscaping Seed Mix

	% Weight	% Purity	% Germination
Perennial rye blend *Lolium perenne*	70	98	90
Chewings and red fescue blend *Festuca rubra var. commutata* or *Festuca rubra*	30	98	90

- Table 4.1.4 lists a turf seed mix for dry situations where there is no need for watering. This mix requires very little maintenance.

Table 4.1.4
Low-Growing Turf Seed Mix

	% Weight	% Purity	% Germination
Dwarf tall fescue (several varieties) *Festuca arundinacea var.*	45	98	90
Dwarf perennial rye (Barclay) *Lolium perenne var. barclay*	30	98	90
Red fescue *Festuca rubra*	20	98	90
Colonial bentgrass *Agrostis tenuis*	5	98	90

- Table 4.1.5 lists a mix for bioswales and other intermittently wet areas.

Table 4.1.5
Bioswale Seed Mix*

	% Weight	% Purity	% Germination
Tall or meadow fescue *Festuca arundinacea* or *Festuca elatior*	75-80	98	90
Seaside/Creeping bentgrass *Agrostis palustris*	10-15	92	85
Redtop bentgrass *Agrostis alba* or *Agrostis gigantea*	5-10	90	80

* *Modified Briargreen, Inc. Hydroseeding Guide Wetlands Seed Mix*

- Table 4.1.6 lists a low-growing, relatively non-invasive seed mix appropriate for very wet areas that are not regulated wetlands. Apply this mixture at a rate of 60 pounds per acre. Consult Hydraulic Permit Authority (HPA) for seed mixes if applicable.

Table 4.1.6
Wet Area Seed Mix*

	% Weight	% Purity	% Germination
Tall or meadow fescue *Festuca arundinacea* or *Festuca elatior*	60-70	98	90
Seaside/Creeping bentgrass *Agrostis palustris*	10-15	98	85
Meadow foxtail *Alepocurus pratensis*	10-15	90	80
Alsike clover *Trifolium hybridum*	1-6	98	90
Redtop bentgrass *Agrostis alba*	1-6	92	85

** Modified Briargreen, Inc. Hydroseeding Guide Wetlands Seed Mix*

- Table 4.1.7 lists a recommended meadow seed mix for infrequently maintained areas or non-maintained areas where colonization by native plants is desirable. Likely applications include rural road and utility right-of-way. Seeding should take place in September or very early October in order to obtain adequate establishment prior to the winter months. Consider the appropriateness of clover, a fairly invasive species, in the mix. Amending the soil can reduce the need for clover.

Table 4.1.7
Meadow Seed Mix

	% Weight	% Purity	% Germination
Redtop or Oregon bentgrass *Agrostis alba* or *Agrostis oregonensis*	20	92	85
Red fescue *Festuca rubra*	70	98	90
White dutch clover *Trifolium repens*	10	98	90

- **Roughening and Rototilling:**
  - The seedbed should be firm and rough. Roughen all soil no matter what the slope. Track walk slopes before seeding if engineering purposes require compaction. Backblading or smoothing of slopes greater than 4H:1V is not allowed if they are to be seeded.
  - Restoration-based landscape practices require deeper incorporation than that provided by a simple single-pass rototilling treatment. Wherever practical, initially rip the subgrade to improve long-term permeability, infiltration, and water inflow qualities. At a minimum, permanent areas shall use soil amendments to achieve organic matter and permeability performance defined in engineered soil/landscape systems. For systems that are deeper than 8 inches complete the rototilling process in multiple lifts, or prepare the engineered soil system per specifications and place to achieve the specified depth.
- **Fertilizers:**
  - Conducting soil tests to determine the exact type and quantity of fertilizer is recommended. This will prevent the over-application of fertilizer.
  - Organic matter is the most appropriate form of fertilizer because it provides nutrients (including nitrogen, phosphorus, and potassium) in the least water-soluble form.
  - In general, use 10-4-6 N-P-K (nitrogen-phosphorus-potassium) fertilizer at a rate of 90 pounds per acre. Always use slow-release fertilizers because they are more efficient and have fewer environmental impacts. Do not add fertilizer to the hydromulch machine, or agitate, more than 20 minutes before use. Too much agitation destroys the slow-release coating.
  - There are numerous products available that take the place of chemical fertilizers. These include several with seaweed extracts that are beneficial to soil microbes and organisms. If 100 percent cottonseed meal is used as the mulch in hydroseed, chemical fertilizer may not be necessary. Cottonseed meal provides a good source of long-term, slow-release, available nitrogen.
- **Bonded Fiber Matrix and Mechanically Bonded Fiber Matrix:**
  - On steep slopes use Bonded Fiber Matrix (BFM) or Mechanically Bonded Fiber Matrix (MBFM) products. Apply BFM/MBFM products at a minimum rate of 3,000 pounds per acre of mulch with approximately 10 percent tackifier. Achieve a minimum of 95 percent soil coverage during application. Numerous products are available commercially. Installed products per manufacturer's instructions. Most products require 24-36 hours to cure before rainfall and cannot be installed on wet or saturated soils.

Generally, products come in 40-50 pound bags and include all necessary ingredients except for seed and fertilizer.

- BFMs and MBFMs provide good alternatives to blankets in most areas requiring vegetation establishment. Advantages over blankets include:
  - BFM and MBFMs do not require surface preparation.
  - Helicopters can assist in installing BFM and MBFMs in remote areas.
  - On slopes steeper than 2.5H:1V, blanket installers may require ropes and harnesses for safety.
  - Installing BFM and MBFMs can save at least $1,000 per acre compared to blankets.

Maintenance Standards

Reseed any seeded areas that fail to establish at least 80 percent cover (100 percent cover for areas that receive sheet or concentrated flows). If reseeding is ineffective, use an alternate method such as sodding, mulching, or nets/blankets. If winter weather prevents adequate grass growth, this time limit may be relaxed at the discretion of the local authority when sensitive areas would otherwise be protected.

- Reseed and protect by mulch any areas that experience erosion after achieving adequate cover. Reseed and protect by mulch any eroded area.
- Supply seeded areas with adequate moisture, but do not water to the extent that it causes runoff.

Approved as Equivalent

Ecology has approved products as able to meet the requirements of BMP C120. The products did not pass through the Technology Assessment Protocol – Ecology (TAPE) process. Local jurisdictions may choose not to accept this product approved as equivalent, or may require additional testing prior to consideration for local use. The products are available for review on Ecology's website at http://www.ecy.wa.gov/programs/wq/stormwater/newtech/equivalent.html

BMP C121: Mulching

Purpose

Mulching soils provides immediate temporary protection from erosion. Mulch also enhances plant establishment by conserving moisture, holding fertilizer, seed, and topsoil in place, and moderating soil temperatures. There is an enormous variety of mulches that can be used. This section discusses only the most common types of mulch.

Conditions of Use

As a temporary cover measure, mulch should be used:

- For less than 30 days on disturbed areas that require cover.
- At all times for seeded areas, especially during the wet season and

during the hot summer months.

- During the wet season on slopes steeper than 3H:1V with more than 10 feet of vertical relief.

Mulch may be applied at any time of the year and must be refreshed periodically.

- For seeded areas mulch may be made up of 100 percent: cottonseed meal; fibers made of wood, recycled cellulose, hemp, kenaf; compost; or blends of these. Tackifier shall be plant-based, such as guar or alpha plantago, or chemical-based such as polyacrylamide or polymers. Any mulch or tackifier product used shall be installed per manufacturer's instructions. Generally, mulches come in 40-50 pound bags. Seed and fertilizer are added at time of application.

Design and Installation Specifications

For mulch materials, application rates, and specifications, see Table 4.1.8. Always use a 2-inch minimum mulch thickness; increase the thickness until the ground is 95% covered (i.e. not visible under the mulch layer). Note: Thickness may be increased for disturbed areas in or near sensitive areas or other areas highly susceptible to erosion.

Mulch used within the ordinary high-water mark of surface waters should be selected to minimize potential flotation of organic matter. Composted organic materials have higher specific gravities (densities) than straw, wood, or chipped material. Consult Hydraulic Permit Authority (HPA) for mulch mixes if applicable.

Maintenance Standards

- The thickness of the cover must be maintained.
- Any areas that experience erosion shall be remulched and/or protected with a net or blanket. If the erosion problem is drainage related, then the problem shall be fixed and the eroded area remulched.

Table 4.1.8
Mulch Standards and Guidelines

Mulch Material	Quality Standards	Application Rates	Remarks
Straw	Air-dried; free from undesirable seed and coarse material.	2"-3" thick; 5 bales per 1,000 sf or 2-3 tons per acre	Cost-effective protection when applied with adequate thickness. Hand-application generally requires greater thickness than blown straw. The thickness of straw may be reduced by half when used in conjunction with seeding. In windy areas straw must be held in place by crimping, using a tackifier, or covering with netting. Blown straw always has to be held in place with a tackifier as even light winds will blow it away. Straw, however, has several deficiencies that should be considered when selecting mulch materials. It often introduces and/or encourages the propagation of weed species and it has no significant long-term benefits. It should also not be used within the ordinary high-water elevation of surface waters (due to flotation).
Hydromulch	No growth inhibiting factors.	Approx. 25-30 lbs per 1,000 sf or 1,500 - 2,000 lbs per acre	Shall be applied with hydromulcher. Shall not be used without seed and tackifier unless the application rate is at least doubled. Fibers longer than about ¾-1 inch clog hydromulch equipment. Fibers should be kept to less than ¾ inch.
Composted Mulch and Compost	No visible water or dust during handling. Must be produced in accordance with WAC 173-350, Solid Waste Handling Standards. .	2" thick min.; approx. 100 tons per acre (approx. 800 lbs per yard)	More effective control can be obtained by increasing thickness to 3". Excellent mulch for protecting final grades until landscaping because it can be directly seeded or tilled into soil as an amendment. Composted mulch has a coarser size gradation than compost. It is more stable and practical to use in wet areas and during rainy weather conditions. Do not use composted mulch near wetlands or near phosphorous impaired water bodies.
Chipped Site Vegetation	Average size shall be several inches. Gradations from fines to 6 inches in length for texture, variation, and interlocking properties.	2" thick min.;	This is a cost-effective way to dispose of debris from clearing and grubbing, and it eliminates the problems associated with burning. Generally, it should not be used on slopes above approx. 10% because of its tendency to be transported by runoff. It is not recommended within 200 feet of surface waters. If seeding is expected shortly after mulch, the decomposition of the chipped vegetation may tie up nutrients important to grass establishment.
Wood-based Mulch or Wood Straw	No visible water or dust during handling. Must be purchased from a supplier with a Solid Waste Handling Permit or one exempt from solid waste regulations.	2" thick min.; approx. 100 tons per acre (approx. 800 lbs. per cubic yard)	This material is often called "hog or hogged fuel." The use of mulch ultimately improves the organic matter in the soil. Special caution is advised regarding the source and composition of wood-based mulches. Its preparation typically does not provide any weed seed control, so evidence of residual vegetation in its composition or known inclusion of weed plants or seeds should be monitored and prevented (or minimized).
Wood Strand Mulch	A blend of loose, long, thin wood pieces derived from native conifer or deciduous trees with high length-to-width ratio.	2" thick min.	Cost-effective protection when applied with adequate thickness. A minimum of 95-percent of the wood strand shall have lengths between 2 and 10-inches, with a width and thickness between 1/16 and ⅜-inches. The mulch shall not contain resin, tannin, or other compounds in quantities that would be detrimental to plant life. Sawdust or wood shavings shall not be used as mulch. (WSDOT specification (9-14.4(4))

BMP C122: Nets and Blankets

Purpose

Erosion control nets and blankets are intended to prevent erosion and hold seed and mulch in place on steep slopes and in channels so that vegetation can become well established. In addition, some nets and blankets can be used to permanently reinforce turf to protect drainage ways during high flows. Nets (commonly called matting) are strands of material woven into an open, but high-tensile strength net (for example, coconut fiber matting). Blankets are strands of material that are not tightly woven, but instead form a layer of interlocking fibers, typically held together by a biodegradable or photodegradable netting (for example, excelsior or straw blankets). They generally have lower tensile strength than nets, but cover the ground more completely. Coir (coconut fiber) fabric comes as both nets and blankets.

Conditions of Use

Erosion control nets and blankets should be used:

- To aid permanent vegetated stabilization of slopes 2H:1V or greater and with more than 10 feet of vertical relief.
- For drainage ditches and swales (highly recommended). The application of appropriate netting or blanket to drainage ditches and swales can protect bare soil from channelized runoff while vegetation is established. Nets and blankets also can capture a great deal of sediment due to their open, porous structure. Nets and blankets can be used to permanently stabilize channels and may provide a cost-effective, environmentally preferable alternative to riprap. 100 percent synthetic blankets manufactured for use in ditches may be easily reused as temporary ditch liners.

Disadvantages of blankets include:

- Surface preparation required.
- On slopes steeper than 2.5H:1V, blanket installers may need to be roped and harnessed for safety.
- They cost at least $4,000-6,000 per acre installed.

Advantages of blankets include:

- Installation without mobilizing special equipment.
- Installation by anyone with minimal training
- Installation in stages or phases as the project progresses.
- Installers can hand place seed and fertilizer as they progress down the slope.
- Installation in any weather.
- There are numerous types of blankets that can be designed with various parameters in mind. Those parameters include: fiber blend, mesh strength, longevity, biodegradability, cost, and availability.

Design and Installation Specifications

- See Figure 4.1.3 and Figure 4.1.4 for typical orientation and installation of blankets used in channels and as slope protection. Note: these are typical only; all blankets must be installed per manufacturer's installation instructions.
- Installation is critical to the effectiveness of these products. If good ground contact is not achieved, runoff can concentrate under the product, resulting in significant erosion.
- Installation of Blankets on Slopes:
    1. Complete final grade and track walk up and down the slope.
    2. Install hydromulch with seed and fertilizer.
    3. Dig a small trench, approximately 12 inches wide by 6 inches deep along the top of the slope.
    4. Install the leading edge of the blanket into the small trench and staple approximately every 18 inches. NOTE: Staples are metal, "U"-shaped, and a minimum of 6 inches long. Longer staples are used in sandy soils. Biodegradable stakes are also available.
    5. Roll the blanket slowly down the slope as installer walks backwards. NOTE: The blanket rests against the installer's legs. Staples are installed as the blanket is unrolled. It is critical that the proper staple pattern is used for the blanket being installed. The blanket is not to be allowed to roll down the slope on its own as this stretches the blanket making it impossible to maintain soil contact. In addition, no one is allowed to walk on the blanket after it is in place.
    6. If the blanket is not long enough to cover the entire slope length, the trailing edge of the upper blanket should overlap the leading edge of the lower blanket and be stapled. On steeper slopes, this overlap should be installed in a small trench, stapled, and covered with soil.
- With the variety of products available, it is impossible to cover all the details of appropriate use and installation. Therefore, it is critical that the design engineer consult the manufacturer's information and that a site visit takes place in order to ensure that the product specified is appropriate. Information is also available at the following web sites:
    1. WSDOT (Section 3.2.4):

       http://www.wsdot.wa.gov/NR/rdonlyres/3B41E087-FA86-4717-932D-D7A8556CCD57/0/ErosionTrainingManual.pdf
    2. Texas Transportation Institute:

       http://www.txdot.gov/business/doing_business/product_evaluation/erosion_control.htm

- Use jute matting in conjunction with mulch (BMP C121). Excelsior, woven straw blankets and coir (coconut fiber) blankets may be installed without mulch. There are many other types of erosion control nets and blankets on the market that may be appropriate in certain circumstances.
- In general, most nets (e.g., jute matting) require mulch in order to prevent erosion because they have a fairly open structure. Blankets typically do not require mulch because they usually provide complete protection of the surface.
- Extremely steep, unstable, wet, or rocky slopes are often appropriate candidates for use of synthetic blankets, as are riverbanks, beaches and other high-energy environments. If synthetic blankets are used, the soil should be hydromulched first.
- 100-percent biodegradable blankets are available for use in sensitive areas. These organic blankets are usually held together with a paper or fiber mesh and stitching which may last up to a year.
- Most netting used with blankets is photodegradable, meaning they break down under sunlight (not UV stabilized). However, this process can take months or years even under bright sun. Once vegetation is established, sunlight does not reach the mesh. It is not uncommon to find non-degraded netting still in place several years after installation. This can be a problem if maintenance requires the use of mowers or ditch cleaning equipment. In addition, birds and small animals can become trapped in the netting.

Maintenance Standards

- Maintain good contact with the ground. Erosion must not occur beneath the net or blanket.
- Repair and staple any areas of the net or blanket that are damaged or not in close contact with the ground.
- Fix and protect eroded areas if erosion occurs due to poorly controlled drainage.

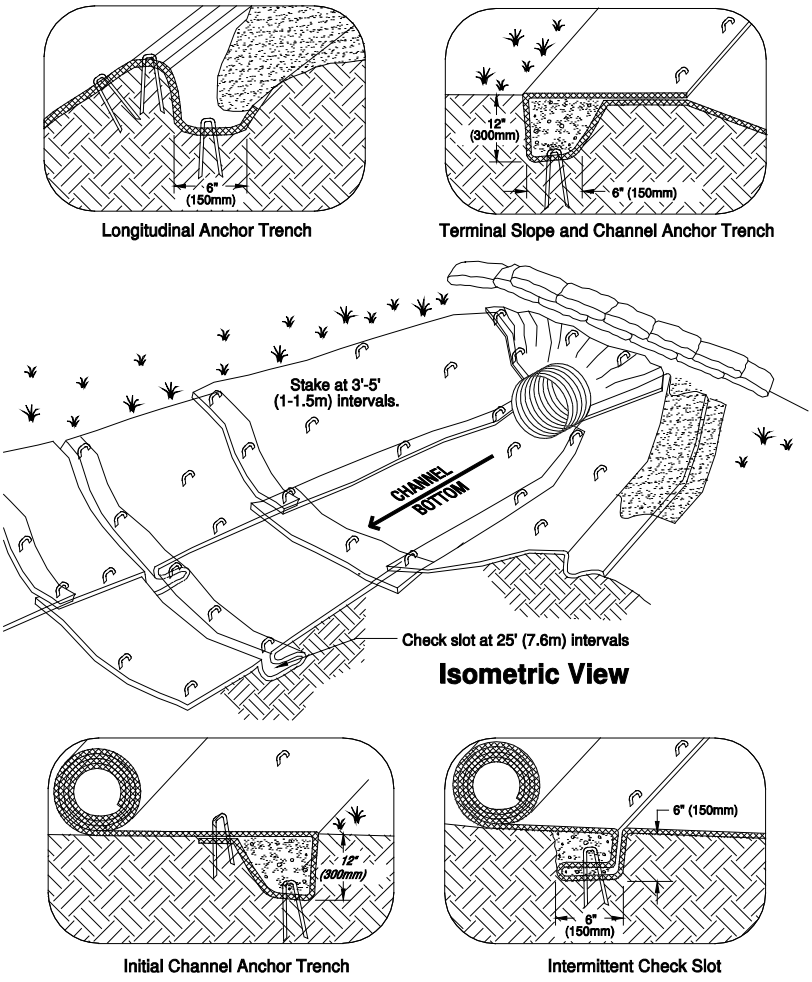


Figure 4.1.3 – Channel Installation

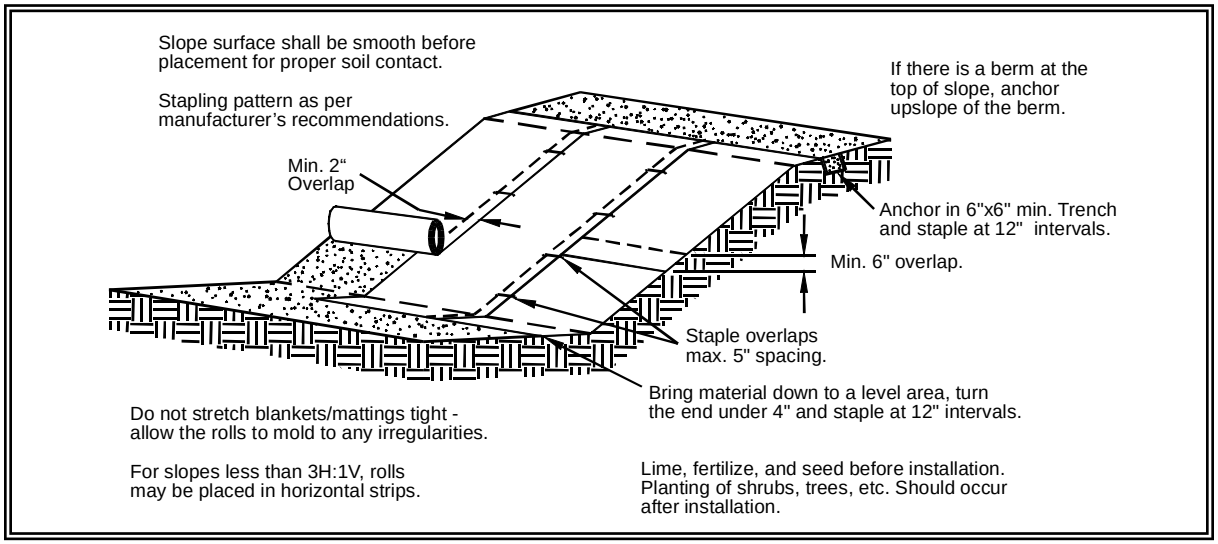


Figure 4.1.4 – Slope Installation

BMP C123: Plastic Covering

Purpose

Plastic covering provides immediate, short-term erosion protection to slopes and disturbed areas.

Conditions of Use

Plastic covering may be used on disturbed areas that require cover measures for less than 30 days, except as stated below.

- Plastic is particularly useful for protecting cut and fill slopes and stockpiles. Note: The relatively rapid breakdown of most polyethylene sheeting makes it unsuitable for long-term (greater than six months) applications.
- Due to rapid runoff caused by plastic covering, do not use this method upslope of areas that might be adversely impacted by concentrated runoff. Such areas include steep and/or unstable slopes.
- Plastic sheeting may result in increased runoff volumes and velocities, requiring additional on-site measures to counteract the increases. Creating a trough with wattles or other material can convey clean water away from these areas.
- To prevent undercutting, trench and backfill rolled plastic covering products.
- While plastic is inexpensive to purchase, the added cost of installation, maintenance, removal, and disposal make this an expensive material, up to $1.50-2.00 per square yard.
- Whenever plastic is used to protect slopes install water collection measures at the base of the slope. These measures include plastic-covered berms, channels, and pipes used to covey clean rainwater away from bare soil and disturbed areas. Do not mix clean runoff from a plastic covered slope with dirty runoff from a project.
- Other uses for plastic include:
    1. Temporary ditch liner.
    2. Pond liner in temporary sediment pond.
    3. Liner for bermed temporary fuel storage area if plastic is not reactive to the type of fuel being stored.
    4. Emergency slope protection during heavy rains.
    5. Temporary drainpipe (“elephant trunk”) used to direct water.

Design and Installation Specifications

- Plastic slope cover must be installed as follows:
    1. Run plastic up and down slope, not across slope.
    2. Plastic may be installed perpendicular to a slope if the slope length is less than 10 feet.
    3. Minimum of 8-inch overlap at seams.

4. On long or wide slopes, or slopes subject to wind, tape all seams.
5. Place plastic into a small (12-inch wide by 6-inch deep) slot trench at the top of the slope and backfill with soil to keep water from flowing underneath.
6. Place sand filled burlap or geotextile bags every 3 to 6 feet along seams and tie them together with twine to hold them in place.
7. Inspect plastic for rips, tears, and open seams regularly and repair immediately. This prevents high velocity runoff from contacting bare soil which causes extreme erosion.
8. Sandbags may be lowered into place tied to ropes. However, all sandbags must be staked in place.

- Plastic sheeting shall have a minimum thickness of 0.06 millimeters.
- If erosion at the toe of a slope is likely, a gravel berm, riprap, or other suitable protection shall be installed at the toe of the slope in order to reduce the velocity of runoff.

Maintenance Standards

- Torn sheets must be replaced and open seams repaired.
- Completely remove and replace the plastic if it begins to deteriorate due to ultraviolet radiation.
- Completely remove plastic when no longer needed.
- Dispose of old tires used to weight down plastic sheeting appropriately.

Approved as Equivalent

Ecology has approved products as able to meet the requirements of BMP C123. The products did not pass through the Technology Assessment Protocol – Ecology (TAPE) process. Local jurisdictions may choose not to accept this product approved as equivalent, or may require additional testing prior to consideration for local use. The products are available for review on Ecology's website at http://www.ecy.wa.gov/programs/wq/stormwater/newtech/equivalent.html

BMP C124: Sodding

Purpose

The purpose of sodding is to establish permanent turf for immediate erosion protection and to stabilize drainage ways where concentrated overland flow will occur.

Conditions of Use

Sodding may be used in the following areas:

- Disturbed areas that require short-term or long-term cover.
- Disturbed areas that require immediate vegetative cover.
- All waterways that require vegetative lining. Waterways may also be seeded rather than sodded, and protected with a net or blanket.

Design and Installation Specifications

Sod shall be free of weeds, of uniform thickness (approximately 1-inch thick), and shall have a dense root mat for mechanical strength.

The following steps are recommended for sod installation:

- Shape and smooth the surface to final grade in accordance with the approved grading plan. The swale needs to be overexcavated 4 to 6 inches below design elevation to allow room for placing soil amendment and sod.
- Amend 4 inches (minimum) of compost into the top 8 inches of the soil if the organic content of the soil is less than ten percent or the permeability is less than 0.6 inches per hour. See http://www.ecy.wa.gov/programs/swfa/organics/soil.html for further information.
- Fertilize according to the supplier's recommendations.
- Work lime and fertilizer 1 to 2 inches into the soil, and smooth the surface.
- Lay strips of sod beginning at the lowest area to be sodded and perpendicular to the direction of water flow. Wedge strips securely into place. Square the ends of each strip to provide for a close, tight fit. Stagger joints at least 12 inches. Staple on slopes steeper than 3H:1V. Staple the upstream edge of each sod strip.
- Roll the sodded area and irrigate.
- When sodding is carried out in alternating strips or other patterns, seed the areas between the sod immediately after sodding.

Maintenance Standards

If the grass is unhealthy, the cause shall be determined and appropriate action taken to reestablish a healthy groundcover. If it is impossible to establish a healthy groundcover due to frequent saturation, instability, or some other cause, the sod shall be removed, the area seeded with an appropriate mix, and protected with a net or blanket.

BMP C125: Topsoiling / Composting

Purpose

Topsoiling and composting provide a suitable growth medium for final site stabilization with vegetation. While not a permanent cover practice in itself, topsoiling and composting are an integral component of providing permanent cover in those areas where there is an unsuitable soil surface for plant growth. Use this BMP in conjunction with other BMPs such as seeding, mulching, or sodding.

Native soils and disturbed soils that have been organically amended not only retain much more stormwater, but they also serve as effective biofilters for urban pollutants and, by supporting more vigorous plant growth, reduce the water, fertilizer and pesticides needed to support

installed landscapes. Topsoil does not include any subsoils but only the material from the top several inches including organic debris.

Conditions of Use

- Permanent landscaped areas shall contain healthy topsoil that reduces the need for fertilizers, improves overall topsoil quality, provides for better vegetal health and vitality, improves hydrologic characteristics, and reduces the need for irrigation.
- Leave native soils and the duff layer undisturbed to the maximum extent practicable. Stripping of existing, properly functioning soil system and vegetation for the purpose of topsoiling during construction is not acceptable. Preserve existing soil systems in undisturbed and uncompacted conditions if functioning properly.
- Areas that already have good topsoil, such as undisturbed areas, do not require soil amendments.
- Restore, to the maximum extent practical, native soils disturbed during clearing and grading to a condition equal to or better than the original site condition's moisture-holding capacity. Use on-site native topsoil, incorporate amendments into on-site soil, or import blended topsoil to meet this requirement.
- Topsoiling is a required procedure when establishing vegetation on shallow soils, and soils of critically low pH (high acid) levels.
- Beware of where the topsoil comes from, and what vegetation was on site before disturbance, invasive plant seeds may be included and could cause problems for establishing native plants, landscaped areas, or grasses.
- Topsoil from the site will contain mycorrhizal bacteria that are necessary for healthy root growth and nutrient transfer. These native mycorrhiza are acclimated to the site and will provide optimum conditions for establishing grasses. Use commercially available mycorrhiza products when using off-site topsoil.

Design and Installation Specifications

Meet the following requirements for areas requiring disruption and topsoiling:

- Maximize the depth of the topsoil wherever possible to provide the maximum possible infiltration capacity and beneficial growth medium. Topsoil shall have:
    - A minimum depth of 8-inches. Scarify subsoils below the topsoil layer at least 4-inches with some incorporation of the upper material to avoid stratified layers, where feasible. Ripping or re-structuring the subgrade may also provide additional benefits regarding the overall infiltration and interflow dynamics of the soil system.

- A minimum organic content of 10% dry weight, and 5% organic matter content in turf areas. Incorporate organic amendments to a minimum 8-inch depth except where tree roots or other natural features limit the depth of incorporation.
- A pH between 6.0 and 8.0 or matching the pH of the undisturbed soil.
- If blended topsoil is imported, then fines should be limited to 25 percent passing through a 200 sieve.

- Accomplish the required organic content and pH by either returning native topsoil to the site and/or incorporating organic amendments.
  - To meet the organic content use compost that meets the definition of "composted materials" in WAC 173-350-220. This code is available online at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-350-220.

    The compost must also have an organic matter content of 35% to 65%, and a carbon to nitrogen ratio below 25H:1V.

    The carbon to nitrogen ratio may be as high as 35H:1V for plantings composed entirely of plants native to the Puget Sound Lowlands region.
  - For till soils use a mixture of approximately two parts soil to one part compost. This equates to 4 inches of compost mixed to a depth of 12 inches in till soils. Increasing the concentration of compost beyond this level can have negative effects on vegetal health, while decreasing the concentrations can reduce the benefits of amended soils.
  - Gravel or cobble outwash soils, may require different approaches. Organics and fines easily migrate through the loose structure of these soils. Therefore, the importation of at least 6 inches of quality topsoil, underlain by some type of filter fabric to prevent the migration of fines, may be more appropriate for these soils.
- The final composition and construction of the soil system will result in a natural selection or favoring of certain plant species over time. For example, incorporation of topsoil may favor grasses, while layering with mildly acidic, high-carbon amendments may favor more woody vegetation.
- Allow sufficient time in scheduling for topsoil spreading prior to seeding, sodding, or planting.
- Take care when applying top soil to subsoils with contrasting textures. Sandy topsoil over clayey subsoil is a particularly poor combination, as water creeps along the junction between the soil layers and causes the topsoil to slough. If topsoil and subsoil are not properly bonded, water will not infiltrate the soil profile evenly and it will be difficult to

establish vegetation. The best method to prevent a lack of bonding is to actually work the topsoil into the layer below for a depth of at least 6 inches.

- Field exploration of the site shall be made to determine if there is surface soil of sufficient quantity and quality to justify stripping. Topsoil shall be friable and loamy (loam, sandy loam, silt loam, sandy clay loam, and clay loam). Avoid areas of natural ground water recharge.
- Stripping shall be confined to the immediate construction area. A 4-inch to 6-inch stripping depth is common, but depth may vary depending on the particular soil. All surface runoff control structures shall be in place prior to stripping.
- Do not place topsoil while in a frozen or muddy condition, when the subgrade is excessively wet, or when conditions exist that may otherwise be detrimental to proper grading or proposed sodding or seeding.
- In any areas requiring grading remove and stockpile the duff layer and topsoil on site in a designated, controlled area, not adjacent to public resources and critical areas. Stockpiled topsoil is to be reapplied to other portions of the site where feasible.
- Locate the topsoil stockpile so that it meets specifications and does not interfere with work on the site. It may be possible to locate more than one pile in proximity to areas where topsoil will be used.

Stockpiling of topsoil shall occur in the following manner:

- Side slopes of the stockpile shall not exceed 2H:1V.
- Between October 1 and April 30:
  - An interceptor dike with gravel outlet and silt fence shall surround all topsoil.
  - Within 2 days complete erosion control seeding, or covering stockpiles with clear plastic, or other mulching materials.
- Between May 1 and September 30:
  - An interceptor dike with gravel outlet and silt fence shall surround all topsoil if the stockpile will remain in place for a longer period of time than active construction grading.
  - Within 7 days complete erosion control seeding, or covering stockpiles with clear plastic, or other mulching materials.
- When native topsoil is to be stockpiled and reused the following should apply to ensure that the mycorrhizal bacterial, earthworms, and other beneficial organisms will not be destroyed:
  1. Re-install topsoil within 4 to 6 weeks.

2. Do not allow the saturation of topsoil with water.
3. Do not use plastic covering.

Maintenance Standards

- Inspect stockpiles regularly, especially after large storm events. Stabilize any areas that have eroded.
- Establish soil quality and depth toward the end of construction and once established, protect from compaction, such as from large machinery use, and from erosion.
- Plant and mulch soil after installation.
- Leave plant debris or its equivalent on the soil surface to replenish organic matter.
- Reduce and adjust, where possible, the use of irrigation, fertilizers, herbicides and pesticides, rather than continuing to implement formerly established practices.

BMP C126: Polyacrylamide (PAM) for Soil Erosion Protection

Purpose

Polyacrylamide (PAM) is used on construction sites to prevent soil erosion.

Applying PAM to bare soil in advance of a rain event significantly reduces erosion and controls sediment in two ways. First, PAM increases the soil's available pore volume, thus increasing infiltration through flocculation and reducing the quantity of stormwater runoff. Second, it increases flocculation of suspended particles and aids in their deposition, thus reducing stormwater runoff turbidity and improving water quality.

Conditions of Use

PAM shall not be directly applied to water or allowed to enter a water body.

In areas that drain to a sediment pond, PAM can be applied to bare soil under the following conditions:

- During rough grading operations.
- In Staging areas.
- Balanced cut and fill earthwork.
- Haul roads prior to placement of crushed rock surfacing.
- Compacted soil roadbase.
- Stockpiles.
- After final grade and before paving or final seeding and planting.
- Pit sites.

- Sites having a winter shut down. In the case of winter shut down, or where soil will remain unworked for several months, PAM should be used together with mulch.

Design and Installation Specifications

PAM may be applied with water in dissolved form. The preferred application method is the dissolved form.

PAM is to be applied at a maximum rate of 2/3 pound PAM per 1,000 gallons water (80 mg/L) per 1 acre of bare soil. Table 4.1.9 can be used to determine the PAM and water application rate for a disturbed soil area. Higher concentrations of PAM **do not** provide any additional effectiveness.

Table 4.1.9
PAM and Water Application Rates

Disturbed Area (ac)	PAM (lbs)	Water (gal)
0.50	0.33	500
1.00	0.66	1,000
1.50	1.00	1,500
2.00	1.32	2,000
2.50	1.65	2,500
3.00	2.00	3,000
3.50	2.33	3,500
4.00	2.65	4,000
4.50	3.00	4,500
5.00	3.33	5,000

The Preferred Method:

- Pre-measure the area where PAM is to be applied and calculate the amount of product and water necessary to provide coverage at the specified application rate (2/3 pound PAM/1000 gallons/acre).
- PAM has infinite solubility in water, but dissolves very slowly. Dissolve pre-measured dry granular PAM with a known quantity of clean water in a bucket several hours or overnight. Mechanical mixing will help dissolve the PAM. Always add PAM to water - not water to PAM.
- Pre-fill the water truck about 1/8 full with water. The water does not have to be potable, but it must have relatively low turbidity – in the range of 20 NTU or less.
- Add PAM /Water mixture to the truck
- Completely fill the water truck to specified volume.
- Spray PAM/Water mixture onto dry soil until the soil surface is uniformly and completely wetted.

An Alternate Method:

PAM may also be applied as a powder at the rate of 5 lbs. per acre. This must be applied on a day that is dry. For areas less than 5-10 acres, a hand-held “organ grinder” fertilizer spreader set to the smallest setting will work. Tractor-mounted spreaders will work for larger areas.

The following shall be used for application of powdered PAM:

- Powered PAM shall be used in conjunction with other BMPs and not in place of other BMPs.
- Do not use PAM on a slope that flows directly into a stream or wetland. The stormwater runoff shall pass through a sediment control BMP prior to discharging to surface waters.
- Do not add PAM to water discharging from site.
- When the total drainage area is greater than or equal to 5 acres, PAM treated areas shall drain to a sediment pond.
- Areas less than 5 acres shall drain to sediment control BMPs, such as a minimum of 3 check dams per acre. The total number of check dams used shall be maximized to achieve the greatest amount of settlement of sediment prior to discharging from the site. Each check dam shall be spaced evenly in the drainage channel through which stormwater flows are discharged off-site.
- On all sites, the use of silt fence shall be maximized to limit the discharges of sediment from the site.
- All areas not being actively worked shall be covered and protected from rainfall. PAM shall not be the only cover BMP used.
- PAM can be applied to wet soil, but dry soil is preferred due to less sediment loss.
- PAM will work when applied to saturated soil but is not as effective as applications to dry or damp soil.
- Keep the granular PAM supply out of the sun. Granular PAM loses its effectiveness in three months after exposure to sunlight and air.
- Proper application and re-application plans are necessary to ensure total effectiveness of PAM usage.
- PAM, combined with water, is very slippery and can be a safety hazard. Care must be taken to prevent spills of PAM powder onto paved surfaces. During an application of PAM, prevent over-spray from reaching pavement as pavement will become slippery. If PAM powder gets on skin or clothing, wipe it off with a rough towel rather than washing with water-this only makes cleanup messier and take longer.
- Some PAMs are more toxic and carcinogenic than others. Only the most environmentally safe PAM products should be used.

The specific PAM copolymer formulation must be anionic. **Cationic PAM shall not be used in any application because of known aquatic toxicity problems.** Only the highest drinking water grade PAM, certified for compliance with ANSI/NSF Standard 60 for drinking water treatment, will be used for soil applications. Recent media attention and high interest in PAM has resulted in some entrepreneurial exploitation of the term "polymer." All PAM are polymers, but not all polymers are PAM, and not all PAM products comply with ANSI/NSF Standard 60. PAM use shall be reviewed and approved by the local permitting authority.

- PAM designated for these uses should be "water soluble" or "linear" or "non-crosslinked". Cross-linked or water absorbent PAM, polymerized in highly acidic (pH<2) conditions, are used to maintain soil moisture content.
- The PAM anionic charge density may vary from 2-30 percent; a value of 18 percent is typical. Studies conducted by the United States Department of Agriculture (USDA)/ARS demonstrated that soil stabilization was optimized by using very high molecular weight (12-15 mg/mole), highly anionic (>20% hydrolysis) PAM.

- PAM tackifiers are available and being used in place of guar and alpha plantago. Typically, PAM tackifiers should be used at a rate of no more than 0.5-1 lb. per 1000 gallons of water in a hydromulch machine. Some tackifier product instructions say to use at a rate of 3 –5 lbs. per acre, which can be too much. In addition, pump problems can occur at higher rates due to increased viscosity.

Maintenance Standards

- PAM may be reapplied on actively worked areas after a 48-hour period.
- Reapplication is not required unless PAM treated soil is disturbed or unless turbidity levels show the need for an additional application. If PAM treated soil is left undisturbed a reapplication may be necessary after two months. More PAM applications may be required for steep slopes, silty and clayey soils (USDA Classification Type "C" and "D" soils), long grades, and high precipitation areas. When PAM is applied first to bare soil and then covered with straw, a reapplication may not be necessary for several months.
- Loss of sediment and PAM may be a basis for penalties per RCW 90.48.080.

BMP C130: Surface Roughening

Purpose

Surface roughening aids in the establishment of vegetative cover, reduces runoff velocity, increases infiltration, and provides for sediment trapping through the provision of a rough soil surface. Horizontal depressions are

created by operating a tiller or other suitable equipment on the contour or by leaving slopes in a roughened condition by not fine grading them.

Use this BMP in conjunction with other BMPs such as seeding, mulching, or sodding.

Conditions for Use

- All slopes steeper than 3H:1V and greater than 5 vertical feet require surface roughening to a depth of 2 to 4 inches prior to seeding..
- Areas that will not be stabilized immediately may be roughened to reduce runoff velocity until seeding takes place.
- Slopes with a stable rock face do not require roughening.
- Slopes where mowing is planned should not be excessively roughened.

Design and Installation Specifications

There are different methods for achieving a roughened soil surface on a slope, and the selection of an appropriate method depends upon the type of slope. Roughening methods include stair-step grading, grooving, contour furrows, and tracking. See Figure 4.1.5 for tracking and contour furrows. Factors to be considered in choosing a method are slope steepness, mowing requirements, and whether the slope is formed by cutting or filling.

- Disturbed areas that will not require mowing may be stair-step graded, grooved, or left rough after filling.
- Stair-step grading is particularly appropriate in soils containing large amounts of soft rock. Each "step" catches material that sloughs from above, and provides a level site where vegetation can become established. Stairs should be wide enough to work with standard earth moving equipment. Stair steps must be on contour or gullies will form on the slope.
- Areas that will be mowed (these areas should have slopes less steep than 3H:1V) may have small furrows left by disking, harrowing, raking, or seed-planting machinery operated on the contour.
- Graded areas with slopes steeper than 3H:1V but less than 2H:1V should be roughened before seeding. This can be accomplished in a variety of ways, including "track walking," or driving a crawler tractor up and down the slope, leaving a pattern of cleat imprints parallel to slope contours.
- Tracking is done by operating equipment up and down the slope to leave horizontal depressions in the soil.

Maintenance Standards

- Areas that are graded in this manner should be seeded as quickly as possible.
- Regular inspections should be made of the area. If rills appear, they should be re-graded and re-seeded immediately.

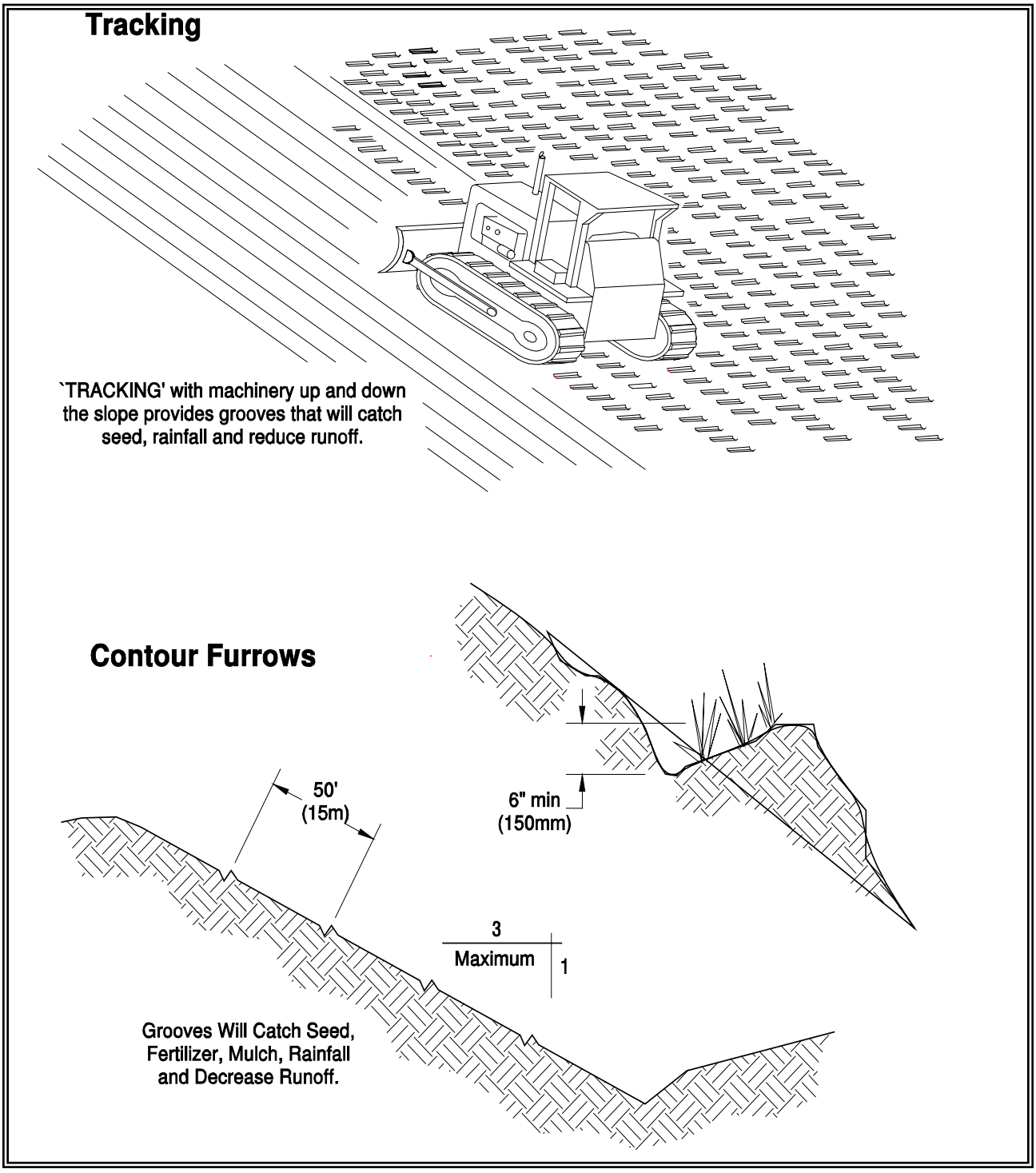


Figure 4.1.5 – Surface Roughening by Tracking and Contour Furrows

BMP C131: Gradient Terraces

Purpose

Gradient terraces reduce erosion damage by intercepting surface runoff and conducting it to a stable outlet at a non-erosive velocity.

Conditions of Use

- Gradient terraces normally are limited to denuded land having a water erosion problem. They should not be constructed on deep sands or on soils that are too stony, steep, or shallow to permit practical and economical installation and maintenance. Gradient terraces may be used only where suitable outlets are or will be made available. See Figure 4.1.6 for gradient terraces.

Design and Installation Specifications

- The maximum vertical spacing of gradient terraces should be determined by the following method:

  VI = (0.8)s + y

  Where: VI = vertical interval in feet

  s = land rise per 100 feet, expressed in feet

  y = a soil and cover variable with values from 1.0 to 4.0

  Values of "y" are influenced by soil erodibility and cover practices. The lower values are applicable to erosive soils where little to no residue is left on the surface. The higher value is applicable only to erosion-resistant soils where a large amount of residue (1½ tons of straw/acre equivalent) is on the surface.

- The minimum constructed cross-section should meet the design dimensions.
- The top of the constructed ridge should not be lower at any point than the design elevation plus the specified overfill for settlement. The opening at the outlet end of the terrace should have a cross section equal to that specified for the terrace channel.
- Channel grades may be either uniform or variable with a maximum grade of 0.6 feet per 100 feet length (0.6%). For short distances, terrace grades may be increased to improve alignment. The channel velocity should not exceed that which is nonerosive for the soil type.
- All gradient terraces should have adequate outlets. Such an outlet may be a grassed waterway, vegetated area, or tile outlet. In all cases the outlet must convey runoff from the terrace or terrace system to a point where the outflow will not cause damage. Vegetative cover should be used in the outlet channel.
- The design elevation of the water surface of the terrace should not be lower than the design elevation of the water surface in the outlet at their junction, when both are operating at design flow.

- Vertical spacing determined by the above methods may be increased as much as 0.5 feet or 10 percent, whichever is greater, to provide better alignment or location, to avoid obstacles, to adjust for equipment size, or to reach a satisfactory outlet. The drainage area above the terrace should not exceed the area that would be drained by a terrace with normal spacing.
- The terrace should have enough capacity to handle the peak runoff expected from a 2-year, 24-hour design storm without overtopping.
- The terrace cross-section should be proportioned to fit the land slope. The ridge height should include a reasonable settlement factor. The ridge should have a minimum top width of 3 feet at the design height. The minimum cross-sectional area of the terrace channel should be 8 square feet for land slopes of 5 percent or less, 7 square feet for slopes from 5 to 8 percent, and 6 square feet for slopes steeper than 8 percent. The terrace can be constructed wide enough to be maintained using a small vehicle.

Maintenance Standards

- Maintenance should be performed as needed. Terraces should be inspected regularly; at least once a year, and after large storm events.

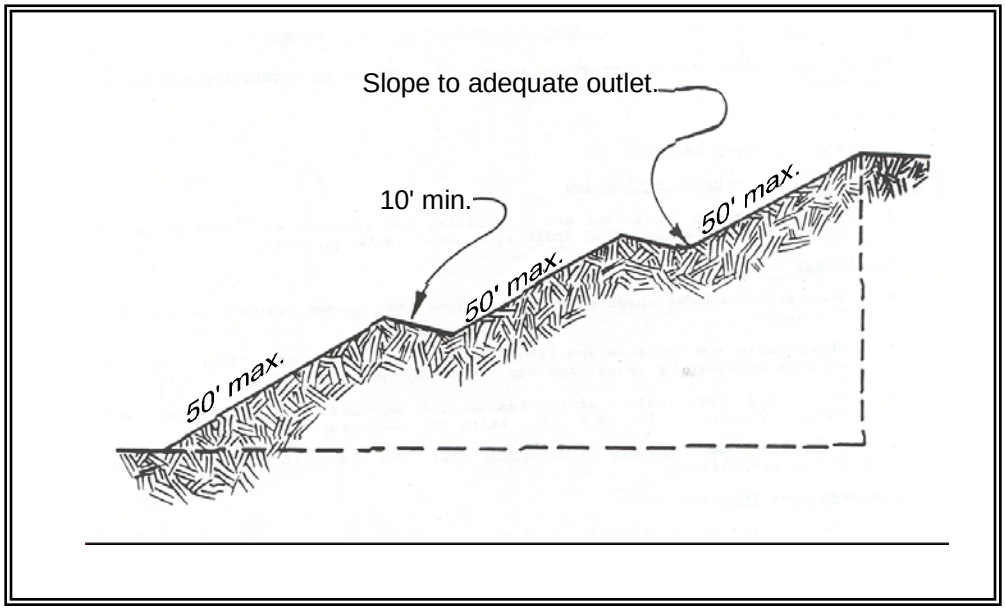


Figure 4.1.6 – **Gradient Terrace**s

BMP C140: Dust Control

Purpose

Dust control prevents wind transport of dust from disturbed soil surfaces onto roadways, drainage ways, and surface waters.

Conditions of Use

- In areas (including roadways) subject to surface and air movement of dust where on-site and off-site impacts to roadways, drainage ways, or surface waters are likely.

Design and Installation Specifications

- Vegetate or mulch areas that will not receive vehicle traffic. In areas where planting, mulching, or paving is impractical, apply gravel or landscaping rock.
- Limit dust generation by clearing only those areas where immediate activity will take place, leaving the remaining area(s) in the original condition. Maintain the original ground cover as long as practical.
- Construct natural or artificial windbreaks or windscreens. These may be designed as enclosures for small dust sources.
- Sprinkle the site with water until surface is wet. Repeat as needed. To prevent carryout of mud onto street, refer to Stabilized Construction Entrance (BMP C105).
- Irrigation water can be used for dust control. Irrigation systems should be installed as a first step on sites where dust control is a concern.
- Spray exposed soil areas with a dust palliative, following the manufacturer's instructions and cautions regarding handling and application. Used oil is prohibited from use as a dust suppressant. Local governments may approve other dust palliatives such as calcium chloride or PAM.
- PAM (BMP C126) added to water at a rate of 0.5 lbs. per 1,000 gallons of water per acre and applied from a water truck is more effective than water alone. This is due to increased infiltration of water into the soil and reduced evaporation. In addition, small soil particles are bonded together and are not as easily transported by wind. Adding PAM may actually reduce the quantity of water needed for dust control. Use of PAM could be a cost-effective dust control method.

Techniques that can be used for unpaved roads and lots include:

- Lower speed limits. High vehicle speed increases the amount of dust stirred up from unpaved roads and lots.
- Upgrade the road surface strength by improving particle size, shape, and mineral types that make up the surface and base materials.
- Add surface gravel to reduce the source of dust emission. Limit the amount of fine particles (those smaller than .075 mm) to 10 to 20 percent.

- Use geotextile fabrics to increase the strength of new roads or roads undergoing reconstruction.
- Encourage the use of alternate, paved routes, if available.
- Restrict use of paved roadways by tracked vehicles and heavy trucks to prevent damage to road surface and base.
- Apply chemical dust suppressants using the admix method, blending the product with the top few inches of surface material. Suppressants may also be applied as surface treatments.
- Pave unpaved permanent roads and other trafficked areas.
- Use vacuum street sweepers.
- Remove mud and other dirt promptly so it does not dry and then turn into dust.
- Limit dust-causing work on windy days.
- Contact your local Air Pollution Control Authority for guidance and training on other dust control measures. Compliance with the local Air Pollution Control Authority constitutes compliance with this BMP.

Maintenance Standards Respray area as necessary to keep dust to a minimum.

BMP C150: Materials on Hand

Purpose Keep quantities of erosion prevention and sediment control materials on the project site at all times to be used for regular maintenance and emergency situations such as unexpected heavy summer rains. Having these materials on-site reduces the time needed to implement BMPs when inspections indicate that existing BMPs are not meeting the Construction SWPPP requirements. In addition, contractors can save money by buying some materials in bulk and storing them at their office or yard.

Conditions of Use

- Construction projects of any size or type can benefit from having materials on hand. A small commercial development project could have a roll of plastic and some gravel available for immediate protection of bare soil and temporary berm construction. A large earthwork project, such as highway construction, might have several tons of straw, several rolls of plastic, flexible pipe, sandbags, geotextile fabric and steel "T" posts.
- Materials are stockpiled and readily available before any site clearing, grubbing, or earthwork begins. A large contractor or developer could keep a stockpile of materials that are available for use on several projects.
- If storage space at the project site is at a premium, the contractor could maintain the materials at their office or yard. The office or yard must be less than an hour from the project site.

Design and Installation Specifications

Depending on project type, size, complexity, and length, materials and quantities will vary. A good minimum list of items that will cover numerous situations includes:

Material
Clear Plastic, 6 mil
Drainpipe, 6 or 8 inch diameter
Sandbags, filled
Straw Bales for mulching,
Quarry Spalls
Washed Gravel
Geotextile Fabric
Catch Basin Inserts
Steel "T" Posts
Silt fence material
Straw Wattles

Maintenance Standards

- All materials with the exception of the quarry spalls, steel "T" posts, and gravel should be kept covered and out of both sun and rain.
- Re-stock materials used as needed.

BMP C151: Concrete Handling

Purpose

Concrete work can generate process water and slurry that contain fine particles and high pH, both of which can violate water quality standards in the receiving water. Concrete spillage or concrete discharge to surface waters of the State is prohibited. Use this BMP to minimize and eliminate concrete, concrete process water, and concrete slurry from entering waters of the state.

Conditions of Use

Any time concrete is used, utilize these management practices. Concrete construction projects include, but are not limited to, the following:

- Curbs
- Sidewalks
- Roads
- Bridges
- Foundations
- Floors
- Runways

Design and Installation

- Wash out concrete truck chutes, pumps, and internals into formed areas only. Assure that washout of concrete trucks is performed off-

Specifications

site or in designated concrete washout areas. Do not wash out concrete trucks onto the ground, or into storm drains, open ditches, streets, or streams. Refer to BMP C154 for information on concrete washout areas.

- Return unused concrete remaining in the truck and pump to the originating batch plant for recycling. Do not dump excess concrete on site, except in designated concrete washout areas.
- Wash off hand tools including, but not limited to, screeds, shovels, rakes, floats, and trowels into formed areas only.
- Wash equipment difficult to move, such as concrete pavers in areas that do not directly drain to natural or constructed stormwater conveyances.
- Do not allow washdown from areas, such as concrete aggregate driveways, to drain directly to natural or constructed stormwater conveyances.
- Contain washwater and leftover product in a lined container when no formed areas are available,. Dispose of contained concrete in a manner that does not violate ground water or surface water quality standards.
- Always use forms or solid barriers for concrete pours, such as pilings, within 15-feet of surface waters.
- Refer to BMPs C252 and C253 for pH adjustment requirements.
- Refer to the Construction Stormwater General Permit for pH monitoring requirements if the project involves one of the following activities:
  - Significant concrete work (greater than 1,000 cubic yards poured concrete or recycled concrete used over the life of a project).
  - The use of engineered soils amended with (but not limited to) Portland cement-treated base, cement kiln dust or fly ash.
  - Discharging stormwater to segments of water bodies on the 303(d) list (Category 5) for high pH.

Maintenance Standards

Check containers for holes in the liner daily during concrete pours and repair the same day.

BMP C152: Sawcutting and Surfacing Pollution Prevention

Purpose

Sawcutting and surfacing operations generate slurry and process water that contains fine particles and high pH (concrete cutting), both of which can violate the water quality standards in the receiving water. Concrete spillage or concrete discharge to surface waters of the State is prohibited. Use this BMP to minimize and eliminate process water and slurry created through sawcutting or surfacing from entering waters of the State.

Conditions of Use

Utilize these management practices anytime sawcutting or surfacing operations take place. Sawcutting and surfacing operations include, but are not limited to, the following:

- Sawing
- Coring
- Grinding
- Roughening
- Hydro-demolition
- Bridge and road surfacing

Design and Installation Specifications

- Vacuum slurry and cuttings during cutting and surfacing operations.
- Slurry and cuttings shall not remain on permanent concrete or asphalt pavement overnight.
- Slurry and cuttings shall not drain to any natural or constructed drainage conveyance including stormwater systems. This may require temporarily blocking catch basins.
- Dispose of collected slurry and cuttings in a manner that does not violate ground water or surface water quality standards.
- Do not allow process water generated during hydro-demolition, surface roughening or similar operations to drain to any natural or constructed drainage conveyance including stormwater systems. Dispose process water in a manner that does not violate ground water or surface water quality standards.
- Handle and dispose cleaning waste material and demolition debris in a manner that does not cause contamination of water. Dispose of sweeping material from a pick-up sweeper at an appropriate disposal site.

Maintenance Standards

Continually monitor operations to determine whether slurry, cuttings, or process water could enter waters of the state. If inspections show that a violation of water quality standards could occur, stop operations and immediately implement preventive measures such as berms, barriers, secondary containment, and vacuum trucks.

BMP C153: Material Delivery, Storage and Containment

Purpose

Prevent, reduce, or eliminate the discharge of pollutants to the stormwater system or watercourses from material delivery and storage. Minimize the storage of hazardous materials on-site, store materials in a designated area, and install secondary containment.

Conditions of Use

These procedures are suitable for use at all construction sites with delivery and storage of the following materials:

- Petroleum products such as fuel, oil and grease
- Soil stabilizers and binders (e.g. Polyacrylamide)
- Fertilizers, pesticides and herbicides
- Detergents
- Asphalt and concrete compounds
- Hazardous chemicals such as acids, lime, adhesives, paints, solvents and curing compounds
- Any other material that may be detrimental if released to the environment

Design and Installation Specifications

The following steps should be taken to minimize risk:

- Temporary storage area should be located away from vehicular traffic, near the construction entrance(s), and away from waterways or storm drains.
- Material Safety Data Sheets (MSDS) should be supplied for all materials stored. Chemicals should be kept in their original labeled containers.
- Hazardous material storage on-site should be minimized.
- Hazardous materials should be handled as infrequently as possible.
- During the wet weather season (Oct 1 – April 30), consider storing materials in a covered area.
- Materials should be stored in secondary containments, such as earthen dike, horse trough, or even a children's wading pool for non-reactive materials such as detergents, oil, grease, and paints. Small amounts of material may be secondarily contained in "bus boy" trays or concrete mixing trays.
- Do not store chemicals, drums, or bagged materials directly on the ground. Place these items on a pallet and, when possible, and within secondary containment.
- If drums must be kept uncovered, store them at a slight angle to reduce ponding of rainwater on the lids to reduce corrosion. Domed plastic covers are inexpensive and snap to the top of drums, preventing water from collecting.

Material Storage Areas and Secondary Containment Practices:

- Liquids, petroleum products, and substances listed in 40 CFR Parts 110, 117, or 302 shall be stored in approved containers and drums and shall not be overfilled. Containers and drums shall be stored in temporary secondary containment facilities.
- Temporary secondary containment facilities shall provide for a spill containment volume able to contain 10% of the total enclosed container volume of all containers, or 110% of the capacity of the largest container within its boundary, whichever is greater.
- Secondary containment facilities shall be impervious to the materials stored therein for a minimum contact time of 72 hours.
- Secondary containment facilities shall be maintained free of accumulated rainwater and spills. In the event of spills or leaks, accumulated rainwater and spills shall be collected and placed into drums. These liquids shall be handled as hazardous waste unless testing determines them to be non-hazardous.
- Sufficient separation should be provided between stored containers to allow for spill cleanup and emergency response access.
- During the wet weather season (Oct 1 – April 30), each secondary containment facility shall be covered during non-working days, prior to and during rain events.
- Keep material storage areas clean, organized and equipped with an ample supply of appropriate spill clean-up material (spill kit).
- The spill kit should include, at a minimum:
    - 1-Water Resistant Nylon Bag
    - 3-Oil Absorbent Socks 3”x 4’
    - 2-Oil Absorbent Socks 3”x 10’
    - 12-Oil Absorbent Pads 17”x19”
    - 1-Pair Splash Resistant Goggles
    - 3-Pair Nitrile Gloves
    - 10-Disposable Bags with Ties
    - Instructions

BMP C154: Concrete Washout Area

Purpose

Prevent or reduce the discharge of pollutants to stormwater from concrete waste by conducting washout off-site, or performing on-site washout in a designated area to prevent pollutants from entering surface waters or ground water.

Conditions of Use

Concrete washout area best management practices are implemented on construction projects where:

- Concrete is used as a construction material
- It is not possible to dispose of all concrete wastewater and washout off-site (ready mix plant, etc.).
- Concrete trucks, pumpers, or other concrete coated equipment are washed on-site.
- Note: If less than 10 concrete trucks or pumpers need to be washed out on-site, the washwater may be disposed of in a formed area awaiting concrete or an upland disposal site where it will not contaminate surface or ground water. The upland disposal site shall be at least 50 feet from sensitive areas such as storm drains, open ditches, or water bodies, including wetlands.

Design and Installation Specifications

Implementation

The following steps will help reduce stormwater pollution from concrete wastes:

- Perform washout of concrete trucks off-site or in designated concrete washout areas only.
- Do not wash out concrete trucks onto the ground, or into storm drains, open ditches, streets, or streams.
- Do not allow excess concrete to be dumped on-site, except in designated concrete washout areas.
- Concrete washout areas may be prefabricated concrete washout containers, or self-installed structures (above-grade or below-grade).
- Prefabricated containers are most resistant to damage and protect against spills and leaks. Companies may offer delivery service and provide regular maintenance and disposal of solid and liquid waste.
- If self-installed concrete washout areas are used, below-grade structures are preferred over above-grade structures because they are less prone to spills and leaks.
- Self-installed above-grade structures should only be used if excavation is not practical.

Education

- Discuss the concrete management techniques described in this BMP with the ready-mix concrete supplier before any deliveries are made.
- Educate employees and subcontractors on the concrete waste management techniques described in this BMP.
- Arrange for contractor's superintendent or Certified Erosion and Sediment Control Lead (CESCL) to oversee and enforce concrete waste management procedures.
- A sign should be installed adjacent to each temporary concrete washout facility to inform concrete equipment operators to utilize the proper facilities.

Contracts

Incorporate requirements for concrete waste management into concrete supplier and subcontractor agreements.

Location and Placement

- Locate washout area at least 50 feet from sensitive areas such as storm drains, open ditches, or water bodies, including wetlands.
- Allow convenient access for concrete trucks, preferably near the area where the concrete is being poured.
- If trucks need to leave a paved area to access washout, prevent track-out with a pad of rock or quarry spalls (see BMP C105). These areas should be far enough away from other construction traffic to reduce the likelihood of accidental damage and spills.
- The number of facilities you install should depend on the expected demand for storage capacity.
- On large sites with extensive concrete work, washouts should be placed in multiple locations for ease of use by concrete truck drivers.

On-site Temporary Concrete Washout Facility, Transit Truck Washout Procedures:

- Temporary concrete washout facilities shall be located a minimum of 50 ft from sensitive areas including storm drain inlets, open drainage facilities, and watercourses. See Figures 4.1.7 and 4.1.8.
- Concrete washout facilities shall be constructed and maintained in sufficient quantity and size to contain all liquid and concrete waste generated by washout operations.
- Approximately 7 gallons of wash water are used to wash one truck chute.
- Approximately 50 gallons are used to wash out the hopper of a concrete pump truck.

- Washout of concrete trucks shall be performed in designated areas only.
- Concrete washout from concrete pumper bins can be washed into concrete pumper trucks and discharged into designated washout area or properly disposed of off-site.
- Once concrete wastes are washed into the designated area and allowed to harden, the concrete should be broken up, removed, and disposed of per applicable solid waste regulations. Dispose of hardened concrete on a regular basis.
- Temporary Above-Grade Concrete Washout Facility
  - Temporary concrete washout facility (type above grade) should be constructed as shown on the details below, with a recommended minimum length and minimum width of 10 ft, but with sufficient quantity and volume to contain all liquid and concrete waste generated by washout operations.
  - Plastic lining material should be a minimum of 10 mil polyethylene sheeting and should be free of holes, tears, or other defects that compromise the impermeability of the material.
- Temporary Below-Grade Concrete Washout Facility
  - Temporary concrete washout facilities (type below grade) should be constructed as shown on the details below, with a recommended minimum length and minimum width of 10 ft. The quantity and volume should be sufficient to contain all liquid and concrete waste generated by washout operations.
  - Lath and flagging should be commercial type.
  - Plastic lining material shall be a minimum of 10 mil polyethylene sheeting and should be free of holes, tears, or other defects that compromise the impermeability of the material.
  - Liner seams shall be installed in accordance with manufacturers' recommendations.
  - Soil base shall be prepared free of rocks or other debris that may cause tears or holes in the plastic lining material.

Maintenance Standards

Inspection and Maintenance

- Inspect and verify that concrete washout BMPs are in place prior to the commencement of concrete work.
- During periods of concrete work, inspect daily to verify continued performance.
  - Check overall condition and performance.
  - Check remaining capacity (% full).

    - If using self-installed washout facilities, verify plastic liners are intact and sidewalls are not damaged.
    - If using prefabricated containers, check for leaks.
- Washout facilities shall be maintained to provide adequate holding capacity with a minimum freeboard of 12 inches.
- Washout facilities must be cleaned, or new facilities must be constructed and ready for use once the washout is 75% full.
- If the washout is nearing capacity, vacuum and dispose of the waste material in an approved manner.
    - Do not discharge liquid or slurry to waterways, storm drains or directly onto ground.
    - Do not use sanitary sewer without local approval.
    - Place a secure, non-collapsing, non-water collecting cover over the concrete washout facility prior to predicted wet weather to prevent accumulation and overflow of precipitation.
    - Remove and dispose of hardened concrete and return the structure to a functional condition. Concrete may be reused on-site or hauled away for disposal or recycling.
- When you remove materials from the self-installed concrete washout, build a new structure; or, if the previous structure is still intact, inspect for signs of weakening or damage, and make any necessary repairs. Re-line the structure with new plastic after each cleaning.

Removal of Temporary Concrete Washout Facilities

- When temporary concrete washout facilities are no longer required for the work, the hardened concrete, slurries and liquids shall be removed and properly disposed of.
- Materials used to construct temporary concrete washout facilities shall be removed from the site of the work and disposed of or recycled.
- Holes, depressions or other ground disturbance caused by the removal of the temporary concrete washout facilities shall be backfilled, repaired, and stabilized to prevent erosion.

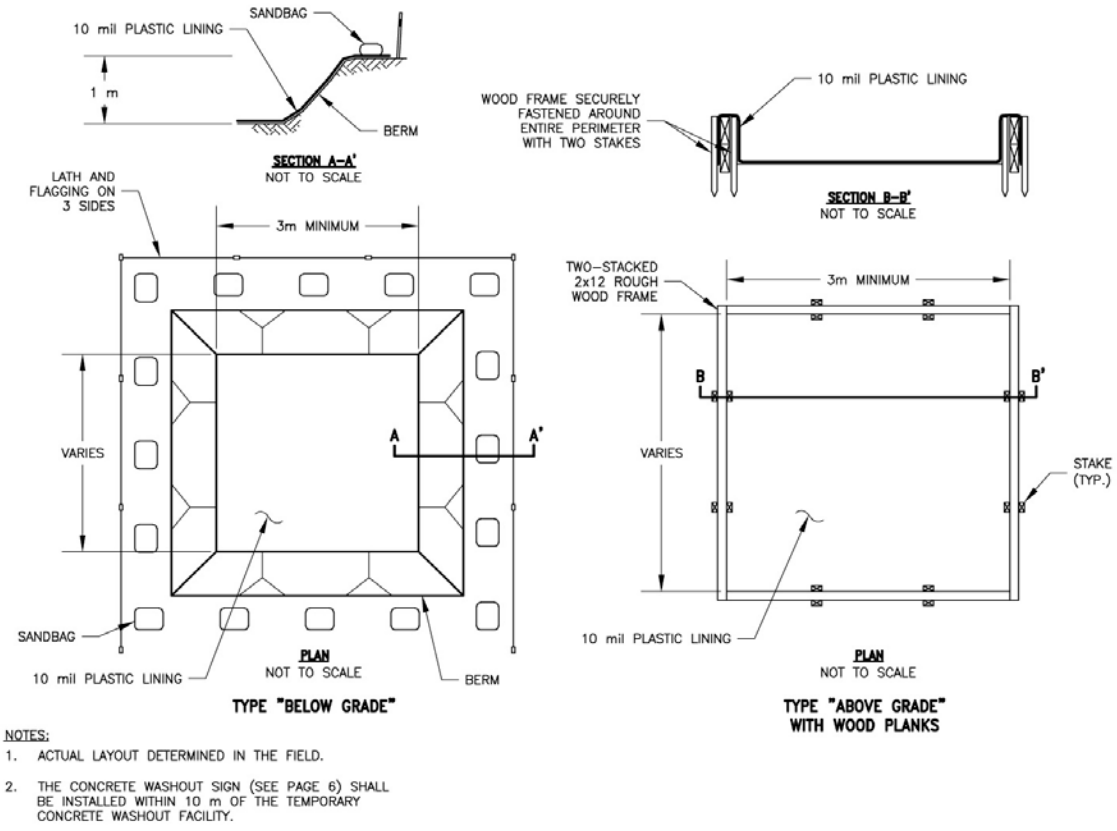


Figure 4.1.7a – Concrete Washout Area

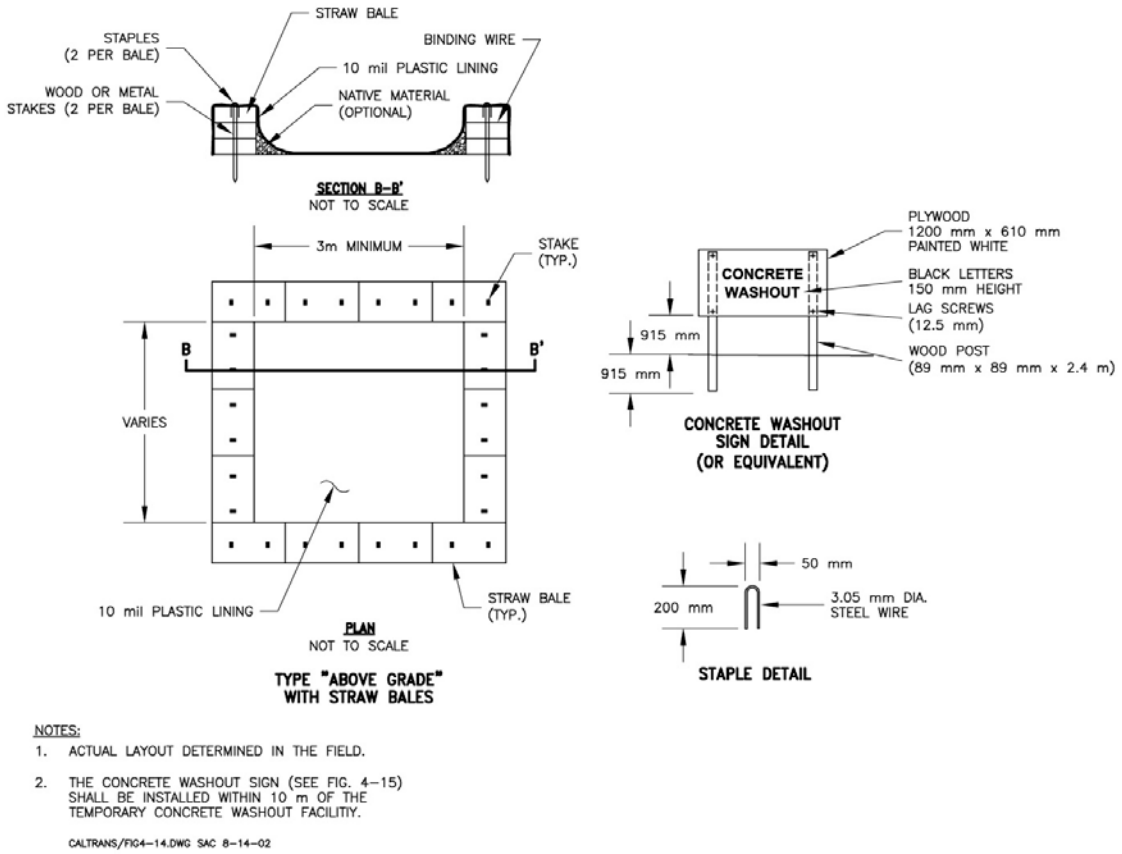


Figure 4.1.7b – Concrete Washout Area

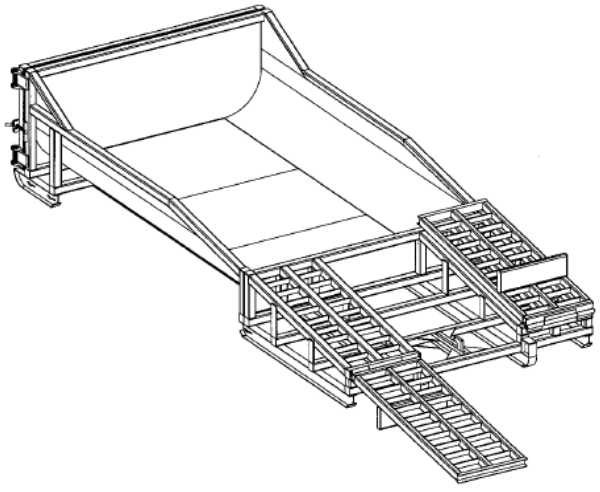


Figure 4.1.8 – Prefabricated Concrete Washout Container w/Ramp

BMP C160: Certified Erosion and Sediment Control Lead

Purpose

The project proponent designates at least one person as the responsible representative in charge of erosion and sediment control (ESC), and water quality protection. The designated person shall be the Certified Erosion and Sediment Control Lead (CESCL) who is responsible for ensuring compliance with all local, state, and federal erosion and sediment control and water quality requirements.

Conditions of Use

A CESCL shall be made available on projects one acre or larger that discharge stormwater to surface waters of the state. Sites less than one acre may have a person without CESCL certification conduct inspections; sampling is not required on sites that disturb less than an acre.

- The CESCL shall:
  - Have a current certificate proving attendance in an erosion and sediment control training course that meets the minimum ESC training and certification requirements established by Ecology (see details below).

    Ecology will maintain a list of ESC training and certification providers at:
    http://www.ecy.wa.gov/programs/wq/stormwater/cescl.html

    OR

  - Be a Certified Professional in Erosion and Sediment Control (CPESC); for additional information go to: www.cpesc.net

Specifications

- Certification shall remain valid for three years.
- The CESCL shall have authority to act on behalf of the contractor or developer and shall be available, or on-call, 24 hours per day throughout the period of construction.
- The Construction SWPPP shall include the name, telephone number, fax number, and address of the designated CESCL.
- A CESCL may provide inspection and compliance services for multiple construction projects in the same geographic region.

Duties and responsibilities of the CESCL shall include, but are not limited to the following:

- Maintaining permit file on site at all times which includes the Construction SWPPP and any associated permits and plans.
- Directing BMP installation, inspection, maintenance, modification, and removal.

- Updating all project drawings and the Construction SWPPP with changes made.
- Completing any sampling requirements including reporting results using WebDMR.
- Keeping daily logs, and inspection reports. Inspection reports should include:
    - Inspection date/time.
    - Weather information; general conditions during inspection and approximate amount of precipitation since the last inspection.
    - A summary or list of all BMPs implemented, including observations of all erosion/sediment control structures or practices. The following shall be noted:
        1. Locations of BMPs inspected.
        2. Locations of BMPs that need maintenance.
        3. Locations of BMPs that failed to operate as designed or intended.
        4. Locations of where additional or different BMPs are required.
        - Visual monitoring results, including a description of discharged stormwater. The presence of suspended sediment, turbid water, discoloration, and oil sheen shall be noted, as applicable.
        - Any water quality monitoring performed during inspection.
        - General comments and notes, including a brief description of any BMP repairs, maintenance or installations made as a result of the inspection.
- Facilitate, participate in, and take corrective actions resulting from inspections performed by outside agencies or the owner.

BMP C162: Scheduling

Purpose Sequencing a construction project reduces the amount and duration of soil exposed to erosion by wind, rain, runoff, and vehicle tracking.

Conditions of Use The construction sequence schedule is an orderly listing of all major land-disturbing activities together with the necessary erosion and sedimentation control measures planned for the project. This type of schedule guides the contractor on work to be done before other work is started so that serious erosion and sedimentation problems can be avoided.

Following a specified work schedule that coordinates the timing of land-disturbing activities and the installation of control measures is perhaps the most cost-effective way of controlling erosion during construction. The removal of surface ground cover leaves a site vulnerable to accelerated

erosion. Construction procedures that limit land clearing provide timely installation of erosion and sedimentation controls, and restore protective cover quickly can significantly reduce the erosion potential of a site.

Design Considerations

- Minimize construction during rainy periods.
- Schedule projects to disturb only small portions of the site at any one time. Complete grading as soon as possible. Immediately stabilize the disturbed portion before grading the next portion. Practice staged seeding in order to revegetate cut and fill slopes as the work progresses.

4.2 Runoff Conveyance and Treatment BMPs

This section contains the standards and specifications for Runoff Conveyance and Treatment BMPs. Table 4.2.1, below, shows the relationship of the BMPs in Section 4.2 to the Construction Stormwater Pollution Prevention Plan (SWPPP) Elements described in Section 3.3.3.

Table 4.2.1 Runoff Conveyance and Treatment BMPs by SWPPP Element

BMP or Element Name	Element #1 Preserve Vegetation/Mark Clearing Limits	Element #2 Establish Construction Access	Element #5 Stabilize Soils	Element #6 Protect Slopes	Element #8 Stabilize Channels and Outlets	Element #9 Control Pollutants	Element #11 Maintain BMPs	Element #12 Manage the Project	Element #13 Protect Low Impact Development
BMP C101: Preserving Natural Vegetation	✓								
BMP C102: Buffer Zones	✓								✓
BMP C103: High Visibility Plastic or Metal Fence	✓								✓
BMP C105: Stabilized Construction Entrance / Exit		✓							
BMP C106: Wheel Wash		✓							
BMP C107: Construction Road/Parking Area Stabilization		✓							
BMP C120: Temporary and Permanent Seeding			✓	✓					
BMP C121: Mulching			✓	✓					
BMP C122: Nets and Blankets			✓	✓	✓				
BMP C123: Plastic Covering			✓						
BMP C124: Sodding			✓						
BMP C125: Topsoiling / Composting			✓						
BMP C126: Polyacrylamide for Soil Erosion Protection			✓						
BMP C130: Surface Roughening			✓	✓					
BMP C131: Gradient Terraces			✓	✓					
BMP C140: Dust Control			✓						
BMP C150: Materials On Hand							✓	✓	
BMP C151: Concrete Handling						✓			
BMP C152: Sawcutting and Surfacing Pollution Prevention						✓			
BMP C153: Material Delivery, Storage and Containment						✓			
BMP C154: Concrete Washout Area						✓			
BMP C160: Certified Erosion and Sediment Control Lead							✓	✓	
BMP C162: Scheduling								✓	

BMP C200: Interceptor Dike and Swale

Purpose

Provide a ridge of compacted soil, or a ridge with an upslope swale, at the top or base of a disturbed slope or along the perimeter of a disturbed construction area to convey stormwater. Use the dike and/or swale to intercept the runoff from unprotected areas and direct it to areas where erosion can be controlled. This can prevent storm runoff from entering the work area or sediment-laden runoff from leaving the construction site.

Conditions of Use

Where the runoff from an exposed site or disturbed slope must be conveyed to an erosion control facility which can safely convey the stormwater.

- Locate upslope of a construction site to prevent runoff from entering disturbed area.
- When placed horizontally across a disturbed slope, it reduces the amount and velocity of runoff flowing down the slope.
- Locate downslope to collect runoff from a disturbed area and direct water to a sediment basin.

Design and Installation Specifications

- Dike and/or swale and channel must be stabilized with temporary or permanent vegetation or other channel protection during construction.
- Channel requires a positive grade for drainage; steeper grades require channel protection and check dams.
- Review construction for areas where overtopping may occur.
- Can be used at top of new fill before vegetation is established.
- May be used as a permanent diversion channel to carry the runoff.
- Sub-basin tributary area should be one acre or less.
- Design capacity for the peak flow from a 10-year, 24-hour storm, assuming a Type 1A rainfall distribution, for temporary facilities. Alternatively, use 1.6 times the 10-year, 1-hour flow indicated by an approved continuous runoff model. For facilities that will also serve on a permanent basis, consult the local government's drainage requirements.

Interceptor dikes shall meet the following criteria:

Top Width	2 feet minimum.
Height	1.5 feet minimum on berm.
Side Slope	2H:1V or flatter.
Grade	Depends on topography, however, dike system minimum is 0.5%, and maximum is 1%.
Compaction	Minimum of 90 percent ASTM D698 standard proctor.

Horizontal Spacing of Interceptor Dikes:

Average Slope	Slope Percent	Flowpath Length
20H:1V or less	3-5%	300 feet
(10 to 20)H:1V	5-10%	200 feet
(4 to 10)H:1V	10-25%	100 feet
(2 to 4)H:1V	25-50%	50 feet

Stabilization depends on velocity and reach

Slopes <5% Seed and mulch applied within 5 days of dike construction (see BMP C121, Mulching).

Slopes 5 - 40% Dependent on runoff velocities and dike materials. Stabilization should be done immediately using either sod or riprap or other measures to avoid erosion.

- The upslope side of the dike shall provide positive drainage to the dike outlet. No erosion shall occur at the outlet. Provide energy dissipation measures as necessary. Sediment-laden runoff must be released through a sediment trapping facility.
- Minimize construction traffic over temporary dikes. Use temporary cross culverts for channel crossing.

Interceptor swales shall meet the following criteria:

Bottom Width	2 feet minimum; the cross-section bottom shall be level.
Depth	1-foot minimum.
Side Slope	2H:1V or flatter.
Grade	Maximum 5 percent, with positive drainage to a suitable outlet (such as a sediment pond).
Stabilization	Seed as per BMP C120, *Temporary and Permanent Seeding*, or *BMP C202, Channel Lining*, 12 inches thick riprap pressed into the bank and extending at least 8 inches vertical from the bottom.

- Inspect diversion dikes and interceptor swales once a week and after every rainfall. Immediately remove sediment from the flow area.
- Damage caused by construction traffic or other activity must be repaired before the end of each working day.

Check outlets and make timely repairs as needed to avoid gully formation. When the area below the temporary diversion dike is permanently stabilized, remove the dike and fill and stabilize the channel to blend with the natural surface.

BMP C201: Grass-Lined Channels

Purpose

To provide a channel with a vegetative lining for conveyance of runoff. See Figure 4.2.1 for typical grass-lined channels.

Conditions of Use

This practice applies to construction sites where concentrated runoff needs to be contained to prevent erosion or flooding.

- When a vegetative lining can provide sufficient stability for the channel cross section and at lower velocities of water (normally dependent on grade). This means that the channel slopes are generally less than 5 percent and space is available for a relatively large cross section.
- Typical uses include roadside ditches, channels at property boundaries, outlets for diversions, and other channels and drainage ditches in low areas.
- Channels that will be vegetated should be installed before major earthwork and hydroseeded with a bonded fiber matrix (BFM). The vegetation should be well established (i.e., 75 percent cover) before water is allowed to flow in the ditch. With channels that will have high flows, erosion control blankets should be installed over the hydroseed. If vegetation cannot be established from seed before water is allowed in the ditch, sod should be installed in the bottom of the ditch in lieu of hydromulch and blankets.

Design and Installation Specifications

Locate the channel where it can conform to the topography and other features such as roads.

- Locate them to use natural drainage systems to the greatest extent possible.
- Avoid sharp changes in alignment or bends and changes in grade.
- Do not reshape the landscape to fit the drainage channel.
- The maximum design velocity shall be based on soil conditions, type of vegetation, and method of revegetation, but at no times shall velocity exceed 5 feet/second. The channel shall not be overtopped by the peak runoff from a 10-year, 24-hour storm, assuming a Type 1A rainfall distribution." Alternatively, use 1.6 times the 10-year, 1-hour flow indicated by an approved continuous runoff model to determine a flow rate which the channel must contain.
- Where the grass-lined channel will also function as a permanent stormwater conveyance facility, consult the drainage conveyance requirements of the local government with jurisdiction.

- An established grass or vegetated lining is required before the channel can be used to convey stormwater, unless stabilized with nets or blankets.
- If design velocity of a channel to be vegetated by seeding exceeds 2 ft/sec, a temporary channel liner is required. Geotextile or special mulch protection such as fiberglass roving or straw and netting provides stability until the vegetation is fully established. See Figure 4.2.2.
- Check dams shall be removed when the grass has matured sufficiently to protect the ditch or swale unless the slope of the swale is greater than 4 percent. The area beneath the check dams shall be seeded and mulched immediately after dam removal.
- If vegetation is established by sodding, the permissible velocity for established vegetation may be used and no temporary liner is needed.
- Do not subject grass-lined channel to sedimentation from disturbed areas. Use sediment-trapping BMPs upstream of the channel.
- V-shaped grass channels generally apply where the quantity of water is small, such as in short reaches along roadsides. The V-shaped cross section is least desirable because it is difficult to stabilize the bottom where velocities may be high.
- Trapezoidal grass channels are used where runoff volumes are large and slope is low so that velocities are nonerosive to vegetated linings. (Note: it is difficult to construct small parabolic shaped channels.)
- Subsurface drainage, or riprap channel bottoms, may be necessary on sites that are subject to prolonged wet conditions due to long duration flows or a high water table.
- Provide outlet protection at culvert ends and at channel intersections.
- Grass channels, at a minimum, should carry peak runoff for temporary construction drainage facilities from the 10-year, 24-hour storm without eroding. Where flood hazard exists, increase the capacity according to the potential damage.
- Grassed channel side slopes generally are constructed 3H:1V or flatter to aid in the establishment of vegetation and for maintenance.
- Construct channels a minimum of 0.2 foot larger around the periphery to allow for soil bulking during seedbed preparations and sod buildup.

Maintenance Standards

During the establishment period, check grass-lined channels after every rainfall.

- After grass is established, periodically check the channel; check it after every heavy rainfall event. Immediately make repairs.
- It is particularly important to check the channel outlet and all road crossings for bank stability and evidence of piping or scour holes.

- Remove all significant sediment accumulations to maintain the designed carrying capacity. Keep the grass in a healthy, vigorous condition at all times, since it is the primary erosion protection for the channel.

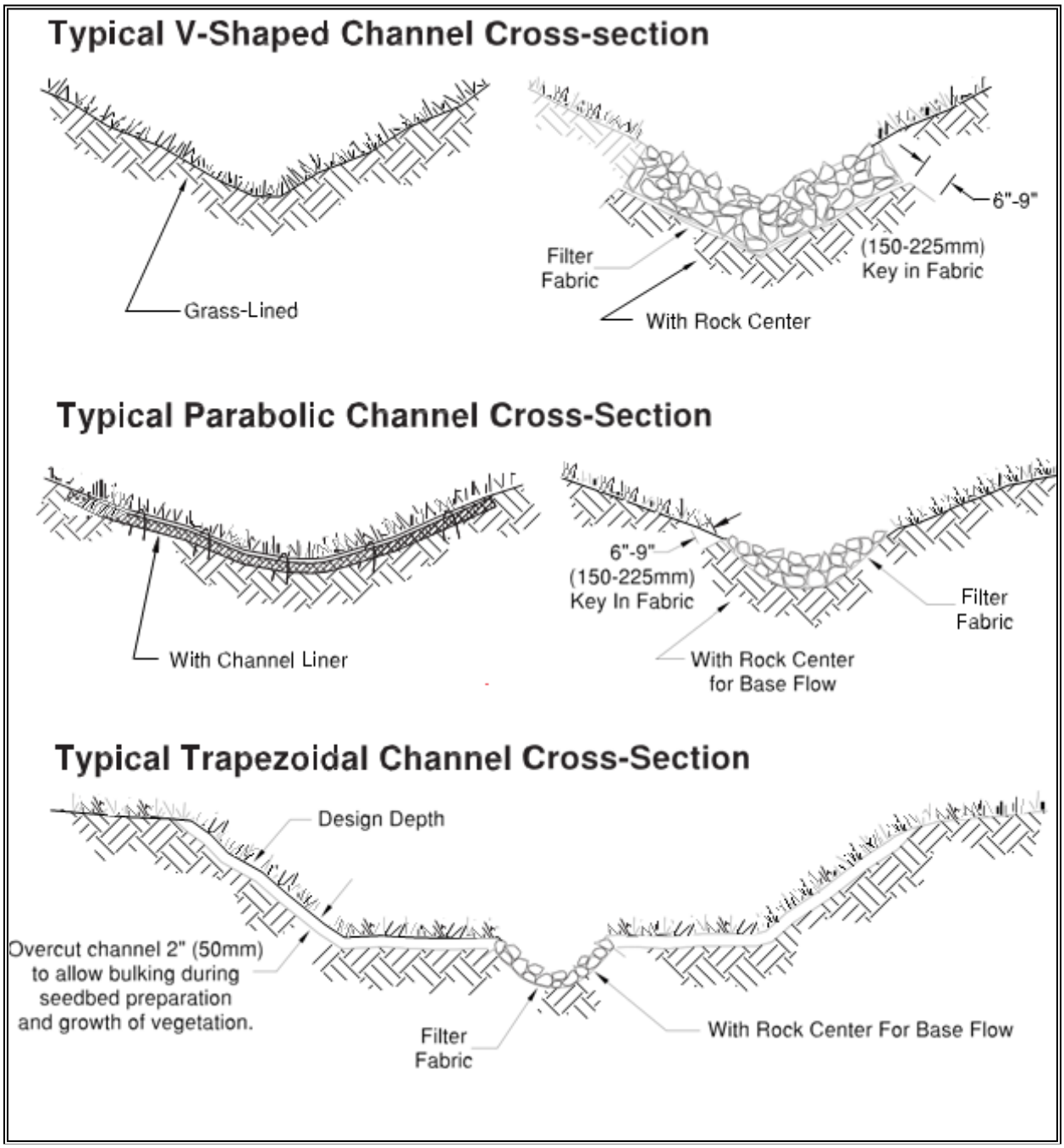
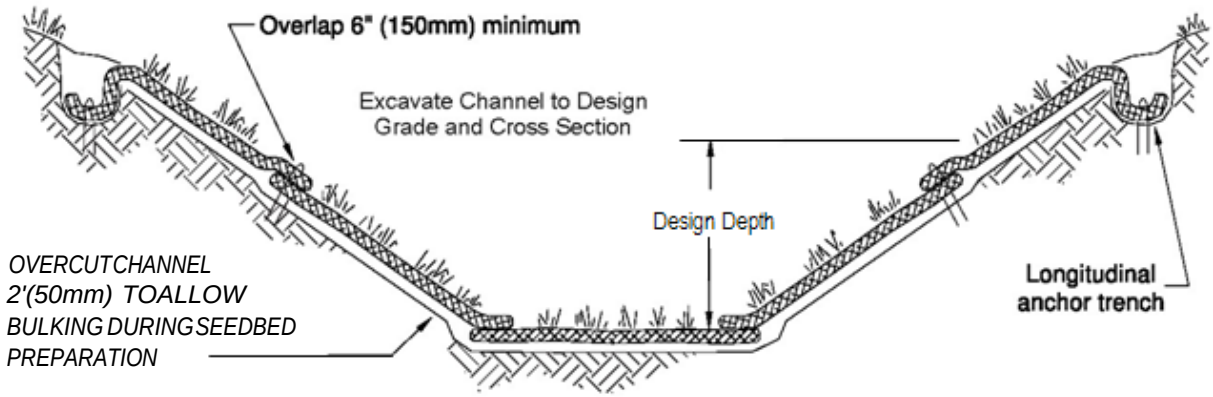
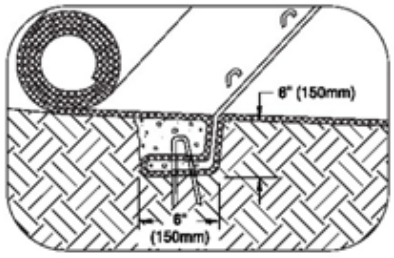
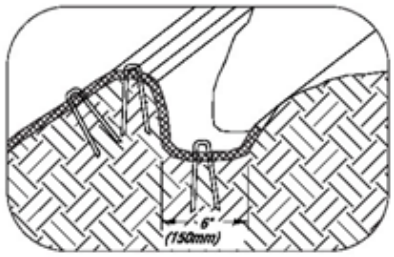


Figure 4.2.1 – Typical Grass-Lined Channels



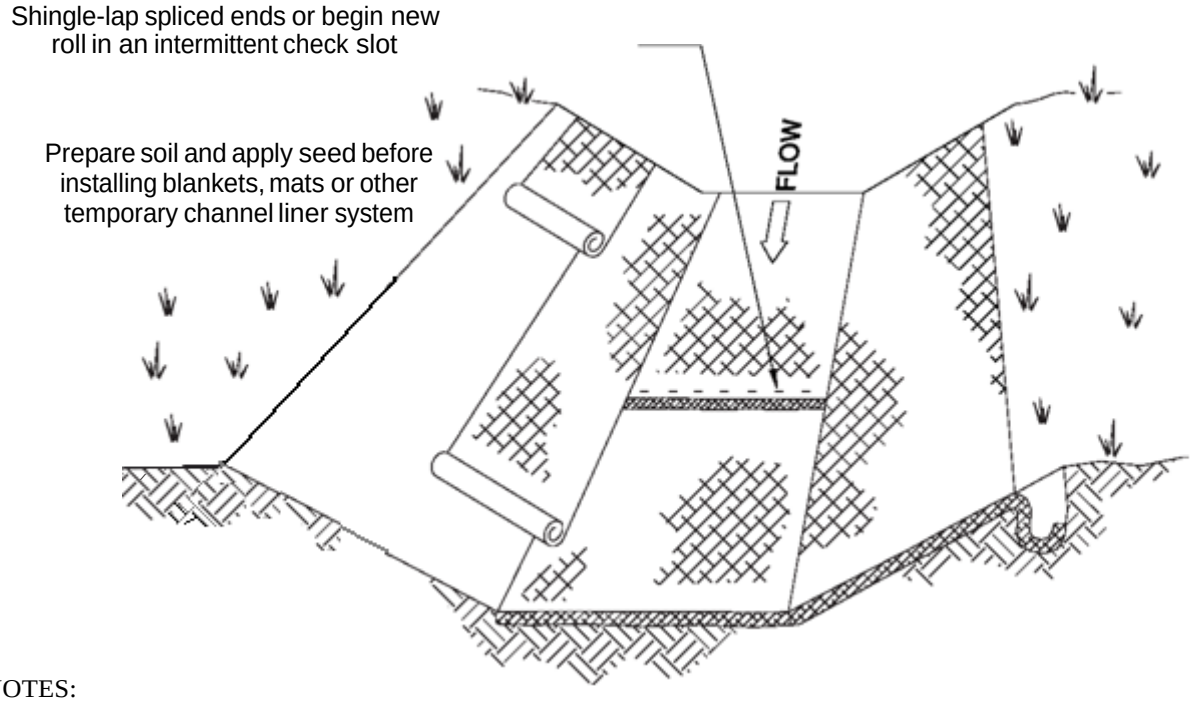


TYPICAL INSTALLATION WITH EROSION CONTROL BLANKETS OR TURF REINFORCEMENT MATS



Intermittent Check Slot

Longitudinal Anchor Trench



NOTES:

1 Design velocities exceeding 2 ft/sec (0.5m/sec) require temporary blankets, mats or similar liners to protect seed and soil until vegetation becomes established.

2 Grass-lined channels with design velocities exceeding 6 ft/sec (2m/sec) should include turf reinforcement mats.

Figure 4.2.2 – Temporary Channel Liners

BMP C202: Channel Lining

Purpose

To protect channels by providing a channel liner using either blankets or riprap.

Conditions of Use

When natural soils or vegetated stabilized soils in a channel are not adequat to prevent channel erosion.

- When a permanent ditch or pipe system is to be installed and a temporary measure is needed.
- In almost all cases, synthetic and organic coconut blankets are more effective than riprap for protecting channels from erosion. Blankets can be used with and without vegetation. Blanketed channels can be designed to handle any expected flow and longevity requirement. Some synthetic blankets have a predicted life span of 50 years or more, even in sunlight.
- Other reasons why blankets are better than rock include the availability of blankets over rock. In many areas of the state, rock is not easily obtainable or is very expensive to haul to a site. Blankets can be delivered anywhere. Rock requires the use of dump trucks to haul and heavy equipment to place. Blankets usually only require laborers with hand tools, and sometimes a backhoe.
- The Federal Highway Administration recommends not using flexible liners whenever the slope exceeds 10 percent or the shear stress exceeds 8 lbs/ft^2.

Design and Installation Specifications

See BMP C122 for information on blankets.

Since riprap is used where erosion potential is high, construction must be sequenced so that the riprap is put in place with the minimum possible delay.

- Disturbance of areas where riprap is to be placed should be undertaken only when final preparation and placement of the riprap can follow immediately behind the initial disturbance. Where riprap is used for outlet protection, the riprap should be placed before or in conjunction with the construction of the pipe or channel so that it is in place when the pipe or channel begins to operate.
- The designer, after determining the riprap size that will be stable under the flow conditions, shall consider that size to be a minimum size and then, based on riprap gradations actually available in the area, select the size or sizes that equal or exceed the minimum size. The possibility of drainage structure damage by children shall be considered in selecting a riprap size, especially if there is nearby water or a gully in which to toss the stones.
- Stone for riprap shall consist of field stone or quarry stone of approximately rectangular shape. The stone shall be hard and angular

and of such quality that it will not disintegrate on exposure to water or weathering and it shall be suitable in all respects for the purpose intended.

- A lining of engineering filter fabric (geotextile) shall be placed between the riprap and the underlying soil surface to prevent soil movement into or through the riprap. The geotextile should be keyed in at the top of the bank.
- Filter fabric shall not be used on slopes greater than 1-1/2H:1V as slippage may occur. It should be used in conjunction with a layer of coarse aggregate (granular filter blanket) when the riprap to be placed is 12 inches and larger.

BMP C203: Water Bars

Purpose

A small ditch or ridge of material is constructed diagonally across a road or right-of-way to divert stormwater runoff from the road surface, wheel tracks, or a shallow road ditch. See Figure 4.2.3.

Conditions of use

Clearing right-of-way and construction of access for power lines, pipelines, and other similar installations often require long narrow right-of-ways over sloping terrain. Disturbance and compaction promotes gully formation in these cleared strips by increasing the volume and velocity of runoff. Gully formation may be especially severe in tire tracks and ruts. To prevent gullying, runoff can often be diverted across the width of the right-of-way to undisturbed areas by using small predesigned diversions.

- Give special consideration to each individual outlet area, as well as to the cumulative effect of added diversions. Use gravel to stabilize the diversion where significant vehicular traffic is anticipated.

Design and Installation Specifications

Height: 8-inch minimum measured from the channel bottom to the ridge top.

- Side slope of channel: 2H:1V maximum; 3H:1V or flatter when vehicles will cross.
- Base width of ridge: 6-inch minimum.
- Locate them to use natural drainage systems and to discharge into well vegetated stable areas.
- Guideline for Spacing:

Slope %	Spacing (ft)
< 5	125
5 - 10	100
10 - 20	75
20 - 35	50
> 35	Use rock lined ditch

- Grade of water bar and angle: Select angle that results in ditch slope less than 2 percent.
- Install as soon as the clearing and grading is complete. Reconstruct when construction is complete on a section when utilities are being installed.
- Compact the ridge when installed.
- Stabilize, seed and mulch the portions that are not subject to traffic. Gravel the areas crossed by vehicles.

Maintenance Standards

Periodically inspect right-of-way diversions for wear and after every heavy rainfall for erosion damage.

- Immediately remove sediment from the flow area and repair the dike.
- Check outlet areas and make timely repairs as needed.
- When permanent road drainage is established and the area above the temporary right-of-way diversion is permanently stabilized, remove the dikes and fill the channel to blend with the natural ground, and appropriately stabilize the disturbed area.

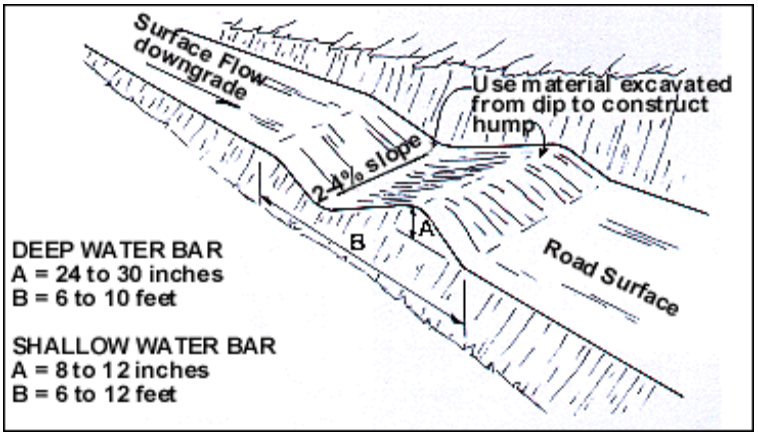


Figure 4.2.3 – Water Bar

BMP C204: Pipe Slope Drains

Purpose

To use a pipe to convey stormwater anytime water needs to be diverted away from or over bare soil to prevent gullies, channel erosion, and saturation of slide-prone soils.

Conditions of Use

Pipe slope drains should be used when a temporary or permanent stormwater conveyance is needed to move the water down a steep slope to avoid erosion (Figure 4.2.4).

On highway projects, pipe slope drains should be used at bridge ends to collect runoff and pipe it to the base of the fill slopes along bridge approaches. These can be designed into a project and included as bid items. Another use on road projects is to collect runoff from pavement and pipe it away from side slopes. These are useful because there is generally a time lag between having the first lift of asphalt installed and the curbs, gutters, and permanent drainage installed. Used in conjunction with sand bags, or other temporary diversion devices, these will prevent massive amounts of sediment from leaving a project.

Water can be collected, channeled with sand bags, Triangular Silt Dikes, berms, or other material, and piped to temporary sediment ponds.

Pipe slope drains can be:

- Connected to new catch basins and used temporarily until all permanent piping is installed;
- Used to drain water collected from aquifers exposed on cut slopes and take it to the base of the slope;
- Used to collect clean runoff from plastic sheeting and direct it away from exposed soil;
- Installed in conjunction with silt fence to drain collected water to a controlled area;
- Used to divert small seasonal streams away from construction. They have been used successfully on culvert replacement and extension jobs. Large flex pipe can be used on larger streams during culvert removal, repair, or replacement; and,
- Connected to existing down spouts and roof drains and used to divert water away from work areas during building renovation, demolition, and construction projects.

There are now several commercially available collectors that are attached to the pipe inlet and help prevent erosion at the inlet.

Design and Installation Specifications

Size the pipe to convey the flow. The capacity for temporary drains shall be sufficient to handle the peak flow from a 10-year, 24-hour storm event, assuming a Type 1A rainfall distribution. Alternatively, use 1.6 times the 10-year, 1-hour flow indicated by an approved continuous runoff model.

Consult local drainage requirements for sizing permanent pipe slope drains.

- Use care in clearing vegetated slopes for installation.
- Re-establish cover immediately on areas disturbed by installation.
- Use temporary drains on new cut or fill slopes.
- Use diversion dikes or swales to collect water at the top of the slope.
- Ensure that the entrance area is stable and large enough to direct flow into the pipe.
- Piping of water through the berm at the entrance area is a common failure mode.
- The entrance shall consist of a standard flared end section for culverts 12 inches and larger with a minimum 6-inch metal toe plate to prevent runoff from undercutting the pipe inlet. The slope of the entrance shall be at least 3 percent. Sand bags may also be used at pipe entrances as a temporary measure.
- The soil around and under the pipe and entrance section shall be thoroughly compacted to prevent undercutting.
- The flared inlet section shall be securely connected to the slope drain and have watertight connecting bands.
- Slope drain sections shall be securely fastened together, fused or have gasketed watertight fittings, and shall be securely anchored into the soil.
- Thrust blocks should be installed anytime 90 degree bends are utilized. Depending on size of pipe and flow, these can be constructed with sand bags, straw bales staked in place, “t” posts and wire, or ecology blocks.
- Pipe needs to be secured along its full length to prevent movement. This can be done with steel “t” posts and wire. A post is installed on each side of the pipe and the pipe is wired to them. This should be done every 10-20 feet of pipe length or so, depending on the size of the pipe and quantity of water to divert.
- Interceptor dikes shall be used to direct runoff into a slope drain. The height of the dike shall be at least 1 foot higher at all points than the top of the inlet pipe.
- The area below the outlet must be stabilized with a riprap apron (see BMP C209 Outlet Protection, for the appropriate outlet material).

- If the pipe slope drain is conveying sediment-laden water, direct all flows into the sediment trapping facility.
- Materials specifications for any permanent piped system shall be set by the local government.

Maintenance Standards

Check inlet and outlet points regularly, especially after storms.

The inlet should be free of undercutting, and no water should be going around the point of entry. If there are problems, the headwall should be reinforced with compacted earth or sand bags.

- The outlet point should be free of erosion and installed with appropriate outlet protection.
- For permanent installations, inspect pipe periodically for vandalism and physical distress such as slides and wind-throw.
- Normally the pipe slope is so steep that clogging is not a problem with smooth wall pipe, however, debris may become lodged in the pipe.

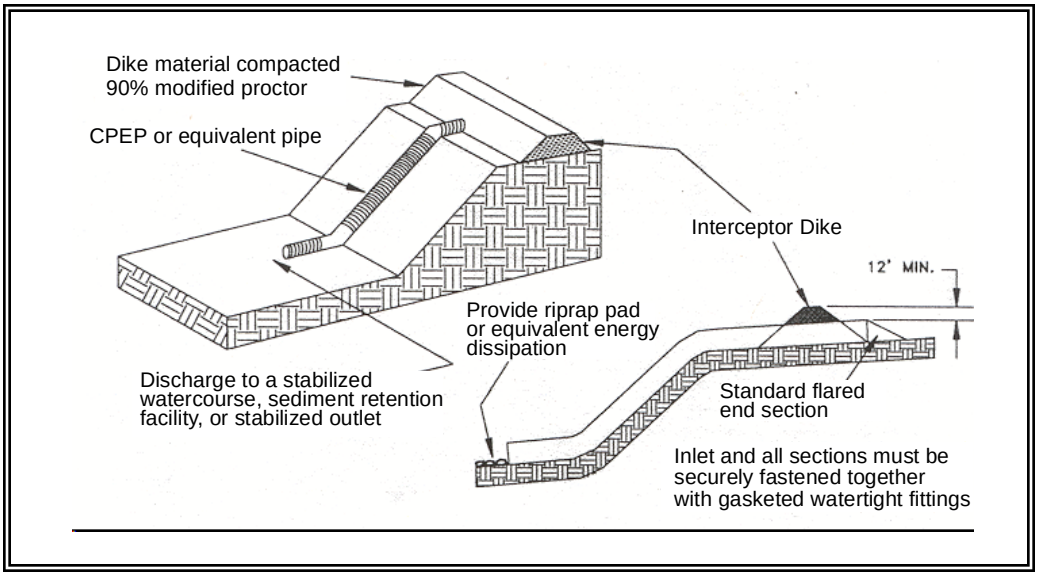


Figure 4.2.4 – Pipe Slope Drain

BMP C205: Subsurface Drains

Purpose

To intercept, collect, and convey ground water to a satisfactory outlet, using a perforated pipe or conduit below the ground surface. Subsurface drains are also known as "french drains." The perforated pipe provides a dewatering mechanism to drain excessively wet soils, provide a stable base for construction, improve stability of structures with shallow foundations, or to reduce hydrostatic pressure to improve slope stability.

Conditions of Use

Use when excessive water must be removed from the soil. The soil permeability, depth to water table and impervious layers are all factors which may govern the use of subsurface drains.

Design and Installation Specifications

Relief drains are used either to lower the water table in large, relatively flat areas, improve the growth of vegetation, or to remove surface water.

Relief drains are installed along a slope and drain in the direction of the slope.

They can be installed in a grid pattern, a herringbone pattern, or a random pattern.

- **Interceptor drains** are used to remove excess ground water from a slope, stabilize steep slopes, and lower the water table immediately below a slope to prevent the soil from becoming saturated.

Interceptor drains are installed perpendicular to a slope and drain to the side of the slope.

They usually consist of a single pipe or series of single pipes instead of a patterned layout.

- **Depth and spacing of interceptor drains** --The depth of an interceptor drain is determined primarily by the depth to which the water table is to be lowered or the depth to a confining layer. For practical reasons, the maximum depth is usually limited to 6 feet, with a minimum cover of 2 feet to protect the conduit.
- The soil should have depth and sufficient permeability to permit installation of an effective drainage system at a depth of 2 to 6 feet.
- An adequate outlet for the drainage system must be available either by gravity or by pumping.
- The quantity and quality of discharge needs to be accounted for in the receiving stream (additional detention may be required).
- This standard does not apply to subsurface drains for building foundations or deep excavations.
- The capacity of an interceptor drain is determined by calculating the maximum rate of ground water flow to be intercepted. Therefore, it is

good practice to make complete subsurface investigations, including hydraulic conductivity of the soil, before designing a subsurface drainage system.

- **Size of drain**--Size subsurface drains to carry the required capacity without pressure flow. Minimum diameter for a subsurface drain is 4 inches.
- The minimum velocity required to prevent silting is 1.4 ft./sec. The line shall be graded to achieve this velocity at a minimum. The maximum allowable velocity using a sand-gravel filter or envelope is 9 ft/sec.
- Filter material and fabric shall be used around all drains for proper bedding and filtration of fine materials. Envelopes and filters should surround the drain to a minimum of 3-inch thickness.
- The outlet of the subsurface drain shall empty into a sediment pond through a catch basin. If free of sediment, it can then empty into a receiving channel, swale, or stable vegetated area adequately protected from erosion and undermining.
- The trench shall be constructed on a continuous grade with no reverse grades or low spots.
- Soft or yielding soils under the drain shall be stabilized with gravel or other suitable material.
- Backfilling shall be done immediately after placement of the pipe. No sections of pipe shall remain uncovered overnight or during a rainstorm. Backfill material shall be placed in the trench in such a manner that the drain pipe is not displaced or damaged.
- Do not install permanent drains near trees to avoid the tree roots that tend to clog the line. Use solid pipe with watertight connections where it is necessary to pass a subsurface drainage system through a stand of trees.
- **Outlet**--Ensure that the outlet of a drain empties into a channel or other watercourse above the normal water level.
- Secure an animal guard to the outlet end of the pipe to keep out rodents.
- Use outlet pipe of corrugated metal, cast iron, or heavy-duty plastic without perforations and at least 10 feet long. Do not use an envelope or filter material around the outlet pipe, and bury at least two-thirds of the pipe length.
- When outlet velocities exceed those allowable for the receiving stream, outlet protection must be provided.

Maintenance Standards

Subsurface drains shall be checked periodically to ensure that they are free-flowing and not clogged with sediment or roots.

- The outlet shall be kept clean and free of debris.
- Surface inlets shall be kept open and free of sediment and other debris.
- Trees located too close to a subsurface drain often clog the system with their roots. If a drain becomes clogged, relocate the drain or remove the trees as a last resort. Drain placement should be planned to minimize this problem.
- Where drains are crossed by heavy vehicles, the line shall be checked to ensure that it is not crushed.

BMP C206: Level Spreader

Purpose

To provide a temporary outlet for dikes and diversions consisting of an excavated depression constructed at zero grade across a slope. To convert concentrated runoff to sheet flow and release it onto areas stabilized by existing vegetation or an engineered filter strip.

Conditions of Use

Used when a concentrated flow of water needs to be dispersed over a large area with existing stable vegetation.

- Items to consider are:
    1. What is the risk of erosion or damage if the flow may become concentrated?
    2. Is an easement required if discharged to adjoining property?
    3. Most of the flow should be as ground water and not as surface flow.
    4. Is there an unstable area downstream that cannot accept additional ground water?
- Use only where the slopes are gentle, the water volume is relatively low, and the soil will adsorb most of the low flow events.

Design and Installation Specifications

Use above undisturbed areas that are stabilized by existing vegetation.

If the level spreader has any low points, flow will concentrate, create channels and may cause erosion.

- Discharge area below the outlet must be uniform with a slope flatter than 5H:1V.
- Outlet to be constructed level in a stable, undisturbed soil profile (not on fill).
- The runoff shall not re-concentrate after release unless intercepted by another downstream measure.

- The grade of the channel for the last 20 feet of the dike or interceptor entering the level spreader shall be less than or equal to 1 percent. The grade of the level spreader shall be 0 percent to ensure uniform spreading of storm runoff.
- A 6-inch high gravel berm placed across the level lip shall consist of washed crushed rock, 2- to 4-inch or 3/4-inch to 1½-inch size.
- The spreader length shall be determined by estimating the peak flow expected from the 10-year, 24-hour design storm. The length of the spreader shall be a minimum of 15 feet for 0.1 cfs and shall increase by 10 feet for each 0.1 cfs thereafter to a maximum of 0.5 cfs per spreader. Use multiple spreaders for higher flows.
- The width of the spreader should be at least 6 feet.
- The depth of the spreader as measured from the lip should be at least 6 inches and it should be uniform across the entire length.
- Level spreaders shall be setback from the property line unless there is an easement for flow.
- Level spreaders, when installed every so often in grassy swales, keep the flows from concentrating. Materials that can be used include sand bags, lumber, logs, concrete, and pipe. To function properly, the material needs to be installed level and on contour. Figures 4.2.5Figure425 and 4.2.6 provide a cross-section and a detail of a level spreader. A capped perforated pipe could also be used as a spreader.

Maintenance Standards

The spreader should be inspected after every runoff event to ensure that it is functioning correctly.

- The contractor should avoid the placement of any material on the structure and should prevent construction traffic from crossing over the structure.
- If the spreader is damaged by construction traffic, it shall be immediately repaired.

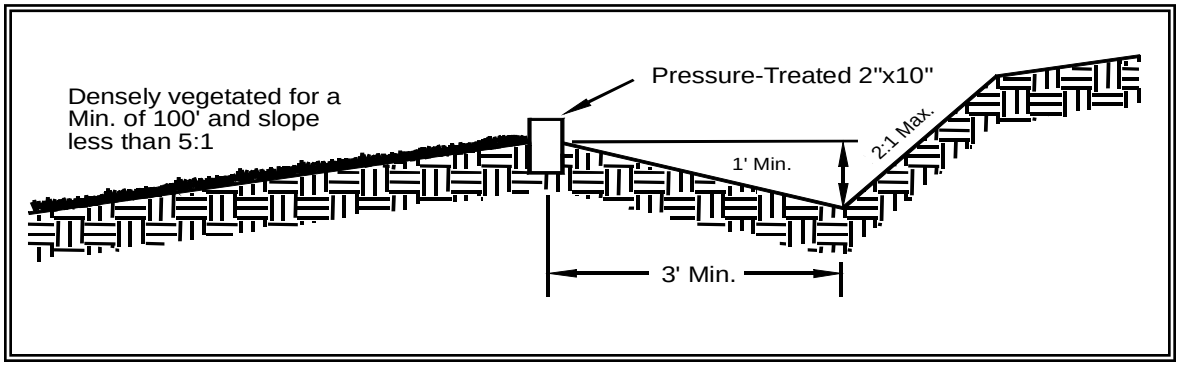


Figure 4.2.5 – Cross Section of Level Spreader

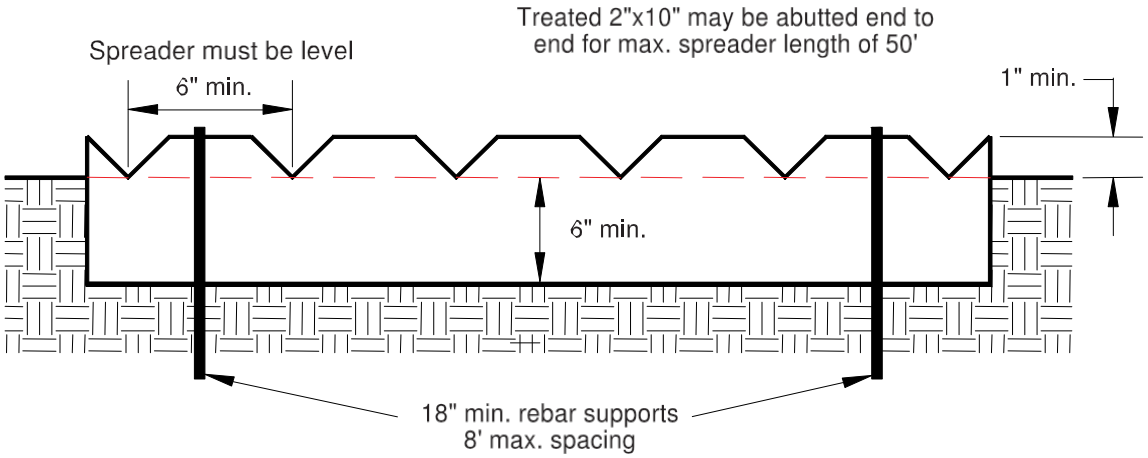


Figure 4.2.6 – Detail of Level Spreader

BMP C207: Check Dams

Purpose Construction of small dams across a swale or ditch reduces the velocity of concentrated flow and dissipates energy at the check dam.

Conditions of Use Where temporary channels or permanent channels are not yet vegetated, channel lining is infeasible, and/or velocity checks are required.

- Check dams may not be placed in streams unless approved by the State Department of Fish and Wildlife. Check dams may not be placed in wetlands without approval from a permitting agency.
- Do not place check dams below the expected backwater from any salmonid bearing water between October 1 and May 31 to ensure that there is no loss of high flow refuge habitat for overwintering juvenile salmonids and emergent salmonid fry.
- Construct rock check dams from appropriately sized rock. The rock used must be large enough to stay in place given the expected design flow through the channel. The rock must be placed by hand or by mechanical means (no dumping of rock to form dam) to achieve complete coverage of the ditch or swale and to ensure that the center of the dam is lower than the edges.
- Check dams may also be constructed of either rock or pea-gravel filled bags. Numerous new products are also available for this purpose. They tend to be re-usable, quick and easy to install, effective, and cost efficient.
- Place check dams perpendicular to the flow of water.
- The dam should form a triangle when viewed from the side. This prevents undercutting as water flows over the face of the dam rather than falling directly onto the ditch bottom.

- Before installing check dams impound and bypass upstream water flow away from the work area. Options for bypassing include pumps, siphons, or temporary channels.
- Check dams in association with sumps work more effectively at slowing flow and retaining sediment than just a check dam alone. A deep sump should be provided immediately upstream of the check dam.
- In some cases, if carefully located and designed, check dams can remain as permanent installations with very minor regrading. They may be left as either spillways, in which case accumulated sediment would be graded and seeded, or as check dams to prevent further sediment from leaving the site.
- The maximum spacing between the dams shall be such that the toe of the upstream dam is at the same elevation as the top of the downstream dam.
- Keep the maximum height at 2 feet at the center of the dam.
- Keep the center of the check dam at least 12 inches lower than the outer edges at natural ground elevation.
- Keep the side slopes of the check dam at 2H:1V or flatter.
- Key the stone into the ditch banks and extend it beyond the abutments a minimum of 18 inches to avoid washouts from overflow around the dam.
- Use filter fabric foundation under a rock or sand bag check dam. If a blanket ditch liner is used, filter fabric is not necessary. A piece of organic or synthetic blanket cut to fit will also work for this purpose.
- In the case of grass-lined ditches and swales, all check dams and accumulated sediment shall be removed when the grass has matured sufficiently to protect the ditch or swale - unless the slope of the swale is greater than 4 percent. The area beneath the check dams shall be seeded and mulched immediately after dam removal.
- Ensure that channel appurtenances, such as culvert entrances below check dams, are not subject to damage or blockage from displaced stones. Figure 4.2.7 depicts a typical rock check dam.

Maintenance Standards

Check dams shall be monitored for performance and sediment accumulation during and after each runoff producing rainfall. Sediment shall be removed when it reaches one half the sump depth.

- Anticipate submergence and deposition above the check dam and erosion from high flows around the edges of the dam.
- If significant erosion occurs between dams, install a protective riprap liner in that portion of the channel.

Approved as Equivalent

Ecology has approved products as able to meet the requirements of BMP C207. The products did not pass through the Technology Assessment Protocol – Ecology (TAPE) process. Local jurisdictions may choose not to accept this product approved as equivalent, or may require additional testing prior to consideration for local use. The products are available for review on Ecology's website at http://www.ecy.wa.gov/programs/wq/stormwater/newtech/equivalent.html

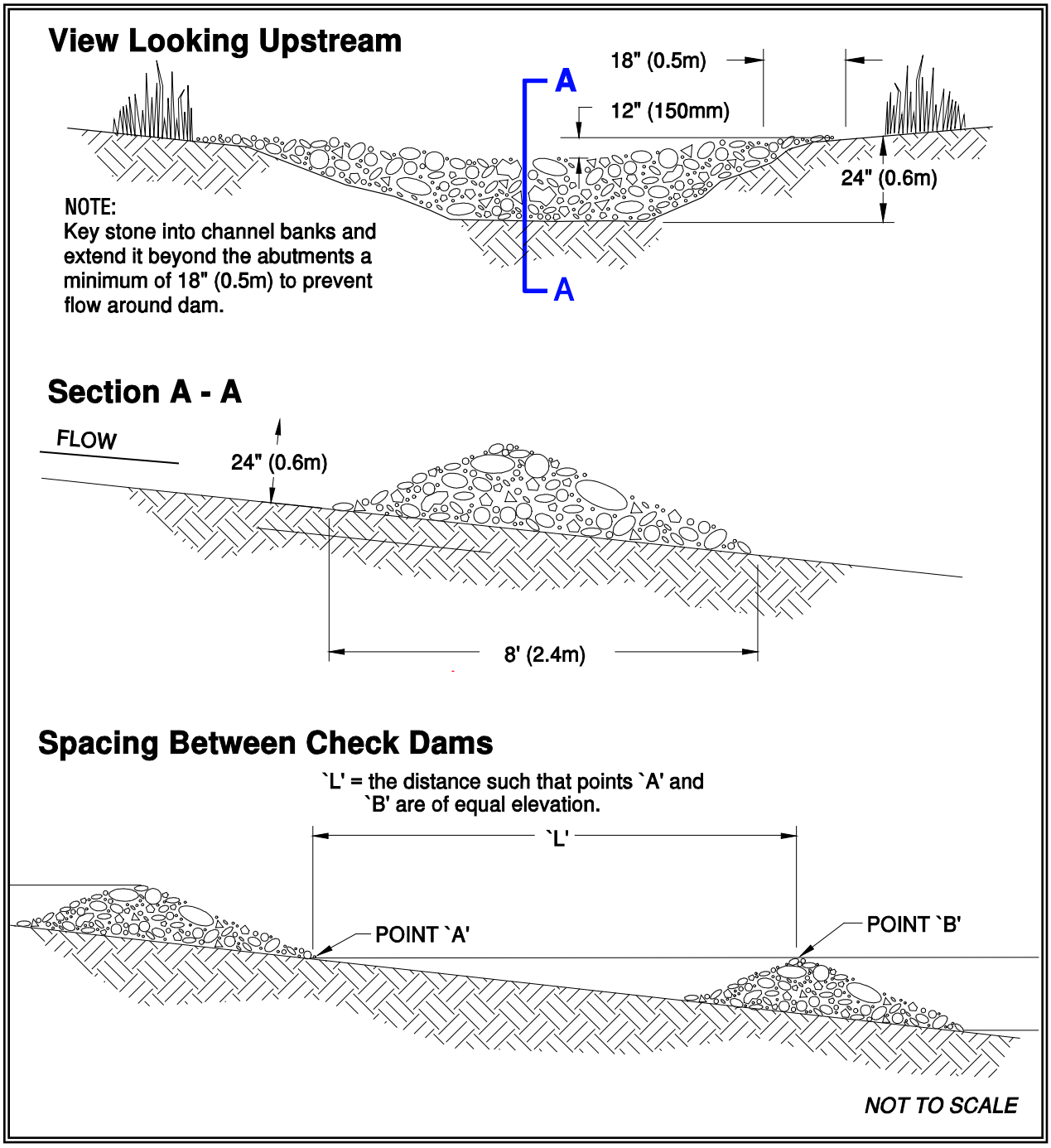


Figure 4.2.7 – Rock Check Dam

BMP C208: Triangular Silt Dike (TSD) (Geotextile-Encased Check Dam)

Purpose

Triangular silt dikes may be used as check dams, for perimeter protection, for temporary soil stockpile protection, for drop inlet protection, or as a temporary interceptor dike.

Conditions of use

- May be used on soil or pavement with adhesive or staples.
- TSDs have been used to build temporary:
  1. sediment ponds;
  2. diversion ditches;
  3. concrete wash out facilities;
  4. curbing;
  5. water bars;
  6. level spreaders; and,
  7. berms.

Design and Installation Specifications

Made of urethane foam sewn into a woven geosynthetic fabric.

It is triangular, 10 inches to 14 inches high in the center, with a 20-inch to 28-inch base. A 2–foot apron extends beyond both sides of the triangle along its standard section of 7 feet. A sleeve at one end allows attachment of additional sections as needed.

- Install with ends curved up to prevent water from flowing around the ends.
- The fabric flaps and check dam units are attached to the ground with wire staples. Wire staples should be No. 11 gauge wire and should be 200 mm to 300 mm in length.
- When multiple units are installed, the sleeve of fabric at the end of the unit shall overlap the abutting unit and be stapled.
- Check dams should be located and installed as soon as construction will allow.
- Check dams should be placed perpendicular to the flow of water.
- When used as check dams, the leading edge must be secured with rocks, sandbags, or a small key slot and staples.
- In the case of grass-lined ditches and swales, check dams and accumulated sediment shall be removed when the grass has matured sufficiently to protect the ditch or swale unless the slope of the swale is greater than 4 percent. The area beneath the check dams shall be seeded and mulched immediately after dam removal.

Maintenance

- Triangular silt dams shall be inspected for performance and sediment

Standards

accumulation during and after each runoff producing rainfall. Sediment shall be removed when it reaches one half the height of the dam.

- Anticipate submergence and deposition above the triangular silt dam and erosion from high flows around the edges of the dam. Immediately repair any damage or any undercutting of the dam.

BMP C209: Outlet Protection

Purpose

Outlet protection prevents scour at conveyance outlets and minimizes the potential for downstream erosion by reducing the velocity of concentrated stormwater flows.

Conditions of use

Outlet protection is required at the outlets of all ponds, pipes, ditches, or other conveyances, and where runoff is conveyed to a natural or manmade drainage feature such as a stream, wetland, lake, or ditch.

Design and Installation Specifications

The receiving channel at the outlet of a culvert shall be protected from erosion by rock lining a minimum of 6 feet downstream and extending up the channel sides a minimum of 1–foot above the maximum tailwater elevation or 1-foot above the crown, whichever is higher. For large pipes (more than 18 inches in diameter), the outlet protection lining of the channel is lengthened to four times the diameter of the culvert.

- Standard wingwalls, and tapered outlets and paved channels should also be considered when appropriate for permanent culvert outlet protection. (See WSDOT Hydraulic Manual, available through WSDOT Engineering Publications).
- Organic or synthetic erosion blankets, with or without vegetation, are usually more effective than rock, cheaper, and easier to install. Materials can be chosen using manufacturer product specifications. ASTM test results are available for most products and the designer can choose the correct material for the expected flow.
- With low flows, vegetation (including sod) can be effective.
- The following guidelines shall be used for riprap outlet protection:
    1. If the discharge velocity at the outlet is less than 5 fps (pipe slope less than 1 percent), use 2-inch to 8-inch riprap. Minimum thickness is 1-foot.
    2. For 5 to 10 fps discharge velocity at the outlet (pipe slope less than 3 percent), use 24-inch to 48-inch riprap. Minimum thickness is 2 feet.
    3. For outlets at the base of steep slope pipes (pipe slope greater than 10 percent), an engineered energy dissipater shall be used.
- Filter fabric or erosion control blankets should always be used under riprap to prevent scour and channel erosion.

- New pipe outfalls can provide an opportunity for low-cost fish habitat improvements. For example, an alcove of low-velocity water can be created by constructing the pipe outfall and associated energy dissipater back from the stream edge and digging a channel, over-widened to the upstream side, from the outfall. Overwintering juvenile and migrating adult salmonids may use the alcove as shelter during high flows. Bank stabilization, bioengineering, and habitat features may be required for disturbed areas. This work may require a HPA. See Volume V for more information on outfall system design.

Maintenance Standards

- Inspect and repair as needed.
- Add rock as needed to maintain the intended function.
- Clean energy dissipater if sediment builds up.

BMP C220: Storm Drain Inlet Protection

Purpose

Storm drain inlet protection prevents coarse sediment from entering drainage systems prior to permanent stabilization of the disturbed area.

Conditions of Use

Use storm drain inlet protection at inlets that are operational before permanent stabilization of the disturbed drainage area. Provide protection for all storm drain inlets downslope and within 500 feet of a disturbed or construction area, unless conveying runoff entering catch basins to a sediment pond or trap.

Also consider inlet protection for lawn and yard drains on new home construction. These small and numerous drains coupled with lack of gutters in new home construction can add significant amounts of sediment into the roof drain system. If possible delay installing lawn and yard drains until just before landscaping or cap these drains to prevent sediment from entering the system until completion of landscaping. Provide 18-inches of sod around each finished lawn and yard drain.

Table 4.2.2 lists several options for inlet protection. All of the methods for storm drain inlet protection tend to plug and require a high frequency of maintenance. Limit drainage areas to one acre or less. Possibly provide emergency overflows with additional end-of-pipe treatment where stormwater ponding would cause a hazard.

Table 4.2.2
Storm Drain Inlet Protection

Type of Inlet Protection	Emergency Overflow	Applicable for Paved/ Earthen Surfaces	Conditions of Use
Drop Inlet Protection			
Excavated drop inlet protection	Yes, temporary flooding will occur	Earthen	Applicable for heavy flows. Easy to maintain. Large area Requirement: 30' X 30'/acre
Block and gravel drop inlet protection	Yes	Paved or Earthen	Applicable for heavy concentrated flows. Will not pond.
Gravel and wire drop inlet protection	No		Applicable for heavy concentrated flows. Will pond. Can withstand traffic.
Catch basin filters	Yes	Paved or Earthen	Frequent maintenance required.
Curb Inlet Protection			
Curb inlet protection with a wooden weir	Small capacity overflow	Paved	Used for sturdy, more compact installation.
Block and gravel curb inlet protection	Yes	Paved	Sturdy, but limited filtration.
Culvert Inlet Protection			
Culvert inlet sediment trap			18 month expected life.

Design and Installation Specifications

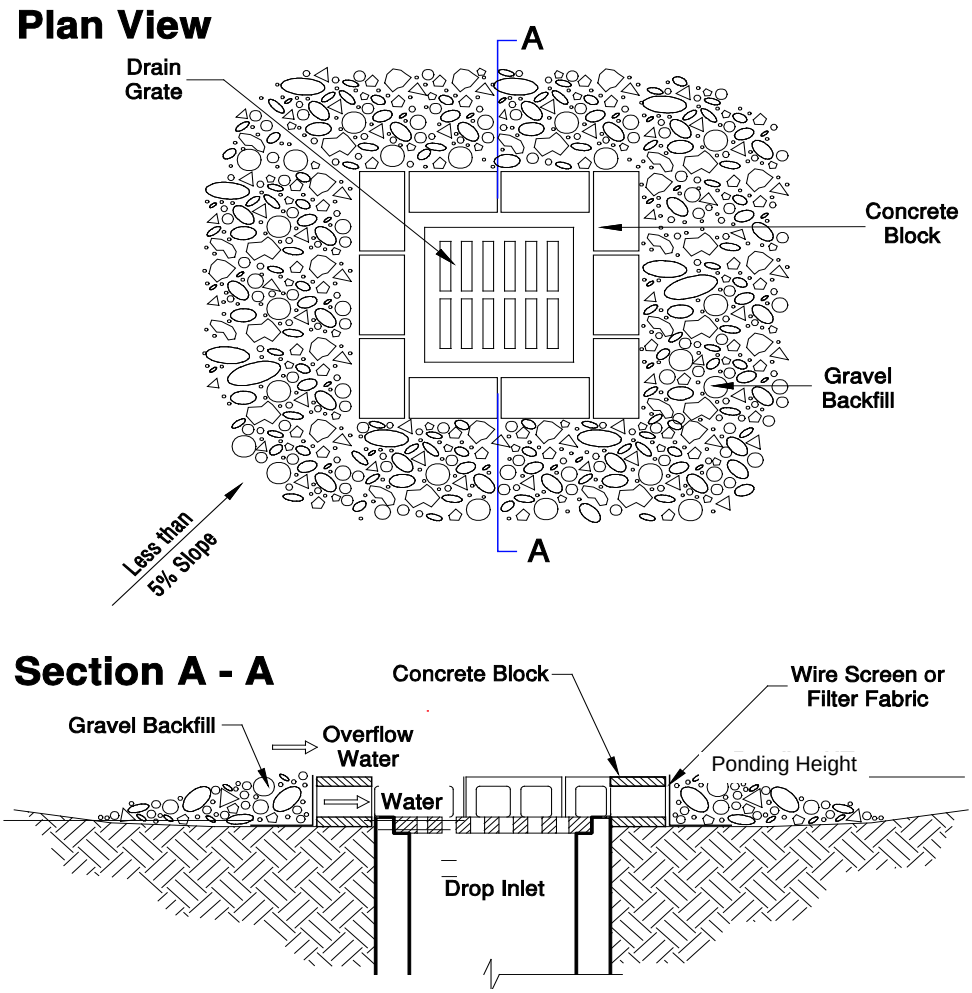
Excavated Drop Inlet Protection - An excavated impoundment around the storm drain. Sediment settles out of the stormwater prior to entering the storm drain.

- Provide a depth of 1-2 ft as measured from the crest of the inlet structure.
- Slope sides of excavation no steeper than 2H:1V.
- Minimum volume of excavation 35 cubic yards.
- Shape basin to fit site with longest dimension oriented toward the longest inflow area.
- Install provisions for draining to prevent standing water problems.
- Clear the area of all debris.
- Grade the approach to the inlet uniformly.
- Drill weep holes into the side of the inlet.
- Protect weep holes with screen wire and washed aggregate.
- Seal weep holes when removing structure and stabilizing area.

- Build a temporary dike, if necessary, to the down slope side of the structure to prevent bypass flow.

Block and Gravel Filter - A barrier formed around the storm drain inlet with standard concrete blocks and gravel. See Figure 4.2.8.

- Provide a height of 1 to 2 feet above inlet.
- Recess the first row 2-inches into the ground for stability.
- Support subsequent courses by placing a 2x4 through the block opening.
- Do not use mortar.
- Lay some blocks in the bottom row on their side for dewatering the pool.
- Place hardware cloth or comparable wire mesh with ½-inch openings over all block openings.
- Place gravel just below the top of blocks on slopes of 2H:1V or flatter.
- An alternative design is a gravel donut.
- Provide an inlet slope of 3H:1V.
- Provide an outlet slope of 2H:1V.
- Provide a1-foot wide level stone area between the structure and the inlet.
- Use inlet slope stones 3 inches in diameter or larger.
- Use gravel ½- to ¾-inch at a minimum thickness of 1-foot for the outlet slope.



Notes:
1. Drop inlet sediment barriers are to be used for small, nearly level drainage areas. (less than 5%)
2. Excavate a basin of sufficient size adjacent to the drop inlet.
3. The top of the structure (ponding height) must be well below the ground elevation downslope to prevent runoff from bypassing the inlet. A temporary dike may be necessary on the downslope side of the structure.

Figure 4.2.8 – Block and Gravel Filter

Gravel and Wire Mesh Filter - A gravel barrier placed over the top of the inlet. This structure does not provide an overflow.

- Use a hardware cloth or comparable wire mesh with ½-inch openings.
- Use coarse aggregate.
- Provide a height 1-foot or more, 18-inches wider than inlet on all sides.
- Place wire mesh over the drop inlet so that the wire extends a minimum of 1-foot beyond each side of the inlet structure.
- Overlap the strips if more than one strip of mesh is necessary.

- Place coarse aggregate over the wire mesh.
- Provide at least a 12-inch depth of gravel over the entire inlet opening and extend at least 18-inches on all sides.

Catchbasin Filters – Use inserts designed by manufacturers for construction sites. The limited sediment storage capacity increases the amount of inspection and maintenance required, which may be daily for heavy sediment loads. To reduce maintenance requirements combine a catchbasin filter with another type of inlet protection. This type of inlet protection provides flow bypass without overflow and therefore may be a better method for inlets located along active rights-of-way.

- Provides 5 cubic feet of storage.
- Requires dewatering provisions.
- Provides a high-flow bypass that will not clog under normal use at a construction site.
- Insert the catchbasin filter in the catchbasin just below the grating.

Curb Inlet Protection with Wooden Weir – Barrier formed around a curb inlet with a wooden frame and gravel.

- Use wire mesh with ½-inch openings.
- Use extra strength filter cloth.
- Construct a frame.
- Attach the wire and filter fabric to the frame.
- Pile coarse washed aggregate against wire/fabric.
- Place weight on frame anchors.

Block and Gravel Curb Inlet Protection – Barrier formed around a curb inlet with concrete blocks and gravel. See Figure 4.2.9.

- Use wire mesh with ½-inch openings.
- Place two concrete blocks on their sides abutting the curb at either side of the inlet opening. These are spacer blocks.
- Place a 2x4 stud through the outer holes of each spacer block to align the front blocks.
- Place blocks on their sides across the front of the inlet and abutting the spacer blocks.
- Place wire mesh over the outside vertical face.
- Pile coarse aggregate against the wire to the top of the barrier.

Curb and Gutter Sediment Barrier – Sandbag or rock berm (riprap and aggregate) 3 feet high and 3 feet wide in a horseshoe shape. See Figure 4.2.10.

- Construct a horseshoe shaped berm, faced with coarse aggregate if using riprap, 3 feet high and 3 feet wide, at least 2 feet from the inlet.
- Construct a horseshoe shaped sedimentation trap on the outside of the berm sized to sediment trap standards for protecting a culvert inlet.

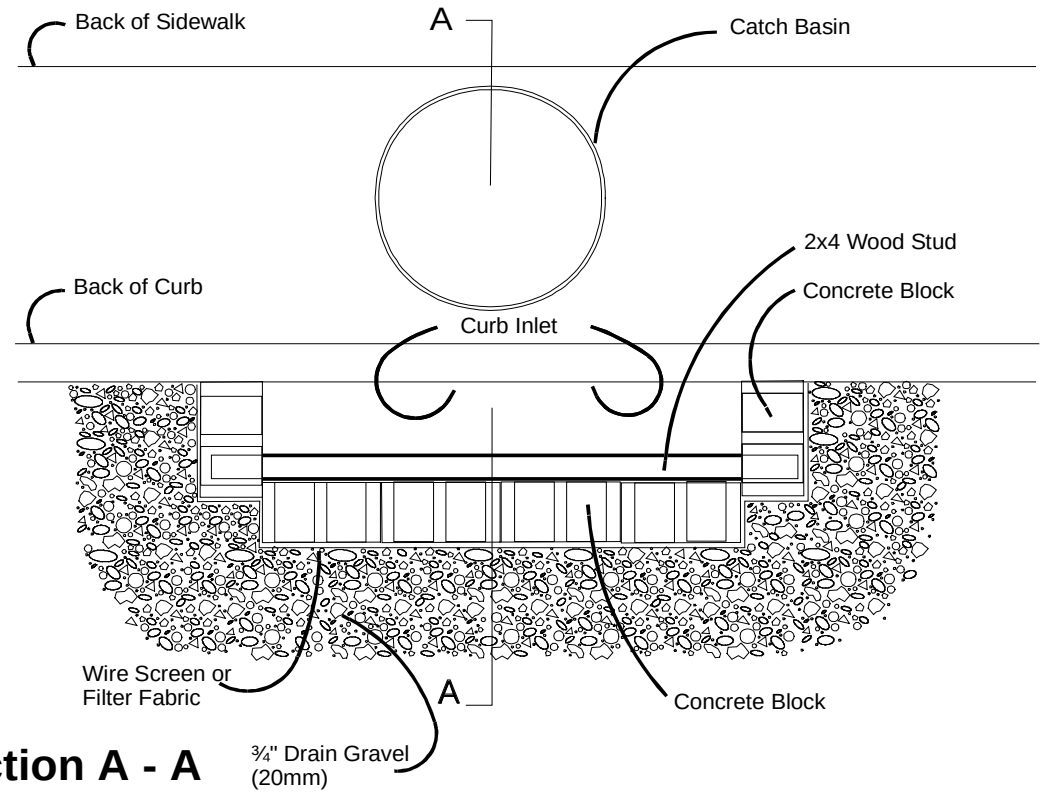
Maintenance Standards

- Inspect catch basin filters frequently, especially after storm events. Clean and replace clogged inserts. For systems with clogged stone filters: pull away the stones from the inlet and clean or replace. An alternative approach would be to use the clogged stone as fill and put fresh stone around the inlet.
- Do not wash sediment into storm drains while cleaning. Spread all excavated material evenly over the surrounding land area or stockpile and stabilize as appropriate.

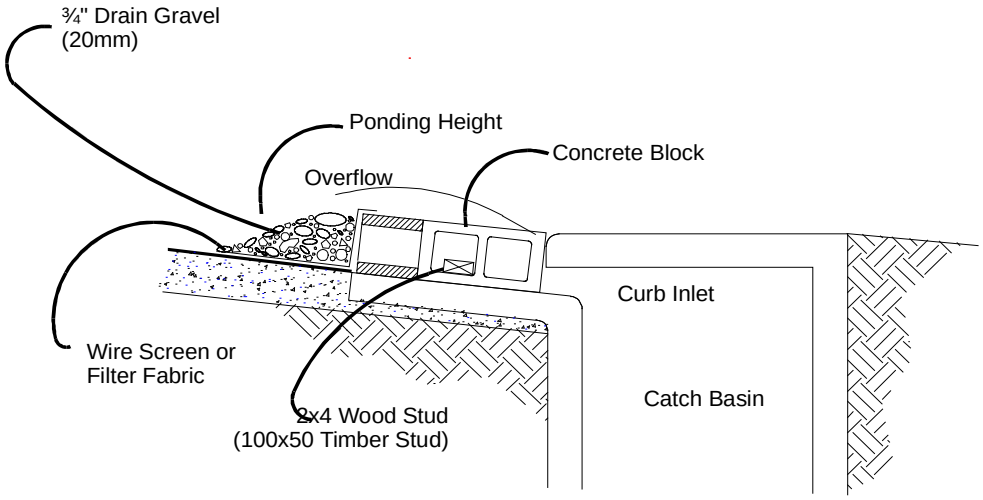
Approved as Equivalent

Ecology has approved products as able to meet the requirements of BMP C220. The products did not pass through the Technology Assessment Protocol – Ecology (TAPE) process. Local jurisdictions may choose not to accept this product approved as equivalent, or may require additional testing prior to consideration for local use. The products are available for review on Ecology's website at http://www.ecy.wa.gov/programs/wq/stormwater/newtech/equivalent.html

Plan View



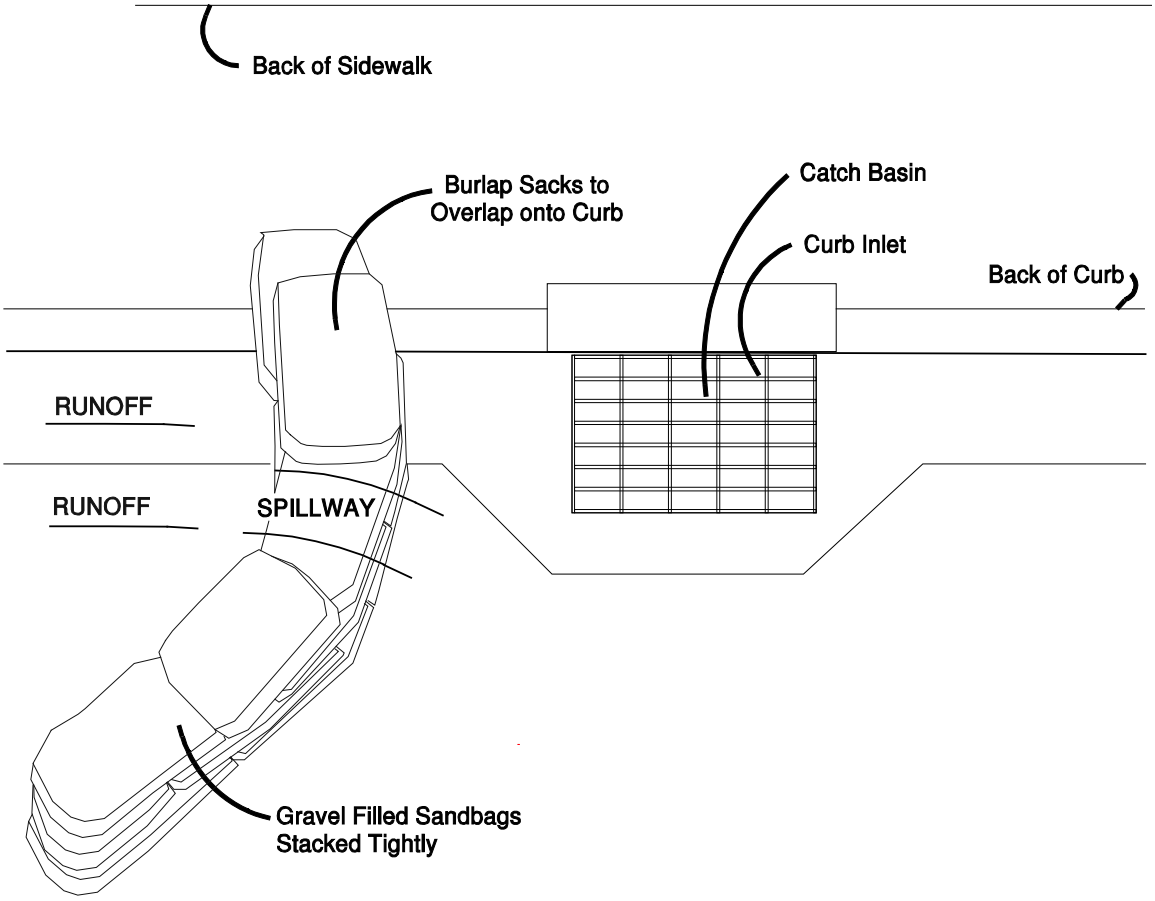
Section A - A



NOTES:
1. Use block and gravel type sediment barrier when curb inlet is located in gently sloping street segment, where water can pond and allow sediment to separate from runoff.
2. Barrier shall allow for overflow from severe storm event.
3. Inspect barriers and remove sediment after each storm event. Sediment and gravel must be removed from the traveled way immediately.

Figure 4.2.9 – Block and Gravel Curb Inlet Protection

Plan View



NOTES:
1. Place curb type sediment barriers on gently sloping street segments, where water can pond and allow sediment to separate from runoff.
2. Sandbags of either burlap or woven `geotextile' fabric, are filled with gravel, layered and packed tightly.
3. Leave a one sandbag gap in the top row to provide a spillway for overflow.
4. Inspect barriers and remove sediment after each storm event. Sediment and gravel must be removed from the traveled way immediately.

Figure 4.2.10 – Curb and Gutter Barrier

BMP C231: Brush Barrier

Purpose

The purpose of brush barriers is to reduce the transport of coarse sediment from a construction site by providing a temporary physical barrier to sediment and reducing the runoff velocities of overland flow.

Conditions of Use

- Brush barriers may be used downslope of all disturbed areas of less than one-quarter acre.
- Brush barriers are not intended to treat concentrated flows, nor are they intended to treat substantial amounts of overland flow. Any concentrated flows must be conveyed through the drainage system to a sediment pond. The only circumstance in which overland flow can be treated solely by a brush barrier, rather than by a sediment pond, is when the area draining to the barrier is small.
- Brush barriers should only be installed on contours.

Design and Installation Specifications

- Height 2 feet (minimum) to 5 feet (maximum).
- Width 5 feet at base (minimum) to 15 feet (maximum).
- Filter fabric (geotextile) may be anchored over the brush berm to enhance the filtration ability of the barrier. Ten-ounce burlap is an adequate alternative to filter fabric.
- Chipped site vegetation, composted mulch, or wood-based mulch (hog fuel) can be used to construct brush barriers.
- A 100 percent biodegradable installation can be constructed using 10-ounce burlap held in place by wooden stakes. Figure 4.2.11 depicts a typical brush barrier.

Maintenance Standards

- There shall be no signs of erosion or concentrated runoff under or around the barrier. If concentrated flows are bypassing the barrier, it must be expanded or augmented by toed-in filter fabric.
- The dimensions of the barrier must be maintained.

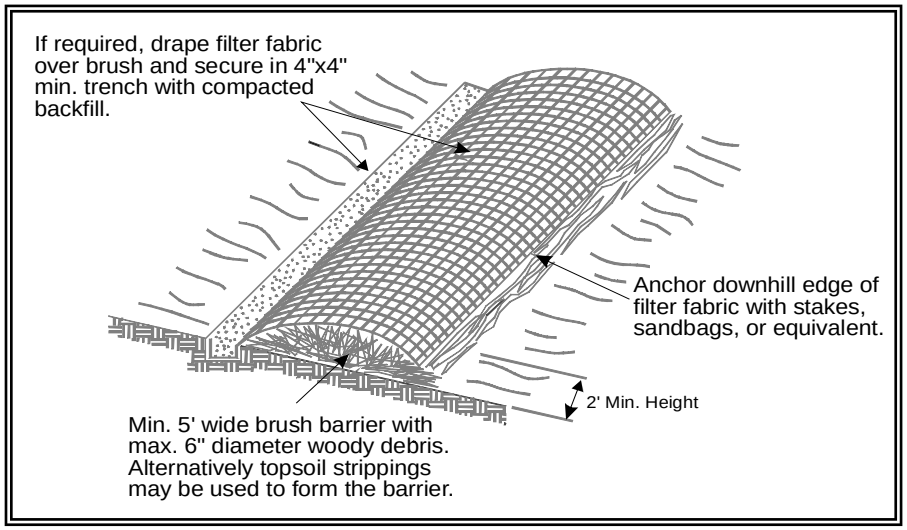


Figure 4.2.11 – Brush Barrier

BMP C232: Gravel Filter Berm

Purpose

A gravel filter berm is constructed on rights-of-way or traffic areas within a construction site to retain sediment by using a filter berm of gravel or crushed rock.

Conditions of Use

Where a temporary measure is needed to retain sediment from rights-of-way or in traffic areas on construction sites.

Design and Installation Specifications

- Berm material shall be ¾ to 3 inches in size, washed well-grade gravel or crushed rock with less than 5 percent fines.
- Spacing of berms:
  - Every 300 feet on slopes less than 5 percent
  - Every 200 feet on slopes between 5 percent and 10 percent
  - Every 100 feet on slopes greater than 10 percent
- Berm dimensions:
  - 1 foot high with 3H:1V side slopes
  - 8 linear feet per 1 cfs runoff based on the 10-year, 24-hour design storm

Maintenance Standards

- Regular inspection is required. Sediment shall be removed and filter material replaced as needed.

BMP C233: Silt Fence

Purpose

Use of a silt fence reduces the transport of coarse sediment from a construction site by providing a temporary physical barrier to sediment and reducing the runoff velocities of overland flow. See Figure 4.2.12 for details on silt fence construction.

Conditions of Use

Silt fence may be used downslope of all disturbed areas.

- Silt fence shall prevent soil carried by runoff water from going beneath, through, or over the top of the silt fence, but shall allow the water to pass through the fence.
- Silt fence is not intended to treat concentrated flows, nor is it intended to treat substantial amounts of overland flow. Convey any concentrated flows through the drainage system to a sediment pond.
- Do not construct silt fences in streams or use in V-shaped ditches. Silt fences do not provide an adequate method of silt control for anything deeper than sheet or overland flow.

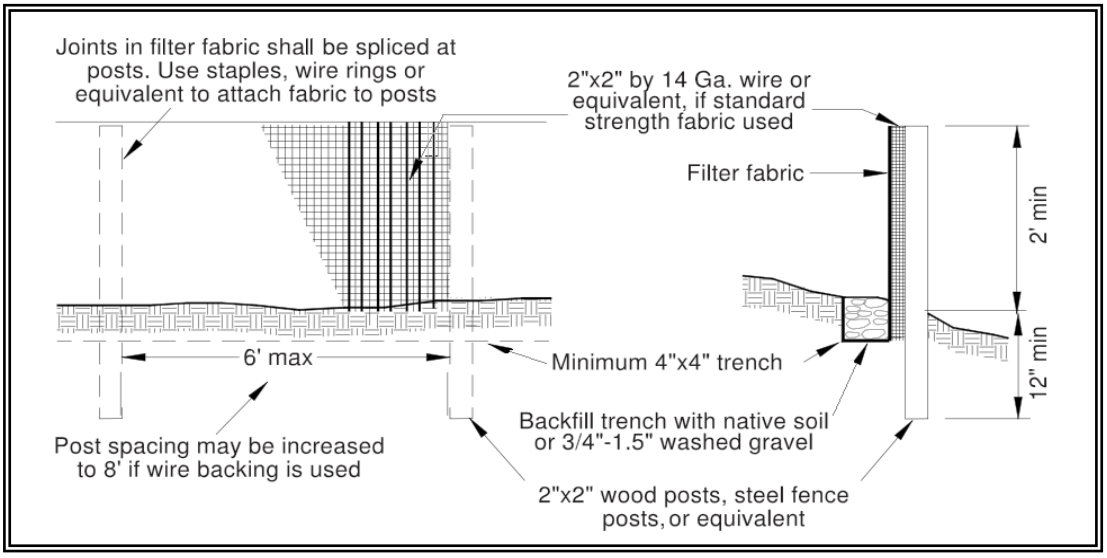


Figure 4.2.12 – Silt Fence

Design and Installation Specifications

- Use in combination with sediment basins or other BMPs.
- Maximum slope steepness (normal (perpendicular) to fence line) 1H:1V.
- Maximum sheet or overland flow path length to the fence of 100 feet.
- Do not allow flows greater than 0.5 cfs.
- The geotextile used shall meet the following standards. All geotextile properties listed below are minimum average roll values (i.e., the test result for any sampled roll in a lot shall meet or exceed the values shown in Table 4.2.3):

Table 4.2.3
Geotextile Standards

Polymeric Mesh AOS (ASTM D4751)	0.60 mm maximum for slit film woven (#30 sieve). 0.30 mm maximum for all other geotextile types (#50 sieve). 0.15 mm minimum for all fabric types (#100 sieve).
Water Permittivity (ASTM D4491)	0.02 sec^{-1} minimum
Grab Tensile Strength (ASTM D4632)	180 lbs. Minimum for extra strength fabric. 100 lbs minimum for standard strength fabric.
Grab Tensile Strength (ASTM D4632)	30% maximum
Ultraviolet Resistance (ASTM D4355)	70% minimum

- Support standard strength fabrics with wire mesh, chicken wire, 2-inch x 2-inch wire, safety fence, or jute mesh to increase the strength of the

fabric. Silt fence materials are available that have synthetic mesh backing attached.

- Filter fabric material shall contain ultraviolet ray inhibitors and stabilizers to provide a minimum of six months of expected usable construction life at a temperature range of 0°F. to 120°F.
- One-hundred percent biodegradable silt fence is available that is strong, long lasting, and can be left in place after the project is completed, if permitted by local regulations.
- Refer to Figure 4.2.12 for standard silt fence details. Include the following standard Notes for silt fence on construction plans and specifications:

    1. The contractor shall install and maintain temporary silt fences at the locations shown in the Plans.
    2. Construct silt fences in areas of clearing, grading, or drainage prior to starting those activities.
    3. The silt fence shall have a 2-feet min. and a 2½-feet max. height above the original ground surface.
    4. The filter fabric shall be sewn together at the point of manufacture to form filter fabric lengths as required. Locate all sewn seams at support posts. Alternatively, two sections of silt fence can be overlapped, provided the Contractor can demonstrate, to the satisfaction of the Engineer, that the overlap is long enough and that the adjacent fence sections are close enough together to prevent silt laden water from escaping through the fence at the overlap.
    5. Attach the filter fabric on the up-slope side of the posts and secure with staples, wire, or in accordance with the manufacturer's recommendations. Attach the filter fabric to the posts in a manner that reduces the potential for tearing.
    6. Support the filter fabric with wire or plastic mesh, dependent on the properties of the geotextile selected for use. If wire or plastic mesh is used, fasten the mesh securely to the up-slope side of the posts with the filter fabric up-slope of the mesh.
    7. Mesh support, if used, shall consist of steel wire with a maximum mesh spacing of 2-inches, or a prefabricated polymeric mesh. The strength of the wire or polymeric mesh shall be equivalent to or greater than 180 lbs. grab tensile strength. The polymeric mesh must be as resistant to the same level of ultraviolet radiation as the filter fabric it supports.
    8. Bury the bottom of the filter fabric 4-inches min. below the ground surface. Backfill and tamp soil in place over the buried portion of the filter fabric, so that no flow can pass beneath the fence and

scouring cannot occur. When wire or polymeric back-up support mesh is used, the wire or polymeric mesh shall extend into the ground 3-inches min.

9. Drive or place the fence posts into the ground 18-inches min. A 12–inch min. depth is allowed if topsoil or other soft subgrade soil is not present and 18-inches cannot be reached. Increase fence post min. depths by 6 inches if the fence is located on slopes of 3H:1V or steeper and the slope is perpendicular to the fence. If required post depths cannot be obtained, the posts shall be adequately secured by bracing or guying to prevent overturning of the fence due to sediment loading.
10. Use wood, steel or equivalent posts. The spacing of the support posts shall be a maximum of 6-feet. Posts shall consist of either:
    - Wood with dimensions of 2-inches by 2-inches wide min. and a 3-feet min. length. Wood posts shall be free of defects such as knots, splits, or gouges.
    - No. 6 steel rebar or larger.
    - ASTM A 120 steel pipe with a minimum diameter of 1-inch.
    - U, T, L, or C shape steel posts with a minimum weight of 1.35 lbs./ft.
    - Other steel posts having equivalent strength and bending resistance to the post sizes listed above.
11. Locate silt fences on contour as much as possible, except at the ends of the fence, where the fence shall be turned uphill such that the silt fence captures the runoff water and prevents water from flowing around the end of the fence.
12. If the fence must cross contours, with the exception of the ends of the fence, place gravel check dams perpendicular to the back of the fence to minimize concentrated flow and erosion. The slope of the fence line where contours must be crossed shall not be steeper than 3H:1V.
    - Gravel check dams shall be approximately 1-foot deep at the back of the fence. Gravel check dams shall be continued perpendicular to the fence at the same elevation until the top of the check dam intercepts the ground surface behind the fence.
    - Gravel check dams shall consist of crushed surfacing base course, gravel backfill for walls, or shoulder ballast. Gravel check dams shall be located every 10 feet along the fence where the fence must cross contours.

- Refer to Figure 4.2.13 for slicing method details. Silt fence installation using the slicing method specifications:

1. The base of both end posts must be at least 2- to 4-inches above the top of the filter fabric on the middle posts for ditch checks to drain properly. Use a hand level or string level, if necessary, to mark base points before installation.
2. Install posts 3- to 4-feet apart in critical retention areas and 6- to 7-feet apart in standard applications.
3. Install posts 24-inches deep on the downstream side of the silt fence, and as close as possible to the filter fabric, enabling posts to support the filter fabric from upstream water pressure.
4. Install posts with the nipples facing away from the filter fabric.
5. Attach the filter fabric to each post with three ties, all spaced within the top 8-inches of the filter fabric. Attach each tie diagonally 45 degrees through the filter fabric, with each puncture at least 1-inch vertically apart. Each tie should be positioned to hang on a post nipple when tightening to prevent sagging.
6. Wrap approximately 6-inches of fabric around the end posts and secure with 3 ties.
7. No more than 24-inches of a 36-inch filter fabric is allowed above ground level.

   Compact the soil immediately next to the filter fabric with the front wheel of the tractor, skid steer, or roller exerting at least 60 pounds per square inch. Compact the upstream side first and then each side twice for a total of four trips. Check and correct the silt fence installation for any deviation before compaction. Use a flat-bladed shovel to tuck fabric deeper into the ground if necessary.

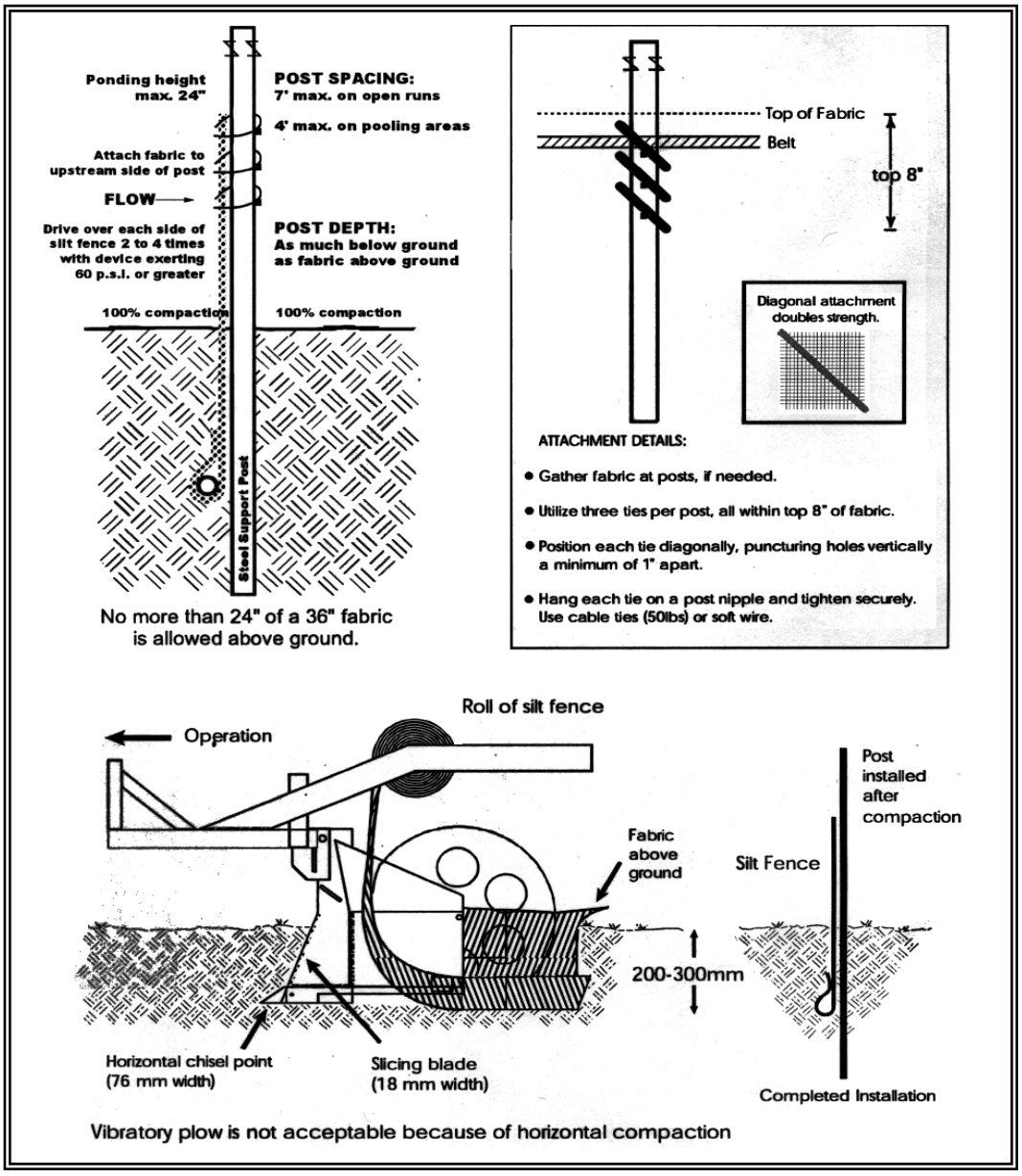


Figure 4.2.13 – Silt Fence Installation by Slicing Method

Maintenance Standards

- Repair any damage immediately.
- Intercept and convey all evident concentrated flows uphill of the silt fence to a sediment pond.
- Check the uphill side of the fence for signs of the fence clogging and acting as a barrier to flow and then causing channelization of flows parallel to the fence. If this occurs, replace the fence or remove the trapped sediment.

- Remove sediment deposits when the deposit reaches approximately one-third the height of the silt fence, or install a second silt fence.
- Replace filter fabric that has deteriorated due to ultraviolet breakdown.

BMP C234: Vegetated Strip

Purpose

Vegetated strips reduce the transport of coarse sediment from a construction site by providing a temporary physical barrier to sediment and reducing the runoff velocities of overland flow.

Conditions of Use

- Vegetated strips may be used downslope of all disturbed areas.
- Vegetated strips are not intended to treat concentrated flows, nor are they intended to treat substantial amounts of overland flow. Any concentrated flows must be conveyed through the drainage system to a sediment pond. The only circumstance in which overland flow can be treated solely by a strip, rather than by a sediment pond, is when the following criteria are met (see Table 4.2.4):

Table 4.2.4
Contributing Drainage Area for Vegetated Strips

Average Contributing area Slope	Average Contributing area Percent Slope	Max Contributing area Flowpath Length
1.5H:1V or flatter	67% or flatter	100 feet
2H:1V or flatter	50% or flatter	115 feet
4H:1V or flatter	25% or flatter	150 feet
6H:1V or flatter	16.7% or flatter	200 feet
10H:1V or flatter	10% or flatter	250 feet

Design and Installation Specifications

- The vegetated strip shall consist of a minimum of a 25-foot flowpath length continuous strip of dense vegetation with topsoil. Grass-covered, landscaped areas are generally not adequate because the volume of sediment overwhelms the grass. Ideally, vegetated strips shall consist of undisturbed native growth with a well-developed soil that allows for infiltration of runoff.
- The slope within the strip shall not exceed 4H:1V.
- The uphill boundary of the vegetated strip shall be delineated with clearing limits.

Maintenance Standards

- Any areas damaged by erosion or construction activity shall be seeded immediately and protected by mulch.
- If more than 5 feet of the original vegetated strip width has had vegetation removed or is being eroded, sod must be installed.
- If there are indications that concentrated flows are traveling across the buffer, surface water controls must be installed to reduce the flows

entering the buffer, or additional perimeter protection must be installed.

BMP C235: Wattles

Purpose

Wattles are temporary erosion and sediment control barriers consisting of straw, compost, or other material that is wrapped in biodegradable tubular plastic or similar encasing material. They reduce the velocity and can spread the flow of rill and sheet runoff, and can capture and retain sediment. Wattles are typically 8 to 10 inches in diameter and 25 to 30 feet in length. Wattles are placed in shallow trenches and staked along the contour of disturbed or newly constructed slopes. See Figure 4.2.14 for typical construction details. WSDOT Standard Plan I-30.30-00 also provides information on Wattles (http://www.wsdot.wa.gov/Design/Standards/Plans.htm#SectionI)

Conditions of Use

- Use wattles:
  - In disturbed areas that require immediate erosion protection.
  - On exposed soils during the period of short construction delays, or over winter months.
  - On slopes requiring stabilization until permanent vegetation can be established.
- The material used dictates the effectiveness period of the wattle. Generally, Wattles are typically effective for one to two seasons.
- Prevent rilling beneath wattles by properly entrenching and abutting wattles together to prevent water from passing between them.

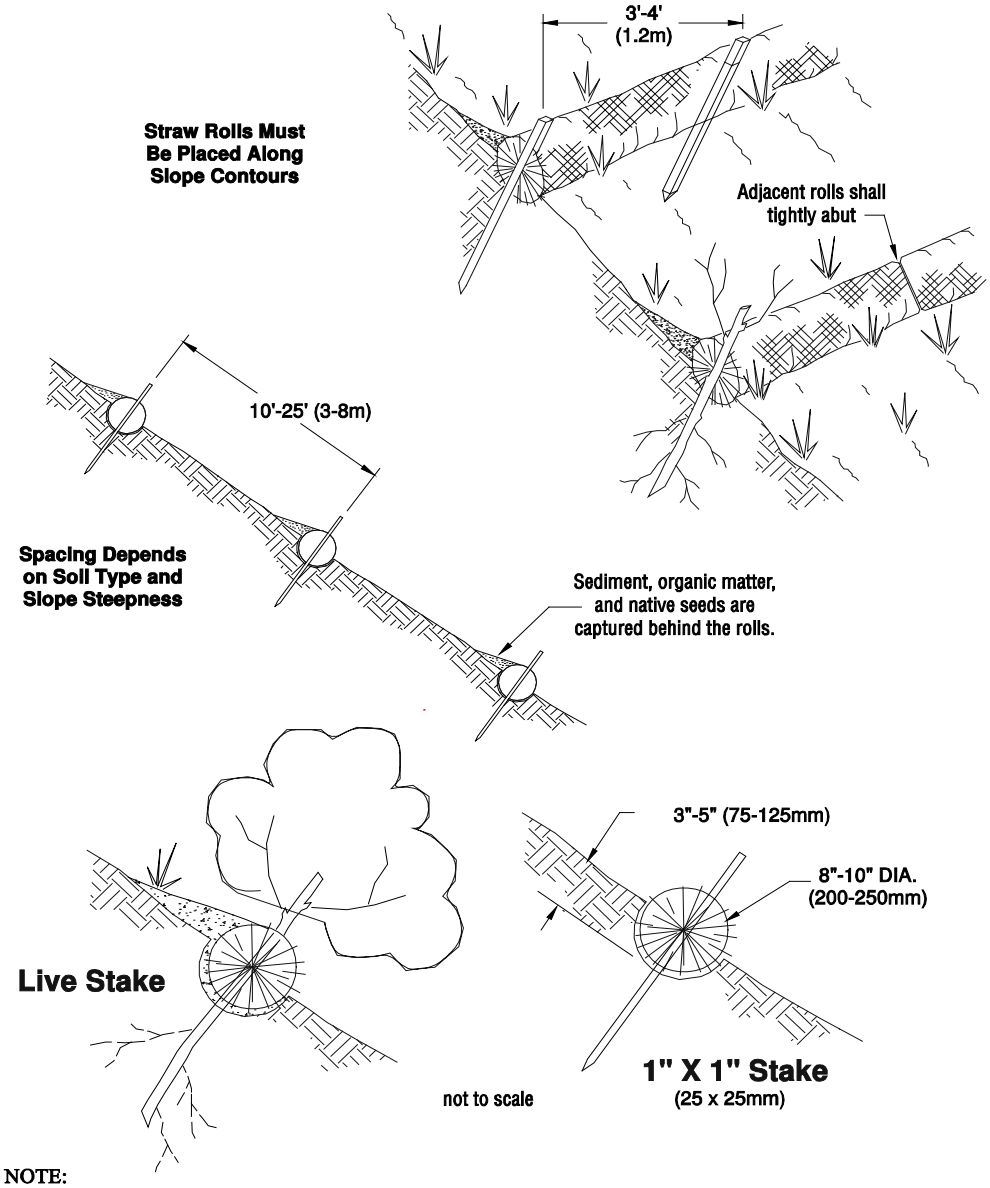
Design Criteria

- Install wattles perpendicular to the flow direction and parallel to the slope contour.
- Narrow trenches should be dug across the slope on contour to a depth of 3- to 5-inches on clay soils and soils with gradual slopes. On loose soils, steep slopes, and areas with high rainfall, the trenches should be dug to a depth of 5- to 7- inches, or 1/2 to 2/3 of the thickness of the wattle.
- Start building trenches and installing wattles from the base of the slope and work up. Spread excavated material evenly along the uphill slope and compacted using hand tamping or other methods.
- Construct trenches at intervals of 10- to 25-feet depending on the steepness of the slope, soil type, and rainfall. The steeper the slope the closer together the trenches.
- Install the wattles snugly into the trenches and abut tightly end to end. Do not overlap the ends.
- Install stakes at each end of the wattle, and at 4-foot centers along entire length of wattle.

- If required, install pilot holes for the stakes using a straight bar to drive holes through the wattle and into the soil.
- Wooden stakes should be approximately 3/4 x 3/4 x 24 inches min. Willow cuttings or 3/8-inch rebar can also be used for stakes.
- Stakes should be driven through the middle of the wattle, leaving 2 to 3 inches of the stake protruding above the wattle.

Maintenance Standards

- Wattles may require maintenance to ensure they are in contact with soil and thoroughly entrenched, especially after significant rainfall on steep sandy soils.



NOTE:
1. Straw roll installation requires the placement and secure staking of the roll in a trench, 3"-5" (75-125mm) deep, dug on contour. runoff must not be allowed to run under or around roll.

Figure 4.2.14 – Wattles

- Inspect the slope after significant storms and repair any areas where wattles are not tightly abutted or water has scoured beneath the wattles.

Approved as Equivalent

Ecology has approved products as able to meet the requirements of BMP C235. The products did not pass through the Technology Assessment Protocol – Ecology (TAPE) process. Local jurisdictions may choose not to accept this product approved as equivalent, or may require additional testing prior to consideration for local use. The products are available for review on Ecology's website at http://www.ecy.wa.gov/programs/wq/stormwater/newtech/equivalent.html

BMP C236: Vegetative Filtration

Purpose

Vegetative Filtration may be used in conjunction with BMP C241 Temporary Sediment Ponds, BMP C206 Level Spreader and a pumping system with surface intake to improve turbidity levels of stormwater discharges by filtering through existing vegetation where undisturbed forest floor duff layer or established lawn with thatch layer are present. Vegetative Filtration can also be used to infiltrate dewatering waste from foundations, vaults, and trenches as long as runoff does not occur.

Conditions of Use

- For every five acre of disturbed soil use one acre of grass field, farm pasture, or wooded area. Reduce or increase this area depending on project size, ground water table height, and other site conditions.
- Wetlands shall not be used for filtration.
- Do not use this BMP in areas with a high ground water table, or in areas that will have a high seasonal ground water table during the use of this BMP.
- This BMP may be less effective on soils that prevent the infiltration of the water, such as hard till.
- Using other effective source control measures throughout a construction site will prevent the generation of additional highly turbid water and may reduce the time period or area need for this BMP.
- Stop distributing water into the vegetated area if standing water or erosion results.

Design Criteria

- Find land adjacent to the project that has a vegetated field, preferably a farm field, or wooded area.
- If the project site does not contain enough vegetated field area consider obtaining permission from adjacent landowners (especially for farm fields).
- Install a pump and downstream distribution manifold depending on the project size. Generally, the main distribution line should reach 100 to 200-feet long (many large projects, or projects on tight soil, will

require systems that reach several thousand feet long with numerous branch lines off of the main distribution line).

- The manifold should have several valves, allowing for control over the distribution area in the field.
- Install several branches of 4" schedule 20, swaged-fit common septic tight-lined sewer line, or 6" fire hose, which can convey the turbid water out to various sections of the field. See Figure 4.2.15.
- Determine the branch length based on the field area geography and number of branches. Typically, branches stretch from 200-feet to several thousand feet. Always, lay branches on contour with the slope.
- On uneven ground, sprinklers perform well. Space sprinkler heads so that spray patterns do not overlap.
- On relatively even surfaces, a level spreader using 4-inch perforated pipe may be used as an alternative option to the sprinkler head setup. Install drain pipe at the highest point on the field and at various lower elevations to ensure full coverage of the filtration area. Pipe should be place with the holes up to allow for a gentle weeping of stormwater evenly out all holes. Leveling the pipe by staking and using sandbags may be required.
- To prevent the over saturation of the field area, rotate the use of branches or spray heads. Do this as needed based on monitoring the spray field.
- Monitor the spray field on a daily basis to ensure that over saturation of any portion of the field doesn't occur at any time. The presence of standing puddles of water or creation of concentrated flows visually signify that over saturation of the field has occurred.
- Since the operator is handling contaminated water, physically monitor the vegetated spray field all the way down to the nearest surface water, or furthest spray area, to ensure that the water has not caused overland or concentrated flows, and has not created erosion around the spray nozzle.
- Monitoring usually needs to take place 3-5 times per day to ensure sheet-flow into state waters. Do not exceed water quality standards for turbidity.
- Ecology strongly recommends that a separate inspection log be developed, maintained and kept with the existing site logbook to aid the operator conducting inspections. This separate "Field Filtration Logbook" can also aid the facility in demonstrating compliance with permit conditions.

Maintenance Standards

- Inspect the spray nozzles daily, at a minimum, for leaks and plugging from sediment particles.

- If erosion, concentrated flows, or over saturation of the field occurs, rotate the use of branches or spray heads or move the branches to a new field location.
- Check all branches and the manifold for unintended leaks.

Flowpath Guidelines for Vegetative Filtration		
Average Slope	Average Area % Slope	Estimated Flowpath Length (ft)
1.5H:1V	67%	250
2H:1V	50%	200
4H:1V	25%	150
6H:1V	16.7%	115
10H:1V	10%	100



Figure 4.2.15 – Manifold and Braches in a wooded, vegetated spray field

APPENDIX C – Soils Report

January 22, 2026

Alex Holtze
ASH Holdings LLC
3425 Merryman Pl SE
Olympia, WA 98501

Re: 5th Ave Townhomes Soils Report for Design Infiltration Rates
Site Address: 585 5th Ave SW, Tumwater, WA 98512
Tax Parcel No.: 33203200001

Dear Mr. Holtze:

At your request, I have prepared this soils report. A site visit was performed on 12/12/25 to assess site conditions.

The subject site consists of an undeveloped lot in a mostly cleared area of a residential area. The lot is located on the west side of 5th Avenue SW.

The site topography is generally sloping from the west to east. The property is bordered on all sides by residential lots. The approximately 1.69 acre (Per Thurston County Assessor data) property is vegetated with grass, shrubs and a few trees.

The United States Natural Resource Conservation Service maps the soils in the area as Kapowsin silt loam. These soils are listed as Type D soils.

Groundwater was in one of the test pits.

The existing tributary offsite Stormwater generally sheet flows onto the site on the northern portion of the property. The stormwater then drains through the property and discharges via sheet flow on the southwestern portion of the parcel. The project is located in an aquifer recharge area and a wellhead protection area as defined by the Thurston County Health Department, the EPA or by the county. There are no known ravines, or wetlands located on the site. There are no known basin plans for the area. Refer to the attachments for applicable Soils Maps.

The Washington Geologic Information Portal lists the onsite soils as the following:

Geologic Unit Label: Qgd

Geologic Age: Quaternary (Pleistocene)

Lithology: Pleistocene continental glacial drift

Geologic Unit Description: Pleistocene till and outwash clay, silt, sand, gravel, cobbles, and boulders deposited by or originating from continental glaciers; locally includes peat, nonglacial sediments, modified land, and artificial fill.

There were two test pits dug and three small pit infiltration test dug onsite to determine soil infiltration feasibility. It appeared to have soils consistent with Kapowsin silt loam. There were three soil sieve test performed at the bottom of each of the small pit infiltration test locations. Each of the tests revealed similar soils shown to be SM - Silty Sand with Gravel down to approximately 42". Below this level to approximately 5' is fractured weathered basalt. Ground water was observed in the lower test pit located in the flow line of the natural grade in the weathered basalt. It appeared to be flowing quickly.

On 12/12/26 The there small pit infiltration tests were performed per Thurston County Surface Water Design Manual.

Small Pit Test 1: The measured infiltration rate was 12.00 inches per hour.

Idesign = Imeasured x Ftesting x Fgeometry x Fplugging

For single ring: Fgeometry = 4D/W + 0.05 = 4(12in/48 in) + 0.05 = 1.05 therefore use 1.0
Fplugging = 0.8 for fine sands and loamy sands
Ftesting = 0.5

Idesign = 4.8 inches per hour

As a result of this test the recommended design infiltration rate for the infiltration trench and permeable pavement is 4.8 inches per hour.

Small Pit Test 2: The measured infiltration rate was 33 inches per hour.

Idesign = Imeasured x Ftesting x Fgeometry x Fplugging

For single ring: Fgeometry = 4D/W + 0.05 = 4(12in/48 in) + 0.05 = 1.05 therefore use 1.0
Fplugging = 0.8 for fine sands and loamy sands
Ftesting = 0.5

Idesign = 4.8 inches per hour

As a result of this test the recommended design infiltration rate for the infiltration trench and permeable pavement is 13.2 inches per hour.

Small Pit Test 3: The measured infiltration rate was 3.20 inches per hour.

Idesign = Imeasured x Ftesting x Fgeometry x Fplugging

For single ring: Fgeometry = 4D/W + 0.05 = 4(12in/48 in) + 0.05 = 1.05 therefore use 1.0
Fplugging = 0.8 for fine sands and loamy sands
Ftesting = 0.5

Idesign = 1.28 inches per hour

As a result of the above tests we recommend using a design infiltration rate of 4.8 in/hr for the onsite bioretention pond and 1.28 in/hr for the frontage bioretention pond.

Once again, thank you for the opportunity to work with you on this project. Please feel free to give me a call if you have any questions.

Sincerely,

The Land Developer, Inc.



Erik B. Ainsworth, PE
President



Attachments:
SCS Soils Map
Site plan with soil logs
Sieve Report



Map Scale: 1:1,770 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 25 50 100 150

Feet: 0 50 100 200 300

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

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

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

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

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

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

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

Soil Survey Area: Thurston County Area, Washington
Survey Area Data: Version 18, Aug 27, 2024

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

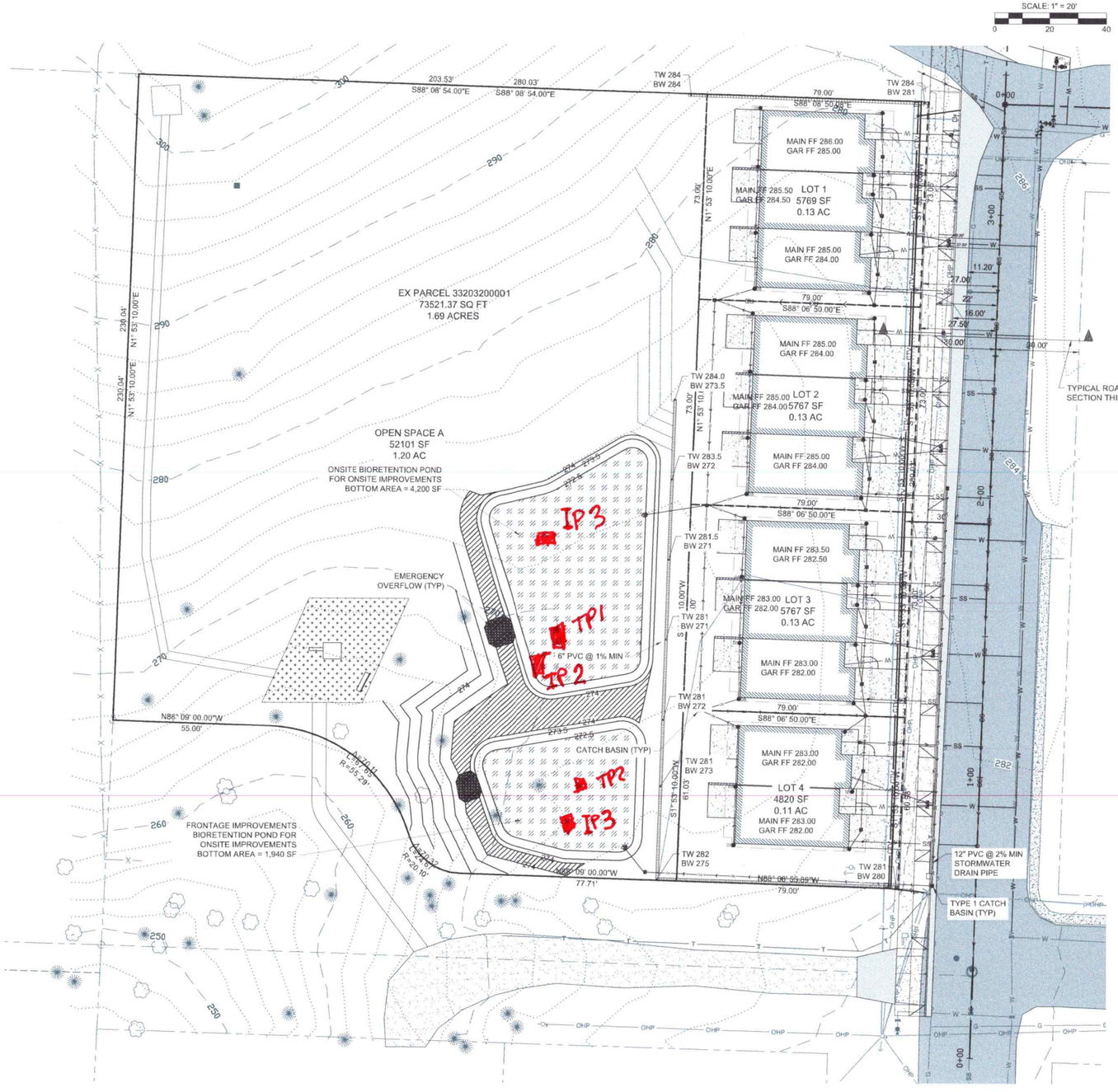
Date(s) aerial images were photographed: Jul 31, 2022—Aug 14, 2023

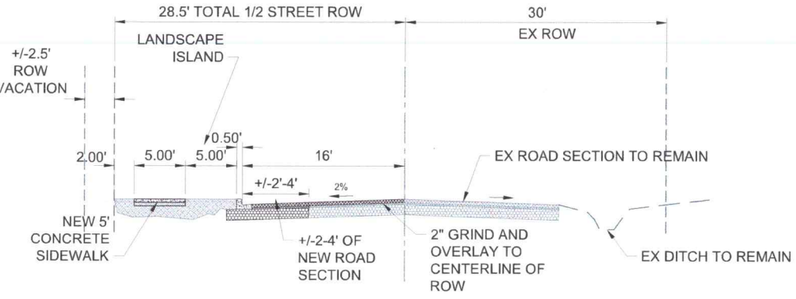
The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
39	Giles silt loam, 3 to 15 percent slopes	0.2	1.7%
52	Kapowsin silt loam, 15 to 30 percent slopes	13.5	98.3%
Totals for Area of Interest		**13.7**	**100.0%**

SE 1/4, SECTION 27, TOWNSHIP 18 N., RANGE 2 W., W.M.





B FRONTAGE STREET SECTION
N.T.S.

THE LAND DEVELOPER'S ENGINEERED SOLUTION
a division of THE LAND DEVELOPER, INC.
5737 LINDERSON WAY SW.
TUMWATER, WA. 98501
PO BOX 4420, TUMWATER, WA. 98501
(360) 890-4806
E-MAIL: erik@thelanddeveloper.com

STATE OF WASHINGTON ERIK A. BRAATEN 38284 REGISTERED PROFESSIONAL ENGINEER
9/24/2026

REVISIONS: DATE:

5TH AVE TOWNHOMES

GRADING & DRAINAGE PLAN

PROJECT:
HOLTZE TOWNHOMES
5 585 S 5TH AVE SW
TUMWATER, WA 98512

CLIENT:
ASH HOLDINGS LLC
3425 MERRYMAN PL SE
OLYMPIA, WA 98501

DRAWN BY: EBA
DATE: 9/24/25
AGENCY NO:
SHEET: 3 OF 4
JOB NO: 21-132

Project: 5th Ave Townhomes	Project Number: 23-093	Client: Alex Holtze	Test Pit No. 2
Address, City, State 585 5th Ave SW, Tumwater, WA 98512		Excavator pit test	
Logged By: EBA	Date: Started: 11AM		
Weather: Overcast	Completed: 12:00PM		
	Backfilled: YES		
	Groundwater Depth: None observed	Elevation:	Total Depth of test pit: 8'

Depth (feet)	Sample Type	Sample Number	Blow Counts (blows/foot)	Graphic Log	Lithology **Soil Group Name:** modifier, color, moisture, density/consistency, grain size, other descriptors **Rock Description:** modifierm color, hardness/degree of concentration, bedding and joint characteristics, solutions, void conditions.	Dry Density (pcf)	Moisture Content (%)	Additional Test
					Brown silty sand with gravel topsoil with roots			
	☒	3			Brown Medium Dense Silty Sand with Gravel SM Bulk/ Bag Sample			
5					Brown Medium Dense fractured weathered basalt			
					End test pit @ 5 ft, No groundwater observed			
10								

Civil Engineering

Boring Log: Sheet __of ___

- Standard Penetration Slit Spoon Sampler (SPT)
- California Sampler
- Shelby Tube
- CPP Sampler
- Bulk/ Bag Sample
- Stabllized Ground water
- Groundwater At time of Drilling

Project: 5th Ave Townhomes	Project Number: 23-093	Client: Alex Holtze	Test Pit No. 1
Address, City, State 585 5th Ave SW, Tumwater, WA 98512		Excavator pit test	
Logged By: EBA	Date: Started: 11AM		
Weather: Overcast	Completed: 12:00PM		
	Backfilled: YES		
	Groundwater Depth: Observed @ 42"	Elevation:	Total Depth of test pit: 8'

Depth (feet)	Sample Type	Sample Number	Blow Counts (blows/foot)	Graphic Log	Lithology **Soil Group Name:** modifier, color, moisture, density/consistency, grain size, other descriptors **Rock Description:** modifierm color, hardness/degree of concentration, bedding and joint characteristics, solutions, void conditions.	Dry Density (pcf)	Moisture Content (%)	Additional Test
					Brown silty sand with gravel topsoil with roots			
	☒	1			Brown Medium Dense Silty Sand with Gravel SM Bulk/ Bag Sample			
	▼							
					Brown Medium Dense fractured weathered basalt GROUNDWATER FLOWING THROUGH FRACTURED ROCK			
5								
					End test pit @ 5 ft, groundwater observed @ 42"			
10								

Civil Engineering

Boring Log: Sheet __of ___

- Standard Penetration Slit Spoon Sampler (SPT)
- California Sampler
- Shelby Tube
- CPP Sampler
- Bulk/ Bag Sample
- ▼ Stabllized Ground water
- ▽ Groundwater At time of Drilling

MATERIALS TESTING & CONSULTING, INC.

Testing Laboratory: Olympia Laboratory

Sieve Report

Project:	5th Townhomes / Q.C. - The Land Developers - 2025	**Date Received:**	16-Dec-25
Project #:	21-132 / 25S036	**Sampled By:**	Client
Client:	The Land Developer's Engineered Solution	**Date Tested:**	17-Dec-25
Source:	IP2 @ 1.5'	**Tested By:**	G. Dudley
Sample#:	S25-1009	**Control No.:**	

Unified Soil Classification System, ASTM-2487
SM, Silty Sand with Gravel
Sample Color:
Brown

Method(s) ASTM D-2216, ASTM D-2419, ASTM D4318, ASTM D-5281

Specifications
No Specs

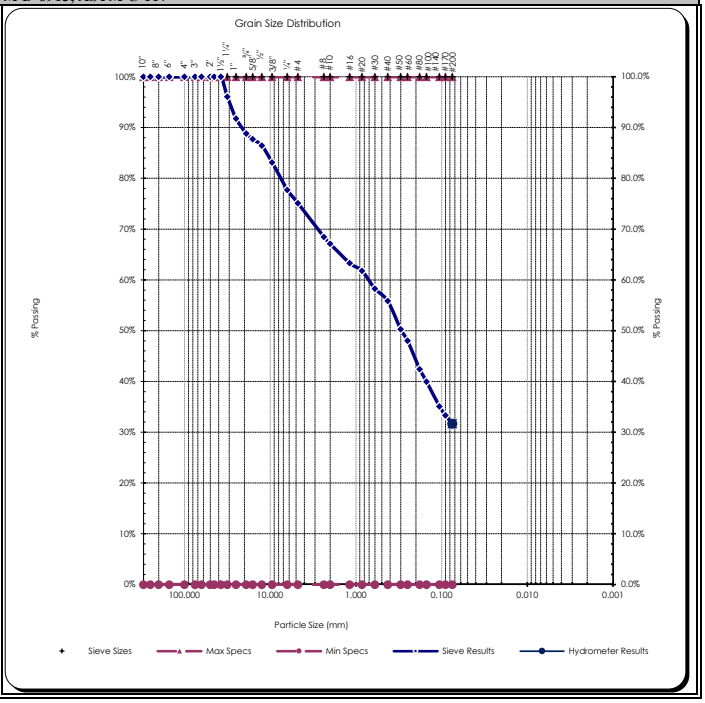
Sample Meets Specs ? N/A

$D_{(5)}$ =	0.012	mm	% Gravel =	24.9%	Coeff. of Curvature, C_C = 0.29
$D_{(10)}$ =	0.024	mm	% Sand =	43.4%	Coeff. of Uniformity, C_U = 30.55
$D_{(15)}$ =	0.036	mm	% Silt & Clay =	31.7%	Fineness Modulus = 2.73
$D_{(30)}$ =	0.071	mm	Liquid Limit =	n/a	Plastic Limit = n/a
$D_{(50)}$ =	0.294	mm	Plasticity Index =	n/a	Moisture %, as sampled = 19.6%
$D_{(60)}$ =	0.723	mm	Sand Equivalent =	n/a	Req'd Sand Equivalent =
$D_{(90)}$ =	21.372	mm	Fracture %, 1 Face =	n/a	Req'd Fracture %, 1 Face =
Dust Ratio =	21/37		Fracture %, 2+ Faces =	n/a	Req'd Fracture %, 2+ Faces =

Method(s) ASTM C-136, ASTM D-6913, ASTM C-117

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
12.00"	300.00		100%	100.0%	0.0%
10.00"	250.00		100%	100.0%	0.0%
8.00"	200.00		100%	100.0%	0.0%
6.00"	150.00		100%	100.0%	0.0%
4.00"	100.00		100%	100.0%	0.0%
3.00"	75.00		100%	100.0%	0.0%
2.50"	63.00		100%	100.0%	0.0%
2.00"	50.00		100%	100.0%	0.0%
1.75"	45.00		100%	100.0%	0.0%
1.50"	37.50	100%	100%	100.0%	0.0%
1.25"	31.50		96%	100.0%	0.0%
1.00"	25.00	92%	92%	100.0%	0.0%
3/4"	19.00	89%	89%	100.0%	0.0%
5/8"	16.00		88%	100.0%	0.0%
1/2"	12.50	86%	86%	100.0%	0.0%
3/8"	9.50	83%	83%	100.0%	0.0%
1/4"	6.30		78%	100.0%	0.0%
#4	4.75	75%	75%	100.0%	0.0%
#8	2.36	68%	68%	100.0%	0.0%
#10	2.00	67%	67%	100.0%	0.0%
#16	1.18		63%	100.0%	0.0%
#20	0.850	62%	62%	100.0%	0.0%
#30	0.600		58%	100.0%	0.0%
#40	0.425	56%	56%	100.0%	0.0%
#50	0.300		50%	100.0%	0.0%
#60	0.250	48%	48%	100.0%	0.0%
#80	0.180	42%	42%	100.0%	0.0%
#100	0.150	40%	40%	100.0%	0.0%
#140	0.106		35%	100.0%	0.0%
#170	0.090		33%	100.0%	0.0%
#200	0.075	31.7%	31.7%	100.0%	0.0%

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Comments:

Reviewed by: Chandler Kirk-Patterson
Chandler Kirk-Patterson
WABO Supervising Laboratory Technician

- End of Report -

MATERIALS TESTING & CONSULTING, INC.

Testing Laboratory: Olympia Laboratory

Sieve Report

Project:	5th Townhomes / Q.C. - The Land Developers - 2025	**Date Received:**	16-Dec-25
Project #:	21-132 / 25S036	**Sampled By:**	Client
Client:	The Land Developer's Engineered Solution	**Date Tested:**	17-Dec-25
Source:	IP3 @ 1.5'	**Tested By:**	G. Dudley
Sample#:	S25-1010	**Control No.:**	

Unified Soil Classification System, ASTM-2487
SM, Silty Sand with Gravel
Sample Color:
Brown

Method(s) ASTM D-2216, ASTM D-2419, ASTM D4318, ASTM D-5281

Specifications
No Specs

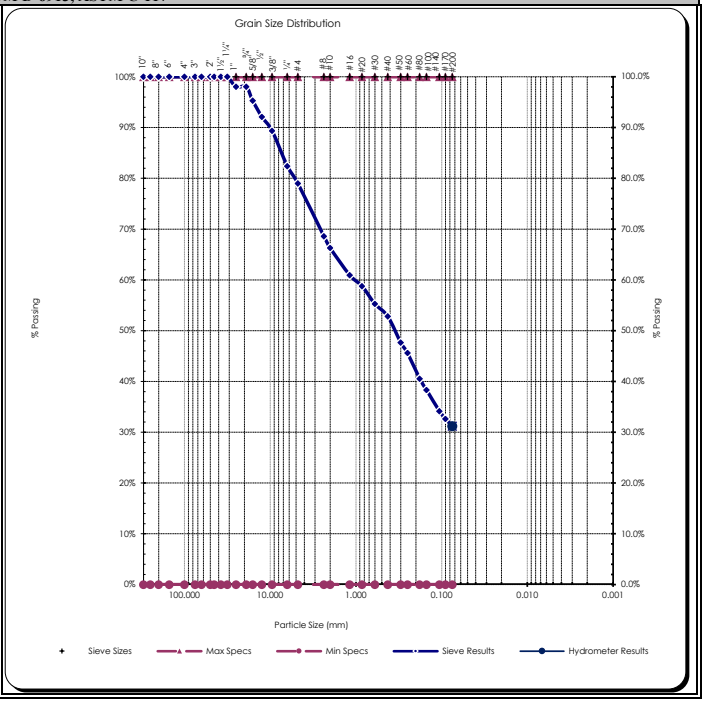
Sample Meets Specs ? N/A

$D_{(5)}$ =	0.012	mm	% Gravel =	21.0%	Coeff. of Curvature, C_C = 0.21
$D_{(10)}$ =	0.024	mm	% Sand =	47.8%	Coeff. of Uniformity, C_U = 43.13
$D_{(15)}$ =	0.036	mm	% Silt & Clay =	31.2%	Fineness Modulus = 2.63
$D_{(30)}$ =	0.072	mm	Liquid Limit =	n/a	Plastic Limit = n/a
$D_{(50)}$ =	0.357	mm	Plasticity Index =	n/a	Moisture %, as sampled = 21.0%
$D_{(60)}$ =	1.037	mm	Sand Equivalent =	n/a	Req'd Sand Equivalent =
$D_{(90)}$ =	10.200	mm	Fracture %, 1 Face =	n/a	Req'd Fracture %, 1 Face =
Dust Ratio =	13/22		Fracture %, 2+ Faces =	n/a	Req'd Fracture %, 2+ Faces =

Method(s) ASTM C-136, ASTM D-6913, ASTM C-117

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
12.00"	300.00		100%	100.0%	0.0%
10.00"	250.00		100%	100.0%	0.0%
8.00"	200.00		100%	100.0%	0.0%
6.00"	150.00		100%	100.0%	0.0%
4.00"	100.00		100%	100.0%	0.0%
3.00"	75.00		100%	100.0%	0.0%
2.50"	63.00		100%	100.0%	0.0%
2.00"	50.00		100%	100.0%	0.0%
1.75"	45.00		100%	100.0%	0.0%
1.50"	37.50		100%	100.0%	0.0%
1.25"	31.50	100%	100%	100.0%	0.0%
1.00"	25.00	98%	98%	100.0%	0.0%
3/4"	19.00	98%	98%	100.0%	0.0%
5/8"	16.00		95%	100.0%	0.0%
1/2"	12.50	92%	92%	100.0%	0.0%
3/8"	9.50	89%	89%	100.0%	0.0%
1/4"	6.30		82%	100.0%	0.0%
#4	4.75	79%	79%	100.0%	0.0%
#8	2.36	69%	69%	100.0%	0.0%
#10	2.00	66%	66%	100.0%	0.0%
#16	1.18		61%	100.0%	0.0%
#20	0.850	59%	59%	100.0%	0.0%
#30	0.600		55%	100.0%	0.0%
#40	0.425	53%	53%	100.0%	0.0%
#50	0.300		48%	100.0%	0.0%
#60	0.250	46%	46%	100.0%	0.0%
#80	0.180	41%	41%	100.0%	0.0%
#100	0.150	38%	38%	100.0%	0.0%
#140	0.106		34%	100.0%	0.0%
#170	0.090		33%	100.0%	0.0%
#200	0.075	31.2%	31.2%	100.0%	0.0%

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Comments:

Reviewed by: Chandler Kirk-Patterson
Chandler Kirk-Patterson
WABO Supervising Laboratory Technician

- End of Report -

MATERIALS TESTING & CONSULTING, INC.

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Sieve Report

Project:	5th Townhomes / Q.C. - The Land Developers - 2025	**Date Received:**	16-Dec-25
Project #:	21-132 / 25S036	**Sampled By:**	Client
Client:	The Land Developer's Engineered Solution	**Date Tested:**	17-Dec-25
Source:	IP1 @ 1.5'	**Tested By:**	G. Dudley
Sample#:	S25-1008	**Control No.:**	

Unified Soil Classification System, ASTM-2487
SM, Silty Sand with Gravel
Sample Color:
Brown

Method(s) ASTM D-2216, ASTM D-2419, ASTM D4318, ASTM D-5281

Specifications
No Specs

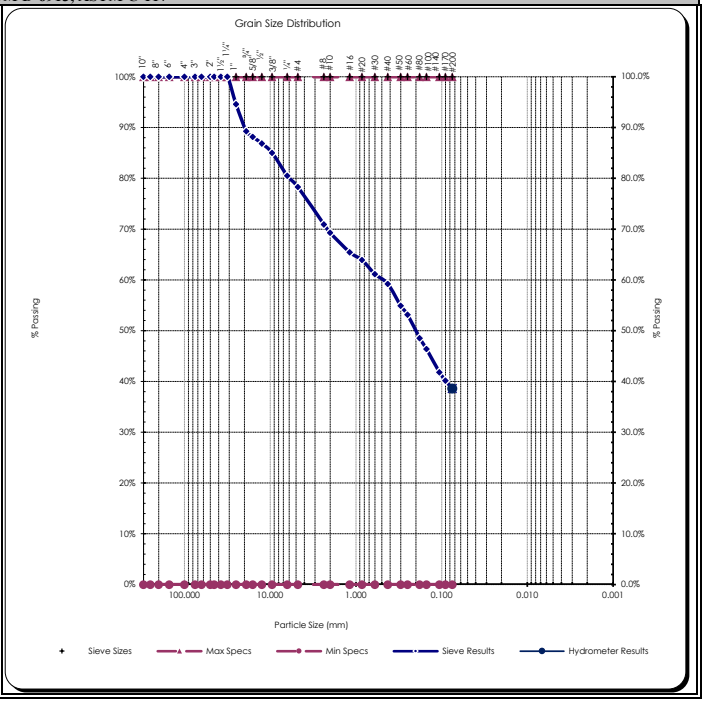
Sample Meets Specs ? N/A

$D_{(5)}$ =	0.010	mm	% Gravel =	21.7%	Coeff. of Curvature, C_C = 0.35
$D_{(10)}$ =	0.019	mm	% Sand =	39.7%	Coeff. of Uniformity, C_U = 25.51
$D_{(15)}$ =	0.029	mm	% Silt & Clay =	38.6%	Fineness Modulus = 2.49
$D_{(30)}$ =	0.058	mm	Liquid Limit =	n/a	Plastic Limit = n/a
$D_{(50)}$ =	0.202	mm	Plasticity Index =	n/a	Moisture %, as sampled = 22.2%
$D_{(60)}$ =	0.496	mm	Sand Equivalent =	n/a	Req'd Sand Equivalent =
$D_{(90)}$ =	19.810	mm	Fracture %, 1 Face =	n/a	Req'd Fracture %, 1 Face =
Dust Ratio =	58/89		Fracture %, 2+ Faces =	n/a	Req'd Fracture %, 2+ Faces =

Method(s) ASTM C-136, ASTM D-6913, ASTM C-117

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
12.00"	300.00		100%	100.0%	0.0%
10.00"	250.00		100%	100.0%	0.0%
8.00"	200.00		100%	100.0%	0.0%
6.00"	150.00		100%	100.0%	0.0%
4.00"	100.00		100%	100.0%	0.0%
3.00"	75.00		100%	100.0%	0.0%
2.50"	63.00		100%	100.0%	0.0%
2.00"	50.00		100%	100.0%	0.0%
1.75"	45.00		100%	100.0%	0.0%
1.50"	37.50		100%	100.0%	0.0%
1.25"	31.50	100%	100%	100.0%	0.0%
1.00"	25.00	95%	95%	100.0%	0.0%
3/4"	19.00	89%	89%	100.0%	0.0%
5/8"	16.00		88%	100.0%	0.0%
1/2"	12.50	87%	87%	100.0%	0.0%
3/8"	9.50	85%	85%	100.0%	0.0%
1/4"	6.30		80%	100.0%	0.0%
#4	4.75	78%	78%	100.0%	0.0%
#8	2.36	71%	71%	100.0%	0.0%
#10	2.00	69%	69%	100.0%	0.0%
#16	1.18		65%	100.0%	0.0%
#20	0.850	64%	64%	100.0%	0.0%
#30	0.600		61%	100.0%	0.0%
#40	0.425	59%	59%	100.0%	0.0%
#50	0.300		55%	100.0%	0.0%
#60	0.250	53%	53%	100.0%	0.0%
#80	0.180	49%	49%	100.0%	0.0%
#100	0.150	46%	46%	100.0%	0.0%
#140	0.106		42%	100.0%	0.0%
#170	0.090		40%	100.0%	0.0%
#200	0.075	38.6%	38.6%	100.0%	0.0%

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Comments:

Reviewed by: Chandler Kirk-Patterson
Chandler Kirk-Patterson
WABO Supervising Laboratory Technician

- End of Report -

PIT TEST 1

AVERAGE INF RATE:	0.200	IN/MIN
	12.00	in/hr
	1	F-GEOMETRY
	0.8	F PLUGGING
	0.5	F TESTING
ADJ INF RATE:	4.8	IN/HR

PIT TEST 2

AVERAGE INF RATE:	0.550	IN/MIN
	33.00	in/hr
	1	F-GEOMETRY
	0.8	F PLUGGING
	0.5	F TESTING
ADJ INF RATE:	13.2	IN/HR

PIT TEST 3

AVERAGE INF RATE:	0.053	IN/MIN
	3.20	in/hr
	1	F-GEOMETRY
	0.8	F PLUGGING
	0.5	F TESTING
ADJ INF RATE:	1.28	IN/HR

APPENDIX D – Maintenance and Source Control Manual

HOMEOWNER'S STORMWATER MAINTENANCE PLAN

of

5th Ave Townhomes Plat
585 5th Ave SW
Tumwater, WA 98512

for

ASH Holdings LLC
3425 Merryman Pl SE
Olympia, WA 98501
aholtze@gmail.com

by

THE LAND DEVELOPER'S
ENGINEERED SOLUTION
A Division of THE LAND DEVELOPER, Inc.

Erik B. Ainsworth, PE
PO Box 4420
Tumwater, WA 98501
(360) 250-3973

January 23, 2026

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I. 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.

What Types of Stormwater Facilities Are There?

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. Roof infiltration trenches serve in infiltrate roof runoff directly into the ground reducing offsite stormwater discharges.

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. Also 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

Your Stormwater Facilities

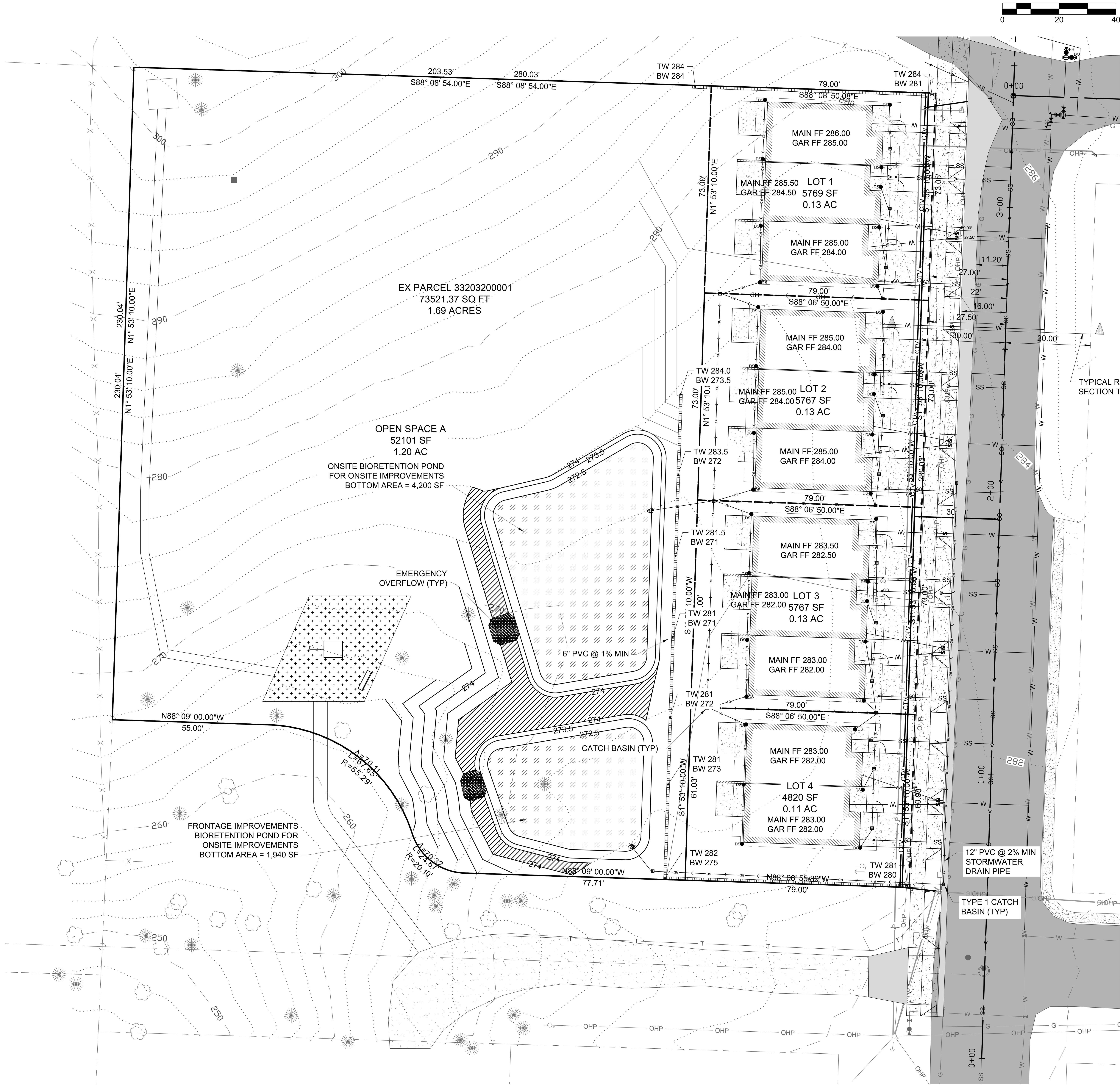
This section consists of two parts that are to be used together: the Facility Key and the Site Plan. Review the Site Plan and identify the numbers denoting a feature of the system. Then check the Facility Key for the feature type and checklist name.

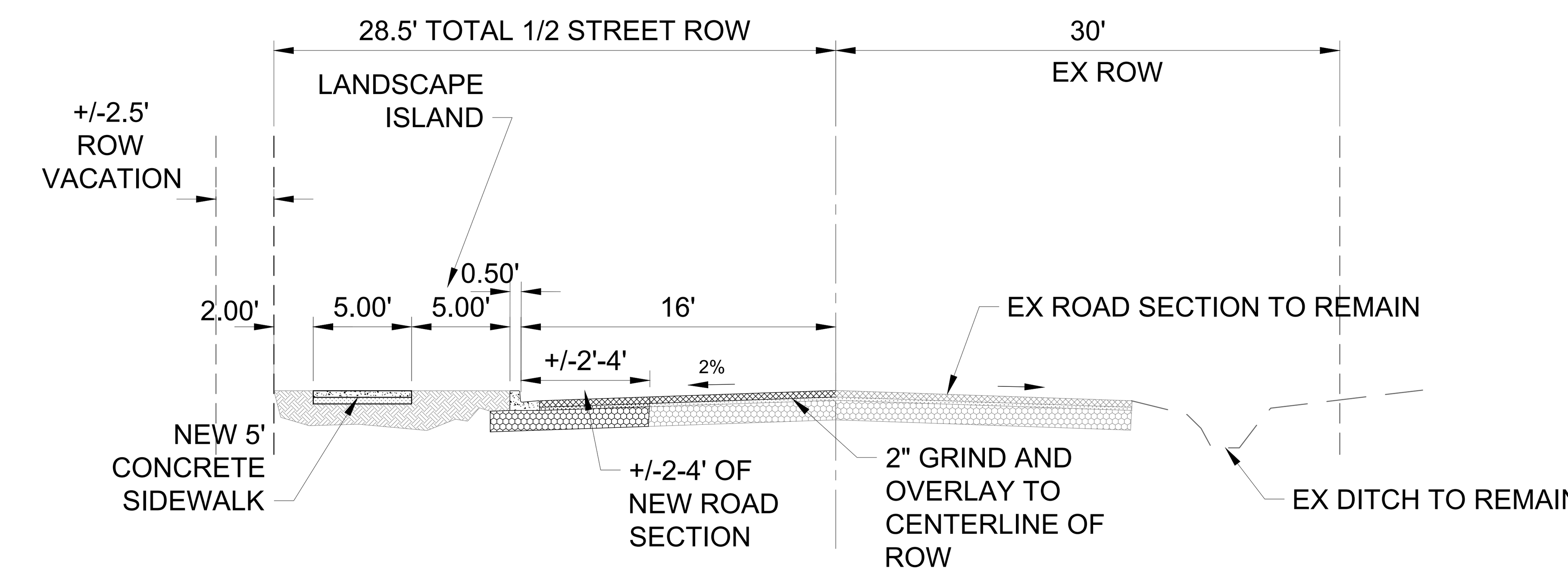
Facility Key

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

Type of Feature & Checklist Name	Location on Site Plan
Grounds & Landscaping	1
Bioretention Pond	2
Catch Basin	3
Conveyance System	4
Downspouts	5

SE 1/4, SECTION 27, TOWNSHIP 18 N., RANGE 2 W., W.M.





B FRONTAGE STREET SECTION
N.T.S.

THE LAND DEVELOPER'S ENGINEERED SOLUTION
a division of THE LAND DEVELOPER, INC.
5737 LINDERSON WAY SW,
TUMWATER, WA. 98501
PO BOX 4420, TUMWATER, WA. 98501
(360) 890-4806
E-MAIL: erik@thelanddeveloper.com

REGISTERED PROFESSIONAL ENGINEER 38284
9/24/2025

REVISIONS: | DATE:

5TH AVE TOWNHOMES

GRADING & DRAINAGE PLAN

PROJECT:
HOLTZE TOWNHOMES
S 585 S 5TH AVE SW
TUMWATER, WA 98512

CLIENT:
ASH HOLDINGS LLC
3425 MERRYMAN PL SE
OLYMPIA, WA 98501

DRAWN BY: EBA
DATE: 9/24/25
AGENCY NO:
SHEET: 3 OF 4
JOB NO: 21-132

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.
- ❑ Inspect inlet and outlet pipes for blockages. Clear all blockages.
- ❑ Inspect Amended soil area and infiltration trench cleanouts.

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.*

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	(253) 798-7250
Washington State University (WSU) Cooperative Extension	(360) 786-5445

DEVELOPER INFORMATION

ASH Holdings LLC
3425 Merryman Pl SE
Olympia, WA 98501
aholtze@gmail.com

ENGINEER'S INFORMATION

THE LAND DEVELOPER'S ENGINEERED SOLUTION
a division of The Land Developer, LLC
PO Box 4420
Tumwater, WA 98501
(360) 250-3973

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 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.
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 Tumwater 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 Tumwater and ask for technical assistance.

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

Table C-15. Maintenance Checklist for Fencing/Shrubbery Screen/Other Landscaping

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 Tumwater and ask for technical assistance.

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

#36 – Maintenance Checklist for Downspout Full Infiltration Systems:

Drainage System Feature	Defect or Problem	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed	Maintenance Frequency	Completed
Rock trench/well	Inflow disruption	Accumulated trash, debris, or sediment on drain rock surface impeding sheet flow into facility.	Sheet flow re-established. Material removed and disposed of in accordance with applicable solid waste requirements.		
Rock trench/well	Inflow disruption	Vegetation/moss present on drain rock surface impeding sheet flow into facility.	Material removed and sheet flow re-established.		
Rock trench/well	Inflow disruption	Water ponding at surface, or standing water in subgrade observation port.	Inflow to facility is consistent and no ponding is observed. Inlet piping is clear and/or rock or sand reservoirs have been replaced.		
Inlet/outlet pipe conveyance	Conveyance blockage	Accumulation of trash, debris, or sediment in roof drains, gutters, driveways drains, area drains, etc.	Conveyance systems are clear of debris and free-flowing.		
Inlet/outlet pipe conveyance	Conveyance blockage	Pipes to or from sump, trench, or drywell have accumulated sediment or is plugged.	Pipe systems are clear of debris and free-flowing.		
Inlet/outlet pipe conveyance	Conveyance damage	Pipes to or from sump, trench, or drywell is cracked, broken, or misaligned.	Pipe systems are undamaged and free-flowing.		
Roof downspout	Splash pad malfunction	Splash pad missing or damaged.	Splash pad installed and functioning correctly		
Storage sump	Sediment in sump	Excess sediment accumulate in sump.	Material removed and disposed of in accordance with applicable solid waste requirements.		
Storage sump	Access lid problems	Access lid cannot be opened or is missing.	Access lid is functioning as designed. Refer to record drawings to confirm type, function, and required components.		

#20 – Maintenance Checklist for Grounds (Landscaping):

Drainage System Feature	Defect or Problem	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed	Maintenance Frequency	Completed
General	Weeds (nonpoisonous)	Weeds growing in more than 20 percent of the landscaped area (trees and shrubs only). See also Thurston County Noxious weeds list.	Weeds present in less than five percent of the landscaped area.		
General	Insect Hazard	Any presence of poison ivy or other poisonous vegetation or insect nests.	No poisonous vegetation or insect nests present in landscaped area.		
General	Trash or Litter	See Detention Ponds (Checklist #1).	See Detention Ponds (Checklist #1).		
General	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.		
Trees and shrubs	Damage	Limbs or parts of trees or shrubs that are split or broken which affect more than 25 percent of the total foliage of the tree or shrub.	Trim trees/shrubs to restore shape. Replace trees/shrubs with severe damage.		
Trees and shrubs	Damage	Trees or shrubs that have been blown down or knocked over.	Tree replanted, inspected for injury to stem or roots. Replace if severely damaged.		
Trees and shrubs	Damage	Trees or shrubs which are not adequately supported or are leaning over, causing exposure of the roots.	Stakes and rubber-coated ties placed around young trees/shrubs for support.		

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

II. Chapter 3 – Best Management Practices for SFR's

ATTACHMENT B

Permanent Pollution Source Control Program

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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 Storm and Surface Water Utility at (360) 867-2099 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 Storm and Surface Water Utility at (360) 867-2099.

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 Storm and Surface Water Utility 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) 867-2491 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: http://www.co.thurston.wa.us/solidwaste/recycling/recycling-curbside.html

- 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) 867-2491 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: http://www.co.thurston.wa.us/solidwaste/organics/organics-home.htm

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.

- 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) 867-2491 to get free composter designs and materials lists or see: http://www.co.thurston.wa.us/solidwaste/index.htm.

- 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.
- 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 Storm and Surface Water Utility (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.

QUICK REFERENCE PHONE NUMBERS AND WEB SITES

PHONE NUMBERS

Environmental Protection Agency (U.S. EPA) – Region X	800-424-4372
Thurston County:	
Stormwater Utility	360-754-4681
Department of Public Works	360-867-2300
After-hours water and sewer emergencies (paging service)	800-926-7761
Thurston County Waste Line (automated information)	360-867-2491
LOTT Alliance Industrial Pretreatment Program	360-528-5708
Development Services – Permits	360-786-5490
Weed Control/ Noxious Chemical Use	360-786-5576
Thurston County Public Health and Social Services Department:	
On-Site Sewage	360-754-3355 x 6518
Asbestos Removal	360-786-5461
Hazardous Waste Section	360-786-5457
Solid Waste	360-786-5461
University of Washington Center for Urban Water Resources	206-543-6272
Washington State Department of Agriculture	360-902-2010 877-301-4555
Washington State Department of Ecology	360-407-6000
Southwest Regional Office	360-407-6300
Dangerous/Hazardous Waste	360-407-6300
NPDES Stormwater or Wastewater Permits	360-407-6400
Spill Reporting	800-424-8802
Recycling	800-732-9253
Groundwater Quality and Protection	360-407-6400
Underground and Aboveground Storage Tanks	360-407-7170
Washington State University/Thurston County Cooperative Extension	360-867-2151
Industrial Materials Exchange	206-296-4899
Nisqually Tribe	360-456-5221
Confederated Tribes of the Chehalis	360-273-5911
Olympic Region Clean Air Agency (ORCAA)	800-422-5623
Underground Utility Locate “Call Before You Dig”	800-424-5555

WEB PAGES

Washington State Departments:

Washington State Department of Health
<http://www.doh.wa.gov/>

Washington Department of Fish and Wildlife
<http://wdfw.wa.gov/>

Washington State Government Information and Services
<http://www.access.wa.gov/>

Washington State Department of Ecology – Flood Information
<http://www.ecy.wa.gov/programs/sea/floods/>

Washington State Department of Ecology - Digital Coastal Atlas
<http://www.ecy.wa.gov/programs/sea/SMA/atlas_home.html>

Washington State Department of Ecology - Stormwater Home Page
<http://www.ecy.wa.gov/programs/wq/stormwater/index.html>

Salmon and Watershed Information Management (SWIM) Team
<http://www.swim.wa.gov/>

Federal Departments:

Federal Emergency Management Agency (FEMA)
<http://fema.gov/>

U.S. EPA Office of Water, Academy 2000
<http://epa.gov/watertrain/>

U.S. Geological Survey (USGS) Departments:

USGS Historical Water Resource Data
<http://wa.water.usgs.gov/realtime/historical.html>

USGS National Water Information System (NWISWeb)
<http://water.usgs.gov/nwis/>

TerraServer (zoom in on USGS aerial photos anywhere in the USA)
<http://terraserver-usa.com/>

Water Quality and NPDES:

Natural Resources Conservation Service (NRCS) and U.S. Department of Agriculture (USDA)
<http://www.nrcs.usda.gov/>

National Climatic Data Center Data Archive
<http://www.ncdc.noaa.gov/>

National Weather Service Hydrologic Forecasts (River Flooding)
<http://ahps2.wrh.noaa.gov/ahps2/index.php?wfo=sew>

USGS Real Time Gauging Info
<http://wa.water.usgs.gov/realtime/current.html>

U.S. Army Corps of Engineers Real Time Gauge Info
<http://www.nwd-wc.usace.army.mil/nws/hh/basins/puy.html>

The Central Puget Sound Water Suppliers' Forum
<http://www.ci.seattle.wa.us/Forum>

Thurston County:

Thurston County Homepage
<http://www.co.Thurston.wa.us/>

Thurston County Stormwater Utility
< http://www.co.thurston.wa.us/stormwater/>

Thurston County Mapping
<http://www.geodata.org>

Thurston Conservation District
<http://www.Thurstoncountycd.org/>

Thurston County Public Health and Social Services
<http://www.co.thurston.wa.us/health/ehadm/index.html>

Other Agencies:

NWS River Forecast Center - Flood Outlook
<http://www.nwrfc.noaa.gov/river/fop.cgi>

NOAA Tide and Current Predictions
<http://co-ops.nos.noaa.gov/tp4days.html>

Appendix E Stormwater Maintenance Agreement

Appendix F WWHM Hydraulic Analysis

WWHM2012

PROJECT REPORT

General Model Information

WWHM2012 Project Name: 21-132bio-pond-frontage3
Site Name:
Site Address:
City:

Report Date:	1/12/2026
Gage:	Courthouse
Data Start:	1955/10/01
Data End:	2011/09/30
Timestep:	15 Minute
Precip Scale:	0.000 (adjusted)
Version Date:	2023/03/31
Version:	4.2.19

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	acre
C, Forest, Mod	0.2
Pervious Total	0.2
Impervious Land Use	acre
Impervious Total	0
Basin Total	0.2

Mitigated Land Use

Basin 1

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Pasture, Mod	0.02
Pervious Total	0.02
Impervious Land Use	acre
ROADS MOD	0.18
Impervious Total	0.18
Basin Total	0.2

Routing Elements
Predeveloped Routing

Mitigated Routing

Bioretention 1

Bottom Length: 50.00 ft.
Bottom Width: 13.00 ft.
Material thickness of first layer: 1.5
Material type for first layer: SMMWW 12 in/hr
Material thickness of second layer: 0
Material type for second layer: Sand
Material thickness of third layer: 0
Material type for third layer: GRAVEL
Infiltration On
Infiltration rate: 1.28
Infiltration safety factor: 1
Wetted surface area On
Total Volume Infiltrated (ac-ft.): 40.263
Total Volume Through Riser (ac-ft.): 0.001
Total Volume Through Facility (ac-ft.): 40.264
Percent Infiltrated: 100
Total Precip Applied to Facility: 3.347
Total Evap From Facility: 1.396
Underdrain not used
Discharge Structure
Riser Height: 1 ft.
Riser Diameter: 10 in.
Element Flows To:
Outlet 1 Outlet 2

Bioretention Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.0298	0.0000	0.0000	0.0000
0.0330	0.0296	0.0002	0.0000	0.0000
0.0659	0.0292	0.0005	0.0000	0.0000
0.0989	0.0289	0.0007	0.0000	0.0000
0.1319	0.0285	0.0009	0.0000	0.0000
0.1648	0.0282	0.0012	0.0000	0.0008
0.1978	0.0278	0.0014	0.0000	0.0013
0.2308	0.0274	0.0017	0.0000	0.0020
0.2637	0.0271	0.0019	0.0000	0.0028
0.2967	0.0267	0.0022	0.0000	0.0038
0.3297	0.0264	0.0025	0.0000	0.0051
0.3626	0.0260	0.0027	0.0000	0.0065
0.3956	0.0257	0.0030	0.0000	0.0082
0.4286	0.0253	0.0033	0.0000	0.0101
0.4615	0.0250	0.0036	0.0000	0.0124
0.4945	0.0247	0.0039	0.0000	0.0149
0.5275	0.0243	0.0042	0.0000	0.0178
0.5604	0.0240	0.0045	0.0000	0.0210
0.5934	0.0236	0.0048	0.0000	0.0245
0.6264	0.0233	0.0051	0.0000	0.0267
0.6593	0.0230	0.0054	0.0000	0.0271
0.6923	0.0226	0.0057	0.0000	0.0275
0.7253	0.0223	0.0060	0.0000	0.0279
0.7582	0.0220	0.0064	0.0000	0.0284
0.7912	0.0217	0.0067	0.0000	0.0288

0.8242	0.0213	0.0070	0.0000	0.0292
0.8571	0.0210	0.0074	0.0000	0.0296
0.8901	0.0207	0.0077	0.0000	0.0301
0.9231	0.0204	0.0081	0.0000	0.0305
0.9560	0.0200	0.0084	0.0000	0.0309
0.9890	0.0197	0.0088	0.0000	0.0314
1.0220	0.0194	0.0092	0.0000	0.0318
1.0549	0.0191	0.0096	0.0000	0.0323
1.0879	0.0188	0.0099	0.0000	0.0327
1.1209	0.0185	0.0103	0.0000	0.0332
1.1538	0.0182	0.0107	0.0000	0.0336
1.1868	0.0179	0.0111	0.0000	0.0341
1.2198	0.0176	0.0115	0.0000	0.0345
1.2527	0.0173	0.0119	0.0000	0.0350
1.2857	0.0170	0.0123	0.0000	0.0354
1.3187	0.0167	0.0127	0.0000	0.0359
1.3516	0.0164	0.0132	0.0000	0.0363
1.3846	0.0161	0.0136	0.0000	0.0368
1.4176	0.0158	0.0140	0.0000	0.0373
1.4505	0.0155	0.0145	0.0000	0.0377
1.4835	0.0152	0.0149	0.0000	0.0382
1.5000	0.0149	0.0151	0.0000	0.0385

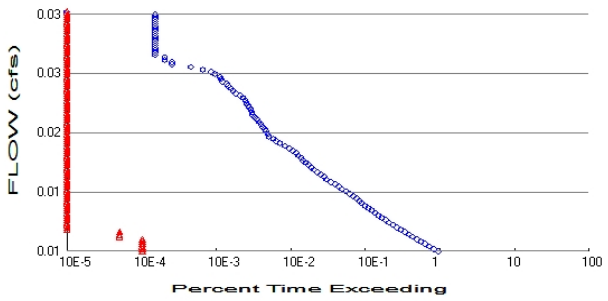
Bioretention Surface Hydraulic Table

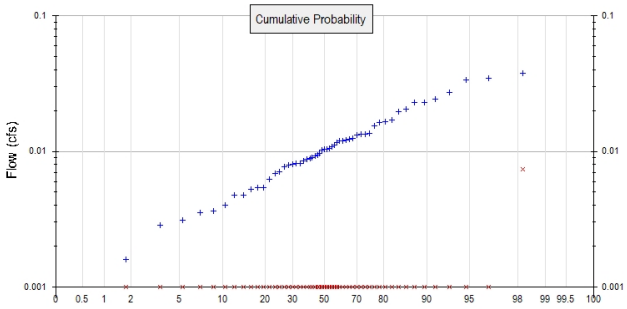
Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	To Amended(cfs)	Infilt(cfs)
1.5000	0.0298	0.0151	0.0000	0.1806	0.0005
1.5330	0.0302	0.0161	0.0000	0.1806	0.0010
1.5659	0.0305	0.0171	0.0000	0.1885	0.0014
1.5989	0.0309	0.0181	0.0000	0.1925	0.0019
1.6319	0.0313	0.0192	0.0000	0.1964	0.0024
1.6648	0.0317	0.0202	0.0000	0.2004	0.0029
1.6978	0.0320	0.0212	0.0000	0.2044	0.0034
1.7308	0.0324	0.0223	0.0000	0.2083	0.0039
1.7637	0.0328	0.0234	0.0000	0.2123	0.0044
1.7967	0.0332	0.0245	0.0000	0.2163	0.0049
1.8297	0.0336	0.0256	0.0000	0.2202	0.0054
1.8626	0.0340	0.0267	0.0000	0.2242	0.0059
1.8956	0.0343	0.0278	0.0000	0.2282	0.0064
1.9286	0.0347	0.0289	0.0000	0.2321	0.0069
1.9615	0.0351	0.0301	0.0000	0.2361	0.0074
1.9945	0.0355	0.0313	0.0000	0.2401	0.0079
2.0275	0.0359	0.0324	0.0000	0.2440	0.0084
2.0604	0.0363	0.0336	0.0000	0.2480	0.0089
2.0934	0.0367	0.0348	0.0000	0.2520	0.0094
2.1264	0.0371	0.0360	0.0000	0.2560	0.0100
2.1593	0.0375	0.0373	0.0000	0.2599	0.0105
2.1923	0.0379	0.0385	0.0000	0.2639	0.0110
2.2253	0.0383	0.0398	0.0000	0.2679	0.0115
2.2582	0.0387	0.0410	0.0000	0.2718	0.0121
2.2912	0.0391	0.0423	0.0000	0.2758	0.0126
2.3242	0.0396	0.0436	0.0000	0.2798	0.0131
2.3571	0.0400	0.0449	0.0000	0.2837	0.0137
2.3901	0.0404	0.0463	0.0000	0.2877	0.0142
2.4231	0.0408	0.0476	0.0000	0.2917	0.0147
2.4560	0.0412	0.0490	0.0000	0.2956	0.0153
2.4890	0.0416	0.0503	0.0000	0.2996	0.0158
2.5220	0.0421	0.0517	0.0288	0.3009	0.0164
2.5549	0.0425	0.0531	0.1136	0.3009	0.0169

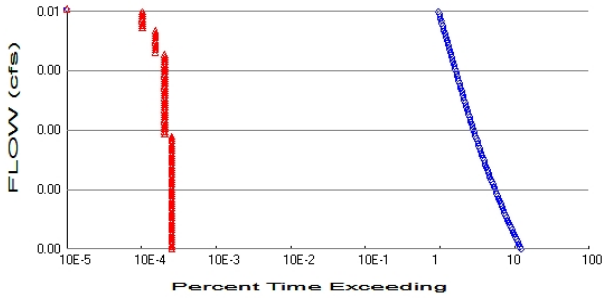
2.5879	0.0429	0.0545	0.2289	0.3009	0.0175
2.6209	0.0433	0.0559	0.3652	0.3009	0.0180
2.6538	0.0438	0.0574	0.5151	0.3009	0.0186
2.6868	0.0442	0.0588	0.6708	0.3009	0.0192
2.7198	0.0446	0.0603	0.8245	0.3009	0.0197
2.7527	0.0451	0.0618	0.9685	0.3009	0.0203
2.7857	0.0455	0.0632	1.0962	0.3009	0.0208
2.8187	0.0459	0.0648	1.2026	0.3009	0.0214
2.8516	0.0464	0.0663	1.2861	0.3009	0.0220
2.8846	0.0468	0.0678	1.3487	0.3009	0.0226
2.9176	0.0473	0.0694	1.4134	0.3009	0.0231
2.9505	0.0477	0.0709	1.4681	0.3009	0.0237
2.9835	0.0482	0.0725	1.5209	0.3009	0.0240
3.0000	0.0484	0.0733	1.5719	0.3009	0.0000

Analysis Results

POC 1







\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 0.2
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 0.02
Total Impervious Area: 0.18

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.010246
5 year	0.017609
10 year	0.022503
25 year	0.028447
50 year	0.032631
100 year	0.036583

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	0.010	0.000
1957	0.021	0.000
1958	0.010	0.000
1959	0.008	0.000
1960	0.034	0.000
1961	0.009	0.000
1962	0.004	0.000
1963	0.024	0.000
1964	0.009	0.000
1965	0.009	0.000
1966	0.005	0.000
1967	0.020	0.000
1968	0.013	0.000
1969	0.005	0.000
1970	0.008	0.000
1971	0.010	0.000
1972	0.038	0.000
1973	0.010	0.000
1974	0.012	0.000
1975	0.005	0.000
1976	0.012	0.000
1977	0.003	0.000
1978	0.008	0.000
1979	0.008	0.000
1980	0.009	0.000
1981	0.017	0.000
1982	0.008	0.000
1983	0.013	0.000
1984	0.034	0.000
1985	0.004	0.000
1986	0.015	0.000
1987	0.012	0.000
1988	0.006	0.000
1989	0.007	0.000
1990	0.016	0.000
1991	0.027	0.000
1992	0.011	0.000
1993	0.005	0.000
1994	0.005	0.000
1995	0.013	0.000
1996	0.023	0.000
1997	0.001	0.000
1998	0.002	0.000
1999	0.010	0.000
2000	0.007	0.000
2001	0.003	0.000
2002	0.014	0.000
2003	0.008	0.000
2004	0.023	0.007
2005	0.009	0.000
2006	0.012	0.000
2007	0.012	0.000
2008	0.017	0.000
2009	0.012	0.000
2010	0.004	0.000
2011	0.011	0.000

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	0.0376	0.0074
2	0.0344	0.0000
3	0.0339	0.0000
4	0.0272	0.0000
5	0.0241	0.0000
6	0.0231	0.0000
7	0.0228	0.0000
8	0.0206	0.0000
9	0.0197	0.0000
10	0.0170	0.0000
11	0.0167	0.0000
12	0.0164	0.0000
13	0.0154	0.0000
14	0.0136	0.0000
15	0.0135	0.0000
16	0.0134	0.0000
17	0.0132	0.0000
18	0.0124	0.0000
19	0.0123	0.0000
20	0.0122	0.0000
21	0.0120	0.0000
22	0.0119	0.0000
23	0.0116	0.0000
24	0.0112	0.0000
25	0.0108	0.0000
26	0.0104	0.0000
27	0.0104	0.0000
28	0.0103	0.0000
29	0.0103	0.0000
30	0.0097	0.0000
31	0.0094	0.0000
32	0.0092	0.0000
33	0.0090	0.0000
34	0.0089	0.0000
35	0.0087	0.0000
36	0.0085	0.0000
37	0.0082	0.0000
38	0.0081	0.0000
39	0.0080	0.0000
40	0.0079	0.0000
41	0.0077	0.0000
42	0.0071	0.0000
43	0.0069	0.0000
44	0.0063	0.0000
45	0.0054	0.0000
46	0.0054	0.0000
47	0.0052	0.0000
48	0.0048	0.0000
49	0.0048	0.0000
50	0.0040	0.0000
51	0.0036	0.0000
52	0.0035	0.0000
53	0.0031	0.0000
54	0.0029	0.0000

55	0.0016	0.0000
56	0.0010	0.0000

LID Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0008	241717	5	0	Pass
0.0009	232488	5	0	Pass
0.0009	224045	5	0	Pass
0.0010	215994	5	0	Pass
0.0010	208533	5	0	Pass
0.0010	201464	5	0	Pass
0.0011	194611	5	0	Pass
0.0011	188190	5	0	Pass
0.0012	181867	5	0	Pass
0.0012	175878	5	0	Pass
0.0013	169987	5	0	Pass
0.0013	164470	5	0	Pass
0.0013	159129	5	0	Pass
0.0014	154181	5	0	Pass
0.0014	149272	5	0	Pass
0.0015	144716	5	0	Pass
0.0015	140298	5	0	Pass
0.0016	136017	5	0	Pass
0.0016	131914	5	0	Pass
0.0016	128045	5	0	Pass
0.0017	124118	5	0	Pass
0.0017	120446	5	0	Pass
0.0018	116931	5	0	Pass
0.0018	113456	5	0	Pass
0.0019	110196	5	0	Pass
0.0019	106917	5	0	Pass
0.0019	103893	5	0	Pass
0.0020	100869	5	0	Pass
0.0020	97924	5	0	Pass
0.0021	95037	5	0	Pass
0.0021	92308	5	0	Pass
0.0022	89598	5	0	Pass
0.0022	87085	5	0	Pass
0.0023	84670	5	0	Pass
0.0023	82431	5	0	Pass
0.0023	80252	5	0	Pass
0.0024	78190	5	0	Pass
0.0024	76187	5	0	Pass
0.0025	74165	5	0	Pass
0.0025	72240	5	0	Pass
0.0026	70277	5	0	Pass
0.0026	68431	5	0	Pass
0.0026	66664	5	0	Pass
0.0027	64995	5	0	Pass
0.0027	63384	5	0	Pass
0.0028	61833	5	0	Pass
0.0028	60282	5	0	Pass
0.0029	58888	5	0	Pass
0.0029	57474	4	0	Pass
0.0029	56119	4	0	Pass
0.0030	54843	4	0	Pass
0.0030	53567	4	0	Pass
0.0031	52310	4	0	Pass

0.0031	51171	4	0	Pass
0.0032	49993	4	0	Pass
0.0032	48756	4	0	Pass
0.0033	47597	4	0	Pass
0.0033	46537	4	0	Pass
0.0033	45536	4	0	Pass
0.0034	44495	4	0	Pass
0.0034	43513	4	0	Pass
0.0035	42512	4	0	Pass
0.0035	41569	4	0	Pass
0.0036	40685	4	0	Pass
0.0036	39821	4	0	Pass
0.0036	39016	4	0	Pass
0.0037	38192	4	0	Pass
0.0037	37367	4	0	Pass
0.0038	36562	4	0	Pass
0.0038	35757	4	0	Pass
0.0039	34952	4	0	Pass
0.0039	34225	4	0	Pass
0.0039	33479	4	0	Pass
0.0040	32831	4	0	Pass
0.0040	32105	4	0	Pass
0.0041	31457	4	0	Pass
0.0041	30710	4	0	Pass
0.0042	30082	4	0	Pass
0.0042	29395	4	0	Pass
0.0043	28806	4	0	Pass
0.0043	28177	4	0	Pass
0.0043	27588	4	0	Pass
0.0044	27039	3	0	Pass
0.0044	26469	3	0	Pass
0.0045	25978	3	0	Pass
0.0045	25448	3	0	Pass
0.0046	24918	3	0	Pass
0.0046	24388	3	0	Pass
0.0046	23858	3	0	Pass
0.0047	23367	3	0	Pass
0.0047	22817	3	0	Pass
0.0048	22326	3	0	Pass
0.0048	21815	2	0	Pass
0.0049	21344	2	0	Pass
0.0049	20893	2	0	Pass
0.0049	20461	2	0	Pass
0.0050	20048	2	0	Pass
0.0050	19610	2	0	Pass
0.0051	19161	2	0	Pass
0.0051	18695	2	0	Pass

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0051	18695	2	0	Pass
0.0054	16168	2	0	Pass
0.0057	14002	2	0	Pass
0.0060	12367	2	0	Pass
0.0062	10976	2	0	Pass
0.0065	9686	2	0	Pass
0.0068	8510	1	0	Pass
0.0071	7517	1	0	Pass
0.0073	6649	1	0	Pass
0.0076	5853	0	0	Pass
0.0079	5182	0	0	Pass
0.0082	4626	0	0	Pass
0.0085	4118	0	0	Pass
0.0087	3637	0	0	Pass
0.0090	3258	0	0	Pass
0.0093	2928	0	0	Pass
0.0096	2661	0	0	Pass
0.0098	2399	0	0	Pass
0.0101	2144	0	0	Pass
0.0104	1933	0	0	Pass
0.0107	1758	0	0	Pass
0.0110	1634	0	0	Pass
0.0112	1489	0	0	Pass
0.0115	1353	0	0	Pass
0.0118	1215	0	0	Pass
0.0121	1081	0	0	Pass
0.0123	961	0	0	Pass
0.0126	855	0	0	Pass
0.0129	775	0	0	Pass
0.0132	682	0	0	Pass
0.0135	596	0	0	Pass
0.0137	545	0	0	Pass
0.0140	500	0	0	Pass
0.0143	444	0	0	Pass
0.0146	400	0	0	Pass
0.0148	369	0	0	Pass
0.0151	337	0	0	Pass
0.0154	310	0	0	Pass
0.0157	288	0	0	Pass
0.0160	271	0	0	Pass
0.0162	249	0	0	Pass
0.0165	231	0	0	Pass
0.0168	211	0	0	Pass
0.0171	187	0	0	Pass
0.0173	164	0	0	Pass
0.0176	141	0	0	Pass
0.0179	126	0	0	Pass
0.0182	114	0	0	Pass
0.0185	100	0	0	Pass
0.0187	96	0	0	Pass
0.0190	92	0	0	Pass
0.0193	88	0	0	Pass
0.0196	82	0	0	Pass

0.0198	78	0	0	Pass
0.0201	75	0	0	Pass
0.0204	69	0	0	Pass
0.0207	65	0	0	Pass
0.0210	61	0	0	Pass
0.0212	59	0	0	Pass
0.0215	57	0	0	Pass
0.0218	54	0	0	Pass
0.0221	53	0	0	Pass
0.0224	50	0	0	Pass
0.0226	48	0	0	Pass
0.0229	45	0	0	Pass
0.0232	41	0	0	Pass
0.0235	36	0	0	Pass
0.0237	33	0	0	Pass
0.0240	31	0	0	Pass
0.0243	28	0	0	Pass
0.0246	27	0	0	Pass
0.0249	24	0	0	Pass
0.0251	23	0	0	Pass
0.0254	22	0	0	Pass
0.0257	19	0	0	Pass
0.0260	17	0	0	Pass
0.0262	13	0	0	Pass
0.0265	9	0	0	Pass
0.0268	5	0	0	Pass
0.0271	5	0	0	Pass
0.0274	4	0	0	Pass
0.0276	4	0	0	Pass
0.0279	3	0	0	Pass
0.0282	3	0	0	Pass
0.0285	3	0	0	Pass
0.0287	3	0	0	Pass
0.0290	3	0	0	Pass
0.0293	3	0	0	Pass
0.0296	3	0	0	Pass
0.0299	3	0	0	Pass
0.0301	3	0	0	Pass
0.0304	3	0	0	Pass
0.0307	3	0	0	Pass
0.0310	3	0	0	Pass
0.0312	3	0	0	Pass
0.0315	3	0	0	Pass
0.0318	3	0	0	Pass
0.0321	3	0	0	Pass
0.0324	3	0	0	Pass
0.0326	3	0	0	Pass

Water Quality

Water Quality BMP Flow and Volume for POC #1

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

LID Report

LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment
retention 1 POC	☐	36.64			☐	100.00			
Total Volume Infiltrated		36.64	0.00	0.00		100.00	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Passed

Model Default Modifications

Total of 0 changes have been made.

PERLND Changes

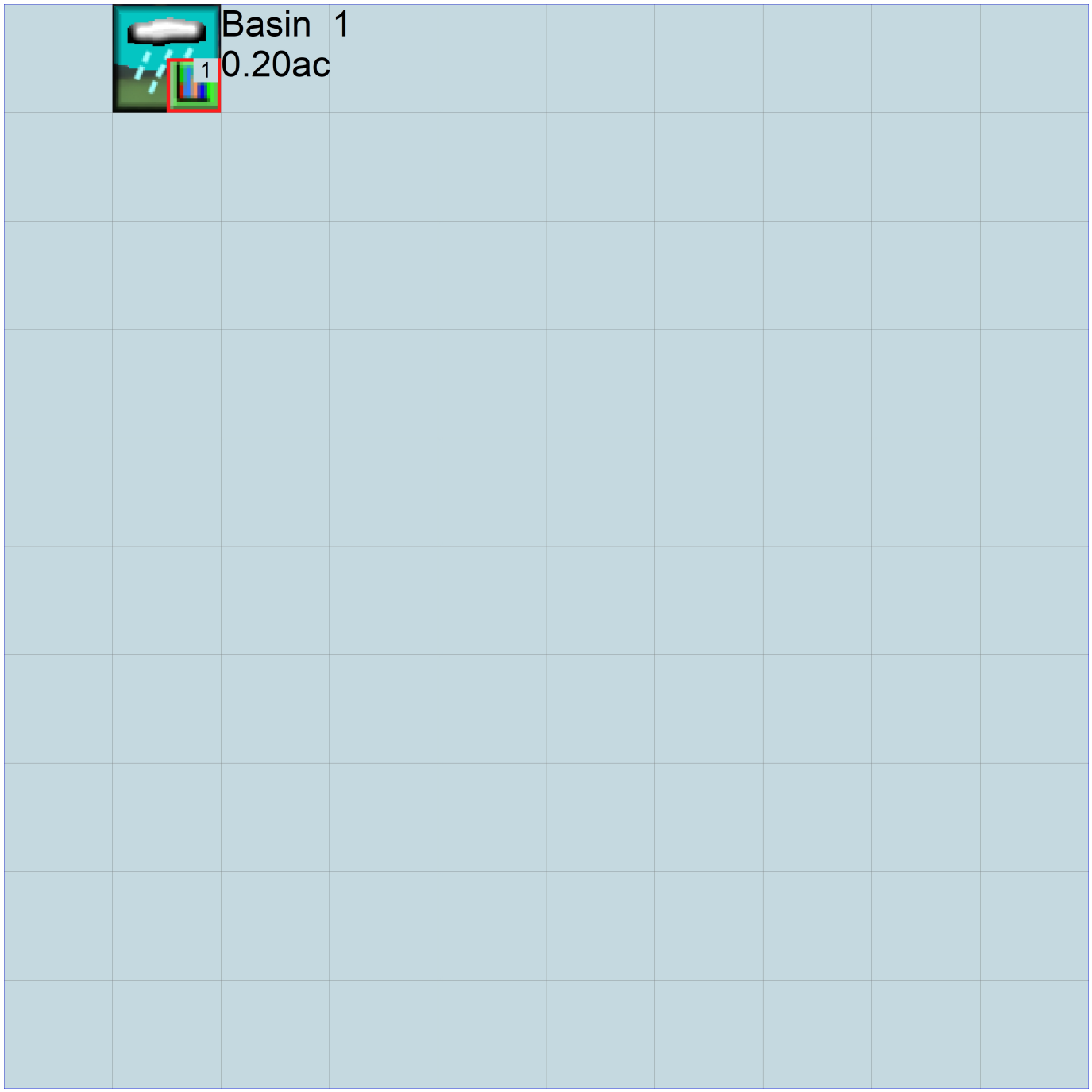
No PERLND changes have been made.

IMPLND Changes

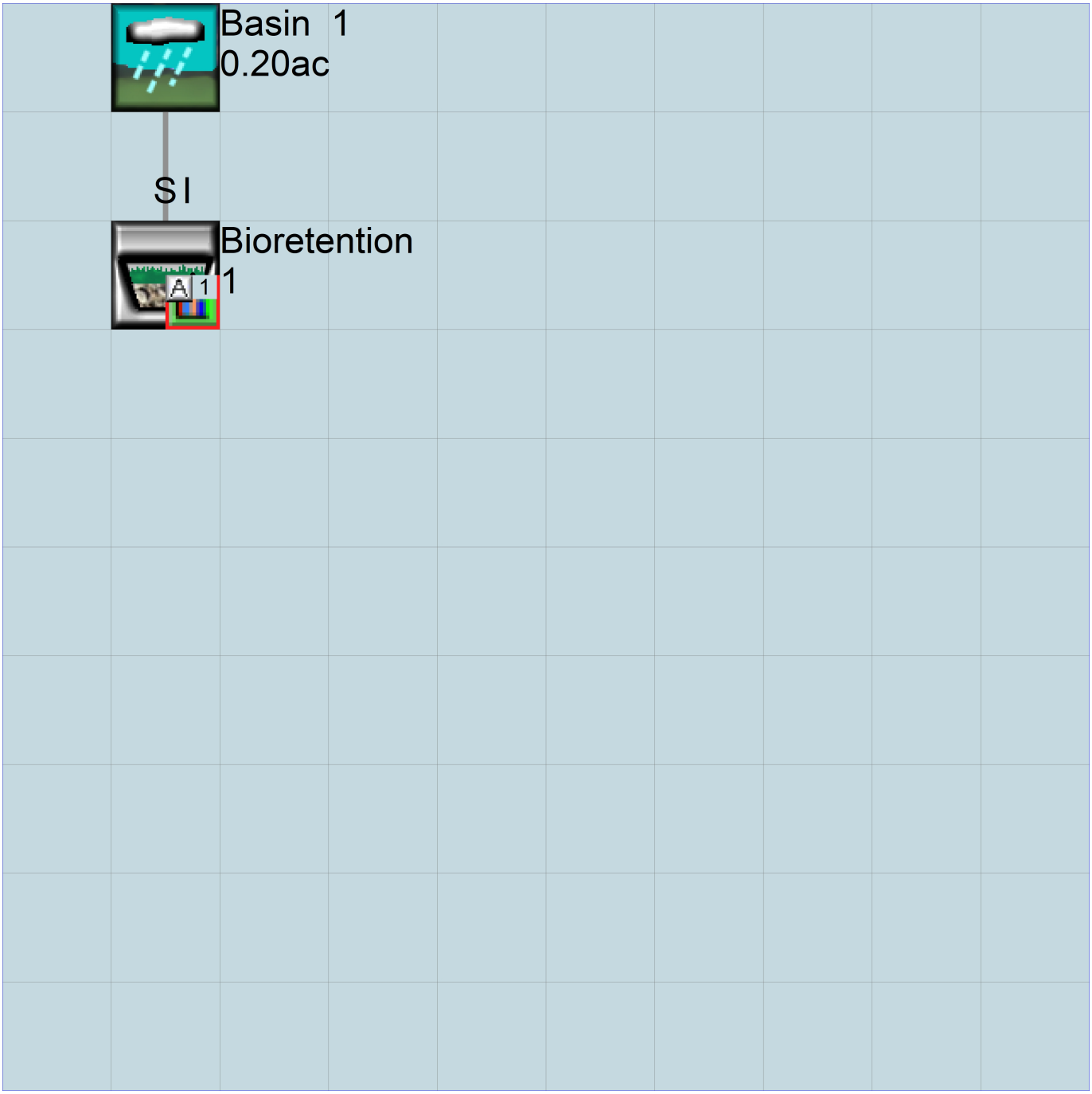
No IMPLND changes have been made.

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   21-132bio-pond-frontage3.wdm
MESSU       25   Pre21-132bio-pond-frontage3.MES
            27   Pre21-132bio-pond-frontage3.L61
            28   Pre21-132bio-pond-frontage3.L62
            30   POC21-132bio-pond-frontage31.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      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           ***
   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 ***
   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  *********
   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 ***
   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
   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
   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 ***
   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
   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  11                         0.2     COPY   501     12
PERLND  11                         0.2     COPY   501     13

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

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



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

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

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

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

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

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

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1              PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1              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   21-132bio-pond-frontage3.wdm
MESSU       25   Mit21-132bio-pond-frontage3.MES
            27   Mit21-132bio-pond-frontage3.L61
            28   Mit21-132bio-pond-frontage3.L62
            30   POC21-132bio-pond-frontage31.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      14
      IMPLND       2
      GENER        2
      RCHRES       1
      RCHRES       2
      COPY         1
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Surface retention  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 ***
    2        24
  END OPCODE
  PARM
    #    #         K ***
    2             0.
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                          in  out           ***
   14     C, Pasture, 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 ***
   14         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  *********
   14         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 ***
   14         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
   14              0       4.5      0.06       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
   14              0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                                  ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   14           0.15       0.4       0.3         6       0.5       0.4
  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
   14              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
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections ****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    ***
    2         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    4    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
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    2            400      0.05       0.1      0.08
```

```
  END IWAT-PARM2

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

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

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Basin  1***
PERLND  14                        0.02     RCHRES   1      2
PERLND  14                        0.02     RCHRES   1      3
IMPLND   2                        0.18     RCHRES   1      5

******Routing******
PERLND  14                        0.02     COPY     1     12
IMPLND   2                        0.18     COPY     1     15
PERLND  14                        0.02     COPY     1     13
RCHRES   1                           1     RCHRES   2      8
RCHRES   2                           1     COPY   501     17
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
GENER    2 OUTPUT TIMSER      .0011111     RCHRES   1     EXTNL  OUTDGT 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     Surface retentio-008    3    1    1    1   28    0    1
    2     Bioretention  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
    2         1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ******************* PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
    1         4    0    0    0    0    0    0    0    0    0    1    9
    2         4    0    0    0    0    0    0    0    0    0    1    9
  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  6  0  0       0  1  0  0  0        2  1  2  2  2
    2       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       0.0       0.0
    2              2      0.01       0.0       0.0       0.0       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  6.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
    2            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
*** User-Defined Variable Quantity Lines
***                          addr
***                         <------>
*** kwd  varnam optyp  opn  vari  s1 s2 s3 tp multiply  lc ls ac as agfn ***
  <****> <----> <----> <-> <----><-><-><-><-><--------> <><-> <><-> <--> ***
  UVQUAN vol2   RCHRES   2 VOL              4
  UVQUAN v2m2   GLOBAL     WORKSP  1        3
  UVQUAN vpo2   GLOBAL     WORKSP  2        3
  UVQUAN v2d2   GENER    2 K       1        3
*** User-Defined Target Variable Names
***                  addr or                       addr or
***                 <------>                      <------>
*** kwd   varnam ct  vari  s1 s2 s3  frac oper     vari  s1 s2 s3  frac oper
  <****>  <----><-> <----><-><-><-> <---> <-->    <----><-><-><-> <---> <-->
  UVNAME  v2m2    1 WORKSP  1         1.0 QUAN
  UVNAME  vpo2    1 WORKSP  2         1.0 QUAN
  UVNAME  v2d2    1 K       1         1.0 QUAN
*** opt foplop dcdts  yr mo dy hr mn d t   vnam  s1 s2 s3 ac quantity  tc  ts rp
  <****><-><--><><-><--> <> <> <> <><><>  <----><-><-><-><-><--------> <> <-><->
  GENER   2                               v2m2            =  693.47
*** Compute remaining available pore space
  GENER   2                               vpo2            =  v2m2
  GENER   2                               vpo2           -=  vol2
*** Check to see if VPORA goes negative; if so set VPORA = 0.0
IF (vpo2 < 0.0) THEN
  GENER   2                               vpo2            =  0.0
END IF
*** Infiltration volume
  GENER   2                               v2d2            =  vpo2
END SPEC-ACTIONS
FTABLES
  FTABLE      2
   47    5
     Depth      Area    Volume  Outflow1  Outflow2  Velocity  Travel Time***
      (ft)   (acres) (acre-ft)   (cfs)      (cfs)   (ft/sec)    (Minutes)***
  0.000000  0.029798  0.000000  0.000000  0.000000
  0.032967  0.029614  0.000227  0.000000  0.000000
  0.065934  0.029248  0.000459  0.000000  0.000000
  0.098901  0.028884  0.000694  0.000000  0.000000
  0.131868  0.028522  0.000935  0.000000  0.000004
  0.164835  0.028161  0.001179  0.000000  0.000849
  0.197802  0.027802  0.001428  0.000000  0.001348
  0.230769  0.027445  0.001682  0.000000  0.002000
  0.263736  0.027090  0.001940  0.000000  0.002823
  0.296703  0.026736  0.002203  0.000000  0.003835
```

```
  0.329670  0.026385  0.002470  0.000000  0.005053
  0.362637  0.026035  0.002742  0.000000  0.006497
  0.395604  0.025687  0.003018  0.000000  0.008184
  0.428571  0.025341  0.003299  0.000000  0.010135
  0.461538  0.024996  0.003585  0.000000  0.012367
  0.494505  0.024654  0.003875  0.000000  0.014902
  0.527473  0.024313  0.004170  0.000000  0.017759
  0.560440  0.023974  0.004470  0.000000  0.020959
  0.593407  0.023636  0.004774  0.000000  0.024522
  0.626374  0.023301  0.005084  0.000000  0.026693
  0.659341  0.022967  0.005398  0.000000  0.027108
  0.692308  0.022635  0.005717  0.000000  0.027524
  0.725275  0.022305  0.006041  0.000000  0.027943
  0.758242  0.021977  0.006370  0.000000  0.028365
  0.791209  0.021650  0.006704  0.000000  0.028789
  0.824176  0.021326  0.007042  0.000000  0.029215
  0.857143  0.021003  0.007386  0.000000  0.029643
  0.890110  0.020682  0.007735  0.000000  0.030074
  0.923077  0.020362  0.008089  0.000000  0.030507
  0.956044  0.020045  0.008448  0.000000  0.030942
  0.989011  0.019729  0.008812  0.000000  0.031380
  1.021978  0.019415  0.009181  0.000000  0.031819
  1.054945  0.019103  0.009555  0.000000  0.032262
  1.087912  0.018793  0.009934  0.000000  0.032706
  1.120879  0.018484  0.010319  0.000000  0.033153
  1.153846  0.018177  0.010709  0.000000  0.033602
  1.186813  0.017873  0.011104  0.000000  0.034054
  1.219780  0.017569  0.011504  0.000000  0.034508
  1.252747  0.017268  0.011910  0.000000  0.034964
  1.285714  0.016969  0.012321  0.000000  0.035423
  1.318681  0.016671  0.012738  0.000000  0.035883
  1.351648  0.016375  0.013160  0.000000  0.036346
  1.384615  0.016081  0.013587  0.000000  0.036812
  1.417582  0.015788  0.014020  0.000000  0.037280
  1.450549  0.015498  0.014458  0.000000  0.037750
  1.483516  0.015209  0.014901  0.000000  0.038222
  1.500000  0.014922  0.015920  0.000000  0.038459
  END FTABLE  2
  FTABLE      1
   47    6
     Depth      Area    Volume  Outflow1  Outflow2  Outflow3  Velocity  Travel
Time***
      (ft)   (acres) (acre-ft)   (cfs)      (cfs)     (cfs)   (ft/sec)
(Minutes)***
  0.000000  0.014922  0.000000  0.000000  0.000000  0.000476
  0.032967  0.030167  0.000988  0.000000  0.180556  0.000476
  0.065934  0.030537  0.001989  0.000000  0.188492  0.000954
  0.098901  0.030910  0.003002  0.000000  0.192460  0.001435
  0.131868  0.031284  0.004027  0.000000  0.196429  0.001917
  0.164835  0.031660  0.005065  0.000000  0.200397  0.002403
  0.197802  0.032037  0.006115  0.000000  0.204365  0.002890
  0.230769  0.032417  0.007177  0.000000  0.208334  0.003380
  0.263736  0.032798  0.008252  0.000000  0.212302  0.003872
  0.296703  0.033181  0.009339  0.000000  0.216270  0.004366
  0.329670  0.033566  0.010440  0.000000  0.220238  0.004863
  0.362637  0.033953  0.011553  0.000000  0.224207  0.005362
  0.395604  0.034341  0.012678  0.000000  0.228175  0.005864
  0.428571  0.034731  0.013817  0.000000  0.232143  0.006367
  0.461538  0.035123  0.014968  0.000000  0.236111  0.006873
  0.494505  0.035517  0.016133  0.000000  0.240080  0.007382
  0.527473  0.035913  0.017310  0.000000  0.244048  0.007892
  0.560440  0.036310  0.018501  0.000000  0.248016  0.008405
  0.593407  0.036710  0.019704  0.000000  0.251984  0.008921
  0.626374  0.037111  0.020921  0.000000  0.255953  0.009438
  0.659341  0.037514  0.022151  0.000000  0.259921  0.009958
  0.692308  0.037918  0.023395  0.000000  0.263889  0.010480
  0.725275  0.038325  0.024651  0.000000  0.267857  0.011005
  0.758242  0.038733  0.025922  0.000000  0.271826  0.011532
  0.791209  0.039143  0.027205  0.000000  0.275794  0.012061
  0.824176  0.039555  0.028502  0.000000  0.279762  0.012593
```

```
  0.857143  0.039968  0.029813  0.000000  0.283730  0.013127
  0.890110  0.040384  0.031138  0.000000  0.287699  0.013663
  0.923077  0.040801  0.032476  0.000000  0.291667  0.014201
  0.956044  0.041220  0.033828  0.000000  0.295635  0.014742
  0.989011  0.041641  0.035194  0.000000  0.299603  0.015285
  1.021978  0.042063  0.036573  0.028803  0.300926  0.015831
  1.054945  0.042488  0.037967  0.113632  0.300926  0.016378
  1.087912  0.042914  0.039375  0.228879  0.300926  0.016928
  1.120879  0.043342  0.040797  0.365247  0.300926  0.017481
  1.153846  0.043772  0.042233  0.515121  0.300926  0.018036
  1.186813  0.044203  0.043683  0.670824  0.300926  0.018593
  1.219780  0.044637  0.045147  0.824493  0.300926  0.019152
  1.252747  0.045072  0.046626  0.968497  0.300926  0.019714
  1.285714  0.045509  0.048119  1.096154  0.300926  0.020278
  1.318681  0.045948  0.049627  1.202640  0.300926  0.020844
  1.351648  0.046388  0.051149  1.286061  0.300926  0.021412
  1.384615  0.046831  0.052685  1.348651  0.300926  0.021983
  1.417582  0.047275  0.054236  1.413410  0.300926  0.022557
  1.450549  0.047721  0.055802  1.468143  0.300926  0.023132
  1.483516  0.048168  0.057383  1.520907  0.300926  0.023710
  1.500000  0.048393  0.058179  1.571901  0.300926  0.024000
  END FTABLE  1
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1              PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1              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
WDM      2 PREC     ENGL    1              RCHRES   1     EXTNL  PREC
WDM      1 EVAP     ENGL    0.5            RCHRES   1     EXTNL  POTEV
WDM      1 EVAP     ENGL    0.76           RCHRES   2     EXTNL  POTEV

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
RCHRES   2 HYDR   RO     1 1        1      WDM   1000 FLOW     ENGL      REPL
RCHRES   2 HYDR   O      1 1        1      WDM   1001 FLOW     ENGL      REPL
RCHRES   2 HYDR   O      2 1        1      WDM   1002 FLOW     ENGL      REPL
RCHRES   2 HYDR   STAGE  1 1        1      WDM   1003 STAG     ENGL      REPL
RCHRES   1 HYDR   STAGE  1 1        1      WDM   1004 STAG     ENGL      REPL
RCHRES   1 HYDR   O      1 1        1      WDM   1005 FLOW     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        8
RCHRES     OFLOW  OVOL   2                 RCHRES         INFLOW IVOL
  END MASS-LINK    8

  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

Mitigated HSPF Message File

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WWHM2012

PROJECT REPORT

General Model Information

WWHM2012 Project Name: 21-132bio-pond-LOTS3
Site Name:
Site Address:
City:

Report Date:	1/13/2026
Gage:	Courthouse
Data Start:	1955/10/01
Data End:	2011/09/30
Timestep:	15 Minute
Precip Scale:	0.000 (adjusted)
Version Date:	2023/03/31
Version:	4.2.19

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	acre
C, Forest, Mod	0.76
Pervious Total	0.76
Impervious Land Use	acre
Impervious Total	0
Basin Total	0.76

Mitigated Land Use

Basin 1

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
C, Pasture, Mod	0.19
Pervious Total	0.19

Impervious Land Use	acre
ROOF TOPS FLAT	0.43
POND	0.14
Impervious Total	0.57
Basin Total	0.76

Routing Elements
Predeveloped Routing

Mitigated Routing

Bioretention 1

Bottom Length: 110.00 ft.
Bottom Width: 20.00 ft.
Material thickness of first layer: 1.5
Material type for first layer: SMMWW 12 in/hr
Material thickness of second layer: 0
Material type for second layer: Sand
Material thickness of third layer: 0
Material type for third layer: GRAVEL
Infiltration On
Infiltration rate: 3
Infiltration safety factor: 1
Wetted surface area On
Total Volume Infiltrated (ac-ft.): 137.647
Total Volume Through Riser (ac-ft.): 0
Total Volume Through Facility (ac-ft.): 137.647
Percent Infiltrated: 100
Total Precip Applied to Facility: 10.458
Total Evap From Facility: 3.954
Underdrain not used
Discharge Structure
Riser Height: 1 ft.
Riser Diameter: 10 in.
Element Flows To:
Outlet 1 Outlet 2

Bioretention Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.0792	0.0000	0.0000	0.0000
0.0330	0.0789	0.0008	0.0000	0.0000
0.0659	0.0782	0.0015	0.0000	0.0000
0.0989	0.0775	0.0023	0.0000	0.0000
0.1319	0.0769	0.0031	0.0000	0.0000
0.1648	0.0762	0.0039	0.0000	0.0028
0.1978	0.0756	0.0047	0.0000	0.0044
0.2308	0.0749	0.0055	0.0000	0.0064
0.2637	0.0742	0.0064	0.0000	0.0090
0.2967	0.0736	0.0072	0.0000	0.0122
0.3297	0.0729	0.0081	0.0000	0.0160
0.3626	0.0723	0.0089	0.0000	0.0204
0.3956	0.0716	0.0098	0.0000	0.0256
0.4286	0.0710	0.0107	0.0000	0.0315
0.4615	0.0703	0.0115	0.0000	0.0382
0.4945	0.0697	0.0124	0.0000	0.0457
0.5275	0.0690	0.0133	0.0000	0.0542
0.5604	0.0684	0.0143	0.0000	0.0636
0.5934	0.0677	0.0152	0.0000	0.0740
0.6264	0.0671	0.0161	0.0000	0.0854
0.6593	0.0665	0.0170	0.0000	0.0979
0.6923	0.0658	0.0180	0.0000	0.1116
0.7253	0.0652	0.0190	0.0000	0.1265
0.7582	0.0646	0.0199	0.0000	0.1426
0.7912	0.0639	0.0209	0.0000	0.1600

0.8242	0.0633	0.0219	0.0000	0.1788
0.8571	0.0627	0.0229	0.0000	0.1989
0.8901	0.0620	0.0239	0.0000	0.2030
0.9231	0.0614	0.0249	0.0000	0.2049
0.9560	0.0608	0.0259	0.0000	0.2068
0.9890	0.0602	0.0270	0.0000	0.2088
1.0220	0.0596	0.0280	0.0000	0.2107
1.0549	0.0589	0.0291	0.0000	0.2127
1.0879	0.0583	0.0301	0.0000	0.2147
1.1209	0.0577	0.0312	0.0000	0.2166
1.1538	0.0571	0.0323	0.0000	0.2186
1.1868	0.0565	0.0334	0.0000	0.2206
1.2198	0.0559	0.0345	0.0000	0.2226
1.2527	0.0553	0.0356	0.0000	0.2246
1.2857	0.0547	0.0367	0.0000	0.2266
1.3187	0.0541	0.0379	0.0000	0.2286
1.3516	0.0535	0.0390	0.0000	0.2306
1.3846	0.0529	0.0402	0.0000	0.2326
1.4176	0.0523	0.0413	0.0000	0.2346
1.4505	0.0517	0.0425	0.0000	0.2366
1.4835	0.0511	0.0437	0.0000	0.2386
1.5000	0.0505	0.0443	0.0000	0.2397

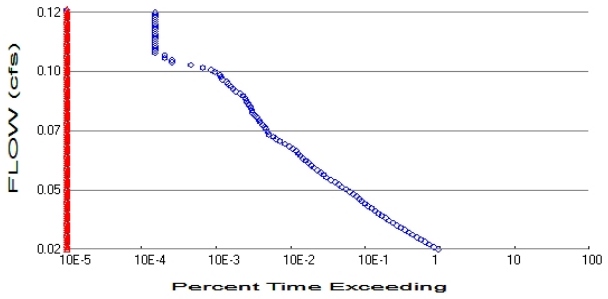
Bioretention Surface Hydraulic Table

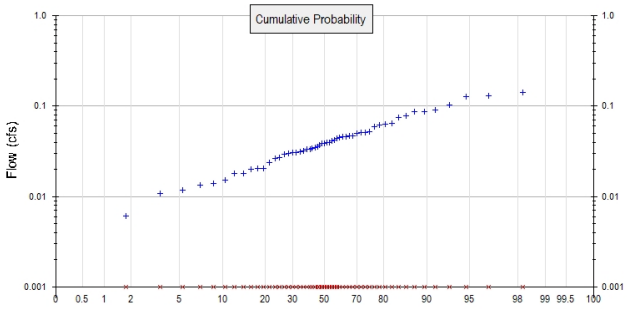
Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	To Amended(cfs)	Infilt(cfs)
1.5000	0.0792	0.0443	0.0000	0.6111	0.0020
1.5330	0.0799	0.0469	0.0000	0.6111	0.0041
1.5659	0.0806	0.0495	0.0000	0.6380	0.0061
1.5989	0.0812	0.0522	0.0000	0.6514	0.0082
1.6319	0.0819	0.0549	0.0000	0.6648	0.0102
1.6648	0.0826	0.0576	0.0000	0.6783	0.0123
1.6978	0.0833	0.0604	0.0000	0.6917	0.0144
1.7308	0.0840	0.0631	0.0000	0.7051	0.0164
1.7637	0.0847	0.0659	0.0000	0.7186	0.0185
1.7967	0.0853	0.0687	0.0000	0.7320	0.0206
1.8297	0.0860	0.0715	0.0000	0.7454	0.0227
1.8626	0.0867	0.0744	0.0000	0.7589	0.0248
1.8956	0.0874	0.0772	0.0000	0.7723	0.0269
1.9286	0.0881	0.0801	0.0000	0.7857	0.0290
1.9615	0.0888	0.0830	0.0000	0.7991	0.0311
1.9945	0.0895	0.0860	0.0000	0.8126	0.0332
2.0275	0.0902	0.0889	0.0000	0.8260	0.0353
2.0604	0.0909	0.0919	0.0000	0.8394	0.0375
2.0934	0.0916	0.0949	0.0000	0.8529	0.0396
2.1264	0.0923	0.0980	0.0000	0.8663	0.0417
2.1593	0.0930	0.1010	0.0000	0.8797	0.0439
2.1923	0.0937	0.1041	0.0000	0.8932	0.0460
2.2253	0.0944	0.1072	0.0000	0.9066	0.0482
2.2582	0.0952	0.1103	0.0000	0.9200	0.0504
2.2912	0.0959	0.1135	0.0000	0.9335	0.0525
2.3242	0.0966	0.1167	0.0000	0.9469	0.0547
2.3571	0.0973	0.1198	0.0000	0.9603	0.0569
2.3901	0.0980	0.1231	0.0000	0.9737	0.0591
2.4231	0.0987	0.1263	0.0000	0.9872	0.0612
2.4560	0.0995	0.1296	0.0000	1.0006	0.0634
2.4890	0.1002	0.1329	0.0000	1.0140	0.0656
2.5220	0.1009	0.1362	0.0288	1.0185	0.0678
2.5549	0.1016	0.1395	0.1136	1.0185	0.0700

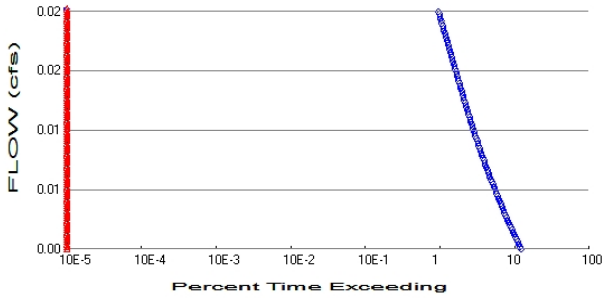
2.5879	0.1024	0.1429	0.2289	1.0185	0.0723
2.6209	0.1031	0.1463	0.3652	1.0185	0.0745
2.6538	0.1038	0.1497	0.5151	1.0185	0.0767
2.6868	0.1046	0.1531	0.6708	1.0185	0.0789
2.7198	0.1053	0.1566	0.8245	1.0185	0.0812
2.7527	0.1061	0.1601	0.9685	1.0185	0.0834
2.7857	0.1068	0.1636	1.0962	1.0185	0.0857
2.8187	0.1075	0.1671	1.2026	1.0185	0.0879
2.8516	0.1083	0.1707	1.2861	1.0185	0.0902
2.8846	0.1090	0.1742	1.3487	1.0185	0.0924
2.9176	0.1098	0.1779	1.4134	1.0185	0.0947
2.9505	0.1105	0.1815	1.4681	1.0185	0.0970
2.9835	0.1113	0.1851	1.5209	1.0185	0.0981
3.0000	0.1117	0.1870	1.5719	1.0185	0.0000

Analysis Results

POC 1







\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 0.76
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 0.19
Total Impervious Area: 0.57

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.038937
5 year	0.066916
10 year	0.08551
25 year	0.108099
50 year	0.123999
100 year	0.139016

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	0.039	0.000
1957	0.078	0.000
1958	0.037	0.000
1959	0.031	0.000
1960	0.129	0.000
1961	0.034	0.000
1962	0.013	0.000
1963	0.092	0.000
1964	0.034	0.000
1965	0.036	0.000
1966	0.020	0.000
1967	0.075	0.000
1968	0.051	0.000
1969	0.018	0.000
1970	0.031	0.000
1971	0.039	0.000
1972	0.143	0.000
1973	0.040	0.000
1974	0.044	0.000
1975	0.020	0.000
1976	0.045	0.000
1977	0.012	0.000
1978	0.032	0.000
1979	0.031	0.000
1980	0.033	0.000
1981	0.063	0.000
1982	0.029	0.000
1983	0.050	0.000
1984	0.131	0.000
1985	0.015	0.000
1986	0.059	0.000
1987	0.047	0.000
1988	0.024	0.000
1989	0.026	0.000
1990	0.062	0.000
1991	0.103	0.000
1992	0.041	0.000
1993	0.020	0.000
1994	0.018	0.000
1995	0.051	0.000
1996	0.087	0.000
1997	0.004	0.000
1998	0.006	0.000
1999	0.040	0.000
2000	0.027	0.000
2001	0.011	0.000
2002	0.052	0.000
2003	0.030	0.000
2004	0.088	0.000
2005	0.035	0.000
2006	0.046	0.000
2007	0.045	0.000
2008	0.064	0.000
2009	0.047	0.000
2010	0.014	0.000
2011	0.043	0.000

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	0.1427	0.0000
2	0.1306	0.0000
3	0.1287	0.0000
4	0.1032	0.0000
5	0.0917	0.0000
6	0.0877	0.0000
7	0.0868	0.0000
8	0.0784	0.0000
9	0.0748	0.0000
10	0.0645	0.0000
11	0.0633	0.0000
12	0.0624	0.0000
13	0.0587	0.0000
14	0.0519	0.0000
15	0.0511	0.0000
16	0.0509	0.0000
17	0.0502	0.0000
18	0.0471	0.0000
19	0.0468	0.0000
20	0.0462	0.0000
21	0.0455	0.0000
22	0.0452	0.0000
23	0.0441	0.0000
24	0.0425	0.0000
25	0.0411	0.0000
26	0.0397	0.0000
27	0.0396	0.0000
28	0.0391	0.0000
29	0.0391	0.0000
30	0.0370	0.0000
31	0.0358	0.0000
32	0.0350	0.0000
33	0.0342	0.0000
34	0.0337	0.0000
35	0.0330	0.0000
36	0.0321	0.0000
37	0.0311	0.0000
38	0.0308	0.0000
39	0.0305	0.0000
40	0.0300	0.0000
41	0.0291	0.0000
42	0.0268	0.0000
43	0.0261	0.0000
44	0.0238	0.0000
45	0.0205	0.0000
46	0.0204	0.0000
47	0.0199	0.0000
48	0.0182	0.0000
49	0.0181	0.0000
50	0.0152	0.0000
51	0.0138	0.0000
52	0.0133	0.0000
53	0.0118	0.0000
54	0.0109	0.0000

55	0.0060	0.0000
56	0.0037	0.0000

LID Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0031	241717	0	0	Pass
0.0033	232488	0	0	Pass
0.0034	223849	0	0	Pass
0.0036	215994	0	0	Pass
0.0038	208533	0	0	Pass
0.0039	201464	0	0	Pass
0.0041	194532	0	0	Pass
0.0043	188033	0	0	Pass
0.0044	181808	0	0	Pass
0.0046	175780	0	0	Pass
0.0048	169968	0	0	Pass
0.0049	164352	0	0	Pass
0.0051	159090	0	0	Pass
0.0053	154102	0	0	Pass
0.0054	149252	0	0	Pass
0.0056	144657	0	0	Pass
0.0058	140298	0	0	Pass
0.0059	135959	0	0	Pass
0.0061	131914	0	0	Pass
0.0063	128006	0	0	Pass
0.0064	124118	0	0	Pass
0.0066	120427	0	0	Pass
0.0067	116833	0	0	Pass
0.0069	113417	0	0	Pass
0.0071	110137	0	0	Pass
0.0072	106898	0	0	Pass
0.0074	103834	0	0	Pass
0.0076	100830	0	0	Pass
0.0077	97845	0	0	Pass
0.0079	95018	0	0	Pass
0.0081	92269	0	0	Pass
0.0082	89598	0	0	Pass
0.0084	87046	0	0	Pass
0.0086	84650	0	0	Pass
0.0087	82392	0	0	Pass
0.0089	80252	0	0	Pass
0.0091	78170	0	0	Pass
0.0092	76148	0	0	Pass
0.0094	74125	0	0	Pass
0.0096	72181	0	0	Pass
0.0097	70257	0	0	Pass
0.0099	68392	0	0	Pass
0.0101	66683	0	0	Pass
0.0102	65034	0	0	Pass
0.0104	63384	0	0	Pass
0.0105	61892	0	0	Pass
0.0107	60302	0	0	Pass
0.0109	58927	0	0	Pass
0.0110	57513	0	0	Pass
0.0112	56198	0	0	Pass
0.0114	54863	0	0	Pass
0.0115	53625	0	0	Pass
0.0117	52349	0	0	Pass

0.0119	51230	0	0	Pass
0.0120	49993	0	0	Pass
0.0122	48736	0	0	Pass
0.0124	47617	0	0	Pass
0.0125	46537	0	0	Pass
0.0127	45536	0	0	Pass
0.0129	44495	0	0	Pass
0.0130	43533	0	0	Pass
0.0132	42512	0	0	Pass
0.0134	41589	0	0	Pass
0.0135	40685	0	0	Pass
0.0137	39841	0	0	Pass
0.0139	39016	0	0	Pass
0.0140	38231	0	0	Pass
0.0142	37367	0	0	Pass
0.0143	36582	0	0	Pass
0.0145	35757	0	0	Pass
0.0147	34991	0	0	Pass
0.0148	34225	0	0	Pass
0.0150	33518	0	0	Pass
0.0152	32831	0	0	Pass
0.0153	32144	0	0	Pass
0.0155	31457	0	0	Pass
0.0157	30730	0	0	Pass
0.0158	30082	0	0	Pass
0.0160	29434	0	0	Pass
0.0162	28806	0	0	Pass
0.0163	28217	0	0	Pass
0.0165	27608	0	0	Pass
0.0167	27019	0	0	Pass
0.0168	26489	0	0	Pass
0.0170	25959	0	0	Pass
0.0172	25448	0	0	Pass
0.0173	24918	0	0	Pass
0.0175	24407	0	0	Pass
0.0177	23858	0	0	Pass
0.0178	23367	0	0	Pass
0.0180	22817	0	0	Pass
0.0181	22346	0	0	Pass
0.0183	21815	0	0	Pass
0.0185	21364	0	0	Pass
0.0186	20893	0	0	Pass
0.0188	20480	0	0	Pass
0.0190	20048	0	0	Pass
0.0191	19634	0	0	Pass
0.0193	19163	0	0	Pass
0.0195	18717	0	0	Pass

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0195	18717	0	0	Pass
0.0205	16168	0	0	Pass
0.0216	13994	0	0	Pass
0.0226	12371	0	0	Pass
0.0237	10976	0	0	Pass
0.0247	9690	0	0	Pass
0.0258	8514	0	0	Pass
0.0269	7526	0	0	Pass
0.0279	6649	0	0	Pass
0.0290	5853	0	0	Pass
0.0300	5182	0	0	Pass
0.0311	4626	0	0	Pass
0.0321	4120	0	0	Pass
0.0332	3637	0	0	Pass
0.0343	3258	0	0	Pass
0.0353	2928	0	0	Pass
0.0364	2661	0	0	Pass
0.0374	2399	0	0	Pass
0.0385	2140	0	0	Pass
0.0395	1933	0	0	Pass
0.0406	1760	0	0	Pass
0.0416	1631	0	0	Pass
0.0427	1486	0	0	Pass
0.0438	1352	0	0	Pass
0.0448	1215	0	0	Pass
0.0459	1079	0	0	Pass
0.0469	959	0	0	Pass
0.0480	855	0	0	Pass
0.0490	775	0	0	Pass
0.0501	682	0	0	Pass
0.0511	593	0	0	Pass
0.0522	543	0	0	Pass
0.0533	500	0	0	Pass
0.0543	443	0	0	Pass
0.0554	401	0	0	Pass
0.0564	368	0	0	Pass
0.0575	336	0	0	Pass
0.0585	310	0	0	Pass
0.0596	288	0	0	Pass
0.0606	269	0	0	Pass
0.0617	249	0	0	Pass
0.0628	231	0	0	Pass
0.0638	211	0	0	Pass
0.0649	187	0	0	Pass
0.0659	164	0	0	Pass
0.0670	141	0	0	Pass
0.0680	126	0	0	Pass
0.0691	114	0	0	Pass
0.0701	100	0	0	Pass
0.0712	96	0	0	Pass
0.0723	92	0	0	Pass
0.0733	88	0	0	Pass
0.0744	82	0	0	Pass

0.0754	77	0	0	Pass
0.0765	74	0	0	Pass
0.0775	69	0	0	Pass
0.0786	65	0	0	Pass
0.0797	61	0	0	Pass
0.0807	59	0	0	Pass
0.0818	57	0	0	Pass
0.0828	54	0	0	Pass
0.0839	53	0	0	Pass
0.0849	50	0	0	Pass
0.0860	48	0	0	Pass
0.0870	45	0	0	Pass
0.0881	41	0	0	Pass
0.0892	36	0	0	Pass
0.0902	33	0	0	Pass
0.0913	31	0	0	Pass
0.0923	28	0	0	Pass
0.0934	27	0	0	Pass
0.0944	24	0	0	Pass
0.0955	23	0	0	Pass
0.0965	22	0	0	Pass
0.0976	19	0	0	Pass
0.0987	17	0	0	Pass
0.0997	13	0	0	Pass
0.1008	9	0	0	Pass
0.1018	5	0	0	Pass
0.1029	5	0	0	Pass
0.1039	4	0	0	Pass
0.1050	4	0	0	Pass
0.1060	3	0	0	Pass
0.1071	3	0	0	Pass
0.1082	3	0	0	Pass
0.1092	3	0	0	Pass
0.1103	3	0	0	Pass
0.1113	3	0	0	Pass
0.1124	3	0	0	Pass
0.1134	3	0	0	Pass
0.1145	3	0	0	Pass
0.1156	3	0	0	Pass
0.1166	3	0	0	Pass
0.1177	3	0	0	Pass
0.1187	3	0	0	Pass
0.1198	3	0	0	Pass
0.1208	3	0	0	Pass
0.1219	3	0	0	Pass
0.1229	3	0	0	Pass
0.1240	3	0	0	Pass

Water Quality

Water Quality BMP Flow and Volume for POC #1

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

LID Report

LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment
retention 1 POC	☐	125.26			☐	100.00			
Total Volume Infiltrated		125.26	0.00	0.00		100.00	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Passed

Model Default Modifications

Total of 0 changes have been made.

PERLND Changes

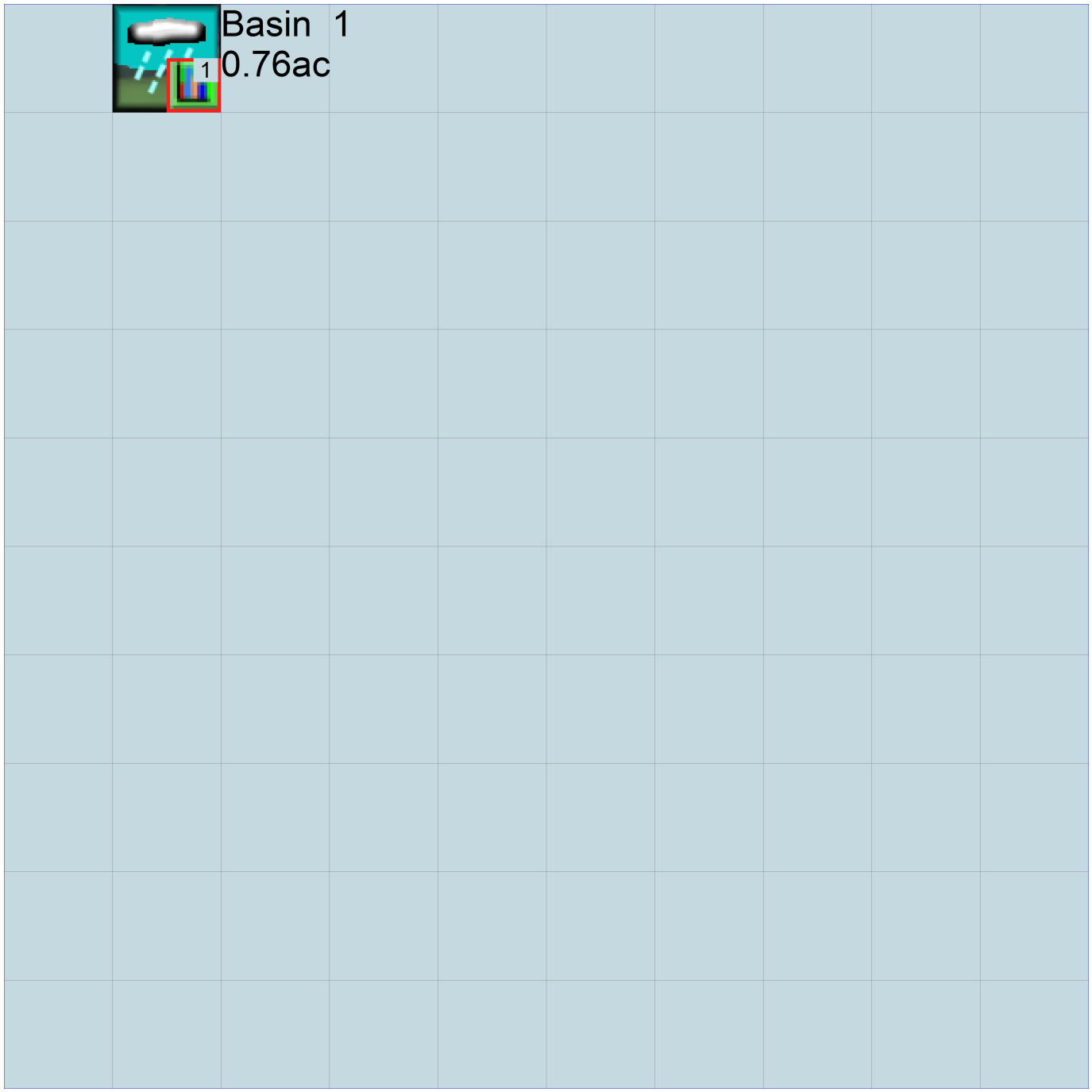
No PERLND changes have been made.

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   21-132bio-pond-LOTS3.wdm
MESSU       25   Pre21-132bio-pond-LOTS3.MES
            27   Pre21-132bio-pond-LOTS3.L61
            28   Pre21-132bio-pond-LOTS3.L62
            30   POC21-132bio-pond-LOTS31.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      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           ***
   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 ***
   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  *********
   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 ***
   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
   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
   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 ***
   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
   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  11                        0.76     COPY   501     12
PERLND  11                        0.76     COPY   501     13

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

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



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

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

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

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

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

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

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1              PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1              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   21-132bio-pond-LOTS3.wdm
MESSU       25   Mit21-132bio-pond-LOTS3.MES
            27   Mit21-132bio-pond-LOTS3.L61
            28   Mit21-132bio-pond-LOTS3.L62
            30   POC21-132bio-pond-LOTS31.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      14
      IMPLND       4
      IMPLND      14
      GENER        2
      RCHRES       1
      RCHRES       2
      COPY         1
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title---------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Surface retention  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 ***
    2        24
  END OPCODE
  PARM
    #    #         K ***
    2             0.
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                          in  out            ***
   14     C, Pasture, 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 ***
   14         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  *********
   14         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 ***
   14         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
   14              0       4.5      0.06       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
   14              0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                              ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   14           0.15       0.4       0.3         6       0.5       0.4
  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
   14              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           ***
    4      ROOF TOPS/FLAT         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   ***
    4         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    *********
    4         0    0    4    0    0    4    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     ***
    4         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
    4            400      0.01       0.1       0.1
   14            400      0.01       0.1       0.1
  END IWAT-PARM2

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

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

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Basin  1***
PERLND  14                       0.19     RCHRES   1      2
PERLND  14                       0.19     RCHRES   1      3
IMPLND   4                       0.43     RCHRES   1      5
IMPLND  14                       0.14     RCHRES   1      5

******Routing******
PERLND  14                       0.19     COPY     1     12
IMPLND   4                       0.43     COPY     1     15
IMPLND  14                       0.14     COPY     1     15
PERLND  14                       0.19     COPY     1     13
RCHRES   1                          1     RCHRES   2      8
RCHRES   2                          1     COPY   501     17
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
GENER    2 OUTPUT TIMSER      .0011111     RCHRES   1     EXTNL  OUTDGT 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     Surface retentio-008    3    1    1    1   28    0    1
    2     Bioretention  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
    2         1    0    0    0    0    0    0    0    0    0
```

```
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ******************* PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
    1         4    0    0    0    0    0    0    0    0    0    1    9
    2         4    0    0    0    0    0    0    0    0    0    1    9
  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  6  0  0       0  1  0  0  0       2  1  2  2  2
    2        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       0.0       0.0
    2              2      0.02       0.0       0.0       0.0       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  6.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
    2            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
*** User-Defined Variable Quantity Lines
***                          addr
***                         <------>
*** kwd  varnam optyp  opn  vari  s1 s2 s3 tp multiply  lc ls ac as agfn ***
  <****> <----> <----> <-> <----><-><-><-><-><--------> <><-> <><-> <--> ***
  UVQUAN vol2   RCHRES   2 VOL             4
  UVQUAN v2m2   GLOBAL     WORKSP  1        3
  UVQUAN vpo2   GLOBAL     WORKSP  2        3
  UVQUAN v2d2   GENER    2 K       1        3
*** User-Defined Target Variable Names
***                  addr or                       addr or
***                 <------>                      <------>
*** kwd   varnam ct  vari  s1 s2 s3  frac oper     vari  s1 s2 s3  frac oper
  <****>  <----><-> <----><-><-><-> <---> <-->    <----><-><-><-> <---> <-->
  UVNAME  v2m2    1 WORKSP  1         1.0 QUAN
  UVNAME  vpo2    1 WORKSP  2         1.0 QUAN
  UVNAME  v2d2    1 K       1         1.0 QUAN
*** opt foplop dcdts  yr mo dy hr mn d t   vnam  s1 s2 s3 ac quantity  tc  ts rp
  <****><-><--><><-><--> <> <> <> <><><>  <----><-><-><-><-><--------> <> <-><->
  GENER   2                               v2m2           =  2144.58
*** Compute remaining available pore space
  GENER   2                               vpo2           =  v2m2
  GENER   2                               vpo2          -=  vol2
*** Check to see if VPORA goes negative; if so set VPORA = 0.0
IF (vpo2 < 0.0) THEN
  GENER   2                               vpo2           =  0.0
END IF
*** Infiltration volume
  GENER   2                               v2d2           =  vpo2
END SPEC-ACTIONS
FTABLES
  FTABLE      2
   47    5
     Depth      Area    Volume  Outflow1  Outflow2  Velocity  Travel Time***
      (ft)   (acres) (acre-ft)   (cfs)      (cfs)   (ft/sec)    (Minutes)***
```

```
  0.000000  0.079224  0.000000  0.000000  0.000000
  0.032967  0.078888  0.000766  0.000000  0.000000
  0.065934  0.078218  0.001541  0.000000  0.000000
  0.098901  0.077550  0.002324  0.000000  0.000000
  0.131868  0.076883  0.003117  0.000000  0.000014
  0.164835  0.076218  0.003919  0.000000  0.002772
  0.197802  0.075555  0.004730  0.000000  0.004373
  0.230769  0.074894  0.005549  0.000000  0.006446
  0.263736  0.074234  0.006378  0.000000  0.009038
  0.296703  0.073576  0.007216  0.000000  0.012198
  0.329670  0.072921  0.008064  0.000000  0.015973
  0.362637  0.072267  0.008920  0.000000  0.020410
  0.395604  0.071614  0.009785  0.000000  0.025555
  0.428571  0.070964  0.010660  0.000000  0.031457
  0.461538  0.070315  0.011544  0.000000  0.038161
  0.494505  0.069668  0.012438  0.000000  0.045717
  0.527473  0.069023  0.013340  0.000000  0.054171
  0.560440  0.068380  0.014252  0.000000  0.063572
  0.593407  0.067738  0.015173  0.000000  0.073968
  0.626374  0.067098  0.016104  0.000000  0.085409
  0.659341  0.066461  0.017044  0.000000  0.097943
  0.692308  0.065824  0.017994  0.000000  0.111621
  0.725275  0.065190  0.018953  0.000000  0.126493
  0.758242  0.064558  0.019921  0.000000  0.142610
  0.791209  0.063927  0.020899  0.000000  0.160024
  0.824176  0.063298  0.021887  0.000000  0.178785
  0.857143  0.062671  0.022884  0.000000  0.198946
  0.890110  0.062045  0.023891  0.000000  0.202973
  0.923077  0.061422  0.024907  0.000000  0.204908
  0.956044  0.060800  0.025933  0.000000  0.206849
  0.989011  0.060180  0.026969  0.000000  0.208795
  1.021978  0.059562  0.028014  0.000000  0.210746
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  FTABLE      1
   47    6
     Depth      Area    Volume  Outflow1  Outflow2  Outflow3  Velocity  Travel
Time***
      (ft)   (acres) (acre-ft)   (cfs)      (cfs)     (cfs)   (ft/sec)
(Minutes)***
  0.000000  0.050505  0.000000  0.000000  0.000000  0.002036
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  0.230769  0.083972  0.018829  0.000000  0.705129  0.014364
  0.263736  0.084658  0.021608  0.000000  0.718560  0.016438
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```

```
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WDM      2 PREC     ENGL    1              PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1              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
WDM      2 PREC     ENGL    1              RCHRES   1     EXTNL  PREC
WDM      1 EVAP     ENGL    0.5            RCHRES   1     EXTNL  POTEV
WDM      1 EVAP     ENGL    0.76           RCHRES   2     EXTNL  POTEV

END EXT SOURCES

EXT TARGETS
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RCHRES   2 HYDR   RO     1 1        1      WDM   1000 FLOW     ENGL      REPL
RCHRES   2 HYDR   O      1 1        1      WDM   1001 FLOW     ENGL      REPL
RCHRES   2 HYDR   O      2 1        1      WDM   1002 FLOW     ENGL      REPL
RCHRES   2 HYDR   STAGE  1 1        1      WDM   1003 STAG     ENGL      REPL
RCHRES   1 HYDR   STAGE  1 1        1      WDM   1004 STAG     ENGL      REPL
RCHRES   1 HYDR   O      1 1        1      WDM   1005 FLOW     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
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<Name>             <Name> # #<-factor->     <Name>                <Name> # #***
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  END MASS-LINK    2

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

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

  MASS-LINK        8
RCHRES     OFLOW  OVOL   2                RCHRES         INFLOW IVOL
  END MASS-LINK    8

  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

Mitigated HSPF Message File

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Appendix G Compost Amended Soil Details

Chapter 6 – Postconstruction Soil Quality and Depth (Ecology BMP T5.13)

Most projects require that site soils meet minimum quality and depth requirements at project completion. Requirements may be achieved by either retaining and protecting undisturbed soil or restoring the soil (e.g., amending with compost) in disturbed areas.

Additional guidance for this BMP can be found in *Building Soil: Guidelines and Resources for Implementing Soil Quality and Depth BMP T5.13* (Stenn et al. 2012), which is available at: <www.buildingsoil.org>.

Naturally occurring (undisturbed) soil, soil organisms, and vegetation provide the following important stormwater management functions:

- Water infiltration
- Nutrient, sediment, and pollutant adsorption
- Sediment and pollutant biofiltration
- Water interflow storage and transmission
- Pollutant decomposition

These functions are largely lost when development strips away native soil and vegetation and replaces it with minimal soil and sod. Not only are these important stormwater management functions lost, but such landscapes can become PGPS themselves due to compaction; increased use of pesticides, fertilizers, and other landscaping and household/industrial chemicals; the concentration of pet wastes; and pollutants that accompany roadside litter.

Postconstruction soil quality and depth requirements help to regain greater stormwater functions in the postdevelopment landscape, provide increased treatment of pollutants and sediments that result from development and habitation, and minimize the need for some landscaping chemicals (thus reducing pollution through prevention).

6.1.1 Applications and Limitations

- When used in combination with other on-site stormwater management BMPs, soil preservation and amendment can help achieve compliance with the Performance Standard option of Minimum Requirement #5.
- On sites underlain by cemented till layers, which are nearly impermeable, the upper soil horizon (native topsoil) processes most of the stormwater on the site. Ensure that the existing depth of the upper soil horizon is either left in place, or

removed and replaced (according to the requirements herein) during the grading process.

- On sites underlain by outwash soils, the existing topsoil is not usually as deep (as with till soils), but must still be preserved or replaced.

- Portions of the site composed of till soils with slopes greater than 33 percent need not implement this BMP.

6.1.2 Modeling and Sizing

Lawn and landscaped areas that meet the requirements of this section may be modeled, using approved runoff models, as "pasture" rather than "lawn" surface over the underlying soil (till or outwash).

In addition, flow control credit is given in runoff modeling when postconstruction soil quality and depth BMP requirements are met and used as part of a dispersion design under the conditions described in Chapters 9 through 15.

6.1.3 Postconstruction Soil Quality and Depth Design Criteria

This section describes the implementation options and design requirements for postconstruction soil quality and depth. Typical cross-sections of compost-amended soil in planting bed and turf applications are shown in Figure 6.1. Design criteria are provided in this section for the following elements.

- Implementation options

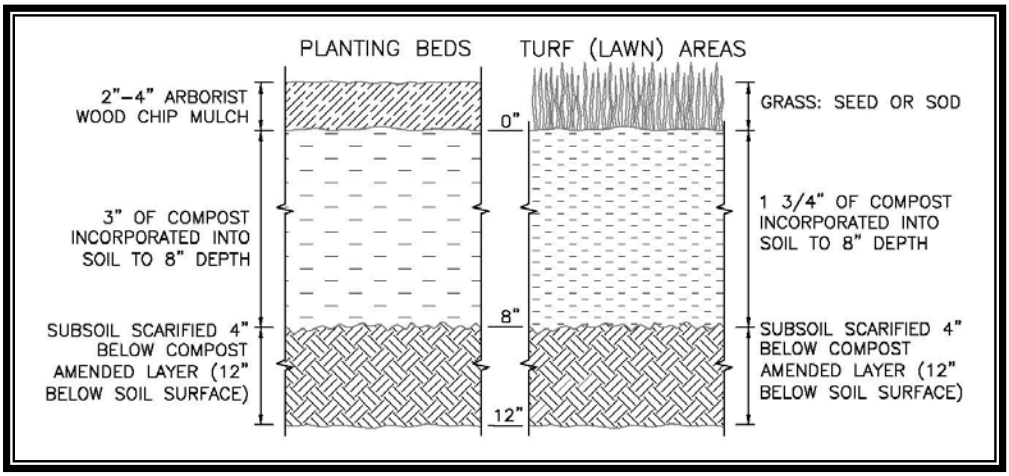
- Soil retention

- Soil amendment

- Soil stockpiling

- Soil importing

- Postconstruction Soil Quality and Depth Plan



Source: Seattle 2016 (reproduced with permission)

Figure 6.1. Cross-Section of Soil Amendment.

Implementation Options

The soil quality design requirements can be met by using one of the four options listed below. Additional details for each option are provided in the subsequent subsections.

1. Retain and Protect Undisturbed Soil

   - Leave undisturbed vegetation and soil, and protect from compaction by fencing and keeping materials storage and equipment off these areas during construction.

   - For all areas where soil or vegetation is disturbed, use option 2, 3, or 4.

2. Amend Soil

   - Soil amendments shall be applied to all areas that are being set aside as non-buildable areas (open space or natural resource protection areas) and are in need of rehabilitation because of past land use disturbances such as clearing and intrusion of invasive species. The purpose is to enhance and accelerate the rehabilitation of the soil structure. The application will be non-destructive to the existing vegetation that is retained by taking care to taper depths of soil amendment near the surface roots.

   - Amend existing site topsoil or subsoil either at default "preapproved" rates, or at custom calculated rates to meet the soil quality guidelines based on engineering tests of the soil and amendment. (Refer to the *Building Soil* manual [Stenn et al. 2012] or web site <www.buildingsoil.org> for custom calculation methods.)

3. Stockpile Soil

   - Stockpile existing topsoil during grading and replace it prior to planting. Amend stockpiled topsoil if needed to meet the organic matter or depth requirements either at the default "preapproved" rate or at a custom calculated rate (refer to the *Building Soil* manual [Stenn et al. 2012] or web site <www.buildingsoil.org> for custom calculation method). Scarify subsoil and mulch planting beds, as described under the Soil Amendment heading below.

4. Import Soil

   - Import topsoil mix of sufficient organic content and depth to meet the requirements. Imported soils must not contain excessive clay or silt fines (more than 5 percent passing the U.S. #200 sieve) because that could restrict stormwater infiltration. Use imported topsoil that meets default "preapproved" rates.

   - Scarify subsoil and mulch planting beds, as described under the "Soil Amendment" heading below.

Note: more than one method may be used on different portions of the same site.

Soil Retention

In buildable areas where minimal excavation foundation systems may be applied, existing topsoils shall be left in place to the greatest extent feasible and shaped or feathered only with tracked grading equipment not exceeding 650 pounds per square foot machine loads. Where some re-grading is required, re-compaction of placed materials, which may include topsoils free of vegetated matter, shall be limited to the minimum densities required by the foundation system engineering.

Soil Amendment

If soil retention and protection is not feasible, disturbed soil must be amended. Soil organic matter is often missing from disturbed soils. Replenish organic matter by amending with compost. It is important that the materials used to meet the Postconstruction Soil Quality and Depth BMP are appropriate and beneficial to the plant cover to be established. Likewise, it is important that imported topsoils improve soil conditions and do not have an excessive percent of clay or silt fines.

Amend existing site topsoil or subsoil either at default "preapproved" soil amendment rates or at custom calculated rates to meet the soil quality guidelines based on engineering tests of the soil and amendment. Both options are described in further detail below.

All areas subject to clearing and grading that have not been covered by impervious surface, incorporated into a drainage facility, or engineered as structural fill or slope must, at project completion, demonstrate the following:

- A topsoil layer meeting these requirements:
    - Turf areas: Place 1.75 inches of compost and till-in to an 8-inch depth. Achieve an organic matter content, as measured by the loss-on-ignition test, of a minimum 4 percent (target 5 percent) organic matter content[1].
    - Planting beds: Place 3 inches of compost and till-in to an 8-inch depth. Achieve an organic matter content, as measured by the loss-on-ignition test, of a minimum 8 percent (target 10 percent) dry weight[1].
    - A pH from 6.0 to 8.0 or matching the pH of the original undisturbed soil.
    - A minimum depth of 8 inches.
- Root zones where tree roots limit the depth of incorporation of amendments are exempted from this requirement. Fence and protect these root zones from stripping of soil, grading, or compaction to the maximum extent practical.
- Scarify (loosen) subsoils below the topsoil layer at least 4 inches for a finished minimum depth of 12 inches of uncompacted soil. Incorporate some of the upper material to avoid stratified layers, where feasible.
- For turf installations: Water or roll to compact to 85 percent of maximum dry density, rake to level, and remove surface woody debris and rocks larger than 1-inch diameter (*Building Soil* manual [Stenn et al. 2012] or web site <www.buildingsoil.org>).
- After planting: Mulch planting beds with 2 to 4 inches of organic material such as arborist wood chips, bark, shredded leaves, compost, etc. Do not use fine bark because it can seal the soil surface.
- Use compost and other materials that meet the following organic content requirements:
    - The organic content for "preapproved" amendment rates can only be met using compost meeting the compost specification for bioretention (see Chapter 9), with the exception that the compost may have up to 35 percent biosolids or manure. The compost must have an organic matter content of 40 percent to 65 percent, and a carbon to nitrogen ratio below 25:1. The carbon to nitrogen ratio may be as high as 35:1 for plantings composed entirely of plants native to the Puget Sound Lowlands region (*Building Soil* manual [Stenn et al. 2012] or web site <www.buildingsoil.org>).

[1] Acceptable test methods for determining loss-on-ignition soil organic matter include the most current version of ASTM D2974 "Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils" and TMECC 05.07-A "Loss-On-Ignition Organic Matter Method"

- Within the 1-year capture zone of any drinking water well or wellhead protection area, compost used within the site shall not include biosolids or animal manure components, as these can result in large concentrations of nitrates leaching into groundwater aquifers and are consequently prohibited within the wellhead protection area.

- Calculated amendment rates may be met through use of composted materials as defined above, or other organic materials amended to meet the carbon to nitrogen ratio requirements, and not exceeding the contaminant limits identified in Table 220-B, Testing Parameters, in WAC 173-350-220 (*Building Soil* manual [Stenn et al. 2012] or web site <www.buildingsoil.org>).

Ensure that the resulting soil is conducive to the type of vegetation to be established.

Soil Stockpiling

In any areas requiring grading, remove and stockpile the duff layer and topsoil on site in a designated, controlled area, which is not adjacent to public resources and critical areas. Reapply to other portions of the site where feasible.

- In buildable areas of the site, where conventional grading is required, the areas requiring cuts shall have the upper native topsoil removed and stockpiled for replacement for areas of the development utilized for stormwater and/or vegetation management (yards, bioretention areas, interflow pathways, vegetated channels, or degraded natural resource protection areas).

- The depth of upper native topsoil required to be stockpiled and replaced shall be the entire depth of the native topsoil horizon up to a maximum of 3 feet.

- Over-excavation of cut sections may be necessary if the cut is in a location that will be used for stormwater management. Cut to a depth that will allow replacement of stockpiled native topsoil to the entire depth that was on the site predevelopment, up to a maximum of 3 feet.

- Cut sections where native topsoil replacement is required shall require ripping of any cemented till layers to a depth of 6 inches. Subsequently, the replacement of stockpiled topsoil shall be thoroughly mixed into the ripped till to provide a gradual transition between the cemented till layer and the topsoil.

- Stockpiled topsoil shall be replaced in lifts no greater than 1 foot deep and compacted by rolling to a density that matches existing conditions.

- Amend stockpiled topsoil if needed to meet the organic matter or depth requirements either at the default “preapproved” rate or at a custom calculated rate (refer to the Building Soil manual [Stenn et al. 2012] or web site <www.buildingsoil.org> for custom calculation method).

Importing Soil

The default preapproved rates for imported topsoils are:

- For planting beds: Use a mix by volume of 35 percent compost with 65 percent mineral soil to achieve the requirement of a minimum 8 percent (target 10 percent) organic matter by loss-on-ignition test

- For turf areas: Use a mix by volume of 20 percent compost with 80 percent mineral soil to achieve the requirement of a minimum 4 percent (target 5 percent) organic matter by loss-on-ignition test.

Soil Management Plan

A Soil Management Plan must be included in the project submittal, i.e., the Construction SWPPP, and Drainage Control Plan or Abbreviated Plan. Refer to Volume I, Section 3.3, for Soil Management Plan requirements.

6.1.4 Construction Criteria

Most of the construction requirements for small-scale infiltration and dispersion facilities included in Chapter 6, also apply to postconstruction soil quality and depth. Minimum construction requirements for disturbed areas include:

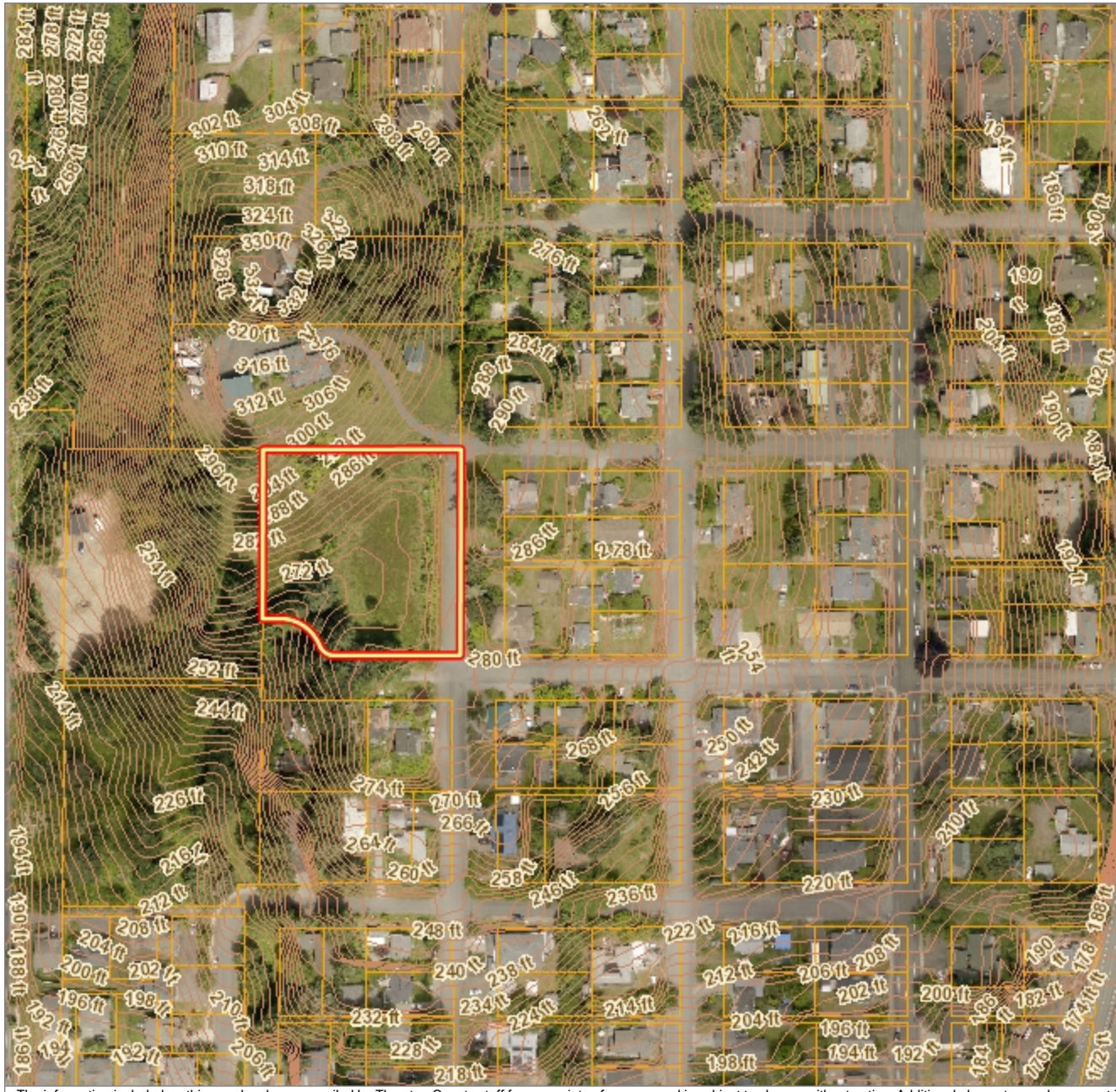
- Install soil to meet postconstruction soil quality and depth BMP requirements toward the end of construction, and once established, protect from compaction and erosion

- Plant soil with appropriate vegetation and mulch planting beds installation.

6.1.5 Operations and Maintenance Criteria

The most important maintenance issue is to replenish the soil organic matter by leaving leaf litter and grass clippings on site (or by adding compost and mulch regularly). This BMP is designed to reduce the need for irrigation, fertilizers, herbicides, and pesticides.

Appendix H Regional Drainage Basin Map



DRAINAGE BASIN

Legend

- Contours 2ft 1996 (NGVD 29)
- Parcel Boundaries

Scale 1: 3,883

0 200 400

Feet

Map Created Using GeoData Public Website

Published: 2/5/2025

Note:

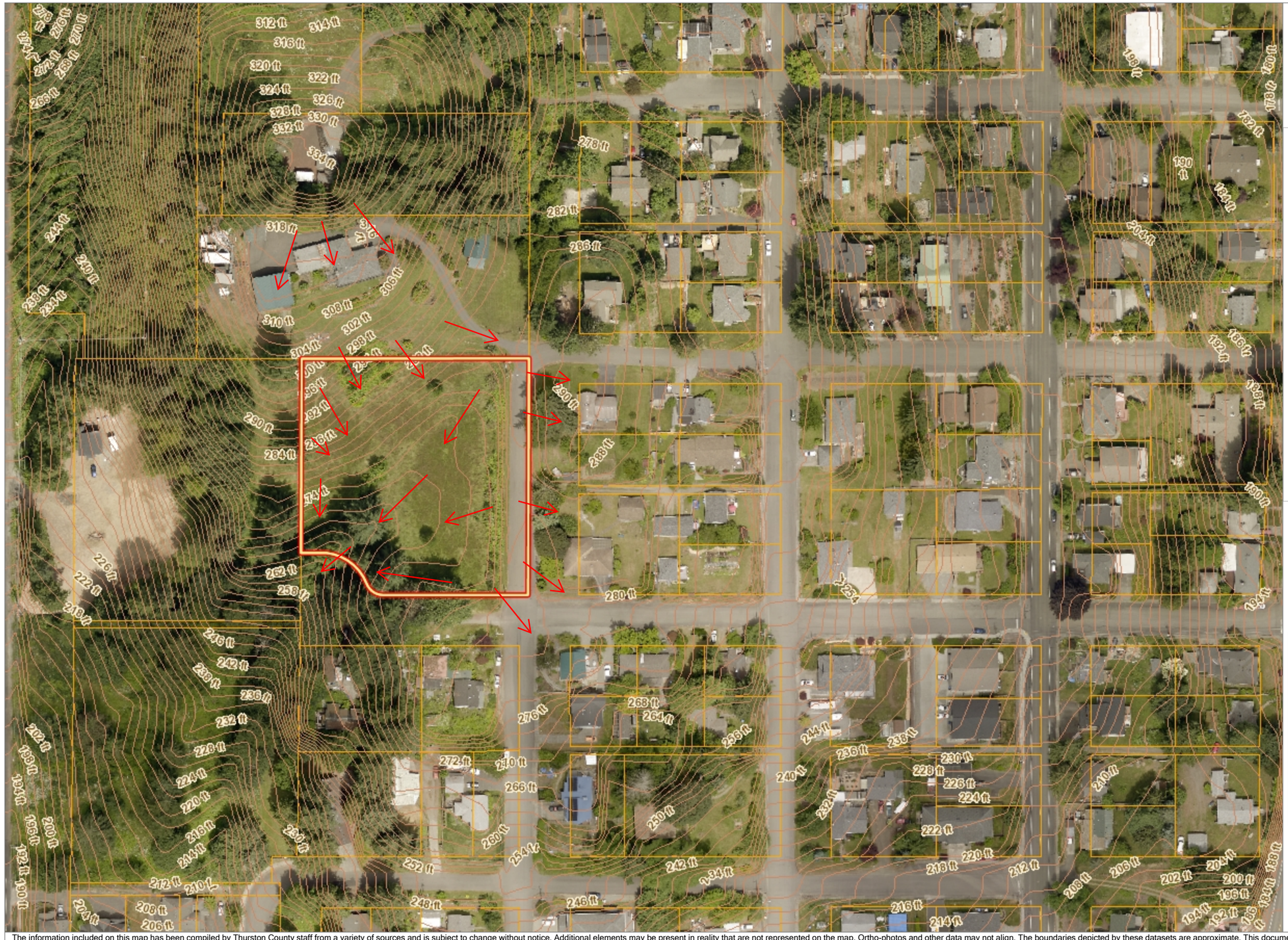
THURSTON COUNTY
WASHINGTON
SINCE 1852

Thurston County GeoData Center

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BASIN MAP



Legend

- Contours 2ft 1996 (NGVD 29)
- Parcel Boundaries

Scale 1: 2,084

0 100 200

Feet

Map Created Using GeoData Public Website

Published: 2/5/2025

Note:

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