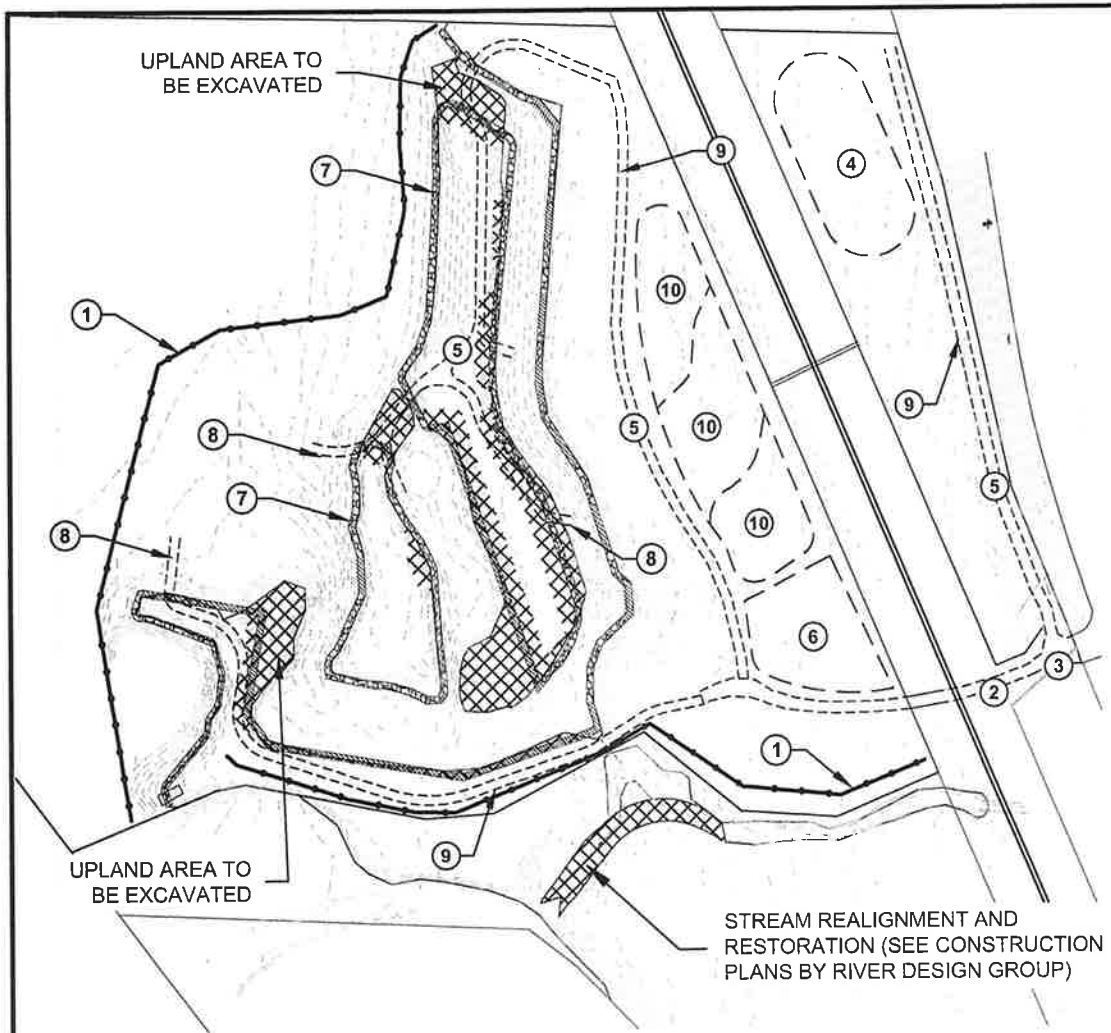
APPENDIX 6.a

PRELIMINARY SWPPP SITE PLAN PHASES

Idaho Club Joint Permit Application



PRELIMINARY STORM WATER POLLUTION PREVENTION PLAN (SWPPP) PHASE 1

KEY NOTES

1. INSTALL WIRE REINFORCED SILT FENCE (AKA SEDIMENT FENCING) AT THE BEGINNING OF PROJECT, AND MAINTAIN DURING ENTIRE PROJECT. SILT FENCE TO BE INSTALLED AT 3' AND 10' INTERVALS WATER-WARD FROM THE FURTHEST EXTENT OF EXCAVATION AND ALONG THE TOP OF EMBANKMENTS NOT BEING EXCAVATED. DO NOT INSTALL SILT FENCE AS A BARRIER FOR CHANNELIZED FLOW LEAVING THE SITE. REMOVE ALL SILT FENCE AFTER FINAL STABILIZATION. SEE BMP 65: SILT FENCE.
2. CONSTRUCT STABILIZED CONSTRUCTION ENTRANCE BEFORE BEGINNING PROJECT. SEE BMP 40: VEHICLE SEDIMENT CONTROL
3. PREVENT MATERIAL TRACKING ONTO PUBLIC STREETS DURING ALL PHASES OF CONSTRUCTION, BY UTILIZING STABILIZED CONSTRUCTION ENTRANCE, VEHICLE WASHING AND STREET SWEEPING. SEE BMP 40: VEHICLE SEDIMENT CONTROL, BMP 47: CONSTRUCTION EQUIPMENT WASHING AND MAINTENANCE, AND BMP 75: STREET SWEEPING.
4. GENERAL MATERIAL STOCK PILE & CONSTRUCTION MATERIAL STORAGE AREA, SEE BMP 44: STOCKPILE MANAGEMENT AND BMP 37: STAGING AREAS
5. BMP 43: DUST CONTROL SHALL BE IMPLEMENTED DURING DRY TIMES WHEN SOIL IS ANTICIPATED TO BECOME AIR BORN.
6. VEHICLE EQUIPMENT REFUELING, CLEANING, MAINTENANCE AND REPAIR PER BMP 83 AND BMP 84.
7. SHORELINE RIPRAP PROTECTION PER BMP 53 AND BMP 56
8. TRUCK AND EQUIPMENT ACCESS POINTS PER BMP 62.
9. STABILIZED CONSTRUCTION ROAD AND STAGING AREAS CROSSING PER BMP 41.
10. DE-WATERING PER BMP 73. INSTALL TEMPORARY SEDIMENTATION AND DE-WATERING INFILTRATION SURFACE STRUCTURES OR BASINS. TO BE IMPLEMENTED BY THE CONTRACTOR AFTER SEDIMENT PERIMETER PROTECTIONS ARE IN PLACE, BUT BEFORE MAJOR SITE DISTURBANCES HAVE BEGUN.

PROFESSIONAL ENGINEER REGISTERED 8607 5/9/2024 STATE OF IDAHO B. SCOTT BROWN

N

0 100 200 400

SCALE IN FEET
CONTOUR INTERVAL IS 1'
DATUM: NGVD '29

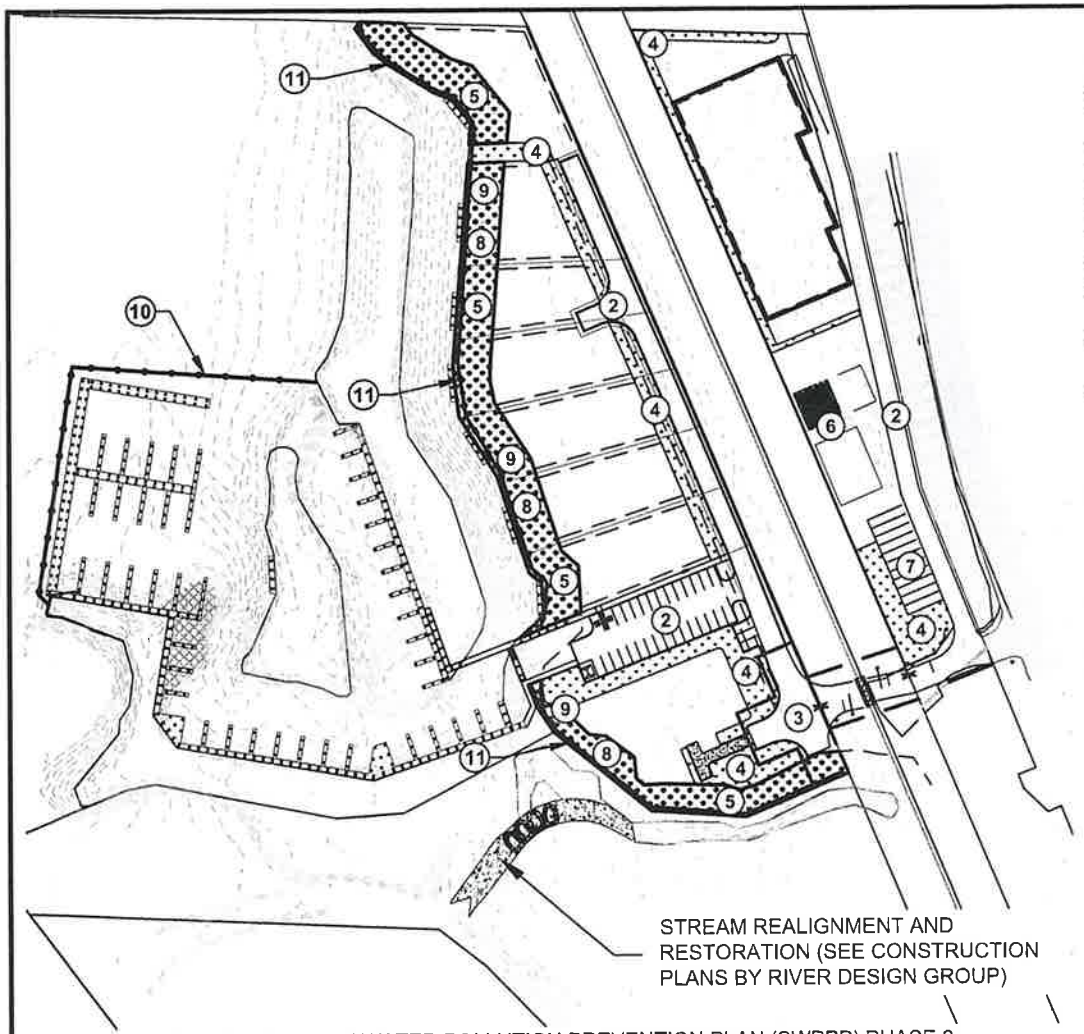
NOTE: SOME ELEVATIONS, CONTOUR LINES, AND ORIGINAL HIGH WATER MARK DEPICTED IN THIS DRAWING IS PER 2017 TOPOGRAPHIC SURVEY PREPARED BY WELCH-COMER ENGINEERS AND SURVEYORS

APPLICANT:	VALIANT IDAHO II, LLC
LOCATION:	BONNER COUNTY, IDAHO SECTION 16 & 17, T 57 N, R 1 E, B.M.
WATERBODY:	LAKE PEND OREILLE
DA NUMBER:	

SHEET TITLE: PRELIMINARY SWPPP PHASE 1
PROJECT: IDAHO CLUB NORTH LAKE P.U.D.

DATE: 05/08/2024
SCALE: AS SHOWN
DRAWN: NCF
CHECKED: BSB
PROJ. NO.: 22043-20-001
CAD FILE: E-VALIANT

James A. Sewell and Associates, LLC
1319 N. DIVISION
SANDPOINT, IDAHO 83864, (208) 263-4160



PRELIMINARY STORM WATER POLLUTION PREVENTION PLAN (SWPPP) PHASE 2

THIS DRAWING IS TO BE USED FOR PERMITTING PURPOSES - NOT FOR CONSTRUCTION

PROFESSIONAL ENGINEER REGISTERED 8607 5/9/2024 STATE OF IDAHO B. SCOTT BROWN

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SCALE IN FEET
CONTOUR INTERVAL IS 1'
DATUM: NGVD '29

NOTE: SOME ELEVATIONS, CONTOUR LINES, AND ORIGINAL HIGH WATER MARK DEPICTED ON THIS DRAWING ARE PER 2017 TOPOGRAPHIC SURVEY PREPARED BY WELCH-COMER ENGINEERS AND SURVEYORS.

KEY NOTES

1. BMP 43: DUST CONTROL SHALL BE IMPLEMENTED DURING DRY TIMES WHEN SOIL IS ANTICIPATED TO BECOME AIR BORN.
2. IMPERVIOUS SURFACE, SEE BMP 71.
3. CONCRETE WASHOUT AREA. SEE BMP 49: CONCRETE WASTE MANAGEMENT.
4. CONSTRUCT TREATMENT SWALE PER BMP 9
5. 40-FT WIDE VEGETATED BUFFER (PLANTINGS PER COUNTY CODE)
6. SANITARY AND SEPTIC WASTE PER BMP 50.
7. VEHICLE EQUIPMENT REFUELING, CLEANING, MAINTENANCE AND REPAIR PER BMP 83 AND BMP 84.
8. ALL AREAS WITHIN 100' OF OPEN WATER THAT ARE DISTURBED SHALL BE SEEDED AND COVERED WITH EITHER CLEAN, WEED FREE ANCHORED STRAW, EROSION BLANKET, OR HYDRO-SEEDING MULCH WITH BONDED FIBER MIX WITHIN 24 HOURS OF REACHING FINISH GRADE PER BMP 32 AND 52.
9. ALL AREAS WITHIN 100' OF OPEN WATER, BUT NOT AT FINAL GRADE, WILL BE PROTECTED AT THE END OF EACH DAY WITH A TEMPORARY MULCH COVER SIMILAR TO NOTE 14 ABOVE, IF THEY ARE TO BE LEFT UNWORKED FOR MORE THAN 24 HOURS PER BMP 52.
10. FLOATING TURBIDITY CURTAIN TO BE INSTALLED AND ADJUSTED AS NEEDED DURING BARGE PILE DRIVING AND DOCK WORK PER BMP 71.
11. INSTALL WIRE REINFORCED SILT FENCE (AKA SEDIMENT FENCING) AT THE BEGINNING OF PROJECT, AND MAINTAIN DURING ENTIRE PROJECT. SILT FENCE TO BE INSTALLED AT 3' AND 10' INTERVALS WATER-WARD FROM THE FURTHEST EXTENT OF EXCAVATION AND ALONG THE TOP OF EMBANKMENTS NOT BEING EXCAVATED. DO NOT INSTALL SILT FENCE AS A BARRIER FOR CHANNELIZED FLOW LEAVING THE SITE. REMOVE ALL SILT FENCE AFTER FINAL STABILIZATION. SEE BMP 65: SILT FENCE.

APPLICANT:	VALIANT IDAHO II, LLC
LOCATION:	BONNER COUNTY, IDAHO SECTION 16 & 17, T 57 N, R 1 E, B.M.
WATERBODY:	LAKE PEND OREILLE
DA NUMBER:	
SHEET TITLE:	PRELIMINARY SWPPP PHASE 2
PROJECT:	IDAHO CLUB NORTH LAKE P.U.D.

James A. Sewell and Associates, LLC
1319 N. DIVISION
SANDPOINT, IDAHO 83864, (208) 263-4160

DATE: 05/08/2024
SCALE: AS SHOWN
DRAWN: NCF
CHECKED: BSB
PROJ. NO.: 22043-20-001
CAD FILE: E-VALIANT
SHT 15 OF 15

APPENDIX 6.b

PRELIMINARY SWPPP BMPs

Idaho Club Joint Permit Application

BMP 9: Vegetated (Biofiltration) Swale

Description

Biofiltration swales, commonly called grass or vegetated swales, are densely vegetated open channels designed to convey storm water runoff slowly to facilitate particle settling, filtration, adsorption, and some biological uptake of pollutants. They have mild longitudinal slopes and are wider and shallower than standard storm drain channels to maximize flow residence time (Figure 20).

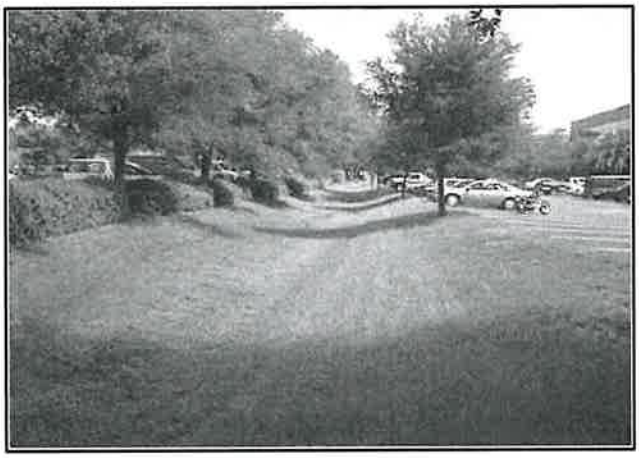


Figure 20. Vegetated swale (Virginia DCR 2011).

Applicability

Biofiltration swales apply in areas with low-to-moderate slopes (less than 6%), although drop structures can be integrated into the design so that they can be used on steeper sites. Swales are linear in nature, so they are well suited for treating runoff from roadways and can be used to replace traditional curb and gutter systems. They are also useful for providing conveyance to and from other BMPs as part of a treatment train within an integrated storm water management plan. For example, placing a sedimentation basin (BMP 25) upstream of a biofiltration swale will help protect the swale from excessive siltation and decrease erosion potential. Low flow vegetated swales can also be placed within retention or detention ponds (BMPs 22 and 23).

Biofiltration swales can provide runoff treatment of conventional pollutants, such as suspended solids, metals, oil and grease, and petroleum hydrocarbons, but are less effective with nutrients. Vegetated swales, when used as a primary treatment measure, should be located off-line from the primary conveyance/ detention system to enhance effectiveness. When a facility is off-line, it is not located within the primary flow path, and runoff is diverted from the primary conveyance to the facility. Swales can also be made smaller when they are located off-line.

Primary BMP Functions and Controls

☐ Construction	☒ Permanent
☐ Erosion Control	☒ Sediment Control
☐ Source Control	☐ Flood Control
☐ Infiltration	☒ Filtration

Typical Effectiveness for Targeted Pollutants

◖	Sediment
○	Phosphorus
◖	Metals
○	Bacteria
◖	Hydrocarbons
○	Litter

Other BMP Considerations

Relative Cost	$
Maintenance Requirements	Medium
Ease of Installation	Easy
Freeze/Thaw Resistance	Fair
Max. Tributary Drainage Area	15 acres
Max. Slope	6%
NRCS Soil Group	BC
Min. Ground Water Separation	3 feet
Min. Bedrock Separation	3 feet

Limitations

The presence of dense vegetation is the key to the effectiveness of biofiltration swales. Sites that are arid or semiarid should weigh the value of the swale against irrigation needs of the vegetation, although using native vegetation can reduce or eliminate the need for irrigation. Also, vegetated swales are not appropriate for storm water hotspots with highly contaminated runoff due to the variability in their performance between storms (Washington State Department of Ecology 2012).

For a vegetated swale, the minimum channel length is 100 feet for adequate pollution removal.

Biofilters should be protected from siltation by a presettling basin (BMP 25) when the erosion potential is high; otherwise, presettling is not generally needed for normal operation. However, a series arrangement of a retention/detention pond and biofilter can offer extra protection to sensitive receiving waters, due to the complementary pollutant removal mechanisms that can operate in the two devices. Equipping both sides of the swale with vegetative buffers or filter strips will also help reduce loading and decrease swale maintenance.

Design Basis

The design for biofiltration swales focuses on providing adequate conveyance through dense vegetation at a slow rate and shallow depth to facilitate sediment removal and infiltration. The following steps and criteria outline the design procedure for vegetated swales.

Design Discharge

Determine the peak flow to be conveyed by the swale for the water quality design storm under fully developed conditions. The swale should also have capacity to safely pass the major storm (10 year, 25 year, or 100 year depending on specifications of the local agency). Use hydrologic procedures presented in section 3.6 to determine peak flows.

Longitudinal Slope

Establish the horizontal location of the swale and determine the longitudinal slope. Minimally, the channel slope should be between 1% and 5% but ideally between 2% and 4% if grasses are used to vegetate the swale. Swales with slopes less than 2% should include underdrains placed beneath the channel to ensure positive drainage, or they should be planted with vegetation that can withstand periods of ponding water. For slopes greater than 4%, log or rock check dams (BMP 60) or drop structures can be used approximately every 50 feet so that a maximum 4% slope can be maintained between structures. Energy dissipation measures should be used downstream of each drop structure.

Flow Depth

Select a flow depth based on the vegetation to be used in the swale. To be effective, the depth of flow for the water quality design storm should not exceed the height of the vegetation. The maximum depth of flow is approximately 2 inches for mowed vegetation, 4 inches for infrequently mowed vegetation, and 6 inches for unmowed vegetation, depending on species.

Geometry

Determine the geometry of the swale based on the longitudinal slope, flow rate, and flow depth. Use either a trapezoidal or triangular shape with side slopes no steeper than 3:1 (horizontal: vertical). For ease of construction and maintenance, the recommended geometry is a trapezoidal shape with a minimum bottom width of 2 feet and 4:1 side slopes. The maximum bottom width should be 10 feet unless a divider is used (Figure 21).

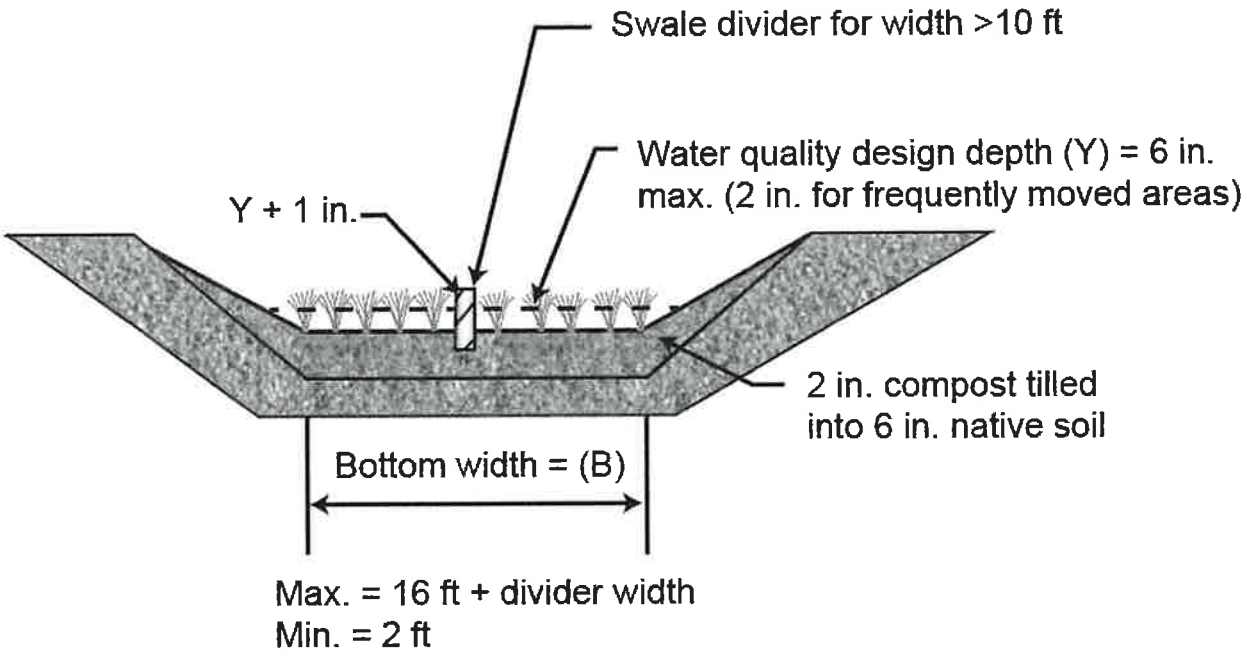


Figure 21. Typical biofiltration swale cross section (adapted from King County 2009).

Manning's equation for open channel flow can be used to size the swale. Select a value for the Manning's roughness coefficient, n, based on the vegetation to be used (generally n = 0.2 to 0.3 for grass or other dense vegetation that is not submerged by the very shallow flow depth). For a trapezoidal channel with shallow flow, the hydraulic radius can be approximated to the depth of flow and Manning's equation can be expressed as follows (Equation 8):

$$B = \frac{Q * n}{1.49\, y^{\frac{5}{3}} S^{\frac{1}{2}}} - Zy$$

Equation 8. Swale bottom width.

Where:

B = bottom width of swale (feet)
y = depth of flow (feet)
S = longitudinal slope of swale (feet per feet)
Z = side slope of the swale in the form Z:1 (H:V)
Q = design flow rate (cubic feet per second)

Velocity

Use the calculated bottom width and swale geometry to check the velocity within the swale. The velocity can be calculated using Equation 9:

$$V = \frac{Q}{A}$$

Equation 9. Channel velocity.

Where:

V = velocity (feet per second)
A = cross-sectional area of flow (square feet) = $By + Zy^2$
Q = flow (cubic feet per second)

The velocity of the water should not exceed 1 foot per second during the water quality design storm and should not exceed 3 feet per second during the major storm. If the velocity exceeds the maximums, adjust the swale design until the conditions are met. This adjustment may entail changing the bottom width, reducing the flow by installing a flow divider, or changing the vegetation type to increase the allowable depth.

Hydraulic Residence Time

For biofiltration, maximize water contact with vegetation and the soil surface. A minimum hydraulic residence time of 9 minutes is required to provide adequate pollutant removal. In no case should residence time be less than 5 minutes. For better pollutant removal, a longer residence time is recommended.

Compute the hydraulic residence time using Equation 10:

$$t = \frac{L}{V * 60}$$

Equation 10. Hydraulic residence time.

Where

t = hydraulic residence time (minutes)
L = length of the swale (feet)
V = flow velocity (feet per second)

If the hydraulic residence time is less than 9 minutes, reconfigure the swale to increase the length. It may be necessary to use a wide-radius curved path, where land is not adequate for a linear swale (avoid sharp bends to reduce erosion or provide for erosion protection).

Check the surface area of the swale compared to the tributary drainage area. As a general rule, the total surface area of the swale should be approximately 1% of the total drainage area.

High Flows

High flows during a major storm should either be conveyed safely by the swale or bypass the swale through a parallel pipe with a flow-regulating device inside the inlet structure. If the swale is to convey high flows, consider channel erosion control and vegetation destruction, and perform a stability analysis. The swale should provide at least 1 foot of freeboard over the water quality storm and safely pass the major storm with a maximum velocity of 3 feet per second.

Slopes

For swales with longitudinal slopes less than 2%, install an underdrain under the channel if grasses are desired. The underdrain should be installed within an 8-inch aggregate layer. Use either a 4- or 6-inch diameter perforated high-density polyethylene pipe for the underdrain and include cleanouts every 150 feet. A filter sock around the pipe should not be used as it can cause the pipe perforations to clog. The underdrain can daylight to either a storm water inlet or through the face of a grade control structure at the end of the swale.

Alternatively, emergent wetland plant species can be used when some period of soil saturation is expected or where particular pollutant uptake characteristics are desired.

Soils

The soils within the swale should support a dense growth of vegetation, which can eliminate very heavy clay soils. Soils in hydrologic soil groups A, B, and C with good infiltration qualities and lower runoff potentials are preferred.

Below the design water depth, install an erosion control blanket, at least 4 inches of topsoil, and the selected biofiltration seed mix. Above the design water line, use an erosion control seed mix with straw mulch or sod.

Vegetation

Select vegetation based on pollution control objectives and according to what will best establish and survive in the site conditions. Select close-growing, water-resistant grasses with a height of 6 inches or less. Grasses over 6 inches tend to flatten down when water is flowing over them, which prevents settling of sediment.

In swales next to roadways where deicer is regularly used, salt-tolerant species should be used. Selecting different, low-growing ground covers for the swale's side slopes can lessen the amount of mowing required.

Construction Guidelines

The success of biofiltration swales depends more on proper construction and maintenance than any other factor. Construction guidelines include the following:

- Avoid compaction during construction and protect the area from construction activities.
- Use netting to protect plants from predation during establishment.
- Provide irrigation as necessary.
- Perform fine grading, soil amendment, and seeding after stabilizing upgradient surfaces.

Maintenance

Inspect and maintain biofiltration swales to ensure the vegetation remains healthy and rills or gullies are repaired. The following measure should be taken:

- Inspect swales at least every 6 months, preferably during and after storm events. Check for uniform vegetative cover and traffic impacts. Spot replace vegetation as necessary.

- Mow grasses if needed for good growth. Mowing requirements vary for different grass species. Remove clippings to maintain the performance capacity of the swale.
- Remove sediment as needed near culverts and the channel to maintain flow capacity.
- Remove leaves, litter, and oily materials. Clean curb cuts and level spreaders as needed.
- Control weeds as needed. Mechanical weed control by pulling or mowing is preferred to chemical herbicides.
- Irrigate if necessary to establish and maintain vegetation.
- Fertilizing is often unnecessary because runoff from lawns and other areas provides enough nutrients. If needed, use only biodegradable, nontoxic fertilizers and apply at a rate and formula compatible with plant uptake and soil group. Soil tests may be necessary to determine existing soil fertility and proper application rate.
- Perform public education for residents living near biofilter swales; describe their purpose and the importance of keeping them free of debris.

Additional Resources

EPA (US Environmental Protection Agency). No date. *Grassed Swales*. Water: Best Management Practices Fact Sheet. *https://www.swbmp.vwrrc.vt.edu/wp-content/uploads/BMP_Spec_No_10_DRY_SWALE.pdf*

Goldberg, J. 1993. *Dayton Avenue Swale Biofiltration Study*. Seattle Engineering Department, Seattle, WA.

Schueler, T. 1997. "Comparative Pollutant Removal Capability of Urban BMPs: A Reanalysis." *Watershed Protection Techniques* 2(2): 379–383.

Virginia DCR (Virginia Department of Conservation and Recreation). 2011. *Dry Swales*. Ver. 1.8. Stormwater Design Specification No. 10. *http://vwrrc.vt.edu/swc/april_22_2010_update/DCR_BMP_Spec_No_10_DRY_SWALE_Final_Draft_v1-8_04132010.htm*

Washington State Department of Ecology. 2012. *Stormwater Management Manual for Western Washington*. Lacey, WA. Publ. 12-10-030. *http://www.ecy.wa.gov/programs/wq/stormwater/manual.html*

BMP 32: Landscaping

Description

Landscaping on new or redeveloped sites establishes vegetated cover that stabilizes the soil, reduces storm water runoff through infiltration, minimizes invasive species, acts as a long-term biofiltering system, and improves aesthetics. Landscaping methods include seeding, sodding, and planting perennial grasses, legumes, native shrubs or wild flowers, bushes, and trees (Figure 84).

Figure 84. Native and drought tolerant plants (Driggs, Idaho).

Seeding is the practice of planting seeds on a prepared soil surface. Sodding refers to placing rolls or strips of grass-covered mats held together by dense root systems on the soil surface. Planting establishes vegetation using living plants grown to a specified size or age.

Using native and/or drought-resistant vegetation is strongly encouraged for all landscaping efforts. *Stormwater Plant Materials: A Resource Guide* (City of Boise 2000) or the *North Idaho Native and Beneficial Plant List* (Sterling Codifiers 2014) offers additional design guidance about plant selection and landscaping techniques to maximize water quality benefits.

Primary BMP Functions and Controls

☒ Construction	☒ Permanent
☒ Erosion Control	☒ Sediment Control
☐ Source Control	☐ Flood Control
☒ Filtration	☐ Infiltration

Typical Effectiveness for Targeted Pollutants

◖	Sediment
○	Nitrogen
◖	Phosphorus
◖	Metals
○	Bacteria
○	Hydrocarbons
○	Litter

Other BMP Considerations

Relative Cost	$
Maintenance Requirements	Low
Ease of Installation	Easy
Freeze/Thaw Resistance	Good
Max. Tributary Drainage Area	Unlimited
Max. Site Slope	Varies
NRCS Soil Group	ABCD
Min. Ground Water Separation	3 feet
Min. Bedrock Separation	3 feet

Applicability

Landscaping can be applied and is encouraged on all sites, even those in urban environments. Seeding and sodding can be used for permanent erosion control. Sodding and planting is most appropriate in locations where vegetation establishment is needed quickly, such as immediate erosion control. Possible uses for sod include buffer zones, dikes, swales, slopes, outlets, level spreaders, and filter strips.

Planting is most appropriate for permanent vegetation establishment where seeding and other slope treatments are either not effective or not appropriate. Such areas may include the following:

- Extremely rocky slopes or areas with generally poor soils.
- Areas or sites with established natural vegetation in significant amounts, which are difficult to seed and mulch effectively.
- Areas where special attention to landscape aesthetics or biological diversity is needed.
- Wetlands and wildlife habitat areas where it may be critical to plant the desired species initially so that the site is not overrun by weeds or undesirable plant species that detract from the intended use of the site.
- Where specific types of trees and shrubs are necessary to remove excess moisture from the soil.
- In areas that require soil stabilization and erosion control sooner than can be provided by seeding, such as along streams, rivers, and lakes (the riparian edge).

Limitations

All landscaping should take place at the proper time of year for both the method of application (seeding, sodding, and planting) and the specific species involved. Generally, it is not recommended to landscape during very hot and dry weather. Depending on site conditions and vegetation species used, irrigation may be required either temporarily or permanently to ensure vegetation establishment and prevent die off.

Sodding and planting is more costly than seeding. However, establishing grasses and plants from seed will take longer than sodding or planting. Landscape establishment will occur more quickly in high precipitation areas, usually over 20 inches of rain annually during the growing season, as opposed to arid or semiarid regions. Sodding usually provides less vegetation diversity than either seeding or planting.

Design Basis

Using native drought-resistant vegetation is strongly encouraged for all landscaping efforts. Native species require little or no maintenance (i.e., watering or fertilizing), mimic natural conditions, and may help limit the introduction of invasive species.

All revegetation efforts should be performed according to local requirements, and lists of acceptable landscape plant species should be obtained from an agronomist or the local cooperative extension. Successful landscaping projects depend on selecting suitable species for the site location considering climate and elevation, surrounding species, using healthy vegetation, and revegetating when the season and weather conditions are favorable. The site should be properly prepared and be adequately maintained to ensure long-term survival of the vegetation.

Seeding

Effective seeding requires proper seedbed preparation and should be conducted with various forms of mulching, matting, and annual grass (cereal grain) as a nurse crop to help protect the seed and retain soil moisture.

Before seeding, ensure that site conditions are capable of supporting seeding efforts. If site conditions lack proper nutrient values, organic content, microorganisms, or root restrictions, a

seedbed should be established. Seedbeds may consist of topsoil (BMP 31), compost, or soil enhancements (BMP 7).

Sodding

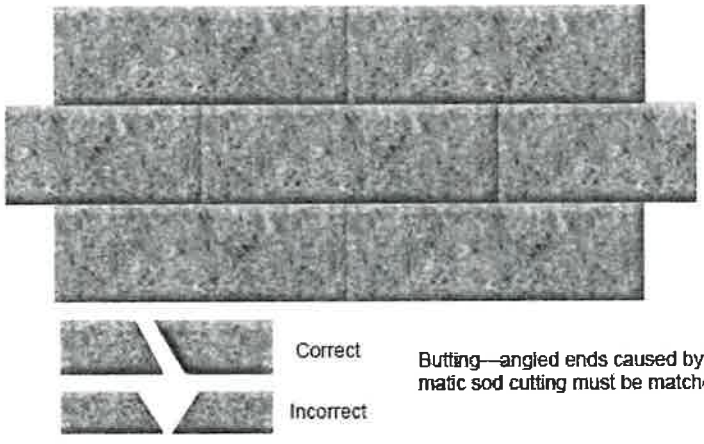
As long as moisture conditions are adequate, sod may be placed at any time of year. Turf, or sod, consists of matted earth formed by grass and soil bound together by a root layer. Rethinking turf as the primary ground cover does not imply that all grassy areas should be replaced. Turf should be planted only where it is desirable and will be used to support designated land uses (e.g., athletic fields or recreation areas) and in an appropriate amount. Turf grass does not always provide the needed erosion control, so interim use of a cover crop to improve soil fertility and stability between construction completion and final planting may be beneficial. Consult a local agronomist, a soil scientist, or an extension office for the proper selection and application of cover crops.

Follow these guidelines for establishing turf in residential areas:

- Place turf in rear yards close to the residence where the bulk of recreational activity is likely to occur.
- Use drought-tolerant and native species of grass.
- To avoid a monoculture, use various species of turf grass in your landscaped areas.

The soil surface should be at final grade and roughened before laying down sod. Topsoil (BMP 31) may be needed in areas where soil textures or conditions are inadequate (such as dense or impermeable soils). Sod may be placed directly on the ground without topsoil only if it has been specifically grown for sites with no topsoil. Add lime and fertilizers as needed to promote good plant growth conditions. Sodding should take place immediately after the soil bed is established, and it should be rolled or compacted immediately after installation to ensure firm contact with the underlying soil.

Sod is commercially available in rolled strips that can be applied in staggered rows or other patterns. Areas not covered by the specified pattern may be seeded to reduce expense. When placed on steep slopes, lay the sod parallel to flow with staggered joints or peg down (or both) and place chicken wire, jute, or other netting over the sod for extra protection against lifting. If slopes will be mowed, do not place sod on grades greater than 3:1 (Figure 85 and Figure 86).



Lay sod in a staggered pattern with strips butted tightly against each other. A sharpened mason's trowel can be used to tuck down the ends and trim pieces.

Butting—angled ends caused by the automatic sod cutting must be matched correctly.

Figure 85. Sod laying pattern.

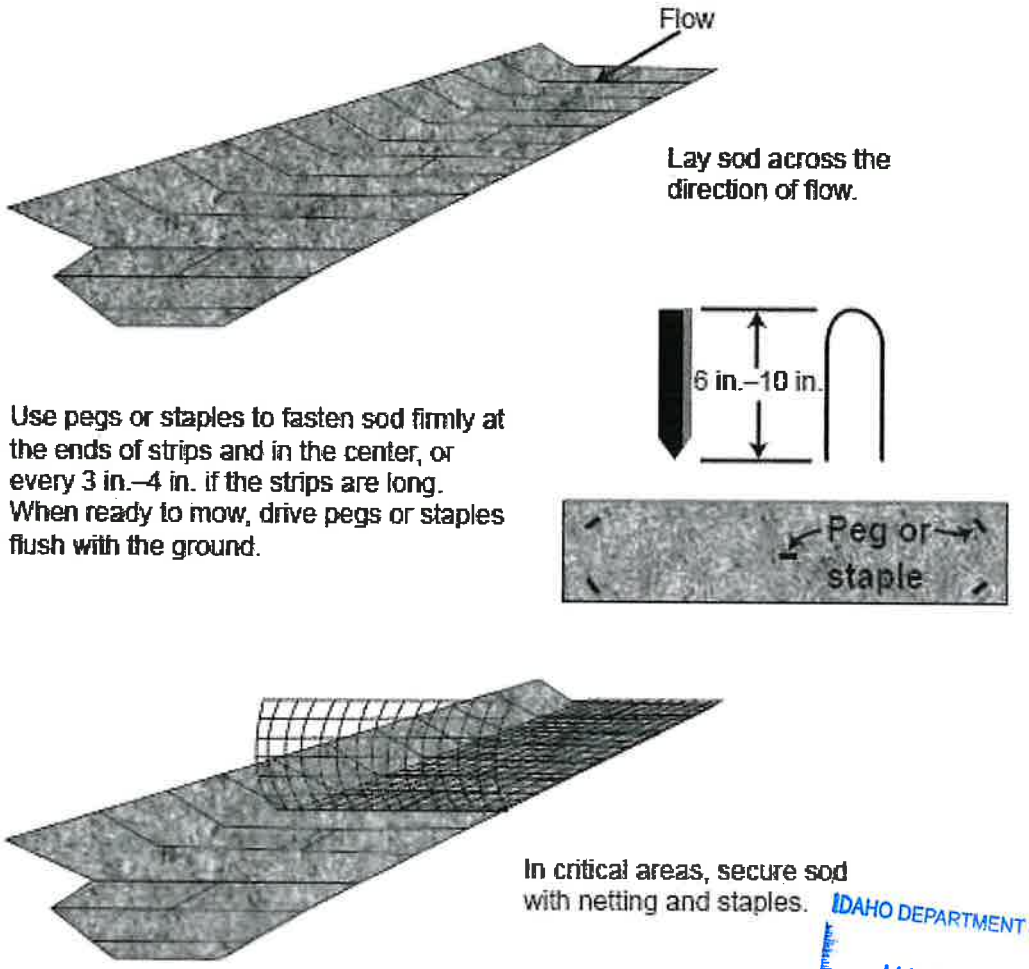


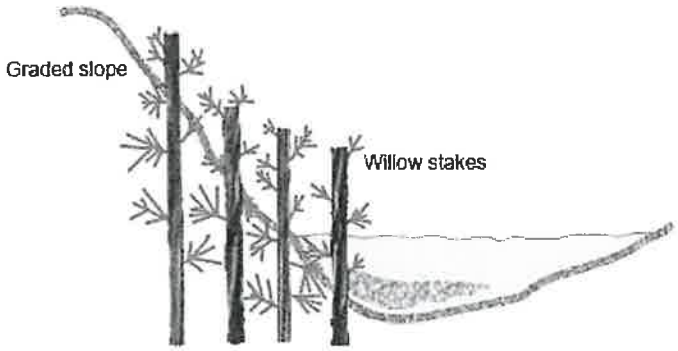
Figure 86. Steep slope details.

Planting

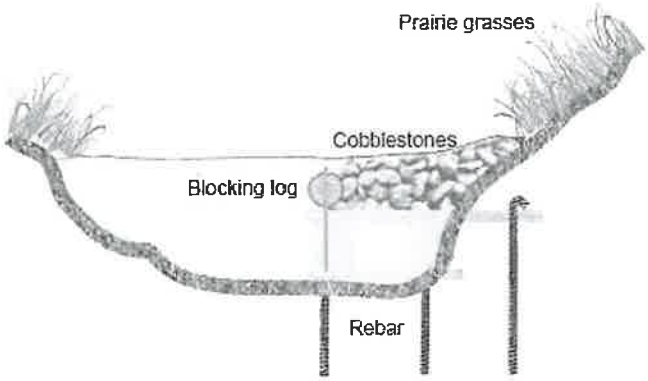
Planted material may be grown from either cuttings or seed. At delivery to a job site, the plants may be potted (in containers), root wrapped, or bare rootstock. Some species are successfully planted as sprigs or tubelings. Vegetative planting may be combined with seeded grasses and legumes that provide immediate surface coverage. Planting methods are shown in Figure 87, Figure 88, and Figure 89.

Examine plant materials before use to ensure that species, container sizes, and root and soil conditions are acceptable. If possible, the growth medium for containerized plants should be similar to the soil type on the revegetation site. Container size guidelines are as follows:

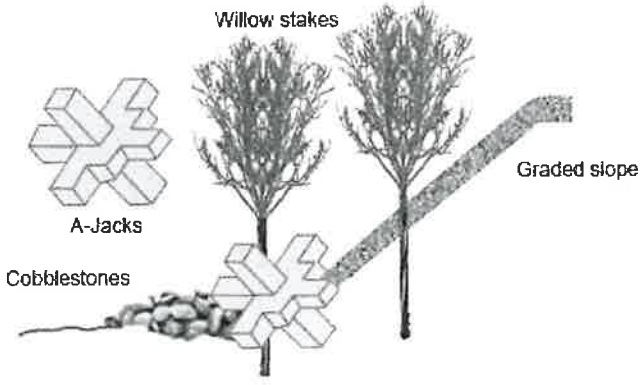
- Tree species may be bare rootstock or potted stock. Pots and containers should be adequate size for the tree, shrub, or plant that it contains.
- Shrub species may be bare rootstock or potted stock.
- Peat pots are not recommended as research shows greater plant mortality from drying. If peat pots are used, remove any exposed peat pot material showing after planting.



Willow posts installed below depth of streambed scour

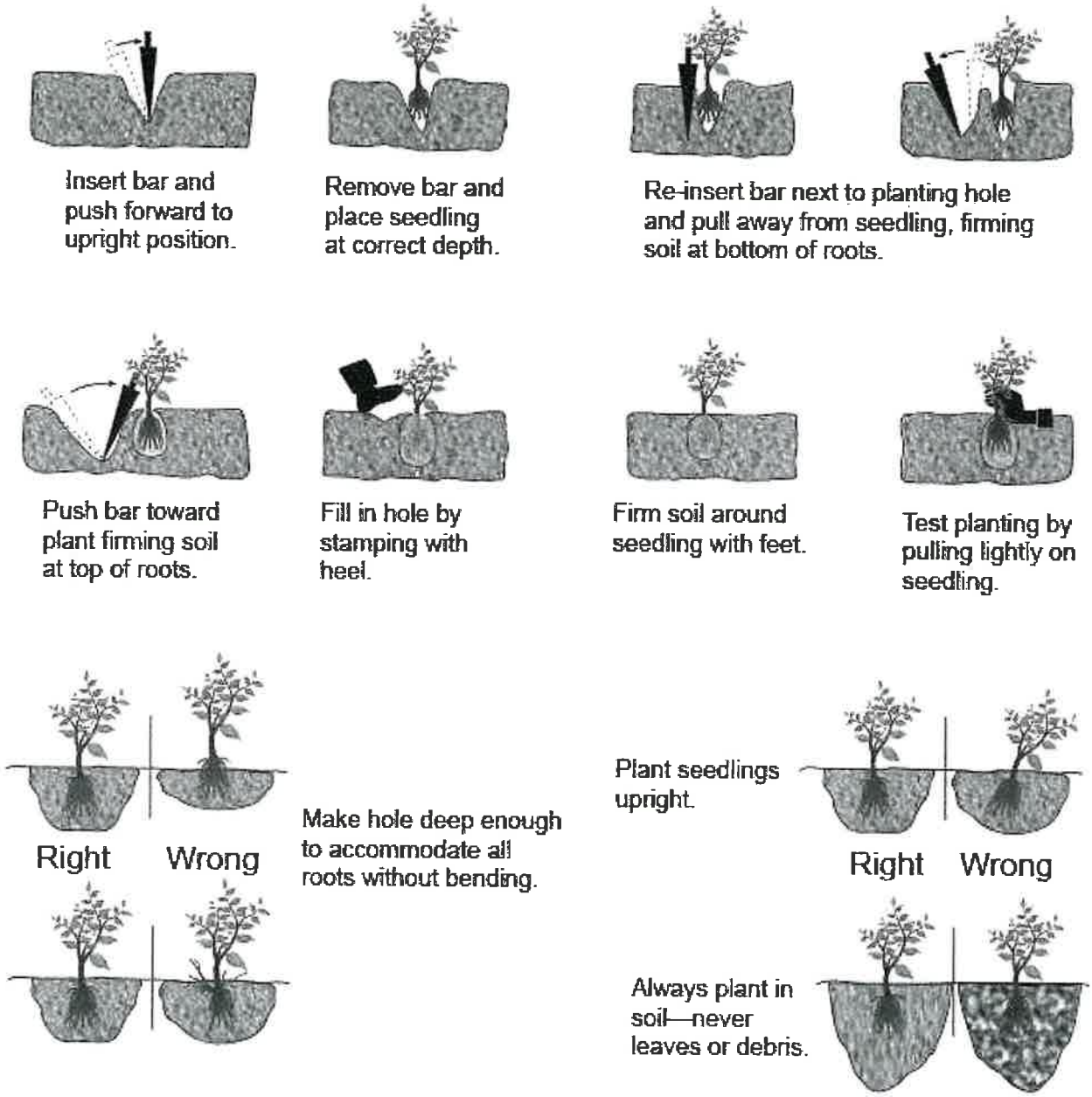


Lunker with riprap below baseflow stage. Rebar is driven below bed scour depth



A-jack bank structures

Figure 87. Planting methods on graded slopes.



Planting bare-root seedlings (modified from Division of Forestry, Virginia)

Figure 88. Planting methods for seedlings.

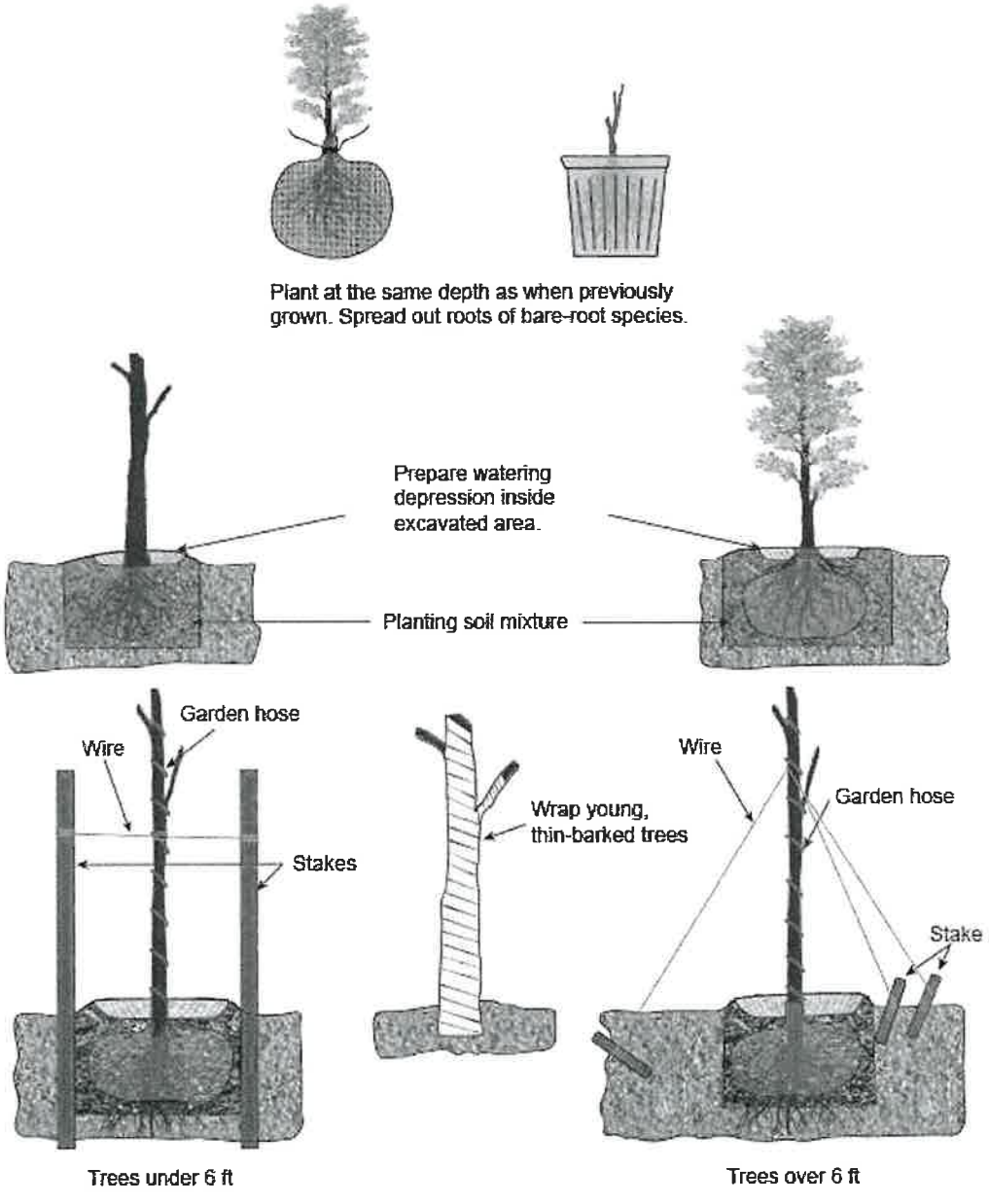


Figure 89. Planting methods for trees.

Construction Guidelines

Before temporary seeding, all runoff control measures should be in place to prevent seed loss during a storm event.

As permanent landscaping is the last phase of reclaiming disturbed soils, all other construction activities should be completed before the final placement of landscaping materials. During construction, avoid compacting areas to be landscaped (BMP 45: Minimize Soil Compaction) as overly compacted planting beds will not vegetation as quickly or thoroughly.

Before planting, the locations of the trees, shrubs, ground covers, and other vegetation should be marked and approved.

Store bundled bare root planting stock, whether tree or shrub species, in a cool, moist place from time of receipt until time of planting. This time should not exceed 10 days. Store potted plant stock in the shade and out-of-doors and maintain a moist soil from the time of receipt to the time of planting. This time should not exceed 30 days.

Maintenance

- Inspect all landscaped areas on a regular basis and after each major storm event to check for areas where corrective measures may have to be made.
- Indicate which areas need to be reseeded, resodded, replanted or where other remedial actions are necessary to ensure the vegetation is permanently established.
- Proper irrigation of landscaped areas during the first 2 years following construction is suggested to increase the survival of the vegetation.
- Any seeded area that has failed to establish at least an 80% ground cover within 1 month should be reseeded. If reseeding is ineffective, an alternative method, such as sodding, should replace seeding efforts.

Additional Resources

City of Boise. 2000. *Stormwater Plant Materials: A Resource Guide*. Boise, ID: Boise Public Works.

Colorado UDFCD (Colorado Urban Drainage and Flood Control District). 2010. *Urban Storm Drainage Criteria Manual, Volume 3 Best Management Practices*. Denver, CO. *http://udfcd.org/wp-content/uploads/2014/07/Title-Page.pdf*

King County (King County, Washington). 2009. *King County, Washington Surface Water Design Manual.* Seattle, WA: King County, Department of Natural Resources.

NRCS (US Department of Agriculture Natural Resources Conservation Service). 2004. *Plant Guide: Kentucky Bluegrass*. Baton Rouge, LA: National Plants Data Center. *http://plants.usda.gov/plantguide/pdf/pg_popr.pdf*

Sterling Codifiers, Inc. 2014. "Appendix B—North Idaho Native and Beneficial Plant List." *Bonner County, Idaho County Code*. Bonner County, ID. *https://evogov.s3.amazonaws.com/media/136/media/61416.pdf*

Washington State Department of Ecology. 2012. *Stormwater Management Manual for Western Washington*. Lacey, WA. Publ. 12-10-030. *http://www.ecy.wa.gov/programs/wq/stormwater/manual.html*

BMP 37: Staging Areas

Description

Staging areas are clearly designated locations where construction equipment, vehicles, stockpiles, waste bins, office trailers, and other construction-related materials may be stored on site. Staging areas should be located, constructed, and maintained to prevent the discharge of sediment, solid waste, dust, trash, debris, or other pollutants from the site (Figure 98).

Figure 98. Construction staging area (Colorado UDFCD 2010).

Applicability

Most construction sites require a staging area. The size of the staging area depends on the size and type of the project and duration of construction.

Limitations

Some sites have limited space available, and it may be desirable to place the staging area off site or within an adjacent roadway. Staging areas in roadways require special measures to prevent materials from washing into existing storm inlets.

Measures to prevent storm water from entering the staging area tend to concentrate flow and can result in excessive erosion downstream if additional BMPs are not installed.

Primary BMP Functions and Controls

☒ Construction	☐ Permanent
☐ Erosion Control	☒ Sediment Control
☒ Source Control	☐ Flood Control
☐ Filtration	☐ Infiltration

Typical Effectiveness for Targeted Pollutants

●	Sediment
◖	Phosphorus
◖	Metals
◖	Bacteria
◖	Hydrocarbons
◖	Litter

Other BMP Considerations

Relative Cost	$
Maintenance Requirements	Medium
Ease of Installation	Medium
Freeze/Thaw Resistance	Good
Max. Tributary Drainage Area	N/A
Max. Upstream Slope	N/A
NRCS Soil Group	ABCD
Min. Ground Water Separation	N/A
Min. Bedrock Separation	N/A

Design Basis

Size and Location

Size the staging area so that it provides appropriate space to accommodate storage and parking needs, as well as loading and unloading operations. When designing the stabilized staging area, minimize the area of disturbance to the maximum extent practical as oversizing the staging area may disturb existing vegetation in excess of the project requirements (BMP 1: Minimize Land Disturbance and BMP 39: Clearing Limits). Oversizing increases costs and requires long-term stabilization after the

construction period. Consider using off-site parking areas and restrict vehicle access to the site if possible to minimize the size needed for staging.

Place staging areas where site impacts will be minimized and at least 50 feet away from streams, surface waters, or wetlands. If possible, locate the staging area in a place that will be disturbed, such as the planned location for a road or parking area, and move it as construction progresses to limit the amount of unnecessary site disturbance.

Features

The staging area should have a stabilized surface, either paved or covered with 2- to 4-inch diameter aggregate at 3 to 6 inches deep, and accessed by a stabilized construction entrance. If the staging area is located in an area that would not be otherwise disturbed, consider using construction mats in lieu of rock to minimize long-term stabilization needs. BMP 41: Stabilized Construction Roads and Staging Areas provides more information on surface treatment requirements.

The grading in and around the staging area should control uncontaminated flow by diverting it around areas that may have pollutants and also contain potentially contaminated flows or divert them to treatment facilities.

Surround the staging area by construction fencing to prevent unauthorized access to construction materials. Perimeter sediment controls such as silt fence (BMP 65), sediment fiber rolls (BMP 64), or other measures should also be installed around the area as appropriate.

Materials storage should follow guidelines from BMP 77: Outdoor Storage, BMP 46: Spill Prevention and Control, and BMP 87: Outdoor Loading and Unloading of Materials. To comply with the Construction General Permit (EPA 2012b), storage areas for building products must provide either cover (e.g., plastic sheeting or temporary roofs) to prevent these products from coming into contact with rainwater, or a similarly effective means designed to prevent the discharge of pollutants from these areas.

Materials should be stored separately as appropriate using guidelines from BMP 48: Hazardous Materials Management. Hazardous or toxic wastes should be stored separate from construction and domestic waste. Flammable and combustible material should be segregated and stored in appropriately sized secondary containment.

Flow Diversion

Limiting the flow across staging areas reduces the volume of storm water that may carry pollutants from the area and require treatment. If the staging area cannot be located away from areas expected to receive significant volumes of storm water runoff, flow diversion BMPs, such as storm water conveyances, dikes, or berms, are needed.

Storm Water Conveyances

Storm water conveyances include either temporary or permanent channels, gutters, drains, or sewers. The conveyances are constructed or lined with many different materials, including concrete, clay tiles, asphalt, plastics, metals, riprap, compacted soils, and vegetation. By their

nature, storm water conveyances concentrate flow, and storm water should be routed through stabilized structures to discharge to a receiving water or other storm water BMP.

In planning for storm water conveyances, consider the amount and speed of typical storm water runoff. Also, consider the storm water drainage patterns, so that channels may be located to collect the most flow and built to handle the appropriate runoff volume. When deciding on the type of material for the conveyance, consider the material's resistance, durability, and compatibility with any pollutants it may carry.

Conveyance systems are most easily installed when a facility is initially constructed. Where possible, use existing grades to decrease costs. Grades should be positive to allow for the continued movement of the runoff through the conveyance system; however, grades should not increase velocity, causing excess erosion. When assessing erosion potential, consider the materials used for lining the conveyance and types of outlet controls provided. Reference the following BMPs for additional design parameters.

- BMP 28: Conveyance Furrows for Roof Runoff
- BMP 56: Riprap Slope Protection
- BMP 57: Pipe Slope Drain
- BMP 68: Temporary Swale

Dikes and Berms

Diversion dikes or berms are ridges built to block runoff from passing beyond a certain point. In planning for dike installation, consider the slope of the drainage area, height of the dike, amount of runoff it will need to divert, and type of conveyance that will be used with the dike. Steeper slopes result in higher volumes of runoff and higher velocities, which the dike should be capable of handling. Dikes are limited in their ability to manage large volumes of runoff. Temporary dikes (usually made of dirt) generally only last for 18 months or less but can become permanent structures by stabilizing them with vegetation. Slope protection such as vegetation is crucial for preventing the erosion of the dike. For additional design parameters, see BMP 69: Diversion Dike and BMP 70: Temporary Berms.

Construction Guidelines

Staging areas should be planned and designed before starting construction; however, certain BMPs, such as dikes and berms, may be constructed at any time. Implementing staging areas and associated drainage needs should also be incorporated into BMP 36: Construction Timing.

Specific construction methods apply to the type of conveyance, dikes, berms, graded areas, and pavements being used. Refer to applicable BMPs for construction guidelines.

Maintenance

Maintenance of staging areas includes inspecting and repairing the stabilized surface, repairing perimeter controls, and following good housekeeping practices.

Storm water diversions, such as conveyances and dikes, should be inspected regularly and within 24 hours of a storm event. Daily inspections may be required during periods of prolonged rainfall

as heavy storms may clog or damage the conveyances or wash away parts of temporary dikes. Any necessary repairs should be made immediately to ensure the structure continues to function effectively.

Inspect unpaved, graded areas to check for gullies and other signs of erosion. Inspect paving regularly for cracks that may allow contaminants to seep into the ground. Ensure drains receiving the discharge from the paved area remain free of clogged sediment or other debris so that the water does not back up into areas where pollutants may be.

When construction is complete, debris, unused stockpiles, and materials should be recycled or disposed of properly (Section 3.10.7, "Construction Disposal Alternatives"). Permanently stabilize staging areas with vegetation or other surface cover planned for the development.

Additional Resources

Colorado UDFCD (Colorado Urban Drainage and Flood Control District). 2010. *Urban Storm Drainage Criteria Manual, Volume 3 Best Management Practices*. Denver, CO. *http://udfcd.org/wp-content/uploads/2014/07/Title-Page.pdf*

ITD (Idaho Transportation Department). 2014. *Best Management Practices.* Boise, ID: ITD.

BMP 40: Vehicle Sediment Control

Description

This BMP describes measures to minimize track out of sediment from construction vehicles exiting the construction site onto off-site streets, other paved areas, and sidewalks. Sediment transported off site onto paved streets is a significant problem because it is difficult to effectively remove, and any sediment not removed ends up in the drainage system.

Temporary devices, such as a pad of coarse aggregate or a construction mat, should be installed at all exits from the construction site to a public roadway to stabilize the road and remove sediment (Figure 102). Additional controls to remove sediment from tires, such as wheel washing, rumble strips, and rattle plates, can also be used where necessary.

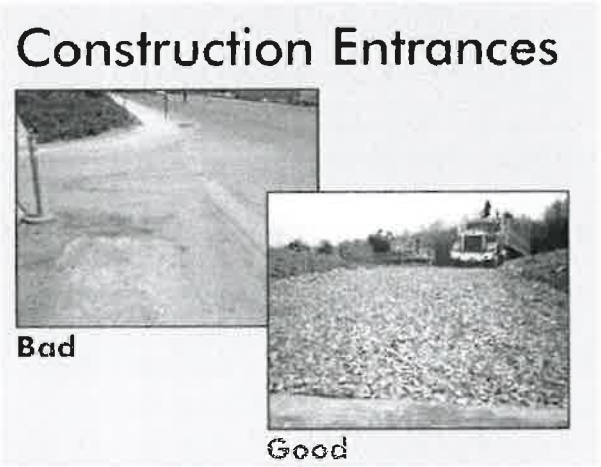


Figure 102. Stabilized gravel construction entrance examples (EPA 2003).

Applicability

Vehicle sediment control is appropriate for all construction sites in the following locations:

- Wherever vehicles are entering or leaving a construction site to or from a public right-of-way, street, alley, sidewalk or parking area.
- At any unpaved entrance/exit location where risk exists of transporting mud or sediment onto paved roads.

Vehicle sediment control is particularly important during wet weather periods when mud is easily tracked off site, during dry weather where dust is a concern, and when poorly drained, clayey soils are present on site.

Primary BMP Functions and Controls

☒ Construction	☐ Permanent
☐ Erosion Control	☒ Sediment Control
☐ Source Control	☐ Flood Control
☐ Filtration	☐ Infiltration

Typical Effectiveness for Targeted Pollutants

●	Sediment
○	Phosphorus
○	Metals
○	Bacteria
○	Hydrocarbons
○	Litter

Other BMP Considerations

Relative Cost	$
Maintenance Requirements	Medium
Ease of Installation	Medium
Freeze/Thaw Resistance	Good
Max. Tributary Drainage Area	N/A
Max. Slope	15%
NRCS Soil Group	ABCD
Min. Ground Water Separation	N/A
Min. Bedrock Separation	N/A

Limitations

Vehicle sediment control using stabilized construction entrances are most effective when installed on level ground. If wheel washing is needed due to high sediment loads, washwater will need to be available and an additional sediment trap (BMP 66) may need to be installed.

Design Basis

Vehicle sediment controls include aggregate pad construction entrances and turf mat construction entrances. Additional controls may be needed if the stabilized construction entrance does not remove sufficient amounts of sediment from vehicle and equipment tires. The following sections provide design information for these practices.

Access and exits should be limited to one route if possible or two for linear projects such as roadways where more than one access/exit is necessary. Construction entrances should avoid crossing existing sidewalks if possible. If they must cross a sidewalk, the full length of the sidewalk should be covered and protected from sediment leaving the site.

Construct entrances on a level surface, and if feasible, grade to drain towards the construction site to reduce off-site runoff. Runoff from a stabilized construction entrance should drain to a sediment trap or a sediment basin, and a culvert should be installed under the entrance to convey water along the ditch of the public road if necessary.

Aggregate Pad Construction Entrance

A coarse aggregate pad underlain with a geotextile fabric is a common technique for stabilizing construction entrances (Figure 103). The width should be at least 15 feet but not less than the full width of points where ingress or egress occurs. At sites where traffic volume is high, the entrance should be wide enough for two vehicles to pass safely. Flare the entrance where it meets the existing road to provide a sufficient turning radius.

The recommended minimum length should be 50 feet, although 100 feet is preferred. The aggregate should include 3- to 6-inch diameter rock. The placement depth should be 9 inches minimum or as recommended by a soils engineer based on the maximum expected vehicle loads. For entrances that will become permanent or for long-term installations during construction, two layers may be needed with a base layer of 2- to 8-inch diameter crushed stone and a top layer of 2 inch diameter or smaller stone.

Place geotextile filter fabric under the aggregate to prevent fine sediment from pumping up into the rock pad and to reduce maintenance and loss of aggregate. The geotextile should be a nonwoven fabric consisting only of continuous chain polymeric filaments or yarns of polyester. The geotextile should be inert to commonly encountered chemicals, hydrocarbons, and mildew and rot resistant.

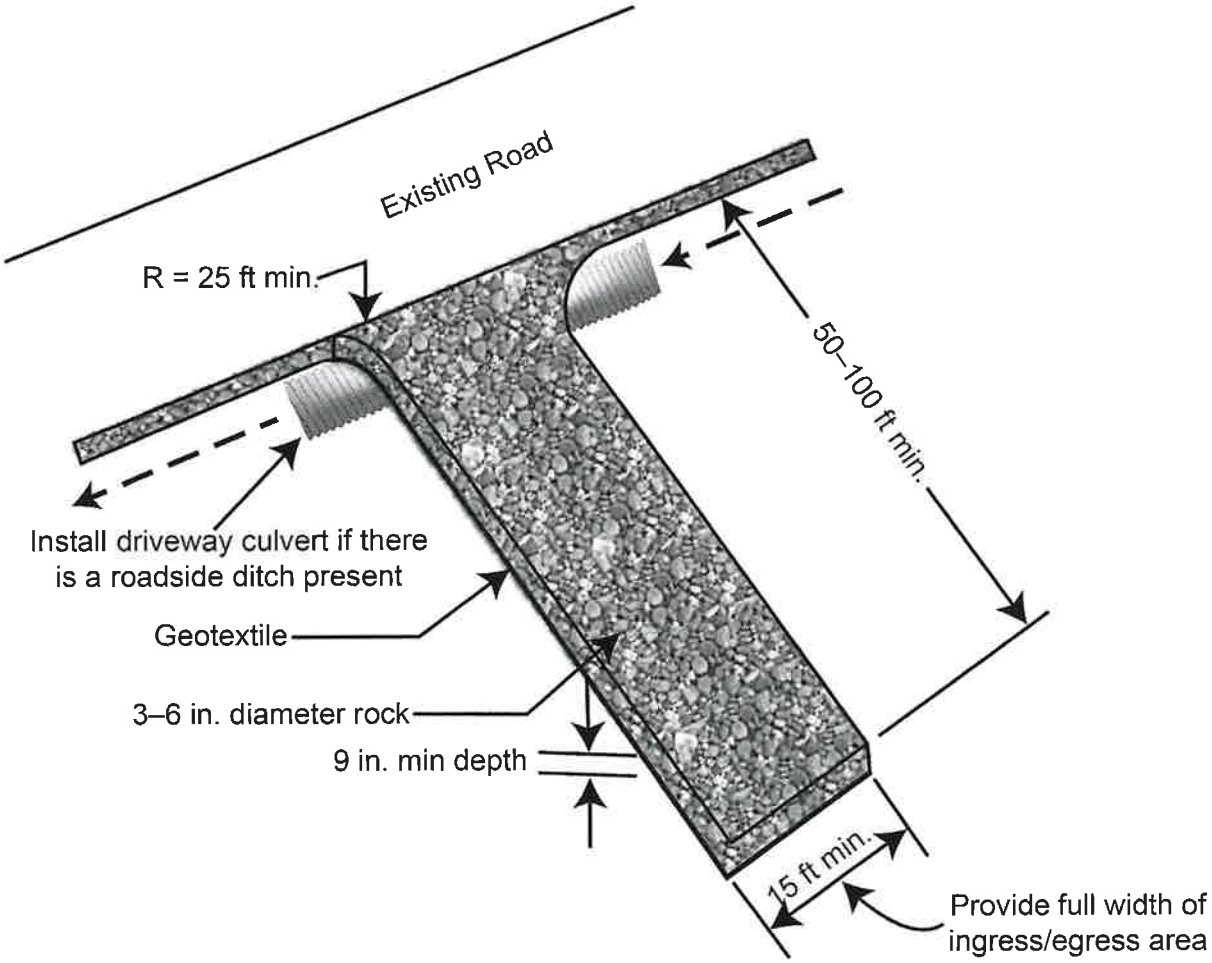


Figure 103. Aggregate pad construction entrance (adapted from King County 2009).

Construction Mat or Turf Reinforcement Mat

For small construction sites with low traffic volume, use a construction mat or turf reinforcement mat to stabilize the entrance (Figure 104 and Figure 105). The mats are made of steel, high-density polyethylene, timber, or a woven geotextile. Turf mats do not remove a significant amount of sediment from vehicles but do stabilize the entrance and prevent vehicles from causing rutting. These mats are especially suited for sites containing saturated soils, wetlands, or soft/poor subgrade as they provide immediate stabilization and some protection to existing vegetation. Some mats can be removed and reused on multiple sites.

Figure 104. Construction mat (*Matrax*).

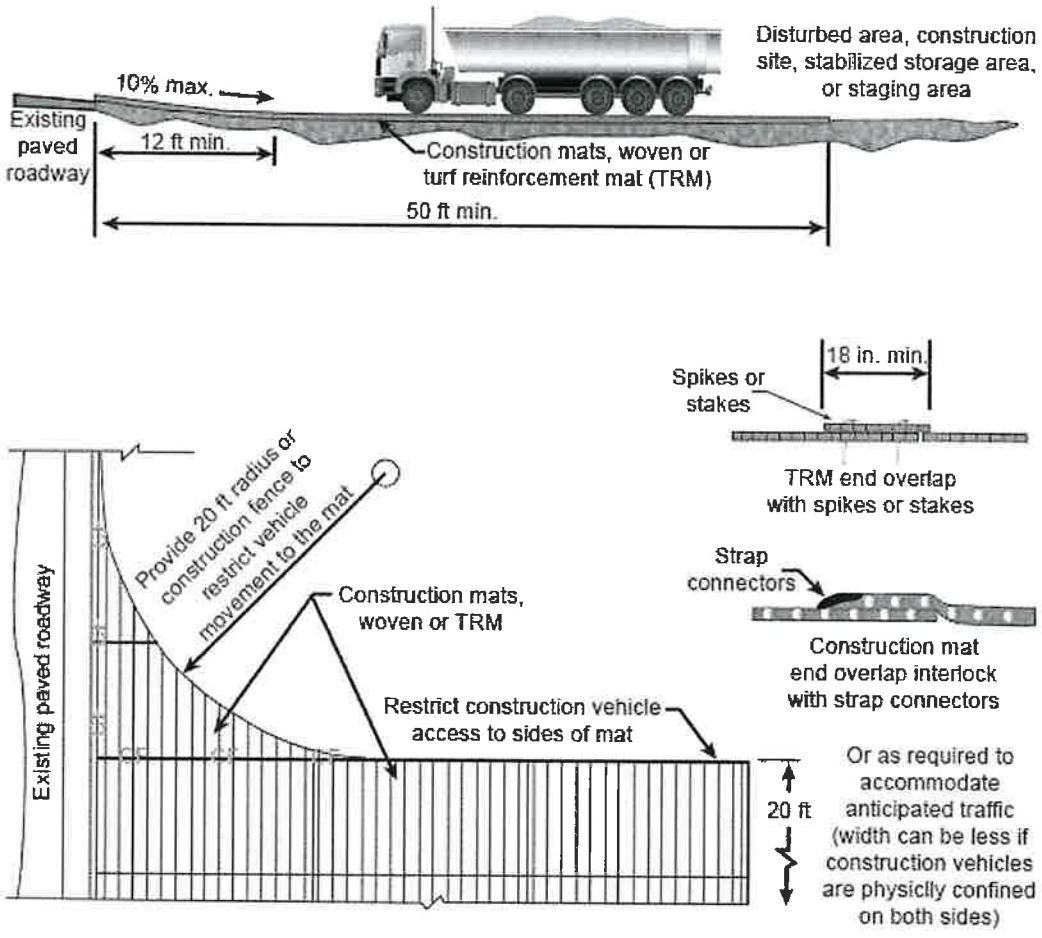


Figure 105. Vehicle-tracking control with construction mat or turf reinforcement mat (Colorado UDFCD 2010).

Additional Controls

If the stabilized construction entrance does not remove sufficient amounts of sediment from vehicle and equipment tires due to site conditions, additional controls may be required. Examples of additional controls include, but are not limited to, wheel washing, mountable berms, rumble strips, and rattle plates.

Wheel-washing facilities can be included within the stabilized construction entrance (Figure 106). It can be as simple as handheld power washing equipment to more advance systems. When washing is required, perform on an area stabilized with aggregate that drains into an approved sediment trap.

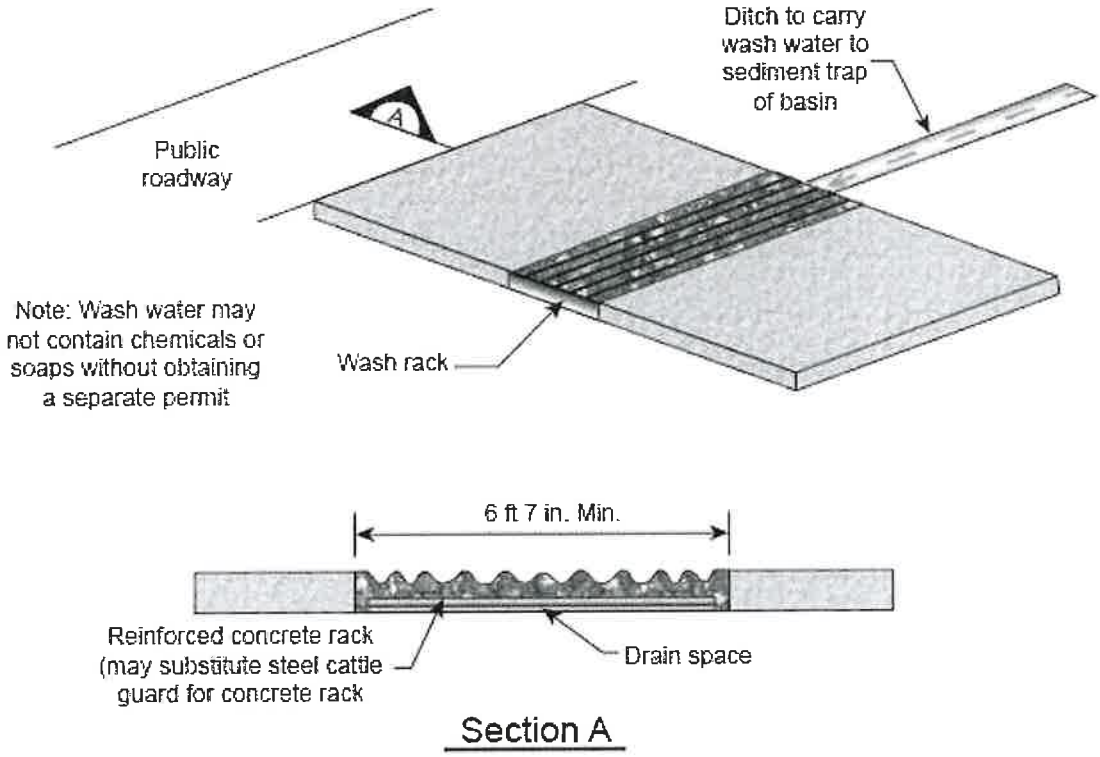


Figure 106. Aggregate vehicle-tracking control with wash rack (Colorado UDFCD 2010).

Mountable berms can be used in construction entrances to *bump* soil off of tires. These berms should be used when the entrance cannot be graded to flow away from the road. A mountable berm traps the pad water and keeps it from entering the adjacent road.

Rumble strips and rattle plates are constructed of steel panels with ridges or corrugations or pipes welded to a steel frame and can be installed within the construction entrance to remove additional sediment from vehicles. Rumble strips loosen and remove dirt and mud from vehicle tires as they pass over the construction entrance. Construct barriers around the sides of the rumble strips to ensure all construction vehicle and equipment tires travel over the rumble strips.

Rumble strip dimensions vary but typically are 8 feet long x 10 feet wide. Place rumble strip panels on a stable base and in the center of an aggregate entrance (Figure 107).

Figure 107. Rattle plates in construction entrance (*The Bag Lady*).

If sediment is tracked out of the construction site and onto off-site streets, sidewalks, or other paved areas, remove the sediment by sweeping, shoveling, or vacuuming. Complete cleanup by the end of the same work day when the track out occurs or by the end of the next work day if track out occurs on a nonwork day. Sediment should not be hosed or swept into an off-site storm water conveyance, storm drain inlet, or surface water.

Construction Guidelines

Stabilized construction entrances and any additional vehicle sediment controls should be installed as the first step in clearing and grading. Clear all vegetation, roots, and all other obstructions to prepare for grading, and ensure the entrance is properly graded and compacted before placing the geotextile fabric in the aggregate construction entrances.

All employees, subcontractors, and suppliers should be required to use the stabilized construction entrance. Place signage to direct construction traffic to the designated stabilized entrance, and use fencing where practical to restrict traffic to the stabilized construction entrance. Vehicle speeds should be limited to control dust (BMP 43: Dust Control). The stabilized construction entrance may be removed after final site stabilization is achieved or after the temporary BMPs are no longer needed. If stabilized entrances are located in a permanent site entrance, a geotechnical engineer should approve the subgrade after removal and before building the permanent entrance.

Maintenance

Inspect construction entrances and additional controls regularly and after storm events. Inspect local roads, sidewalks, and other paved surfaces adjacent to the site daily and sweep or vacuum accumulated sediment. Keep all temporary roadway ditches clear.

Construction entrances should be maintained in a condition that will prevent tracking or flow of mud onto public rights-of-way. Aggregate entrances may require periodic top dressing with additional 2 inches of stone (as conditions demand). If the aggregate pad is clogged with sediment, remove the aggregate and separate and dispose of the sediment. Rumble strips and rattle plates

must be kept clean to function properly. Sweep or scrape panels, and if water is used, discharge the washwater into a sediment trap adjacent to the rumble strips.

Additional Resources

Colorado UDFCD (Colorado Urban Drainage and Flood Control District). 2010. *Urban Storm Drainage Criteria Manual, Volume 3 Best Management Practices*. Denver, CO. *http://udfcd.org/wp-content/uploads/2014/07/Title-Page.pdf*

EPA (US Environmental Protection Agency). 2014. *Construction Entrances*. Water: Best Management Practices. *https://www.epa.gov/npdes/national-menu-best-management-practices-bmps-stormwater#constr*

King County (King County, Washington). 2009. *King County, Washington Surface Water Design Manual.* Seattle, WA: King County, Department of Natural Resources.

BMP 41: Stabilized Construction Roads and Staging Areas

Description

Stabilized construction roads and staging areas are clearly designated areas where construction equipment and vehicles travel and stockpiles, waste bins, material storage, and other construction-related equipment are stored. Stabilizing these areas immediately after grading reduces erosion caused by construction traffic and construction activities (Figure 108).

Methods for reducing erosion on stabilized construction roads are included in BMP 42.

Figure 108. Temporary construction access road (ITD 2014).

Applicability

Stabilize roads and staging areas whenever they are used by construction traffic or where concentrated traffic occurs, such as around materials storage areas. Stabilization is especially important for construction during wet weather, where dust can be a problem, on slopes greater than 5%, and/or adjacent to water bodies. This practice is also important on large sites where heavy equipment traverses the site for large grading operations.

Primary BMP Functions and Controls

☒ Construction	☐ Permanent
☒ Erosion Control	☒ Sediment Control
☐ Source Control	☐ Flood Control
☐ Filtration	☐ Infiltration

Typical Effectiveness for Targeted Pollutants

- ● Sediment
- ○ Phosphorus
- ○ Metals
- ○ Bacteria
- ○ Hydrocarbons
- ○ Litter

Other BMP Considerations

Relative Cost	$
Maintenance Requirements	Medium
Ease of Installation	Medium
Freeze/Thaw Resistance	Good
Max. Tributary Drainage Area	N/A
Max. Slope	15%
NRCS Soil Group	ABCD
Min. Ground Water Separation	N/A
Min. Bedrock Separation	3 feet

Limitations

During design and planning, minimize the disturbance area to the maximum extent practical. Oversizing the stabilized staging area may result disturbing existing vegetation more than required for the project. Excess disruption increases costs and requirements for long-term stabilization after construction.

Temporary roads that encroach on jurisdictional wetlands require appropriate permits.

Design Basis

Location

Place construction roads and staging areas where site impacts will be minimized and as far away as possible

from streams, surface waters, or wetlands. Sites that include permanent roads or parking areas are recommended for construction roads and staging areas.

Temporary roads should mimic the natural slope, not disrupt natural drainage pathways, and have a maximum longitudinal slope of 15%. Grade the roads to prevent runoff from leaving the site. Roadways should be graded to drain transversely into stabilized drainage swales or gravel berms next to the road. Direct intercepted runoff from the road to a sediment trap (BMP 66) or other sediment control measure.

Surface

Roads and staging areas should be constructed to handle the maximum expected loads during construction, and whenever possible, placed on a firm, compacted subgrade. If design recommendations are not available from a geotechnical or civil engineer, stabilize the surface by either paving or placing 2- to 4-inch diameter aggregate 3 to 6 inches deep.

The aggregate can be crushed rock, gravel base, recycled concrete, or crushed surfacing base course. Early application of road base is generally suitable where a layer of coarse aggregate is specified for final road construction.

Geotextile Fabric

Most installations will include geotextile fabric placed over the entire area to be covered with aggregate. Work on single residential lots will generally not need geotextile fabric unless there is potential for excessive erosion, a high water table, or other risk factors. The geotextile should be a woven or nonwoven fabric consisting only of continuous chain polymeric filaments or polyester yarns. The geotextile should be rot resistant and inert to commonly encountered chemicals, hydrocarbons, and mildew. ITD's *Standard Specifications for Highway Construction*, Section 718 provides guidance on geotextile properties for a variety of applications (ITD 2017).

Fencing

Construction fencing may be needed to limit access of vehicles to roads and staging areas that are stabilized and to prevent unauthorized access to construction materials.

Sediment Control

Perimeter sediment controls such as silt fence (BMP 65), sediment fiber rolls (BMP 64), or other measures may be needed around construction staging areas. Erosion control methods for temporary roads include road sloping, rolling dips, waterbars, open-top box culverts, or level spreaders. BMP 42: Erosion Prevention on Construction Roads provides more information.

Construction Guidelines

Construction roads and staging areas should be stabilized immediately after grading. If construction roads do not adequately reduce track out to adjacent property or roadways, a wheel wash system may be required as described in BMP 40: Vehicle Sediment Control.

Maintenance

Inspect all devices regularly, especially after large storm events. Make repairs promptly to avoid progressive damage. Aggregate should be added as required to maintain a stable driving surface and to stabilize areas that have eroded. Remove accumulated sediments as necessary from roadside swales to ensure proper functioning.

After construction is complete, temporary construction roads and staging areas should be removed and the area, regraded, and restored to preconstruction condition or better using permanent erosion and sediment control BMPs. Remove or stabilized trapped sediment and permanently stabilize disturbed areas. When a temporary construction road or staging area is used for a permanent road or parking surface, the subgrade is subject to inspection before final paving.

Additional Resources

ITD (Idaho Transportation Department). 2017. "Geotextiles." Section 718. *Standard Specifications for Highway Construction*. Boise, ID.

ITD (Idaho Transportation Department). 2014. "Sediment Control Best Management Practices." SC-12 Temporary Roads and Standard Drawing P-1-F. *Best Management Practices*. *http://apps.itd.idaho.gov/apps/env/BMP/PDF%20Files%20for%20BMP/Chapter%201/Chapter%201%20Erosion%20Control%20Best%20Management%20Practices.pdf*

BMP 43: Dust Control

Description

Dust control and wind erosion prevention BMPs keep soil particles from entering the air as a result of land-disturbing construction activities by protecting the soil surface, roughening the surface, and/or reducing the surface wind velocity (Figure 113).

Figure 113. Sprinkling water for dust control on a pathway construction project, Driggs, Idaho.

Dust control practices apply to either disturbed graded areas or construction roadways. For disturbed graded areas, practices such as seeding or sodding (BMP 32), mulching (BMP 52), using soil binders (BMP 55), sprinkling, surface roughing (BMP 58) or practices that provide prompt surface cover can be used. For construction roadways, practices such as using a stabilized surface (BMP 41), sprinkling, or using chemical dust tackifiers are options. Wind barriers can control wind currents and minimize the amount of dust transported into air and water.

Applicability

Use control measures on any construction site where the potential exists for air or water pollution from dust, especially when open, dry areas of soil are anticipated on site and where heavy construction activity such as clearing, grading, excavation, demolition, or excessive vehicle traffic takes place. Dust control is especially important in regions experiencing long periods without rain and during the summer when soil can become dry and vulnerable to transport by wind. In many cases, water erosion control measures incorporated into the project will indirectly prevent wind erosion.

Limitations

Vegetative dust control measures may not be practical during dry periods without a reliable supply of establishment water. Other methods should be stipulated in the project contract to ensure that dust control is not overlooked.

Primary BMP Functions and Controls

☒ Construction	☐ Permanent
☒ Erosion Control	☐ Sediment Control
☐ Source Control	☐ Flood Control
☐ Filtration	☐ Infiltration

Typical Effectiveness for Targeted Pollutants

●	Sediment
○	Phosphorus
◖	Metals
○	Bacteria
◖	Hydrocarbons
○	Litter

Other BMP Considerations

Relative Cost	$
Maintenance Requirements	Medium
Ease of Installation	Easy
Freeze/Thaw Resistance	Good
Max. Tributary Drainage Area	N/A
Max. Upstream Slope	N/A
NRCS Soil Group	ABCD
Min. Ground Water Separation	N/A
Min. Bedrock Separation	N/A

Wind barriers (such as walls or fences) can be part of the long-term dust control strategy in arid and semiarid areas, but they are not a substitute for permanent stabilization.

Chemically treated subgrades may make the soil water repellent, interfering with long-term infiltration and vegetation/revegetation of the site. Some chemical dust suppressants may be subject to freezing and may contain solvents that must be handled properly.

Overwatering may cause erosion and wash sediment or other constituents into the drainage system.

Design Basis

Develop a dust control plan before construction. The plan should evaluate the site with potential dust emission sources identified, provide a selection of dust control methods for each area of the site, determine the maintenance needed, and monitor the effectiveness of the selected dust control measures. The site evaluation should consider the soil type, prevailing wind direction, and effects of other prescribed erosion control measures.

Dust Prevention

The best method of controlling dust is to prevent dust production:

- **Minimize the surface area disturbed**—By limiting the amount of bare soil exposed at one time, less ground is disturbed, less dust is raised while working, and less cleanup is required when work is done. During project design, identify areas where ground disturbance will not be allowed and fence or provide signage during construction. Design and locate haul roads, detours, and staging areas to avoid unnecessary exposure of bare ground.
- **Limit dusty work on windy days**—Minimize amount of ground disturbance occurring when potential for wind erosion is highest. Apply dust suppression measures when needed. Monitor dust suppression efforts to ensure dust emissions are adequately controlled. Depending on weather conditions, adjust to fewer or more frequent application intervals.
- **Clean up dusty spills immediately**—Do not wait for the next scheduled housekeeping; the mess will just get bigger and cleanup will take longer.
- **Plan ahead to limit dust**—Avoid using areas most susceptible to wind erosion. In the storm water site plan, specify staging or work-sequencing techniques that minimize the risk of wind erosion from bare soil. In most cases, a change will be required from traditional construction techniques that allow large areas to be disturbed at the outset of construction and remain exposed for long periods of time.

Graded Areas

Clearing and grading activities create the opportunity for large amounts of dust to become airborne. Stabilize graded areas as soon as practicable after disturbance and do not leave open areas uncovered. The following practices can help with dust control in graded areas:

- **Grow vegetative ground cover**—Exposed areas that are not being paved should be stabilized using vegetation and landscaping (BMP 32) to prevent wind and water erosion. When rainfall is insufficient to establish vegetative cover, mulching (BMP 52) conserves

moisture, prevents surface crusting, reduces run-off erosion, and helps to establish vegetation. It is a critical treatment on sites with erosive slopes.

- **Use wind barriers**—Barriers prevent erosion by obstructing the wind near the ground and preventing the soil from blowing off site. Wind, snow, or silt fences or similar barriers are temporary measures that can reduce wind velocity. Perennial grass, bushes, stands of trees, rock walls, wooden board fences, or earthen banks are more permanent measures that can serve as wind barriers. A wind barrier generally protects soil downwind for a distance of 10 times the height of the barrier. If additional protection is needed, use other methods with the barrier.
- **Surface roughening**—Deep tillage in large open areas brings soil clods to the surface where they rest on top of dust, preventing it from becoming airborne. Tilling or disking should leave 6-inch (minimum) furrows, preferably perpendicular to the prevailing wind direction, to gain the greatest reduction in wind erosion. If the surface cannot be furrowed perpendicular to the prevailing wind direction, roughening the surface by using a ripper/scarifier (grader) or a ripper (cat) will produce the desired result of a 6-inch irregular surface. BMP 58: Slope Roughening provides more information.

Construction Roadways and Storage Areas

Temporary construction roads and storage areas should be stabilized using recommendations in BMP 42: Erosion Prevention on Construction Roads to minimize the amount of dust generated by construction vehicles. Other recommendations for dust control on construction roadways and storage areas include the following:

- **Water and/or sweep often**—Sprinkle the site with water until the surface is wet. Apply at a rate of 3 gallons per acre so that the soil is wet but not saturated or muddy and so that no dust is being generated. To ensure vehicle traffic is not picking up dust from wind action and carryout, water and sweep roadways often. Fewer treatments are necessary in cool, wet weather.
- **Spray-on chemical soil treatments (palliatives)**—Spray-on soil binders form a bond between soil particles keeping them grounded. Chemicals include mineral salts, petroleum resins, asphalt emulsion, acrylics, and adhesives. These treatments must be reapplied periodically to ensure continued effectiveness. Chemical tackifiers should only be used on mineral soils, and the chemicals should not create any adverse effects on storm water, plant life, surface water, or ground water. Check with DEQ to ensure the material to be applied is not harmful and may be used for this purpose.
- **Reduce speed limits**—Reduce speed limits on unpaved surfaces to 10 to 15 miles per hour for well-traveled areas and heavy vehicles. Never exceed 25 miles per hour for any vehicle on any unpaved surface.
- **Prevent transport of dusty material off site**—Minimize transport of dusty material off site by rinsing vehicles before they leave the property, tightly cover loaded trucks, and provide stabilized construction roads and staging areas (BMP 41).
- **Enclose storage and handling areas**—If dusty materials are frequently loaded and unloaded in storage and handling areas, enclose the areas to reduce dust production. Use storage silos, three-sided bunkers, or open-ended buildings. If handling is less frequent, try wind fencing. Conveyor loading may require enclosure or the use of water or foam spray bars both above and below the belt surface to reduce emissions.

- **Keep storage piles covered**—When storage piles are not in use, apply a physical cover or a dust suppressant spray to reduce dust emissions. Limit the working face of the pile to the downwind side. Most emissions come from loading the pile, loadout from the pile, and truck and loader traffic in the immediate area if the pile is batch loaded. Keep the drop height low to reduce dust and the ground at the base of the pile clear of spills.

Construction Guidelines

Dust control measures should be considered and selected before clearing and grading activities. During construction, monitor dust control activities on a regular basis to ensure the measures taken are adequately preventing airborne dust from leaving the site.

Maintenance

Dust control requires constant attention: it is not a one-time or once-in-awhile activity. Dust control sprinkling may have to be done several times a day during hot, dry weather.

Areas protected by mulch, adhesive emulsions, or barriers need to be checked at regular intervals according to the inspection schedule in the storm water plan.

Apply spray-on chemical treatments using the manufacturer's specified rates and according to all federal, state, and local regulations. Chemical products should be stored, handled, and disposed of according to all applicable local and state regulations and policies.

Additional Resources

DEQ (Idaho Department of Environmental Quality). 2013. *Controlling Fugitive Dust at Construction Sites.* Boise, ID: DEQ.

EPA (US Environmental Protection Agency). 2014. *Dust Control.* Water: Best Management Practices. *https://www.epa.gov/npdes/national-menu-best-management-practices-bmps-stormwater#constr*

BMP 44: Stockpile Management

Description

Stockpile management procedures and practices reduce or eliminate air and storm water pollution from stockpiled erodible materials, such as soil, sawdust, landscaping bark, compost, sand, fly ash, stucco, hydrated lime, Portland cement concrete rubble, asphalt concrete, asphalt concrete rubble, aggregate base, aggregate subbase, premixed aggregate, asphalt minder (or *cold mix* asphalt), and pressure-treated wood. Raw material stockpiles can easily erode during storm events and contribute suspended solids, nutrients, metals, and pH changes to storm water runoff (Figure 114).

Figure 114. Covered stockpile (ITD 2014).

Applicability

Implement stockpile management on all construction sites that stockpile and store erodible materials or have land-clearing debris composed, in whole or in part, of sediment or soil.

Limitations

Covering alone may not protect exposed materials from contact with storm water runoff and run-on. Using plastic sheeting to cover stockpiles can increase runoff volume and rates and potentially cause failure of sediment controls placed around the stockpile's perimeter. In extremely windy areas, tarpaulins and sheeting may require additional weights or securing.

Design Basis

Location

Locate stockpiles a minimum of 50 feet away from concentrated storm water flows, drainage courses, and inlets and outside of any natural buffers (BMP 2) and in areas that will remain undisturbed for the longest period of time as construction progresses.

Do not place stockpiles in streets or paved areas unless no other practical alternative exists.

Primary BMP Functions and Controls

☒ Construction	☐ Permanent
☒ Erosion Control	☐ Sediment Control
☒ Source Control	☐ Flood Control
☐ Filtration	☐ Infiltration

Typical Effectiveness for Targeted Pollutants

●	Sediment
◖	Phosphorus
◖	Metals
○	Bacteria
○	Hydrocarbons
◖	Litter

Other BMP Considerations

Relative Cost	$
Maintenance Requirements	Low
Ease of Installation	Easy
Freeze/Thaw Resistance	Good
Max. Tributary Drainage Area	N/A
Max. Upstream Slope	N/A
NRCS Soil Group	ABCD
Min. Ground Water Separation	N/A
Min. Bedrock Separation	N/A

Covering

Covering prevents storm water from coming into contact with potential pollutants, minimizes sediment discharge, and reduces material loss from blowing wind. Covering is a simple, effective, and inexpensive way to reduce or prevent pollution from stockpiles. Materials used as stockpile covers include tarpaulins, plastic sheeting, and pervious fabrics; mulches (BMP 52), vegetation (BMP 32), or soil binders (BMP 55) can be used for soil stockpiles that will be in place for longer periods of time.

Plastic sheeting with nylon reinforcement can be more durable than standard sheeting; avoid sheeting made of photodegradable plastics. Due to the relatively rapid breakdown of most polyethylene sheeting, it is unsuitable for applications over 6 months.

Sediment Control

Place a temporary sediment control barrier around the stockpile's perimeter to protect it from storm water run-on from the site and the site from runoff from the stockpile. Perimeter control barriers such as berms (BMP 70), dikes (BMP 69), fiber rolls (BMP 64), silt fences (BMP 65), or biofilter bags (BMP 63) can be used. For stockpiles located on paved areas, rock socks are recommended for perimeter control, and all inlets with the potential to receive sediment from the stockpile should be protected (BMP 74: Inlet Protection).

Implement dust and wind erosion control practices as appropriate on all stockpiled material. Place bagged materials on pallets and under cover.

Accumulated sediment on pavement or other impervious surfaces should not be hosed down or swept into any storm water conveyance (unless connected to a sediment basin, sediment trap, or similarly effective control), storm drain inlet, or surface water.

Nonactive Stockpile Protection

Nonactive stockpiles of the following materials should be protected as follows:

Soil stockpiles—Cover soil stockpiles or protect with soil stabilization measures and a temporary perimeter sediment barrier at all times. Unless permit requirements or other local regulations specify otherwise, soil stockpiles should be covered or stabilized within 14 days after the stockpile is placed or sooner if site conditions, such as highly erodible soils or expected rainfall, warrant. For site discharges to impaired waters, complete stabilization activities within 7 calendar days.

Stockpiles of Portland cement concrete rubble, asphalt concrete, asphalt concrete rubble, aggregate base, or aggregate subbase—Cover and protect stockpiles with a temporary perimeter sediment barrier at all times.

Stockpiles of *cold mix*—Place cold mix stockpiles on and cover with plastic sheeting, or a comparable material, at all times and surround covered stockpile with a berm.

Stockpiles/storage of pressure-treated wood—Cover pressure-treated wood with plastic sheeting or comparable material at all times and surround with a berm.

Stockpiles of fly ash, stucco, and hydrated lime (basic materials)—At all times, cover stockpiles of materials that may raise the pH of runoff with plastic sheeting and surround with a berm.

Active Stockpile Protection

For actively used stockpiles, the perimeter sediment control barrier should have a stabilized designated access point on the upgradient side of the stockpile. Divert runoff around or away from the stockpile on the upstream side of the stockpile.

Cover all actively used stockpiles before the onset of precipitation. Stockpiles of *cold mix*, treated wood, and basic materials should be placed on and covered with plastic sheeting or a comparable material and surrounded by a berm before the onset of precipitation.

Construction Guidelines

Stockpiles should be protected immediately if they are not scheduled to be used within 14 days of placement.

To cover stockpiles with tarpaulins or plastic sheeting, obtain enough fabric or sheeting to cover the indicated volume or area. Anchor the edges of the covering with stakes, tie-down ropes, large rocks, tires, or other readily available, heavy objects. Maintain an overlap of 3 feet along the borders and securely anchor the overlap area so that it does not separate (by wind or other causes).

Maintenance

During the rainy season, inspect the stockpile BMPs weekly before forecasted rain events, daily during extended rain or high wind events, and after the rain or high wind events end. During the nonrainy season, inspect BMPs every 2 weeks. Make any necessary repairs after inspection.

Repair and/or replace perimeter controls and covers as needed to keep them functioning properly. Sediment should be removed when it reaches one-third of the barrier height.

Frequently inspect coverings for damage and general wear. Repair or replace coverings immediately, or as needed. Inspect plastic sheeting more frequently during periods of high winds or extreme heat.

Additional Resources

CASQA (California Stormwater Quality Association). 2015. "Stockpile Management." *California Stormwater Best Management Practices Handbook: Construction.* Menlo Park, CA. *https://www.casqa.org/resources*

ITD (Idaho Department of Transportation). 2014. "Stockpile Management." *Best Management Practices.* Boise, ID: ITD. *https://apps.itd.idaho.gov/apps/env/BMP/PDF%20Files%20for%20BMP/Chapter%204/WM-4%20Stockpile%20Management.pdf*

BMP 47: Construction Equipment Washing and Maintenance

Description

A good construction vehicle and equipment washing and maintenance facility prevents the discharge of pollutants from these operations to surface water or ground water. A typical vehicle/equipment washing and maintenance system is a lined or paved, depressed area that collects the water used in washing trucks, cars, or other construction vehicles/equipment and drains the wastewater into a collection or treatment system (Figure 117).

Figure 117. Vehicle and equipment wash area (CALTRANS 2003).

Ideally, vehicle maintenance should not occur on active construction sites. However, if it must occur, the following practices should be used to minimize or eliminate pollutant discharge.

Applicability

Use vehicle washing and maintenance BMPs on all sites where vehicle and equipment cleaning and maintenance are performed. BMPs are particularly important on projects where the soil is silty or a heavy clay, and it is likely that dirt and mud will be transported off site. It is also important for projects taking place during the rainy season and in areas where water is expected to be encountered (high ground water table) during project construction.

Primary BMP Functions and Controls

☒ Construction	☐ Permanent
☐ Erosion Control	☒ Sediment Control
☐ Source Control	☐ Flood Control
☐ Filtration	☐ Infiltration

Typical Effectiveness for Targeted Pollutants

●	Sediment
●	Phosphorus
◖	Metals
○	Bacteria
◖	Hydrocarbons
○	Litter

Other BMP Considerations

Relative Cost	$$
Maintenance Requirements	Low
Ease of Installation	Easy
Freeze/Thaw Resistance	Good
Max. Tributary Drainage Area	N/A
Max. Slope	5%
NRCS Soil Group	ABCD
Min. Ground Water Separation	N/A
Min. Bedrock Separation	N/A

Limitations

Limitations depend on the method chosen for disposing of vehicle washwater. If washwater is discharged to a sediment pond on site, sufficient acreage is required. If washwater is discharged to off-site sanitary sewer systems or hazardous waste disposal facilities, the cost of connection or disposal could be a limitation. Discharge of treated washwater to waters of the state (including canals, rivers, ponds, streams, lakes, and ground water) may require pretreatment to remove turbidity or separate oils, as well as federal, state, or local permits.

Design Basis

Washing vehicles generates liquid, semisolid, and solid wastes. These wastes should be contained on site and treated before discharged off site. A stabilized construction entrance (BMP 41) should be installed at the vehicle wash/maintenance area to reduce off-site tracking of mud, dirt, and rocks.

Wash Location and Design

Vehicle washing on site should be located within a structure or building equipped with appropriate disposal facilities. If this is not available, locate outside vehicle wash stations away from storm drain inlets, drainage facilities, and watercourses, and divert site drainage away from the wash area. Vehicle washing and maintenance should be conducted in disturbed areas (staging areas) but should not be conducted in a cut or fill area until grading has been performed or where a high volume of construction traffic exists. Avoid highly erodible soils or frequently wet areas.

Outdoor vehicle wash areas should be lined or paved with concrete or asphalt and have a berm to contain runoff and prevent run-on. It should also be equipped with a sump for collecting and disposing of washwater.

Clearly mark the wash areas with signage and educate employees and subcontractors on proper washing procedures. Include the location of the washing facilities in the SWPPP.

Wash Practices

Use the smallest amount of water and no, or a minimal amount of, detergents if possible. Use a positive shut-off valve and a high-pressure spray to conserve water. Water alone can remove most dirt adequately, but if detergents must be used, they should not contain phosphates. Use biodegradable products that are free of halogenated solvents.

Washwater Discharge

On-site washwater can be contained for evaporative drying with any residual waste disposed of properly. Washwater can also be discharged to surface water if it is permitted and pretreated. Treatment is required for all discharges to waters of the state because they can be contaminated with degreasers, hydrofluoric acid, hydrochloric acid, nitric acid, phosphoric acid, oil, hydraulic fluids, lubrication, and engine cleaning solvents. Contact the local permitting authority to determine proper treatment and disposal methods.

Other discharge options for vehicle washwater include the following:

- Lagoon—A pond-like structure that uses physical, chemical, and biological processes to treat wastewater. They are easy to install and require low maintenance. Safety is a concern, so the area must be fenced from the public.
- Land application system—A method of reusing wastewater by applying it to land for irrigation and to assimilate it into the soil structure. Land application systems require large land area and may need to be permitted.
- Filtering and recycling washwater—A good conservation measure that includes using a sediment basin with a turbidity curtain. Monitoring of the operation could be intensive.

- Municipal wastewater treatment plant—Available only in areas where a municipal wastewater treatment plant exists and the operation is capable of handling the load. This is the best option for limiting liability on larger construction projects. Vehicle and equipment washing activities should be reviewed to determine if oil and sediment controls are needed to comply with any applicable sanitary sewer discharge limits.

Vehicle Maintenance

Vehicle maintenance or repairs should not be conducted in the wash area. Designate a special paved area for vehicle repair.

Properly maintaining and inspecting vehicles and equipment can prevent hazardous chemical leaks. A spill prevention and cleanup plan (BMP 46) should be in place if a hazardous spill or leak occurs.

Properly dispose of any hazardous waste from vehicle maintenance activities, including used oil, antifreeze, solvents, and other automotive-related chemicals (BMP 48).

Construction Guidelines

Vehicle sediment controls including vehicle and equipment washing areas should be installed as the first step in clearing and grading. The location and design should follow the design guidelines listed above.

Maintenance

Ensure the system controls are working as designed and make any repairs as necessary (e.g., repairs to berms or conveyance to any off-site disposal facility). Inspect local roads, sidewalks, and other paved surfaces adjacent to the site daily and sweep up or vacuum accumulated sediment.

Additional Resources

CALTRANS (California Department of Transportation, Division of Construction). 2003. *Construction Site Best Management Practice Manual*. Sacramento, CA.

EPA (US Environmental Protection Agency). 2014. *Vehicle Maintenance and Washing Areas at Construction Sites*. WaterSense at Work: Best Management Practices for Commercial and Institutional Facilities. *https://www.epa.gov/sites/production/files/2017-02/documents/watersense-at-work_final_508c3.pdf.*

BMP 49: Concrete Waste Management

Description

Concrete waste management prevents pollutant discharge to storm water from concrete waste by conducting off-site washout, performing on-site washout in a designated area, and training employees and subcontractors on proper management techniques (Figure 119).

Concrete washwater typically contains toxic metals and is caustic and corrosive with a high pH around 12 (EPA 2012a).

Figure 119. Hay bale temporary washout pit (*On Site Washout*).

Applicability

This BMP applies to all project sites that will generate concrete washwater or liquid concrete waste from on-site concrete mixing or concrete delivery. This includes sites with concrete pours for features such as foundations, footings, curbs, sidewalks, floors, piles, and for projects that generate cementitious (i.e., properties of cement) washwater and solids from materials such as mortar, plaster, stucco, and grout.

Check local permitting requirements and regulations for concrete waste management to ensure compliance.

Primary BMP Functions and Controls

☒ Construction	☐ Permanent
☐ Erosion Control	☐ Sediment Control
☒ Source Control	☐ Flood Control
☐ Filtration	☐ Infiltration

Typical Effectiveness for Targeted Pollutants

○	Sediment
○	Phosphorus
●	Metals
○	Bacteria
○	Hydrocarbons
○	Litter

Other BMP Considerations

Relative Cost	$$
Maintenance Requirements	Medium
Ease of Installation	Easy
Freeze/Thaw Resistance	Good
Max. Tributary Drainage Area	N/A
Max. Upstream Slope	N/A
NRCS Soil Group	ABCD
Min. Ground Water Separation	3 feet
Min. Bedrock Separation	N/A

Limitations

Off-site washout of concrete wastes may not always be possible. On-site washout facilities should be lined or a waterproof containment system should be used if shallow ground water is present to prevent ground water contamination.

Washout areas that are lined with plastic can make it difficult to recycle or reuse hardened concrete because the lining becomes bound up with the concrete.

Using aboveground hay bale washout pits may not be feasible for concrete pumping trucks with low hanging hoppers.

Design Basis

Washing out concrete trucks should be completed at an approved off-site location if possible or in designated on-site areas only. Do not wash out concrete trucks into storm drains, open ditches, streets, or streams. Several types of washout containment systems can be used, and all concrete washout water and solids should be recycled or reused. The approach to the concrete washout areas should be stabilized with gravel (BMP 41) or a paved construction road.

Site Selection

Locate concrete washout areas at least 50 feet from storm drains, open ditches, or water bodies. The washout site should not be located in an area where shallow ground water may be present, such as near natural drainages, springs, or wetlands. Washouts should be located at least 400 feet away from any natural drainage pathway or water body and at least 1,000 feet from wells or drinking water sources.

Place washouts in a location accessible to concrete trucks and where the majority of the concrete will be poured. On large sites with extensive concrete work, use multiple locations to make it more convenient and increase compliance with the BMP guidelines. Provide clear signage at the concrete washout area.

Washout Containers

A washout pit can be constructed either above or below grade. Above grade pits can be constructed with hay bales lined with a polyethylene liner. Below grade pits can be constructed by excavating an area, berming around three sides of the pit, and lining the pit with plastic. A minimum length and width of 10 feet is recommended, although a larger size may be needed to contain the anticipated waste based on the estimated concrete volume to be used. The polyethylene lining should be impermeable with a 16-mil minimum thickness.

Prefabricated concrete washout containers made of vinyl or metal are available from several different vendors. The containers are usually portable, reusable, and easier to install than hay bale washout pits or excavated pits.

Washout boxes or buckets with pumps can be mounted on the back of ready mix concrete trucks. The boxes or buckets are used to capture water from washing the chute after a pour is completed, and the washwater and solids can be returned to the ready mix plant for recycling.

Construction Guidelines

The following practices will reduce storm water pollution from concrete wastes:

- Avoid mixing excess amounts of fresh concrete or cement on site.
- Avoid dumping excess concrete in nondesignated dumping areas.
- Wash out wastes into the temporary pit where the concrete can set, broken up, and disposed of properly.
- When washing concrete to remove fine particles and expose the aggregate, drain the water to a bermed or level area.

- Avoid washing sweepings from exposed aggregate concrete into the street or storm drain. Instead, collect and return sweepings to an aggregate base stockpile or dispose of in the trash.
- Train employees and subcontractors in proper concrete waste management.

After construction is completed, remove concrete waste from the washout pit, and restore and reclaim the area.

Maintenance

Inspect concrete washout facilities daily and after heavy rains to check for leaks and damage to the facility.

If using a temporary pit, dispose of the hardened concrete on a regular basis. Washout pits should be cleaned or additional facilities should be constructed when the washout is 75% full, or there is less than 4 inches of freeboard for an aboveground facility or 1 foot of freeboard for a belowgrade facility.

Inspect the plastic lining of temporary pits to ensure it has not been damaged. Reline as necessary.

Before heavy rains, lower the liquid level in the washout container or cover the container to avoid overflow during the storm.

Additional Resources

EPA (US Environmental Protection Agency. 2012. *Concrete Washout*. Stormwater Best Management Practice. *http://www.epa.gov/npdes/pubs/concretewashout.pdf*

BMP 50: Sanitary and Septic Waste Management

Description

Proper sanitary and septic waste management prevents the pollutant discharge to storm water from sanitary and septic waste by providing convenient, well-maintained septic waste facilities, and arranging for regular service and disposal (Figure 120). Portable sanitary facilities are self-contained units consisting of gravity fed holding tanks that temporarily store human waste.

This BMP does not cover permanent developments that will have permanent sanitary sewer facilities with proper on-site or off-site disposal according to local regulations.

Figure 120. Portable sanitary facility (ITD 2014).

Applicability

Portable sanitary facilities are often needed to supplement permanent facilities at special events or on construction sites. Per OSHA requirements, construction sites that do not have sanitary sewer service available shall be provided with a toilet facility, unless the crew is mobile and has transportation readily available to a nearby toilet facility.

Limitations

Access to the septic waste facility must be provided so that they can be regularly serviced. A sufficient number of units should be provided to accommodate all personnel on site.

Design Basis

Sanitary and septic wastes for portable and permanent facilities should be disposed of according to state and local requirements. The following guidance applies to placing, operating, and disposing of portable and temporary sanitary systems.

Primary BMP Functions and Controls

☒ Construction	☐ Permanent
☐ Erosion Control	☐ Sediment Control
☒ Source Control	☐ Flood Control
☐ Filtration	☐ Infiltration

Typical Effectiveness for Targeted Pollutants

○	Sediment
○	Phosphorus
○	Metals
●	Bacteria
○	Hydrocarbons
●	Litter

Other BMP Considerations

Relative Cost	$
Maintenance Requirements	Easy
Ease of Installation	Easy
Freeze/Thaw Resistance	N/A
Max. Tributary Drainage Area	N/A
Max. Upstream Slope	N/A
NRCS Soil Group	N/A
Min. Ground Water Separation	N/A
Min. Bedrock Separation	N/A

Portable Sanitary Facilities

- Locate portable sanitary facilities in a convenient location but away from high traffic areas. If site conditions allow, place facilities at least 50 feet from a drainage facility or watercourse.
- Ensure that a licensed sanitary and septic waste hauler maintains sanitary and septic facilities and keeps them in good working order. A list of permitted septic tank pumpers is available at: *https://www.deq.idaho.gov/water-quality/wastewater/septic-and-septage/*.
- Avoid using biocides, such as formaldehyde, to prevent odor. Use nonformaldehyde, biological treatments to breakdown wastes and minimize odor.
- Stake or secure portable units to a fixed object to prevent overturning, especially in high wind areas.
- Under section 4.1.2(6) of the Americans with Disabilities Act Accessibility Guidelines, at least 5% of single-user portable toilets clustered at a single location must be accessible.
- Always treat and dispose of portable toilet waste according to state and local requirements. Municipal sewage treatment plants are an acceptable disposal option for untreated portable toilet wastes.
- Do not discharge or bury untreated wastewater.
- Dispose of sewage from recreational vehicles (RVs) at approved facilities, which include wastewater treatment plants, RV parks, dealers or storage facilities, or recreational sites. A list of RV dump stations in Idaho is provided at *http://www.rvdumps.com/idaho/*.

Temporary Septic Systems

- If using an on-site disposal system such as a temporary septic system, comply with local health agency requirements.
- On-site disposal systems must be designed per DEQ's *Technical Guidance Manual for Individual and Subsurface Sewage Disposal Systemshttps://www.deq.idaho.gov/water-quality/wastewater/septic-and-septage/.* If discharging to a centralized sanitary sewer system, contact the local wastewater treatment plant for permitting and other requirements. Ensure that temporary septic systems treat wastes to required levels before discharging.
- Ensure that temporary sanitary facilities discharging to a sanitary sewer system are properly connected to help eliminate illicit discharges.

Maintenance

- Inspect facilities weekly before forecasted rain events and daily during periods of extended rain.
- Contact service contractors immediately if leaks are detected.
- Arrange for regular waste collection for portable facilities.

Additional Resources

CASQA (California Stormwater Quality Association). 2004. *California Stormwater Best Management Practices Handbook: New Development and Redevelopment*. Menlo Park, CA. *https://www.casqa.org*

DEQ (Idaho Department of Environmental Quality). 2018. *Technical Guidance Manual for Individual and Subsurface Sewage Disposal Systems*. Boise, ID: DEQ. *https://www.deq.idaho.gov/water-quality/wastewater/septic-and-septage/*

ITD (Idaho Transportation Department). 2014. *Best Management Practices.* Boise, ID: ITD.

BMP 52: Mulching

Description

Mulching is a temporary soil stabilization or erosion control practice where materials such as straw, grass, grass hay, compost, or wood chips or fibers are placed on or incorporated into the soil surface. Hydraulic mulching, or hydromulching, is a process that combines mulching materials with a tacking agent and is applied in slurry with water to temporarily stabilize bare slopes or other bare areas. Hydromulching is an economical way to protect slopes from erosion (Figure 122).

Figure 122. Wood chips dispensed on the side of a road to help slow runoff.

In addition to stabilizing soils, mulching can reduce the velocity of storm water runoff over an area. When used together with seeding or planting, mulching aids in plant growth by holding the seed, fertilizers, and topsoil in place, helping to retain moisture, and insulating against extreme temperatures.

Primary BMP Functions and Controls

☒Construction	☐Permanent
☒Erosion Control	☒Sediment Control
☐Source Control	☐Flood Control
☐Filtration	☐Infiltration

Typical Effectiveness for Targeted Pollutants

◖	Sediment
◖	Phosphorus
○	Metals
○	Bacteria
○	Hydrocarbons
○	Litter

Other BMP Considerations

Relative Cost	$
Maintenance Requirements	Easy
Ease of Installation	Easy
Freeze/Thaw Resistance	Good
Max. Tributary Drainage Area	2 acres
Max. Upstream Slope (conventional)	50%
Max. Upstream Slope (hydromulch)	15%
NRCS Soil Group	ABCD
Min. Ground Water Separation	N/A
Min. Bedrock Separation	N/A

Applications

Mulching protects the soil surface from splash erosion. It retards runoff, traps sediment, and creates more favorable conditions to assist germination and early plant development. The following mulches are suitable for use at construction sites:

- Vegetative materials—wheat straw, rye straw, barley straw, and grass hay
- Wood products—wood cellulose fibers, wood chips, bark, and sawdust
- Other organic materials—leaves, peat, manure, and compost
- Rock products—gravel and crushed stone
- Fabricated mulch—jute, burlap, coconut (coir), excelsior, and Kraft paper string

Mulch is an immediate, effective, and inexpensive means of controlling dust and erosion and aids revegetation of construction sites. It protects exposed soils subject to heavy erosion, retains moisture (minimizing watering needs), and requires no removal as most of mulching materials deteriorate naturally.

Mulch is often used alone in areas where temporary seeding cannot be used because of the season or climate. It may be used with other treatments for increased effectiveness. Use of mulch may or may not require a binder, netting, or tacking agent to hold the mulch in place. On steep slopes and critical areas, such as waterways, mulch matting is used with netting or can be anchored to hold it in place.

To aid in establishing vegetation, mulch seeded and planted areas where slopes are steeper than 2:1, where runoff is flowing across the area, or when seedlings need protection from bad weather. If the mulching effect is to be maintained longer than 3 months, the preferred mulch is vegetative material. Wheat straw is the most preferred vegetative material, followed by rye straw, barley straw, or grass hay.

Wood chips are suitable for areas that will not be closely mowed and around ornamental plantings. Chips decompose slowly and do not require tacking. Wood chips can be very inexpensive if they are obtained from trees cleared on the site. Chips should not be used on slopes greater than 6% because they tend to wash down slopes.

Bark mulch is suitable for areas planted with grasses that will not be closely mowed. The bark may be applied mechanically or by hand.

Crushed stone and gravel mulches are appropriate for dust control and soil protection on low-use dirt roads, driveways, and other areas of light vehicular activity within the construction site.

Hydromulching is an effective way to increase water retention (reducing erosion) from 6 months up to 1 year. Beyond 1 year, the effectiveness drops off. Hydraulic mulching can be applied to areas that are within about 200 feet of a road or that can otherwise be reached by truck. Small roadside slopes and large, relatively flat areas are well adapted to this method. When adequate moisture exists, the slurry can be combined with seed and fertilizer to initiate stabilization and revegetation in a single application. Mulch usually lasts about 1 year. The growing vegetation is needed to provide continued stabilization.

Limitations

Disadvantages of mulch include the following:

- It may delay germination of some seeds because cover reduces the soil surface temperature.
- Mulch can be easily blown or washed away by runoff if not secured or incorporated. Lightweight mulch, such as straw, requires matting, crimping, or other methods to hold it in place.
- Some mulch materials, such as wood chips, may absorb nutrients necessary for plant growth.
- Straw mulch provides organic matter as it breaks down and is incorporated into the soil. If applications are too heavy, however, soil nutrient levels (especially nitrogen) may decline during decomposition. Prescribed application rates of the straw mulch and specified fertilizer should be strictly followed. Using a fertilizer low in phosphorus is recommended.
- Synthetic spray-on materials are not recommended except for temporary dust/erosion control or for steep, rocky slopes where other mulches and mechanical methods cannot be effectively applied. The synthetic mulches may create impervious surfaces and can have adverse effects on water quality.

- Avoid applying mulch as the only control on long slopes. Break up concentrated flows on these slopes using methods recommended in other BMPs.
- Hydromulching loses effectiveness after 1 year.
- Hydromulching is only suited for physically stable slopes (at natural angle of repose, or less).
- Avoid hydromulching on long uninterrupted slopes. Break up concentrated flows with other BMPs, such as BMP 59: Gradient Terracing or BMP 60: Check Dams.

Design Basis

Stone and Gravel

- After the gravel or stone is applied, construction traffic may move over it. Areas that become compacted or depressed should be remulched to the same level as the remaining area to prevent flows from the site from becoming channelized into these depressions.
- After activities are completed on site, the gravel or stone mulch may be left in place during revegetation operations.
- When used for driveways or dirt roads, a filter blanket should be placed under the gravel.

Straw

- Straw mulch forms a loose layer when applied over a loose soil surface. To protect the mulch from wind drifting and water damage, stabilize it by covering with netting, such as jute, or by spraying it with a tacking agent. Straw mulch should cover the entire seeded area or exposed slope. The mulch should extend into existing vegetation or stabilized areas on all sides to prevent wind or water damage, which may start at the edges of the mulched area
- Apply straw fibers to form a uniform cover of loose straw through which 20% or less of the original ground surface can be seen. No large clumps of unscattered straw should exist after application.
- On small slopes, straw mulch should be applied by hand broadcasting to a uniform depth of 2 to 3 inches. On larger slopes, straw can be blown onto the slope to achieve a uniform cover of 2 to 3 inches.

Wood Chips

- Due to bacterial action during decomposition, nutrient concentrations in the soil may be depressed under a layer of wood chips. Applications should not exceed the specified thickness that would cause a marked decline in some soil nutrients for longer periods.
- When using wood chips to mulch revegetation projects, the specified application of fertilizer should be increased approximately 25% to replenish soil nutrients lost due to breakdown of wood chips.

Mulch Effectiveness

- Crushed stone and gravel mulches retain their effectiveness indefinitely if properly applied and protected from compacting traffic. Sediment generation is reduced 70% to 90%, and nutrient generation is reduced 50% to 70%.

- Straw mulches and hydromulches initially have a high sediment and nutrient reduction, but breakdown of the organic fibers decreases their effectiveness with time. Sediment and nutrient reduction estimates are shown in Table 22.
- Wood chips deteriorate more slowly than wood fiber and, therefore, retain their effectiveness longer. Sediment and nutrient reduction estimates for wood chips is shown in Table 22.

Table 22. Estimated removal efficiencies of mulches.

Age of Mulch	Wood Chips		Hydromulch		Straw (without vegetation)	
	Sediment Reduction (%)	Nutrient Reduction (%)	Sediment Reduction (%)	Nutrient Reduction (%)	Sediment Reduction (%)	Nutrient Reduction (%)
0–2 months	90–95	60–80	70–80	50–70	90–95	60–80
2 months–1 year	90–95	60–80	70–80	50–70	70–90	50–70
1–2 years	80–90	50–70	40–60	20–50	40–60	20–50
More than 2 years	50–60	30–50	10–30	0–10	10–30	0–10

Construction Guidelines

Seeding (temporary or permanent) can take place before or concurrently with mulching. Other surface runoff control measures should be installed before seeding and mulching. If seed is applied before mulch, mulch should be applied to seeded areas immediately after seeding.

Mulches should not be applied when free surface water is present but may be applied to damp ground.

The choice of materials for mulching will be based on the type of soil to be protected, site conditions, season, and economics.

Straw Mulch

The straw should be stabilized to prevent it from being damaged by water or wind (blown away). Use one of the following methods to apply straw mulch:

- Hand punching can be used on small sites, sites with rock and stone on the surface, sites with slopes that are steeper than 3:1, or sites that have been wattled. Take care not to damage wattling or planted vegetation. Use a spade or shovel to punch the straw into the slope until all areas have straw standing perpendicularly to the slope and embedded at least 4 inches into the slope. The straw bunches should resemble the tufts of a toothbrush.
- Roller punching can be used on large, gently sloping sites without significant outcroppings of rock and stone. Do not use roller punching on sites that have been wattled (unless adequate space exists between lines of wattling) or on planted sites. A roller equipped with straight studs not less than 6 inches, from 4 to 6 inches wide, and approximately 3/4-inch thick will best accomplish the desired effect. Studs should stand approximately 8 inches apart and should be staggered. All corners should be rounded to prevent withdrawing the straw from the soil. Vegetative planting may be conducted following roller punching.
- Crimper punching involves specially designed straw-crimping rollers, which are suitable for use wherever roller punching can be used. The crimpers consist of serrated disk blades,

set 4 to 8 inches apart, which force straw mulch into the soil. Crimping should be done in two directions with the final pass conducted across the slope rather than up and down it.

- Tacking agents may be used on any type of site but are best used only on very stony or rocky soils or small, steep slopes. Apply 28.5 cubic feet per acre (ft^3/ac) of the tacking agent or its equivalent over the straw mulch. Agents that are neutral or nearly neutral in color and have demonstrated effectiveness for the soils and climate of the application area are acceptable.
- Matting may be used on large, steep areas that cannot be punched with a roller. Jute or wood excelsior on plastic netting should be applied over unpunched straw (BMP 54: Matting).

Hydromulching

- Wood fiber may be dyed to aid in uniform placement. Dyes should not stain concrete or painted surfaces nor injure plant or animal life when applied at the manufacturer's recommended rate.
- Application of the slurry should proceed until a uniform cover is achieved. The applicator should not be directed at one location for too long or the applied water will cause erosion.
- The hydraulic mulching machine should be equipped with a gear-driven pump and a paddle agitator. Agitation by recirculation from the pump is not acceptable. Agitation should be sufficient to produce homogeneous slurry of tacking agent and mulch (and seed fertilizer, if used).
- Application rates according to the manufacturer's recommendation for each site situation should be used.

Maintenance

Inspect all mulched areas periodically according to the inspection interval prescribed in the project site storm water plan and after runoff-producing storm events. Inspect for damage due to wind, water, or human disturbance. Repair damaged areas of the mulch immediately. If hydromulching, repair damaged areas at the original specifications. Reseed or replant such areas, if necessary, before replacing the mulch cover. Straw mulch and other organic products do not have to be removed when the vegetation becomes established.

Additional Resources

EPA (US Environmental Protection Agency). 2014. "Mulching." *Stormwater Best Management Practices: Compost Blankets*. *https://www3.epa.gov/npdes/pubs/compostblankets.pdf*

BMP 53: Geotextile

Description

Geotextiles are porous fabrics made by weaving or bonding fibers from synthetic materials such as polypropylene, polyester, polyethylene, nylon, PVC, glass, or mixtures of these materials.

Geotextiles stabilize disturbed soil areas and protect soils from wind or water erosion by providing a continuous sheet over the exposed surface and reducing raindrop impact (Figure 123). The fabrics protect new vegetation and aid in vegetation growth and establishment by preventing topsoil loss and retarding evaporation of soil moisture. Geotextiles can also provide material separation for riprap (BMP 56) or subgrade reinforcement.

Matting (BMP 54) or netting made of biodegradable materials (e.g., jute, wood fiber, straw, coconut, paper, or cotton) used for these purposes is less durable.

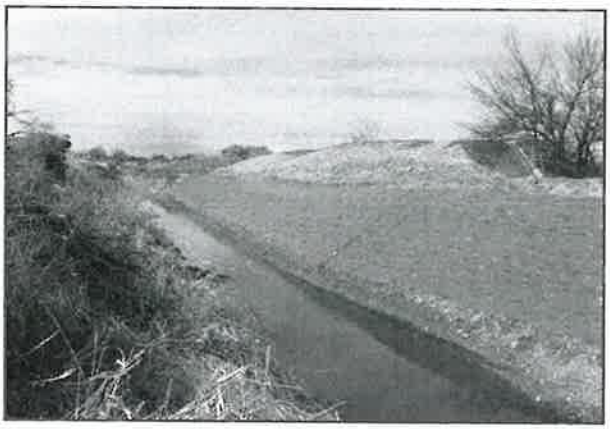


Figure 123. Geotextile channel lining (ITD 2014).

Primary BMP Functions and Controls

☒ Construction	☒ Permanent
☒ Erosion Control	☐ Sediment Control
☐ Source Control	☐ Flood Control
☐ Filtration	☐ Infiltration

Typical Effectiveness for Targeted Pollutants

- ● Sediment
- ○ Nitrogen
- ○ Phosphorus
- ◖ Metals
- ○ Bacteria
- ○ Hydrocarbons
- ○ Litter

Other BMP Considerations

Relative Cost	$$
Maintenance Requirements	Low
Ease of Installation	Easy
Freeze/Thaw Resistance	Good
Max. Tributary Drainage Area	100 acres
Max. Slope	50%
NRCS Soil Group	ABCD
Min. Ground Water Separation	NA
Min. Bedrock Separation	NA

Applicability

Geotextiles can be used on disturbed slopes and within channels, ditches, and swales. They are especially applicable for steep slopes, high flows, off-season planting, or if other factors prevent the use of organic matting. Use geotextiles along streambanks to establish bioengineered revetments where rock or riprap revetments are not appropriate. Geotextile advantages include the following:

- Ease and convenience.
- Quick and effective protection against erosion problems.
- A wide variety of geotextile products are available to match specific needs.
- Synthetic geotextiles may be removed and reused if economically feasible.
- Better resistance to high-flow situations than organic matting.

Limitations

- Effectiveness may be reduced drastically if the fabric is not properly selected, designed, or installed.
- Many synthetic geotextiles are sensitive to light and should be protected from direct sunlight before installation.
- Geotextiles that are not biodegradable should not be used where their presence or appearance is aesthetically unacceptable.
- Geotextiles should not be placed on 50% slopes if they are to be covered with overlying material.
- While geotextiles are affordable, their costs are usually higher than other erosion control techniques. Focus using geotextiles in areas where other erosion control techniques are ineffective (e.g., steep slopes, channels, periods where planting and seeding cannot take place).
- Geotextiles are not well suited in excessively rocky sites where a vegetated cover is unlikely or areas where the final vegetation will be mowed (staples and netting catch in mowers).

Design Basis

Geotextile fabrics are typically either woven or nonwoven polypropylene material. Nonwoven fabrics resemble felt whereas woven fabrics consist of two or more strands of material interlaced at right angles. The fabrics are available in various thicknesses, tensile strengths, permittivity, and ultraviolet stability; the proper material selection depends on the application. Products are available for up to 50% slopes. Typically, woven fabrics are preferred where high strength properties are needed; nonwoven fabrics are preferred where water transmission is needed. Use woven monofilament geotextiles where both strength and filtration are important. For erosion control applications, geotextiles should have the characteristics shown in Table 23.

Table 23. Recommended geotextile properties (CASQA 2004a).

Property	Minimum Value	Testing Method
Thickness	0.06 inches	—
Tensile strength	150 pounds (warp) 80 pounds (fill)	ASTM D 4632
Permittivity	0.07 sec-1	ASTM D 4491
Ultraviolet stability	70%	ASTM D 4355

Some synthetic geotextiles persist a very long time and should be considered a permanent measure. Others remain intact for less than 1 year. Those types designed to help establish vegetation will eventually photo-degrade or decompose. If a short-term degradable product is needed, see BMP 54: Matting.

Anchorage requirements depend on slope, soils, and expected runoff flow rates. General recommendations for anchorage are as follows:

- Anchor the fabric with U-shaped wire staples (minimum 8 gauge), metal geotextile stake pins (0.20 inch diameter with 1.5-inch steel washer), or triangular wooded stakes driven

perpendicularly into the slope face. All anchors should be a minimum of 6 inches long (up to 18 inches recommended in loose soils) and have sufficient penetration to resist pullout.

- Anchor spacing should be denser for steeper slopes. Steep slopes (1:1 to 2:1 H:V) should have a minimum of 2 anchors per square yard. Moderate slopes (2:1 to 3:1 H:V) should have a minimum of 1.5 staples per square yard. Check manufacturer's recommendations for staple patterns and density.

Anchorage can be selected using static analysis for a horizontal anchoring system as provided in Equation 30, Equation 31, and Equation 32. Figure 124 provides a cross-sectional diagram of a horizontally anchored geotextile system.

$$T_{GMallow} = \sigma_{allow} * t$$

Equation 30. Allowable geomembrane tension.

$$\sigma_{allow} = \frac{\sigma_{ult}}{FS}$$

Equation 31. Allowable geomembrane stress used to determine factor of safety.

$$T_{ATallow} = \frac{\gamma * d * L * (\tan\delta_U + \tan\delta_L)}{\cos\beta - \sin\beta * \tan\delta_L}$$

Equation 32. Allowable anchor trench tension.

Where

σ_{allow} = allowable geomembrane stress

t = geomembrane thickness

σ_{ult} = ultimate geomembrane stress (e.g., yield or break)

$T_{ATallow}$ = allowable anchor trench tension

d = thickness of the cover soil

L = embedment length

δ_L = (flexible membrane liners)/soil friction angle (below geomembrane)

δ_U = cover soil and geomembrane friction angle (above geomembrane)

β = side slope angle

FS = factor of safety

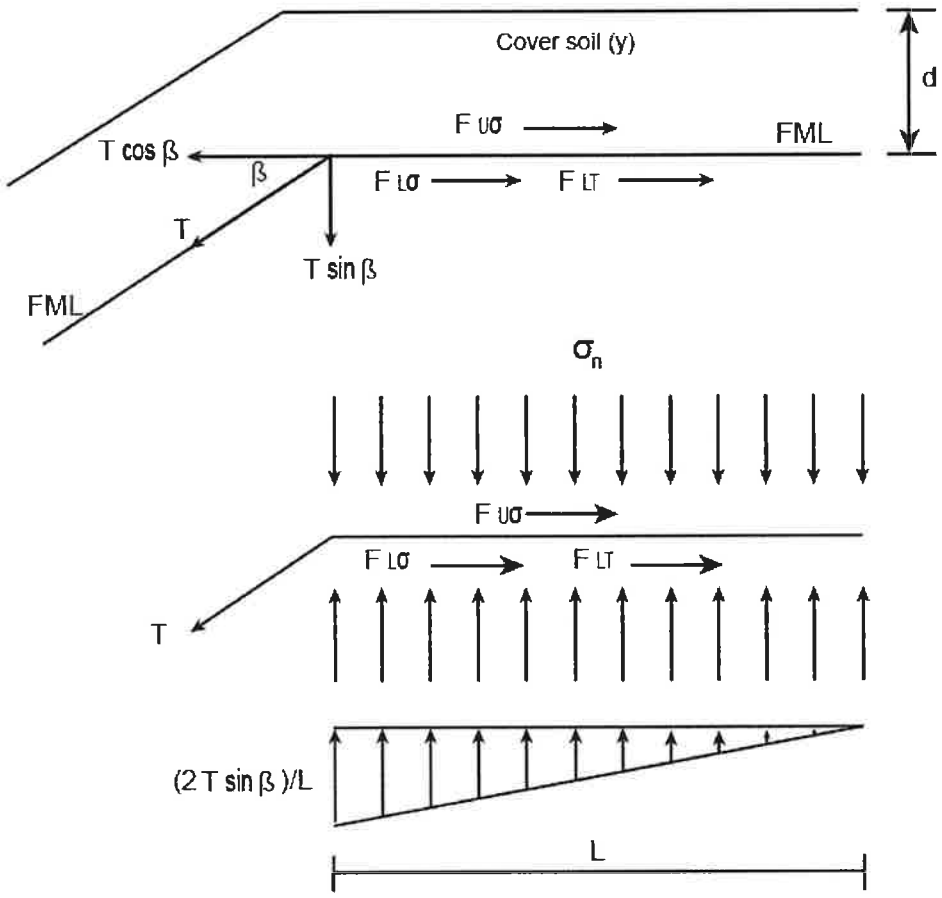


Figure 124. Cross-sectional diagram of a horizontally anchored geotextile system.

Construction Guidelines

When applying a geotextile to an exposed surface, anchor it into place to provide a continuous cover. Follow the manufacturer's recommendations for installation on slopes and within channels (Figure 125). After the fabric is placed, avoid driving equipment over the fabric, especially if wet soil conditions exist. Use the following guidelines for installation:

- The soil should be reasonably smooth. Fill and compact any rills and gullies. Remove protruding rocks and other obstructions.
- Apply the individual rolls up and down the slope, from the top to the bottom—never along the contour.
- Overlap the sides of the rolls at least 4 inches and ensure at least a 3-foot overlap when an uphill roll joins a downhill roll. The uphill roll should overlie the downhill roll.
- Extend the fabric beyond the edge of the mulched or seeded area at least 1 foot at the sides and 3 feet at the top and bottom of the area. If existing vegetation or structures mark the boundaries of the area, the fabric should continue into the stable vegetated area or to the edge of the structure.
- At the top of the area, bury the end of each roll in a trench at least 8 inches deep. Backfill and tamp the trench.

- Ensure the fabric makes uniform contact with the slope face underneath. No *bridging* of rills or gullies should be allowed.
- When using fabric designed for seeding or revegetation, follow the manufacturer's guidelines for proper seedbed preparation, seed application, and/or planting.

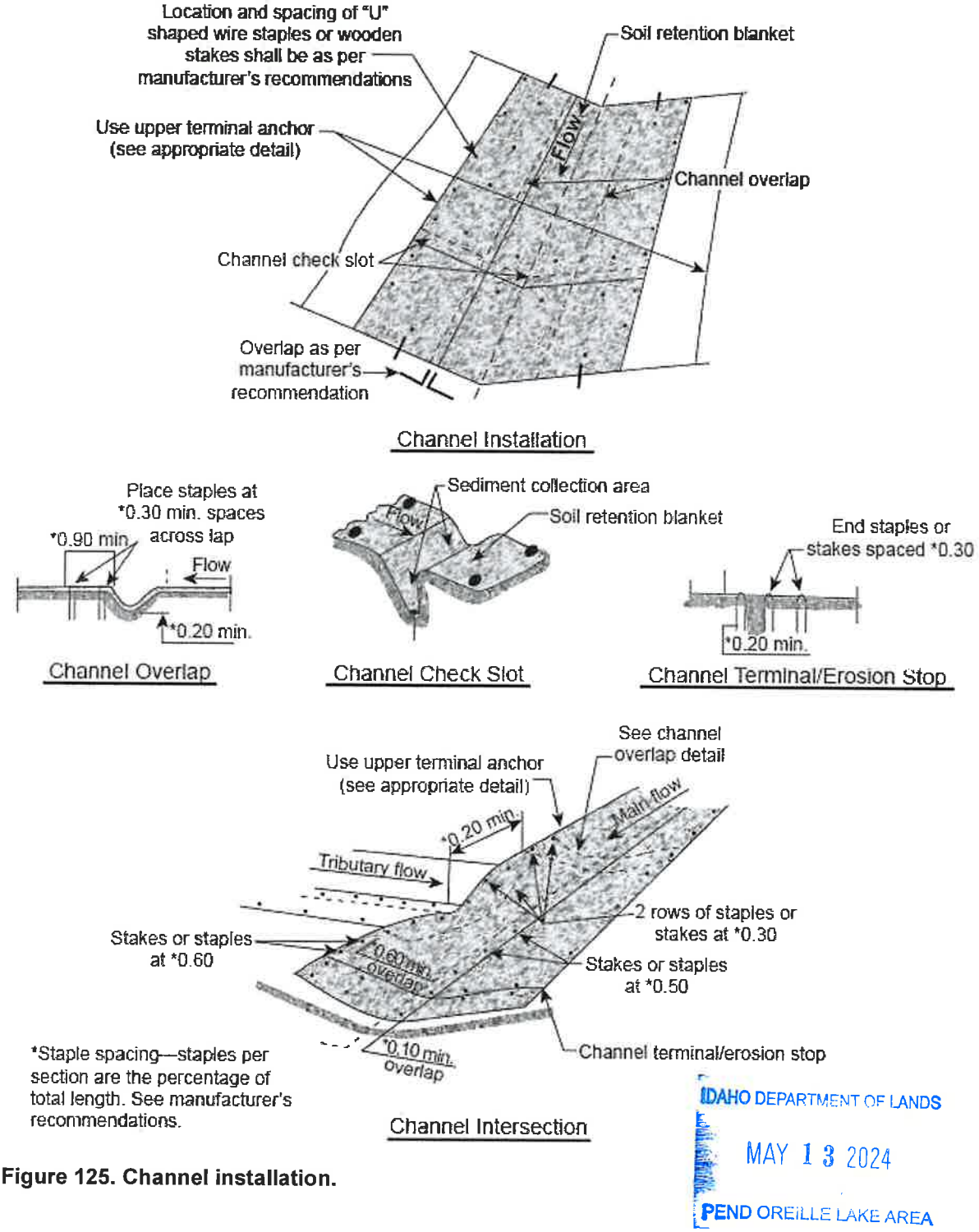


Figure 125. Channel installation.

Maintenance

Inspect weekly or monthly during drier periods and within 24 hours after each runoff-producing storm. To ensure proper functioning, complete one inspection during the first runoff-producing event after installation. Check that the fabric is uniformly in contact with the soil, the lap joints are secure, and staples are flush with the ground. If fabric sheeting is damaged or missing, replace it immediately to restore full protection. Inspect sheeting to ensure that channelization and erosion are not occurring underneath fabric (sediment outwash is the most visible sign).

Products used for temporary control may be removed and reused if it is done without leaving the area susceptible to erosion and the fabric is suitable for reuse.

Additional Resources

CASQA (California Stormwater Quality Association). 2004. *California Stormwater Best Management Practices Handbook: New Development and Redevelopment*. Menlo Park, CA. *https://www.casqa.org*

ITD (Idaho Transportation Department). 2014. *Best Management Practices.* Boise, ID: ITD.

BMP 56: Riprap Slope Protection

Description

Slopes that experience high runoff velocities from concentrated flows can be unstable and cause excessive erosion and sedimentation. Riprap slope protection is created by layers or piles of rock placed over the soil surface. Riprap, when used as slope protection, protects against erosion, stabilizes the slope, and dissipates the energy of surface water flow (Figure 129).

If used along a surface water body such as a river, lake, or stream, permits may be required from Idaho Department of Lands, IDWR, and US Army Corps of Engineers (each agency has local offices throughout the state). These agencies may have specifications for placing riprap so inquire early in the design to facilitate obtaining the permits.

Figure 129. Riprap stabilization of the Salmon River Road, Riggins, Idaho.

Applicability

Riprap slope protection can be used on channel side slopes or bottoms, cut and fill slopes, streambanks, bridge embankments, below dikes or detention pond spillways, or any area where the velocity of flow may cause erosion.

Limitations

The steepness of the slope limits the applicability of riprap since slopes steeper than 1V:2H can cause riprap loss due to erosion and sliding. It may be difficult to remove sediment from riprap without completely removing and replacing the riprap. If used improperly, riprap can increase erosion. In addition, riprap can be more expensive than other stabilization options.

Design Basis

The design of riprap slope protection depends on the soil conditions, site characteristics, and expected flows. When designing riprap slope protection, apply the following guidelines.

Primary BMP Functions and Controls

☐ Construction	☒ Permanent
☒ Erosion Control	☐ Sediment Control
☐ Source Control	☐ Flood Control
☐ Filtration	☐ Infiltration

Typical Effectiveness for Targeted Pollutants

◖	Sediment
○	Nitrogen
○	Phosphorus
○	Metals
○	Bacteria
○	Hydrocarbons
◖	Litter

Other BMP Considerations

Relative Cost	$$
Maintenance Requirements	Low
Ease of Installation	Easy
Freeze/Thaw Resistance	Good
Max. Tributary Drainage Area	5 acre
Max. Upstream Slope	40%
NRCS Soil Group	ABCD
Min. Ground Water Separation	NA
Min. Bedrock Separation	NA

Gradation

Rock riprap material should be composed of a well-graded mixture of angular stone size so that 50% of the pieces, by weight, are larger than the D_{50} size as determined using standard testing methods. A well-graded mixture is defined as a mixture that includes a variety of stone sizes so that the voids between the stones are filled. Riprap gradations that fall within the range of D_{100}/D_{50} and D_{50}/D_{20} from 3.0 to 1.5 are acceptable.

Size

Size the riprap so the permissible shear stress of the riprap material is greater than the hydrodynamic force of water flowing in the channel or over the slope. The permissible shear stress (Table 26) indicates the force required to initiate movement of the stone particles (Equation 33–Equation 35).

Table 26. Typical permissible shear stresses for bare soil and stone linings (FHWA 2005).

Lining Category	Lining Type	Permissible Shear Stress (pounds per square foot)
Bare soil[a] Cohesive (PI = 10)	Clayey sands	0.037–0.095
	Inorganic silts	0.027–0.11
	Silty sands	0.024–0.072
Bare soil[a] Cohesive (PI ≥ 20)	Clayey sands	0.094
	Inorganic silts	0.083
	Silty sands	0.072
	Inorganic clays	0.14
Bare soil[b] Cohesive (PI ≤ 10)	Finer than coarse sand D_{75} < 0.05 inches	0.02
	Fine gravel D_{75} = 0.3 inches	0.12
	Gravel D_{75} = 0.6 inches	0.24
Gravel mulch[c]	Coarse gravel D_{50} = 1 inch	0.4
	Very coarse gravel D_{50} = 2 inches	0.8
Rock riprap[c]	D_{50} = 0.5 feet	2.4
	D_{50} = 1 foot	4.8

a. Based on Equation 33 assuming a soil void ratio of 0.5 (USDA 1987).
b. Based on Equation 34 derived from USDA (1987).
c. Based on Equation 35 Shield's parameter equal to 0.047

$$\tau_{p,soil} = (c_1 PI^2 + c_2 PI + c_3)(c_4 + c_5 e)^2 c_6$$

Equation 33. Permissible soil shear stress for cohesive soils.

Where:

$\tau_{p,soil}$ = soil permissible shear stress (lb/ft^2)
PI = plasticity index
e = void ratio
$c_1, c_2, c_3, c_4, c_5, c_6$ = coefficients (Table 27)

Table 27. Coefficients for permissible soil shear stress (USDA 1987).

ASTM Soil Classification	Applicable Range	C_1	C_2	C_3	C_4	C_5	C_6 (SI)	C_6 (CU)
GM	10 ≤ PI ≤ 20 20 ≤ PI	1.07	14.3	47.7 0.076	1.42 1.42	-0.61 -0.61	$4.8x10^{-3}$ 48.	10^{-4} 1.0
GC	10 ≤ PI ≤ 20 20 ≤ PI	0.0477	2.86	42.9 0.119	1.42 1.42	-0.61 -0.61	$4.8x10^{-2}$ 48.	10^{-3} 1.0
SM	10 ≤ PI ≤ 20 20 ≤ PI	1.07	7.15	11.9 0.058	1.42 1.42	-0.61 -0.61	$4.8x10^{-3}$ 48.	10^{-4} 1.0
SC	10 ≤ PI ≤ 20 20 ≤ PI	1.07	14.3	47.7 0.076	1.42 1.42	-0.61 -0.61	$4.8x10^{-3}$ 48.	10^{-4} 1.0
ML	10 ≤ PI ≤ 20 20 ≤ PI	1.07	7.15	11.9 0.058	1.48 1.48	-0.57 -0.57	$4.8x10^{-3}$ 48.	10^{-4} 1.0
CL	10 ≤ PI ≤ 20 20 < PI	1.07	14.3	47.7 0.076	1.48 1.48	-0.57 -0.57	$4.8x10^{-3}$ 48.	10^{-4} 1.0
MH	10 ≤ PI ≤ 20 20 ≤ PI	0.0477	1.43	10.7 0.058	1.38 1.38	-0.373 -0.373	$4.8x10^{-2}$ 48.	10^{-3} 1.0
CH	20 ≤ PI	—	—	0.097	1.38	-0.373	48.	1.0

Notes: GM—silty gravels, gravel-sand silt mixtures; GC—clayey gravels, gravel-sand-clay mixtures; SM—silty sands, sand-silt mixtures; SC—clayey sands, sand-clay mixtures; ML—inorganic silts, very fine sands, rock flour, silty or clayey fine sands; CL—inorganic clays of low-to-medium plasticity, gravelly clays, sandy clays, silty clays, lean clays; MH—inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts; CH—inorganic clays of high plasticity, fat clays

$$\tau_{p,soil} = \alpha D_{75}$$

Equation 34. Permissible soil shear stress for course-grained noncohesive soils.

Where:

$\tau_{p,soil}$ = soil permissible shear stress (lb/ft^2)

D_{75} = soil size where 75% of the material is finer (in.)

α = unit conversion constant, 0.75 (SI), 0.4 (CU)

$$\tau_p = F_*(\gamma_s - \gamma)D_{50}$$

Equation 35. Permissible shear stress for riprap and gravel linings.

Where:

τ_p = permissible shear stress (lb/ft^2)

F_* = Shield's parameter, dimensionless

γ_s = specific weight of the stone (lb/ft^2)

γ = specific weight of the water (62.4 lb/ft^2)

D_{50}= mean riprap size (ft)

The maximum shear stress on a channel bottom can be calculated using Equation 36.

$$\tau = \gamma ds$$ **Equation 36. Shear stress at the bottom of a channel.**

Where

τ = maximum shear stress at channel bottom (lb/ft^2)

γ= unit weight of water, 62.4 lb/ft^3

d = maximum flow depth (ft)

s = channel gradient (ft/ft)

The maximum shear on the side of a channel is generally less than that on the channel bottom and is given by Equation 37:

$$\tau_s = K_1 \tau$$ **Equation 37. Shear stress at the side of a channel.**

Where

τ_s = side shear stress (lb/ft^2)

τ = maximum shear stress at channel bottom (lb/ft^2)

K_1= ratio of channel side shear to bottom shear stress

For trapezoidal and triangular channels, where Z is the horizontal dimension (1:Z, V:H) Equation 38 may be applied for K_1:

$K_1 = 0.77$ for $Z \leq 1.5$

$K_1 = 0.066Z\ 0.67$ for $1.5 < Z < 5$

$K_1 = 1.0$ for $5 \leq Z$

Equation 38. Ratio values for side shear to bottom shear stress.

Thickness

The thickness of the riprap layer varies depending on the application but in no case should it be less than 6 inches. For smaller rock sizes where D_{50} is 15 inches or less, a thickness of 1.5 to 2 times D_{100} is recommended. For D_{50} greater than 15 inches, a thickness of 1.2 to 1 times D_{100} can be used. Table 28 lists some examples of riprap sizes and thicknesses for various unit shear stresses.

Table 28. Example rock riprap sizes and thickness.

Unit Shear Stress (pounds per square foot)	D_{50} (inches)	D_{100} (inches)	Minimum Blanket Thickness (inches)
0.67	2	4	6
2.00	6	9	14
3.00	9	14	20
4.00	12	18	27
5.00	15	22	32
6.00	18	27	32
7.80	21	32	38
8.00	24	36	43

Stone Quality

Riprap should consist of field stone or rough unhewn quarry stone. The stone must be hard and *angular* (to create an interlocking stone blanket) and of a quality that will not disintegrate with exposure to water, weathering, or freeze/thaw cycles. The specific gravity of the individual stones should be at least 2.5 to prevent scour and mobilization of the material. Table 29 lists common rock types and their specific gravities. Note that although talc and sandstone meet the specific gravity requirement, these materials should not be used in riprap construction because of water solubility and scouring concerns. Use best judgment when selecting riprap material.

Table 29. Common rock types and associated specific gravity and density (EDUMine 2018).

Rock Type	Specific Gravity	Ton/yd^3
Basalt	2.8–3.0	2.11–2.36
Granite	2.6–2.7	2.19–2.28
Quartzite	2.6–2.8	2.19–2.36
Gneiss	2.6–2.9	2.19–2.44
Dolomite	2.50–2.60	2.36–2.44
Talc	2.6–2.8	2.19–2.36
Sandstone	2.2–2.8	1.85–2.36

Filter

A filter is a layer of material placed between the riprap and the underlying soil to prevent soil movement into and through the riprap. The need for a filter depends on the characteristics of the native material underlying the riprap, but it is needed in most cases.

Filters can be either gravel or a geosynthetic fabric. Geosynthetic fabrics can be woven or nonwoven monofilament yarns and should have adequate permeability to prevent uplift pressures from forming (Table 30). Other basic requirements include a thickness of 10–60 mils, grab strength of 90–120 pounds, and conform to ASTM D-1777 and ASTM D5034 and D5035.

Table 30. Maximum apparent opening size for geotextile filters (FHWA 1998).

Soil Type	Maximum Apparent Opening Size for Geotextile Filters (millimeters)
Noncohesive, less than 15% passing the 0.075 mm (US #200) sieve	0.43
Noncohesive, 15% to 50% passing the 0.075 mm (US #200) sieve	0.25
Noncohesive, more that 50% passing the 0.075 mm (US #200) sieve	0.22
Cohesive, plasticity index greater than 7	0.30

Gravel filter blankets should be designed by comparing particle sizes of the riprap material and the underlying base material using Equation 39, Equation 40, and Equation 41 (FHWA 2005). The recommended minimum filter thickness is 6 inches.

$$\frac{D_{15\ UPPER}}{D_{85\ LOWER}} < 5$$ **Equation 39. Lower particle size ratio.**

$$5 < \frac{D_{15\ UPPER}}{D_{15\ LOWER}} < 40$$ **Equation 40. Medium particle size ratio.**

$$\frac{D_{50\ UPPER}}{D_{50\ LOWER}} < 40$$ **Equation 41. Upper particle size ratio.**

In the equations above, *upper* refers to the overlying material, and *lower* refers to the underlying material. These relationships must hold between the filter blanket and base material and between the riprap and filter blanket.

Placement

Riprap placement shall follow immediately after filter placement. Place riprap so it forms a dense, well-graded mass of stone with minimum voids. Riprap shall be placed at its full thickness in one lift.

In a channel, place riprap so it extends to the maximum flow depth, or to a point where vegetation will satisfactorily control erosion. Ensure riprap extends to five times the bottom width upstream and downstream at the beginning and ending of the curve and the entire curved section.

On slopes, key the toe of the riprap in at the base. The toe should be excavated to 2 feet deep. The design thickness of the riprap shall be extended to a minimum of 3 feet horizontally from the slope. The finished grade of the riprap should blend with the surrounding area. Figure 130 and Figure 131 show cross sections of riprap placed in channels and on channel side slopes.

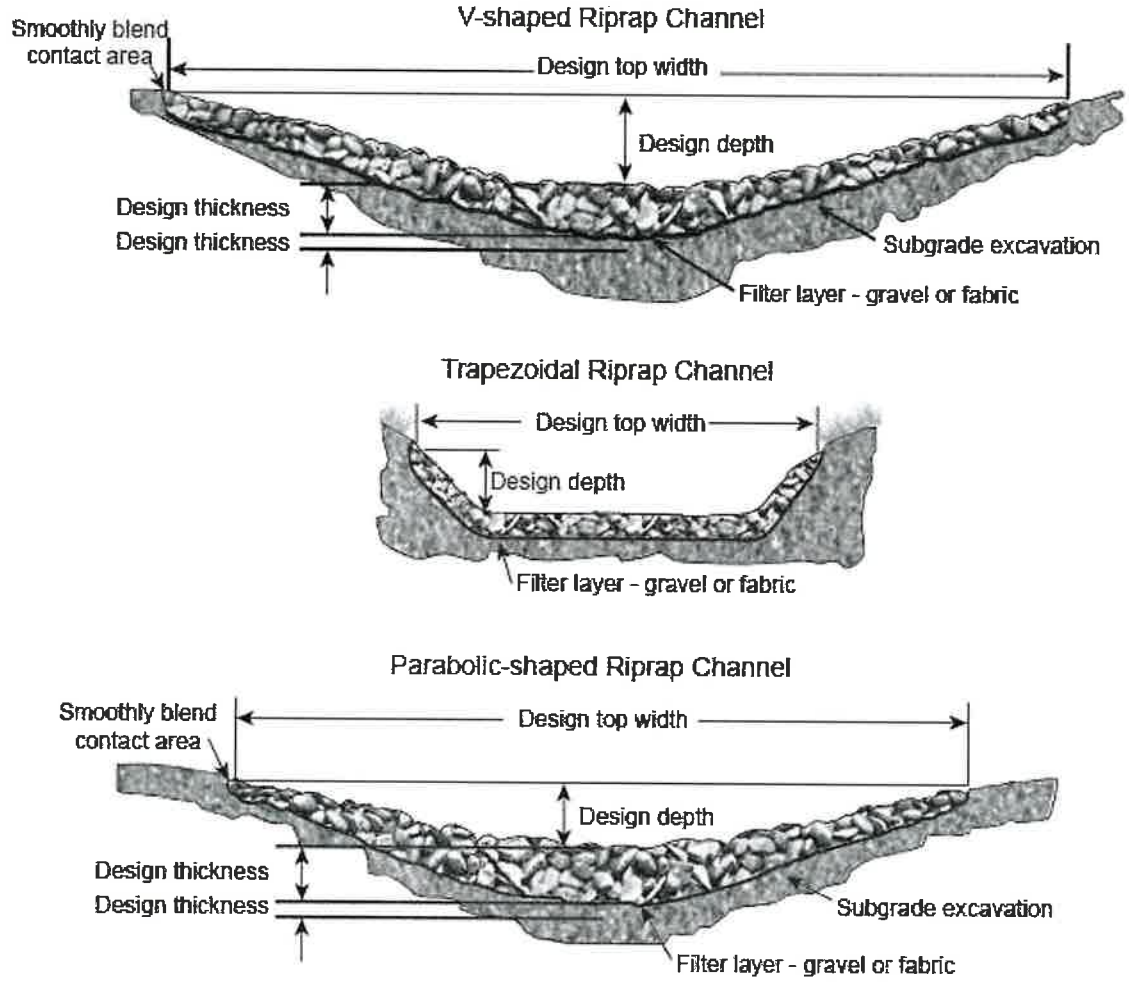


Figure 130. Riprap channel cross sections.

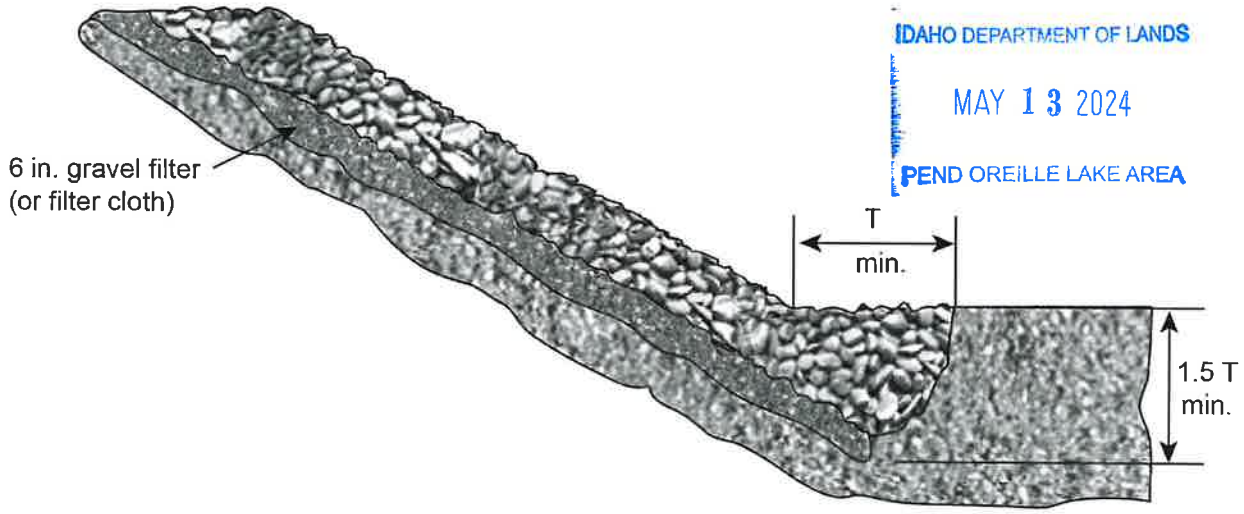


Figure 131. Riprap on channel side slope.

Grouted Riprap

Grouted riprap consists of a stone bed with voids filled with grout or concrete to form a veneer of cementitious-bonded aggregate armor. Grouting riprap is an option if the required stone sizes are not available for a conventional riprap installation or in areas of high shear stress or nonuniform flow conditions, such as at transitions in channel shape or at energy dissipation structures.

Grouted riprap should consist of stone with less than 5% passing a 2-inch sieve and have qualities similar to nongrouted riprap. The median rock size should not exceed 0.67 times the blanket thickness. Figure 132 illustrates the relationship between design velocity and recommended riprap blanket thickness for grouted installations.

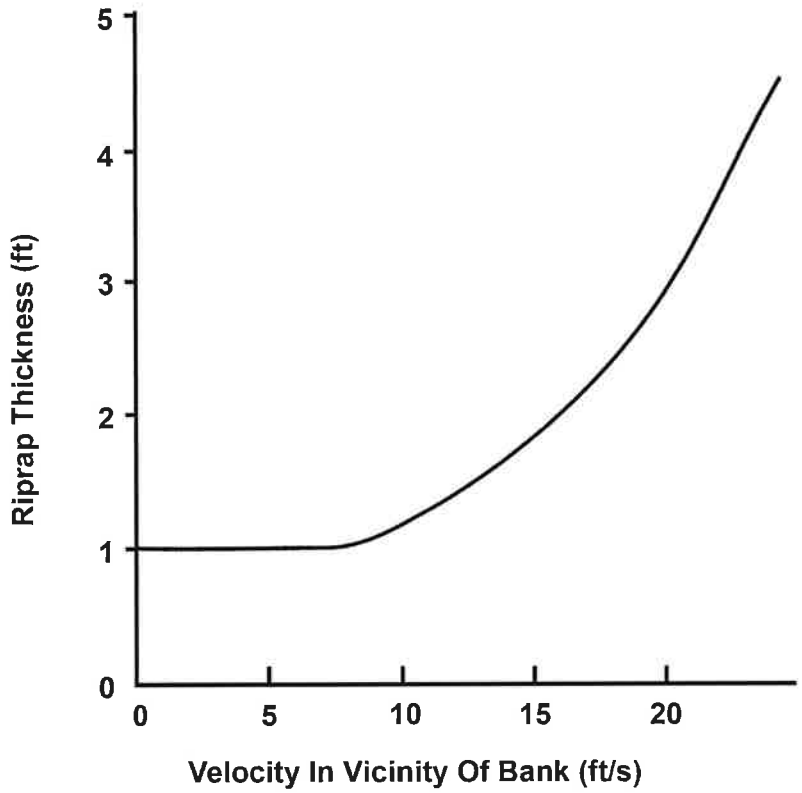
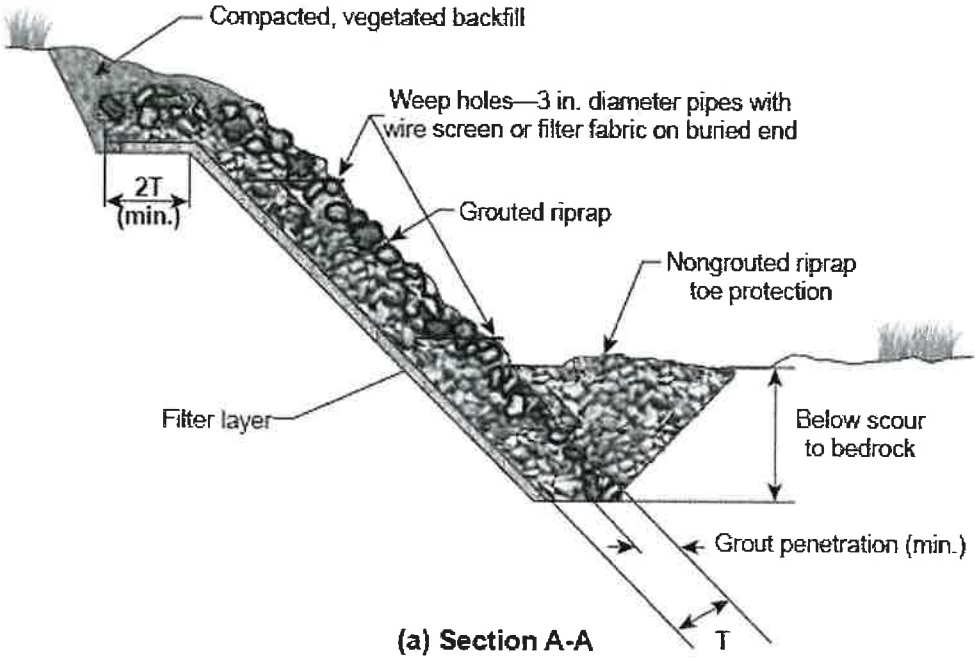
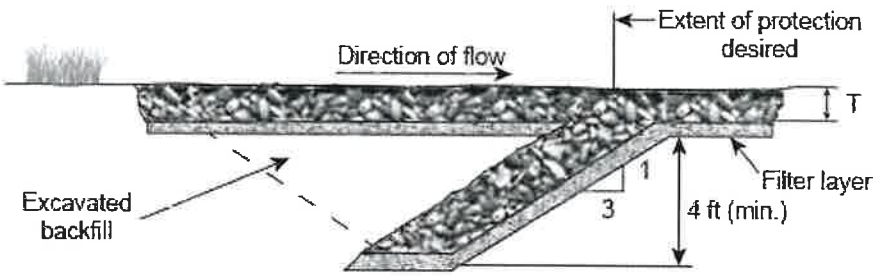


Figure 132. Grouted riprap thickness as a function of flow velocity (UDOT 2004).

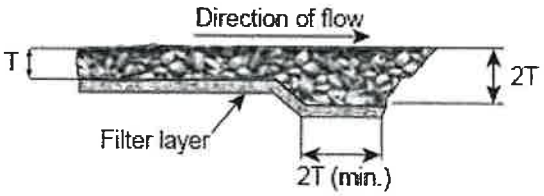
Grouted riprap is a rigid revetment and will not conform to changes in the bank geometry due to settlement. Special attention should be placed on edge treatment, foundation design, and mechanisms for hydrostatic pressure relief to avoid failure from undermining or lining breakup. To form a firm foundation, the bank should be free of all trees and debris and tamped or lightly compacted to provide sufficient bearing capacity to support the dry weight of the revetment alone or the submerged weight of the revetment plus the weight of the water in the wedge above the revetment for design conditions, whichever is greater. Pressure relief should be provided using weep holes that extend through the grout surface to the interface with the gravel underdrain layer. Recommended edge treatments and weep holes are illustrated in Figure 133.



(a) Section A-A



(b) Section B-B



(c) Section C-C

Figure 133. Grouted riprap cross section (top), upstream end treatment (middle), and downstream end treatment (bottom).

Construction Guidelines

- The subgrade for the filter and riprap should be prepared to the final grades. Any fill required in the subgrade should be compacted to a density approximately equal to that of the surrounding undisturbed material.
- Geosynthetic fabric should be protected from punching, cutting, or tearing. Any damage other than an occasional small hole should be repaired by placing another piece of cloth over the damaged part or by completely replacing the cloth. All overlaps whether for repairs or for joining two pieces of cloth should be a minimum of 1 foot.
- Riprap stone should be placed by equipment and constructed to the full course thickness in one operation to avoid displacement of underlying materials.
- The stone for riprap should be delivered and placed in a manner that ensures it is reasonably homogenous with the smaller stones and spalls filling the voids between the larger stones.
- Take care when placing riprap to prevent damage to the filter fabric. A combination of hand or equipment placement may be necessary depending on size and location of the riprap.
- Grout strength of 2,000 to 2,500 psi is recommended for grouted riprap installations.
- Underwater placement of grouted riprap should be avoided.
- Rock should be wet immediately before commencing grouting operations for grouted riprap installation.
- Complete construction of the riprap protection before allowing erosive flows to pass over the protected surface.

Maintenance

Once riprap has been installed, the maintenance needs are relatively low. Inspect after heavy storms and high flows for scouring and any dislodged stones. Repair all damage promptly.

Additional Resources

CASQA (California Stormwater Quality Association). 2004. *California Stormwater Best Management Practices Handbook: New Development and Redevelopment*. Menlo Park, CA. *https://www.casqa.org*

FHWA (US Department of Transportation Federal Highway Administration). 2005. *Design of Roadside Channels with Flexible Linings*. Hydraulic Engineering Circular-15 (HEC-15). Publication No. FHWA-NHI-05-114. *http://www.fhwa.dot.gov/engineering/hydraulics/library_arc.cfm?pub_number=15&id=32*

Hazra and ODOT (Hazra Engineering Company and Oregon Department of Transportation, Geo/Environmental Section). 2005. *ODOT Erosion Control Manual: Guidelines for Developing and Implementing Erosion and Sediment Controls.*

ITD (Idaho Transportation Department). 2014. *Best Management Practices.* Boise, ID: ITD.

UDOT (Utah Department of Transportation). 2004. *UDOT Manual of Instruction—Roadway Drainage, Bank Protection.* *http://www.udot.utah.gov/main/uconowner.gf?n=200403161050503*

BMP 60: Check Dams

Description

Check dams are used to capture sediment, reduce or prevent excessive bank and bottom erosion, and reduce runoff velocity. These small dams are constructed across open channels, swales, or drainageways. Typically constructed out of rock and gravel, logs, treated lumber, sandbags, or manufactured barriers, check dams may be temporary or permanent (Figure 143).

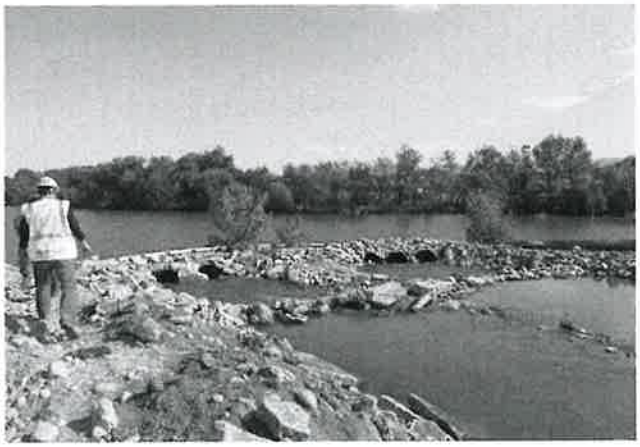


Figure 143. A rock check dam reduces runoff velocity.

Applicability

Check dams are often used in natural or constructed channels or swales where adequate vegetation cannot be quickly established. Temporary check dams are used during construction to slow runoff velocities, capture sediment, and prevent erosion. Permanent check dams can reduce runoff velocities and reduce or prevent erosion in open channels, swales, and drainage ways. Permanent check dams can be used with biofiltration swales (BMP 9) to reduce velocities and enhance filtration.

Limitations

Never place check dams in live flowing streams unless approved by appropriate local, state, and/or federal authorities. Check dams should not be used as stand-alone trapping devices.

Design Basis

- Drainage area to the check dam should be between 1 and 4 acres.
- Check dams should be spaced so that the toe of each upstream dam is never higher than the top of the next downstream check dam. Excavating a sump immediately upstream from the check dam may improve its effectiveness.

Primary BMP Functions and Controls

☒ Construction	☒ Permanent
☐ Erosion Control	☒ Sediment Control
☐ Source Control	☒ Flood Control
☐ Filtration	☐ Infiltration

Typical Effectiveness for Targeted Pollutants

●	Sediment
○	Phosphorus
◖	Metals
○	Bacteria
◖	Hydrocarbons
○	Litter

Other BMP Considerations

Relative Cost	$$
Maintenance Requirements	Medium
Ease of Installation	Medium
Freeze/Thaw Resistance	Good
Max. Tributary Drainage Area	4 acres
Max. Slope	50%
NRCS Soil Group	ABCD
Min. Ground Water Separation	N/A
Min. Bedrock Separation	2 feet

- Maximum toe to crest height should be 2 feet. The center of the dam should be at least 6 inches lower than either edge to form a weir for the outfall.
- The check dam should be as much as 20 inches wider than the banks of the channel to prevent undercutting as overflow water reenters the channel.
- When installing a series of check dams in a channel, provide outlet stabilization below the lowest check dam (where the risk of erosion is greatest) and consider the use of channel linings or protection such as matting or riprap where significant erosion or prolonged submergence may occur.
- Materials (Figure 144 and Figure 145):
  - Stone—2 to 16 inches in diameter
  - Logs—6 to 8 inches in diameter
  - Sandbags filled with pea gravel
  - Filter fabric meeting the standard specifications (BMP 65: Silt Fence)
- Logs should be driven into the ground a minimum of 28 inches.

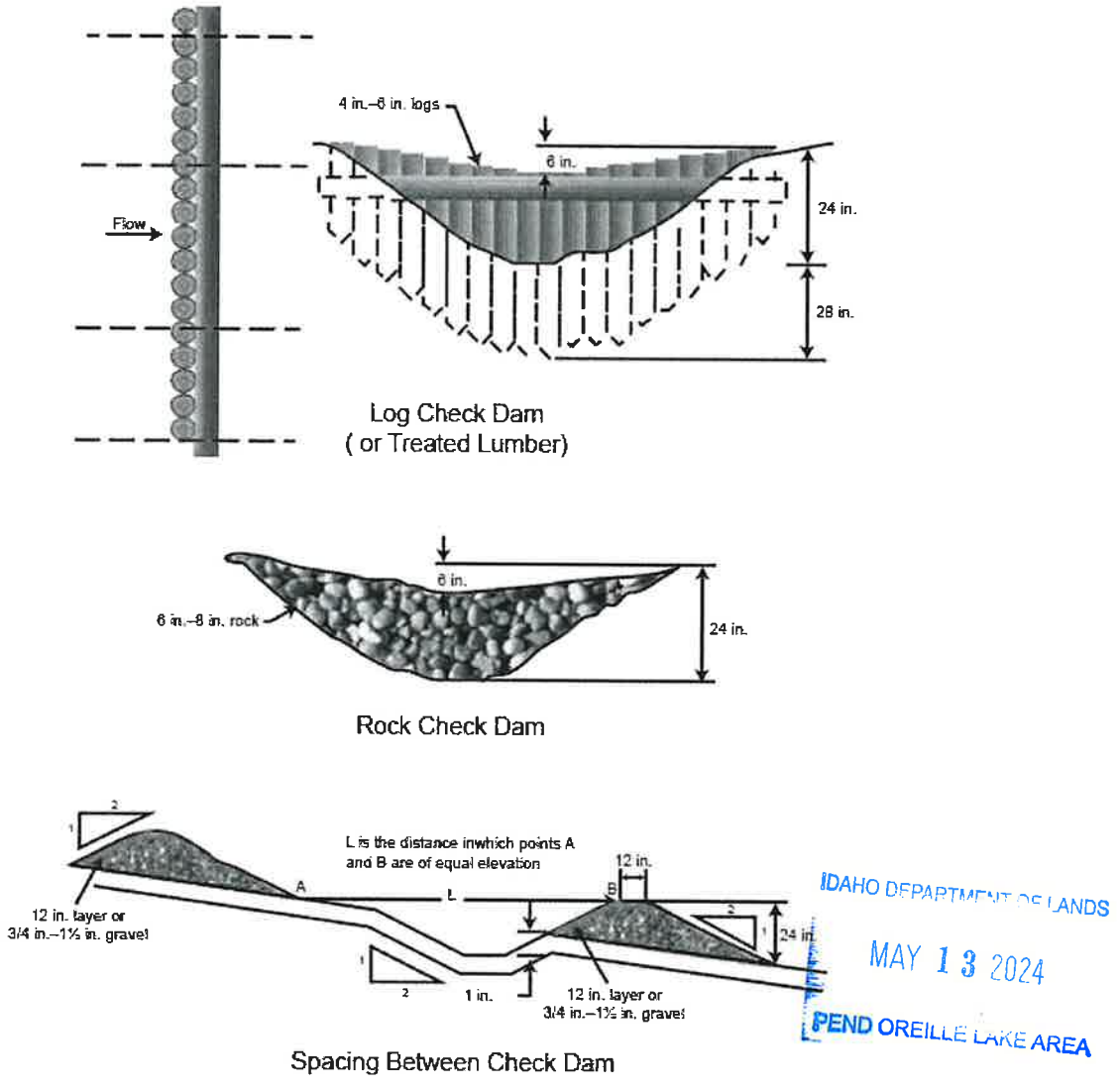


Figure 144. Log and rock check dams.

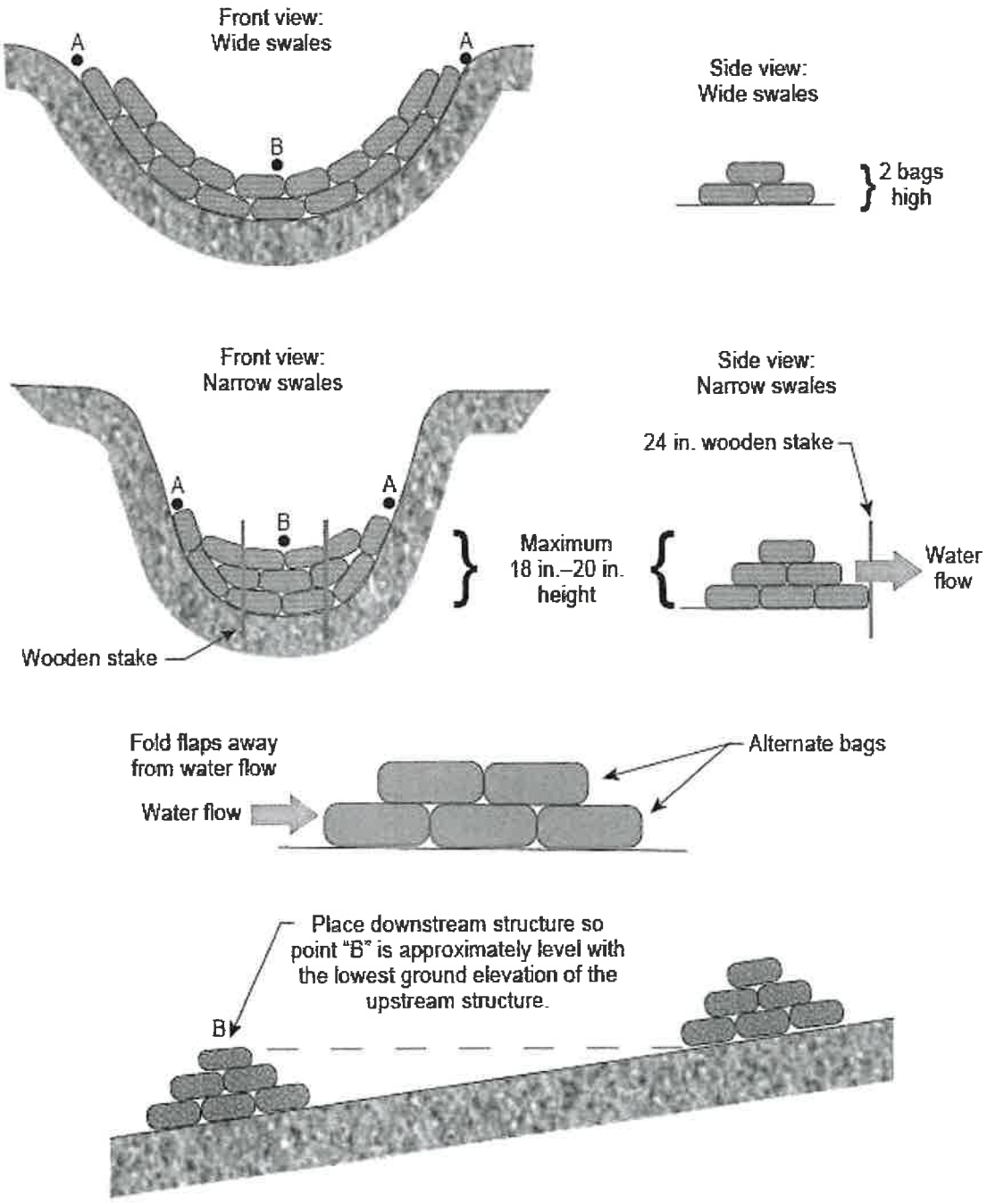


Figure 145. Bag check dam.

Construction Guidelines

Rock check dams—Place the stones on filter fabric either by hand or by using appropriate machinery; do not dump stones in place. Keep the side slopes 2:1 or flatter. Line the upstream side of the dam with a layer of 3/4 to 1-1/2-inch gravel; 12 inches deep is an option for additional channel protection.

Log check dams—Firmly embedded the logs in the ground. Filter cloth may be attached to the upstream side of the dam to retard flow and trap additional sediment. If a filter cloth is used, securely staple it to the top of the dam and adequately anchor in the streambed.

Bag check dams—Ensure all bags are securely sealed. Place the bags by hand or use appropriate machinery to place them in an interlocking pattern.

Manufactured barriers—An array of three-dimensional manufactured barriers is also available: triangular and burrito-shaped, prefilled and fillable on site, reusable and disposable, and temporary and permanent. Triangular silt dikes are temporary, reusable barriers consisting of a triangular urethane foam core covered by permeable, woven geotextile fabric. Usually from 16 to 20 inches wide at the base and 8 to 10 inches high, a silt dike is used at the toe of a slope to contain sediment from runoff or perpendicular to the flow of water in a drainage ditch.

The flexibility of the materials in manufactured barriers allows conformity to many channel configurations:

- Fasten to soil with staples or to rock and pavement with adhesives.
- Build temporary sediment ponds, diversion ditches, concrete wash-out facilities, curbing, water bars, level spreaders, and berms.

Riprap may be necessary on the downstream side of the dam to protect the channel from scour.

Maintenance

- Inspect the check dams regularly and after every runoff-producing storm to ensure structural integrity. Repair as needed to ensure the BMP is in good working order.
- Remove accumulated debris, trash, and leaves. Remove sediment from behind the dam when the depth reaches of one-half the original height of the dam (measure at this center).
- Dispose of all materials properly so pollution problems are not increased at the disposal site.
- Restore stone as necessary so the dams maintain the correct height.
- On bag dams, inspect the sandbag fabric for signs of deterioration.
- Ensure that contributing drainage area has been completely stabilized before removing a temporary check dam.

Additional Resources

EPA (US Environmental Protection Agency). 2014. *Check Dams*. Water: Best Management Practices. *http://water.epa.gov/polwaste/npdes/swbmp/Check-Dams.cfm*

BMP 62: Temporary Stream Crossing

Description

A temporary stream crossing provides a safe and stable means for construction vehicles to cross streams or watercourses without moving sediment into streams, damaging the streambed or channel, or causing flooding. A bridge or culvert allows construction vehicles temporary access across a stream or watercourse (Figure 149).

Figure 149. Temporary stream crossing using culverts (Ohio EPA 2014).

Applicability

A temporary stream crossing is used when heavy equipment must be moved from one side of a stream channel to another, or where light-duty construction vehicles have to cross the stream channel frequently for a short time period. Temporary stream crossings should be installed only when it is necessary to cross a stream and alternative routes to access the site are not feasible or a permanent crossing is not feasible or not yet constructed.

The specific vehicle loads and conditions of the stream will dictate the type of stream crossing that is appropriate.

Bridges are the preferred method to cross a stream as they provide the least obstruction to flows and fish migration.

Culverts are relatively easy to construct; a pipe (or pipes) can be placed in the channel and covered with aggregate. Temporary culverts can result in disturbance to the channel during construction and removal.

Limitations

- Temporary bridges may be expensive to install.
- Culverts cause greater disturbance during installation and removal. In sensitive stream systems, these impacts may not be justifiable.

Primary BMP Functions and Controls

☒ Construction	☐ Permanent
☐ Erosion Control	☒ Sediment Control
☐ Source Control	☒ Flood Control
☐ Filtration	☐ Infiltration

Typical Effectiveness for Targeted Pollutants

●	Sediment
○	Phosphorus
◖	Metals
○	Bacteria
◖	Hydrocarbons
○	Litter

Other BMP Considerations

Relative Cost	$$
Maintenance Requirements	Easy
Ease of Installation	Hard
Freeze/Thaw Resistance	Good
Max. Tributary Drainage Area	5 acres
Max. Upstream Slope	25%
NRCS Soil Group	ABCD
Min. Ground Water Separation	N/A
Min. Bedrock Separation	6 feet

- Always attempt to minimize or eliminate the need to cross streams. Temporary stream crossings are a direct source of pollution so make every effort to use an alternate method such as a longer detour. When it is necessary to cross a stream, a well-planned approach minimizes damage to the streambank and reduces erosion.

Using stream crossing measures below the high-water mark of a stream or other water body considered a water of the United States should be carefully evaluated for local, state, and federal permit requirements. All necessary permits must be obtained before commencing work within the water body.

Design Basis

In-stream excavation should be limited to what is necessary to install the temporary bridge or culvert as described below:

General

- Locate the temporary crossing where the least soil disturbance will occur in the existing waterway banks. When possible, locate the crossing at the point receiving minimal surface runoff.
- Locate culverts and bridges so a direct line of approach exists at both the entrance and exit. Do not allow abrupt bends at the entrance or exit unless suitable erosion protection is provided.
- Align the centerline of both roadway approaches with the crossing alignment centerline at a minimum distance of 50 feet from each bank of the waterway being crossed. If physical or right-of-way restraints preclude the 50 feet minimum, provide a shorter distance. All fill materials associated with the roadway approach should be clean rock (nonerodible) and limited to a maximum height of 2 feet above the existing floodplain elevation.
- Construct a water diverting structure such as a swale (across the roadway on both roadway approaches) 50 feet (maximum) on either side of the waterway crossing. This structure will prevent roadway surface runoff from directly entering the waterway. Measure the 50 feet from the top of the waterway bank. Design the diverting structure according to the BMP fact sheet in this catalog for the individual design standard chosen. If the roadway approach is constructed with a reverse grade away from the waterway, a diverting structure is not required.
- Ensure all crossings are as narrow as practical to provide safe passage of equipment and minimize the impact to the streambank and riparian vegetation.
- Remove all temporary crossings within 14 calendar days after the structure is no longer needed.

Materials

- Use only clean rock (3/4 inch to 4 inches). Do not use erodible fill, such as earth or soil materials, for construction within the waterway channel.
- Use filter cloth, consisting of either woven or nonwoven plastic, polypropylene, or nylon, to distribute the load, retain fines, increase drainage of the aggregate, and reduce mixing of the aggregate with the subgrade soil. Filter cloths should be used as required by the specific method.

Considerations for Choosing a Specific Type of Crossing

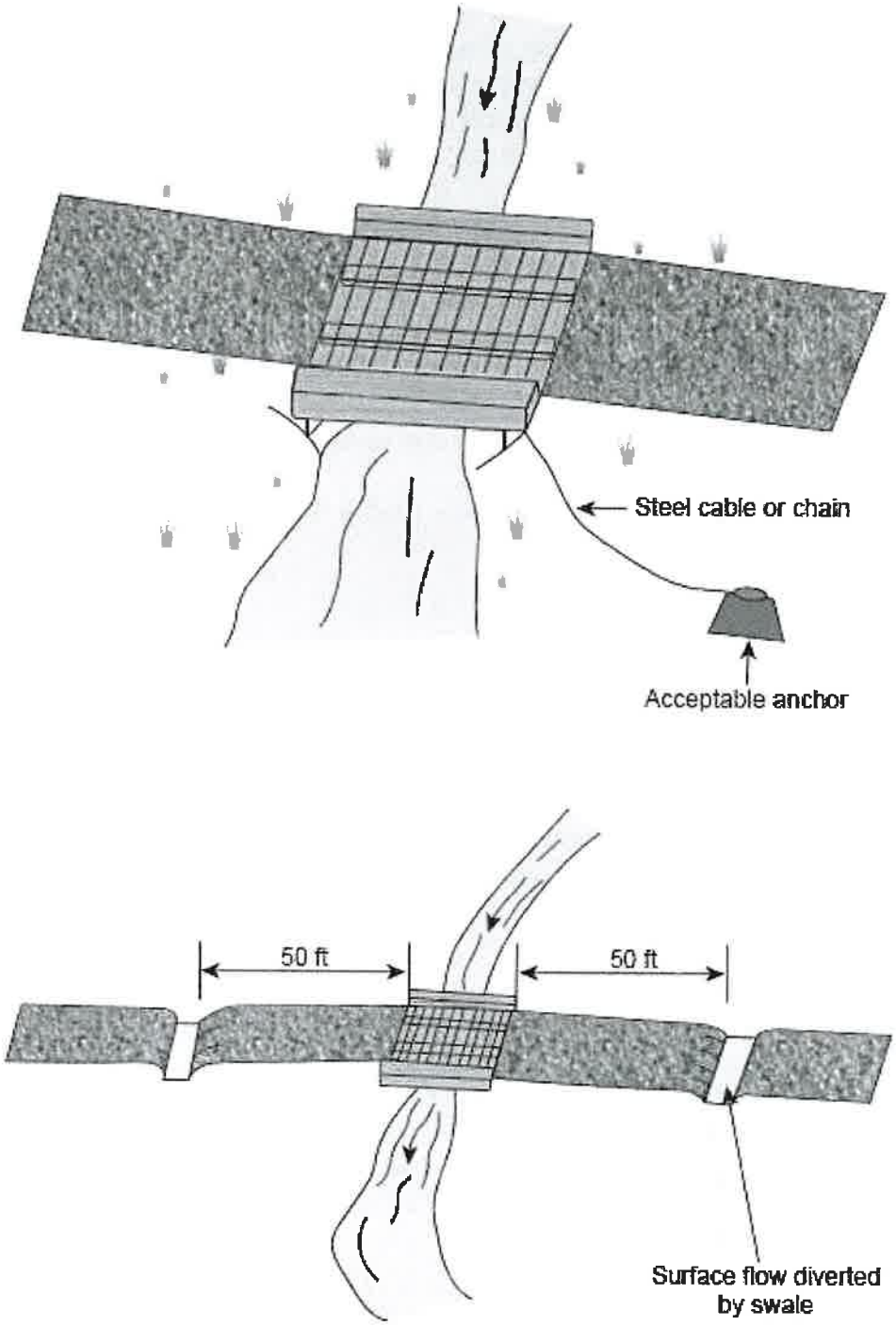
- Select a design that least disrupts the existing terrain of the stream reach. Consider the effort required to restore the area after the temporary crossing is removed.
- Locate the temporary crossing where the least soil disturbance will occur in the existing waterway banks. When possible locate the crossing at the point receiving minimal surface runoff.
- Consider that the physical constraints of a site may prevent selecting one or more of the standard stream crossings.
- Consider that the time of year may prevent selecting one or more of the standard stream crossings due to fish spawning or migration restrictions.
- Consider vehicular loads, traffic patterns, and crossing frequency when choosing a specific type of stream crossing.
- Keep in mind that crossings require various amounts of maintenance and bridges require the least maintenance.
- Consider that ease of removal and subsequent damage to the waterway are factors in the stream crossings chosen.

Temporary Bridge

- As the preferred method for waterway crossings, temporary bridge construction causes the least disturbance to the waterway bed and banks when compared to culverts or fords (Figure 150).
- Temporary bridges pose the least potential for creating barriers to aquatic migration. The construction of a temporary bridge or culvert should not cause a significant water level difference between the upstream and downstream water surface elevations.
- Most bridges can be quickly removed and reused.

Temporary Culvert

- A temporary access culvert is consists of a section of circular pipe, pipe arches, or oval pipes of reinforced concrete, corrugated metal, or structural plate used to convey flowing water through the crossing (Figure 151).
- Select culvert material and depth of cover based on the expected construction load.
- Temporary culverts are used when the channel is too wide for normal bridge construction, or the anticipated load may prove unsafe for single-span bridges.
- The length of the temporary culvert should extend a minimum of 1 foot beyond a stable side slope from the road crossing.
- Temporary culverts can be salvaged and reused.



Temporary Access Bridge

Figure 150. Temporary access bridge.

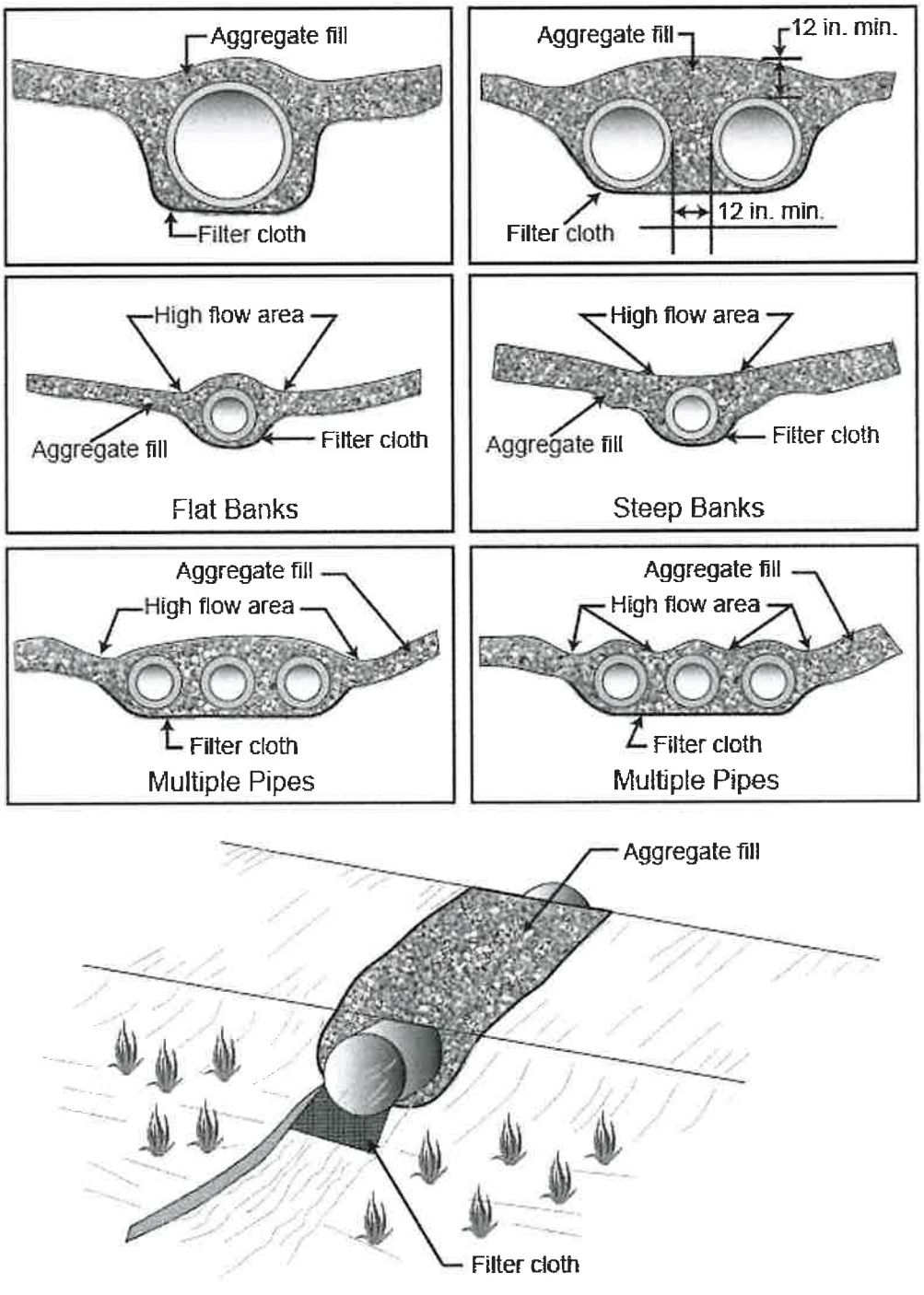


Figure 151. Temporary access culvert.

Construction Guidelines

Temporary Bridge

- Construction, use, or removal of a temporary access bridge will not normally have any time-of-year restrictions since construction, use, or removal should not affect the stream or its banks.
- Construct a temporary bridge structure at or above bank elevation to prevent entrapping floating materials and debris.
- Place abutments parallel to and on stable banks.
- Construct bridges to span the entire channel. If the channel width exceeds 8 feet (as measured from top-of-bank to top-of-bank), a temporary footing, pier, or bridge support may be constructed within the waterway. One additional footing, pier, or bridge support will be permitted for each additional 8-foot width of the channel. No footing, pier, or bridge support will be permitted within the channel for waterways less than 8-feet wide.
- Stringers should either be logs, sawn timber, prestressed concrete beams, metal beams, or other approved materials.
- Decking materials should be of sufficient strength to support the anticipated load. All decking members should be placed perpendicular to the stringers, butted tightly, and securely fastened to the stringers. Butt decking materials tightly to prevent any soil material tracked onto the bridge from falling into the waterway below.
- Run planking (optional) should be securely fastened to the length of the span. Provided one run plank for each track of the equipment wheels. Although run planks are optional, they may be necessary to properly distribute loads.
- Install curbs or fenders along the outer sides of the deck. Curbs or fenders are an option to provide additional safety.
- Securely anchor bridges at only one end using steel cable or chain. Anchoring at only one end prevents channel obstruction if floodwaters float the bridge. Acceptable anchors are large trees, large boulders, or driven steel anchors. Anchoring should be sufficient to prevent the bridge from floating downstream and possibly causing an obstruction to the flow.
- Stabilize all areas disturbed during installation within 14 calendar days of the disturbance.

Temporary Culvert

- All culverts must be strong enough to support the maximum expected loads.
- The size of the culvert pipe should be the largest pipe diameter that will fit into the existing channel without major excavation of the waterway channel or without major approach fills. If a channel width exceeds 3 feet, additional pipes may be used until the cross-sectional area of the pipes is greater than 60% of the cross-sectional area of the existing channel. The minimum culvert size used is a 12-inch diameter pipe.
- The culvert should extend a minimum of 1 foot beyond the upstream and downstream toe of the aggregate placed around the culvert. The culvert should never exceed 40 feet in length.
- Place filter cloth the streambed and streambanks before placing the pipe culvert and aggregate. The filter cloth should cover the streambed and extend a minimum 6 inches and

a maximum of 1 foot beyond the end of the culvert and bedding material. Filter cloth reduces settlement and improves crossing stability.

- Install the invert elevation of the culvert on the natural streambed grade to minimize interference with fish migration (free passage of fish).
- Cover the culvert with a minimum of 1 foot of aggregate. If multiple culverts are used, separate them by at least 12 inches of compacted aggregate fill.
- Stabilize all areas disturbed during culvert installation within 14 calendar days of the disturbance.

Maintenance

- Inspections should be performed periodically and after runoff events to ensure that the bridge, culvert, streambed, and the streambanks are in good condition and that sediment is not entering the stream or blocking fish passage or migration.
- Maintenance should be performed, as needed, to ensure that the structure complies with the standards and specifications, including removing and disposing of any trapped sediment or debris. The decking and curbs of bridges should be kept free of sediment. Sediment should be disposed of outside of the floodplain and stabilized. Areas adjacent to the crossing shall maintain vegetative stabilization.
- When the temporary crossing is no longer needed, all structures, including abutments and other bridging materials, should be removed within 14 calendar days. In all cases, the crossing materials should be removed within 1 year of installation or according to permit requirements.
- Final cleanup should consist of removing the temporary crossing from the waterway, removing all construction materials, restoring the original stream channel cross section, and protecting the streambanks from erosion. All removed materials should be stored outside the waterway floodplain.
- Removing the bridge or culvert and cleaning up of the area should be accomplished without construction equipment working in the waterway channel if possible. Otherwise, turbidity curtains (BMP 71) can be used to minimize downstream turbidity caused by bridge or culvert removal.
- All areas disturbed during removal should be stabilized within 14 calendar days of the disturbance.

Additional Resources

EPA (US Environmental Protection Agency). 2014. *Temporary Stream Crossings*. Water: Best Management Practices. *http://water.epa.gov/polwaste/npdes/swbmp/Temporary-Stream-Crossings.cfm*

BMP 63: Biofilter Bags

Description

Biofilter bags are plastic mesh bags filled with wood chips, compost, or similar biological material used as temporary sediment barriers. Biofilter bags detain storm water runoff and allow a slow rate of discharge to pass through the biological material, which allows sediment to settle and filters runoff. The bags may also be used to divert small amounts of runoff around active work areas or direct runoff to a slope drain, sediment trap, or other filtration/sedimentation BMP (Figure 152).

Figure 152. Compost filter socks used to slow and filter runoff.

Applicability

Biofilter bag barriers are an effective temporary measure that can be rapidly deployed at storm drain inlets, across minor swales and ditches, as diversion dikes and berms, along property lines, to reduce energy from concentrated flow, and for other applications where a temporary barrier is needed and structural strength is not required. These barriers are versatile and can be constructed in many combinations to achieve the required structure.

These are common locations to place biofilter bag barriers:

- At the toe of embankment slopes
- As filter cores for log check dams
- In front of silt fences
- As check dams in unlined ditches
- Surrounding inlets along paved streets (BMP 74: Inlet Protection)
- Around temporary stockpile areas
- Parallel and upgradient of roadways to keep sediment from paved areas

Primary BMP Functions and Controls

☒ Construction	☐ Permanent
☒ Erosion Control	☒ Sediment Control
☐ Source Control	☐ Flood Control
☒ Filtration	☐ Infiltration

Typical Effectiveness for Targeted Pollutants

◖	Sediment
○	Nitrogen
○	Phosphorus
○	Metals
○	Bacteria
○	Hydrocarbons
◖	Litter

Other BMP Considerations

Relative Cost	$
Maintenance Requirements	Low
Ease of Installation	Easy
Freeze/Thaw Resistance	Fair
Max. Tributary Drainage Area	NA
Max. Upstream Slope	10%
NRCS Soil Group	ABCD
Min. Ground Water Separation	NA
Min. Bedrock Separation	NA

Limitations

- Biofilter bags are barriers suitable only where flow rates are low (1 cfs or less).
- The bags have a limited life span and require regular inspections and repair and periodic replacement (approximately every 2–3 months).

BMP 65: Silt Fence

Description

A silt fence is a temporary sediment barrier created with a porous fabric stretched and attached to supporting posts. Woven wire fence backing is necessary with several types of filter fabric commonly used. The silt fence ponds sediment-laden storm water runoff, and the sediment is retained by settling (Figure 157).

Figure 157. Silt fence (York County Conservation District 2009).

Applicability

Silt fences can be used around the perimeter of a disturbed area to intercept sediment while allowing water to percolate through. The fences should remain in place until the disturbed area is permanently stabilized.

Silt fences can also be used along the toe of fills, on the downhill side of large through-cut areas, along streams, at grade breaks on cut/fill slopes, and above interceptor dikes.

Limitations

Silt fence is a popular BMP choice on construction sites, but to work effectively, it must be properly designed, installed, and maintained.

Do not use silt fences where water concentrates in a ditch, channel, or drainageway or where soil conditions prevent the minimum fabric toe-in depth or minimum depth for installation of support posts. If concentrated flow occurs after installation, place rock berms or other corrective measures in the areas of concentrated flow.

Silt fences should not be used in places where vehicle or equipment crossing is expected.

Primary BMP Functions and Controls

☒ Construction	☐ Permanent
☒ Erosion Control	☒ Sediment Control
☐ Source Control	☐ Flood Control
☐ Filtration	☐ Infiltration

Typical Effectiveness for Targeted Pollutants

●	Sediment
○	Phosphorus
◖	Metals
○	Bacteria
○	Hydrocarbons
◖	Litter

Other BMP Considerations

Relative Cost	$
Maintenance Requirements	Medium
Ease of Installation	Easy
Freeze/Thaw Resistance	Good
Max. Tributary Drainage Area	0.25 acres/ 100 lineal feet
Max. Upstream Slope	33%
NRCS Soil Group	ABCD
Min. Ground Water Separation	2 feet
Min. Bedrock Separation	2 feet

Design Basis

Location

Proper placement and design of silt fence is critical to its effectiveness. Silt fence installed along a contour should have a maximum disturbed tributary drainage area of 10,000 ft^2 per 100 feet of fence with a maximum tributary slope length of 150 feet and a tributary slope gradient of 3:1. Longer and steeper slopes require additional measures, such as multiple rows of silt fence or other sediment control. Placement and length should also consider the maximum allowable slope lengths contributing runoff to a silt fence as listed in Table 35.

Table 35. Maximum allowable slope lengths.

Slope Steepness	Maximum Slope Length (feet)
2:1	50
3:1	75
4:1	125
5:1	175
Flatter than 5:1	200

Place the silt fence as close to the contour as possible, with the area below the fence undisturbed or stabilized. Long runs of silt fence should be avoided to limit opportunities for large areas of concentrated water. Extend each end of the silt fence upslope to prevent runoff from going around the end. Multiple J-hooks can be used to break up long runs and provide ministorage areas to pond small amounts of water.

The location and details for silt fence should be shown on the SWPPP map and contain the following minimum requirements:

- Type, size, and spacing of fence posts
- Size of woven wire fences
- Type of filter fabric used
- Method of anchoring the filter fabric
- Method of fastening the filter fabric to the fencing support

Materials

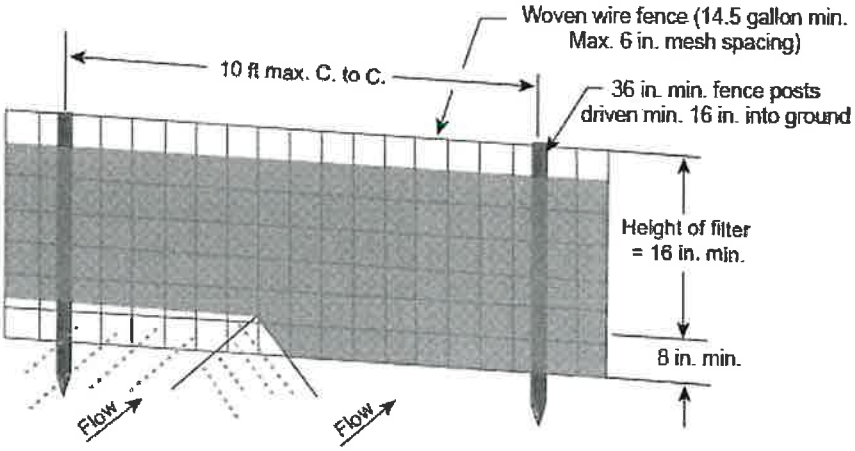
The filter fabric should meet specifications for silt fence materials included in ASTM D6461, unless otherwise approved by the appropriate erosion and sediment control plan approval authority. The fabric can be woven, nonwoven, or monofilament with a minimum width of 36 inches (Figure 158 and Figure 159).

Support posts should be 36 to 48 inches long and can be either wood or steel. Wood posts should be sound quality wood with a minimum cross-sectional area of 3 square inches, typically 2 x 2 inches nominal dimensions. Steel posts can be standard "T" or "U" sections weighing not less than 1 pound per linear foot. Steel posts can be easier to drive into compacted ground to a

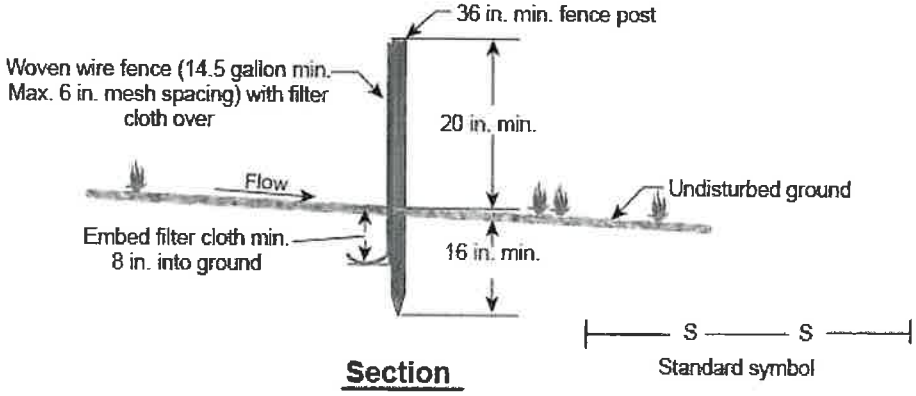
depth sufficient enough to hold the fabric up and support the horizontal load of retained water and sediment.

Woven wire fence can be used to help the silt fence withstand heavy rain or high wind events. Wire fencing should be a minimum 14.5 gage with a maximum 6-inch mesh opening, or as approved.

In lieu of constructing silt fence on site using the above recommended materials, prefabricated units can be used if installed per the manufacturer's instructions. Prefabricated fences do not allow for variable post spacing or posting after the ground is compacted.



Perspective View



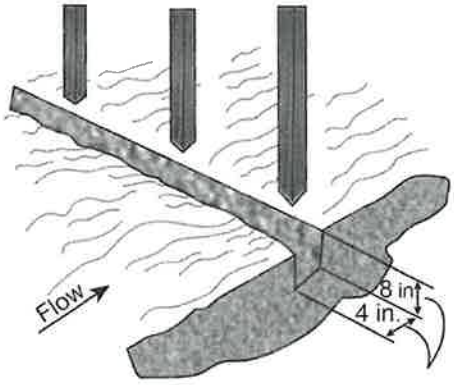
Section

Construction Notes for Fabricated Silt Fence

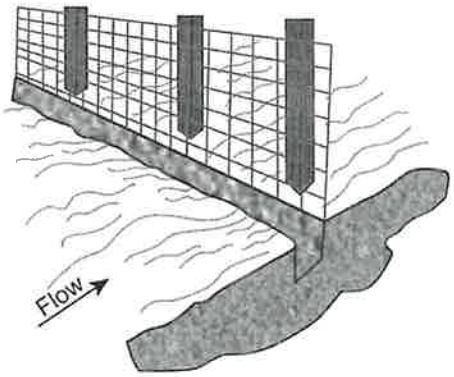
1. Woven wire fence to be fastened securely to fence posts with wire ties or staples.
2. Filter cloth to be fastened securely to woven wire fence with ties spaced every 24 in. at top and mid-section.
3. When two sections of filter cloth adjoin each other, they shall be overlapped by 6 in. and folded.
4. Maintenance shall be performed as needed and material removed when bulges develop in the silt fence.

Figure 158. Silt fence diagram.

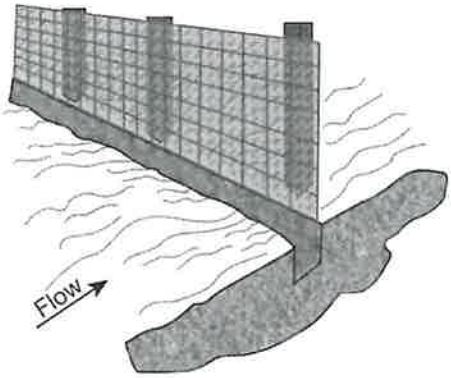
1. Set posts and excavate a 4 in. x 8 in. trench upslope along the line of the posts.



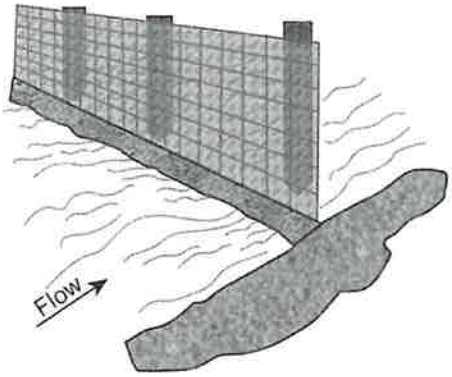
2. Staple wire fencing to the post.



3. Attach the filter fabric to the wire fence and extend it into the trench.



4. Backfill and compact the excavated soil and replace sod.



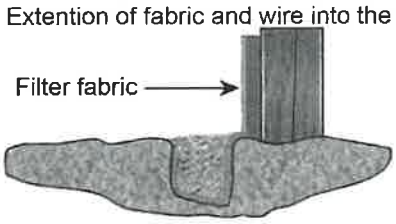


Figure 159. Silt fence construction diagram.

Construction Guidelines

Install the silt fence after cutting and slashing trees and before excavating haul roads, fill benches, or any soil-disturbing construction activity within the contributing drainage areas.

Silt fence can be installed using either the traditional trenching method or the static slicing method. The trenching method places the fence along a 6-inch wide x 8-inch deep trench; the fabric is keyed into the trench; and the trench is backfilled and compacted. To reduce sediment load, replace the vegetation or sod removed to create the trench.

The static slicing method uses a narrow blade pulled behind a tractor to create a 12-inch deep slit where the silt fence fabric is placed. Once the fabric is installed, the soil is compacted on both sides of the slit using tractor tires. The static slicing method achieves better performance with less time and effort than the trenching method (EPA 2012b).

Other guidelines for constructing and installing a silt fence include the following:

- Space posts 10 feet apart when a woven wire fence is used and no more than 6 feet apart when using extra-strength filter fabric (without a wire fence). Extend the posts a minimum of 18 inches into the ground, 24 inches if heavy sediment load is expected, and 30 inches if heavy wire-backed fencing is used. For prefabricated fencing, use the manufacturer's recommendations for post embedment depth.
- If standard strength filter fabric is used, fasten the optional wire mesh support fence to the upslope side of the posts using heavy duty wire staples, tie wires, or hog rings. Extend the wire mesh support to the bottom of the trench. Staple or wire the filter fabric to the fence.
- Extra strength filter fabric does not require a wire mesh support fence. Staple or wire the filter fabric directly to the posts.
- Do not attach filter fabric to trees.
- Where ends of filter fabric come together, overlap, fold, and staple the ends to prevent sediment bypass.
- Where joints in the fabric are required, splice it together only at a support post, with a minimum 6 inch overlap, and securely seal the joint.
- Extend the embedded filter fabric in a flap anchored by backfill to prevent the fabric from pulling out of ground.

Maintenance

Silt fences should be inspected periodically and after runoff events for damage (such as layover or tearing by wind, animals, or equipment) and for the amount of accumulated sediment. Remove the sediment when it reaches one-half the height of the silt fence. Where access is available, machinery can be used; otherwise, the sediment should be removed manually.

- Remove sediment deposits before heavy rain or when high water is anticipated.
- Place sediment deposits in an area protected by sediment and erosion control measures and where little danger of erosion exists.
- The life span of silt fence is generally 5 to 8 months. Remove and replace damaged silt fencing.
- If the silt fence has become clogged and no longer drains, replace it or install a second silt fence either above or below the original fence to collect additional sediment.
- Do not remove the silt fence until land-disturbing activities are completed and contributing drainage areas have been stabilized. Ensure the fabric is cut at ground level; remove the wire and posts and remaining sediment; and rake, seed, and mulch the area immediately.

Additional Resources

EPA (US Environmental Protection Agency). 2012. *Silt Fences*. Stormwater Best Management Practice. *http://www.epa.gov/npdes/pubs/siltfences.pdf*

BMP 71: Turbidity Curtains

Description

With the proper use of erosion and sediment control BMPs, sediment should not enter waters of the United States. However, for construction work that must occur within or immediately adjacent to a water body, the increase in turbidity should be addressed. Turbidity curtains, or silt curtains or particle curtains, contain and settle sediment within lakes, rivers, and other water bodies (Figure 173).

Figure 173. Sediment trapped inside a turbidity curtain.

A turbidity curtain consists of vertically suspended material that hangs from floats along its top and ballast weights at its bottom. The curtains can completely contain sediment and water within a specific area or prevent sediment from moving past the curtain, allowing time for suspended sediment to settle to the bottom of the water body.

Applicable federal, state, and local permits must be obtained before any construction within waters of the United States or use of a silt curtain where pollutants will be added to the water inside the curtain. A silt fence (BMP 65) or silt fence material ***cannot*** be used as a silt curtain; these two BMPs function very differently and are not interchangeable.

Primary BMP Functions and Controls

☒ Construction	☐ Permanent
☐ Erosion Control	☒ Sediment Control
☐ Source Control	☐ Flood Control
☐ Filtration	☐ Infiltration

Typical Effectiveness for Targeted Pollutants

●	Sediment
○	Phosphorus
○	Metals
○	Bacteria
○	Hydrocarbons
◖	Litter

Other BMP Considerations

Relative Cost	$
Maintenance Requirements	Low
Ease of Installation	Medium
Freeze/Thaw Resistance	Fair
Max. Tributary Drainage Area	N/A
Max. Upstream Slope	N/A
NRCS Soil Group	N/A
Min. Ground Water Separation	N/A
Min. Bedrock Separation	N/A

Applicability

Turbidity curtains can be used within rivers, streams, lakes, reservoirs, or other water bodies that are downstream or adjacent to projects that involve ground disturbance, dredging, or filling within or immediately adjacent to a waterway. Project examples include bridge construction, dam removal and restoration, or pipeline crossings.

Limitations

Do not install turbidity curtains within water bodies unless they are specifically engineered to withstand expected water velocity, wind and boat wakes, and

are approved by appropriate local, state, and/or federal authorities. The curtains are not recommended for operations in the open ocean.

Design Basis

Turbidity curtains should be designed and selected for specific site conditions. For sites with flow velocities or currents greater than 5 feet per second, a qualified engineer and product manufacturer should approve of the use (Figure 174).

Many proprietary turbidity curtains are available, and only curtains successfully field tested by the manufacturer should be used. Follow the manufacturer's recommendations for designing and deploying silt curtains. Many manufacturers and state transportation departments classify turbidity curtains into three categories:

- Type I—For small inland lakes, ponds, and canals with calm conditions and no current, sheltered from wind and waves
- Type II—For rivers, lakes, and streams with moving water and moderate current (velocities up to 3.5 feet per second) and/or moderate wind and wave action
- Type III—For nearshore ocean environments and tidal areas and rivers, bays, and lakes with strong currents and high velocities (up to 5 feet per second), and significant wind and wave action (more than 1 foot).

In still, shallow water not subject to wind or currents, the curtain should extend to a depth that allows at least 2 feet of clearance between the bottom of the curtain and the bottom of the water body and be anchored or staked. In moving water or where significant wind or wave action is present, a 10 to 12 foot depth is most practical, even in deep water. Curtains deeper than this can be subject to very large loads with consequent strain on the material and mooring system.

Materials should have ultraviolet light inhibitors and tensile strength sufficient to withstand predicted flows and a slippery surface that causes the sediment particle to slide down the length of the curtain. All material seams and line attachments should be sewn or vulcanized welded into place. Use materials with bright colors, when applicable, to alert boaters or swimmers recreating near the work site.

If hydrocarbons could be present, the turbidity curtain should have a line of oil sorbent boom placed parallel to the curtain for its full length. The floating sorbent boom can be anchored directly to the turbidity curtain to absorb any hydrocarbons before they can contact the curtain.

Flotation devices for turbidity curtains should be flexible, buoyant units contained in an individual flotation sleeve or collar attached to the curtain. If the curtain will be deployed for an extended period of time in an area frequented by waterfowl, floats should be enclosed in a material of sufficient weight to resist the efforts of geese to use the stuffing as nest material. The anchoring systems should be designed based on the anticipated conditions and anchored every 100 feet at a minimum (Figure 175). In areas with high wave action or high flows, anchors may need to be spaced at shorter intervals to prevent tangling. All anchors should have a floating anchor buoy or other identifying mark. A safe means should be available for workers to maintain the silt curtain because resetting the anchors and repairing the curtain are sometimes necessary. Navigation lights should be added if the curtain is to remain deployed all night.

Deployment of the silt curtain is as important as the curtain design. Due to dredging equipment, or currents, obstacles, or other factors, curtains cannot completely circle the project. Manufacturer recommendations on deployment should be followed given these circumstances; it should not be a trial and error process.

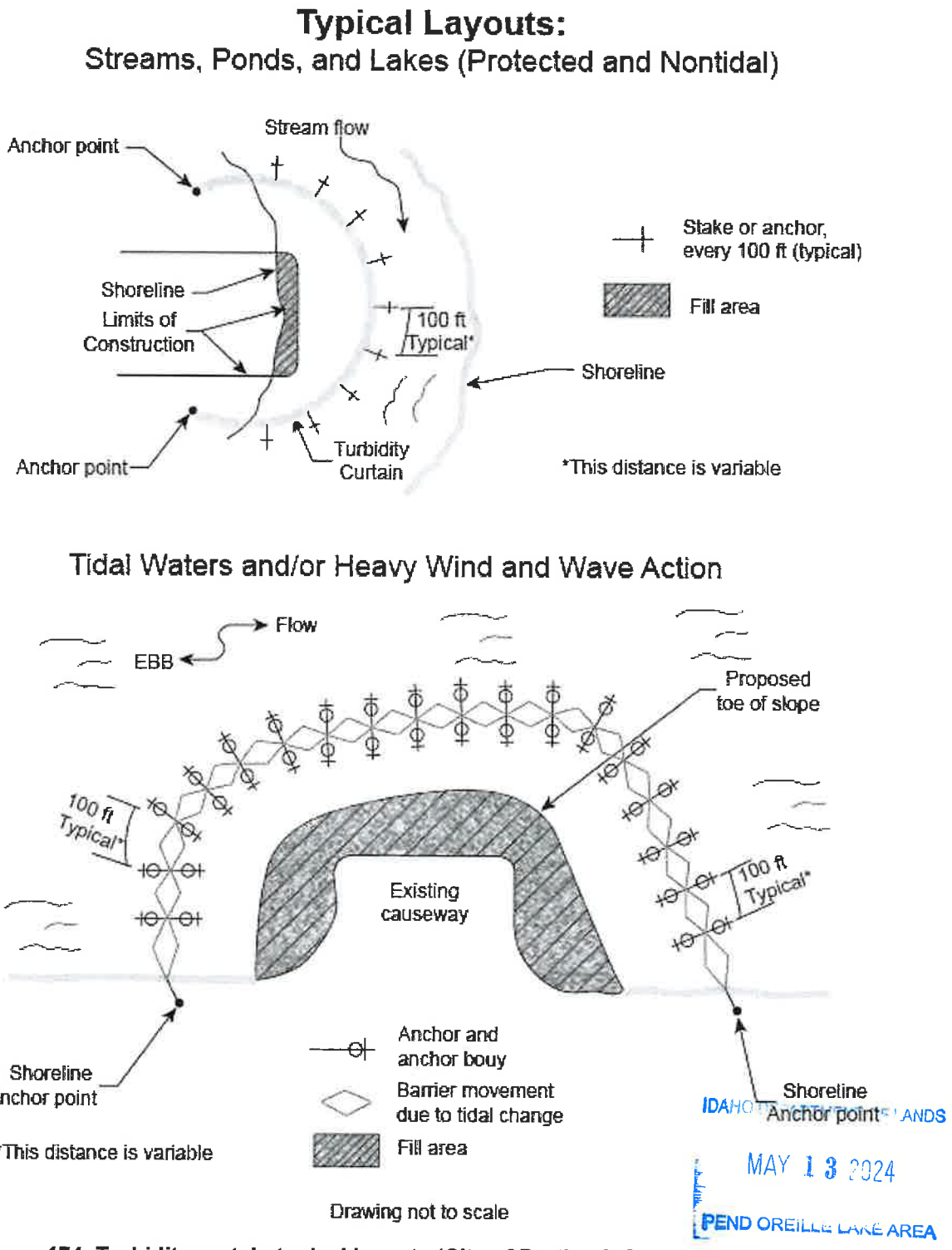


Figure 174. Turbidity curtain typical layouts (City of Portland, Oregon 2008).

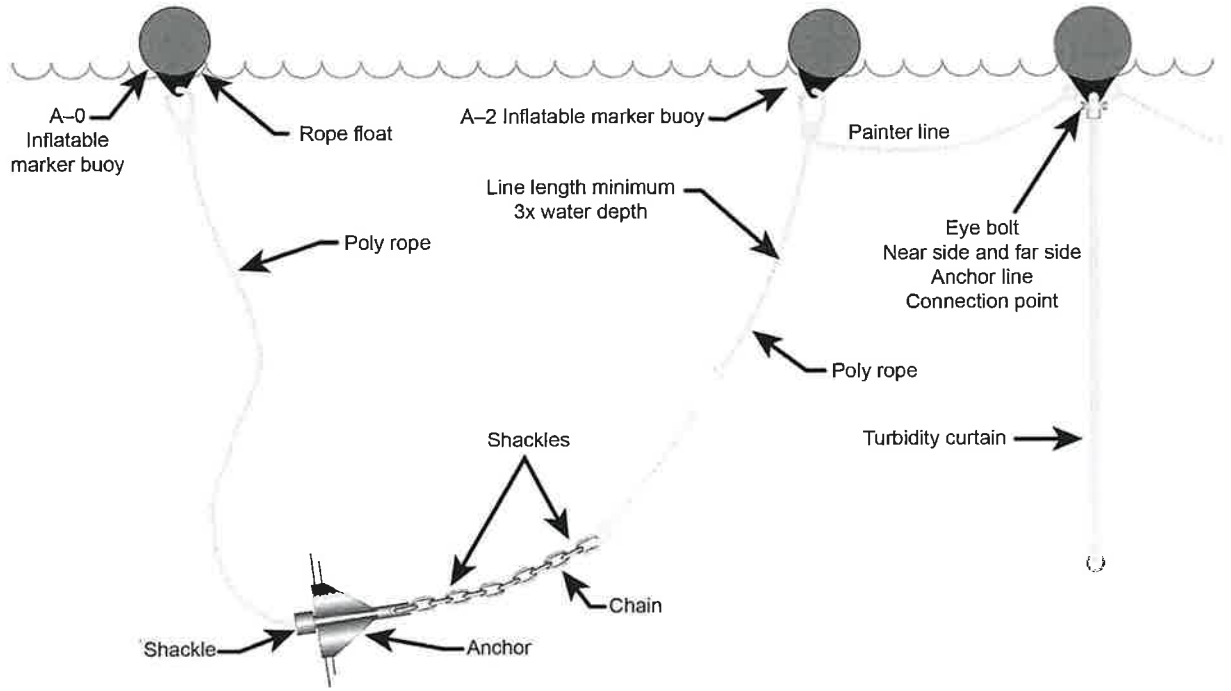


Figure 175. Turbidity curtain anchoring detail (*GEI Works*).

Construction Guidelines

Install turbidity curtains according to applicable permit requirements and follow the manufacturer's recommendations and guidelines for installation and safety measures.

Maintenance

Turbidity curtains should be inspected daily when construction is actively occurring or when it is located in a navigable water body. If turbid water is being released from a curtain, check the bottom anchors, joints, flotation, and material. Ensure the bottom of the curtain is not resting on the bed of the water body because sweeping motion created by wind and boat wakes can create a considerable amount of turbidity. Make repairs as needed, following the manufacturer's instructions for fabric and material repair. If repeated repairs are required for a curtain, the curtain strength relative to the flow velocity may need to be reevaluated or an alternative deployment strategy used.

When the project is finished, wait until the turbidity of the water inside the curtain matches the water outside of the curtain; the curtain can then be removed and cleaned before storage. All cleaning operations should use good sediment control practices to ensure the sediment does not reenter the waterway.

Remove turbidity curtains soon as the water within the curtain clears and matches the clarity of the water outside the curtain. Follow the manufacturer's recommendations for removal, and to prevent sediment resuspension, carefully pull the curtain towards the construction site. The removal area should be clear of any obstructions that could tear the fabric. Properly dispose of trapped sediment.

Additional Resources

City of Portland Oregon. 2008. *Erosion and Sediment Control Manual*. Portland, OR. *https://www.portlandoregon.gov/bds/article/94539*

Elastic/American Marine, Inc. 2015. *Turbidity Curtains*. Carmi, IL. *www.turbiditycurtains.com*

Illinois Urban Manual. 2012. "Silt Curtain-Floating." *Illinois Urban Manual Practice Standard. http://www.aiswcd.org/wp-content/uploads/2013/06/urbst9171.pdf*

Abasco. 2017. "Turbidity and Silt Curtain Installation." Sediment Control Products. Humble, TX. *https://www.abasco.com/turbiditycurtaininstallation.html*

BMP 72: Flocculation

Description

High levels of turbidity can significantly degrade the habitat quality of receiving waters for fish and other aquatic life. Flocculation using chemical treatment systems reduces turbidity in storm water by adding a chemical agent, or flocculant, that binds suspended soil particles together to form larger particles that are easier to settle out of the water.

Anionic polymers used with positive calcium ions can effectively flocculants reduce turbidity in storm water without harming aquatic life in the receiving water body. Chitosan is an example of a flocculation polymer; typical additives include DADMAC, gypsum, alum, and aluminum and iron chlorides.

The treatment chemicals used must comply with relevant federal, state, and local requirements. Cationic chemicals require special permitting; contact the appropriate EPA office for authorization. In the storm water management plan, document the chemicals to be used. Use only approved chemicals.

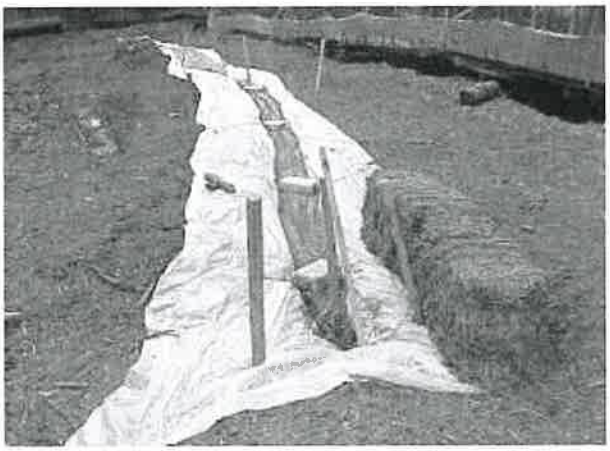


Figure 176. Floc logs located in channel (*Applied Polymer Systems*).

Primary BMP Functions and Controls

☒ Construction	☐ Permanent
☐ Erosion Control	☒ Sediment Control
☐ Source Control	☐ Flood Control
☐ Filtration	☐ Infiltration

Typical Effectiveness for Targeted Pollutants

- ● Sediment
- ◖ Phosphorus
- ◖ Metals
- ○ Bacteria
- ○ Hydrocarbons
- ○ Litter

Other BMP Considerations

Relative Cost	$$$
Maintenance Requirements	High
Ease of Installation	Medium
Freeze/Thaw Resistance	Good
Max. Tributary Drainage Area	N/A
Max. Upstream Slope	N/A
NRCS Soil Group	ABCD
Min. Ground Water Separation	N/A
Min. Bedrock Separation	N/A

Applicability

Flocculation is used at sites with fine-grained materials (i.e., clays and fine silts), which discharge to sensitive waters with turbidity limits that cannot be achieved using traditional BMPs. It can be used on sites where a sediment retention pond cannot be constructed to the required size due to space limitations or when a pond is not sufficient to control turbidity.

Flocculants are applied to sedimentation ponds or tanks, or applied to water flowing through a channel that empties into a sediment basin using flow-through devices (e.g., floc logs) (Figure 176). Flocculants should only be applied and the flocculated sediments removed from runoff before it enters the water body or used with a turbidity curtain in the receiving water body.

Limitations

Flocculation is not intended to be used as a stand-alone BMP and should be used with other erosion and sediment controls placed before and after the chemical treatment. For example, sediment basins (BMP 66), sand filters (BMP 12), geotextile sediment bags (BMP 53), or other sedimentation controls should be used downstream of a chemical treatment system to settle or filter out flocculated sediment.

Flocculation chemical treatment systems require a higher level of operator expertise and monitoring than other BMPs. Dosages can vary with each storm, treated waters may require pH adjustments, and the potential for aquatic life toxicity due to overdosing are just some complications that require special knowledge. The chemicals require proper storage and handling.

Design Basis

For flocculation to be effective, three fundamental processes must be present: chemical binding, settling, and floc collection. Designing polymer flocculation systems often involves using multiple BMPs that work well together. A specifically trained engineer or chemist should evaluate the chemical treatment system.

Chemical Binding

The key to the chemical binding process is selecting the right chemical flocculant with the proper dose and ensuring it is well mixed. Select chemicals based on the types of soils likely to be exposed during construction and the expected turbidity, pH, and flow rate of storm water flowing into the chemical treatment system or area. Petroleum-based polymers should not be used, and all chemicals must be nontoxic to aquatic organisms.

Hundreds of anionic polymers can be used; site-specific soil sampling and geotechnical analysis by a qualified professional is recommended to determine the most effective polymer or polymer blend and its reaction time. A specific chemical should be matched to specific soil type. Several tests are available to measure the dispersive characteristics of the soil ("Standard Test Method for Particle-Size Analysis of Soil" [ASTM D422], "Dispersive Characteristics of Clay Soil by Double Hydrometer" [ASTM D422-11], and "Standard Test Methods for Identification and Classification of Dispersive Clay Soils by the Pinhole Test" [ASTM D4647]). To be effective, the desired pH of the storm water for polymers is typically 6.5 to 8.5. Because polymers tend to lower the pH, the storm water must have sufficient buffering capacity, which is a function of its alkalinity.

An optimum dosage rate for every combination of sediment and chemical yields the lowest residual turbidity after settling. Increasing the flocculant application rate will not necessarily result in better performance. The chemicals should be used according to good engineering practices with dosing specifications and sediment removal specifications provided by the supplier. Mixing the flocculant into the water with the right amount of energy ensures proper dispersion and chemical binding. Too little energy input into the water during flocculation results in flocs that are too small; too much energy can destroy floc as it is formed. When using passive flocculants, such as floc logs, consult the manufacturer for recommended quantity and location.

Before use in the field, conduct jar tests (ASTM D2035) to demonstrate the turbidity reduction necessary to meet the water quality criteria of the receiving water can be achieved. Test conditions, including but not limited to raw water quality and chemical dosage, should indicate the field conditions. These small scale tests indicate potential treatment capability and the various chemical dose rates required for effective treatment.

Settling and Floc Collection

Downstream of the chemical treatment, a settling or collection system should remove the flocculated sediment; chemically treated storm water should not be directly discharged from the construction site (Figure 177). Before discharge, treated storm water should be sampled and tested for compliance with pH, flocculent chemical concentration, and turbidity limits. The pH should not be below 6.5 to avoid creating a toxic environment for aquatic organisms and should generally be within 0.2 standard units of the receiving water pH. Sampling and testing for other pollutants may also be necessary at some sites.

Because different chemicals require different mixing times and result in various floc sizes, settling rates vary. Settling can be facilitated within a sedimentation pond (BMP 25), a sedimentation tank (BMP 67), mechanical sand filters (BMP 12), or along a constructed channel that widens or becomes shallow to slow velocity. Floc collection can be accomplished using geotextile sediment bags (BMP 53), turbidity curtains (BMP 71), or sediment collection matting.

For batch treatment systems, the combination of the sediment basin or other storm water detention area and treatment capacity should be large enough to treat storm water during multiple day storm events. Bypass should be provided around the chemical treatment system and into a settling pond to accommodate extreme storm events. Primary settling should be encouraged in the sediment basin/storage pond. If the downstream water body does not have flow control requirements, it is recommended, at a minimum, the untreated storm water storage pond is sized to hold 1.5 times the runoff volume of the 10-year, 24-hour storm event. If flow control requirements are present, these will establish sediment basin size, volume, and drawdown design criteria. The simplest approach to sizing the treatment cell is to multiply the allowable discharge flow rate by the desired drawdown time.

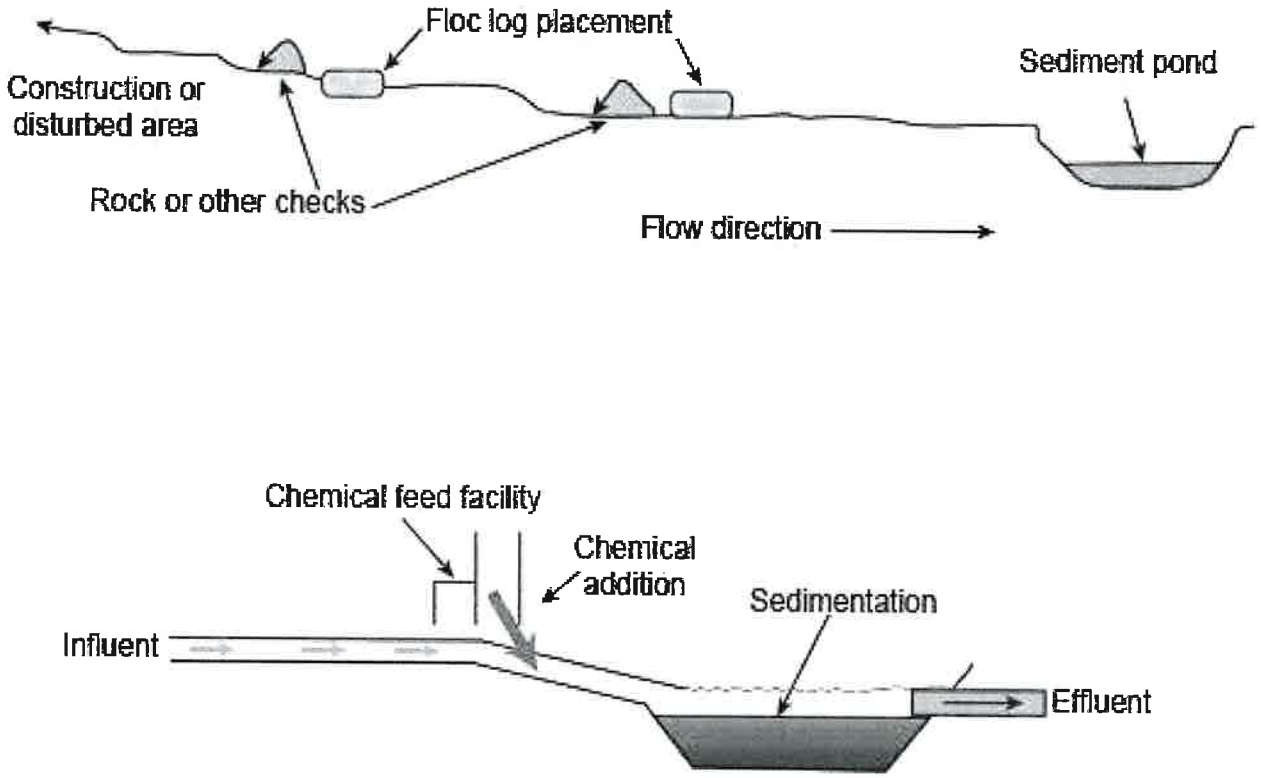


Figure 177. Schematic of chemical treatment along a channel using floc logs (top: *Applied Polymer Systems*) and chemical feed facility (bottom: CALTRANS 2010).

Construction Guidelines

Properly handle chemicals during construction and store in leak-proof containers under storm-resistant cover surrounded by secondary containment structures. Chemical treatment systems must be operated and maintained by properly trained individuals. All persons handling treatment chemicals must be trained in proper use, handling, and dosing. MSDS should be maintained visibly on site.

Maintenance

Chemical storage and dosing equipment must be inspected and maintained and the entire treatment system should be monitored continuously when in use. Monitoring reports and tests records should be kept on site; records include, but are not limited to, logs of pH conductivity, turbidity, temperature, rainfall, total volume treated and discharged, discharge time and flow rate, type and amount of chemicals used, residual chemical in treated water if it is to be discharged into a water body, and settling time.

Sediment sludge should be removed from the floc collection system or pond. Removal is typically required at least once during a wet season, or when the sediment collection area has reached one-third of its capacity. Large amounts of settled sediment in sedimentation basins can be collected and disposed of using excavation equipment. Removed sediment should be stabilized with

vegetation, disposed of at an approved site, or buried. Disposal and final stabilization of the flocculated materials should be planned for in advance and monitored during construction.

Additional Resources

CALTRANS (California Department of Transportation, Division of Construction). 2010. *Treatment BMP Technology Report*. Sacramento, CA. CTSW-RT-09-239.06. *http://www.dot.ca.gov/hq/env/stormwater/pdf/CTSW-RT-09-239-06.pdf*

EPA (US Environmental Protection Agency). 2013. *Polymer Flocculation.* Stormwater Best Management Practice. *http://www.siltstop.com/pictures/US%20EPA%20Polymer%20Flocculant%20Handout,%203-14.pdf*

FHWA (Federal Highway Administration). 2008. *Best Management Practices for Chemical Treatment Systems for Construction Stormwater and Dewatering*. FHWA-WFL/TD-09-001. *https://www.fhwa.dot.gov/innovativeprograms/pdfs/centers/local_aid/BestManagementPracticesforChemicalTreatmentSystems.pdf*

Washington State Department of Ecology. 2012. *Stormwater Management Manual for Western Washington.* Lacey, WA. Publ. 12-10-030. *http://www.ecy.wa.gov/programs/wq/stormwater/manual.html*

BMP 73: Dewatering

Description

Dewatering is used to control and appropriately dispose of ground water or rainwater from excavations or inundated areas. Both storm water and nonstorm water discharges are typically pumped to a dewatering BMP that removes sediment and treats the water as needed and then conveys or pumps it to a receiving water body or well-vegetated area. BMPs used with dewatering are sediment basins (BMP 66), portable sediment tanks (BMP 67), or dewatering filter bags (Figure 178).

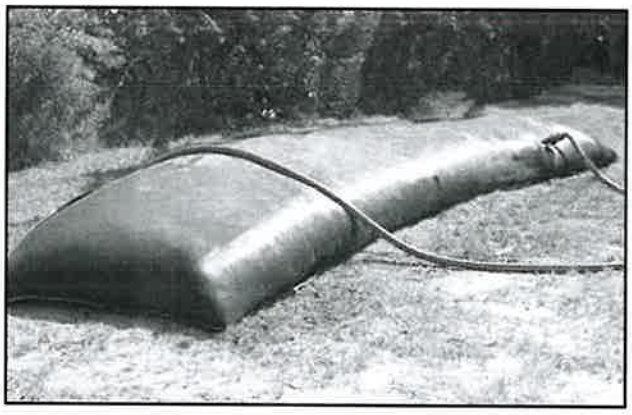


Figure 178. Bags used to filter silt and sediment from dewatering operations (*GEI Works*).

Dewatering discharge may require a permit or other authorization from the local drainage authority. Discharges to surface waters and ground waters must comply with IDAPA 58.01.02 and IDAPA 58.01.11. Permits from IDWR may also be needed.

Primary BMP Functions and Controls

☒ Construction	☐ Permanent
☒ Erosion Control	☒ Sediment Control
☐ Source Control	☐ Flood Control
☐ Filtration	☐ Infiltration

Typical Effectiveness for Targeted Pollutants

- ● Sediment
- ○ Phosphorus
- ○ Metals
- ○ Bacteria
- ○ Hydrocarbons
- ○ Litter

Other BMP Considerations

Relative Cost	$$$
Maintenance Requirements	High
Ease of Installation	Hard
Freeze/Thaw Resistance	N/A
Max. Tributary Drainage Area	N/A
Max. Upstream Slope	N/A
NRCS Soil Group	N/A
Min. Ground Water Separation	N/A
Min. Bedrock Separation	N/A

Applicability

Dewatering BMPs are applicable in the following types of locations:

- Construction sites saturated after a large storm event
- Excavations for building foundations
- Utilities, maintenance, and infrastructure installation and repair project sites:
  - Electrical conduits
  - Vaults/tanks
  - Sewer and storm drain systems
  - Phone and cable lines
  - Gas or other fuel lines
- Excavated sites or graded areas with existing conditions such as ponds and wetlands

Limitations

In Idaho, all dewatering activities regardless of the discharge volume require compliance with the "Water Quality Standards" (IDAPA 58.01.02). Dewatering operations for nonstorm water require and must

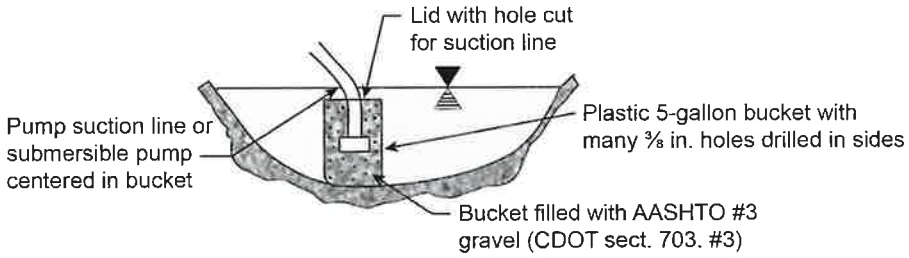
comply with applicable permits, local ordinances, and regulations. The presence of contaminated water requires coordinating with the local DEQ office and the local drainage authority to guarantee proper treatment and disposal.

Design Basis

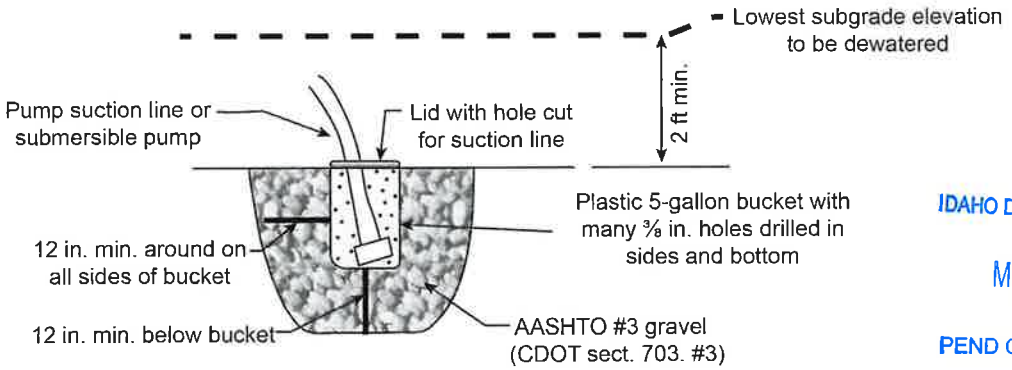
Dewatering BMP selection will vary on site topographic and geological conditions, anticipated discharge quantities, and discharge location. Dewatering discharges should be treated to remove sediment and any contaminants before discharging from the site. Depending on season, flow rate, volume, or residual contamination, the discharge may be allowed to flow to the following:

- The ground and vegetated areas in a manner that ensures no erosion or erosive runoff leaving the site, which may require a permit or other authorization from the local drainage authority.
- The storm drain system, which may require a permit or letter of authorization with discharge restrictions.
- The sanitary sewer, which may require a permit or letter of authorization with discharge restrictions.

Figure 179 illustrates methods for placing a pump to dewater a pond filled with water or using a submersible pump.



D-1. Dewatering Pond Already Filled with Water



D-1. Dewatering Sump for Submurged Pump

Figure 179. Dewatering for pond already filled with water (top) and dewatering sump for submerged pump (bottom) (Colorado UDFCD 2010).

Treatment

The site should be assessed for the issues listed below to assist the local drainage authority in determining which treatment and discharge option to approve:

- Perform a historical site assessment for soil and ground water records. If contaminants are suspected, the water should be tested by a certified laboratory. Results should be discussed with municipal and DEQ staff before any dewatering activities.
- If the water is cloudy or turbid, the dissolved and/or settleable solids in the water should be filtered or settled out before discharge. Evaluate geotechnical information on soil grain size distribution and hydrometer settling characteristics to select an appropriate filtration and sedimentation BMP.
- In addition to a review of water and/or soil laboratory results, determine if contaminants are present in impounded water by inspecting for odors, discoloration, and/or an oily sheen.
- If contaminants may be, or are present, a certified laboratory should test the proposed discharge waters with results submitted to the local drainage authority. Sampling and testing requirements will be determined on a case-by-case basis depending on site history or suspected pollutants. Contact DEQ or the local authority responsible for receiving water bodies or treatment systems before testing for assistance in identifying the required parameters of concern and any sampling requirements. After review, the local drainage authority will specify if any pretreatment is required before discharge.

To treat water that has been pumped from an inundated area, sedimentation BMPs such as a sediment trap (BMP 66) or a portable sediment tank (BMP 67) can be used. Settling tanks should contain sampling ports for potential contaminant analysis. Effluent should be allowed to settle in a sedimentation BMP for a minimum of 4 hours or until the water is clear (Figure 180).

In some cases, on-site chemical treatments may be required to facilitate removing clays and fine silts. Any use of chemicals to improve effluent water quality should have state and EPA approval before use. BMP 72: Flocculation provides more information on chemical treatment.

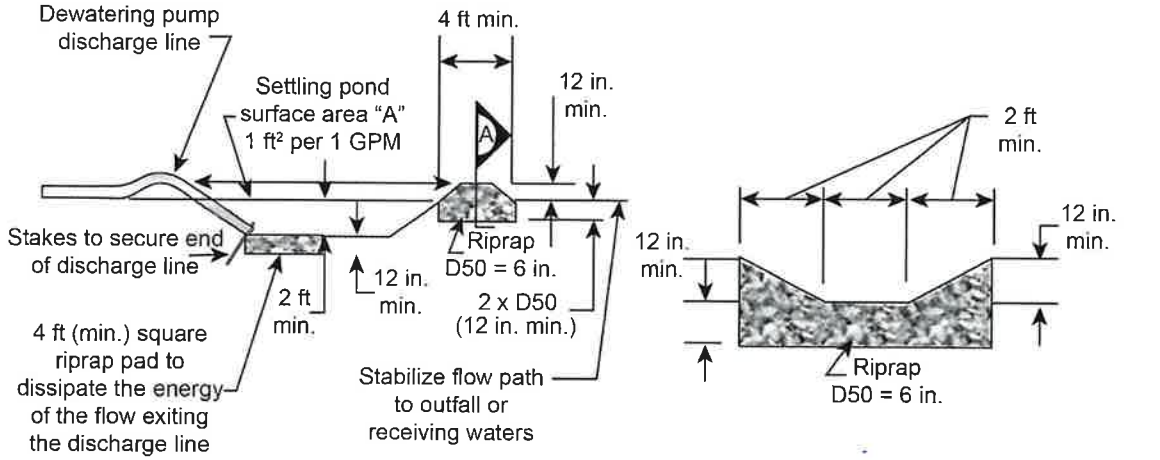


Figure 180. Sump discharge and settling basin (Colorado UDFCD 2010)

Filtering through a sieve or other filter media (swimming pool filter) may be an option for filtering construction dewatering operations. Simple on-site filter systems can be constructed including: wrapping the ends of the suction and discharge pipes with filter fabric; discharging through a series of drums filled with successively finer gravel and sand; and other filtering techniques like those described in BMP 74: Inlet Protection.

Portable tanks can be used to receive pumped water through the top of the tank, which then passes through a filter fabric that retains sediment and the filtered water is discharged through the bottom of the tank. Dewatering tanks can remove settleable solids, some visible oil and grease, some metals, and trash. The tank size depends on flow volume, constituents of concern, and residency period required.

A dewatering filter bag is a square or rectangular bag made of nonwoven geotextile fabric into which water is pumped (Figure 181). The filter bag collects sand, silt, and fines as filtered water seeps out. These systems do not always work on fine clay soils, and they should not be placed within water bodies or wetlands. Depending on site conditions and soil composition, additional downgradient erosion controls such as fiber rolls (BMP 64) or silt fencing (BMP 65) may be needed.

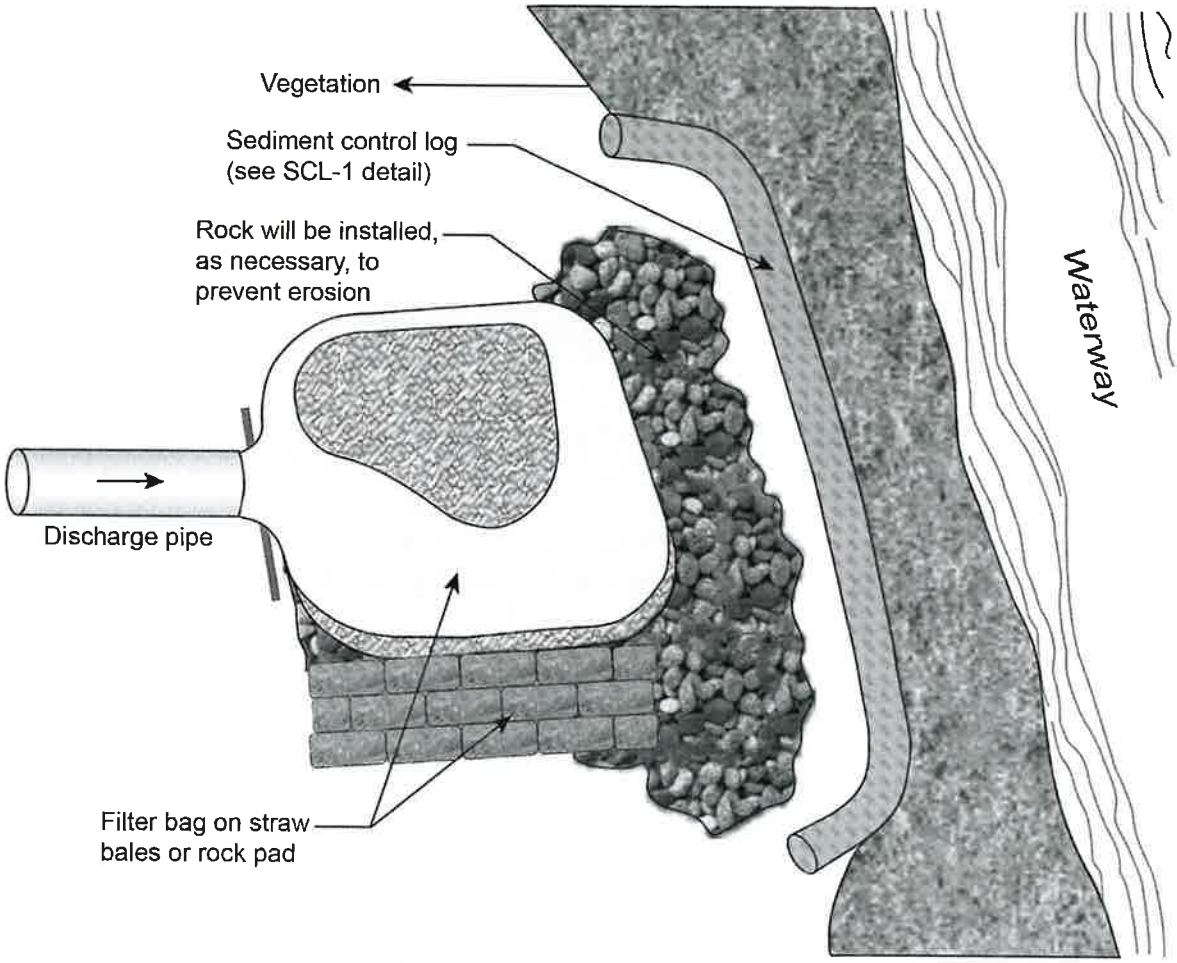
Construction Guidelines

Inspect and verify that dewatering BMPs are in place and functioning before dewatering activities begin. As part of the SWPPP, a dewatering plan should be submitted and reviewed by a certified professional engineer before dewatering-related work. The plan should detail the following:

- Location of dewatering activities and equipment, as well as discharge points
- Expected quantity of water to be discharged
- Pump capacity
- Any additional erosion and sediment control required at the point of discharge
- Water quality sampling locations (if required)

Maintenance

- Check the filtering devices daily to ensure they are unclogged and operating correctly. Maintenance and inspections of dewatering BMPs should be proactive and not reactive. Adjustments may be needed depending on the amount of sediment in the water being pumped.
- Systems should be filled in or otherwise removed when permanent dewatering controls are in place and connected to an approved treatment and receiving system.
- Sediment should be proactively removed from a sediment basin before the basin reaches half full to avoid high flows transporting previously settled material. Filtered sediment material should be dried and reused on site in a mixture with other site soils or should be appropriately disposed of based on composition and levels of contaminants present.



DW-4. Dewatering Filter Bag

Dewatering installation notes:

1. See plan view for:
   - Location of dewatering equipment.
   - Type of dewatering operation (DW-1 to DW-4).
2. The owner of contractor shall obtain a construction discharge (dewatering) permit from the state prior to any dewatering operations discharging from the site. All dewatering shall be in accordance with the requirements of the permit.
3. The owner or operator shall provide, operate, and maintain dewatering systems of sufficient size and capacity to permit excavation and subsequent construction in dry conditions and to lower and maintain the ground water level a minimum of 2–ft below the lowest point of excavation and continuously maintain excavations free of water until backfilled to final grade.

Figure 181. Dewatering filter bag (Colorado UDFCD 2010).

Additional Resources

CASQA (California Stormwater Quality Association). 2015. *California Stormwater Best Management Practices Handbook: Construction.* Menlo Park, CA. *https://www.casqa.org*

Colorado UDFCD (Colorado Urban Drainage and Flood Control District). 2010. *Urban Storm Drainage Criteria Manual, Volume 3 Best Management Practices*. Denver, CO. *http://udfcd.org/wp-content/uploads/2014/07/Title-Page.pdf*

Hazra and ODOT (Hazra Engineering Company and Oregon Department of Transportation, Geo/Environmental Section). 2005. *ODOT Erosion Control Manual: Guidelines for Developing and Implementing Erosion and Sediment Controls.*

ITD (Idaho Transportation Department). 2014. *Best Management Practices.* Boise, ID: ITD.

BMP 74: Inlet Protection

Description

Sediment and debris in storm water runoff from construction sites can clog storm water systems and contaminate downstream receiving water bodies. Inlet protection BMPs temporarily prevent sediment-laden runoff from entering storm drain inlets.

Figure 182. Inlet protection wattle (ITD 2014).

Inlet protection measures include abovegrade barriers (e.g., rock socks, sediment control logs, silt fence, gravel and mesh, or block and gravel), inserts (e.g., bags, racks, baskets, or *witch's hats* described in BMP 13: Catch-Basin Inserts), mats, and over excavations (Figure 182). Take care to not increase flooding with diverted flow from protected inlets.

Applicability

Inlet protection applies when sediment-laden runoff from a construction site threatens to enter an existing inlet or an inlet in place before permanent stabilization. Protection may include inlets in the general proximity of the construction area and is not limited to inlets on the construction site.

Limitations

Inlet protection is not a stand-alone BMP and should be used with other upgradient BMPs, especially in conditions of high flow or heavily laden sediment. Divert drainage areas greater than 1 acre to a sediment trap (BMP 66).

Some inlet protection methods, such as gravel and mesh filters and block and gravel filters, require significant space around the inlet and should not be used unless sufficient space is available to avoid a traffic hazard. Ponding around the inlet structure may also be a problem to traffic on site.

Inlet protection BMPs require a high level of maintenance to function properly. If sediment or other

Primary BMP Functions and Controls

☒ Construction	☐ Permanent
☒ Erosion Control	☒ Sediment Control
☐ Source Control	☐ Flood Control
☒ Filtration	☐ Infiltration

Typical Effectiveness for Targeted Pollutants

●	Sediment
○	Phosphorus
○	Metals
○	Bacteria
○	Hydrocarbons
◖	Litter

Other BMP Considerations

Relative Cost	$
Maintenance Requirements	High
Ease of Installation	Easy
Freeze/Thaw Resistance	Good
Max. Tributary Drainage Area	1 acre
Max. Upstream Slope	5%
NRCS Soil Group	ABCD
Min. Ground Water Separation	2 feet
Min. Bedrock Separation	2 feet

debris clogs the inlet and completely blocks flows, inlet control measures can cause localized flooding and erosion in unprotected areas.

Design Basis

Proper inlet protection design depends on inlet type and site configuration. When selecting the type of inlet protection BMP, consider factors such as type of inlet (e.g., curb or area, sump or on-grade conditions), traffic, anticipated flows, ability to secure the BMP properly, safety, and other site-specific considerations. To function correctly, inlet protection systems must ensure flow does not bypass the inlet and cause downstream erosion or flooding. The BMP should also not block flows from filtering into the inlet or catch basin.

Several types of inlet protection are presented below. Additional inlet protection systems and manufactured devices are available and may be selected for use as appropriate. The following design considerations can be applied to most inlet protection BMPs.

- Slope gradient—The drainage area should be fairly flat, with slopes of 5% or less. With filter fabric designs, the area immediately surrounding the inlet should not exceed a slope of 1%.
- Devices should be installed without inhibiting construction-related traffic or workers, or creating pedestrian hazards.
- Retrieval edges, cords, bars, chains, or other mechanisms should be flagged or marked for retrieval under submerged conditions.
- Ponding—Determine the extent of ponding and associated diverted flow expected at inlet protection locations. Both ponding and diverted runoff should not adversely affect construction-related activities or increase downstream erosion. Diverted flow can be managed through proper inlet protection placement and, where needed, additional erosion and sedimentation controls placed downstream of diverted flow.

Catch-Basin Inserts

Catch-basin insert filters (BMP 13) are available from manufacturers and are placed in the catch basin just below the grating. These inserts are a good choice along active roads with traffic and provide flow bypass without ponding around the inlet or creating a traffic hazard. Use these products according to the manufacturer's recommendations with fabrics and other materials sized to handle projected site runoff and sediment load.

Washed Gravel and Wire Mesh Filter

A washed gravel barrier using wire mesh and filter fabric is placed on top of a grate inlet (Figure 183). This structure does not provide an overflow.

- To achieve maximum trapping efficiency, orient the longest dimension of the basin toward the longest inflow area.
- Remove any obstructions to excavating and grading. Excavate sump area, grade slopes, and properly dispose of soil.
- Secure the inlet grate to prevent seepage of sediment-laden water.

- Place wire mesh over the drop inlet so the wire extends a minimum of 1 foot beyond each side of the inlet structure. Overlap the strips of mesh if more than one is necessary.
- Place filter fabric over the mesh, extending at least 1 foot beyond the inlet opening on all sides.
- Ensure that weep holes in the inlet structure are protected by filter fabric and gravel.
- Place stone or gravel over the fabric/wire mesh to, at least, 20 inches deep.

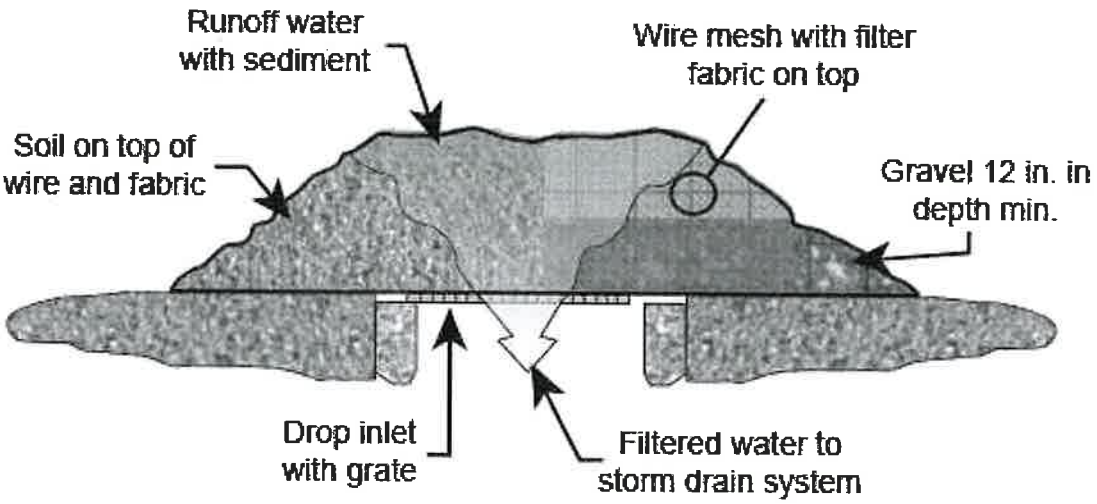


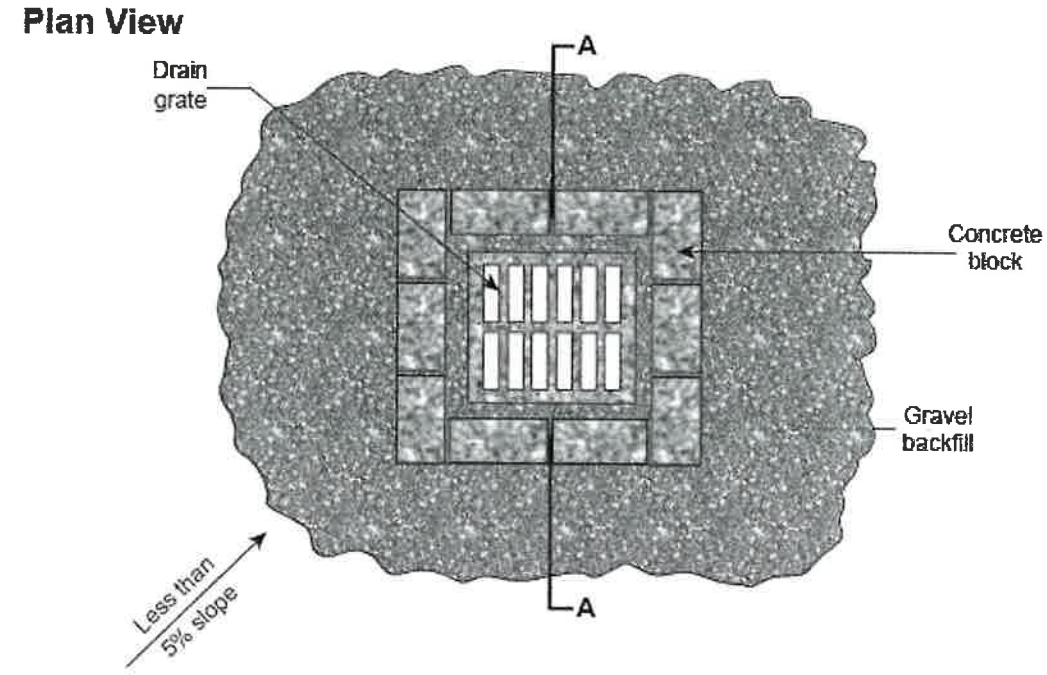
Figure 183. Washed gravel and wire mesh filter.

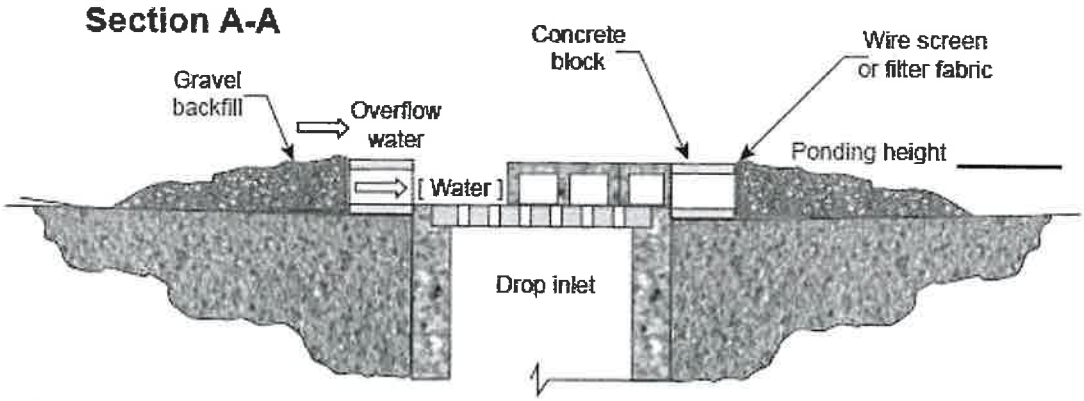
Block and Gravel Filter

The block and gravel filter is a barrier formed around a curb inlet with concrete blocks and gravel (Figure 184).

- Block and gravel filters can be used in areas of heavy flow, high velocities, and where overflow capability is needed.
- A block-and-gravel inlet protection device can be provided with an overexcavation sediment-trapping sump (Figure 184). The excavation should be 1 to 2 feet deep as measured from the crest or grate of the inlet. Side slopes should be 2:1 maximum. The recommended volume of excavation is 860 ft^3/acre of upgradient ground disturbed.
- To achieve maximum trapping efficiency, the longest dimension of the basin should be oriented toward the longest inflow area.
- Open ends of the block should face outward, not upward, with the ends of adjacent blocks abutting.
- On each side of the structure, lay one block on its side to allow for dewatering (BMP 73) of the pool if needed.
- The block barrier should be 1 to 2 feet high. Depending on block dimensions, the barrier may be placed 4 to 12 inches deep.
- Secure the inlet grate to prevent seepage of sediment-laden water.
- Place wire mesh over the drop inlet so the wire extends a minimum of 12 to 20 inches beyond each side of the inlet structure. Overlap the strips of mesh if more than one is necessary.

- Place filter fabric (optional) over the mesh and extend it at least 20 inches beyond the inlet structure.
- Place concrete blocks over the filter fabric in a single row lengthwise on their sides and flush with the edge of the inlet. Excavate the foundation a minimum of 2 inches below the crest of the inlet. The bottom row of blocks should be against the edge of the structure for lateral support.
- Before backfilling, place wire mesh over the outside vertical end of the blocks so that stone does not wash down the inlet.
- Place gravel against the wire mesh to the top of the blocks.





Notes:

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

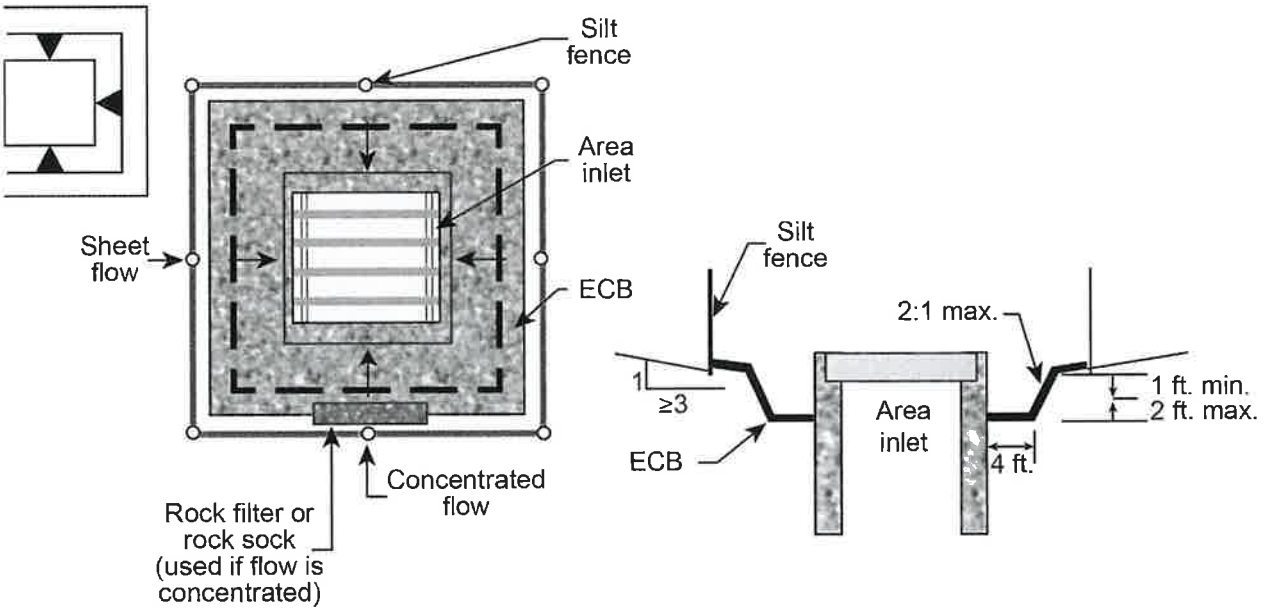
Figure 184. Block and gravel filter (King County 2009).

Swale or Overexcavation Inlet Protection

Swale or overexcavations around an inlet create a sediment-trapping pool that removes sediments by settling and/or flow through a drainage structure protected by filter fabric.

- Excavate completely around inlet to a depth of 1 to 2 feet below notch elevation.
- If the inlet is not in a low point, construct a diversion dike (BMP 69) in the ditch line below it. The top of the dike must be at least 6 inches higher than the top of frame (weir).

- Drive a 2- x 4-inch post 1 foot into the ground at four corners of the inlet. Place nail strips between posts on the ends of the inlet. Assemble the top portion of the 2 x 4 frame using overlap joint shown in Figure 185. The top of frame (weir) should be 6 inches below the edge of the roadway or diversion dike (BMP 69) adjacent to inlet.
- Stretch wire mesh tightly around frame and fasten securely. Ends should meet at the post.
- Stretch the filter cloth tightly over the wire mesh, extending the cloth from top of the frame to 18 inches below the inlet notch elevation. Fasten securely to the frame. Ends should meet at the post, overlapped and folded, and fastened down.
- Backfill around the inlet in compacted 6-inch layers until the layer of earth is even with the notch elevation on the ends and top elevation on the sides.



IP-5. Overexcavation Inlet Protection

Instalation Notes:

1. This form of inlet protection is pimarily applicable for sites that have not yet reached final grade and should be used only for inlets with a relatively small contributing drainage area.
2. When using for concentrated flows, shape basin 2:1 ratio with length oriented towards direction of flow.
3. Sediment must be periodically removed from the overexcavated area.

Figure 185. Overexcavation inlet protection (Colorado UDFCD 2010).

Curb Inlet Protection

- Place a layer of washed stone in front of a curb inlet to filter runoff before entering the inlet.
- Attach a continuous piece of wire mesh to the 2 x 4 weir (measuring throat length plus 2 feet to either side) as shown in (Figure 186).
- Place a piece of approved filter cloth (such as 40–85 sieve) of the same dimensions as the wire mesh over the wire mesh and securely attach to the 2 x 4 weir.

- Securely nail the 2 x 4 weir to 9-inch long vertical spacers located between the weir and inlet face (maximum 6 feet apart).
- Place the assembly against the inlet throat and nail (minimum 2 feet) lengths of 2 x 4 to the top of the weir at the spacer locations. These 2 x 4 anchors should extend across the inlet top and be held in place by gravel-filled bags or alternate weight.
- Place the assembly so the end spacers are a minimum of 1 foot beyond both ends of the throat opening.
- Form the wire mesh and filter cloth to the concrete gutter and against the face of curb on both sides of the inlet. Place clean 2-inch stone over the wire mesh and filter fabric to prevent water from entering the inlet under or around the filter cloth.
- Ensure storm flow does not bypass inlet by installing temporary earth or asphalt dikes directing flow into inlet.

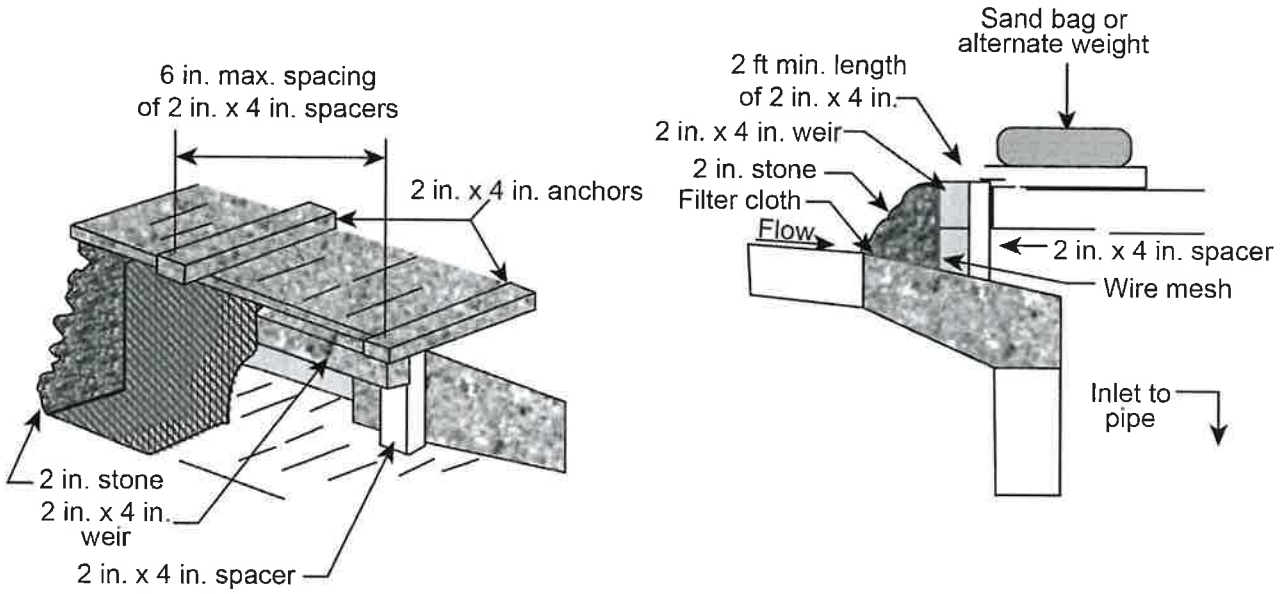
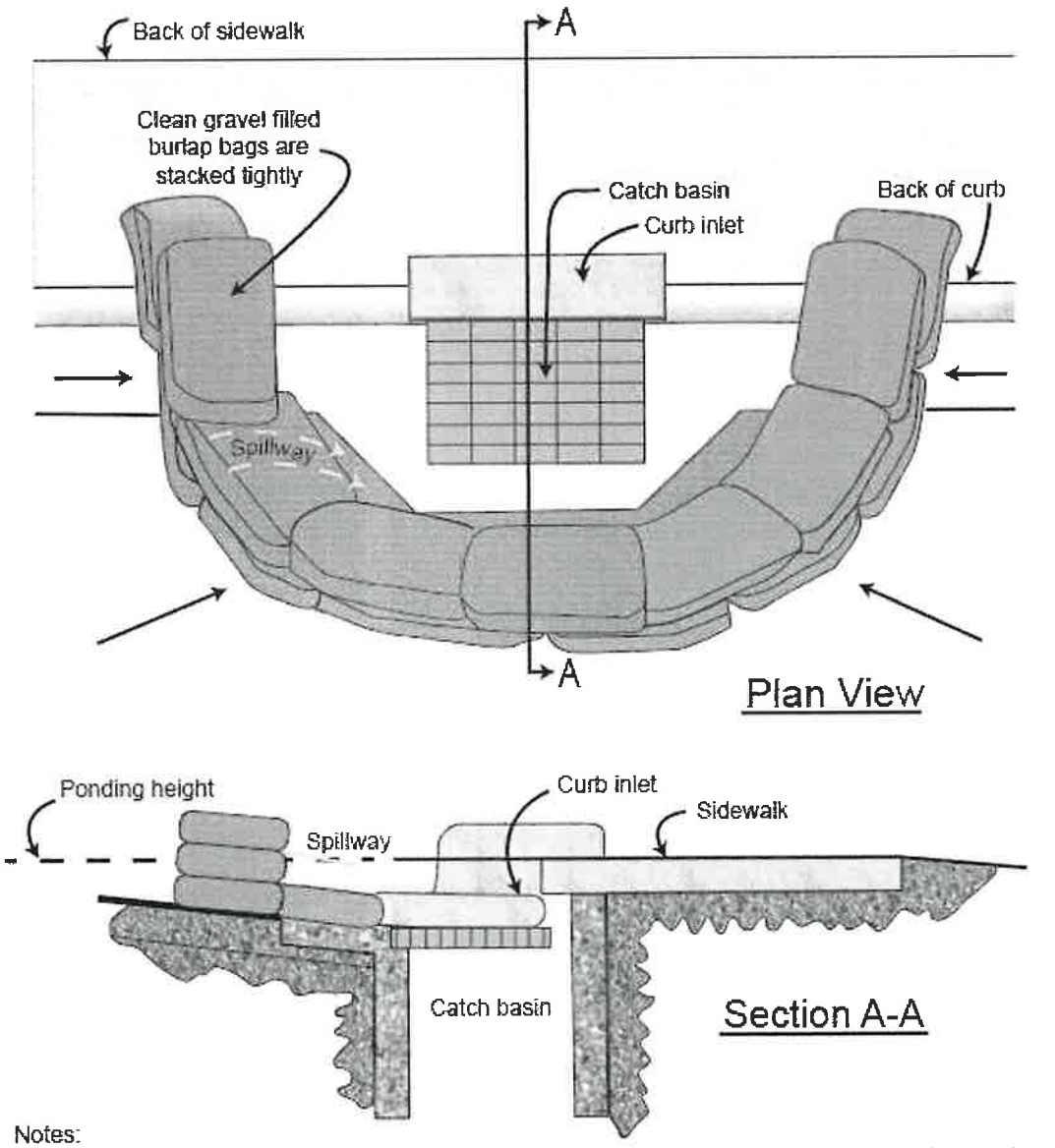


Figure 186. Curb inlet protection detail.

Rock Sock Inlet Protection

Rock socks are bags filled with washed gravel that can be placed around a sump inlet as shown in Figure 187.



Notes:

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

Figure 187. Rock sock inlet protection.

Construction Guidelines

Inlet protection devices should be installed around existing inlets before earth-disturbing activities begin. The type of inlet protection selected should consider if freezing conditions might be experienced during its use. Inspections and field adjustments may be necessary to ensure proper installation and performance.

Inlet protection should remain in place and operational up to 30 days after the drainage area is completely stabilized. Unless cleaned for reuse as a permanent site control or cleaned and left to biodegrade, all inlet inserts should be removed after construction is completed (or after site stabilization is established).

Maintenance

Inspect regularly and after every storm. Make any repairs necessary to ensure inlet protection measures are in good working order. Check for tears in filter fabric that allow untreated sediment-laden runoff to enter into the inlet.

Remove accumulated sediment and restore the trap to its original dimensions when sediment has accumulated to half the design depth of the trap. Remove sediment accumulations located upstream of inlet protection to maintain effectiveness. All sediments removed should be disposed of properly. On gravel-and-mesh devices, clean (or remove and replace) the stone filter if it becomes clogged.

Replace inlet inserts per manufacturer's instructions or when device no longer drains. At no time should devices be punctured or otherwise modified to bypass flows.

Additional Resources

CASQA (California Stormwater Quality Association). 2015. *California Stormwater Best Management Practices Handbook: Construction.* Menlo Park, CA. *http://www.casqa.org/.*

Colorado UDFCD (Colorado Urban Drainage and Flood Control District). 2010. *Urban Storm Drainage Criteria Manual, Volume 3 Best Management Practices*. Denver, CO. *http://udfcd.org/wp-content/uploads/2014/07/Title-Page.pdf*

EPA (US Environmental Protection Agency). 2011. *Storm Drain Inlet Protection. https://www.epa.gov/npdes/national-menu-best-management-practices-bmps-stormwater-documents*

Hazra and ODOT (Hazra Engineering Company and Oregon Department of Transportation, Geo/Environmental Section). 2005. *ODOT Erosion Control Manual: Guidelines for Developing and Implementing Erosion and Sediment Controls.*

ITD (Idaho Transportation Department). 2014. *Best Management Practices.* Boise, ID: ITD.

BMP 75: Street Sweeping

Description

Streets, roads, and highways accumulate potential storm water pollutants such as sediment, debris, trash, road salt, and trace metals. Street sweeping, if conducted properly, can reduce the pollutant load to receiving waters, reduce potential clogging of storm sewer systems and downstream BMPs, and control dust (Figure 188).

Figure 188. Regenerative air system sweeper for the City of Hayden, Idaho.

Applicability

Street sweeping can be used in most urban areas where sediment and litter accumulation is a concern. In cold climates, street sweeping used during ice-free periods and after the spring snowmelt removes the salt, sand, and grit applied to the roads throughout the winter. Permeable pavements (BMP 19) should be vacuumed with appropriate equipment as part of basic routine maintenance to ensure the pavement operates effectively.

Streets adjacent to an active construction site should be swept when necessary as part of the construction site storm water management plan. Construction sites should also take measures to control sediment track out (BMP 40: Vehicle Sediment Control) to limit the need for street sweeping.

Limitations

Street sweeping is not effective at removing oil and grease. Older mechanical sweepers are limited in ability to remove fine sediment, and sweepers with newer technology can be costly.

Design Basis

Three types of street-sweeping technologies are available: traditional mechanical sweepers that use a broom and conveyor belt, vacuum-assisted sweepers, and regenerative air sweepers that blast air onto the pavement to loosen sediment particles and vacuum

Primary BMP Functions and Controls

☐ Construction	☒ Permanent
☐ Erosion Control	☒ Sediment Control
☒ Source Control	☐ Flood Control
☐ Filtration	☐ Infiltration

Typical Effectiveness for Targeted Pollutants

●	Sediment
○	Phosphorus
◖	Metals
○	Bacteria
○	Hydrocarbons
●	Litter

Other BMP Considerations

Relative Cost	$$$
Maintenance Requirements	Medium
Ease of Installation	N/A
Freeze/Thaw Resistance	Good
Max. Tributary Drainage Area	N/A
Max. Upstream Slope	N/A
NRCS Soil Group	N/A
Min. Ground Water Separation	N/A
Min. Bedrock Separation	N/A

them into a hopper. For maximum particulate removal, sweepers should be operated at optimum manufacturer-recommended speeds and sweeping patterns, with brushes properly adjusted.

The various sweeping technologies are appropriate in different situations. In general, mechanical broom sweepers remove larger and heavier debris than other technologies and are better for removing construction debris and granular materials such as millings and gravel. Vacuum-assisted sweepers clean rough and potholed roadways and with extended nozzles can efficiently clean street gutters. A benefit of regenerative air sweepers is they do not vent or exhaust back into the atmosphere, but the debris must be small enough to be picked up. Some regenerative air sweepers also use water to control ambient dust and lubricate the impeller.

Schedule

A regular sweeping schedule is recommended with a minimum monthly sweeping of curbed streets during the nonwinter months when the streets are clear of snow. More frequent street sweeping may be needed depending on site conditions and in the vicinity of active construction sites. Complete street sweeping during dry weather. Wet cleaning or flushing of streets should be avoided; use dry methods where possible.

Street-sweeping schedules should be posted with signs along streets and on the municipality's website so that the public knows to not park cars along the street during designated sweeping days.

Consider increasing sweeping frequency based on factors such as traffic volume, land use, field observations of sediment and trash accumulation, and proximity to watercourses:

- Increase sweeping frequency for streets with high pollutant loads, especially in high traffic and industrial areas.
- Conduct street sweepings before the wet season to remove accumulated sediments.
- Increase the sweeping frequency for streets in special problems areas, such as streets around special events, areas of high litter, or high erosion zones.

To evaluate the effectiveness of a street-sweeping program, municipalities should maintain accurate logs of the number of curb-miles swept and the amount of waste collected.

Sweepings Storage and Disposal

Street sweeping material includes sediment, salt, trace metals, leaves, trash, and other debris. The collected sweepings contain pollutants that should be tested before disposal to determine if the material is hazardous. Municipalities must adhere to all federal and state regulations that apply to the sweeping's disposal and reuse.

The debris and dirt from street sweeping activities should be stored and disposed of properly. Swept material should not be stored along the side of the street or near a storm drain inlet. Keep debris storage to a minimum during the wet season or ensure debris piles are contained or covered.

Maintenance

Street-sweeping equipment should be regularly maintained and kept in good working order. Regularly inspect vehicles and equipment for leaks and repair promptly. Keep spare parts in stock to prevent downtime. Maintenance requirements may be greater for certain types of sweepers. Replace old sweepers with new technologically advanced sweepers, such as regenerative air sweepers, that maximize pollutant removal.

Additional Resources

CASQA (California Stormwater Quality Association). 2004. *Stormwater Best Management Practice Handbook: Municipal*. Menlo Park, CA. *http://www.casqa.org/*

EPA (US Environmental Protection Agency). 2017. *Parking Lot and Street Cleaning.*

BMP 76: Storm Water System Cleaning

Description

A storm water system is a network of gutters, catch °basins, inlets, pipes, and detention facilities that collect and convey storm water runoff to a receiving water body. Proper BMP implementation should prevent pollutants from entering the storm water system, but some common pollutants will be found in storm systems including trash and debris, sediments, oil and grease, antifreeze, paints, cleaners and solvents, pesticides, fertilizers, animal waste, and detergents (Figure 189).

Routine cleaning of the storm water system reduces the amount of pollutants that reach receiving waters, prevents clogging of drains and inlets, and ensures the system can function hydraulically to avoid flooding.

Figure 189. Cleaning a sediment trap.

Applicability

Storm water system cleaning should be done periodically on all storm water systems by the municipality or other responsible party, such as homeowner associations, businesses, landowners, or industries for systems located on private land.

Given special attention to portions of the storm water system with relatively flat grades or low flows because they rarely achieve high enough flows to flush out pollutants.

Limitations

The time and cost for storm water system cleaning can be significant. Communities may target recurrent problem areas or prioritize to determine what areas will be maintained and when they will be maintained.

Design Basis

A variety of jet/vacuum vehicles can be used to remove debris from storm water inlets and pipes. This equipment breaks up clogged/accumulated material with high-pressure water jets and vacuums

Primary BMP Functions and Controls

☐ Construction	☒ Permanent
☐ Erosion Control	☒ Sediment Control
☒ Source Control	☐ Flood Control
☐ Filtration	☐ Infiltration

Typical Effectiveness for Targeted Pollutants

●	Sediment
○	Phosphorus
◖	Metals
○	Bacteria
◖	Hydrocarbons
●	Litter

Other BMP Considerations

Relative Cost	$$
Maintenance Requirements	Medium
Ease of Installation	NA
Freeze/Thaw Resistance	Good
Max. Tributary Drainage Area	5 acres
Max. Upstream Slope	25%
NRCS Soil Group	ABCD
Min. Ground Water Separation	3 feet
Min. Bedrock Separation	6 feet

the material from the system. A variety of methods for cleaning inlets are available, including manual cleaning, vacuum cleaning, and vacuum combination jet cleaning.

Schedule

Storm water systems should be regularly inspected, with more frequent inspections during the wet season to check for problem areas where sediment or trash accumulates more often.

Storm water systems should be cleaned so blockage of storm pipe outlets is prevented. The sump in catch basins and inlets should not exceed 40%–50% of its storage capacity. There should never be less than 6 inches of clearance from the debris surface to the invert of the lowest pipe. Catch basins with very little storage volume may need more frequent inspections and cleaning.

Semiannual cleaning of systems in residential streets and monthly cleaning of systems in industrial streets are recommended. Schedule more frequent cleaning in the fall as leaves can contribute 25% of the nutrient load in inlets. Inspection and cleaning before the wet season is recommended.

Staff Training

Operators must be properly trained in inlet maintenance including waste collection and disposal methods. Staff should also be trained to report water quality problems and unauthorized nonstorm water discharges to the proper authorities. Evidence of illegal discharges or illicit connections to the storm water system include paint spills, oil sheen, and discoloring and odors.

Tracking

Accurate records of the number of catch basins cleaned and the amount of waste collected should be kept and may be required by MS4 or other permits held by the municipality. Track the location and maintenance of storm drains using a database and spatial referencing system (e.g., Global Positioning System or geographic information system). Knowing the type and era of the storm drain system can be useful because some inlets/catch basins are self-cleaning while others have some trapping capacity.

Use a recording system for tracking illegal dumping incidents and include the location, quantities, date and time, mode of dumping, and responsible parties (BMP 46: Spill Prevention and Control). Stenciling storm drains with messages such as "Dump No Waste – Drains to Stream" can prevent illegal disposal of pollutants.

Material Disposal

Most waste from storm system cleaning is of acceptable quality for landfills. If it is suspected that waste contains hazardous materials, it should be tested and disposed of accordingly. Water used in storm system cleaning should be collected and properly disposed of at a sanitary wastewater treatment facility.

Additional Resources

CWP (Center for Watershed Protection). 2009. *Urban Stormwater Restoration Manual Series 8: Municipal Practices and Programs.* Ellicott, MD.

EPA (US Environmental Protection Agency). 2017. *Storm Drain System Cleaning.* *https://www.epa.gov/npdes/npdes-stormwater-program*

BMP 77: Outdoor Storage

Description

Storm water can become polluted when contaminants in materials or liquids stored on-site wash off or dissolve into storm water runoff. If raw materials or liquids must be stored outdoors due to indoor space limitations, proper storage techniques can prevent or reduce the discharge of pollutants to storm water.

Contaminant prevention is achieved by reducing contact with storm water, installing safeguards against accidental releases, using secondary containment, conducting regular inspections, and training employees in safe handling and operating procedures and spill cleanup techniques.

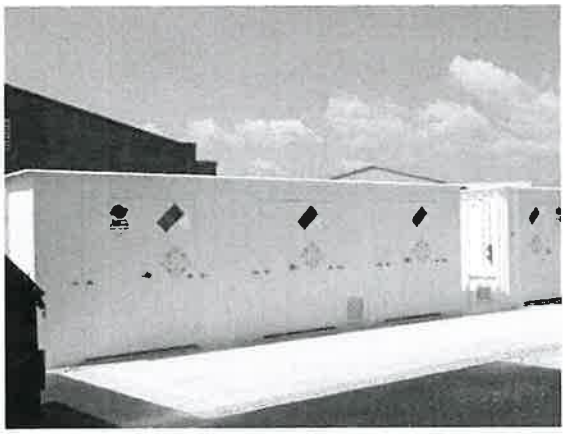


Figure 190. Outdoor storage of hazardous materials (*SafeSpace*).

Applicability

Proper outdoor storage should be used at all construction sites, industrial sites, commercial facilities, and municipal facilities when storing sensitive materials (Figure 190):

- Soil stabilizers and binders
- Fertilizers, pesticides, and herbicides
- Detergents and other cleaning compounds
- Building material and site waste
- Waste oils and petroleum-based products
- Solvents and liquids
- Construction equipment
- Asphalt and concrete compounds
- Hazardous wastes and materials
- Any substance detrimental to environmental conditions

Primary BMP Functions and Controls

☒ Construction	☐ Permanent
☐ Erosion Control	☐ Sediment Control
☒ Source Control	☐ Flood Control
☐ Filtration	☐ Infiltration

Typical Effectiveness for Targeted Pollutants

○	Sediment
○	Phosphorus
◖	Metals
○	Bacteria
◖	Hydrocarbons
○	Litter

Other BMP Considerations

Relative Cost	$$$
Maintenance Requirements	Medium
Ease of Installation	Hard
Freeze/Thaw Resistance	N/A
Max. Tributary Drainage Area	N/A
Max. Upstream Slope	N/A
NRCS Soil Group	N/A
Min. Ground Water Separation	N/A
Min. Bedrock Separation	N/A

Limitations

Tarps and temporary protective structures can be susceptible to wind damage. Permanent storage sheds should meet building and fire code requirements and may need a building permit before construction.

Accidental releases of materials from aboveground liquid storage tanks, drums, and dumpsters present

the potential for contaminating storm and ground waters with many pollutants. Properly training employees in spill cleanup procedures prevents contamination. This requires additional time and resources to educate employees.

Design Basis

Depending on location, materials, and storage capacity, some facilities may be covered by the SPCC rule and will be required to prepare and implement a SPCC plan. EPA provides more information at *http://www2.epa.gov/oil-spills-prevention-and-preparedness-regulations/overview-spill-prevention-control-and.* Use the following design approaches to protect materials from rainfall, run-on, runoff, and wind dispersal:

Storage Areas

- All sensitive materials should be covered at all times. Cover the storage area with a roof when possible.
- If material cannot be covered with a roof, protect the material with a temporary covering made of polyethylene, polypropylene, or hypalon, and secure it with weighted tires or sandbags.
- Locate outdoor storage areas on nonpermeable paved surfaces free of cracks and gaps, where possible.
- When sensitive materials cannot be located in a storage container or on a nonpermeable paved surface, line the soil or gravel with an impermeable barrier.
- A minimum slope of 1.5 % is recommended for outdoor storage areas to minimize water pooling on site. Minimizing water pooling is particularly important with materials that may leach pollutants into storm or ground water, such as compost, logs, and wood chips.
- Build a berm around storage areas to minimize storm water run-on and contain unexpected spills.
- Design the storm water system to minimize catch basins in the interior of the area as catch basins in the interior tend to fill rapidly with manufacturing material.
- Always have MSDS available for all materials detrimental to soil and/or water quality. The MSDS should include information on procedures for handling substances in a safe manner and information on physical characteristics, toxicity, reactivity, storage, disposal, and spill-handling procedures.

Container Management

To limit the possibility of storm water pollution, containers used to store dangerous waste or other liquids should be kept inside a building unless this is impractical due to site constraints. If the containers are placed outside, employ the following procedures:

- Place dumpsters used to store items awaiting transfer to a landfill in a lean-to structure or keep otherwise covered. Keep dumpsters in good condition.
- Tell employees to avoid dumping liquids in dumpsters and ensure dumpster lids are always closed.
- Place a fillet (radius) on both sides of the curb to facilitate moving the dumpster.
- Keep waste container drums in an area such as a service bay and ensure the drums have tight-fitting lids affixed at all times. If drums are kept outside, store them in a lean-to type

structure, shed or walled- in container to keep rainfall from reaching the drums. The storage area should have berms and be paved with an appropriate material.
- Label containers or tanks clearly.

Storage of Liquids

With the design approaches listed above, use the following measures to protect liquid in storage containers:

- Store hazardous materials to meet specific federal, state, and local standards. Some sensitive areas, such as source water protection zones, may require special containment.
- Use a *doghouse* shed for storing small liquid containers if the environment is appropriate. A doghouse shed consists of two solid structural walls and two canvas-covered walls. The floor is wire mesh and above secondary containment.
- Place tight-fitting lids on all containers. Secure drums stored in areas where unauthorized persons may gain access to prevent accidental spillage or unauthorized use.
- Liquid storage containers should be resistant to corrosion or damage from the materials stored for the duration of use on site.
- Berm or surround the tank or container with an appropriate secondary containment system with an impervious surface (see below).
- Place drip pans or absorbent materials beneath all mounted taps and at all potential drip and spill locations during filling and unloading.
- Place containers used for removing liquid in a containment area. Use a drip pan at all times.
- Install overflow protection devices to warn the operator or provide automatic shutdown of transfer pumps.
- Install protection guards (bollards) around tanks and piping to prevent construction vehicle damage.
- Label containers or tanks clearly.
- Install an oil and water separator, if necessary, in facilities with *spill ponds.* Facilities using spill ponds designed to intercept, treat, and/or divert spills should contact the appropriate regulatory agency regarding environmental compliance.
- Facilities storing reactive, ignitable, or flammable liquids should comply with fire codes. A SPCC plan may be required when storing contaminated or hazardous liquids on site.

Secondary Containment

Liquid storage tanks should be surrounded by a secondary containment system with an impervious surface. Leaks can be detected more easily and spills can be contained when secondary containment systems, such as berms, dikes, liners, vaults, or double-walled tanks, are installed. In an emergency, dikes can be used for controlling large spills or releases from liquid storage transfer areas.

Containment dikes are berms or retaining walls designed to hold spills. The dike surrounds the area and holds the spill, keeping spill materials separated from storm water. Containment dikes should be large enough to contain 100% of the volume of the largest container plus the amount of rainwater equal to a 25-year storm event. Diked areas used as secondary containment for vehicles containing liquid waste should be capable of holding an amount equal to the volume of the tank

truck compartment. The containment area design must include a means to remove uncontaminated storm water to maintain capacity and effectiveness.

Dike construction material should be impervious and strong enough to safely hold spilled materials. Dike materials consist of earth, concrete, synthetic materials, metal, or other impervious materials. Avoid using metal containers, concrete, and some plastics for dike materials if strong acids or bases will be stored outside. These dike materials could react with strong acids or bases if a spill occurs. More active organic chemicals may require special liners for dikes.

Curbing is common at many facilities in small areas where handling and transfer of liquid materials occur. Curbing is usually small scale and does not contain large spills like diking. Curbing can redirect contaminated storm water away from the storage area and can be used in areas where liquid materials are transferred from one container to another. Asphalt is a common material used for curbing; however, earth, concrete, synthetic materials, metal, or other impenetrable materials may also be used. Curbs should have manually controlled pump systems rather than common drainage systems to collect spilled materials. The curbed area should be inspected regularly to clear clogged debris and maintained frequently to prevent overflow of any spilled materials. Slope the liquid storage area, located inside the curb, to a drain. Install a dead-end holding tank in the drain for used oil or dangerous waste.

Construction Guidelines

All employees should receive training for properly handling outdoor material, liquid storage containers, and spill cleanup procedures. Employees should be familiar with the SPCC plan and have the tools and knowledge to immediately begin cleanup when a spill occurs. When dangerous waste, liquid chemicals, or other wastes are loaded or unloaded at the construction site, ensure properly trained employees are present.

Use engineering safeguards to reduce accidental releases of pollutants and prevent operator errors:

- Overflow protection devices on tank systems warn the operator to shut down transfer pumps when the tank reaches full capacity.
- Protective guards (bollards) around tanks and piping prevent vehicle or forklift damage.
- Clearly tag or label all containers, tanks, and valves.

Maintenance

Good maintenance practices are prevent storm water contamination from materials and liquids stored on site:

- Keep outdoor storage containers in good condition, check regularly for leaks, and ensure storage container lids are on tightly.
- Sweep paved storage areas monthly. Do not hose down areas contributing to storm drains.
- Store and maintain appropriate spill cleanup materials, such as brooms, dustpans, and vacuum sweepers, near the storage area.
- Schedule frequent waste collection to prevent overfilling storage containers.

Conduct the following inspections weekly or before storm events:

- Inspect for damage or cracks and repair or patch curbing as necessary.

- Check for accumulated rainfall in the secondary containment system (remove and discharge properly).
- Check for external corrosion and structural failure.
- Check for spills and overfills due to operator error.
- Check for failure of piping system (pipes, pumps, flanges, coupling, hoses, and valves).
- Check for leaks or spills when pumping liquids or gases from a truck or rail car to a storage facility or vice versa.
- Inspect new tank or container installation for loose fittings, poor welding, and improper or poorly fitted gaskets.
- Inspect tank foundations, connections, coatings, tank walls, and piping system. Look for corrosion, leaks, cracks, scratches, and other physical damage that may weaken the tank or container system. Correct problems or potential problems immediately.
- Inspect tanks, containers, and containment-holding tanks daily for leaks and spills. Replace leaking and/or deteriorating containers and collect all spilled liquids for proper disposal.
- Inspect tank systems and regularly test the tank's integrity to identify problem areas. Registered and specifically trained professional engineers can identify and correct potential problems such as loose fittings, poor welding, and improperly or poorly fitted gaskets on newly installed tank systems.
- During and after significant storms or spills, inspect dikes for washout or overflows.

Additional Resources

CASQA (California Stormwater Quality Association). 2015. *California Stormwater Best Management Practices Handbook: Construction.* Menlo Park, CA. *http://www.casqa.org/*

EPA (US Environmental Protection Agency). 2017. *General Construction Waste Management, Hazardous Waste Storage. https://www.epa.gov/hw/learn-basics-hazardous-waste*

Washington State Department of Ecology. 2012. *Stormwater Management Manual for Western Washington*. Lacey, WA. Publ. 12-10-030. *http://www.ecy.wa.gov/programs/wq/stormwater/manual.html*

BMP 78: Fertilizer Management

Description

Proper fertilizer application, storage, handling, and disposal prevent contamination of surface water and ground water and adverse impacts to aquatic life. Proper management also prevents increased algae growth in water bodies. Nitrogen and phosphorous are the fertilizer components of greatest concern to water quality (Figure 191).

Figure 191. Landscape fertilizing.

Applicability

Good fertilizer management applies to all locations in agricultural production or landscaping, including those maintained by municipalities, individual homeowners, businesses, commercial operations, or homeowner associations.

Limitations

Few limitations are associated with implementing proper fertilizer management practices. Some larger sites in agricultural production or areas with extensive landscaping may require employees trained specifically for managing these facilities. Other options include hiring agricultural or horticultural professionals to manage and maintain these facilities who know the proper use of fertilizers.

Fertilizer applied through an irrigation system (chemigation) has regulatory requirements including equipment inspection before use. For more information, visit the Idaho State Department of Agriculture (ISDA 2006) at *https://agri.idaho.gov/main/chemigation/*. These requirements are designed to protect the source of irrigation water, whether it is ground water, surface water, or a municipal water supply from contamination.

Primary BMP Functions and Controls

☒ Construction	☒ Permanent
☐ Erosion Control	☐ Sediment Control
☒ Source Control	☐ Flood Control
☐ Filtration	☐ Infiltration

Typical Effectiveness for Targeted Pollutants

○	Sediment
●	Nitrogen
●	Phosphorus
○	Metals
○	Bacteria
○	Hydrocarbons
○	Litter

Other BMP Considerations

Relative Cost	$
Maintenance Requirements	Low
Ease of Installation	N/A
Freeze/Thaw Resistance	N/A
Max. Tributary Drainage Area	N/A
Max. Upstream Slope	N/A
NRCS Soil Group	N/A
Min. Ground Water Separation	N/A
Min. Bedrock Separation	N/A

Design Basis

Within landscape areas, one of the best practices to reduce or eliminate the need for fertilizers is to use native and adapted vegetative species. These types of plants do not require additional fertilization because

they grow well in native soil without added fertilizers. Additionally, native and adapted plants require less water and irrigation, which reduces the potential for irrigation runoff water to transport chemicals off site.

For landscaping areas, agricultural fields, or residential gardens that do require replacing soil nutrients through fertilization, select the appropriate fertilizer type and apply it at the appropriate rate and time using the right method. Fertilizers should be selected based on the site's unique soil, plant, and climatic conditions to minimize the amount of nitrogen or phosphorous that is not used by plants and lost either through leaching or runoff.

Fertilizer Selection

Using the appropriate form of nitrogen fertilizer can reduce leaching to ground water sources. For example, nitrate forms of nitrogen fertilizer are readily available to plants but are subject to leaching losses. Nitrate forms should be used when plants are vigorously growing and can use the amount applied. Ammonium nitrogen fertilizers are not mobile because the ammonium form of nitrogen binds to soil particles and the plant roots have to reach the soil particle where the ammonium nitrogen is located. In warm and moist soil conditions, bacteria convert the ammonium nitrogen into the nitrate form, which takes a few days to a few weeks depending on the conditions. In addition, some types of ammonium nitrogen are subject to volatilization and significant losses may occur if not incorporated into the soil after application. Sources of organic nitrogen, such as compost or aged manure, are converted over time by soil microbes into forms available to plants, and are another fertilizer option to use.

Phosphorous fertilizers are less subject to leaching because most forms of phosphorus bind to the soil particles and do not move through the soil column. Surface water runoff that carries soil particles containing phosphorus into rivers or streams are a concern. To minimize phosphorous in surface runoff, use it only when needed as determined through soil testing and at the recommended rates.

Application Rate

Soils should be tested and evaluated for nutrient deficiencies every year to determine the amount of fertilizer needed for a particular location. In addition to soil characteristics, account for other sources that will contribute nitrogen and phosphorous to the soil. Sources of nitrogen include plants in the legume family, irrigation water, and organic matter. A portion of the soil organic matter is converted over time by soil microbes into forms of phosphorous and nitrogen that are available for the plant to use. It may take several years for the phosphorus and nitrogen contained in organic material to become *plant available*. For more information on fertilizer application see the *University of Idaho Extension* (2011).

Application Timing

The timing of fertilizer application is important. Fertilizers should ideally be applied during the time of year that is optimal for maximum vegetation uptake and growth. Generally, in the spring is best with small additional applications in certain areas throughout the growing season. When application practices allow the nitrate form to remain in the soil after the growing season, the nitrate can potentially leach into the ground water. Fertilizers should not be applied during high temperatures, windy conditions, or immediately before or during rainfall events.

Application Techniques

Use application techniques that increase efficiency and allow the lowest effective application rate. Fertilizer placement in the root zone enhances plant nutrient uptake and minimizes losses. Subsurface-applied or incorporated fertilizer should be used instead of surface application of fertilizer. Mechanically incorporate surface-applied fertilizers after application. Never apply fertilizers to frozen ground or near surface waters or storm water conveyance channels and limit use on slopes and areas with high runoff or overland flow.

Fertilizers should be applied according to the label instructions. Overapplying fertilizers can pollute surface water and ground water resources. Mix and load sprayers in an area with spill control in place.

Storage and Handling

Follow label directions for storing and mixing fertilizer and disposing of empty containers. Protect permanent fertilizer storage and mixing sites from spills, leaks, or storm water infiltration and locate them away from wellheads and surface water bodies.

Fertilizers should be stored in enclosed areas, in covered impervious containment (plastic sheeting or temporary roofs), or use a similarly effective means to prevent these chemicals from coming into contact with rainwater (BMP 77: Outdoor Storage and BMP 46: Spill Prevention and Control). MSDS should be readily accessible at all times.

Maintenance

Keep fertilizer application equipment properly calibrated according to the manufacturer's instructions and in good repair. For larger agriculture operations, recalibrate equipment periodically to compensate for wear in pumps, nozzles, and metering systems. Calibrate sprayers when new nozzles are installed.

Keep and review records to evaluate the effectiveness of pesticides used. Comply with all disposal requirements included on the registered fertilizer label.

Additional Resources

Colorado UDFCD (Colorado Urban Drainage and Flood Control District). 2010. *Urban Storm Drainage Criteria Manual, Volume 3 Best Management Practices*. Denver, CO. *http://udfcd.org/wp-content/uploads/2014/07/Title-Page.pdf*

EPA (US Environmental Protection Agency). 2001. *Source Water Protection Practices Bulletin: Managing Agricultural Fertilizer Application to Prevent Contamination of Drinking Water. http://nepis.epa.gov/Exe/ZyNET.exe/*

EPA (US Environmental Protection Agency). 2017. *Municipal Landscaping. https://archive.epa.gov/greenacres/web/html/index.html*

University of Idaho Extension. 2014. Idaho Master Gardener Program Handbook. 16th ed. Moscow, ID. *http://www.extension.uidaho.edu/mg/resources/handbook-MGHbook.pdf*

BMP 79: Pesticide Management

Description

Pesticides are used to control organisms considered to be pests and include herbicides, insecticides, fungicides, rodenticides, and others. Pesticides must be properly applied, stored, handled, and disposed of to prevent contamination of surface water and ground water (Figure 192).

Figure 192. Pesticide application.

Applicability

Good pesticide and herbicide management applies in all locations with landscaping, including those maintained by municipalities, individual homeowners, businesses, commercial operations, or homeowner associations.

Limitations

Some pesticides are categorized as *restricted use* pesticides because they are excessively hazardous to the environment or the applicator. These pesticides may only be used by a certified applicators licensed by the State of Idaho. EPA (2015) provides a list of restricted pesticides *http://www2.epa.gov/pesticide-worker-safety/restricted-use-products-rup-report*.

All pesticides are regulated by the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and any use of a pesticide in a "manner inconsistent with label instructions is a violation of this Act."

Design Basis

One of the best practices to reduce or eliminate the need for pesticides and herbicides is to use native and adapted vegetative species within landscape areas. Native and adapted plants require less water and irrigation, which reduces the potential for irrigation runoff water to transport chemicals off site. Many native plants are also naturally resistant to pests.

Primary BMP Functions and Controls

☒ Construction	☒ Permanent
☐ Erosion Control	☐ Sediment Control
☒ Source Control	☐ Flood Control
☐ Filtration	☐ Infiltration

Typical Effectiveness for Targeted Pollutants

○	Sediment
●	Nitrogen
●	Phosphorus
○	Metals
○	Bacteria
○	Hydrocarbons
○	Litter

Other BMP Considerations

Relative Cost	$
Maintenance Requirements	Low
Ease of Installation	N/A
Freeze/Thaw Resistance	N/A
Max. Tributary Drainage Area	N/A
Max. Upstream Slope	N/A
NRCS Soil Group	N/A
Min. Ground Water Separation	N/A
Min. Bedrock Separation	N/A

Pesticides and herbicides should be selected according to the characteristics of the site and the particular pest or weed. Half-life, solubility, and adsorption should be compared to site characteristics to determine the safest chemical. Pesticides should readily degrade in the environment and/or have properties that strongly bind it to the soil.

Application Guidelines

All pesticides, herbicides, and other chemicals should be applied according to the product label instructions. Avoid overapplying chemicals that can pollute surface water and ground water resources.

Pesticides and herbicides should not be applied during high temperatures, windy conditions, or immediately before or during rainfall events. Freshly treated wet applications should dry thoroughly before human or animal traffic enter the area. Mix and load sprayers in an area where spill control is in place.

Records and signage of pesticide application, emergency information, and pesticide safety may be required by EPA's Pesticide Worker Protection Standard: *https://www.epa.gov/pesticide-worker-safety/pesticide-worker-protection-standard-how-comply-manual*.

Owners of agricultural establishments and members of their immediate families are exempt from many worker protection requirements.

Local regulations may limit the application of pesticides around wells and surface water. Generally, pesticides should not be sprayed in proximity of open waters, including wetlands, ponds, stream, sloughs, or ditches, unless they are approved for use near wetlands and ponds to control aquatic weeds or mosquitos. Section 3.5.6 provides more information on mosquito control for storm water BMPs.

Integrated Pest Management

Integrated pest management (IPM) focuses on long-term prevention of pests or their damage by managing the ecosystem using targeted biological, chemical, cultural, and physical measures that remove pests with minimal or no use of chemical pesticides. IPM programs generally include five major components as follows:

1. Pest identification
2. Monitoring and assessing pest numbers and damage
3. Guidelines for when management action is needed—consider pest occurrence and history when developing pest management strategies
4. Preventing pest problems
5. Using a combination of biological, cultural, physical/mechanical and chemical management tools

IPM Management Tools

Biological control is the use of natural enemies—predators, parasites, pathogens, and competitors—to control pests and their damage. Invertebrates, plant pathogens, nematodes, weeds,

and vertebrates have many natural enemies. For example, introduce natural enemies of pests such as lady beetles (or lady bugs) and green lacewings. Pesticide use may kill these natural enemies.

Cultural controls reduce pest establishment, reproduction, dispersal, and survival. Changing irrigation practices can reduce pest problems—too much water can increase root disease and weeds. Proper plant selection, planting time, and planting method can reduce susceptibility to insects, pests, and diseases.

Mechanical and physical controls kill a pest directly or make the environment unsuitable for it. Traps for rodents are examples of mechanical control. Physical controls include mulches for weed management, solar heating, handpicking, mowing, hoeing, steam sterilization of the soil for disease management, or barriers such as screens to keep birds and insects out or *collars* around seedlings. The use of soil amendments, such as compost, is known to control some common diseases in plants and installing an amended soil and landscape system can preserve both plant and soil systems. Rotate annual garden plants to reduce the buildup of soil-borne pests. Clean up plant litter and remove weeds before they go to seed. Remove infested plant residue from the garden so pests do not overwinter.

Chemical control uses pesticides. In IPM, pesticides are used only when needed and in combination with other approaches for more effective, long-term control. Pesticides are selected and applied to minimizes possible harm to people and the environment. Consider applying environmentally friendly chemical alternatives such as insecticidal soaps, horticultural oils, and other such measures when practical and effective and when mechanical approaches are impractical.

With IPM, use the most selective pesticide to do the job and the safest for other organisms and air, soil, and water quality; use pesticides in bait stations rather than sprays; or spy-spray a few weeds instead of an entire area. Spot treat pests rather treating the entire area, and time pesticide application to minimize host plant damage and maximize pest control.

Storage and Handling

Do not store large quantities of pesticides for long periods of time. Adopt the *first in, first out* principle and use the oldest products first.

Pesticides should be stored in enclosed areas, in covered impervious containment (plastic sheeting or temporary roofs), or in a similar manner to prevent the chemicals from coming into contact with rainwater (BMP 77: Outdoor Storage and BMP 46: Spill Prevention and Control). MSDS should be readily accessible at all times.

Maintenance

Keep pesticide equipment properly calibrated according to manufacturer's instructions and in good repair. Recalibrate equipment periodically to compensate for wear in pumps, nozzles, and metering systems. Calibrate sprayers when new nozzles are installed. Keep and review records to evaluate the effectiveness of pesticides used. Comply with all disposal requirements included on the registered pesticide, herbicide, or insecticide label.

Additional Resources

Colorado UDFCD (Colorado Urban Drainage and Flood Control District). 2010. *Urban Storm Drainage Criteria Manual, Volume 3 Best Management Practices*. Denver, CO. *http://udfcd.org/wp-content/uploads/2014/07/Title-Page.pdf*

EPA (US Environmental Protection Agency). 2016. *Municipal Landscaping*. *https://archive.epa.gov/greenacres/web/html/index.html*

University of Idaho Extension. 2016. *Idaho Master Gardener Program Handbook*. 18th ed. Moscow, ID. *http://www.extension.uidaho.edu/mg/resources/handbook/MGHbook.pdf*

BMP 80: Building and Grounds Maintenance

Description

To prevent or reduce pollutant discharge to storm water from buildings and grounds maintenance, wash and clean up with as little water as possible, prevent and clean up spills immediately, keep debris from entering the storm drains, and maintain the storm water collection system. Overwatering, overfertilizing, improper herbicide or pesticide application, and improper disposal of trimmings and clippings can all contribute to serious water pollution problems (Figure 193).

Figure 193. Leaf clean up in Idaho Falls, Idaho.

General Information

Common maintenance activities generate wastes that must be properly disposed. Buildings and grounds maintenance involves landscaping, general maintenance, pest control, parking area and storm water system maintenance, and waste removal. Painting and other building repairs are covered in BMP 90.

Landscaping

- Leave or plant drought-tolerant vegetation to reduce water, fertilizer, and pesticide needs.
- Save water and prevent pollution by watering lawns sensibly. Lawns and gardens typically need the equivalent of 1 inch of rainfall per week. Overwatering to the point of runoff can carry polluting nutrients to the nearest water body.
- Conserve water by using irrigation practices such as drip irrigation, soaker hoses, or microspray systems.
- Consider planting a vegetated buffer zone adjacent to streams or other water bodies.
- Compost all yard clippings, or use them as mulch to save water and keep down weeds.
- Practice organic gardening and reduce or eliminate the need for pesticides and fertilizers.
- Pull weeds instead of spraying them.

Primary BMP Functions and Controls

☒ Construction	☒ Permanent
☐ Erosion Control	☐ Sediment Control
☒ Source Control	☐ Flood Control
☐ Filtration	☐ Infiltration

Typical Effectiveness for Targeted Pollutants

○	Sediment
●	Nitrogen
●	Phosphorus
○	Metals
○	Bacteria
○	Hydrocarbons
○	Litter

Other BMP Considerations

Relative Cost	$
Maintenance Requirements	Low
Ease of Installation	N/A
Freeze/Thaw Resistance	N/A
Max. Tributary Drainage Area	N/A
Max. Upstream Slope	N/A
NRCS Soil Group	N/A
Min. Ground Water Separation	N/A
Min. Bedrock Separation	N/A

General Maintenance

- Dispose of all waters from cleaning carpets, upholstery, and other surfaces into the sink or toilet and not the street or storm drain.
- Water from pressure washing decks, driveways, roofs, or other hard surfaces may contain suspended solids and other pollutants that should not be directly discharged to drainage systems. Redirect pressure washing wastewater to vegetated areas or areas such as gravel, lawns, landscaping, or bare soil for infiltration. If this cannot be accomplished, filter the washwater through filter fabric or other filtering media to collect the suspended solids before discharging the water to a drainage system. Remove filter fabric upon completion and dispose of it in the trash.
- If chemicals are used during the pressure-washing process, the wastewater should be collected and disposed of in a sanitary sewer system or discharged to a landscaped area where it can infiltrate on site.
- Sweep parking lots, storage areas, driveways, and sidewalks monthly to collect dust, waste, and debris. Avoid hosing down the area to a storm drain.
- Dispose of washwater, sweepings, and sediments properly. Section 3.10.7 provides disposal alternatives.
- Ensure that rooftop drains drain directly to an on-site storm drain system or a grass-covered area.

Safe Substitutes for Pest Control

Pest control should be done in a safe manner to prevent washing pesticides into the storm water system and causing water pollution. Some environmentally safe substitutes for pesticides include the following:

- Garden aphids and mites—Mix 1 tablespoon of liquid soap and 1 cup of vegetable oil. Add 1 teaspoon of this mixture to a cup of water and spray. (Oil may harm vegetable plants in the cabbage family.)
- Caterpillars—When caterpillars are eating, apply products containing Bacillus thuringiensis to leaves.
- Ants—Place boric acid powder or hydramethylnon baits in problem areas, cracks, and insect walkways. It is a mild poison, so ensure it is inaccessible to children and pets.
- Roaches—Apply boric acid powder to cracks and entry points (see ants above). Place bay leaves on pantry shelves.

Parking Area and Storm Sewer Maintenance

Evaluate any parking area that drains to the same storm drain system for suitable BMPs. Sweeping the parking area periodically and cleaning the catch basins (if they are part of the drainage system) are suitable BMPs. A vacuum sweeper is the best method of sweeping, rather than mechanical brush sweeping. Mechanical brush sweeping does not remove fine particulates as effectively as a vacuum sweeper.

Catch basins in parking lots generally need to be cleaned every 6 to 12 months, or whenever the holding tank is one-half full. A holding tank that is more than one-half full is not effective at removing additional particulate pollutants from the storm water. If the storm drain lines have a low

gradient, (less than 0.5 feet in elevation drop per 100 feet of line), material may settle in the lines during small, frequent storms. If the storm drain system has not been cleaned recently, check the lines. If the lines are not cleaned, the catch basins will likely fill up (during the next significant storm) with material washed from the lines. Install *turndown* elbows or similar devices on the outlets of the catch basins to retain floatables or oil and grease.

Sediments from parking areas and storm sewer maintenance are generally low in metals and other pollutants. To ensure that metals or other pollutants are not present, the material should be tested. If contaminant concentrations are high, use other BMPs to eliminate or reduce pollutants.

Using a vacuum truck to clean the storm drain system will generate dirty water, so disposed of the water properly.

Clearly mark the storm drain inlets, either with a color code (to distinguish from process water inlets if present) or with a painted stencil. The stencil should read "DO NOT DUMP WASTE." Ensuring that storm drain inlets are clearly marked reduces inadvertent dumping of liquid wastes.

Waste Removal

For a quick reference on disposal alternatives for specific wastes, see section 3.10.7.

- Compost piles should be located on an unpaved area where runoff can soak into the ground or be filtered by grass and other vegetation. Compost piles should be located in an area of the property not prone to water ponding during storms and kept well away from wetlands, streams, lakes, and other drainage paths.
- Avoid putting hazardous or nondecomposable waste in the pile.
- Cover the compost pile to keep storm water from washing nutrients into waterways and to keep excess water from cooling down the pile, which will slow down the rate of decomposition.
- Build bins of wood, chicken wire or fencing material to contain compost so it cannot be washed away. Building a small earthen dike around a compost pile is an effective means of preventing nutrient-rich compost drainage from reaching storm water paths.
- Do not blow or rake leaves into the street, gutter, or storm drains. Never dispose of grass clippings or other vegetation in or near storm drains, streams, or lakes.
- In communities with curbside yard waste recycling, place clippings and pruning waste in approved containers for pickup, or take clippings to a landfill that composts yard waste.

BMP 81: Loading Dock Design Features

Description

When raw materials are handled in loading dock areas, precipitation or storm water runoff that comes in contact with such materials may become contaminated. Properly designed outdoor loading docks with covers and containment features reduce the chance of pollution entering storm water runoff (Figure 194).

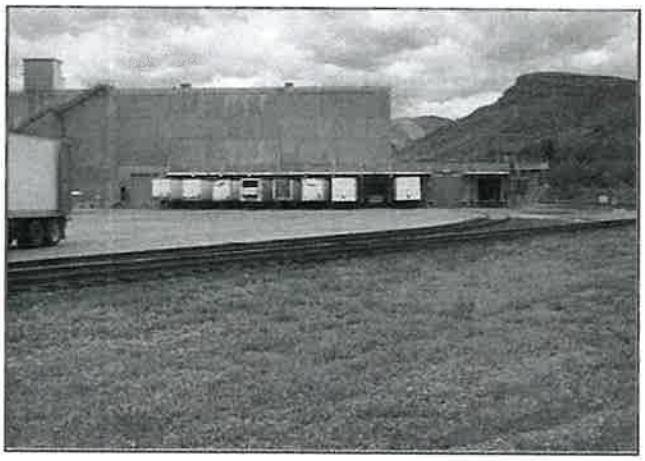


Figure 194. Covered truck loading dock (Colorado UDFCM 2010).

Applicability

This BMP applies to the following material transfer areas:

- Loading/unloading areas
- Bay doors without docks
- Any building access point designed to receive a truck, trailer, or specifically intended to receive or distribute materials to and from trucks or trailers

Limitations

Some features of loading dock facilities may have limitations such as underground holding tanks with shutoff valves that are engineering intensive and an expensive requirement.

Design Basis

Cover

Whenever possible, loading docks should be designed with a permanent covering. The roof cover should be sufficiently sized to prevent any precipitation from reaching the protected contents underneath. Proactively covering loading docks is an effective method of source control.

The first 3 feet of the paved area, measured from the building or dock face, should be covered and hydraulically isolated by grading, berms, or drains to prevent uncontaminated storm water from running onto the area and carrying away pollutants.

Primary BMP Functions and Controls

☐ Construction	☒ Permanent
☐ Erosion Control	☐ Sediment Control
☒ Source Control	☐ Flood Control
☐ Filtration	☐ Infiltration

Typical Effectiveness for Targeted Pollutants

○	Sediment
○	Phosphorus
○	Metals
○	Bacteria
◖	Hydrocarbons
◖	Litter

Other BMP Considerations

Relative Cost	$$
Maintenance Requirements	Easy
Ease of Installation	Medium
Freeze/Thaw Resistance	Good
Max. Tributary Drainage Area	N/A
Max. Slope	N/A
NRCS Soil Group	ABCD
Min. Ground Water Separation	N/A
Min. Bedrock Separation	N/A

Isolation

Bay doors and other indoor material transfer areas should prevent runoff from entering the building. This design may be achieved through grading, berming, or drains transferring runoff to an appropriate collection point.

Holding Tank

Use berms, curbs, dikes, or slopes to prevent run-on to paved loading areas so storm water is not added to waste in a holding tank. Dikes can be made of timbers, concrete curbing, or other similar materials (BMP 69).

Ensure the inlet carries liquid to a holding tank with large enough capacity to contain the entire volume of a potential spill, in addition to runoff from the applicable design event, while the valve is closed. Consult with a professional engineer when sizing the holding tank. The tank should be equipped with an outflow pipe to allow discharge of normal uncontaminated runoff to the storm drain. Keep the holding tank outlet valve closed at all times except when storm water or other acceptable fluids need to be discharged.

The use of an oil and water separator (BMP 15) upgradient and in-line with the holding tank may be effective removing petroleum-based pollutants before discharge to the holding tank. The upper contaminated layer in the oil and water separator can then be removed at less cost than treatment and/or transport of contaminated liquid in the holding tank.

If the inlet connects to a storm drain, test accumulated liquid before discharging to the storm drain. Ensure the liquid does not contain pollutants before you discharge it to the storm drain. This discharge may require an NPDES permit.

If the inlet connects to a sanitary sewer, test accumulated liquid before discharging to the sanitary sewer (BMP 50). Ensure its quality is within the parameters specified in the wastewater discharge permit before opening the valve for discharge.

Paving

Pave and grade the sloped or recessed loading area to direct flow toward either a central collection point or toward a dead-end holding tank. Pave the area with concrete if materials such as gasoline will be handled; gasoline can react with asphalt. If the area is already paved with asphalt, apply a sealant to the surface. Ensure that the paved surface is free of gaps and cracks.

Other

Retain the needed equipment and trained personnel on site (BMP 91) for immediate cleanup of spills (BMP 46).

Maintenance

- Inspect the holding tank regularly to ensure it is not overfilled.
- Test the holding tank contents before discharge or disposal.
- Inspect and maintain berms, curbs, dikes, or slopes regularly.

Additional Resources

Central Oregon Intergovernmental Council. 2010. *Central Oregon Stormwater Manual*. Bend, OR.

Colorado UDFCD (Colorado Urban Drainage and Flood Control District). 2010. *Urban Storm Drainage Criteria Manual, Volume 3 Best Management Practices*. Denver, CO. *http://udfcd.org/wp-content/uploads/2014/07/Title-Page.pdf*

Washington State Department of Ecology. 2012. *Stormwater Management Manual for Western Washington*. Lacey, WA. Publ. 12-10-030. *http://www.ecy.wa.gov/programs/wq/stormwater/manual.html*

BMP 82: Equipment Yard Design Features

Description

Equipment yards storing vehicles and equipment can generate wastes, such as solvents, antifreeze, oils, and greases, from cleaning and maintenance activities or improperly maintained equipment. Properly designed equipment yards control storm water pollution by reducing or eliminating polluted runoff from contaminating storm water and preventing unnecessary run-on of storm water onto the site (Figure 195).

Spill prevention controls (BMP 46) and on-site personnel training (BMP 91) should also be implemented in equipment yards.

Figure 195. Equipment yard during construction of the Salmon River Road, Riggins, Idaho.

Applicability

These design features apply to all equipment yards, both temporary construction and permanent facilities, and wherever vehicles or equipment are stored, cleaned, maintained, or fueled.

Limitations

A large area may be required for structural equipment yard BMPs to accommodate proper grading, berming, or segregated service areas. If the equipment yard cannot be designed properly, consider storing equipment off site in a more suitable location.

Design Basis

Ideally, equipment storage, maintenance, and process areas should be covered and the area around it graded to drain away from the building or covered area.

- The roof cover option used at a given site is subject to the site layout, available space, affordability, and limitations imposed by other regulations. Examples of storage options include, but are not limited to, the following:

Primary BMP Functions and Controls

☒ Construction	☒ Permanent
☐ Erosion Control	☐ Sediment Control
☒ Source Control	☐ Flood Control
☐ Filtration	☐ Infiltration

Typical Effectiveness for Targeted Pollutants

●	Sediment
○	Phosphorus
◖	Metals
○	Bacteria
◖	Hydrocarbons
○	Litter

Other BMP Considerations

Relative Cost	$$
Maintenance Requirements	Medium
Ease of Installation	Medium
Freeze/Thaw Resistance	N/A
Max. Tributary Drainage Area	N/A
Max. Upstream Slope	N/A
NRCS Soil Group	N/A
Min. Ground Water Separation	N/A
Min. Bedrock Separation	N/A

- A prefabricated storage shed to enclose and cover materials (ensure these structures meet applicable building and fire codes).
- A lean-to structure against an existing building to cover materials and prevent contact with rain.
- A stand-alone canopy that provides cover but no walls.

If the equipment yard cannot be covered, the following recommendations minimize storm water run-on and runoff from the area:

- Grade the equipment yard to drain to a longitudinal drain or install curbs or berms to direct all storm water to a central collection point in the yard and then to the sanitary sewer according to applicable industrial pretreatment requirement and approval of the sewer authority.
- Consider paving the surface with concrete in areas where asphalt may react with spilled liquids (BMP 46: Spill Prevention and Control).
- Provide BMPs such as an oil and water separators (BMP 15) if there is the possibility for oil to be released. All sites should implement source controls (BMP 46).
- Segregate the area where vehicles are serviced and install special permanent controls:
  - Drain the area to a single collection point, preferably connected to a holding tank. Consult with a professional engineer for proper sizing of the holding tank for the required design storm. The drain may require an oil and water separators (BMP 15) or sand and grease trap and should be approved by local regulatory authorities.
  - Grade the activity area higher than the parking lot or surround the activity area with a berm, curb, or dike to prevent storm water run-on.
  - Construct a special area that segregates the *dirtiest* equipment (e.g., roof tar and asphalt paving equipment) from other equipment. Use berms, curbs, or dikes to keep discharges, leaks, and runoff separate from other activity areas.

Maintenance

- Regularly maintain oil and water separators and sand and grease traps.
- Periodically inspect equipment yard pavement, berming, and curbing for gaps or cracks, and repair immediately.

Additional Resources

CASQA California Stormwater Quality Association. 2004. *California Stormwater Best Management Practices Handbook: New Development and Redevelopment*. Menlo Park, CA. *http://www.casqa.org/*

Washington State Department of Ecology. 2012. *Stormwater Management Manual for Western Washington*. Lacey, WA. Publ. 12-10-030. *http://www.ecy.wa.gov/programs/wq/stormwater/manual.html*

BMP 83: Vehicle and Equipment Refueling

Description

BMPs for transferring fuel to vehicles, equipment, or storage tanks prevent storm water pollution from heavy metals, toxic materials, and oil and grease (Figure 196). Controlling the source of contaminants is particularly important because these contaminants are not easily removed by other storm water treatment controls. Source control can be provided through careful design of the initial fuel storage area, retrofitting existing installations, and using proper spill control and cleanup procedures.

Figure 196. Mobile fueling truck (ITD 2014).

Ideally, vehicles and equipment used on construction sites would use permanent, off-site refueling stations because these stations are usually better equipped to handle fuel spills according to local, state, and federal regulations. If off-site facilities cannot be used, properly designed fleet or equipment fueling areas can control storm water pollution by reducing or eliminating pollutants entering storm water.

Primary BMP Functions and Controls

☒ Construction	☒ Permanent
☐ Erosion Control	☐ Sediment Control
☒ Source Control	☐ Flood Control
☐ Filtration	☐ Infiltration

Typical Effectiveness for Targeted Pollutants

○	Sediment
○	Phosphorus
◖	Metals
○	Bacteria
●	Hydrocarbons
○	Litter

Other BMP Considerations

Relative Cost	$$
Maintenance Requirements	Medium
Ease of Installation	Easy
Freeze/Thaw Resistance	NA
Max. Tributary Drainage Area	NA
Max. Upstream Slope	NA
NRCS Soil Group	NA
Min. Ground Water Separation	NA
Min. Bedrock Separation	NA

Applicability

This BMP applies to both temporary fueling facilities for construction sites and permanent commercial or industrial fueling facilities. Construction sites often use either mobile refuelers or aboveground storage tanks with secondary containment. Mobile fueling, also known as fleet fueling, wet fueling, or wet hosing, is the practice of filling vehicle fuel tanks using tank trucks that are driven to the yards or sites where the vehicles to be fueled are located. BMP 77 provides more information on secondary containment and outdoor storage of liquid materials.

Limitations

Retrofitting existing fueling areas to minimize storm water exposure or spill runoff is more difficult than using good design and initially installing fueling areas that incorporate storm water BMPs.

Maintenance is critical for proper functioning of oil and water separators.

Design Basis

Vehicle and Equipment Fueling Design Features

- Cover the fueling area to prevent rain from falling directly on the activity area. The cover's minimum dimensions should be equal to or greater than the area within the grade break or the fuel dispensing area to ensure adequate coverage.
- Equip the storm drain and sewer inlets that drain the fueling area with a shutoff valve to keep fuel out of the drain in the event of a fuel spill. Keep the valve closed at all times except during rain events where no contamination is present. Curtail fueling activities when the shutoff valve should be open, or use a large drip pan under the vehicle to capture any spilled fuel.
- Separate the fueling area from the rest of the facility, not only to contain any fuel spills, but also to prevent storm water run-on. Select from the following drainage design guidelines:
  - Grade the fueling area so it is either *mounded* or elevated. A mounded grading scheme is recommended.
  - Grade the entire fueling area to drain to a single collection point inlet. Design the grading to prevent run-on.
  - Install high berms around the area to redirect water from a large storm to a single collection point inlet.
  - Install a holding tank where accumulated liquids can be pumped.
  - Pave the fueling area with concrete rather than asphalt; asphalt can react with or absorb gasoline and other materials.
  - Apply a suitable sealant to protect the asphalt from spilled fuels in areas where covering the asphalt is not feasible and the fuel island is surrounded by pavement.
  - Install an oil and water separator (BMP 15) to collect spills if a dead-end holding tank is not used.
  - Install vapor recovery nozzles to control drips as well as air pollution.

Spill Management and Reporting

- Prepare an emergency response plan with designated personal available on site or on call to properly implement and manage spills (BMP 46).
- Keep appropriate absorbents on hand and convenient to fueling areas.
- Report uncontrolled spills to local agencies such as the local police department or fire department.
- Report significant spills into a water body to the National Response Center at (800) 424-8802.

Designated Fueling Area

For facilities with large amounts of mobile equipment that currently use a mobile fuel truck to fuel the equipment, consider establishing a designated fueling area. Except for tracked equipment, such as bulldozers or small forklifts, most vehicles can travel to a designated area with little lost time. Place temporary *caps*, such as a bentonite mat or a spill mat, over nearby catch basins or manhole covers to prevent spilled fluid from entering the storm drain. Upon fueling is completed, remove the mat and dispose as hazardous waste.

The following spill control measures (BMP 46) reduce spilling or reduce the loss of spilled fuels from the site:

- Discourage *topping off* vehicle fuel or underground storage tanks. Topping off tanks increases the risk of spilling fuel onto the ground.
- Use secondary containment when transferring fuel from the tank truck to the fuel tank.
- Store and maintain appropriate spill cleanup materials in a location known to all employees near the fueling operation; ensure that employees are familiar with the site's spill control plan and proper spill cleanup procedures.
- Use absorbent materials on small spills. Remove the absorbent materials promptly and dispose as hazardous waste.
- Obey all federal and state requirements for both underground and aboveground storage tanks.
- Avoid mobile fueling of industrial equipment around the facility; transport the equipment to designated fueling areas.
- Train employees in proper fueling procedures.
- Do not leave fueling operations unattended.

Maintenance

- Using a qualified professional, periodically test aboveground and belowground tanks for integrity.
- Inspect and maintain holding tanks, oil and water separators, and on-site treatment or recycling units regularly.
- Inspect the holding tank regularly to ensure it is not overfilled.
- Test holding tank contents before discharge or disposal.
- Inspect and maintain berms, curbs, dikes, or slopes regularly.
- Regularly clean oil and water separators at the appropriate intervals.
- Keep ample supplies of spill cleanup materials on site.
- Inspect fueling areas and storage tanks regularly.
- Repair and patch berms as needed.

Additional Resources

CASQA (California Stormwater Quality Association). 2015. *California Stormwater Best Management Practices Handbook: Construction.* Menlo Park, CA. *http://www.casqa.org/*

EPA (US Environmental Protection Agency). 2012. *EPA Construction General Permit*. National Pollutant Discharge Elimination System Stormwater Program. *http://www.epa.gov/npdes/stormwater-discharges-construction-activities#overview*

EPA (US Environmental Protection Agency). 2020. *Municipal Vehicle Fueling*. *https://www.epa.gov/npdes/oil-and-gas-stormwater-permitting#undefined*

ITD (Idaho Transportation Department). 2014. *Best Management Practices*. Boise, ID: ITD.

King County (King County, Washington). 2009. *King County, Washington Surface Water Design Manual*. Seattle, WA: King County, Department of Natural Resources.

BMP 84: Vehicle and Equipment Cleaning, Maintenance, and Repair

Description

Proper vehicle and equipment cleaning, maintenance, and repair procedures prevent pollutants, heavy metals, and toxic materials from entering ground water and surface water supplies and creating public health and environmental risks (Figure 197). Wastes often generated by cleaning, maintenance, and repair activities include, but are not limited to the following:

- Solvents
- Antifreeze
- Brake fluids
- Batteries
- Motor oils
- Fuels
- Lubrication greases

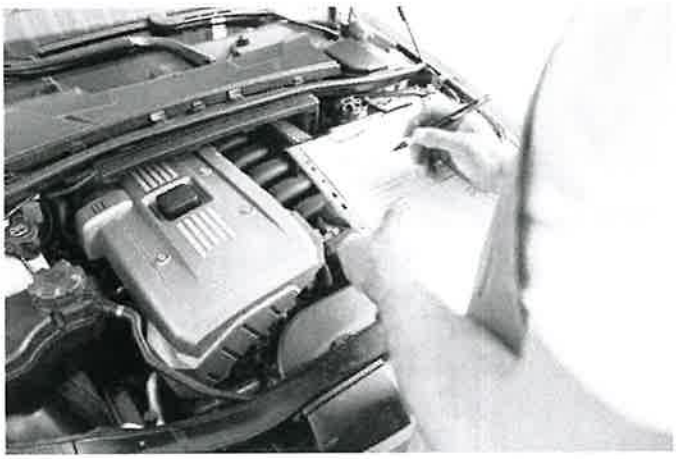


Figure 197. Vehicle maintenance prevents pollution.

Primary BMP Functions and Controls

☒ Construction	☒ Permanent
☐ Erosion Control	☐ Sediment Control
☒ Source Control	☐ Flood Control
☐ Filtration	☐ Infiltration

Typical Effectiveness for Targeted Pollutants

●	Sediment
○	Phosphorus
◖	Metals
○	Bacteria
◖	Hydrocarbons
○	Litter

Other BMP Considerations

Relative Cost	$$
Maintenance Requirements	Medium
Ease of Installation	Medium
Freeze/Thaw Resistance	N/A
Max. Tributary Drainage Area	N/A
Max. Upstream Slope	N/A
NRCS Soil Group	N/A
Min. Ground Water Separation	N/A
Min. Bedrock Separation	N/A

Applicability

This BMP applies in all locations where vehicle and equipment cleaning, maintenance, and repair take place with a focus on permanent facilities, such as auto repair shops, industrial facilities, fleet storage facilities, and residential homes. BMP 47: Construction Equipment Washing and Maintenance provides information on temporary facilities located on construction sites.

Limitations

Many common vehicle maintenance and washing routines contribute to environmental pollution. Businesses that are unable to comply with the following guidelines should have their vehicles washed at a commercial establishment or mobile washer that conforms to these specifications.

Vehicle and equipment cleaning, maintenance, and repair can generate significant pollutant concentrations and may require permitting.

monitoring, pretreatment, and inspections. Contact local wastewater treatment plant staff for additional information and the appropriate local authority to guarantee compliance with local standards.

Space and time limitations may preclude all work being conducted indoors.

Training is a key aspect of this BMP—ensure employees are trained to properly to prevent spills and leaks.

Design Basis

Vehicle and Equipment Cleaning

Washing vehicles and equipment outdoors or in areas where washwater flows onto the ground can pollute storm water and ground water due to the presence of diesel, gasoline, hydraulic fluid, or oil residues in the washwater. Facilities that wash or steam clean a large number of vehicles or equipment should consider contracting this work to a commercial business, which is generally better equipped to handle and dispose of washwater properly. Contracting out this work can also be economical because it eliminates the need for a separate washing/cleaning operation.

Steam cleaning and washing should be conducted on site only if the site is equipped to capture all the water and other wastes. If washing/cleaning must occur on site, wash vehicles in a designated area. Direct liquid to designated areas where it can be pretreated to remove pollutants before discharge to the sanitary sewer.

Disposal Site Options

Storm Drain—Discharges from vehicle and equipment cleaning, maintenance and repair activities should never be directed to storm drains. In areas designated for cleaning, maintenance, and repair activities, stencil "DO NOT DUMP WASTE" on the storm drain inlets.

Sanitary Sewer—Pump into sanitary system cleanout/sink or into an on-site private sanitary sewer manhole; verify with the facility manager that it is not a storm drain manhole. Solids separation will be required before disposal to prevent clogging the system.

Landscape or Soil Area—Discharge should be directed to an area sufficient to contain all the water. (Note: Be aware that soapy washwater may degrade habitat and adversely affect landscaping). The area should be used for minimum discharge flows only. Repetitive use of the same area or excessive wash volume to the same area may be illegal. Discuss discharge practices with property owner.

If disposal to the sanitary sewer and/or to a landscaped area is not possible, contract with a company capable of hauling the washwater off site to an authorized disposal site.

Designated Wash Areas

The designated wash areas must provide the following:

- Clearly labeled
- Paved with concrete
- Covered and contained to prevent contact with storm water
- Sloped for washwater collection
- Connected to the sanitary sewer or to a dead-end holding tank
- Equipped with an oil and water separator
- Allowable to rinse down the body of a vehicle with just cold water without implementing any BMPs

Several proprietary products are commercially available that enable runoff collection.

Some unavoidable evaporation may occur from paved surfaces. If a significant amount of washwater runoff evaporates at the site before it can be collected, and the site is routinely used for this purpose, the paved area itself should be cleaned every 6 months, or at the end of the wash service contract, whichever comes first. Any washwater used during this procedure should be collected and discharged to a sanitary sewer.

Cleaning and Degreasing Engines, Equipment, and Auto and Truck Drive Trains

It is likely that pollutants (petroleum products and metals) from engine-cleaning activities are concentrated in these washwaters, so the local wastewater treatment plant will require treatment before discharge into the sanitary sewer. Contact the local wastewater treatment plant for requirements and additional information.

If a sanitary sewer is not available or treatment of the washwater is not feasible, contact a company capable of hauling (i.e., tanker truck) the washwater off site to dispose at an authorized site.

Household Automobile Washing

- Wash your car directly over a vegetated or pervious area or ensure the washwater drains to a vegetated or pervious area, which allows the water and soap to soak into the ground instead of running off into a local water body.
- Ideally, no soap or detergent should be used, but if you do use one, select one without phosphates.
- Sweep driveways and street gutters before washing vehicles to cleanup dirt, leaves, trash, and other materials that may flow to the storm drain along with your washwater. This practice reduces storm drain maintenance costs and protects water quality.
- Use commercially available products that allow you to clean a vehicle without water. Developed for areas where water is scarce, these products save water and reduce pollution.
- Use a nozzle on the hose to save water.
- Do not wash your car if rain is expected.
- Consider not washing your car at home. Use a commercial car wash with a recycle system that discharges wastewater to the sanitary sewer for treatment.

Vehicle and Equipment Maintenance and Repair

Vehicle or equipment maintenance and repair is a potentially significant source of storm water pollution. Activities that can contaminate storm water include engine repair and service (e.g., parts cleaning, spilled fuel, and oil), fluid replacement, and outdoor equipment storage and parking (leaking engines). When performing maintenance and repair, the following practices should be addressed:

- Keep equipment and the equipment yard clean; ensure oil and grease accumulations do not build up excessively.
- Ensure incoming vehicles are checked for oil and fluid leaks.
- Use a properly sized drip pan underneath leaking vehicles and equipment when storing vehicles or performing maintenance. Drain pans (usually 1 x 1 foot) are generally too small to contain certain equipment fluids, such as antifreeze. Drip pans (3x 3 feet) may have to be purchased or fabricated when needed.
- Store idle equipment under cover.
- Inspect equipment for leaks on a regular basis, particularly vehicles parked or stored long term.
- Use an indoor garage or vehicle maintenance area designed to prevent storm water pollution. Avoid changing motor oil or performing equipment maintenance in inappropriate areas.
- Recycle greases, used oil or oil filters, antifreeze, cleaning solutions, automotive batteries, hydraulic fluids, and transmission fluids. Collect and store these recyclable materials separately in secondary containment.
- Ensure oil filters are completely drained for at least 24 hours before recycling or disposing of them.
- Do not pour materials down storm drains or hose down work areas; sweep work areas instead.
- Use rags for small spills, a damp mop for general cleanup, and dry absorbent materials for larger spills. Avoid hosing down areas. Dry floor-cleaning methods may not be sufficient for some spills (BMP 46).
- Clean equipment yard storm drain inlets regularly and especially after large storms.
- Train employees in spill prevention and cleanup procedures.
- Store cracked batteries in a nonleaking secondary container, even if all the acid has drained out. If a battery is dropped, treat it as if it is cracked and store it in a containment area until you are sure it is not leaking.

Waste Reduction

- Parts are often cleaned using solvents such as trichloroethylene, 1,1,1-trichloroethane, or methylene chloride. Dispose of these cleaners as hazardous waste.
- Clean without using liquid cleaning products (e.g., using a wire brush) whenever possible to reduce hazardous waste.
- Use liquid cleaners at a centralized station so the solvents and residues stay in one area.
- Locate properly sized drip pans, drip boards, and drying racks to direct drips back into a solvent tank or fluid-holding tank for reuse.

Safer Alternatives

If possible, eliminate or reduce the amount of hazardous materials and waste by substituting nonhazardous or less hazardous materials:

- Use noncaustic detergents instead of caustic cleaning agents for parts cleaning (ask your supplier about alternative cleaning agents).
- Use phosphorus free cleaners whenever possible.
- Use detergent-based or water-based cleaning systems in place of organic solvent degreasers.
- Replace toxic solvents with nontoxic solvents.
- Choose recyclable cleaning agents.
- Reduce the number of solvents used to make recycling easier and lower hazardous waste management costs. Often, one solvent can perform a job as well as two solvents.

Interior Shop Area Cleaning

When possible, follow these shop area cleaning BMPs:

- Do not hose down the shop floor into streets or parking lots. Dry sweep regularly.
- Use nontoxic cleaning products. Baking soda paste works well on battery heads, cable clamps and chrome; mix the soda with a mild, biodegradable dishwashing soap to clean wheels and tires; for windows, mix white vinegar or lemon juice with water.
- To reduce or eliminate waste, fix sources of drips or leaks where possible. Routinely inspect the engine compartment, and regularly replace worn seals on equipment.
- To avoid or control spills and leaks:
  - Prepare and use easy to find spill containment and cleanup kits. Include safety equipment and cleanup materials appropriate to the type and quantity of materials that could spill.
  - Pour kitty litter, sawdust, or cornmeal on spills.
  - Change fluids carefully. Use a drip pan to avoid spills. Prevent fluid leaks from stored vehicles. Drain fluids such as unused gas, transmission and hydraulic oil, brake and radiator fluid from vehicles or parts kept in storage. Simple work practices reduce the chance of spills.
  - Use a funnel to pour liquids (like lubricants or motor oil) and place a tray underneath to catch spills. Place drip pans under the spouts of liquid storage containers. Clean up spills immediately.
  - See BMP 46: Spill Prevention and Control for more information.

Household Automobile Maintenance

- Recycle all oils, antifreeze, solvents, and batteries. Many local car parts dealers and gas stations accept used oil. A household hazardous waste facility in your area may accept oil, oil filters, antifreeze, and solvents. Some communities and counties hold household hazardous waste turn-in days that will accept car wastes including old batteries. Old batteries can be worth money, so call battery shops find out if they purchase used batteries.

- Never dump new or used automotive fluids or solvents on the ground, in a storm drain or street gutter, or in a water body. Eventually, the waste will make its way to local surface waters or ground water, including the water we drink.
- Do not mix wastes. The chlorinated solvents in some carburetor cleaners can contaminate a huge tank of used oil, rendering it unsuitable for recycling. Keep wastes in separate containers, label properly, and store them out of the weather.
- To dispose of a used oil filter, punch a hole in the top and let it drain for 24 hours. A large funnel in the top of the oil storage container comes in handy for draining. After draining the filter, wrap it in two layers of plastic and dispose of it in your regular garbage or recycle at a local household hazardous waste facility if one is available.
- Use care in draining and collecting antifreeze to prevent accidental spills. Spilled antifreeze can be deadly to cats and dogs that ingest it.
- Perform service activities on concrete or asphalt or over a plastic tarp to make spill cleanup easier. Keep a bag of kitty litter available to absorb spills. If a spill occurs, sprinkle a layer of absorbent on the spill, let it absorb for a while, and then sweep it up. Place the contaminated litter in a plastic bag, tie it up, and dispose in the regular garbage. Do not leave kitty litter in the rain as it is difficult to clean up.
- For outside autobody work, use a tarp to catch material from grinding, sanding, and painting. Double bag the waste in plastic and place it in the garbage.

Reporting

Report uncontrolled spills to the local police or fire departments. A significant spill into a water body should be reported to the National Response Center at (800) 424-8802.

Maintenance

- Inspections shall be conducted as required by the NPDES permit or contract specifications.
- BMPs should be inspected weekly, before rain events, daily during rain events, and after rain events.
- Inspect and maintain berms, curbs, dikes, or slopes regularly.
- Regularly clean oil and water separators at the appropriate intervals.
- Keep ample supplies of spill cleanup materials on-site.
- Inspect and maintain holding tanks, oil and water separators, and on-site treatment or recycling units regularly.

Additional Resources

CASQA (California Stormwater Quality Association). 2015. *California Stormwater Best Management Practices Handbook: Construction.* Menlo Park, CA. *http://www.casqa.org/*

EPA (US Environmental Protection Agency). 2012. *EPA Construction General Permit*. National Pollutant Discharge Elimination System Stormwater Program. *http://www.epa.gov/npdes/stormwater-discharges-construction-activities#overview*

EPA (US Environmental Protection Agency). 2017. *Municipal Vehicle and Equipment Maintenance*. *https://www.epa.gov/npdes/national-menu-best-management-practices-bmps-stormwater-documents*

EPA (US Environmental Protection Agency). 2017. *Menu of BMPs: Municipal Vehicle and Equipment Washing*. *https://www3.epa.gov/npdes/pubs/sector_s_airtransmaint.pdf*

ITD (Idaho Transportation Department). 2014. *Best Management Practices.* Boise, ID: ITD.

BMP 85: Remote Access Roads and Rail Corridors

Description

Remote access roads, such as forest roads, active roads, incidental haul roads, inactive roads, and low-volume logging roads, as well as rail corridors can contribute to storm water pollution and added runoff due to increases in impervious area, contamination from materials used during construction, and more vehicular traffic. Properly designed and maintained storm water controls will minimize adverse effects from roads and rail corridors (Figure 198).

Figure 198. Remote access road with rolling drain dip (University of Idaho 2015).

Applicability

All linear projects such as access roads, rail corridors, streets, and utility projects within right of ways pose unique storm water management challenges and should follow the guidelines in this BMP.

Limitations

Certain site layout and use requirements, such as a narrow right of way, may prohibit implementing portions of this BMP.

Design Basis

- Follow design criteria for appropriate transportation corridor BMPs to remove storm water pollutants, control erosion, and promote infiltration.
- Maintain all BMPs used along roads and corridors according to the respective guidelines.

Access and Construction Guidelines

When available, existing roads and disturbed areas should be used before constructing new roads. For new roads, consider the following (Figure 199):

- The *right of way* is generally publicly owned land acquired for and devoted to

Primary BMP Functions and Controls

☒ Construction	☒ Permanent
☒ Erosion Control	☐ Sediment Control
☒ Source Control	☐ Flood Control
☐ Filtration	☐ Infiltration

Typical Effectiveness for Targeted Pollutants

●	Sediment
◖	Phosphorus
◖	Metals
◖	Bacteria
●	Hydrocarbons
○	Litter

Other BMP Considerations

Relative Cost	$$
Maintenance Requirements	Medium
Ease of Installation	Medium
Freeze/Thaw Resistance	N/A
Max. Tributary Drainage Area	N/A
Max. Upstream Slope	N/A
NRCS Soil Group	N/A
Min. Ground Water Separation	N/A
Min. Bedrock Separation	N/A

transportation purpose, under and adjacent to the highway. The right-of-way line marks the limit between the land secured for public use and adjacent private property.

- *Clearing limits* determine the removal all obstructing vegetation as designated on the ground or on the road construction drawings.
- *Roadway* or *construction limits* define the area of active construction.

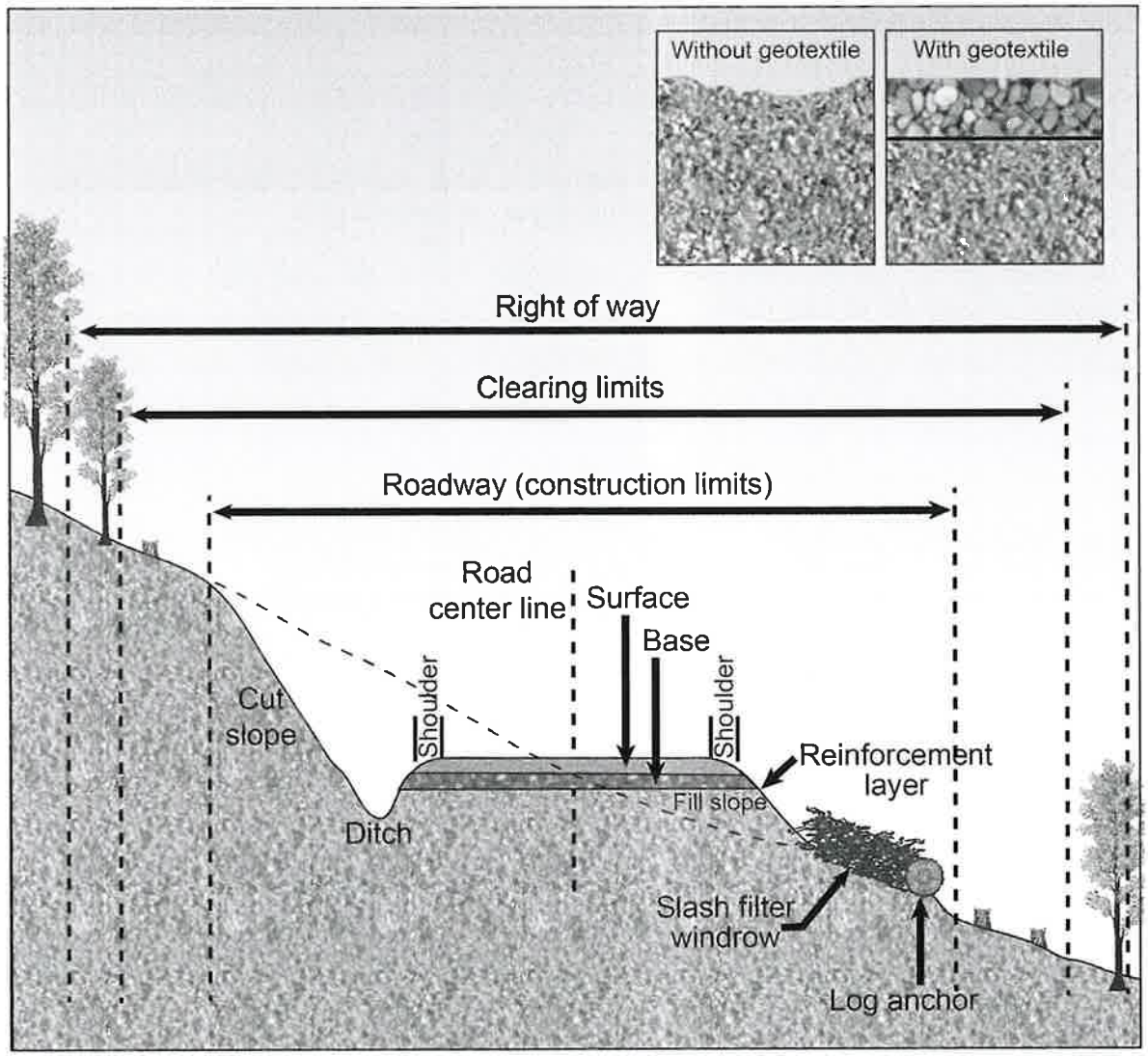


Figure 199. Typical cross section for new road construction (University of Idaho 2015).

General recommendations include the following:

- Grade roads high in the center, or crown, and slope outward to divert water to the sides of the road. Storm water should not be allowed to drain across the width of the road but carried in ditches or roadside culverts. An exception would be locations where the road must be superelevated around sharp turns.
- Some soils may produce road sections with a *soft bottom*, where the road surface does not compact properly. In these situations, rock surfacing may become buried in the subgrade and require reapplication. A variety of synthetic materials, called geotextiles (BMP 53), can be effective for separating rock and soil layers.

- Common forest road drainage techniques include rolling drain dips, cross ditches, relief culverts and roadside ditching. Each of these options is discussed in *Idaho Forestry Best Management Practices Manual* (University of Idaho 2015) at *http://www.uidaho.edu/extension/idahoforestrybmps*.
- Slash filter windrows, structures made out of waste logs and compacted slash, are placed along the roadside to prevent erosion. Combining slash filter windrows with other BMPs such as seeding (BMP 32) and mulching (BMP 52) provides the most effective method of reducing sediment delivery to streams.
- In less stable soils that tend to give way easily, gentle cut and fill slope angles above and below the driving surface will decrease erosion from these slopes.
- On more stable soils or solid rock, less material is likely to tumble down onto the road surface or give way below it, allowing for steeper cut slope angles.

Before road construction begins, determine the appropriate road profiles for each section of the road, as well as cut and fill slope angles.

Full-bench construction excavates the hill slope so that the entire road surface is cut into the hillside and no fill is deposited on the downhill side (Figure 200). Excavated material is hauled to stable disposal locations. The Idaho Forest Practices Act (IDAPA 20.02.01.040) requires "roads constructed on slopes greater than 60% in unstable or erodible soils shall be full benched without fill slope disposal. Fills must be kept to a minimum at stream and draw crossings. A variance is required if a full bench is not used."

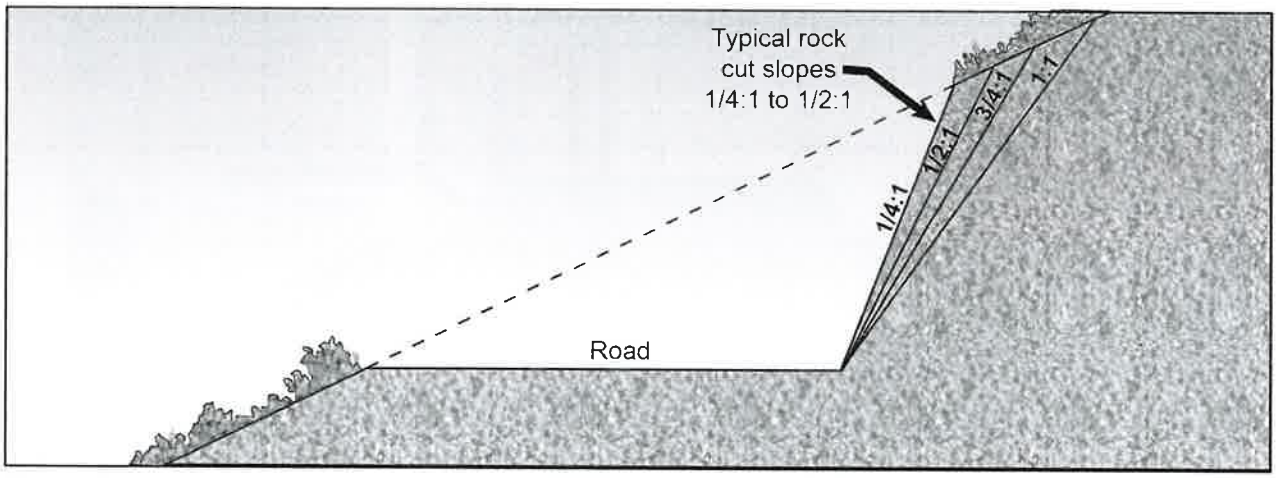


Figure 200. Full-bench construction (University of Idaho 2015).

Balanced cut and fill construction uses materials excavated on the uphill side of a road as compacted fill material on the downslope side (Figure 201). In Idaho, this is the most common road construction method where full-bench methods are not required. The road design should match the soil group, generally with more moderate slope angles for less stable soils.

If small dips or draws must be filled and/or small hills must be removed, balance the cuts and fills and keep material hauling a short a distance if possible. If material must be moved long distances from cut areas to fill locations, costs can increase rapidly.

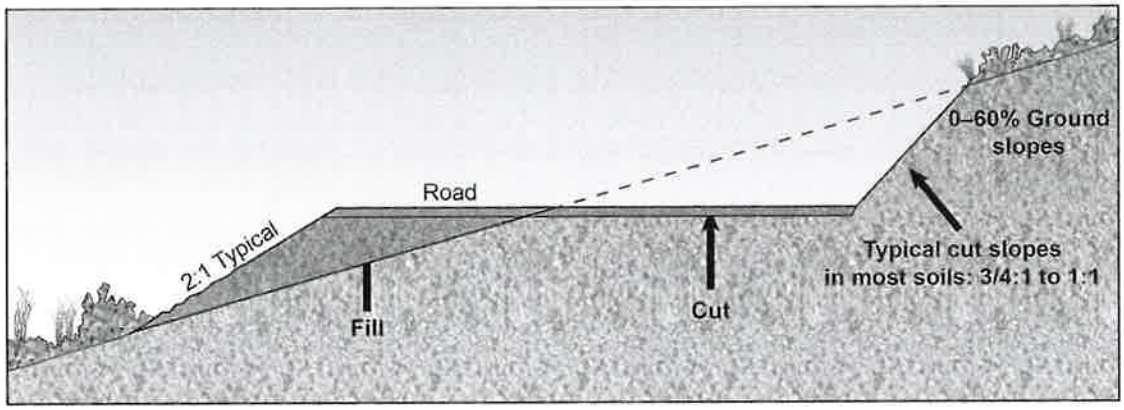


Figure 201. Balanced cut and fill construction (University of Idaho 2015).

Through-cut construction is used where the ground must be cut through to avoid an overly steep road grade, such as on the crest of a steep hill (Figure 202).

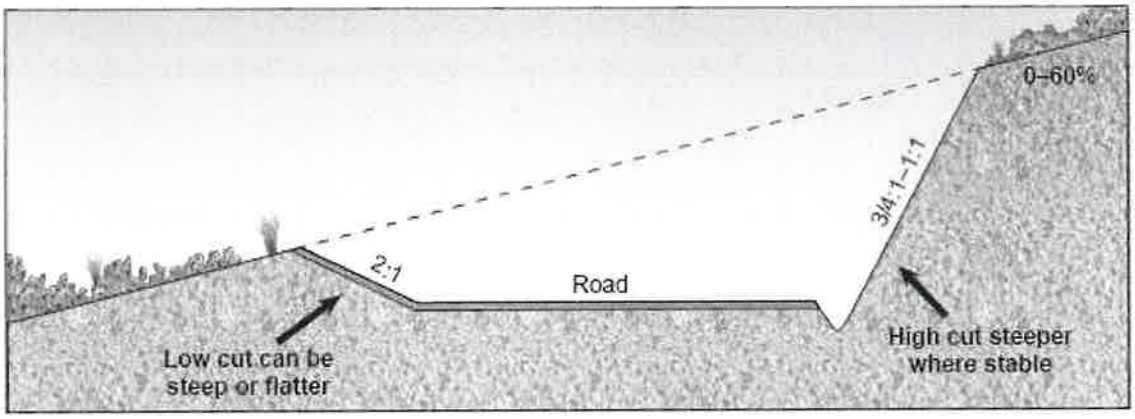


Figure 202. Through-cut construction (University of Idaho 2015).

Through-fill construction is the opposite of a through cut. It is a segment of road that is entirely composed of fill material, with fill slopes on both sides of the road. Through-fill construction is often used on flat terrain where water is likely to pond and to cross draws or wet or swampy ground (Figure 203).

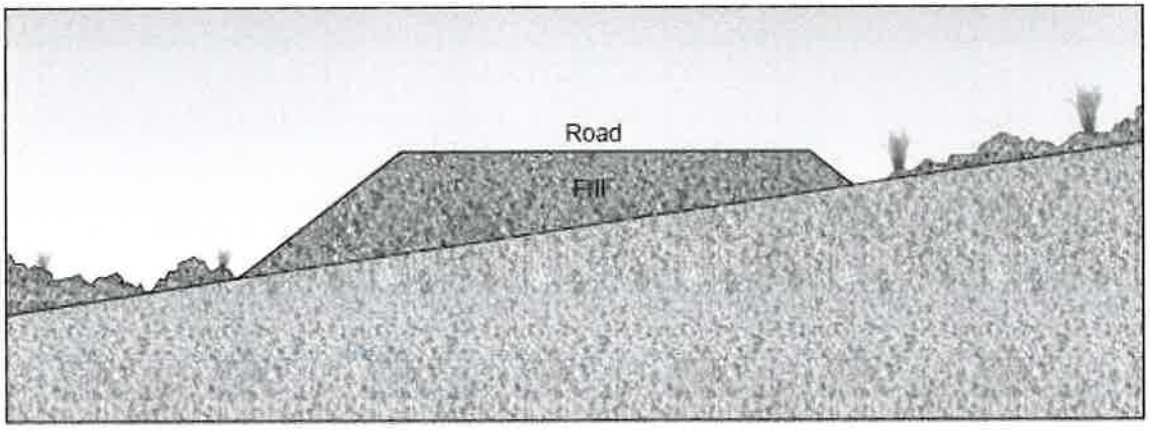


Figure 203. Through-fill construction (University of Idaho 2015).

Rail Corridor Guidelines

- Use less-toxic wood preservatives, such as ammoniacal copper zinc arsenate or copper naphthenate, instead of creosote and pentachlorophenol on railroad ties or use concrete or other nonwooden ties. While these preservatives are approved for railroad ties, they are not generally suggested for general public or residential use.
- Control spills and dust from railroad unloading (BMP 87). If the rail line delivers or picks up liquids in bulk or in containers, add spill-control loading docks with shutoff valves (BMPs 46 and 81). If parked railroad cars drip fluids, install a drip pan between the rails at the loading dock.

Maintenance

Inspect roadside BMPs according to their respective maintenance and inspection requirements.

Additional Resources

EPA (US Environmental Protection Agency). 2014. Chromated Copper Arsenate (CCA): *Consumer Safety Information Sheet: Inorganic Arsenical Pressure-Treated Wood. https://www.atsdr.cdc.gov/CCA-Treated_Wood_Factsheet.pdf http://www.beyondpesticides.org/assets/media/documents/infoservices/pesticidesandyou/spring%2003/cca%20factsheet.pdf*

Railway Tie Association. 2015. *Information, Education, Research & Development, Stewardship. http://www.rta.org/*

University of Idaho. 2015. *Idaho Forestry Best Management Practices*. Moscow, ID: College of Natural Resources. *http://www.uidaho.edu/extension/idahoforestrybmps/*

BMP 86: Nonstorm Water Discharges to Drains

Description

Nonstorm water discharge can occur via an illicit connection, which is any nonapproved physical connection to a publicly maintained storm drain system, or via illegal dumping into a storm drain (Figure 204). Nonstorm water discharges may be composed of solids or liquids that have not been permitted by the public entity responsible for operating and maintaining the storm water system. Facilities subject to EPA storm water permit regulations may be required to certify that the storm water collection system has been tested or evaluated for the presence of nonstorm water discharges.

Figure 204. Messages on storm drain inlets can prevent illicit discharges.

Nonstorm water discharges to the storm water collection system may include any water used directly in the manufacturing process (process wastewater), used motor oil, radiator coolant, antifreeze, outdoor secondary containment water, vehicle and equipment washwater, sink and drinking fountain wastewater, sanitary wastes, or other wastewaters. Section 3.10.7 "Construction Disposal Alternatives" provides more information on properly disposing materials.

Primary BMP Functions and Controls

☒ Construction	☒ Permanent
☐ Erosion Control	☐ Sediment Control
☒ Source Control	☐ Flood Control
☐ Filtration	☐ Infiltration

Typical Effectiveness for Targeted Pollutants

●	Sediment
◖	Phosphorus
◖	Metals
○	Bacteria
◖	Hydrocarbons
◖	Litter

Other BMP Considerations

Relative Cost	$
Maintenance Requirements	Medium
Ease of Installation	Easy
Freeze/Thaw Resistance	N/A
Max. Tributary Drainage Area	N/A
Max. Upstream Slope	N/A
NRCS Soil Group	N/A
Min. Ground Water Separation	N/A
Min. Bedrock Separation	N/A

Applicability

This BMP applies to all storm water management systems. Nonstorm water discharges may happen at any time during the life of a system and reporting such discharges should occur whenever discovered.

While nonstorm water discharge control measures are usually implemented by municipal governments, they may also be relevant to campus-scale developments, private homeowner associations, or industrial operations.

Limitations

- Many facilities do not have accurate, up-to-date schematic drawings of existing drainage networks and associated contributing areas, which makes evaluating the system difficult.
- Video or visual inspections can identify illicit connections to the storm sewer, but further testing is sometimes required (e.g., dye, smoke, and laboratory testing) to identify sources.

Design Basis

Practice guidelines for preventing nonstorm water discharges to drains include three general categories: identification, eliminating illicit connections, and public education. Proper spill prevention, control, and response measures (BMP 46) are important for preventing storm water contamination from accidental spills. Using an integrated municipal storm water and wastewater planning approach can prevent illicit connections and facilitate sustainable and comprehensive solutions that protect human health and improve water quality. See EPA's Integrated Municipal Storm Water and Wastewater Planning at *https://www.epa.gov/npdes/national-menu-best-management-practices-bmps-storm water-documents.*

Identify Nonstorm Water Discharges

The following approaches may identify nonstorm water discharges or illicit connections to a storm water system:

- **On-site inspection**—Inspect each discharge point during dry weather. While on site, review both visual factors (i.e., staining or unusual colors in runoff, traces of oil, excessive sediment, and abnormally high flow) and any unusual odors present at the outfall. Storm water runoff may continue for 3 days or more after an event, and ground water may infiltrate into the underground storm water collection system. Understand these drainage aspects in addition to base flow conditions when visually assessing a system.
- **Field survey**—Inspect the contributing drainage area for structures, buildings, industrial areas, and impervious surfaces located near the nonstorm water discharge location. Note where these contributing areas join the storm drain system in question.
- **Piping schematic review**—Review *as-built* piping schematics for all systems to determine if there are any connections to the storm water collection system. The piping schematic is a map of pipes and drainage systems used to carry wastewater, cooling water, and sanitary wastes. Drawings may need to be obtained from a variety of sources, such as municipalities, state agencies, and city and county building departments.
- **Smoke testing**—Use smoke testing of wastewater and storm water collection systems to detect connections between the two systems. During dry weather, the storm water collection system is filled with smoke and then traced to sources. The appearance of smoke at the base of a toilet indicates a possible connection between the sanitary and the storm water systems.
- **Dye testing**—Perform a dye test by releasing a dye into either the sanitary or process wastewater system and examine the discharge points from the storm water collection system for the dye color.
- **Video inspection**—Use mobile video cameras remotely through storm water system lines to observe possible illicit connections into storm water systems. Public works staff can observe and record the videos and note any visible illegal connections.

- **Laboratory testing**—Sample water quality for high levels of fecal coliform, petroleum hydrocarbons, or other contaminants to determine the source of the nonstorm water discharge. Follow appropriate sampling standards to ensure accurate results.

Eliminate Illicit Connections

- If illicit connections are identified, promptly notify the owner of the illicit connection or discharge incidents at the time of discovery and remove the nonstorm water discharge. Prevent any new illicit connections by identifying where the appropriate connection should be made or what disposal alternative is available.
- Replumb sewer lines and properly connect the lines to the sanitary sewer system if applicable.
- Isolate problem areas from the storm water system.
- Plug illicit discharge points.
- Document that nonstorm water discharges have been eliminated by recording tests performed, methods used, dates of testing, and any on-site drainage points observed.

The following can prevent any new illicit connections:

- Ensure that existing building and plumbing codes prohibit physical connections of nonstorm water discharges to the storm drain system.
- Have a permit program in place to review and approve any proposed connection into a storm sewer.
- Require visual inspection of new developments or redevelopments during the construction phase to ensure that proper plumbing connections are implemented. Train field inspectors and develop field inspection procedures that prevent new illicit connections of sanitary sewer lines to storm sewers.

Public Education

Public education and awareness reduce illegal dumping and some types of illicit discharges. For example, many citizens may not be aware that storm water systems drain to streams rather than wastewater treatment plants or may not be aware of the environmental damage caused by discharging soapy water, pet waste, and other household wastes into the storm system. Developing a public outreach strategy is a key aspect in meeting the minimum measures for public education and public involvement required by MS4 permits. Per the EPA minimum measure, MS4 entities must complete the following:

- Distribute educational materials to the community or
- Conduct equivalent outreach activities about the impacts of storm water discharges on water bodies and the steps that the public can take to reduce pollutants in storm water runoff.

Public outreach strategies must reach the following:

- Public agencies and officials
- Program managers, inspectors, and municipal employees
- Business and industry owners and operators
- Nongovernmental organizations and volunteers
- Students, citizens, and the general public

Outreach is used to increase awareness and education, or inspire action. A good campaign is tailored to a selected audience, addresses current practices, and motivates change. Local governments should choose those public awareness and education approaches most effective for their communities and the intended audiences:

- Enact and publicize information from ordinances that prohibit illegal dumping and illicit connections. Many local governments already have such ordinances; however, citizens are often unaware of them. Publicity, including news articles, door hangers, utility bill inserts, radio or TV advertisements, or website highlights, increase awareness. These efforts are particularly effective when connected to a specific water quality problem such as a nearby stream or lake impairments due to bacteria and/or nutrients.
- Community-based social marketing programs can effectively invoke change through social pressure. Social marketing can be used to understand the audience, develop an effective message, and get the message out.
- Use storm drain stenciling of messages, such as "No Dumping - Drains to Stream/River/Lake," on storm drains to discourage dumping directly into the storm drain.
- Provide citizens with readily available contact information to report illegal dumping. Install a *hotline* telephone number to handle calls from citizens reporting illegal dumping or accidental spills.
- Create brochures and other guidance related to illegal discharges to the storm drain. Educational efforts should alert business owners that nonstorm water discharges are not allowed and provide guidance on BMPs to implement. For example, power washing discharges are process wastewater that may not be discharged to the storm sewer system. When power washing is conducted, storm drain inlet protection, wet vacuuming, collection systems, and/or other appropriate measures to prevent washwater from entering the storm drain system should be implemented.
- Provide well-marked proper disposal or collection sites for wastewater.
- Provide information on proper disposal of hazardous waste and local programs for hazardous waste collection or drop-off.
- Employee training (BMP 91) should especially emphasize proper disposal of nonstorm water discharges.

Maintenance

Periodically inspect and maintain storm drain inlets, especially those with a history of illicit connections. Clean out catch basins so that accumulated pollutants do not wash down the storm drains.

Additional Resources

Cunningham Environmental Consulting, 2011. *Social Marketing Strategies for Stormwater Business Outreach: Summary of Recent Research in the Puget Sound Region: Assistance for Developing and Implementing Local Programs*. Bainbridge Island, WA.

EPA (US Environmental Protection Agency). 2010. *Getting in Step: A Guide for Conducting Watershed Outreach Campaigns* 3rd ed. Washington, DC: Office of Water. EPA 841-B-10-002. *http://cfpub.epa.gov/npstbx/files/getnstepguide.pdf*

EPA (US Environmental Protection Agency). 2011. *Nonpoint Source (NPS) Outreach Toolbox.* *http://cfpub.epa.gov/npstbx/*

Washington State Department of Ecology. 2012. *Stormwater Management Manual for Western Washington.* Lacey, WA. Publ. 12-10-030. *http://www.ecy.wa.gov/programs/wq/stormwater/manual.html*

BMP 87: Outdoor Loading and Unloading of Materials

Description

Often the loading and unloading of materials must take place outside. Material loading or unloading can occur off vehicles, from containers, or by direct liquid transfer. Materials spilled, leaked, or lost during loading and unloading may collect in the soil or on other surfaces and be carried away by storm water runoff. Additionally, rainfall may wash pollutants from machinery used to unload or move materials.

To prevent these pollutants from entering storm water runoff, limit the exposure of material to rainfall, prevent storm water run-on, check equipment regularly for leaks, and contain spills during transfer operations (Figure 205).

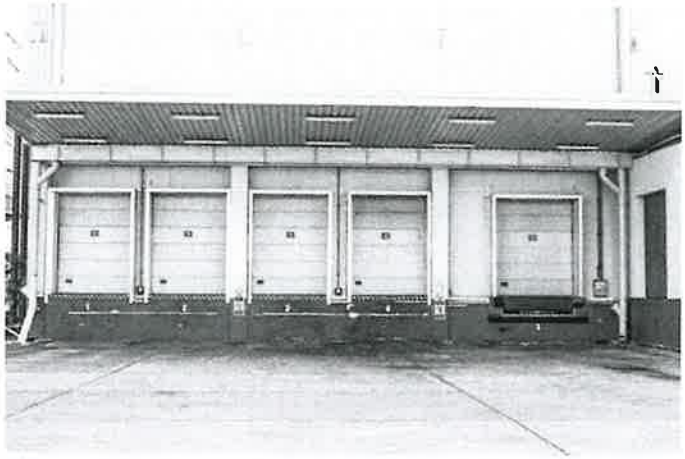


Figure 205. Covered loading dock prevents storm water contamination.

Applicability

This BMP applies to all construction, industrial, and commercial activities that require outdoor loading and unloading of materials.

Limitations

Space and time limitations may prevent all transfers from being performed indoors or in covered areas, such as a loading dock (BMP 81: Loading Dock Design Features). Dry weather transfers are not always possible.

Design Basis

Loading or unloading of liquids should occur indoors whenever possible to reduce the chance of spills that are not completely contained from entering storm water runoff. Direct discharges from outdoor loading areas to the sanitary sewer or treatment plant, or treat in a manner consistent with local wastewater treatment plant requirements and permit requirements.

Primary BMP Functions and Controls

☒ Construction	☒ Permanent
☐ Erosion Control	☐ Sediment Control
☒ Source Control	☐ Flood Control
☐ Filtration	☐ Infiltration

Typical Effectiveness for Targeted Pollutants

○	Sediment
○	Phosphorus
◖	Metals
○	Bacteria
◖	Hydrocarbons
◖	Litter

Other BMP Considerations

Relative Cost	$
Maintenance Requirements	Medium
Ease of Installation	Easy
Freeze/Thaw Resistance	N/A
Max. Tributary Drainage Area	N/A
Max. Upstream Slope	N/A
NRCS Soil Group	ABCD
Min. Ground Water Separation	N/A
Min. Bedrock Separation	N/A

Use the following guidelines for outdoor loading and unloading of materials:

- Whenever possible, cover outside loading and unloading docks to reduce exposure of materials to rain.
- Use overhangs or door skirts that enclose the trailer.
- Park tank trucks in designated areas where spills or leaks can be contained if necessary while materials are being delivered.
- Design loading and unloading areas (BMP 81) to prevent storm water run-on. Use design techniques such as grading or berming (BMP 70) and position roof downspouts to direct storm water away from loading and unloading areas.
- Have an emergency spill cleanup plan readily available and train employees (BMP 91) in spill containment and cleanup (BMP 46).
- Establish disposal areas for cleanup materials next to or near each loading and unloading area.
- Use drip pans under hoses and pipe connections during liquid transfer operations.
- Train employees, such as fork lift drivers, to properly transfer materials and contain and clean up spills.

For loading and unloading tank trucks to aboveground and belowground storage tanks, the following procedures should be used:

- Pave and grade the sloped or recessed loading area to direct flow toward either a central collection point, an inlet with a shutoff valve, or toward a dead-end holding tank.
- Design the transfer area to prevent run-on of storm water from adjacent areas. Slope the pad and berm around the uphill side of the transfer area to reduce run-on.
- Design the transfer area to prevent runoff of spilled liquids from the area.
- Replace aged or worn valves and piping. Select a style of valve that can be safely and effectively operated given the constraints of the location and product.
- Post signage at the point of delivery describing the proper procedure for opening and shutting valves and valve safety locks to ensure valves are fully turned off and to prevent opening by accident or vandalism.

For loading and unloading rail cars to outside storage tanks, use the following procedures:

- Place appropriate spill control equipment at locations where spillage may occur, such as hose connections, hose reels, and filler nozzles. Use drip pans when making or breaking connections.
- Install drip pan systems between the rails to collect spillage from tank cars.
- Remove solid debris as soon as operations permit.
- Avoid hosing off paved surfaces. Use a vacuum truck or sweeper for large areas.

Maintenance

The following maintenance activities should be conducted on a regular basis:

- Conduct facility inspections and make repairs as necessary. The frequency of repairs may depend on the age of the facility.
- Check loading and unloading equipment for leaks in valves, pumps, flanges, and connections.

- Inspect access roads and parking lots to identify and clean up spills on an on-going basis.
- Inspect the holding tank to ensure it is not overfilled.
- Test the holding tank contents before discharge or disposal.
- Inspect and maintain berms, curbs, dikes, or slopes.

Additional Resources

Central Oregon Intergovernmental Council. 2010. *Central Oregon Stormwater Manual*. Bend, OR.

Colorado UDFCD (Colorado Urban Drainage and Flood Control District). 2010. *Urban Storm Drainage Criteria Manual, Volume 3 Best Management Practices*. Denver, CO. *http://udfcd.org/wp-content/uploads/2014/07/Title-Page.pdf*

ITD (Idaho Transportation Department). 2014. *Best Management Practices.* Boise, ID: ITD.

Washington State Department of Ecology. 2012. *Stormwater Management Manual for Western Washington*. Lacey, WA. Publ. 12-10-030. *http://www.ecy.wa.gov/programs/wq/stormwater/manual.html*

BMP 88: Outdoor Process Equipment

Description

Industrial and commercial outdoor process activities that may adversely impact storm water runoff include, but are not limited to, compressors, cooling towers, air conditioners, rock grinding or crushing, painting or coating, grinding or sanding, parts degreasing or cleaning, and wastewater and solid waste treatment and disposal. Proper outdoor process equipment operations and maintenance prevents storm water contamination from substances such as toxic compounds, oil and grease, heavy metals, nutrients, suspended solids, and other pollutants (Figure 206).

Figure 206. Cooling tower at the Amalgamated Sugar Company in Nampa, Idaho.

Storm water runoff from certain industrial facilities may require coverage under the Multi-Sector General Permit administered by EPA. Refer to the following EPA website for information (EPA 2015): *https://www.epa.gov/sites/production/files/2015-10/documents/msgp2015_finalpermit.pdf*.

Primary BMP Functions and Controls

☐ Construction	☒ Permanent
☐ Erosion Control	☐ Sediment Control
☒ Source Control	☐ Flood Control
☐ Filtration	☐ Infiltration

Typical Effectiveness for Targeted Pollutants

◖	Sediment
○	Phosphorus
◖	Metals
○	Bacteria
◖	Hydrocarbons
○	Litter

Other BMP Considerations

Relative Cost	$$
Maintenance Requirements	Low
Ease of Installation	Easy
Freeze/Thaw Resistance	N/A
Max. Tributary Drainage Area	N/A
Max. Upstream Slope	N/A
NRCS Soil Group	ABCD
Min. Ground Water Separation	N/A
Min. Bedrock Separation	N/A

Applicability

The guidelines in this BMP apply to all existing and planned industrial and commercial areas.

Limitations

Space and cost limitations may prevent enclosing or covering equipment. All outdoor storage buildings, coverings, and awnings should meet building and fire code requirements.

Design Basis

In outdoor process equipment areas, infiltration may be regulated and should be managed appropriately and in many cases, containment may be required. Discharges from these activities should be prevented, collected, and diverted from the storm water management systems. The following guidelines apply for proper handling of outdoor process equipment wastes:

- Identify all equipment and activities that may impact storm water.
- Whenever possible, move the activity indoors.
- Perform an activity only during dry periods.
- Substitute nontoxic materials for toxic materials; consider implementing a substance substitution program. More information on substance substitution is found at
  - Chemhat: *http://www.chemhat.org/*; Substitution Portal: *http://www.subsport.eu/*
  - State of Washington, Department of Ecology Quick Chemical Assessment Tool: *https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Preventing-hazardous-waste-pollution/Safer-alternatives/Quick-tool-for-assessing-chemicals*
  - Green Screen: *http://www.greenscreenchemicals.org/*
- Alter the activity to prevent exposure of pollutants to storm water.
- Cover the area with permanent or temporary roofing.
- If an area used by an activity is large enough to make full enclosure prohibitively expensive, provide just a roof and leave the sides open. Providing a roof eliminates the need for ventilation and lighting systems, yet still provides some protection from rain.
- Use ground cloths and/or drip pans where applicable.
- Cover exposed outdoor open process tanks (i.e., dip tanks) when they are not in use.
- Minimize storm water contact with outside manufacturing operations with berming (BMP 70) and drainage routing.
- Connect the process equipment area, through floor drains, to the sanitary sewer or to the facility wastewater treatment system. Contact the wastewater treatment plant staff, and obtain any applicable permits before connecting to a wastewater system.
- Use storm drain inlet protection (BMP 74) to capture particulate pollutants. Do not install storm drains in areas used for equipment repair.
- Store and maintain appropriate spill cleanup materials in a location known to all employees. Ensure employees are trained (BMP 91) in spill control plan and cleanup procedures, as well as storm water discharge prohibitions. Document training using a log or another method. Air compressors and other equipment sometimes produce small quantities of blowdown water that can contain lubricating oil and other pollutants. Blowdown water may not be discharged to the storm drain. Connect the blowdown to the sanitary sewer (with prior approval from the wastewater treatment plant) and place drip pans beneath any leaks.
- Condensate on exterior surfaces or compressors, building cooling equipment, and other machinery may be directed to the storm drain. Route condensate to a storm drain so it does not pick up pollutants as it flows across the site. Contact wastewater treatment plant staff for information on what can be discharged to the sanitary sewer system.
- Recycle wastes whenever possible instead of disposing unwanted materials.
- Separate wastes for easier recycling. Keep hazardous and nonhazardous wastes separate, do not mix used oil and solvents, and keep chlorinated solvents separate from nonchlorinated solvents.

Maintenance

- Perform routine preventive maintenance, including checking process equipment for leaks, malfunctions, staining on and around equipment, and other evidence of leaks.
- Sweep the processing area daily where applicable. Avoid hosing down and focus on dry cleaning techniques in areas where washwater can run into a storm drain.

Additional Resources

CASQA (California Stormwater Quality Association). 2014. *California Stormwater Best Management Practices Handbook: Industrial and Commercial*. Menlo Park, CA. *http://www.casqa.org/*

Lake Forest (City of Lake Forest, CA.) 2015. *Outdoor Process Equipment Operations and Maintenance*. Industrial and Commercial Business Activities.

Weber County (Weber County, Utah). 2009. *Industrial BMPs*. *http://www.webercountyutah.gov/Engineering/swm/*

BMP 89: Contaminated Soil Management

Description

Soil on construction, highly urbanized, or industrial sites can become contaminated with chemicals, hydrocarbons, oils, or other materials from spills, illicit discharges, or leaks from underground storage tanks. Properly managing contaminated soil prevents pollution of storm water runoff (Figure 207).

Figure 207. Soil contamination.

Applicability

Soil at construction, highly urbanized, or industrial sites must be managed if the soil becomes contaminated.

Limitations

Contaminated soil that cannot be managed on site must be disposed off site by a licensed hazardous waste hauler, which can be costly. The presence of contaminated soil can indicate contaminated ground water, requiring costly cleanup by a certified professional.

Design Basis

Storm water pollution from contaminated soil can be prevented or reduced by conducting preconstruction surveys, inspecting excavations regularly, and remediating contaminated soil promptly. Procedures and practices presented in this BMP are general, so the contractor should identify appropriate practices and procedures for the specific contaminates known to exist or discovered on site. Site cleanup may also require involving state and federal agencies. Owners and contractors should ensure their actions are consistent with any cleanup plans and agency directives. For more information, contact the local DEQ office at *https://www.deq.idaho.gov/regional-offices/* and for contaminated site cleanup and other waste management issues, visit: *https://www.deq.idaho.gov/waste-management-and-remediation/sampling-investigation-and-cleanup/*

Primary BMP Functions and Controls

☒ Construction	☐ Permanent
☐ Erosion Control	☒ Sediment Control
☒ Source Control	☐ Flood Control
☐ Filtration	☐ Infiltration

Typical Effectiveness for Targeted Pollutants

●	Sediment
◖	Phosphorus
◖	Metals
○	Bacteria
◖	Hydrocarbons
○	Litter

Other BMP Considerations

Relative Cost	$
Maintenance Requirements	Medium
Ease of Installation	Easy
Freeze/Thaw Resistance	N/A
Max. Tributary Drainage Area	N/A
Max. Upstream Slope	N/A
NRCS Soil Group	ABCD
Min. Ground Water Separation	N/A
Min. Bedrock Separation	N/A

Prevent Contamination

Preventing leaks and spills of hazardous materials (BMP 46) on site can avoid costly cleanup and lost project time. Review measures to prevent spills, such as those described in the project SWPPP, SPCC plan, and permit requirements, and keep appropriate materials on hand to reduce the impact if a spill should occur. Inform personnel of the importance of spill prevention before work begins. Contamination prevention is much less expensive than soil removal and disposal.

Identify Contaminated Soil

Conduct a thorough, preconstruction survey inspection of the site, and review documents related to the site. These documents may include history of land use on the site; records of spills, accidents, or unauthorized dumping; or agency records of past cleanup efforts. Inspect excavations during construction activities regularly, especially on sites more likely to be contaminated based on past site use. Look for signs of contaminated soils or surfaces:

- Noticeable spills
- Leaking containers or equipment
- Discolored soil
- Differences in soil properties
- Unexpected odors
- Underground tanks, pipes, and debris
- Acid or alkaline solutions from exposed soil or rock formations high in acid or alkaline forming elements.

Initial investigation of suspected soils should be sampled using an appropriate protocol (e.g., soil sampling guide: *http://www.epa.gov/OUST/cat/mason.pdf* or DEQ's Brownfields program: *https://www.deq.idaho.gov/waste-management-and-remediation/sampling-investigation-and-cleanup/brownfields-in-idaho/*) and analyzed at a certified laboratory. After this initial effort, more intensive sampling should be guided by a sampling and analysis plan and a quality assurance plan with possible oversight from state or federal agencies.

Handling and Disposing of Contaminated Soil

If contaminated soil is found on site, work with the appropriate regulatory agencies and follow state and federal regulations to develop options for treatment and/or disposal. Agencies include the US Department of Transportation, EPA, OSHA, DEQ, and state or local regulatory authorities. The following are general guidelines for handling contaminated soil:

- Minimize on-site storage of contaminated soil and remove and dispose of the soil properly according to applicable regulations (section 3.10.7).
- Whenever possible, avoid temporarily stockpiling contaminated soil on site. When stockpiling is necessary, use the following precautions:
  - Store the contaminated soil in a covered area or with plastic sheeting or tarps.

- Berm (BMP 70) and trench around the stockpile to prevent storm water run-on and runoff. Place stockpiles as far away from storm drains and waterways as the worksite allows.
- Some contaminants require personal protective equipment (PPE) and other actions to prevent workers from becoming contaminated. Train workers to use these measures before handling contaminated soil and have the necessary PPE readily available.

Construction and Maintenance

The water pollution control manager, foreman, or construction superintendent should monitor contaminated soil storage and disposal. Air quality should also be monitored continuously during excavation operations. Well-educated and trained personnel (BMP 91) are essential for properly managing contaminated soil.

Additional Resources

CASQA California Stormwater Quality Association. 2004. *California Stormwater Best Management Practices Handbook: New Development and Redevelopment*. Menlo Park, CA. *http://www.casqa.org/*

ITD (Idaho Transportation Department). 2014. *Best Management Practices.* Boise, ID: ITD.

BMP 90: Building Repair, Remodeling, and Construction

Description

Building repair, remodeling, and construction activities are common on any site, including small, single-family home construction projects and large industrial sites. Building activities may vary from minor building repair to major remodeling or construction of new facilities. Many of these activities generate contaminants that may pollute storm water. Solvents, paints, paint and varnish removers, finishing residues, kerosene, adhesive residues, and asbestos materials are examples of contaminants present during repair and remodeling activities (Figure 208).

Figure 208. Lead-based paint removal.

Introducing these pollutants into storm water runoff may be prevented by using soil erosion controls, enclosing or covering building material storage areas, using good housekeeping practices, using safer alternative products, and training employees.

Applicability

These BMP guidelines apply wherever discharge of pollutants to storm water from building repair, remodeling, and construction is possible.

Limitations

- Hazardous waste that cannot be reused or recycled should be disposed of by a licensed hazardous waste hauler or taken to a hazardous waste disposal facility.
- CESQG should either dispose of the waste in the landfill or at a household hazardous waste collection facility that may take this type of waste for a fee. CESQGs generate 100 kilograms or less per month of hazardous waste or 1 kilogram or less per month of acutely hazardous waste.

Primary BMP Functions and Controls

☒ Construction	☐ Permanent
☐ Erosion Control	☒ Sediment Control
☒ Source Control	☐ Flood Control
☐ Filtration	☐ Infiltration

Typical Effectiveness for Targeted Pollutants

●	Sediment
○	Phosphorus
◖	Metals
○	Bacteria
◖	Hydrocarbons
◖	Litter

Other BMP Considerations

Relative Cost	$
Maintenance Requirements	Medium
Ease of Installation	Easy
Freeze/Thaw Resistance	N/A
Max. Tributary Drainage Area	N/A
Max. Upstream Slope	N/A
NRCS Soil Group	N/A
Min. Ground Water Separation	N/A
Min. Bedrock Separation	N/A

For more information on CESQG requirements, see 40 CFR 261.5 at *http://www.ecfr.gov/cgi-bin/text-idx?SID=fd0088f229a2b010b961949aabfbef41&mc=true&node=pt40.26.261&rgn=div5#se40.26.261_15*.

- Safer alternative products may not be available, suitable, or effective in every case.
- Physical site constraints such as site layout, square footage, and terrain may be a limiting factor when attempting to implement BMPs.

Design Basis

The following housekeeping practices reduce the risk of storm water contamination from building repair, remodeling, and construction activities.

Good Housekeeping

- Keep the work site clean and orderly. Straighten up and sweep the area regularly to remove debris. Avoid hosing down the area to a storm drain. Educate employees on proper housekeeping practices (BMP 91: Employee Training).
- Reuse and recycle construction material when possible.
- Inform on-site contractors of company policy and include appropriate provisions in the contract to ensure proper housekeeping and disposal practices are implemented.
- Advise truck drivers to not wash vehicles over the storm drain. Have a designated wash area that does not drain to a storm drain (BMP 84: Vehicle and Equipment Cleaning, Maintenance, and Repair). Put an impermeable tarp over wood, gravel, or other material piles. Sweep up wood chips, paint chips, and other residues daily, and conduct a thorough cleanup at the end of the project (BMP 77: Outdoor Storage).
- Use soil erosion control techniques, such as matting (BMP 54), mulching (BMP 52), or soil binders (BMP 55), if bare ground is temporarily exposed.
- Store and dispose of waste materials properly. Sections 3.10.5–3.10.7 provide disposal alternatives. Many old buildings contain asbestos in wall texture, flooring, paint, caulking, or roofing that must be removed and disposed of properly by qualified personnel. To determine if asbestos is present, qualified personnel should take a sample of the material to a lab for testing.
- Use safer alternative products such as those labeled green, nontoxic, or organic.

Soil and Erosion Control

- If the work involves exposing large areas of soil, employ the appropriate soil erosion and control techniques such as BMP 32: Landscaping.
- If old buildings are being torn down and not replaced in the near future, stabilize the site using measures described in BMP 90: Building, Repair, Remodeling, and Construction.

Painting Operations

- Lead paint, which is a hazard to children, may be present in buildings constructed before 1978. Reduce the risk of lead exposure by hiring a certified lead inspector to check for lead paint in the work area. When cutting into surfaces painted with lead paint, even if the paint is covered by layers of newer paint, creating hazardous lead dust is a risk. Homeowners

conducting building renovations should set up safely, control the dust, and clean up completely. To minimize lead hazards, hire a trained lead-safe certified renovation, repair, and painting contractor. These contractors have been trained in special methods to minimize dust and clean up thoroughly, reducing the chance of lead contamination. To permanently eliminate the lead, hire a trained and certified lead abatement contractor to abate, or remove, the lead from the area before work begins.

- If painting requires scraping or sandblasting the existing surface, use an impermeable ground cloth to collect the chips. Dispose of the residue properly. If the paint contains lead or tributyl tin, it is considered a hazardous waste and should be disposed of properly.
- Spray painting operations should be properly enclosed or covered to avoid drift. Use temporary scaffolding to hang drop cloths or draperies to prevent drift. Use application equipment that minimizes overspray. Avoid spray painting and sandblasting on windy days. Be aware of air quality restrictions on spray paints that contain volatile chemicals. Substitute water-based spray paints for paints that contain volatile chemicals.
- While ensuring proper ventilation, mix paint indoors so that if a spill occurs, the spill will not be exposed to rain and consequently washed into a storm drain. Even during dry weather, a spill cleanup will never be 100% effective. Dried paint will eventually erode from a surface and wash away in storms. Alternatively, mix paint outdoors on a disposable, impermeable mat with an edge to prevent spills.
- If using water-based paints, clean the equipment in a sink connected to the sanitary sewer. Clean up oil-based paint where waste paint and solvents can be collected and handled as small quantity hazardous waste. Do not pour the waste paint down a sink or storm drain. Properly store leftover paints for further use or properly dispose of them. Section 3.10.7, "Construction Disposal Alternatives" provides more information.
- Store paints, solvents, or others similar materials in a covered area if these materials must be left outdoors. If welding occurs in the area, keep paints and solvents in explosion proof cabinets or containers.
- Use ground or drop cloths under painting, scraping, and sandblasting activities. Use either a ground cloth or oversized tub for spill containment when mixing paint and cleaning tools.

Wood Preservatives, Pavement Seal Coating, and Other Outdoor Surface Treatments

- Quickly clean up spills when using sealants on wood, pavement, or roofs. When repairing roofs, line the gutters with rags, or if small particles have accumulated in the gutter, either sweep or wash out the gutter and trap the particles at the outlet of the downspout. A sock or geofabric placed over the outlet may effectively trap the materials. Remove the sock after completing the job and dispose in the trash.
- If the downspout is tight-lined, place a temporary plug at the first convenient point in the storm drain and pump out the water with a vactor truck.

Storm Drainage System

- During modifications or upgrades if it is discovered that floor drains are not connected to a sanitary sewer system and the potential for contaminant discharge exist, permanently cap the drains.

- Evaluate the surrounding storm drainage system—the remodel or addition may necessitate an upgrade.
- Ensure that nearby storm drains are clearly marked to minimize the chance of inadvertent disposal of residual paints and other liquids (BMP 86: Nonstorm water Discharges to Drains).
- After construction is completed, clean the storm drain system.
- Use a storm drain cover, inlet protection (BMP 74) or other runoff control to keep pollutants, dust, sediment, or washwater from entering the storm drain system.

Maintenance

When implementing these BMPs, use the respective maintenance guidelines.

Additional Resources

EPA (US Environmental Protection Agency). 2015. *Categories of Hazardous Waste Generators.* *http://www2.epa.gov/hwgenerators/categories-hazardous-waste-generators#cesqg*

EPA (US Environmental Protection Agency). 2015. *Renovation, Repair, and Painting Program.* Lead. *http://www2.epa.gov/lead/renovation-repair-and-painting-program*

ITD (Idaho Transportation Department). 2014. *Best Management Practices.* Boise, ID: ITD.

BMP 91: Employee Training

Description

Employee training ensures proper installation, maintenance, and subsequent operational success of storm water BMPs. In-house employee training programs are established to teach employees about storm water management, potential contaminant sources, and BMPs (Figure 209).

Programs should provide personnel with an understanding of SWPPP for municipal facilities or construction sites as appropriate. Cover BMP operation and maintenance, safety hazards, practices for preventing discharges, and procedures for responding quickly and properly to toxic and hazardous material incidents.

Figure 209. Employee meeting in Valley County, Idaho (*Midas Gold*).

Applicability

Employees directly involved in storm water activities or potentially polluting activities should receive general storm water and targeted BMP training tailored to their activities. Training should include municipal employees, construction personnel and supervisors, and commercial or industrial operators who oversee storm water BMPs. Education all staff, regardless of field responsibilities, about general storm water awareness and detection of illicit discharges.

Limitations

Common challenges an employee training program may encounter include the following:

- Lack of commitment from senior management
- Poor communication between all parties involved
- Lack of employee motivation
- Lack of incentive to become involved in BMP implementation

Primary BMP Functions and Controls

☒ Construction	☒ Permanent
☐ Erosion Control	☐ Sediment Control
☒ Source Control	☐ Flood Control
☐ Filtration	☐ Infiltration

Typical Effectiveness for Targeted Pollutants

- ◖ Sediment
- ◖ Phosphorus
- ◖ Metals
- ◖ Bacteria
- ◖ Hydrocarbons
- ◖ Litter

Other BMP Considerations

Relative Cost	$
Maintenance Requirements	Easy
Ease of Implementation	Easy
Freeze/Thaw Resistance	N/A
Max. Tributary Drainage Area	N/A
Max. Upstream Slope	N/A
NRCS Soil Group	N/A
Min. Ground Water Separation	N/A
Min. Bedrock Separation	N/A

Approaches and Best Management Practices

The following are specific criteria for implementing an employee training program:

- Ensure strong commitment and periodic input from senior management.
- Communicate frequently to ensure adequate understanding of the storm water management plan goals and objectives.
- Use experience from past spills to prevent future spills.
- Make employees aware of BMP monitoring and spill reporting procedures.
- Develop operating manuals and standard procedures.
- Continue education in an on-going, yearly process.

An employee training program should be an on-going, yearly process. Typically, training combines formal classroom-style programs held on an annual basis with more frequent weekly *tailgate* meetings held on site and covering general project updates and short BMP training sessions. Consider the following training suggestions:

- Integrate storm water training with existing training programs that are required for your business or municipality by other regulations such as the Hazardous Waste Operations and Emergency Response (HAZWOPER) standard (29 CFR 1910.120) and SPCC plan (40 CFR 112). Many commercial and industrial facilities have employee training programs that address health- and safety-related issues. Training on storm water management and BMPs can and should be incorporated into these programs.
- In Section 3.10.7, "Construction Disposal Alternatives," use Table 11 to train employees in proper and consistent methods for disposing of materials.
- Check employees' work practices periodically to ensure BMPs are properly implemented. Post informational and reminder signs in common work areas and stencil "DO NOT DUMP WASTE" messages on storm drains.
- Be aware that site owners are also responsible for customer activities. Ask customers to avoid discarding liquids into trashcans or liquids or solids into storm drains.
- Employ ongoing education through
  - Posters and bulletin boards
  - Employee meetings and training courses
  - Field training programs followed by a discussion of site-specific BMPs by trained personnel

Maintenance

After training, managers should periodically check the employees work to ensure that BMPs are being installed and maintained properly. Ensure facility SWPPP and BMP guidance documents are available to employees after training is completed.

Additional Resources

CASQA California Stormwater Quality Association. 2004. *California Stormwater Best Management Practices Handbook: New Development and Redevelopment*. Menlo Park, CA. *http://www.casqa.org/*

EPA (US Environmental Protection Agency). 1999. *Employee Training*. Stormwater Management Fact Sheet. *http://www3.epa.gov/npdes/pubs/empltrng.pdf*

EPA (US Environmental Protection Agency). 2015. *Municipal Employee Training and Education.* National Pollutant Discharge Elimination System (NPDES). *https://www.epa.gov/npdes/tmdl-npdes-permits-training-user-guides*

BMP 92: Restaurant Control Practices

Description

Common restaurant pollutants may include high-use parking areas, outdoor storage of solid and liquid waste, oil and grease disposal, restaurant cooking vent filters, and cleaning materials contaminated with food waste on site. Proper restaurant management practices can prevent storm water contamination from restaurant waste (Figure 210).

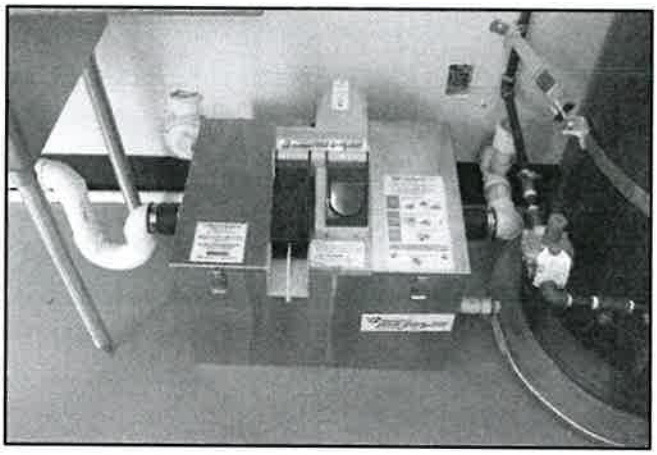


Figure 210. Kitchen grease trap (City of Meridian 2016).

Applicability

Businesses that provide prepared food to the public including drive-through facilities, grocery stores, and food trucks.

Limitations

Common challenges to encourage proper restaurant BMPs include the following:

- Lack of commitment from management
- Poor communication between full-time and part-time, and seasonal staff
- Lack of employee motivation
- No plan for proper disposal of wastes

Primary BMP Functions and Controls

☐ Construction	☒ Permanent
☐ Erosion Control	☐ Sediment Control
☒ Source Control	☐ Flood Control
☐ Filtration	☐ Infiltration

Typical Effectiveness for Targeted Pollutants

○	Sediment
●	Phosphorus
◖	Metals
◖	Bacteria
○	Hydrocarbons
○	Litter

Other BMP Considerations

Relative Cost	$$
Maintenance Requirements	Medium
Ease of Installation	Medium
Freeze/Thaw Resistance	N/A
Max. Tributary Drainage Area	N/A
Max. Upstream Slope	N/A
NRCS Soil Group	N/A
Min. Ground Water Separation	N/A
Min. Bedrock Separation	N/A

Best Practices and Guidelines

Conduct Employee and Client Education

Employees can prevent pollution when they are properly trained (BMP 91) and aware of BMPs. In the employee training program, promote the following BMPs:

- Inspect storage containers regularly and keep in good condition.
- Place materials inside rigid, durable, water-tight, and rodent-proof containers with tight fitting covers.

- Store materials inside a building or build a covered area paved and designed to prevent runoff from entering storm drains (BMP 77: Outdoor Storage).
- Place plastic sheeting over materials or containers and secure the cover with ties and weighted objects. (Not appropriate for storing liquids.)
- Post BMPs where employees and customers can see them. Showing customers you protect the environment is a good form of public outreach and education.
- Explain BMPs to other food businesses through merchant associations or chambers of commerce. Raise employee and customer awareness by stenciling "DO NOT DUMP WASTE" on storm drains near the work place.

Cleaning Restaurant Floor Mats and Exhaust Filters

- Do not wash restaurant equipment outdoors or allow washwater to enter a storm drain. Clean floor mats, grills, and filters inside a mop sink that discharges to an approved grease interception device (BMP 15: Oil and Water Separators). Ensure designated wash areas are properly connected to the sanitary sewer system.
- Never clean greasy equipment in an area where wastewater can flow to the gutter, storm drain, or street.
- Cover, repair, or replace leaky dumpsters and compactors and have dedicated drains beneath the trash receptacles connected to the sanitary sewer.

Kitchen Grease

- Save oil, grease, and meat fat for recycling in tallow bins or other sealed containers. **Never pour these materials into sinks, floor drains, or storm drains**. Do not contaminate recyclable fats with waste grease from an oil and water interceptor or grease trap.
- Place "No Grease" signs above kitchen sinks and in front of dishwashers to minimize the amount of grease discharged to the grease interceptor.
- Collect excess frying grease into a separate container for proper disposal.
- Local recycling/hauling company may pick up and dispose or recycle grease and/or tallow.

Kitchen Waste Disposal

- Ensure that kitchen drains are properly connected to the sanitary sewer system.
- Purchase recycled products where possible, which also ensures a use for recyclable materials. Recycle materials that are readily recycled in your area:
  - Food waste (nongreasy, nonanimal food waste can be composted)
  - Paper and cardboard (many forms of nonchemically treated paper products may also be composted)
  - Glass
  - Plastics
  - Aluminum and tin containers
  - Wood pallets
  - Oil and grease.
- Separate wastes. Keep recyclable wastes and compost in separate containers according to the type of material if required by the local waste hauler.
- Use nondisposable products. Serve food on reusable dishware rather than paper, plastic, or Styrofoam and use cloth napkins rather than paper ones.

- Buy the least toxic products available. Look for *nontoxic*, *nonpetroleum based*, *free of ammonia, phosphates, dye or perfume*, or *readily biodegradable* on the label. Avoid chlorinated compounds, petroleum distillates, phenols, and formaldehyde. Use water-based products whenever possible. Look for and use *recycled* and *recyclable* containers.

Outdoor Areas

- Keep outside areas free of trash and debris. Clean outdoor eating areas frequently using dry cleaning methods such as sweeping or vacuuming.
- Dry sweep pavement areas including *drive-through* areas, parking lots, outdoor eating areas, and dumpster or tallow bin areas frequently. If using water for cleaning, use a mop and bucket and dispose of washwater in a mop sink or floor drain plumbed to the sanitary sewer.
- Major cleaning of exterior surfaces should include capturing all washwater and disposing it to the sanitary sewer to comply with local regulations. Do not allow washwater to enter the street gutter or storm drain.
- Do not use grassy swales for disposing washwater from equipment maintenance or routine cleaning. Grassy swales are used for infiltration of storm water only. Ensure all employees are aware washwater should not be dumped into grassy swales.
- Special events such as those held in parking lots or fields require advanced planning to accommodate wastewater or process water disposal. Remind food vendors and attendees storm water inlets and grassy swales are not available for disposing washwater or any liquid and post visible signage around these facilities.

Maintenance

Maintain (routinely clean or pump out) grease control equipment. Check interceptor regularly to ensure it is less than 25% full of grease and settled solids, contains outlet Ts, and the structure is in good operating condition. Keep records on site of grease control equipment pumping, cleaning, and maintenance.

Additional Resources

Central Oregon Intergovernmental Council. 2010. *Central Oregon Stormwater Manual*. Bend, OR.

EPA (US Environmental Protection Agency). 2012. *WaterSense at Work: Best Management Practices for Commercial and Institutional Facilities*. EPA 832-F-12-034. *https://www.epa.gov/sites/production/files/2017-02/documents/watersense-at-work_final_508c3.pdf*

Washington State Department of Ecology. 2012. *Stormwater Management Manual for Western Washington*. Lacey, WA. Publ. 12-10-030. *http://www.ecy.wa.gov/programs/wq/stormwater/manual.html*

BMP 93: Marinas

Description

Marinas may pose a threat to the health of aquatic systems and may create environmental hazards when these facilities are poorly planned or managed. Pollution from storm water runoff from marinas can be greatly reduced by properly siting marinas and using the best available design and construction practices and appropriate operation and maintenance practices (Figure 211).

Figure 211. Boat storage and moorage on Lake Coeur d'Alene, Idaho.

Applicability

This BMP applies to all marinas located adjacent and/or above a water body where materials and equipment are used on boats, docks, or other platforms.

Limitations

Certain activities commonly performed at a marina site, such as dredge and fill operations may be federally regulated under CWA §404 permit and §401 certification and may require implementing other BMPs such as dewatering (BMP 73) and sediment and erosion control (BMP 42). Other applicable permits include the EPA's Vessel General Permit and MSGP for marinas.

Primary BMP Functions and Controls

☒ Construction	☒ Permanent
☒ Erosion Control	☒ Sediment Control
☒ Source Control	☐ Flood Control
☐ Filtration	☐ Infiltration

Typical Effectiveness for Targeted Pollutants

○	Sediment
◖	Nitrogen
◖	Phosphorus
◖	Metals
◖	Bacteria
●	Hydrocarbons
●	Litter

Other BMP Considerations

Relative Cost	$ to $$$
Maintenance Requirements	Variable
Ease of Installation	Variable
Freeze/Thaw Resistance	NA
Max. Tributary Drainage Area	NA
Max. Upstream Slope	NA
NRCS Soil Group	NA
Min. Ground Water Separation	NA
Min. Bedrock Separation	NA

Design Basis

Marina Siting and Design

In selecting a marina site and developing a design, consider the need for efficient flushing of marina waters as a prime factor along with safety and vessel protection. Sites located on open water or at the mouths of streams and tributaries have higher flushing rates. Sites located in coves or toward the heads of creeks and tributaries tend to have lower flushing rates and are less suited for marina site placement.

Shoreline Stabilization

Activities associated with a marina and boating operations may cause shoreline erosion. BMP 38: Preserve Topsoil and Vegetation and BMP 41: Stabilized Construction Roads and Staging Areas will minimize shoreline erosion. These approaches have shown the greatest success in low-wave-energy areas where underlying soil types provide the stability required for plant growth. Under suitable conditions, an important advantage of vegetation is its relatively low initial cost. In areas of heavy erosion, BMP 56: Riprap Slope Protection may be required to stabilize shorelines. Identifying the cause of the erosion problem is essential for selecting the appropriate technique to address the problem.

Offshore marine structures to stabilize shorelines and navigation channels include bulkheads, jetties, and breakwaters. These structures are designed to dissipate incoming wave energy that could otherwise contribute to shoreline erosion. While structures may provide shoreline protection, unintended consequences may arise including accelerated scouring and increased erosion of unprotected downstream shorelines. Gabions (BMP 33) and energy dissipation devices (BMP 35) dissipate incoming wave energy and reduce scouring. Bulkhead retaining walls are appropriate in some circumstances but can have negative impacts on aquatic habitat due to changes they can cause to the beach profile and composition. Riprap and other quarried stone can impact the pH of the receiving waters, causing harm to native fish and wildlife. Practices incorporating more native materials, such as trees used for log-toes and matting with native vegetation, should be considered first.

Storm Water Runoff

Source controls and structural facilities can be used to control storm water runoff from a marina and include storm water filters (BMP 14), wet ponds (BMP 22), wetlands (BMP 24), infiltration basins and trenches (BMPs 17 and 18), dewatering systems (BMP 73), grassed swales and vegetated filter strips (BMPs 9 and 11), porous pavement (BMP 19), oil-grit separators (BMP 15), catch basins, catch-basin inserts (BMP 13), outdoor storage (BMP 77), and hydrodynamic separators (BMP 16).

Source control BMPs apply to activities occurring on site and reduce or control the potential for pollutant discharge. Source controls include, but are not limited to, the following:

- Using drip pans and absorbent materials for equipment and vehicles.
- Ensuring an adequate supply of spill cleanup materials available on site.
- Placing drip pans under all vehicles and equipment on docks, barges, or other structures over water bodies when the vehicle or equipment is expected to be idle for more than 1 hour.
- Providing watertight curbs or toe boards to contain spills and prevent materials, tools, and debris from leaving boats, platforms, and docks.
- Properly storing materials to prevent discharges to receiving waters via wind (BMP 77: Outdoor Storage).
- Identifying types of spill control measures to employ, including material and equipment storage. Ensure staff is trained in using the materials, deployment and access of control measures, and reporting measures.

Waste Management

Solid waste can be controlled at marinas by designating work areas for boat repair and maintenance, regularly maintaining these areas, and providing proper disposal and recycling facilities. Establishing fish cleaning areas, cleaning rules, educating boaters, and implementing fish composting where appropriate may also limit unnecessary fish waste. Offering septic pumping for slip owners manages both solid and liquid waste at marinas.

Fueling Operations

Prevent potential pollution from fueling stations by locating and designing fueling stations so spills can be contained in a limited area that provides spill containment equipment and have a spill contingency plan available. Equipment fueling information is included in BMP 83.

Fuel and oil are commonly released into surface waters during bilge pumping, fueling operations through the fuel tank air vent, and fueling from spills directly into surface waters and into boats. Oil and grease from the operating and maintaining inboard engines are a source of petroleum in bilges. Achieve petroleum control by using automatic shutoff nozzles and fuel and air separators on air vents or tank stems of inboard fuel tanks to reduce the amount of fuel spilled into surface waters during boat fueling. To minimize spills, promote using oil-absorbing materials in the bilge areas of all boats with inboard engines.

Construction Guidelines

When a marina is sited and constructed, current regulations for materials related to bulkheads, piers, and pilings should be reviewed. Guidelines are periodically updated as materials are determined to be hazardous to the environment, particularly marina coatings and treatments.

Maintenance

Boat Operations

Management practices can affect boat operations, such as prohibiting motorized vessels from areas containing important shallow-water habitat and establishing and enforcing no-wake zones to decrease turbidity.

To protect water quality, boat cleaning practices should include hand washing the boat hull on land and using phosphate-free and biodegradable detergents and cleaning compounds. If required to clean the boat hull while on the water, do so by mechanical means only (i.e., scraping, scouring, or rubbing) without using detergents or chemical cleaners.

Purge boat coolant should into a proper receptacle and replace with freshwater before launch or pickup by the owner.

General Operations

- Inspect and verify activity-based BMPs are in place before beginning marina activities. While activities associated with the BMP are under way, inspect BMPs according to general permit requirements for the associated project type and risk level. At a minimum,

inspect BMPs weekly before forecasted rain events, daily during extended rain events, and after rain events.

- Ensure employees and subcontractors implement the appropriate measures for storing and using materials and equipment.
- Inspect and maintain all associated BMPs and perimeter controls to ensure continuous protection of the water courses, including waters of the United States.
- At all times, avoid breaking up fuel spills with a detergent. Use oil absorbent materials to capture fuel spills and petroleum-based products discharged to surface waters.
- In case of spills, contact the appropriate local authority as soon as possible.

General marina operations should follow BMP 46: Spill Prevention and Control, BMP 83: Vehicle and Equipment Refueling, BMP 84: Vehicle and Equipment Cleaning, Maintenance, and Repair, BMP 50: Sanitary and Septic Waste Management, and BMP 51: Solid Waste Storage and Disposal.

Additional Resources

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BMP 94: Swimming Pool and Spa Maintenance

Description

Discharges from public or private swimming pools, spas, hot tubs, and fountains can negatively impact surface water quality if the facility is not operated and maintained properly. Pollutants of concern include chemicals used for disinfectant, such as chlorine, chloramine or bromine, as well as algaecides, diatomaceous earth, phosphorous, and nitrogen.

Water from spas and hot tubs are also at an elevated temperature. This water, if improperly discharged to the storm drain system, can have negative effects on receiving water and be toxic to terrestrial and aquatic ecosystems.

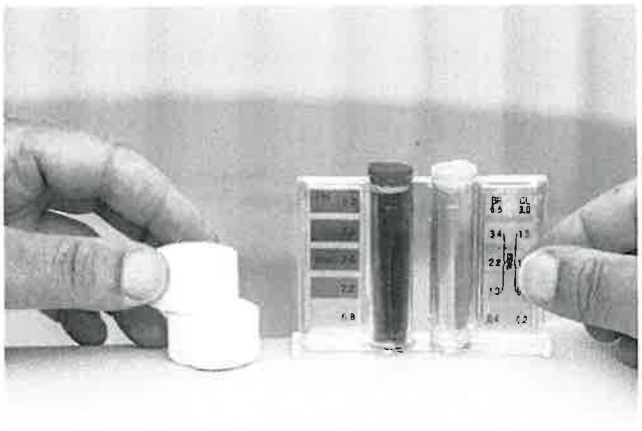

Figure 212. Check pool chemical levels.

Properly operating and maintaining pools, spas, hot tubs, and fountains used for recreational or decorative purposes will minimize potential environmental impacts (Figure 212).

BMP Classification

☐ Structural	☒ Nonstructural
☒ Permanent	☐ Construction
☐ Preconstruction/Site Planning	

Primary BMP Functions and Controls

☐ Erosion Control	☐ Sediment Control
☐ Infiltration	☐ Flood Control
☒ Site Management	☒ Source Control

Typical Effectiveness for Targeted Pollutants

○	Sediment
○	Phosphorus
◖	Metals
◖	Bacteria
◖	Hydrocarbons
○	Litter

Other BMP Considerations

Relative Initial Cost	$
Ease of Implementation	Easy
Ongoing Maintenance and Costs	Low

Applicability

These BMPs apply to all public or private pools, spas, hot tubs, and fountains that use chemicals and/or are heated.

Additionally, public swimming pools must comply with the "Rules Governing Construction & Operation of Public Swimming Pools in Idaho" (IDAPA 16.02.14) and obtain permits from the applicable Idaho public health district. Owners and operators must comply with those regulations, policies, and procedures. The following guidelines do not exempt or supersede any requirements of the regulatory agencies.

Best Practices and Guidelines

Minimize Discharges

The best way to limit the impact of discharges from pools, spas, and fountains is to minimize the amount of discharges and avoid fully draining the facility if

possible. To minimize the need to drain these types of facilities, the following periodic maintenance steps should be performed according to manufacturer's specifications:

- Develop and regularly update a facility maintenance plan
- Clean the pool, spa, or hot tub regularly and remove unwanted residue buildup and floating solids.
- Maintain proper levels of chlorine or other disinfecting chemicals.
- Maintain water filtration and circulation requirements and reoxygenate if necessary.
- Manage pH levels and water hardness to reduce copper pipe erosion that can stain the facility and pollute receiving waters.

Discharge to Sanitary Sewer or Storm Drain System

If the facility must be drained, water should be discharged to a sanitary sewer or a storm drain system with approval from the sanitary sewer or storm drain system authority. Do not discharge to a septic tank as it may cause the system to fail. If discharging to a public sanitary sewer or storm drain system is not possible, a suitable disposal method approved by DEQ should be established. Whenever possible, hire a professional pool service company to collect all pool water for proper disposal. Confirm the pool company has the proper permits and where the water is disposed.

Discharges to Ground

If pool and spa water is allowed to be discharged to the ground, a natural pervious or landscaped area, or to a storm drainage system, these practices should be followed before discharge:

- Water quality
  - Dechlorinate and pH-adjust the water. Contact a pool chemical supplier to obtain proper neutralizing chemicals or discharge after the chlorine has reached a nondetect level using a standard testing method.
  - Reoxygenate by turning on the aeration system, if necessary.
  - Ensure the water is free of any coloration, dirt suds, algae, or acid-cleaning wastes.
  - Allow the water to cool to air temperature
- Control the location and rate of flow to minimize soil erosion and local flooding. Water discharged to the ground should not cross property lines and should not produce runoff.

Diatomaceous Earth

Diatomaceous earth used in pool filters is harmful to many aquatic species and cannot be disposed in surface waters, on the ground, into storm drainage systems, or into septic systems. Dry the earth out as much as possible; bag it in plastic, and dispose at the landfill. When cleaning diatomaceous earth filters, backwash onto dirt and ensure only infiltration, and not runoff, occurs.

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Glossary

Adjustable gate valve	A knife gate valve, activated by a handwheel, used to control the internal diameter of reverse-slope pipe, or to allow rapid opening of the pond drain pipe.
Adsorption	Adhesion of the molecules of a gas, liquid, or dissolved substance to a surface. Adsorption differs from absorption in that adsorption is the assimilation or incorporation of a gas, liquid, or dissolved substance into another substance.
Aggregate	Stone or rock gravel used to fill in an infiltration device such as a trench or porous pavement. Clean-washed aggregate has been washed clean so that no sediment is included.
Aquatic bench	A 10- to 15- foot bench around the inside perimeter of a permanent pool that is approximately 1 foot deep. Normally vegetated with emergent plants, the bench augments pollutant removal, provides habitat, conceals trash and water levels, and enhances safety.
Areal	An expanse of land or a region
Artificial marsh creation	Simulation of natural marsh features and functions via topographic and hydraulic modifications on nonmarsh landscapes. Typical objectives for artificial marsh creation include ecosystem replacement or storm water management.
Bacteria	Single-celled microorganisms that lack chlorophyll; some cause disease, and others are necessary to sustain life (see fecal coliform bacteria).
Bacterial decomposition or microbial decomposition	Microorganisms, or bacteria, have the ability to degrade organic compounds as food resources and to absorb nutrients and metals into their tissues to support growth.
Bank run	Gravelly deposits consisting of smooth round stones, generally indicating the existence of a prehistoric sea. Such deposits are usually found in coastal plain regions.
Bank stabilization	Methods of securing the structural integrity of earthen stream channel banks with structural supports to prevent bank slumping and undercutting of riparian trees, and overall erosion prevention. To maintain the ecological integrity of the system, recommended techniques use willow stakes, imbricated riprap, or brush bundles.
Bankfull discharge	A condition where streamflow completely fills the stream channel up to the top of the bank. In undisturbed watersheds, the discharge condition occurs on average every 1-1/2 to 2 years and controls the shape and form of natural channels.

Baseflow	The portion of stream flow that is not from storm runoff and is supported by ground water seepage into a channel.
Best management practice (BMP)	In this catalog, a BMP is a source or treatment control designed to reduce pollution in storm water runoff. Source controls are measures or devices designed to keep pollutants out of runoff. Examples include covers and roofs on outdoor storage processing areas and berms and sumps around outdoor source areas. Treatment controls are typically structural devices designed to temporarily store or treat urban storm water runoff to reduce flooding, remove pollutants, and provide other amenities (e.g., enhance aesthetics and wildlife habitat).
Biochemical oxygen demand (BOD)	The quantity of dissolved oxygen used by microorganisms (e.g., bacteria) during the biochemical oxidation of matter (both organic and oxidizable inorganic matter) over a specified period of time.
Biofiltration	The use of natural materials and vegetation to trap and remove pollutants from storm water. Grass swales and constructed wetlands can be used for biofiltration.
Biological monitoring	Periodic surveys of aquatic biota as an indicator of the general health of a water body. Biological monitoring surveys can span the trophic spectrum, from macroinvertebrates to fish species.
California bearing ratio (CBR)	A penetration test for evaluating the mechanical strength of road subgrades and basecourses.
Catchbasin	A structure at the point where a street gutter empties into a sewer, built to catch debris that would not easily pass through the sewer.
Catchment area	See contributing watershed area. Also known as drainage catchment area.
Cation exchange capacity (CEC)	The total capacity of a soil to hold exchangeable cations. CEC is an inherent soil characteristic and is difficult to alter significantly. It influences the soil's ability to hold onto essential nutrients and provides a buffer against soil acidification.
Channel	A natural or artificial waterway that periodically or continuously contains moving water. It has a definite bed and banks that confine the water.
Channel erosion	The widening, deepening, and headward cutting of small channels and waterways, due to erosion caused by moderate to larger floods.

Check dam	A small dam (a) placed perpendicular to a stream to enhance aquatic habitat, or (b) placed perpendicular in biofiltration swales to reduce water velocities, promote sediment deposition, and enhance infiltration.
Check valve	A device to provide positive closure that effectively prohibits the flow of material in the opposite direction of normal flow when operation of the irrigation system, pumping plant, or injection unit fails or is shut down (ASAE 1989).
Chemical oxygen demand (COD)	The quantity of maximum oxidizable matter in a sample.
Coalescing plate (CP) separator	A device made up of a series of parallel inclined plates that are closely spaced which is used to promote the removal of oil and other nonaqueous particles from storm water.
Compost storm water filter (CSF)	The filter that percolates storm water through compost, trapping particulates and adsorbing dissolved materials such as metals and nutrients.
Contributing watershed area	Portion of the watershed contributing its runoff to the site or BMP in question.
Conveyance system	The drainage facilities, both natural and human-made, which collect, contain, and provide for the flow of surface water and urban runoff from the highest points on the land down to receiving waters. The natural elements of the conveyance system include swales and small drainage courses, streams, rivers, lakes, and wetlands. The human-made elements of the conveyance system include gutters, ditches, pipes, channels, and most retention/detention facilities.
Cross section	A vertical section of a stream channel or structure that provide a side view of the structure; transect taken at right angles to flow direction.
Culvert	A covered channel or a large-diameter pipe that directs flow below the ground level.
Clean Water Act (CWA)	Federal Water Pollution Control Act (33 USC §1251 et seq. 1972), commonly known as the CWA, establishes the structure for regulating discharges into waters of the United States and establishes surface water quality standards.
Debris	Any material, organic or inorganic, floating or submerged, moved by a flowing stream.
Deciduous	Trees that shed leaves in the fall/winter.
Delta-T	Magnitude of change in the temperature of downstream waters.

Design storm	A rainfall event of specified size and return frequency (e.g., a storm that occurs only once every 2 years) used to calculate the runoff volume and peak discharge rate to a BMP.
Detention	The temporary storage of storm water runoff in a structural device (BMP) to reduce the peak discharge rates and to provide settling of pollutants.
Detention pond	A constructed pond or vault that temporarily stores storm water runoff and releases it at controlled rates.
Detention time	Time required for detention of storm water runoff in a storm water quality facility (see Detention).
Dewatering	Refers to a process used in detention/retention facilities, where water is completely discharged or drawn down to a preestablished pool elevation. Dewatering allows the facility to recover its design storage capacity in a relatively short time after a storm event.
Discharge	Outflow—The flow of a stream, canal, or aquifer. Discharge of a canal or stream into a lake, river, or ocean. In hydraulics, flow rate (i.e., fluid flow); a volume of fluid passing a point per unit of time, expressed as cubic feet per second, cubic meters per second, gallons per minute, gallons per day, or millions of gallons per day.
Dissolved oxygen (DO)	Oxygen present (dissolved) in water and available for use by fish and other aquatic animals. If the amount of DO in the water is too low, aquatic animals will suffocate.
Diversion	A channel, embankment, or other man-made structure constructed to divert water from one area to another (Soil Conservation Society of America 1982).
Downstream scour	Downstream channel erosion usually associated with an upstream structure that has altered hydraulic conditions in the channel.
Drainage basin or subbasin	See Watershed.
Drawdown	The gradual reduction in water level in a pond BMP due to the combined effect of infiltration and evaporation.
Dripline	An imaginary line around a tree or shrub at a distance from the trunk equivalent to the canopy spread.
Drop structure	Placement of logs with a weir notch across a stream channel. Water flowing through the weir creates a plunge pool downstream of the structure and creates fish habitat.

Dry pond conversion	Modification made to an existing dry storm water management pond to increase pollutant removal efficiencies. For example, the modification may involve a decrease in orifice size to create extended detention times, or the alteration of the riser to create a permanent pool and/or shallow marsh system.
Dry weather flow	Flow occurring during the dry season (May–September), which may be associated with reservoir releases or releases of water from industrial or residential activities.
Dry well	A well where storm water is disposed for infiltration. These devices are not recommended for areas with high water table conditions.
Earthen berm	An earthen mound used to direct the flow of runoff around or through a BMP.
Embankment	A bank (of earth or riprap) used to keep back water.
Emergent plant	An aquatic plant that is rooted in the sediment but whose leaves are at or above the water surface. Such wetland plants provide habitat for wildlife and waterfowl in addition to removing storm water pollutants.
End-of-pipe control	Water quality control technologies suited for the control of existing urban storm water at the point of storm sewer discharge to a stream. Due to typical space constraints, these technologies are usually designed to provide water quality control rather than quantity control.
Energy dissipation	The loss of kinetic energy of moving water due to internal turbulence, boundary friction, change in flow direction, contraction, or expansion.
Erosion	The wearing away of the land surface by running water, wind, ice, or other geological processes.
Exfiltration	The downward movement of runoff through the bottom of an infiltration BMP into the subsoil.
Extended detention (ED)	A storm water design feature that provides gradual release of a volume of water (0.25–1.0 inches per impervious acre) over a 12- to 48-hour interval time to increase settling of urban pollutants, and protect channel from frequent flooding.
Extended detention (ED) control device	A pipe or series of pipes extending from the riser of a storm water pond and used to gradually release storm water from the pond over a 12- to 48-hour interval.

Extended detention (ED) pond	A conventional ED pond temporarily detains a portion of storm water runoff for up to 24 hours after a storm using a fixed orifice. ED ponds allow urban pollutants to settle out. ED ponds are normally dry between storm events and do not have any permanent standing water. An enhanced ED pond is designed to prevent clogging and resuspension and provides greater flexibility in achieving target detention times. A pond may be equipped with plunge pools near the inlet, a micropool at the outlet, and use an adjustable reverse-sloped pipe at the ED control device.
Extended detention zone	A pondscaping zone extending from the normal pool to the maximum water surface elevation during extended detention events. Plants within this zone must withstand temporary inundation from 5 to 30 times per year.
Filter fabric	See Geotextile fabric.
Floodplain	Any lowland bordering a stream and inundated periodically by its waters.
Flow splitter	An engineered, hydraulic structure designed to divert a portion of stream flow to a BMP located out of the channel, or to direct storm water to a parallel pipe system, or to bypass a portion of baseflow around a pond.
Forebay	An extra storage area provided near an inlet of a BMP to trap incoming sediments before they accumulate in a pond BMP.
Fragipan	A loamy, brittle subsurface horizon low in porosity and content of organic matter and low or moderate in clay but high in silt or very fine sand.
Freeboard	The vertical distance between the design water surface elevation and the elevation of the bank, levee, or revetment that contains the water.
Frequent flooding	A phenomenon in urban streams where the number of bankfull and subbankfull flood events increases sharply after the development. The frequency of these disruptive floods is a direct function of watershed imperviousness.
Fringe marsh creation	Planting emergent aquatic vegetation along the perimeter of open water to enhance pollutant uptake, increase forage and cover for wildlife and aquatic species, and improve the appearance of a pond.
Gabion	A large rectangular box of heavy gauge wire mesh that holds large cobbles or boulders. Used in streams and ponds to change flow patterns, stabilize banks, or prevent erosion.

Geomembrane	Lining of filter fabric on the bottom and sides of porous pavement to prevent lateral or upward movement of soil into the stone reservoir.
Geotextile fabric	Textile of relatively small mesh or pore size used to (a) allow wallow water to pass through while keeping sediment out (permeable), or (b) prevent both runoff and sediment from passing through (impermeable). Also known as filter fabric.
Grading	The cutting and/or filling of the land surface to a desired slope or elevation.
Grassed swale	An earthen conveyance system where the filtering action of grass and soil infiltration are used to remove pollutants from urban storm water. An enhanced grass swale, or biofilter, uses checkdams and wide depressions to increase runoff storage and promote greater settling of pollutants.
Gravel	Sediment particles larger than sand and ranging from 2 to 64 mm (0.25 to 3 inches) in diameter.
Gravitational settling	The tendency of particulate matter to drop out of storm water runoff as it flows downstream when runoff velocities are moderate and/or slopes are not too steep.
Ground water table	The level below which the soil is saturated—the pore spaces between the individual soil particles are filled with water. Above the ground water table and below the ground surface, water in the soil does not fill all pore spaces.
Habitat	A place where a biological organism lives. The organic and nonorganic surroundings that provide life requirements such as food and shelter.
Head	Pressure
Heavy metals	Metals of relatively high atomic weight, including but not limited to chromium, copper, lead, mercury, nickel, and zinc. These metals are generally found in minimal quantities in storm water but can be highly toxic even at trace levels.
Hotspots	Hotspots are commercial, industrial, institutional, municipal, or transportation-related operations that generate or can generate relatively high concentrations of pollutants, such as hydrocarbons, trace metals, or toxicants, and/or present a higher potential risk for spills, leaks, or illicit discharges. Examples are vehicle service, fueling, maintenance and equipment cleaning areas; vehicle fleet storage areas; airports; industrial sites; landfills/solid waste facilities; laundries and dry cleaners; shopping centers; and outdoor storage and loading/unloading areas of hazardous materials.

Impermeable	Properties that prevent the movement of water through the material.
Impervious surface	Material that resists or blocks the passage of water.
Infiltration	The penetration of water through the ground surface into subsurface soil or the penetration of water from the soil into sewer or other pipes through defective joints, connections, or manhole walls. The infiltration rate is expressed in terms of inches/hour. Infiltration rates will be slower when the soil is dense (e.g., clays) and faster when the soil is loosely compacted (e.g., sands). Also refers to seepage of ground water into sewer pipes through cracks and joints.
Inlet	(1) A drainage passway. (2) A short, narrow waterway connecting a bay, lagoon, or similar body of water with a large parent body of water. (3) An arm of the sea (or other body of water) that is long compared to its width and may extend a considerable distance inland.
Level spreader	A device used to spread out storm water runoff uniformly over the ground surface as sheet flow (i.e., not through channels). Level spreaders prevent concentrative, erosive flows from occurring and enhance infiltration.
Lowflow channel	An incised or paved channel from inlet to outlet in a dry basin, designed to carry low runoff flows and/or baseflow directly to the outlet without detention.
Micropool	A smaller permanent pool used in a storm water pond due to extenuating circumstances (i.e., concern over the thermal impacts of larger ponds, impacts on existing marshes, or lack of topographic relief).
Microtopography	Contours along the bottom of a shallow wetland system. A complex microtopography creates a great variety of environmental conditions that favor the unique requirements of many different species of marsh plants.
Multiple pond system	A collective term for a cluster of pond designs that incorporate redundant runoff treatment techniques within a single pond or series of ponds. These pond designs employ a combination of two or more of the following: extended detention, permanent pool, shallow marsh, or infiltration. The wet ED pond is an example of a multiple pond system.

Natural buffer	A low sloping area of maintained grassy or woody vegetation located between a pollutant source and a water body. A natural buffer is formed when a designated portion of a developed piece of land is left unaltered from its natural state during development. A natural vegetative buffer differs from a vegetated filter strip in that it is natural and does not need to be used solely for water quality purposes. To be effective, the areas must be protected against concentrated flow.
National Pollutant Discharge Elimination System (NPDES)	A provision of the Clean Water Act prohibiting discharge of pollutants into waters of the United States unless a special permit is issued by EPA, a state, or a tribal government.
Nutrients	Elements or substances, such as nitrogen or phosphorus, needed for the growth and development of living things (e.g., plants). Large amounts of these substances reaching water bodies can lead to reduced water quality and eutrophication by promoting excessive aquatic algae growth. Some nutrients can be toxic at high concentrations.
Observation well	A test well installed in certain infiltration and filtration BMPs to monitor draining times after installation.
Off-line BMP	A water quality facility designed to treat a portion of storm water that has been diverted from a stream, storm drain, or other conveyance.
Off-line treatment	A BMP system located outside of the stream channel or drainage path. A flow splitter is typically used to divert runoff from the channel and into the BMP for subsequent treatment.
Oil and water (or oil and grit) separator	A BMP consisting of a three-stage underground retention system designed to remove heavy particulates and absorbed hydrocarbons. Also known as a water quality inlet.
Outfall	The point of discharge for a river, drain, pipe, etc.
Parallel pipe system	A technique for protecting sensitive streams. Excess storm water runoff is piped in a parallel direction along the stream buffer instead of discharged directly into the stream.
Passive treatment facility	A facility that uses natural materials and vegetation to cleanse storm water and/or reduce storm water flow. Examples include grass swales, constructed wetlands, etc.
Percolation	The downward movement of water through the soil.
Permanent pool	A 3- to 10-foot deep pool in a storm water pond system that provides removal of urban pollutants through settling and biological uptake. (Also referred to as a wet pond).
Permeability	The quality of a soil horizon that enables water or air to move through it.

Physical infiltration	The separation of particulates from runoff by grass, leaves, and other organic matter on the surface, as the runoff passes across or through the ground.
Pilot channel	A riprap or paved channel that routes runoff through a BMP to prevent erosion of the surface.
Plunge pool	A small permanent pool located at either the inlet to a BMP or at the outfall from a BMP. The primary purpose of the pool is to dissipate the velocity of storm water runoff, but it also can provide some pretreatment, as well.
Pollutant	Generally, any substance introduced into the environment that adversely affects the usefulness of a resource.
Pollution	Impairment of water quality caused by man-made waste discharges or natural processes.
Pondscaping	A method of designing the plant structure of a storm water marsh or pond using inundation zones. The proposed marsh or pond system is divided into zones that differ in the level and frequency of inflow. For each zone, plant species are chosen based on their potential to thrive, given the inflow pattern of the zone.
Porous pavement	An alternative to conventional pavement whereby runoff is diverted through a porous asphalt layer and into an underground tone reservoir. The stored runoff then gradually infiltrates into the subsoil. Porous pavement is not recommended for use in areas with high water table conditions.
Positive drainage	A drainage condition in which water flows away from a structure or site.
Retrofit	The creation/modification of storm water management systems in developed areas by constructing wet ponds, infiltration systems, marsh plantings, streambank stabilization, and other BMP techniques to improve water quality and create aquatic habitat. A retrofit consists of constructing a new BMP in the developed area, enhancing an older storm water management structure, or a combination of improvement and new construction.
Reverse slope pipe	A pipe extending downward from the riser into the permanent pool that sets the water surface elevation of pool. The lower end of the pipe is located up to 1 foot below the water surface. This technique is a useful for regulating ED times in a storm water wetland, and the pip seldom clogs.
Riparian zone	A relatively narrow strip of land that borders a stream or river, often coinciding with the maximum water surface elevation of the 100-year storm.

Riparian reforestation	Replanting the banks and floodplain of a stream with native forest and shrub species to stabilize erodible soils, improve both surface and ground water quality, increase stream shading, and enhance wildlife habitat.
Riprap	A combination of large stone, cobbles, and boulders used to line channels, stabilize banks, reduce runoff velocities, or filter out sediment.
Riser	A vertical pipe extending from the bottom of a pond BMP used to control the discharge rate from a BMP for a specified design storm.
Root zone	The part of the soil that is, or can be, penetrated by plant roots (Soil Conservation Society of America 1982).
Rototilling	Mechanical means of tilling, or rotating, the soil.
Runoff	See storm water runoff.
Runoff conveyance	Methods for safely conveying storm water to a BMP to minimize disruption of the stream network and promote infiltration or filtering the runoff.
Runoff frequency spectrum	The frequency distribution unit are runoff volumes generated by a long-term continuous time-series of rainfall events. Used to develop BMP and storm water sizing rules.
Runoff pretreatment	Techniques to capture or trap coarse sediments before they enter a BMP, preserve storage volumes, or prevent clogging with in the BMP. Examples include forebays and micropools for pond BMPs, and plunge pools, grass filter strips, and filter fabric for infiltration BMPs.
Run-on	Off-site flow onto a site.
Safety bench	A 10- to 15- foot wide bench located just outside the perimeter of a permanent pool. The bench extends around the entire shoreline to provide maintenance access and eliminate hazards.
Sand filter	A technique for treating storm water, where the first flush of runoff is diverted into a self-contained bed of sand. The runoff is then strained through the sand, collected in underground pipes, and returned back to the stream or channel. An enhanced sand filter uses layers of peat, limestone, and/or topsoil and may also have a grass cover crop. The adsorptive media of an enhanced sand filter is expected to improve removal rates.
Scour	Concentrated erosive action of flowing water in streams that removes material from the bed and banks.

Sediment	The product of erosion processes; the solid material, both mineral and organic, that is in suspension, is being transported, or has been moved from its site of origin by air, water, gravity, or ice (USDA-SCS 1991).
Sedimentation	The process of sand and mud settling and building up on the bottom of a creek, river, lake, or wetland.
Sediment forebay	Storm water design feature that uses a small basin to settle out incoming sediments before they are delivered to a storm water BMP. Particularly useful in tandem with infiltration devices, wet ponds, or marshes.
Seedbanks	The large number and diversity of dormant seeds of plant species existing in the soil. The seeds may exist within the soil for years before they germinate under the proper moisture, temperature, or light conditions. Within marsh soils, this seedbank helps to maintain aboveground plant diversity and can also be used to rapidly establish marsh plants within a newly constructed storm water marsh.
Seepage	Water escaping through or emerging from the ground along an extensive line or surface as contrasted with a spring, where the water emerges from a localized spot (Soil Conservation Society of America 1982).
Septic	Produced by anaerobic decomposition of organic matter with accompanying foul odors.
Sheet flow	Water, usually storm runoff, flowing in a thin layer over the ground surface (Soil Conservation Society of America 1982).
Short circuiting	The passage of runoff through a BMP in less than the theoretical or design treatment time.
Slope	The degree of deviation of a surface from horizontal, measured as a percentage, as a numerical ratio, or in degrees (Soil Conservation Society of America 1982).
Sinuosity	A measure of the wiggliness of a watercourse (Gordon, McMahon, and Finlayson 1992). While sinuosity has a number of definitions, the most commonly used is the sinuosity index: SI = Channel (Thalweg) Distance Downvalley distance
Source control	A pollution control measure that operates by keeping pollutants from entering storm water
Storm drain (or storm sewer)	Above and belowground structures for transporting storm water to streams or outfalls for flood control purposes.

Storm water runoff	Excess precipitation not retained by vegetation, surface depressions, or infiltration, which collects on the surface and drains into a surface water body.
Storm water site plan	A plan prepared during the project design phase to show the BMPs and techniques that will be used to control storm water pollution during construction and after construction is complete.
Storm water treatment	Detention, retention, filtering, or infiltration of a given volume of storm water to remove urban pollutants and reduce frequent flooding.
Stream buffer	A variable width strip of vegetated land adjacent to a stream that is preserved from development activity to protect water quality and aquatic and terrestrial habitats.
Subsoil	The bed or stratum of earth lying below the surface soil.
Substrate amendments	A technique to improve the texture, and organic content of soils in a newly excavated pond system. The addition of organic rich soils is often required to ensure the survival of aquatic and terrestrial landscaping around ponds.
Suspended sediment	The very fine soil particles that remain in suspension in water for a considerable period of time (Soil Conservation Society of America 1982).
Swale	A natural depression or wide shallow ditch used to temporarily store, route, or filter runoff.
Topography	The relative positions and elevations of the natural or man-made features of an area that describe the configuration of its surface (Soil Conservation Society of America, 1982).
Total maximum daily load (TMDL)	The sum of individual waste load allocations for point sources and load allocations for nonpoint sources and natural background. The Idaho Department of Environmental Quality has the authority to set TMDLs for water quality-limited bodies.
Toxic	Related to or caused by a poison, hazardous waste, or toxin.
Trash and debris removal	Mechanical or manual removal of debris, snags, and trash deposits from the streambanks to improve the appearance of the stream.
Underdrain	Plastic pipes with holes drilled through the top that are installed on the bottom of a sand filter to collect and remove excess runoff.
Urban runoff	Storm water that passes through and out of developed areas to a stream or other body of water (see storm water runoff).

Vacuum sweeping	Method of removing quantities of coarse-grained sediments from porous pavements to prevent clogging. Not effective in removing fine-grained pollutants.
Vegetated filter strip	A vegetated section of land designed to accept runoff as overload sheet flow from upstream development. It may adopt any natural vegetated form, from grass meadow to small forest. The dense vegetative cover facilitates pollutant removal. A filter strip cannot treat high-velocity flows; therefore, they are generally recommended for use in agriculture and low-density development. A vegetated filter strip differs from a natural buffer in that the strip is not natural; rather, it is designed and constructed specifically for pollutant removal. A filter strip can also be an enhanced natural buffer, but the removal capability of the natural buffer is improved through engineering and maintenance activities such as land grading or installing a level spreader. A filter strip also differs from a grassed swale in that a swale is a concave vegetated conveyance system, where a filter strip has a fairly level surface.
Velocity	The distance water travels in a given direction in a stream during an interval of time.
Watershed or drainage basin	A geographic area where all surface water drains into a particular body of water (e.g., a river or stream).
Weephole	A small opening or pipe left in a revetment or bulkhead to allow ground water drainage.
Weir	A structure extending across the width of a channel intended to impound, delay, or in some way alter the flow of water through the channel. A check dam is a type of weir as is any kind of dam.
Wet pond	A conventional wet pond has a permanent pool of water for treating incoming storm water runoff. In enhanced wet pond designs, a forebay is installed to trap incoming sediments where they can be easily removed; a fringe marsh is also established around the perimeter of the pond.
Wet weather flow	Water derived primarily from rain, melting snow, or irrigation during the wet season (i.e., October–April) that flows over the surface of the ground.

Wetland	A conventional wetland for storm water quality control is a shallow pool that creates suitable growing conditions for marsh plants. Designed to maximize pollutant removal through marsh uptake, retention, and settling. A wetland is a constructed system typically not located within a delineated natural wetland. In addition, a storm water wetland differs from an artificial wetland created to comply with mitigation requirements and does not replicate all the ecological functions of natural wetlands. An enhanced storm water wetland is designed for more effective pollutant removal and species diversity. Its design includes a forebay, complex microtopography, and pondscaping with multiple species of marsh trees, shrubs, and plants.
Wetland mitigation	Regulatory requirement to replace wetland areas destroyed or impacted by proposed land disturbances with artificially created wetland areas.
Wetland mulch	A technique for establishing low or high marsh areas where the top 12 inches of marsh soil from a donor marsh are spread thinly over the surface of a created marsh site as a mulch. The seedbank and organic matter of the mulch helps to rapidly establish a diverse marsh system.
Wetland plant uptake	Marsh plant species rely on nutrients (i.e., phosphorous and nitrogen) as a food source; they may intercept and remove nutrients from either surface or subsurface flow.