Construction Stormwater Pollution Prevention Plan

PREPARED FOR:

Maracu, LLC
15001 35th Avenue West, Suite 14-101
Lynnwood, WA 98087

PROJECT:

Division Street Buckley Plat
Buckley, WA 98321
2160741.10

PREPARED BY:

Ryan Inouye, EIT
Project Engineer

REVIEWED BY:

Scott T. Kaul, PE, LEED AP
Project Manager

J. Matthew Weber, PE
Principal

DATE:

December 2017
I hereby state that this Construction Stormwater Pollution Prevention Plan for the Division Street Buckley Plat has been prepared by me or under my supervision, and meets the standard of care and expertise that is usual and customary in this community for professional engineers. I understand that City of Buckley does not and will not assume liability for the sufficiency, suitability, or performance of drainage facilities prepared by me.
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Best Management Practices (BMPs)

BMP C101........Preserving Natural Vegetation
BMP C103........High Visibility Plastic or Metal Fence
BMP C105........Stabilized Construction Entrance
BMP C106........Wheel Wash
BMP C107........Construction Road/Parking Area Stabilization
BMP C120........Temporary and Permanent Seeding
BMP C121........Mulching
BMP C123........Plastic Covering
BMP C140........Dust Control
BMP C150 ........Materials on Hand
BMP C154........Concrete Washout Area
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BMP C235..........Wattles
BMP C241.........Temporary Sediment Pond
BMP C250........Construction Stormwater Chemical Treatment
BMP C251........Construction Stormwater Filtration
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Exhibit 3

Sediment Pond Calculations
1.0 Introduction

In 1972, Congress passed the Federal Water Pollution Control Act (FWPCA), also known as the Clean Water Act (CWA), to restore and maintain the quality of the nation's waterways. The ultimate goal was to make sure that rivers and streams were fishable, swimmable, and drinkable. In 1987, the Water Quality Act (WQA) added provisions to the CWA that allowed the Environmental Protection Agency to govern stormwater discharges from construction sites. The National Pollutant Discharge Elimination System (NPDES) General Permit includes provisions for development of a Stormwater Pollution Prevention Plan (SWPPP) to maximize the potential benefits of pollution prevention and sediment and erosion control measures at construction sites.

Development, implementation, and maintenance of the Construction SWPPP (CSWPPP) will provide the selected General Contractor with the framework for reducing soil erosion and minimizing pollutants in stormwater during construction of the proposed improvements.

This CSWPPP will:

- Define the characteristics of the site and the type of construction that will occur.
- Describe the existing site conditions, including existing land use, soil types at the site, and the location of surface waters that are located on or next to the site.
- Identify the body or bodies of water that will receive runoff from the construction site, including the ultimate body of water that receives the stormwater.
- Identify the drainage areas and potential stormwater contaminants.
- Describe the stormwater management controls and various Best Management Practices (BMPs) necessary to reduce erosion, sediment, and pollutants in stormwater discharge.
- Create an implementation schedule to ensure that the practices described in this CSWPPP are in fact implemented, and to evaluate the plan's effectiveness in reducing erosion, sediment, and pollutant levels in stormwater discharged from the site.
- Identify the CSWPPP Coordinator with a description of this person's duties.
- Identify the Stormwater Pollution Prevention Team (SWPP Team) that will assist in implementation of the CSWPPP during construction.
- Describe the facility monitoring plan and how controls will be coordinated with construction activities.
- Describe the implementation schedule and provisions for amendment of the plan.
- Describe the final stabilization/termination design to minimize erosion and prevent stormwater impacts after construction is complete.
2.0 **Project Description**

This report accompanies the preliminary plat application for the Division Street Buckley Plat project.

The project includes a single parcel (0619102016) located within Buckley city limits within the Northeast Quarter of Section 10, Township 19 North, Range 6 East, Willamette Meridian, in Pierce County, Washington. The parcel covers approximately 15.34 acres. The site is accessed from Division Street.

The project involves the creation of a residential development, including public roads, stormwater management systems, sanitary sewer, water, and other miscellaneous utilities. In order to achieve the proposed design grades, an estimated 6,000 cubic yards of fill material will need to be imported.

3.0 **Existing Site Conditions**

The parcel has a uniform grass cover in the proposed development area. There are several trees and shrubs running beside the drainage ditch along the west side of the property.

4.0 **Adjacent Areas and Drainage**

The site is generally flat, and generally slopes from the north to the south. There is minimal runon to the site from the east, based on surveyed elevations.

A roadside ditch is located along South Division Street. A ditch immediately north of the site appears to convey stormwater from the northern properties. There is an existing small drainage ditch that runs through the site along the eastern side and along the southern side. The South Division Street roadside ditch is relatively flat and connected by a series of 18-inch and 12-inch culverts at crossings.

5.0 **Critical Areas**

There are no known existing critical areas.

6.0 **Soils**

The Natural Resources Conservation Service (NRCS) classifies the onsite soil as Buckley Loam (8A). The soil was formed in the Osceola mudflow under coniferous and deciduous trees. Buckley loam is characterized as level, poorly drained, with high seasonal groundwater. The soil is classified as Type C for stormwater modeling.

An onsite soil investigation was conducted by South Sound Geotechnical Consulting. The soils encountered generally match the characteristics of Buckley loam, as described by NRCS. A copy of the geotechnical report is being submitted under separate cover.

7.0 **Potential Erosion Problems**

The site will remain relatively flat. Therefore, there are no anticipated or potential erosion problems. The following Construction Stormwater Pollution Prevent Elements will be adhered to prevent erosion of soils onsite.
8.0 **Construction Stormwater Pollution Prevention Elements**

The purpose of this section is to describe how each of the 13 Construction Stormwater Pollution Prevention Elements has been addressed and to identify the type and location of BMPs used to satisfy the required element. If an element is not applicable to the project, a reason is provided.

8.1 **Preserve Vegetation/Mark Clearing Limits**

Prior to beginning land-disturbing activities, clearing limits will be marked with high visibility flagging in the open areas. Clearing limits adjacent to wetland areas will be marked with high visibility plastic or metal fence (BMP C103); stake wire fence may also be used.

8.2 **Establish Construction Access**

A stabilized construction entrance will be used to prevent the transport of sediment onto the adjacent paved surfaces. Construction entrances are proposed at the north and south ends of the site, at the location where the proposed roadways will connect to South Division Street.

If sediment is transported onto the road surface, the road shall be cleaned each day by shoveling or sweeping prior to washing. Sediment removal by washing alone will not be allowed. If sediment is tracked from the site, the City may require stabilization of internal roads and car parking areas to contain the sediment, or require the installation of a wheel wash basin.

Dump trucks hauling material to and from the site will be covered by a tarp.

8.3 **Control Flow Rates**

The temporary sediment pond (BMP C241) will be provided with an outlet structure containing an orifice and a notched weir riser. Detention pond construction is required prior to pavement of impervious surfaces. The design calculations for the temporary sediment pond are included in Exhibit 3.

8.4 **Install Sediment Controls**

Structural control measures will be used to reduce erosion and retain sediment on the construction site. The control measures are selected to fit specific site and seasonal conditions.

The temporary erosion and sediment control (TESC) plans include the following structural measures:

1. Stabilized construction entrance to prevent transport of sediment onto existing asphalt pavement on Spiketon Road. The entrance shall be constructed using quarry spalls per the detail on the plans.

2. Filter fabric fencing around portions of the perimeter of the site to prevent sediment-laden stormwater from being transported offsite, including fencing between construction activities and critical areas.

3. Temporary interceptor swales with rock check dams to direct surface runoff to the proposed sediment-trapping facility.
4. Rock check dams are provided in the interceptor swales to reduce flow velocities and remove sediment from the runoff. The check dams are spaced so that the toe of the upstream check dam is at the same elevation as the top of the downstream dam. Sediment shall be removed before or when it reaches half of the original dam height.

5. A temporary sediment pond is provided to remove sediment from concentrated flows collected by the interceptor swales prior to discharge to the existing drainage ditch adjacent to the site. The sediment pond is sized based on developed project runoff rates for the 2-year event, as determined using the 2012 Department of Ecology Stormwater Management Manual for Western Washington (SMMWW), BMP C241. See Exhibit 3 for temporary sediment pond sizing calculations.

8.5 Stabilize Soils

Since source control is the most important form of erosion control, construction practices must adhere to stringent cover requirements.

More specifically, during the period of May 1 through September 30, the Contractor will not be allowed to leave soils unprotected for more than 15 days, and immediate seeding will be required for areas brought to finish grade with no further work planned for the next 30 days. Areas to be paved may be armored with crushed rock subbase in place of other stabilizing measures. The area of clearing will be limited to the amount that can be stabilized by September 30 of that year.

During the period of October 1 through April 30, all disturbed soil areas will be covered or stabilized within 5 days or 24 hours when a major storm event is predicted. Cover measures may include mulching, netting, plastic sheeting, erosion control blankets, or free draining material. The extent of clearing shall be limited to the amount of land that can be covered or stabilized within 24 hours.

Soil stockpiles shall be stabilized by plastic covering (BMP 123) or surrounded by filter fabric fence. The stockpiles shall be a minimum of 50 feet from critical areas, including wetland buffers and drainage swales.

Dust control (BMP C140) will be provided by sprinkling the site with water.

Permanent erosion control measures will include site paving and seeding of exposed soils.

8.6 Protect Slopes

Slopes shall be stabilized as described above. Temporary and permanent seeding and plastic sheeting will be used to reduce erosion of exposed soils on slopes. Runoff shall be directed away from slopes by grading and the use of interceptor swales.

8.7 Protect Drain Inlets

Storm drain inlets shall be protected so surface water runoff does not enter the conveyance system without first being filtered. Inlets shall be inspected weekly, at a minimum, and daily during storm events. Storm Drain Inlet Protection (BMP C220) will be provided. Drain inlets made operable during construction shall be protected until site is completely stabilized.
8.8 Stabilize Channels and Outlets

Special attention, including rock armoring, shall be made to swale outfalls to the pond and where swales intersect. Rock check dams shall be provided in the interceptor swales to reduce flow velocities. If erosion is noted in segments of the swales, they shall be rock armored.

8.9 Control Pollutants

The Contractor shall be responsible for controlling pollutants at the work site. Key elements, such as centralized areas for equipment and concrete truck washing and temporary storage of debris and other stockpiled materials, are the responsibility of the Contractor.

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

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

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

Wheel wash or tire bath wastewater shall be discharged to a separate on-site treatment system or to the sanitary sewer.

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

BMPs shall be used to prevent or treat contamination of stormwater runoff by pH modifying sources. These sources include, but are not limited to, bulk cement, cement kiln dust, fly ash, new concrete washing and curing waters, waste streams generated from concrete grinding and sawing, exposed aggregate processes, and concrete pumping and mixer washout waters. Stormwater discharges shall not cause or contribute to a violation of the water quality standard for pH in the receiving water.

Construction sites with significant concrete work shall adjust the pH of stormwater if necessary to prevent violations of water quality standards.

Table 1 below lists several pollutants that are commonly found on construction sites that have the potential to contaminate storm runoff. These pollutants will be present, mainly in areas of building and pavement construction. The Contractor and the CSWPPP/TESC coordinator will be responsible for identifying areas where these pollutants are being used and monitor runoff coming from these areas. Pollutant sources will be covered with plastic if contaminated runoff is observed from these areas. If contaminated runoff is found in the sediment trap or soils, the Erosion Control Specialist will direct the Contractor to remove the polluted water/soil and dispose of it in an approved area offsite.
Table 1 – Potential Construction Site Stormwater Pollutants

<table>
<thead>
<tr>
<th>Trade Name Material</th>
<th>Chemical/Physical Description(^{(1)})</th>
<th>Stormwater Pollutants(^{(1)})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pesticides (insecticides, fungicides, herbicide, rodenticides)</td>
<td>Various colored to colorless liquid, powder, pellets, or grains</td>
<td>Chlorinated hydrocarbons, organophosphates, carbamates, arsenic</td>
</tr>
<tr>
<td>Fertilizer</td>
<td>Liquid or solid grains</td>
<td>Nitrogen, phosphorous</td>
</tr>
<tr>
<td>Plaster</td>
<td>White granules or powder</td>
<td>Calcium sulphate, calcium carbonate, sulfuric acid</td>
</tr>
<tr>
<td>Cleaning solvents</td>
<td>Colorless, blue, or yellow-green liquid</td>
<td>Perchloroethylene, methylene chloride, trichloroethylene, petroleum distillates</td>
</tr>
<tr>
<td>Asphalt</td>
<td>Black solid</td>
<td>Oil, petroleum distillates</td>
</tr>
<tr>
<td>Concrete</td>
<td>White solid</td>
<td>Limestone, sand</td>
</tr>
<tr>
<td>Glue, adhesives</td>
<td>White or yellow liquid</td>
<td>Polymers, epoxies</td>
</tr>
<tr>
<td>Paints</td>
<td>Various colored liquid</td>
<td>Metal oxides, Stoddard solvent, talc, calcium carbonate, arsenic</td>
</tr>
<tr>
<td>Curing compounds</td>
<td>Creamy white liquid</td>
<td>Naphtha</td>
</tr>
<tr>
<td>Wastewater from construction equipment washing</td>
<td>Water</td>
<td>Soil, oil &amp; grease, solids</td>
</tr>
<tr>
<td>Wood preservatives</td>
<td>Clear amber or dark brown liquid</td>
<td>Stoddard solvent, petroleum distillates, arsenic, copper, chromium</td>
</tr>
<tr>
<td>Hydraulic oil/fluids</td>
<td>Brown oily petroleum hydrocarbon</td>
<td>Mineral oil</td>
</tr>
<tr>
<td>Gasoline</td>
<td>Colorless, pale brown or pink petroleum hydrocarbon</td>
<td>Benzene, ethyl benzene, toluene, xylene, MTBE</td>
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<tr>
<td>Diesel fuel</td>
<td>Clear, blue-green to yellow liquid</td>
<td>Petroleum distillate, oil &amp; grease, naphthalene, xylenes</td>
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<tr>
<td>Kerosene</td>
<td>Pale yellow liquid petroleum hydrocarbon</td>
<td>Coal oil, petroleum distillates</td>
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<tr>
<td>Antifreeze/coolant</td>
<td>Clear green/yellow liquid</td>
<td>Ethylene glycol, propylene glycol, heavy metals (copper, lead, zinc)</td>
</tr>
<tr>
<td>Erosion</td>
<td>Solid Particles</td>
<td>Soil, Sediment</td>
</tr>
</tbody>
</table>

\(^{(1)}\) Data obtained from MSDS when available

### 8.9.1 Required BMPs

The following BMPs or equivalent measures are required of all businesses and agencies during concrete pouring and asphalt application at temporary sites:

- Employees must be educated on the pollution hazards of concrete and asphalt application and cutting.

- Loose aggregate chunks and dust must be swept or shoveled and collected (not hosed down a storm drain) for recycling or proper disposal at the end of each work day, especially at work sites such as streets, driveways, parking lots, sidewalks, curbs, and gutters where rain can readily pick up the loose material and carry it to the nearest stormwater conveyance. Small amounts of excess concrete, grout, and mortar can be disposed of in the trash.

- Storm drain covers or similarly effective containment devices must be placed over all nearby drains at the beginning of each day. Shovel or vacuum slurry and remove from the site. All accumulated runoff and solids must be collected and properly disposed at the end of each workday, or more often if necessary.
- Exposed aggregate washing, where the top layer of unhardened concrete is hosed or scraped off to leave a rough finish, must be done with a mechanism for containment and collection of the discarded concrete slurry (such as the storm drain covers mentioned above). The easiest way to contain the wash water will be to direct the washings to a hole in the ground where the water can percolate into the ground and the solids later covered with soil.

- If directed to a drain, a catch basin filter insert must be used to remove the solids. This is especially useful if the activity must proceed on rainy days.

- Cleaning of concrete application and mixing equipment or concrete vehicles on the work site must be done in a designated area where the rinse water is controlled. The rinse water must either be collected for proper disposal or put into a hole in the ground where the water can percolate away and the solids later covered with soil or recovered and disposed or recycled.

The use of any treatment BMP must not result in the violation of groundwater, surface water, or drinking water quality standards.

**8.10 Control Dewatering**

Dewatering may be required for construction of proposed utilities. Trench dewatering shall be discharged to the temporary sediment pond.

**8.11 Maintain BMPs**

In order for the Erosion and Sediment Control (ESC) facilities to function properly, they must be maintained and sediment removed on a regular basis. Inspection and sediment removal shall be performed on all ESC facilities, as described in the following inspection schedule.

Erosion control facilities shall not be allowed to fall into disrepair. All ESC facilities shall be inspected, at a minimum, according to the following schedule.

- **Dry Season:** Once a week.
- **Wet Season:** Daily and after every storm event that produces runoff.

Needed repairs shall be made within 24 hours or immediately, if possible.

The following inspection/maintenance schedules shall be utilized to ensure the ESC facilities are functioning as designed:

**Construction Entrance**

- The construction entrance shall be inspected once a week during the dry season and after every rainfall event during the wet season. If the entrance is not preventing sediment from being tracked onto adjacent pavement, then alternate measures to keep the pavement free of sediment shall be used. This may include street sweeping, an increase in the dimension of the entrance, or the installation of a wheel wash.

- Any quarry spalls that are loosened from the pad that end up on the roadway shall be removed immediately. Additional rock shall be added periodically to maintain proper function of the pad.
• If vehicles are entering or exiting the site at points other than the approved entrance, temporary fencing shall be installed to control traffic.

Sediment Trapping Facility

• The temporary sediment pond shall be inspected once a week during the dry season and after every rainfall event during the wet season.

• Sediment shall be removed from the pond when it reaches 1-foot in depth.

• The staff gauge shall be inspected and replaced if damaged then repositioned after dredging. Any damage to the pond slopes shall be repaired.

• Check pond slopes for raveling. Concentrated flows shall not be allowed to flow down the pond slopes without providing rock armoring.

• Inspect outlet to ensure it is functioning properly and is not plugged.

Temporary and Permanent Seeding

• Seeding may be used throughout the project on disturbed areas. During the dry season, areas that have reached final grade, or are not being actively worked, shall be seeding within 15 days. Seeded areas shall be supplied with adequate moisture, but not watered to the extent that it causes runoff.

• During the wet season, all disturbed areas not being actively worked shall be seeded or stabilized with mulch or plastic sheeting.

• During the wet season, no more area shall be exposed than can be controlled and effectively stabilized by the end of each working day.

• To prevent seed from being washed away, confirm that all other approved erosion/sedimentation control facilities have been installed and are functioning properly.

• Any seeded areas that fail to establish 80 percent cover (100 percent cover for areas that receive sheet or concentrated flows) shall be reseeded. If reseeding is ineffective, an alternate method shall be used.

• Seeded areas shall be inspected after every rainfall event during the wet season. Any areas that experience erosion shall be reseeded and protected by mulch. If the erosion problem is drainage related, the problem shall be fixed and the eroded area reseeded and protected by mulch.

• Seeding shall not be used in areas subject to heavy vehicular traffic.

Mulching

• Mulching shall be inspected once a week during the dry season and after every rainfall event during the wet season.

• Mulch shall be inspected to verify that the proper thickness is being maintained if applicable.
- Any areas that experience erosion shall be re-mulched and/or protected with a net or blanket. If the erosion problem is drainage related, the problem shall be fixed and the eroded area re-mulched.

**Plastic Covering**
- Plastic sheeting shall be inspected once a week during both the wet and dry season.
- Torn sheets must be replaced and open seams repaired.
- If the plastic begins to deteriorate due to ultraviolet radiation, it must be completely removed and replaced.
- When the plastic is no longer needed, it shall be completely removed.
- If tires are used to weight down the plastic sheeting, they must be disposed of properly.

**Inlet Protection**
- Catch basin filter inserts shall be inspected frequently, especially after storm events. If the filter becomes clogged, it should be cleaned or replaced.
- Inserts shall be replaced when tears are detected.

**Silt Fence**
- Any damage shall be repaired immediately.
- If concentrated flows are evident uphill of the fence, they must be intercepted and conveyed 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 causing channelization of flows parallel to the fence. If this occurs, replace the fence or remove the trapped sediment.
- Sediment deposits shall be removed when the deposit reaches approximately one-third the height of the silt fence, or a second silt fence shall be installed.
- If the filter fabric (geotextile) has deteriorated due to ultraviolet breakdown, it shall be replaced.

**Temporary Interceptor Swale**
- If erosion is noted on the swale side slopes, provide armoring using quarry spalls or sod.
- If the soil infiltration rate is reduced by siltation causing prolonged ponding in the swale, scarify the bottom to a depth of 12 inches minimum.
Rock Check Dams

- 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.
- If significant erosion occurs between dams, install a protective riprap liner in that portion of the channel.

The maintenance inspection report will be made after each inspection. Copies of the report forms to be completed by the CSWPPP coordinator are attached as Exhibit 1 of this CSWPPP. Completed forms will be provided to the City Inspector and will also be maintained onsite during the entire construction project. If construction activities or design modifications are made to the site plan that could impact stormwater, or if AHBL determines that the measures are not adequate to prevent erosion and the discharge of sediment from the site (based on turbidity measurements), this CSWPPP will be amended appropriately. The amended CSWPPP will have a description of the new activities that contribute to the increased pollutant loading and the planned source control activities.

8.12 Manage the Project

The following practices will be required during construction to properly manage activities:

- Comply with seasonal work limitations.
- Inspect, maintain, and repair BMPs.
- Identify a Certified Erosion and Sediment Control Lead (CESCL).
- Maintain the CSWPPP onsite at all times, including narrative and plans.

8.13 Protect Low Impact Development BMP’s

Protect future detention and constructed wetland areas from compaction. Grades shall be left 2 feet above the bottom of the proposed ponds to prevent compaction. All finished grades of ponds shall not be brought to final grade until after the remainder of the site has been graded.

9.0 Construction Sequence and Phasing

9.1 Construction Sequence

The construction sequence is described below:

1. Clearly mark the clearing limits by flagging and/or high visibility fence.
2. Schedule and attend preconstruction meeting with City of Buckley.
3. Provide miscellaneous demolition and clear and grub area within clearing limits required for installation of temporary erosion control facilities. All erosion and sediment control facilities shown on the erosion control plan shall be installed prior to or as a first stage of site preparation.
4. Provide inlet sediment protection on existing catch basins, as shown.
5. Clear and grub the remainder of the site within clearing limits, and rough grade site.

6. Provide cover measures, as required, to include armoring, mulching, and hydroseeding, to stabilize denuded areas and prevent the transport of sediment-laden stormwater offsite.

7. Provide storm system and miscellaneous utilities as shown on the plans. Provide inlet protection on all new catch basins.

8. Fine grade site and pave. Coordinate with City for required inspections.

9. Stabilize all remaining disturbed areas.

10. Coordinate with City for final inspection.

11. Remove remaining temporary erosion control devices when area has been permanently stabilized with vegetation and removal is approved by the City.

9.2 Construction Phasing

The project is anticipated to be constructed in a single phase.

10.0 Construction Schedule

Construction is scheduled to begin in summer of 2018. Completion of the final project phase will be based on market conditions, but mass grading activities will be primarily limited to the dry season.

11.0 Financial/Ownership Responsibilities

Maracu, LLC is the party responsible for initiation of bonds and other financial securities. The project must comply with City of Buckley financial liability requirements.

12.0 Engineering Calculations

The project includes a proposed temporary sediment pond. Sediment pond calculations are provided in Exhibit 3.

13.0 Certified Erosion and Sediment Control Lead (CESCL)

The General Contractor shall be required to provide a CESCL prior to construction. Once this individual is identified, the City Inspector will be notified.

The contractor will designate their CESCL here:

Name: ____________________________________________

Address: __________________________________________

Phone: ____________________________________________

Fax Number: ________________________________________
The CESCL is required to meet Washington State Department of Ecology (DOE) certification requirements. The City Inspector will be provided with CESCL information.

The duties of the CESCL include:

- Implement the CSWPPP/TESC plan with the aid of the SWPP Team.
- Oversee maintenance practices identified as BMPs in the CSWPPP.
- Conduct or provide for inspection and monitoring activities.
- Sample stormwater for turbidity using a turbidity meter.
- Identify other potential pollutant sources and make sure they are added to the plan.
- Identify any deficiencies in the CSWPPP and make sure they are corrected.
- Ensure that any changes in construction plans are addressed in the CSWPPP.

To aid in the implementation of the CSWPPP, the members of the SWPP Team include the following: General Contractor, City of Buckley Inspector, Owner, the geotechnical engineering consultant, and AHBL.

The General Contractor will ensure that all housekeeping and monitoring procedures are implemented, while the CESCL will ensure the integrity of the structural BMPs. The SWPP Team will observe construction and erosion control practices and recommend revisions or additions to the CSWPPP and drawings.

This analysis is based on data and records either supplied to or obtained by AHBL, Inc. These documents are referenced within the text of the analysis. The analysis has been prepared utilizing procedures and practices within the standard accepted practices of the industry.

AHBL, Inc.

Ryan Inouye, EIT
Project Engineer

RI/Isk

December 2017
Exhibit 1

Inspection Logs
Division Street Buckley Plat
Stormwater Pollution Prevention Plan
Inspection and Maintenance Report Form

To be completed every 7 days and within 24 hours of a rainfall event of 0.5 inches or more

Inspector: Date:
Inspector’s Qualifications:

Days since last rainfall: Amount of last rainfall: inches

Stabilization Measures

<table>
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<tr>
<th>Drainage Area</th>
<th>Date Since Last Disturbance</th>
<th>Date of Next Disturbance</th>
<th>Stabilized (yes/No)</th>
<th>Stabilized With</th>
<th>Condition</th>
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<tbody>
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Stabilization required:

To be performed by: On or before: 

AHBL
Structural Controls:

Date:

Inlet Protection

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<th>Drainage Area Perimeter</th>
<th>Has Silt Reached 1/3 of holding capacity?</th>
<th>Is Inlet Protection Properly Secured?</th>
<th>Is There Evidence of tearing or Overtopping?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>

Maintenance required for inlet protection:

To be performed by: ___________________________  On or before: ______________
Division Street Buckley Plat
Stormwater Pollution Prevention Plan
Inspection and Maintenance Report Form

Changes required to the pollution prevention plan:

Reasons for changes:

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Signature: ___________________________ Date: ____________________
Exhibit 2

Best Management Practices (BMPs)

BMP C101..............................Preserving Natural Vegetation
BMP C103..............................High Visibility Plastic or Metal Fence
BMP C105..............................Stabilized Construction Entrance
BMP C106..............................Wheel Wash
BMP C107..............................Construction Road/Parking Area Stabilization
BMP C120..............................Temporary and Permanent Seeding
BMP C121..............................Mulching
BMP C123..............................Plastic Covering
BMP C140..............................Dust Control
BMP C150..............................Materials on Hand
BMP C154..............................Concrete Washout Area
BMP C151..............................Concrete Handling
BMP C152..............................Sawcutting and Surface Pollution Prevention
BMP C153..............................Material Delivery, Containment & Storage
BMP C160..............................Certified Erosion and Sediment Control Lead
BMP C162..............................Scheduling
BMP C200..............................Interceptor Dike and Swale
BMP C207..............................Check Dams
BMP C209..............................Outlet Protection
BMP C220..............................Storm Drain Inlet Protection
BMP C233..............................Silt Fence
BMP C235..............................Wattles
BMP C241..............................Temporary Sediment Pond
BMP C250..............................Construction Stormwater Chemical Treatment
BMP C251..............................Construction Stormwater Filtration
BMP C252..............................High pH Neutralization Using C02
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 to 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 the county or other agencies.

*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. County ordinances to save natural vegetation and trees should be reviewed.
- 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 to 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:
  
  o 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.
  
  o Backfill the trench as soon as possible.
  
  o 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 C103: High Visibility Fence

Purpose

Fencing is intended to:

- Restrict clearing to approved limits
- Prevent disturbance of sensitive areas, their buffers, and other areas required to be left undisturbed
- Limit construction traffic to designated construction entrances, exits or internal roads
- Protect areas where marking with flagging/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 4 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 6 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 pounds/feet using the American Society for Testing and Materials (ASTM) D4595 testing method.
- If appropriate install fabric silt fence in accordance with BMP C233 to act as high visibility fence. Except that the silt fence shall be at least 3 feet high and must be highly visible to meet the requirements of this BMP.
- Metal fences are the least preferred but might be appropriate to address security concerns. Metal fencing shall be designed and installed according to the manufacturer's specifications.
- Metal fences shall be at least 4 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, based on lot size and configuration.

Design and Installation Specifications

- See Attachments Section C, Detail 4.0 for details. Note: the 100 foot 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 feet).

- 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. For single family residential lots pad may be reduced in length to fit site, to no less than 20 feet long, and in depth, to 6-inch thick with 4-inch to 6-inch quarry spalls, provided that performance standards are still met.

- 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 minimum
  - Grab Tensile Elongation (ASTM D4632): 30 percent maximum
  - Mullen Burst Strength (ASTM D3786-80a): 400 psi minimum
  - AOS (ASTM D4751): 20 to 45 (U.S. standard sieve size).

- Fencing (see BMP C103) shall be installed as necessary to restrict traffic to the construction entrance.
Whenever possible, the entrance shall be constructed on a firm, compacted subgrade. This can substantially increase the effectiveness of the pad and reduce the need for maintenance.

**Maintenance Standards**

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

- 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.

- 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.

- 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 onsite. 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 may be required. 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 as these sweepers create dust and throw soil into nearby 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.
**Approved as Equivalent**

Ecology has approved specific products as able to meet the requirements of BMP C105. The products did not pass through the Technology Assessment Protocol – Ecology (TAPE) process. The county has reviewed these products for application in Pierce County, and has developed a county-specific list of the approved and prohibited products. This county-specific list can be obtained from Pierce County Planning and Land Services’ (PALS) web site: <piercecountywa.org/PALS>. The county web site is updated routinely, but the latest list from Ecology is available on Ecology’s web site at <www.ecy.wa.gov/programs/wq/stormwater/newtech/equivalent.html>.

Contact the county if a new Ecology approved product is not listed on the county web site.
**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/exit (see BMP C105) is not preventing sediment from being tracked onto pavement.

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

- Pressure washing combined with an adequately sized and surfaced pad with direct drainage to a large 10-foot x 10-foot sump can be very effective.

**Design and Installation Specifications**

- Suggested details are shown in Figure 3.1. A minimum of 6 inches of asphalt treated base over crushed base material or 8 inches over a good subgrade is recommended to pave the wheel wash.

- Discharge wheel wash or tire bath wastewater to a separate onsite treatment system that prevents discharge to surface water, such as closed-loop recirculation or upland land application, or to the sanitary sewer with county approval. For discharges to the sanitary sewer, permits must be obtained from the County Industrial Pretreatment Program at (253) 798-3013.

- Wheel wash or tire bath wastewater should not include wastewater from concrete washout areas.

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

Figure 3.1. Wheel Wash.

Maintenance Standards

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

The washwater should be changed a minimum of once per day. On large earthwork jobs where more than 10 to 20 trucks per hour are expected, the washwater will need to be changed more often.
BMP C107: Construction Road/Parking Area Stabilization

Purpose

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

Conditions of Use

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

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

Design and Installation Specifications

- On areas that will receive asphalt as part of the project, install the first lift as soon as possible. Is not appropriate when final surface is porous/permeable.

- 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. 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 stormwater drainage system (see BMP C220).
Maintenance Standards

- Inspect stabilized areas regularly, especially after large storm events.
- Crushed rock, gravel base, hog fuel, 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 preconstruction 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 with a well-established vegetative cover. This 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.
- Where the term “fully established” is used to describe vegetative cover or plantings, it shall be understood to mean that healthy vegetation covers 90 percent of exposed soil.
- Inspect 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) that will prevent erosion.

Design and Installation Specifications

- Seed retention/detention ponds as required.
- Install channels intended for vegetation before starting major earthwork and hydroseeded with a Bonded Fiber Matrix (BFM). 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.

- The seedbed should be firm and rough. All soil should be roughened no matter what the slope. If compaction is required for engineering purposes, slopes must be track walked before seeding. Backblading or smoothing of slopes greater than 4:1 is not allowed if they are to be seeded.

- New and more effective restoration-based landscape practices rely on deeper incorporation than that provided by a simple single-pass rototilling treatment. Wherever practical the subgrade should be initially ripped 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 the rototilling process should be done in multiple lifts, or the prepared soil system shall be prepared properly and then placed to achieve the specified depth.

- Organic matter is the most appropriate form of “fertilizer” because it provides nutrients (including nitrogen, phosphorus, and potassium) in the least watersoluble form. A natural system typically releases 2 to 10 percent of its nutrients annually. Chemical fertilizers have since been formulated to simulate what organic matter does naturally.

- In general, 10-4-6 N-P-K (nitrogen-phosphorus-potassium) fertilizer can be used at a rate of 90 pounds per acre. Slow-release fertilizers should always be used because they are more efficient and have fewer environmental impacts. It is recommended that areas being seeded for final landscaping conduct soil tests to determine the exact type and quantity of fertilizer needed. This will prevent the over-application of fertilizer. Fertilizer should not be added to the hydromulch machine and agitated more than 20 minutes before it is to be used. If agitated too much, the slow-release coating is destroyed.

- There are numerous products available on the market that takes 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 is a good source of long-term, slow-release, available nitrogen.

- Hydroseed applications shall include a minimum of 1,500 pounds per acre of mulch with 3 percent tackifier. See BMP C121: Mulching for specifications.

- On steep slopes, BFM or Mechanically Bonded Fiber Matrix (MBFM) products should be used. BFM/MBFM products are applied at a minimum rate
of 3,000 pounds per acre of mulch with approximately 10 percent tackifier. Application is made so that a minimum of 95 percent soil coverage is achieved. Numerous products are available commercially and should be installed per manufacturer’s instructions. Most products require 24 to 36 hours to cure before a rainfall and cannot be installed on wet or saturated soils. Generally, these products come in 40 to 50 pound bags and include all necessary ingredients except for seed and fertilizer.

- BFM and MBFMs have some advantages over blankets:
  - No surface preparation required
  - Can be installed via helicopter in remote areas
  - On slopes steeper than 2.5:1, blanket installers may need to be roped and harnessed for safety
  - They are at least $1,000 per acre cheaper installed.

- In most cases, the shear strength of blankets is not a factor when used on slopes, only when used in channels. BFM and MBFMs are good alternatives to blankets in most situations where vegetation establishment is the goal.

- 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 also soil preservation and amendment in Volume III, Section 3.1.

- When installing seed via hydoseeding operations, only about one-third 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 to 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 to 1,000 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 or Mechanically Bonded Fiber Matrix (MBFM) (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 county may be used.

- Other mixes may be appropriate, depending on the soil type and hydrology of the area.

- Table 3.2 represents the standard mix for areas requiring a temporary vegetative cover.

### Table 3.2. Temporary Erosion Control Seed Mix.

<table>
<thead>
<tr>
<th>Seed Mix</th>
<th>% Weight</th>
<th>% Purity</th>
<th>% Germination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chewings or annual blue grass (<em>Festuca rubra</em> var. <em>commutata</em> or <em>Poa annua</em>)</td>
<td>40</td>
<td>98</td>
<td>90</td>
</tr>
<tr>
<td>Perennial rye (<em>Lolium perenne</em>)</td>
<td>50</td>
<td>98</td>
<td>90</td>
</tr>
<tr>
<td>Redtop or colonial bentgrass (<em>Agrostis alba</em> or <em>Agrostis tenuis</em>)</td>
<td>5</td>
<td>92</td>
<td>85</td>
</tr>
<tr>
<td>White dutch clover (<em>Trifolium repens</em>)</td>
<td>5</td>
<td>98</td>
<td>90</td>
</tr>
</tbody>
</table>
• Table 3.3 lists a recommended mix for landscaping seed.

**Table 3.3. Landscaping Seed Mix.**

<table>
<thead>
<tr>
<th>% Weight</th>
<th>% Purity</th>
<th>% Germination</th>
</tr>
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<tbody>
<tr>
<td>Perennial rye blend (<em>Lolium perenne</em>)</td>
<td>70</td>
<td>98</td>
</tr>
<tr>
<td>Chewings and red fescue blend (<em>Festuca rubra</em> var. commutata or <em>Festuca rubra</em>)</td>
<td>30</td>
<td>98</td>
</tr>
</tbody>
</table>

• Table 3.4 lists a turf seed mix in dry situations where there is no need for watering. This mix requires very little maintenance.

**Table 3.4. Low-Growing Turf Seed Mix.**

<table>
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<tr>
<th>% Weight</th>
<th>% Purity</th>
<th>% Germination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dwarf tall fescue (several varieties) (<em>Festuca arundinacea</em> var.)</td>
<td>45</td>
<td>98</td>
</tr>
<tr>
<td>Dwarf perennial rye (Barclay) (<em>Lolium perenne</em> var. Barclay)</td>
<td>30</td>
<td>98</td>
</tr>
<tr>
<td>Red fescue (<em>Festuca rubra</em>)</td>
<td>20</td>
<td>98</td>
</tr>
<tr>
<td>Colonial bentgrass (<em>Agrostis tenuis</em>)</td>
<td>5</td>
<td>98</td>
</tr>
</tbody>
</table>

• Table 3.5 lists a mix for bioswales and other intermittently wet areas.

**Table 3.5. Bioswale Seed Mix.a**

<table>
<thead>
<tr>
<th>% Weight</th>
<th>% Purity</th>
<th>% Germination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tall or meadow fescue (<em>Festuca arundinacea</em> or <em>Festuca elatior</em>)</td>
<td>75 to 80</td>
<td>98</td>
</tr>
<tr>
<td>Seaside/Creeping bentgrass (<em>Agrostis palustris</em>)</td>
<td>10 to 15</td>
<td>92</td>
</tr>
<tr>
<td>Redtop bentgrass (<em>Agrostis alba</em> or <em>Agrostis gigantea</em>)</td>
<td>5 to 10</td>
<td>90</td>
</tr>
</tbody>
</table>

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

• Table 3.6 lists a low-growing, relatively non-invasive seed mix appropriate for very wet areas that are not regulated wetlands. Apply this mixture at a rate of 60 pounds per acre. Consult Hydraulic Permit Authority (HPA) for seed mixes if applicable.
Table 3.6. Wet Area Seed Mix.a

<table>
<thead>
<tr>
<th>% Weight</th>
<th>% Purity</th>
<th>% Germination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tall or meadow fescue (<em>Festuca arundinacea</em> or <em>Festuca elatior</em>)</td>
<td>60 to 70</td>
<td>98</td>
</tr>
<tr>
<td>Seaside/Creeping bentgrass (<em>Agrostis palustris</em>)</td>
<td>10 to 15</td>
<td>98</td>
</tr>
<tr>
<td>Meadow foxtail (<em>Alepocurus pratensis</em>)</td>
<td>10 to 15</td>
<td>90</td>
</tr>
<tr>
<td>Alsike clover (<em>Trifolium hybridum</em>)</td>
<td>1 to 6</td>
<td>98</td>
</tr>
<tr>
<td>Redtop bentgrass (<em>Agrostis alba</em>)</td>
<td>1 to 6</td>
<td>92</td>
</tr>
</tbody>
</table>

a Modified Briargreen, Inc. Hydroseeding Guide Wetlands Seed Mix

- Table 3.7 lists a recommended meadow seed mix for infrequently maintained areas or non-maintained areas where colonization by native plants is desirable. Likely applications include rural road and utility right-of-way. Seeding should take place in September or very early October in order to obtain adequate establishment prior to the winter months. Consider the appropriateness of clover, a fairly invasive species, in the mix. Amending the soil can reduce the need for clover.

Table 3.7. Meadow Seed Mix.

<table>
<thead>
<tr>
<th>% Weight</th>
<th>% Purity</th>
<th>% Germination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Redtop or Oregon bentgrass (<em>Agrostis alba</em> or <em>Agrostis oregonensis</em>)</td>
<td>20</td>
<td>92</td>
</tr>
<tr>
<td>Red fescue (<em>Festuca rubra</em>)</td>
<td>70</td>
<td>98</td>
</tr>
<tr>
<td>White dutch clover (<em>Trifolium repens</em>)</td>
<td>10</td>
<td>98</td>
</tr>
</tbody>
</table>

**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, an alternate method, such as sodding, mulching, or nets/blankets, shall be used. If winter weather prevents adequate grass growth, this time limit may be relaxed at the discretion of the county 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 specific products as able to meet the requirements of BMP C120. The products did not pass through the Technology Assessment Protocol – Ecology
(TAPE) process. The county has reviewed these products for application in Pierce County, and has developed a county-specific list of the approved and prohibited products. This county-specific list can be obtained from Pierce County Planning and Land Services’ (PALS) web site: <piercecountywa.org/PALS>. The county web site is updated routinely, but the latest list from Ecology is available on Ecology’s web site at <www.ecy.wa.gov/programs/wq/stormwater/newtech/equivalent.html>. Contact the county if a new Ecology approved product is not listed on the county web site.
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 to 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 3.8. Always use a 2-inch minimum mulch thickness; increase the thickness until the ground is 95 percent covered (i.e., not visible under the mulch layer). Note: Thicknesses 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

- Mulch may be applied at any time of the year and must be refreshed periodically
• Minimum Percent passing 3” sieve openings 100 percent
• Minimum Percent passing 1” sieve openings 90 percent
• Minimum Percent passing 0.75” sieve openings 70 percent
• Minimum Percent passing 0.25” sieve openings 40 percent.

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.

Table 3.8. Mulch Standards and Guidelines.

<table>
<thead>
<tr>
<th>Mulch Material</th>
<th>Quality Standards</th>
<th>Application Rates</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Straw</td>
<td>Air-dried; free from undesirable seed and coarse material.</td>
<td>2” to 3” thick; five bales per 1,000 sf or 2 to 3 tons per acre</td>
<td>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).</td>
</tr>
<tr>
<td>Hydromulch</td>
<td>No growth inhibiting factors.</td>
<td>Approx. 25 to 30 lbs per 1,000 sf or 1,500 to 2,000 lbs per acre</td>
<td>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 0.75 to 1-inch clog hydromulch equipment. Fibers should be kept to less than 0.75 inch.</td>
</tr>
<tr>
<td>Compost</td>
<td>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.</td>
<td>2” thick min.; approx. 100 tons per acre (approx. 800 lbs per yard)</td>
<td>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 or the soil preservation and amendment BMP see Volume III, Section 3.1. 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.</td>
</tr>
<tr>
<td>Chipped Site Vegetation</td>
<td>Average size shall be several inches. Gradations from fines to 6 inches in length for texture, variation, and interlocking properties.</td>
<td>2” thick min.</td>
<td>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 percent 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.</td>
</tr>
</tbody>
</table>
### Mulch Material

<table>
<thead>
<tr>
<th>Material</th>
<th>Quality Standards</th>
<th>Application Rates</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood-based Mulch or Wood Straw</td>
<td>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.</td>
<td>2” thick min.; approx. 100 tons per acre (approx. 800 lbs. per cubic yard)</td>
<td>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).</td>
</tr>
<tr>
<td>Wood Strand Mulch</td>
<td>A blend of loose, long, thin wood pieces derived from native conifer or deciduous trees with high length-to-width ratio.</td>
<td>2” thick min.</td>
<td>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 one-sixteenth and three-eighths 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))</td>
</tr>
</tbody>
</table>

### 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.
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 6 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 onsite 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 to $2 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 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:
  - Run plastic up and down slope, not across slope.
  - Plastic may be installed perpendicular to a slope if the slope length is less than 10 feet.
  - Minimum of 8-inch overlap at seams.
  - On long or wide slopes, or slopes subject to wind, tape all seams.
  - 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.
  - 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.
  - 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.
  - 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 6 mil.

- 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 specific products as able to meet the requirements of BMP C123. The products did not pass through the Technology Assessment Protocol – Ecology (TAPE) process. The county has reviewed these products for application in Pierce
County, and has developed a county-specific list of the approved and prohibited products. This county-specific list can be obtained from Pierce County Planning and Land Services’ (PALS) web site: <piercecountywa.org/PALS>. The county web site is updated routinely, but the latest list from Ecology is available on Ecology’s web site at <www.ecy.wa.gov/programs/wq/stormwater/newtech/equivalent.html>. Contact the county if a new Ecology approved product is not listed on the county web site.
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

For use in areas (including roadways) subject to surface and air movement of dust where onsite and offsite impacts to roadways, drainage ways, or surface waters are likely.

Design and Installation Specifications

Vegetate or mulch areas that will not receive vehicle traffic. In areas where planting, mulching, or paving is impractical, apply gravel or landscaping rock.

- Limit dust generation by clearing only those areas where immediate activity will take place, leaving the remaining area(s) in the original condition. Maintain the original ground cover as long as practical.
- Construct natural or artificial windbreaks or windscreens. These may be designed as enclosures for small dust sources.
- Sprinkle the site with water until surface is wet. Repeat as needed. To prevent carryout of mud onto street, refer to Stabilized Construction Entrance (BMP C105).
- Irrigation water can be used for dust control. Irrigation systems should be installed as a first step on sites where dust control is a concern.
- Spray exposed soil areas with a dust palliative, following the manufacturer’s instructions and cautions regarding handling and application. Oil based products are prohibited from use as a dust suppressant. The county may approve other dust palliatives such as calcium chloride or PAM.
- PAM (BMP C126) added to water at a rate of 0.5 pounds 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 0.75 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 Puget Sound Clean Air Agency (<www.pscleanair.org>) for guidance and training on other dust control measures. Compliance with Puget Sound Clean Air Agency guidance and BMPs 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 onsite 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 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 that will cover numerous situations includes:

<table>
<thead>
<tr>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear Plastic, 6 mil</td>
</tr>
<tr>
<td>Drainpipe, 6- or 8-inch diameter</td>
</tr>
<tr>
<td>Sandbags, filled</td>
</tr>
<tr>
<td>Straw Bales for mulching,</td>
</tr>
<tr>
<td>Quarry Spalls</td>
</tr>
<tr>
<td>Washed Gravel</td>
</tr>
<tr>
<td>Geotextile Fabric</td>
</tr>
<tr>
<td>Catch Basin Inserts</td>
</tr>
<tr>
<td>Steel &quot;T&quot; Posts</td>
</tr>
<tr>
<td>Silt fence material</td>
</tr>
<tr>
<td>Straw Wattles</td>
</tr>
</tbody>
</table>
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.

- Restock 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

Ensure that washout of concrete trucks, chutes, pumps, and internals is performed at an approved offsite location or in designated concrete washout areas, in accordance with BMP C154. Do not wash out concrete trucks onto the ground, or into storm drains, open ditches, streets, or streams.

Return unused concrete remaining in the truck and pump to the originating batch plant for recycling. Do not dump excess concrete onsite, 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 groundwater or surface water quality standards.

• Always use forms or solid barriers for concrete pours, such as pilings, within 15 feet of surface waters.

• Refer to BMPs C252 and C253 for pH adjustment requirements.

• Refer to the Construction Stormwater General Permit for pH monitoring requirements if the project involves one of the following activities:
  
  o Significant concrete work (greater than 1,000 cubic yards poured concrete or recycled concrete used over the life of a project)
  
  o 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 repaired 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 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 groundwater 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 groundwater or surface water quality standards.
- Handle and dispose cleaning waste material and demolition debris in a manner that does not cause contamination of water. Dispose of sweeping material from a pick-up sweeper at an appropriate disposal site.
**Maintenance Standards**

Continually monitor operations to determine whether slurry, cuttings, or process water could enter waters of the State. If inspections show that a violation of water quality standards could occur, stop operations and immediately implement preventive measures such as berms, barriers, secondary containment, and vacuum trucks.
BMP C153: Material Delivery, Storage, and Containment

Purpose

Prevent, reduce, or eliminate the discharge of pollutants to the stormwater system or watercourses from material delivery and storage. Minimize the storage of hazardous materials onsite, 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 onsite should be minimized.
- Hazardous materials should be handled as infrequently as possible.
- During the wet weather season (October 1 to 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, in 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 percent of the total enclosed container volume of all containers, or 110 percent 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 (October 1 to 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 cleanup material (spill kit).

• The spill kit should include, at a minimum:
  o 1 water resistant nylon bag
  o 3 oil absorbent socks 3 inches x 4 feet
  o 2 oil absorbent socks 3 inches x 10 feet
  o 12 oil absorbent pads 17 inches x 19 inches
  o 1 pair splash resistant goggles
  o 3 pair nitrile gloves
  o 10 disposable bags with ties
  o Instructions.
BMP C154: Concrete Washout Area

Purpose

Prevent or reduce the discharge of pollutants to stormwater from concrete waste by conducting washout offsite, or performing onsite washout in a designated area to prevent pollutants from entering surface waters or groundwater.

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 offsite (ready mix plant, etc.).
- Concrete trucks, pumpers, or other concrete coated equipment are washed onsite.
- Note: If fewer than 10 concrete trucks or pumpers need to be washed out onsite, the washwater may be disposed of in a formed area awaiting concrete or an upland disposal site where it will not contaminate surface or groundwater. 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 offsite 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 onsite, except in designated concrete washout areas.
- Concrete washout areas may be prefabricated concrete washout containers, or self-installed structures (above-grade or below-grade).
- Prefabricated containers are most resistant to damage and protect against spills and leaks. Companies may offer delivery service and provide regular maintenance and disposal of solid and liquid waste.
• If self-installed concrete washout areas are used, below-grade structures are preferred over above-grade structures because they are less prone to spills and leaks.

• Self-installed above-grade structures should only be used if excavation is not practical.

**Education:**

• Discuss the concrete management techniques described in this BMP with the ready-mix concrete supplier before any deliveries are made.

• Educate employees and subcontractors on the concrete waste management techniques described in this BMP.

• Arrange for contractor’s superintendent or Certified Erosion and Sediment Control Lead (CESCL) to oversee and enforce concrete waste management procedures.

• A sign should be installed adjacent to each temporary concrete washout facility to inform concrete equipment operators to utilize the proper facilities.

**Contracts:**

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

**Location and Placement:**

• Locate washout area at least 50 feet from sensitive areas such as storm drains, open ditches, or water bodies, including wetlands.

• Allow convenient access for concrete trucks, preferably near the area where the concrete is being poured.

• If trucks need to leave a paved area to access washout, prevent track-out with a pad of rock or quarry spalls (see BMP C105). These areas should be far enough away from other construction traffic to reduce the likelihood of accidental damage and spills.

• The number of facilities you install should depend on the expected demand for storage capacity.

• On large sites with extensive concrete work, washouts should be placed in multiple locations for ease of use by concrete truck drivers.
Onsite Temporary Concrete Washout Facility, Transit Truck Washout Procedures:

- Temporary concrete washout facilities shall be located a minimum of 50 feet from sensitive areas including storm drain inlets, open drainage facilities, and water courses. See Figure 3.5, as well as Attachments Section C, Details 23.0 and 23.1.

- 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 offsite.

- 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 feet, 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 feet. 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 (percent 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 percent full.

• If the washout is nearing capacity, vacuum and dispose of the waste material in an approved manner.
  
  o Do not discharge liquid or slurry to waterways, storm drains or directly onto ground.
  
  o Do not use sanitary sewer without a permit that must be obtained from the County Industrial Pretreatment Program at (253) 798-3013.
  
  o 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.
  
  o Remove and dispose of hardened concrete and return the structure to a functional condition. Concrete may be reused onsite 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.
BMP C160: Certified Erosion and Sediment Control Lead

Purpose

The project applicant designates at least one person as the responsible representative in charge of erosion and sediment control, and water quality protection. The designated person shall be the CESCL who is responsible for ensuring compliance with all local, state, and federal Construction SWPPP and water quality requirements.

Conditions of Use

A CESCL shall be made available on projects disturbing ground 1 acre or larger and that discharge stormwater to surface waters of the State. Projects disturbing less than 1 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 training and certification requirements established by Ecology (see details below)
- Ecology will maintain a list of erosion and sediment control training and certification providers at: <www.ecy.wa.gov/programs/wq/stormwater/cescl.html>
- OR
- Be a Certified Professional in Erosion and Sediment Control (CPESC); for additional information go to: <www.cpesc.net>.

Specifications

Certification shall remain valid for 3 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, email address, 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:
  o Inspection date/time.
  o Weather information; general conditions during inspection and approximate amount of precipitation since the last inspection.
  o A summary or list of all BMPs implemented, including observations of all erosion/sediment control structures or practices. The following shall be noted:
    − Locations of BMPs inspected
    − Locations of BMPs that need maintenance
    − Locations of BMPs that failed to operate as designed or intended
    − Locations of where additional or different BMPs are required.
  o 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.
  o Any water quality monitoring performed during inspection.
  o 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.
3.2 Runoff Conveyance and Treatment BMPs

This section contains the standards and specifications for Runoff Conveyance and Treatment BMPs. Table 3.10 shows the relationship of the BMPs in Section 3.2 to the Construction Stormwater Pollution Prevention Plan (SWPPP) Elements described in Section 2.3.3.

**Table 3.10. Runoff Conveyance and Treatment BMPs by SWPPP Element**

<table>
<thead>
<tr>
<th>BMP or Element Name</th>
<th>Element #3 Control Flow Rates</th>
<th>Element #4 Install Sediment Controls</th>
<th>Element #6 Protect Storm Drain Inlets</th>
<th>Element #7 Protect Storm Drain Inlets</th>
<th>Element #8 Stabilize Channels and Outlets</th>
<th>Element #9 Control Pollutants</th>
<th>Element #10 Control Dewatering</th>
<th>Element #13 Protect Low Impact Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMP C200: Interceptor Dike and Swale</td>
<td>✓</td>
<td></td>
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<tr>
<td>BMP C201: Grass-Lined Channels</td>
<td>✓</td>
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<tr>
<td>BMP C202: Channel Lining</td>
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<tr>
<td>BMP C203: Water Bars</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>BMP C204: Pipe Slope Drains</td>
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<tr>
<td>BMP C205: Subsurface Drains</td>
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<tr>
<td>BMP C206: Level Spreader</td>
<td>✓</td>
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<tr>
<td>BMP C207: Check Dams</td>
<td>✓</td>
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<tr>
<td>BMP C208: Triangular Silt Dike (TSD) (Geotextile Encased Check Dam)</td>
<td>✓</td>
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<tr>
<td>BMP C209: Outlet Protection</td>
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<tr>
<td>BMP C220: Storm Drain Inlet Protection</td>
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<tr>
<td>BMP C231: Brush Barrier</td>
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<tr>
<td>BMP C232: Gravel Filter Berm</td>
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<td>BMP C233: Silt Fence</td>
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<td>BMP C234: Vegetated Strip</td>
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<td>BMP C235: Wattles</td>
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<tr>
<td>BMP C236: Vegetated Filtration</td>
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<tr>
<td>BMP C240: Sediment Trap</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>BMP C241: Temporary Sediment Pond</td>
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<td>BMP C250: Construction Stormwater Chemical Treatment</td>
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<tr>
<td>BMP C251: Construction Stormwater Filtration</td>
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<tr>
<td>BMP C252: High pH Neutralization Using CO₂</td>
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<tr>
<td>BMP C251: pH Control for High pH Water</td>
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</table>
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. See Attachments Section C, Detail 17.0 for an example schematic.

Conditions of Use

Where the runoff from an exposed site or disturbed slope must be conveyed to an erosion control facility which can safely contain 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.
- Subbasin tributary area should be 1 acre or less.
- Design capacity for the peak flow from a 10-year, 24-hour storm event assuming a NRCS Type 1A rainfall distribution resolved to 10-minute time steps, for temporary facilities. Alternatively, use 1.6 times the 10-year, 1-hour time step flow indicated by an approved continuous runoff model. If a 15-minute (or less) time step is used, no correction factor is required. For conveyance systems that will also serve on a permanent basis see design standards in Volume III, Chapter 4.
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 percent, maximum is 1 percent
- Compaction: Minimum of 90 percent ASTM D698 standard proctor.
- Horizontal Spacing of Interceptor Dikes:

<table>
<thead>
<tr>
<th>Average Slope</th>
<th>Slope %</th>
<th>Flowpath Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 20H:1V or flatter</td>
<td>3 – &lt; 5%</td>
<td>300 feet</td>
</tr>
<tr>
<td>(10 to 20)H:1V</td>
<td>5 – &lt; 10%</td>
<td>200 feet</td>
</tr>
<tr>
<td>(&gt; 4 to 10)H:1V</td>
<td>10 – &lt; 25%</td>
<td>100 feet</td>
</tr>
<tr>
<td>(2 to 4)H:1V</td>
<td>25 – 50%</td>
<td>50 feet</td>
</tr>
</tbody>
</table>

- Stabilization depends on velocity and reach:
  - Slopes less than 5 percent: Seed and mulch applied within 5 days of dike construction (see BMP C121, Mulching).
  - Slopes 5 to 40 percent: 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 of 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 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 WDFW. Check dams may not be placed in wetlands without approval from the appropriate 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 (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 products are also available for this purpose. They tend to be reusable, quick and easy to install, effective, and cost efficient. Straw bales are not an allowed construction material.

- 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. Attachments Section C, Detail 19.0 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.
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:
  - If the discharge velocity at the outlet is less than 5 feet per second (pipe slope typically less than 10 percent), use 2-inch to 8-inch riprap. Minimum thickness is 1 foot.
  - 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 III, Chapter 4 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 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. Consider erosion protection methods around each finished lawn and yard drain until area is stabilized.

Table 3.11 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 1 acre or less. Possibly provide emergency overflows with additional end-of-pipe treatment where stormwater ponding would cause a hazard.

Table 3.11. Storm Drain Inlet Protection.

<table>
<thead>
<tr>
<th>Type of Inlet Protection</th>
<th>Emergency Overflow</th>
<th>Applicable for Paved/Earthen Surfaces</th>
<th>Conditions of Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drop Inlet Protection</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Excavated drop inlet protection</td>
<td>Yes, temporary flooding will occur</td>
<td>Earthen</td>
<td>Applicable for heavy flows. Easy to maintain. Large area Requirement: 30 x 30-feet/acre</td>
</tr>
<tr>
<td>Block and gravel drop inlet protection</td>
<td>Yes</td>
<td>Paved or Earthen</td>
<td>Applicable for heavy concentrated flows. Will not pond.</td>
</tr>
<tr>
<td>Gravel and wire drop inlet protection</td>
<td>No</td>
<td></td>
<td>Applicable for heavy concentrated flows. Will pond. Can withstand traffic.</td>
</tr>
<tr>
<td>Catch basin filters</td>
<td>Yes</td>
<td>Paved or Earthen</td>
<td>Frequent maintenance required.</td>
</tr>
<tr>
<td>Curb Inlet Protection</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Curb inlet protection with a wooden weir</td>
<td>Small capacity overflow</td>
<td>Paved</td>
<td>Used for sturdy, more compact installation.</td>
</tr>
<tr>
<td>Lock and gravel curb inlet protection</td>
<td>Yes</td>
<td>Paved</td>
<td>Sturdy, but limited filtration.</td>
</tr>
<tr>
<td>Culvert Inlet Protection</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Culvert inlet sediment trap</td>
<td></td>
<td></td>
<td>18 month expected life.</td>
</tr>
</tbody>
</table>
**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 to 2 feet 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 also Attachments Section C, Detail 2.0.
  - 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 2 x 4 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 one-half-inch openings over all block openings
  - Place washed rock, 0.75- to 3-inch diameter, just below the top of blocks on slopes of 2H:1V or flatter.
• **Gravel and Wire Mesh Filter:** A gravel barrier placed over the top of the inlet. This structure does not provide an overflow. See also Attachments Section C, Detail 3.0.
  
  o Use a hardware cloth or comparable wire mesh with one-half-inch openings
  
  o Use coarse aggregate
  
  o Provide a height 1 foot or more, 18 inches wider than inlet on all sides
  
  o Place wire mesh over the drop inlet so that the wire extends a minimum of 1 foot beyond each side of the inlet structure
  
  o Overlap the strips if more than one strip of mesh is necessary
  
  o Place coarse aggregate over the wire mesh
  
  o Provide at least a 12-inch depth of gravel over the entire inlet opening and extend at least 18 inches on all sides.

• **Curb Inlet Protection with Wooden Weir:** Barrier formed around a curb inlet with a wooden frame and gravel.
  
  o Wire mesh with one-half-inch openings
  
  o Extra strength filter cloth
  
  o Construct a frame.

• **Catch Basin 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 catch basin filter with another type of inlet protection. The combination of inlet protection and filters may provide flow bypass without overflow and therefore may be a better method for inlets located along active rights-of-way.
  
  o Provides 5 cubic feet of storage
  
  o Requires dewatering provisions
  
  o Provides a high-flow bypass that will not clog under normal use at a construction site
  
  o Insert the catch basin filter in the catch basin 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 one-half-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 an inlet with concrete blocks and gravel. See Figure 3.11.
  - Use wire mesh with 0.5-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 2 x 4 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 3.12.
  - 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.

• **Inlet Fabric Fence Filter:** Attachments Section C, Detail 1.0 provides an illustration of the use of filter fabric as an inlet protection option.
Figure 3.11. Block and Gravel Curb Inlet Protection.

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

- Inspect catch basin filters frequently, especially after storm events. Clean or replace clogged inserts. For systems with clogged stone filters pull away 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 specific products as able to meet the requirements of BMP C220. The products did not pass through the Technology Assessment Protocol – Ecology.
(TAPE) process. The county has reviewed these products for application in Pierce County, and has developed a county-specific list of the approved and prohibited products. This county-specific list can be obtained from Pierce County Planning and Land Services’ (PALS) web site: <piercecountywa.org/PALS>. The county web site is updated routinely, but the latest list from Ecology is available on Ecology’s web site at <www.ecy.wa.gov/programs/wq/stormwater/newtech/equivalent.html>. Contact the county if a new Ecology approved product is not listed on the county web site.
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 Attachments Section C, Detail 8.0 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.

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 cubic feet per second.
- 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 3.12).
  - Standard strength fabrics must be supported with wire mesh, chicken wire, 2-inch x 2-inch wire, safety fence, or jute mesh to increase the strength of the fabric to the 180 lbs minimum threshold. 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 6 months of expected usable construction life at a temperature range of 0°F. to 120°F.
Table 3.12. Geotextile Standards.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Polymeric Mesh AOS (ASTM D4751)</strong></td>
<td>0.60 mm maximum for film wovens (US #30 sieve). 0.30 mm maximum for all other geotextile types (US #50 sieve). 0.15 mm minimum for all fabric types (US #100 sieve).</td>
</tr>
<tr>
<td><strong>Water Permittivity (ASTM D4491)</strong></td>
<td>0.02 sec⁻¹ minimum</td>
</tr>
<tr>
<td><strong>Grab Tensile Strength (ASTM D4632)</strong></td>
<td>30% maximum</td>
</tr>
<tr>
<td><strong>Ultraviolet Resistance (ASTM D4355)</strong></td>
<td>70% minimum</td>
</tr>
</tbody>
</table>

- Include the following standard notes for silt fence on construction plans and specifications:
  
  o The contractor shall install and maintain temporary silt fences at the locations shown in the plans.

  o Construct silt fences in areas of clearing, grading, or drainage prior to starting those activities.

  o The silt fence shall have a 2 feet min. and 2.5 feet max. height above the original ground surface.

  o 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.

  o 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.

  o 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.

  o 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 pounds grab tensile strength. The polymeric mesh must be as resistant to the same level of ultraviolet radiation as the filter fabric it supports.
o Bury the bottom of the filter fabric 8 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. The wire or polymeric mesh shall extend into the ground 3 inches min.

o Drive or place the fence posts into the ground 18 inches minimum. A 12-inch minimum 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.

o 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 reinforcement bar 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 pounds/feet.
  – Other steel posts having equivalent strength and bending resistance to the post sizes listed above.

o 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.

o 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.
Silt fence installation using the slicing method specification details follow:

- 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 check dams to drain properly. Use a hand level or string level, if necessary, to mark base points before installation.

- Install posts 3 to 4 feet apart in critical retention areas and 6 to 7 feet apart in standard applications. 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.

- Install posts with the nipples facing away from the filter fabric.

- 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.

- Wrap approximately 6 inches of fabric around the end posts and secure with three ties.

- No more than 24 inches of a 36-inch filter fabric is allowed above ground level, 12 inches must be buried.

- 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.

**Maintenance Standards**

- Repair any damage immediately.

- Intercept and convey all evident concentrated flows uphill of the fence to a sediment pond.

- Check the uphill side of the fence for signs of the fence clogging and acting as a barrier to flow and then causing channelization of flows parallel to the fence. If this occurs, replace the fence or remove the trapped sediment.

- Remove sediment deposits when the deposit reaches approximately one-third the height of the silt fence, or install a second silt fence.

- Replace filter fabric that has deteriorated due to ultraviolet breakdown.
BMP C235: Wattles

Purpose

Wattles are TESC 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 3.13 for typical construction details.

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. Typically, wattles are effective for one to two wet 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 one-half to two-thirds 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 on contours at intervals of 10 to 25 feet apart depending on the steepness of the slope, soil type, and rainfall. The steeper the slope, the closer together the trenches.
Figure 3.13. Straw Wattles.

- 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 0.75 x 0.75 x 24 inches min. Willow cuttings or 0.375-inch rebar can also be used for stakes. Note: rebar must be removed at end of project if used, while other fasteners maybe permitted to remain if all parts of the wattles are biodegradable and shown in plans for permanent erosion control.

**Maintenance Standards**

• Stakes should be driven through the middle of the wattle, leaving 2 to 3 inches of the stake protruding above the wattle.

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

• 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 specific products as able to meet the requirements of BMP C235. The products did not pass through the Technology Assessment Protocol – Ecology (TAPE) process. The county has reviewed these products for application in Pierce County, and has developed a county-specific list of the approved and prohibited products. This county-specific list can be obtained from Pierce County Planning and Land Services’ (PALS) web site: <piercecountywa.org/PALS>. The county web site is updated routinely, but the latest list from Ecology is available on Ecology’s web site at <www.ecy.wa.gov/programs/wq/stormwater/newtech/equivalent.html>. Contact the county if a new Ecology approved product is not listed on the county web site.
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 BMP.

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 ponds 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. If fencing of the pond is planned, the type of fence and its location shall be shown on the Construction SWPPP.

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

- See Attachments Section C, Details 5.0, 5.1, and 5.2 for details.

- Projects that are constructing permanent detention facilities or infiltration basins and trenches can use the rough-graded permanent facilities for traps. The surface area requirements of the sediment pond 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 ponds 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 pond to help prevent clogging.
Determining Pond Geometry:

- Obtain the discharge from the hydrologic calculations of the peak flow for the 2-year recurrence interval runoff event \( Q_2 \). Use a 15-minute time step and an approved continuous runoff model for the developed (unmitigated) site. If the time of concentration is less than 30 minutes, a 5-minute time step may be required. The 10-year recurrence interval 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:

\[
SA = 2 \times \frac{Q_2}{0.00096}
\]

OR

2,080 square feet per cubic feet per second (cfs) of inflow

- See BMP C240 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 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 recurrence interval storm. If, due to site conditions and pond geometry, a separate emergency spillway is not
feasible, the principal spillway must pass the entire peak runoff expected from the 100-year recurrence interval 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 recurrence interval 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 pond discharge to the predevelopment discharge limitations as stated in Minimum Requirement #7: Flow Control. However, if the basin for a permanent stormwater detention pond is used for a temporary sedimentation pond, the control structure for the permanent pond can be used to maintain predevelopment discharge limitations. The size of the pond, 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 3.15 for riser inflow curves.

- **Principal Spillway:** Determine the required diameter for the principal spillway (riser pipe). The diameter shall be the minimum necessary to pass the discharge from the 10-year recurrence interval runoff event \((Q_{10})\). Use a 15-minute time step and an approved continuous runoff model for the developed (unmitigated) site. If the time of concentration is less than 30 minutes, a 5-minute time step may be required. The 10-year recurrence interval 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. Use Figure 3.15 to determine this diameter \((h = 1\text{-foot})\). 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 indicated by an approved continuous runoff model using a 15-minute time step.

- **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/second²)
Figure 3.15. Riser Inflow Curves.

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

$$D = 24x \sqrt[3]{\frac{A_o}{\pi}} = 13.54x \sqrt[3]{A_o}$$
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 1 foot below the top of the riser. Wire-backed, 2- to 3-foot high, extra strength filter fabric supported by treated 4 x 4-inches can be used as a divider. 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, 1-foot intervals above the pond bottom shall be prominently marked on the riser or a staff gauge.

If an embankment of more than 6 feet is proposed, the pond must comply with the criteria contained in Volume III, Section 3.12.1, regarding dam safety for detention BMPs. An electronic version of the Dam Safety Guidelines is available at [<www.ecy.wa.gov/programs/wr/dams/GuidanceDocs.html>](http://www.ecy.wa.gov/programs/wr/dams/GuidanceDocs.html).

The most common structural failure of sedimentation 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 sequences to prevent piping will be:

- Tight connections between riser and barrel and other pipe connections
- Adequate anchoring of riser
- Proper soil compaction of the embankment and riser footing
- 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.
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 Construction SWPPP 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 both Ecology and Pierce County is required for the use of chemical treatment regardless of site size. 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 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 web site: [www.ecy.wa.gov/programs/wq/stormwater/newtech/index.html](http://www.ecy.wa.gov/programs/wq/stormwater/newtech/index.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 6 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 <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 (dependent 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, floculent 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 Flow-Through 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 non-corrosive containment for acid, caustic, buffering compound, and treatment chemical
- Emergency shower and eyewash
- Monitoring equipment.

**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 the volume of 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 Volume III, Chapter 2. 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 2 hours of settling.

If the discharge is directly to a lake, flow control exempt receiving water listed in Volume I, 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 flow rate for an 8-hour period. For a chitosan-enhanced sand filtration system, the treatment system flow rate should be sized using a hydraulic loading rate between 6 to 8 gpm/ft². 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 Volume III, Chapter 2. 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 predeveloped condition for the range of predeveloped discharge rates from 50 percent of the 2-year flow through the 10-year flow as predicted by an approved continuous runoff model. The predeveloped 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:
o Determine the predeveloped flow durations to be matched by entering the existing land use area under the “Predeveloped” scenario in WWHM. The default flow range is from 50 percent of the 2-year flow through the 10-year flow.

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

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

o 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.

o Notes on SSD table characteristics:

The pump discharge rate would likely be initially set at just below 50 percent of the 2-year flow from the predeveloped 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 50 percent of the 2-year. The increase(s) above 50 percent 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.

o 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 50 percent 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 stormwater drainage system, the allowable discharge rate may be limited by the capacity of the public system. It may be necessary to clean the municipal stormwater drainage system prior to the start of the discharge to prevent scouring solids from the drainage system. If the municipal stormwater 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 onsite. 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:**
  
  o 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 onsite to prevent significant erosion. All sites shall use a truck wheel wash to prevent tracking of sediment offsite.

**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 or Pierce County 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 Pierce County and the appropriate regional Ecology office must be obtained at each site where polymer use is proposed prior to use. For more guidance on stormwater chemical treatment, see BMP C250.

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/ft², 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/ft², because they do not have backwash systems. To date, 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 preset 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 flow rate for an 8-hour period. For a chitosan-enhanced sand filtration system, the treatment system flow rate should be sized using a hydraulic loading rate between 6 to 8 gpm/ft². 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 Volume III, Chapter 2. 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 predeveloped condition for the range of predeveloped discharge rates from 50 percent of the 2-year flow through the 10-year flow as predicted by an approved continuous runoff model. The predeveloped 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:

- Determine the predeveloped flow durations to be matched by entering the land use area under the “Predeveloped” scenario in WWHM. The default flow range is from 50 percent of the 2-year flow through the 10-year flow.

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

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

- There are two possible ways to model stormwater filtration systems:

  1. 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 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 one-half if the 2-year flow from the predeveloped 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 50 percent of the 2-year. The increase(s) above 50 percent 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.

2. 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:

- 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.

- 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.
• 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 50 percent 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 water bodies 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 CO₂

**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 washout, 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. Groundwater standard for calcium and other dissolved solids in Washington State is less than 500 mg/l.

**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 CO₂ Sparging**

- Rapidly neutralizes high pH water.

- Cost effective and safer to handle than acid compounds.

- CO₂ 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$_2$O), carbonic acid (H$_2$CO$_3$) is formed which can further dissociate into a proton (H$^+$) and a bicarbonate anion (HCO$_3^-$) as shown below:

$$\text{CO}_2 + \text{H}_2\text{O} \leftrightarrow \text{H}_2\text{CO}_3 \leftrightarrow \text{H}^+ + \text{HCO}_3^-$$

- 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.

- 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:
  
  o Prior to treatment, Pierce County must be notified.
  
  o Every effort should be made to isolate the potential high pH water in order to treat it separately from other stormwater onsite.
  
  o Water should be stored in an acceptable storage facility, detention pond, or containment cell prior to treatment.
  
  o 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.
  
  o 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.
  
  o In the pH adjustment structure, add CO$_2$ until the pH falls in the range of 6.9 to 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.

- Slowly release the water to discharge making sure water does not get stirred up in the process. Release about 80 percent of the water from the structure leaving any sludge behind.

- Discharge treated water through a pond or drainage system.

- 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 percent 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.

**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, telephone number, and email address
  - Date of treatment
  - Weather conditions
  - Project name and location
  - Volume of water treated
  - pH of untreated water
o Amount of CO₂ needed to adjust water to a pH range of 6.9 to 7.1
o pH of treated water
o Discharge location and description.

A copy of this record should be given to the client/contractor who should retain the record for 3 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 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.

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).

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 groundwater quality standards

- Infiltration techniques should be consistent with Volume V, Chapter 6.

Dispersion:

- Use sheet flow or concentrated flow dispersion in Volume III, Section 3.2.

Sanitary Sewer Disposal:

- Pierce County approval is required prior to disposal via the sanitary sewer. Permits must be obtained from the County Industrial Pretreatment Program at (253) 798-3013.

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 offsite 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.
3.3 Protection of LID Facilities During Construction

3.3.1 Introduction

To ensure that LID stormwater facilities and BMPs will be fully functional after construction, it is important to protect these BMPs during construction activities. Protecting native soil and vegetation, minimizing soil compaction, and retaining the hydrologic function of LID BMPs during the site preparation and construction phases are some of the most important practices during the development process.

The purpose of this section is to provide designers, builders, and inspectors with guidance and tools for meeting Minimum Requirement #2, Element #13 – Protect Low Impact Development BMPs. This section does not provide guidance on construction or design of LID BMPs (see Volume III, V, and VI), or cover all Construction SWPPP practices (see Sections 3.1 and 3.2), but rather focuses on how to most efficiently reduce impacts on LID BMPs specifically during construction. **The practices specified in Section 3.3 must be applied to protect LID BMPs, unless the given practice does not apply to the project site conditions or activities.**

3.3.2 General Erosion and Sediment Control BMPs Applicable to LID

Overall Construction Stormwater Pollution Prevention Plan (SWPPP) requirements are specified in Volume I, Minimum Requirement #2 and Volume II. In general, Construction SWPPP BMPs limit the impact of site disturbance, erosion, and sediment deposition during construction. Some Construction SWPPP BMPs (presented in more detail in Sections 3.1 and 3.2) focus on providing a physical barrier or deterrent to help minimize construction-related site disturbance and/or erosion, while other Construction SWPPP BMPs help protect the site from concentrated (i.e., erosive) flows. General Construction SWPPP BMPs and their application for protection of LID BMPs are summarized below. These BMPs must be considered for projects subject to Minimum Requirement #2 that are proposing to construct LID BMPs.

<table>
<thead>
<tr>
<th>Construction SWPPP BMP</th>
<th>Application</th>
<th>Section Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMP C103: High Visibility Fence</td>
<td>Use fencing to limit clearing; prevent disturbance of sensitive areas, their buffers, and other areas; limit construction traffic; and protect areas where marking with flagging may not provide adequate protection</td>
<td>3.1</td>
</tr>
<tr>
<td>BMP C200: Interceptor Dike and Swale</td>
<td>Use an interceptor dike and/or swale to intercept the runoff from unprotected areas and direct it to areas where erosion can be controlled</td>
<td>3.2</td>
</tr>
<tr>
<td>BMP C201: Grass-Lined Channels</td>
<td>Use grass lined channels where concentrated runoff may cause erosion and flooding of the site</td>
<td>3.2</td>
</tr>
<tr>
<td>BMP C207: Check Dams</td>
<td>Use check dams in swales or ditches to reduce the velocity and dissipate concentrated flow</td>
<td>3.2</td>
</tr>
<tr>
<td>BMP C208: Triangular Silt Dike (TSD) (Geotextile-Encased Check Dam)</td>
<td>Use triangular silt dikes as check dams, for perimeter protection, temporary soil stockpile protection, drop inlet protection, or as a temporary interceptor dike</td>
<td>3.2</td>
</tr>
</tbody>
</table>
### Construction Site Planning and Sequencing Requirements

<table>
<thead>
<tr>
<th>Construction Site Planning and Sequencing Requirements</th>
<th>Construction Site Planning and Sequencing Techniques</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limit clearing and grading activities</td>
<td>• Keep grading to a minimum by incorporating natural topographic depressions into the development.</td>
</tr>
<tr>
<td></td>
<td>• Shape final lot grades and topographic features early (i.e., at the site development stage) where feasible.</td>
</tr>
<tr>
<td></td>
<td>• Limit the amount of cut and fill in areas with permeable soils.</td>
</tr>
<tr>
<td></td>
<td>• Limit clearing to road, utility, building pad, lawn areas, and the minimum amount of extra land necessary to maneuver machinery (e.g., a 10-foot perimeter around a building).</td>
</tr>
<tr>
<td>Limit construction activity in areas designated for LID</td>
<td>• Clearly document – and plan to meet and walk through the site with equipment operators prior to construction – to clarify construction boundaries, limits of disturbance, and construction activities in the vicinity of LID BMPs.</td>
</tr>
</tbody>
</table>
Limit construction activity in areas designated for LID (continued)
- General/primary contractor must inform other subcontractors of applicable LID BMP protection requirements. This is particularly important when working around permeable pavement.

Limit clearing and grading during heavy rainfall seasons
- Time construction activities to start during the summer (lowest precipitation) and end in the fall (when conditions are favorable for the establishment of vegetation), if feasible.

Minimize the amount and time that graded areas are left exposed
- Complete construction and erosion control activities in one section of the site before beginning activity in another section.

Utilize permeable and nutrient rich soils
- Preserve any portion of the site with permeable soils to promote infiltration of stormwater runoff.
  - Leave areas of rich topsoil in place, or if excavated, utilize elsewhere on the site to amend areas with sparse or nutrient deficient topsoil.

Reduce impact of construction access roads
- Reduce the number and size (width/length) of construction access roads.
- Locate construction access roads in areas where future roads and utility corridors will be placed (unless utilizing permeable pavement).

Promote sheet flow and minimize concentrated runoff
- Avoid grading that results in steep, continuous slopes, especially in areas contributing runoff to LID BMPs.

LID BMP activation
- LID BMPs shall not begin operation until all erosion-causing project improvements (including use of access roads that may contribute sediment) are completed and all exposed ground surfaces are stabilized by revegetation or landscaping in upland areas potentially contributing runoff to the BMP.

### Activities During Construction

Many common construction-phase activities pose a risk to LID BMPs. The following techniques will help minimize these impacts. Techniques to be used for protection of LID BMPs include:

<table>
<thead>
<tr>
<th>Erosion Control Requirements</th>
<th>Erosion Control Techniques</th>
</tr>
</thead>
</table>
| Protect native topsoil during the construction phase, and reuse onsite | - Where practicable, protect areas of rich topsoil. If excavation is necessary, stockpile native soils that can be used on the site after construction.  
- Stockpile materials in areas designated for clearing and grading (such as parking areas and future impervious roadways) and away from infiltration and other stormwater facilities.  
- Cover small stockpiles with weed barrier material that sheds moisture yet allows air transmission. Large stockpiles may need to be seeded and/or mulched. |
Erosion Control Requirements | Erosion Control Techniques
--- | ---
Protect native topsoil during the construction phase, and reuse onsite (continued) | • Do not relocate topsoil or other material to areas where they can cover critical root zones, suffocate vegetation, or erode into adjacent streams.

Use effective revegetation methods | • Use native plant species adapted to the local environment.
• Plant during late fall, winter, or early spring months when vegetation is likely to establish quickly and survive.
• Utilize proper seedbed preparation.
• Fertilize and mulch to protect germinating plants. Apply 1 inch of compost topped with 2 inches of mulch.
• Protect areas designated for revegetation from soil compaction by restricting heavy equipment.
• Provide proper soil amendments where necessary (refer to Volume III, Section 3.1).
• During storage, plants should be protected by solar screens when possible to prevent overexposure and excessive drying.

Perform preconstruction, routine, and post-construction inspections | • Conduct a preconstruction inspection to verify that adequate barriers have been placed around vegetation retention areas, infiltration facilities (as needed), and structural controls are implemented properly.
• Conduct routine inspections to verify that structural controls are being maintained and effectively protecting LID BMPs throughout construction.
• Conduct a final inspection to verify that revegetation areas are stabilized and that permanent LID BMPs are in place and functioning properly.

3.3.4 BMP-specific Construction Techniques

This section outlines construction-phase BMP protection techniques specific to categories of LID BMPs (e.g., infiltration and dispersion) as well as specific LID BMPs (permeable pavement, bioretention areas/rain gardens, and vegetated roofs). The BMP protection techniques presented previously in Section 3.3.3 are applicable to the overall construction site to help protect LID BMPs. The techniques outlined in this section are based on the specific BMP functions, targeting typical construction activities that pose a risk to individual BMPs.

Infiltration and Dispersion Facility Construction Techniques

It is critical that appropriate methods are used to protect infiltration and dispersion BMPs from compaction and sediment loading during construction. For infiltration facilities in particular, the subgrade soils must be protected from clogging and over-compaction to maintain the soil permeability and ensure BMP performance. Techniques for protection of infiltration and dispersion BMPs during various stages of construction are summarized below.
## Construction Stage

### Techniques for Protecting Infiltration and Dispersion Facilities

**Prior to construction**
- The infiltration/dispersion area shall be clearly identified (e.g., using flagging or high visibility fencing) and protected prior to construction to prevent compaction of underlying soils by vehicle traffic.
- Develop a soil and vegetation management plan showing areas to be protected and restoration methods for disturbed areas before land clearing starts.
- The Construction SWPPP sheets must outline construction sequencing that will protect the infiltration/dispersion area during construction.
- Construction SWPPP BMPs and protection techniques identified in Sections 3.3.2 and 3.3.3 shall be implemented as applicable. In particular, be sure to stabilize upslope construction areas (e.g., using silt fences, berms, mulch, or other Construction SWPPP BMPs) and minimize overland flow distances.

**Excavation**
- Excavation of infiltration/dispersion areas shall be performed by machinery operating adjacent to the BMP. No heavy equipment with narrow tracks, narrow tires, or large lugged high pressure tires shall be allowed on the infiltration/dispersion area footprint.
- Where feasible, excavate infiltration/dispersion areas to final grade only after all disturbed areas in the up-gradient project drainage area have been permanently stabilized. (If infiltration areas must be excavated before permanent site stabilization, initial excavation must be conducted to no less than 6 inches of the final elevation of the facility floor.)
- Excavation of infiltration areas shall not be allowed during wet or saturated conditions.
- The use of draglines and trackhoes should be considered for constructing infiltration and dispersion areas.
- The sidewalls and bottom of an infiltration facility excavation must be raked or scarified to a minimum depth of 3 inches after final excavation to restore infiltration rates.
- Scarify soil along the dispersion flow path if disturbed during construction.

**Sediment control**
- Bioretention, rain garden, and permeable pavement BMPs shall not be used as sediment control facilities, and all drainage shall be directed away from the BMP location after initial rough grading.
- Direct construction site flow away from the infiltration/dispersion area using applicable Construction SWPPP BMPs (e.g., temporary diversion swales).

### Permeable Pavement

There are many potential applications and site scenarios where permeable pavement can be applied. The following techniques highlight the most broadly applicable techniques to be used to protect permeable pavement BMPs during construction. Refer to the previous section for construction protection methods that are applicable to all infiltration BMPs, as well as Section 3.3.2 and 3.3.3 for general site protection measures. In addition to those techniques, the following techniques apply specifically for protection of permeable pavement during construction:
• Use procedural BMPs to plan construction. For example, phase construction to minimize compaction, sedimentation, or structural damage to the permeable pavement.

• Use physical Construction SWPPP BMPs and/or grade the site to avoid sediment laden runoff from reaching permeable pavements.

• Place protective surfaces (e.g., waterproof tarps and steel plates) over any permeable pavement areas used for construction staging.

• Do not drive sediment-laden construction equipment on the base material or pavement. Do not allow sediment-laden runoff on permeable pavements or base materials.

• Once the pavement is finished and set, cover the pavement surface with plastic and geotextile to protect from other construction activities. Close and protect the pavement area until the site is permanently stabilized.

• Incorporate measures to protect road subgrade from over compaction and sedimentation if permeable pavement roads are used for construction access.
  
  o Cover the aggregate base or pavement surface with protective geotextile fabric and protect fabric with steel plates or gravel. Gravel should only be used to protect the fabric placed over aggregate base.
  
  o Once construction is complete and the site is permanently stabilized, remove protective geotextile, clean, and complete pavement installation.

Refer to the detailed permeable pavement BMP information in Volume III, Section 3.5 for general permeable pavement construction criteria.

**Bioretention Areas and Rain Gardens**

As with permeable pavements, there are many potential applications and site scenarios where bioretention and rain garden BMPs can be applied. The following techniques highlight the most broadly applicable techniques to be used to protect bioretention and rain garden BMPs during construction. Refer to the beginning of this section for construction protection methods that are applicable to all infiltration BMPs, as well as Section 3.3.2 and 3.3.3 for general site protection measures. In addition to those techniques, the following techniques apply specifically for protection of bioretention and rain garden BMPs during construction:

• **Excavation:**
  
  o If machinery must operate in the bioretention area for excavation, use lightweight, low ground-contact pressure equipment and rip the base at completion to scarify soil to a minimum of 12 inches.
• Protect bioretention soil mix from compaction during construction
  
  o Do not place bioretention soil mix if saturated or during wet periods.
  
  o Check for compaction prior to planting. If compaction occurs, aerate the bioretention soil and then proceed to plant.

Refer to the detailed bioretention and rain garden BMP information in Volume III, Section 3.4 and 3.8 for general bioretention and rain garden construction criteria.

**Vegetated Roofs**

The following additional techniques apply for protection of vegetated roof facilities during construction:

• Because of their location and complexity, vegetated roofs typically require more planning and coordination effort relative to ground-level landscaping. For new construction, a critical path approach is highly recommended to establish the sequence of tasks for construction of the vegetated roof system.

• During construction, it is vitally important that the waterproof membrane be protected once installed. The waterproofing should be tested prior to placement of the growth media and other subsequent vegetated roof materials.

Refer to the detailed vegetated roof BMP information in Volume III for general construction criteria.
Exhibit 3

Sediment Pond Calculations
TEMPORARY SEDIMENT POND AND SEDIMENT TRAP SIZING

SURFACE AREA (SA) = 2 \times Q_2/0.00096

3.5' POND DEPTH, SIDE SLOPE 3:1

<table>
<thead>
<tr>
<th>BASIN</th>
<th>Q_2</th>
<th>Q_{10}</th>
<th>Q_{100}</th>
<th>SA_2</th>
<th>SA_{10}</th>
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</thead>
<tbody>
<tr>
<td>TEMPORARY SEDIMENT POND</td>
<td>4.44</td>
<td>8.28</td>
<td>12.62</td>
<td>9,250</td>
<td>17,250</td>
</tr>
</tbody>
</table>

NOTE: SURFACE AREA FOR THE 10 YEAR STORM WAS SELECTED FOR ALL BASINS LARGER THAN 3 ACRES.

ORIFICE AND RISER SIZING

\[ A_0 = SA \left(2 \times 3.5\right)^{1/2} / \left(0.6 \times 3600 \times 24 \times 32.2\right)^{1/2} \]

ORIFICE DIAMETER (D) = 13.54 \times SA^{1/2}

<table>
<thead>
<tr>
<th>BASIN</th>
<th>SA</th>
<th>A_0</th>
<th>D</th>
<th>RISER DIAMETER</th>
</tr>
</thead>
<tbody>
<tr>
<td>TEMPORARY SEDIMENT POND</td>
<td>17,250</td>
<td>0.083</td>
<td>3.91&quot;</td>
<td>18&quot;</td>
</tr>
</tbody>
</table>

NOTE: USE ORIFICE DIAMETER 3-15/16"

OVERFLOW SPILLWAY SIZING

\[ L_{100} = \left[Q_{100}/(3.21h^{3/2})\right] - 2.4 H^{5/2} \]

<table>
<thead>
<tr>
<th>BASIN</th>
<th>Q_{100}</th>
<th>H</th>
<th>L</th>
</tr>
</thead>
<tbody>
<tr>
<td>TEMPORARY SEDIMENT POND</td>
<td>6.05</td>
<td>0.3</td>
<td>23.2</td>
</tr>
</tbody>
</table>

Q_{100} = 100-YEAR STORM (CFS)
H = OVERFLOW HEIGHT (FT)
L = LENGTH OF SPILLWAY (FT)
### Total Site Event Summary

<table>
<thead>
<tr>
<th>Event</th>
<th>Peak Q (cfs)</th>
<th>Peak T (hrs)</th>
<th>Hyd Vol (acft)</th>
<th>Area (ac)</th>
<th>Method</th>
<th>Raintype</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 year</td>
<td>4.4405</td>
<td>8.00</td>
<td>1.5757</td>
<td>16.2500</td>
<td>SBUH</td>
<td>TYPE1A</td>
</tr>
<tr>
<td>5 year</td>
<td>6.3341</td>
<td>8.00</td>
<td>2.1805</td>
<td>16.2500</td>
<td>SBUH</td>
<td>TYPE1A</td>
</tr>
<tr>
<td>10 year</td>
<td>8.2778</td>
<td>8.00</td>
<td>2.8046</td>
<td>16.2500</td>
<td>SBUH</td>
<td>TYPE1A</td>
</tr>
<tr>
<td>25 year</td>
<td>10.2448</td>
<td>8.00</td>
<td>3.4410</td>
<td>16.2500</td>
<td>SBUH</td>
<td>TYPE1A</td>
</tr>
<tr>
<td>50 year</td>
<td>11.4301</td>
<td>8.00</td>
<td>3.8271</td>
<td>16.2500</td>
<td>SBUH</td>
<td>TYPE1A</td>
</tr>
<tr>
<td>100 year</td>
<td>12.6169</td>
<td>8.00</td>
<td>4.2157</td>
<td>16.2500</td>
<td>SBUH</td>
<td>TYPE1A</td>
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</table>

### Record Id: Total Site

<table>
<thead>
<tr>
<th>Design Method</th>
<th>SBUH</th>
<th>Rainfall type</th>
<th>TYPE1A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hyd Intv</td>
<td>10.00 min</td>
<td>Peaking Factor</td>
<td>484.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Abstraction Coeff</td>
<td>0.20</td>
</tr>
<tr>
<td>Pervious Area (AMC 2)</td>
<td>16.25 ac</td>
<td>DCIA</td>
<td>0.00 ac</td>
</tr>
<tr>
<td>Pervious CN</td>
<td>91.00</td>
<td>DC CN</td>
<td>0.00</td>
</tr>
<tr>
<td>Pervious TC</td>
<td>6.62 min</td>
<td>DC TC</td>
<td>0.00 min</td>
</tr>
</tbody>
</table>

#### Pervious CN Calc

<table>
<thead>
<tr>
<th>Description</th>
<th>SubArea</th>
<th>Sub cn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newly graded area</td>
<td>16.25 ac</td>
<td>91.00</td>
</tr>
<tr>
<td>Pervious Composited CN (AMC 2)</td>
<td>91.00</td>
<td></td>
</tr>
</tbody>
</table>

#### Pervious TC Calc

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Length</th>
<th>Slope</th>
<th>Coeff</th>
<th>Misc</th>
<th>TT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sheet</td>
<td>something</td>
<td>300.00 ft</td>
<td>1.00%</td>
<td>0.0110</td>
<td>2.50 in</td>
<td>4.36 min</td>
</tr>
<tr>
<td>Channel (cont)</td>
<td>ditch</td>
<td>1000.00 ft</td>
<td>1.00%</td>
<td>0.0110</td>
<td></td>
<td>2.27 min</td>
</tr>
</tbody>
</table>

Pervious TC 6.62 min

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