CITY OF PORT ANGELES
DEPARTMENT OF COMMUNITY & ECONOMIC DEVELOPMENT BUILDING DIVISION-
321 E. 5TH STREET, PORT ANGELES, WA 98362
Building Permit Inspection Requests: https://www.cityofpa.us/986/Virtual-Inspections

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     Application Number  . . . . .  23-00000725            Date   1/04/24
     Application pin number  . . .  675875
     Property Address  . . . . . .  1248 E LAURIDSEN BLVD
     ASSESSOR PARCEL NUMBER:        06-30-11-5-1-0900-0000-
     Application type description   INDUSTRIAL  NEW CONST
     Subdivision Name  . . . . . .
     Property Use  . . . . . . . .
     Property Zoning . . . . . . .
     Application valuation . . . .      238448
-------------------------------------------------------------------------------
     Application desc
      New 115KV electrical substation
-------------------------------------------------------------------------------

     Owner                                Contractor
     -----------------------              -------------------------
     PUBLIC UTILITY DISTRICT NO. 1        OWNER
     PO BOX 1090
     PORT ANGELES         WA 983620207

-------------------------------------------------------------------------------
     Permit  . . . . . .  BUILDING PERMIT - COMMERCIAL
     Additional desc . .  NEW ELECTRICAL SUBSTATION
     Permit Fee  . . . .     1798.65         Plan Check Fee . .     1169.12
     Issue Date  . . . .     1/04/24         Valuation  . . . .      238448
     Expiration Date . .     7/02/24

         Qty   Unit Charge  Per                                   Extension
                            BASE FEE                               1020.25
      139.00        5.6000 THOU  BL-100,001-500K (9.80 PER K)        778.40
-------------------------------------------------------------------------------
     Special Notes and Comments
      8/7/2023, 1:23:27 PM  MSANDERS

      Heat and Smoke detection to be connected to PUD SCADA system
      for PUD response.

      CONDITION:
      The developer shall comply with any and all requirements
      and/or mitigation measures identified through the SEPA
      review process (PZ 23-43) for this project. No development
      may commence until a threshold determination has been issued
      and the required comment period has ended.

      CONDITION:
      Existing vegetation in the western portion of the site west
      of the proposed substation building site and east of the
      western property boundary of Parcel No. 063011510900 shall
      be maintained to the extent necessary to preserve a visual
      screen compliant with Subsection 17.40.065 PAMC between the
      substation and the abutting residentially owned land.

      CONDITION:
      Lighting shall comply with Sections 17.40.065 and 17.40.070
      PAMC. All lighting on the site shall be directed or shaded
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REPORT SALES TAX
on your state excise tax form to the City of Port Angeles
(Location Code 0502)

The issuance of a permit does not authorize any construction or other activity in violation of, nor does the issuance supersede or cancel the provisions of, any state or local law regulating construction or the performance of construction. The permit does not authorize any construction or other activity in violation of the Governor's COVID-19 Emergency Proclamations and related Guidance Memoranda. Separate Permits are required for electrical work, SEPA, Environmentally Sensitive Area, utilities, and private/public Improvements. This permit becomes null and void if the work or construction authorized is not commenced, or if required inspections have not been requested, with 180 days from the last inspection. During the Governor's COVID-19 Emergency Proclamation the City, in its sole discretion, may allow for or extend the life of building permits beyond the typical 180-day lifespan. All work done pursuant to this permit must comply with all applicable local, state, and federal laws and regulations governing the work even if such local, state, or federal laws or regulation is not expressly specified herein.

Special Notes and Comments
so as to shine away from neighboring property as far as is practical.

CONDITION:
Parcel Nos. 06-30-11-51-0900 and 06-30-11-51-0100 shall be consolidated prior to commencement of substation construction.

GENERAL INFORMATION:
No construction or other land disturbing activity is authorized in a location that would impede the function of or access to utility infrastructure or easements that may exist on the property, regardless of whether such features were depicted on the site plan. The applicant is advised of the provision contained in Section 14.01.050 PAMC.

The applicant is encouraged to check for the existence of CC&Rs or other private agreements that may prohibit the proposed development. Such agreements are not reviewed or enforced by the City, so permit approval does not constitute any evaluation of whether the proposal is consistent with private agreements that may exist.

GENERAL INFORMATION:
Any new permanent fence or wall shall comply with Section 17.94.140 PAMC.
-PUBLIC WORKS & UTILITIES ELECTRICAL ENGINEERING CONDITIONS OF APPROVAL-

Substation structure has no relationship to, or impact on, the City s electrical system. Electrical Engineering has no further comments nor conditions.

-PUBLIC WORKS & UTILITES ENGINEERING GENERAL CONDITIONS OF APPROVAL-

All excavation and construction work within the City right of way requires an approved right of way construction permit per 11.08.020 PAMC. The permit application shall be submitted by the contractor that will be doing the work. Application shall include any necessary vehicular and pedestrian traffic control plan(s) and satisfactory evidence of contractor insurance naming the City as an additional insured.

All workmanship, materials and requirements to meet City Urban Services Standards and Guidelines. See & follow attached city standard detail drawings.

Maximum residential driveway width is 20 feet per 11.08.140

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Special Notes and Comments
PAMC.

Driveway approaches located within the public right of way from curbed streets shall be constructed of class 3000 cement concrete a minimum of 6 inches in thickness including that portion of the sidewalk that crosses the driveway.

Contractor to provide load tickets for all concrete deliveries.

Temp erosion control and surface restoration responsibility of applicant.

-PUBLIC WORKS ENGINEERING STORMWATER CONDITIONS OF APPROVAL-

_____
_____

REQUIRED STORMWATER INSPECTIONS

a) Pre-Construction Erosion Control Insp.
b) During Construction Erosion Control Insp.
c) Stormwater Facilities Insp.
d) Post-Construction Erosion/PWKS Final Insp.

STORMWATER SITE SPECIFIC CONDITIONS OF APPROVAL

1. Draft O&M manual and agreement will need to be updated and re-submitted for review and comment towards the end of the project. A recorded copy of the agreement and manual is required prior to scheduling a final inspection.

2. NOTE a revised WWHM report was performed by the design engineer on 12.20.2023. The flow control orifices shall match the results of the approved 12.20.2023 WWHM report.

STORMWATER STANDARD CONDITIONS OF APPROVAL

3. All red-line revisions made by the reviewing authority to the permit application, Stormwater Management Plan (SWMP), or Stormwater Pollution Prevention Plan (SWPPP) shall be incorporated as part of the approved plan set.

4. The applicant is required to follow the approved SWMP and SWPPP throughout the life of the project. All approved BMPs shall be installed, maintained, and removed per the most recent Stormwater Management Manual for Western Washington (SWMMWW) specifications and/or manufacturer specifications.

5. Any deviation from or amendment to the approved SWMP or

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Special Notes and Comments
SWPPP must be documented and approved in advance by Public Works, Engineering.

6. All activities conducted onsite shall be done so in accordance with the 13 Elements of Stormwater Pollution Prevention.

7. Deposition of sediment or other pollutants onto City streets or into the City s stormwater conveyance system is a violation of City ordinance. Efforts to minimize and remediate track out are required. Any soils tracked out onto City streets shall be cleaned up by the contractor at the end of each day or earlier, weather dictating.

8. Prior to final approval, all disturbed soils not covered by an impervious surface shall meet Soil Quality and Depth requirements (BMP T5.13) and shall be permanently stabilized. All material receipts and/or truck tickets shall be retained by the applicant and submitted to the City for verification.

PUBLIC WORKS INSPECTIONS

Pre-Construction Erosion and Sediment Control Inspection

1. The contractor is required to request a pre-construction erosion and sediment control inspection. Scheduling should be as follows:

a) Mark off perimeter and undisturbed areas with visible flagging.
b) Install Construction Entrance
c) Install temporary erosion and sediment controls
d) Install Inlet Protections
e) Obtain and store Materials on Hand (BMP C150)
f) Dig Foundation
g) Protect stockpiles and un-worked exposed soils
h) Identify location and method of managing concrete washout (does not need to be installed), if applicable
i) Schedule an inspection.

**NOTE: Passing your PWKS pre-construction inspection is required before any land disturbing activity may occur.
During Construction Erosion and Sediment Control Inspection

2. Per the SWPPP agreement, the contractor is required to manage construction BMPs to ensure compliance with City regulations and protect downstream waterbodies. At any time during the project the City may perform an inspection of the site to ensure BMPs are performing as designed. These are

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Special Notes and Comments
periodic spot-inspections that are usually performed in conjunction with other building related inspections. Any BMP(s) identified by the inspector as needing maintenance, repair, or upgrade shall be addressed post-haste by the contractor or other responsible party.
Stormwater Facility Inspections

3. Bioswale After excavation and before amendment and seeding, Schedule an inspection.

4. Detention Pond after excavation and before amendment and seeding, schedule an inspection.

5. Flow Control Structure after installation, schedule an inspection.

Post Construction Erosion and Sediment Control Inspection

6. A Post-Construction Erosion and Sediment Control Inspection and sign-off is required prior to permit close-out. All permanent stormwater management BMPs shall be installed and functional prior to sign-off. All documentation verifying soil testing, amendments, and quantities shall be submitted and verified prior to sign-off. Schedule an inspection.

PWKS ENGINEERING INSPECTION REQUEST PROCEDURE:

To schedule an inspection of permitted work:
1. To schedule an inspection of permitted work
2. Go to the City s website, cityofpa.us
3. Select Business at the top of the webpage
4. Select Inspection Requests
5. Select the large blue button - Public Works Engineering Inspection Requests
6. Schedule your inspection

The inspection request phone line has been discontinued. Please do not call to schedule your inspections.

You are selecting the day you wish for the inspection to take place and are asked for a preferred time of day, morning or afternoon. We will try our best to accommodate your preference, but it is not guaranteed. Also note that you must request your inspection by noon the business day before the date of inspection. Inspections are performed on business days only, Monday Friday, excluding holidays.

The inspector will contact you to confirm time and date of the inspection(s). The required fields are; Name, Email

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Application Number . . . . . 23-00000725 Date 1/04/24
Application pin number . . . 675875

Special Notes and Comments
Address, Address of location where the work is being done, Permit Type, Permit Number, and Preferred time of day. An inspection request cannot be made until all these fields are filled out.
Thank you for scheduling your inspection.

Other Fees . . . . . STATE SURCHARGE COMM 25.00

Fee summary	Charged	Paid	Credited	Due
Permit Fee Total	1798.65	1798.65	.00	.00
Plan Check Total	1169.12	1169.12	.00	.00
Other Fee Total	25.00	25.00	.00	.00
Grand Total	2992.77	2992.77	.00	.00

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BUILDING PERMIT INSPECTION RECORD

IT IS UNLAWFUL TO COVER, INSULATE OR CONCEAL ANY WORK BEFORE INSPECTED AND ACCEPTED.

POST PERMIT IN CONSPICUOUS LOCATION. KEEP PERMIT AND APPROVED PLANS AT JOB SITE.

Inspection Type	Date	Accepted By	Comments
Foundation			
Footings			
Stemwall			
Foundation Drainage/Downspouts			
Piers			
Post Holes (Pole Buildings)			
Plumbing			
Under Floor / Slab			
Rough-in			
Water Line (Meter to Bldg)			
Gas Line			
Back Flow/Water			
Air Seal:			
Walls			
Ceiling			
Framing:			
Joists / Girders / Under Floor			
Shear Wall / Hold Downs			
Walls / Roof / Ceiling			
Drywall (Interior Braced Panel Only)			
T-bar			
Insulation:			
Slab			
Wall / Floor / Ceiling			
Mechanical:			
Heat Pump / furnace / FAU / Ducts			
Rough-in			
Gas Line			
Wood Stove / Pellet / Chimney			
Commercial Hood / Ducts			
Manufactured Homes			
Footing / Slab			
Blocking & Hold Downs			
Skirting			
Planning Dept. Separate Permit #s			SEPA:
Parking / Lighting			ESA:
Landscaping			Shoreline:

FINAL INSPECTIONS REQUIRED PRIOR TO OCCUPANCY/USE

Inspection Types	Date	Accepted By
Electrical - 417-4735		
Construction Right of way Here		
Fire - 417-4653		
Planning - Request Inspection Here		
Building - Request Inspection Here		

CITY OF PORT ANGELES
PUBLIC WORKS & UTILITIES
321 E. 5th Street Port Angeles, WA 98362
PWKS permit Inspection Requested Here

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Application Number  . . . . .  23-00000725            Date   1/04/24
Application pin number  . . .  675875
Property Address  . . . . . .  1248 E LAURIDSEN BLVD
ASSESSOR PARCEL NUMBER:        06-30-11-5-1-0900-0000-
Application type description   INDUSTRIAL  NEW CONST
Subdivision Name  . . . . . .
Property Use  . . . . . .
Property Zoning . . . . . .
Application valuation . . . .      238448
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Application desc
 New 115KV electrical substation
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Owner                                Contractor
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PUBLIC UTILITY DISTRICT NO. 1        OWNER
PO BOX 1090
PORT ANGELES         WA 983620207
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Permit  . . . . . .  PW ENGINEERING REVIEW STORM
Additional desc . .  STROMWATER REVIEW
Permit Fee  . . . .      325.00        Plan Check Fee . .         .00
Issue Date  . . . .     1/04/24        Valuation  . . . .           0
Expiration Date . .     7/02/24

    Qty   Unit Charge  Per                                  Extension
                          BASE FEE                             300.00
   1.00       25.0000 ECH   PW ENG REVIEW STORM BASE            25.00
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Permit  . . . . . .  PUBLIC WORKS INSPECTION
Additional desc . .  SW INSPECTIONS
Permit Fee  . . . .      990.00        Plan Check Fee . .         .00
Issue Date  . . . .     1/04/24        Valuation  . . . .           0
Expiration Date . .     7/02/24

    Qty   Unit Charge  Per                                  Extension
  11.00       90.0000 HR    PW INSPECTION                      990.00
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Special Notes and Comments
 8/7/2023, 1:23:27 PM  MSANDERS

 Heat and Smoke detection to be connected to PUD SCADA system
 for PUD response.

 CONDITION:
 The developer shall comply with any and all requirements
 and/or mitigation measures identified through the SEPA
 review process (PZ 23-43) for this project. No development
 may commence until a threshold determination has been issued
 and the required comment period has ended.

 CONDITION:
 Existing vegetation in the western portion of the site west
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(Location Code 0502)

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Special Notes and Comments
of the proposed substation building site and east of the western property boundary of Parcel No. 063011510900 shall be maintained to the extent necessary to preserve a visual screen compliant with Subsection 17.40.065 PAMC between the substation and the abutting residentially owned land.

CONDITION:
Lighting shall comply with Sections 17.40.065 and 17.40.070 PAMC. All lighting on the site shall be directed or shaded so as to shine away from neighboring property as far as is practical.

CONDITION:
Parcel Nos. 06-30-11-51-0900 and 06-30-11-51-0100 shall be consolidated prior to commencement of substation construction.

GENERAL INFORMATION:
No construction or other land disturbing activity is authorized in a location that would impede the function of or access to utility infrastructure or easements that may exist on the property, regardless of whether such features were depicted on the site plan. The applicant is advised of the provision contained in Section 14.01.050 PAMC.

The applicant is encouraged to check for the existence of CC&Rs or other private agreements that may prohibit the proposed development. Such agreements are not reviewed or enforced by the City, so permit approval does not constitute any evaluation of whether the proposal is consistent with private agreements that may exist.

GENERAL INFORMATION:
Any new permanent fence or wall shall comply with Section 17.94.140 PAMC.
-PUBLIC WORKS & UTILITIES ELECTRICAL ENGINEERING CONDITIONS OF APPROVAL-

Substation structure has no relationship to, or impact on, the City s electrical system. Electrical Engineering has no further comments nor conditions.

-PUBLIC WORKS & UTILITES ENGINEERING GENERAL CONDITIONS OF APPROVAL-

All excavation and construction work within the City right of way requires an approved right of way construction permit per 11.08.020 PAMC. The permit application shall be submitted by the contractor that will be doing the work. Application shall include any necessary vehicular and

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Special Notes and Comments
pedestrian traffic control plan(s) and satisfactory evidence of contractor insurance naming the City as an additional insured.

All workmanship, materials and requirements to meet City Urban Services Standards and Guidelines. See & follow attached city standard detail drawings.

Maximum residential driveway width is 20 feet per 11.08.140 PAMC.

Driveway approaches located within the public right of way from curbed streets shall be constructed of class 3000 cement concrete a minimum of 6 inches in thickness including that portion of the sidewalk that crosses the driveway.

Contractor to provide load tickets for all concrete deliveries.

Temp erosion control and surface restoration responsibility of applicant.

-PUBLIC WORKS ENGINEERING STORMWATER CONDITIONS OF APPROVAL-

_____
_____

REQUIRED STORMWATER INSPECTIONS

a) Pre-Construction Erosion Control Insp.
b) During Construction Erosion Control Insp.
c) Stormwater Facilities Insp.
d) Post-Construction Erosion/PWKS Final Insp.

STORMWATER SITE SPECIFIC CONDITIONS OF APPROVAL

1. Draft O&M manual and agreement will need to be updated and re-submitted for review and comment towards the end of the project. A recorded copy of the agreement and manual is required prior to scheduling a final inspection.

2. NOTE a revised WWHM report was performed by the design engineer on 12.20.2023. The flow control orifices shall match the results of the approved 12.20.2023 WWHM report.

STORMWATER STANDARD CONDITIONS OF APPROVAL

3. All red-line revisions made by the reviewing authority to the permit application, Stormwater Management Plan (SWMP), or Stormwater Pollution Prevention Plan (SWPPP) shall be

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Special Notes and Comments
incorporated as part of the approved plan set.

4. The applicant is required to follow the approved SWMP and SWPPP throughout the life of the project. All approved BMPs shall be installed, maintained, and removed per the most recent Stormwater Management Manual for Western Washington (SWMMWW) specifications and/or manufacturer specifications.

5. Any deviation from or amendment to the approved SWMP or SWPPP must be documented and approved in advance by Public Works, Engineering.

6. All activities conducted onsite shall be done so in accordance with the 13 Elements of Stormwater Pollution Prevention.

7. Deposition of sediment or other pollutants onto City streets or into the City s stormwater conveyance system is a violation of City ordinance. Efforts to minimize and remediate track out are required. Any soils tracked out onto City streets shall be cleaned up by the contractor at the end of each day or earlier, weather dictating.

8. Prior to final approval, all disturbed soils not covered by an impervious surface shall meet Soil Quality and Depth requirements (BMP T5.13) and shall be permanently stabilized. All material receipts and/or truck tickets shall be retained by the applicant and submitted to the City for verification.

PUBLIC WORKS INSPECTIONS

Pre-Construction Erosion and Sediment Control Inspection

1. The contractor is required to request a pre-construction erosion and sediment control inspection. Scheduling should be as follows:

a) Mark off perimeter and undisturbed areas with visible flagging.
b) Install Construction Entrance
c) Install temporary erosion and sediment controls
d) Install Inlet Protections
e) Obtain and store Materials on Hand (BMP C150)
f) Dig Foundation
g) Protect stockpiles and un-worked exposed soils
h) Identify location and method of managing concrete washout (does not need to be installed), if applicable
i) Schedule an inspection.

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CITY OF PORT ANGELES
PUBLIC WORKS & UTILITIES
321 E. 5th Street Port Angeles, WA 98362
PWKS permit Inspection Requested Here

Application Number . . . . . 23-00000725 Date 1/04/24
Application pin number . . . 675875

Special Notes and Comments
**NOTE: Passing your PWKS pre-construction inspection is required before any land disturbing activity may occur.
During Construction Erosion and Sediment Control Inspection

2. Per the SWPPP agreement, the contractor is required to manage construction BMPs to ensure compliance with City regulations and protect downstream waterbodies. At any time during the project the City may perform an inspection of the site to ensure BMPs are performing as designed. These are periodic spot-inspections that are usually performed in conjunction with other building related inspections. Any BMP(s) identified by the inspector as needing maintenance, repair, or upgrade shall be addressed post-haste by the contractor or other responsible party.
Stormwater Facility Inspections

3. Bioswale After excavation and before amendment and seeding, Schedule an inspection.

4. Detention Pond after excavation and before amendment and seeding, schedule an inspection.

5. Flow Control Structure after installation, schedule an inspection.

Post Construction Erosion and Sediment Control Inspection

6. A Post-Construction Erosion and Sediment Control Inspection and sign-off is required prior to permit close-out. All permanent stormwater management BMPs shall be installed and functional prior to sign-off. All documentation verifying soil testing, amendments, and quantities shall be submitted and verified prior to sign-off. Schedule an inspection.

PWKS ENGINEERING INSPECTION REQUEST PROCEDURE:

To schedule an inspection of permitted work:
1. To schedule an inspection of permitted work
2. Go to the City s website, cityofpa.us
3. Select Business at the top of the webpage
4. Select Inspection Requests
5. Select the large blue button - Public Works Engineering Inspection Requests
6. Schedule your inspection

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You are selecting the day you wish for the inspection to

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on your state excise tax form to the City of Port Angeles
(Location Code 0502)

The issuance of a permit does not authorize any construction or other activity in violation of, nor does the issuance supersede or cancel, the provisions of, any state or local law regulating construction or the performance of construction. The permit does not authorize any construction or other activity in violation of the Governor's COVID-19 Emergency Proclamations and related Guidance Memoranda. Separate Permits are required for electrical work, SEPA, Environmentally Sensitive Area, utilities, and private/public Improvements. This permit becomes null and void if the work or construction authorized is not commenced, or if required inspections have not been requested, with 180 days from the last inspection. During the Governor's COVID-19 Emergency Proclamation the City, in its sole discretion, may allow for or extend the life of building permits beyond the typical 180-day lifespan. All work done pursuant to this permit must comply with all applicable local, state, and federal laws and regulations governing the work even if such local, state, or federal laws or regulation is not expressly specified herein.

Application Number . . . . . 23-00000725 Date 1/04/24
Application pin number . . . 675875

Special Notes and Comments
take place and are asked for a preferred time of day, morning or afternoon. We will try our best to accommodate your preference, but it is not guaranteed. Also note that you must request your inspection by noon the business day before the date of inspection. Inspections are performed on business days only, Monday Friday, excluding holidays.

The inspector will contact you to confirm time and date of the inspection(s). The required fields are; Name, Email Address, Address of location where the work is being done, Permit Type, Permit Number, and Preferred time of day. An inspection request cannot be made until all these fields are filled out.
Thank you for scheduling your inspection.

Other Fees . . . . . STATE SURCHARGE COMM 25.00

Fee summary	Charged	Paid	Credited	Due
Permit Fee Total	1315.00	1315.00	.00	.00
Plan Check Total	.00	.00	.00	.00
Other Fee Total	25.00	25.00	.00	.00
Grand Total	1340.00	1340.00	.00	.00

REPORT SALES TAX
on your state excise tax form to the City of Port Angeles
(Location Code 0502)

The issuance of a permit does not authorize any construction or other activity in violation of, nor does the issuance supersede or cancel, the provisions of, any state or local law regulating construction or the performance of construction. The permit does not authorize any construction or other activity in violation of the Governor's COVID-19 Emergency Proclamations and related Guidance Memoranda. Separate Permits are required for electrical work, SEPA, Environmentally Sensitive Area, utilities, and private/public Improvements. This permit becomes null and void if the work or construction authorized is not commenced, or if required inspections have not been requested, with 180 days from the last inspection. During the Governor's COVID-19 Emergency Proclamation the City, in its sole discretion, may allow for or extend the life of building permits beyond the typical 180-day lifespan. All work done pursuant to this permit must comply with all applicable local, state, and federal laws and regulations governing the work even if such local, state, or federal laws or regulation is not expressly specified herein.

PERMIT INSPECTION RECORD

Public Works inspections are requested on the City Website Here

IT IS UNLAWFUL TO COVER, INSULATE OR CONCEAL ANY WORK BEFORE INSPECTED AND ACCEPTED. POST PERMIT IN CONSPICUOUS LOCATION. KEEP PERMIT AND APPROVED PLANS AT JOB SITE.

Inspection Type	Date	Accepted		Comments
		YES	NO	
PUBLIC WORKS AND UTILITIES (ENGINEERING DIVISION)				
WATERLINE / METER				
SEWER CONNECTION				
SEWER REPAIR				
PARKING				
SIDEWALK				
CURB & GUTTER				
DRIVEWAY				
EROSION CONTROL:				
PRE-CONSTRUCTION				
DURING CONSTRUCTION				
DURING CONSTRUCTION				
DURING CONSTRUCTION				
DURING CONSTRUCTION				
POST CONSTRUCTION				
PERMANENT STORMWATER SYSTEM:				
ROUGH-IN				
STORMWATER CONNECTION				
FINAL				
STORMWATER FACILITIES				
ROUGH-IN				
FINAL				
FINAL INSPECTIONS REQUIRED PRIOR TO OCCUPANCY/USE				
RESIDENTIAL	**DATE**	**YES**	**NO**	**COMMENTS**
PW ENGINEERING Request Inspection Here				
FIRE 360 417-4653				
PLANNING Request Inspection Here				
BUILDING Request Inspection Here				
COMMERCIAL				**COMMENTS**
PW ENGINEERING Request Inspection Here				
FIRE 360 417-4653				
PLANNING Request Inspection Here				
BUILDING Request Inspection Here				
N:PWKS\ENGINEER\Fees – Public Works\Public Works permit				

LIBERTY STREET SUBSTATION
PROJECT REPORT
CLALLAM COUNTY PUD #1

PROJECT LOCATION:
LAURIDSEN BOULEVARD & LIBERTY STREET
PORT ANGELES, WASHINGTON
PARCEL NO: 06-30-11-51-0900

Prepared for:
CLALLAM COUNTY PUD #1
104 HOOKER ROAD
CARLSBORG, WASHINGTON 98382

Prepared by:
ZENOVIC & ASSOCIATES, INCORPORATED
301 EAST 6TH STREET, SUITE #1
PORT ANGELES, WASHINGTON 98362

Project No. 23071
Prepared November 15, 2023

INTRODUCTION

This project report has been prepared to demonstrate compliance with the City of Port Angeles (City) stormwater requirements. The intent of this report is to comprehensively describe the stormwater management system for the proposed Liberty Street Sub-Station located southwest of the intersection of Lauridsen Boulevard and Liberty Street in Port Angeles. This project includes construction of a power substation, access roads, and stormwater facilities.

This project falls under the requirements of a large project stormwater plan per Section 5.04.01.2 of the Port Angeles Urban Services Standards and Guidelines (USSG, Jan. 2017) and the *2019 Stormwater Management Manual for Western Washington* (DOE). Per the flow chart provided in Chapter 5 of the USSG this project is required to comply with minimum requirements 1-9.

Included in the Appendices of this report are the Stormwater Flow Chart, Project Plans, Stormwater treatment and flow control calculations, Offsite Drainage Report and Map, and Source Control BMP's. A Stormwater Pollution Prevention Plan and Operation and Maintenance Manual will be submitted as separate documents along with this report.

BACKGROUND

The project is located on parcel 06-30-11-51-0900, southwest of the intersection of Lauridsen Boulevard and Liberty Street. The parcels encompass 4.74 acres which has previously been partially cleared but is undeveloped apart from an existing road approach from Park Street in the southwest corner of the site and overhead power utilities which cross the site. The site is generally gently sloped to the north from Park Street toward Lauridsen Boulevard (average slope of 3%). There is a steep fill slope on the north side of Park Street that is assumed to have been created during the construction of Park Street. This bank will not be affected by this project.

The NRCS Soils survey classifies the site as Clallam gravelly sandy loam with the following features (please note that these are classifications are generalizations and are not intended to take precedence over observed field data):

- Clallam gravelly sandy loam typical soil profile consists of 0 to 10 inches of gravelly ashy sandy loam, 10 to 28 inches very gravelly ashy sandy loam, and 28 to 60 inches very gravelly sandy loam.
- The typical depth to densic material is 20 to 40 inches.
- Typical depth to water table is 18 to 36 inches.

Onsite investigations found soil consistent with the Clallam soil types with the site being underlain by dense till material. Two test pits were dug in anticipation of performing Pilot Infiltration Tests, however both test pits filled with groundwater (approximately 12" below ground surface) before the tests could be performed. One additional pit was

excavated to a depth of 36" with no material change from those in the first two pits. Crews from Clallam PUD #1 also performed 9 test pits throughout the proposed substation pad area. This office was not present to observe the soils conditions when those pits were excavated, but review of photographs of the work indicate that the soils are consistent with those encountered during our investigations.

A test pit map and logs are included in Appendix F of this report.

PROJECT SUMMARY

This project includes construction of a Substation Yard with a footprint of approximately 19,600 square feet. The project also includes the installation of approximately 6,700 square feet of access roads, and removal/replacement of approximately 164 square feet of existing sidewalk. The total hard surfaces being added and/or replaced as part of this project is 26,464 square feet. Total area disturbed by this project will be approximately 42,500 square feet

DRAINAGE AREA SUMMARIES

	BASIN #1	BASIN #2	BASIN #3
Overall Area	71,220 s.f.	24,750 s.f	990 s.f.
Substation Area	-	19,600 s.f.	-
Sidewalk	-	-	250 s.f.
Access Roads	7,000 s.f.	2,765 s.f.	740 s.f.
Pond Area	3,325 s.f.	-	-
Disturbed Lawn/Landscaped Area	6,450 s.f.	2,385	-
Undisturbed Area	57,145 s.f.	-	-

DRAINAGE PLAN MINIMUM REQUIREMENTS

Per the USSG this project is required to comply with minimum requirements #1 through #9 Section 5.05 of the USSG. This section is intended to address each requirement in that section.

Minimum Requirement #1 – Stormwater Site Plan

A stormwater site plan has been prepared for this project and is included with this report in Appendix B.

Minimum Requirement #2 – Stormwater Pollution Prevention Plan

The site plan includes temporary erosion and sedimentation control BMP's to be implemented as part of this project. A Stormwater Pollution Prevention Plan narrative has been prepared and submitted to the City as a separate document.

Minimum Requirement #3 – Source Control of Pollution

The following source controls will be implemented on this project:

- S411 – BMPs Landscaping and Lawn/Vegetation Management.
- S417 - BMPs for Maintenance of Stormwater Drainage and Treatment Systems
- S421 – BMPs for Parking and Storage of Vehicles and Equipment

Copies of these BMPs are attached in Appendix E.

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

Runoff from the site currently drains to the north side of the site where it enters an existing ditch which parallels Lauridsen Boulevard. The ditch on the west side of the project is generally level and it is assumed to drain in both the east and west directions. Runoff flowing to the east enters an existing culvert which drains to a 15 inch diameter concrete pipe on the north side of Lauridsen Boulevard which eventually discharges to Peabody Creek at the 9th Street Outfall just west of Race Street. Runoff flowing to the west enters a catch basin structure and then discharges to the same 15 inch diameter pipe just further to the west.

Once developed, the site will discharge to the same stormwater system and thus maintain the existing drainage path. Runoff from the developed portion of the site will be collected, treated through onsite biofiltration swales, detained in an onsite detention pond and discharged the existing ditchline on the northwest side of the site. The ditchline in the northeast will be maintained.

Minimum Requirement #5 – On-site Stormwater Management

This project triggers minimum requirements #1-9 and discharges to Peabody Creek therefore shall employ On-site Stormwater BMPs from List #2 (Chapter 5, USSG) for all surfaces within each type of surface listed or demonstrate compliance with the LID Performance Standard. The following are the BMPs that will be utilized for each category and the infeasibility criteria for those BMPs not utilized.

1. Lawn and Landscaped Areas

Post-construction soil quality and depth (BMP T5.13) will be utilized for all lawn and landscaped areas that are disturbed during the course of construction. Guidelines are included in the project plans.

2. Roof Areas

There are no roof areas included in this project.

Other Hard Surfaces (driveway and sidewalks)

Full dispersion is infeasible as a large portion of the site has already been cleared and it is not possible to retain 65% of the site in a forested or natively vegetated condition.

Permeable pavements are infeasible as there is high groundwater (interflow) present on this site.

Bioretention/Rain Gardens are infeasible as there is high groundwater (interflow) present on this site.
Sheet Flow Dispersion will be used for portions of the driveway area. Approximately 3,200 square feet of the driveway at the south end of the site will be dispersed into adjacent vegetation. As there is more than a 100' flow path for flows from those portions of the driveway, they are considered ineffective impervious surfaces and are not included in the flow control calculations as driveway area.

Sheet flow dispersion is not feasible for the remaining access roads and substation yard due to inadequate flow paths.

Minimum Requirement #6: Runoff Treatment

Runoff Treatment is required for this development as there will be more than 5,000 square feet of Pollution Generating Impervious Surfaces (PGIS) added as part of this project.

The site will be required to provide Enhanced Treatment as the site is a commercial project which discharges to a freshwater water body that has aquatic life (Peabody Creek). Enhanced Treatment will be achieved through a continuous inflow bioswale to treat runoff from the collected driveway areas and the substation yard.

Runoff treatment calculations are provided in Appendix C

Minimum Requirement #7: Flow Control

Flow control is required for this project as it includes the installation of mor than 10,000 square feet of hard surfaces and discharges to a freshwater body which is not flow control exempt (Peabody Creek). The goal for this project is to meet the flow performance standard put forth by Ecology. The flow control performance standard is stated as follows, "Stormwater discharges shall match developed discharge durations to pre-developed durations for the range of pre-developed discharge rates from 50% of the 2-year peak flow up to the full 50-year peak flow."

A detention pond was designed using WWHM2012 to meet the performance standard. The outfall for the pond will be to an existing ditch along the south side of Lauridsen Boulevard. Sizing and calculations of the pond sizing can be found in Appendix C. Note that in the model, Point of Connection #1 is the point analyzed for flow control. Point of Connection #2 is included to show treatment flow rates for the bio-swale.

Minimum Requirement #8: Wetland Protection

The drainage outfall route does not impact any existing or potential wetland area. All runoff is contained within Peabody Creek. No wetlands have been found along the drainage route.

Minimum Requirement #9: Operation and Maintenance Manual

This project is required to provide an Operation and Maintenance Manual for all stormwater facilities associated with this project. Additionally, a stormwater Maintenance Agreement between the project proponent and the City will be required. Copies of these documents have been prepared and will be submitted as a separate document along with this report.

APPENDIX A
STORMWATER FLOW CHART

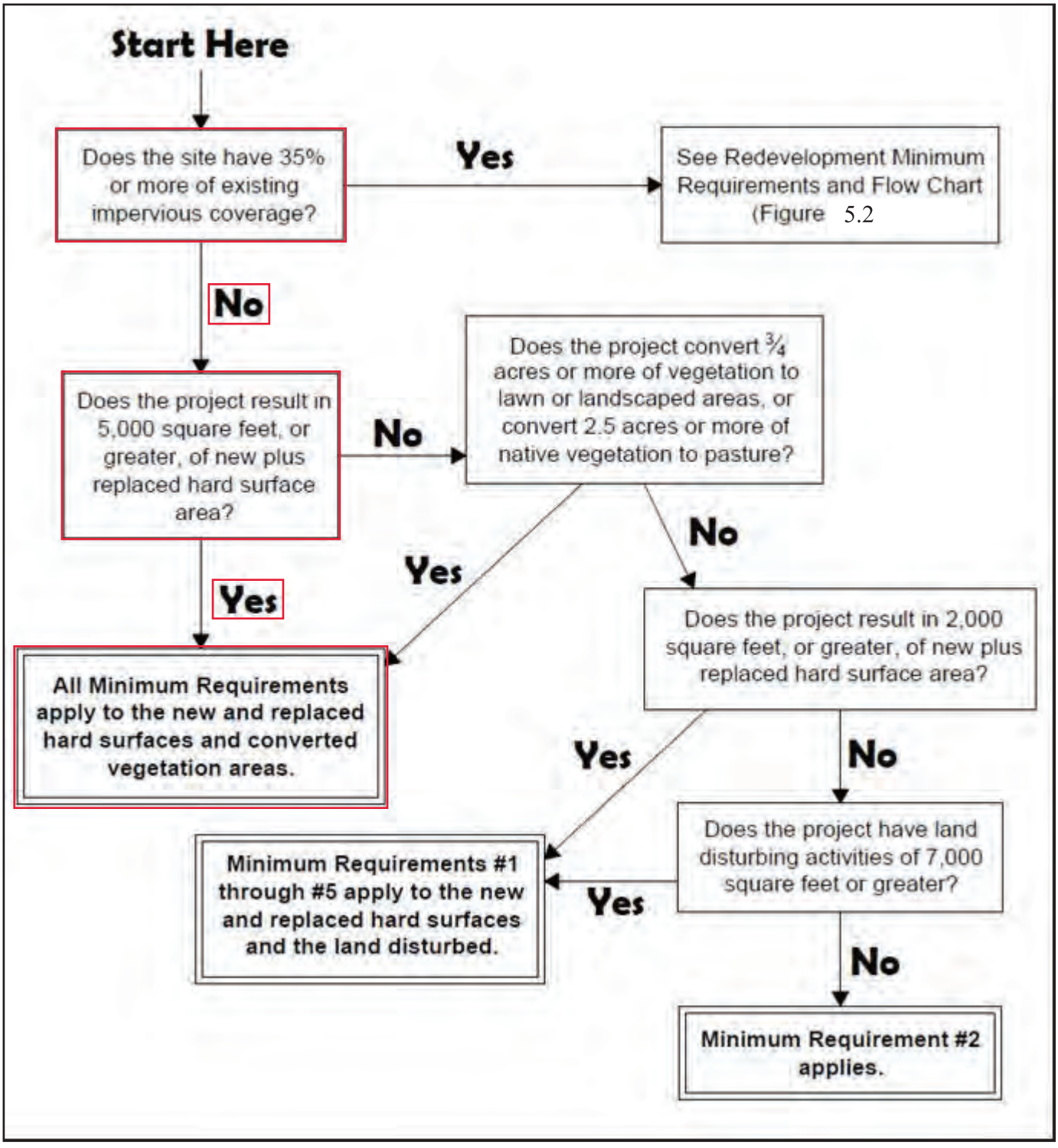
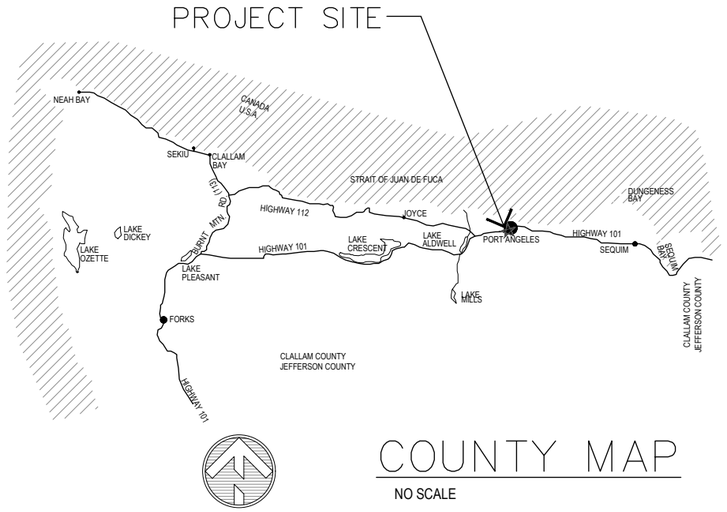


Figure 5.1. Flow Chart for Determining Requirements for New Development

APPENDIX B
PROJECT PLANS

CITY MAP

NO SCALE



COUNTY MAP

NO SCALE

PROJECT INFORMATION

APPLICANT:	CLALLAM COUNTY PUD #1 PO BOX 1000 CARLSBORG, WA 98324
OWNER:	CLALLAM COUNTY PUD #1 PO BOX 1000 CARLSBORG, WA 98324
PROPOSED PROJECT:	LIBERTY STREET SUBSTATION
ZONING:	PBP - PUBLIC BUILDING AND PARKS
UTILITIES:	STORM & SANITARY SEWER, & WATER - CITY OF PORT ANGELES POWER - CALLAM COUNTY PUD #1 TELEPHONE - N/A CABLE TELEVISION - N/A
PARCEL NO.:	06-30-11-51-0900
DATE OF PREPARATION:	JUNE 2023
PROPERTY DESCRIPTION:	BLOCKS 12 & 13 OF CAMPBELL'S ADDITION TO PORT ANGELES TOGETHER WITH VACATED PORTIONS OF ABUTTING RIGHTS OF WAYS, SEE SURVEY RECORDED IN VOLUME 47 OF SURVEYS, PAGE 13 FOR ADDITIONAL ENCUMBRANCES.

HORIZONTAL AND VERTICAL DATUM:

CITY OF PORT ANGELES

HORIZ. NAD 83/91

VERT. NAVD 88

TOPOGRAPHIC DATA AS NOTED PROVIDED BY THE CLALLAM COUNTY PUD. DATA INCLUDED SURFACE ELEVATIONS IN THE AREA NOTED IN THE PLANS, THE SIDEWALK ON THE NORTH SIDE OF THE PROJECT AREA AND THE EDGE OF ROADWAY AROUND THE SITE.

BENCHMARK:

TBD

DRAWING INDEX

C1 COVER SHEET WITH GENERAL NOTES
C2 TESC & DEMO PLAN
C3 TESC DETAILS
C4 SITE PLAN
C5 DRAINAGE DETAILS

CALL BEFORE YOU DIG
1-800-424-5555
FOR UNDERGROUND UTILITY LOCATION SERVICE

GENERAL NOTES:

1. ALL WORKMANSHIP AND MATERIALS SHALL BE IN ACCORDANCE WITH THE CITY OF PORT ANGELES STANDARDS, THE CURRENT EDITION OF THE WASHINGTON STATE DEPARTMENT OF TRANSPORTATION (WSDOT) STANDARD SPECIFICATIONS FOR ROAD, BRIDGE AND MUNICIPAL CONSTRUCTION (STANDARD SPECIFICATIONS), AND ANY PROJECT SPECIFIC SPECIAL PROVISIONS OR CONDITIONS AND REQUIREMENTS.

2. TEMPORARY EROSION/WATER POLLUTION MEASURES ARE REQUIRED AND SHALL COMPLY WITH CHAPTER 6 OF THE CITY OF PORT ANGELES' URBAN SERVICES STANDARDS AND GUIDELINES AND THE CURRENT EDITION OF THE WASHINGTON STATE DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS FOR ROAD, BRIDGE AND MUNICIPAL CONSTRUCTION.

3. EXISTING AND NEWLY CONSTRUCTED STORM WATER DRAINAGE SYSTEMS SHALL BE PROTECTED FROM CONSTRUCTION SITE RUNOFF.

4. A PRECONSTRUCTION MEETING SHALL BE HELD WITH THE CITY PRIOR TO THE START OF CONSTRUCTION.

5. HORIZONTAL AND VERTICAL CONTROLS/DATUM AS ADOPTED BY THE CITY SHALL BE USED, UNLESS APPROVED OTHERWISE.

6. ALL APPROVALS AND PERMITS REQUIRED BY THE CITY SHALL BE OBTAINED BY THE CONTRACTOR PRIOR TO THE START OF CONSTRUCTION, UNLESS OTHERWISE APPROVED BY THE CITY ENGINEER.

7. THE CONTRACTOR SHALL BE FULLY RESPONSIBLE FOR THE LOCATION AND PROTECTION OF ALL EXISTING UTILITIES. THE CONTRACTOR SHALL VERIFY ALL UTILITY LOCATIONS PRIOR TO CONSTRUCTION BY CALLING UNDERGROUND LOCATE AT 1-800-424-5555 A MINIMUM OF 48 HOURS PRIOR TO ANY EXCAVATION WORK.

8. THE CONTRACTOR SHALL BE FULLY RESPONSIBLE FOR TEMPORARY TRAFFIC CONTROL. THE CONTRACTOR SHALL, BY LETTER TO THE CITY ENGINEER, INDICATE THAT WSDOT STANDARD "K" PLANS SHALL BE UTILIZED FOR TEMPORARY TRAFFIC CONTROL. IF THE CURRENT WSDOT STANDARD "K" PLANS ARE NOT UTILIZED, THE CONTRACTOR SHALL PROVIDE A TRAFFIC CONTROL PLAN(S) FOR REVIEW AND APPROVAL BY THE CITY ENGINEER IN ACCORDANCE WITH THE MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES (MUTCD). THE CITY ENGINEER SHALL HAVE FIVE DAYS FOR REVIEW OF ANY PROPOSED TRAFFIC CONTROL PLAN. NO WORK MAY BE CONDUCTED WITHOUT AN APPROVED TRAFFIC CONTROL PLAN.

9. THE CONTRACTOR SHALL HAVE A COPY OF THE APPROVED PLANS AT THE CONSTRUCTION SITE AT ALL TIMES.

10. SPECIAL STRUCTURES SHALL BE INSTALLED PER PLANS AND MANUFACTURER'S RECOMMENDATIONS.

11. ALL DISTURBED AREAS SHALL RECEIVE TEMPORARY AND PERMANENT EROSION CONTROL IN THE FORM OF VEGETATION ESTABLISHMENT SUCH AS GRASS SEEDING. A MEANS SHALL BE ESTABLISHED TO PROTECT THE PERMANENT STORM DRAIN SYSTEM PRIOR TO ESTABLISHMENT OF THE PERMANENT EROSION CONTROL MEASURES. THESE METHODS SHALL BE INCLUDED IN THE EROSION AND SEDIMENT CONTROL PLANS IN ACCORDANCE WITH CHAPTER 6 THE CITY OF PORT ANGELES URBAN SERVICES STANDARDS AND GUIDELINES.

12. CONSTRUCTION WORK HOURS SHALL BE RESTRICTED TO 7 A.M. TO 10 P.M. PRIOR WRITTEN APPROVAL OF THE CITY ENGINEER SHALL BE REQUIRED FOR WORK BETWEEN 10 P.M. AND 7 A.M.; A VARIANCE FROM THE CITY BOARD OF ADJUSTMENT WILL BE REQUIRED TO WORK DURING THESE HOURS. A VARIANCE REQUIRES A MINIMUM OF 60 DAYS TO OBTAIN; THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL COSTS AND EFFORTS TO OBTAIN THE VARIANCE

13. THE CITY CONSTRUCTION INSPECTOR SHALL BE NOTIFIED A MINIMUM OF 24 HOURS IN ADVANCE OF THE NEED FOR AN INSPECTION.

14. PER THE PROVISIONS OF THE CURRENT WSDOT STANDARD SPECIFICATIONS RELATED TO PUBLIC CONVENIENCE AND SAFETY, THE CONTRACTOR SHALL MAINTAIN READY ACCESS TO DRIVEWAYS, HOUSES, AND BUILDINGS ALONG THE LINE OF WORK.

15. A MINIMUM OF ONE WAY TRAVEL THROUGH THE PROJECT AREA SHALL BE MAINTAINED AT ALL TIMES, UNLESS OTHERWISE APPROVED BY THE CITY ENGINEER.

16. SHOULD ACCESS TO A PROPERTY ADJOINING THE PROJECT REQUIRE TEMPORARY CLOSURE ANTICIPATED TO HAVE A DURATION EXCEEDING 15 MINUTES, THE CONTRACTOR SHALL COORDINATE THE TEMPORARY CLOSURE WITH THE PROPERTY OWNER/RESIDENT. A MINIMUM OF 24 HOURS ADVANCE NOTIFICATION SHALL BE PROVIDED TO THE PROPERTY OWNER/RESIDENT PRIOR TO ANY SUCH TEMPORARY CLOSURE.

APPROVED FOR CONSTRUCTION _____ DATE: _____ APPROVAL EXPIRES: _____
CITY ENGINEER

ZENOVIC & ASSOCIATES
INCORPORATED
301 E. 6TH STREET, SUITE 1
PORT ANGELES, WA 98362
PHONE: (360) 417-0501
FAX: (360) 417-0514
EMAIL: ZENOVIC@ZENOVIC.NET

REVISIONS:

DATE	MARK	NOTE

TITLE: LIBERTY STREET SUBSTATION - CORNER OF LIBERTY STREET & LAURIDSEN BOULEVARD, PORT ANGELES, WA

COVER SHEET & GENERAL NOTES

CLIENT:
CLALLAM COUNTY PUD #1
104 HOOKER ROAD
SEQUIM, WA 98382

SCALE: NTS

FILE: 23071 - E2

JOB NO: 23071

DATE: August 30, 2023

SET: PERMIT

SHEET **C1**

SITE PLAN

Scale: 1" = 30'

0 30' 60' 90'

EROSION CONTROL NOTES:

1. ALL EROSION CONTROL MEASURES SHALL BE CONSTRUCTED AND MAINTAINED IN ACCORDANCE WITH THE REQUIREMENTS OF THE STORMWATER MANAGEMENT MANUAL FOR WESTERN WASHINGTON (DOE, 2019) AND THE PORT ANGELES URBAN SERVICES, STANDARDS AND GUIDELINES (2017) HEREAFTER REFERRED TO AS THE URBAN SERVICES.
2. ALL DISTURBED AREAS, EXCEPT THOSE ON WHICH ACTIVE CONSTRUCTION IS TAKING PLACE, SHALL BE EITHER SEEDED AND MULCHED OR PROTECTED WITH APPROPRIATE PLASTIC SHEETING WITHIN 2 DAYS OF DISTURBANCE BETWEEN OCTOBER 1 AND APRIL 30 AND WITHIN 7 DAYS BETWEEN MAY 1 AND SEPTEMBER 30.
3. STABILIZED CONSTRUCTION ENTRANCE TO BE INSTALLED PRIOR TO CLEARING AND GRADING ACTIVITIES.
4. ALL EROSION CONTROL MEASURES SHALL BE INSPECTED WEEKLY AND AFTER MAJOR STORM EVENTS. ANY DEFICIENCIES SHALL BE REPAIRED IMMEDIATELY.
5. CATCH BASIN INSERTS PER DETAIL A/C2 TO BE INSTALLED IN ALL EXISTING AND NEWLY INSTALLED BASIN AND REMAIN IN PLACE UNTIL AREA DRAINAGE TO AFFECTED BASIN IS FULLY STABILIZED.
6. ANY MATERIAL THAT IS CARRIED OFFSITE BY VEHICLE WHEELS AND DEPOSITED ON PUBLIC ROADWAYS SHALL BE CLEANED UP IMMEDIATELY.
7. SAWCUTTING SHALL BE DONE WITH WATER TO PREVENT DUST AND THE RESULTING SLURRY IS TO BE VACUUMED UP IMMEDIATELY.
8. CONCRETE TRUCKS TO WASHOUT IN DESIGNATED CONCRETE WASHOUT AREA IN ACCORDANCE WITH BMP C154.
9. ADJACENT PROPERTIES SHALL BE PROTECTED FROM SEDIMENT DEPOSITION BY APPROPRIATE USE OF VEGETATIVE BUFFER STRIPS, SEDIMENT BARRIERS OR FILTERS, DIKES OR MULCHING, OR BY A COMBINATION OF THESE MEASURES.
10. THE TESC MEASURES SHOWN ON THIS PLAN REPRESENT THE MINIMUM REQUIREMENTS REQUIRED TO COMPLY WITH THE TERMS AND CONDITIONS OF SECTION 6.03.1 OF THE URBAN SERVICES.
11. THE CONTRACTOR SHALL BE RESPONSIBLE TO ENSURE THE EROSION CONTROL MEASURES USED ARE FUNCTIONING EFFECTIVELY AND THE SITE CONTINUALLY COMPLIES WITH THE REQUIREMENTS OF THE URBAN SERVICES.
12. DEMOLITION DEBRIS LEFT ONSITE SHALL BE COVERED AT THE END OF EACH SHIFT WITH PLASTIC COVERING OR EQUIVALENT.
13. **DISTURBED SOILS ARE TO AMENDED PER BMP T5.13.**
14. UPON COMPLETION OF THE PROJECT, ALL DISTURBED AREAS NOT OTHERWISE PAVED OR LANDSCAPED SHALL BE HYDRO-SEEDED WITH THE LANDSCAPE SEED MIX BELOW UNLESS OTHERWISE SPECIFIED.

LANDSCAPE SEED MIX

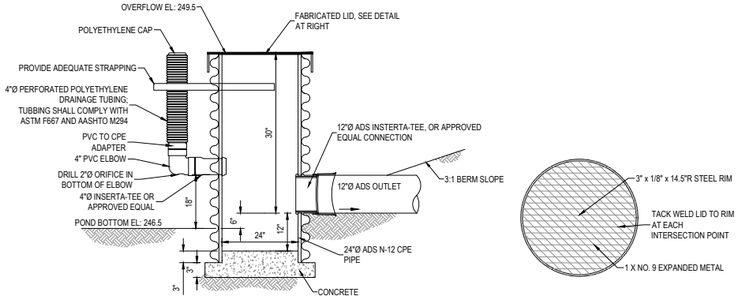
SEED TYPE	% WEIGHT	% PURITY	% GERMINATION
PERENNIAL RYE	70	98	90
CHEWINGS AND RED FESCUE BLEND	30	98	85

1. SEED TO BE APPLIED AT A RATE OF 120 lbs/acre.
2. MULCH TO BE APPLIED AT A MIN. RATE OF 1500 lbs/acre WITH 3% TACKIFIER.
3. FERTILIZER (10-4-6 N-P-K) TO BE APPLIED AT A RATE OF 90 lbs/acre.

WET AREA SEED MIX

SEED TYPE	% WEIGHT	% PURITY	% GERMINATION
TALL OR MEADOW FESCUE	60-70	98	90
SEASIDE/CREEPING BENTGRASS	10-15	98	85
MEADOW FOXTAIL	10-15	90	80
ALSIKE CLOVER	1-6	98	90
REDTOP BENTGRASS	1-6	92	85

1. SEED TO BE APPLIED AT A RATE OF 120 lbs/acre.
2. MULCH TO BE APPLIED AT A MIN. RATE OF 1500 lbs/acre WITH 3% TACKIFIER.
3. FERTILIZER (10-4-6 N-P-K) TO BE APPLIED AT A RATE OF 90 lbs/acre.



FABRICATED LID

A / C2 SEDIMENT POND RISER DETAIL

Scale: NTS

ZENOVIC & ASSOCIATES
INCORPORATED
301 E. 6TH STREET, SUITE 1
PORT ANGELES, WA 98362
PHONE: (360) 417-0501
FAX: (360) 417-0514
EMAIL: ZENOVIC@ZENOVIC.NET

REVISIONS:

DATE	MARK	NOTE

TITLE: LIBERTY STREET SUBSTATION - CORNER OF LIBERTY STREET & LAURIDSEN BOULEVARD , PORT ANGELES, WA

TESC/DEMO PLAN

CLIENT: CLALLAM COUNTY PUD #1
104 HOOKER ROAD
SEQUIM, WA 98382

SCALE: 1"=30'

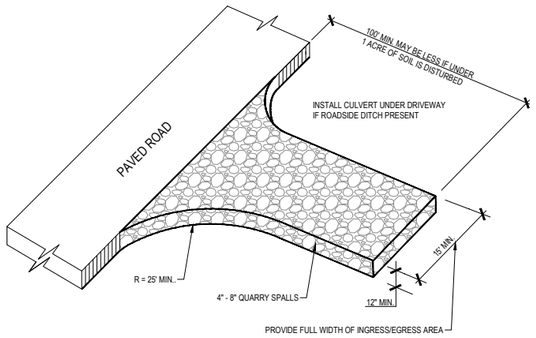
FILE: 23071 - E2

JOB NO: 23071

DATE: August 30, 2023

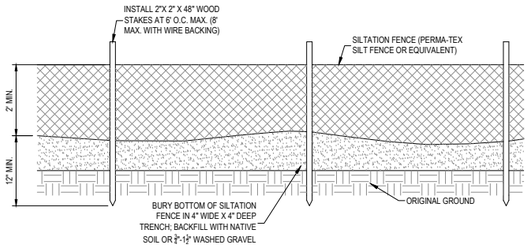
SET: PERMIT

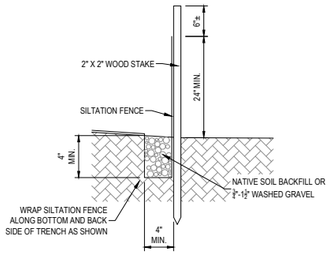
SHEET **C2**



A C3 STABILIZED CONSTRUCTION ENTRANCE

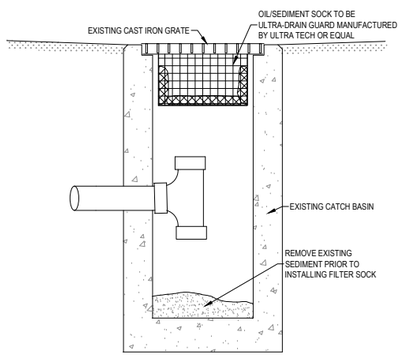
Scale: NTS





B C3 SILTATION FENCE DETAILS

Scale: NTS



C C3 INLET PROTECTION

Scale: N.T.S.

ZENOVIC & ASSOCIATES
INCORPORATED
301 E. 6TH STREET, SUITE 1
PORT ANGELES, WA 98362
PHONE: (360) 417-0501
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EMAIL: ZENOVIC@ZENOVIC.NET

REVISIONS:

DATE	MARK	NOTE

TITLE: LIBERTY STREET SUBSTATION - CORNER OF LIBERTY STREET & LAURIDSEN BOULEVARD , PORT ANGELES, WA

TESC DETAILS

CLIENT: CLALLAM COUNTY PUD #1
104 HOOKER ROAD
SEQUIM, WA 98382

SCALE: NTS

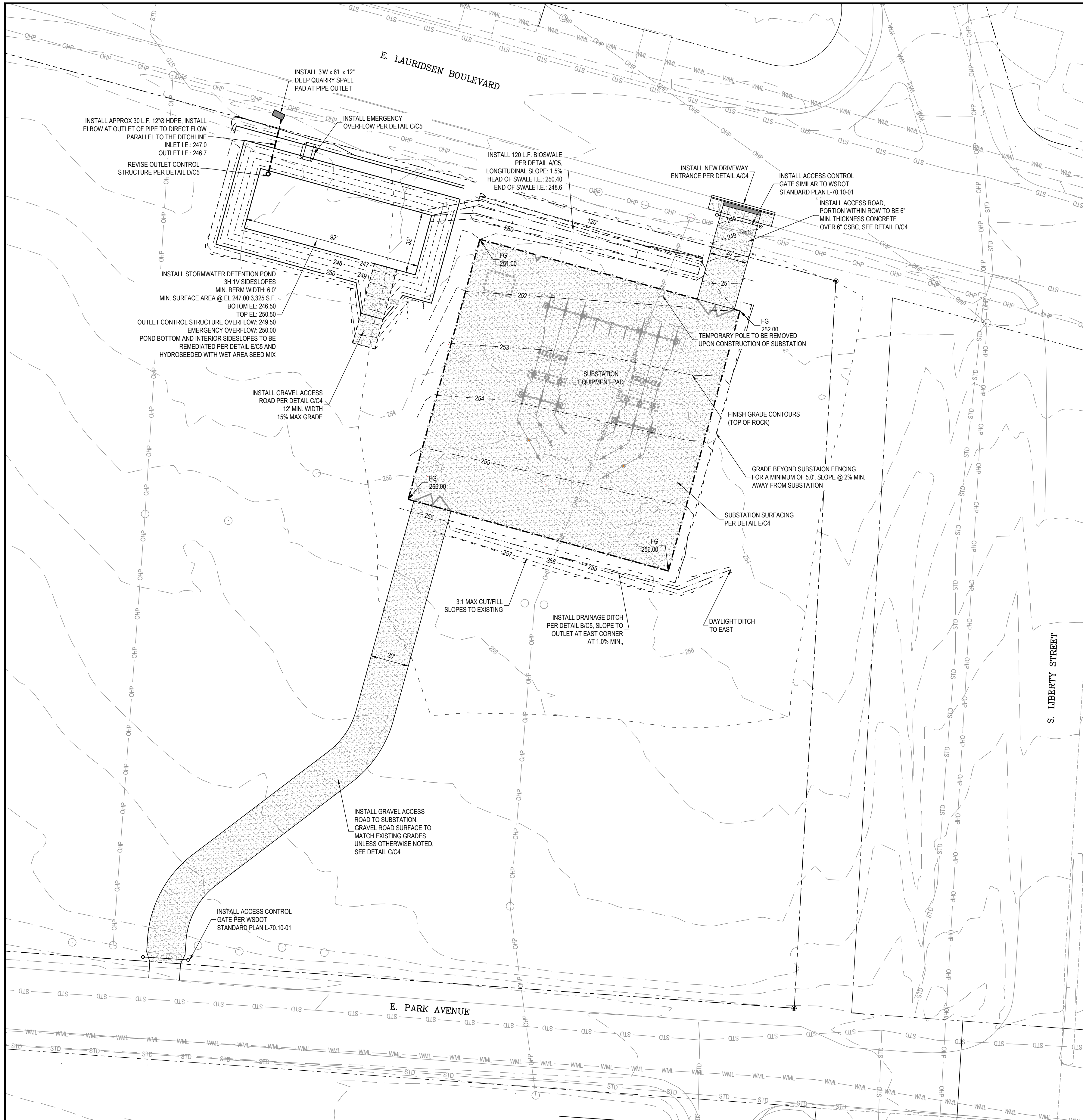
FILE: 23071 - E2

JOB NO: 23071

DATE: August 30, 2023

SET: PERMIT

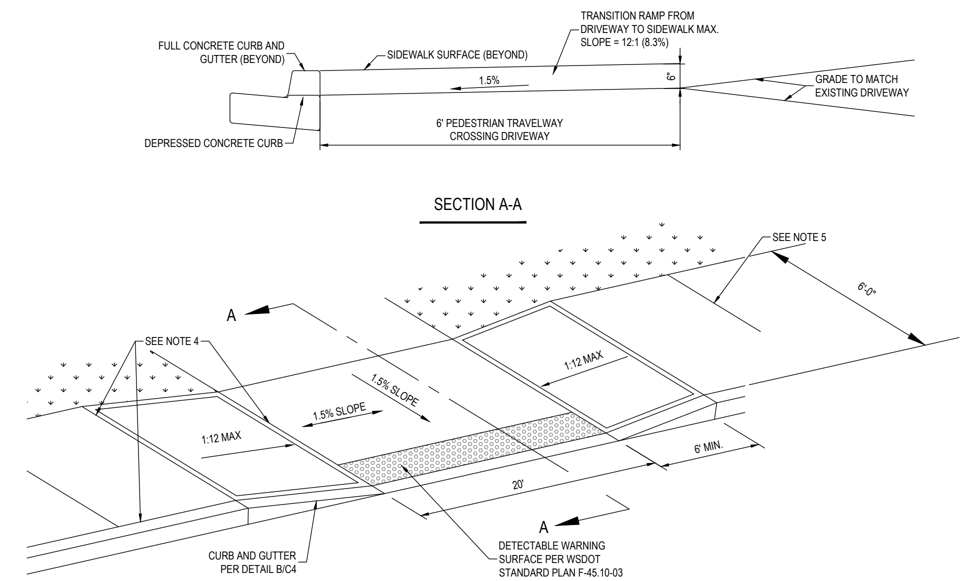
SHEET C3



SITE PLAN

Scale: 1" = 30'

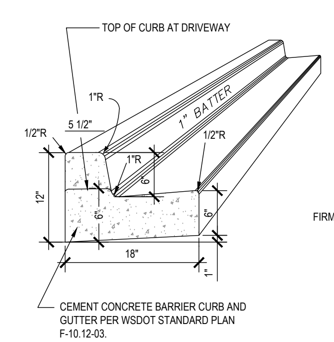
0 30' 60' 90'



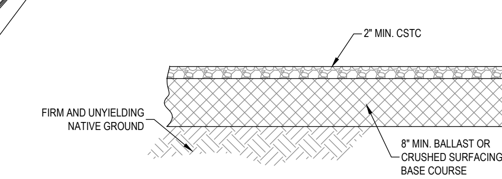
NOTES:

1. THE PEDESTRIAN TRAVELWAY SHALL HAVE A MAXIMUM CROSS SLOPE OF 48:1 (2%).
2. INSTALL RAMPS ON BOTH SIDES OF THE DRIVEWAY AS SHOWN ON THE PLANS. RAMPS SHALL BE AS LONG AS NECESSARY TO PROVIDE A MAXIMUM SLOPE OF 12:1 PARALLEL AND PERPENDICULAR TO THE EXISTING PLANE ON WHICH THE RAMP IS TO BE CONSTRUCTED.
3. CEMENT CONCRETE SHALL BE CLASS 4000, MIN. 6" THICK INCLUDING RAMPS
4. ASPHALT IMPREGNATED EXPANSION JOINT, FULL DEPTH AT BACK OF CURB AND EVERY 20 FEET AT TRANSVERSE JOINTS. JOINT MATERIAL NOT REQUIRED AT BACK OF CURB IF RAMP AND/OR DRIVEWAY IS POURED SEPARATELY CREATING A COLD JOINT.
5. CRACK JOINTS EVERY 5 FEET IN WALK.
6. HERBICIDE (RESIDUAL) TO BE APPLIED BEFORE POURING CONCRETE.
7. EXPOSED AGGREGATE OR SPECIAL SURFACE TREATMENT NOT ALLOWED IN RIGHT OF WAY

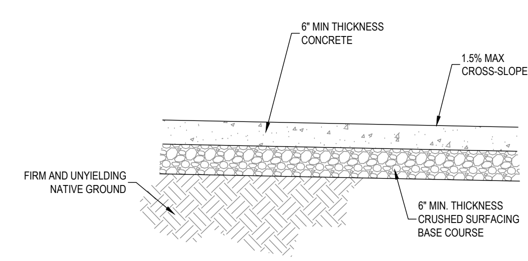
A/C4 DRIVEWAY APRON
Scale: NTS



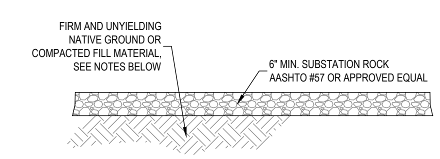
B/C4 CURB AND GUTTER
Scale: NTS



C/C4 GRAVEL ACCESS ROAD SECTION
Scale: N.T.S.



D/C4 CONCRETE DRIVEWAY SECTION
Scale: N.T.S.



NOTES:

1. BASED ON ONSITE TEST PITS, SUITABLE BEARING MATERIAL IS APPROXIMATELY 12" BELOW EXISTING GRADE.
2. ONSITE MATERIAL BELOW APPROXIAMTELY 12" MAY BE SUITABLE FOR USED AS FILL MATERIAL IN TRAVELLED AREAS. NOTE THAT THIS MATERIAL IS VERY MOISTURE SENSITIVE AND WILL NOT BE USABLE DURING WET WEATHER CONDITIONS. ALTERNATIVELY, GRAVEL BASE PER WSDOT STANDARD SPEC 9-03.10. MATERIAL TO BE COMPACTED TO 95% MAX DRY DENSITY.

E/C4 SUBSTATION SURFACING
Scale: N.T.S.

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SITE PLAN

CLIENT: CLALLAM COUNTY PUD #1
104 HOOKER ROAD
SEQUIM, WA 98382

SCALE: 1" = 30'

FILE: 23071 - E2

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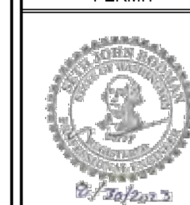
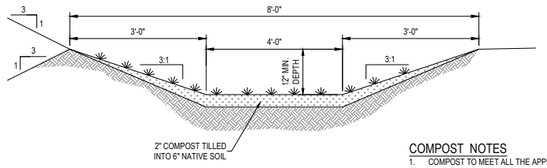


SHEET C4



COMPOST NOTES

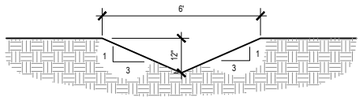
1. COMPOST TO MEET ALL THE APPLICABLE REQUIREMENTS OF BMP T7.40 (SWMMWW, 2019, ECY).

BIOFILTRATION NOTES

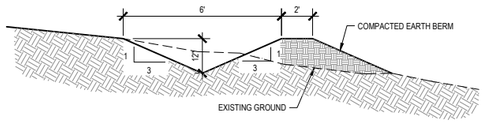
1. SEE PLAN FOR LONGITUDINAL SLOPE OF SWALE
2. HYDROSEED WITH A MIX OF 52% PERENNIAL RYE, 35% WINTER RYE, AND 13% CLOVER.
3. AVOID COMPACTION OF SOILS DURING CONSTRUCTION. IF COMPACTION OCCURS, TILL SOILS BEFORE HYDROSEEDING.

A / C5 BIO–FILTRATION SWALE – 4' WIDTH

Scale: NTS



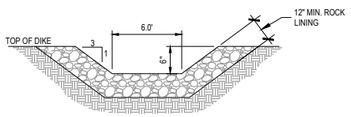
DRAINAGE DITCH



DRAINAGE DITCH W/ BERM

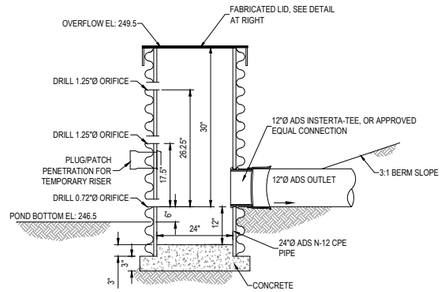
B / C5 DRAINAGE DITCH SECTIONS

Scale: NTS



C / C5 POND OVERFLOW SECTION

Scale: NTS

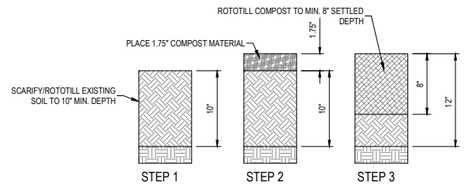


D / C5 POND RISER DETAIL

Scale: NTS

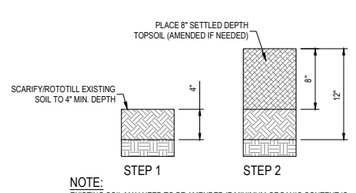
METHOD 1

AMENDING EXISTING TOPSOIL OR SUBSOIL IN TURF AREAS



METHOD 2

REPLACING STRIPPED TOPSOIL IN TURF AND PLANTING AREAS

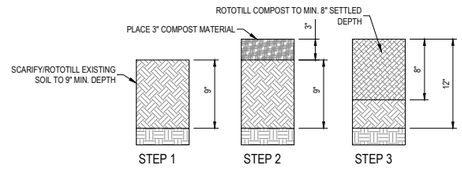


NOTE:

EXISTING SOIL MAY NEED TO BE AMENDED IF MINIMUM ORGANIC CONTENT IS INSUFFICIENT OR THERE IS INSUFFICIENT MATERIAL TO MEET THE REQUIRED DEPTHS.

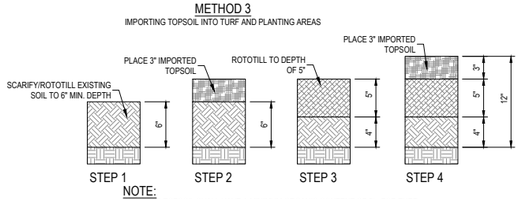
METHOD 1

AMENDING EXISTING TOPSOIL OR SUBSOIL IN PLANTING AREAS



METHOD 3

IMPORTING TOPSOIL INTO TURF AND PLANTING AREAS



NOTE:

IMPORTED TOPSOIL SHALL HAVE A MINIMUM ORGANIC CONTENT OF 5% FOR TURF AREAS AND 10% FOR PLANTING AREAS. ADDITIONALLY, THE SOIL SHALL BE CLASSIFIED AS SAND OR SANDY LOAM AS DEFINED BY THE USDA.

COMPOST REQUIREMENTS:

COMPOST MUST:

1. MEET THE REQUIREMENTS OF "COMPOSTED MATERIAL" IN WAC 173-350-100 AND COMPLY WITH TESTING PARAMETERS AND OTHER STANDARDS IN WAC 173-350-220.
2. BE PRODUCED AT A COMPOSTING FACILITY THAT IS PERMITTED BY THE JURISDICTIONAL HEALTH AUTHORITY.
3. ORIGINATE FROM A MINIMUM OF 65% BY VOLUME FROM RECYCLED PLANT WASTE COMPRISED OF "YARD DEBRIS," "CROP RESIDUES," AND "BULKING AGENTS" AS DEFINED IN WAC 173-350-100. A MAXIMUM OF 35% BY VOLUME OF "POST-CONSUMER FOOD WASTE" AS DEFINED IN WAC 173-350-100 INCLUDING BIO-SOLIDS AND MANURE MAY BE SUBSTITUTED FOR RECYCLED PLANT WASTE.
4. HAVE NO VISIBLE FREE WATER OR HAVE NO DUST PRODUCED WHEN HANDLING THE MATERIAL.
5. BE TESTED WITH THE U.S. COMPOSTING COUNCIL "TEST METHOD FOR THE EXAMINATION OF COMPOST AND COMPOSTING" (TMECC) AS ESTABLISHED IN THE COMPOSTING COUNCIL'S "SEAL OF TESTING ASSURANCE" (STA) PROGRAM.
6. BE SCREENED TO THE FOLLOWING GRADATIONS FOR FINE COMPOST WHEN TESTED IN ACCORDANCE WITH TMECC TEST METHOD 02.02-B, "SAMPLE SIEVING FOR AGGREGATE SIZE CLASSIFICATION."
   - MIN. % PASSING 2": 100%
   - MIN. % PASSING 1": 99%
   - MIN. % PASSING ⅜": 90%
   - MIN. % PASSING ¼": 75%
7. HAVE pH BETWEEN 6.0 AND 8.5 (TMECC 04.11-A), AND "PHYSICAL CONTAMINANTS" (AS DEFINED IN WAC 173-350-100) CONTENT LESS THAN 1% BY WEIGHT (TMECC 03.08-A) TOTAL, NOT TO EXCEED 0.25% FILM PLASTIC BY DRY WEIGHT.
8. HAVE MINIMUM ORGANIC MATTER CONTENT OF 40% (TMECC 05.07-A "LOSS ON IGNITION").
9. HAVE SOLUBLE SALT CONTENT LESS THAN 4.0 dS/m (mmhos/cm)(TMMECC 04.10-A "ELECTRICAL CONDUCTIVITY, 1:5 SLURRY METHOD, MASS BASIS")
10. HAVE MATURITY INDICATORS GREATER THAN 80% FOR BOTH EMERGENCE AND VIGOR FROM A CUCUMBER BIOASSAY (TMECC 05.05-A "SEEDLING EMERGENCE AND RELATIVE GROWTH").
11. HAVE STABILITY OF 7 mg CO2-C/g OM/DAY OR BELOW (TMECC 05.08-B "CARBON DIOXIDE EVOLUTION RATE").
12. HAVE A CARBON TO NITROGEN (C:N) OF LESS THAN 25:1 (TMECC 05.02A "CARBON TO NITROGEN RATIO" WHICH USES 04.01 "ORGANIC CARBON" AND 04.02D "TOTAL NITROGEN BY OXIDATION"). THE C:N RATIO MAY BE UP TO 35:1 FOR PLANTINGS COMPOSED ENTIRELY OF PUGET SOUND LOWLAND NATIVE SPECIES.

GENERAL NOTES:

1. TOPSOIL LAYER SHALL HAVE A MINIMUM DEPTH OF 8 INCHES EXCEPT WHERE TREE ROOTS LIMIT THE DEPTH OF TOPSOIL AMENDMENT INCORPORATION.
2. SUBSOILS SHALL BE SCARIFIED TO A MINIMUM DEPTH OF 4 INCHES TO ACHIEVE A TOTAL "LOOSE" DEPTH OF 12 INCHES
3. TOPSOIL SHALL HAVE A MINIMUM ORGANIC CONTENT OF 10% DRY WEIGHT IN PLANTING BEDS, AND MINIMUM 5% ORGANIC MATTER IN TURF AREAS, AND A pH FROM 6.0 TO 8.0 OR MATCHING THE pH OF THE UNDISTURBED SOIL.
4. PLANTING BEDS ARE TO BE MULCHED WITH 2 INCHES OF ORGANIC MATERIAL.
5. "PRE-APPROVED" SOIL AMENDMENT RATES ARE AS FOLLOWS:
   - TURF AREAS: 1.75" COMPOST PER 6.25" EXISTING SOIL
   - PLANTING AREAS: 3" COMPOST PER 5" EXISTING SOIL
6. PROJECT PROPONENT MAY UTILIZE A CALCULATED AMENDMENT RATE IF THEY CAN DEMONSTRATE THAT THE AMENDED TOPSOIL WILL MEET THE MINIMUM ORGANIC CONTENTS LISTED ABOVE.
7. TURF AREAS SHALL BE WATER OR ROLL COMPACTED TO 85% MAXIMUM DRY DENSITY
8. RAKE SMOOTH AND REMOVE WOODY DEBRIS AND ROCKS LARGER THAN 1" IN DIAMETER (2" FOR PLANTING AREAS).

SUBMITTALS:

CONTRACTOR/OWNER SHALL PROVIDE THE FOLLOWING INFORMATION TO THE CITY OF PORT ANGELES PUBLIC WORKS DEPARTMENT:

1. **CITY OF PORT ANGELES WORKSHEET D.**
2. **TRUCK TICKETS DETAILING SOURCE AND QUANTITY OF IMPORTED COMPOST OR TOPSOIL MATERIAL.**
3. **SOIL TEST REPORTS IF NOT USING PRE-APPROVED MATERIALS. IF USING EXISTING TOPSOIL (METHOD 2), EXISTING TOPSOIL MUST BE TESTED TO ENSURE COMPLIANCE WITH THE MINIMUM ORGANIC CONTENT ABOVE.**

E / C5 BMP T5.13 – POST CONSTRUCTION QUALITY AND DEPTH

Scale: NTS

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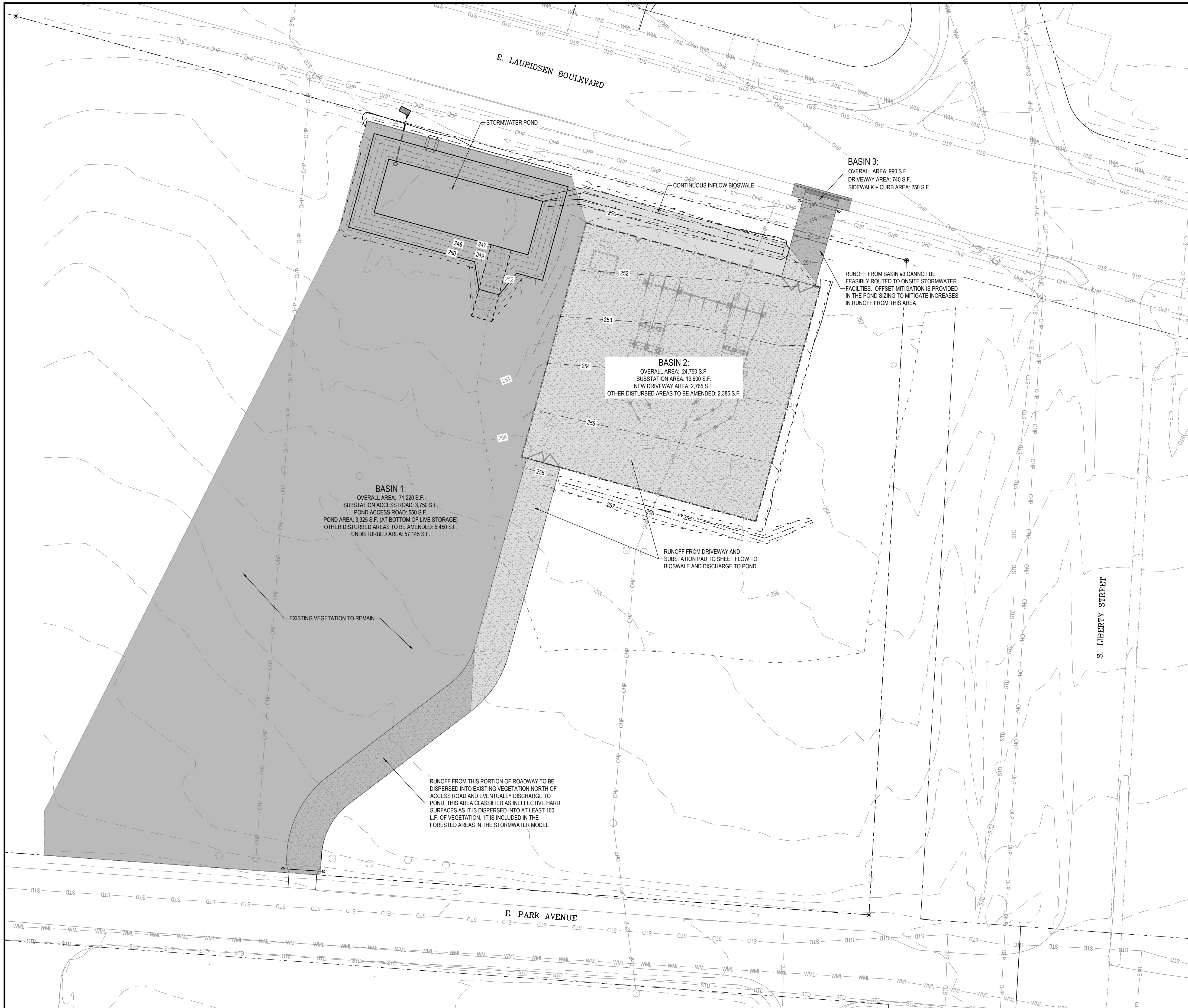
SHEET

C5



SITE PLAN

Scale: 1" = 30'

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BASIN MAP

CLIENT: CLALLAM COUNTY PUD #1
104 HOOKER ROAD
SEQUIM, WA 98382

SCALE: 1" = 30'

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8/30/2023

SHEET C6

APPENDIX C
STORMWATER CALCULATIONS

WWHM2012

PROJECT REPORT

General Model Information

Project Name:	23071 - E1
Site Name:	
Site Address:	
City:	
Report Date:	11/15/2023
Gage:	Port Angelis
Data Start:	1948/10/01
Data End:	2009/09/30
Timestep:	15 Minute
Precip Scale:	1.000
Version Date:	2021/08/18
Version:	4.2.18

POC Thresholds

Low Flow Threshold for POC1:	50 Percent of the 2 Year
High Flow Threshold for POC1:	50 Year
Low Flow Threshold for POC2:	50 Percent of the 2 Year
High Flow Threshold for POC2:	50 Year

Landuse Basin Data

Predeveloped Land Use

BASIN 1+2+3

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Forest, Flat	2.2289
Pervious Total	2.2289
Impervious Land Use	acre
Impervious Total	0
Basin Total	2.2289

Element Flows To:

Surface	Interflow	Groundwater

Basin 2 - For Treatment

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
Pervious Total	0
Impervious Land Use	acre
ROADS FLAT	0.5211
Impervious Total	0.5211
Basin Total	0.5211

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Basin 1

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
C, Forest, Flat	1.3979
C, Pasture, Mod	0.1481
Pervious Total	1.546

Impervious Land Use	acre
ROADS FLAT	0.0126
POND	0.0763
Impervious Total	0.0889
Basin Total	1.6349

Element Flows To:

Surface	Interflow	Groundwater
Trapezoidal Pond 1	Trapezoidal Pond 1	

Basin 2

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
C, Pasture, Flat	0.0547
Pervious Total	0.0547

Impervious Land Use	acre
ROADS FLAT	0.0634
PARKING FLAT	0.45
Impervious Total	0.5134
Basin Total	0.5681

Element Flows To:

Surface	Interflow	Groundwater
Trapezoidal Pond 1	Trapezoidal Pond 1	

Basin 3

Bypass:	Yes
GroundWater:	No
Pervious Land Use	acre
Pervious Total	0
Impervious Land Use	acre
ROADS MOD	0.0227
Impervious Total	0.0227
Basin Total	0.0227

Element Flows To:

Surface	Interflow	Groundwater

Routing Elements
Predeveloped Routing

Mitigated Routing

Trapezoidal Pond 1

Bottom Length:	95.00 ft.
Bottom Width:	35.00 ft.
Depth:	3.5 ft.
Volume at riser head:	0.2546 acre-feet.
Side slope 1:	3 To 1
Side slope 2:	3 To 1
Side slope 3:	3 To 1
Side slope 4:	3 To 1
Discharge Structure	
Riser Height:	2.5 ft.
Riser Diameter:	18 in.
Orifice 1 Diameter:	0.72 in. Elevation:0 ft.
Orifice 2 Diameter:	1.25 in. Elevation:1.4575 ft.
Orifice 3 Diameter:	1.25 in. Elevation:2.18541666666669 ft.
Element Flows To:	
Outlet 1	Outlet 2

Pond Hydraulic Table

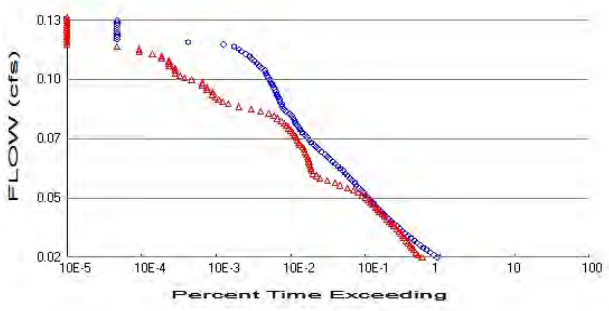
Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.076	0.000	0.000	0.000
0.0389	0.077	0.003	0.002	0.000
0.0778	0.077	0.006	0.003	0.000
0.1167	0.078	0.009	0.004	0.000
0.1556	0.079	0.012	0.005	0.000
0.1944	0.079	0.015	0.006	0.000
0.2333	0.080	0.018	0.006	0.000
0.2722	0.081	0.021	0.007	0.000
0.3111	0.082	0.024	0.007	0.000
0.3500	0.082	0.027	0.008	0.000
0.3889	0.083	0.031	0.008	0.000
0.4278	0.084	0.034	0.009	0.000
0.4667	0.084	0.037	0.009	0.000
0.5056	0.085	0.040	0.010	0.000
0.5444	0.086	0.044	0.010	0.000
0.5833	0.087	0.047	0.010	0.000
0.6222	0.087	0.051	0.011	0.000
0.6611	0.088	0.054	0.011	0.000
0.7000	0.089	0.057	0.011	0.000
0.7389	0.090	0.061	0.012	0.000
0.7778	0.090	0.064	0.012	0.000
0.8167	0.091	0.068	0.012	0.000
0.8556	0.092	0.072	0.013	0.000
0.8944	0.093	0.075	0.013	0.000
0.9333	0.093	0.079	0.013	0.000
0.9722	0.094	0.082	0.013	0.000
1.0111	0.095	0.086	0.014	0.000
1.0500	0.096	0.090	0.014	0.000
1.0889	0.096	0.094	0.014	0.000
1.1278	0.097	0.097	0.014	0.000
1.1667	0.098	0.101	0.015	0.000
1.2056	0.099	0.105	0.015	0.000
1.2444	0.099	0.109	0.015	0.000

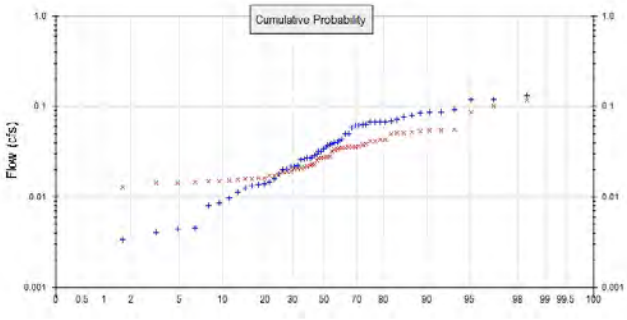
1.2833	0.100	0.113	0.015	0.000
1.3222	0.101	0.117	0.016	0.000
1.3611	0.102	0.121	0.016	0.000
1.4000	0.103	0.125	0.016	0.000
1.4389	0.103	0.129	0.016	0.000
1.4778	0.104	0.133	0.023	0.000
1.5167	0.105	0.137	0.027	0.000
1.5556	0.106	0.141	0.030	0.000
1.5944	0.107	0.145	0.033	0.000
1.6333	0.107	0.149	0.035	0.000
1.6722	0.108	0.154	0.037	0.000
1.7111	0.109	0.158	0.039	0.000
1.7500	0.110	0.162	0.041	0.000
1.7889	0.111	0.166	0.043	0.000
1.8278	0.111	0.171	0.044	0.000
1.8667	0.112	0.175	0.046	0.000
1.9056	0.113	0.179	0.047	0.000
1.9444	0.114	0.184	0.049	0.000
1.9833	0.115	0.188	0.050	0.000
2.0222	0.115	0.193	0.051	0.000
2.0611	0.116	0.197	0.053	0.000
2.1000	0.117	0.202	0.054	0.000
2.1389	0.118	0.206	0.055	0.000
2.1778	0.119	0.211	0.056	0.000
2.2167	0.120	0.216	0.065	0.000
2.2556	0.120	0.220	0.070	0.000
2.2944	0.121	0.225	0.074	0.000
2.3333	0.122	0.230	0.077	0.000
2.3722	0.123	0.235	0.080	0.000
2.4111	0.124	0.240	0.083	0.000
2.4500	0.125	0.244	0.086	0.000
2.4889	0.126	0.249	0.088	0.000
2.5278	0.126	0.254	0.164	0.000
2.5667	0.127	0.259	0.367	0.000
2.6056	0.128	0.264	0.640	0.000
2.6444	0.129	0.269	0.966	0.000
2.6833	0.130	0.274	1.336	0.000
2.7222	0.131	0.279	1.738	0.000
2.7611	0.132	0.284	2.165	0.000
2.8000	0.132	0.290	2.607	0.000
2.8389	0.133	0.295	3.053	0.000
2.8778	0.134	0.300	3.496	0.000
2.9167	0.135	0.305	3.924	0.000
2.9556	0.136	0.310	4.329	0.000
2.9944	0.137	0.316	4.703	0.000
3.0333	0.138	0.321	5.041	0.000
3.0722	0.139	0.327	5.336	0.000
3.1111	0.140	0.332	5.588	0.000
3.1500	0.140	0.337	5.798	0.000
3.1889	0.141	0.343	5.972	0.000
3.2278	0.142	0.348	6.119	0.000
3.2667	0.143	0.354	6.331	0.000
3.3056	0.144	0.360	6.488	0.000
3.3444	0.145	0.365	6.641	0.000
3.3833	0.146	0.371	6.791	0.000
3.4222	0.147	0.377	6.938	0.000
3.4611	0.148	0.382	7.081	0.000
3.5000	0.149	0.388	7.222	0.000

3.5389	0.150	0.394	7.360	0.000

Analysis Results

POC 1





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 2.2289
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 1.6007
Total Impervious Area: 0.625

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.034551
5 year	0.068269
10 year	0.089731
25 year	0.113606
50 year	0.12871
100 year	0.141618

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0.027089
5 year	0.0431
10 year	0.056075
25 year	0.075428
50 year	0.092162
100 year	0.111028

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1949	0.032	0.037
1950	0.037	0.035
1951	0.032	0.023
1952	0.010	0.012
1953	0.013	0.021
1954	0.092	0.087
1955	0.080	0.042
1956	0.036	0.035
1957	0.050	0.027
1958	0.014	0.015

1959	0.042	0.043
1960	0.067	0.036
1961	0.086	0.050
1962	0.013	0.016
1963	0.028	0.018
1964	0.027	0.025
1965	0.022	0.017
1966	0.020	0.019
1967	0.076	0.051
1968	0.020	0.016
1969	0.008	0.016
1970	0.016	0.023
1971	0.134	0.027
1972	0.085	0.041
1973	0.040	0.022
1974	0.022	0.036
1975	0.026	0.020
1976	0.030	0.034
1977	0.004	0.019
1978	0.003	0.015
1979	0.004	0.027
1980	0.062	0.055
1981	0.040	0.053
1982	0.058	0.034
1983	0.062	0.043
1984	0.022	0.015
1985	0.072	0.035
1986	0.120	0.102
1987	0.050	0.028
1988	0.026	0.038
1989	0.027	0.016
1990	0.034	0.022
1991	0.069	0.055
1992	0.068	0.052
1993	0.015	0.015
1994	0.001	0.014
1995	0.009	0.014
1996	0.038	0.017
1997	0.067	0.054
1998	0.004	0.013
1999	0.119	0.116
2000	0.038	0.021
2001	0.011	0.015
2002	0.063	0.038
2003	0.043	0.036
2004	0.067	0.051
2005	0.014	0.020
2006	0.063	0.032
2007	0.087	0.027
2008	0.018	0.028
2009	0.029	0.019

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	0.1336	0.1164
2	0.1196	0.1018
3	0.1189	0.0866

4	0.0921	0.0555
5	0.0872	0.0547
6	0.0861	0.0543
7	0.0848	0.0529
8	0.0796	0.0524
9	0.0763	0.0509
10	0.0724	0.0507
11	0.0690	0.0498
12	0.0680	0.0435
13	0.0671	0.0429
14	0.0669	0.0415
15	0.0667	0.0412
16	0.0633	0.0384
17	0.0633	0.0378
18	0.0623	0.0366
19	0.0616	0.0358
20	0.0579	0.0356
21	0.0499	0.0356
22	0.0497	0.0351
23	0.0429	0.0351
24	0.0420	0.0349
25	0.0403	0.0341
26	0.0399	0.0336
27	0.0385	0.0319
28	0.0377	0.0282
29	0.0371	0.0277
30	0.0356	0.0274
31	0.0338	0.0272
32	0.0322	0.0271
33	0.0318	0.0270
34	0.0300	0.0251
35	0.0286	0.0228
36	0.0278	0.0226
37	0.0271	0.0221
38	0.0269	0.0219
39	0.0263	0.0214
40	0.0261	0.0207
41	0.0220	0.0205
42	0.0219	0.0204
43	0.0216	0.0193
44	0.0203	0.0192
45	0.0200	0.0192
46	0.0178	0.0175
47	0.0160	0.0172
48	0.0146	0.0172
49	0.0140	0.0163
50	0.0137	0.0162
51	0.0133	0.0160
52	0.0126	0.0158
53	0.0113	0.0154
54	0.0097	0.0150
55	0.0086	0.0150
56	0.0080	0.0149
57	0.0045	0.0146
58	0.0044	0.0143
59	0.0041	0.0141
60	0.0034	0.0127
61	0.0009	0.0124

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0173	19661	12266	62	Pass
0.0184	17577	10846	61	Pass
0.0195	15832	10098	63	Pass
0.0207	14200	9524	67	Pass
0.0218	12808	9007	70	Pass
0.0229	11612	8545	73	Pass
0.0240	10598	8025	75	Pass
0.0252	9631	7529	78	Pass
0.0263	8718	7107	81	Pass
0.0274	7946	6757	85	Pass
0.0285	7285	6378	87	Pass
0.0297	6699	6021	89	Pass
0.0308	6134	5653	92	Pass
0.0319	5625	5200	92	Pass
0.0330	5159	4842	93	Pass
0.0342	4729	4502	95	Pass
0.0353	4344	4141	95	Pass
0.0364	4015	3829	95	Pass
0.0375	3741	3574	95	Pass
0.0387	3469	3317	95	Pass
0.0398	3217	3110	96	Pass
0.0409	2988	2909	97	Pass
0.0420	2800	2669	95	Pass
0.0432	2633	2511	95	Pass
0.0443	2479	2348	94	Pass
0.0454	2327	2169	93	Pass
0.0465	2158	1960	90	Pass
0.0477	2007	1715	85	Pass
0.0488	1859	1473	79	Pass
0.0499	1745	1224	70	Pass
0.0510	1634	977	59	Pass
0.0522	1541	842	54	Pass
0.0533	1433	661	46	Pass
0.0544	1335	523	39	Pass
0.0555	1243	472	37	Pass
0.0567	1160	421	36	Pass
0.0578	1079	408	37	Pass
0.0589	994	400	40	Pass
0.0600	920	392	42	Pass
0.0612	844	380	45	Pass
0.0623	776	377	48	Pass
0.0634	711	368	51	Pass
0.0646	665	359	53	Pass
0.0657	617	345	55	Pass
0.0668	551	335	60	Pass
0.0679	503	325	64	Pass
0.0691	475	309	65	Pass
0.0702	442	286	64	Pass
0.0713	405	273	67	Pass
0.0724	376	260	69	Pass
0.0736	354	253	71	Pass
0.0747	335	241	71	Pass
0.0758	305	229	75	Pass

0.0769	290	216	74	Pass
0.0781	279	203	72	Pass
0.0792	262	188	71	Pass
0.0803	249	173	69	Pass
0.0814	241	158	65	Pass
0.0826	231	141	61	Pass
0.0837	220	127	57	Pass
0.0848	204	109	53	Pass
0.0859	184	84	45	Pass
0.0871	173	63	36	Pass
0.0882	165	43	26	Pass
0.0893	160	31	19	Pass
0.0904	154	26	16	Pass
0.0916	151	23	15	Pass
0.0927	147	21	14	Pass
0.0938	142	19	13	Pass
0.0949	136	19	13	Pass
0.0961	132	16	12	Pass
0.0972	126	16	12	Pass
0.0983	121	14	11	Pass
0.0994	117	14	11	Pass
0.1006	112	10	8	Pass
0.1017	107	8	7	Pass
0.1028	104	7	6	Pass
0.1039	100	6	6	Pass
0.1051	95	6	6	Pass
0.1062	87	6	6	Pass
0.1073	80	5	6	Pass
0.1084	75	5	6	Pass
0.1096	70	5	7	Pass
0.1107	63	4	6	Pass
0.1118	60	4	6	Pass
0.1130	54	3	5	Pass
0.1141	46	2	4	Pass
0.1152	43	2	4	Pass
0.1163	37	1	2	Pass
0.1175	27	0	0	Pass
0.1186	9	0	0	Pass
0.1197	1	0	0	Pass
0.1208	1	0	0	Pass
0.1220	1	0	0	Pass
0.1231	1	0	0	Pass
0.1242	1	0	0	Pass
0.1253	1	0	0	Pass
0.1265	1	0	0	Pass
0.1276	1	0	0	Pass
0.1287	1	0	0	Pass

Water Quality

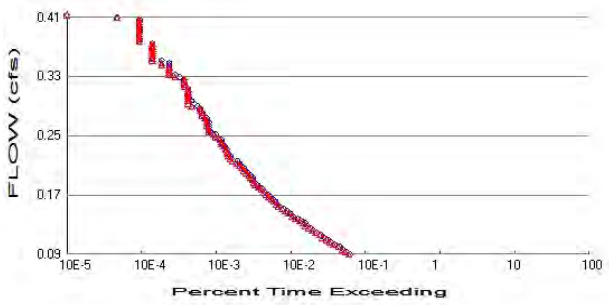
Water Quality BMP Flow and Volume for POC #1

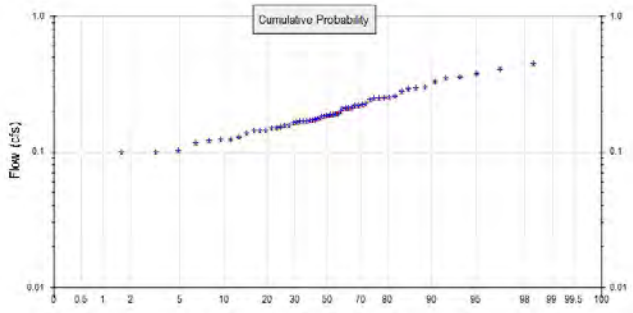
On-line facility volume:	0.0642 acre-feet
On-line facility target flow:	0.0895 cfs.
Adjusted for 15 min:	0.0895 cfs.
Off-line facility target flow:	0.0493 cfs.
Adjusted for 15 min:	0.0493 cfs.

LID Report

LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment
Trapezoidal Pond 1 POC	☐	74.71			☐	0.00			
Total Volume Infiltrated		74.71	0.00	0.00		0.00	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Failed

POC 2





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #2
Total Pervious Area: 0
Total Impervious Area: 0.5211

Mitigated Landuse Totals for POC #2
Total Pervious Area: 0.0547
Total Impervious Area: 0.5134

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #2

Return Period	**Flow(cfs)**
2 year	0.188671
5 year	0.256194
10 year	0.302665
25 year	0.363427
50 year	0.4102
100 year	0.45828

Flow Frequency Return Periods for Mitigated. POC #2

Return Period	**Flow(cfs)**
2 year	0.18652
5 year	0.253594
10 year	0.299801
25 year	0.360262
50 year	0.406831
100 year	0.454726

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #2

Year	**Predeveloped**	**Mitigated**
1949	0.249	0.247
1950	0.166	0.164
1951	0.351	0.346
1952	0.128	0.126
1953	0.296	0.292
1954	0.248	0.248
1955	0.192	0.191
1956	0.170	0.168
1957	0.167	0.165
1958	0.200	0.197
1959	0.244	0.240

1960	0.220	0.218
1961	0.176	0.173
1962	0.156	0.154
1963	0.189	0.186
1964	0.354	0.350
1965	0.123	0.123
1966	0.143	0.141
1967	0.184	0.183
1968	0.178	0.176
1969	0.168	0.166
1970	0.250	0.246
1971	0.407	0.409
1972	0.211	0.211
1973	0.173	0.172
1974	0.099	0.098
1975	0.254	0.251
1976	0.219	0.217
1977	0.145	0.142
1978	0.149	0.147
1979	0.299	0.295
1980	0.151	0.149
1981	0.279	0.276
1982	0.256	0.254
1983	0.209	0.206
1984	0.144	0.142
1985	0.329	0.328
1986	0.191	0.190
1987	0.450	0.443
1988	0.171	0.169
1989	0.186	0.183
1990	0.223	0.220
1991	0.209	0.208
1992	0.187	0.184
1993	0.121	0.119
1994	0.103	0.101
1995	0.099	0.098
1996	0.117	0.115
1997	0.152	0.152
1998	0.168	0.165
1999	0.211	0.208
2000	0.293	0.289
2001	0.099	0.098
2002	0.183	0.181
2003	0.137	0.135
2004	0.183	0.181
2005	0.227	0.223
2006	0.163	0.162
2007	0.378	0.377
2008	0.157	0.155
2009	0.123	0.121

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #2

Rank	Predeveloped	Mitigated
1	0.4497	0.4431
2	0.4074	0.4095
3	0.3779	0.3773
4	0.3538	0.3495

5	0.3507	0.3456
6	0.3293	0.3284
7	0.2993	0.2949
8	0.2961	0.2917
9	0.2931	0.2888
10	0.2790	0.2764
11	0.2563	0.2539
12	0.2542	0.2505
13	0.2498	0.2481
14	0.2495	0.2472
15	0.2485	0.2462
16	0.2436	0.2404
17	0.2267	0.2233
18	0.2232	0.2199
19	0.2201	0.2176
20	0.2193	0.2169
21	0.2110	0.2109
22	0.2109	0.2083
23	0.2095	0.2079
24	0.2087	0.2056
25	0.2004	0.1974
26	0.1916	0.1910
27	0.1908	0.1900
28	0.1891	0.1863
29	0.1869	0.1842
30	0.1862	0.1835
31	0.1843	0.1832
32	0.1828	0.1812
33	0.1826	0.1806
34	0.1784	0.1758
35	0.1757	0.1731
36	0.1733	0.1720
37	0.1711	0.1687
38	0.1703	0.1678
39	0.1684	0.1661
40	0.1677	0.1653
41	0.1670	0.1646
42	0.1657	0.1638
43	0.1635	0.1617
44	0.1575	0.1552
45	0.1561	0.1543
46	0.1521	0.1521
47	0.1509	0.1494
48	0.1491	0.1469
49	0.1446	0.1424
50	0.1437	0.1416
51	0.1429	0.1408
52	0.1368	0.1351
53	0.1280	0.1265
54	0.1234	0.1225
55	0.1228	0.1210
56	0.1213	0.1195
57	0.1168	0.1152
58	0.1026	0.1011
59	0.0994	0.0980
60	0.0991	0.0977
61	0.0991	0.0976

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0943	1317	1289	97	Pass
0.0975	1192	1149	96	Pass
0.1007	1080	1033	95	Pass
0.1039	976	939	96	Pass
0.1071	833	797	95	Pass
0.1103	737	712	96	Pass
0.1135	675	644	95	Pass
0.1167	597	571	95	Pass
0.1199	537	525	97	Pass
0.1231	475	459	96	Pass
0.1262	429	414	96	Pass
0.1294	397	375	94	Pass
0.1326	356	340	95	Pass
0.1358	331	317	95	Pass
0.1390	294	283	96	Pass
0.1422	267	245	91	Pass
0.1454	229	221	96	Pass
0.1486	210	201	95	Pass
0.1518	190	183	96	Pass
0.1550	171	165	96	Pass
0.1581	149	147	98	Pass
0.1613	141	136	96	Pass
0.1645	134	126	94	Pass
0.1677	123	118	95	Pass
0.1709	115	107	93	Pass
0.1741	105	101	96	Pass
0.1773	97	92	94	Pass
0.1805	90	86	95	Pass
0.1837	82	79	96	Pass
0.1869	77	72	93	Pass
0.1901	70	69	98	Pass
0.1932	67	65	97	Pass
0.1964	65	62	95	Pass
0.1996	62	59	95	Pass
0.2028	57	54	94	Pass
0.2060	53	51	96	Pass
0.2092	50	47	94	Pass
0.2124	46	44	95	Pass
0.2156	44	41	93	Pass
0.2188	41	35	85	Pass
0.2220	34	33	97	Pass
0.2251	33	31	93	Pass
0.2283	31	30	96	Pass
0.2315	30	30	100	Pass
0.2347	30	29	96	Pass
0.2379	28	27	96	Pass
0.2411	26	25	96	Pass
0.2443	25	25	100	Pass
0.2475	25	24	96	Pass
0.2507	21	21	100	Pass
0.2539	21	20	95	Pass
0.2571	18	17	94	Pass
0.2602	17	17	100	Pass

0.2634	17	17	100	Pass
0.2666	17	16	94	Pass
0.2698	17	16	94	Pass
0.2730	16	16	100	Pass
0.2762	16	15	93	Pass
0.2794	14	14	100	Pass
0.2826	14	14	100	Pass
0.2858	13	13	100	Pass
0.2890	13	13	100	Pass
0.2921	12	10	83	Pass
0.2953	11	9	81	Pass
0.2985	10	9	90	Pass
0.3017	9	9	100	Pass
0.3049	9	9	100	Pass
0.3081	9	9	100	Pass
0.3113	9	9	100	Pass
0.3145	9	9	100	Pass
0.3177	8	8	100	Pass
0.3209	8	8	100	Pass
0.3241	8	8	100	Pass
0.3272	8	8	100	Pass
0.3304	7	6	85	Pass
0.3336	6	5	83	Pass
0.3368	5	5	100	Pass
0.3400	5	5	100	Pass
0.3432	5	5	100	Pass
0.3464	5	4	80	Pass
0.3496	5	4	80	Pass
0.3528	4	3	75	Pass
0.3560	3	3	100	Pass
0.3592	3	3	100	Pass
0.3623	3	3	100	Pass
0.3655	3	3	100	Pass
0.3687	3	3	100	Pass
0.3719	3	3	100	Pass
0.3751	3	3	100	Pass
0.3783	2	2	100	Pass
0.3815	2	2	100	Pass
0.3847	2	2	100	Pass
0.3879	2	2	100	Pass
0.3911	2	2	100	Pass
0.3942	2	2	100	Pass
0.3974	2	2	100	Pass
0.4006	2	2	100	Pass
0.4038	2	2	100	Pass
0.4070	2	2	100	Pass
0.4102	1	1	100	Pass

Water Quality

Water Quality BMP Flow and Volume for POC #2

On-line facility volume:	0.0597 acre-feet
On-line facility target flow:	0.0835 cfs.
Adjusted for 15 min:	0.0835 cfs.
Off-line facility target flow:	0.046 cfs.
Adjusted for 15 min:	0.046 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
Total Volume Infiltrated		0.00	0.00	0.00		0.00	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Failed

POC 3

POC #3 was not reported because POC must exist in both scenarios and both scenarios must have been run.

Model Default Modifications

Total of 0 changes have been made.

PERLND Changes

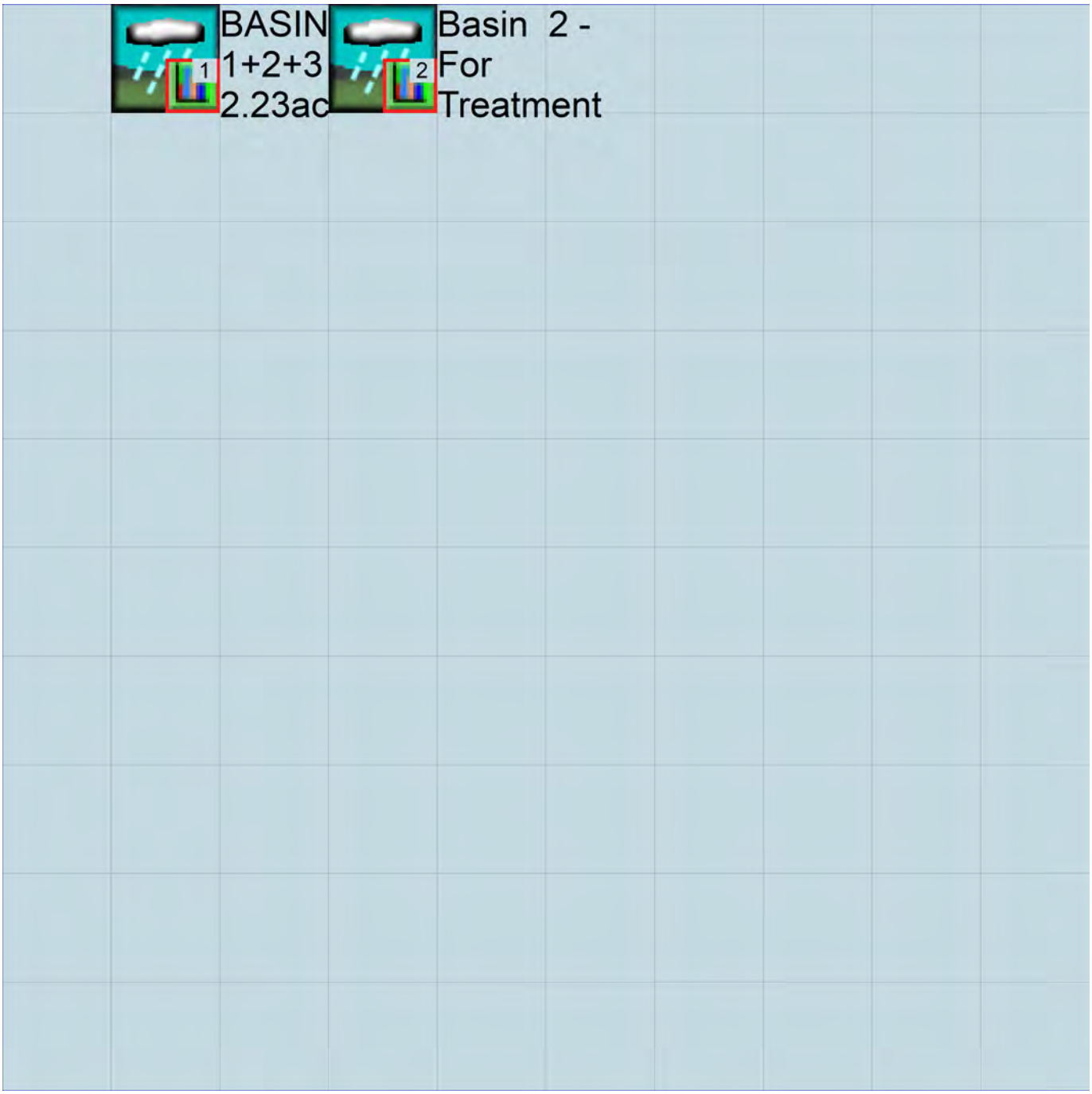
No PERLND changes have been made.

IMPLND Changes

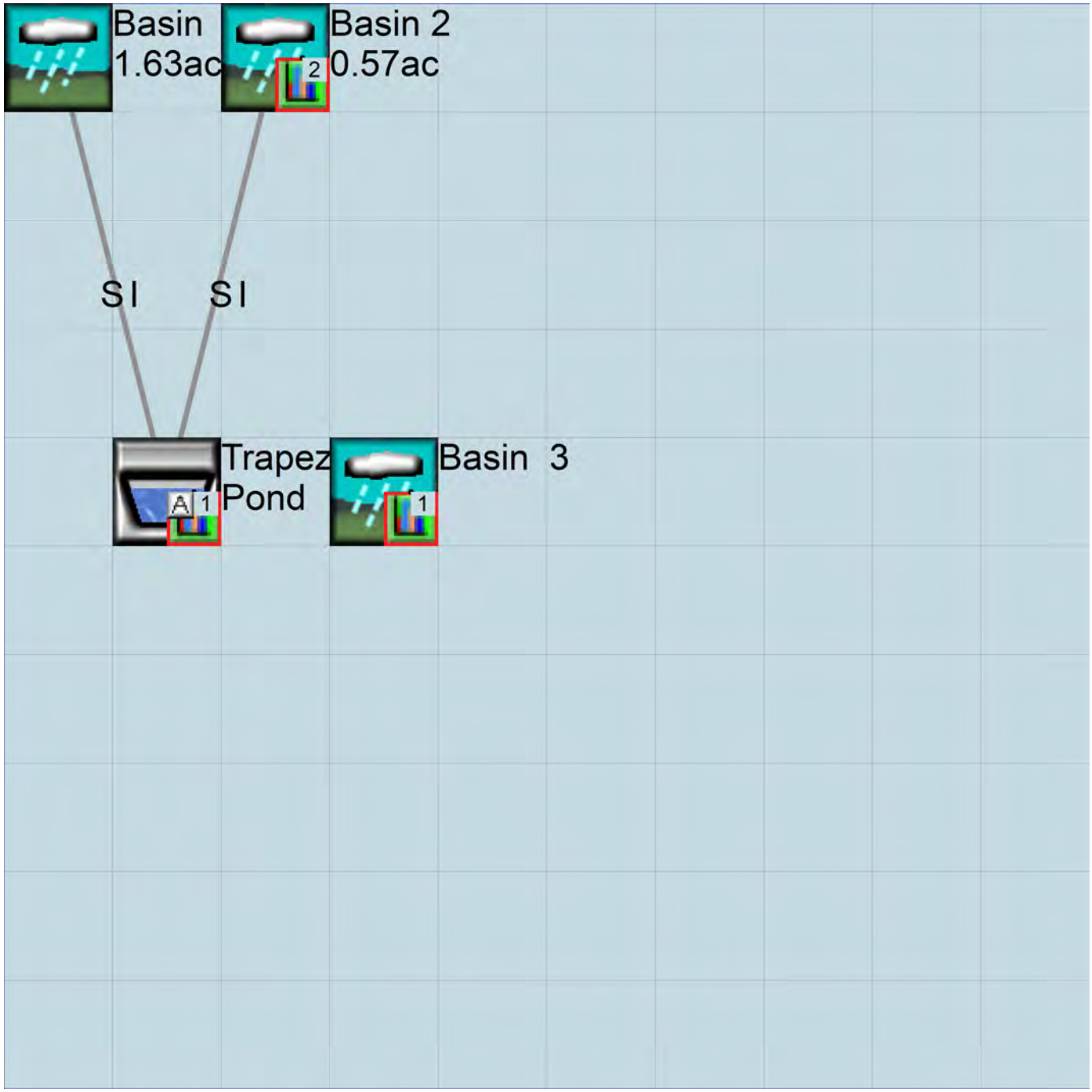
No IMPLND changes have been made.

Appendix

Predeveloped Schematic



Mitigated Schematic



Predeveloped UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1948 10 01        END    2009 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   23071 - E1.wdm
MESSU       25   Pre23071 - E1.MES
            27   Pre23071 - E1.L61
            28   Pre23071 - E1.L62
            30   POC23071 - E11.dat
            31   POC23071 - E12.dat
END FILES

OPN SEQUENCE
    INGRP               INDELT 00:15
      PERLND      10
      IMPLND       1
      COPY       501
      COPY       502
      DISPLY       1
      DISPLY       2
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        BASIN 1+2+3                 MAX                    1    2   30    9
    2        Basin  2 -  For Treatment   MAX                    1    2   31    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  502         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           ***
   10     C, Forest, Flat         1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************ Active Sections ******************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   10         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  *********
   10         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 ***
   10         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
   10              0       4.5      0.08       400      0.05       0.5     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   10               0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                                  ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   10            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
   10              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           ***
    1      ROADS/FLAT             1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

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

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

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    1            400      0.01       0.1       0.1
  END IWAT-PARM2
```

```
  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    1             0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    1             0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
BASIN 1+2+3***
PERLND  10                      2.2289     COPY   501     12
PERLND  10                      2.2289     COPY   501     13
Basin  2 -  For Treatment***
IMPLND   1                      0.5211     COPY   502     15

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

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



<-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
COPY   502 OUTPUT MEAN   1 1     48.4      WDM    502 FLOW     ENGL      REPL
END EXT TARGETS

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

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

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


END MASS-LINK

END RUN
```

Mitigated UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1948 10 01        END    2009 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   23071 - E1.wdm
MESSU       25   Mit23071 - E1.MES
            27   Mit23071 - E1.L61
            28   Mit23071 - E1.L62
            31   POC23071 - E12.dat
            30   POC23071 - E11.dat
END FILES

OPN SEQUENCE
    INGRP               INDELT 00:15
      PERLND      10
      PERLND      14
      IMPLND       1
      IMPLND      14
      PERLND      13
      IMPLND      11
      IMPLND       2
      RCHRES       1
      COPY       502
      COPY         1
      COPY       501
      COPY       601
      DISPLY       2
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    2        Basin 2                    MAX                    1    2   31    9
    1        Trapezoidal Pond  1        MAX                    1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  502         1    1
  501         1    1
  601         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           ***
   10     C, Forest, Flat         1    1    1    1   27    0
```

```
   14     C, Pasture, Mod         1    1    1    1   27    0
   13     C, Pasture, Flat        1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************ Active Sections ******************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   10         0    0    1    0    0    0    0    0    0    0    0    0
   14         0    0    1    0    0    0    0    0    0    0    0    0
   13         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  *********
   10         0    0    4    0    0    0    0    0    0    0    0    0    1    9
   14         0    0    4    0    0    0    0    0    0    0    0    0    1    9
   13         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 ***
   10         0    0    0    0    0    0    0    0    0    0    0
   14         0    0    0    0    0    0    0    0    0    0    0
   13         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
   10              0       4.5      0.08       400      0.05       0.5     0.996
   14              0       4.5      0.06       400       0.1       0.5     0.996
   13              0       4.5      0.06       400      0.05       0.5     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   10              0         0         2         2         0         0         0
   14              0         0         2         2         0         0         0
   13              0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                              ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   10            0.2       0.5      0.35         6       0.5       0.7
   14           0.15       0.4       0.3         6       0.5       0.4
   13           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
   10              0         0         0         0       2.5          1         0
   14              0         0         0         0       2.5          1         0
   13              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           ***
    1      ROADS/FLAT             1    1    1   27    0
   14      POND                   1    1    1   27    0
```

```
   11      PARKING/FLAT           1    1    1   27    0
    2      ROADS/MOD              1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************ Active Sections ****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    1         0    0    1    0    0    0
   14         0    0    1    0    0    0
   11         0    0    1    0    0    0
    2         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    1         0    0    4    0    0    0    1    9
   14         0    0    4    0    0    0    1    9
   11         0    0    4    0    0    0    1    9
    2         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     ***
    1         0    0    0    0    0
   14         0    0    0    0    0
   11         0    0    0    0    0
    2         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    1           400      0.01       0.1       0.1
   14           400      0.01       0.1       0.1
   11           400      0.01       0.1       0.1
    2           400      0.05       0.1      0.08
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    1             0         0
   14             0         0
   11             0         0
    2             0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    1             0         0
   14             0         0
   11             0         0
    2             0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                <--Area-->     <-Target->   MBLK   ***
<Name>   #                <-factor->     <Name>   #   Tbl#   ***
Basin  1***
PERLND  10                    1.3979     RCHRES   1      2
PERLND  10                    1.3979     RCHRES   1      3
PERLND  14                    0.1481     RCHRES   1      2
PERLND  14                    0.1481     RCHRES   1      3
IMPLND   1                    0.0126     RCHRES   1      5
```

```
IMPLND  14                      0.0763     RCHRES   1      5
Basin 2***
PERLND  13                      0.0547     RCHRES   1      2
PERLND  13                      0.0547     RCHRES   1      3
IMPLND   1                      0.0634     RCHRES   1      5
IMPLND  11                        0.45     RCHRES   1      5
Basin 2***
PERLND  13                      0.0547     COPY   502     12
PERLND  13                      0.0547     COPY   502     13
IMPLND   1                      0.0634     COPY   502     15
IMPLND  11                        0.45     COPY   502     15
Basin  3***
IMPLND   2                      0.0227     COPY   501     15
IMPLND   2                      0.0227     COPY   601     15

******Routing******
PERLND  10                      1.3979     COPY     1     12
PERLND  14                      0.1481     COPY     1     12
IMPLND   1                      0.0126     COPY     1     15
IMPLND  14                      0.0763     COPY     1     15
PERLND  10                      1.3979     COPY     1     13
PERLND  14                      0.1481     COPY     1     13
PERLND  13                      0.0547     COPY     1     12
IMPLND   1                      0.0634     COPY     1     15
IMPLND  11                        0.45     COPY     1     15
PERLND  13                      0.0547     COPY     1     13
RCHRES   1                           1     COPY   501     16
END SCHEMATIC

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



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

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG           ***
                                       in  out                              ***
    1     Trapezoidal Pond-005    1    1    1    1   28    0    1
  END GEN-INFO
  *** Section RCHRES***

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

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

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

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

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
  FTABLE      1
   91    4
     Depth      Area    Volume  Outflow1 Velocity  Travel Time***
      (ft)   (acres) (acre-ft)   (cfs)   (ft/sec)    (Minutes)***
  0.000000  0.076331  0.000000  0.000000
  0.038889  0.077029  0.002982  0.002774
  0.077778  0.077729  0.005991  0.003923
  0.116667  0.078432  0.009028  0.004805
  0.155556  0.079137  0.012092  0.005548
  0.194444  0.079845  0.015183  0.006203
  0.233333  0.080555  0.018302  0.006795
  0.272222  0.081267  0.021448  0.007340
  0.311111  0.081982  0.024623  0.007847
  0.350000  0.082700  0.027825  0.008323
  0.388889  0.083420  0.031055  0.008773
  0.427778  0.084143  0.034313  0.009201
  0.466667  0.084868  0.037599  0.009610
  0.505556  0.085595  0.040914  0.010002
  0.544444  0.086325  0.044257  0.010380
  0.583333  0.087058  0.047628  0.010744
  0.622222  0.087793  0.051028  0.011097
  0.661111  0.088531  0.054456  0.011438
  0.700000  0.089271  0.057914  0.011770
  0.738889  0.090013  0.061400  0.012092
  0.777778  0.090759  0.064915  0.012407
  0.816667  0.091506  0.068459  0.012713
  0.855556  0.092256  0.072032  0.013012
  0.894444  0.093009  0.075634  0.013305
  0.933333  0.093764  0.079266  0.013591
  0.972222  0.094522  0.082927  0.013871
  1.011111  0.095282  0.086618  0.014146
  1.050000  0.096044  0.090338  0.014415
  1.088889  0.096809  0.094088  0.014680
  1.127778  0.097577  0.097868  0.014939
  1.166667  0.098347  0.101677  0.015195
  1.205556  0.099120  0.105517  0.015446
  1.244444  0.099895  0.109387  0.015693
  1.283333  0.100672  0.113287  0.015937
  1.322222  0.101453  0.117217  0.016176
  1.361111  0.102235  0.121177  0.016412
  1.400000  0.103020  0.125169  0.016645
  1.438889  0.103808  0.129190  0.016875
  1.477778  0.104598  0.133243  0.023139
  1.516667  0.105390  0.137326  0.027639
  1.555556  0.106186  0.141440  0.030823
  1.594444  0.106983  0.145585  0.033455
  1.633333  0.107783  0.149761  0.035759
  1.672222  0.108586  0.153968  0.037840
  1.711111  0.109391  0.158206  0.039755
  1.750000  0.110199  0.162476  0.041542
  1.788889  0.111009  0.166777  0.043224
  1.827778  0.111821  0.171110  0.044820
  1.866667  0.112636  0.175474  0.046343
```

```
  1.905556  0.113454  0.179871  0.047801
  1.944444  0.114274  0.184299  0.049205
  1.983333  0.115097  0.188759  0.050559
  2.022222  0.115922  0.193251  0.051869
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  2.177778  0.119247  0.211541  0.056746
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  2.294444  0.121767  0.225600  0.074100
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  2.722222  0.131201  0.279697  1.738906
  2.761111  0.132073  0.284816  2.165674
  2.800000  0.132949  0.289969  2.607171
  2.838889  0.133826  0.295156  3.053820
  2.877778  0.134706  0.300378  3.495961
  2.916667  0.135589  0.305633  3.924122
  2.955556  0.136474  0.310924  4.329384
  2.994444  0.137362  0.316248  4.703813
  3.033333  0.138252  0.321607  5.040969
  3.072222  0.139144  0.327001  5.336446
  3.111111  0.140039  0.332430  5.588475
  3.150000  0.140937  0.337893  5.798566
  3.188889  0.141837  0.343391  5.972183
  3.227778  0.142740  0.348925  6.119469
  3.266667  0.143645  0.354494  6.331599
  3.305556  0.144552  0.360097  6.488573
  3.344444  0.145462  0.365737  6.641818
  3.383333  0.146375  0.371411  6.791588
  3.422222  0.147290  0.377121  6.938110
  3.461111  0.148208  0.382867  7.081586
  3.500000  0.149128  0.388649  7.222199
  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

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
RCHRES   1 HYDR   RO     1 1        1      WDM   1000 FLOW     ENGL       REPL
RCHRES   1 HYDR   STAGE  1 1        1      WDM   1001 STAG     ENGL       REPL
COPY     1 OUTPUT MEAN   1 1     48.4      WDM    701 FLOW     ENGL       REPL
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    801 FLOW     ENGL       REPL
COPY   601 OUTPUT MEAN   1 1     48.4      WDM    901 FLOW     ENGL       REPL
COPY     2 OUTPUT MEAN   1 1     48.4      WDM    702 FLOW     ENGL       REPL
COPY   502 OUTPUT MEAN   1 1     48.4      WDM    802 FLOW     ENGL       REPL
COPY   602 OUTPUT MEAN   1 1     48.4      WDM    902 FLOW     ENGL       REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
```

```
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK        2
PERLND     PWATER SURO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    2

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

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

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

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

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

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


END MASS-LINK

END RUN
```

Predeveloped HSPF Message File

Mitigated HSPF Message File

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BIOFILTRATION SWALE DESIGN

ZENOVIC & ASSOCIATES
301 EAST 6TH STREET, SUITE 1
PORT ANGELES, WA 98362

PROJECT: PUD Liberty Substation
LOCATION: Lauridsen Blvd. & Liberty Street
PARCEL NO: 06-30-11-51-0900

DATE: 6/30/2023
JOB NO. 23071
AUTHOR: Seth Rodman

Reference: Stormwater Management Manual for Western Washington (D.O.E. 2019)
Volume V, Chapter 9

Biofiltration Swale

Preliminary Steps (P)

P-1	Water Quality Flowrate (Q) =	0.0835	cfs	Online Flow Rate - POC #2
P-2	Longitudinal slope =	0.015	ft/ft	
P-3	Assume vegetation will be grass-legume mixture and infrequently mowed			

Design Steps (D)

D-1	Water depth (y) =	0.333	ft	
D-2	Manning coefficient (n) =	0.24		
D-3	Swale Shape =	trapezoidal w/ 3:1 side slope (z) =		*3.0*
D-4	Approximate btm. Width (b) =	$\frac{2.5*Q*n}{1.49*y^{1.67}*S^{0.5}} - z*y$		
	b ~	0.72	ft	**use b =** **4.00 ft**
D-5	Calculate Area (A) =	b*y +z*y^2		6
	A =	1.66	ft^2	
D-6	Calculate Velocity (V) =	k*Q/A		k = 1.8 from figure V7.7
	V =	0.090	ft/sec	
D-7	Calculate Length (L) =	V*t*60	sec/min	where t = 18 min.
	L =	97.5114	ft. min.	**use L =** **120 ft.**

Stability Check (SC)

SC-1 100 Yr. Flowrate Q_{100}= 0.4583 cfs (100 year flow rate POC#2)

SC-2 Fair Coverage Estimate @2"

SC-3 Moderate Retardance Estimated C Vmax = 3 (from table V-7.2)

SC-4 Try n= 0.052

SC-5 VR_{approx}= 2.3 (from figure V-7.9)

SC-6 Calculate Hydraulic Radius R= VR_{approx} / Vmax

R= 0.767

SC-7 VR_{actual}= (1.49/n)*(R^1.67)*(s^.5)

VR_{actual}= 2.252

SC-8 Check to see that VR_{approx} is within 5% of VR Actual

-5%	5%	
2.190	2.415	**OK**

If not ok then select new trial n value

SC-9 Check Velocity V_{actual}= VR_{actual}/R

V= 2.94 ft/s **OK**

SC-10 Calculate Stability Area ($A_{stability}$)= Q_{100}/V_{actual}

$A_{stability}$= 0.16

SC-11 Check to see that $A_{stablility}$ < A **OK**

SC-12 Calculte Flow Depth (y)= $\frac{-b \pm \sqrt{b^2 - 4Z(-A)}}{2Z}$

y= 0.038 Ft.

y= 0.455 In.

SC-13 Use greater value of y from D1 or above to calculate swale parameters 0.333 Ft.

Y_T= 0.833 Ft.

T= 5.72 Ft.

SC-14 Recalculate Hydraulic Radius (R)= $\frac{by_T + Zy_T^{\,2}}{b + 2y_T\sqrt{Z^2+1}}$

R= 0.584

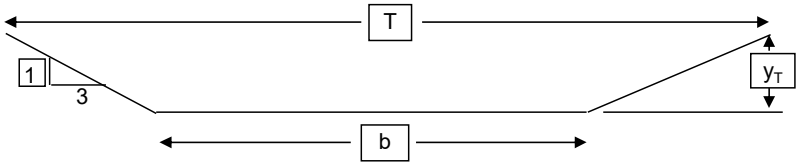
SC-15 Calc. Flow Capacity Q_{cap}= $\frac{1.49\,AR^{0.67}s^{0.5}}{n}$

Q_{cap}= 2.87 cfs

Check Q_{cap}>Q_{100} **OK**

Final Swale Parameters

Length (L)=	120	Ft.
Slope (s)=	0.02	Ft./Ft.
Bottom Width (b)=	0.72	Ft.
Channel Depth (y_T)=	0.833	Ft.
Top Width (T)=	5.72	Ft.



APPENDIX D
OFFSITE DRAINAGE PLAN AND REPORT

1.0 REPORT SUMMARY

This off-site analysis report has been prepared to fulfill the requirements of Section 5.04.01.3 of the Urban Services and Standards and Section 3.5.3 Volume 1 of the *2019 Stormwater Management Manual for Western Washington (Manual).*

The intent of this report is to identify and evaluate offsite water quality, erosion, slope stability, and drainage impacts that may be caused or aggravated by the proposed two-tenant commercial building.

2.0 EXISTING CONDITIONS

The project is located on parcels 06-30-11-51-0900, southwest of the intersection of Lauridsen Boulevard and Liberty Street. The parcels encompass 4.74 acres which has previously been partially cleared but is undeveloped apart from an existing road approach from Park Street in the southwest corner of the site and overhead power utilities which cross the site. The site is generally gently sloped to the north from Park Street toward Lauridsen Boulevard (average slope of 3%). There is a steep fill slope on the north side of Park Street that is assumed to have been created during the construction of Park Street. This bank will not be affected by this project.

Runoff from the site currently drains to the north side of the site where it enters an existing ditch which parallels Lauridsen Boulevard. The ditch on the west side of the project is generally level and it is assumed to drain in both the east and west directions. Runoff flowing to the east enters an existing culvert which drains to a 15 inch diameter concrete pipe on the north side of Lauridsen Boulevard which eventually discharges to Peabody Creek at the 9th Street Outfall just west of Race Street. Runoff flowing to the west enters a catch basin structure and then discharges to the same 15 inch diameter pipe just further to the west.

Peabody Creek is an impaired water body listed in Washington State's 303(d) list for Benthic Macroinvertebrates Bioassessments, Turbidity and Bacteria – Fecal Coliform. Project sites discharging to this Creek may be required to both treat and detain stormwater to assist in the effort to protect this stream.

3.0 PROPOSED DEVELOPMENT

This project includes construction of a Substation Yard with a footprint of approximately 19,600 square feet. The project also includes the installation of approximately 6,700 square feet of access roads, and removal/replacement of approximately 164 square feet of existing sidewalk. The total hard surfaces being added and/or replaced as part of this project is 26,086 square feet. Total area disturbed by this project will be 42,500 square feet

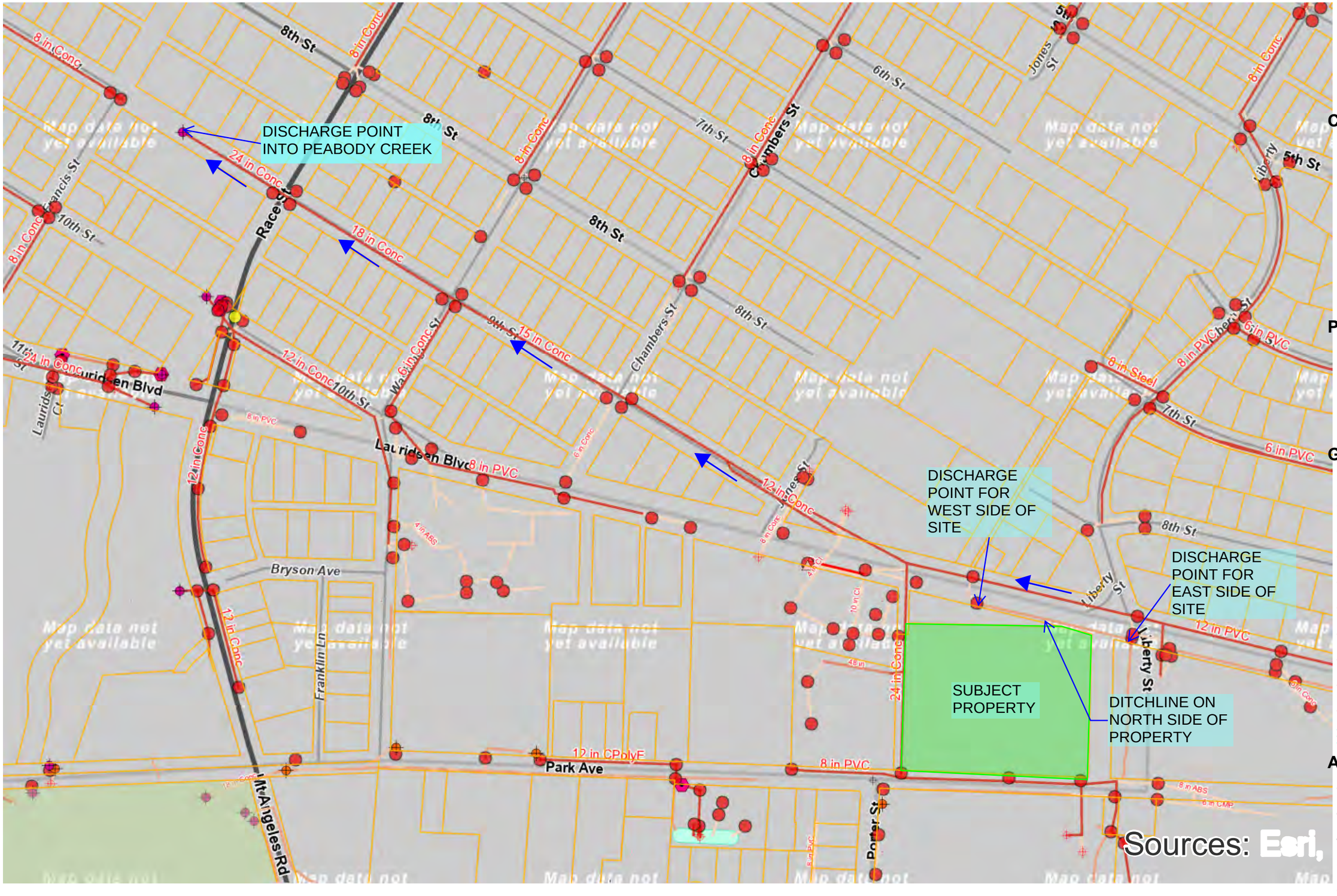
Runoff from the developed portion of the site will be collected, treated through onsite biofiltration swales, detained in an onsite detention pond and discharged the existing ditchline on the northwest side of the site. The ditchline in the northeast will be maintained. There are currently no known capacity or structural issues in the receiving stormwater system.

A map of the Off-site drainage path is included in Appendix A.

4.0 CONCLUSION

As the project will provide treatment of runoff and detention of runoff to limit flows from the site to pre-developed conditions, this project will serve to improve the both the quality and quantity of stormwater discharging to Peabody Creek over the existing conditions, and will not cause or contribute to any downstream issues.

APPENDIX A
OFFSITE DRAINAGE MAP



CatchBasin

- Active
- Proposed
- Abandoned
- Removed
- Storage Basin

Vertical Datum = NAVD88
Horizontal Datum = NAD83/91
Print date: 6/21/2023

Chamber

- Diversion Chamber
- Aquaswirl
- Dry Well
- Energy Dissipator
- Filter Chamber
- Vortech
- Wet Well

Pressure main

- Active
- Proposed
- Abandoned
- Unknown status

Gravity main

- Cav Filter Strip
- Collector
- Culvert
- Ditches
- Inline Storage
- Interceptor
- Main
- Outfall
- Overflow
- DMain unknown status
- Ponds (storm structures)

Arterials

- Collector
- Minor
- Principal
- <all other values>
- Side streets
- County roads

APPENDIX E
SOURCE CONTROL POLLUTION BMPS

S411 BMPs for Landscaping and Lawn / Vegetation Management

Description of Pollutant Sources: Landscaping can include grading, soil transfer, vegetation planting, and vegetation removal. Examples include weed control on golf course lawns, access roads, and utility corridors and during landscaping; and residential lawn/plant care. Proper management of vegetation can minimize excess nutrients and pesticides.

Pollutant Control Approach: Maintain appropriate vegetation to control erosion and the discharge of stormwater pollutants. Prevent debris contamination of stormwater. Where practicable, grow plant species appropriate for the site, or adjust the soil properties of the site to grow desired plant species.

Applicable BMPs:

- Install engineered soil/landscape systems to improve the infiltration and regulation of stormwater in landscaped areas.
- Select the right plants for the planting location based on proposed use, available maintenance,soil conditions, sun exposure, water availability, height, sight factors, and space available.
- Ensure that plants selected for planting are not on the noxious weed list. For example, butterfly bush often gets planted as an ornamental but is actually on the noxious weed list.

  The Washington State Noxious Weed List can be found at the following webpage:

  https://www.nwcb.wa.gov/printable-noxious-weed-list
- Do not dispose of collected vegetation into waterways or storm sewer systems.
- Do not blow vegetation or other debris into the drainage system.
- Dispose of collected vegetation such as grass clippings, leaves, sticks by composting or recycling.
- Remove, bag, and dispose of class A & B noxious weeds in the garbage immediately.
- Do not compost noxious weeds as it may lead to spreading through seed or fragment if the composting process is not hot enough.
- Use manual and/or mechanical methods of vegetation removal (pincer-type weeding tools, flame weeders, or hot water weeders as appropriate) rather than applying herbicides, where practical.
- Use at least an eight-inch "topsoil" layer with at least 8 percent organic matter to provide a sufficient vegetation-growing medium.
    - Organic matter is the least water-soluble form of nutrients that can be added to the soil. Composted organic matter generally releases only between 2 and 10 percent of its total nitrogen annually, and this release corresponds closely to the plant growth cycle. Return natural plant debris and mulch to the soil, to continue recycling nutrients indefinitely.
- Select the appropriate turfgrass mixture for the climate and soil type.
    - Certain tall fescues and rye grasses resist insect attack because the symbiotic endophytic fungi found naturally in their tissues repel or kill common leaf and stem-eating lawn insects.

        - The fungus causes no known adverse effects to the host plant or to humans.
        - Tall fescues and rye grasses do not repel root-feeding lawn pests such as Crane Fly larvae.
        - Tall fescues and rye grasses are toxic to ruminants such as cattle and sheep
    - Endophytic grasses are commercially available; use them in areas such as parks or golf courses where grazing does not occur.
    - Local agricultural or gardening resources such as Washington State University Extension office can offer advice on which types of grass are best suited to the area and soil type.
- Use the following seeding and planting BMPs, or equivalent BMPs, to obtain information on grass mixtures, temporary and permanent seeding procedures, maintenance of a recently planted area, and fertilizer application rates: BMP C120: Temporary and Permanent Seeding, BMP C121: Mulching, BMP C123: Plastic Covering, and BMP C124: Sodding.
- Adjusting the soil properties of the subject site can assist in selection of desired plant species. Consult a soil restoration specialist for site-specific conditions.

Recommended Additional BMPs:

- Conduct mulch-mowing whenever practicable.
- Use native plants in landscaping. Native plants do not require extensive fertilizer or pesticide applications. Native plants may also require less watering.
- Use mulch or other erosion control measures on soils exposed for more than one week during the dry season (May 1 to September 30) or two days during the rainy season (October 1 to April 30).
- Till a topsoil mix or composted organic material into the soil to create a well-mixed transition layer that encourages deeper root systems and drought-resistant plants.
- Apply an annual topdressing application of 3/8” compost. Amending existing landscapes and turf systems by increasing the percent organic matter and depth of topsoil can:
    - Substantially improve the permeability of the soil.
    - Increase the disease and drought resistance of the vegetation.
    - Reduces the demand for fertilizers and pesticides.
- Disinfect gardening tools after pruning diseased plants to prevent the spread of disease.
- Prune trees and shrubs in a manner appropriate for each species.
- If specific plants have a high mortality rate, assess the cause and replace with another more appropriate species.
- When working around and below mature trees, follow the most current American National Standards Institute (ANSI) ANSI A300 standards (see http://www.tcia.org/TCIA/BUSINESS/ANSI_A300_Standards_/TCIA/BUSINESS/A300_Standards/A300_Standards.aspx?hkey=202ff566-4364-4686-b7c1-2a365af59669) and International Society of Arboriculture BMPs to the extent practicable (e.g., take care to minimize any damage to tree roots and avoid compaction of soil).
- Monitor tree support systems (stakes, guys, etc.).
    - Repair and adjust as needed to provide support and prevent tree damage.

    - Remove tree supports after one growing season or maximum of 1 year.
    - Backfill stake holes after removal.
- When continued, regular pruning (more than one time during the growing season) is required to maintain visual sight lines for safety or clearance along a walk or drive, consider relocating the plant to a more appropriate location.
- Make reasonable attempts to remove and dispose of class C noxious weeds.
- Re-seed bare turf areas until the vegetation fully covers the ground surface.
- Watch for and respond to new occurrences of especially aggressive weeds such as Himalayan blackberry, Japanese knotweed, morning glory, English ivy, and reed canary grass to avoid invasions.
- Plant and protect trees per BMP T5.16: Tree Retention and Tree Planting.
- Aerate lawns regularly in areas of heavy use where the soil tends to become compacted. Conduct aeration while the grasses in the lawn are growing most vigorously. Remove layers of thatch greater than ¾-inch deep.
- Set the mowing height at the highest acceptable level and mow at times and intervals designed to minimize stress on the turf. Generally mowing only 1/3 of the grass blade height will prevent stressing the turf.
    - Mowing is a stress-creating activity for turfgrass.
    - Grass decreases its productivity when mowed too short and there is less growth of roots and rhizomes. The turf becomes less tolerant of environmental stresses, more disease prone and more reliant on outside means such as pesticides, fertilizers, and irrigation to remain healthy.

Additional BMP Information:

- King County's *Best Management Practices for Golf Course Development and Operation* (King County, 1993) has additional BMPs for Turfgrass Maintenance and Operation.
- King County, Seattle Public Utilities, and the Saving Water Partnership have created the following natural lawn and garden care resources that include guidance on building healthy soil with compost and mulch, selecting appropriate plants, watering, using alternatives to pesticides, and implementing natural lawn care techniques.
    - *Natural Yard Care - Five steps to make your piece of the planet a healthier place to live* (King County and SPU, 2008)
    - *The Natural Lawn & Garden Series: Smart Watering* (Saving Water Partnership, 2006)
    - *Natural Lawn Care for Western Washington* (Saving Water Partnership, 2007)
    - *The Natural Lawn & Garden Series: Growing Healthy Soil; Choosing the Right Plants; and Natural Pest, Weed and Disease Control* (Saving Water Partnership, 2012)
- The International Society of Arboriculture (ISA) is a group that promotes the professional practice of arboriculture and fosters a greater worldwide awareness of the benefits of trees through research, technology, and education. ISA standards used for managing trees, shrubs, and other woody plants are the American National Standards Institute (ANSI) A300 standards. The ANSI A300 standards are voluntary industry consensus standards developed by the Tree Care Industry Association (TCIA) and written by the Accredited Standards Committee (ASC). The ANSI standards can be found on the ISA website: www.isa-arbor.com/education/publications/index.aspx

- Washington State University's *Gardening in Washington State* website at http://gardening.wsu.edu contains Washington State specific information about vegetation management based on the type of landscape.
- See the *Pacific Northwest Plant Disease Management Handbook* (Pscheidt and Ocamb, 2016) for information on disease recognition and for additional resources.

S417 BMPs for Maintenance of Stormwater Drainage and Treatment Systems

Description of Pollutant Sources: Facilities include roadside catch basins on arterials and within residential areas, conveyance systems, detention facilities such as ponds and vaults, oil/water separators, biofilters, settling basins, infiltration systems, and all other types of stormwater treatment systems presented in Volume V. Oil and grease, hydrocarbons, debris, heavy metals, sediments and contaminated water are found in catch basins, oil and water separators, settling basins, etc.

Pollutant Control Approach: Provide maintenance and cleaning of debris, sediments, and other pollutants from stormwater collection, conveyance, and treatment systems to maintain proper operation.

Applicable Operational BMPs:

Maintain stormwater treatment facilities per the operations and maintenance (O&M) procedures presented in Appendix V-A: BMP Maintenance Tables in addition to the following BMPs:

- Inspect and clean treatment BMPs, conveyance systems, and catch basins as needed, and determine necessary O&M improvements.
- Promptly repair any deterioration threatening the structural integrity of stormwater facilities. These include replacement of clean-out gates, catch basin lids, and rock in emergency spillways.
- Ensure adequacy of storm sewer capacities and prevent heavy sediment discharges to the sewer system.
- Regularly remove debris and sludge from BMPs used for peak-rate control, treatment, etc. and discharge to a sanitary sewer if approved by the sewer authority, or truck to an appropriate local or state government approved disposal site.
- Clean catch basins when the depth of deposits reaches 60 percent of the sump depth as measured from the bottom of basin to the invert of the lowest pipe into or out of the basin. However, in no case should there be less than six inches clearance from the debris surface to the invert of the lowest pipe. Some catch basins (for example, WSDOT's *Catch Basin Type 1L* (WSDOT, 2011)) may have as little as 12 inches sediment storage below the invert. These catch basins need frequent inspection and cleaning to prevent scouring. Where these catch basins are part of a stormwater collection and treatment system, the system owner/operator may choose to concentrate maintenance efforts on downstream control devices as part of a systems approach.
- Properly dispose of all solids, polluted material, and stagnant water collected through system cleaning. Do not decant water back into the drainage system from eductor trucks or vacuum equipment since there may be residual contaminants in the cleaning equipment. Do not jet material downstream into the public drainage system.
- Clean woody debris in a catch basin as frequently as needed to ensure proper operation of the catch basin.
- Post warning signs; “Dump No Waste - Drains to Ground Water,” “Streams,” “Lakes,” or emboss on or adjacent to all storm drain inlets where possible.
- Disposal of sediments and liquids from the catch basins must comply with Appendix IV-B: Management of Street Waste Solids and Liquids.

Publication No.19-10-021

S421 BMPs for Parking and Storage of Vehicles and Equipment

Description of Pollutant Sources: Public and commercial parking lots such as retail store, fleet vehicle (including rent-a-car lots and car dealerships), equipment sale and rental parking lots, and parking lot driveways, can be sources of toxic hydrocarbons and other organic compounds, including oils and greases, metals, and suspended solids.

Pollutant Control Approach: If the parking lot meets the site use thresholds to determine if the site is expected to generate high concentrations of oil, as defined in Step 2: Determine if an Oil Control BMP is Required in III-1.2 Choosing Your Runoff Treatment BMPs, provide oil removal equipment for the contaminated stormwater runoff.

Applicable Operational BMPs:

- If a parking lot must be washed, discharge the washwater to a sanitary sewer, if allowed by the local sewer authority, or other approved wastewater treatment system, or collect washwater for off-site disposal.
- Do not hose down the area to a storm sewer or receiving water. Vacuum sweep parking lots, storage areas, and driveways regularly to collect dirt, waste, and debris. Mechanical or hand sweeping may be necessary for areas where a vacuum sweeper cannot reach.
- Clean up vehicle and equipment fluid drips and spills immediately.
- Place drip pans below leaking vehicles (including inoperative vehicles and equipment) in a manner that catches leaks or spills, including employee vehicles. Drip pans must be managed to prevent overfilling and the contents disposed of properly.

Recommended Operational BMPs:

- Encourage employees to repair leaking personal vehicles.
- Encourage employees to carpool or use public transit through incentives.
- Encourage customers to use public transit by rewarding valid transit pass holders with discounts.
- Install catch basin inserts to collect excess sediment and oil if necessary. Inspect and maintain catch basin inserts to ensure they are working correctly.

Applicable Treatment BMPs:

Establishments subject to high-use intensity are significant sources of oil contamination of stormwater. Examples of potential high use areas include customer parking lots at fast food stores, grocery stores, taverns, restaurants, large shopping malls, discount warehouse stores, quick-lube shops, and banks.

Refer to Step 2: Determine if an Oil Control BMP is Required in III-1.2 Choosing Your Runoff Treatment BMPs for the site use thresholds that determine if an oil control BMP is required, and for a list of oil control BMPs.

APPENDIX F
SOILS INVESTIGATION MAP

TEST PIT LOGS:

TEST PITS EXCAVATED ON MARCH 6TH, 2023

TEST PIT #1
0-12" BROWN SANDY LOAM (TOPSOIL)
12-18" ASHY SANDY LOAM, HEAVILY MOTTLED
18-24" DENSE LOAMY SAND (TILL)
ACTIVE WATER SEEPAGE AT 12", HOLE FILLED TO WITHIN 12" OF GROUND SURFACE BY FOLLOWING DAY

TEST PIT #2
0-10" BROWN SANDY LOAM (TOPSOIL)
10-16" ASHY SANDY LOAM, HEAVILY MOTTLED
18-24" DENSE LOAMY SAND (TILL)
ACTIVE WATER SEEPAGE AT 12", HOLE FILLED TO WITHIN 12" OF GROUND SURFACE BY FOLLOWING DAY

TEST PIT #3
0-12" BROWN SANDY LOAM (TOPSOIL)
12-16" ASHY SANDY LOAM, HEAVILY MOTTLED
16-36" DENSE LOAMY SAND (TILL)
ACTIVE WATER SEEPAGE AT 12", HOLE WAS BACKFILLED SAME DAY SO WAS NOT CHECKED FOLLOWING DAY

SOILS INVESTIGATION MAP

TITLE: *LIBERTY STREET SUBSTATION - CORNER OF LIBERTY STREET & LAURIDSEN BOULEVARD , PORT ANGELES, WA*

CLIENT: *CLALLAM COUNTY PUD #1*
104 HOOKER ROAD
SEQUIM, WA 98382

ZENOVIC & ASSOCIATES INCORPORATED
301 EAST 6TH ST. SUITE 1
PORT ANGELES, WA 98362
PHONE: (360) 417-0501
FAX: (360) 417-0514
EMAIL: ZENOVIC@ZENOVIC.NET

SCALE: *1" = 80'*

DATE: *11/15/2023*

FILE: *23071 - E2*

JOB NO: *23071*

11/15/2023

SHEET 1 **OF** 1

LIBERTY STREET SUBSTATION
STORMWATER POLLUTION PREVENTION PLAN
CLALLAM COUNTY PUD #1

PROJECT LOCATION:
LAURIDSEN BOULEVARD & LIBERTY STREET
PORT ANGELES, WASHINGTON
PARCEL NO: 06-30-11-51-0900

Prepared for:
CLALLAM COUNTY PUD #1
104 HOOKER ROAD
CARLSBORG, WASHINGTON 98382

Prepared by:
ZENOVIC & ASSOCIATES, INCORPORATED
301 EAST 6TH STREET, SUITE #1
PORT ANGELES, WASHINGTON 98362

Project No. 23071
November 15, 2023

INTRODUCTION

This project report has been prepared to demonstrate compliance with the City of Port Angeles (City) stormwater requirements. The intent of this report is to comprehensively describe the construction stormwater pollution prevention plan for the proposed Liberty Street Sub-Station located southwest of the intersection of Lauridsen Boulevard and Liberty Street in Port Angeles. This project includes construction of a power substation, access roads, and stormwater facilities.

This project is required to complete a Large Project Stormwater Pollution Prevention Plan in accordance with Section 6.04 of the *Port Angeles Urban Services Standards and Guidelines (2017).*

Included in the Appendices of this report are the Project Plans and Best Management Practices.

SITE INFORMATION

The project is located on parcel 06-30-11-51-0900, southwest of the intersection of Lauridsen Boulevard and Liberty Street. The parcels encompass 4.74 acres which has previously been partially cleared but is undeveloped apart from an existing road approach from Park Street in the southwest corner of the site and overhead power utilities which cross the site. The site is generally gently sloped to the north from Park Street toward Lauridsen Boulevard (average slope of 3%). There is a steep fill slope on the north side of Park Street that is assumed to have been created during the construction of Park Street. This bank will not be affected by this project.

The NRCS Soils survey classifies the site as Clallam gravelly sandy loam with the following features (please note that these are classifications are generalizations and are not intended to take precedence over observed field data):

- Clallam gravelly sandy loam typical soil profile consists of 0 to 10 inches of gravelly ashy sandy loam, 10 to 28 inches very gravelly ashy sandy loam, and 28 to 60 inches very gravelly sandy loam.
- The typical depth to densic material is 20 to 40 inches.
- Typical depth to water table is 18 to 36 inches.

Onsite investigations found soil consistent with the Clallam soil types with the site being underlain by dense till material. Two test pits were dug in anticipation of performing Pilot Infiltration Tests, however the both test pits filled with groundwater (approximately 12” below ground surface) before the tests could be performed.

Runoff from the site currently drains to the north side of the site where it enters an existing ditch which parallels Lauridsen Boulevard. The ditch on the west side of the project is generally level and it is assumed to drain in both the east and west directions.

Runoff flowing to the east enters an existing culvert which drains to a 15 inch diameter concrete pipe on the north side of Lauridsen Boulevard which eventually discharges to Peabody Creek at the 9th Street Outfall just west of Race Street. Runoff flowing to the west enters a catch basin structure and then discharges to the same 15 inch diameter pipe just further to the west.

Once developed, the site will discharge to the same stormwater system and thus maintain the existing drainage path. Runoff from the developed portion of the site will be collected, treated through onsite biofiltration swales, detained in an onsite detention pond and discharged the existing ditch line on the northwest side of the site. The ditch line in the northeast will be maintained.

CONSTRUCTION SCHEDULE

As this project has not yet been approved or awarded the following schedule is general and should be revised to accurately represent the construction schedule.

April 1, 2024	Install TESC elements
April 1, 2024	Clear and grub site, Demo existing sidewalk
April 8, 2024	Mass grading including pond and outlet structure
April 22, 2024	Install substation rock and access road
May 1, 2024	Substation construction & Stormwater filtration structures
August 5, 2024	Stabilize Soils
August 12, 2024	Remove TESC elements, Project Close-out and Clean-up

THIRTEEN ELEMENTS

The following is a list of the thirteen required elements of a stormwater pollution prevention plan and how they will be implemented for this project.

ELEMENT #1 – MARK CLEARING LIMITS

Clearing limits will be marked with high visibility fencing and/or silt fencing. Silt fence will be installed along the north edge of the project area and partially up the west and east sides. High visibility fencing will be installed along all sides of the project where silt fencing is not present. Areas outside of the marked clearing limits will not be disturbed as part of this project.

ELEMENT #2 – ESTABLISH CONSTRUCTION ACCESS

Stabilized construction entrances will be installed at all entrances/exits to the site. As shown on the plans a stabilized entrance will be installed at the existing road approach off of Park Avenue. A second access may be established off of Lauridsen Boulevard depending on the workflow. Even with a stabilized construction entrance, vehicles will be encouraged not to traverse disturbed areas of the site and then adjacent paved surfaces.

Access roads and the substation will be graveled as soon as possible to provide stabilized access.

ELEMENT #3 – CONTROL FLOW RATES

The detention pond will be installed as a first order of grading and will act as a sediment pond (BMP C241) to both reduce flow rates from the project area and provides some settlement of suspended solids. Check dams (BMP C209) will be installed in the existing ditchline along the north side of the project site to reduce flow rates and promote settlement of solids.

ELEMENT #4 – INSTALL SEDIMENT CONTROLS

Inlet Protection (BMP C220) will be installed in existing inlets in Lauridsen Boulevard prior to clearing and grading activities. Silt Fence (BMP C233) will be installed on the downstream side of the project area to prevent sediment laden runoff leaving the site.

ELEMENT #5 – STABILIZE SOILS

This project is planned to be completed primarily in the dry season with stabilization of soils with gravel as soon as possible. However any disturbed soils will be stabilized within 7 days during the dry season (May 1 – September 30) and 2 days during the wet season (October 1 – April 30) of being exposed and unworked with either mulching BMP C121 or plastic sheeting BMP C123.

The completed project will be stabilized with gravel surfacing and seeding (BMP C120)

ELEMENT #6 – PROTECT SLOPES

There will be no steep slopes onsite.

ELEMENT #7 – PROTECT DRAIN INLETS

Inlet Protection (BMP C220) will be installed in existing inlets in Lauridsen Boulevard prior to clearing and grading activities.

ELEMENT #8 – STABILIZE CHANNELS AND OUTLETS

Check dams (BMP C207) will be installed in the existing ditchline along the north edge of the site and the outlet from the proposed pond will be protected with Outlet Protection (BMP C209)

ELEMENT #9 – CONTROL POLLUTANTS

The following BMPs will be implemented on an as needed basis during the applicable construction activities:

- BMP C151: Concrete Handling
- BMP C152: Sawcutting and Surfacing Pollution Prevention
- BMP C154: Concrete Washout Area

ELEMENT #10 – CONTROL DEWATERING

There is high groundwater on the site (Interflow), but this will be managed by installation of ditch lines to direct the water away from the construction area. No pumping of groundwater is planned.

ELEMENT #11 – MAINTAIN BMPS

BMPs will be inspected weekly and after major storm events to ensure proper installation and function. Any noted deficiencies will be repaired within 2 days.

Sediment will be removed from temporary sediment controls.

Any observed track out onto public roadways will be cleaned up by the end of day.

All BMPs will be removed within 30 days of final stabilization of the site.

ELEMENT #12 – MANAGE THE PROJECT

As noted in the maintenance portion of this report BMPs will be inspected weekly and after major storm events to ensure proper installation and function. BMPs will be reviewed for effectiveness and proper use.

The Contractor will be responsible for inspection and maintenance of BMPs and this SWPPP.

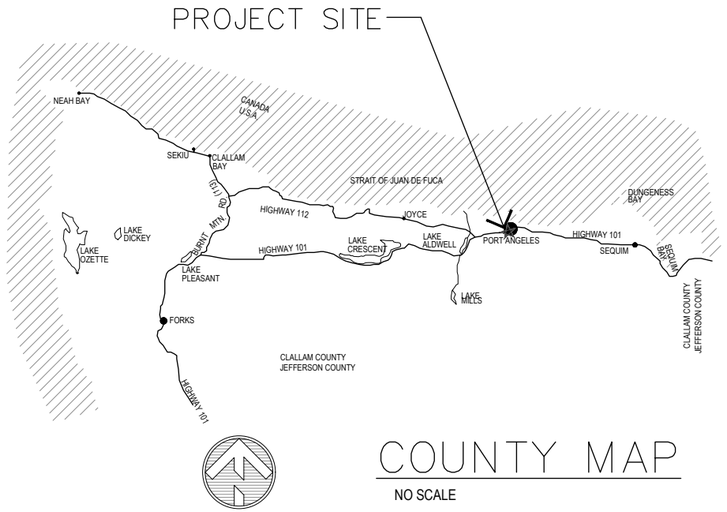
ELEMENT #13 – PROTECT LOW IMPACT DEVELOPMENT BMPS

The area on the west side of the substation area will be utilized for dispersion of runoff from the proposed roadway. This area will be protected from disturbance by the installation of high visibility fencing as noted in Element #1 and shown on the plans.

APPENDIX A
PROJECT PLANS

CITY MAP

NO SCALE



COUNTY MAP

NO SCALE

PROJECT INFORMATION

APPLICANT:	CLALLAM COUNTY PUD #1 PO BOX 1000 CARLSBORG, WA 98324
OWNER:	CLALLAM COUNTY PUD #1 PO BOX 1000 CARLSBORG, WA 98324
PROPOSED PROJECT:	LIBERTY STREET SUBSTATION
ZONING:	PBP - PUBLIC BUILDING AND PARKS
UTILITIES:	STORM & SANITARY SEWER, & WATER - CITY OF PORT ANGELES POWER - CALLAM COUNTY PUD #1 TELEPHONE - N/A CABLE TELEVISION - N/A
PARCEL NO.:	06-30-11-51-0900
DATE OF PREPARATION:	JUNE 2023
PROPERTY DESCRIPTION:	BLOCKS 12 & 13 OF CAMPBELL'S ADDITION TO PORT ANGELES TOGETHER WITH VACATED PORTIONS OF ABUTTING RIGHTS OF WAYS, SEE SURVEY RECORDED IN VOLUME 47 OF SURVEYS, PAGE 13 FOR ADDITIONAL ENCUMBRANCES.

HORIZONTAL AND VERTICAL DATUM:

CITY OF PORT ANGELES

HORIZ. NAD 83/91

VERT. NAVD 88

TOPOGRAPHIC DATA AS NOTED PROVIDED BY THE CLALLAM COUNTY PUD. DATA INCLUDED SURFACE ELEVATIONS IN THE AREA NOTED IN THE PLANS, THE SIDEWALK ON THE NORTH SIDE OF THE PROJECT AREA AND THE EDGE OF ROADWAY AROUND THE SITE.

BENCHMARK:

TBD

DRAWING INDEX

C1	COVER SHEET WITH GENERAL NOTES
C2	TESC & DEMO PLAN
C3	TESC DETAILS
C4	SITE PLAN
C5	DRAINAGE DETAILS

CALL BEFORE YOU DIG
1-800-424-5555
FOR UNDERGROUND UTILITY LOCATION SERVICE

GENERAL NOTES:

1. ALL WORKMANSHIP AND MATERIALS SHALL BE IN ACCORDANCE WITH THE CITY OF PORT ANGELES STANDARDS, THE CURRENT EDITION OF THE WASHINGTON STATE DEPARTMENT OF TRANSPORTATION (WSDOT) STANDARD SPECIFICATIONS FOR ROAD, BRIDGE AND MUNICIPAL CONSTRUCTION (STANDARD SPECIFICATIONS), AND ANY PROJECT SPECIFIC SPECIAL PROVISIONS OR CONDITIONS AND REQUIREMENTS.

2. TEMPORARY EROSION/WATER POLLUTION MEASURES ARE REQUIRED AND SHALL COMPLY WITH CHAPTER 6 OF THE CITY OF PORT ANGELES' URBAN SERVICES STANDARDS AND GUIDELINES AND THE CURRENT EDITION OF THE WASHINGTON STATE DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS FOR ROAD, BRIDGE AND MUNICIPAL CONSTRUCTION.

3. EXISTING AND NEWLY CONSTRUCTED STORM WATER DRAINAGE SYSTEMS SHALL BE PROTECTED FROM CONSTRUCTION SITE RUNOFF.

4. A PRECONSTRUCTION MEETING SHALL BE HELD WITH THE CITY PRIOR TO THE START OF CONSTRUCTION.

5. HORIZONTAL AND VERTICAL CONTROLS/DATUM AS ADOPTED BY THE CITY SHALL BE USED, UNLESS APPROVED OTHERWISE.

6. ALL APPROVALS AND PERMITS REQUIRED BY THE CITY SHALL BE OBTAINED BY THE CONTRACTOR PRIOR TO THE START OF CONSTRUCTION, UNLESS OTHERWISE APPROVED BY THE CITY ENGINEER.

7. THE CONTRACTOR SHALL BE FULLY RESPONSIBLE FOR THE LOCATION AND PROTECTION OF ALL EXISTING UTILITIES. THE CONTRACTOR SHALL VERIFY ALL UTILITY LOCATIONS PRIOR TO CONSTRUCTION BY CALLING UNDERGROUND LOCATE AT 1-800-424-5555 A MINIMUM OF 48 HOURS PRIOR TO ANY EXCAVATION WORK.

8. THE CONTRACTOR SHALL BE FULLY RESPONSIBLE FOR TEMPORARY TRAFFIC CONTROL. THE CONTRACTOR SHALL, BY LETTER TO THE CITY ENGINEER, INDICATE THAT WSDOT STANDARD "K" PLANS SHALL BE UTILIZED FOR TEMPORARY TRAFFIC CONTROL. IF THE CURRENT WSDOT STANDARD "K" PLANS ARE NOT UTILIZED, THE CONTRACTOR SHALL PROVIDE A TRAFFIC CONTROL PLAN(S) FOR REVIEW AND APPROVAL BY THE CITY ENGINEER IN ACCORDANCE WITH THE MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES (MUTCD). THE CITY ENGINEER SHALL HAVE FIVE DAYS FOR REVIEW OF ANY PROPOSED TRAFFIC CONTROL PLAN. NO WORK MAY BE CONDUCTED WITHOUT AN APPROVED TRAFFIC CONTROL PLAN.

9. THE CONTRACTOR SHALL HAVE A COPY OF THE APPROVED PLANS AT THE CONSTRUCTION SITE AT ALL TIMES.

10. SPECIAL STRUCTURES SHALL BE INSTALLED PER PLANS AND MANUFACTURER'S RECOMMENDATIONS.

11. ALL DISTURBED AREAS SHALL RECEIVE TEMPORARY AND PERMANENT EROSION CONTROL IN THE FORM OF VEGETATION ESTABLISHMENT SUCH AS GRASS SEEDING. A MEANS SHALL BE ESTABLISHED TO PROTECT THE PERMANENT STORM DRAIN SYSTEM PRIOR TO ESTABLISHMENT OF THE PERMANENT EROSION CONTROL MEASURES. THESE METHODS SHALL BE INCLUDED IN THE EROSION AND SEDIMENT CONTROL PLANS IN ACCORDANCE WITH CHAPTER 6 THE CITY OF PORT ANGELES URBAN SERVICES STANDARDS AND GUIDELINES.

12. CONSTRUCTION WORK HOURS SHALL BE RESTRICTED TO 7 A.M. TO 10 P.M. PRIOR WRITTEN APPROVAL OF THE CITY ENGINEER SHALL BE REQUIRED FOR WORK BETWEEN 10 P.M. AND 7 A.M.; A VARIANCE FROM THE CITY BOARD OF ADJUSTMENT WILL BE REQUIRED TO WORK DURING THESE HOURS. A VARIANCE REQUIRES A MINIMUM OF 60 DAYS TO OBTAIN; THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL COSTS AND EFFORTS TO OBTAIN THE VARIANCE

13. THE CITY CONSTRUCTION INSPECTOR SHALL BE NOTIFIED A MINIMUM OF 24 HOURS IN ADVANCE OF THE NEED FOR AN INSPECTION.

14. PER THE PROVISIONS OF THE CURRENT WSDOT STANDARD SPECIFICATIONS RELATED TO PUBLIC CONVENIENCE AND SAFETY, THE CONTRACTOR SHALL MAINTAIN READY ACCESS TO DRIVEWAYS, HOUSES, AND BUILDINGS ALONG THE LINE OF WORK.

15. A MINIMUM OF ONE WAY TRAVEL THROUGH THE PROJECT AREA SHALL BE MAINTAINED AT ALL TIMES, UNLESS OTHERWISE APPROVED BY THE CITY ENGINEER.

16. SHOULD ACCESS TO A PROPERTY ADJOINING THE PROJECT REQUIRE TEMPORARY CLOSURE ANTICIPATED TO HAVE A DURATION EXCEEDING 15 MINUTES, THE CONTRACTOR SHALL COORDINATE THE TEMPORARY CLOSURE WITH THE PROPERTY OWNER/RESIDENT. A MINIMUM OF 24 HOURS ADVANCE NOTIFICATION SHALL BE PROVIDED TO THE PROPERTY OWNER/RESIDENT PRIOR TO ANY SUCH TEMPORARY CLOSURE.

APPROVED FOR CONSTRUCTION _____ DATE: _____ APPROVAL EXPIRES: _____
CITY ENGINEER

ZENOVIC & ASSOCIATES
INCORPORATED
301 E. 6TH STREET, SUITE 1
PORT ANGELES, WA 98362
PHONE: (360) 417-0501
FAX: (360) 417-0514
EMAIL: ZENOVIC@ZENOVIC.NET

REVISIONS:

DATE	MARK	NOTE

TITLE: LIBERTY STREET SUBSTATION - CORNER OF LIBERTY STREET & LAURIDSEN BOULEVARD, PORT ANGELES, WA

COVER SHEET & GENERAL NOTES

CLIENT: CLALLAM COUNTY PUD #1
104 HOOKER ROAD
SEQUIM, WA 98382

SCALE: NTS

FILE: 23071 - E2

JOB NO: 23071

DATE: August 30, 2023

SET: PERMIT

STATE OF WASHINGTON
JOHN RODMAN
REGISTERED PROFESSIONAL ENGINEER
8/30/2023

SHEET
C1

SITE PLAN

Scale: 1" = 30'

0 30' 60' 90'

EROSION CONTROL NOTES:

1. ALL EROSION CONTROL MEASURES SHALL BE CONSTRUCTED AND MAINTAINED IN ACCORDANCE WITH THE REQUIREMENTS OF THE STORMWATER MANAGEMENT MANUAL FOR WESTERN WASHINGTON (DOE, 2019) AND THE PORT ANGELES URBAN SERVICES, STANDARDS AND GUIDELINES (2017) HEREAFTER REFERRED TO AS THE URBAN SERVICES.
2. ALL DISTURBED AREAS, EXCEPT THOSE ON WHICH ACTIVE CONSTRUCTION IS TAKING PLACE, SHALL BE EITHER SEEDED AND MULCHED OR PROTECTED WITH APPROPRIATE PLASTIC SHEETING WITHIN 2 DAYS OF DISTURBANCE BETWEEN OCTOBER 1 AND APRIL 30 AND WITHIN 7 DAYS BETWEEN MAY 1 AND SEPTEMBER 30.
3. STABILIZED CONSTRUCTION ENTRANCE TO BE INSTALLED PRIOR TO CLEARING AND GRADING ACTIVITIES.
4. ALL EROSION CONTROL MEASURES SHALL BE INSPECTED WEEKLY AND AFTER MAJOR STORM EVENTS. ANY DEFICIENCIES SHALL BE REPAIRED IMMEDIATELY.
5. CATCH BASIN INSERTS PER DETAIL A/C2 TO BE INSTALLED IN ALL EXISTING AND NEWLY INSTALLED BASIN AND REMAIN IN PLACE UNTIL AREA DRAINAGE TO AFFECTED BASIN IS FULLY STABILIZED.
6. ANY MATERIAL THAT IS CARRIED OFFSITE BY VEHICLE WHEELS AND DEPOSITED ON PUBLIC ROADWAYS SHALL BE CLEANED UP IMMEDIATELY.
7. SAWCUTTING SHALL BE DONE WITH WATER TO PREVENT DUST AND THE RESULTING SLURRY IS TO BE VACUUMED UP IMMEDIATELY.
8. CONCRETE TRUCKS TO WASHOUT IN DESIGNATED CONCRETE WASHOUT AREA IN ACCORDANCE WITH BMP C154.
9. ADJACENT PROPERTIES SHALL BE PROTECTED FROM SEDIMENT DEPOSITION BY APPROPRIATE USE OF VEGETATIVE BUFFER STRIPS, SEDIMENT BARRIERS OR FILTERS, DIKES OR MULCHING, OR BY A COMBINATION OF THESE MEASURES.
10. THE TESC MEASURES SHOWN ON THIS PLAN REPRESENT THE MINIMUM REQUIREMENTS REQUIRED TO COMPLY WITH THE TERMS AND CONDITIONS OF SECTION 6.03.1 OF THE URBAN SERVICES.
11. THE CONTRACTOR SHALL BE RESPONSIBLE TO ENSURE THE EROSION CONTROL MEASURES USED ARE FUNCTIONING EFFECTIVELY AND THE SITE CONTINUALLY COMPLIES WITH THE REQUIREMENTS OF THE URBAN SERVICES.
12. DEMOLITION DEBRIS LEFT ONSITE SHALL BE COVERED AT THE END OF EACH SHIFT WITH PLASTIC COVERING OR EQUIVALENT.
13. **DISTURBED SOILS ARE TO AMENDED PER BMP T5.13.**
14. UPON COMPLETION OF THE PROJECT, ALL DISTURBED AREAS NOT OTHERWISE PAVED OR LANDSCAPED SHALL BE HYDRO-SEEDED WITH THE LANDSCAPE SEED MIX BELOW UNLESS OTHERWISE SPECIFIED.

LANDSCAPE SEED MIX

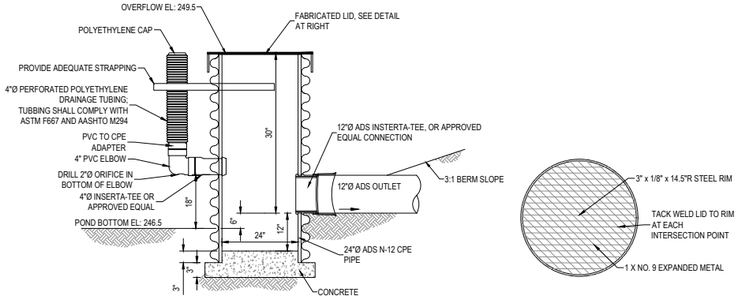
SEED TYPE	% WEIGHT	% PURITY	% GERMINATION
PERENNIAL RYE	70	98	90
CHEWINGS AND RED FESCUE BLEND	30	98	85

1. SEED TO BE APPLIED AT A RATE OF 120 lbs/acre.
2. MULCH TO BE APPLIED AT A MIN. RATE OF 1500 lbs/acre WITH 3% TACKIFIER.
3. FERTILIZER (10-4-6 N-P-K) TO BE APPLIED AT A RATE OF 90 lbs/acre.

WET AREA SEED MIX

SEED TYPE	% WEIGHT	% PURITY	% GERMINATION
TALL OR MEADOW FESCUE	60-70	98	90
SEASIDE/CREEPING BENTGRASS	10-15	98	85
MEADOW FOXTAIL	10-15	90	80
ALSIKE CLOVER	1-6	98	90
REDTOP BENTGRASS	1-6	92	85

1. SEED TO BE APPLIED AT A RATE OF 120 lbs/acre.
2. MULCH TO BE APPLIED AT A MIN. RATE OF 1500 lbs/acre WITH 3% TACKIFIER.
3. FERTILIZER (10-4-6 N-P-K) TO BE APPLIED AT A RATE OF 90 lbs/acre.



FABRICATED LID

A / C2 SEDIMENT POND RISER DETAIL

Scale: NTS

ZENOVIC & ASSOCIATES
INCORPORATED
301 E. 6TH STREET, SUITE 1
PORT ANGELES, WA 98362
PHONE: (360) 417-0501
FAX: (360) 417-0514
EMAIL: ZENOVIC@ZENOVIC.NET

REVISIONS:

DATE	MARK	NOTE

TITLE: LIBERTY STREET SUBSTATION - CORNER OF LIBERTY STREET & LAURIDSEN BOULEVARD, PORT ANGELES, WA

TESC/DEMO PLAN

CLIENT: CLALLAM COUNTY PUD #1
104 HOOKER ROAD
SEQUIM, WA 98382

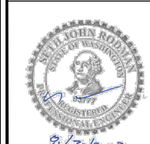
SCALE: 1"=30'

FILE: 23071 - E2

JOB NO: 23071

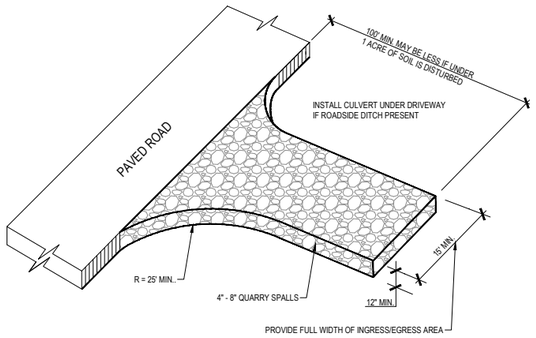
DATE: August 30, 2023

SET: PERMIT



SHEET

C2



A / C3 STABILIZED CONSTRUCTION ENTRANCE

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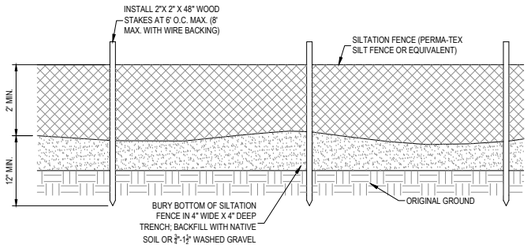
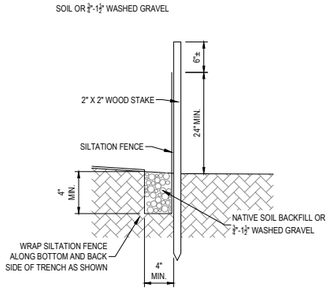
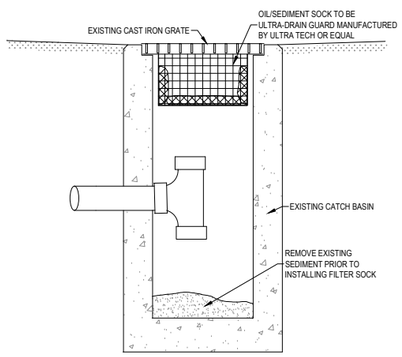




B / C3 SILTATION FENCE DETAILS

Scale: NTS



C / C3 INLET PROTECTION

Scale: N.T.S.

ZENOVIC & ASSOCIATES
INCORPORATED
301 E. 6TH STREET, SUITE 1
PORT ANGELES, WA 98362
PHONE: (360) 417-0501
FAX: (360) 417-0514
EMAIL: ZENOVIC@ZENOVIC.NET

REVISIONS:

DATE	MARK	NOTE

TITLE: LIBERTY STREET SUBSTATION - CORNER OF LIBERTY STREET & LAURIDSEN BOULEVARD , PORT ANGELES, WA

TESC DETAILS

CLIENT: CLALLAM COUNTY PUD #1
104 HOOKER ROAD
SEQUIM, WA 98382

SCALE: NTS

FILE: 23071 - E2

JOB NO: 23071

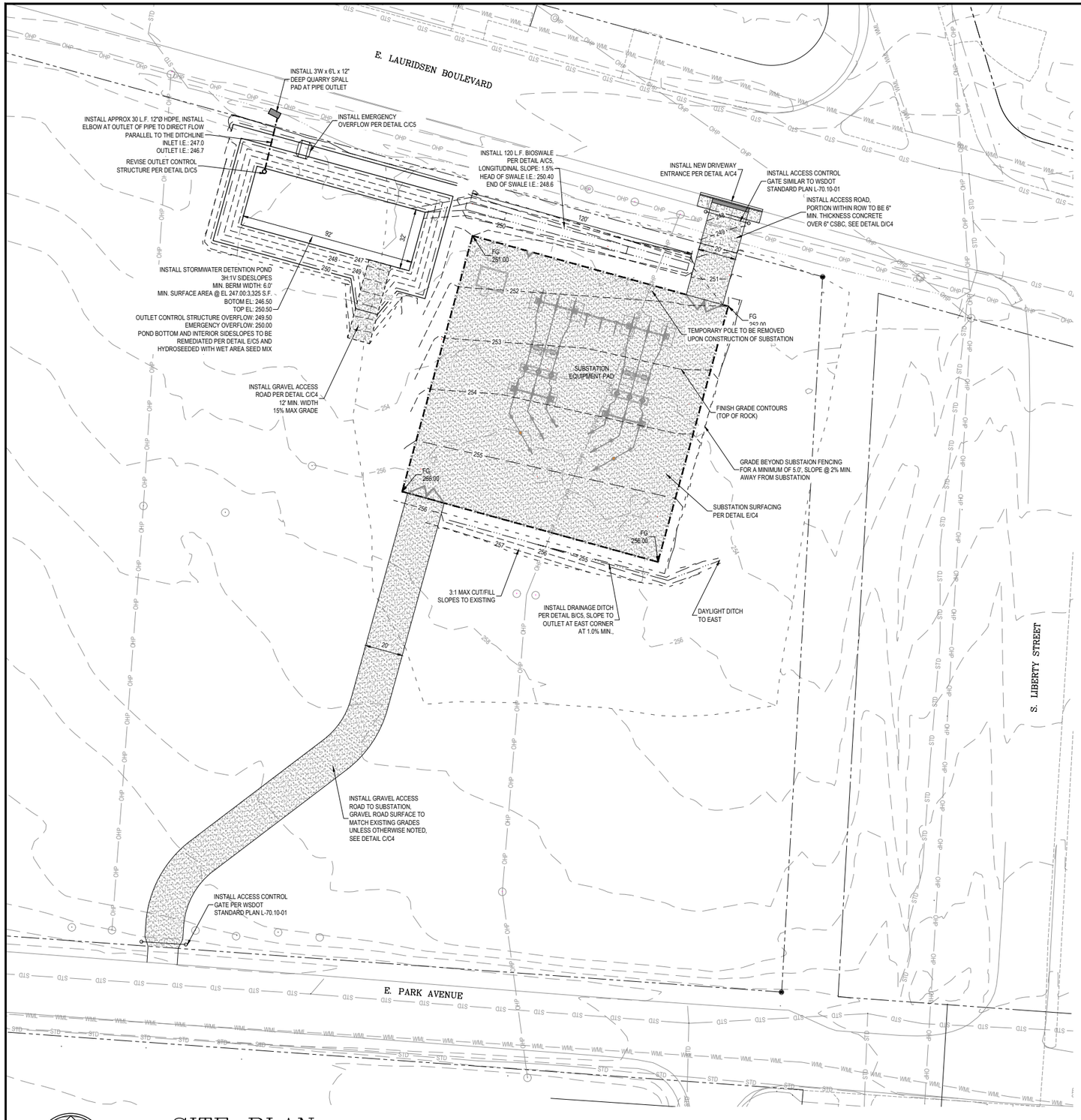
DATE: August 30, 2023

SET: PERMIT

KEITH JOHN ROBINSON
STATE OF WASHINGTON
REGISTERED PROFESSIONAL ENGINEER
8/30/2023

SHEET

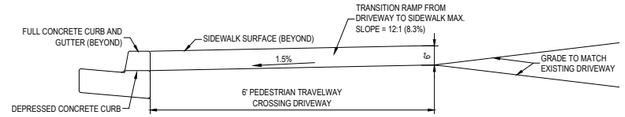
C3



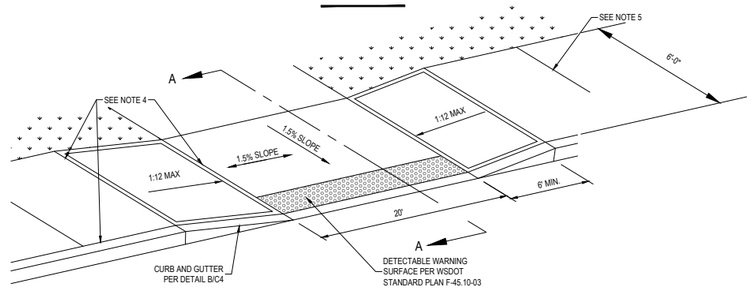
SITE PLAN

Scale: 1" = 30'

0 30' 60' 90'



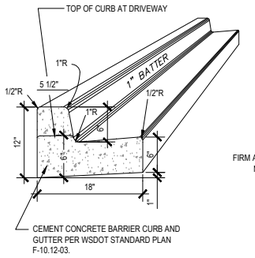
SECTION A-A



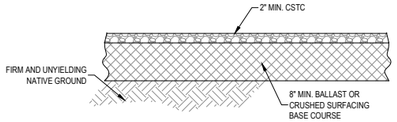
NOTES:

1. THE PEDESTRIAN TRAVELWAY SHALL HAVE A MAXIMUM CROSS SLOPE OF 48:1 (2%).
2. INSTALL RAMPS ON BOTH SIDES OF THE DRIVEWAY AS SHOWN ON THE PLANS. RAMPS SHALL BE AS LONG AS NECESSARY TO PROVIDE A MAXIMUM SLOPE OF 12:1 PARALLEL AND PERPENDICULAR TO THE EXISTING PLANE ON WHICH THE RAMP IS TO BE CONSTRUCTED.
3. CEMENT CONCRETE SHALL BE CLASS 4000, MIN. 6" THICK INCLUDING RAMPS
4. ASPHALT IMPREGNATED EXPANSION JOINT, FULL DEPTH AT BACK OF CURB AND EVERY 20 FEET AT TRANSVERSE JOINTS. JOINT MATERIAL NOT REQUIRED AT BACK OF CURB IF RAMP AND/OR DRIVEWAY IS POURED SEPARATELY CREATING A COLD JOINT.
5. CRACK JOINTS EVERY 5 FEET IN WALK.
6. HERBICIDE (RESIDUAL) TO BE APPLIED BEFORE POURING CONCRETE.
7. EXPOSED AGGREGATE OR SPECIAL SURFACE TREATMENT NOT ALLOWED IN RIGHT OF WAY

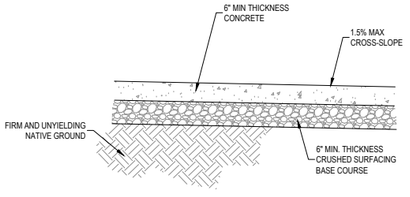
A / C4 DRIVEWAY APRON
Scale: NTS



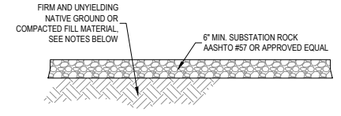
B / C4 CURB AND GUTTER
Scale: NTS



C / C4 GRAVEL ACCESS ROAD SECTION
Scale: N.T.S.



D / C4 CONCRETE DRIVEWAY SECTION
Scale: N.T.S.



NOTES:
1. BASED ON ONSITE TEST PITS, SUITABLE BEARING MATERIAL IS APPROXIMATELY 12" BELOW EXISTING GRADE.
2. ONSITE MATERIAL BELOW APPROXIAMTELY 12" MAY BE SUITABLE FOR USED AS FILL MATERIAL IN TRAVELLED AREAS. NOTE THAT THIS MATERIAL IS VERY MOISTURE SENSITIVE AND WILL NOT BE USABLE DURING WET WEATHER CONDITIONS. ALTERNATIVELY, GRAVEL BASE PER WSDOT STANDARD SPEC 9-03.10. MATERIAL TO BE COMPACTED TO 95% MAX DRY DENSITY.

E / C4 SUBSTATION SURFACING
Scale: N.T.S.

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REVISIONS:		
DATE	MARK	NOTE

TITLE: LIBERTY STREET SUBSTATION - CORNER OF LIBERTY STREET & LAURIDSEN BOULEVARD , PORT ANGELES, WA

SITE PLAN

CLIENT: CLALLAM COUNTY PUD #1
104 HOOKER ROAD
SEQUIM, WA 98382

SCALE: 1" = 30'

FILE: 23071 - E2

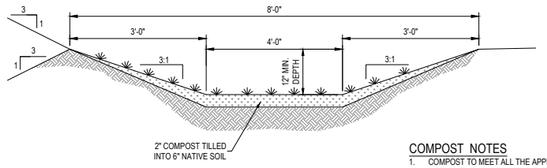
JOB NO: 23071

DATE: August 30, 2023

SET: PERMIT

SHEET

C4



COMPOST NOTES

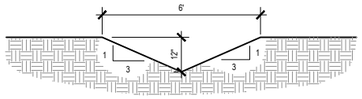
1. COMPOST TO MEET ALL THE APPLICABLE REQUIREMENTS OF BMP T7.40 (SWMMWW, 2019, ECY).

BIOFILTRATION NOTES

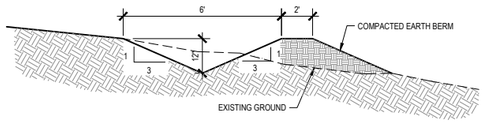
1. SEE PLAN FOR LONGITUDINAL SLOPE OF SWALE
2. HYDROSEED WITH A MIX OF 52% PERENNIAL RYE, 35% WINTER RYE, AND 13% CLOVER.
3. AVOID COMPACTION OF SOILS DURING CONSTRUCTION. IF COMPACTION OCCURS, TILL SOILS BEFORE HYDROSEEDING.

A / C5 BIO-FILTRATION SWALE – 4' WIDTH

Scale: NTS



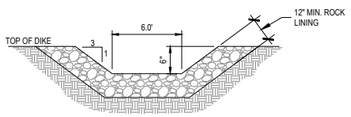
DRAINAGE DITCH



DRAINAGE DITCH W/ BERM

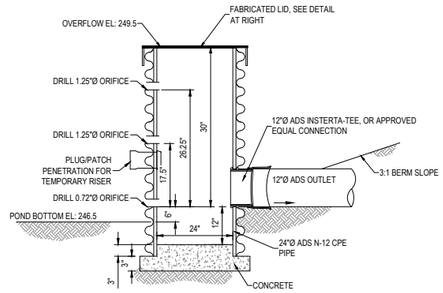
B / C5 DRAINAGE DITCH SECTIONS

Scale: NTS



C / C5 POND OVERFLOW SECTION

Scale: NTS

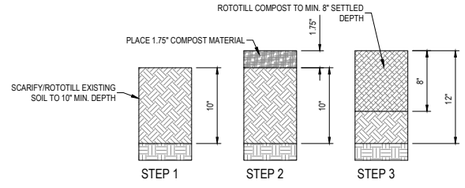


D / C5 POND RISER DETAIL

Scale: NTS

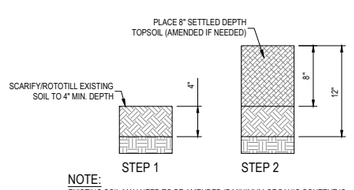
METHOD 1

AMENDING EXISTING TOPSOIL OR SUBSOIL IN TURF AREAS



METHOD 2

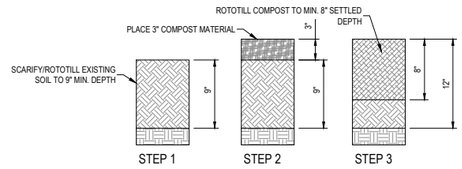
REPLACING STRIPPED TOPSOIL IN TURF AND PLANTING AREAS



NOTE:
EXISTING SOIL MAY NEED TO BE AMENDED IF MINIMUM ORGANIC CONTENT IS INSUFFICIENT OR THERE IS INSUFFICIENT MATERIAL TO MEET THE REQUIRED DEPTHS.

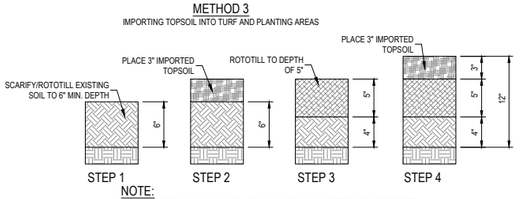
METHOD 1

AMENDING EXISTING TOPSOIL OR SUBSOIL IN PLANTING AREAS



METHOD 3

IMPORTING TOPSOIL INTO TURF AND PLANTING AREAS



NOTE:
IMPORTED TOPSOIL SHALL HAVE A MINIMUM ORGANIC CONTENT OF 5% FOR TURF AREAS AND 10% FOR PLANTING AREAS. ADDITIONALLY, THE SOIL SHALL BE CLASSIFIED AS SAND OR SANDY LOAM AS DEFINED BY THE USDA.

COMPOST REQUIREMENTS:

COMPOST MUST:

1. MEET THE REQUIREMENTS OF "COMPOSTED MATERIAL" IN WAC 173-350-100 AND COMPLY WITH TESTING PARAMETERS AND OTHER STANDARDS IN WAC 173-350-220.
2. BE PRODUCED AT A COMPOSTING FACILITY THAT IS PERMITTED BY THE JURISDICTIONAL HEALTH AUTHORITY.
3. ORIGINATE FROM A MINIMUM OF 65% BY VOLUME FROM RECYCLED PLANT WASTE COMPRISED OF "YARD DEBRIS," "CROP RESIDUES," AND "BULKING AGENTS" AS DEFINED IN WAC 173-350-100. A MAXIMUM OF 35% BY VOLUME OF "POST-CONSUMER FOOD WASTE" AS DEFINED IN WAC 173-350-100 INCLUDING BIO-SOLIDS AND MANURE MAY BE SUBSTITUTED FOR RECYCLED PLANT WASTE.
4. HAVE NO VISIBLE FREE WATER OR HAVE NO DUST PRODUCED WHEN HANDLING THE MATERIAL.
5. BE TESTED WITH THE U.S. COMPOSTING COUNCIL "TEST METHOD FOR THE EXAMINATION OF COMPOST AND COMPOSTING" (TMECC) AS ESTABLISHED IN THE COMPOSTING COUNCIL'S "SEAL OF TESTING ASSURANCE" (STA) PROGRAM.
6. BE SCREENED TO THE FOLLOWING GRADATIONS FOR FINE COMPOST WHEN TESTED IN ACCORDANCE WITH TMECC TEST METHOD 02.02-B, "SAMPLE SIEVING FOR AGGREGATE SIZE CLASSIFICATION."
   - MIN. % PASSING 2": 100%
   - MIN. % PASSING 1": 99%
   - MIN. % PASSING ½": 90%
   - MIN. % PASSING ¼": 75%
7. HAVE pH BETWEEN 6.0 AND 8.5 (TMECC 04.11-A), AND "PHYSICAL CONTAMINANTS" (AS DEFINED IN WAC 173-350-100) CONTENT LESS THAN 1% BY WEIGHT (TMECC 03.08-A) TOTAL, NOT TO EXCEED 0.25% FILM PLASTIC BY DRY WEIGHT.
8. HAVE MINIMUM ORGANIC MATTER CONTENT OF 40% (TMECC 05.07-A "LOSS ON IGNITION").
9. HAVE SOLUBLE SALT CONTENT LESS THAN 4.0 dS/m (mmhos/cm)(TMMECC 04.10-A "ELECTRICAL CONDUCTIVITY, 1:5 SLURRY METHOD, MASS BASIS")
10. HAVE MATURITY INDICATORS GREATER THAN 80% FOR BOTH EMERGENCE AND VIGOR FROM A CUCUMBER BIOASSAY (TMECC 05.05-A "SEEDLING EMERGENCE AND RELATIVE GROWTH").
11. HAVE STABILITY OF 7 mg CO2-C/g OM/DAY OR BELOW (TMECC 05.08-B "CARBON DIOXIDE EVOLUTION RATE").
12. HAVE A CARBON TO NITROGEN (C:N) OF LESS THAN 25:1 (TMECC 05.02A "CARBON TO NITROGEN RATIO" WHICH USES 04.01 "ORGANIC CARBON" AND 04.02D "TOTAL NITROGEN BY OXIDATION"). THE C:N RATIO MAY BE UP TO 35:1 FOR PLANTINGS COMPOSED ENTIRELY OF PUGET SOUND LOWLAND NATIVE SPECIES.

GENERAL NOTES:

1. TOPSOIL LAYER SHALL HAVE A MINIMUM DEPTH OF 8 INCHES EXCEPT WHERE TREE ROOTS LIMIT THE DEPTH OF TOPSOIL AMENDMENT INCORPORATION.
2. SUBSOILS SHALL BE SCARIFIED TO A MINIMUM DEPTH OF 4 INCHES TO ACHIEVE A TOTAL "LOOSE" DEPTH OF 12 INCHES
3. TOPSOIL SHALL HAVE A MINIMUM ORGANIC CONTENT OF 10% DRY WEIGHT IN PLANTING BEDS, AND MINIMUM 5% ORGANIC MATTER IN TURF AREAS, AND A pH FROM 6.0 TO 8.0 OR MATCHING THE pH OF THE UNDISTURBED SOIL.
4. PLANTING BEDS ARE TO BE MULCHED WITH 2 INCHES OF ORGANIC MATERIAL.
5. "PRE-APPROVED" SOIL AMENDMENT RATES ARE AS FOLLOWS:
   - TURF AREAS: 1.75" COMPOST PER 6.25" EXISTING SOIL
   - PLANTING AREAS: 3" COMPOST PER 5" EXISTING SOIL
6. PROJECT PROPONENT MAY UTILIZE A CALCULATED AMENDMENT RATE IF THEY CAN DEMONSTRATE THAT THE AMENDED TOPSOIL WILL MEET THE MINIMUM ORGANIC CONTENTS LISTED ABOVE.
7. TURF AREAS SHALL BE WATER OR ROLL COMPACTED TO 85% MAXIMUM DRY DENSITY
8. RAKE SMOOTH AND REMOVE WOODY DEBRIS AND ROCKS LARGER THAN 1" IN DIAMETER (2" FOR PLANTING AREAS).

SUBMITTALS:

CONTRACTOR/OWNER SHALL PROVIDE THE FOLLOWING INFORMATION TO THE CITY OF PORT ANGELES PUBLIC WORKS DEPARTMENT:

1. **CITY OF PORT ANGELES WORKSHEET D.**
2. **TRUCK TICKETS DETAILING SOURCE AND QUANTITY OF IMPORTED COMPOST OR TOPSOIL MATERIAL.**
3. **SOIL TEST REPORTS IF NOT USING PRE-APPROVED MATERIALS. IF USING EXISTING TOPSOIL (METHOD 2), EXISTING TOPSOIL MUST BE TESTED TO ENSURE COMPLIANCE WITH THE MINIMUM ORGANIC CONTENT ABOVE.**

E / C5 BMP T5.13 – POST CONSTRUCTION QUALITY AND DEPTH

Scale: NTS

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EMAIL: ZENOVIC@ZENOVIC.NET

REVISIONS:		
DATE	MARK	NOTE

TITLE: LIBERTY STREET SUBSTATION - CORNER OF LIBERTY STREET & LAURIDSEN BOULEVARD , PORT ANGELES, WA

DRAINAGE DETAILS

CLIENT: CLALLAM COUNTY PUD #1
104 HOOKER ROAD
SEQUIM, WA 98382

SCALE: NTS

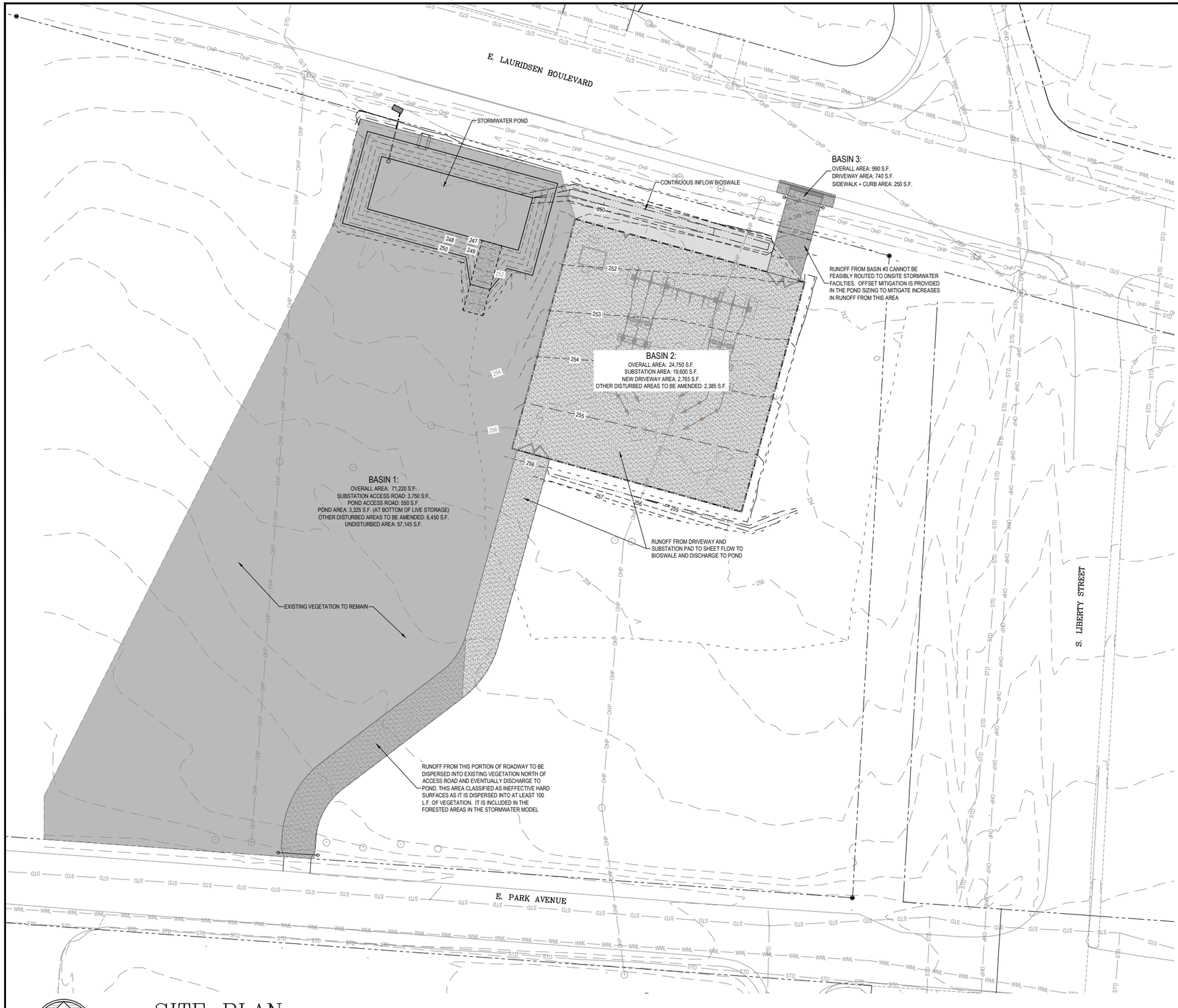
FILE: 23071 - E2

JOB NO: 23071

DATE: August 30, 2023

SET: PERMIT

SHEET C5



SITE PLAN

Scale: 1" = 30'

0 30' 60' 90'

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PORT ANGELES, WA 98362
PHONE: (360) 417-0501
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REVISIONS:

DATE	MARK	NOTE

TITLE: LIBERTY STREET SUBSTATION - CORNER OF LIBERTY STREET & LAURIDSEN BOULEVARD, PORT ANGELES, WA

BASIN MAP

CLIENT:
CLALLAM COUNTY PUD #1
104 HOOKER ROAD
SEQUIM, WA 98382

SCALE: 1" = 30'

FILE: 23071 - E2

JOB NO: 23071

DATE: August 30, 2023

SET: PERMIT

SHEET

C6

APPENDIX B
CONSTRUCTION STORMWATER BMPS

BMP C105: Stabilized Construction Access

Purpose

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

Conditions of Use

Construction accesses 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 subdivision construction sites, provide a stabilized construction access 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 and configuration.

On large commercial, highway, and road projects, the designer should include enough extra materials in the contract to allow for additional stabilized accesses 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 II-3.1: Stabilized Construction Access for details. Note: the 100’ minimum length of the access 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 accesses 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 access stabilization because these products raise pH levels in stormwater and concrete discharge to 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 standards listed in Table II-3.2: Stabilized Construction Access Geotextile Standards.

Table II-3.2: Stabilized Construction Access Geotextile Standards

Geotextile Property	Required Value
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 be paved; this can be used as a stabilized access. Also consider the installation of excess concrete as a stabilized access. During large concrete pours, excess concrete is often available for this purpose.
- Fencing (see BMP C103: High-Visibility Fence) shall be installed as necessary to restrict traffic to the construction access.
- Whenever possible, the access shall be constructed on a firm, compacted subgrade. This can substantially increase the effectiveness of the pad and reduce the need for maintenance.
- Construction accesses should avoid crossing existing sidewalks and back of walk drains if at all possible. If a construction access 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.

Alternative Material Specification

WSDOT has raised safety concerns about the Quarry Spall rock specified above. WSDOT observes that the 4-inch to 8-inch rock sizes can become trapped between Dually truck tires, and then released off-site at highway speeds. WSDOT has chosen to use a modified specification for the rock while continuously verifying that the Stabilized Construction Access remains effective. To remain effective, the BMP must prevent sediment from migrating off site. To date, there has been no performance testing to verify operation of this new specification. Jurisdictions may use the alternative specification, but must perform increased off-site inspection if they use, or allow others to use, it.

Stabilized Construction Accesses may use material that meets the requirements of WSDOT's *Standard Specifications for Road, Bridge, and Municipal Construction* Section 9-03.9(1) (WSDOT, 2016) for ballast except for the following special requirements.

The grading and quality requirements are listed in Table II-3.3: Stabilized Construction Access Alternative Material Requirements.

Table II-3.3: Stabilized Construction Access Alternative Material Requirements

Sieve Size	Percent Passing
2½″	99-100
2″	65-100
¾″	40-80
No. 4	5 max.
No. 100	0-2
% Fracture	75 min.

- All percentages are by weight.
- The sand equivalent value and dust ratio requirements do not apply.

- The fracture requirement shall be at least one fractured face and will apply the combined aggregate retained on the No. 4 sieve in accordance with FOP for AASHTO T 335.

Maintenance Standards

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

- If the access 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 access, or the installation of BMP C106: 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 access(es), BMP C103: High-Visibility Fence 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 II-3.1: Stabilized Construction Access

pdf download

Approved as Functionally Equivalent

Ecology has approved products as able to meet the requirements of this BMP. The products did not pass through the Technology Assessment Protocol – Ecology (TAPE) process. Local jurisdictions may choose not to accept these products, or may require additional testing prior to consideration for local use. Products that Ecology has approved as functionally equivalent are available for review on Ecology's website at:

https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Stormwater-permittee-guidance-resources/Emerging-stormwater-treatment-technologies

BMP C107: Construction Road / Parking Area Stabilization

Purpose

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

Conditions of Use

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

BMP C103: High-Visibility Fence 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 BMP C252: Treating and Disposing of High pH Water is 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 drainage system (see BMP C220: Inlet Protection).

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 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. See BMP T5.13: Post-Construction Soil Quality and Depth.

Design and Installation Specifications

General

- 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 the top of 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 top of 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. See BMP T5.13: Post-Construction Soil Quality and Depth.

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

  Or, enhance vegetation by:
    - Installing the mulch, seed, fertilizer, and tackifier in one lift.
    - Spread or blow straw over the top of the hydromulch at a rate of 800-1000 pounds per acre.
    - 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 Bonded Fiber Matrix/ Mechanically Bonded Fiber Matrix (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 Table II-3.4: Temporary and Permanent Seed Mixes include recommended mixes for both temporary and permanent seeding.
- Apply these mixes, with the exception of the wet area seed mix, at a rate of 120 pounds per acre. This rate can be reduced if soil amendments or slow-release fertilizers are used. Apply the wet area seed mix at a rate of 60 pounds per acre.
- Consult the local suppliers or the local conservation district for their recommendations. 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, depending on the soil type and hydrology of the area.

Table II-3.4: Temporary and Permanent Seed Mixes

Common Name	Latin Name	% Weight	% Purity	% Germination
Temporary Erosion Control Seed Mix A standard mix for areas requiring a temporary vegetative cover.				
Chewings or annual blue grass	*Festuca rubra var. commutata* or *Poa anna*	40	98	90

Common Name	Latin Name	% Weight	% Purity	% Germination
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
Landscaping Seed Mix A recommended mix for landscaping seed.				
Perennial rye blend	*Lolium perenne*	70	98	90
Chewings and red fescue blend	*Festuca rubra var. commutata* or *Festuca rubra*	30	98	90
Low-Growing Turf Seed Mix A turf seed mix for dry situations where there is no need for watering. This mix requires very little maintenance.				
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
Bioswale Seed Mix A seed mix for bioswales and other intermittently wet areas.				
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
Wet Area Seed Mix A low-growing, relatively non-invasive seed mix appropriate for very wet areas that are not regulated wetlands. Consult Hydraulic Permit Authority (HPA) for seed mixes if applicable.				
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
Meadow Seed Mix 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.				
Redtop or Oregon bentgrass	*Agrostis alba* or *Agrostis oregonensis*	20	92	85

Common Name	Latin Name	% Weight	% Purity	% Germination
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 with approximately 10 percent tackifier. Achieve a minimum of 95 percent soil coverage during application. Numerous products are available commercially. 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.
- Install products per manufacturer's instructions.
- 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 75 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, nets, or blankets.

- 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 Functionally Equivalent

Ecology has approved products as able to meet the requirements of this BMP. The products did not pass through the Technology Assessment Protocol – Ecology (TAPE) process. Local jurisdictions may choose not to accept these products, or may require additional testing prior to consideration for local use. Products that Ecology has approved as functionally equivalent are available for review on Ecology's website at:

https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Stormwater-permittee-guidance-resources/Emerging-stormwater-treatment-technologies

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 are a 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, or 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.

Generally, mulches come in 40-50 pound bags. Seed and fertilizer are added at time of application.

Recycled cellulose may contain polychlorinated biphenyl (PCBs). Ecology recommends that products should be evaluated for PCBs prior to use.

Refer to BMP C126: Polyacrylamide (PAM) for Soil Erosion Protection for conditions of use. PAM shall not be directly applied to water or allowed to enter a water body.

Any mulch or tackifier product used shall be installed per the manufacturer's instructions.

Design and Installation Specifications

For mulch materials, application rates, and specifications, see Table II-3.6: Mulch Standards and Guidelines. Consult with the local supplier or the local conservation district for their recommendations. Increase the application rate 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.

Where the option of “Compost” is selected, it should be a coarse compost that meets the size gradations listed in Table II-3.5: Size Gradations of Compost as Mulch Material when tested in accordance with Test Method 02.02-B found in *Test Methods for the Examination of Composting and Compost* (Thompson, 2001).

Table II-3.5: Size Gradations of Compost as Mulch Material

Sieve Size	Percent Passing
3"	100%
1"	90% - 100%
3/4"	70% - 100%
1/4"	40% - 100%

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 the Hydraulic Permit Authority (HPA) for mulch mixes if applicable.

Maintenance Standards

The thickness of the mulch 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 II-3.6: Mulch Standards and Guidelines

Mulch Material	Guideline	Description
Straw	**Quality Standards**	Air-dried; free from undesirable seed and coarse material.
	Application Rates	2"-3" thick; 5 bales per 1,000 sf or 2-3 tons per acre
	Remarks	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	**Quality Standards**	No growth inhibiting factors.
	Application Rates	Approx. 35-45 lbs per 1,000 sf or 1,500 - 2,000 lbs per acre
	Remarks	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 3/4 - 1 inch clog hydromulch equipment. Fibers should be kept to less than 3/4 inch.

Mulch Material	Guideline	Description
Compost	Quality Standards	No visible water or dust during handling. Must be produced per WAC 173-350, Solid Waste Handling Standards, but may have up to 35% biosolids.
	Application Rates	2" thick min.; approx. 100 tons per acre (approx. 750 lbs per cubic yard)
	Remarks	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. Compost used for mulch has a coarser size gradation than compost used for BMP C125: Topsoiling / Composting or BMP T5.13: Post-Construction Soil Quality and Depth. It is more stable and practical to use in wet areas and during rainy weather conditions. Do not use near wetlands or near phosphorous impaired water bodies.
Chipped Site Vegetation	Quality Standards	Gradations from fines to 6 inches in length for texture, variation, and interlocking properties. Include a mix of various sizes so that the average size is between 2- and 4- inches.
	Application Rates	2" thick min.;
	Remarks	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 permanent seeding or planting is expected shortly after mulch, the decomposition of the chipped vegetation may tie up nutrients important to grass establishment. Note: thick application of this material over existing grass, herbaceous species, and some groundcovers could smother and kill vegetation.
Wood-Based Mulch	Quality Standards	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.
	Application Rates	2" thick min.; approx. 100 tons per acre (approx. 750 lbs. per cubic yard)
	Remarks	This material is often called "wood straw" or "hog 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	Quality Standards	A blend of loose, long, thin wood pieces derived from native conifer or deciduous trees with high length-to-width ratio.
	Application Rates	2" thick min.
	Remarks	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 1/2-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. [Specification 9-14.4(4) from the *Standard Specifications for Road, Bridge, and Municipal Construction* (WSDOT, 2016)

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. However, the relatively rapid breakdown of most polyethylene sheeting makes it unsuitable for applications greater than six months.
- 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.
- Although the plastic material is inexpensive to purchase, the cost of installation, maintenance, removal, and disposal add to the total costs of this BMP.
- 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 convey 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:
    - Temporary ditch liner.
    - Pond liner in temporary sediment pond.
    - Liner for bermed temporary fuel storage area if plastic is not reactive to the type of fuel being stored.
    - Emergency slope protection during heavy rains.
    - 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 the slope, not across the slope.
    2. Plastic may be installed perpendicular to a slope if the slope length is less than 10 feet.
    3. Provide a minimum of 8-inch overlap at the 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 Functionally Equivalent

Ecology has approved products as able to meet the requirements of this BMP. The products did not pass through the Technology Assessment Protocol – Ecology (TAPE) process. Local jurisdictions may choose not to accept these products, or may require additional testing prior to consideration for local use. Products that Ecology has approved as functionally equivalent are available for review on Ecology's website at:

https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Stormwater-permittee-guidance-resources/Emerging-stormwater-treatment-technologies

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 rains. Having these materials on-site reduces the time needed to replace existing or implement new 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 should be stockpiled and readily available before any site clearing, grubbing, or earthwork begins. A large contractor or project proponent 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:

- 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 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 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 project components include, but are not limited to:

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

Disposal options for concrete, in order of preference are:

1. Off-site disposal
2. Concrete wash-out areas (see BMP C154: Concrete Washout Area)
3. De minimus washout to formed areas awaiting concrete

Design and Installation Specifications

- Wash concrete truck drums at an approved off-site location or in designated concrete washout areas only. Do not wash out concrete trucks onto the ground (including formed areas awaiting concrete), or into storm drains, open ditches, streets, or streams. Refer to BMP C154: Concrete Washout Area 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 as allowed in BMP C154: Concrete Washout Area.
- Wash small concrete handling equipment (e.g. hand tools, screeds, shovels, rakes, floats, trowels, and wheelbarrows) into designated concrete washout areas or into formed areas awaiting concrete pour.
- At no time shall concrete be washed off into the footprint of an area where an infiltration feature will be installed.

- Wash equipment difficult to move, such as concrete paving machines, in areas that do not directly drain to natural or constructed stormwater conveyance or potential infiltration areas.
- Do not allow washwater from areas, such as concrete aggregate driveways, to drain directly (without detention or treatment) to natural or constructed stormwater conveyances.
- Contain washwater and leftover product in a lined container when no designated concrete washout areas (or formed areas, allowed as described above) are available. Dispose of contained concrete and concrete washwater (process water) properly.
- Always use forms or solid barriers for concrete pours, such as pilings, within 15-feet of surface waters.
- Refer to BMP C252: Treating and Disposing of High pH Water for pH adjustment requirements.
- Refer to the Construction Stormwater General Permit (CSWGP) for pH monitoring requirements if the project involves one of the following activities:
    - Significant concrete work (as defined in the CSWGP).
    - The use of 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 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:

- 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 of process water in a manner that does not violate ground water or surface water quality standards.
- Handle and dispose of 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/or 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

Use at 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 temporary storage area should be located away from vehicular traffic, near the construction entrance(s), and away from waterways or storm drains.
- Safety Data Sheets (SDS) 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 an 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, 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.

- 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.
- 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

Maintenance Standards

- 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.
- Re-stock spill kit materials as needed.

BMP C154: Concrete Washout Area

Purpose

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

Conditions of Use

Concrete washout areas 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 truck drums are washed on-site.

  Note that auxiliary concrete truck components (e.g. chutes and hoses) and small concrete handling equipment (e.g. hand tools, screeds, shovels, rakes, floats, trowels, and wheelbarrows) may be washed into formed areas awaiting concrete pour.

At no time shall concrete be washed off into the footprint of an area where an infiltration feature will be installed.

Design and Installation Specifications

Implementation

- Perform washout of concrete truck drums at an approved off-site location or in designated concrete washout areas only.
- Do not wash out concrete onto non-formed areas, or into storm drains, open ditches, streets, or streams.
- Wash equipment difficult to move, such as concrete paving machines, in areas that do not directly drain to natural or constructed stormwater conveyance or potential infiltration areas.
- Do not allow excess concrete to be dumped on-site, except in designated concrete washout areas as allowed above.
- 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.
- Concrete washout areas shall be constructed and maintained in sufficient quantity and size to contain all liquid and concrete waste generated by washout operations.

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

Concrete Truck Washout Procedures

- Washout of concrete truck drums shall be performed in designated concrete washout areas only.
- Concrete washout from concrete pumper bins can be washed into concrete pumper trucks and discharged into designated concrete washout areas or properly disposed of off-site.

Concrete Washout Area Installation

- Concrete washout areas should be constructed as shown in the figures 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.
- Lath and flagging should be commercial type.
- 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 areas are in place prior to the commencement of concrete work.
- Once concrete wastes are washed into the designated washout 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.
- During periods of concrete work, inspect the concrete washout areas daily to verify continued performance.
    - Check overall condition and performance.
    - Check remaining capacity (% full).
    - If using self-installed concrete washout areas, verify plastic liners are intact and sidewalls are not damaged.
    - If using prefabricated containers, check for leaks.
- Maintain the concrete washout areas to provide adequate holding capacity with a minimum freeboard of 12 inches.
- Concrete washout areas must be cleaned, or new concrete washout areas must be constructed and ready for use once the concrete washout area is 75% full.
- If the concrete washout area 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 discharge to the sanitary sewer without local approval.
    - Place a secure, non-collapsing, non-water collecting cover over the concrete washout area 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 a self-installed concrete washout area, 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 Concrete Washout Areas

- When concrete washout areas are no longer required for the work, the hardened concrete, slurries and liquids shall be removed and properly disposed of.
- Materials used to construct concrete washout areas 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 concrete washout areas shall be backfilled, repaired, and stabilized to prevent erosion.

Figure II-3.7: Concrete Washout Area with Wood Planks

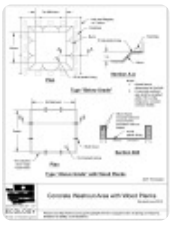

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Figure II-3.8: Concrete Washout Area with Straw Bales

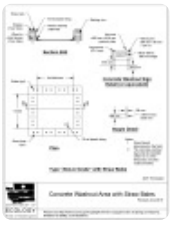

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Figure II-3.9: Prefabricated Concrete Washout Container w/Ramp

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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 ground cover leaves a site vulnerable to erosion. Construction sequencing that limits land clearing, provides timely installation of erosion and sedimentation controls, and restores 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.

BMP C207: Check Dams

Purpose

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

Conditions of Use

Use check dams where temporary 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.

Design and Installation Specifications

- 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 (do not dump the rock to form the 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 check dam should form a triangle when viewed from the side. This prevents undercutting as water flows over the face of the check 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 combined with sumps work more effectively at slowing flow and retaining sediment than 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 check dams shall be such that the downstream 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 check 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.
- See Figure II-3.16: Rock Check Dam.

Maintenance Standards

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

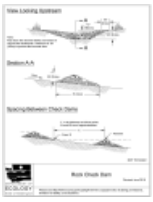
- Anticipate submergence and deposition above the check dam and erosion from high flows around the edges of the dam.
- If significant erosion occurs between dams, install a protective riprap liner in that portion of the channel. See BMP C202: Riprap Channel Lining.

Approved as Functionally Equivalent

Ecology has approved products as able to meet the requirements of this BMP. The products did not pass through the Technology Assessment Protocol – Ecology (TAPE) process. Local jurisdictions may choose not to accept these products, or may require additional testing prior to consideration for local use. Products that Ecology has approved as functionally equivalent are available for review on Ecology's website at:

https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Stormwater-permittee-guidance-resources/Emerging-stormwater-treatment-technologies

Figure II-3.16: Rock Check Dam



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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

Use outlet protection at the outlets of all ponds, pipes, ditches, or other conveyances that discharge 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 pipe shall be protected from erosion by 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 pipes larger than 18 inches in diameter, the outlet protection lining of the channel shall be four times the diameter of the outlet pipe.
- Standard wingwalls, tapered outlets, and paved channels should also be considered when appropriate for permanent culvert outlet protection (WSDOT, 2015).
- BMP C122: Nets and Blankets or BMP C202: Riprap Channel Lining provide suitable options for lining materials.
- With low flows, BMP C201: Grass-Lined Channels can be an effective alternative for lining material.
- The following guidelines shall be used for outlet protection with riprap:
    - If the discharge velocity at the outlet is less than 5 fps, use 2-inch to 8-inch riprap. Minimum thickness is 1-foot.
    - For 5 to 10 fps discharge velocity at the outlet, use 24-inch to 48-inch riprap. Minimum thickness is 2 feet.
    - For outlets at the base of steep slope pipes (pipe slope greater than 10 percent), use an engineered energy dissipator.
    - Filter fabric or erosion control blankets should always be used under riprap to prevent scour and channel erosion. See BMP C122: Nets and Blankets.
- Bank stabilization, bioengineering, and habitat features may be required for disturbed areas. This work may require a Hydraulic Project Approval (HPA) from the Washington State Department of Fish and Wildlife. See I-2.11 Hydraulic Project Approvals.

Maintenance Standards

- Inspect and repair as needed.
- Add rock as needed to maintain the intended function.

- Clean energy dissipator if sediment builds up.

BMP C220: Inlet Protection

Purpose

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

Conditions of Use

Use inlet protection at inlets that are operational before permanent stabilization of the disturbed areas that contribute runoff to the inlet. Provide protection for all storm drain inlets downslope and within 500 feet of a disturbed or construction area, unless those inlets are preceded by a sediment trapping BMP.

Also consider inlet protection for lawn and yard drains on new home construction. These small and numerous drains coupled with lack of gutters 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 II-3.10: Storm Drain Inlet Protection lists several options for inlet protection. All of the methods for inlet protection tend to plug and require a high frequency of maintenance. Limit contributing drainage areas for an individual inlet to one acre or less. If possible, provide emergency overflows with additional end-of-pipe treatment where stormwater ponding would cause a hazard.

Table II-3.10: 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 may occur	Earthen	Applicable for heavy flows. Easy to maintain. Large area requirement: 30'x30'/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	Paved or Earthen	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 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			

Type of Inlet Protection	Emergency Overflow	Applicable for Paved/ Earthen Surfaces	Conditions of Use
Culvert inlet sediment trap	N/A	N/A	18 month expected life.

Design and Installation Specifications

Excavated Drop Inlet Protection

Excavated drop inlet protection consists of an excavated impoundment around the storm drain inlet. Sediment settles out of the stormwater prior to entering the storm drain. Design and installation specifications for excavated drop inlet protection include:

- Provide a depth of 1-2 ft as measured from the crest of the inlet structure.
- Slope sides of excavation should be no steeper than 2H:1V.
- Minimum volume of excavation is 35 cubic yards.
- Shape the excavation to fit the site, with the longest dimension oriented toward the longest inflow area.
- Install provisions for draining to prevent standing water.
- 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.

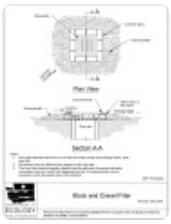
Block and Gravel Filter

A block and gravel filter is a barrier formed around the inlet with standard concrete blocks and gravel. See Figure II-3.17: Block and Gravel Filter. Design and installation specifications for block gravel filters include:

- Provide a height of 1 to 2 feet above the inlet.
- Recess the first row of blocks 2-inches into the ground for stability.
- Support subsequent courses by placing a pressure treated wood 2x4 through the block opening.
- Do not use mortar.
- Lay some blocks in the bottom row on their side to allow for dewatering the pool.
- Place hardware cloth or comparable wire mesh with ½-inch openings over all block openings.
- Place gravel to just below the top of blocks on slopes of 2H:1V or flatter.

- An alternative design is a gravel berm surrounding the inlet, as follows:
    - Provide a slope of 3H:1V on the upstream side of the berm.
    - Provide a slope of 2H:1V on the downstream side of the berm.
    - Provide a 1-foot wide level stone area between the gravel berm and the inlet.
    - Use stones 3 inches in diameter or larger on the upstream slope of the berm.
    - Use gravel ½- to ¾-inch at a minimum thickness of 1-foot on the downstream slope of the berm.

Figure II-3.17: Block and Gravel Filter



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Gravel and Wire Mesh Filter

Gravel and wire mesh filters are gravel barriers placed over the top of the inlet. This method does not provide an overflow. Design and installation specifications for gravel and wire mesh filters include:

- Use a hardware cloth or comparable wire mesh with ½-inch openings.
    - 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 aggregate over the entire inlet opening and extend at least 18-inches on all sides.

Catch Basin Filters

Catch basin filters are 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 catch basin 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. Design and installation specifications for catch basin filters include:

- 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 catch basin filter in the catch basin just below the grating.

Curb Inlet Protection with Wooden Weir

Curb inlet protection with wooden weir is an option that consists of a barrier formed around a curb inlet with a wooden frame and gravel. Design and installation specifications for curb inlet protection with wooden weirs include:

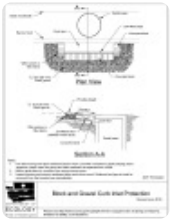
- Use wire mesh with ½-inch openings.
- Use extra strength filter cloth.
- Construct a frame.
- Attach the wire and filter fabric to the frame.
- Pile coarse washed aggregate against the wire and fabric.
- Place weight on the frame anchors.

Block and Gravel Curb Inlet Protection

Block and gravel curb inlet protection is a barrier formed around a curb inlet with concrete blocks and gravel. See Figure II-3.18: Block and Gravel Curb Inlet Protection. Design and installation specifications for block and gravel curb inlet protection include:

- 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.

Figure II-3.18: Block and Gravel Curb Inlet Protection



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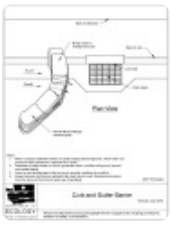
Curb and Gutter Sediment Barrier

Curb and gutter sediment barrier is a sandbag or rock berm (riprap and aggregate) 3 feet high and 3 feet wide in a horseshoe shape. See Figure II-3.19: Curb and Gutter Barrier. Design and installation specifications for curb and gutter sediment barrier include:

- 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 upstream side of the berm. Size the trap to sediment trap standards for protecting a culvert inlet.

Figure II-3.19: Curb and Gutter Barrier



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Maintenance Standards

- Inspect all forms of inlet protection frequently, especially after storm events. Clean and replace clogged catch basin filters. For rock and gravel filters, pull away the rocks from the inlet and clean or replace. An alternative approach would be to use the clogged rock as fill and put fresh rock 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 Functionally Equivalent

Ecology has approved products as able to meet the requirements of this BMP. The products did not pass through the Technology Assessment Protocol – Ecology (TAPE) process. Local jurisdictions may choose not to accept these products, or may require additional testing prior to consideration for local use. Products that Ecology has approved as functionally equivalent are available for review on Ecology's website at:

https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Stormwater-permittee-guidance-resources/Emerging-stormwater-treatment-technologies

BMP C233: Silt Fence

Purpose

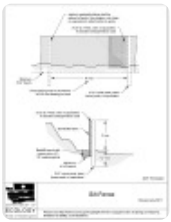
Silt fence reduces the transport of coarse sediment from a construction site by providing a temporary physical barrier to sediment and reducing the runoff velocities of overland flow.

Conditions of Use

Silt fence may be used downslope of all disturbed areas.

- Silt fence shall prevent sediment carried by runoff 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 trapping BMP.
- 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 II-3.22: Silt Fence



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Design and Installation Specifications

- Use in combination with other construction stormwater BMPs.
- Maximum slope steepness (perpendicular to the silt fence line) 1H:1V.
- Maximum sheet or overland flow path length to the silt fence of 100 feet.
- Do not allow flows greater than 0.5 cfs.
- Use geotextile fabric that meets 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 II-3.11: Geotextile Fabric Standards for Silt Fence):

Table II-3.11: Geotextile Fabric Standards for Silt Fence

Geotextile Property	Minimum Average Roll Value

Geotextile Property	Minimum Average Roll Value
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 geotextiles with wire mesh, chicken wire, 2-inch x 2-inch wire, safety fence, or jute mesh to increase the strength of the geotextile. Silt fence materials are available that have synthetic mesh backing attached.
- Silt fence 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 the local jurisdiction.
- Refer to Figure II-3.22: Silt Fence 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 geotextile fabric shall be sewn together at the point of manufacture to form fabric lengths as required. Locate all sewn seams at support posts. Alternatively, two sections of silt fence can be overlapped, provided that the overlap is long enough and that the adjacent silt fence sections are close enough together to prevent silt laden water from escaping through the fence at the overlap.
    5. Attach the geotextile fabric on the up-slope side of the posts and secure with staples, wire, or in accordance with the manufacturer's recommendations. Attach the geotextile fabric to the posts in a manner that reduces the potential for tearing.
    6. Support the geotextile 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 geotextile 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 geotextile fabric it supports.

8. Bury the bottom of the geotextile fabric 4-inches min. below the ground surface. Backfill and tamp soil in place over the buried portion of the geotextile fabric, so that no flow can pass beneath the silt 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 silt 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 minimum dimensions of 2 inches by 2 inches by 3 feet. Wood 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 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.

    - Check dams shall be approximately 1-foot deep at the back of the fence. 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.
    - Check dams shall consist of crushed surfacing base course, gravel backfill for walls, or shoulder ballast. Check dams shall be located every 10 feet along the fence where the fence must cross contours.

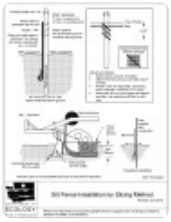
- Refer to Figure II-3.23: Silt Fence Installation by Slicing Method for slicing method details. The following are specifications for silt fence installation using the slicing method:

    1. The base of both end posts must be at least 2- to 4-inches above the top of the geotextile 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 geotextile fabric, enabling posts to support the geotextile fabric from upstream water pressure.
4. Install posts with the nipples facing away from the geotextile fabric.
5. Attach the geotextile fabric to each post with three ties, all spaced within the top 8-inches of the fabric. Attach each tie diagonally 45 degrees through the 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 the geotextile fabric around the end posts and secure with 3 ties.
7. No more than 24-inches of a 36-inch geotextile fabric is allowed above ground level.
8. Compact the soil immediately next to the geotextile 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 the fabric deeper into the ground if necessary.

Figure II-3.23: Silt Fence Installation by Slicing Method



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Maintenance Standards

- Repair any damage immediately.
- Intercept and convey all evident concentrated flows uphill of the silt fence to a sediment trapping BMP.
- Check the uphill side of the silt 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 and 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 geotextile fabric that has deteriorated due to ultraviolet breakdown.

BMP C241: Sediment Pond (Temporary)

Purpose

Sediment ponds are temporary ponds used during construction to remove sediment from runoff originating from disturbed areas of the project site. Sediment ponds are typically designed to remove sediment no smaller than medium silt (0.02 mm). Consequently, they usually reduce turbidity only slightly.

Conditions of Use

- Use a sediment pond where the contributing drainage area to the pond is 3 acres or more. Ponds must be used in conjunction with other Construction Stormwater BMPs to reduce the amount of sediment flowing into the pond.
- Do not install sediment ponds on sites where failure of the BMP would result in loss of life, damage to homes or buildings, or interruption of use or service of public roads or utilities. Also, sediment ponds are attractive to children and can be dangerous. Compliance with local ordinances regarding health and safety must be addressed. If fencing of the pond is required, show the type of fence and its location on the drawings in the Construction SWPPP.
- Sediment ponds that can impound 10 acre-ft (435,600 cu-ft, or 3.26 million gallons) or more, or have an embankment of more than 6 feet, are subject to the Washington Dam Safety Regulations (Chapter 173-175 WAC). See BMP D.1: Detention Ponds for more information regarding dam safety considerations for detention ponds.
- Projects that are constructing permanent Flow Control BMPs or Runoff Treatment BMPs that use ponding for treatment may use the rough-graded or final-graded permanent BMP footprint for the temporary sediment pond. When permanent BMP footprints are used as temporary sediment ponds, the surface area requirement of the temporary sediment pond must be met. If the surface area requirement of the sediment pond is larger than the surface area of the permanent BMP, then the sediment pond shall be enlarged beyond the permanent BMP footprint to comply with the surface area requirement.

  The permanent control structure must be temporarily replaced with a control structure that only allows water to leave the temporary sediment pond from the surface or by pumping. Alternatively, the permanent control structure may used if it is temporarily modified by plugging any outlet holes below the riser. The permanent control structure must be installed as part of the permanent BMP after the site is fully stabilized.

Design and Installation Specifications

General

- See Figure II-3.28: Sediment Pond Plan View, Figure II-3.29: Sediment Pond Cross Section, and Figure II-3.30: Sediment Pond Riser Detail for details.
- Use of permanent infiltration BMP footprints for temporary sediment ponds during construction tends to clog the soils and reduce their capacity to infiltrate. If permanent infiltration BMP footprints are used, the sides and bottom of the temporary sediment pond must only be rough excavated to a minimum of 2 feet above final grade of the permanent infiltration BMP. Final grading of the permanent infiltration BMP shall occur only when all contributing drainage areas are fully stabilized. Any proposed permanent pretreatment BMP prior to the infiltration BMP should be fully constructed and

used with the temporary sediment pond to help prevent clogging of the soils. See Element 13: Protect Low Impact Development BMPs for more information about protecting permanent infiltration BMPs.

- The pond shall be divided into two roughly equal volume cells by a permeable divider that will reduce turbulence while allowing movement of water between the cells. The divider shall be at least one-half the height of the riser, and at least one foot below the top of the riser. Wire-backed, 2- to 3-foot high, high strength geotextile fabric supported by treated 4"x4"s can be used as a divider. Alternatively, staked straw bales wrapped with geotextile fabric may be used. If the pond is more than 6 feet deep, a different divider design must be proposed. A riprap embankment is one acceptable method of separation for deeper ponds. Other designs that satisfy the intent of this provision are allowed as long as the divider is permeable, structurally sound, and designed to prevent erosion under and around the divider.
- The most common structural failure of sediment ponds is caused by piping. Piping refers to two phenomena: (1) water seeping through fine-grained soil, eroding the soil grain by grain and forming pipes or tunnels; and, (2) water under pressure flowing upward through a granular soil with a head of sufficient magnitude to cause soil grains to lose contact and capability for support.

  The most critical construction practices to prevent piping are:

  - Tight connections between the riser and outlet pipe, and other pipe connections.
  - Adequate anchoring of the riser.
  - Proper soil compaction of the embankment and riser footing.
  - Proper construction of anti-seep devices.

Sediment Pond Geometry

To determine the sediment pond geometry, first calculate the design surface area (SA) of the pond, measured at the top of the riser pipe. Use the following equation:

$$SA = 2 \times Q_2/0.00096$$

or

2080 square feet per cfs of inflow

See BMP C240: Sediment Trap for more information on the above equation.

The basic geometry of the pond can now be determined using the following design criteria:

- Required surface area SA (from the equation above) at the top of the riser.
- Minimum 3.5-foot depth from the top of the riser to the bottom of the pond.
- Maximum 3H:1V interior side slopes and maximum 2H:1V exterior slopes. The interior slopes can be increased to a maximum of 2H:1V if fencing is provided at or above the maximum water surface.
- One foot of freeboard between the top of the riser and the crest of the emergency spillway.
- Flat bottom.
- Minimum 1-foot deep spillway.
- Length-to-width ratio between 3:1 and 6:1.

Sediment Pond Discharge

The outlet for the pond consists of a combination of principal and emergency spillways. These outlets must pass the peak runoff expected from the contributing drainage area for a 100-year storm. If, due to site conditions and basin geometry, a separate emergency spillway is not feasible, the principal spillway must pass the entire peak runoff expected from the 100-year storm. However, an attempt to provide a separate emergency spillway should always be made. Base the runoff calculations on the site conditions during construction. The flow through the dewatering orifice cannot be utilized when calculating the 100-year storm elevation because of its potential to become clogged; therefore, available spillway storage must begin at the principal spillway riser crest.

The principal spillway designed by the procedures described below will result in some reduction in the peak rate of runoff. However, the design will not control the discharge flow rates to the extent required to comply with I-3.4.7 MR7: Flow Control. The size of the contributing basin, the expected life of the construction project, the anticipated downstream effects, and the anticipated weather conditions during construction should be considered to determine the need for additional discharge control.

Principal Spillway: Determine the required diameter for the principal spillway (riser pipe). The diameter shall be the minimum necessary to pass the peak volumetric flow rate using a 15-minute time step from a Type 1A, 10-year, 24-hour frequency storm for the developed condition. Use Figure II-3.31: Riser Inflow Curves to determine the riser diameter.

To aid in determining sediment depth, one-foot intervals shall be prominently marked on the riser.

Emergency Overflow Spillway: Size the emergency overflow spillway for the peak volumetric flow rate using a 10-minute time step from a Type 1A, 100-year, 24-hour frequency storm for the developed condition. See BMP D.1: Detention Ponds for additional guidance for Emergency Overflow Spillway design

Dewatering Orifice: Size of the dewatering orifice(s) (minimum 1-inch diameter) using a modified version of the discharge equation for a vertical orifice and a basic equation for the area of a circular orifice. Determine the required area of the orifice with the following equation:

$$A_o = \frac{A_S(2h)^{0.5}}{0.6 \times 3600 T g^{0.5}}$$

where

A_O = orifice area (square feet)

A_S = pond surface area (square feet)

h = head of water above orifice (height of riser in feet)

T = dewatering time (24 hours)

g = acceleration of gravity (32.2 feet/second^2)

Convert the orifice area (in square feet) to the orifice diameter D (in inches):

$$D = 24 \times \sqrt{\frac{A_o}{\pi}} = 13.54 \times \sqrt{A_o}$$

The vertical, perforated tubing connected to the dewatering orifice must be at least 2 inches larger in diameter than the orifice to improve flow characteristics. The size and number of perforations in the tubing should be large enough so that the tubing does not restrict flow. The orifice should control the flow rate.

Figure II-3.28: Sediment Pond Plan View

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Figure II-3.29: Sediment Pond Cross Section

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Figure II-3.30: Sediment Pond Riser Detail

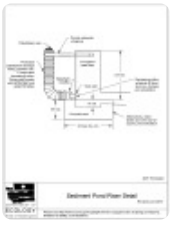

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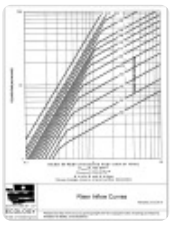
Figure II-3.31: Riser Inflow Curves



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Maintenance Standards

- Remove sediment from the pond when it reaches 1 foot in depth.
- Repair any damage to the pond embankments or slopes.

Construction BMP Standards and Specifications

Factsheet C

Introduction

Best Management Practices (BMPs) are defined as schedules of activities, prohibitions of practices, maintenance procedures, and structural and/or managerial practices, that when used singly or in combination, prevent or reduce the release of pollutants. This factsheet contains standards and specifications for temporary BMPs to be used as applicable during the construction phase of a project. Often using BMPs in combination is the best method to meet Construction Stormwater Pollution Prevention Plan (SWPPP) requirements. The purpose of this Factsheet is to comple all temporary construction BMP standards and details into one location. Select the specific BMPs you plan to use on your project and attached them to your SWPPP (Worksheet B).

This Factsheet contains design standards and specifications for the following BMPs:

Source Control BMPs

- BMP C101: Preserving Natural Vegetation
- BMP C102: Buffer Zones
- BMP C103: High Visibility 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 (PAM) 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

Runoff Conveyance and Treatment BMPs

- BMP C200: Interceptor Dike and Swale
- BMP C201: Grass-Lined Channels
- BMP C202: Channel Lining
- BMP C203: Water Bars
- BMP C204: Pipe Slope Drains
- BMP C205: Subsurface Drains
- BMP C206: Level Spreader
- BMP C207: Check Dams
- BMP C208: Triangular Silt Dike (TSD) (Geotextile-Encased Check Dam)
- BMP C209: Outlet Protection
- BMP C220: Storm Drain Inlet Protection
- BMP C231: Brush Barrier
- BMP C232: Gravel Filter Berm
- BMP C233: Silt Fence
- BMP C234: Vegetated Strip
- BMP C235: Wattles
- BMP C236: Vegetative Filtration
- BMP C240: Sediment Trap
- BMP C241: Temporary Sediment Pond
- BMP C250: Construction Stormwater Chemical Treatment
- BMP C251: Construction Stormwater Filtration
- BMP C252: High pH Neutralization Using CO2
- BMP C253: pH Control for High pH Water

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 loppers 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: Silt Fence 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 II-4.1.1 Stabilized Construction Entrance 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: High Visibility Fence) 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 II-4.1.1 Stabilized Construction Entrance

2014 Figure II-4.1.1 pdf download

Approved as Equivalent

Ecology has approved products as able to meet the requirements of BMP C105: Stabilized Construction Entrance / Exit. 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

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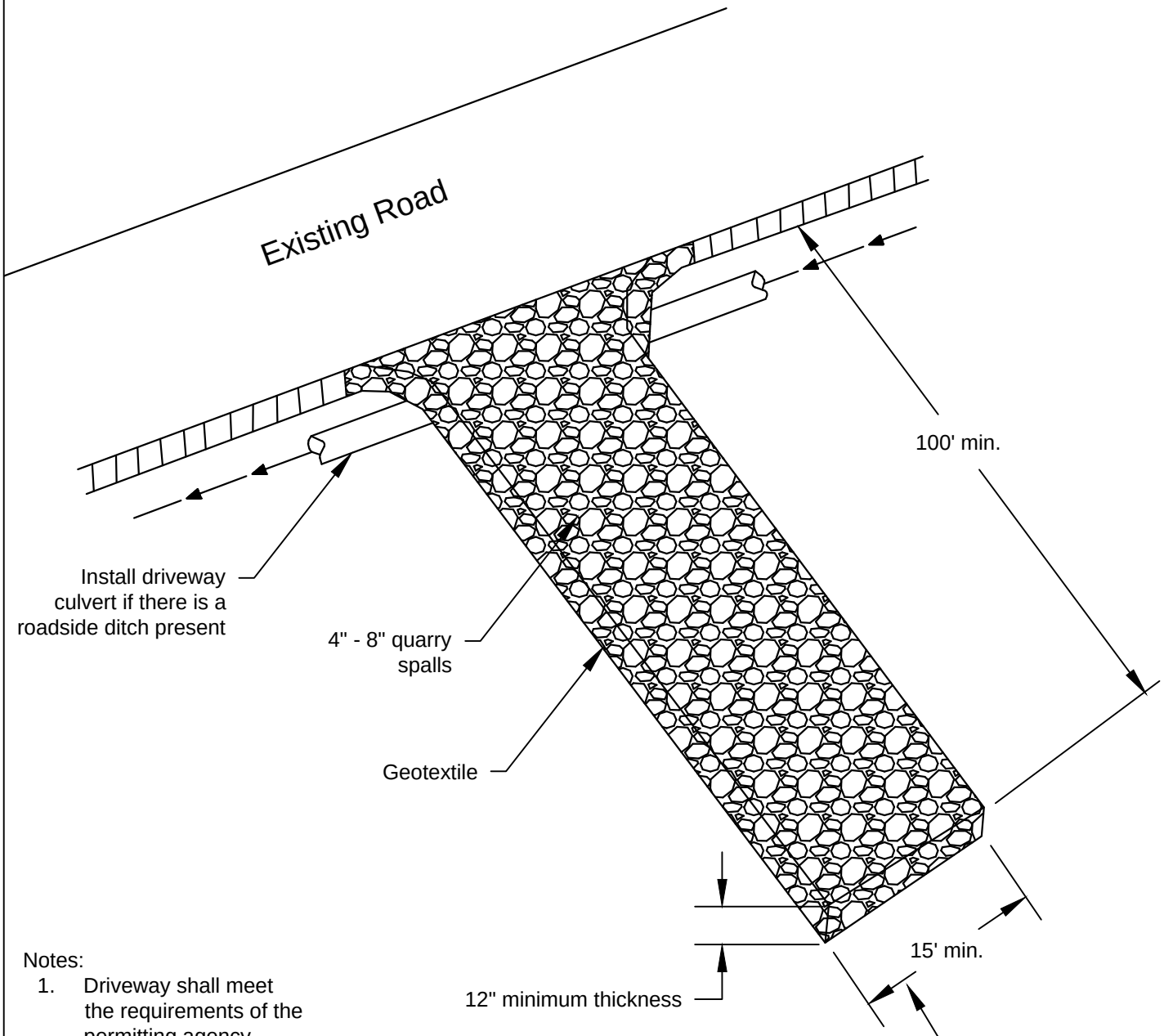


Notes:

1. Driveway shall meet the requirements of the permitting agency.
2. It is recommended that the entrance be crowned so that runoff drains off the pad.

DEPARTMENT OF ECOLOGY
State of Washington

Figure II-4.1.1
Stabilized Construction Entrance

Revised June 2015

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: Stabilized Construction Entrance / Exit) 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 II-4.1.2 Wheel Wash. 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.

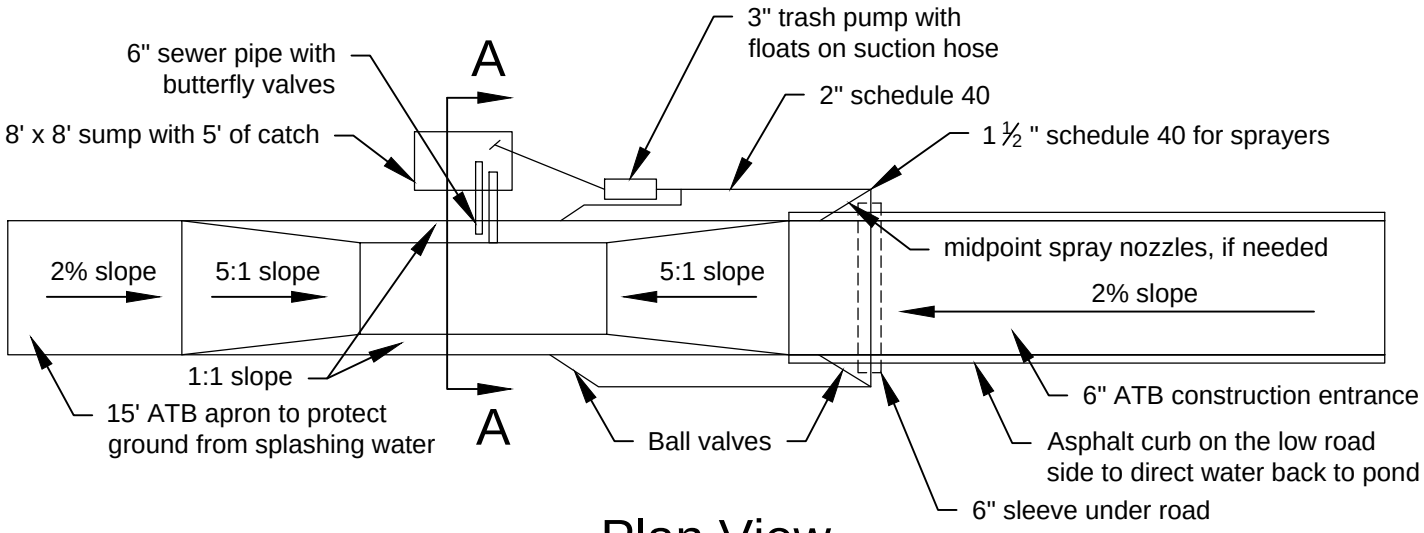
Midpoint spray nozzles are only needed in extremely muddy conditions.

Wheel wash systems should be designed with a small grade change, 6- to 12-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.

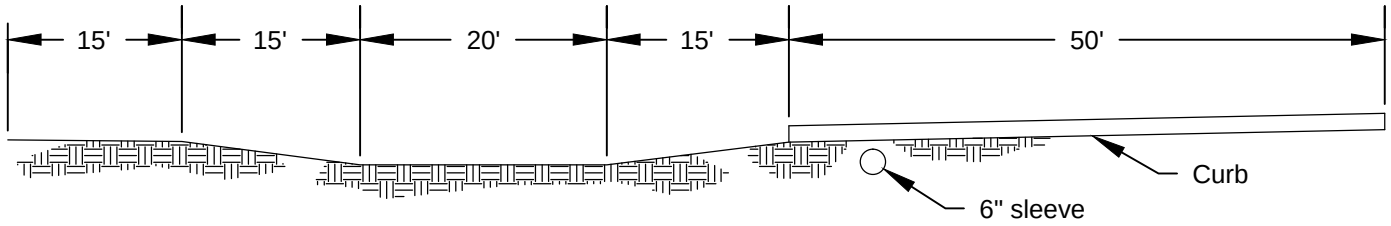
Maintenance Standards

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

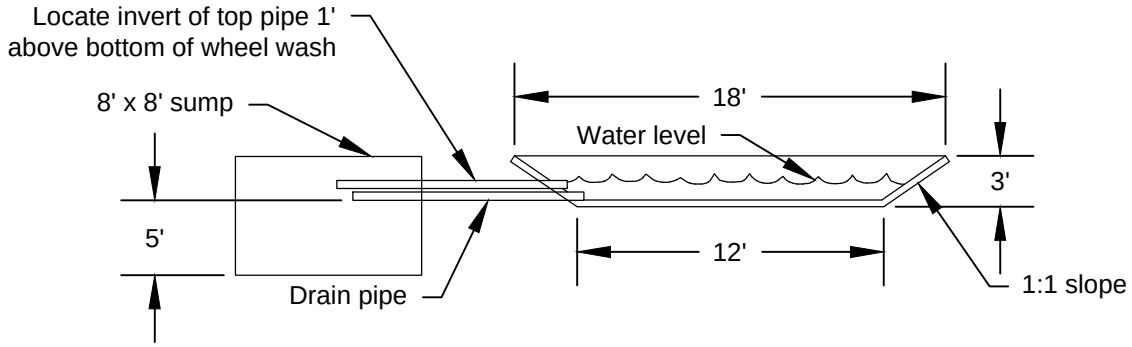
The wash water should be changed a minimum of once per day. On large earthwork jobs where more than 10-20 trucks per hour are expected, the wash water will need to be changed more often.



Plan View



Elevation View



Section A-A

Notes:

1. Build 8' x 8' sump to accomodate cleaning by trackhoe.

NOT TO SCALE

DEPARTMENT OF ECOLOGY
State of Washington

Figure II-4.1.2
Wheel Wash

Revised June 2015

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: High Visibility Fence) 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 (BMP C252: High pH Neutralization Using CO2 and BMP C253: pH Control for High pH Water) 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: Storm Drain Inlet Protection).

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 II-4.1.2 Temporary Erosion Control Seed Mix lists the standard mix for areas requiring a temporary vegetative cover.

Table II-4.1.2 Temporary Erosion Control Seed Mix

	% Weight	% Purity	% Germination
Chewings or annual blue grass	40	98	90

	% Weight	% Purity	% Germination
Festuca rubra var. commutata or *Poa anna*			
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 II-4.1.3 Landscaping Seed Mix lists a recommended mix for landscaping seed.

Table II-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 II-4.1.4 Low-Growing Turf Seed Mix lists a turf seed mix for dry situations where there is no need for watering. This mix requires very little maintenance.

Table II-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

	% Weight	% Purity	% Germination

- Table II-4.1.5 Bioswale Seed Mix* lists a mix for bioswales and other intermittently wet areas.

Table II-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 II-4.1.6 Wet Area Seed Mix* 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 II-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			

	% Weight	% Purity	% Germination

- Table II-4.1.7 Meadow Seed Mix 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 II-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: Temporary and Permanent Seeding. 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 II-4.1.8 Mulch Standards and Guidelines. 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.

Where the option of "Compost" is selected, it should be a coarse compost that meets the following size gradations when tested in accordance with the U.S. Composting Council "Test Methods for the Examination of Compost and Composting" (TMECC) Test Method 02.02-B.

Coarse Compost

Minimum Percent passing 3" sieve openings 100%

Minimum Percent passing 1" sieve openings 90%

Minimum Percent passing ¾" sieve openings 70%

Minimum Percent passing ¼" sieve openings 40%

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 II-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 3/4 - 1 inch clog hydromulch equipment. Fibers should be kept to less than 3/4 inch.
Compost	No visible water or dust during handling. Must be produced per WAC 173-350, Solid Waste Handling Standards, but may have up to 35% biosolids.	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. Compost used for mulch has a coarser size gradation than compost used for BMP C125: Topsoiling / Composting or BMP T5.13: Post-Construction Soil Quality and Depth. It is more stable and practical to use in wet areas and during rainy weather conditions. Do not use 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 3/8-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 II-4.1.3 Channel Installation and Figure II-4.1.4 Slope Installation 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:

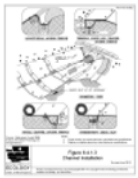
       http://www.txdot.gov/business/doing_business/product_evaluation/erosion_control.htm
- Use jute matting in conjunction with mulch (BMP C121: Mulching). Excelsior, woven straw blankets and coir (coconut fiber) blankets may be installed without mulch. There are many other types of erosion control nets and 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 II-4.1.3 Channel Installation

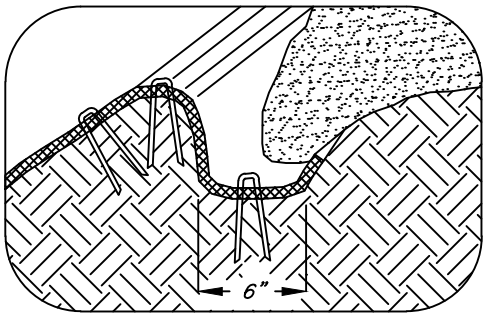


2014 Figure II-4.1.3 pdf download

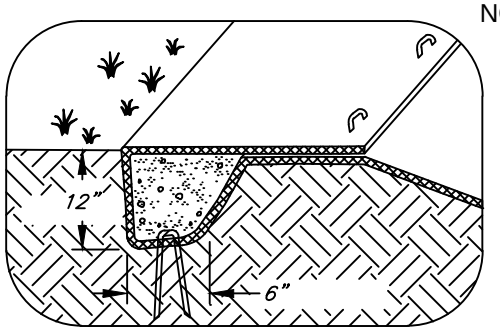
Figure II-4.1.4 Slope Installation

2014 Figure II-4.1.4 pdf download

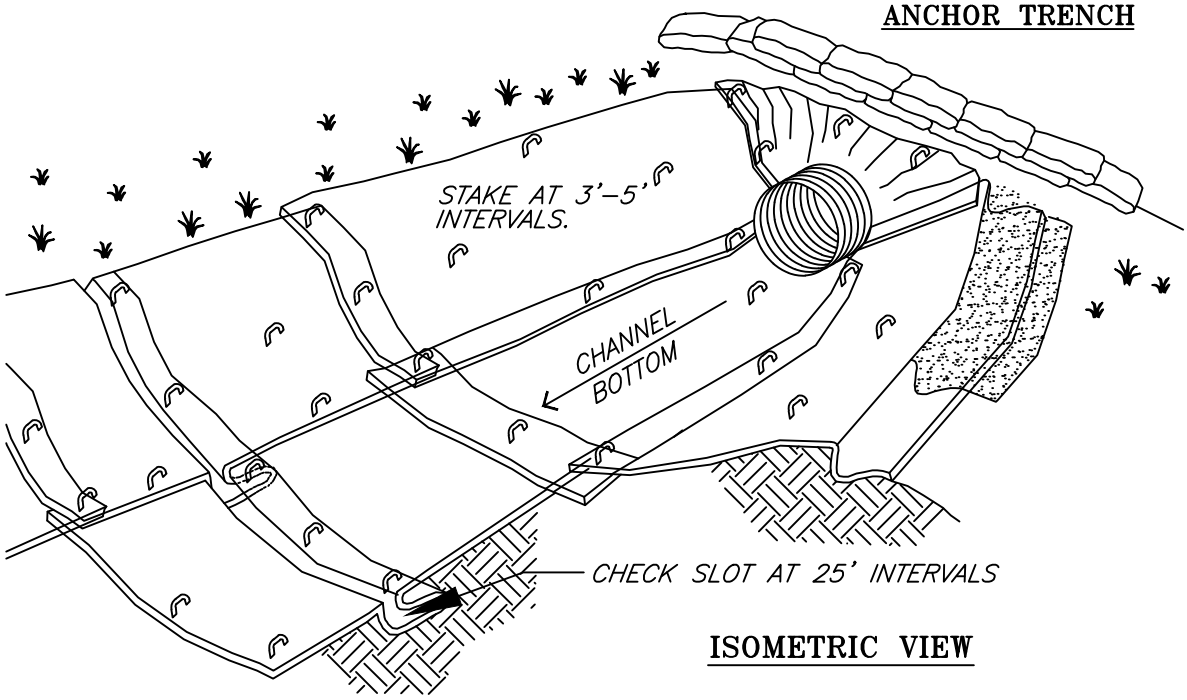
NOT TO SCALE



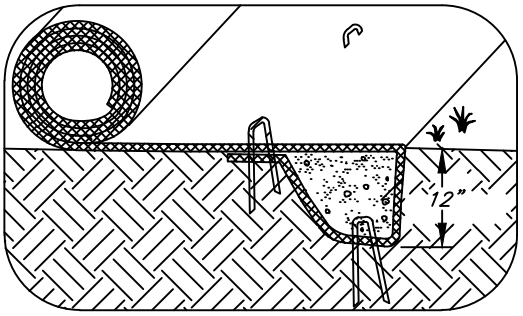
LONGITUDINAL ANCHOR TRENCH



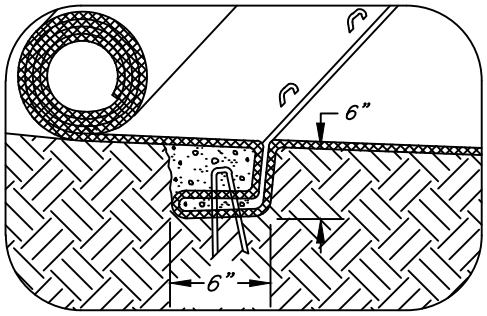
TERMINAL SLOPE AND CHANNEL ANCHOR TRENCH



ISOMETRIC VIEW



INITIAL CHANNEL ANCHOR TRENCH



INTERMITTENT CHECK SLOT

Source: Clackamas County 2009 Erosion Prevention Planning and Design Manual

Notes:

1. Check slots to be constructed per manufacturers specifications.
2. Staking or stapling layout per manufacturers specifications.

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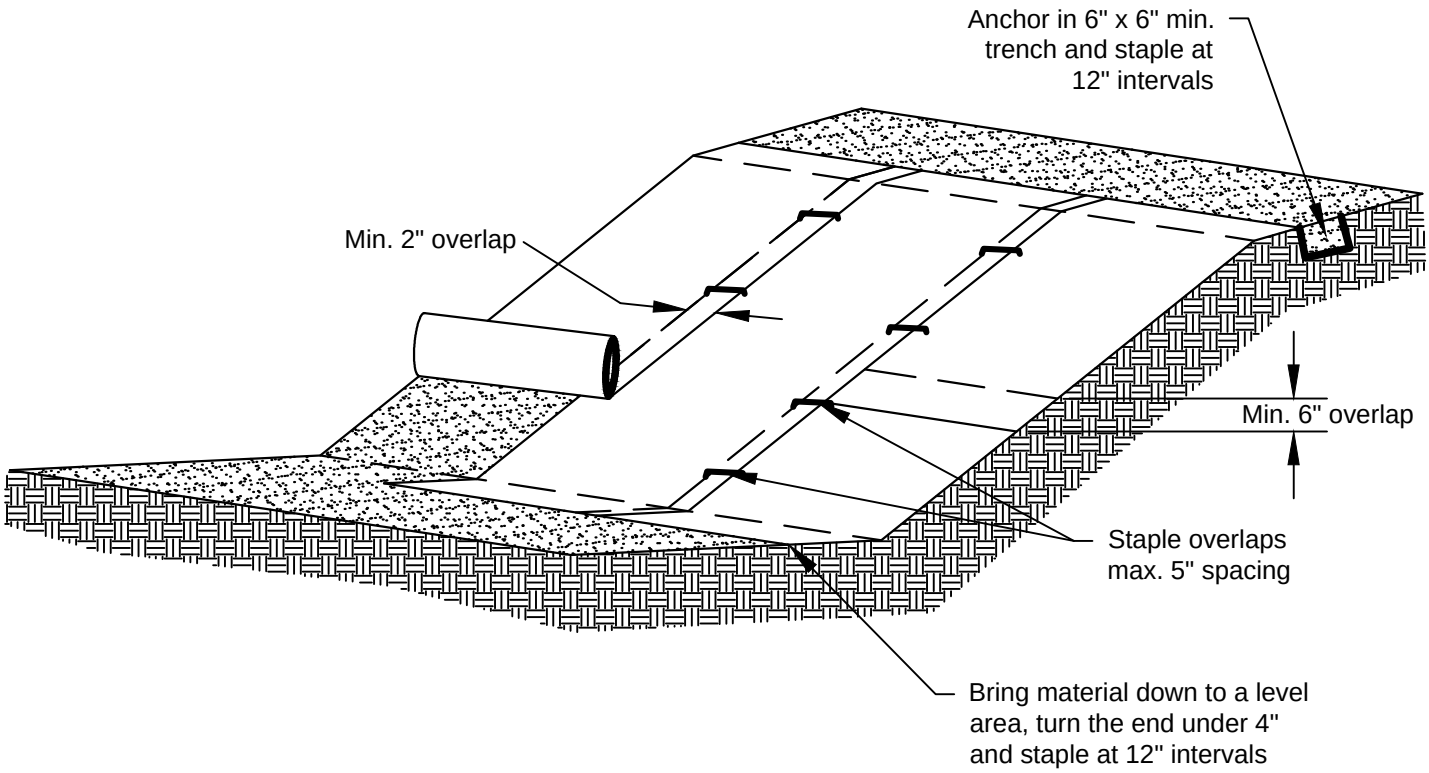
Figure II-4.1.3
Channel Installation

Revised June 2015



Notes:

1. Slope surface shall be smooth before placement for proper soil contact.
2. Stapling pattern as per manufacturer's recommendations.
3. Do not stretch blankets/mattings tight - allow the rolls to mold to any irregularities.
4. For slopes less than 3H:1V, rolls may be placed in horizontal strips.
5. If there is a berm at the top of the slope, anchor upslope of the berm.
6. Lime, fertilize, and seed before installation. Planting of shrubs, trees, etc. should occur after installation.

NOT TO SCALE

DEPARTMENT OF ECOLOGY
State of Washington

Figure II-4.1.4
Slope Installation

Revised June 2015

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: Plastic Covering. 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.

2012 Stormwater Management Manual for Western Washington, as Amended in December 2014 (The 2014 SWMMWW)

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. Note that this BMP is functionally the same as BMP T5.13: Post-Construction Soil Quality and Depth which is required for all disturbed areas that will be developed as lawn or landscaped areas at the completed project site.

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 disturbed areas that will be developed as lawn or landscaped areas at the completed project site:

- 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 in planting beds, 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.
  - Mulch planting beds with 2 inches of organic material

- Accomplish the required organic content, depth, and pH by returning native topsoil to the site, importing topsoil of sufficient organic content, and/or incorporating organic amendments. When using the option of incorporating amendments to meet the organic content requirement, use compost that meets the compost specification for Bioretention (See BMP T7.30: Bioretention Cells, Swales, and Planter Boxes), with the exception that the compost may have up to 35% biosolids or manure.
- Sections three through seven of the document entitled, *Guidelines and Resources for Implementing Soil Quality and Depth BMP T5.13 in WDOE Stormwater Management Manual for Western Washington*, provides useful guidance for implementing whichever option is chosen. It includes guidance for pre-approved default strategies and guidance for custom strategies. Check with your local jurisdiction concerning its acceptance of this guidance. It is available through the organization, Soils for Salmon. As of this printing the document may be found at: http://www.soilsforsalmon.org/pdf/Soil_BMP_Manual.pdf.
- 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 II-4.1.9 PAM and Water Application Rates 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 II-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

Disturbed Area (ac)	PAM (lbs)	Water (gal)
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 II-4.1.5 Surface Roughening by Tracking and Contour Furrows 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.

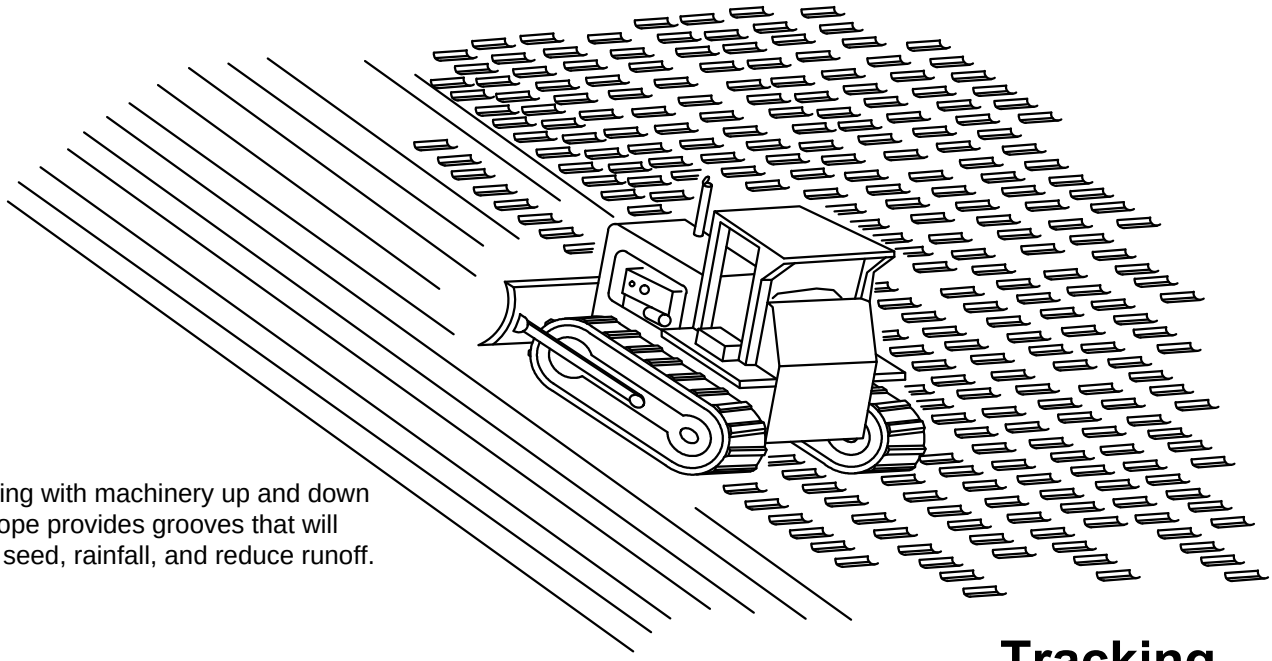
- Disturbed areas that will not require mowing may be stair-step graded, grooved, or left rough after filling.
- Stair-step grading is particularly appropriate in soils containing large amounts of soft rock. Each "step" catches material that sloughs from above, and provides a level site where vegetation 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.

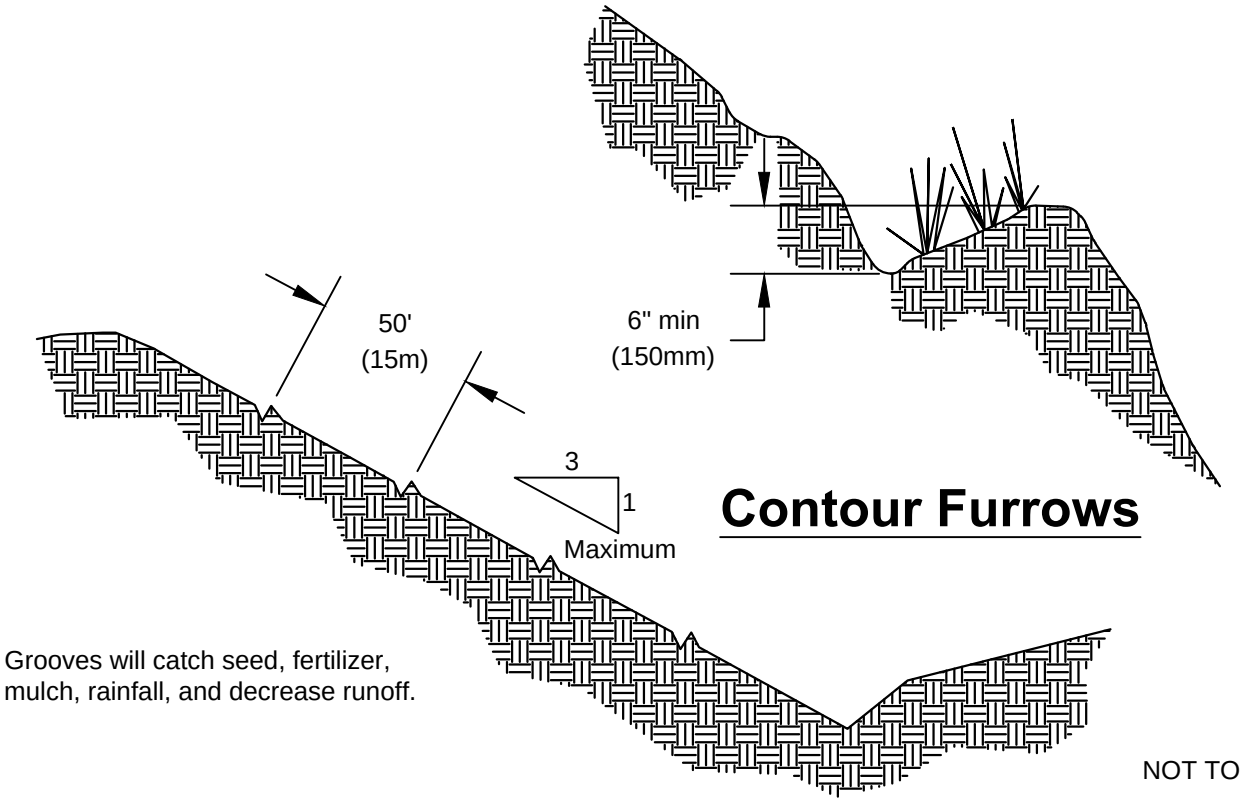
Figure II-4.1.5 Surface Roughening by Tracking and Contour Furrows

2014 Figure II-4.1.5 pdf download



Tracking with machinery up and down the slope provides grooves that will catch seed, rainfall, and reduce runoff.

Tracking



Contour Furrows

Grooves will catch seed, fertilizer, mulch, rainfall, and decrease runoff.

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Figure II-4.1.5
Surface Roughening by Tracking and Contour Furrows

Revised June 2015

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 II-4.1.6 Gradient Terraces 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.

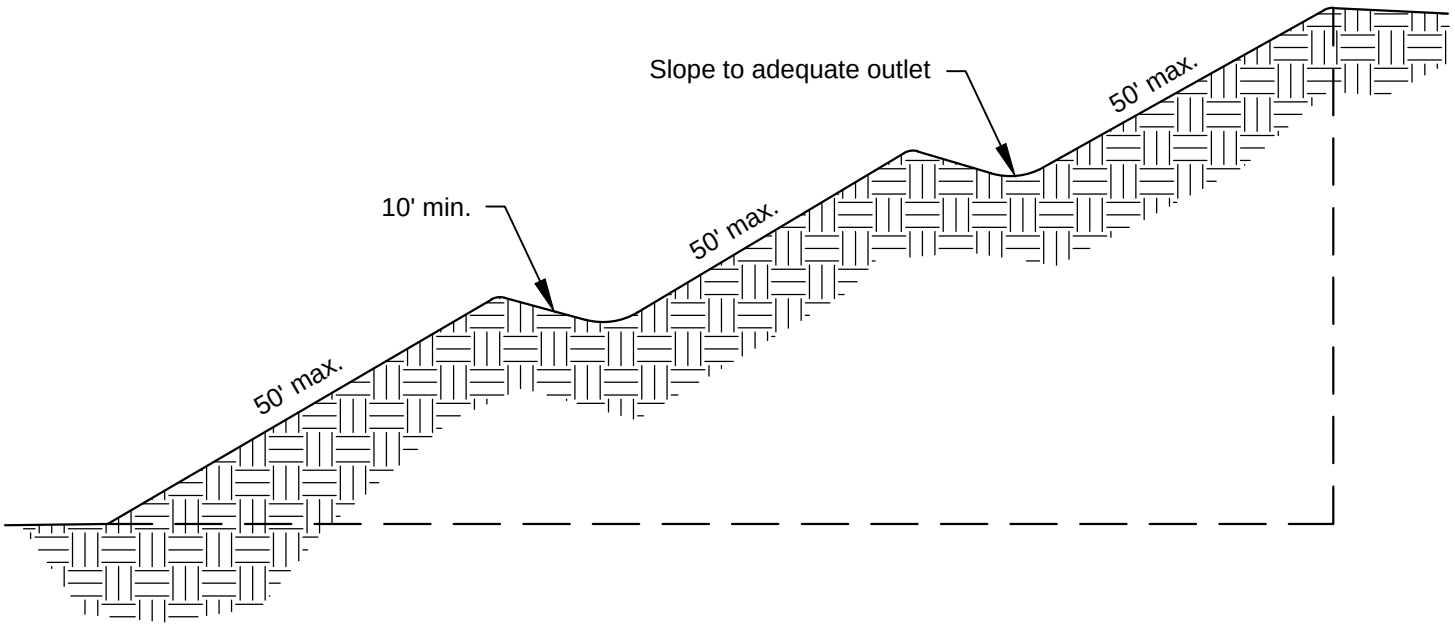
- The terrace should have enough capacity to handle the peak runoff expected from a 2-year, 24-hour design storm without overtopping.
- The terrace cross-section should be proportioned to fit the land slope. The ridge height should include a reasonable settlement factor. The ridge should have a minimum 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 II-4.1.6 Gradient Terraces

2014 Figure II-4.1.6 pdf download



NOT TO SCALE

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State of Washington

Figure II-4.1.6
Gradient Terraces

Revised June 2015

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 BMP C105: Stabilized Construction Entrance / Exit.
- 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: Polyacrylamide (PAM) for Soil Erosion Protection) 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

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 Specifications

- Assure that washout of concrete trucks, chutes, pumps, and internals is performed at an approved off-site location 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: Concrete Washout Area 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 BMP C252: High pH Neutralization Using CO2 and BMP C253: pH Control for High pH Water 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.

2012 Stormwater Management Manual for Western Washington, as Amended in December 2014 (The 2014 SWMMWW)

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 at an approved off-site location 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: Stabilized Construction Entrance / Exit). 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 Figure II-4.1.7a Concrete Washout Area, Figure II-4.1.7b Concrete Washout Area, and Figure II-4.1.8 Prefabricated Concrete Washout Container w/Ramp.
- Concrete washout facilities shall be constructed and maintained in sufficient quantity and size to contain all liquid and concrete waste generated by washout operations.
- 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

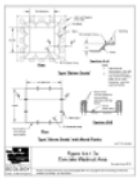
Inspection and Maintenance

- 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

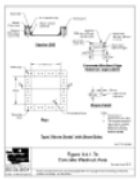
- When temporary concrete washout facilities are no longer required for the work, the hardened concrete, slurries and liquids shall be removed and properly disposed of.
- Materials used to construct temporary concrete washout facilities shall be removed from the site of the work and disposed of or recycled.
- 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 II-4.1.7a Concrete Washout Area



2014 Figure II-4.1.7a pdf download

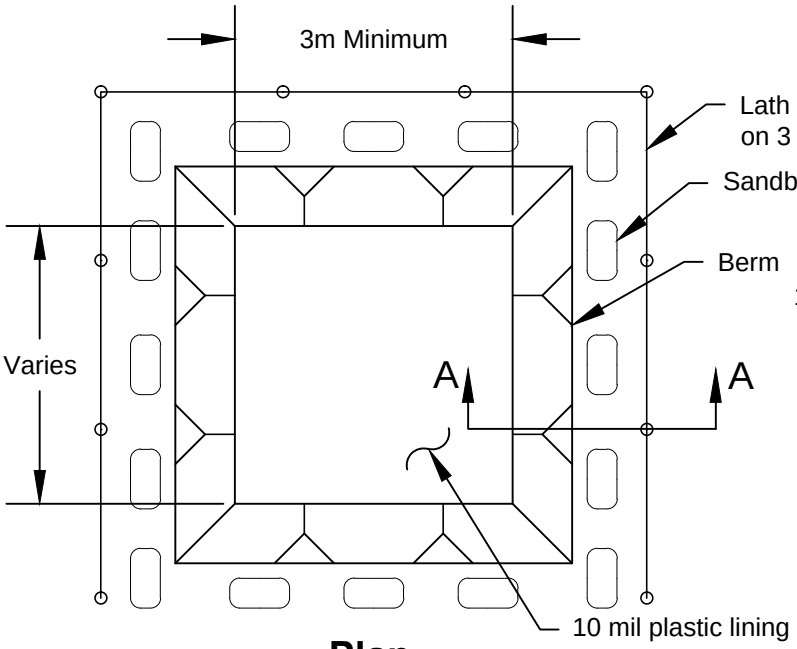
Figure II-4.1.7b Concrete Washout Area



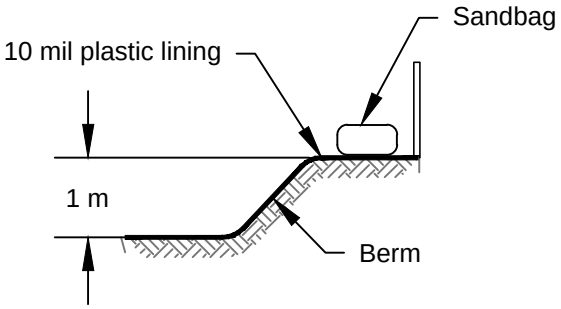
2014 Figure II-4.1b pdf download

Figure II-4.1.8 Prefabricated Concrete Washout Container w/Ramp

2014 Figure II-4.1.8 pdf download



Plan

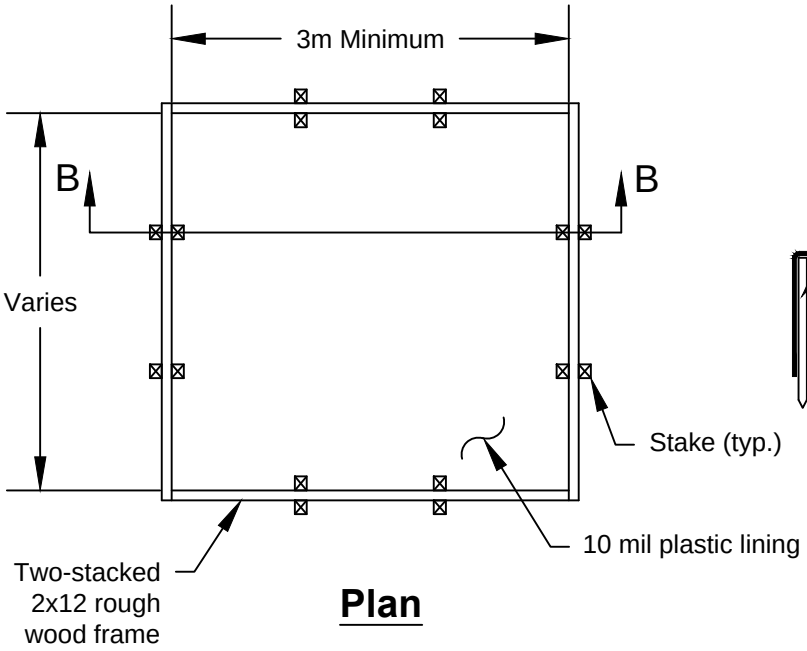


Section A-A

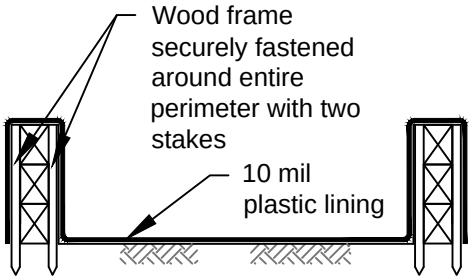
Type "Below Grade"

Notes:

1. Actual layout determined in the field.
2. A concrete washout sign shall be installed within 10 m of the temporary concrete washout facility.



Plan



Section B-B

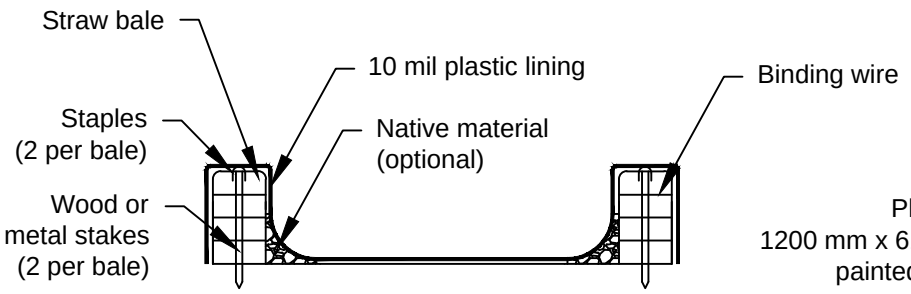
Type "Above Grade" with Wood Planks

NOT TO SCALE

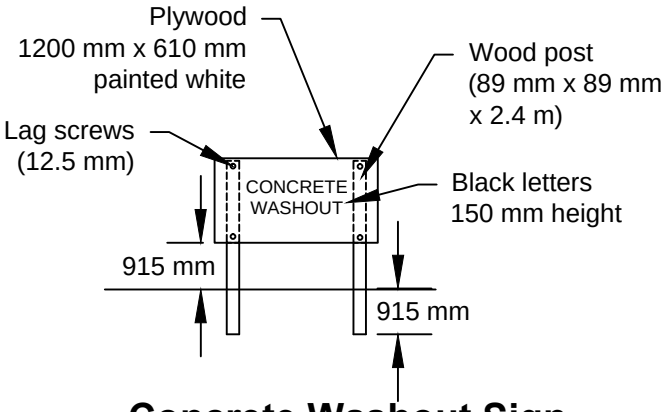
DEPARTMENT OF ECOLOGY
State of Washington

Figure II-4.1.7a
Concrete Washout Area

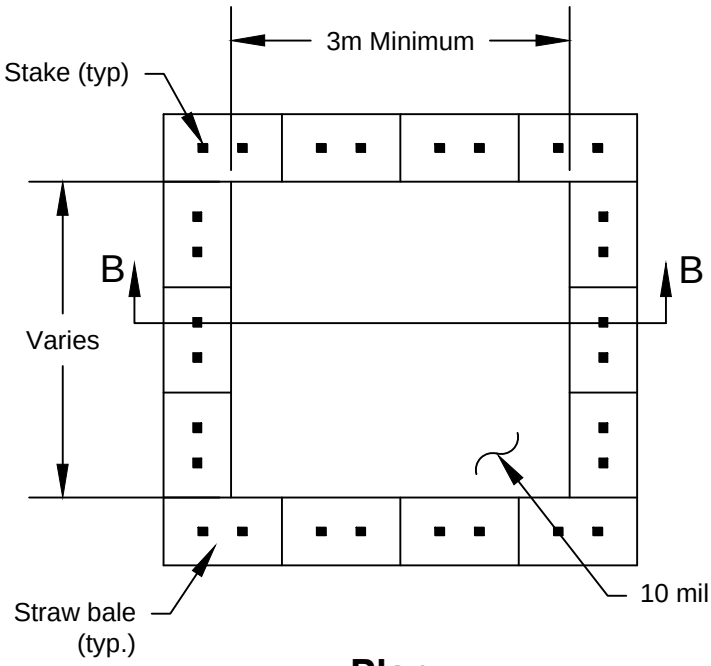
Revised June 2015



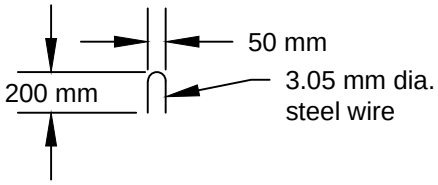
Section B-B



Concrete Washout Sign Detail (or equivalent)



Plan



Staple Detail

Notes:

1. Actual layout determined in the field.
2. The concrete washout sign shall be installed within 10 m of the temporary concrete washout facility.

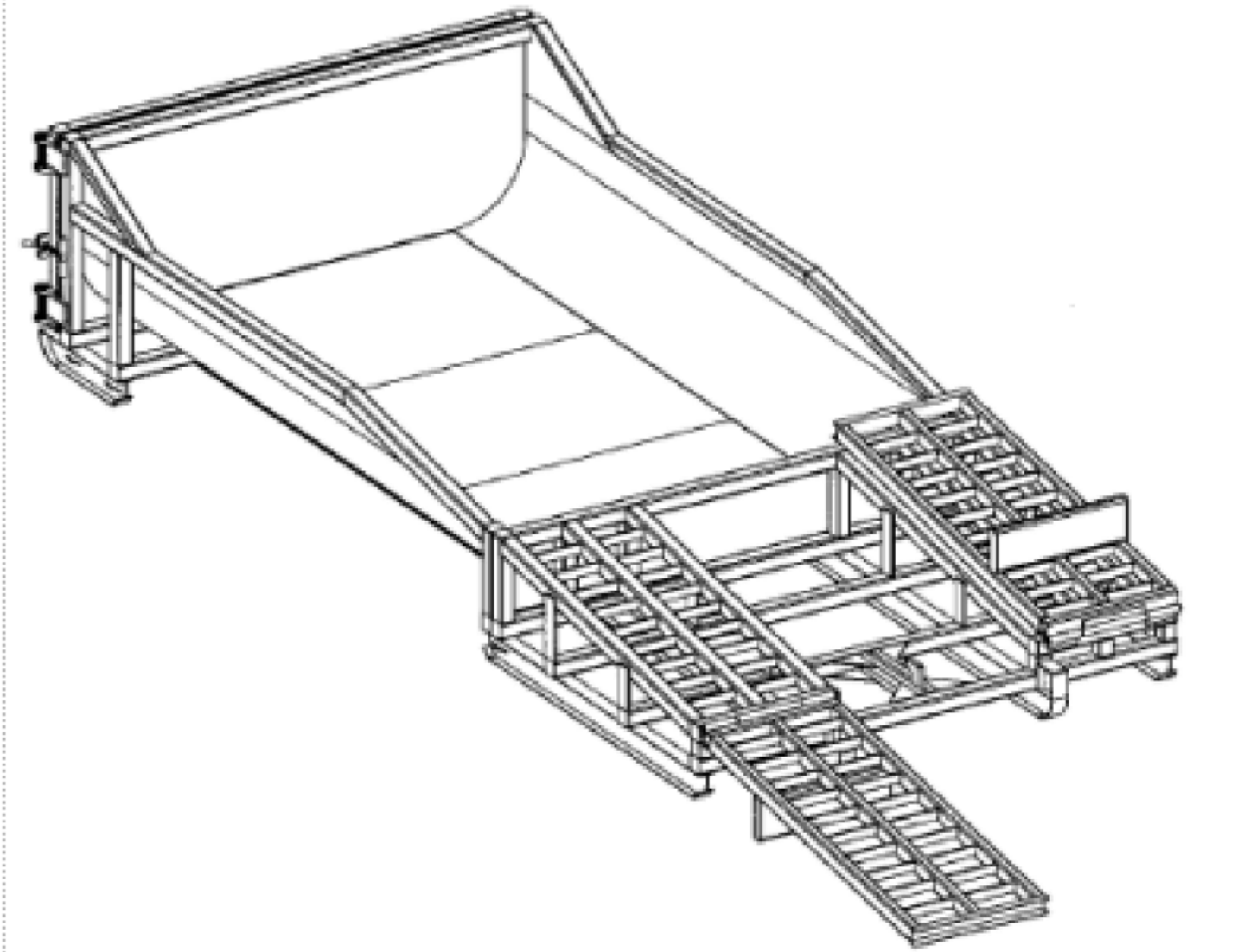
Type "Above Grade" with Straw Bales

NOT TO SCALE

DEPARTMENT OF ECOLOGY
State of Washington

Figure II-4.1.7b
Concrete Washout Area

Revised June 2015



NOT TO SCALE

DEPARTMENT OF
ECOLOGY
State of Washington

Figure II-4.1.8
Prefabricated Concrete Washout Container w/Ramp

Revised June 2015

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:
    http://www.envirocertintl.org/cpesc/

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.

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 volumetric flow rate calculated using a 10-minute time step 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 II-4.2.1 Typical Grass-Lined Channels 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 volumetric flow rate calculated using a 10-minute time step 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 II-4.2.2 Temporary Channel Liners.

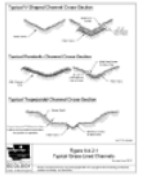
- Check dams shall be removed when the grass has matured sufficiently to protect the ditch or swale unless the slope of the swale is greater than 4 percent. The area beneath the check dams shall be seeded and mulched immediately after dam removal.
- If vegetation is established by sodding, the permissible 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 II-4.2.1 Typical Grass-Lined Channels



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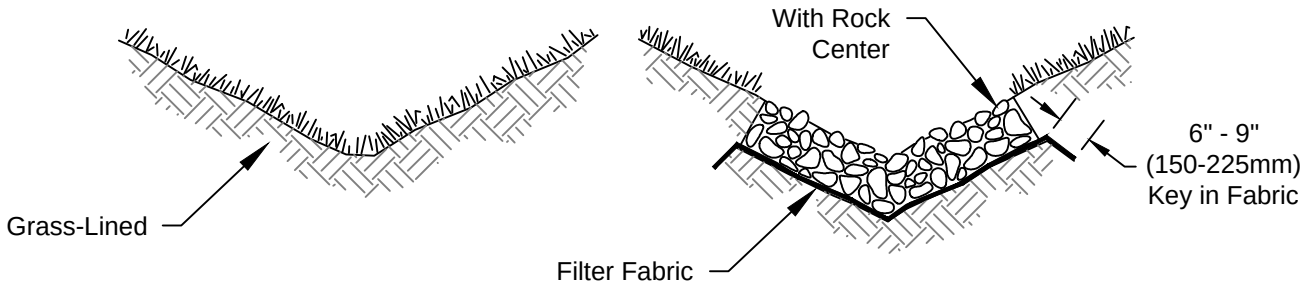
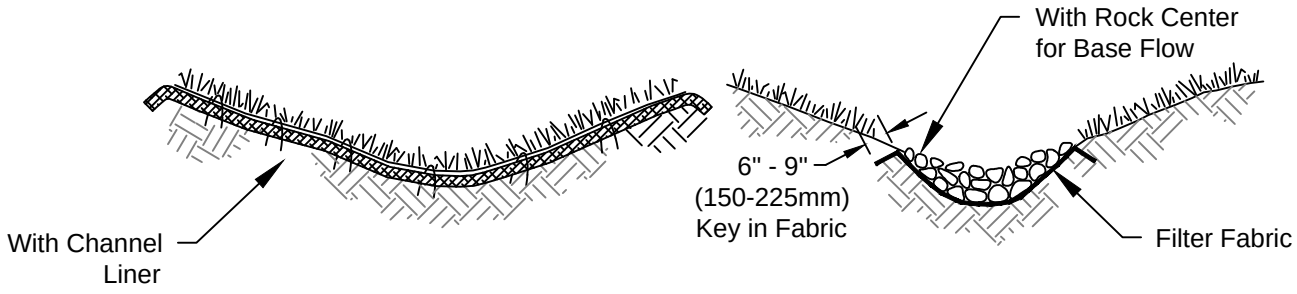
Typical V-Shaped Channel Cross-Section



Typical Parabolic Channel Cross-Section



Typical Trapezoidal Channel Cross-Section

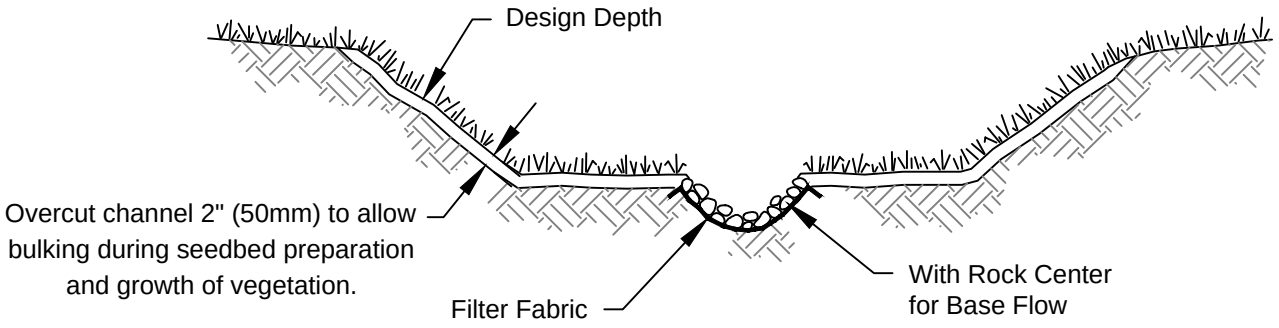


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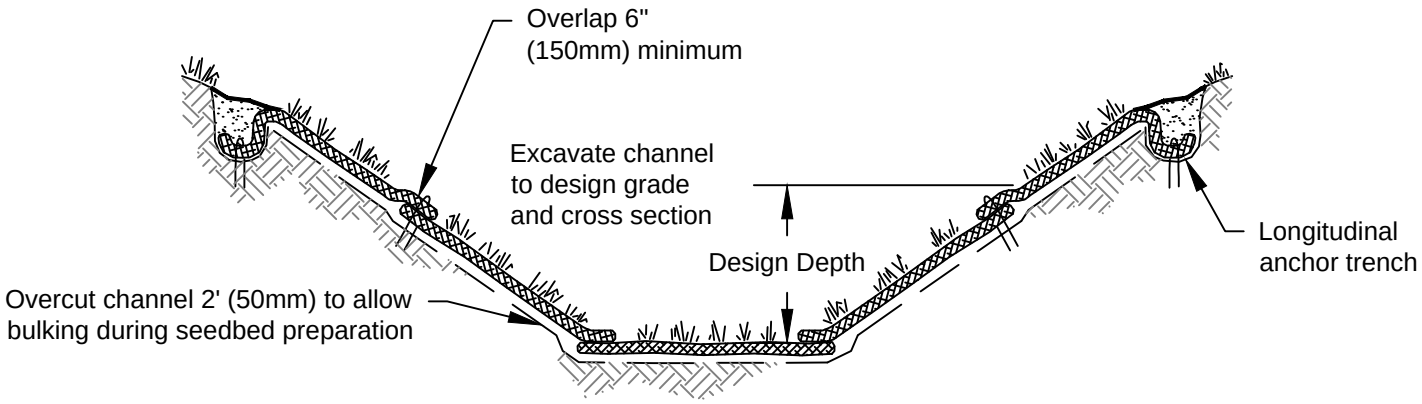
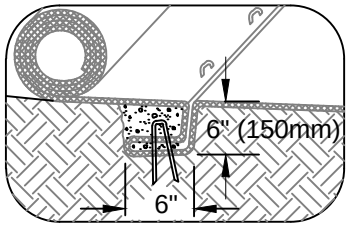
Figure II-4.2.1
Typical Grass-Lined Channels

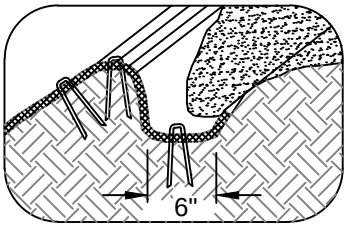
Revised June 2015



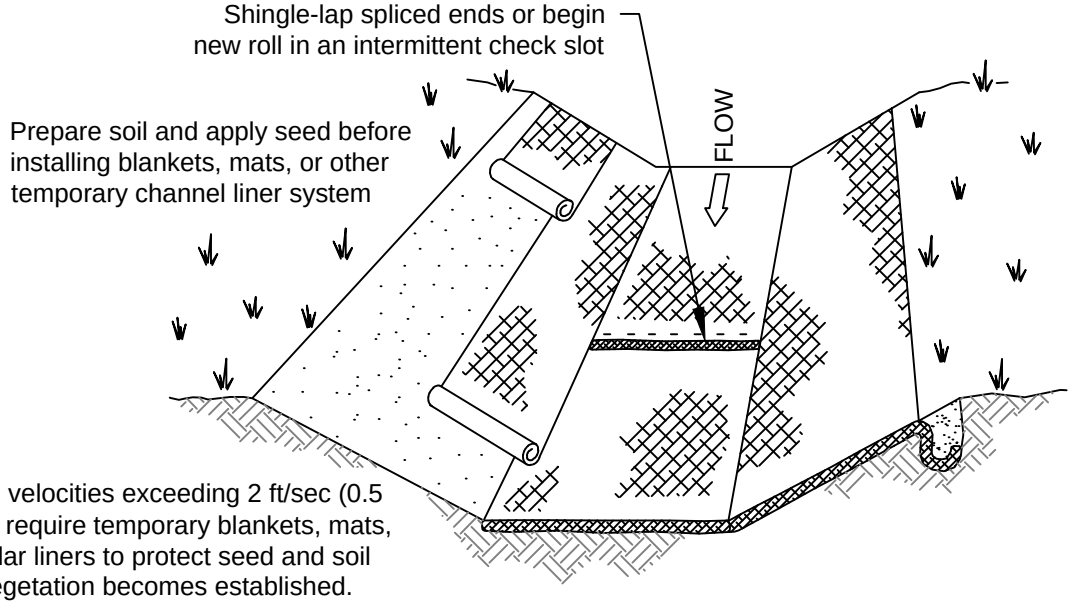


Intermittent Check Slot

Typical installation with erosion control blankets or turf reinforcement mats



Longitudinal Anchor Trench



Notes:

1. Design velocities exceeding 2 ft/sec (0.5 m/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 (2 m/sec) should include turf reinforcement mats.

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Figure II-4.2.2
Temporary Channel Liners

Revised July 2015

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 adequate 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/ft2.

Design and Installation Specifications

See BMP C122: Nets and Blankets 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 II-4.2.3 Water Bar.

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 II-4.2.3 Water Bar

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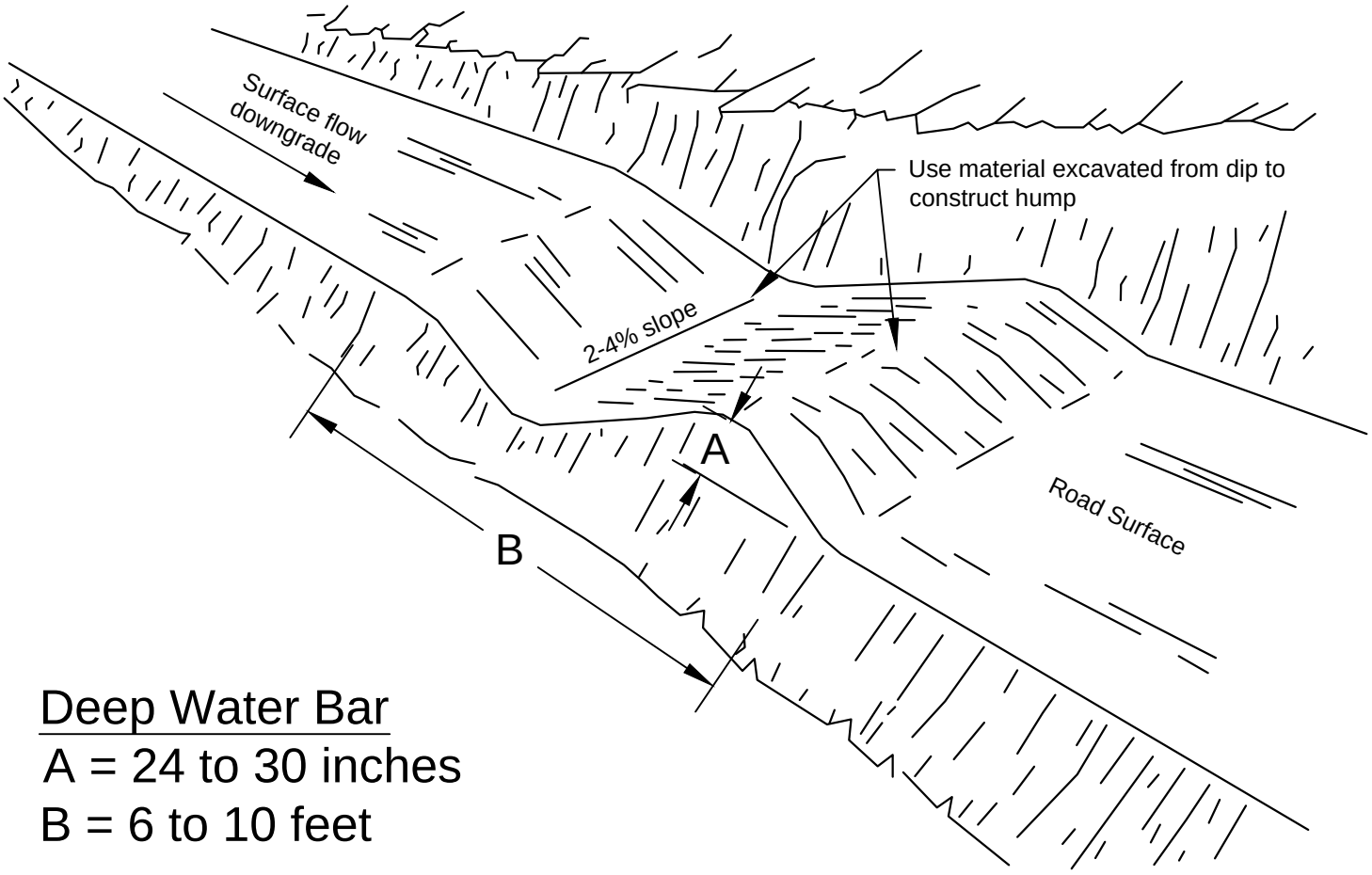

Deep Water Bar

A = 24 to 30 inches

B = 6 to 10 feet

Shallow Water Bar

A = 8 to 12 inches

B = 6 to 12 feet

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Figure II-4.2.3
Water Bar

Revised July 2015

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 II-4.2.4 Pipe Slope Drain).

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 volumetric flow rate calculated using a 10-minute time step 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 II-4.2.4 Pipe Slope Drain

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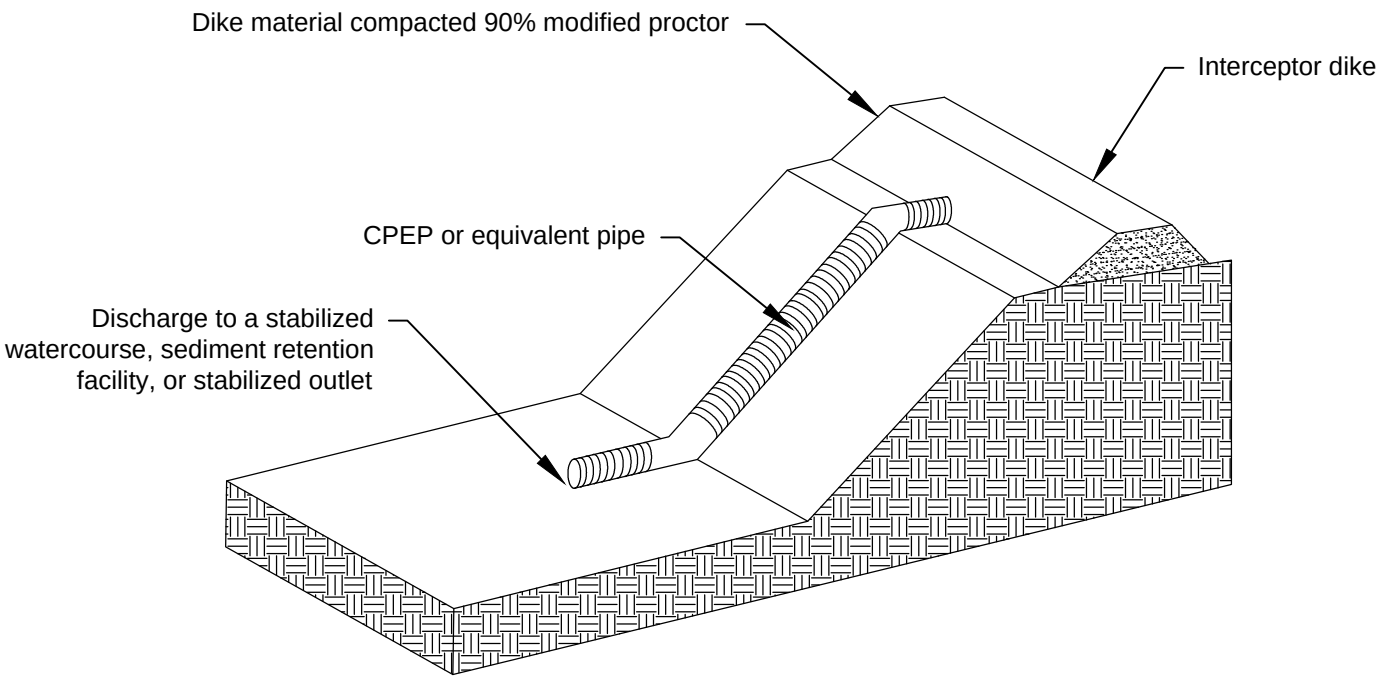

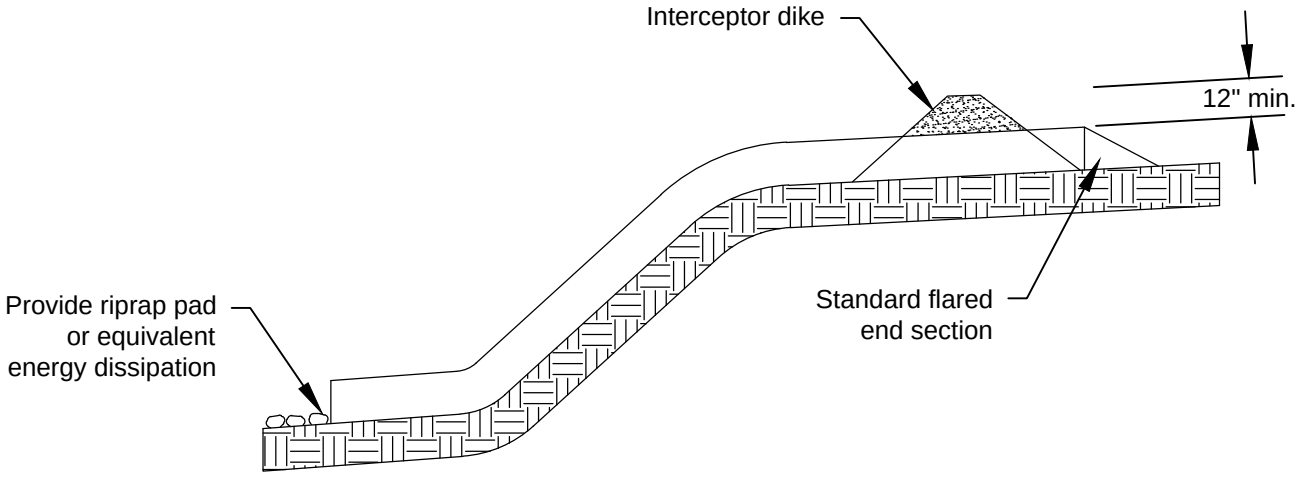

Notes:

1. Inlet and all sections must be securely fastened together with gasketed watertight fittings

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Figure II-4.2.4
Pipe Slope Drain

Revised July 2015

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. BMP C206: Level Spreader and Figure II-4.2.6 Detail of Level Spreader 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 II-4.2.5 Cross Section of Level Spreader

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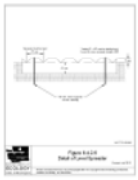
Figure II-4.2.6 Detail of Level Spreader



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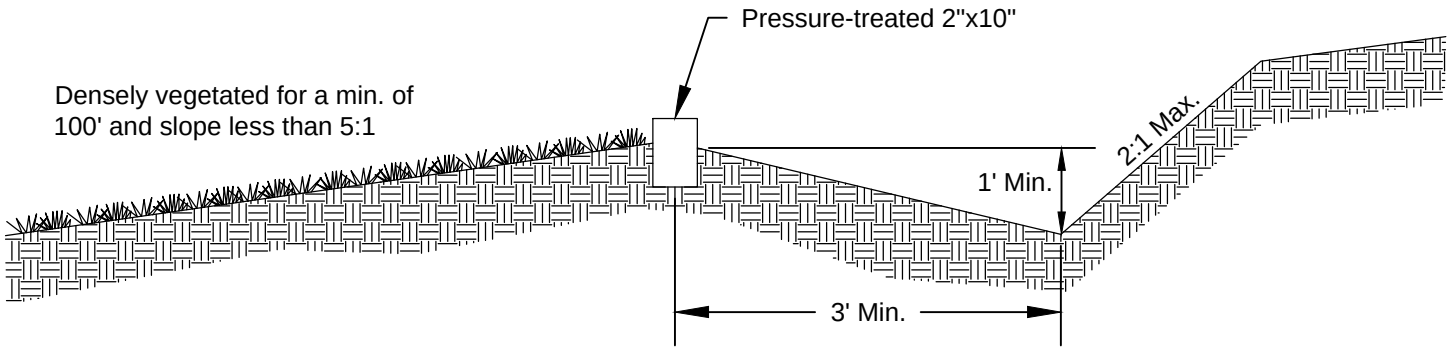

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Figure II-4.2.5
Cross Section of Level Spreader

Revised July 2015

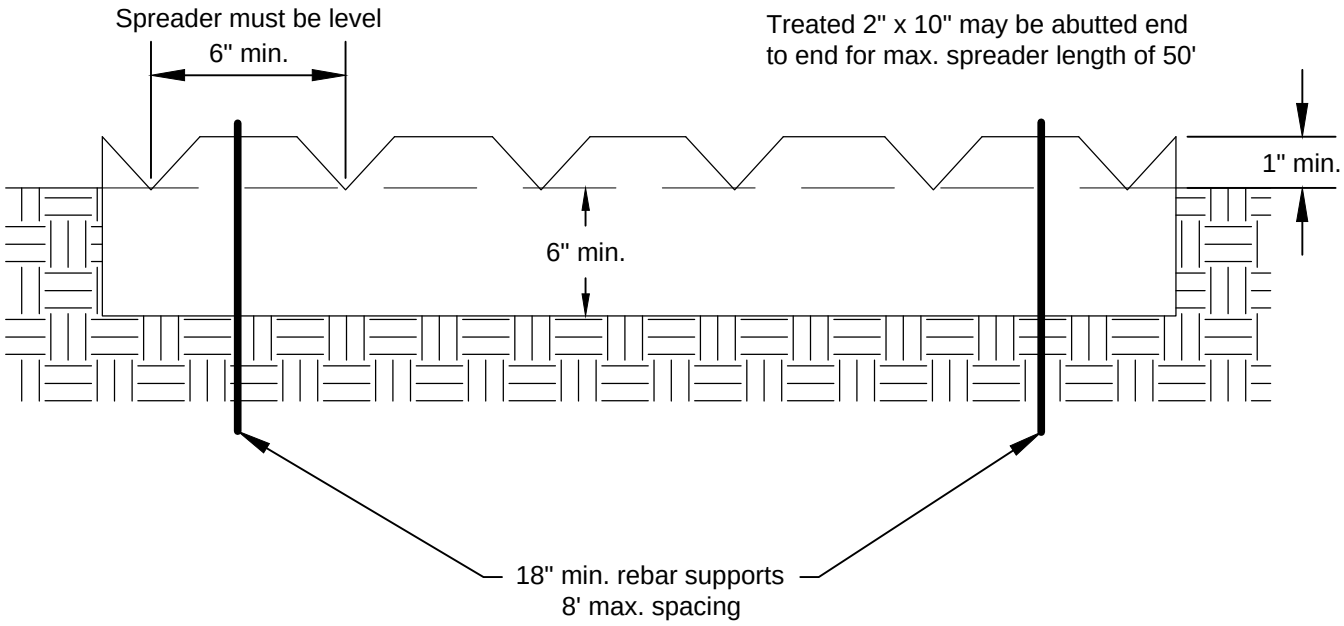

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Figure II-4.2.6
Detail of Level Spreader

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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 II-4.2.7 Rock Check Dam depicts a typical rock check dam.

Maintenance Standards

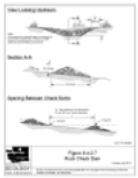
Check dams shall be monitored for performance and sediment accumulation during and after each runoff producing rainfall. Sediment shall be removed when it reaches one half the sump depth.

- 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: Check Dams. 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 II-4.2.7 Rock Check Dam



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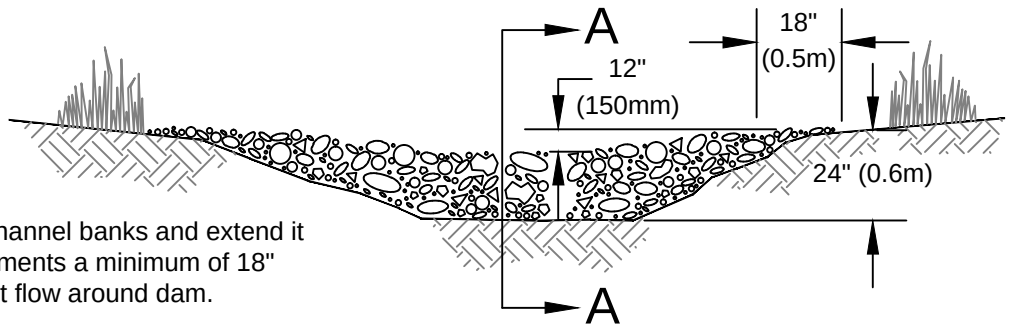
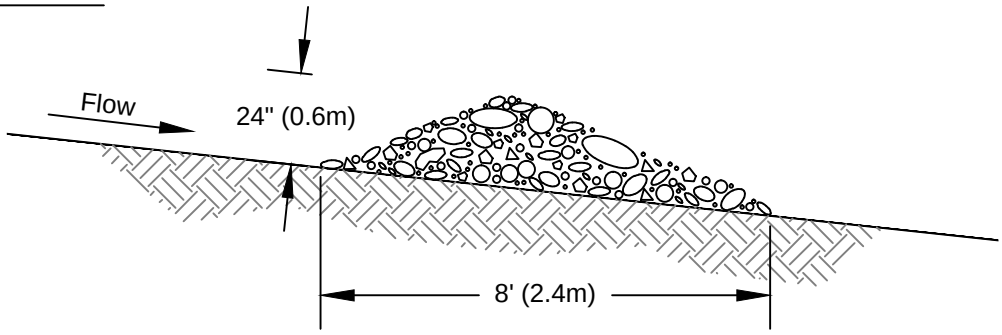
View Looking Upstream



Note:
Key stone into channel banks and extend it beyond the abutments a minimum of 18" (0.5m) to prevent flow around dam.

Section A-A



Spacing Between Check Dams

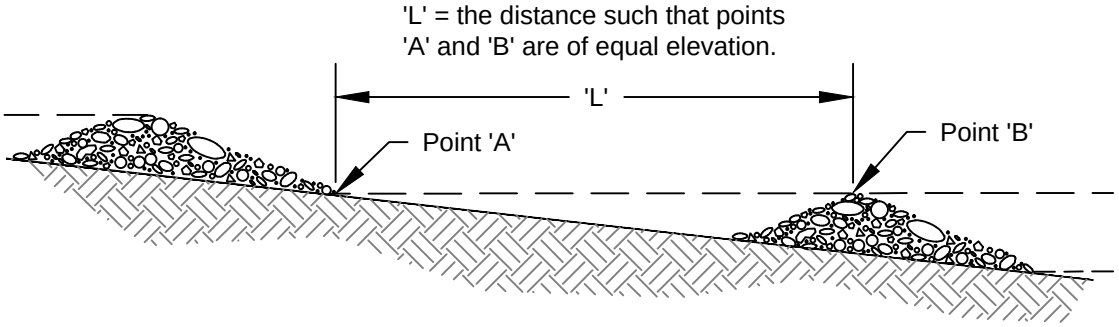


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Figure II-4.2.7
Rock Check Dam

Revised July 2015

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 Standards

- Triangular silt dams shall be inspected for performance and sediment 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 II-4.2.2 Storm Drain Inlet Protection 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 II-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'x30'/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 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 II-4.2.8 Block and Gravel Filter.

- 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.

Figure II-4.2.8 Block and Gravel Filter

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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 II-4.2.9 Block and Gravel Curb Inlet Protection.

- 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 II-4.2.10 Curb and Gutter Barrier.

- 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: Storm Drain Inlet Protection. 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 II-4.2.9 Block and Gravel Curb Inlet Protection

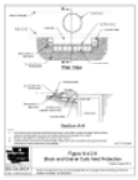

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Figure II-4.2.10 Curb and Gutter Barrier

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APPROVED BY
CITY ENGINEER :

DATE : 1/1/17
REVISED :

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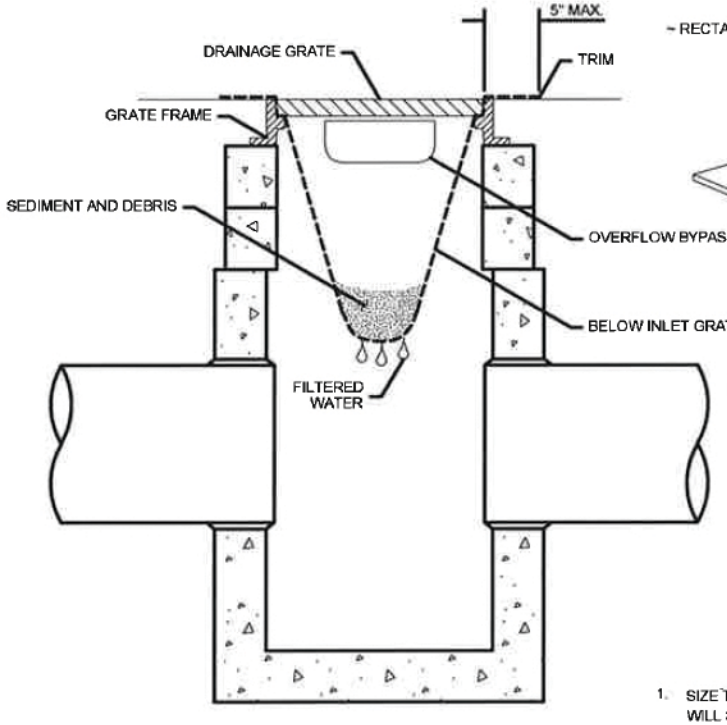

SECTION VIEW
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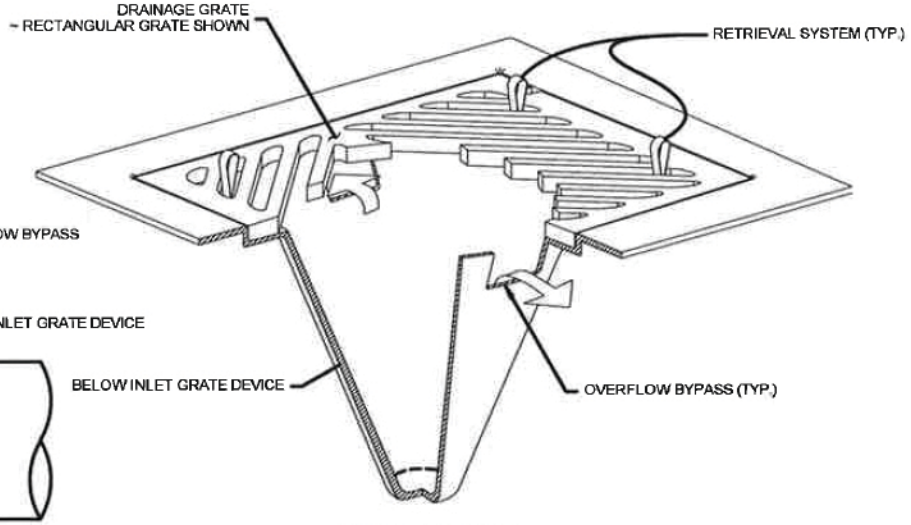

ISOMETRIC VIEW

1. SIZE THE BELOW INLET GRATE DEVICE (BIGD) FOR THE STORM WATER STRUCTURE IT WILL SERVICE.
2. THE BIGD SHALL HAVE A BUILT-IN HIGH-FLOW RELIEF SYSTEM (OVERFLOW BYPASS).
3. THE RETRIEVAL SYSTEM MUST ALLOW REMOVAL OF THE BIGD WITHOUT SPILLING THE COLLECTED MATERIAL.
4. PERFORM MAINTENANCE IN ACCORDANCE WITH STANDARD SPECIFICATION 8-01.3(15).

STORM DRAIN INLET PROTECTION

NOT TO SCALE

STANDARD DETAIL

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 II-4.2.11 Brush Barrier 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 II-4.2.11 Brush Barrier

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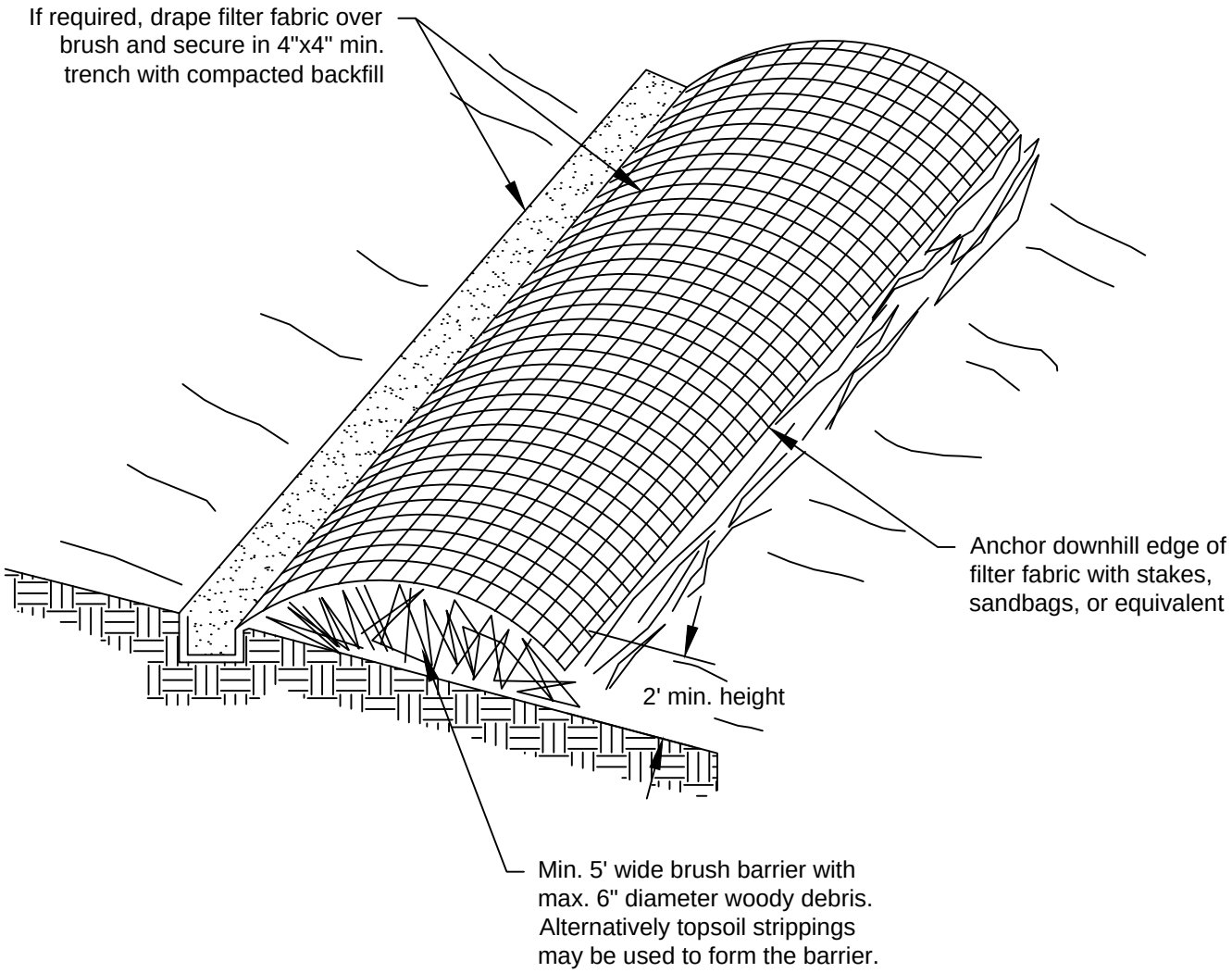

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State of Washington

Figure II-4.2.11
Brush Barrier

Revised September 2015

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

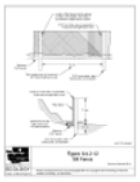
Use of a silt fence reduces the transport of coarse sediment from a construction site by providing a temporary physical barrier to sediment and reducing the runoff velocities of overland flow. See Figure II-4.2.12 Silt Fence for details on silt fence construction.

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 II-4.2.12 Silt Fence



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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 II-4.2.3 Geotextile Standards):

Table II-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 II-4.2.12 Silt Fence 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 II-4.2.13 Silt Fence Installation by Slicing Method 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.

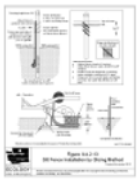
5. Attach the filter fabric to each post with three ties, all spaced within the top 8-inches of the filter fabric. Attach each tie diagonally 45 degrees through the filter fabric, with each puncture at least 1-inch vertically apart. Each tie should be positioned to hang on a post nipple when tightening 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.

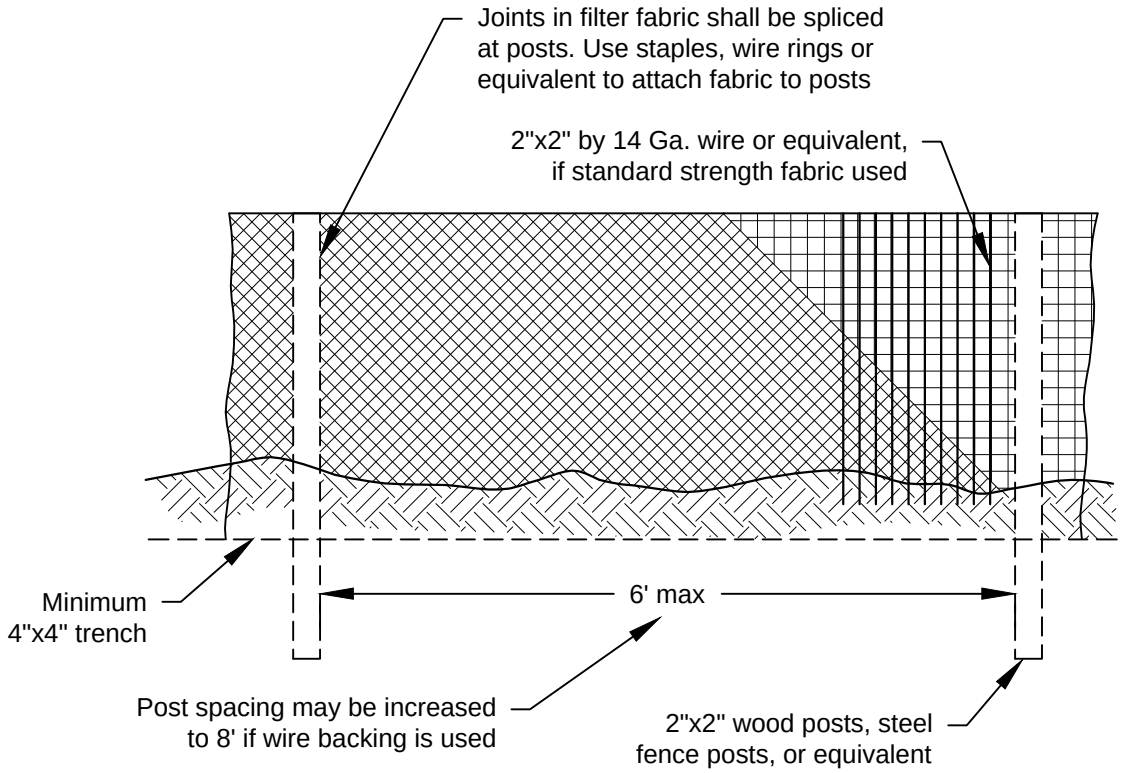
Figure II-4.2.13 Silt Fence Installation by Slicing Method



2014 Figure II-4.2.13 pdf download

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.



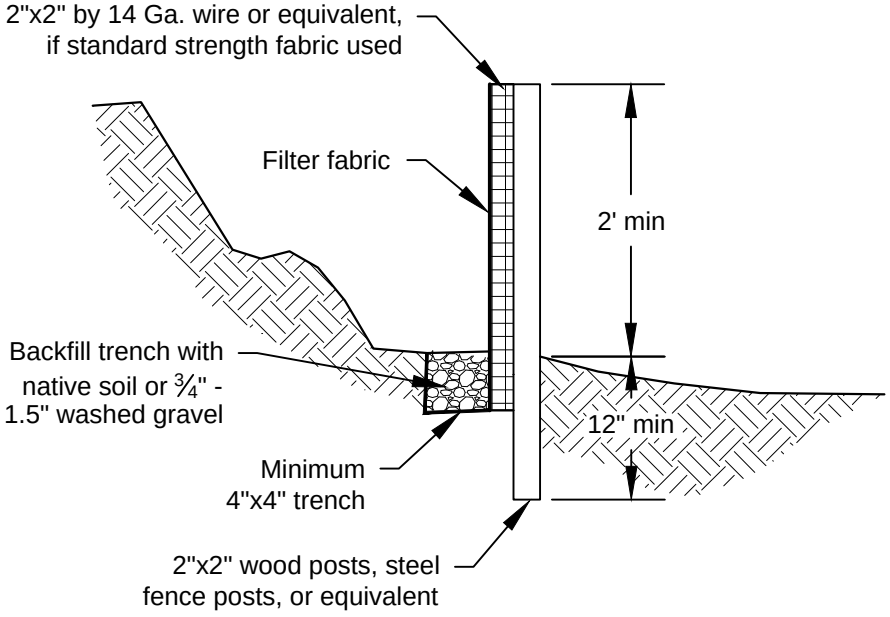


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Figure II-4.2.12
Silt Fence

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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 II-4.2.4 Contributing Drainage Area for Vegetated Strips):

Table II-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 II-4.2.14 Wattles 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.

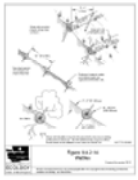
Design Criteria

- 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.

Figure II-4.2.14 Wattles



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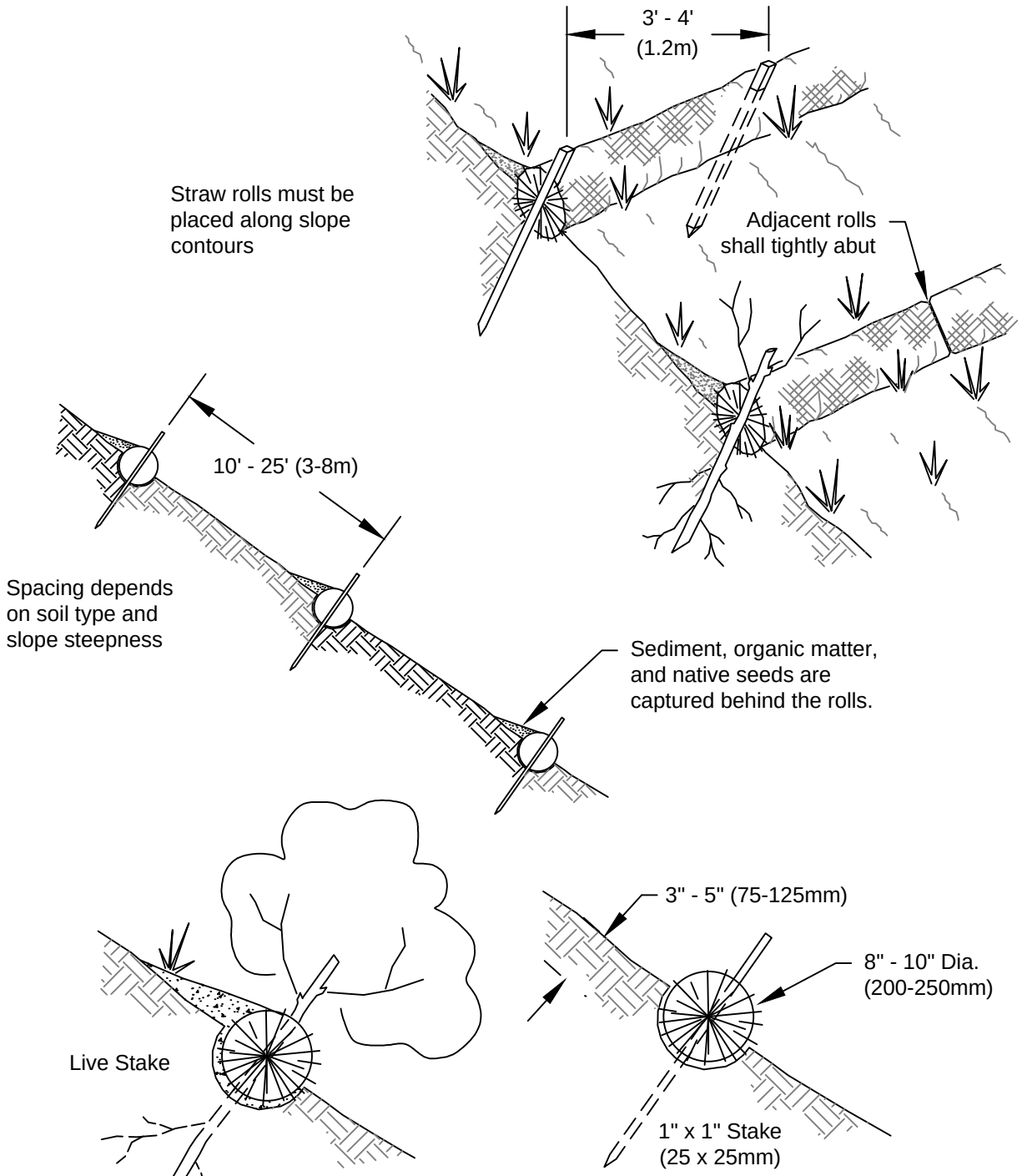
- Inspect the slope after significant storms and repair any areas where wattles are not tightly abutted or water has scoured beneath the wattles.

Approved as Equivalent

Ecology has approved products as able to meet the requirements of BMP C235: Wattles. 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



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.

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Figure II-4.2.14
Wattles

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BMP C236: Vegetative Filtration

Purpose

Vegetative Filtration may be used in conjunction with BMP C241: Temporary Sediment Pond, 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 II-4.2.15 Manifold and Branches in a Wooded, Vegetated Spray Field.
- 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 II-4.2.15 Manifold and Branches in a Wooded, Vegetated Spray Field

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BMP C240: Sediment Trap

Purpose

A sediment trap is a small temporary ponding area with a gravel outlet used to collect and store sediment from sites cleared and/or graded during construction. Sediment traps, along with other perimeter controls, shall be installed before any land disturbance takes place in the drainage area.

Conditions of Use

Prior to leaving a construction site, stormwater runoff must pass through a sediment pond or trap or other appropriate sediment removal best management practice. Non-engineered sediment traps may be used on-site prior to an engineered sediment trap or sediment pond to provide additional sediment removal capacity.

It is intended for use on sites where the tributary drainage area is less than 3 acres, with no unusual drainage features, and a projected build-out time of six months or less. The sediment trap is a temporary measure (with a design life of approximately 6 months) and shall be maintained until the site area is permanently protected against erosion by vegetation and/or structures.

Sediment traps and ponds are only effective in removing sediment down to about the medium silt size fraction. Runoff with sediment of finer grades (fine silt and clay) will pass through untreated, emphasizing the need to control erosion to the maximum extent first.

Whenever possible, sediment-laden water shall be discharged into on-site, relatively level, vegetated areas (see BMP C234: Vegetated Strip). This is the only way to effectively remove fine particles from runoff unless chemical treatment or filtration is used. This can be particularly useful after initial treatment in a sediment trap or pond. The areas of release must be evaluated on a site-by-site basis in order to determine appropriate locations for and methods of releasing runoff. Vegetated wetlands shall not be used for this purpose. Frequently, it may be possible to pump water from the collection point at the downhill end of the site to an upslope vegetated area. Pumping shall only augment the treatment system, not replace it, because of the possibility of pump failure or runoff volume in excess of pump capacity.

All projects that are constructing permanent facilities for runoff quantity control should use the rough-graded or final-graded permanent facilities for traps and ponds. This includes combined facilities and infiltration facilities. When permanent facilities are used as temporary sedimentation facilities, the surface area requirement of a sediment trap or pond must be met. If the surface area requirements are larger than the surface area of the permanent facility, then the trap or pond shall be enlarged to comply with the surface area requirement. The permanent pond shall also be divided into two cells as required for sediment ponds.

Either a permanent control structure or the temporary control structure (described in BMP C241: Temporary Sediment Pond) can be used. If a permanent control structure is used, it may be advisable to partially restrict the lower orifice with gravel to increase residence time while still allowing dewatering of the pond. A shut-off valve may be added to the control structure to allow complete retention of stormwater in emergency situations. In this case, an emergency overflow weir must be added.

A skimmer may be used for the sediment trap outlet if approved by the Local Permitting Authority.

Design and Installation Specifications

- See Figure II-4.2.16 Cross Section of Sediment Trap and Figure II-4.2.17 Sediment Trap Outlet for details.
- If permanent runoff control facilities are part of the project, they should be used for sediment retention.

- To determine the sediment trap geometry, first calculate the design surface area (SA) of the trap, measured at the invert of the weir. Use the following equation:

$$SA = FS(Q_2/V_S)$$

where

Q_2 = Design inflow based on the peak discharge from the developed 2-year runoff event from the contributing drainage area as computed in the hydrologic analysis. The 10-year peak flow shall be used if the project size, expected timing and duration of construction, or downstream conditions warrant a higher level of protection. If no hydrologic analysis is required, the Rational Method may be used.

V_S = The settling velocity of the soil particle of interest. The 0.02 mm (medium silt) particle with an assumed density of 2.65 g/cm3 has been selected as the particle of interest and has a settling velocity (Vs) of 0.00096 ft/sec.

FS = A safety factor of 2 to account for non-ideal settling.

Therefore, the equation for computing surface area becomes:

$$SA = 2 \times Q_2/0.00096$$

or

2080 square feet per cfs of inflow

Note: Even if permanent facilities are used, they must still have a surface area that is at least as large as that derived from the above formula. If they do not, the pond must be enlarged.

- To aid in determining sediment depth, all sediment traps shall have a staff gauge with a prominent mark 1-foot above the bottom of the trap.
- Sediment traps may not be feasible on utility projects due to the limited work space or the short-term nature of the work. Portable tanks may be used in place of sediment traps for utility projects.

Maintenance Standards

- Sediment shall be removed from the trap when it reaches 1-foot in depth.
- Any damage to the pond embankments or slopes shall be repaired.

Figure II-4.2.16 Cross Section of Sediment Trap

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Figure II-4.2.17 Sediment Trap Outlet

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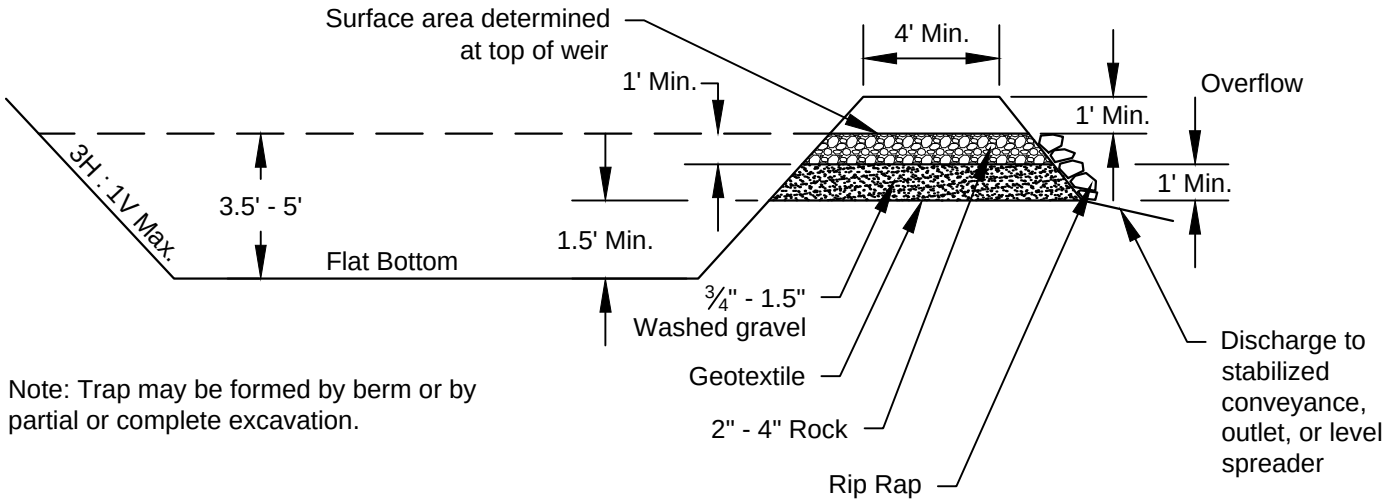

Note: Trap may be formed by berm or by partial or complete excavation.

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Figure II-4.2.16
Cross Section of Sediment Trap

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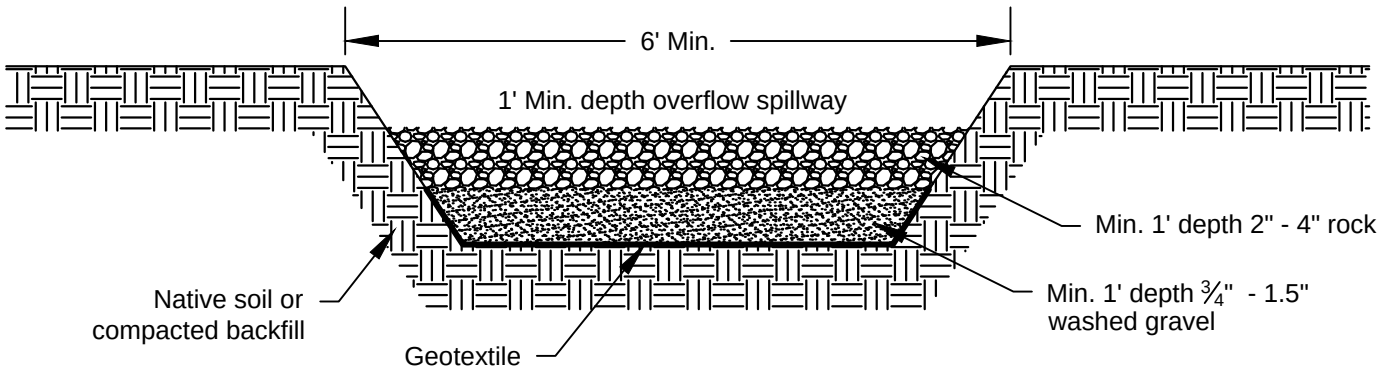

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Figure II-4.2.17
Sediment Trap Outlet

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BMP C241: Temporary Sediment Pond

Purpose

Sediment ponds remove sediment from runoff originating from disturbed areas of the site. Sediment ponds are typically designed to remove sediment no smaller than medium silt (0.02 mm). Consequently, they usually reduce turbidity only slightly.

Conditions of Use

Prior to leaving a construction site, stormwater runoff must pass through a sediment pond or other appropriate sediment removal best management practice.

A sediment pond shall be used where the contributing drainage area is 3 acres or more. Ponds must be used in conjunction with erosion control practices to reduce the amount of sediment flowing into the basin.

Design and Installation Specifications

- Sediment basins must be installed only on sites where failure of the structure would not result in loss of life, damage to homes or buildings, or interruption of use or service of public roads or utilities. Also, sediment traps and ponds are attractive to children and can be very dangerous. Compliance with local ordinances regarding health and safety must be addressed. If fencing of the pond is required, the type of fence and its location shall be shown on the ESC plan.

- Structures having a maximum storage capacity at the top of the dam of 10 acre-ft (435,600 ft^3) or more are subject to the Washington Dam Safety Regulations (Chapter 173-175 WAC).

- See Figure II-4.2.18 Sediment Pond Plan View, Figure II-4.2.19 Sediment Pond Cross Section, and Figure II-4.2.20 Sediment Pond Riser Detail for details.

- If permanent runoff control facilities are part of the project, they should be used for sediment retention. The surface area requirements of the sediment basin must be met. This may require temporarily enlarging the permanent basin to comply with the surface area requirements. The permanent control structure must be temporarily replaced with a control structure that only allows water to leave the pond from the surface or by pumping. The permanent control structure must be installed after the site is fully stabilized. .

- Use of infiltration facilities for sedimentation basins during construction tends to clog the soils and reduce their capacity to infiltrate. If infiltration facilities are to be used, the sides and bottom of the facility must only be rough excavated to a minimum of 2 feet above final grade. Final grading of the infiltration facility shall occur only when all contributing drainage areas are fully stabilized. The infiltration pretreatment facility should be fully constructed and used with the sedimentation basin to help prevent clogging.

- Determining Pond Geometry

  Obtain the discharge from the hydrologic calculations of the peak flow for the 2-year runoff event (Q_2). The 10-year peak flow shall be used if the project size, expected timing and duration of construction, or downstream conditions warrant a higher level of protection. If no hydrologic analysis is required, the Rational Method may be used.

  Determine the required surface area at the top of the riser pipe with the equation:

$$SA = 2 \times Q_2/0.00096$$

or

2080 square feet per cfs of inflow

See BMP C240: Sediment Trap for more information on the derivation of the surface area calculation.

The basic geometry of the pond can now be determined using the following design criteria:

- Required surface area SA (from Step 2 above) at top of riser.
- Minimum 3.5-foot depth from top of riser to bottom of pond.
- Maximum 3H:1V interior side slopes and maximum 2H:1V exterior slopes. The interior slopes can be increased to a maximum of 2H:1V if fencing is provided at or above the maximum water surface.
- One foot of freeboard between the top of the riser and the crest of the emergency spillway.
- Flat bottom.
- Minimum 1-foot deep spillway.
- Length-to-width ratio between 3:1 and 6:1.
- Sizing of Discharge Mechanisms.

The outlet for the basin consists of a combination of principal and emergency spillways. These outlets must pass the peak runoff expected from the contributing drainage area for a 100-year storm. If, due to site conditions and basin geometry, a separate emergency spill-way is not feasible, the principal spillway must pass the entire peak runoff expected from the 100-year storm. However, an attempt to provide a separate emergency spillway should always be made. The runoff calculations should be based on the site conditions during construction. The flow through the dewatering orifice cannot be utilized when calculating the 100-year storm elevation because of its potential to become clogged; therefore, available spillway storage must begin at the principal spillway riser crest.

The principal spillway designed by the procedures contained in this standard will result in some reduction in the peak rate of runoff. However, the riser outlet design will not adequately control the basin discharge to the predevelopment discharge limitations as stated in I-2.5.7 Minimum Requirement #7: Flow Control. However, if the basin for a permanent stormwater detention pond is used for a temporary sedimentation basin, the control structure for the permanent pond can be used to maintain predevelopment discharge limitations. The size of the basin, the expected life of the construction project, the anticipated downstream effects and the anticipated weather conditions during construction, should be considered to determine the need of additional discharge control. See Figure II-4.2.21 Riser Inflow Curves for riser inflow curves.

Figure II-4.2.18 Sediment Pond Plan View

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Figure II-4.2.19 Sediment Pond Cross Section

2014 Figure II-4.2.19 pdf download

Figure II-4.2.20 Sediment Pond Riser Detail

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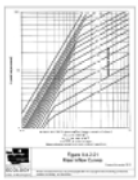
Figure II-4.2.21 Riser Inflow Curves



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Principal Spillway: Determine the required diameter for the principal spillway (riser pipe). The diameter shall be the minimum necessary to pass the site's 15-minute, 10-year flowrate. If using the Western Washington Hydrology Model (WWHM), Version 2 or 3, design flow is the 10-year (1 hour) flow for the developed (unmitigated) site, multiplied by a factor of 1.6. Use Figure II-4.2.21 Riser Inflow Curves to determine this diameter (h = 1-foot). *Note: A permanent control structure may be used instead of a temporary riser.*

Emergency Overflow Spillway: Determine the required size and design of the emergency overflow spillway for the developed 100-year peak flow using the method contained in Volume III.

Dewatering Orifice: Determine the size of the dewatering orifice(s) (minimum 1-inch diameter) using a modified version of the discharge equation for a vertical orifice and a basic equation for the area of a circular orifice. Determine the required area of the orifice with the following equation:

$$A_o = \frac{A_S(2h)^{0.5}}{0.6 \times 3600 T g^{0.5}}$$

where

A_O = orifice area (square feet)

A_S = pond surface area (square feet)

h = head of water above orifice (height of riser in feet)

T = dewatering time (24 hours)

g = acceleration of gravity (32.2 feet/second^2)

Convert the required surface area to the required diameter D of the orifice:

$$D = 24 \times \sqrt{\frac{A_o}{\pi}} = 13.54 \times \sqrt{A_o}$$

The vertical, perforated tubing connected to the dewatering orifice must be at least 2 inches larger in diameter than the orifice to improve flow characteristics. The size and number of perforations in the tubing should be large enough so that the tubing does not restrict flow. The orifice should control the flow rate.

- Additional Design Specifications

  The pond shall be divided into two roughly equal volume cells by a permeable divider that will reduce turbulence while allowing movement of water between cells. The divider shall be at least one-half the height of the riser and a minimum of one foot below the top of the riser. Wire-backed, 2- to 3-foot high, extra strength filter fabric supported by treated 4"x4"s can be used as a divider. Alternatively, staked straw bales wrapped with filter fabric (geotextile) may be used. If the pond is more than 6 feet deep, a different mechanism must be proposed. A riprap embankment is one acceptable method of separation for deeper ponds. Other designs that satisfy the intent of this provision are allowed as long as the divider is permeable, structurally sound, and designed to prevent erosion under or around the barrier.

  To aid in determining sediment depth, one-foot intervals shall be prominently marked on the riser.

  If an embankment of more than 6 feet is proposed, the pond must comply with the criteria contained in Volume III regarding dam safety for detention BMPs.

- The most common structural failure of sedimentation basins is caused by piping. Piping refers to two phenomena: (1) water seeping through fine-grained soil, eroding the soil grain by grain and forming pipes or tunnels; and, (2) water under pressure flowing upward through a granular soil with a head of sufficient magnitude to cause soil grains to lose contact and capability for support.

  The most critical construction sequences to prevent piping will be:

  1. Tight connections between riser and barrel and other pipe connections.
  2. Adequate anchoring of riser.
  3. Proper soil compaction of the embankment and riser footing.
  4. Proper construction of anti-seep devices.

Maintenance Standards

- Sediment shall be removed from the pond when it reaches 1–foot in depth.
- Any damage to the pond embankments or slopes shall be repaired.

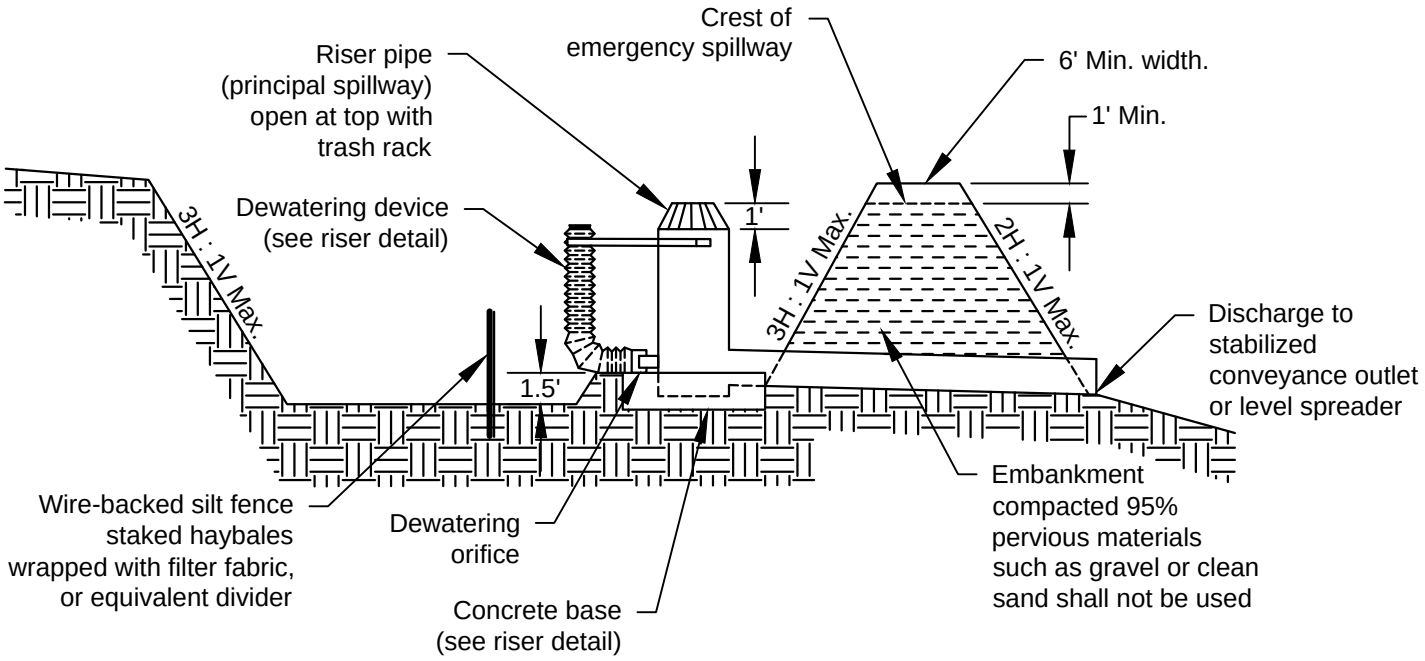

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Figure II-4.2.19
Sediment Pond Cross Section

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BMP C250: Construction Stormwater Chemical Treatment

Purpose

This BMP applies when using stormwater chemicals in batch treatment or flow-through treatment.

Turbidity is difficult to control once fine particles are suspended in stormwater runoff from a construction site. Sedimentation ponds are effective at removing larger particulate matter by gravity settling, but are ineffective at removing smaller particulates such as clay and fine silt. Traditional erosion and sediment control BMPs may not be adequate to ensure compliance with the water quality standards for turbidity in receiving water.

Chemical treatment can reliably provide exceptional reductions of turbidity and associated pollutants. Chemical treatment may be required to meet turbidity stormwater discharge requirements, especially when construction is to proceed through the wet season.

Conditions of Use

Formal written approval from Ecology is required for the use of chemical treatment regardless of site size. The Local Permitting Authority may also require review and approval. When approved, the chemical treatment systems must be included in the Construction Stormwater Pollution Prevention Plan (SWPPP).

Design and Installation Specifications

See Appendix II-B: Background Information on Chemical Treatment for background information on chemical treatment.

Criteria for Chemical Treatment Product Use: Chemically treated stormwater discharged from construction sites must be nontoxic to aquatic organisms. The Chemical Technology Assessment Protocol (CTAPE) must be used to evaluate chemicals proposed for stormwater treatment. Only chemicals approved by Ecology under the CTAPE may be used for stormwater treatment. The approved chemicals, their allowable application techniques (batch treatment or flow-through treatment), allowable application rates, and conditions of use can be found at the Department of Ecology Emerging Technologies website: http://www.ecy.wa.gov/programs/wq/stormwater/newtech/technologies.html.

Treatment System Design Considerations: The design and operation of a chemical treatment system should take into consideration the factors that determine optimum, cost-effective performance. It is important to recognize the following:

- Only Ecology approved chemicals may be used and must follow approved dose rate.
- The pH of the stormwater must be in the proper range for the polymers to be effective, which is typically 6.5 to 8.5
- The coagulant must be mixed rapidly into the water to ensure proper dispersion.
- A flocculation step is important to increase the rate of settling, to produce the lowest turbidity, and to keep the dosage rate as low as possible.
- Too little energy input into the water during the flocculation phase results in flocs that are too small and/or insufficiently dense. Too much energy can rapidly destroy floc as it is formed.
- Care must be taken in the design of the withdrawal system to minimize outflow velocities and to prevent floc discharge. Discharge from a batch treatment system should be directed through a physical filter such as a vegetated swale that would catch any unintended floc discharge. Currently, flow-through systems always discharge through the chemically enhanced sand filtration system.

- System discharge rates must take into account downstream conveyance integrity.

Polymer Batch Treatment Process Description:

A batch chemical treatment system consists of the stormwater collection system (either temporary diversion or the permanent site drainage system), a storage pond, pumps, a chemical feed system, treatment cells, and interconnecting piping.

The batch treatment system shall use a minimum of two lined treatment cells in addition to an untreated stormwater storage pond. Multiple treatment cells allow for clarification of treated water while other cells are being filled or emptied. Treatment cells may be ponds or tanks. Ponds with constructed earthen embankments greater than six feet high or which impound more than 10 acre-feet require special engineering analyses. The Ecology Dam Safety Section has specific design criteria for dams in Washington State (see http://www.ecy.wa.gov/programs/wr/dams/GuidanceDocs.html).

Stormwater is collected at interception point(s) on the site and is diverted by gravity or by pumping to an untreated stormwater storage pond or other untreated stormwater holding area. The stormwater is stored until treatment occurs. It is important that the holding pond be large enough to provide adequate storage.

The first step in the treatment sequence is to check the pH of the stormwater in the untreated stormwater storage pond. The pH is adjusted by the application of carbon dioxide or a base until the stormwater in the storage pond is within the desired pH range, 6.5 to 8.5. When used, carbon dioxide is added immediately downstream of the transfer pump. Typically sodium bicarbonate (baking soda) is used as a base, although other bases may be used. When needed, base is added directly to the untreated stormwater storage pond. The stormwater is recirculated with the treatment pump to provide mixing in the storage pond. Initial pH adjustments should be based on daily bench tests. Further pH adjustments can be made at any point in the process.

Once the stormwater is within the desired pH range (dependant on polymer being used), the stormwater is pumped from the untreated stormwater storage pond to a treatment cell as polymer is added. The polymer is added upstream of the pump to facilitate rapid mixing.

After polymer addition, the water is kept in a lined treatment cell for clarification of the sediment-floc. In a batch mode process, clarification typically takes from 30 minutes to several hours. Prior to discharge samples are withdrawn for analysis of pH, flocculent chemical concentration, and turbidity. If both are acceptable, the treated water is discharged.

Several configurations have been developed to withdraw treated water from the treatment cell. The original configuration is a device that withdraws the treated water from just beneath the water surface using a float with adjustable struts that prevent the float from settling on the cell bottom. This reduces the possibility of picking up sediment-floc from the bottom of the pond. The struts are usually set at a minimum clearance of about 12 inches; that is, the float will come within 12 inches of the bottom of the cell. Other systems have used vertical guides or cables which constrain the float, allowing it to drift up and down with the water level. More recent designs have an H-shaped array of pipes, set on the horizontal.

This scheme provides for withdrawal from four points rather than one. This configuration reduces the likelihood of sucking settled solids from the bottom. It also reduces the tendency for a vortex to form. Inlet diffusers, a long floating or fixed pipe with many small holes in it, are also an option.

Safety is a primary concern. Design should consider the hazards associated with operations, such as sampling. Facilities should be designed to reduce slip hazards and drowning. Tanks and ponds should have life rings, ladders, or steps extending from the bottom to the top.

Polymer Batch Treatment Process Description:

At a minimum, a flow-through chemical treatment system consists of the stormwater collection system (either temporary diversion or the permanent site drainage system), an untreated stormwater storage pond, and the chemically enhanced sand filtration system.

Stormwater is collected at interception point(s) on the site and is diverted by gravity or by pumping to an untreated stormwater storage pond or other untreated stormwater holding area. The stormwater is stored until treatment occurs. It is important that the holding pond be large enough to provide adequate storage.

Stormwater is then pumped from the untreated stormwater storage pond to the chemically enhanced sand filtration system where polymer is added. Adjustments to pH may be necessary before chemical addition. The sand filtration system continually monitors the stormwater for turbidity and pH. If the discharge water is ever out of an acceptable range for turbidity or pH, the water is recycled to the untreated stormwater pond where it can be retreated.

For batch treatment and flow-through treatment, the following equipment should be located in a lockable shed:

- The chemical injector.
- Secondary containment for acid, caustic, buffering compound, and treatment chemical.
- Emergency shower and eyewash.
- Monitoring equipment which consists of a pH meter and a turbidimeter.

System Sizing:

Certain sites are required to implement flow control for the developed sites. These sites must also control stormwater release rates during construction. Generally, these are sites that discharge stormwater directly, or indirectly, through a conveyance system, into a fresh water. System sizing is dependent on flow control requirements.

Sizing Criteria for Batch Treatment Systems for Flow Control Exempt Water Bodies:

The total volume of the untreated stormwater storage pond and treatment ponds or tanks must be large enough to treat stormwater that is produced during multiple day storm events. It is recommended that at a minimum the untreated stormwater storage pond be sized to hold 1.5 times the runoff volume of the 10-year, 24-hour storm event. Bypass should be provided around the chemical treatment system to accommodate extreme storm events. Runoff volume shall be calculated using the methods presented in Chapter III-2 - Hydrologic Analysis. Worst-case land cover conditions (i.e., producing the most runoff) should be used for analyses (in most cases, this would be the land cover conditions just prior to final landscaping).

Primary settling should be encouraged in the untreated stormwater storage pond. A forebay with access for maintenance may be beneficial.

There are two opposing considerations in sizing the treatment cells. A larger cell is able to treat a larger volume of water each time a batch is processed. However, the larger the cell the longer the time required to empty the cell. A larger cell may also be less effective at flocculation and therefore require a longer settling time. The simplest approach to sizing the treatment cell is to multiply the allowable discharge flow rate times the desired drawdown time. A 4-hour drawdown time allows one batch per cell per 8-hour work period, given 1 hour of flocculation followed by two hours of settling.

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

Ponds sized for flow control water bodies must at a minimum meet the sizing criteria for flow control exempt waters.

Sizing Criteria for Flow-Through Treatment Systems for Flow Control Exempt Water Bodies:

When sizing storage ponds or tanks for flow-through systems for flow control exempt water bodies, the treatment system capacity should be a factor. The untreated stormwater storage pond or tank should be sized to hold 1.5 times the runoff volume of the 10-year, 24-hour storm event minus the treatment system flowrate for an 8-hour period. For a chitosan-enhanced sand filtration system, the treatment system flowrate should be sized using a hydraulic loading rate between 6-8 gpm/ft^2. Other hydraulic loading rates may be more appropriate for other systems. Bypass should be provided around the chemical treatment system to accommodate extreme storms. Runoff volume shall be calculated using the methods presented in Chapter III-2 - Hydrologic Analysis. Worst-case land cover conditions (i.e., producing the most runoff) should be used for analyses (in most cases, this would be the land cover conditions just prior to final landscaping).

Sizing Criteria for Flow Control Water Bodies:

Sites that must implement flow control for the developed site condition must also control stormwater release rates during construction. Construction site stormwater discharges shall not exceed the discharge durations of the pre-developed condition for the range of pre-developed discharge rates from ½ of the 2-year flow through the 10-year flow as predicted by an approved continuous runoff model. The pre-developed condition to be matched shall be the land cover condition immediately prior to the development project. This restriction on release rates can affect the size of the storage pond and treatment cells.

The following is how WWHM can be used to determine the release rates from the chemical treatment systems:

1. Determine the pre-developed flow durations to be matched by entering the existing land use area under the “Pre-developed” scenario in WWHM. The default flow range is from ½ of the 2-year flow through the 10-year flow.

2. Enter the post developed land use area in the “Developed Unmitigated” scenario in WWHM.

3. Copy the land use information from the “Developed Unmitigated” to “Developed Mitigated” scenario.

4. While in the “Developed Mitigated” scenario, add a pond element under the basin element containing the post-developed land use areas. This pond element represents information on the available untreated stormwater storage and discharge from the chemical treatment system. In cases where the discharge from the chemical treatment system is controlled by a pump, a stage/storage/discharge (SSD) table representing the pond must be generated outside WWHM and imported into WWHM. WWHM can route the runoff from the post-developed condition through this SSD table (the pond) and determine compliance with the flow duration standard. This would be an iterative design procedure where if the initial SSD table proved to be inadequate, the designer would have to modify the SSD table outside WWHM and re-import in WWHM and route the runoff through it again. The iteration will continue until a pond that complies with the flow duration standard is correctly sized.

   Notes on SSD table characteristics:

   - The pump discharge rate would likely be initially set at just below ½ of the 2-year flow from the pre-developed condition. As runoff coming into the untreated stormwater storage pond increases and the available untreated stormwater storage volume gets used up, it would be necessary to increase the pump discharge rate above ½ of the 2-year. The increase(s) above ½ of the 2-year must be such that they provide some relief to the untreated stormwater storage needs but at the same time will not cause

violations of the flow duration standard at the higher flows. The final design SSD table will identify the appropriate pumping rates and the corresponding stage and storages.

- When building such a flow control system, the design must ensure that any automatic adjustments to the pumping rates will be as a result of changes to the available storage in accordance with the final design SSD table.

5. It should be noted that the above procedures would be used to meet the flow control requirements. The chemical treatment system must be able to meet the runoff treatment requirements. It is likely that the discharge flow rate of ½ of the 2-year or more may exceed the treatment capacity of the system. If that is the case, the untreated stormwater discharge rate(s) (i.e., influent to the treatment system) must be reduced to allow proper treatment. Any reduction in the flows would likely result in the need for a larger untreated stormwater storage volume.

   If the discharge is to a municipal storm drainage system, the allowable discharge rate may be limited by the capacity of the public system. It may be necessary to clean the municipal storm drainage system prior to the start of the discharge to prevent scouring solids from the drainage system. If the municipal storm drainage system discharges to a water body not on the flow control exempt list, the project site is subject to flow control requirements. Obtain permission from the owner of the collection system before discharging to it.

If system design does not allow you to discharge at the slower rates as described above and if the site has a retention or detention pond that will serve the planned development, the discharge from the treatment system may be directed to the permanent retention/detention pond to comply with the flow control requirement. In this case, the untreated stormwater storage pond and treatment system will be sized according to the sizing criteria for flow-through treatment systems for flow control exempt water bodies described earlier except all discharge (water passing through the treatment system and stormwater bypassing the treatment system) will be directed into the permanent retention/detention pond. If site constraints make locating the untreated stormwater storage pond difficult, the permanent retention/detention pond may be divided to serve as the untreated stormwater storage pond and the post-treatment flow control pond. A berm or barrier must be used in this case so the untreated water does not mix with the treated water. Both untreated stormwater storage requirements, and adequate post-treatment flow control must be achieved. The post-treatment flow control pond's revised dimensions must be entered into the WWHM and the WWHM must be run to confirm compliance with the flow control requirement.

Maintenance Standards

Monitoring: At a minimum, the following monitoring shall be conducted. Test results shall be recorded on a daily log kept on site. Additional testing may be required by the NPDES permit based on site conditions.

Operational Monitoring:

- Total volume treated and discharged.
- Flow must be continuously monitored and recorded at not greater than 15-minute intervals.
- Type and amount of chemical used for pH adjustment.
- Amount of polymer used for treatment.
- Settling time.

Compliance Monitoring:

- Influent and effluent pH, flocculent chemical concentration, and turbidity must be continuously monitored and recorded at not greater than 15-minute intervals. pH and turbidity of the receiving water.

Biomonitoring:

Treated stormwater must be non-toxic to aquatic organisms. Treated stormwater must be tested for aquatic toxicity or residual chemicals. Frequency of biomonitoring will be determined by Ecology.

Residual chemical tests must be approved by Ecology prior to their use.

If testing treated stormwater for aquatic toxicity, you must test for acute (lethal) toxicity. Bioassays shall be conducted by a laboratory accredited by Ecology, unless otherwise approved by Ecology. Acute toxicity tests shall be conducted per the CTAPE protocol.

Discharge Compliance: Prior to discharge, treated stormwater must be sampled and tested for compliance with pH, flocculent chemical concentration, and turbidity limits. These limits may be established by the Construction Stormwater General Permit or a site-specific discharge permit. Sampling and testing for other pollutants may also be necessary at some sites. pH must be within the range of 6.5 to 8.5 standard units and not cause a change in the pH of the receiving water of more than 0.2 standard units. Treated stormwater samples and measurements shall be taken from the discharge pipe or another location representative of the nature of the treated stormwater discharge. Samples used for determining compliance with the water quality standards in the receiving water shall not be taken from the treatment pond prior to decanting. Compliance with the water quality standards is determined in the receiving water.

Operator Training: Each contractor who intends to use chemical treatment shall be trained by an experienced contractor . Each site using chemical treatment must have an operator trained and certified by an organization approved by Ecology.

Standard BMPs: Surface stabilization BMPs should be implemented on site to prevent significant erosion. All sites shall use a truck wheel wash to prevent tracking of sediment off site.

Sediment Removal and Disposal:

- Sediment shall be removed from the storage or treatment cells as necessary. Typically, sediment removal is required at least once during a wet season and at the decommissioning of the cells. Sediment remaining in the cells between batches may enhance the settling process and reduce the required chemical dosage.

- Sediment that is known to be non-toxic may be incorporated into the site away from drainages.

BMP C251: Construction Stormwater Filtration

Purpose

Filtration removes sediment from runoff originating from disturbed areas of the site.

Background Information:

Filtration with sand media has been used for over a century to treat water and wastewater. The use of sand filtration for treatment of stormwater has developed recently, generally to treat runoff from streets, parking lots, and residential areas. The application of filtration to construction stormwater treatment is currently under development.

Conditions of Use

Traditional BMPs used to control soil erosion and sediment loss from sites under development may not be adequate to ensure compliance with the water quality standard for turbidity in the receiving water. Filtration may be used in conjunction with gravity settling to remove sediment as small as fine silt (0.5 µm). The reduction in turbidity will be dependent on the particle size distribution of the sediment in the stormwater. In some circumstances, sedimentation and filtration may achieve compliance with the water quality standard for turbidity.

The use of construction stormwater filtration does not require approval from Ecology as long as treatment chemicals are not used. Filtration in conjunction with polymer treatment requires testing under the Chemical Technology Assessment Protocol – Ecology (CTAPE) before it can be initiated. Approval from the appropriate regional Ecology office must be obtained at each site where polymers use is proposed prior to use. For more guidance on stormwater chemical treatment see BMP C250: Construction Stormwater Chemical Treatment.

Design and Installation Specifications

Two types of filtration systems may be applied to construction stormwater treatment: rapid and slow. Rapid sand filters are the typical system used for water and wastewater treatment. They can achieve relatively high hydraulic flow rates, on the order of 2 to 20 gpm/sf, because they have automatic backwash systems to remove accumulated solids. In contrast, slow sand filters have very low hydraulic rates, on the order of 0.02 gpm/sf, because they do not have backwash systems. Slow sand filtration has generally been used to treat stormwater. Slow sand filtration is mechanically simple in comparison to rapid sand filtration but requires a much larger filter area.

Filtration Equipment. Sand media filters are available with automatic backwashing features that can filter to 50 µm particle size. Screen or bag filters can filter down to 5 µm. Fiber wound filters can remove particles down to 0.5 µm. Filters should be sequenced from the largest to the smallest pore opening. Sediment removal efficiency will be related to particle size distribution in the stormwater.

Treatment Process Description. Stormwater is collected at interception point(s) on the site and is diverted to an untreated stormwater sediment pond or tank for removal of large sediment and storage of the stormwater before it is treated by the filtration system. The untreated stormwater is pumped from the trap, pond, or tank through the filtration system in a rapid sand filtration system. Slow sand filtration systems are designed as flow through systems using gravity.

Maintenance Standards

Rapid sand filters typically have automatic backwash systems that are triggered by a pre-set pressure drop across the filter. If the backwash water volume is not large or substantially more turbid than the untreated stormwater stored in the holding pond or tank, backwash return to the untreated stormwater pond or tank may be appropriate. However, other means of treatment and disposal may be necessary.

- Screen, bag, and fiber filters must be cleaned and/or replaced when they become clogged.
- Sediment shall be removed from the storage and/or treatment ponds as necessary. Typically, sediment removal is required once or twice during a wet season and at the decommissioning of the ponds.

Sizing Criteria for Flow-Through Treatment Systems for Flow Control Exempt Water Bodies:

When sizing storage ponds or tanks for flow-through systems for flow control exempt water bodies the treatment system capacity should be a factor. The untreated stormwater storage pond or tank should be sized to hold 1.5 times the runoff volume of the 10-year, 24-hour storm event minus the treatment system flowrate for an 8-hour period. For a chitosan-enhanced sand filtration system, the treatment system flowrate should be sized using a hydraulic loading rate between 6-8 gpm/ft^2. Other hydraulic loading rates may be more appropriate for other systems. Bypass should be provided around the chemical treatment system to accommodate extreme storms. Runoff volume shall be calculated using the methods presented in Chapter III-2 - Hydrologic Analysis. Worst-case conditions (i.e., producing the most runoff) should be used for analyses (most likely conditions present prior to final landscaping).

Sizing Criteria for Flow Control Water Bodies:

Sites that must implement flow control for the developed site condition must also control stormwater release rates during construction. Construction site stormwater discharges shall not exceed the discharge durations of the pre-developed condition for the range of pre-developed discharge rates from 1/2 of the 2-year flow through the 10-year flow as predicted by an approved continuous runoff model. The pre-developed condition to be matched shall be the land cover condition immediately prior to the development project. This restriction on release rates can affect the size of the storage pond, the filtration system, and the flow rate through the filter system.

The following is how WWHM can be used to determine the release rates from the filtration systems:

1. Determine the pre-developed flow durations to be matched by entering the land use area under the “Pre-developed” scenario in WWHM. The default flow range is from ½ of the 2-year flow through the 10-year flow.
2. Enter the post developed land use area in the “Developed Unmitigated” scenario in WWHM.
3. Copy the land use information from the “Developed Unmitigated” to “Developed Mitigated” scenario.
4. There are two possible ways to model stormwater filtration systems:
    a. The stormwater filtration system uses an untreated stormwater storage pond/tank and the discharge from this pond/tank is pumped to one or more filters. In-line filtration chemicals would be added to the flow right after the pond/tank and before the filter(s). Because the discharge is pumped, WWHM can’t generate a stage/storage /discharge (SSD) table for this system. This system is modeled the same way as described in BMP C250: Construction Stormwater Chemical Treatment and is as follows:

        While in the “Developed Mitigated” scenario, add a pond element under the basin element containing the post-developed land use areas. This pond element represents information on the available untreated stormwater storage and discharge from the filtration system. In cases where the discharge from the filtration system is controlled by a pump, a stage/storage/discharge (SSD) table representing the pond must be generated outside WWHM and imported into WWHM. WWHM can route the runoff from the post-developed condition through this SSD table (the pond) and determine compliance with the flow duration standard. This would be an iterative design procedure where if the

initial SSD table proved to be out of compliance, the designer would have to modify the SSD table outside WWHM and re-import in WWHM and route the runoff through it again. The iteration will continue until a pond that enables compliance with the flow duration standard is designed.

Notes on SSD table characteristics:

- The pump discharge rate would likely be initially set at just below ½ if the 2-year flow from the pre-developed condition. As runoff coming into the untreated stormwater storage pond increases and the available untreated stormwater storage volume gets used up, it would be necessary to increase the pump discharge rate above ½ of the 2-year. The increase(s) above ½ of the 2-year must be such that they provide some relief to the untreated stormwater storage needs but at the same time they will not cause violations of the flow duration standard at the higher flows. The final design SSD table will identify the appropriate pumping rates and the corresponding stage and storages.

- When building such a flow control system, the design must ensure that any automatic adjustments to the pumping rates will be as a result of changes to the available storage in accordance with the final design SSD table.

b. The stormwater filtration system uses a storage pond/tank and the discharge from this pond/tank gravity flows to the filter. This is usually a slow sand filter system and it is possible to model it in WWHM as a Filter element or as a combination of Pond and Filter element placed in series. The stage/storage/discharge table(s) may then be generated within WWHM as follows:

    i. While in the “Developed Mitigated” scenario, add a Filter element under the basin element containing the post-developed land use areas. The length and width of this filter element would have to be the same as the bottom length and width of the upstream untreated stormwater storage pond/tank.

    ii. In cases where the length and width of the filter is not the same as those for the bottom of the upstream untreated stormwater storage tank/pond, the treatment system may be modeled as a Pond element followed by a Filter element. By having these two elements, WWHM would then generate a SSD table for the storage pond which then gravity flows to the Filter element. The Filter element downstream of the untreated stormwater storage pond would have a storage component through the media, and an overflow component for when the filtration capacity is exceeded.

WWHM can route the runoff from the post-developed condition through the treatment systems in 4b and determine compliance with the flow duration standard. This would be an iterative design procedure where if the initial sizing estimates for the treatment system proved to be inadequate, the designer would have to modify the system and route the runoff through it again. The iteration would continue until compliance with the flow duration standard is achieved.

5. It should be noted that the above procedures would be used to meet the flow control requirements. The filtration system must be able to meet the runoff treatment requirements. It is likely that the discharge flow rate of ½ of the 2-year or more may exceed the treatment capacity of the system. If that is the case, the untreated stormwater discharge rate(s) (i.e., influent to the treatment system) must be reduced to allow proper treatment. Any reduction in the flows would likely result in the need for a larger untreated stormwater storage volume.

If system design does not allow you to discharge at the slower rates as described above and if the site has a retention or detention pond that will serve the planned development, the discharge from the treatment system may be directed to the permanent retention/detention pond to comply with the flow control requirements. In this case, the untreated stormwater storage pond and treatment system will be sized according to the sizing criteria for flow-through treatment systems for flow control exempt waterbodies described earlier except all discharges (water passing through the treatment system and stormwater bypassing the treatment system) will be directed into the permanent retention/detention pond. If site constraints make locating the untreated stormwater storage pond difficult, the permanent retention/detention pond may be divided to serve as the untreated stormwater discharge pond and the post-treatment flow control pond. A berm or barrier must be used in this case so the untreated water does not mix with the treated water. Both untreated stormwater storage requirements, and adequate post-treatment flow control must be achieved. The post-treatment flow control pond's revised dimensions must be entered into the WWHM and the WWHM must be run to confirm compliance with the flow control requirement.

BMP C252: High pH Neutralization Using CO_2

Purpose

When pH levels in stormwater rise above 8.5 it is necessary to lower the pH levels to the acceptable range of 6.5 to 8.5, this process is called pH neutralization. pH neutralization involves the use of solid or compressed carbon dioxide gas in water requiring neutralization. Neutralized stormwater may be discharged to surface waters under the General Construction NPDES permit.

Neutralized process water such as concrete truck wash-out, hydro-demolition, or saw-cutting slurry must be managed to prevent discharge to surface waters. Any stormwater contaminated during concrete work is considered process wastewater and must not be discharged to surface waters.

Reason for pH Neutralization:

A pH level range of 6.5 to 8.5 is typical for most natural watercourses, and this neutral pH is required for the survival of aquatic organisms. Should the pH rise or drop out of this range, fish and other aquatic organisms may become stressed and may die.

Calcium hardness can contribute to high pH values and cause toxicity that is associated with high pH conditions. A high level of calcium hardness in waters of the state is not allowed.

The water quality standard for pH in Washington State is in the range of 6.5 to 8.5. Ground water standard for calcium and other dissolved solids in Washington State is less than 500 mg/l.

Conditions of Use

Causes of High pH:

High pH at construction sites is most commonly caused by the contact of stormwater with poured or recycled concrete, cement, mortars, and other Portland cement or lime containing construction materials. (See BMP C151: Concrete Handling for more information on concrete handling procedures). The principal caustic agent in cement is calcium hydroxide (free lime).

Advantages of CO_2 Sparging:

- Rapidly neutralizes high pH water.
- Cost effective and safer to handle than acid compounds.
- CO_2 is self-buffering. It is difficult to overdose and create harmfully low pH levels.
- Material is readily available.

The Chemical Process:

When carbon dioxide (CO_2) is added to water (H_2O), carbonic acid (H_2CO_3) is formed which can further dissociate into a proton (H+) and a bicarbonate anion (HCO_3-) as shown below:

$$CO_2 + H_2O \leftrightarrow H_2CO_3 \leftrightarrow H+ + HCO_3-$$

The free proton is a weak acid that can lower the pH. Water temperature has an effect on the reaction as well. The colder the water temperature is the slower the reaction occurs and the warmer the water temperature is the quicker the reaction occurs. Most construction applications in Washington State have water temperatures in the 50°F or higher range so the reaction is almost simultaneous.

Design and Installation Specifications

Treatment Process:

High pH water may be treated using continuous treatment, continuous discharge systems. These manufactured systems continuously monitor influent and effluent pH to ensure that pH values are within an acceptable range before being discharged. All systems must have fail safe automatic shut off switches in the event that pH is not within the acceptable discharge range. Only trained operators may operate manufactured systems. System manufacturers often provide trained operators or training on their devices.

The following procedure may be used when not using a continuous discharge system:

1. Prior to treatment, the appropriate jurisdiction should be notified in accordance with the regulations set by the jurisdiction.
2. Every effort should be made to isolate the potential high pH water in order to treat it separately from other stormwater on-site.
3. Water should be stored in an acceptable storage facility, detention pond, or containment cell prior to treatment.
4. Transfer water to be treated to the treatment structure. Ensure that treatment structure size is sufficient to hold the amount of water that is to be treated. Do not fill tank completely, allow at least 2 feet of freeboard.
5. The operator samples the water for pH and notes the clarity of the water. As a rule of thumb, less CO_2 is necessary for clearer water. This information should be recorded.
6. In the pH adjustment structure, add CO_2 until the pH falls in the range of 6.9-7.1. Remember that pH water quality standards apply so adjusting pH to within 0.2 pH units of receiving water (background pH) is recommended. It is unlikely that pH can be adjusted to within 0.2 pH units using dry ice. Compressed carbon dioxide gas should be introduced to the water using a carbon dioxide diffuser located near the bottom of the tank, this will allow carbon dioxide to bubble up through the water and diffuse more evenly.
7. Slowly discharge the water making sure water does not get stirred up in the process. Release about 80% of the water from the structure leaving any sludge behind.
8. Discharge treated water through a pond or drainage system.
9. Excess sludge needs to be disposed of properly as concrete waste. If several batches of water are undergoing pH treatment, sludge can be left in treatment structure for the next batch treatment. Dispose of sludge when it fills 50% of tank volume.

Sites that must implement flow control for the developed site must also control stormwater release rates during construction. All treated stormwater must go through a flow control facility before being released to surface waters which require flow control.

Maintenance Standards

Safety and Materials Handling:

- All equipment should be handled in accordance with OSHA rules and regulations.
- Follow manufacturer guidelines for materials handling.

Operator Records:

Each operator should provide:

- A diagram of the monitoring and treatment equipment.
- A description of the pumping rates and capacity the treatment equipment is capable of treating.

Each operator should keep a written record of the following:

- Client name and phone number.
- Date of treatment.
- Weather conditions.
- Project name and location.
- Volume of water treated.
- pH of untreated water.
- Amount of CO_2 needed to adjust water to a pH range of 6.9-7.1.
- pH of treated water.
- Discharge point location and description.

A copy of this record should be given to the client/contractor who should retain the record for three years.

BMP C253: pH Control for High pH Water

Purpose

When pH levels in stormwater rise above 8.5 it is necessary to lower the pH levels to the acceptable range of 6.5 to 8.5, this process is called pH neutralization. Stormwater with pH levels exceeding water quality standards may be treated by infiltration, dispersion in vegetation or compost, pumping to a sanitary sewer, disposal at a permitted concrete batch plant with pH neutralization capabilities, or carbon dioxide sparging. BMP C252: High pH Neutralization Using CO2 gives guidelines for carbon dioxide sparging.

Reason for pH Neutralization:

A pH level range of 6.5 to 8.5 is typical for most natural watercourses, and this pH range is required for the survival of aquatic organisms. Should the pH rise or drop out of this range, fish and other aquatic organisms may become stressed and may die.

Conditions of Use

Causes of High pH:

High pH levels at construction sites are most commonly caused by the contact of stormwater with poured or recycled concrete, cement, mortars, and other Portland cement or lime containing construction materials. (See BMP C151: Concrete Handling for more information on concrete handling procedures). The principal caustic agent in cement is calcium hydroxide (free lime).

Design and Installation Specifications

Disposal Methods:

Infiltration

- Infiltration is only allowed if soil type allows all water to infiltrate (no surface runoff) without causing or contributing to a violation of surface or ground water quality standards.
- Infiltration techniques should be consistent with Chapter V-7 - Infiltration and Bioretention Treatment Facilities

Dispersion

Use BMP T5.30: Full Dispersion

Sanitary Sewer Disposal

- Local sewer authority approval is required prior to disposal via the sanitary sewer.

Concrete Batch Plant Disposal

- Only permitted facilities may accept high pH water.
- Facility should be contacted before treatment to ensure they can accept the high pH water.

Stormwater Discharge

Any pH treatment options that generate treated water that must be discharged off site are subject to flow control requirements. Sites that must implement flow control for the developed site must also control stormwater release rates during construction. All treated stormwater must go through a flow control facility before being released to surface waters which require flow control.
