FINAL

MAINTENANCE ACTIVITIES BMP FIELD MANUAL

Storm Water Management Program Plan

Marine Corps Base Hawaii

NPDES Permit No. HI S000007

Prepared by:

Marine Corps Base Hawaii

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Contents

List of Acronyms and Abbreviations

BAT	Best Available Technology
BCT	Best Conventional Technology
BMP	Best Management Practice
CO	Commanding Officer
CFR	Code of Federal Regulations
CWA	Clean Water Act
CWB	State of Hawaii Department of Health, Clean Water Branch
DLNR	State of Hawaii Department of Land and Natural Resources
DOE	Department of Education
DOH	State of Hawaii Department of Health
ECC	Environmental Compliance Coordinator
ECPD	Environmental Compliance and Protection Division
EPA	Environmental Protection Agency
HAR	Hawaii Administrative Rules
HEER	State of Hawaii Department of Health, Hazard Evaluation and Emergency Response
LBP	Lead-Based Paint
MCBH	Marine Corps Base Hawaii
MCCS	Marine Corps Community Services
MCD	Facilities Engineering Maintenance Control Division
MEP	Maximum Extent Practicable
MRO	Facilities Engineering Maintenance Repair Operations
MS4	Municipal Separate Storm Sewer System
NRCS	United States Department of Agriculture, Natural Resource Conservation Service
NGPC	Notice of General Permit Coverage
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Coast Guard National Response Center
OMC	Ohana Military Communities
OSHA	Occupational Safety and Health Administration

PM	Project Manager
PPE	Personal Protective Equipment
PPV	Public-Private Venture
SDS	Safety Data Sheet
SHWB	State of Hawaii Department of Health, Solid and Hazardous Waste Branch
SM	Site Management
SPCC	Spill Prevention Control Countermeasures
SWMP	Storm Water Management Plan
SWPPP	Storm Water Pollution Prevention Plan
USACE	United States Army Corps of Engineers

1 Introduction

1.1 Purpose and Scope

The purpose of this *Maintenance Activities Best Management Practice (BMP) Field Manual* is to provide guidance on common maintenance procedures and BMP selection to reduce or eliminate the discharge of pollutants to State waters to the Maximum Extent Practicable (MEP). While this manual does not constitute an exhaustive list of all BMPs available, it does provide guidance suitable for use by a wide range of individuals at Marine Corps Base Hawaii (MCBH). Each user of the manual is responsible for working within their capabilities obtained through training and experience, and for seeking the advice and consultation of appropriate experts at all times. The target audience for this manual includes: all MCBH maintenance staff, specifically the Facilities Engineering Maintenance Control Division (MCD) and Maintenance Repair Operations (MRO), regulatory agencies (including permit staff and enforcement staff), and general public with an interest in storm water pollution control.

As of the effective date, September 1, 2021, MCBH is required to comply with the conditions of the National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Permit No. HIS000007. In accordance with Part D.1.d.(1) of the MS4 Permit, MCBH is required to develop and implement a Construction BMP Field Manual to establish BMP policy for construction projects. The Maintenance Activities BMP Field Manual is a key element of the Maintenance Activities BMPs Program to protect and restore the water quality of the surrounding surface waters. Refer to Chapter 9 of the Storm Water Management Program (SWMP) Plan for additional information on Maintenance Activities BMPs. Refer to Chapters 6 through 8 of the SWMP Plan for the objectives of MCBH's Base-wide Pollution Prevention and Good Housekeeping Program (Pollution Prevention Program).

1.2 Water Quality Impacts Related to Maintenance Activities

Common maintenance activities such as landscaping, painting, vehicle washing, and repair have the potential to impact the quality of water that surround MCBH. Oil, detergents, paints, lubricants, fertilizers, pesticides, and even green waste such as grass clippings are considered pollutants when found in State waters and estuaries. Selection of the appropriate BMPs can reduce the potential of these common activities to impact sensitive water resources.

1.3 Maintenance Activities and BMP Selection

Selection and implementation of BMPs is based on the pollution risks associated with specific activities. BMPs should be implemented to the MEP which includes addressing projects, regardless of size, that have the potential to impact water quality. Routine maintenance projects are scheduled, or cyclical projects performed, to preserve the life of a system; to restore the original function or delay the deterioration of an existing asset without substantially increasing is structural capacity; or to maintain the original line and grade, hydraulic capacity or original purpose of a facility, system, or asset, in which

land disturbance does not go beyond the original footprint of the previous structure. This field manual contains BMPs for the most common activities performed in the field which include:

- Pavement and maintenance and cleaning
- Drainage system and utility maintenance
- Street cleaning
- Debris and trash removal
- Landscape maintenance
- Exterior maintenance on buildings
- Painting
- Spill clean up

Section 3 covers the general BMPs detailed in this manual. Table 6-1 lists the selected BMP Fact Sheets that can be found in Appendix A. These fact sheets include detailed implementation, operation, and maintenance information.

2 Maintenance Activities Program Organization

As a military installation, MCBH has several agencies that are responsible for the implementation of maintenance BMPs. In general, MCD and MRO are responsible for the general maintenance projects for all facilities within MCBH with the exception of Mokapu Elementary School, Public-Private Venture (PPV) Housing, and commercial tenants managed by Marine Corps Community Services (MCCS). Figure 2-1 shows the agencies responsible for overseeing that all Maintenance Activities Program requirements are met. The grey boxes indicate the agency responsible for implementation of BMPs at the facilities.

The MCBH Environmental Compliance and Protection Division (ECPD) is responsible for general oversight of the Maintenance Activities Program. This includes revising maintenance activity BMPs or policies, as needed, to meet program requirements and to facilitate program implementation.

2.1 Pollution Prevention Program

A crucial component of MCBH's SWMP Plan is its Base-wide Pollution Prevention Program. Generally, this is a multi-faceted maintenance program aimed at reducing pollutants from all MCBH-owned property to the MEP. MCBH-owned property includes facilities, roads, parking lots, maintenance facilities, and its MS4. MCBH's Pollution Prevention Program is separated into four main components including:

1. Debris Control Best Management Practices (BMPs) Program Plan (Chapter 6);
2. Chemical Applications BMPs Program Plan (Chapter 7);
3. Erosion Control BMPs Program Plan (Chapter 8); and
4. Maintenance Activities BMPs Program Plan (Chapter 9).

Each of these components is described in detail in individual chapters as noted above. This field manual focuses on information related to the MCBH SWMP Plan Chapter 9, Maintenance Activities BMPs.

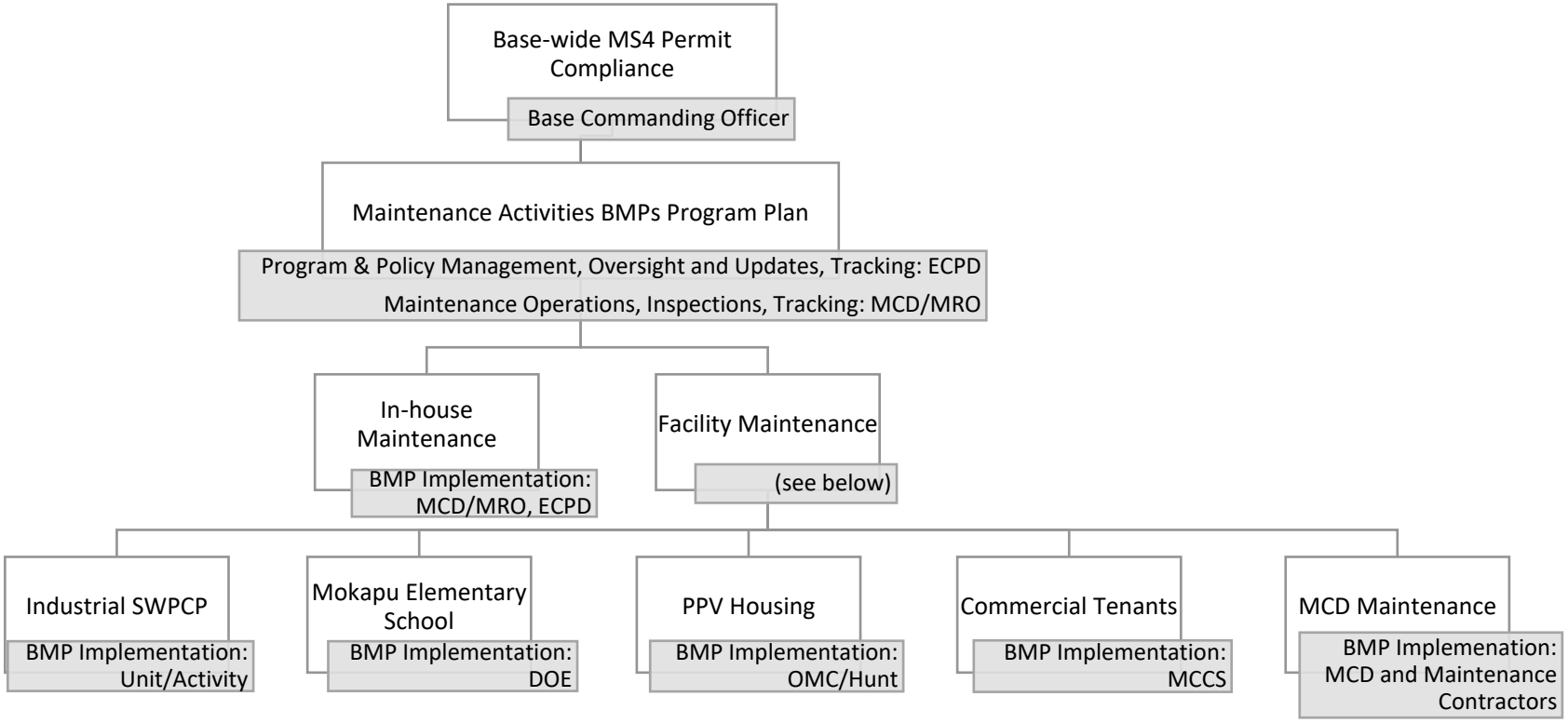

Figure 2-1 Maintenance Activities Program Organizational Chart

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3 BMPs for General Maintenance Activities

By using proper management techniques and practices, it is possible to improve control of the identified potential sources of pollutants and reduce the number of spills/releases to the stormwater system. BMPs and evaluation checklists are in Appendix A. The BMPs have been adapted from the Honolulu International Airport *Storm Water Management Program Plan* and the MCBH 2016 *Storm Water Management Plan, Appendix 11-3 Best Management Practices Fact Sheets*.

This section focuses on the common and universal BMPs related to Good Housekeeping, Street Sweeping, Chemical Applications, Vehicle / Equipment Activities, Material Handling, Waste Management, Inlet protection, Painting, and Spill Prevention. Additional BMPs and information can be found in Appendix A. Continued inspections and maintenance of BMPs are essential to maximizing the effectiveness of the device, application, or procedure.

3.1 Good Housekeeping Practices

Description

Daily maintenance activities require the use of materials and products that may be potential contaminants in storm water. Good housekeeping practices are intended to maintain a clean, safe, and orderly working environment where these materials are used or stored. Implementing the good housekeeping BMPs will reduce the amount of pollutants entering the storm water system.

Limitations

There are no major limitations to the implementation of this BMP.

1	Do not overfill trash dumpsters or leave trash outside of containers. Ensure that materials put into dumpsters will not leak out of dumpsters and commingle with storm water runoff. Use leak-proof dumpsters and keep covered when not in use.
2	Remove and properly dispose of debris from all areas daily.
3	Use appropriate clean up tools in the facility such as a broom for dry sweeping. Do not hose down facility floors with water or use a blower to remove clean up materials. Dry sweep or vacuum all areas to prevent tracking of materials.
4	Maintain ample spill clean-up supplies and keep them in proper physical condition.
5	Use absorbent materials to contain any non-hazardous spills. Promptly clean spills with rags or absorbent material, and properly dispose of cleaning materials. Put spent rags or absorbent material in a durable container until disposal can be facilitated. Disposal of hazardous spilled material should be in accordance with the Solid Waste Storage and Disposal BMP.
6	Inspect storm drain inlets regularly for illicit discharge such as sediment runoff or debris accumulation. Clean and remove debris as necessary.
7	Identify storm drains and waterways in each work area and prevent non-storm water discharges into the storm drainage system.
8	Conduct employee training on all best management practices regularly.

3.2 Street Sweeping Operations

Description

Street, runway, and taxiway sweeping is performed to remove litter and debris from the vehicle and aircraft travelways in order to prevent discharge of potential pollutants into the storm water drainage system, improve safety, and improve aesthetics.

Limitations

Applying BMP will be controlled by weather, air and surface traffic, controlled area access, and maintenance worker safety considerations.

1	Inspect and sweep applicable areas of MCBH regularly. When inspections or complaints indicate, sweep more frequently.
2	Properly maintain sweepers. Adjust broom heights frequently to maximize efficiency of sweeping operations.
3	Properly transport, store, and dispose of sweeper wastes when sweeper is full and when day of sweeping completed. Empty sweepers in designated area to capture solid material and minimize wind-blown materials.
4	Clean sweepers with clean water only in a contained area where water is properly treated and disposed of, such as the airport wash racks.
5	Keep logs of locations swept, tonnage of material swept, and disposal method of debris.

3.3 Fertilizer and Pesticide Applications

Description

Fertilizer and pesticide application may be conducted by tenant facility personnel or a hired contractor to maintain landscaping or to eliminate pests at their facility. Improper use of pesticides and fertilizers can lead to the presence of chemicals in stormwater. Pesticides are defined as chemicals used to kill pest animals or plants. They are typically used to control the growth of weeds or other undesirable vegetation. Occasionally, insecticides or rodenticides are used to control an infestation of insects or to prevent the spread of diseases (i.e., mosquito or rodent control).

Limitations

Fertilizer, pesticide, and herbicide application should not be conducted during inclement weather or applied within six feet of a waterway or on slopes greater than a three to one ratio.

1	Store fertilizers and pesticides in accordance with the Container and Material Storage BMPs in this Manual to minimize potential contact with stormwater runoff.
2	Periodically check the condition of containers. Look for leaking or corroded containers, crystallization on covers or bases of containers, or discolored labels. Dispose waste containers properly in accordance with the BMPs outlined in the Solid Waste Storage and Disposal section of this Manual.
3	Use fertilizers and pesticides only where needed in amounts or rates per the manufacturer's recommendations; DO NOT over apply. Calibrate equipment regularly for proper application and loading rates.
4	Use natural or organic alternatives, if possible.
5	Ensure that any application is a minimum of six feet away from the MS4, drainage system, and State waters.
6	DO NOT apply fertilizers or pesticides before or during rainfall or high winds or on slopes greater than a three to one ratio.
7	Transfer or mix fertilizers and pesticides above an impervious surface or container; clean up spills immediately.
8	Follow all rules and laws, refer to the Hawaii Department of Agriculture, Plant Industry Division, Pesticide Branch for more information on the following: HRS, Administrative Rules, Chapter 66; HRS, Hawaii Pesticide Law, Chapter 149A; Senate Bill 3095; and Act 45 (2018).
9	Conduct employee training, as described under the Good Housekeeping Practices section of this Manual, at a minimum annually, or as required.
10	Consult the Pesticide Program Manager at ECPD for pesticide applications questions and approvals.

3.4 Storm Drain Inlet Protection

Description
Devices of various designs which detain sediment-laden runoff and allow the sediment to settle out of the water prior to discharge into a storm drain inlet or catch basin.

Limitations
- Inlet protection must not create a potential hazard to traffic and pedestrians.
- Drainage area shall not exceed 1 acre.
- Runoff may bypass protected inlets on slopes.
- Ponding will occur at a protected inlet, with possible short-term flooding.
- Straw bales are NOT effective for inlet protection.

1	Protect every storm drain inlet potentially receiving sediment-laden runoff, either by covering the inlet or promoting sedimentation upstream of the inlet.
2	Five types of inlet protection are presented below; however, other effective methods and proprietary devices exist and may be selected: • Filter Fabric Fence: Appropriate for drainage basins less than one acre with less than a 5 percent slope. • Block and Gravel Filter: Appropriate for flows greater than 0.5 cfs. • Gravel and Wire Mesh Filter: Used on curb or drop inlets where construction equipment may drive over the inlet. • Sand Bag Barrier: Used to create a small sediment trap upstream of inlets on sloped, paved streets. • Excavated Drop Inlet Sediment Trap: An excavated area around the inlet to trap sediment. Use only for drainage areas smaller than one acre unless a sediment trap first intercepts the runoff.
3	Select the appropriate type of inlet protection as identified above and design as referred to or as described herein. • Filter Fabric: Must be of sufficient strength and permeability to allow stormwater to pass through and retain sediment. Must be anchored such that the fabric will not fall into the drain when the grate is removed for maintenance.
4	Install inlet protection per manufacturer's recommended procedures and instructions.
5	Provide area around the inlet for water to pond without flooding structures and property.
6	Inspect inlet protection devices prior to an anticipated rainfall event, after the rainfall event, and regularly at the end of each workweek. During extended rainfall events inspect inlet protection devices daily.
7	Remove sediment after each rainfall event or once the containment device is ½ full of sediment.
8	Check for storm drain labels (i.e. "no dumping", "drains to ocean")

3.5 Vehicle and Equipment Maintenance and Repair

Description

Routine maintenance of vehicles and equipment must be done to maintain their proper operation. The maintenance and repair activities conducted may include fluids removal, engine and parts cleaning, or tire repair and replacement. These activities represent a potentially significant source of contaminants due to the harmful materials and waste generated. This BMP is designed to prevent or reduce the impact of contaminates from maintenance and repair on the storm water system.

Limitations

There are no major limitations to the implementation of this BMP.

1	Maintain vehicles and equipment used at the facility in good operating condition.
2	Perform vehicles and equipment maintenance and repair activities in designated areas. When possible indoor or covered areas away from storm water runoff or on the painted area outside the maintenance shop.
3	Inspect damaged vehicles and equipment for fluid leaks and repair as soon as possible. Use drip pans as necessary and empty when full.
4	Remove fluids and batteries from damaged equipment and equipment no longer in use before storage. Store under cover, if possible, until repair or disposal.
5	Transfer removed vehicle fluids to designated storage container as soon as possible.
6	Use drip pans, tarps, or any other drainage control whenever removing fluids to capture any releases of oil, fluids, and solvent.
7	When not in use, store drums/containers of liquid material or waste indoors or under cover and within secondary containment pallets.
8	Designate areas in service bays for parts cleaning. Allow parts to drain over solvent tank or drip pan. Do not wash or rinse parts outdoors and do not allow solvent to drip or spill onto the floor.
9	Use appropriate clean up materials in the facility. Do not hose down with water or use a blower to remove clean up materials. Dry sweep or vacuum all areas.
10	Maintain well stocked spill kits throughout the facility, especially in maintenance areas to protect discharge to receiving waters and storm drain inlets in the event of spill.
11	Conduct employee training annually and as required.

3.6 Vehicle and Equipment Washing

Description

Periodic washing of vehicles and equipment may be performed at approved wash pads that discharges to an oil/water separator (OWS). Wash water may contain oils, greases, heavy metals, sediments, and other pollutants that can pose a threat to storm drain system and receiving water bodies. This BMP is intended to reduce the impact of these activities on storm water runoff.

Limitations

None.

1	Wash vehicles and equipment in designated washing areas using minimal water. Use approved biodegradable detergents.
2	Ensure the designated wash racks or wash areas of the facility are inside a building or on an impervious area where wash water can be contained and directed to an OWS that drains to the sewer system, wells, or retention pond. Obtain all applicable permits.
3	Follow posted directions for wash rack or wash area use.
4	See Solid Waste Storage and Disposal BMP for OWS maintenance.
5	Where applicable, sponge wash vehicles, or equipment with a bucket of water to eliminate excess wash water. Clean up any water on the ground or the floor using absorbent materials or a wet/dry vacuum immediately after washing.
6	Washing of personal vehicles are prohibited.
7	Conduct employee training annually and as required.

3.7 Vehicle and Equipment Fueling

Description

During fueling of vehicles and equipment, there is the potential for leaked or spilled fuel to contaminate storm water. The procedures outlined in this BMP are intended to prevent fuel spills and leaks and reduce their impact on storm water.

Limitations

There are no major limitations to the implementation of this BMP.

1	Perform fueling of aircraft, vehicles, and equipment in designated areas, away from storm drain inlets, drainage channels, or receiving waters.
2	Maintain an ample supply of spill cleanup materials and spill control equipment near fueling areas to protect discharge to storm drain inlets and receiving waters, in the event of a spill. Equip fuel trucks and mobile tanks with spill cleanup materials.
3	No topping off or no unattended fueling.
4	Post proper fueling and cleanup instructions in fueling areas.
5	Do not hose off fueling area. Use absorbents.
6	Inspect storage tanks, hoses and dispensing nozzles daily for cracks and leaks. If any defects are noticed, replace defective parts immediately or remove from service until repaired.
7	Check for proper operation of automatic shut off controls on fuel dispensing nozzles. Repair as needed.
8	Test, monitor, and maintain fuel storage tanks as required by all applicable federal, state and local laws.
9	Use absorbents materials to contain any spills. Promptly clean spills with rags or absorbent material, and properly dispose of cleaning materials. Put spent rags or absorbent material in a durable container until disposal can be facilitated. For larger spills, contact spill response personnel immediately. See Spill Prevention and Response BMP.
10	Train oil and hazardous material handling personnel annually and as required.

3.8 Material Storage

Description

A variety of products and materials that may adversely affect water quality are stored at the Maintenance Facility. This BMP is intended to reduce the potential for the contamination of storm water by minimizing exposure of such products and materials to storm water.

Limitations

There are no major limitations to the implementation of this BMP.

1	Store materials in their original or appropriate containers as recommended by the manufacturer. Store small containers of flammable materials within flammable storage lockers.
2	Ensure that all containers are closed, secured to prevent movement, fastened, stored neatly, and properly labeled.
3	Maintain accurate inventory of stored supplies. Periodically review inventory and properly dispose of materials that are expired or no longer used. Only purchase and store required quantities of hazardous materials.
4	Store materials and containers indoors or in covered areas. Containers holding liquid materials should also be within secondary containment.
5	Identify, list and inventory all chemical substances present in the facility. Compile Material Safety Data Sheets (MSDS) for all chemical substances. Have MSDS data readily accessible for facility employees.
6	Cover containers and materials with a plastic wrap or tarp when storing them outdoors temporarily (24 hours or less). Do not store materials outdoors that may leach pollutants into the storm water or come in contact with storm water runoff.
7	Ensure that aggregate piles are contained by CMU walls, berms, or other device to prevent the material from being carried away in the storm water runoff.
8	Maintain an ample supply of spill clean-up materials near storage areas.
9	Use absorbent materials to contain any spills. Promptly clean spills with rags or absorbent material, and properly dispose of cleaning materials. Put spent rags or absorbent material in a durable container until disposal can be facilitated. For larger spills, contact spill response personnel immediately. See Spill Response BMP.
10	Sweep or vacuum up spilled materials immediately.
11	Inspect material storage and equipment parking areas daily. Look for leaking or corroded containers, chemical discoloration, or other changes in the containers or contents that may indicate a potentially hazardous condition or chemical deterioration.
12	Conduct employee training regularly.

3.9 Material Handling and Use

Description

Prevent or reduce the discharge of pollutants to storm water from material handling by minimizing hazardous material use on site and training employees in the proper handling and use of materials. The loading and unloading of materials usually takes place outside; therefore, materials spilled, leaked, or lost during the process may collect in the soil or on other surfaces and have the potential to be carried away by storm water runoff. Additionally, paint, chemical, and carpentry applications may impact the environment.

Limitations

There are no major limitations to the implementation of this BMP.

1	Use materials only where and when needed to complete the work.
2	Minimize use of hazardous materials on-site. Use less hazardous, alternative materials where possible.
3	Follow manufacturer's instructions regarding uses, protective equipment, ventilation, flammability, and mixing of chemicals.
4	Limit exposure of material to rainfall whenever possible, such as only loading or unloading during dry weather or conducting the loading or unloading indoors or under cover. Avoid placing the loading area near storm drains or cover storm drains during loading or unloading operations.
5	Conduct regular dry sweeping of the loading or unloading areas.
6	Application of fertilizers, herbicides, or pesticides: • Do not over apply. • Prepare only the amount needed. • Follow the recommended usage instructions. • Except on steep slopes, till fertilizer into the soil rather than surface spreading or spraying it. • Apply surface dressings in several smaller applications, as opposed to one large application to allow time for infiltration and to avoid excess material being carried off-site by runoff. • Do not apply these chemicals just before it rains or in high winds. • Log material use for reporting purposes (see attached log sheets).
7	Carpentry Operations: • Use tools that have a vacuum or filter system to reduce airborne saw dust, whenever possible. • Sweep the area frequently to prevent saw dust from leaving the shop. • Dispose of saw dust sweepings in a covered waste bin.

Material Handling and Use (continued)

8	Painting Operations: • Conduct painting indoors or in the paint booth whenever possible. If painting must be done outdoors, such as to test striping, ensure that it is not raining. Note: if it begins to rain before the paint has dried, contain the area and clean it up according to the Spill Response BMP. • Ensure that paints are stored in sound containers to prevent leaks. • Use tarps or other containment devices to prevent paint drips from impacting the storm drains or surface waters. • Clean brushes and materials using a containment system such as solvent washer, bucket, or sink connected to the sanitary sewer. Note: never clean painting materials into the storm drain system. • Properly segregate and label waste paints for disposal according to the Solid Waste BMP. Note: oil-based paints are hazardous wastes.
9	Conduct employee training annually and as required.

3.10 Painting Operations

Description

Prevent or reduce the discharge of pollutants to stormwater from structure repair/ construction and painting by enclosing, covering or providing secondary containment around material storage areas, using good housekeeping practices, using less hazardous alternative products, and training employees.

Limitations

Less hazardous alternative products may not be available, suitable, or effective in every case.

1	Keep the work site clean and orderly.
2	Buy recycled or less hazardous products to the maximum extent practicable.
3	Conduct painting operations consistent with the state and federal safety (Occupational Safety and Health Administration), air quality regulations, and MCBH's air permit.
4	Properly store paints, epoxy compounds, solvents, and other liquid chemicals in water-tight containers with closed lids or covers. All liquids, except for water, must be stored under cover and in proper secondary containment. Containers must be well-labeled. It is recommended to store materials in their original containers.
5	Properly store powder chemicals and materials, such as cement, in sealed container or bags that are well-labeled. Cover and immediately repair or replace damaged containers. It is recommended to store materials in their original containers.
6	Properly store and dispose waste materials generated from the activity.
7	Enclose or cover painting operations to avoid drift.
8	Use application equipment that minimizes overspray.
9	Clean up spills immediately. Keep ample supply of cleanup material onsite at designated locations. Do not clean surfaces or spill by hosing the area down. Eliminate the source of the spill to prevent discharge or a furtherance of an ongoing discharge.
10	Use a drop cloth to collect residue from scraping or sand blasting operations and dispose of the residue properly.
11	Paint chips containing lead or tributyltin are considered a hazardous waste.
12	Remove as much paint from the brushes on painted surface. Clean painting equipment in a sink that is connected to the sanitary sewer, if possible. If not, direct all wash water into a leak-proof container or leak-pit pit. The container or pit must be designed so that no overflows can occur due to inadequate sizing or precipitation. Properly dispose of wash water.
13	Designate and locate onsite wash area a minimum of 50 feet away, or as far as practicable, from storm drain inlets, open drainage facilities, or water bodies.
14	Mix paints in a covered, contained area whenever possible, in case of a spill.

15	Recycle/dispose according to applicable laws and regulations residual paints, solvent, lumber and other materials to the maximum extent practicable.
16	Dispose containers only after all of the product has been used.
17	Make sure that nearby storm drains are well marked to minimize the chance of inadvertent disposal of residual paints and other liquids.
18	Ensure that employees doing the work are properly trained.
19	Dispose of sand blasted material properly. Chips and dust from marine paints or paints containing lead are to be disposed of as hazardous waste. Paint chips and dust from non-
20	Retain a complete set of SDS onsite at a designed location for easy access.
21	Maintain an inventory tracking software for all applications, as required by the air permit.

3.11 Waste Storage and Disposal

Description

The chemicals used at MCBH may ultimately require waste management. The improper handling of solid wastes can allow contaminants to enter the storm water runoff. The discharge of these pollutants can be prevented and reduced by tracking solid waste storage, handling, and disposal as well as reducing the waste generation through reuse and recycling.

The solid waste generated may include, but not be limited to, oil-based paints, solvents, thinners, petroleum products, acid from batteries, anti-freeze, and other compounds. Some of these wastes should be managed as hazardous waste, universal waste, and/or used oil as required by state and federal regulations. Hazardous waste generators are responsible for making a hazardous waste determination and to dispose of the waste properly. Universal waste includes batteries, some pesticides, mercury containing equipment (mercury thermostats), and bulbs (lamps).

The procedures outlined in this BMP are intended to prevent or reduce the discharge of pollutants to storm water and to the land from waste through proper solid waste storage and disposal and training of employees and subcontractors.

Limitations

All hazardous waste that can or cannot be reused or recycled must be disposed of by a certified hazardous waste hauler.

1	Use the entire product before disposing of the container. Minimize use of hazardous materials on-site. Use less hazardous, alternative materials where possible.
2	Do not remove the original product label; it contains important safety and disposal information.
3	Inspect containers regularly and transfer waste from damaged containers into containers that are intact.
4	Identify, list and inventory all chemical substances present in the facility. Compile Material Safety Data Sheets (MSDS) for all chemical substances. Have MSDS data readily accessible for facility employees
5	Only purchase and store required quantities of hazardous materials.
6	Do not clean out brushes or rinse paint containers into the dirt, street, gutter, storm drain, or stream. “Paint out” brushes as much as possible. Water-based paints should be dried and disposed of in a landfill. Dispose of excess oil-based paints and sludge as hazardous waste.
7	Ensure that hazardous waste or chemicals (acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for dry construction debris.

Solid Waste Storage and Disposal (Continued)

8	Designate an indoor or covered hazardous waste collection area.
9	Hazardous wastes should be stored in secure, covered containers, and protected from damage. Place hazardous waste containers in secondary containment.
10	Label hazardous waste containers clearly with the words “Hazardous Waste” and the date when the hazardous waste accumulation began.
11	Do not mix waste, this can cause chemical reactions, make recycling impossible, and complicate disposal.
12	Arrange for regular hazardous waste collection before containers reach capacity.
13	Ensure that hazardous wastes are collected, removed, and disposed of only at authorized disposal sites by an approved hazardous waste hauler. Maintain disposal manifests for a minimum on three years.
14	Recycle any useful waste such as used oil, spent solvents, spent lead acid batteries, scrap metal, and used oil filters, etc. Filter and re-use thinners and solvents.
15	If the facility generates used oil, at a minimum, the facility shall store used oil in appropriate containers, label containers clearly with the words “Used Oil”, and provide secondary containment.
14	If the facility generates Universal Waste, at a minimum, the facility shall store universal waste in appropriate containers, label containers clearly with the words “Universal Waste” followed by “lamps, batteries, etc.”, and mark with the accumulation start date. Dispose of the Universal Waste within a year of the accumulation start date.
17	Place spill cleanup materials where it will be readily accessible.
18	If containers do spill, clean up immediately – follow procedures in Spill Prevention and Response BMP.
19	At minimum, OWSs must be inspected annually and cleaned to remove accumulated oil, grease, floating debris, and sediment in order to maintain solids and petroleum removal efficiency. Maintain an inspection and maintenance log.
20	Conduct employee training annually and as required.
21	Consult the ECPD Solid Waste Program Manager for further questions and approvals.

3.12 Spill Prevention and Response Practices

Description

In the event of a hazardous substance or oil spill, the Environmental Compliance Coordinator (ECC) and ECPD shall be notified immediately (ECPD: 808-630-8246). If the spill cannot be easily addressed using an onsite spill kit and personal protective equipment, call Fed Fire (Military 911). The spill source should be immediately controlled if it is safe to do so by closing valves, switches, and/or turning off power to a device. Then, contain the spill by using sorbent socks or absorbent materials found in a spill kit. After it has been contained, clean up the spilled material in a safe manner using dry methods. All materials should then be properly disposed of.

Limitations

A spill response contractor may need to be retained to respond to large or hazardous spills.

6 Steps to Clean Up an Oil Spill

1	**SAFETY First.** Let someone in command know what's happened. You are going to need HELP Identify the Physical and Chemical Hazards: use the SOS (Safety Data Sheet) Use the Proper (Level D) PPE Gloves, Eye Protection and Splash Guard (apron)
2	**NOTIFY Environmental and the proper Authorities.** Let your supervisor or ECC know Your Supervisor or the ECC may call Emergency Dispatch Fed Fire (Military 911) IMMEDIATELY Call Base ENVIRONMENTAL (808) 630-8246 Rusty or Dave Carter "DC" (808) 349-7300 for ALL spills - even one drop
3	**CONTROL the Source.** Close Valves, Close Switches, Turn Off the Power, Right the Container, Plug the Hole
4	**CONTAIN the Spilled Material.** Cover affected storm drain with appropriately sized "storm drain mat". Use sorbent socks and oil dry to contain the spill and keep it from spreading Use sorbent socks, oil dry or oil sponge to protect the drains Use oil boom for containment if it gets into the water
5	**CLEAN-UP the Spilled Material**. Use sorbent material (pads, rolls or pillows) or adsorball (clay) to soak up the product Use non sparking shovels or brooms and dust pans to pick up the oil dry
6	**DISPOSE (properly) of the Cleanup Materials** Put the sorbent material into clear 6 mil plastic bags. Use clear bags so HAZWASTE can see what's in them (no liquids in the bag) Schedule for HAZWASTE for pick up sorbents and liquids

IMMEDIATELY call ENVIRONMENTAL at (808) 630-8246 RUSTY

or DC (Dave Carter - Damage Control) at (808) 257-3088

Submit a written SPILL REPORT to roger.nall@usmc.mil

4 References

Marine Corps Base Hawaii, *Small Municipal Separate Storm Sewer System (Small MS4) and Industrial Facilities, NPDES Permit No. HIS000007*, 2021

Marine Corps Base Hawaii, *Storm Water Management Plan, Appendix 11-3 Best Management Practices Fact Sheets*, 2016.

State of Hawaii Department of Transportation, Airports Division, *Construction Activities BMP Field Manual*, 2019.

State of Hawaii Department of Transportation, Airports Division, *Best Management Practice Field Manual for Operations at State of Hawaii Airports*, 2022.

5 Disclaimer

The information presented in this MCBH Maintenance Activities BMP Field Manual was adopted from available and most recent sources that have locally acceptable BMPs and stormwater runoff control measures. This manual has been prepared as a reference guideline, however, due to site-specific conditions, the selection of the BMPs must be used in conjunction with the best professional judgment and sound engineering principles to assure proper function and performance of the BMPs contained herein. The author does not guarantee the accuracy or completeness of this document and will not assume any liability or responsibility for the use of, or for any damages resulting from the use of any information contained herein. The detail and the wording in this manual will not necessarily result in compliance with NPDES permit requirements or other requirements specific to the user's site or construction contract. Application of BMPs should comply with applicable federal, state, and county regulations.

6 Selected BMP Fact Sheets

Table 6-1 Selected BMP Fact Sheets

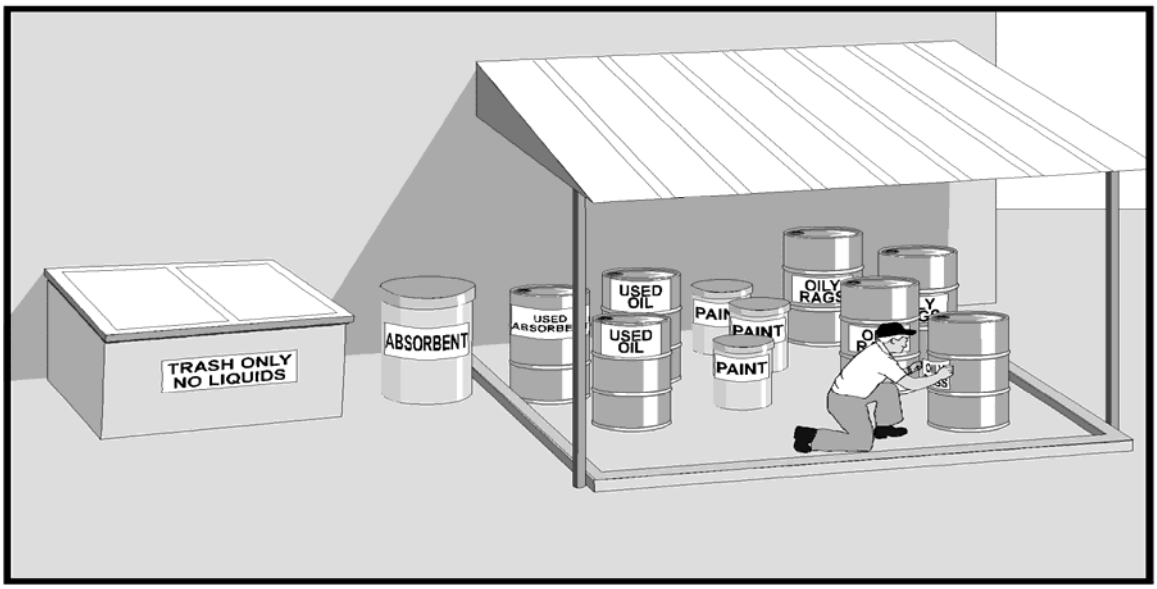
BMP No.	BMP Title
001	Label All Drums, Cans, Containers, Tanks, and Valves
002	Restrict Access to Area and Equipment
003	Perform Regular Cleaning
004	Avoid Hosing Down the Site
005	Perform Regular Pavement Sweeping
006	Control Spills
007	Place Trash Receptacles at Appropriate Locations
008	Train Employees to Properly Dispose of Wastes
009	Permanently Seal Floor Drains that Discharge to the Storm Drain System
010	Confirm that No Industrial Sinks are Connected to the Storm Drain System
011	Construct Berm or Dike Around Critical Areas
012	Pave Bermed Areas
013	Provide Valve for Outlet Pipe in Containment Area
014	Recycle
015	Store Waste and Recycling Materials in Proper Containers
016	Limit Significant Materials Inventory
017	Provide Roof to Cover Source Area
018	Control Roof Downspout Discharge
019	Minimize Storm Water Run-On from Adjacent Facilities and Properties
020	Reduce Waste
021	Repair Leaky Roofs
022	Permanently Seal Drains Within Critical Areas that Discharge to the Storm Drain
023	Place Portable Rubber Mats over Storm Drain Inlets
024	Insert Filter in Catch Basin
025	Place Absorbent Blankets in Catch Basin
026	Routinely Clean Catch Basins
027	Stencil Signs on Storm Drain Inlets
028	Keep Equipment and Vehicles Clean
029	Maintain Equipment in Good Condition
030	Implement Qualifying Tests for Equipment and Vehicle Operators
031	Conduct Refresher Courses in Operating and Safety Procedures
032	Dispose of Obsolete Equipment, Inoperable Vehicles, and Surplus Materials
033	Check Vehicles and Equipment for Leaks
034	Park Vehicles or Equipment Indoors or under a Roof
035	Park Vehicles on an Impervious Surface
036	Designate Special Areas for Draining or Replacing Fluids
037	Drain All Fluids from Stored or Salvaged Vehicles and Equipment
038	Completely Drain Oil Filters Before Disposal
039	Wash Equipment and Vehicles in Designated Area
040	Discharge Wash Water to a Sanitary Sewer
041	Recycle Pressure Wash Solvents
042	Use Drip Pans under Leaking Equipment

BMP No.	BMP Title
043	Designate Areas for Washing Non- Vehicular Air Filters and Other Greasy Equipment
044	Conduct Maintenance within a Building or Covered Area
045	Reduce the Amount of Liquid Cleaning Agents Used
046	Centralize Liquid Solvent Cleaning to One Location
047	Substitute Non-Toxic or Less-Toxic Cleaning Solvents
048	Use Solvents Efficiently
049	Use Outside Contractor for Handling Used Solvents and Other Significant Materials
050	Properly Store Containers
051	Use Overpack Containers or Containment Pallets to Store 55 Gallon Drums or containers Outside of Storage Areas
052	Use "Doghouse" Design for Outdoor Storage of Small Liquid Containers
053	Do Not Store Used Parts or Containers Directly on Ground
054	Do Not Allow Open Flames Near Flammable Material
055	Use Door Skirt or Seal
056	Employ Proper Handling Procedures to Transport Materials and Waste
057	Store Liquids and Significant Materials within a Building or Covered Area
058	Provide Overfill Protection
059	Monitor Major Fueling Operations
060	Provide Absorbent Booms in Unbermed Fueling Areas
061	Eliminate Topping off Tanks
062	Install Leak Detection System
063	Designate Areas for Fueling from Mobile Fuel Tankers
064	Restrict Access to Tanks
065	Lock Fuel Tanks When Not in Use or on Standby
066	Keep Tanks, Piping, and Valves in Good Condition
067	Protect Tanks from Being Damaged by Vehicles
068	Protect Fill Pipe from Being Damaged by Vehicles
069	Provide Protection for Permanent Aboveground Tanks from Discharge of Firearms
070	Enclose Outdoor Sanding and Painting Operations and Use Tarps to Contain and Collect Solid Wastes
071	Vacuum Particulate Wastes from Sanding or Painting Operations
072	Conduct Indoor Sanding and Painting in an Enclosed Area
073	Avoid Sanding or Painting in Windy Weather
074	Use Efficient Painting Equipment
075	Do Not Empty Toilet Tanks During Transit or in the Port
076	Do Not Discharge Bilge Water in Harbor
077	Do Not Discharge Bilge Water in Harbor
078	Use Oil Containment Booms
079	Properly Dispose of Sediment Generated by Cleaning Sanitary Sewer Lines
080	Eliminate Treated Wood Products or Use Wood Treated with Less-Toxic Chemicals
081	Establish Integrated Pest Control
082	Conduct Pesticide Operations under the Supervision of Licensed Applicator
083	Divert Drainage to Treatment Facility/Sanitary Sewer
084	Divert Drainage to a Low-Flow Sump
085	Construct Oil/Water Separator
086	Deleted
087	Deleted
088	Deleted

BMP No.	BMP Title
089	Deleted
090	Deleted
091	Deleted
092	Deleted
093	Deleted
094	Deleted
095	Deleted
096	Construct Concrete Grid Pavement
097	Regularly Inspect and Maintain Storm Water Conveyance System
098	Regularly Inspect and Test Equipment
099	Prepare Appropriate Spill Prevention and Response Plans
100	Conduct Personnel Training Regarding the SWPPP
101	Store Containers Inside Secondary Containment
102	Control Dust and Particulates
103	Do Not Pour or Deposit Waste into Storm Drains
104	Routinely Report Any Observed Non- Storm Water Discharges
105	Deleted
106	Deleted
107	Deleted
108	Deleted
109	Deleted
110	Timing of Construction
111	Staging Areas
112	Preservation of Existing Vegetation
113	Clearing Limits
114	Stabilization of Construction Entrance and Roads
115	Erosion Prevention on Temporary and Private Roads
116	Dust Control
117	Cover for Materials and Equipment
118	Spill Prevention and Control
119	Vehicle/Equipment Washing and Maintenance
120	Waste Management
121	Mulching
122	Hydromulching
123	Geotextile
124	Matting
125	Pipe Slope Drain
126	Slope Roughening
127	Gradient Terracing
128	Retaining Walls
129	Gabions
130	Riprap Slope and Outlet Protection
131	Inlet Protection
132	Check Dams
133	Temporary Stream Crossing
134	Straw Bales/Biofilter Bags
135	Silt Fence

BMP No.	BMP Title
136	Vegetative Buffer Strip
137	Sedimentation Trap (Basin)
138	Portable Sediment Tank
139	Temporary Swale
140	Earth Dike
141	Perimeter Dike/Swale
142	Temporary Berms (Sandbags)
143	Temporary Storm Drain Diversion
144	Topsoiling
145	Seeding
146	Sodding
147	Planting

BMP 001 - LABEL ALL DRUMS, CANS, CONTAINERS, AND TANKS



Description of Potential Pollutant and Source: Drums, cans, and containers can be improperly managed and disposed of due to uncertainty of the container's contents. Tanks which are not labeled may result in improper use of the tank or fuel, which may result in the exposure of significant materials to storm water and/or receiving waters. Similarly, unlabeled valves may be opened without proper precaution due to lack of user information. Storm water quality will be affected if significant materials are improperly disposed to the storm drain and/or receiving waters. Lack of labeling will also make it difficult to quickly identify the type of material released so facility personnel can respond correctly. Labels also identify hazardous materials at the facility and are a good way to request caution in certain areas (e.g., drums indicating flammability).

Description of BMP: Label all drums, valves, pumps, cans, tanks, and containers to reduce the chance of misuse and eventual spills. Labeling ensures that the appropriate procedures, equipment, and storage containers are used. All containers will be labeled as to what is in them.

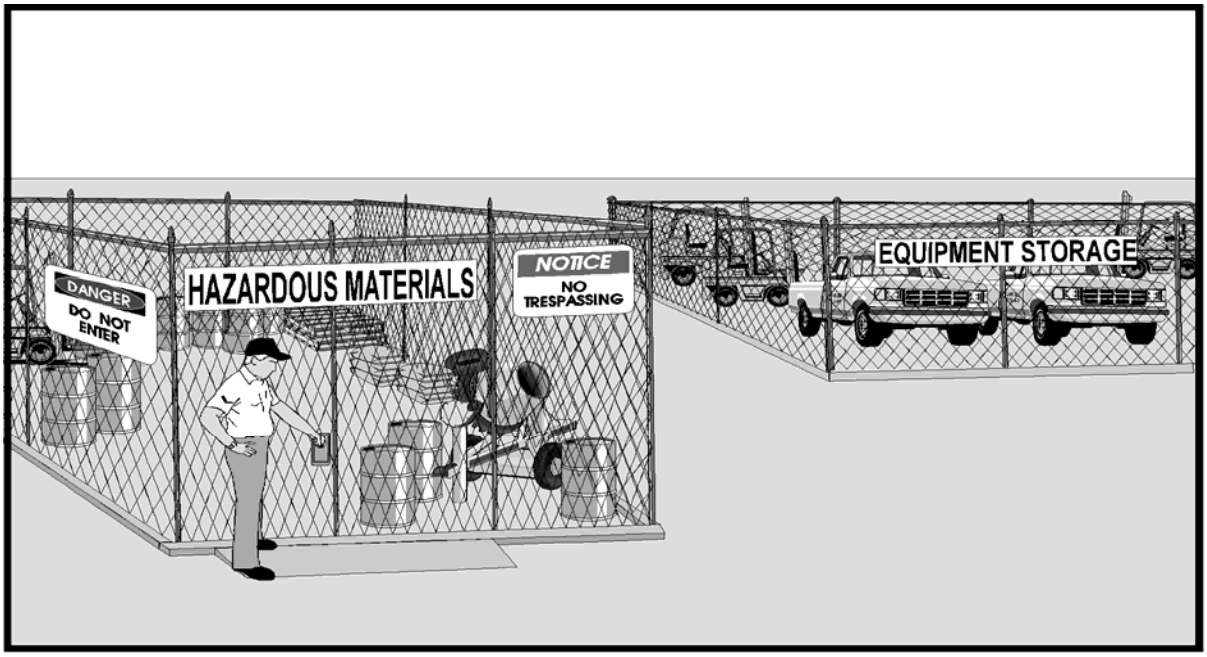
Application Guidance: As needed.

Training: N/A

Effectiveness and Cost: Effectiveness and costs will vary depending on the application.

Limitations: None

BMP 002 - RESTRICT ACCESS TO AREA AND EQUIPMENT



Description of Potential Pollutant and Source: Vandalism of vehicles and facility property may result in the release of significant materials.

Description of BMP: Provide fences and gate areas where vehicles, equipment and materials are stored and are accessible to the public to discourage trespassing. Access to equipment will also be restricted. Only authorized personnel will be allowed to operate equipment. The fences and gates will be properly maintained, and additional security measures including lighting of the area will be implemented if the fencing alone proves insufficient. Where appropriate, security guards or alarms will be used.

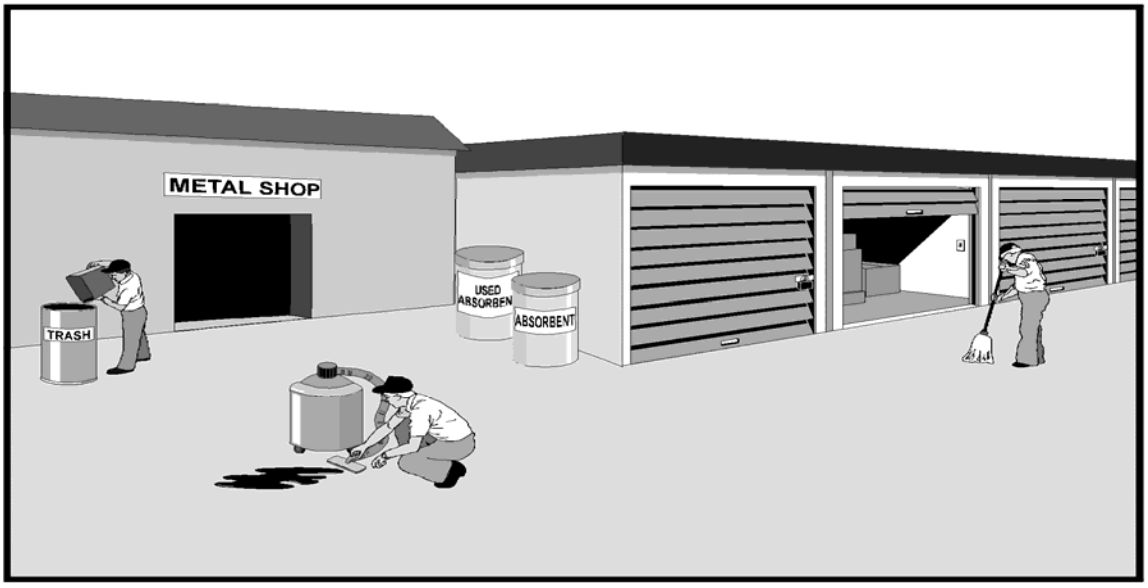
Application Guidance: As needed.

Training: N/A

Effectiveness and Cost: Effectiveness and costs will vary depending on the application.

Limitations: None

BMP 003 - PERFORM REGULAR CLEANING



Description of Potential Pollutant and Source: Dirt, surplus materials, and spilled or dropped materials are often allowed to accumulate in areas such as maintenance shops, manufacturing facilities, metal fabrication shops, loading docks, and storage areas. Pollutants from the accumulated material can be transported by storm water to the storm drain system. A clean and orderly work area reduces the possibility of accidental spills caused by mishandling of chemicals and equipment and should reduce safety hazards to personnel.

Description of BMP: Maintain a regular general sweeping and cleaning schedule to reduce buildup of waste materials and minimizes the amount of significant materials exposed to storm water. General cleaning includes dusting and keeping work areas neat and organized.

Floors and ground surfaces will be kept dry using brooms, shovels, vacuum cleaners, or cleaning machines. It is important to perform dry sweeping and dry cleaning (as opposed to hosing down areas as discussed in BMP 004). Garbage and waste materials will be collected and disposed regularly. Particular emphases will be placed on sweeping and cleaning outdoor areas as close as possible to a forecasted rainfall. Any granular absorbent materials used for spill cleanup will be removed and properly disposed before a rainfall.

Application Guidance: Cleanup and sweeping will be performed daily and more often as necessary to remove all loose trash, paint cans, discarded construction materials, sediment, oil, solvents, plastics and other significant materials. Additional clean up and sweeping will be performed before anticipated storm events. Additionally, a regular sweeping schedule will be maintained.

The frequency for implementing this BMP has been provided as general guidance. However, a facility operator may wish to establish a more suitable frequency. This will require SWPCP implementor to make judgements based on facility operations and conditions. To assign a frequency other than what has been suggested (i.e., more or less frequent), the following criteria will be considered and rated either High, Medium, or Low. If many of the criteria are assigned a High rating, the frequency may be increased. Similarly, if many criteria are assigned a Low rating, the frequency may be decreased. The goal of implementing this BMP is to minimize exposure of pollutants to storm water.

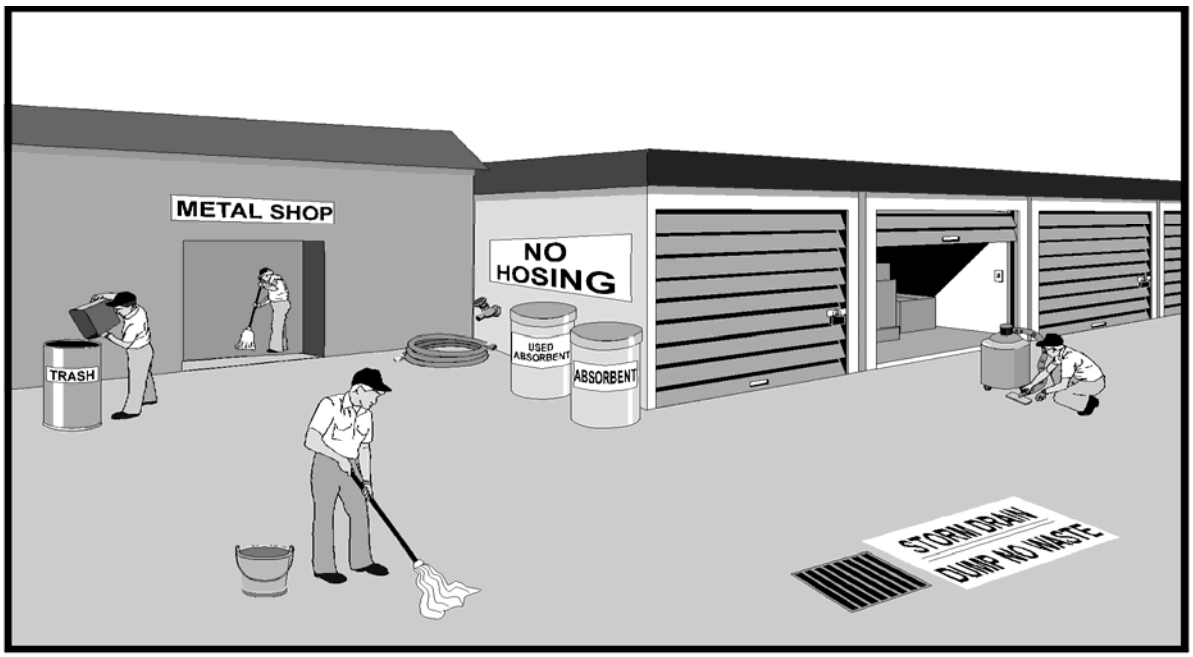
CRITERIA	Rating H=High M=Medium
Probability of exposure of significant materials to storm water	
Quantity of significant materials potentially exposed	
Toxicity of significant materials potentially exposed	
Frequency of use of significant materials potentially exposed	
Evidence of exposure (e.g., stains on pavement, etching of concrete)	
Proximity of source area to outfall or receiving water	
Sensitivity of receiving water to potentially exposed significant materials (e.g., waters with beneficial uses such as human contact, recreation, significant species habitat, etc.)	

Training: Personnel will be trained to ensure that all waste be managed within guidelines of applicable federal, state, and local regulations. Signs will be posted as reminders.

Effectiveness and Cost: Regular general cleaning is a highly effective, low-cost BMP.

Limitations: None

BMP 004 - AVOID HOSING DOWN THE SITE



Description of Potential Pollutant and Source: Cleaning work sites by hosing down causes wash water to transport pollutants to the storm drain where it can be exposed to storm water.

Description of BMP: Use dry methods to clean work sites. Dry methods include sweeping or using damp rags or mops. If possible or practical, hoses will be removed. If hosing down is unavoidable, the downstream drain will be temporarily plugged as described in the following BMPs:

- BMP 032 - Place portable Rubber Mats Over Storm Drain Inlets
- BMP 024 - Insert Filter in Catch Basin
- BMP 025 - Place Absorbent Blankets in Catch Basin

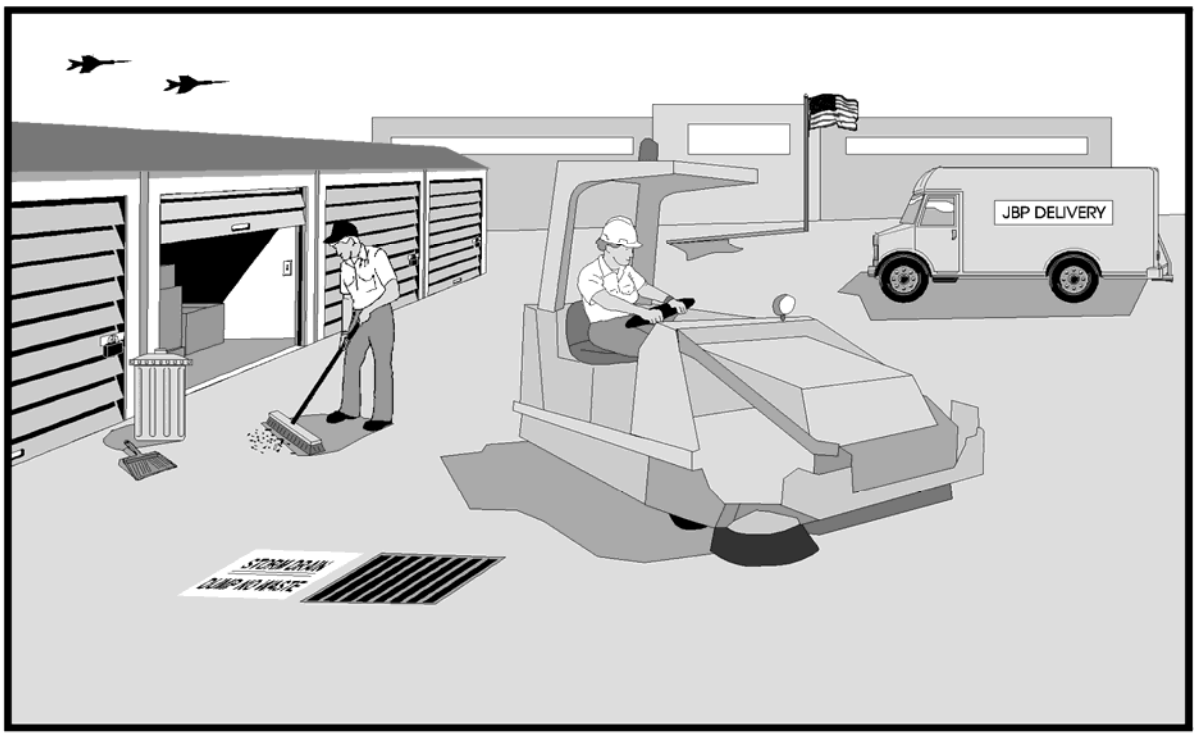
Application Guidance: Methods of dry cleaning will be used whenever possible at all work stations, loading/unloading sites, storage areas, and parking lots.

Training: New personnel will be notified of the policy and signs will be posted. If possible or practical, hoses will be removed.

Effectiveness and Cost: Eliminating hosing down is a highly effective, low-cost BMP.

Limitations: None

BMP 005- PERFORM REGULAR PAVEMENT SWEEPING



Description of Potential Pollutant and Source: Trash, litter and particulate matter typically accumulate on paved surfaces. These materials are then transported during storm events into the storm water system or directly into receiving waters (e.g., from piers).

Description of BMP: Dry sweep paved areas regularly to prevent pollutants and debris from entering storm drains.

Application Guidance: Dry sweeping of paved areas will be performed semi-monthly. Particular emphasis will be placed on sweeping the paved areas prior to the wet season and frequently during the wet season.

The frequency for implementing this BMP has been provided as general guidance. However, a facility operator may wish to establish a more suitable frequency. This will require SWPCP implementors to make judgements based on facility operations and conditions. To assign a frequency other than what has been suggested (i.e., more or less frequent), the following criteria will be considered and rated either High, Medium, or Low. If many of the criteria are assigned a High rating, the frequency may be increased. Similarly, if many criteria are assigned a Low rating, the frequency may be decreased. The goal of implementing this BMP is to minimize exposure of pollutants to storm water.

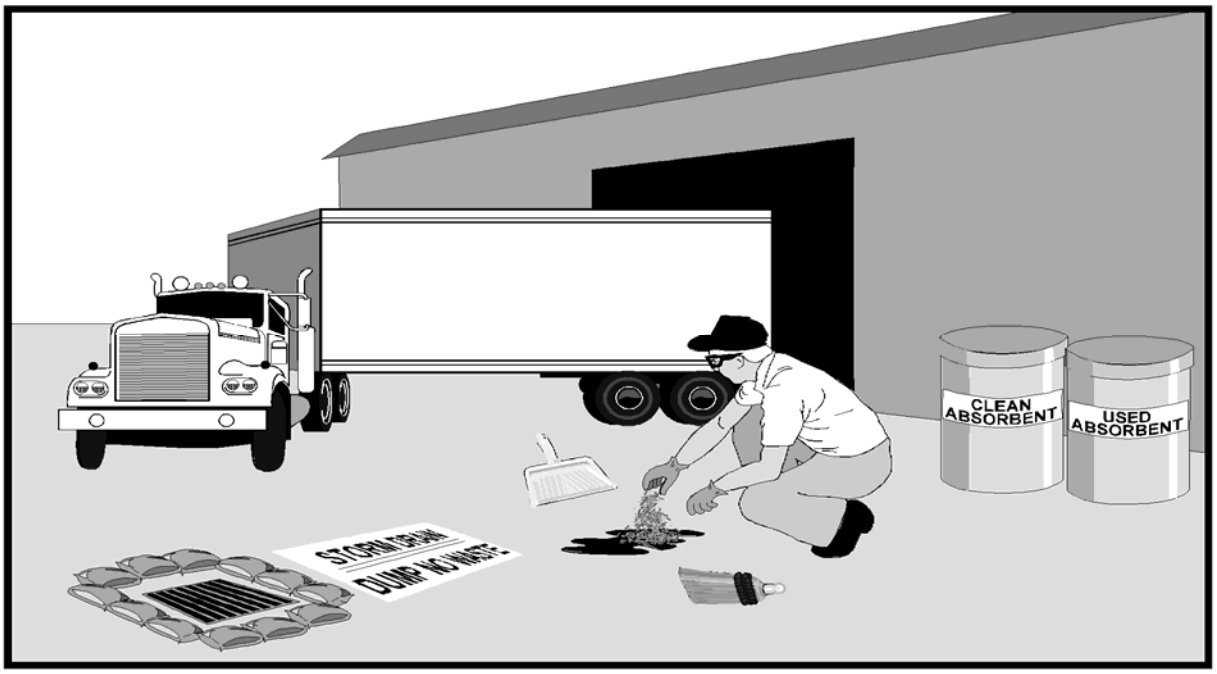
CRITERIA	Rating H=High M=Medium L=Low
Probability of exposure of significant materials to storm water	
Quantity of significant materials potentially exposed	
Toxicity of significant materials potentially exposed	
Frequency of use of significant materials potentially exposed	
Evidence of exposure (e.g., stains on pavement, etching of concrete)	
Proximity of source area to outfall or receiving water	
Sensitivity of receiving water to potentially exposed significant materials (e.g., waters with beneficial uses such as human contact, recreation, significant species habitat, etc.)	

Training: Personnel will be trained to use a small vacuum sweeper, if available, instead of a mechanical brush sweeper since the vacuum is more effective at removing fine particulate matter.

Effectiveness and Cost: Dry sweeping is a moderately effective, high-cost BMP**,** especially if a vacuum sweeper must be purchased.

Limitations: Layout of the site, amount of paved surface area, and the availability of funds for purchase of equipment may limit the use of this practice.

BMP 006 - CONTROL SPILLS



Description of Potential Pollutant and Source: Spills of significant materials may be exposed to storm water and transported to storm drains and/or receiving waters.

Description of BMP: Follow material safety data sheets (MSDS) for handling, storage, and cleanup of all significant materials to reduce the potential for spills.

Any spill, large or small, of significant materials will be controlled to prevent pollutants from being transported to storm drains and/or receiving waters. Appropriate spill control material will be kept on site. Smaller spills will be contained using absorbent material such as kitty litter, straw, or sawdust. Drums of absorbent material will be easily accessible and clearly marked, and containers for spent absorbent material will be readily available. Spent absorbent material will be managed appropriately and disposed of in accordance with applicable regulations. Larger spills will be controlled using spill kits, brooms, and other response equipment commensurate with the size of the spill. The methods outlined in the Activity's spill prevention and response plans (BMP 112) for hazardous materials will be followed for spills of any potential storm water pollutants. The date, time, nature and volume of material spilled, and cleanup measures taken will be recorded for all spills and kept as part of the SWPCP.

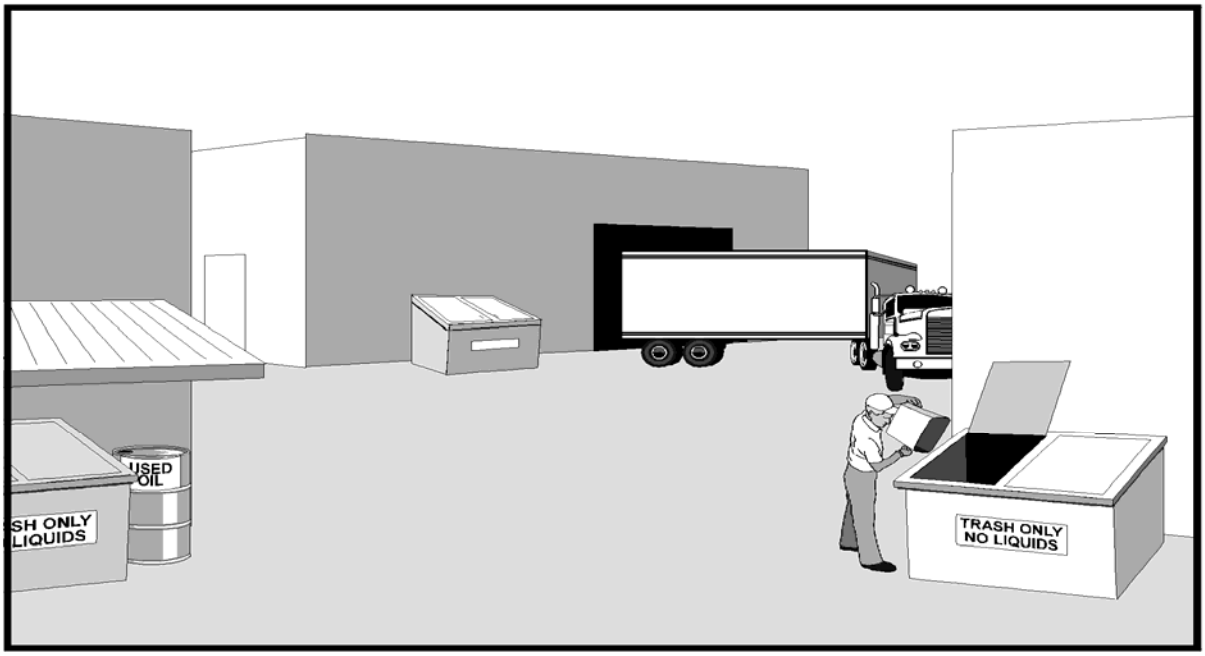
Application Guidance: Controlling spills will be practiced under all working conditions.

Training: Personnel will be trained in spill prevention and response procedures including the use of personal protection equipment (gloves, eye and face protection, etc.). This will include what absorbent or equipment to use, how to use the absorbent or equipment, where to find it, how to dispose of the spent absorbent or other material, and who to notify in the event of a spill.

Effectiveness and Cost: Spill control is a moderately effective, low-cost BMP.

Limitations: None

BMP 007 - PLACE TRASH RECEPTACLES AT APPROPRIATE LOCATIONS



Description of Potential Pollutant and Source: Improperly located or insufficient numbers of trash receptacles will promote poor housekeeping practices. This will increase the opportunity for pollutants from all source areas to reach storm water.

Description of BMP**:** Properly located and sufficient numbers of trash receptacles will promote the proper disposal of waste materials. This reduces the opportunity for pollutants to reach storm water. Trash receptacles will be easily accessible for personnel.

Application Guidelines: Placement of trash receptacles at appropriate locations will always be practiced.

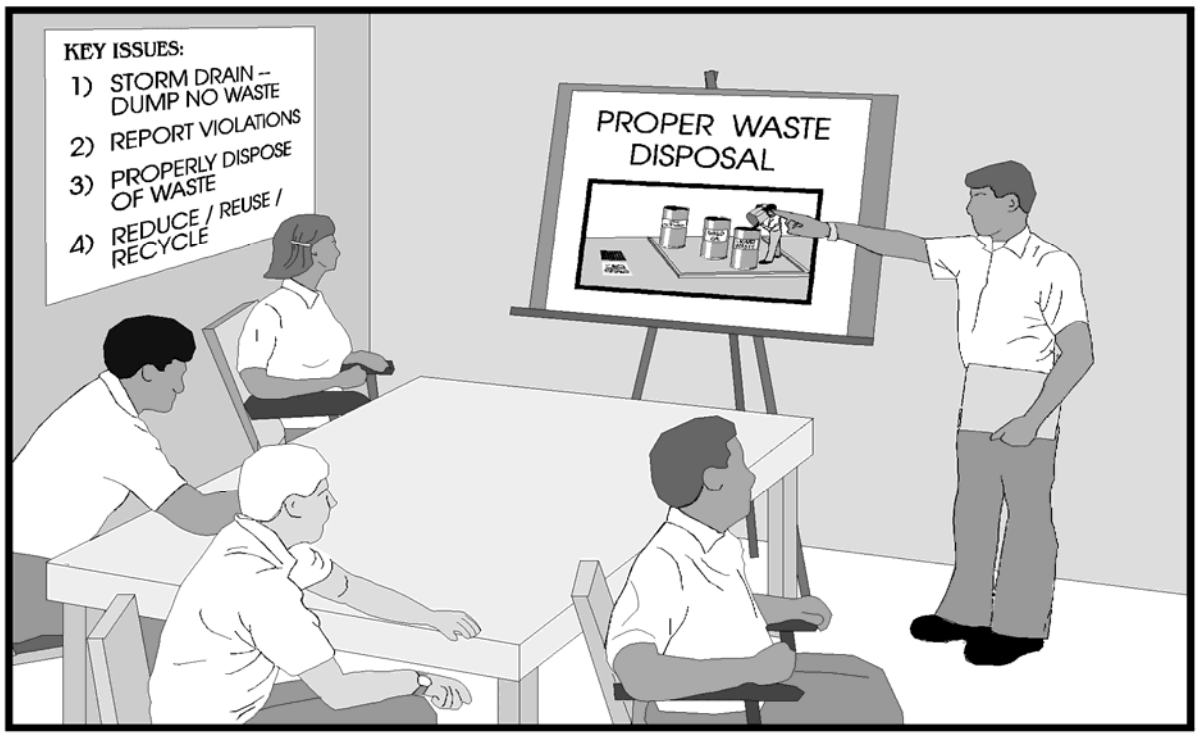
Training: Personnel will be trained as to the location of trash receptacles.

Effectiveness and Cost: Appropriately located trash receptacles are an effective, low-cost BMP.

Limitations: None

PLACEHOLDER

BMP 009 - TRAIN EMPLOYEES TO PROPERLY DISPOSE OF WASTES



Description of Potential Pollutant and Source: Waste poured or deposited into storm drains contains pollutants which will enter the storm drain system and receiving waters without treatment.

Description of BMP: Train employees on proper waste disposal and recycling procedures. Refer also to BMP 118, "Routinely Report Any Observed Non-Storm Water Discharges," and BMP 027, "Stencil Signs on Storm Drain Inlets."

Application Guidance: Training will be performed for all new personnel and semi-annually for all personnel.

The frequency for implementing this BMP has been provided as general guidance. However, a facility operator may wish to establish a more suitable frequency. This will require SWPCP implementors to make judgements based on facility operations and conditions. To assign a frequency other than what has been suggested (i.e., more or less frequent), the following criteria will be considered and rated either High, Medium, or Low. If many of the criteria are assigned a High rating, the frequency may be increased. Similarly, if many criteria are assigned a Low rating, the frequency may be decreased. The goal of implementing this BMP is to minimize exposure of pollutants to storm water.

CRITERIA	Rating H=High M=Medium L=Low
Probability of exposure of significant materials to storm water	
Quantity of significant materials potentially exposed	
Toxicity of significant materials potentially exposed	
Frequency of use of significant materials potentially exposed	
Evidence of exposure (e.g., stains on pavement, etching of concrete)	
Proximity of source area to outfall or receiving water	
Sensitivity of receiving water to potentially exposed significant materials (e.g., waters with beneficial uses such as human contact, recreation, significant species habitat, etc.)	
Frequency of personnel turnover	

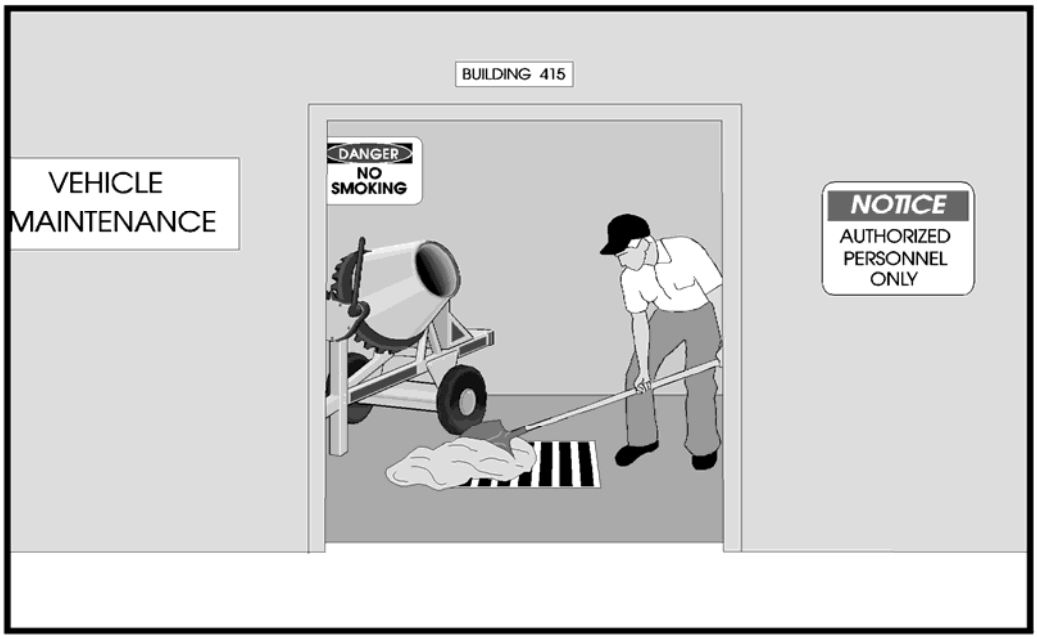
Training: Training will include the following:

- Train personnel at all levels not to pour or deposit wastes into storm drains or storm drain connections.
- Train personnel to properly dispose or recycle materials.
- Train personnel at all levels to report any observable non-storm water discharges.

Effectiveness and Cost: This is a highly effective, low-cost BMP.

Limitations: None

BMP 010 - PERMANENTLY SEAL FLOOR DRAINS THAT DISCHARGE TO THE STORM DRAIN SYSTEM



Description of Potential Pollutant and Source: Floor drains that are connected to the storm drain system provide a pathway for spilled or leaked material to enter the system.

Description of BMP: Permanently seal floor drains inside buildings (whenever this would not adversely affect safety or structural integrity) to prevent accidental illegal dumping of pollutants into the storm water system.

Application Guidance: N/A

Training: N/A

Effectiveness and Cost: This is a highly effective, low-cost BMP.

Limitations: None

BMP 011 - CONFIRM THAT NO INDUSTRIAL SINKS ARE CONNECTED TO THE STORM DRAIN SYSTEM

Description of Potential Pollutant and Source: Industrial sinks and floor drains connected to the storm drain system can introduce pollutants directly to the storm drain system and receiving waters without treatment.

Description of BMP: Connect sinks and floor drains in industrial areas to a sanitary sewer or other disposal location. "As-builts," piping diagrams, and building or site plans will be inspected to verify that the sinks and floor drains are not connected to the storm drain system, especially in casually constructed shop areas. Additional reconnaissance may be performed to look for plumbing changes not shown on available plans. If an illicit connection to the storm drain system is suspected, additional testing will be performed.

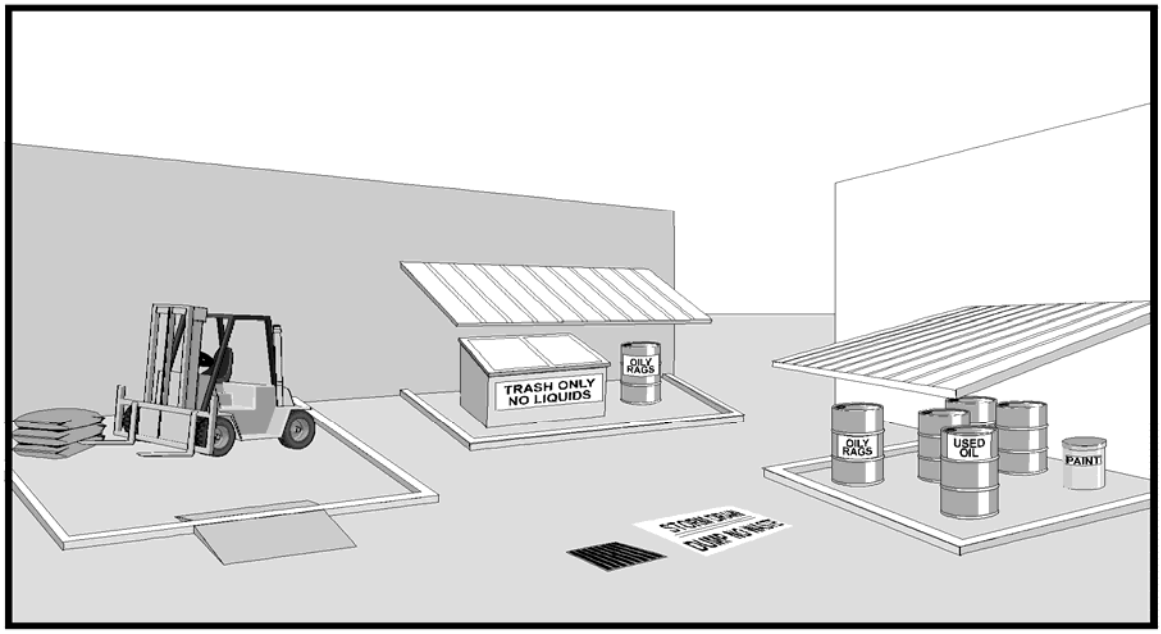
Application Guidance: N/A

Training: N/A

Effectiveness and Cost: This is a highly effective, low- to moderate-cost BMP.

Limitations: None

BMP 012 - CONSTRUCT BERM OR DIKE AROUND CRITICAL AREAS



Description of Potential Pollutant and Source: Critical areas are source areas that have a high likelihood for the release of pollutants. This includes material handling areas, material storage areas, and equipment repair and maintenance areas. As a result of spills and leaks or exposure to storm water, pollutants can flow from critical areas into the storm water system. In addition, small spills and leaks can accumulate on the surface area and be washed away by storm water.

Description of BMP: Construct a raised berm or dike around critical areas. This will provide secondary containment and prevent any spills or leaks from leaving the area. This secondary containment will also be provided where mobile tankers containing fuel are customarily stationed. Construct a ramp to allow vehicle access into the area. (Note: double walled tanks do not require this BMP. Also, 40 CFR 112.7 requires bulk petroleum storage tanks be provided with secondary containment.) A drain valve will be installed and procedures to drain storm water from the bermed area will be posted (see BMP 014).

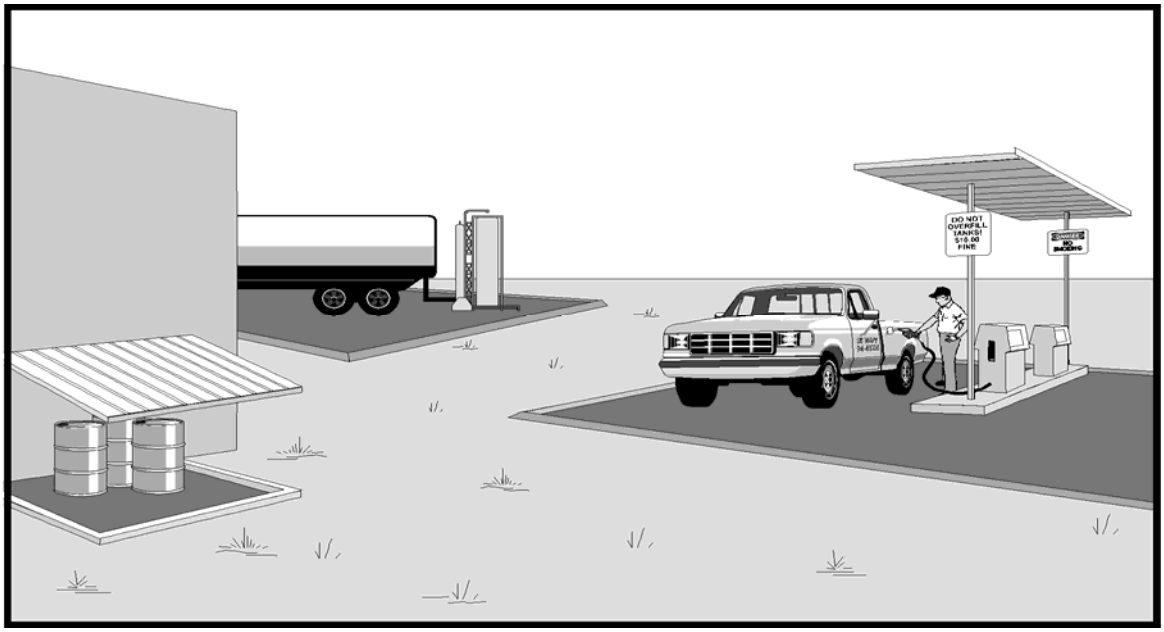
Application Guidance: Install as needed.

Training: N/A

Effectiveness and Cost: This is a highly effective BMP. The cost will vary depending on the size of the fueling operation.

Limitations: The size of some tank and fueling operations areas could make this BMP relatively expensive.

BMP 013 - PAVE BERMED AREAS



Description of Potential Pollutant and Source: Critical areas are source areas that have a high likelihood for the release of pollutants. This includes material handling areas, material storage areas, and equipment repair and maintenance areas. Material which has leaked or spilled on the ground surface may infiltrate into the soil and then be transported to storm drains by storm water.

Description of BMP: Pave bermed areas. (See BMP 012, "Construct Berm or Dike Around Critical Area."). The area within the berm will be sufficiently impervious to prevent infiltration of the material in the event of a spill. The impervious material will be concrete, asphalt concrete, or other impervious paving material. The lining material will also be clay, plastic or another impervious material. A storm drain must not be located within the impervious area. (Note: 40 CFR 112.7 requires bulk petroleum storage tanks be provided with secondary containment.)

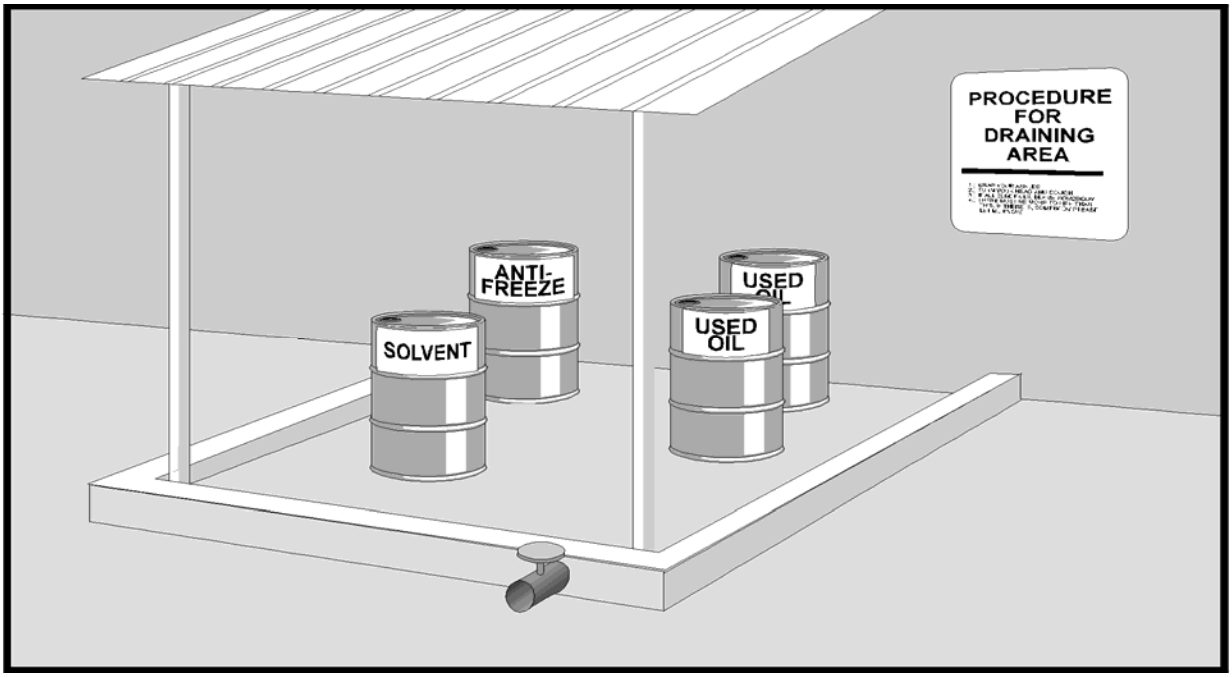
Application Guidance: Install as needed.

Training: N/A

Effectiveness and Cost: This is an effective BMP. Costs will vary based on the size of the area.

Limitations: The size of some tank and fueling operations areas could make this BMP expensive.

BMP 014 - PROVIDE VALVE FOR OUTLET PIPE IN CONTAINMENT AREA



Description of Potential Pollutant and Source: Spilled or leaked material may be discharged from containment areas through open outlet pipe valves or by overflowing.

Description of BMP: Install outlet pipe valves and keep closed. During storm events, containment areas will be drained following guidelines specifically developed for that area. Storm water accumulated in containment areas may be released to the storm drain system after the water quality has been evaluated based on the types of materials stored in the containment area and/or after laboratory analyses. If sheening, discoloration, odor, or evidence of spills is observed, the water will not be discharged to the storm drain system prior to treatment or further evaluation.

In containment areas where oils are stored, skimming spilled oil off the water using absorbents will be adequate treatment prior to discharge to storm drain system. However, the water will either be pumped out and stored pending chemical analytical results or properly disposed.

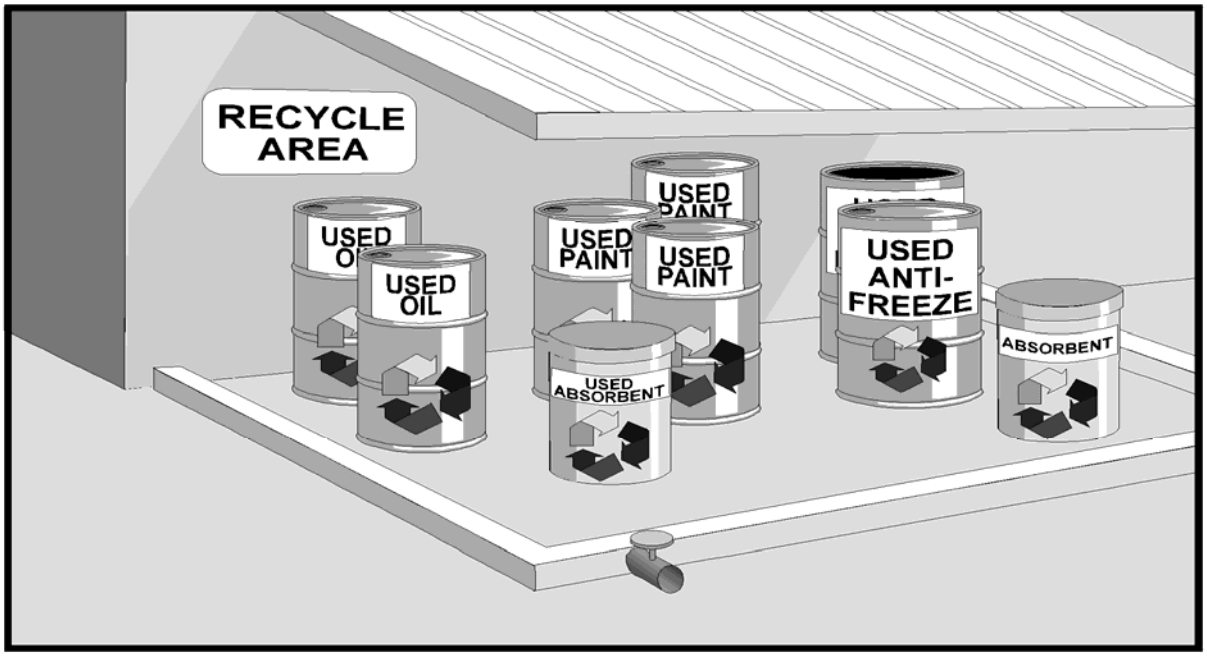
Application Guidance: The accumulated storm water will be released or removed at least every 24 hours during storm events.

Training: Personnel will be trained to drain containment areas according to the procedures developed for each containment area. Personnel will also be trained in the proper method of disposing materials that have been contained in the area after a spill.

Effectiveness and Cost: This is an effective, low to moderate-cost BMP.

Limitations: None

BMP 015 – RECYCLE



Description of Potential Pollutant and Source: Many materials, both hazardous and non-hazardous, can be sources of pollutants. Recycling will be employed to reduce the amount of waste material exposed to storm water on the Activity.

Description of BMP: Recycle materials to the fullest extent possible in all situations.

Application Guidance: Recycling collections will be conducted at least weekly for recyclable items such as solvents, oil, scrap metals, wash water and absorbent materials. Separating the recyclable items facilitates recycling.

The frequency for implementing this BMP has been provided as general guidance. However, a facility operator may wish to establish a more suitable frequency. This will require SWPCP implementors to make judgements based on facility operations and conditions. To assign a frequency other than what has been suggested (i.e., more or less frequent), the following criteria will be considered and rated either High, Medium, or Low. If many of the criteria are assigned a High rating, the frequency may be increased. Similarly, if many criteria are assigned a Low rating, the frequency may be decreased. The goal of implementing this BMP is to minimize exposure of pollutants to storm water.

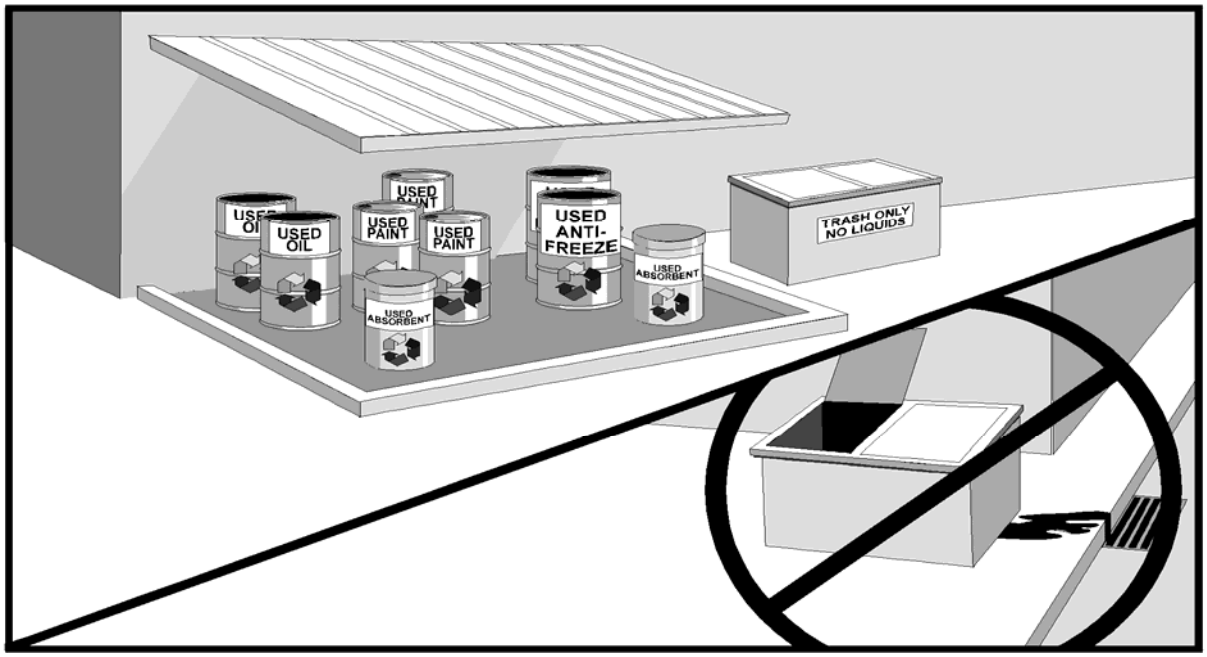
CRITERIA	Rating H=High M=Medium L=Low
Probability of exposure of significant materials to storm water	
Quantity of significant materials potentially exposed	
Toxicity of significant materials potentially exposed	
Frequency of use of significant materials potentially exposed	
Evidence of exposure (e.g., stains on pavement, etching of concrete	
Proximity of source area to outfall or receiving water	
Sensitivity of receiving water to potentially exposed significant materials (e.g., waters with beneficial uses such as human contact, recreation, significant species habitat, etc.)	

Training: Personnel will be trained on proper recycling techniques along with posting and maintenance of signs.

Effectiveness and Cost: Effectiveness and cost will be site specific.

Limitations: Local vendors may not be available to receive certain recyclable materials.

BMP 016 - STORE WASTE AND RECYCLING MATERIALS IN PROPER CONTAINERS



Description of Potential Pollutant and Source: Dry waste, including items such as scrap metal, floor sweepings, metal chips, and paper goods, can be dispersed by wind or operational error if not stored properly. If a dumpster's lid is not kept closed, animals may carry garbage out of the containers. Uncovered dumpsters also expose waste to storm water, which may leak out of the dumpster and into the storm sewer system.

Description of BMP: Locate waste and recycling drums and containers in centralized areas, using proper labeling (both containers and location) and providing easy access. If possible, the area will have secondary containment (see BMPs 012, 013, and 014). Waste containers will be emptied regularly. Dumpsters will all have lids; lids will be kept closed when not in use. If the dumpster has inadequate capacity and it is not possible to keep the cover closed, the frequency of pick-up will be increased, or the dumpster will be replaced with a model of greater capacity.

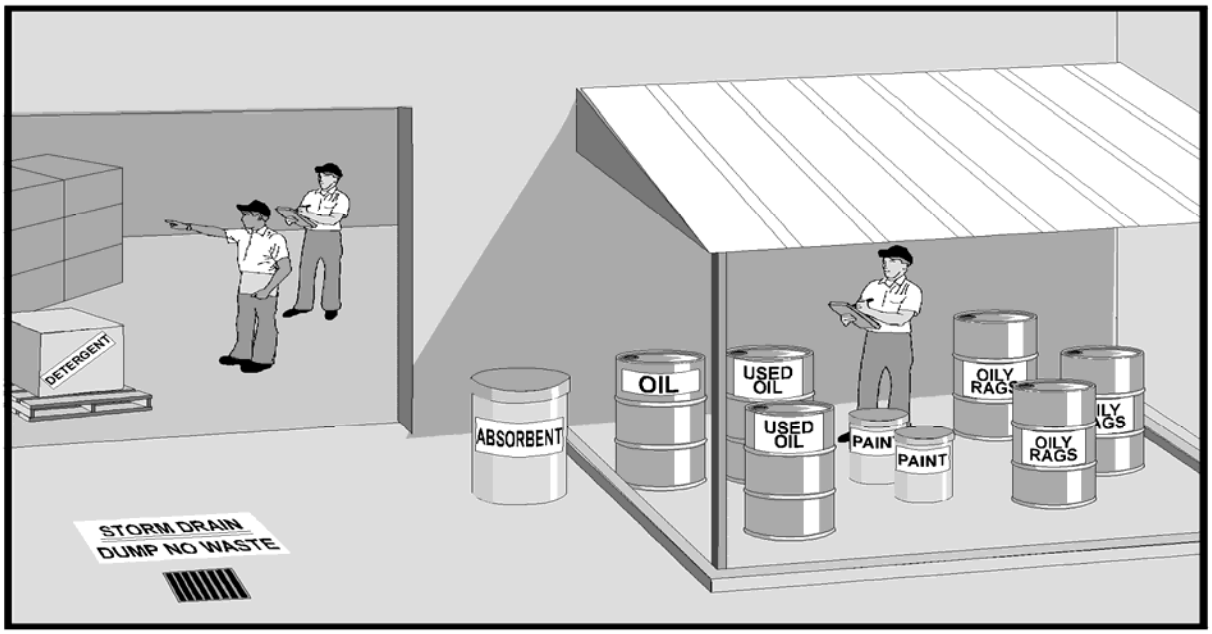
Application Guidance: This BMP will be applied to all waste and recycling storage areas.

Training: Personnel will be trained to monitor waste and recycling storage sites to ensure their materials are properly stored and that there are no overflowing containers.

Effectiveness and Cost: This is a moderately effective, low-cost BMP.

Limitations: None

BMP 017 - LIMIT SIGNIFICANT MATERIALS INVENTORY



Description of Potential Pollutant and Source: Reducing the amount of significant materials reduces the potential for the material to enter the storm drain system.

Description of BMP: Control inventory control to prevent excess storage of unnecessary or infrequently used significant materials.

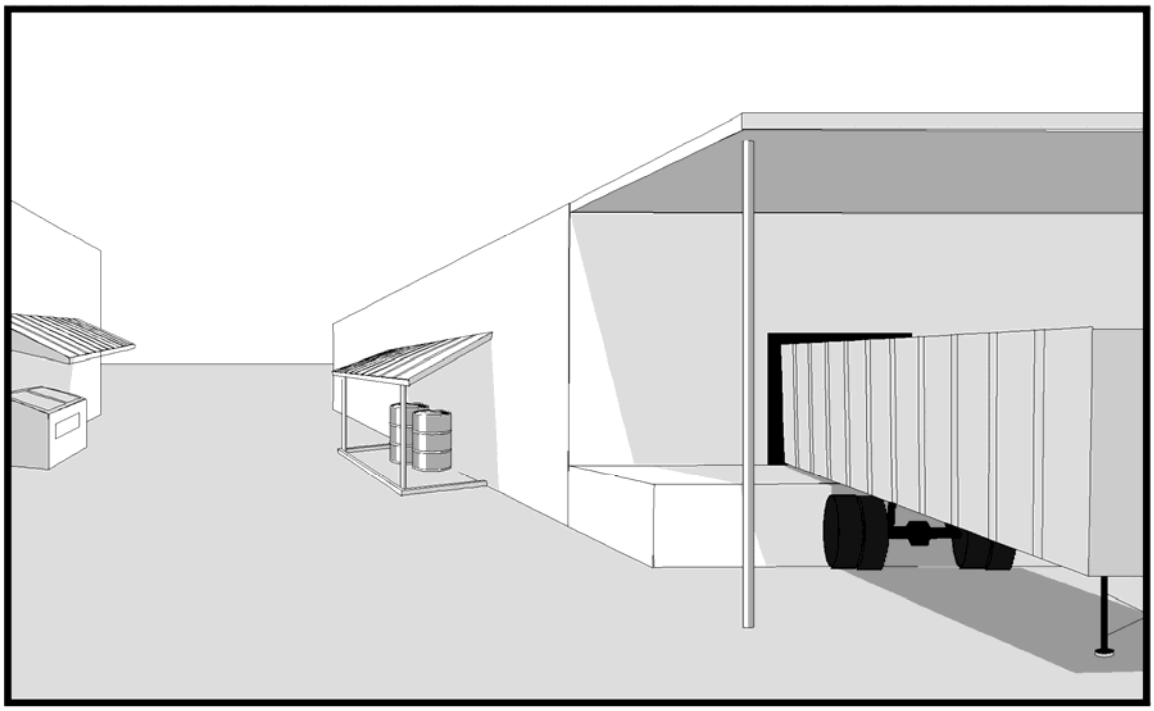
Application Guidance: This BMP will be used m all cases where significant materials are stored.

Training: Procurement officers and warehouse managers will be trained to accurately estimate delivery schedules and user's needs.

Effectiveness and Cost: This is a moderately effective, low-cost BMP.

Limitations: None

BMP 018 - PROVIDE ROOF TO COVER SOURCE AREA



Description of Potential Pollutant and Source: Spills, leaks and outdoor storage of materials can result in the exposure of significant materials to storm water.

Description of BMP: Construct roofs over areas with significant materials to minimize contact with storm water. Roofs are effective covering for fuel transfer areas, material loading/unloading areas, equipment maintenance, metal fabrication, hazardous waste storage, and materials storage areas.

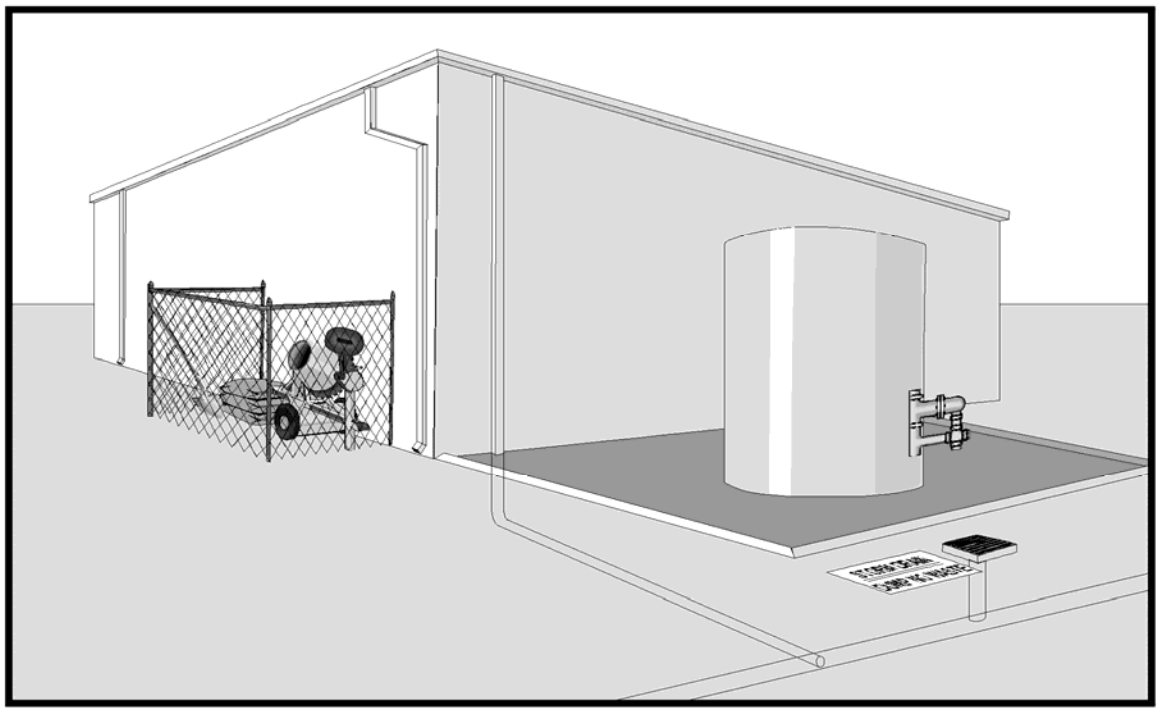
Application Guidance: Install as needed.

Training: N/A

Effectiveness and Cost: Roofs are an effective, variable-cost BMP. Cost can be high for large areas.

Limitations: The height of the equipment or the size of the area may make this BMP infeasible.

BMP 019 - CONTROL ROOF DOWNSPOUT DISCHARGE



Description of Potential Pollutant and Source: Storm water collected on roofs and directed through downspouts to industrial areas can transport pollutants to the storm drain system.

Description of BMP: Control roof runoff in areas where roof downspout discharges flow over areas of high pollutant use or storage, such as areas used for fueling, metal fabricating, lead tool and dye storage, or hazardous waste storage. Roof downspouts will be re-directed to non-industrial areas or connected directly to the storm drain system.

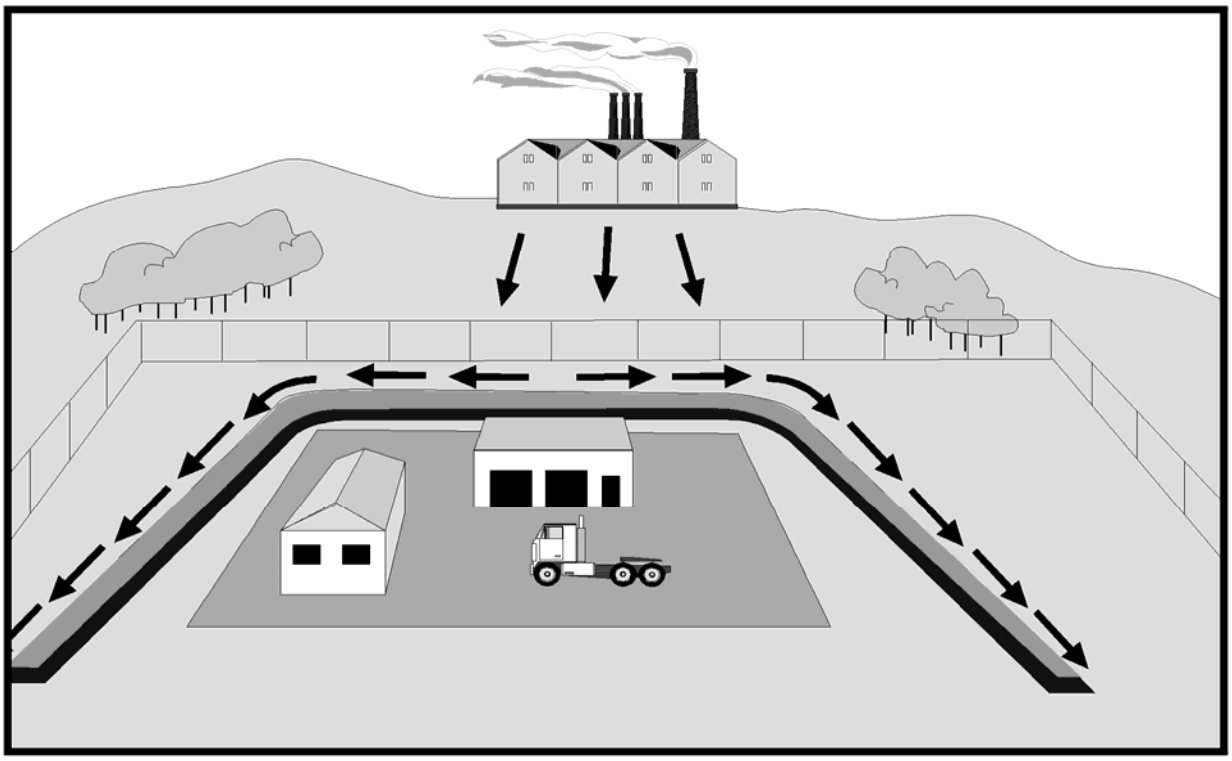
Application Guidance: This BMP will be applied whenever storm water collected on roofs discharges to areas polluted with significant materials.

Training: N/A

Effectiveness and Cost: This BMP can eliminate concentrated roof runoff from flowing through pollutant source areas. Costs vary depending on whether an underground storm drain connection has to be made.

Limitations: None

BMP 020- MINIMIZE STORM WATER RUN-ON FROM ADJACENT FACILITIES AND PROPERTIES



Description of Potential Pollutant and Source: Significant run-on from other facilities or adjacent properties can result in either increased pollutant exposure to storm water on site (from the increased volume of water movement) or in increased transport of off-site pollutants onto the facility.

Description of BMP: Control run-on by berming or using diversion ditches to direct flow away from or around the site. Alternatively, run-on will be slowed by use of vegetated strips, grassed swales, or infiltration basins or trenches.

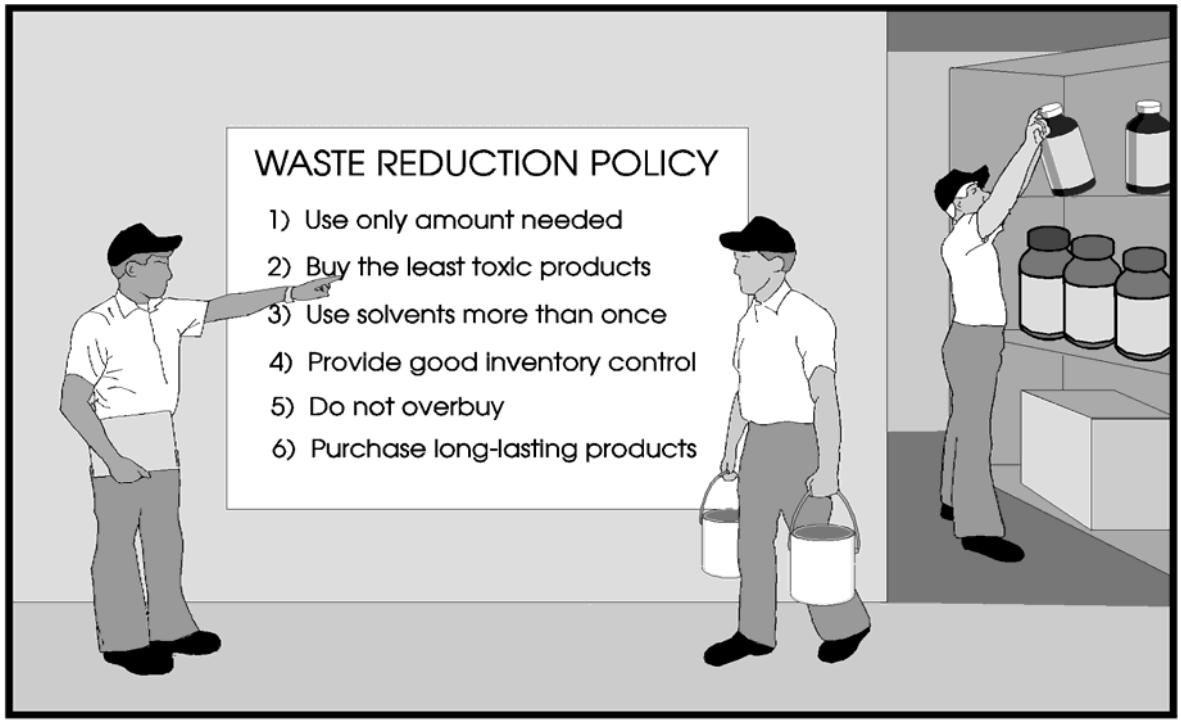
Application Guidance: The BMP will be used whenever a significant volume of off-site drainage flows into an area where possible pollutants are present. This BMP will also be used where run-on may be polluted.

Training: None

Effectiveness and Cost: The BMP can be very effective for flows of low to moderate volume. Cost varies, depending on site area, but could be high.

Limitations: Vehicle and pedestrian safety, and travel can limit the implementation of this BMP, also, diversion channels may not be compatible with existing drainage systems.

BMP 021 - REDUCE WASTE



Description of Potential Pollutant and Source: Reducing the amount of waste produced at a site reduces the amount of significant materials potentially exposed to storm water.

Description of BMP: Reduce waste to minimize or eliminate the discharge of pollutants to storm water. Methods to reduce waste include, but are not limited to, substituting or eliminating raw materials, modifying existing processes or equipment, planning and sequencing production, tracking waste generation, listing amounts of materials disposed, and separating wastes. Personnel will be trained to: use only the amount needed; buy the least toxic products; use solvents more than once; provide good inventory control; do not overbuy; and purchase long-lasting products.

Application Guidance: These methods will be implemented under most working conditions.

Training: None

Effectiveness and Cost: Effectiveness and cost will vary depending on the facility.

Limitations: None

BMP 021A - REPAIR LEAKY ROOFS

Description of Potential Pollutant and Source: Hazardous substances, parts, equipment, vehicles, and materials are often stored indoors or in covered areas. During storage, significant materials such as oil, grease, and solvents may leak or spill onto the floor, ground, or pavement. If storm water enters these areas through leaky roofs, the pollutants may be washed into the storm drain system.

Description of BMP: Repair leaky roofs as required for each building. Alternatively, the stored materials will be moved to another covered area.

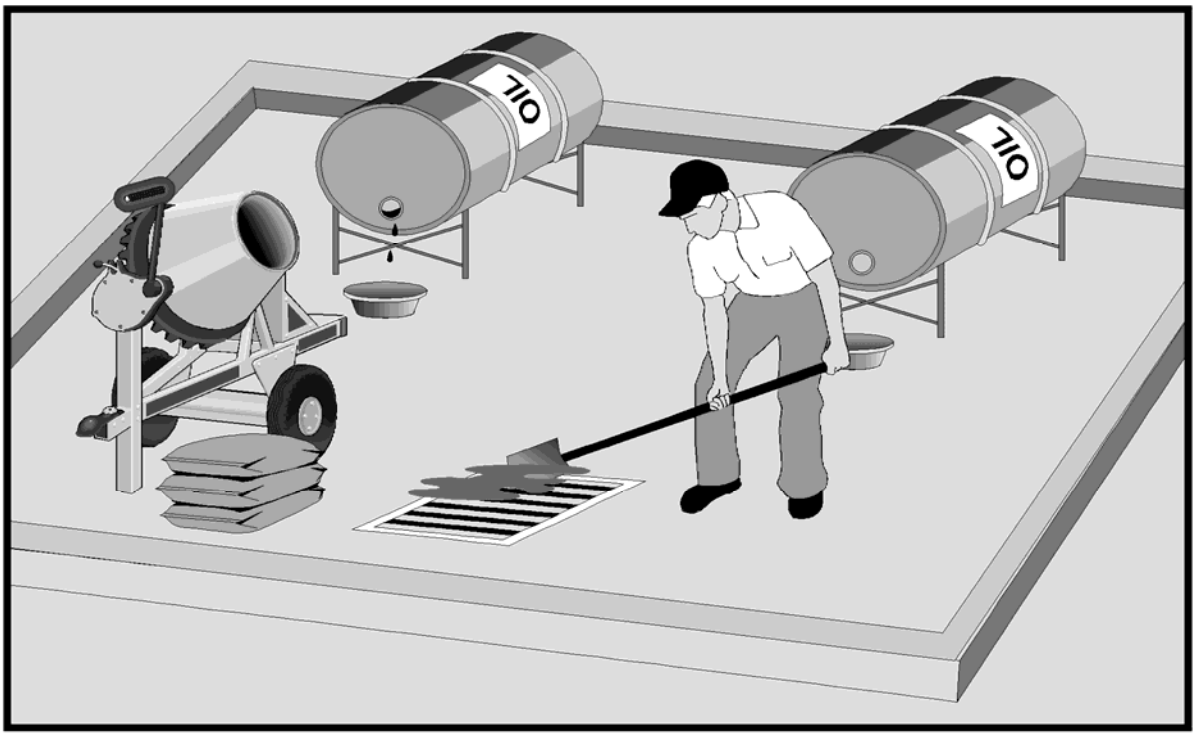
Application Guidance: Leaky roofs will be repaired wherever there 1s a potential for the exposure of significant materials to storm water.

Training: Personnel will be trained to notify their supervisors when leaks are observed in roofs.

Effectiveness and Cost: The BMP is moderately effective. The cost is dependent on the extent of repairs.

Limitations: None

BMP 022 - PERMANENTLY SEAL DRAINS WITHIN CRITICAL AREAS THAT DISCHARGE TO THE STORM DRAIN



Description of Potential Pollutant and Source: Certain activities may result in spills. The spilled material may flow or be washed into nearby storm drains, receiving waters, or surfaces resulting in exposure to storm water.

Description of BMP: Seal drains within the critical areas that discharge to the storm drain to prevent significant materials from being washed into the storm drain system. Critical areas are those that have a high likelihood to release pollutants, including material handling areas, material storage areas, and equipment repair and maintenance areas.

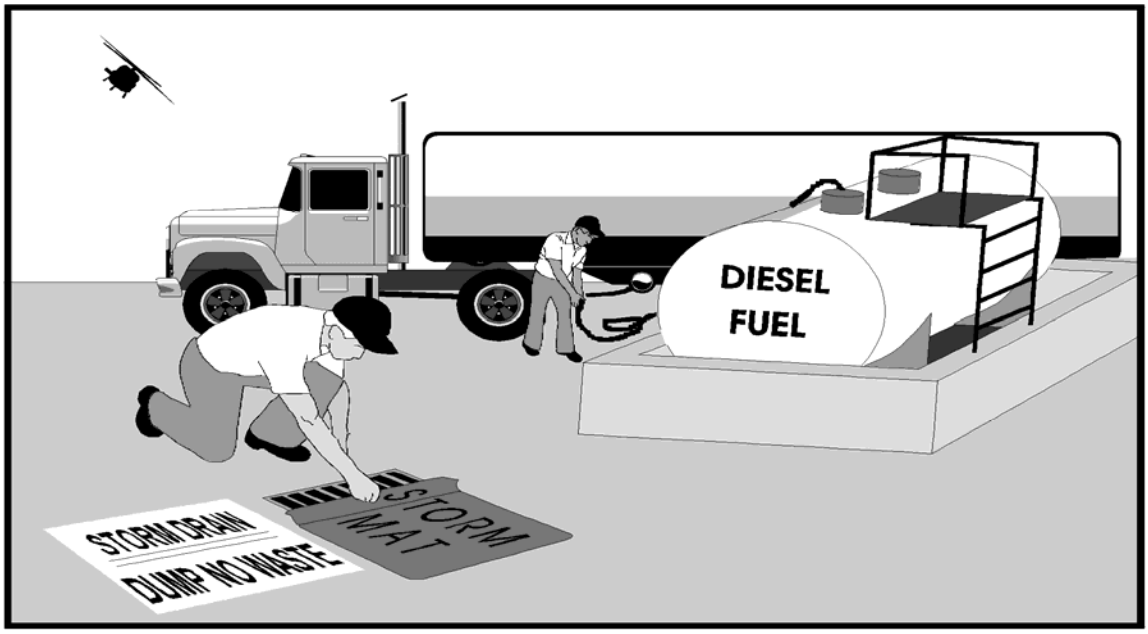
Application Guidance: This BMP will be applied to storm drain inlets in all critical areas as needed.

Training: N/A

Effectiveness and Cost: This is a highly effective, low-cost BMP.

Limitations: If the area draining to the storm drain inlet is large and the inlet is at a low point, this is not a practical BMP. Under the circumstances, implementation of this BMP will result in ponding. In this case, use BMP 023, "Place Portable Rubber Mats over Storm Drain Inlets."

BMP 023 - PLACE PORTABLE RUBBER MATS OVER STORM DRAIN INLETS



Description of Potential Pollutant and Source: Spills are more likely to occur during certain operations, such as materials transfer. If these operations occur near a storm drain, the material may be discharged into the storm drain system.

Description of BMP: If operations which are likely to spill significant materials occur near a storm drain, place a rubber portable mat over the storm drain during the operation. If a spill occurs during the operation, the mat will prevent the pollutant from entering the storm drain system. The spilled material can be properly cleaned up and disposed of before removal of the rubber mat.

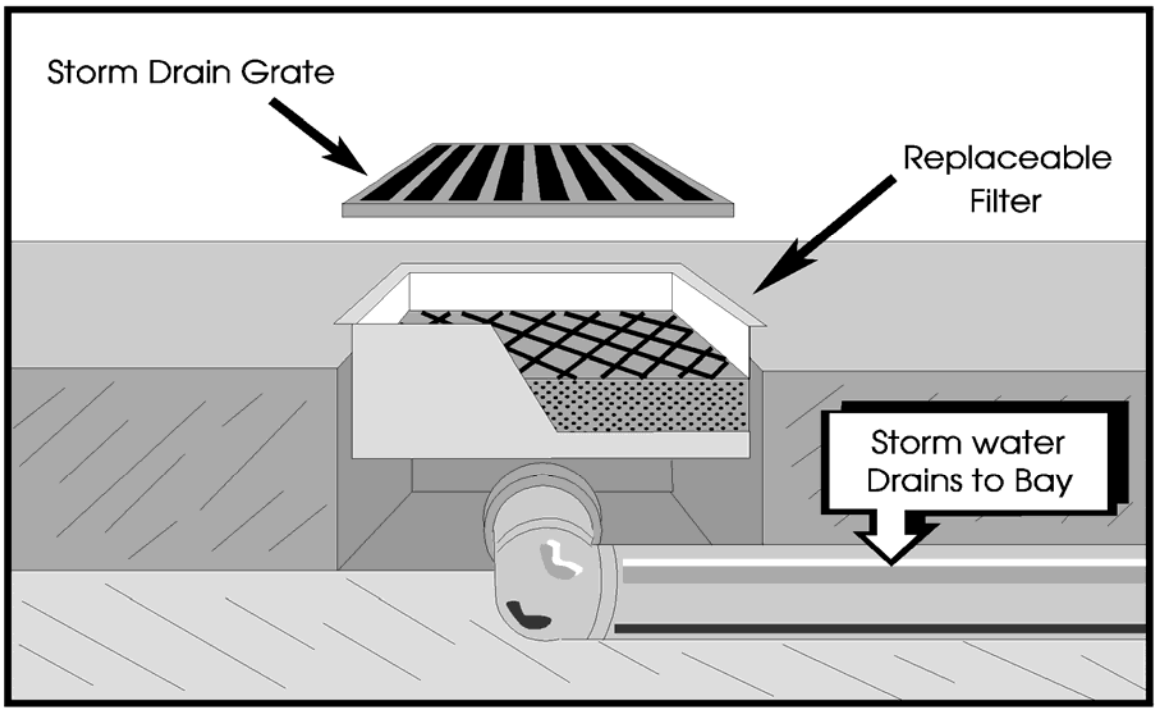
Application Guidance: Portable rubber mats will be placed over the storm drain for the duration of any operation which is likely to discharge pollutants into the storm drain.

Training: Personnel will be trained regarding the use of the portable mat. In addition, personnel will be trained in proper cleanup and disposal of any spilled material.

Effectiveness and Cost: This is a highly effective, low-cost BMP.

Limitations: This BMP works best on flat storm drain inlets.

BMP 024 - INSERT FILTER IN CATCH BASIN



Description of Potential Pollutant and Source: Sediments, oil, and other pollutants generated from industrial activities can pollute storm water.

Description of BMP: Use catch basin filters of sand and organic material to trap sediments, oil, and other storm water contaminants. The filters are designed to be easily retrofitted into existing catch basins by suspending the device inside catch basins. Filters will be replaced regularly according to manufacturer's recommendations.

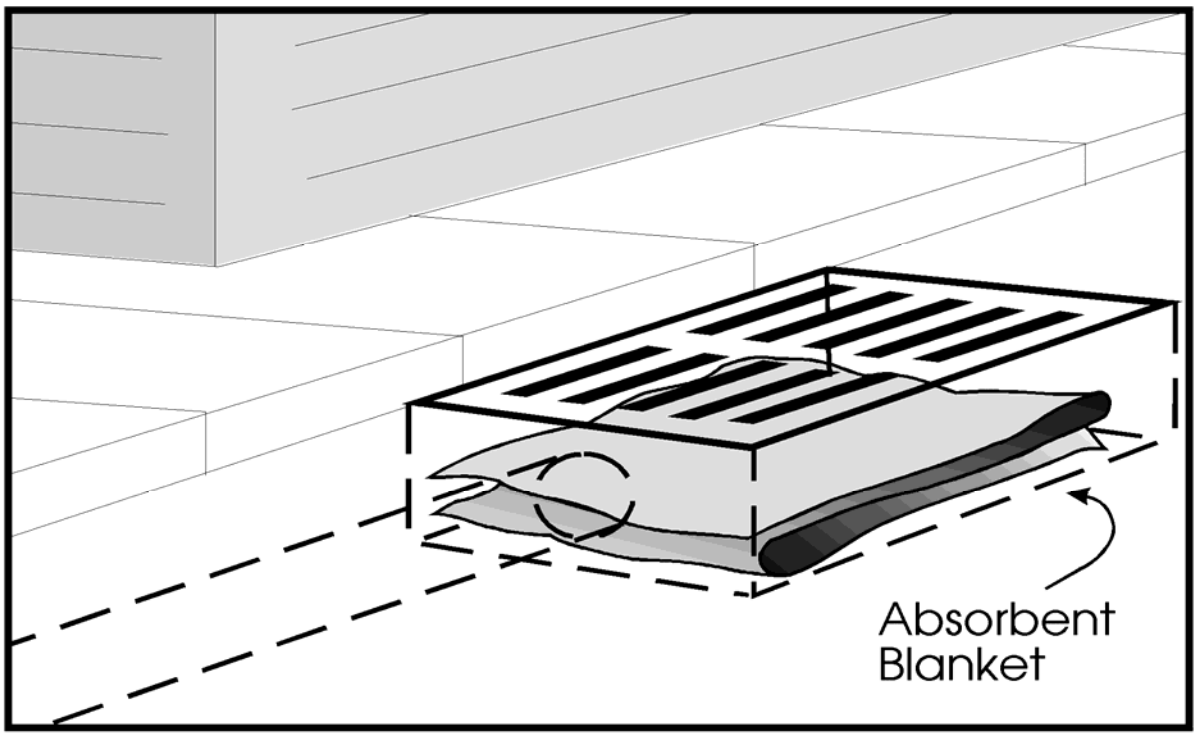
Application Guidance: This BMP will be used in areas where high concentrations of pollutants enter a storm drain catch basin.

Training: None

Effectiveness and Cost: Catch basin filters appear to be a moderately effective, moderate-cost BMP.

Limitations: This BMP should only be used where storm water with high concentrations of pollutants drains into a storm drain inlet.

BMP 025 - PLACE ABSORBENT BLANKETS IN CATCH BASIN



Description of Potential Pollutant and Source: Oil and grease from maintenance activities can be discharged into the storm drain system.

Description of BMP: Place oil and grease absorbing blankets in catch basins and inlets. This BMP will be used in areas where high concentrations of oil and grease are exposed to storm water which can enter a storm drain catch basin or inlet.

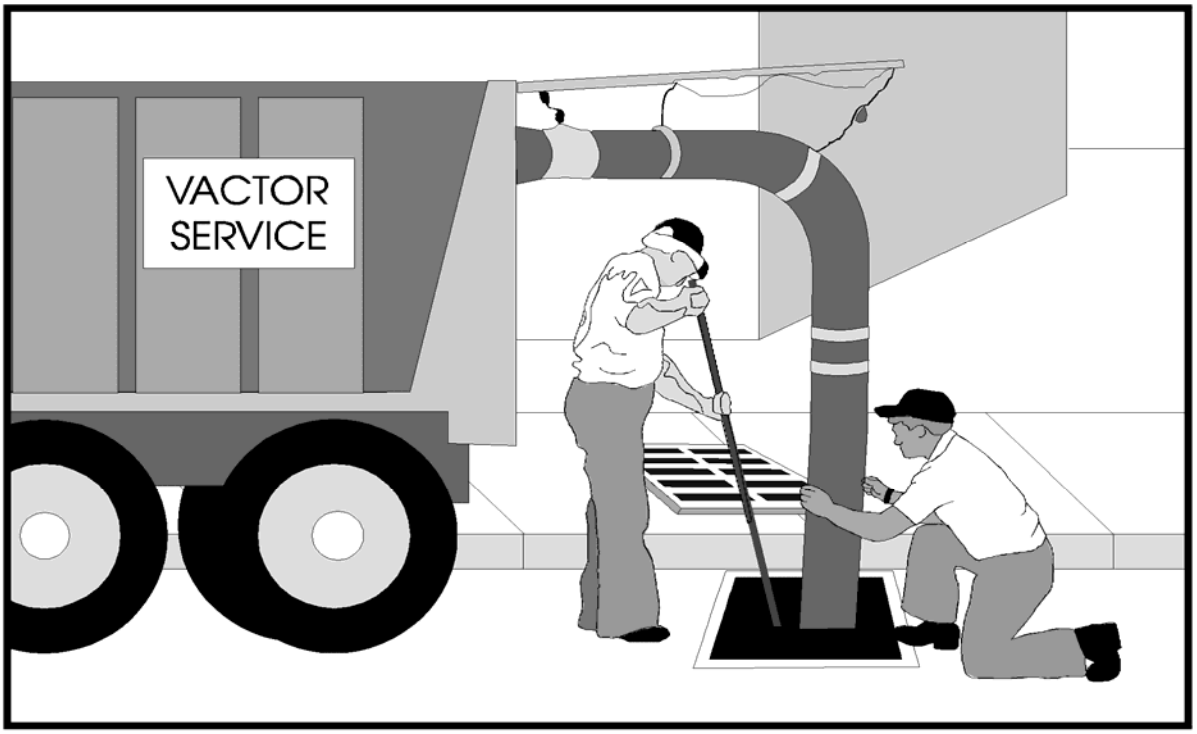
Application Guidance: The blankets will be changed semi-annually (or as needed) to ensure their continued effectiveness.

Training: Personnel will be trained to inspect the blankets monthly and replace them semi-annually or as needed.

Effectiveness and Cost: The blankets are an effective measure to reduce concentrations of hydrocarbons in storm water. The cost is moderate.

Limitations: This BMP can only be used when storm water with high concentrations of oil and grease drains into a storm drain catch basin or inlet.

BMP 026 - ROUTINELY CLEAN CATCH BASINS



Description of Potential Pollutant and Source: Depending on their design, catch basins can accumulate sediment, trash, and debris. If the accumulated pollutants are not removed, they may be resuspended by storm water.

Description of BMP: Clean catch basins routinely to prevent clogging and to remove accumulated pollutants. The accumulated sediment will be tested to determine if it is a hazardous waste and then properly disposed. If the sediment is not a hazardous waste, it may be disposed in a landfill.

Application Guidance: Catch basins will be cleaned at least quarterly. One of these cleanings will be just before the rainy season.

The frequency for implementing this BMP has been provided as general guidance. However, a facility operator may wish to establish a more suitable frequency. This will require SWPCP implementors to make judgements based on facility operations and conditions. To assign a frequency other than what has been suggested (i.e., more or less frequent), the following criteria will be considered and rated either High, Medium, or Low. If many of the criteria are assigned a High rating, the frequency may be increased. Similarly, if many criteria are assigned a Low rating, the frequency may be decreased. The goal of implementing this BMP is to minimize exposure of pollutants to storm water.

CRITERIA	Rating H=High M=Medium L=Low
Probability of exposure of significant materials to storm water in area draining to catch basin	
Quantity of significant materials potentially exposed in area draining to catch basin	
Frequency of use of significant materials potentially exposed in area draining to catch basin	
Evidence of exposure (e.g., stains on pavement, evidence of significant material in drainage system)	
Proximity of source area to outfall or receiving water	
Sensitivity of receiving water to potentially exposed significant materials (e.g., waters with beneficial uses such as human contact, recreation, significant species habitat, etc.)	

Training: Personnel will be trained in the proper testing, removal, and disposal of the sediment, or a qualified contractor will be used to perform these services.

Effectiveness and Cost: This is a moderately effective, low-cost BMP.

Limitations: The accumulated sediments may be a hazardous waste.

BMP 027 - STENCIL SIGNS ON STORM DRAIN INLETS

Description of Potential Pollutant and Source: Storm drain inlets generally discharge to storm drains or directly into receiving waters (i.e., rivers, oceans, lakes). Some storm drain inlets lead to water quality facilities, such as oil/water separators. However, such facilities are typically only 40 to 80 percent effective in reducing pollutant concentrations and may not be effective in treating storm flows. Therefore, material, such as used oil, solvents, and solid waste, that enters the storm drains may be exposed to storm water.

Description of BMP: Clearly mark storm drain inlets to warn against illegal dumping.

Application Guidance: All storm drain inlets will be properly labeled.

Training: None

Effectiveness and Cost:

Limitations: None

BMP 028 - KEEP EQUIPMENT AND VEHICLES CLEAN

Description of Potential Pollutant and Source: Through usage, equipment and vehicles accumulate oil and grease. During rain events, these pollutants are exposed to storm water and transported into the receiving waters.

Description of BMP: Clean equipment and vehicles regularly using either dry or wet methods to reduce the amount of pollutants exposed to rainfall. Dry methods of cleaning are further explained in BMP 003, "Perform Regular Cleaning." Wet methods are further described in BMP 049, "Centralize Liquid Solvent Cleaning to One Location," and BMP 041, "Wash Equipment and Vehicles in Designated Areas."

Application Guidance: All vehicles and equipment exposed to storm water will be washed monthly and as needed to be kept clean. The frequency for implementing this BMP has been provided as general guidance. However, a facility operator may wish to establish a more suitable frequency. This will require SWPCP implementors to make judgements based on facility operations and conditions. To assign a frequency other than what has been suggested (i.e., more or less frequent), the following criteria will be considered and rated either High, Medium, or Low. If many of the criteria are assigned a High rating, the frequency may be increased. Similarly, if many criteria are assigned a Low rating, the frequency may be decreased. The goal of implementing this BMP is to minimize exposure of pollutants to storm water.

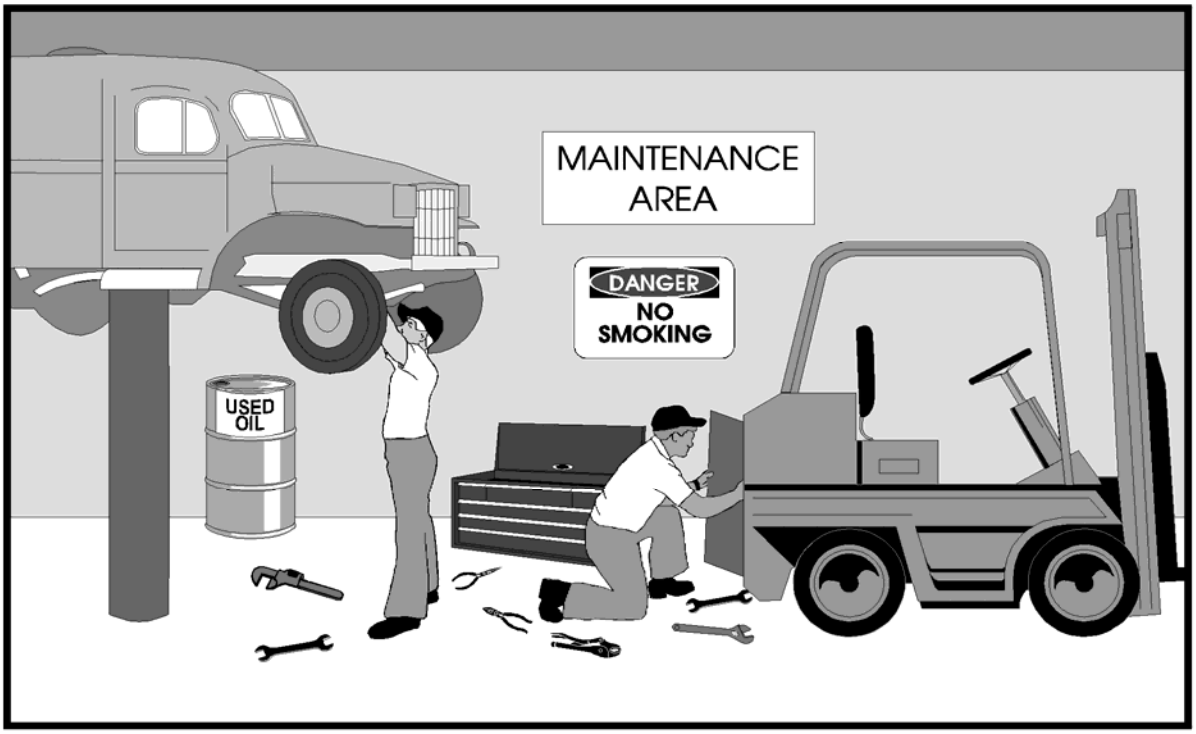
CRITERIA	Rating H=High M=Medium L=Low
Probability of exposure of significant materials to storm water	
Frequency of use of equipment and vehicles	
Proximity of vehicle/equipment use to outfall or receiving water	
Sensitivity of receiving water to potentially exposed significant materials (e.g., waters with beneficial uses such as human contact, recreation, significant species habitat, etc.)	

Training: Personnel will be instructed on how often to clean and wash vehicles or equipment.

Effectiveness and Cost: Keeping equipment and vehicles clean is a highly effective, low-cost BMP.

Limitations: None

BMP 029 - MAINTAIN EQUIPMENT IN GOOD CONDITION



Description of Potential Pollutant and Source: Equipment may leak fuel, grease, oil, or other potential pollutants due to corrosion, loose fittings, poor welding, and improper or poorly fitted gaskets. Without regular inspection of equipment and facilities, leaking or poorly operating equipment may continue to be used without being repaired.

Description of BMP: Keep equipment in good working condition and inspect regularly for fluid leaks. Equipment which is leaking or in poor working condition will be repaired or replaced.

Application Guidance: Equipment will be inspected daily before use for leaks and maintained in good condition at all times. Equipment which is not frequently used will be inspected monthly. The frequency for implementing this BMP has been provided as general guidance. However, a facility operator may wish to establish a more suitable frequency. This will require SWPCP implementors to make judgements based on facility operations and conditions. To assign a frequency other than what has been suggested (i.e., more or less frequent), the following criteria will be considered and rated either High, Medium, or Low. If many of the criteria are assigned a High rating, the frequency may be increased. Similarly, if many criteria are assigned a Low rating, the frequency may be decreased. The goal of implementing this BMP is to minimize exposure of pollutants to storm water.

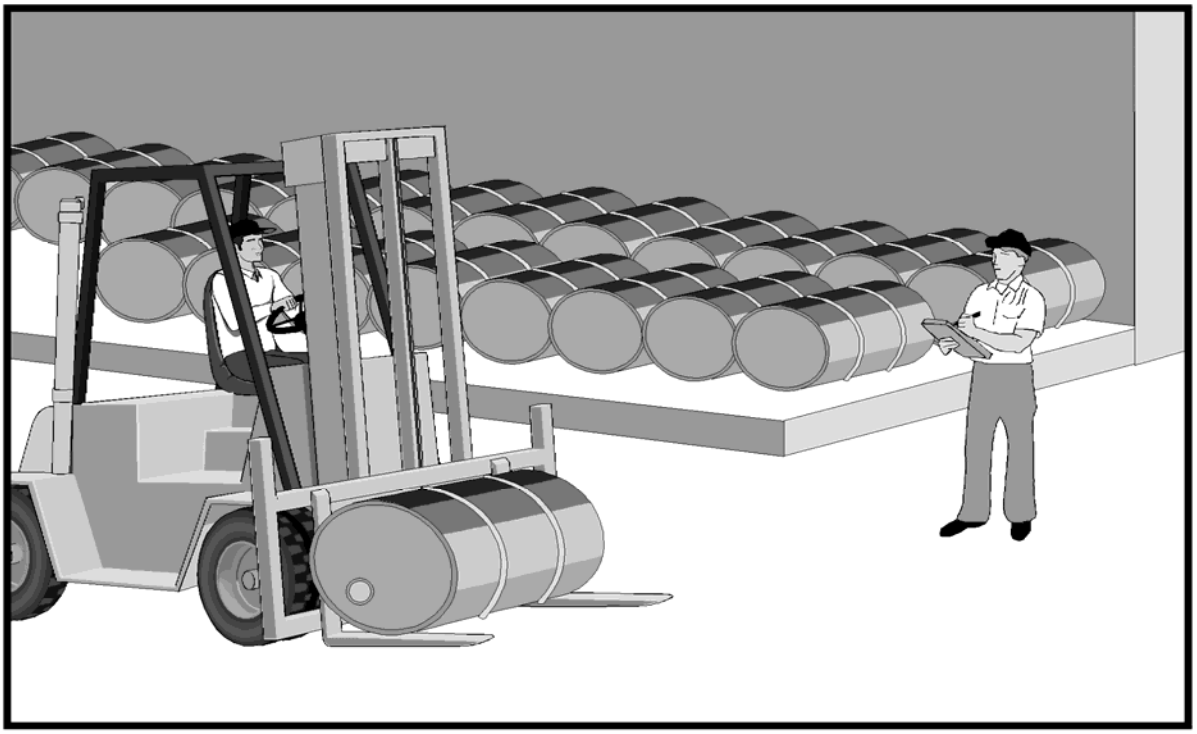
CRITERIA	Rating H=High M=Medium L=Low
Probability of exposure of significant materials to storm water	
Frequency of use of equipment and vehicles	
Intensity of use of equipment	
Old age or poor condition of equipment or systems	
Evidence of exposure (e.g., stains on pavement, etching of concrete)	
Proximity of vehicle/equipment use to outfall or receiving water	
Sensitivity of receiving water to potentially exposed significant materials (e.g., waters with beneficial uses such as human contact, recreation, significant species habitat, etc.)	

Training: Personnel will be trained to regularly inspect for leaks or conditions that could lead to the exposure of significant materials to storm water. Personnel will be trained to routinely inspect equipment before each use. Procedures for notifying the appropriate maintenance personnel if a leak is found will be established.

Effectiveness and Cost: Keeping equipment in good condition is a moderately effective BMP. The cost of repairing or replacing equipment will vary.

Limitations: None

BMP 030 - IMPLEMENT QUALIFYING TESTS FOR EQUIPMENT AND VEHICLE OPERATORS



Description of Potential Pollutant and Source: Through misuse or unfamiliarity with operating procedures, accidents may occur that result in leaks or spills that may expose significant materials to storm water.

Description of BMP: Implement qualifying tests for personnel operating equipment or vehicles to reduce the chances of leaks and spills caused by accidents.

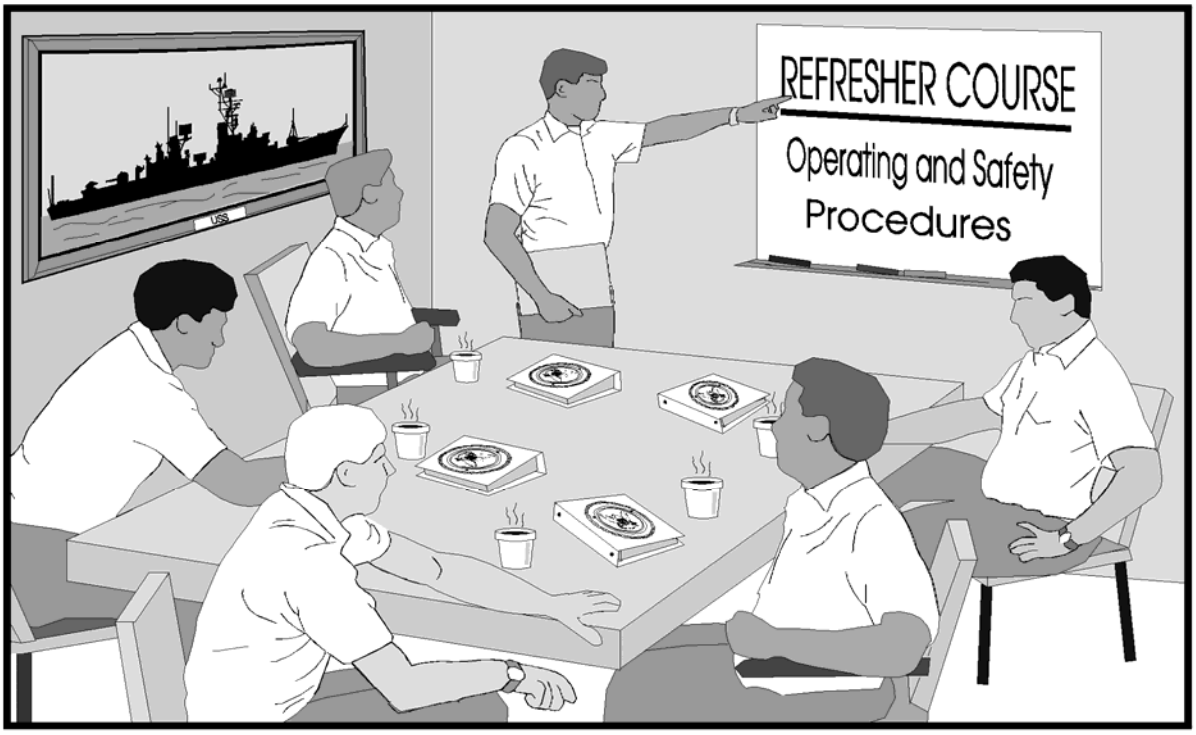
Application Guidance: Qualifying tests will always be used where equipment or vehicles are used.

Training: Personnel will be trained in safe operating procedures, basic maintenance, and spill response procedures associated with the particular equipment or vehicle.

Effectiveness and Cost: Qualifying tests are an effective, variable-cost BMP.

Limitations: None

BMP 031 - CONDUCT REFRESHER COURSES IN OPERATING AND SAFETY PROCEDURES



Description of Potential Pollutant and Source: Through time, personnel may forget certain correct operating and safety procedures, which may result in storm water pollution. Also, personnel need to be informed of new procedures and policies regarding equipment operation.

Description of BMP: Require personnel to have training and refresher courses in operating and safety procedures. This will help to reduce spills and accidents caused by negligence.

Application Guidance: Training and refresher courses will be conducted semi-annually.

The frequency for implementing this BMP has been provided as general guidance. However, a facility operator may wish to establish a more suitable frequency. This will require SWPCP implementors to make judgements based on facility operations and conditions. To assign a frequency other than what has been suggested (i.e., more or less frequent), the following criteria will be considered and rated either High, Medium, or Low. If many of the criteria are assigned a High rating, the frequency may be increased. Similarly, if many criteria are assigned a Low rating, the frequency may be decreased. The goal of implementing this BMP is to minimize exposure of pollutants to storm water.

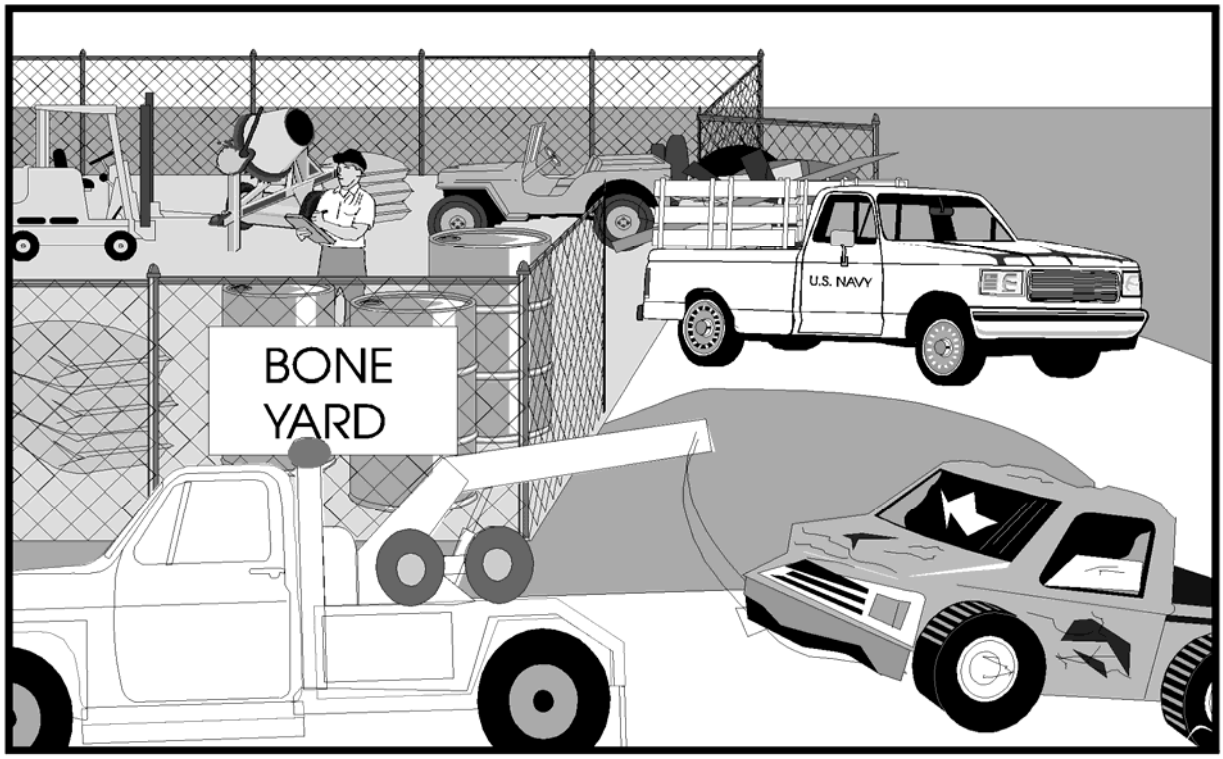
CRITERIA	Rating H=High M=Medium L=Low
Probability of exposure of significant materials to storm water	
Quantity of significant materials potentially exposed	
Toxicity of significant materials potentially exposed	
Frequency of use of significant materials potentially exposed	
Frequency of use of equipment	
Intensity of use of equipment	
Old age or poor condition of equipment and systems	
Evidence of exposure (e.g., stains on pavement, etching of concrete)	
Proximity of source area to outfall or receiving water	
Sensitivity of receiving water to potentially exposed significant materials (e.g., waters with beneficial uses such as human contact, recreation, significant species habitat, etc.)	
Frequency of personnel turnover	

Training: Instructors will be trained. A course will be prepared that covers both equipment manufacturers' recommendations for safety and operations as well as facility procedures and policies regarding equipment operation.

Effectiveness and Cost: Training is a highly effective, moderate-cost BMP.

Limitations: Cost and logistics could be a problem in implementing this practice.

BMP 032 - DISPOSE OF OBSOLETE EQUIPMENT, INOPERABLE VEHICLES, AND SURPLUS MATERIALS



Description of Potential Pollutant and Source: Obsolete equipment, inoperable vehicles, and surplus materials are often stored in areas not subject to routine inspection. These materials often leak a variety of fluids which can be exposed to storm water.

Description of BMP: Dispose of obsolete equipment, inoperable vehicles, and surplus materials at proper sites to reduce the chances of pollutants reaching storm water.

Application Guidance: This practice will be implemented quarterly.

The frequency for implementing this BMP has been provided as general guidance. However, a facility operator may wish to establish a more suitable frequency. This will require SWPCP implementors to make judgements based on facility operations and conditions. To assign a frequency other than what has been suggested (i.e., more or less frequent), the following criteria will be considered and rated either High, Medium, or Low. If many of the criteria are assigned a High rating, the frequency may be increased. Similarly, if many criteria are assigned a Low rating, the frequency may be decreased. The goal of implementing this BMP is to minimize exposure of pollutants to storm water.

CRITERIA	Rating H=High M=Medium L=Low
Probability of exposure of significant materials to storm water	
Quantity of significant materials potentially exposed	
Toxicity of significant materials potentially exposed	
Evidence of exposure (e.g., stains on pavement, evidence of significant materials in drainage system) Proximity of source area to outfall or receiving water	
Sensitivity of receiving water to potentially exposed significant materials (e.g., waters with beneficial uses such as human contact, recreation, significant species habitat, etc.)	

Training: N/A

Effectiveness and Cost: Disposing of unused equipment and supplies is a highly effective, moderate-cost BMP.

Limitations: None

BMP 033 - CHECK VEHICLES AND EQUIPMENT FOR LEAKS

Description of Potential Pollutant and Source: Vehicles, aircraft, or equipment entering or stored at a maintenance facility may be leaking a variety of fluids (fuel, oil, antifreeze, freon, etc.). These materials can be exposed to storm water.

Description of BMP: Inspect all vehicles and equipment at the site, whether incoming, parked, stored, or salvaged, for oil and fluid leaks. Drivers of fleet vehicles, such as delivery trucks, will also check under their vehicles each morning for fluid leaks. If leaks are present, drip pans will be placed under the vehicle or equipment. Once the vehicle is removed from the site, the former parking area will be inspected for stains, and these stains will be cleaned using rags or dry solvents.

Application Guidance: Any vehicle or equipment coming in for repairs, painting, or storage will be inspected for leaks. Fleet vehicles will be inspected each morning. Vehicles that are parked, stored, or salvaged will be provided with drip pans, as will tanker rail cars waiting to be unloaded. The frequency for implementing this BMP has been provided as general guidance. However, a facility operator may wish to establish a more suitable frequency. This will require SWPCP implementors to make judgements based on facility operations and conditions. To assign a frequency other than what has been suggested (i.e., more or less frequent), the following criteria will be considered and rated either High, Medium, or Low. If many of the criteria are assigned a High rating, the frequency may be increased. Similarly, if many criteria are assigned a Low rating, the frequency may be decreased. The goal of implementing this BMP is to minimize exposure of pollutants to storm water.

CRITERIA	Rating H=High M=Medium L=Low
Probability of exposure of significant materials to storm water	
Old age or poor condition of equipment and vehicles	
Evidence of exposure (e.g., stains on pavement)	
Proximity of source area to outfall or receiving water	
Sensitivity of receiving water to potentially exposed significant materials (e.g., waters with beneficial uses such as human contact, recreation, significant species habitat, etc.)	

Training: Signs will be posted to remind personnel of proper procedures.

Effectiveness and Cost: Checking for leaks is a moderately effective, low-cost BMP.

Limitations: None

PLACEHOLDER

BMP 036 - PARK VEHICLE OR EQUIPMENT INDOORS OR UNDER A ROOF

Description of Potential Pollutant and Source: Vehicles and equipment often leak or may be covered with oil and grease. If exposed to storm water, these pollutants can enter the storm drain system receiving waters.

Description of BMP: Park vehicles and equipment indoors or under a roof to eliminate or reduce the exposure of significant materials to storm water.

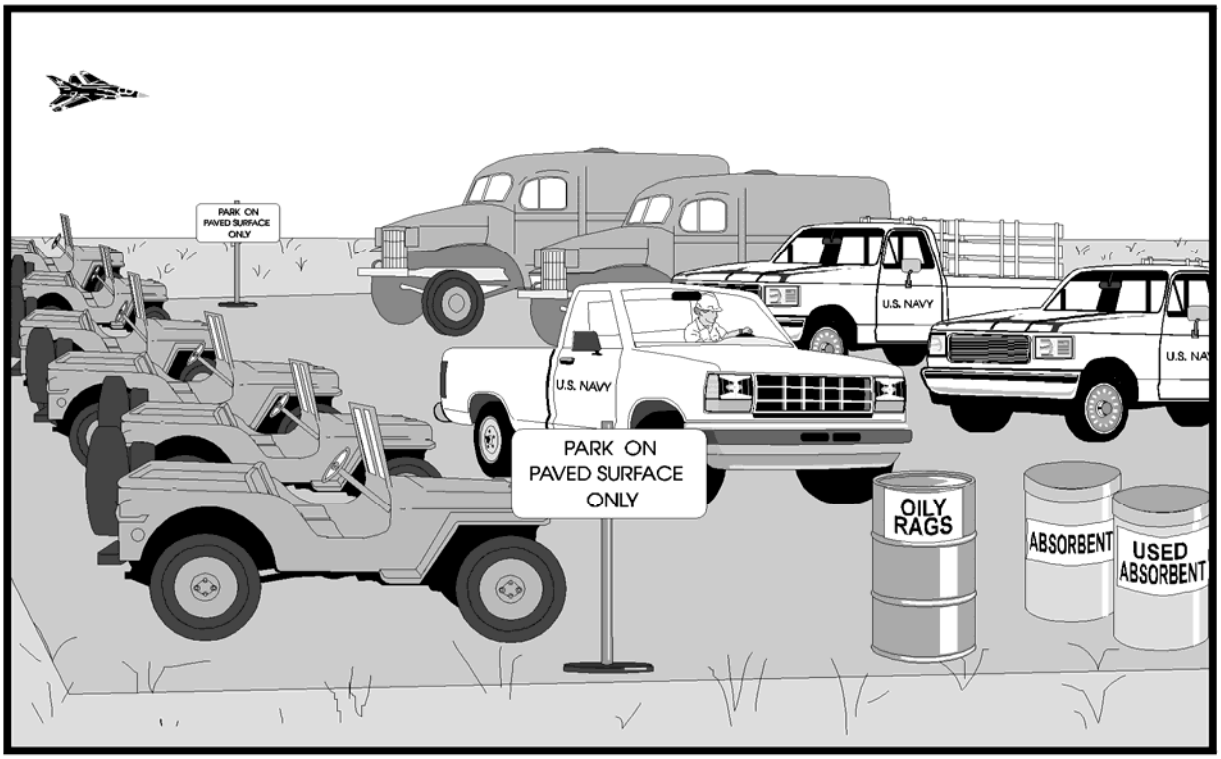
Application Guidance: When available, all vehicles and equipment will be parked indoors or under a roof.

Training: Personnel will be notified of any altered parking locations.

Effectiveness and Cost: Parking vehicles indoors or under cover is a highly effective, low-cost BMP if existing cover is available.

Limitations: The amount of indoor or covered parking available, size of vehicles or equipment and construction costs if cover must be constructed may restrict the use of this practice.

BMP 037 - PARK VEHICLES ON AN IMPERVIOUS SURFACE



Description of Potential Pollutant and Source: Pollutants leaking or spilled onto the ground surface from vehicles can infiltrate into the soil. These pollutants (i.e., oil, fuel, etc.) may then be exposed to storm water and transported to surface water.

Description of BMP: Park vehicles on an impervious surface. For this BMP, an impervious surface is defined as a surface that cannot be readily penetrated by rainfall, such as concrete and asphalt pavement. Leaks and spills will be cleaned from these surfaces.

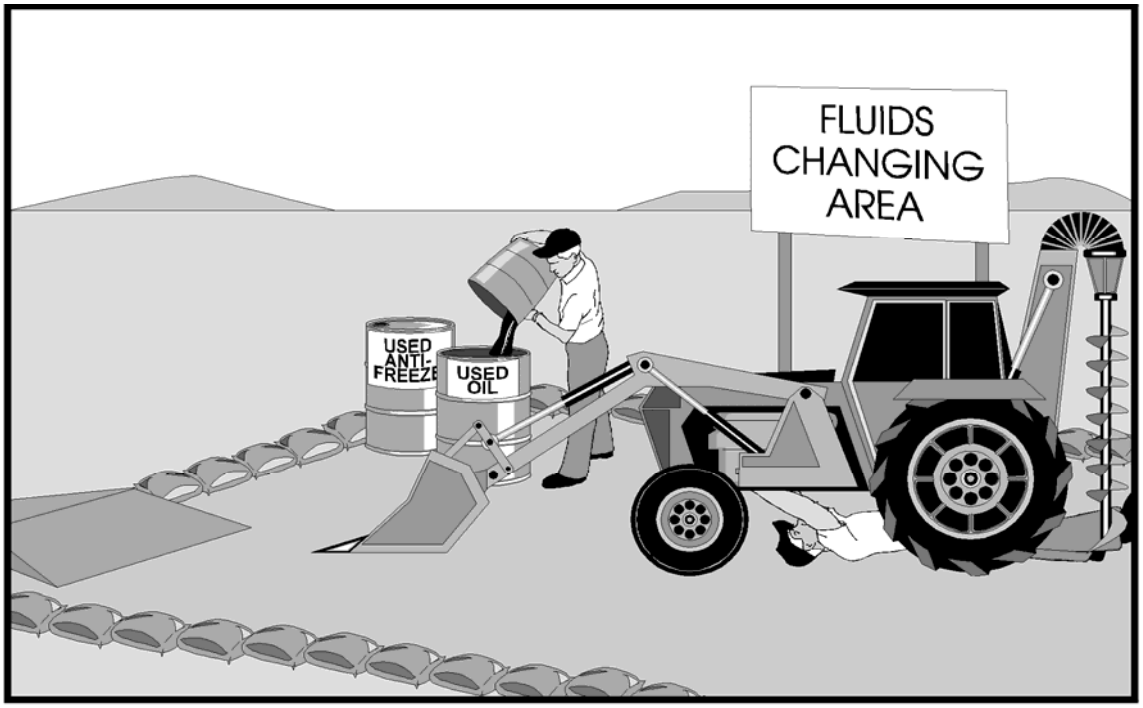
Application Guidance: Vehicles will always be parked on impervious surfaces, especially during the rainy season.

Training: Signs will be posted to remind personnel that all vehicles are to be parked on paved surfaces.

Effectiveness and Cost: Parking vehicles on impervious surfaces is a moderately effective, low-cost BMP.

Limitations: Very large traffic volumes may make implementation of this BMP difficult.

BMP 038 - DESIGNATE SPECIAL AREAS FOR DRAINING OR REPLACING FLUIDS, FLUIDS CHANGING AREA



Description of Potential Pollutant and Source: Draining and replacing motor oil, coolants, and other fluids in uncontrolled areas of the facility can potentially result in improper handling and disposal of waste and accidental spillage in an unprotected area. These materials can then be exposed to storm water.

Description of BMP: Drain and replace motor oil, coolants, and other fluids at designed maintenance facilities to reduce the potential for improper handling activities. If this is not possible, special areas will be designated for these activities. Consideration will be given to placing these areas indoors or using bermed concrete pads if outdoors.

Application Guidance: This procedure will be followed whenever vehicle or equipment maintenance is being performed.

Training: Personnel will be instructed that vehicle maintenance will only be performed at designated areas.

Effectiveness and Cost: Using designated special areas for draining fluids is an effective, low-cost BMP.

Limitations: Existing facilities may be inadequate; construction cost may be prohibitive.

BMP 039 - DRAIN ALL FLUIDS FROM STORED OR SALVAGED VEHICLES AND EQUIPMENT

Description of Potential Pollutant and Source: Vehicles and equipment undergoing long-term storage or salvage often contain a variety of liquids (oil, antifreeze, hydraulic fluid, etc.) that can leak or spill, thereby exposing these materials to storm water.

Description of BMP: Drain, collect, and recycle oil and other fluids from vehicles being stored long term or salvaged (i.e., parts vehicles).

Application Guidance: Vehicles or equipment that are to be stored without use for more than three months will be drained of all fluids. Signs will be posted on these vehicles from which fluids have been drained.

The frequency for implementing this BMP has been provided as general guidance. However, a facility operator may wish to establish a more suitable frequency. This will require SWPCP implementors to make judgements based on facility operations and conditions. To assign a frequency other than what has been suggested (i.e., more or less frequent), the following criteria will be considered and rated either High, Medium, or Low. If many of the criteria are assigned a High rating, the frequency may be increased. Similarly, if many criteria are assigned a Low rating, the frequency may be decreased. The goal of implementing this BMP is to minimize exposure of pollutants to storm water.

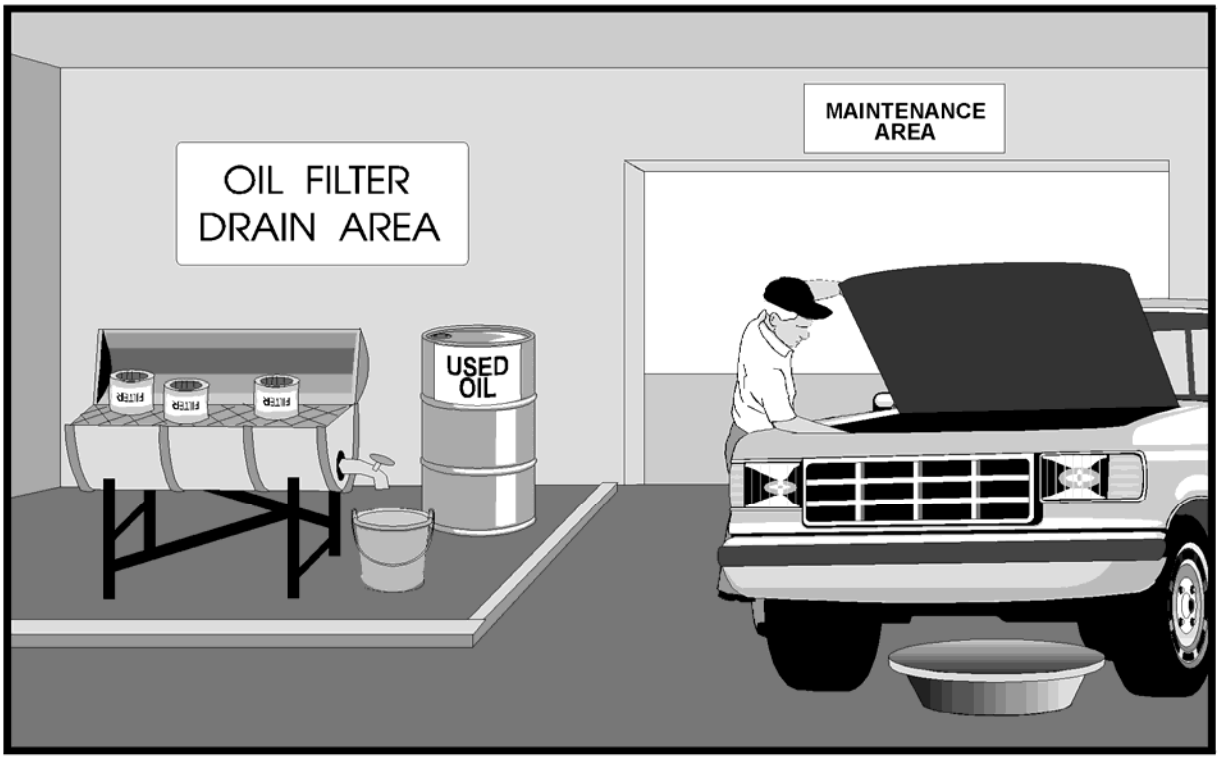
CRITERIA	Rating H=High M=Medium L=Low
Probability of exposure of significant materials to storm water	
Evidence of exposure (e.g., stains on pavement)	
Proximity of source area to outfall or receiving water	
Sensitivity of receiving water to potentially exposed significant materials (e.g., waters with beneficial uses such as human contact, recreation, significant species habitat, etc.)	

Training: Signs will be posted as reminders to personnel.

Effectiveness and Cost: Draining oil and fluids is a moderately effective, low-cost BMP.

Limitations: None

BMP 040 - COMPLETELY DRAIN OIL FILTERS BEFORE DISPOSAL



Description of Potential Pollutant and Source: Oil filters are disposed in trash containers can leak significant materials which can be exposed to storm water.

Description of BMP: Completely drain filters into collection drums before recycling or disposal.

Application Guidance: All filters will be completely drained after being changed.

Training: Signs will be posted to remind personnel of requirement to completely drain oil filters before disposal.

Effectiveness and Cost: Completely draining filters is a moderately effective, low-cost BMP.

Limitations: None

BMP 041 - WASH EQUIPMENT AND VEHICLES IN DESIGNATED AREA

Description of Potential Pollutant and Source: Washing equipment and vehicles outdoors or in areas where wash water flows onto the ground can pollute storm water. It is difficult to control the wastewater from washing operations if it is not done in a designated area.

Description of BMP: Facilities will designate bermed wash areas that contain wash water and prevent contact with storm water. These areas will drain to the sanitary sewer (BMP 042) or to a sump. If a sump is used, wash water will be recycled.

Application Guidance: This practice will be followed wherever vehicles, equipment and aircraft are washed.

Training: N/A

Effectiveness and Cost: This is a highly effective, variable-cost BMP.

Limitations: Pretreatment and monitoring of wash waster discharges to the sanitary sewer may be required. This would greatly increase the cost of this practice. The treatment plant operator will be notified and approval obtained before discharge.

BMP 042 - DISCHARGE WASH WATER TO A SANITARY SEWER

Description of Potential Pollutant and Source: Wash water from vehicle, equipment, and floor cleaning activities often contains such as grease, oil, and gasoline which can be exposed to storm water. Wash water must not be discharged to the storm drain.

Description of BMP: Discharge wash water to a sanitary sewer to ensure that is does not enter a storm drain. (See BMP 041, "Wash Equipment and Vehicles in Designated Areas.") Wash water from mopping floors will also be discharged to the sanitary sewer.

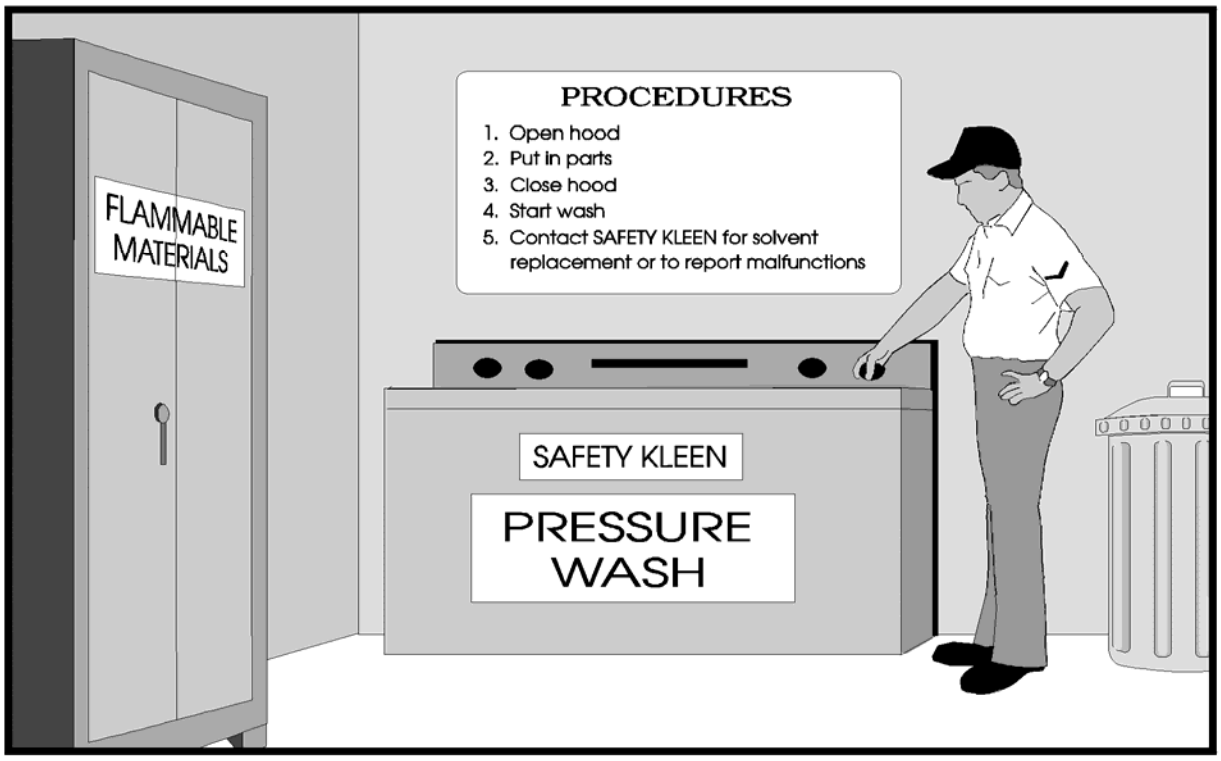
Application Guidance: All wash water from vehicle and equipment cleaning activities will be discharged to a sanitary sewer. In areas where wash water cannot be discharged to a sanitary sewer, wash water will be collected in a dead-end sump, tank, or other device and transported or pumped to the nearest treatment facility for proper disposal.

Training: Personnel will be trained to know where cleaning activities will be performed.

Effectiveness and Cost: Discharging wash water to a sanitary sewer is a highly effective, variable-cost BMP.

Limitations: Pretreatment and monitoring of wash water discharges to the sanitary sewer may be required. This would greatly increase the cost of this practice. The treatment plant operator will be notified and approval obtained before discharge.

BMP 043 - RECYCLE PRESSURE WASH SOLVENTS



Description of Potential Pollutant and Source: Pressure wash wastes from cleaning ships, vehicles, and equipment can contain dirt, oils, grease, and paint particles.

Description of BMP: Recycle pressure wash wastes by using a closed loop system or a "zero discharge system."

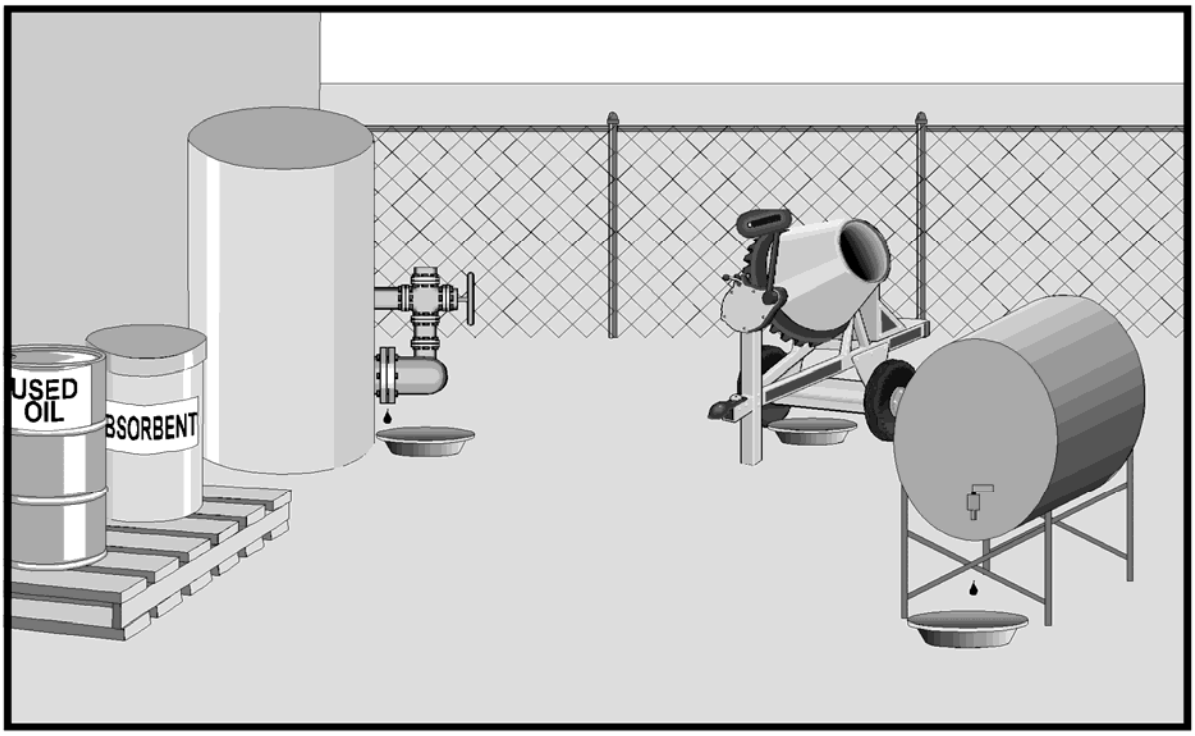
Application Guidance: Pressure wash wastes will be recycled whenever practical.

Training: Personnel will be trained in the proper use of pressure wash systems.

Effectiveness and Cost: This is a highly effective, variable-cost BMP. The cost can vary based on the availability of a local wastewater treatment facility and hauling and disposal costs. Also, the size of the pressure wash facility will affect the cost.

Limitations: None

BMP 044 - USE DRIP PANS UNDER LEAKING EQUIPMENT



Description of Potential Pollutant and Source: Equipment such as pumps, air conditioners, and boilers may leak fluids. These fluids typically contain pollutants that may be exposed to storm water and transported into the storm sewer system if they are not collected.

Description of BMP: Place drip pans under leaking equipment to collect any leaking fluid., This temporary BMP will be used until the equipment is properly repaired or replaced.

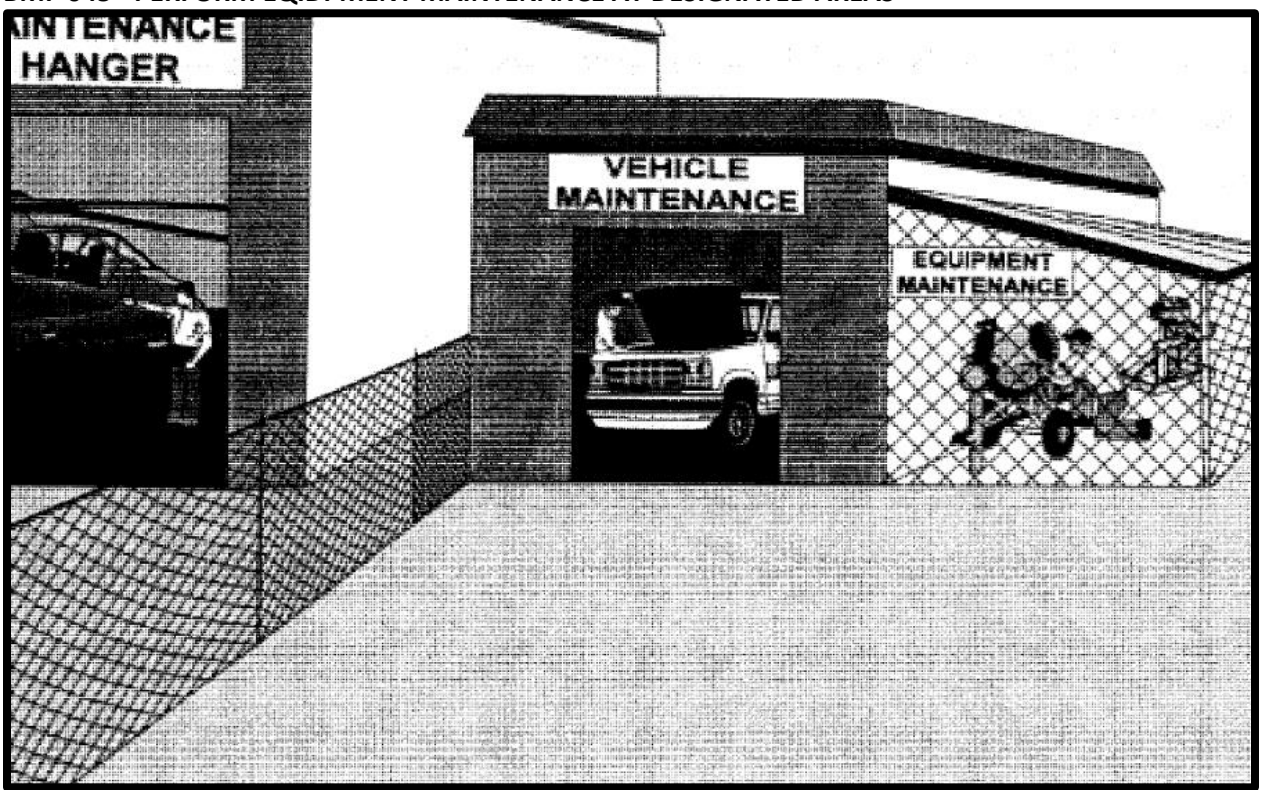
Application Guidance: Any equipment which is leaking fluid will be repaired or replaced. However, until the leak is stopped, a drip pan will be used to collect the fluid.

Training: Personnel will be trained to immediately place a drip pan under leaking equipment and notify the appropriate maintenance personnel. The drip pan will be routinely checked and the collected material disposed properly.

Effectiveness and Cost: This is a highly effective, low-cost BMP

Limitations: None

BMP 045 - PERFORM EQIDPMENT MAINTENANCE AT DESIGNATED AREAS



Description of Potential Pollutant and Source: Equipment maintenance can produce oil, grease, and other materials. These materials contain pollutants that can be exposed to storm water when the maintenance is not performed in designated areas.

Description of BMP: Perform maintenance of equipment only in designated areas. This includes the maintenance of small equipment, such as sandblasters and paint sprayers, as well as large equipment such as construction equipment, tanks, aircraft, and boats. Vehicle repair will only occur at vehicle repair and maintenance facilities.

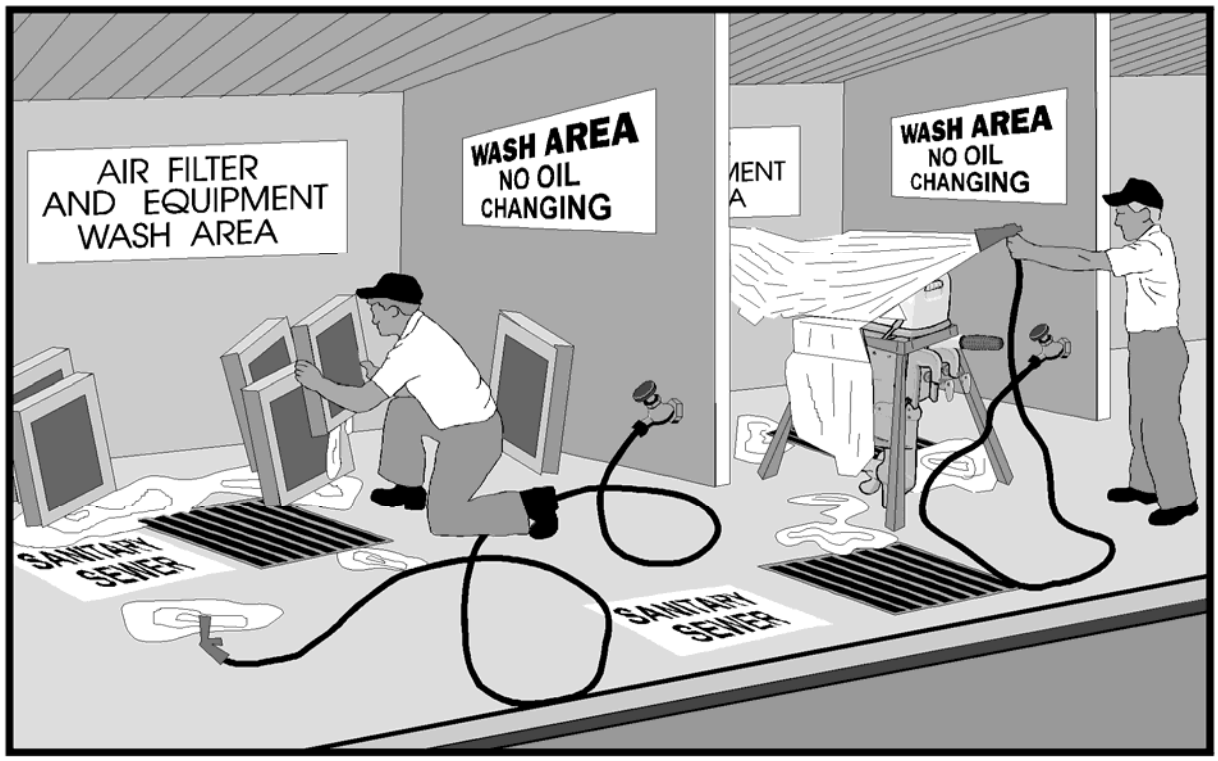
Application Guidance: Whenever possible, all maintenance, including cleaning of equipment will be performed at designated areas.

Training: Personnel will be trained to perform maintenance only in designated areas. Personnel will be informed as to where these areas are located.

Effectiveness and Cost: This is an effective, low-cost BMP.

Limitations: It may not be possible to transport some large equipment to the designated maintenance area. Also, there may not be a designated maintenance area near the broken equipment.

BMP 046 - DESIGNATE AREAS FOR WASHING NON-VEHICULAR AIR FILTERS AND OTHER GREASY EQUIPMENT



Description of Potential Pollutant and Source: Non-vehicular air filters, such as those used in large kitchens, and other equipment accumulate a large amount of grease. Current maintenance may involve cleaning the filters in an area where the oil can be exposed to storm water and enter the storm drain system.

Description of BMP: Clean air filters (from mess hall cooking grills or other facilities where air filters can contain significant amounts of grease and soot) in an area where wash water and grease are contained in a sump or discharged through an oil/water separator to sanitary sewer lines.

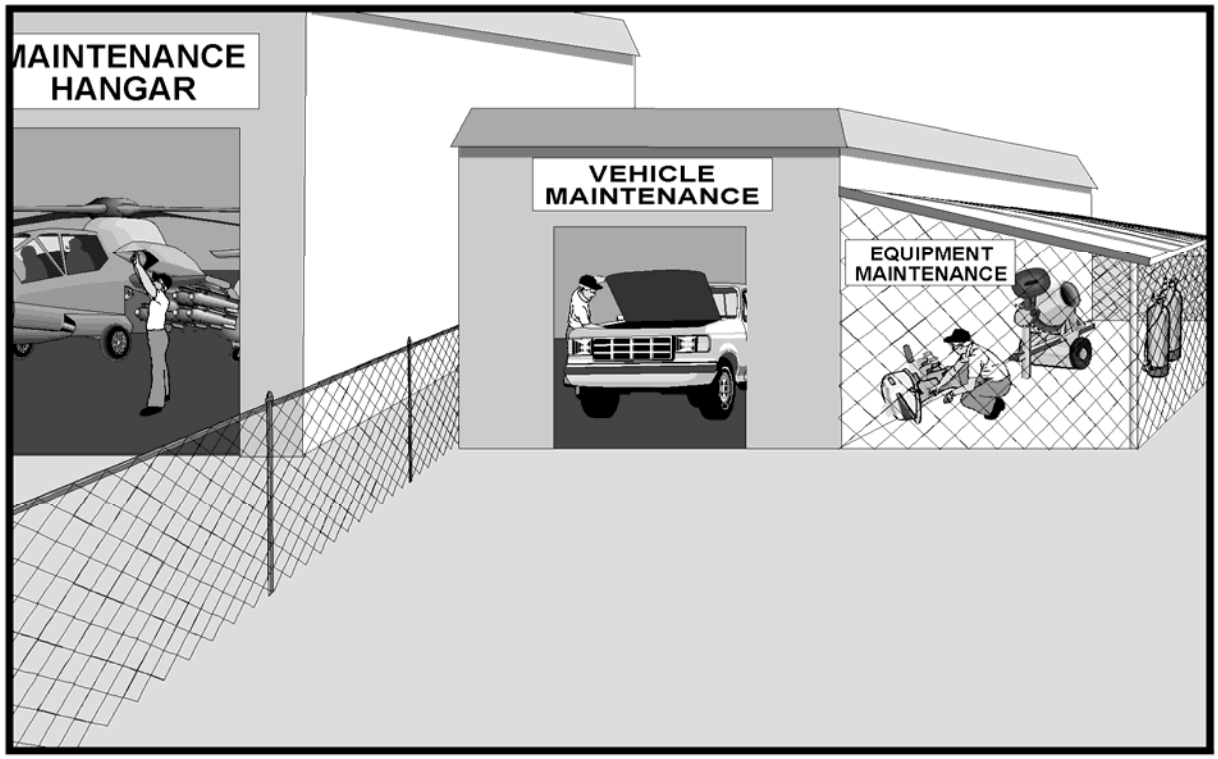
Application Guidance: This practice will be followed whenever greasy filters and other greasy equipment are cleaned.

Training: Personnel will be instructed to clean the air filters and other greasy equipment in areas where the wash water will be discharged through an oil/water separator to a sanitary sewer. A sign will be posted notifying the user where to clean the filter.

Effectiveness and Cost: Cleaning filters in a controlled area is a highly effective, low-cost BMP

Limitations: None

BMP 047 - CONDUCT MAINTENANCE WITHIN A BUILDING OR COVERED AREA



Description of Potential Pollutant and Source: Many pollutants such as oil, grease, or solvents may be leaked or spilled during maintenance activities. If maintenance is performed outside, in an uncovered area, storm water may transport the leaked and spilled material into the storm drain system.

Description of BMP: To the extent practical, conduct maintenance within a building or covered area. This includes performing aircraft/helicopter maintenance in hangars and vehicle maintenance in garages. If maintenance, including fluid top-offs, is performed outdoors, it will be conducted on an impervious surface, such as a concrete pad (see BMP 037). Rainfall runoff from the pad will be directed to a storm water treatment facility. Leaks and spills will be cleaned up as soon as possible using rags or dry absorbents (see BMP 006). Used rags and absorbent will be disposed properly. The garage floor will be cleaned regularly and all wash water from cleaning the floor will be disposed in the sanitary sewer (see BMP 042).

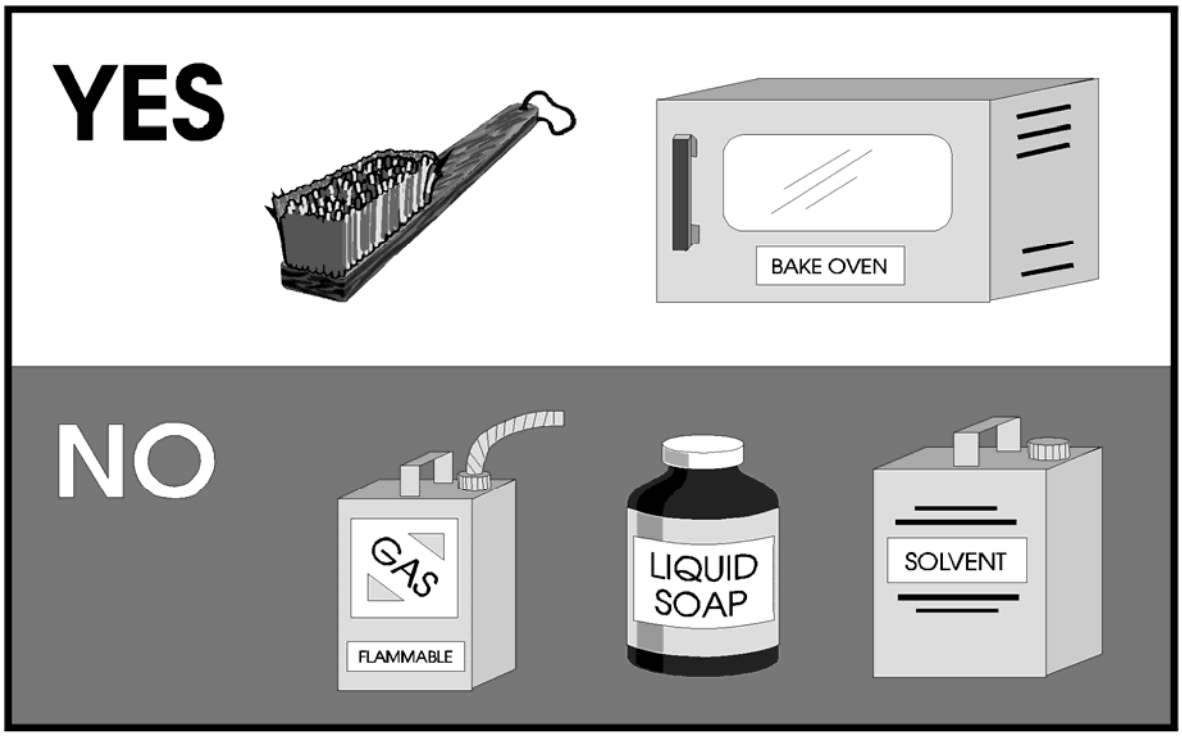
Application Guidance: All maintenance will be conducted within a building or covered area, if possible. If not possible, the maintenance will be done on an impervious surface.

Training: Personnel will be trained to perform all maintenance, including fluid top-offs, only in the designated area. Personnel will be trained in keeping the maintenance area clean.

Effectiveness and Cost: This is a moderately effective BMP. The cost will vary depending upon the availability of a building in which to perform all maintenance.

Limitations: This BMP may not be possible for the maintenance of large equipment and vehicles.

BMP 048 - REDUCE THE AMOUNT OF LIQUID CLEANING AGENTS USED



Description of Potential Pollutant and Source: Liquid cleaners (i.e., soaps, detergents, solvents, gasoline, etc.) are significant materials which must not be exposed to storm water

Description of BMP: Use methods other than liquid cleaning agents to reduce the amount of waste produced and the potential for spills of cleaning liquids. Alternative cleaning methods include scraping parts with a wire brush or using a bake oven.

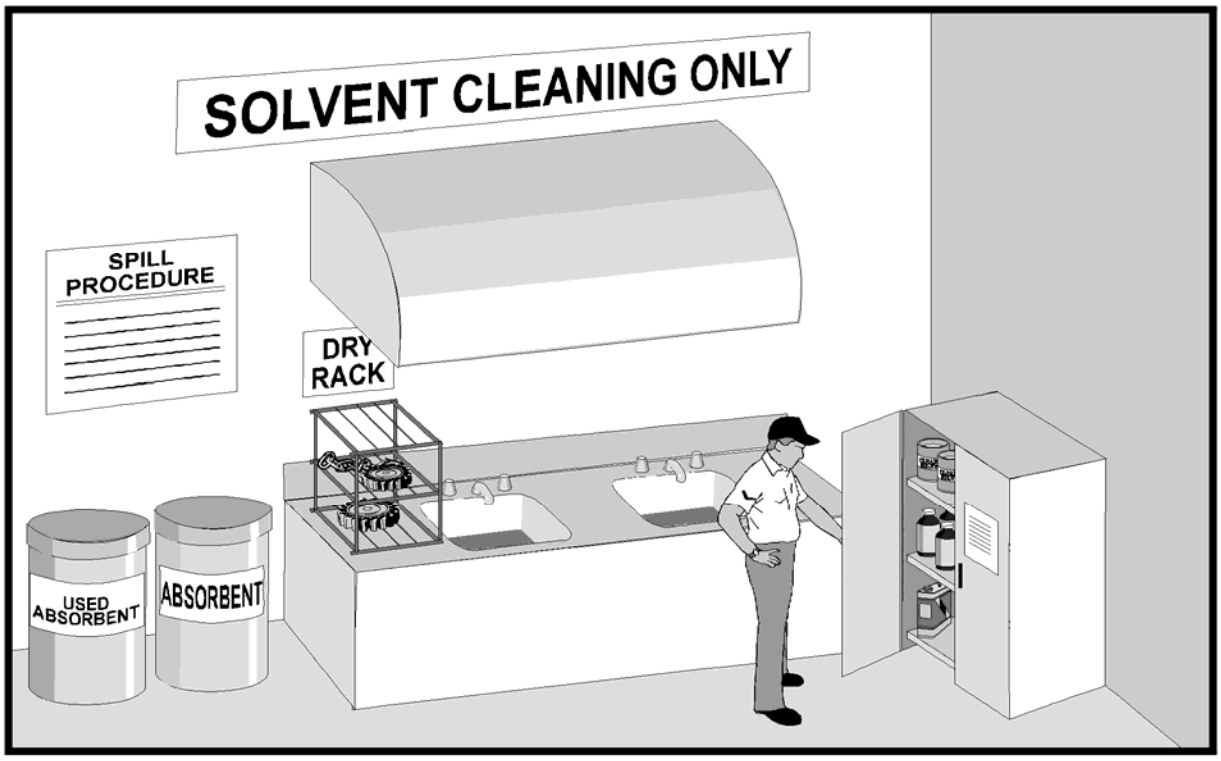
Application Guidance: Substitute cleaning methods will be used in all maintenance operations. These include: vehicle, equipment, aircraft and ship maintenance; metal work; and painting.

Training: Personnel will be trained in selected alternative methods of cleaning. Signs will be posted as reminders.

Effectiveness and Cost: Effectiveness and cost of non-liquid cleaning procedures will be site specific.

Limitations: Substitute cleaning methods may not be adequate for some operations.

BMP 049 - CENTRALIZE LIQUID SOLVENT CLEANING TO ONE LOCATION



Description of Potential Pollutant and Source: Widespread use of liquid solvents to clean parts results in a potential for spills, illegal dumping, and improper use of the solvent.

Description of BMP: If cleaning parts with liquid solvents is unavoidable, conduct cleaning operations in central locations. This practice will reduce the number of personnel using the solvents, promote proper use and disposal, and minimize the potential for spills (assuming that the central locations are properly operated and maintained). Drip pans, drain boards and drying racks will be located adjacent to and oriented such that excess solvent is directed back into a sink or holding tank for recycling. All storage containers will be clearly labeled.

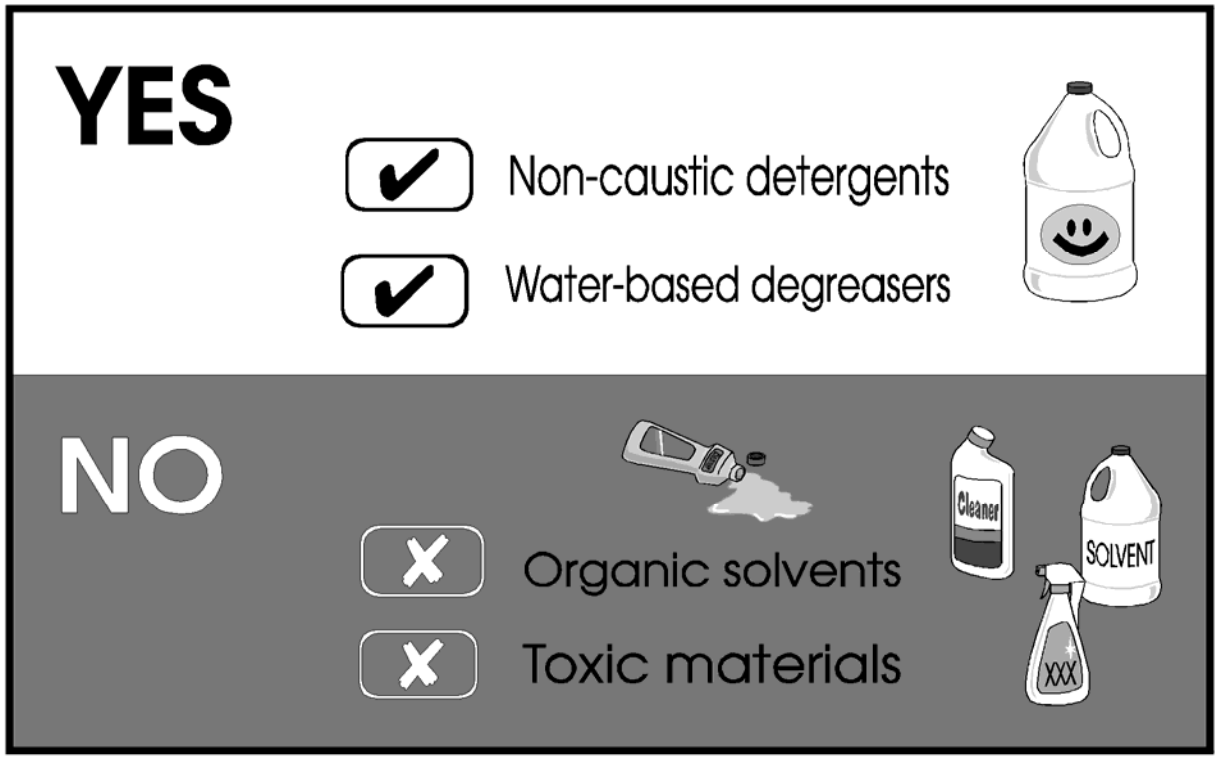
Application Guidance: Central cleaning locations will be used whenever parts are cleaned with liquid solvents in maintenance and salvage operations.

Training: Personnel will be notified of the locations of the cleaning stations. Personnel will be trained in proper procedures, such as removing dipped parts slowly as to avoid spill, and how to recycle used solvent.

Effectiveness and Cost: Central cleaning stations are a moderately effective, moderate-cost BMP.

Limitations: The size of the parts being cleaned may preclude having operations centralized.

BMP 050 - SUBSTITUTE NON-TOXIC OR LESS-TOXIC CLEANING SOLVENTS



Description of Potential Pollutant and Source: Organic solvents, typically used for cleaning equipment and parts, are considered a major pollutant in storm water. Exposure of these materials to storm water can be minimized by using less-toxic substitutes.

Description of BMP: Substitute non-toxic or less-toxic materials to reduce the impact of storm water pollutants. This includes using non-caustic detergents for parts cleaning, detergent or water-based degreasers in place of organic degreasers, replacing chlorinated solvents with non-chlorinated solvents, and using phosphate-free detergents. However, even non-toxic materials are considered storm water pollutants and must be managed properly.

Application Guidance: Less-toxic materials will be substituted whenever possible.

Training: The procurement office will be trained regarding the constituents of cleaning materials and alternative materials. Personnel will be trained to know the differences between new and previously used materials.

Effectiveness and Cost: Effectiveness and cost will vary depending on site conditions.

Limitations: There may be no adequate alternative cleaning solvent available at a reasonable cost.

BMP 051 - USE SOLVENTS EFFICIENTLY

Description of Potential Pollutant and Source: Many repair and maintenance operations use a wide variety of solvents. Spills and leaks of solvents can occur, exposing these materials to storm water. By using these materials efficiently, the potential for exposure can be reduced.

Description of BMP: Reuse solvents or use solvents sparingly to reduce the risk of spills and leaks. Pre-soaking parts in "dirty" solvent before placing in fresh solvent reduces the volume of solvent used.

Application Guidance: This practice will be followed as often as is practical.

Training: Personnel will be trained in efficient use of solvents.

Effectiveness and Cost: Efficient use of solvents is a moderately effective, low-cost BMP.

Limitations: None

BMP 052 - USE OUTSIDE CONTRACTOR FOR HANDLING USED SOLVENTS AND OTHER SIGNIFICANT MATERIALS

Description of Potential Pollutant and Source: Improper storage, handling, and disposal of solvents, oils, paint thinners, and other toxic chemicals can occur with untrained personnel. This can result in exposure of these materials to storm water. Use of contractors specializing in handling these materials can minimize this exposure.

Description of BMP: Use private contractors to handle the disposal and replenishing of solvents, used oil, and other significant materials used in industrial or maintenance operations.

Application Guidance: Private contractors will be used for disposing and replenishing significant materials continually.

The frequency for implementing this BMP has been provided as general guidance. However, a facility operator may wish to establish a more suitable frequency. This will require SWPCP implementors to make judgements based on facility operations and conditions. To assign a frequency other than what has been suggested (i.e., more or less frequent), the following criteria will be considered and rated either High, Medium, or Low. If many of the criteria are assigned a High rating, the frequency may be increased. Similarly, if many criteria are assigned a Low rating, the frequency may be decreased. The goal of implementing this BMP is to minimize exposure of pollutants to storm water.

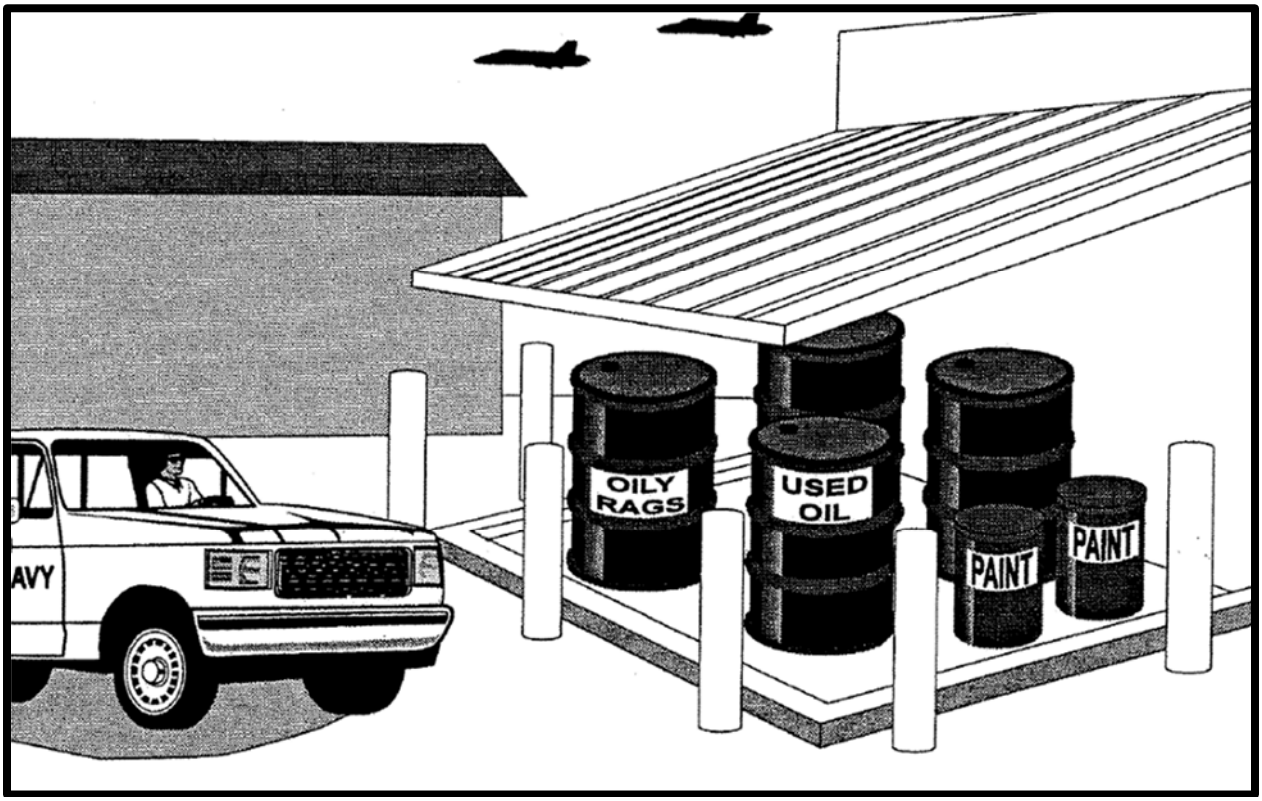
CRITERIA	Rating H=High M=Medium L=Low
Probability of exposure of significant materials to storm water	
Quantity of significant materials potentially exposed	
Toxicity of significant materials potentially exposed	
Frequency of use of significant materials potentially exposed	
Evidence of exposure (e.g., stains on pavement, etching of concrete)	
Proximity of source area to outfall or receiving water	
Sensitivity of receiving water to potentially exposed significant materials (e.g., waters with beneficial uses such as human contact, recreation, significant species habitat, etc.)	

Training: Personnel will be trained to contact the private contractors when services are needed and prepare the proper manifests (records of transportation).

Effectiveness and Cost: This is a moderately effective, moderate-cost BMP.

Limitations: Availability of private contractors may be a limitation. Quantities of materials/waste will also limit the application of this BMP.

BMP 053 - PROTECT STORAGE CONTAINERS FROM BEING DAMAGED BY VEHICLES



Description of Potential Pollutant and Source: If a container is damaged by a vehicle, the contents may leak, exposing the material to storm water.

Description of BMP: Protect storage containers against damage by vehicles. Bollards or traffic barriers may be used if the container location is accessible to vehicles. Fences and curbs may also be used to protect the containers.

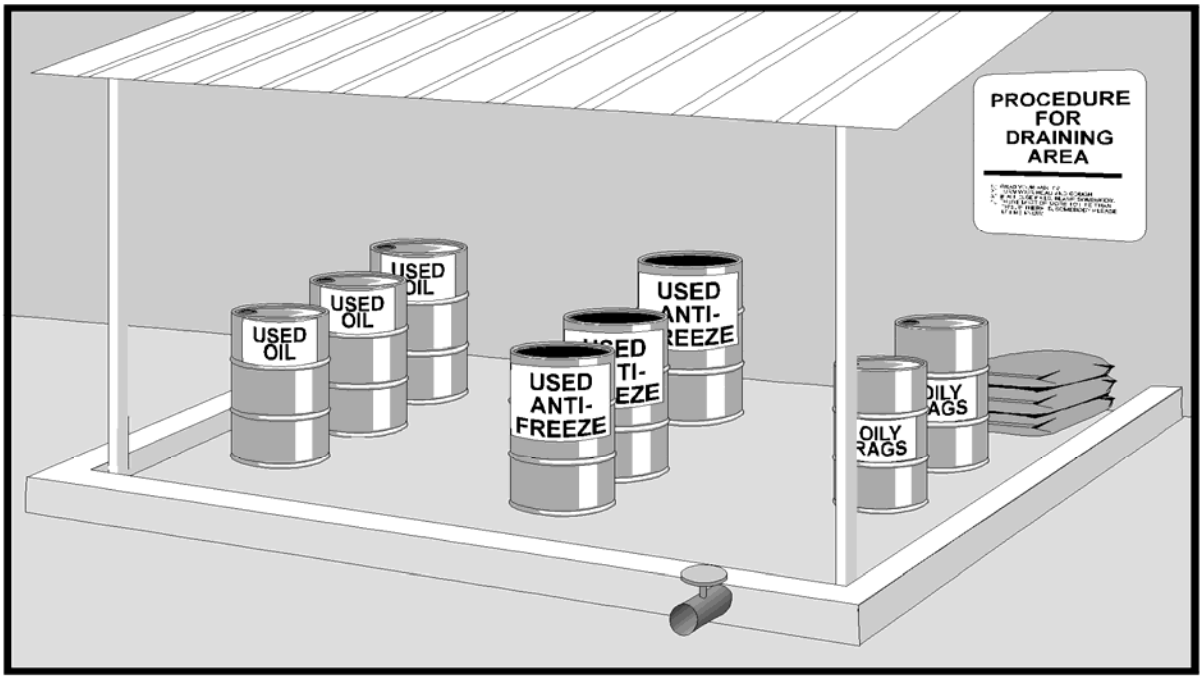
Application Guidance: Containers will be guarded against damage by vehicles.

Training: N/A

Effectiveness and Cost: This is an effective, low-cost BMP.

Limitations: None

BMP 054 - PROPERLY STORE CONTAINERS



Description of Potential Pollutant and Source: Improper storage of containers can result in the exposure of significant materials to storm water.

Description of BMP: Store containers will be properly. This includes the following:

- Providing adequate aisle space (typically 3 feet) to facilitate material transfer and easy access for inspections.
- Storing containers, drums, and bags away from vehicle traffic routes to reduce the potential for mechanical impact and accidental spills. Do not store bags that are easily punctured near high-traffic areas where they may be hit by moving equipment or personnel. Stacking containers according to manufacturer's instructions to avoid damaging the containers from improper weight distribution.
- Storing liquid containers in a bermed area.

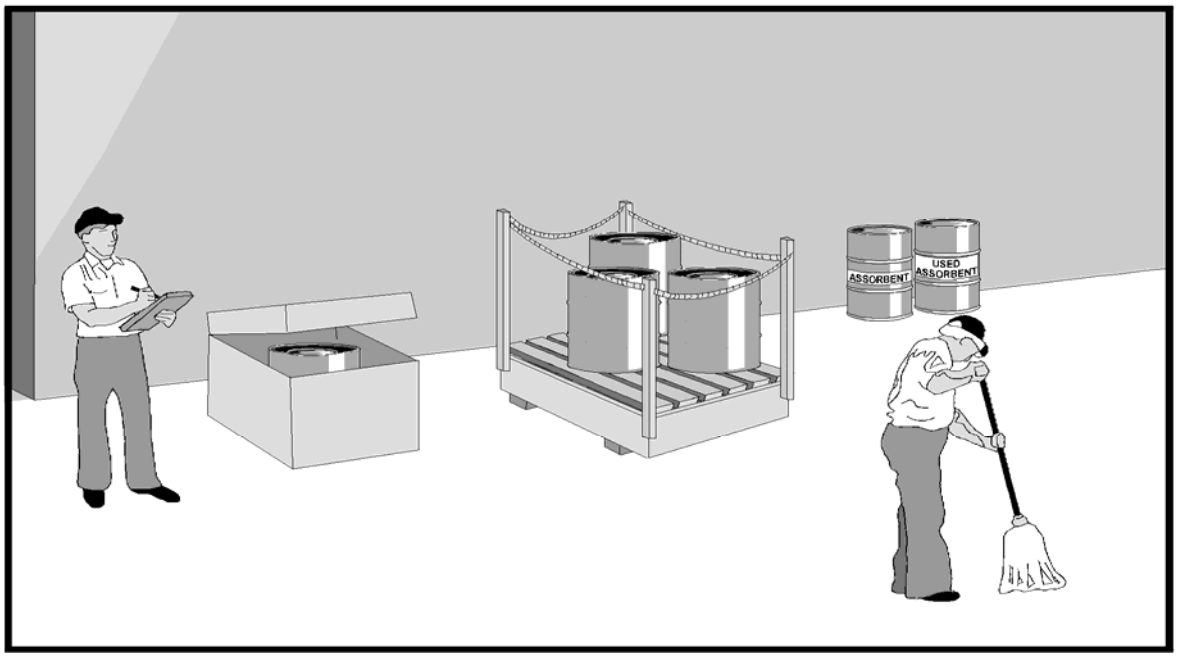
Application Guidance: Containers will be properly stored.

Training: Training on the proper storage of materials will be provided periodically to the appropriate personnel.

Effectiveness and Cost: This is a moderately effective, low-cost BMP.

Limitations: None

BMP 055 - USE OVERPACK CONTAINERS OR CONTAINMENT PALLETS TO STORE 55-GALLON DRUMS OUTSIDE OF STORAGE AREAS



Description of Potential Pollutant and Source: Chemicals, oils, solvents or liquid materials stored outside in 55-gallon drums may leak. The leaking material can then be exposed to storm water and transported to the storm drain system receiving waters.

Description of BMP: Use overpack containers and containment pallets for 55-gallon drums stored outside. Overpack containers and containment pallets are secondary containers usually constructed of plastic. They are large enough to hold the contents of the containers stored in them if they should break or leak. Using overpack containers or containment pallets minimizes the amount of pollutants reaching surface waters due to leaks. Overpack containers will be protected against damage from vehicles.

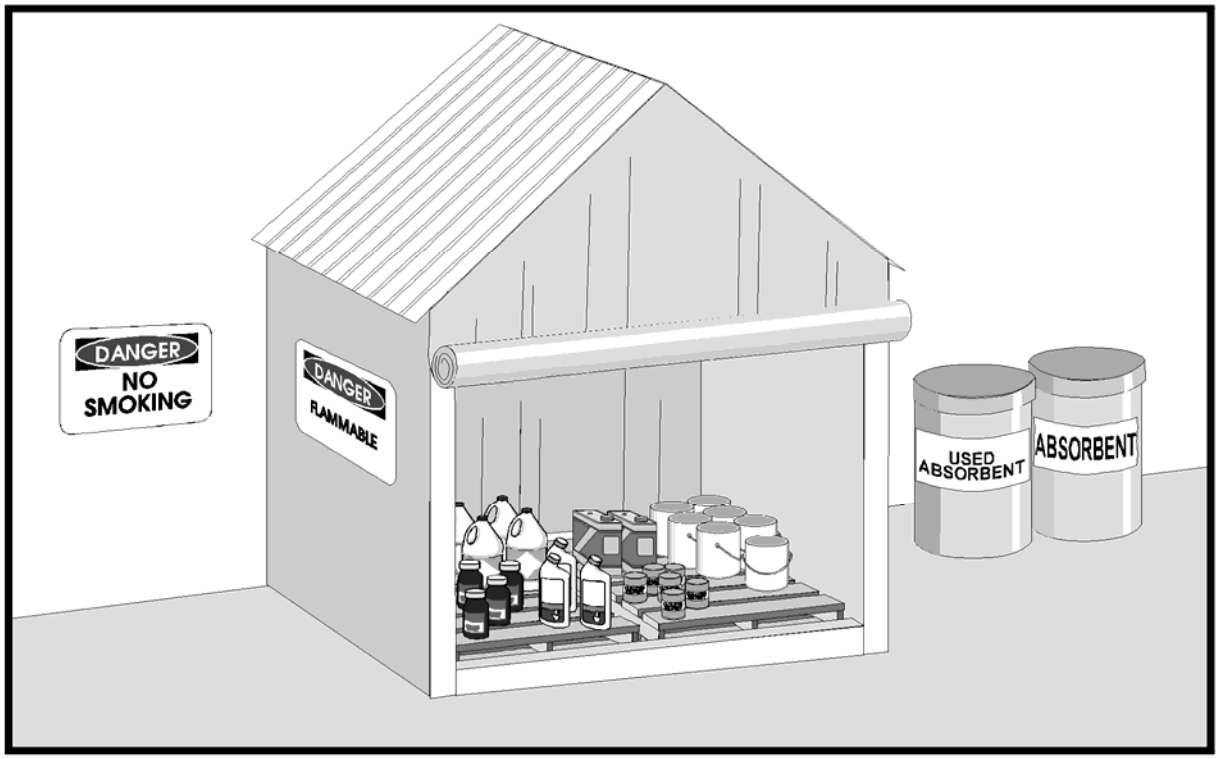
Application Guidance: Overpack containers or containment pallets will be used whenever 55-gallon drums of hazardous materials must be stored outside.

Training: Personnel will be trained to ensure that overpack containers or containment pallets are used.

Effectiveness and Cost: Overpack containers and containment pallets are a highly effective, moderate-cost BMP.

Limitations: Cost could be high if the number of drums needing containment is high.

BMP 056 - USE "DOGHOUSE" DESIGN FOR OUTDOOR STORAGE OF SMALL LIQUID CONTAINERS



Description of Potential Pollutant and Source: Small containers of liquid materials (i.e., paints, solvents, antifreeze, etc.) are often stacked or stored outside. Leaks and spills from these containers can be exposed to storm water and be transported to the storm drain or receiving waters.

Description of BMP: Store small containers of liquid properly. Containers can either be stored inside buildings or in "doghouses." The roof and flooring of a doghouse design prevents direct contact of significant materials with storm water. A doghouse design is a term used to describe a storage shed that has two solid structural walls, a roof, and two canvas walls. The structural walls support the structure, while the canvas walls provide easy access to the liquid containers in the shed. Secondary containment, such as berms and curbs, will also be used for this type of structure to contain any leaks or spills that may occur. A doghouse design has two benefits:

1. Protection of liquid containers from direct contact with rainfall
2. Storage of numerous containers in a centralized location without occupying too much space

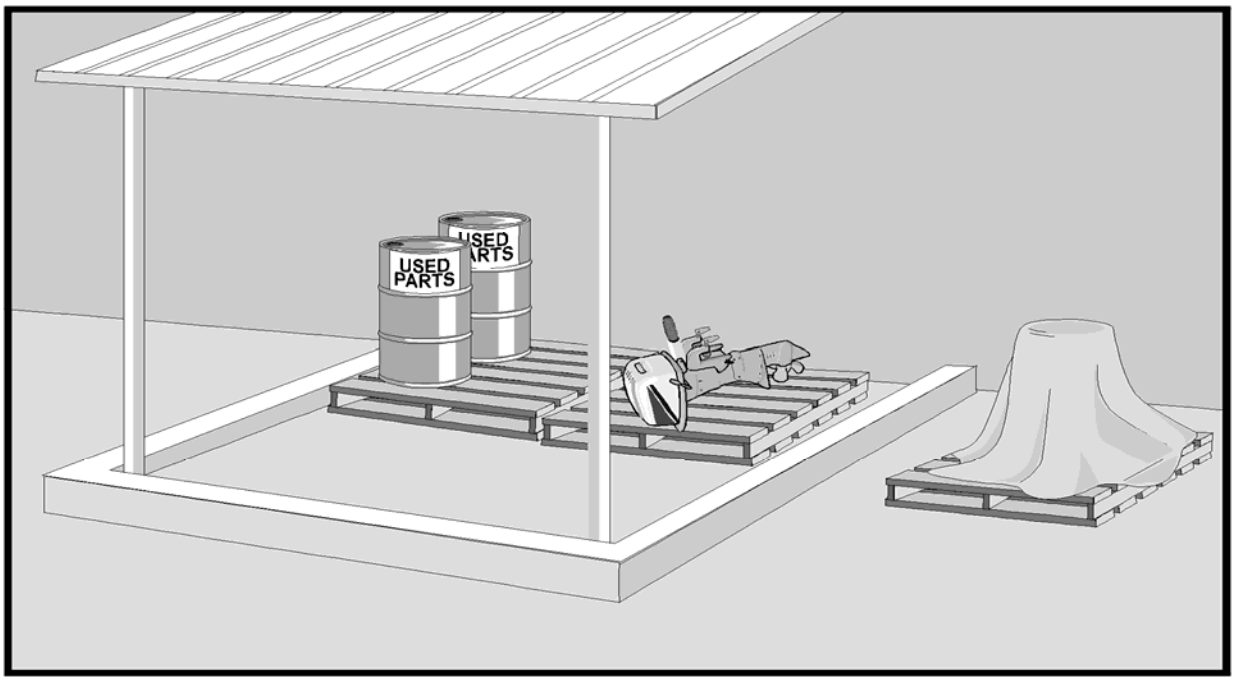
Application Guidance: Liquid containers kept outdoors will be covered at all times.

Training: N/A

Effectiveness and Cost: This is a moderately effective, moderate-cost BMP.

Limitations: Storage sheds often must meet building and fire code requirements. Construction plans should be prepared in consultation with the Federal Fire Department.

BMP 057 - DO NOT STORE USED PARTS OR CONTAINERS DIRECTLY ON GROUND



Description of Potential Pollutant and Source: Used parts are often covered with oil, grease, and other potential pollutants. Containers, such as 55-gallon drums and flammable materials storage lockers, may develop leaks and spill potential pollutants onto the ground or pavement. If the used parts or containers are stored directly on the pavement or ground, significant materials can be exposed to storm water which can transport the pollutants into the storm drain system or receiving waters.

Description of BMP: Do not store used parts and containers directly on the pavement or the ground. If possible, used parts and containers will be stored indoors. If outdoor storage is necessary, smaller parts will be placed inside a leak-proof, covered container, such as a labeled 55-gallon drum, and placed on a wooden pallet. Larger parts will be placed on wooden pallets or waterproof tarpaulins and covered with secure tarpaulins. Containers will be placed on wooden pallets to prevent the bottoms from rusting and to facilitate spill and leak detection. Placing used parts and containers in roofed, bermed storage areas is also acceptable.

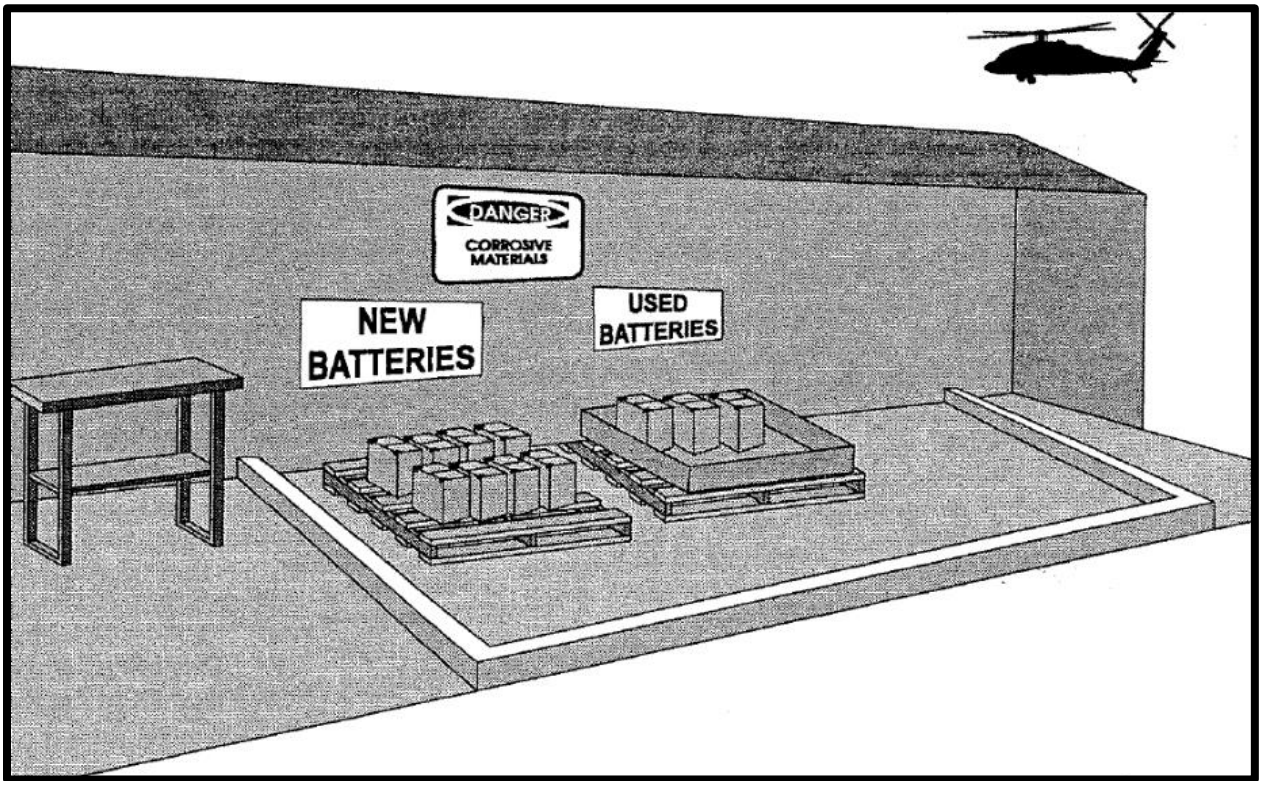
Application Guidance: Proper storage will be provided for used parts and containers.

Training: Personnel will be trained to never store used parts or containers directly on the ground or pavement.

Effectiveness and Cost: This is a moderately effective, low-cost BMP.

Limitations: None

BMP 058 - STORE BATTERIES IN A SECONDARY CONTAINER



Description of Potential Pollutant and Source: Lead-acid batteries can leak battery acid that can become exposed to storm water. These materials can be transported to the storm drain or receiving waters.

Description of BMP: Store all batteries on pallets in a bermed area. Used and cracked batteries will be stored in secondary containers. Storing the batteries on pallets allows the operator to visually detect leaks.

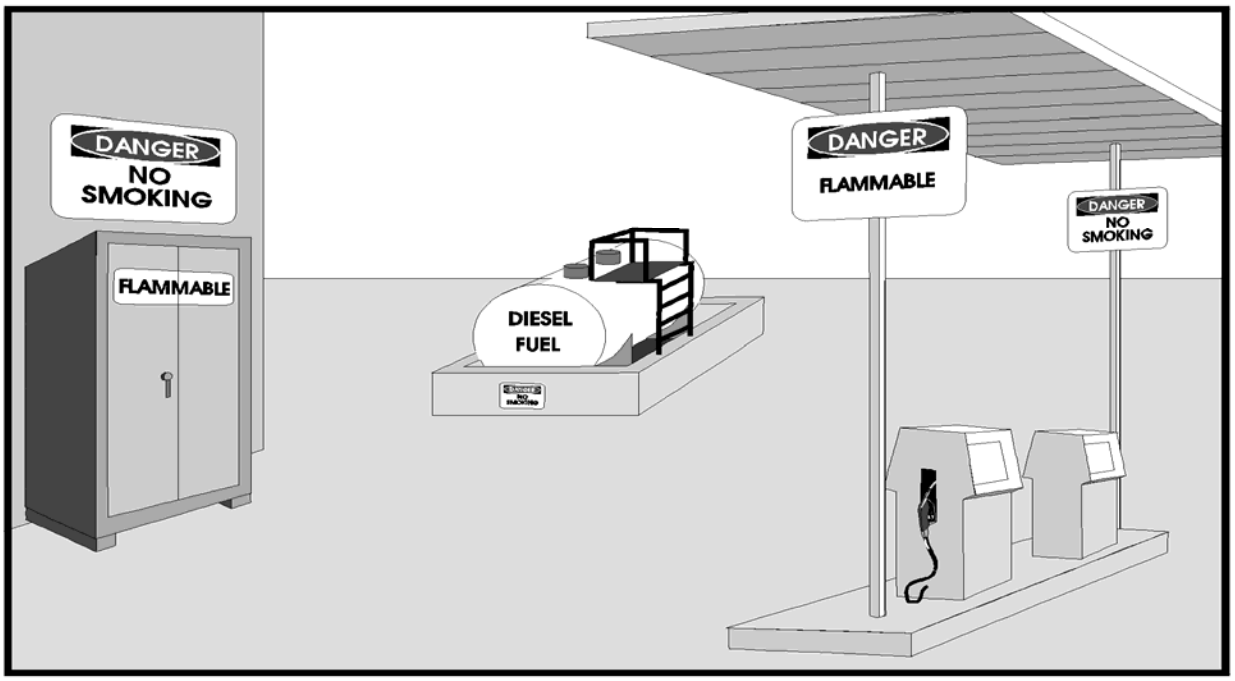
Application Guidance: This practice will be adopted in all vehicle maintenance areas or areas where batteries are stored. Dropped batteries will be treated as cracked.

Training: Signs will be posted as reminders.

Effectiveness and Cost: Secondary containers for cracked batteries is a highly effective, low-cost BMP.

Limitations: Adequacy of storage space in bermed areas; cost of constructing concrete, bermed storage area.

BMP 059 - DO NOT ALLOW OPEN FLAMES NEAR FLAMMABLE MATERIAL



Description of Potential Pollutant and Source: Water or other material used to extinguish a fire often is washed into the storm drain system. This material could contain pollutants from the item on fire. In addition, an area that has been destroyed by a fire is likely to discharge contaminants into the storm drain system. These materials can be exposed to storm water and transported to receiving waters.

Description of BMP: Do not permit open flames of any kind within 50 feet of flammable material. Many paints are flammable. Smoking will be forbidden within flammable material areas, and only spark-proof tools will be used. Signs will be posted indicating flammables and no smoking. (Note: 29 CFR 1910.106 requires this BMP for areas where flammables are stored).

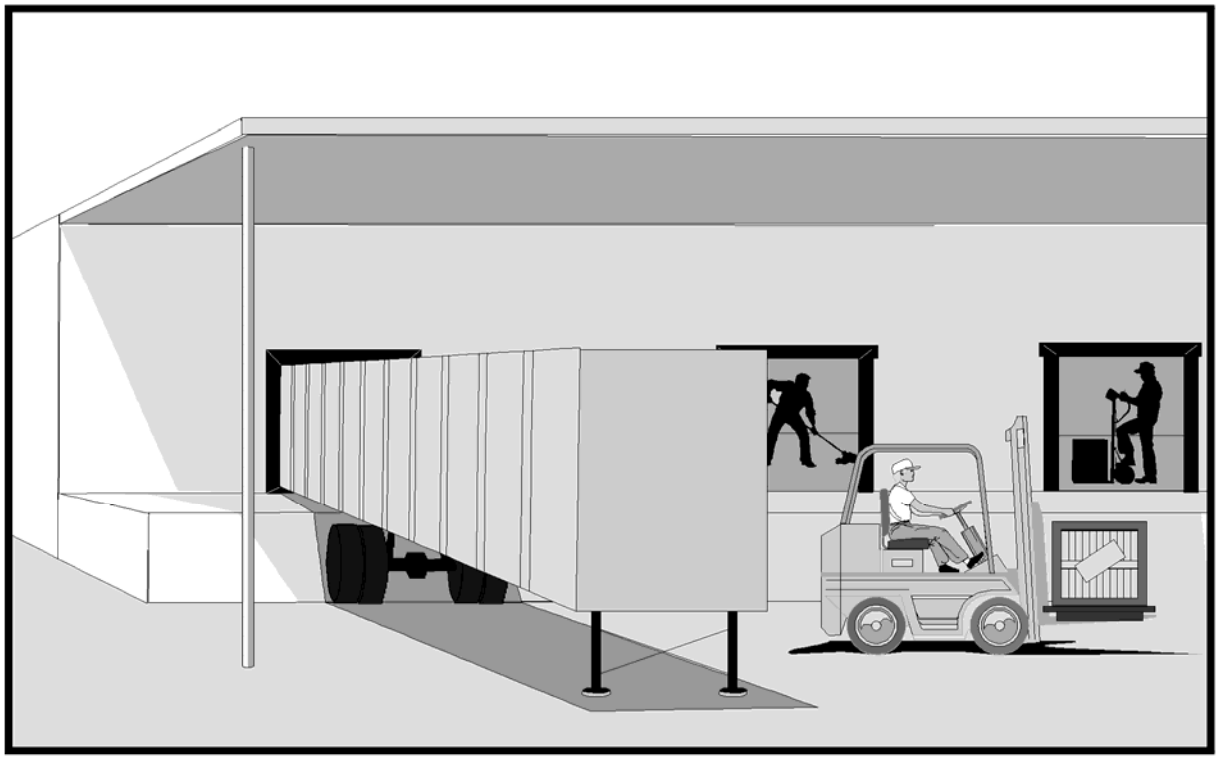
Application Guidance: No open flames or smoking will be allowed near flammable materials that are stored or that are being used. Only spark-proof tools will be used.

Training: Personnel will be trained to routinely check the label on materials to determine if they are flammable. Flammable materials will be properly stored and used.

Effectiveness and Cost: This is an effective, low-cost BMP.

Limitations: None

BMP 060 - USE DOOR SKIRT OR SEAL



Description of Potential Pollutant and Source: Spills often occur during loading and unloading of liquid wastes and other significant materials from trucks and trailers. These materials can be exposed to storm water and transported to the storm drain system and/or receiving waters.

Description of BMP: Use door skirts or seals during loading and unloading. A door skirt is a rubber or plastic strip that encloses a trailer end during loading operations. Existing docking facilities will be retrofitted with door skirts or seals where appropriate.

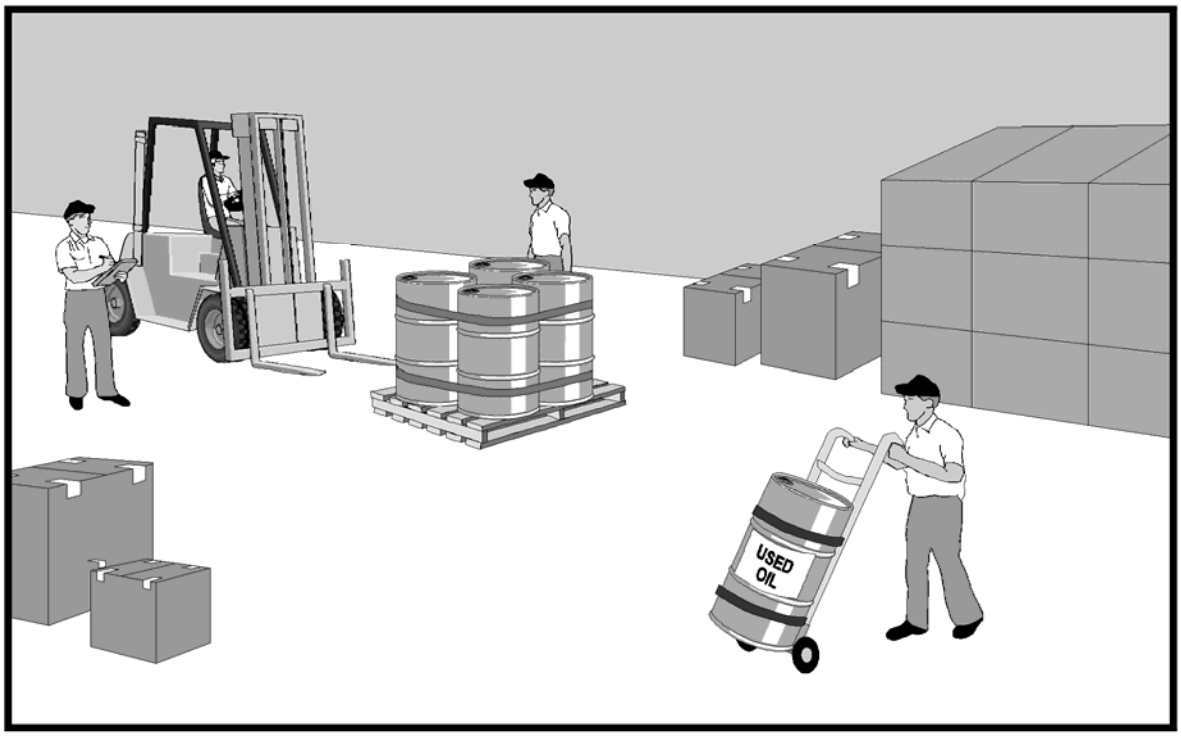
Application Guidance: A door skirt or seal will be installed at docking facilities as appropriate.

Training: N/A

Effectiveness and Cost: The door skirt is a moderately effective, low-cost BMP.

Limitations: None

BMP 061 – EMPTY PROPER HANDLING PROCEEDURES TO TRANSPORT MATERIALS



Description of Potential Pollutant and Source: Materials and waste are usually transported using forklifts, trailers, trucks, etc. If these loads are not properly secured or are handled incorrectly, drums can be ruptured and spills can occur. This can expose the materials to storm water, which can transport them to the storm drain system and/or receiving waters.

Description of BMP: Move drums by using a barrel cart or by placing the drum on a pallet and moving it with a forklift. As a minimum, two persons will assist the forklift operator when transferring a drum to or from a pallet. When multiple drums are stacked on a single pallet, the drums will be secured together with metallic strapping to reduce the potential for spillage due to weight shift. Mechanical puncture of a drum with the tines (i.e., the prongs) of the forklift will be avoided.

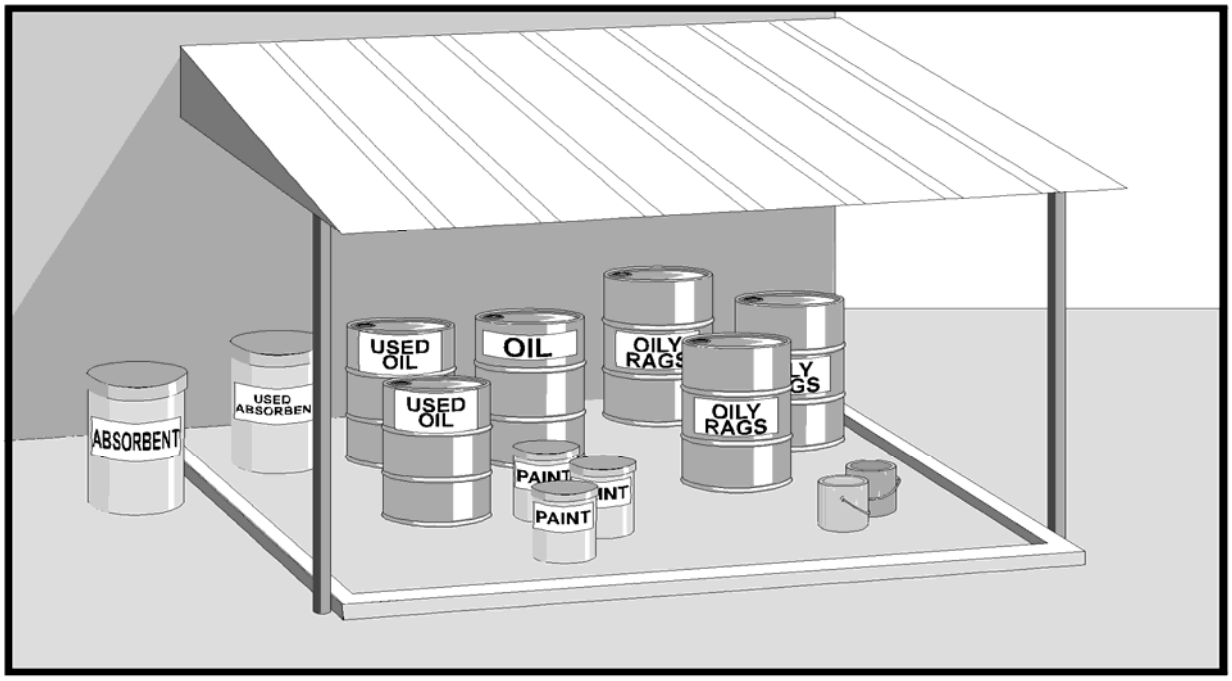
Application Guidance: Significant materials and wastes will be transported according to federal, state, and local regulations at all times.

Training: Personnel will be trained in hazardous material/waste spill prevention procedures.

Effectiveness and Cost: This practice is highly effective, moderate-cost BMP.

Limitations: None

BMP 061B - STORE LIQUIDS AND SIGNIFICANT MATERIALS WITHIN A BUILDING OR COVERED AREA



Description of Potential Pollutant and Source: Many significant materials may be leaked or spilled during storage, handling, or transport. If significant materials are stored outside, in covered areas, these materials can be exposed to storm water, which can transport the leaked or spilled material into the storm drain system.

Description of BMP: To the extent practical, store significant materials within a building or covered area. The materials will be stored on an impervious surface, such as a concrete pad. Rainfall runoff from the pad will be directed to a storm water treatment facility or contained. Leaks and spills will be cleaned up as soon as possible using rags or dry absorbents (see BMP 006). Used rags and absorbents will be disposed of properly. Any wash water from cleaning the floor will be disposed of in the sanitary sewer (see BMP 042).

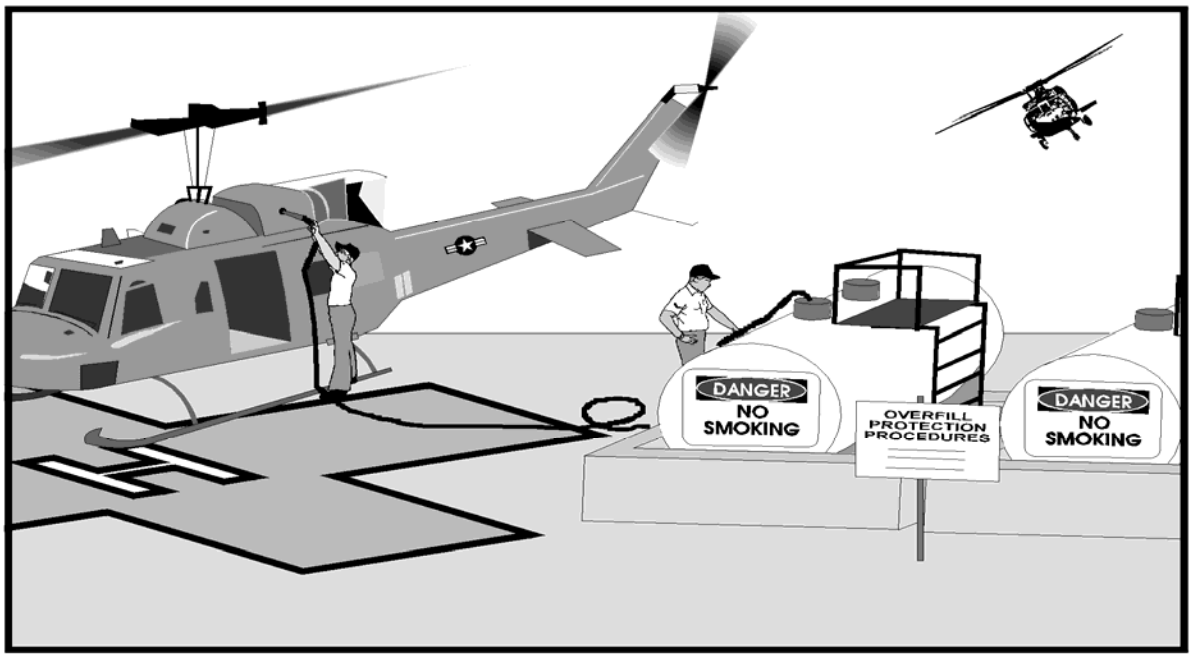
Application Guidance: All significant materials will be stored within a building or covered area.

Training: Personnel will be trained to store significant materials in designated areas.

Effectiveness and Cost: This is a moderately effective BMP. The cost will vary based on whether a building for storing the substances is available.

Limitations: None

BMP 062 - PROVIDE OVERFILL PROTECTION



Description of Potential Pollutant and Source: Overflows during fueling or transfer of fuels or liquids to the storage tanks can expose significant materials to storm water, which can transport them to the storm drain system and/or receiving waters.

Description of BMP: Control overflows by installing overfill prevention equipment that automatically shuts off flow, restricts flow, or sounds an alarm when the tank is almost full. Existing tanks will be retrofitted with this equipment.

Application Guidance: Overfill protection will be used during any fuel or liquid handling operation. This includes vehicles, equipment, aircraft and ships. Overfill protection will be included in initial construction and retrofitting of existing installations.

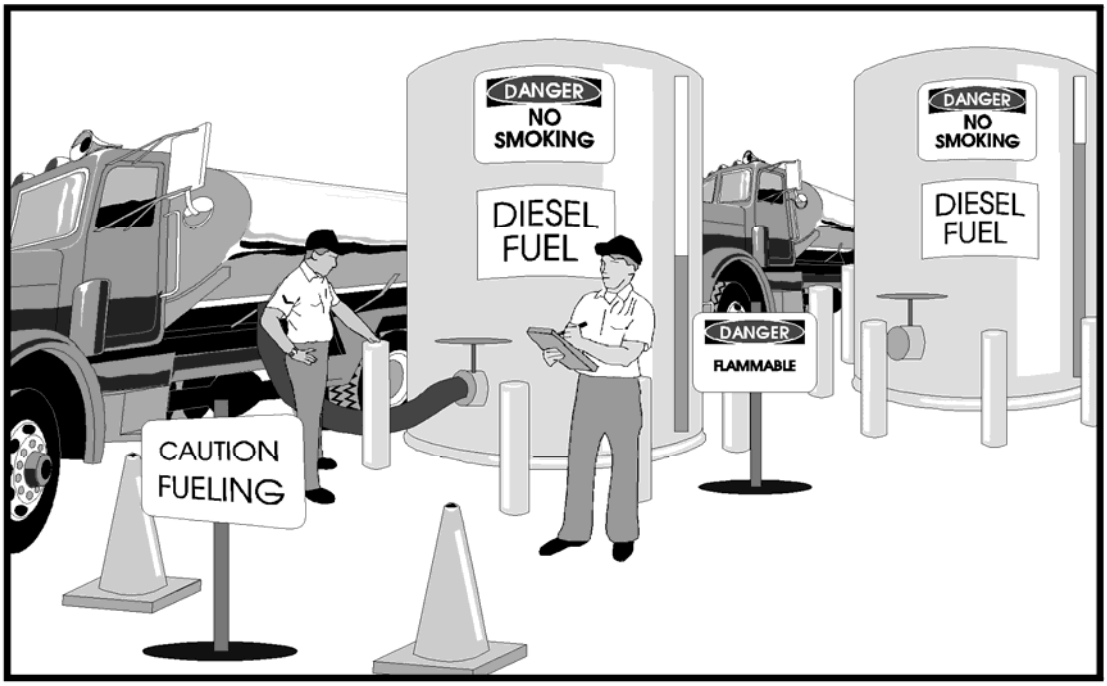
Training: Personnel will be trained in the use of the overfill protection devices at their facilities. Overfill protection procedures will be posted in fueling areas and other liquid material transfer areas.

Effectiveness and Cost: Overfill protection is a highly effective, low-cost BMP.

Limitations: None

PLACEHOLDE

BMP 064 - MONITOR MAJOR FUELING OPERATIONS



Description of Potential Pollutant and Source: Overflows during fueling or transfer of fuels or liquids to the storage tanks can expose significant materials to storm water. These materials can then be transported to the storm drain or receiving waters.

Description of BMP: Monitor fuel transfer operations carefully to reduce overfilling. A policy mandating second party monitoring of fuel transfers will be adopted.

Application Guidance: Fuel transfer operations will be observed during all high-volume transfers. High-volume transfers typically involve a fuel tanker truck.

Training: Personnel will be trained in appropriate emergency spill response actions and proper fueling procedures. Fueling procedures will include the following items: Determine that sufficient space is available in the storage tank or drum to receive the entire trailer compartment's capacity by gauging the tank or drum immediately before discharging additional product into the storage tank. Gauging can be accomplished by using stick readings, sight gauges, or sensor readouts.

- Ensure that the tank trailer is accurately spotted at the proper unloading spot.
- Ensure that the tank trailer brakes are set; the driver remains with the vehicle and observes the transfer lines during the entire unloading procedure.
- Place caution signs in the proximity of the tank trailer to give necessary warning to approaching vehicles and personnel. These signs must remain posted until after the tank trailer is unloaded and disconnected from the discharge connection.
- Ensure that no open flames of any kind are permitted within 100 feet of the tank trailer. Smoking is strictly forbidden within this area. Only spark-proof tools are to be used (see BMP 059).
- Limit performance of unloading operations only to reliable persons properly instructed and made responsible for careful compliance with applicable regulations (see BMP 031).
- Attach ground strap at the facility to bumper of tank trailer unless the transfer hose provides the

proper ground, once the products in the tank and trailer and compartments have been verified as being the same.

- Ensure that the facility storage tank is vented before connecting the unloading line unless unloading uses a vapor recovery system. Connect vapor recovery system(s) if applicable.
- Attach unloading line to the proper connection on the outlet leg of the tank truck.
- Open bottom outlet valve and proper valves in the unloading lines.
- Start product unloading, checking to ensure that there is no leakage at any of the connections. Should leakage appear, immediately stop the unloading process by closing the necessary outlet valves. The driver must continuously observe the connections to ensure that they are secure throughout the fluid transfer process.
- After liquid has been removed, close all valves, disconnect facility unloading from tank trailer, replace cap to outlet, and tighten all other closures.
- Gauge the tank after delivery to ensure that the product amount delivered agrees with the manifest or bill of lading. Be certain that any discrepancies noted at the time of delivery are noted on the manifest or bill of lading and are initialed by the driver.
- Remove all portable signs and release the tank trailer.

Effectiveness and Cost: Observing major fueling operations is a moderately effective, low-cost BMP.

Limitations: None

BMP 065 - PROVIDE ABSORBENT BOOMS IN UNBERMED FUELING AREAS

Description of Potential Pollutant and Source: Spills during major fueling operations may expose potential pollutants to storm water. These materials can be transported to the storm drain system and/or receiving waters.

Description of BMP: Provide absorbent booms at fueling areas which are not bermed. The absorbent booms are portable and are used if a spill occurs during the fueling operations.

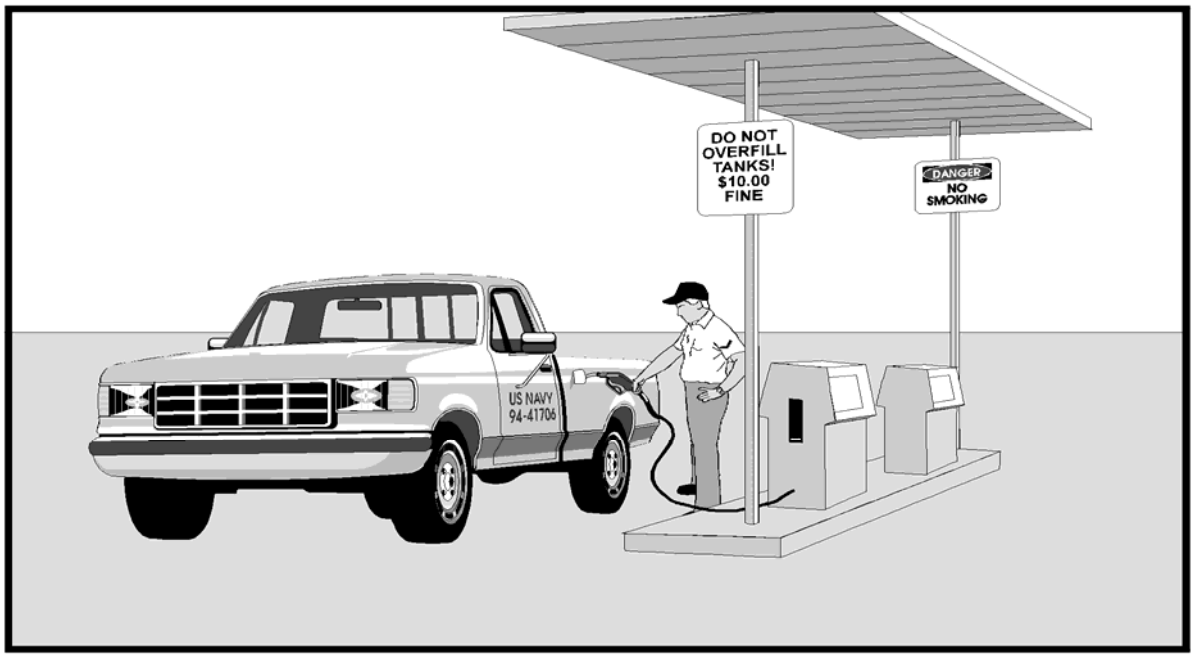
Application Guidance: Absorbent booms will be kept at all fueling areas.

Training: Personnel will be trained regarding the proper use and placement of the absorbent booms to contain spills. This information will be obtained from the manufacturer of the absorbent booms.

Effectiveness and Cost: This is a moderately effective BMP. The cost will vary based on the size of the fueling area.

Limitations: None

BMP 066 - ELIMINATE TOPPING OFF TANKS



Description of Potential Pollutant and Source: Trying to completely fill tanks after the pumps automatically shut off, or "topping off," often results in fuel spills and exposure of significant materials to storm water.

Description of BMP: Eliminate "topping off" fuel tanks. A policy will be developed to discourage "topping off" tanks. The policy will include incentives, posting signs stating the policy, or penalties.

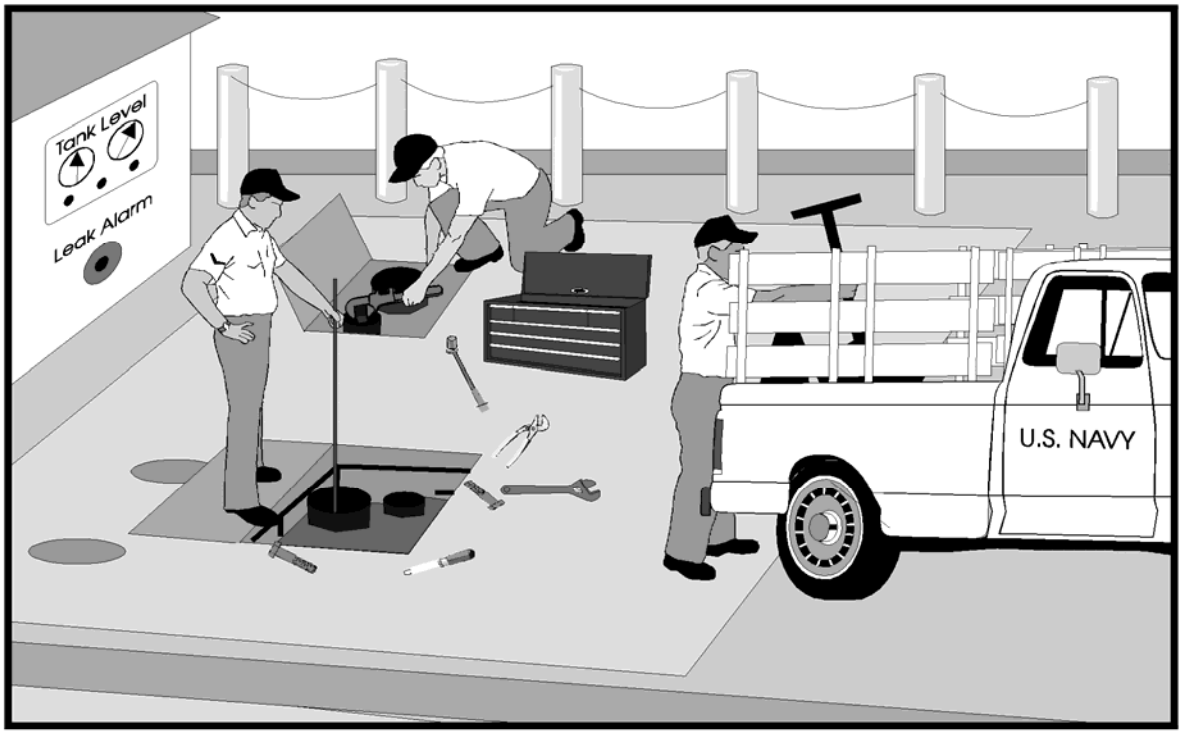
Application Guidance: This BMP will be applied to all fuel or liquid handling operations.

Training: New personnel will be informed of policy and signs should be posted as a reminder.

Effectiveness and Cost: Eliminating "topping off" is a highly effective, low-cost BMP.

Limitations: None

BMP 067 - INSTALL LEAK DETECTION SYSTEM



Description of Potential Pollutant and Source: An underground storage tank may leak fuel which may subsequently become exposed to storm water. These materials can be transported to storm drains and/or receiving waters.

Description of BMP: A leak detection system will be installed on USTs. There are numerous methods of leak detection systems. The more effective and costly methods include tank automatic gaging, vapor monitoring, groundwater monitoring, and interstitial monitoring. A low-cost, but less effective leak detection method involves using inventory control to keep track of the amount of fuel dispensed into the tank versus the amount pumped out.

Application Guidance: Tanks will be monitored for leaks every 30 days. The frequency for implementing this BMP has been provided as general guidance. However, a facility operator may wish to establish a more suitable frequency. This will require SWPCP implementors to make judgements based on facility operations and conditions. To assign a frequency other than what has been suggested (i.e., more or less frequent), the following criteria will be considered and rated either High, Medium, or Low. If many of the criteria are assigned a High rating, the frequency may be increased. Similarly, if many criteria are assigned a Low rating, the frequency may be decreased. The goal of implementing this BMP is to minimize exposure of pollutants to storm water.

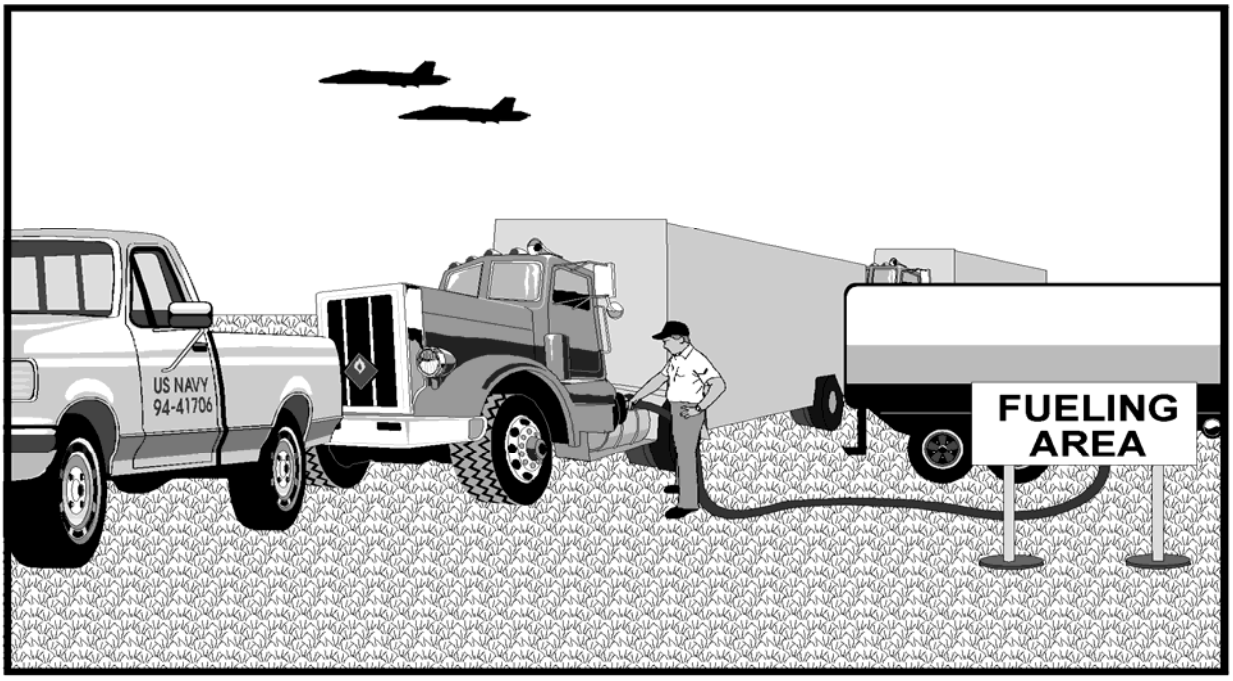
CRITERIA	Rating H=High M=Medium L=Low
Probability of exposure of significant materials to storm water	
Quantity of significant materials potentially exposed	
Toxicity of significant materials potentially exposed	
Frequency of use of tank	
Old age or poor condition of tank	
Evidence of exposure (e.g., stains on ground surface)	
Proximity of source area to outfall or receiving water	
Sensitivity of receiving water to potentially exposed significant materials (e.g., waters with beneficial uses such as human contact, recreation, significant species habitat, etc.)	
Probability of exposure of significant materials to storm water	

Training: Designated personnel will be trained on the operation and maintenance of the leak detection system in use at their facilities.

Effectiveness and Cost: The effectiveness and cost of the leak detection system depends on the method used. Inventory control is a less effective, low-cost BMP. The other methods are highly effective and have higher costs.

Limitations: For previously installed tanks, inventory control may be the most economically feasible option.

BMP 068 - DESIGNATE AREAS FOR FUELING FROM MOBILE FUEL TANKERS



Description of Potential Pollutant and Source: Overflows during fueling can expose significant materials to storm water. These materials can be transported to the storm drain and/or receiving waters.

Description of BMP: Designate areas for fueling to reduce the chances of fuel spills reaching storm water. Minimize the use of mobile fuel tankers. Most vehicles, with the exception of tracked vehicles such as tanks and bulldozers, should be able to travel to designated areas with minimal lost time.

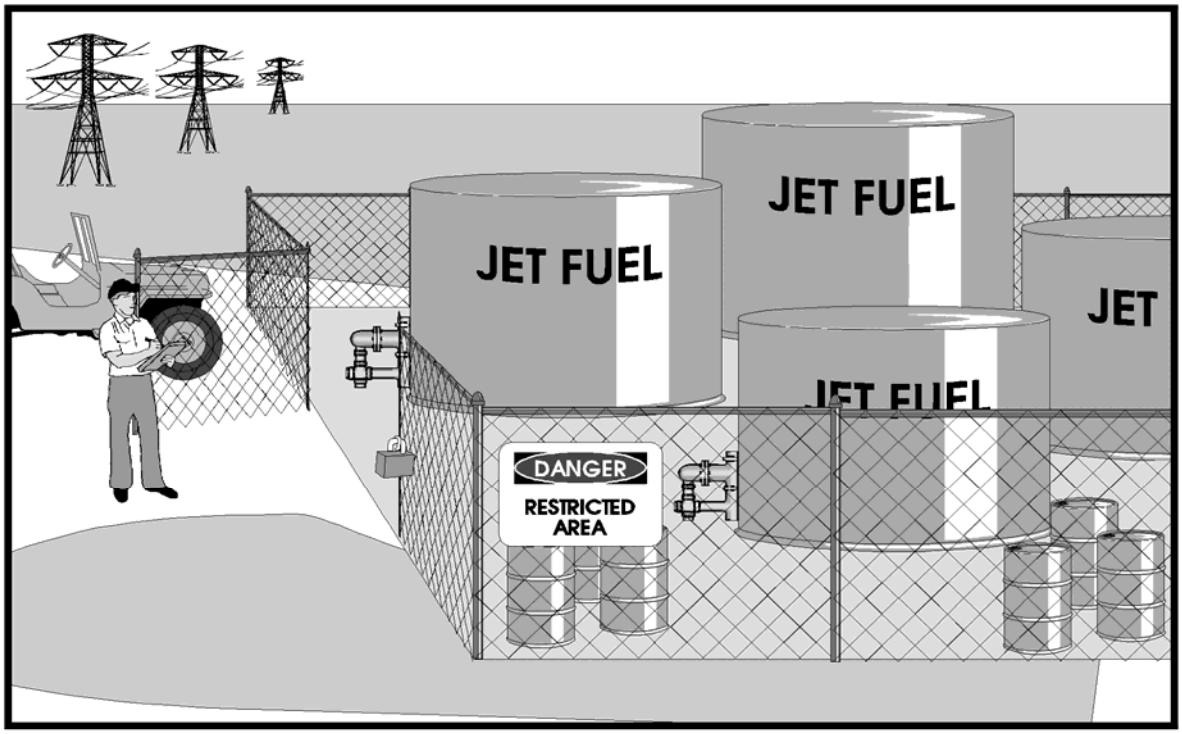
Application Guidance: Fueling areas will be designated whenever a large number of mobile equipment are being used.

Training: Personnel will be notified of the locations of designated fueling areas.

Effectiveness and Cost: Designated fueling areas are a highly effective, low-cost BMP.

Limitations: None

BMP 069 - RESTRICT ACCESS TO TANKS



Description of Potential Pollutant and Source: Improper use or vandalism of fuel tanks may result in discharge of fuel to the ground. This fuel may then be exposed to storm water and transported to the storm drain and/or receiving waters.

Description of BMP: Restrict access to fuel tanks and valves to properly trained personnel. The area can be restricted by a locked gate. This BMP is recommended for fuel tank farms.

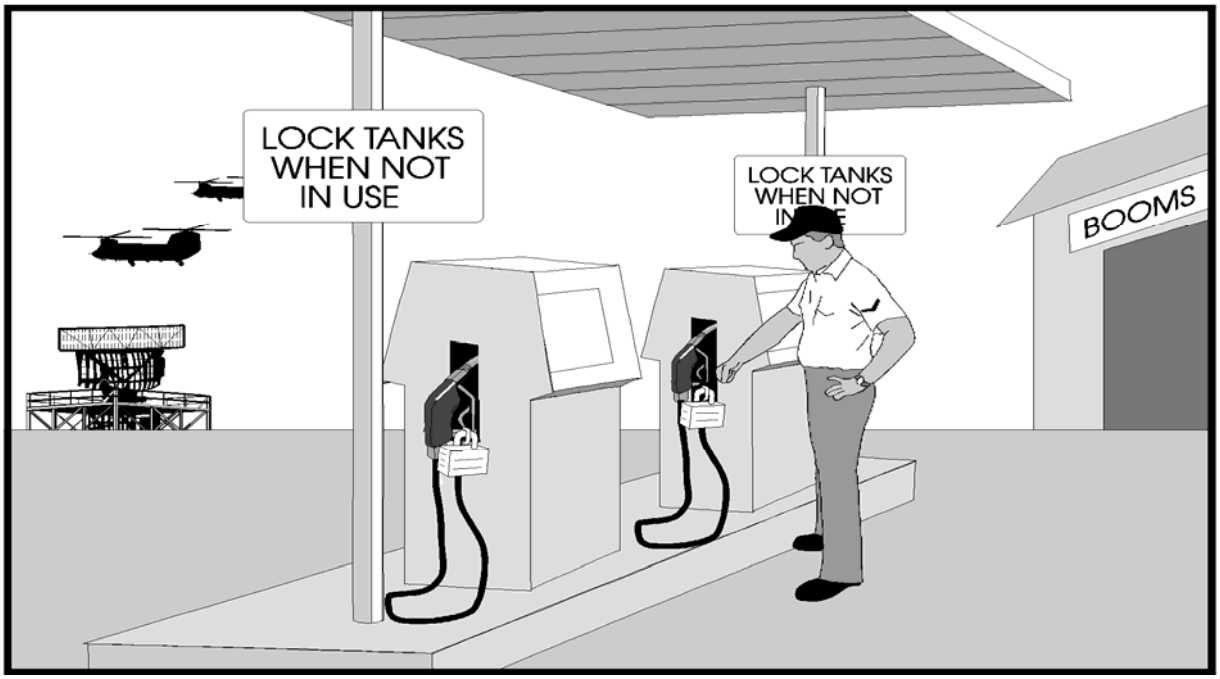
Application Guidance: Access to valves will be restricted at all times to properly trained personnel.

Training: Personnel who use fuel tanks will be trained in the proper operation of the system. Non-trained personnel who need fuel will be informed how to contact trained personnel for fuel dispensing.

Effectiveness and Cost: This is an effective, low-cost BMP.

Limitations: The placement of some tanks may make it difficult to restrict access them.

BMP 070 - LOCK FUEL TANKS WHEN NOT IN USE OR ON STANDBY



Description of Potential Pollutant and Source: Unauthorized use of fuel tanks increases the possibility of accidental fuel spills and exposure to storm water. Unauthorized use after normal hours of operation could potentially result in a large spill of fuel.

Description of BMP: Lock fuel tank valves and fill pipes when idle to ensure that accidental user error does not occur.

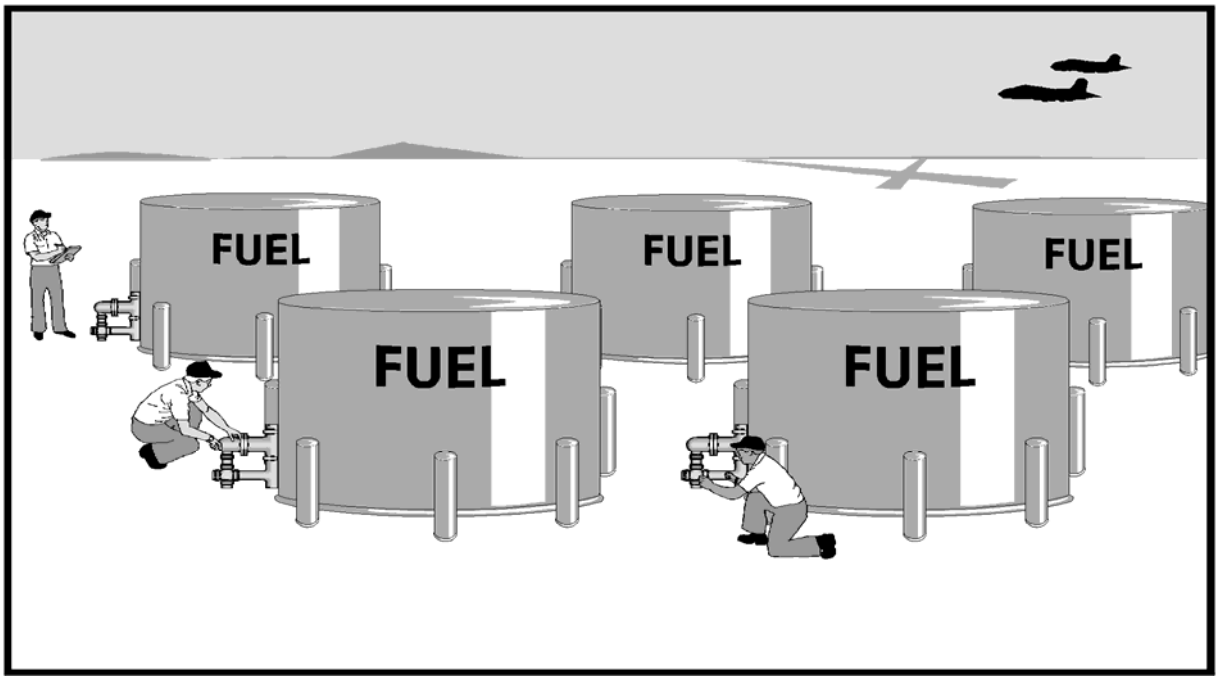
Application Guidance: Idle fuel tanks will be locked at all times.

Training: Personnel operating fuel tanks will be trained to know when tanks should be locked. Tanks which are frequently used will be locked at the end of the normal operating day.

Effectiveness and Cost: Locking tank valves is a highly effective, low-cost BMP.

Limitations: None

BMP 071- KEEP TANKS, PIPING, AND VALVES IN GOOD CONDITION



Description of Potential Pollutant and Source: Tanks, piping, and valves may leak fuel or other significant materials due to corrosion, loose fittings, poor welding, or improperly or poorly fitted gaskets. This can expose these materials to storm water, which can transport them to storm drains and/or receiving waters.

Description of BMP: Keep tanks, piping, and valves in good working condition. Tanks, piping, or valves which are leaking will be repaired or replaced.

Application Guidance: Tanks, piping, and valves will be inspected monthly and kept in good condition at all times. If applicable, preventive maintenance will be performed.

The frequency for implementing this BMP has been provided as general guidance. However, a facility operator may wish to establish a more suitable frequency. This will require SWPCP implementors to make judgements based on facility operations and conditions. To assign a frequency other than what has been suggested (i.e., more or less frequent), the following criteria will be considered and rated either High, Medium, or Low. If many of the criteria are assigned a High rating, the frequency may be increased. Similarly, if many criteria are assigned a Low rating, the frequency may be decreased. The goal of implementing this BMP is to minimize exposure of pollutants to storm water.

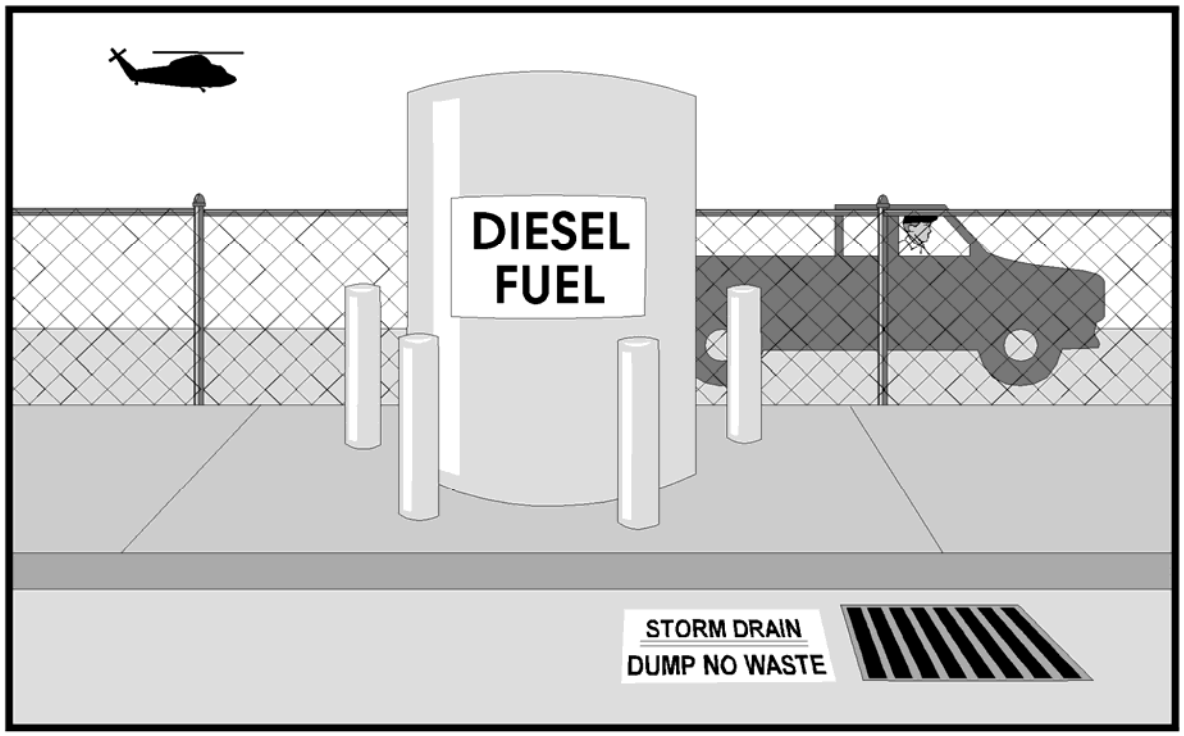
CRITERIA	Rating H=High M=Medium L=Low
Probability of exposure of significant materials to storm water	
Quantity of significant materials potentially exposed	
Toxicity of significant materials potentially exposed	
Frequency of use of tanks, piping, and valves	
Intensity of use of tanks, piping, and valves	
Old age or poor condition of tanks, piping, and valves	
Evidence of exposure (e.g., stains on ground surface)	
Proximity of source area to outfall or receiving water	
Sensitivity of receiving water to potentially exposed significant materials (e.g., waters with beneficial uses such as human contact, recreation, significant species habitat, etc.)	

Training: Personnel will be trained to regularly inspect for leaks or conditions that could lead to the discharge of chemicals, or storm water contact with waste materials. Personnel will be trained to routinely inspect equipment before each use. Tanks, piping, and valves which are not frequently used, will be inspected weekly. Procedures for notifying the appropriate maintenance personnel if a leak is found, will be established.

Effectiveness and Cost: Keeping tanks, piping, and valves in good condition is a highly effective BMP. The cost of repairing or replacing piping and valves is typically low. The cost of repairing or replacing tanks will vary based on the size of the tank and its present condition.

Limitations: None

BMP 072 - PROTECT TANKS FROM BEING DAMAGED BY VEHICLES



Description of Potential Pollutant and Source: If a tank is damaged by a vehicle, fuel, or other significant materials may be leaked from the tank and become exposed to storm water. The materials can then be transported to the storm drain and/or receiving waters.

Description of BMP: Protect tanks from being damaged by vehicles. Bollards or traffic barriers may be used if the tank location is accessible to vehicles. Fences and curbs may also protect the tanks.

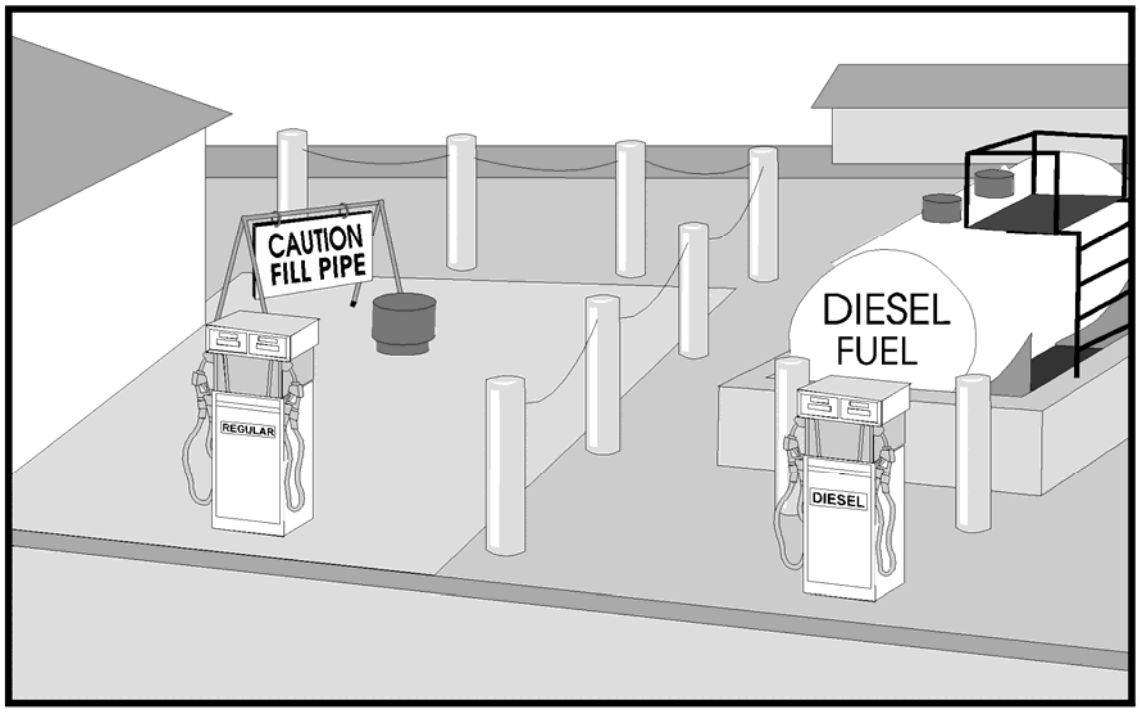
Application Guidance: Tanks will be guarded from being damaged by vehicles.

Training: N/A

Effectiveness and Cost: This is an effective, low-cost BMP.

Limitations: None

BMP 073 - PROTECT FILL PIPE FROM BEING DAMAGED BY VEHICLES



Description of Potential Pollutant and Source: If a fill pipe is damaged by a vehicle, fuel may leak from the tank and become exposed to storm water. These materials or other significant materials can then be transported to the storm drain and/or receiving waters.

Description of BMP: Protect fill pipes from being damaged by vehicles. Bollards or traffic barriers will be used if the tank location is accessible to vehicles.

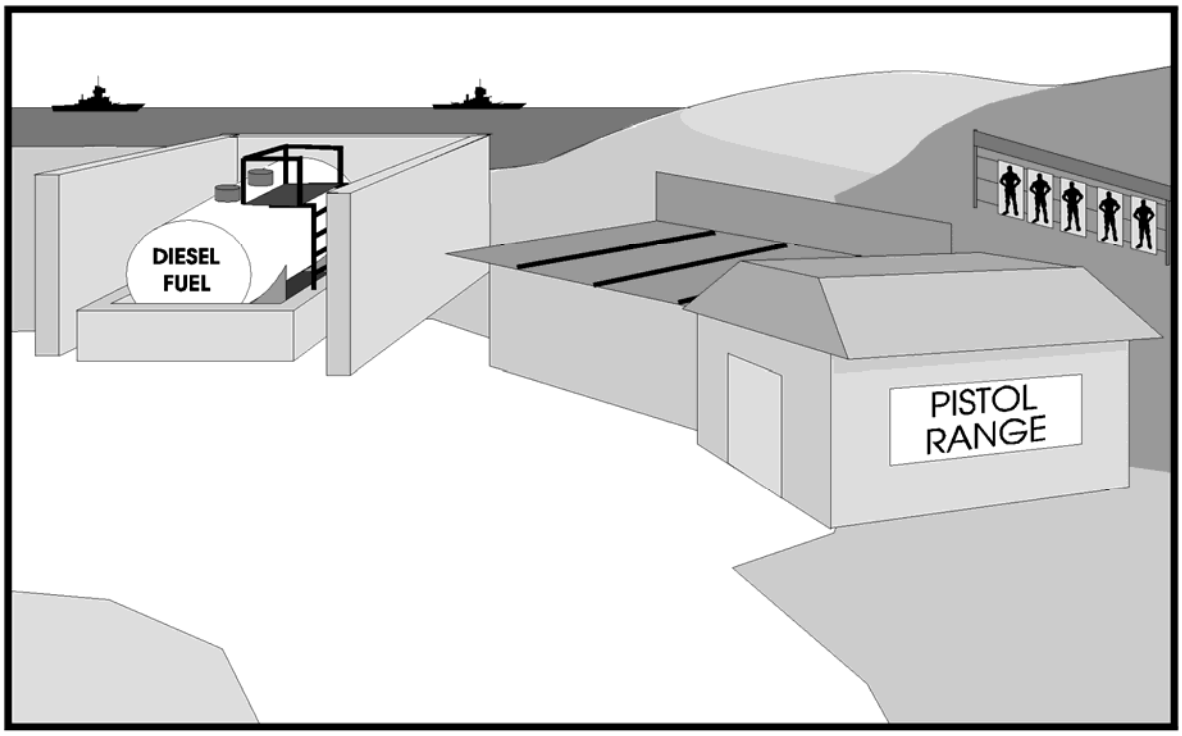
Application Guidance: Fill pipes will be guarded from damage by vehicles.

Training: N/A

Effectiveness and Cost: This is an effective, low-cost BMP.

Limitations: None

BMP 074 - PROVIDE PROTECTION FOR PERMANENT ABOVEGROUND TANKS FROM DISCHARGE OF FIREARMS



Description of Potential Pollutant and Source: Stray munitions may penetrate aboveground storage tanks, causing spills and leaks of fuel or other significant materials. These materials can be exposed to storm water and transported to the storm drain and/or receiving waters.

Description of BMP: Use concrete barriers to protect tanks when aboveground storage tanks are located in areas where firearms are discharged. The concrete will protect against damage from stray fire.

Application Guidance: This practice will be followed wherever there is any chance of firearms being discharged in the vicinity of aboveground storage tanks.

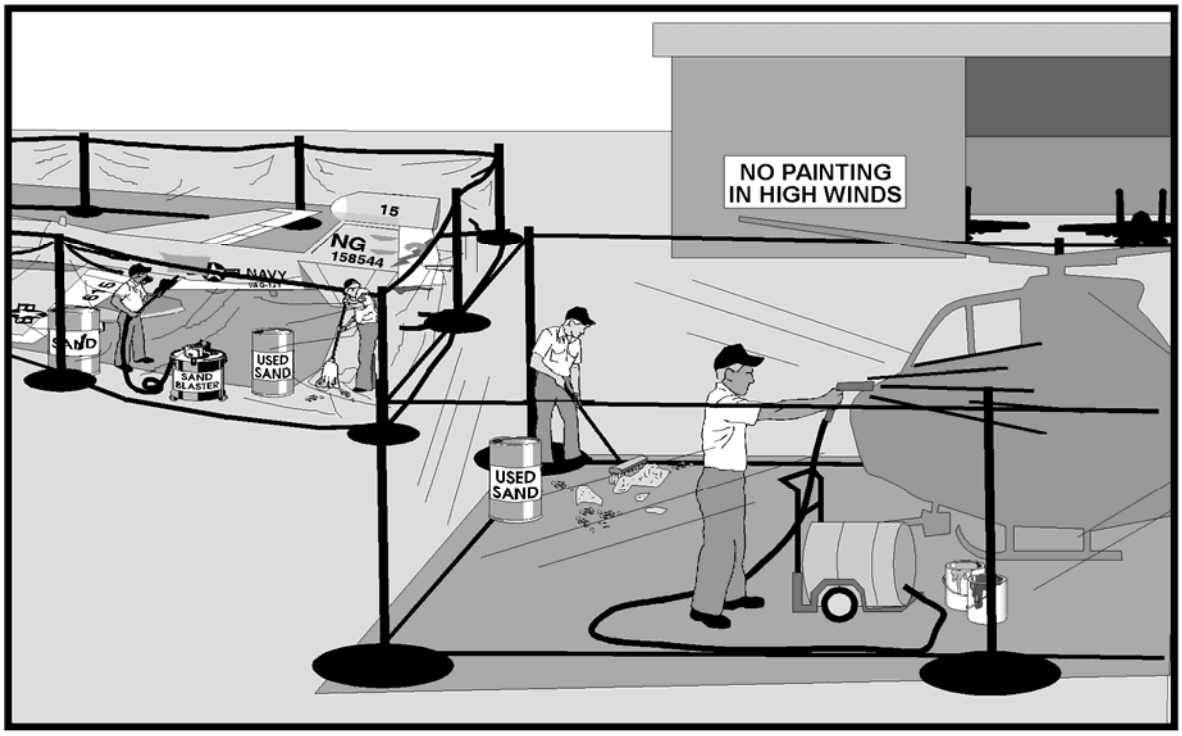
Training: N/A

Effectiveness and Cost: Concrete encapsulation is a highly effective, moderate-cost BMP.

Limitations: N/A

PLACEHOLDER

BMP 076 - ENCLOSE OUTDOOR SANDING AND PAINTING OPERATIONS AND USE TARPS TO CONTAIN AND COLLECT SOLID WASTES



Description of Potential Pollutant and Source: Sanding, in preparation for painting, and painting itself creates wastes including glass, metal, stone and other wastes that may become exposed to storm water if not properly collected and disposed. These materials can then be transported to storm drains and/or receiving waters.

Description of BMP: Contain paint-related wastes by covering all sanding and painting activities with tarps or plastic sheeting and by placing a tarp under and/or around all sanding and painting operations. These wastes will be collected in labeled drums and disposed of appropriately.

Application Guidance: This practice will be used in all sanding and painting operations performed outside of sanding or painting booths.

Training: Personnel will be instructed in procedures for the containment, collection and disposal for the control of particulates from sanding and painting; tarps will be monitored for holes. The waste will be recycled or disposed in a landfill if it is not a hazardous waste. Signs will be posted where sandblasting activities take place to remind personnel about proper disposal practices.

Effectiveness and Cost: Containment, collection and disposal of sandblasting wastes is a highly effective, usually moderate-cost BMP. However, costs for large-scale painting and sanding activities (e.g., ships and large equipment) could be high.

Limitations: The size of some operations may make implementation of this practice difficult.

BMP 077 - VACUUM PARTICULATE WASTES FROM SANDING OR PAINTING OPERATIONS

Description of Potential Pollutant and Source: Sanding, in preparation for painting, and painting itself creates wastes that may become exposed to storm water and transported to storm drains and/or receiving waters.

Description of BMP: Contain paint-related wastes by performing painting and sanding activities in facilities equipped with a vacuum and filters.

Application Guidance: This practice will be used in all sanding and painting operations.

Training: Personnel will be instructed in procedures for proper operation of vacuum and filters.

Effectiveness and Cost: Performing sanding and painting operations under vacuum is a highly effective, usually moderate-cost BMP. However, costs for large-scale sanding and painting activities (e.g., ships and large equipment) could be high.

Limitations: The size of some operations may make implementation of this practice difficult.

PLACEHOLDER

BMP 079 - CONDUCT INDOOR SANDING AND PAINTING IN AN ENCLOSED AREA

Description of Potential Pollutant and Source: Paint, sand, glass, metal or stone particles from painting, sanding and sandblasting operations can become exposed to storm water if not properly contained. These materials may then be transported to storm drains and/or receiving waters.

Description of BMP: Conduct painting, sanding, and sandblasting in an enclosed area to prevent contaminated particles from being exposed to storm water. Wastes from these operations will be disposed of appropriately.

Application Guidance: If possible, all painting, sanding and sandblasting activities will be performed indoors and preferably in an enclosed covered area.

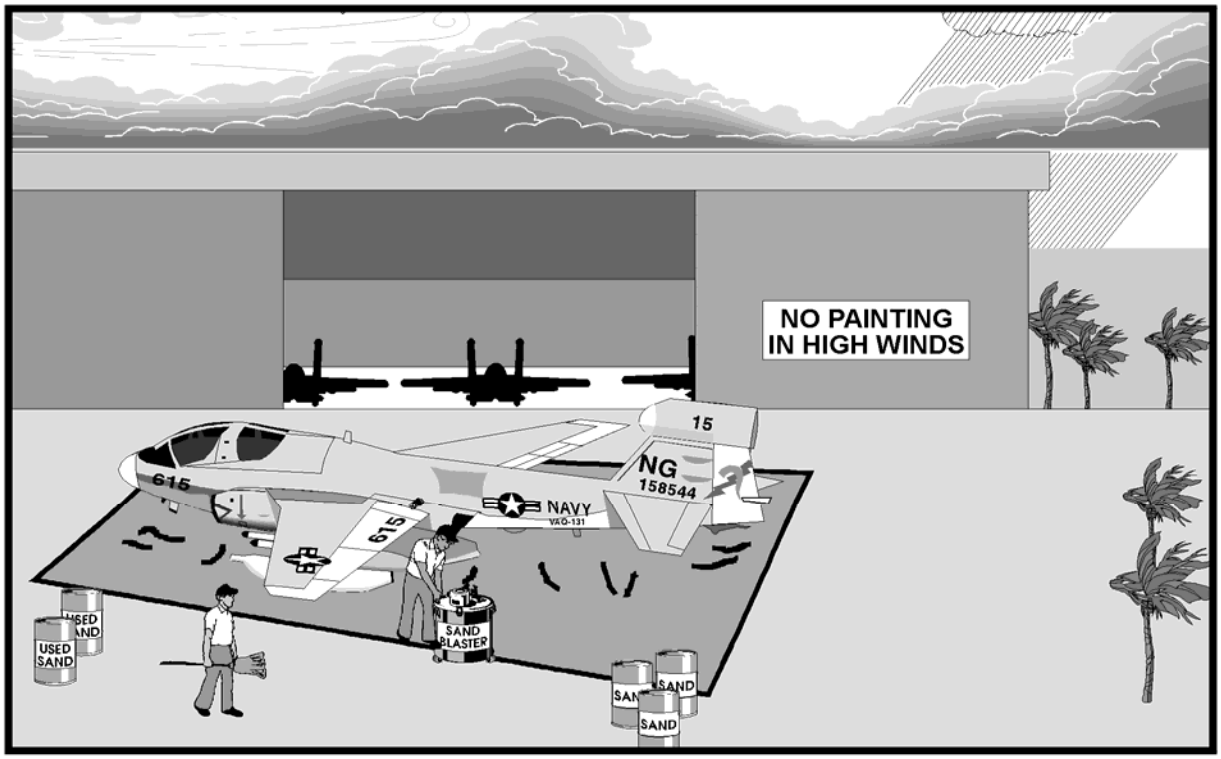
Training: Signs will also be posted to remind personnel about proper locations.

Effectiveness and Cost: Conducting painting, sanding, and sandblasting in an enclosed area is an effective, variable-cost BMP.

Limitations: The size of some activities may make implementation of this BMP difficult.

PLACEHOLDER

BMP 081- AVOID SANDING OR PAINTING IN WINDY WEATHER



Description of Potential Pollutant and Source: Sanding or painting in windy weather will cause dispersal of particulates which can expose them to storm water. These materials can then be transported to storm drains and/or receiving waters.

Description of BMP: If sanding or painting cannot be performed in an enclosed, covered area, avoid performing either operation in windy weather.

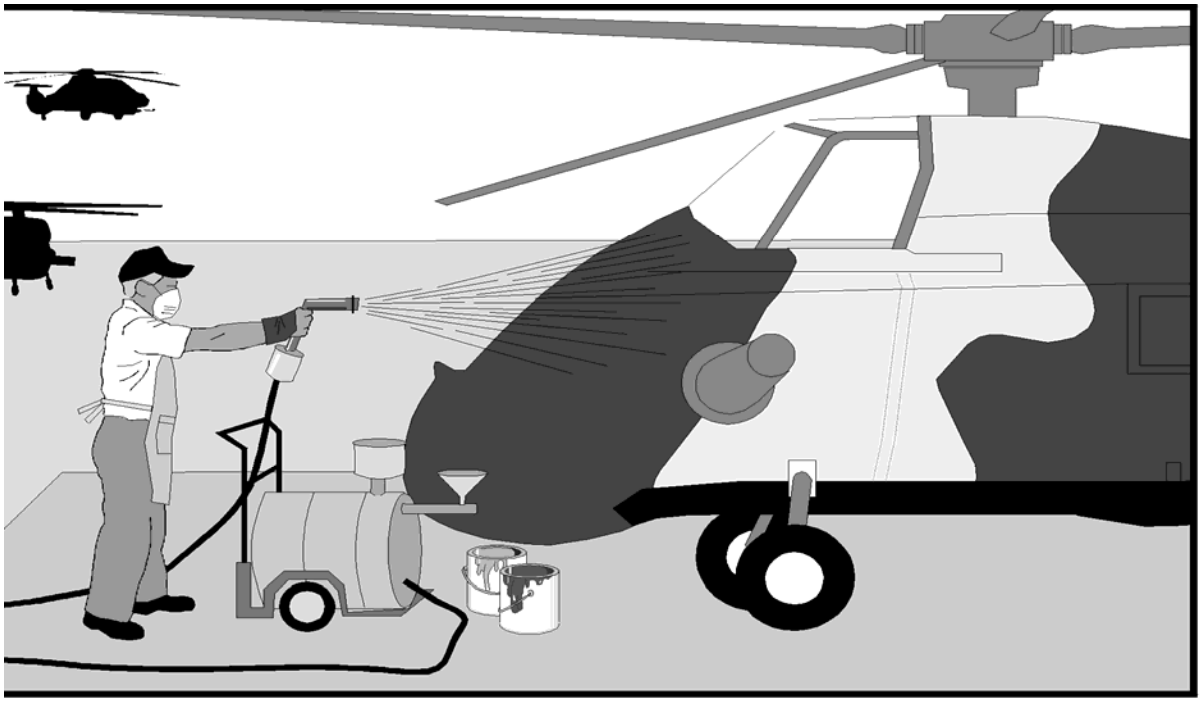
Application Guidance: This practice will be followed at all times.

Training: Personnel will be given instruction as to when it is too windy to perform sanding or painting. This information may be obtained from the equipment manufacturer.

Effectiveness and Cost: Avoiding windy weather is a moderately effective, low-cost BMP.

Limitations: May cause inconvenience.

BMP 082 - USE EFFICIENT PAINTING EQUIPMENT



Description of Potential Pollutant and Source: Traditional painting methods often result in loss of particulate matter to air and ground (paint chips, paint spray) and exposure to storm water. These materials can then be transported to storm drains and/or receiving waters.

Description of BMP: Use efficient painting equipment to reduce the amount of solid pollutants that can reach storm water. Highly efficient painting equipment is now available that reduces over spraying. More efficient equipment includes electrostatic spray guns, air-atomized spray guns, high volume/low pressure spray guns and gravity feed spray guns.

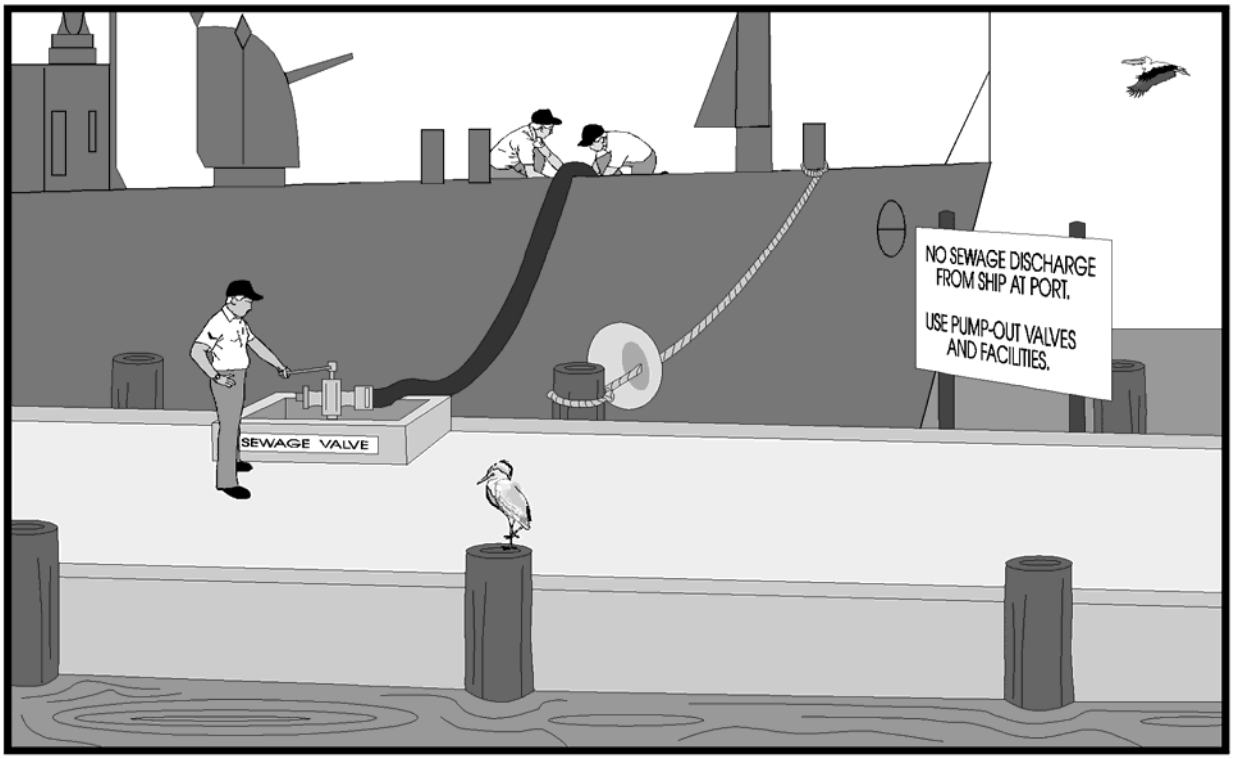
Application Guidance: All spray-painting equipment will be replaced with more efficient equipment when economically feasible.

Training: Personnel will be trained on new equipment. A qualification test may be appropriate.

Effectiveness and Cost: New spray equipment is a moderately effective, variable-cost BMP.

Limitations: Cost may be high to retrofit/replace existing equipment.

BMP 083 - DO NOT EMPTY TOILET TANKS DURING TRANSIT OR IN THE PORT



Description of Potential Pollutant and Source: Toilet holding tanks in trains, aircraft, boats and ships are often emptied directly to the environment during transport or at the port, resulting in potential viral and bacterial contamination of storm water.

Description of BMP: Do not empty toilet holding tanks during transit or into storm drains at the port. Sanitary sewage from ships or boats can be disposed using pump-out stations, portable on-site pump-outs, or commercial mobile pump-out facilities.

Application Guidance: This practice will be implemented for all aircraft, rail cars, boats and ships.

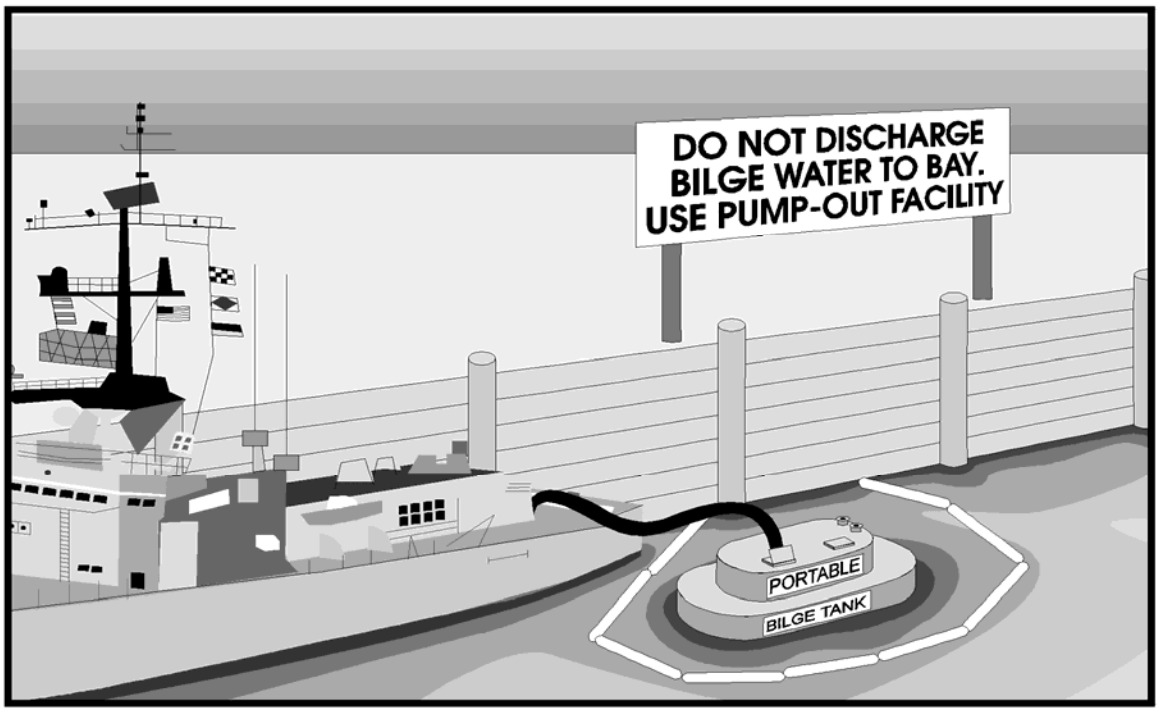
Training: Signs will be posted as reminders.

Effectiveness and Cost: This is a highly effective, low-cost BMP.

Limitations: None

PLACEHOLDER

BMP 085 - DO NOT DISCHARGE BILGE WATER IN HARBOR



Description of Potential Pollutant and Source: Bilge water (sump water collected in the ship bottom) can contain a variety of pollutants, especially oil and grease. Water from throughout the ship, including the engine room, collects in the bilge.

Description of BMP: Eliminate the discharge of bilge water in harbors to reduce the chances of oil and fuel reaching storm water. This wastewater will be pumped to wastewater treatment facilities whenever this service is available.

Application Guidance: This practice will follow for all watercraft.

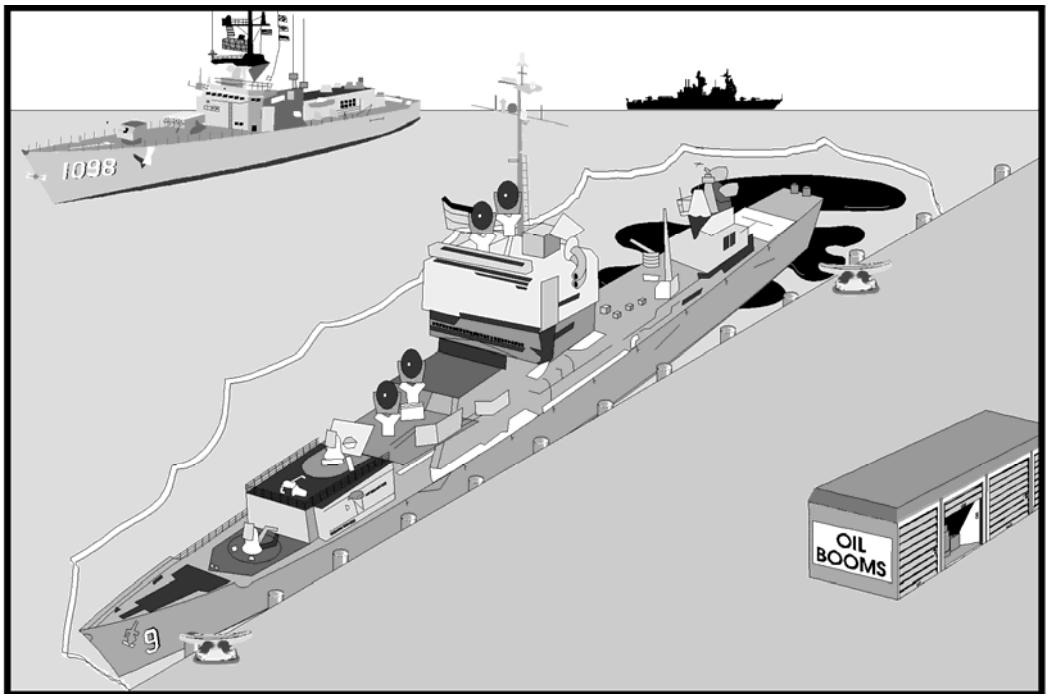
Training: Signs will be posted as reminders.

Effectiveness and Cost: This is a highly effective, variable-cost BMP.

Limitations: Sometimes discharge of bilge water in the harbor may be necessary for proper use of the ship.

PLACEHOLDER

BMP 087 - USE OIL CONTAINMENT BOOMS



Description of Potential Pollutant and Source: Maintenance of ships occurs in wet dock; maintenance may include painting, refueling and scrubbing, all of which generate potential pollutants which may become exposed to storm water and transported to receiving waters.

Description of BMP: Use oil containment booms to contain hydrocarbons that may be exposed to storm water during a ship's stay at a shipyard. Booms enable efficient cleanup of hydrocarbons. An oil containment boom is a barrier composed of a chain of floatable logs, which repel water and absorb oil and fuel.

Application Guidance: Oil containment booms will be place around ships under repair, prior to storms, while they are berthed at the shipyard.

Training: Personnel who deploy the booms will be properly trained in the use of oil containment berms.

Effectiveness and Cost: Oil containment booms are a moderately effective, moderate-cost BMP.

Limitations: None

PLACEHOLDER

BMP 092 - PROPERLY DISPOSE OF SEDIMENT GENERATED BY CLEANING SANITARY SEWER LINES

Description of Potential Pollutant and Source: The cleaning of sewer lines and manholes generates sediments. These sediments contain both inorganic and organic materials, are odorous, and are contaminated with microorganisms and heavy metals which, if improperly managed, can becomes exposed to storm water. These materials can then be transported to storm drains and/or receiving waters.

Description of BMP: Dispose of sediments generated during the cleaning of sewer lines and manholes properly. This will often require disposal in permitted landfills.

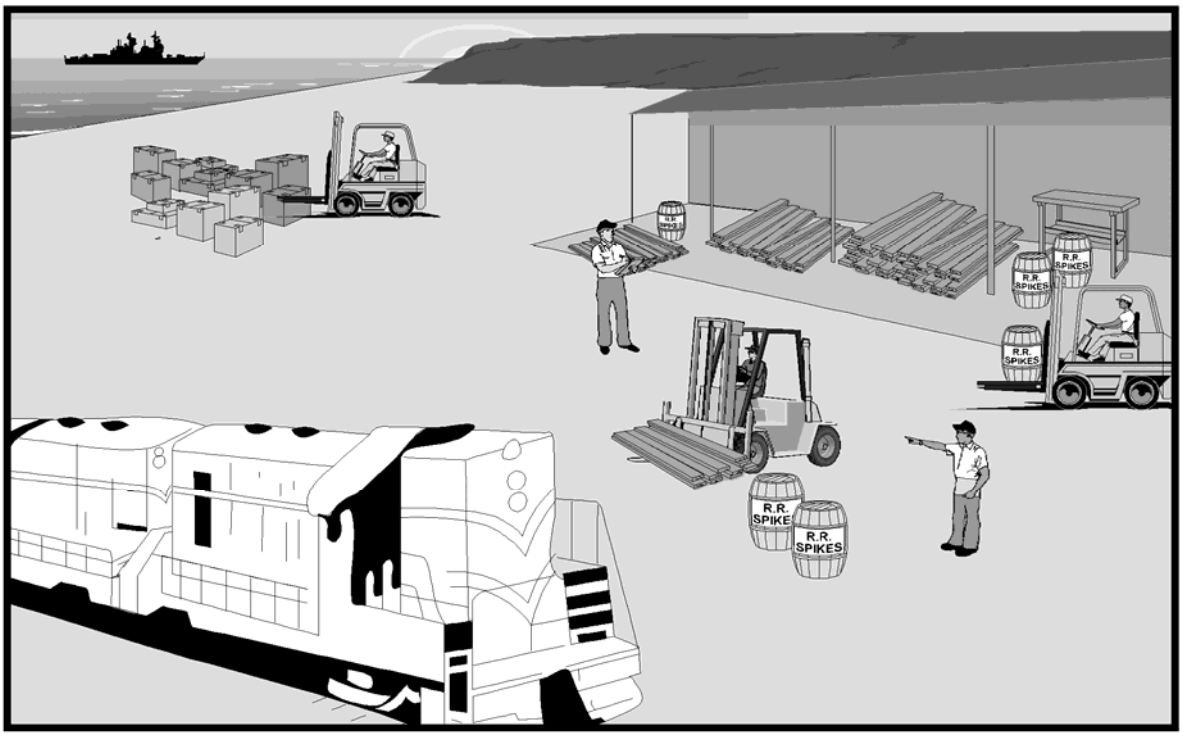
Application Guidance: This BMP will be used whenever cleaning the sewer line.

Training: Personnel will be trained regarding the proper disposal of the sediments.

Effectiveness and Cost: Properly disposing of sediments is a moderately effective, low-cost BMP.

Limitations: None

BMP 093 - ELIMINATE TREATED WOOD PRODUCTS OR USE WOOD TREATED WITH LESS-TOXIC CHEMICALS



Description of Potential Pollutant and Source: Wood products intended for outdoor use are generally coated with toxic chemicals such as creosote or pentachlorophenol, which can leach out of the wood and become exposed to storm water. These materials can then be transported to storm drains and/or receiving waters.

Description of BMP: Substitute, where feasible, alternate materials for wood products that are preserved with creosote or pentachlorophenol to the extent feasible.

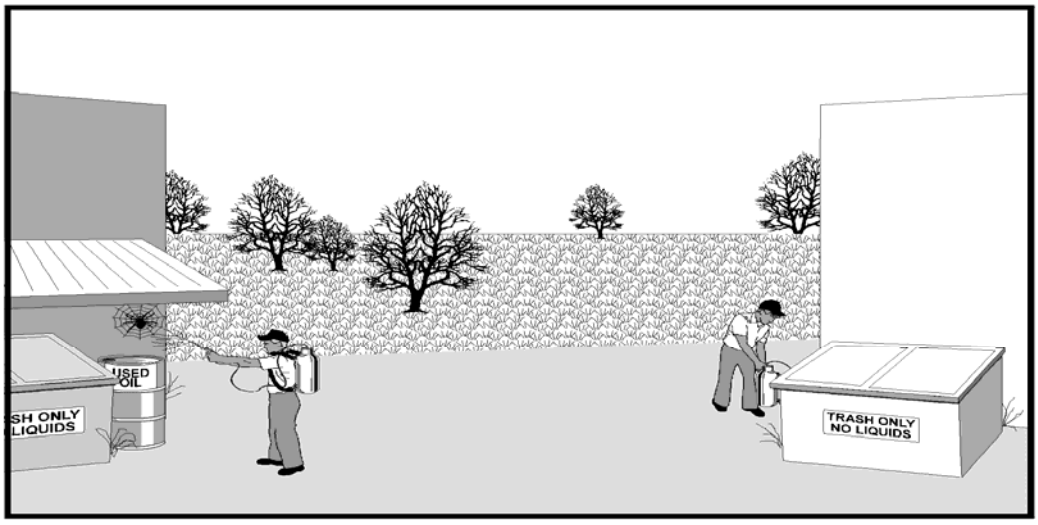
Application Guidance: This practice will be used when installing or replacing piers, railroad ties or utility poles, and other facilities using treated wood products.

Training: N/A

Effectiveness and Cost: This a moderately effective, variable-cost BMP.

Limitations: Cost may be prohibitive and acceptable alternatives may not be available.

BMP 094 - ESTABLISH INTEGRATED PEST CONTROL



Description of Potential Pollutant and Source: Pesticides and herbicides may be spilled, over-applied, and/or incorrectly applied, resulting in exposure of storm water. These materials can then be transported to the storm drain and/or receiving water.

Description of BMP: Establish integrated pest management control. This involves eliminating excessive pesticide use by proper application procedures and/or the use of alternatives. This reduces the amount of pesticides which can potentially enter the storm water. Pesticides include insecticides, herbicides, fungicides and rodenticides.

The use of pesticides for insect and weed control will be minimized by the following:

- Mechanical removal of weeds, eggs, larvae, cocoons and insects
- Habitat changes to minimize pest insect breeding
- Timing of application to the most vulnerable phase of the pest insect breeding
- Concentration of effort on the most affected areas
- Use of natural predators and pathogens specific to pests
- Use of degradable and non-carcinogenic pesticides

Additionally, no pesticides will be applied within three days prior to any predicted rain event. During the wet season, pesticide application will be kept to a minimum.

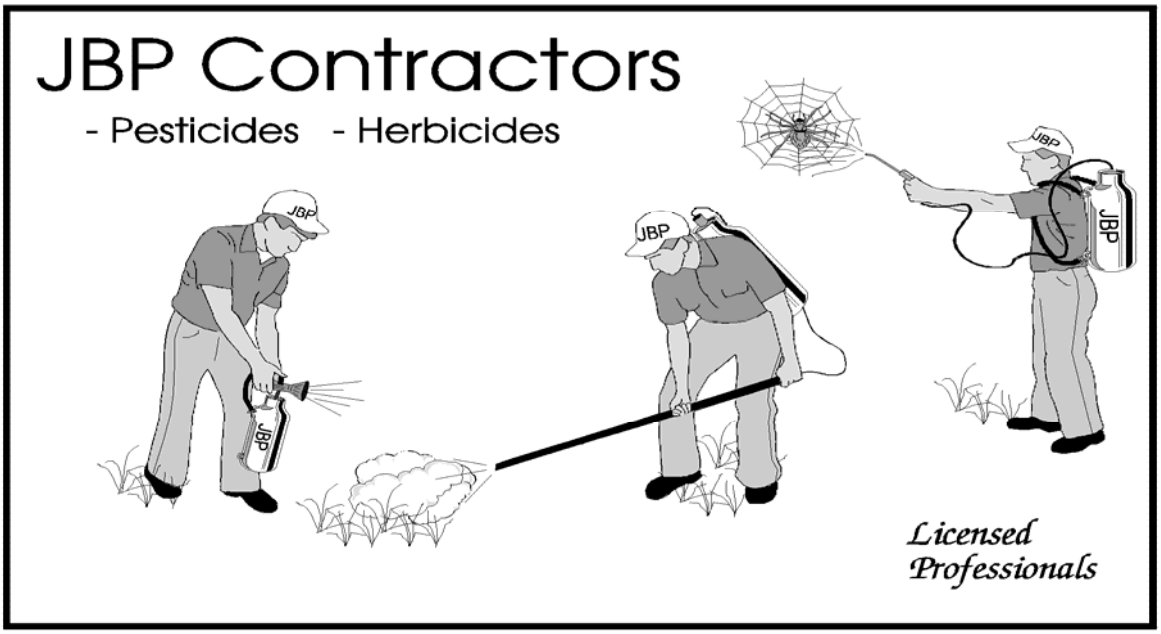
Application Guidance: Injury and tolerance levels will be used to determine if the pest problem is serious enough to justify some kind of treatment. Whenever pest control is necessary, an integrated management plan will be developed.

Training: All persons applying pesticides will be required to understand the pertinent provisions of the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) and state laws and regulations and be certified, if required.

Effectiveness and Cost: Effectiveness and cost will depend on whether natural or pesticide controls are used. This BMP can be highly effective and low cost when properly developed.

Limitations: None

BMP 095 - CONDUCT PESTICIDE OPERATIONS UNDER THE SUPERVISION OF LICENSED APPLICATOR



Description of Potential Pollutant and Source: Pesticides and herbicides may be spilled, over applied, or incorrectly applied, which would result in their exposure to storm water. These materials can then be transported to the storm drain and/or receiving waters.

Description of BMP: Use a licensed pesticide handler to conduct or supervise all activities related to pesticide handling.

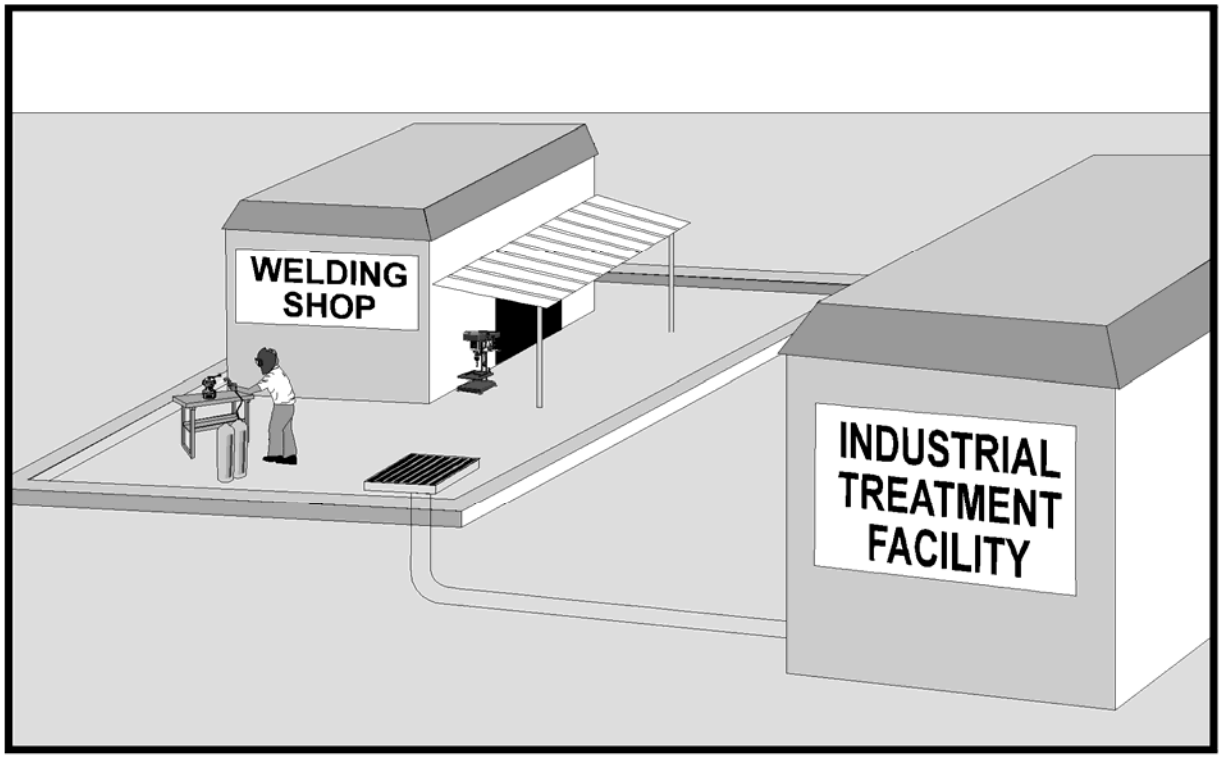
Application Guidance: This BMP will be applied whenever pesticides are used or stored.

Training: Personnel will be trained and certified in the application, mixing, and storage of pesticides.

Effectiveness and Cost: This is a moderately effective, moderate-cost BMP.

Limitations: None

BMP 096 - DIVERT DRAINAGE TO TREATMENT FACILITY/SANITARY SEWER



Description of Potential Pollutant and Source: Diverting drainage to treatment facilities prevents significant materials from entering the storm drain system.

Description of BMP: Use pipes, ditches, swales and other types of conveyance systems to divert drainage from industrial areas which may be exposed to significant materials to a wastewater treatment facility or sanitary sewer.

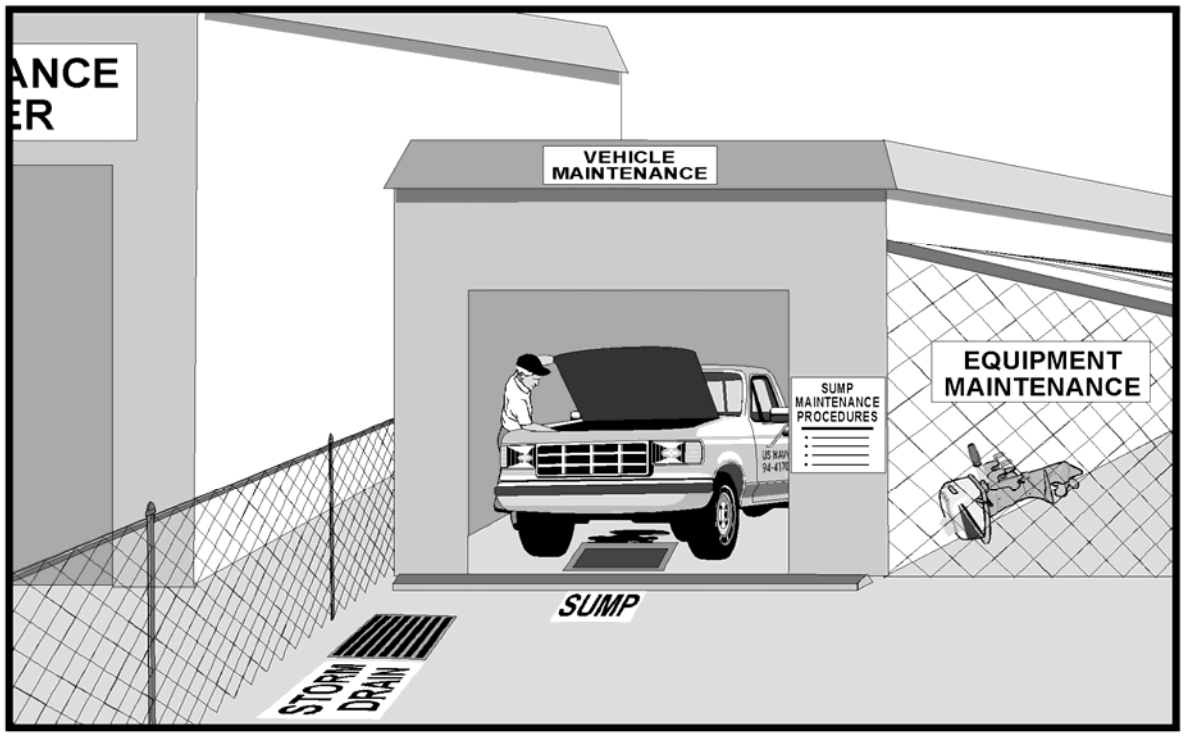
Application Guidance: If source controls cannot be used to keep pollutants from entering the storm water runoff, diverting drainage to treatment facilities/sanitary sewers is the most effective method or reducing pollutants to receiving waters.

Discharge of large quantities of storm water is not practical or allowed by most wastewater treatment facilities. This BMP will only be used for small quantities of highly polluted water. This may include equipment or vehicle wash water, boiler blowdown, or runoff from maintenance areas (with no off-site drainage onto area).

Effectiveness and Cost: Diverting drainage from industrial areas is a highly effective, high-cost BMP. The initial construction cost of a connection to a sanitary sewer may not be high, if a sewer is located nearby. However, the continuing operating cost of the treatment facility which will treat the diverted drainage makes this a high-cost BMP.

Limitations: Permission must be granted by the wastewater treatment facility to divert the drainage to the facility. In addition, certain pollutants in the runoff may not be removed at a traditional treatment facility. This BMP is not feasible if there is a large quantity of runoff that must be controlled.

BMP 097- DIVERT DRAINAGE TO A LOW-FLOW SUMP



Description of Potential Pollutants and Source: Often spills flow directly into the storm drain system. Once the spilled material combines with the runoff in the storm drain, the pollutant concentrations can only be reduced with a structural control such an oil/water separator, wet pond or filtration basin.

Description of BMP: Divert drainage to a low-flow sump to collect small spills and prevent the spilled material from discharging into the rest of the storm drain system.

Application Guidance: Low-flow sumps will be used in areas where discharge into the storm drain system and spills are likely to occur. This may occur at refueling locations, material loading/unloading areas, and maintenance areas.

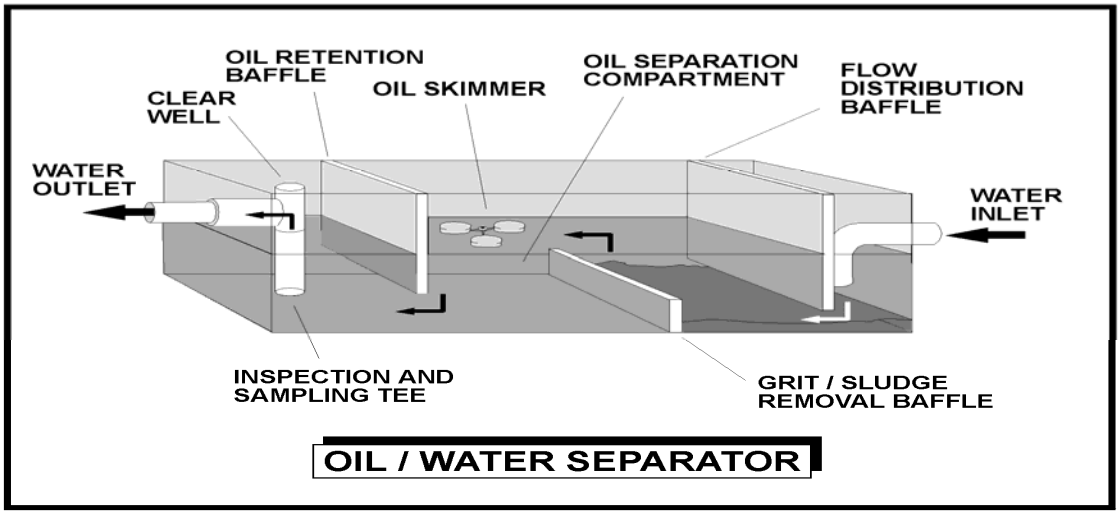
Operation and Maintenance: Low-flow sumps will be cleaned at least four times a year and after any major spill. Materials trapped in the sump will be properly disposed. The frequency of implementation of this BMP has been suggested as general guidance. However, a facility operator may wish to establish a frequency more suitable to the facility. This will require a level of judgement on behalf of the SWPCP implementors. To assign a frequency other than what has been suggested (i.e., more or less frequent), the following criteria should be considered and rated either High, Medium or Low. If many of the criteria are assigned a High rating, consider increasing the frequency. Similarly, if many criteria are assigned a Low rating consider decreasing the frequency. However, it is essential to remember that the goal of this BMP is minimize exposure of pollutants to storm water.

CRITERIA	RATING H=High M=Medium L=Low
Probability of exposure/spills of significant materials to storm water	
Quantity of significant materials potentially exposed	
Frequency of use of significant materials potentially exposed	
Frequency of use of fueling pumps, loading/unloading areas, or maintenance areas	
Old age of poor condition of sump and pump	
Evidence of exposure (e.g., stains on pavement, etching of concrete, evidence of significant materials in drainage system)	
Proximity of source area to outfall or receiving water	
Sensitivity of receiving water to potentially exposed significant materials (e.g., waters with beneficial uses such as human contact, recreation, significant species habitat, etc.)	

Effectiveness and Cost: This BMP is highly effective for small leaks and spills. It is not effective for large spills or leaks. This is a moderate-cost BMP.

Limitations: The sediment removed during maintenance must be tested and may be a hazardous waste and must be disposed of properly.

BMP 098 - CONSTRUCT OIL/WATER SEPARATOR



Description of Potential Pollutants and Source: Oil/water separators are designed to remove petroleum compounds and grease from storm water. Separators will also remove floatable debris and settleable solids.

Description of BMP: Construct oil/water separators. Oil/water separators are underground vaults where storm water is piped in and out of the separator. Oil/water separators come in many configurations. A common configuration is the tree-chamber oil/water separator. The first chamber is the sedimentation chamber that allows for sedimentation of coarse materials and screening of debris. The second chamber provides separation of oil, grease and gasoline. The third chamber is provided to prevent any possibility of a surcharge pressure from occurring and as a safety relief for the structure if a blockage occurs.

Application Guidance: Oil/water separators are applicable to situations where the concentrations of oil-and-grease-related compounds will be usually high and source control cannot provide effective control. This generally occurs at equipment maintenance and washing facilities, gas stations and loading areas. Separators may also be used in areas heavily used by mobile equipment such as loading wharfs at marine ports.

Operation and Maintenance: The degree and frequency of maintenance significantly affects the performance of the oil/water separator. Cleaning the oil/water separator will prevent the accumulated debris and oil to be discharged from the structure during intense storms.

Oil/water separators will be checked monthly during the wet season and will be cleaned at least four times a year. They will always be cleaned in October, before the start of the wet season. The accumulated oil will be properly disposed.

The frequency for implementing this BMP has been provided as general guidance. However, a facility operator may wish to establish a more suitable frequency. This will require SWPCP implementors to make judgements based on facility operations and conditions. To assign a frequency other than what has been suggested (i.e., more or less frequent), the following criteria will be considered and rated either High, Medium or Low. If many of the criteria are assigned a High rating, the frequency may be increased. Similarly, if many criteria are assigned a Low rating, The frequency may be decreased. The goal of implementing this BMP is to minimize exposure of pollutants to storm water.

CRITERIA	RATING H=High M=Medium L=Low
Probability of exposure of significant materials to storm water in area draining to oil/water separator	
Quantity of significant materials potentially exposed in area draining to oil/water separator	
Frequency of use of significant materials potentially exposed in area draining to oil/water separator	
Evidence of exposure (e.g., stains on pavement, etching of concrete) in area draining to oil/water separator	
Proximity of source are to outfall or receiving- water	
Sensitivity of receiving water to potentially exposed significant material (e.g., waters with beneficial uses such as human contact, recreation, significant species habitat, etc.)	

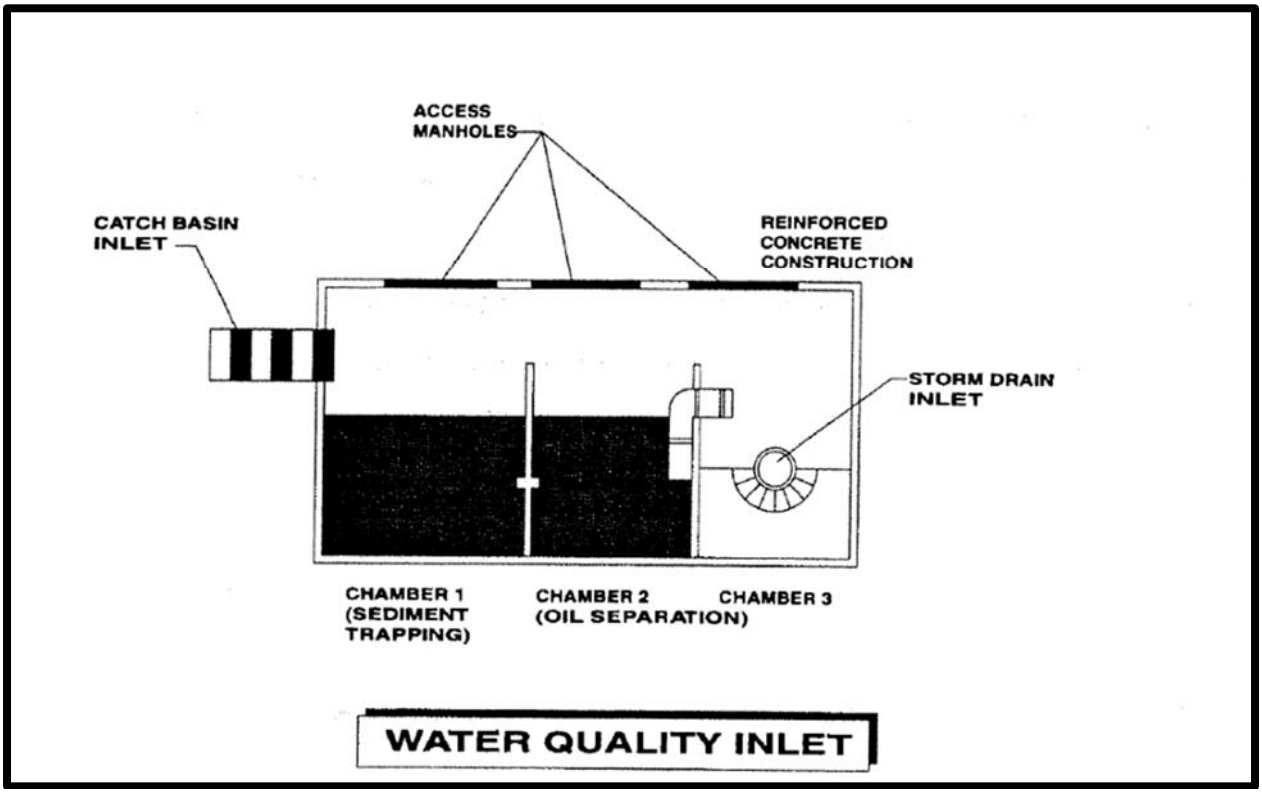
Effectiveness and Cost: This is a moderately effective, high-cost BMP.

Limitations: Oil/water separators are less effective when storm water runoff has high sediment concentrations or detergent levels which disperse oil.

Oil/water separators are only effective for highly pervious drainage areas. Oil/water separators cannot effectively treat large volumes of runoff. The maximum drainage area to oil/water separators is typically one acre.

The sediment removed during maintenance will be tested. If it is a hazardous waste, it will be disposed of accordingly.

BMP 099 - CONSTRUCT WATER QUALITY INLET-CATCH BASIN



Description of Potential Pollutant and Source: Water quality inlet-catch basins provide some removal of settleable solids.

Description of BMP: Construct water quality inlet-catch basins. These are storm drain inlet structures equipped with a small sedimentation basin or grit chamber with a capacity usually ranging from 0.5 to 1.5 cubic yards.

Application Guidance: Water quality inlet-catch basins will be used to remove large particles from storm water in highly impervious areas that have limited space for other storm water management practices. However, when space and costs allow, an oil/water separator will be used instead.

Operation and Maintenance: Accumulated sediment at the bottom of a water quality inlet-catch basin will be removed, or else it can be re-suspended during a storm and actually increase the pollutant load from an individual storm. Water quality inlet-catch basins will be cleaned at least four times a year. One of the cleanings will be just prior to the rainy season.

The frequency for implementing of the BMP has been provided as general guidance. However, a facility operator may wish to establish a more suitable frequency. This will require SWPCP implementors to make judgements based on facility operations and conditions. To assign frequencies other that what has been suggested (i.e., more or less frequent), the following criteria will be considered and rated either High, Medium or Low. If many of the criteria are assigned a High rating, the frequency may be increased. Similarly, if many criteria are assigned a Low rating, the frequency may be decreased. The goal of implementing this BMP is minimize exposure of pollutants to storm water.

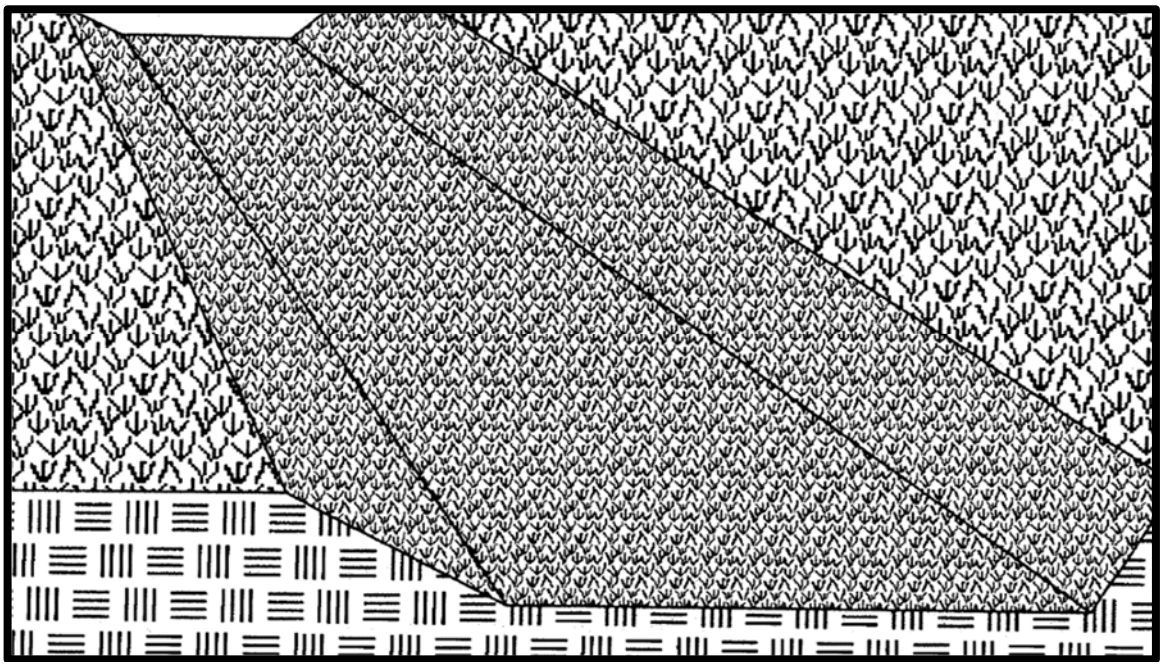
CRITERIA	RATING H=High M=Medium L=Low
Probability of exposure of significant materials to storm water in area draining to water quality inlet	
Quantity of significant materials potentially exposed in area draining to water quality inlet	
Frequency of use of significant materials potentially exposed in area draining to water quality inlet	
Evidence of exposure (e.g., stains on pavement, etching of concrete) in area draining to water quality inlet	
Proximity of source area to outfall or receiving water	
Sensitivity of receiving water to potentially exposed significant materials (e.g., waters with beneficial uses such as human contact, recreation, significant species habitat, etc.)	

Effectiveness and Cost: Water quality inlet-catch basins are somewhat effective in trapping large particles and debris but ineffective in the removal of other pollutants. The average cost of water quality inlet-catch basins are similar to those for standard pre-cast inlets.

Limitations: Water quality inlet-catch basins must be frequently cleaned out in order to provide any pollutant removal. Water quality inlet-catch basins provide little pollutant removal.

The sediment removed during maintenance will be tested. If it is a hazardous waste, it will be properly disposed.

BMP 100 - USE GRASSED SWALES



Description of Potential Pollutant and Source: While concrete storm drains are highly efficient in transporting storm water, they also transport pollutants. However, when grassed swales are used to transport storm water the vegetation helps remove pollutants (by trapping particulates), slows flow velocities, and enhances infiltration,

Description of BMP: Use grassed swales. These are vegetated channels which have a small gradient. To effectively remove pollutants, the swales will have relatively small slope, adequate length, and be planted with erosion-resistant vegetation.

Application Guidance: Swales will replace curb and butter and storm sewer systems where the topography and volume of flow are appropriate and where the vegetation can be maintained. Swales are not feasible on steep slopes or very flat areas.

Operation and Maintenance: Maintenance requirements are basically the same as normal lawn activities such as mowing, watering, spot reseeding, and weed control. However, maintenance of swales can cause water quality problems by mowing too close to the ground or by excessive application of fertilizers.

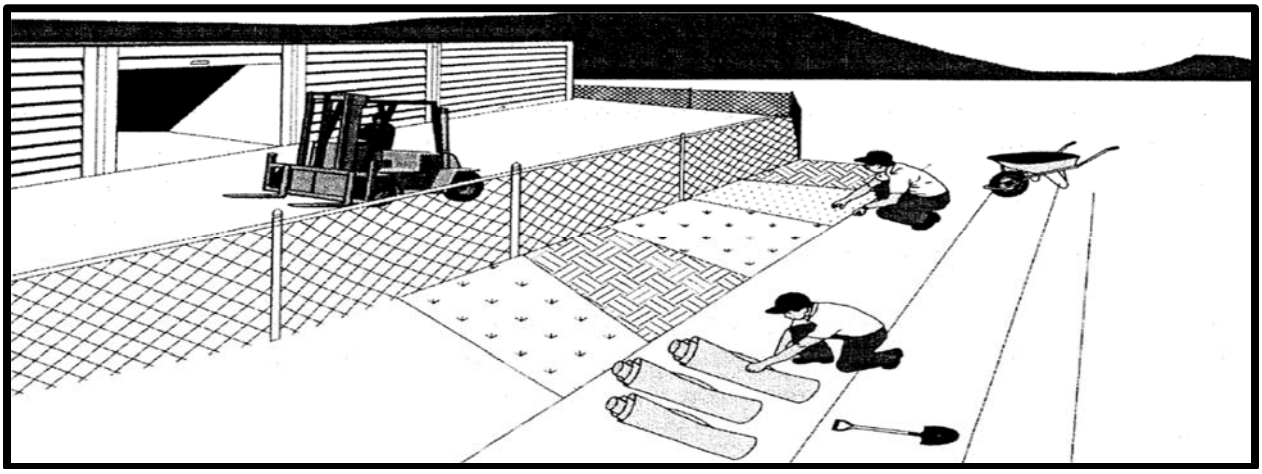
Effectiveness and Cost: Because swales do not have high pollutant removal rates, they are typically used as part of a storm water management system. Properly designed and functioning grassed swales provide some pollutant removal; however, the removal rates are low. In general, swales are not effective in removing soluble pollutants.

Grassed swales are moderately expensive.V

Limitations: This BMP should not be used by itself because pollutant removal rates are low. Grassed swales typically cannot be used on highly impervious sites. Grassed swales are not effective on steep slopes or for short distances.

This BMP may be limited to areas with a constant source of water, depending on the type of vegetation planted.

BMP 101 - PROVIDE VEGETATIVE FILTER STRIPS



Description of Potential Pollutant and Source: Vegetative filter strips are typically located adjacent to a waterway, pollution source area, or property line.

Description of BMP: Provide vegetative filter strips. These are strips of vegetation designed to remove particulates from overland sheet flow. They may be grassed (seeded or sodded), or meadow, or other woodier vegetation. Runoff must be evenly distributed across the filter strip. If the water concentrates and forms a channel, the filter strip will not perform properly. Level spreading devices are often used to distribute the runoff evenly across the strip. A vegetative filter strip is typically twenty-five to three hundred feet long in the direction of flow.

Application Guidance: Vegetative filter strips will be used in areas with low to moderate pollutant concentrations in the runoff. Vegetative filter strips will not be used if the runoff is concentrated, such as in a swale or pipe.

Operation and Maintenance: Maintenance requirements for vegetative filter strips are low. the strips will be inspected frequently the first few months after construction and then annually to make sure a dense, vigorous vegetation is established and the flow does not concentrate.

If natural vegetative succession is allowed to proceed, little other maintenance is required. Natural succession typically enhances pollutant removal and includes the transformation of grass to meadow to second growth forest. Short strips are typically maintained as lawns and must be mowed two to three times a year to suppress weeds and to interrupt natural succession. Accumulated sediment must periodically be removed near the top the strip.

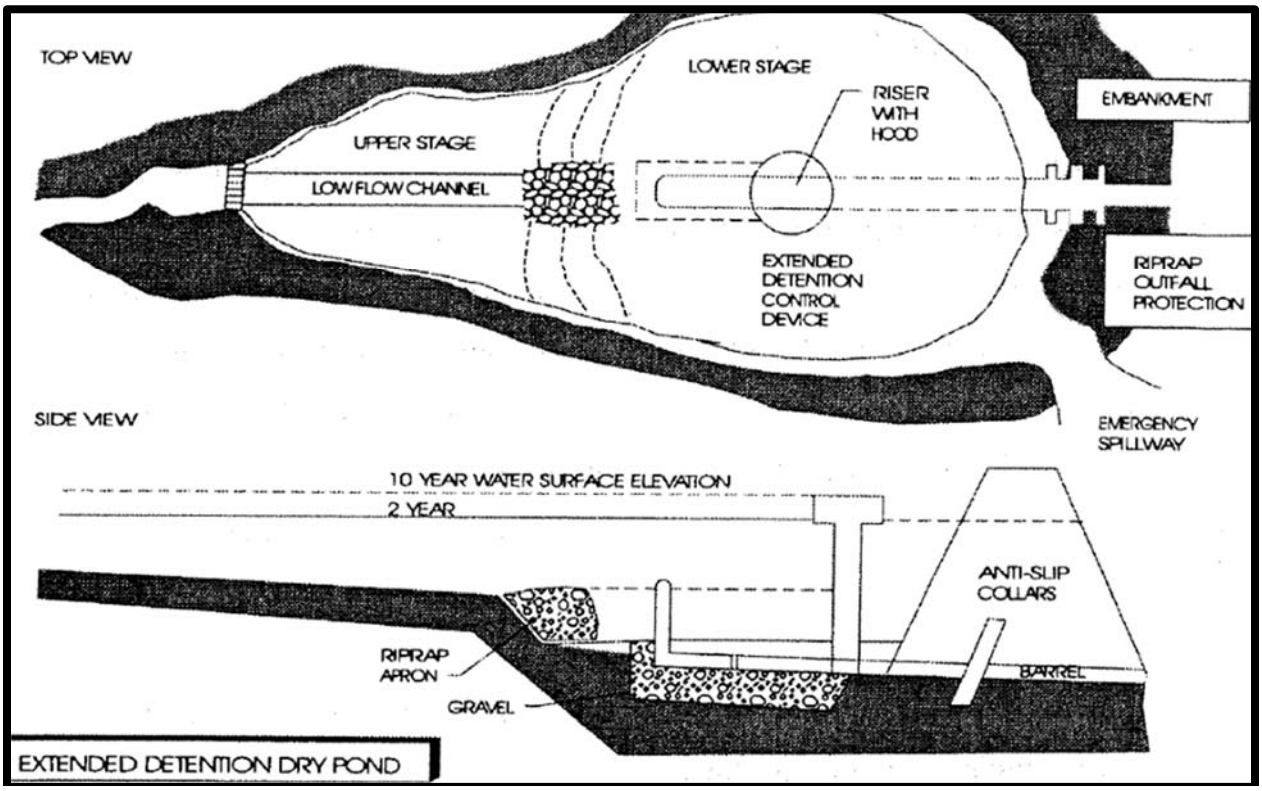
Effectiveness and Cost: Properly designed and functioning vegetative filter strips effectively remove particulates such as sediment, organic matter and may trace metals. Removal of soluble pollutants is not very effective. Forested filter strips appear to be more effective than grassed strips, but a longer length is required for optimal removal rates.

The cost of vegetative filter strips is dependent on the type of vegetation. If the natural vegetation is maintained, the cost is moderate.

Limitations: Vegetative filter strips should not be used if the storm water runoff concentrates. They may not be feasible in areas with limited space.

This BMP may be limited to areas with a constant source of water, depending on the type of vegetation planted.

BMP 102 - CONSTRUCT EXTENDED-DETENTION DRY PONDS



Description of Potential Pollutant and Source: Extended-detention dry ponds may be appropriate for large sites (over approximately five acres) where sources of pollution are dispersed and cannot be adequately controlled by source control BMPs.

Description of BMP: Construct extended-detention dry ponds. These are basins typically composed of stages: an upper stage which remains dry except for larger storms and a lower stage which is designed for typical storms. The pond's outlet structure is typically sized for water to be detained at least twelve hours, but fully drained within seventy-two hours.

Application Guidance: There must be an undeveloped area available to construct an extended-detention dry pond. At the proposed pond location, there will not be shallow (less than approximately two feet) groundwater or rock. If the soils are permeable, an infiltration basin will be constructed instead.

Extended-detention dry ponds are a practical means of retrofitting dry ponds to obtain water quality benefits. Until recently, dry ponds were often built to provide flood control, but they did not provide water quality benefits.

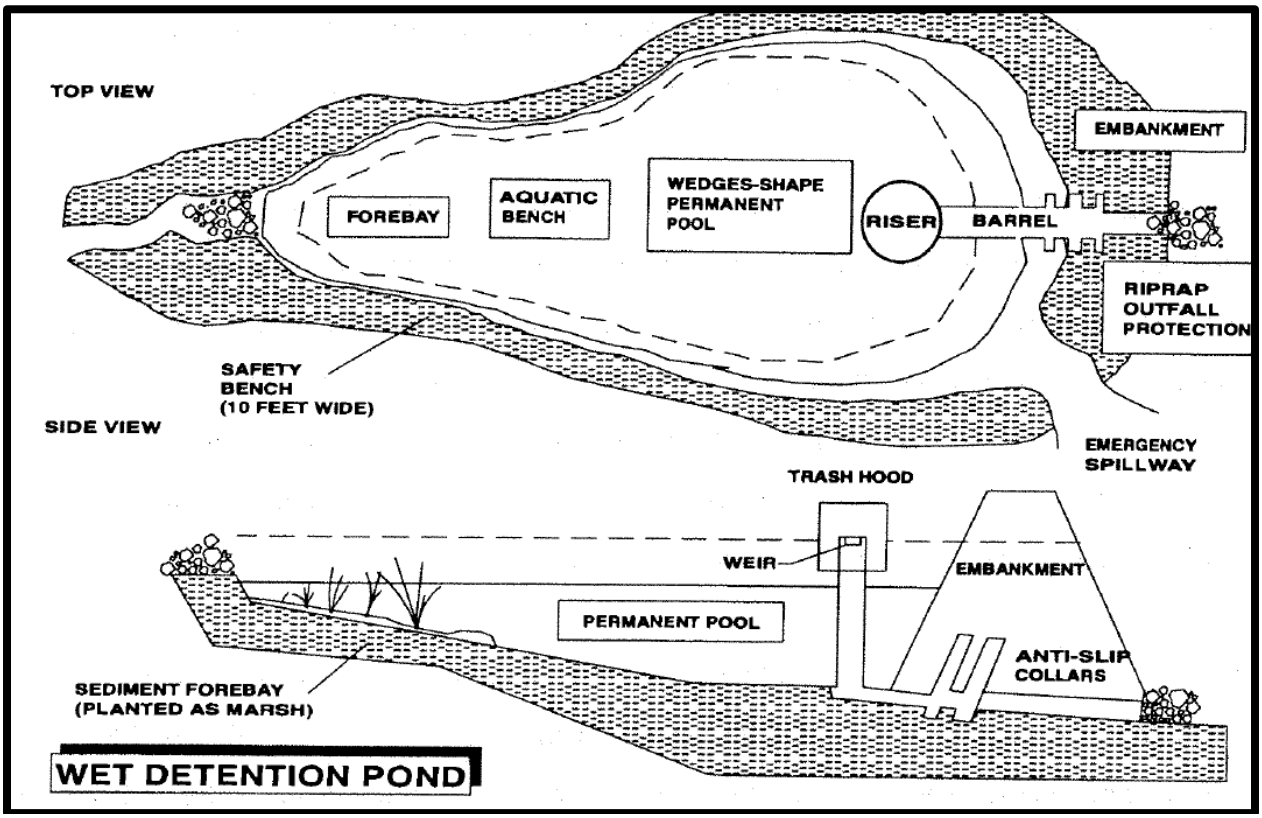
Operation and Maintenance: Routine maintenance includes mowing, debris/litter removal, inlet and outlet maintenance and inspection. In addition, nuisance control may be necessary for odors and mosquito problems that are caused by occasional standing water and soggy conditions within the lower stage of an extended detention pond. Non-routine maintenance includes sediment removal. Sediment removal for extended-detention dry ponds is typically recommended every five to ten years with more frequent spot removals around the outlet control device. The sediment removed during maintenance must be tested; if it is a hazardous waste, it must be properly disposed.

Effectiveness and Cost: The pollutant removal rates for suspended pollutants is moderate. The removal rates for soluble pollutants are low.

This is a relatively high-cost BMP. The cost of these ponds is directly related to the area draining to it. In addition, if the bedrock layer is close to the surface, high excavation costs may make extended-detention dry ponds impractical.

Limitations: Extended-detention dry ponds can breed mosquitoes and create undesirable odors if not adequately maintained. Space constraints often limit the use of extended dry ponds.

BMP 103 - CONSTRUCT WET DETENTION PONDS



Description of Potential Pollutant and Source: Wet detention ponds may be appropriate for large sites (over approximately ten acres) where sources of pollution are dispersed and cannot be adequately controlled by source control BMPs.

Description of BMP: Construct wet detention ponds. These are basins designed to maintain a permanent pool of water and temporarily store storm water runoff until it is released from the structure at flow rates less than predevelopment rates. Wet ponds may include extended detention which stores storm water for an extended period of time.

Application Guidance: There must be an undeveloped area available to construct a wet detention pond. Wet ponds typically require more than twice as much space as extended-detention dry ponds. Wet ponds will only be used in areas with a constant base flow of water or where an alternative source of water is available such as an irrigation water line. Pond liners are required if the native soils are permeable or if there is fractured bedrock. If the bedrock layer is close to the surface, high excavation costs may make the wet pond impractical. Wet ponds are not typically used in heavily urbanized areas because of space constraints.

Operation and Maintenance: Wet ponds require routine maintenance, similar to extended-detention dry ponds. These ponds can be expected to lose approximately one percent of their runoff storage capacity per year due to sediment accumulation. The sediments accumulate out of sight, under the permanent pool. Wet ponds require less frequent sediment removal compared to extended-detention dry ponds. The recommended sediment clean-out cycle is about every ten to twenty years. The sediment removed during maintenance must be tested; if it is a hazardous waste, it must be properly disposed.

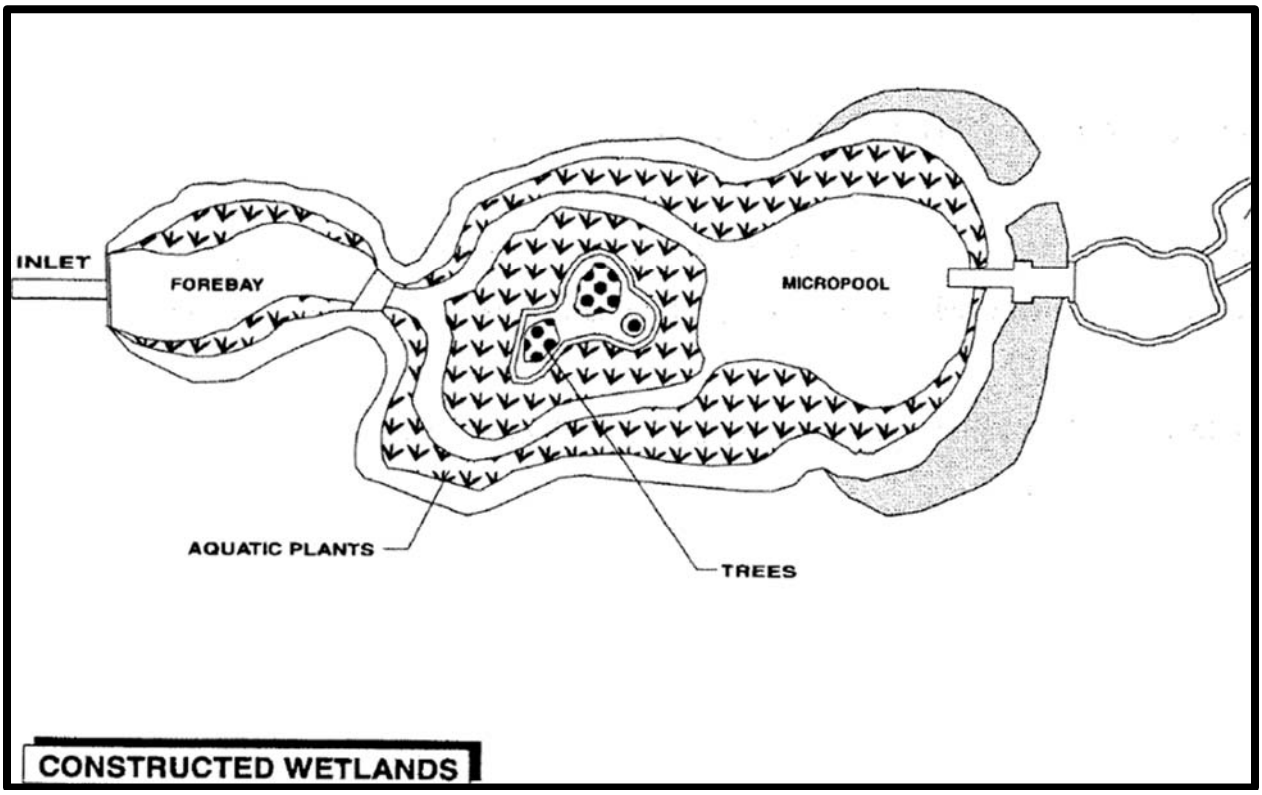
Effectiveness and Cost: Wet Pond pollutant removal efficiency depends on its shape and size. The larger

the wet pond is, the greater the removal efficiency. This is a high-cost BMP. The cost of wet ponds is directly related to the area draining to it. In addition, if the bedrock layer is close to the surface, the cost may increase exponentially.

Limitations: If poorly located, a wet pond can cause sediment and groundwater contamination, have poor water quality, and support degraded habitat. Wet ponds require large areas of land which limits their use in densely urbanized areas with expensive land. A base flow or supplemental water source is needed to maintain a wet pond's water level.

If wetlands are established as a result of the wet pond construction, the maintenance of the pond may be restricted by wetland regulations.

BMP 104 - PROVIDE CONSTRUCTED WETLANDS



Description of Potential Pollutant and Source: Constructed wetlands may be appropriate for large sites (over approximately five acres) where sources of pollution are dispersed and cannot be adequately controlled by source control BMPs.

Description of BMP: Provide constructed wetlands. These are newly created shallow marsh wetlands that are specifically designed to provide urban runoff control.

Application Guidance: Constructed wetlands are typically used for drainage areas greater that five areas. there must be a large undeveloped area available to construct wetlands. Wetlands typically require one percent of the total drainage area and require more space than any other BMP.

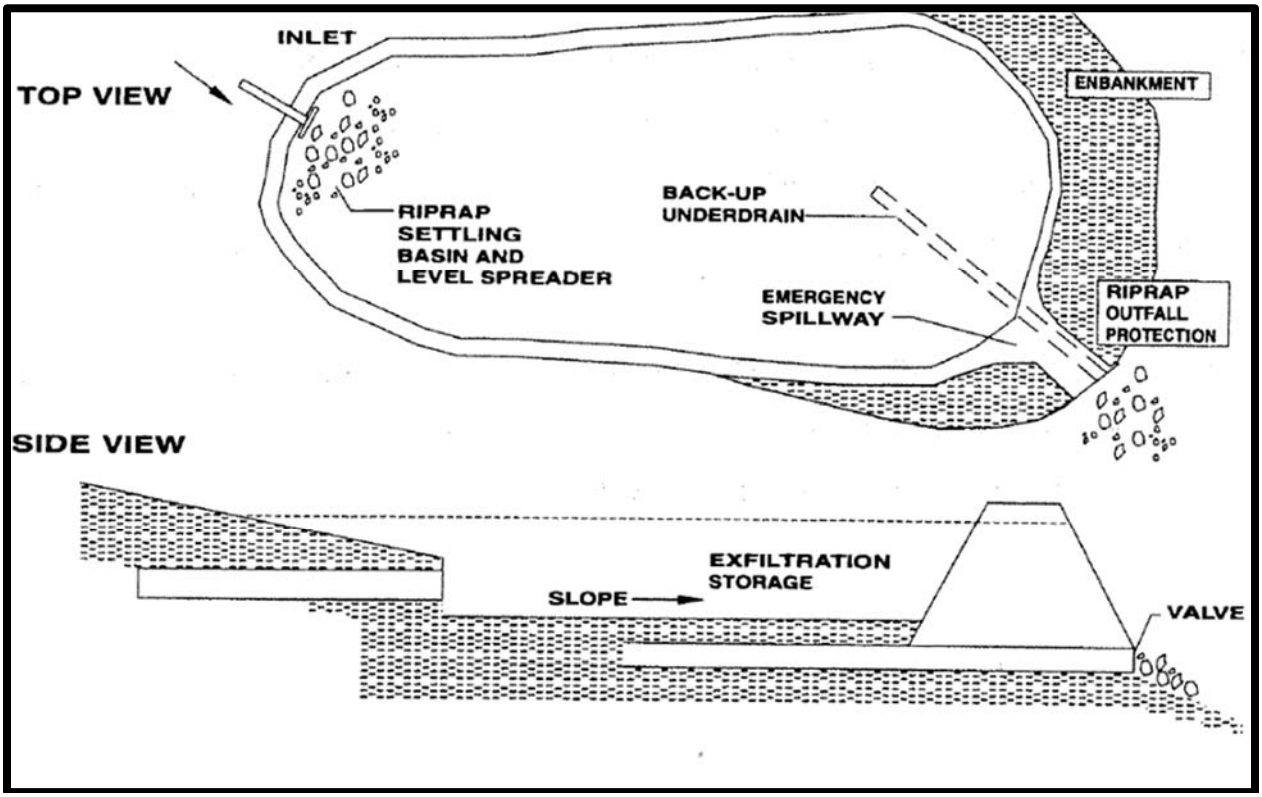
Operation and Maintenance: Constructed wetlands require maintenance similar to that required by wet ponds (see BMP 103). In addition, wetland vegetation should be harvested annually to provide nutrient removal and prevent flushing of dead vegetation from the wetland during the die-down season.

Effectiveness and Cost: This is an effective, high-cost BMP.

Limitations: Storm water wetlands require considerable space which limits their use in densely urbanized areas with expensive land. A base flow is needed to maintain water levels.

The maintenance of wetlands may be restricted by wetland regulations.

BMP 105- CONSTRUCT INFILTRATION BASINS



Description of Potential Pollutant and Source: Infiltration basins may be appropriate for large sites (over approximately five acres) where sources of pollution are dispersed and cannot be adequately controlled by source control BMPs.

Description of BMP: Construct infiltration basins. Infiltration basins temporarily store runoff while it percolates into the soil through the basins' bottom and sides. Infiltration basins are designed to drain within seventy-two hours and, therefore, are generally dry. Infiltration basins must be designed to trap coarse sediment before it enters the basin proper and clogs the surface soil pores on the basin floor.

Application Guidance: In-line infiltration basins are typically used for drainage areas of five to fifty acres. There will be at least four feet of permeable soil between the bottom of the basin and bedrock or high-water table. There must be a low potential for long-term erosion in the watershed. There must be an open space available to construct an infiltration basin.

Operation and Maintenance: Routine maintenance requirements include inspecting the basin after every major storm for the first few months after construction and semi-annually thereafter (prior to and following the wet season), mowing frequently enough to prevent woody growth, removing litter and debris, and re-vegetating eroded areas. Accumulated sediment should be removed periodically. The sediment removed during maintenance must be tested; if it is a hazardous waste, it must be properly disposed.

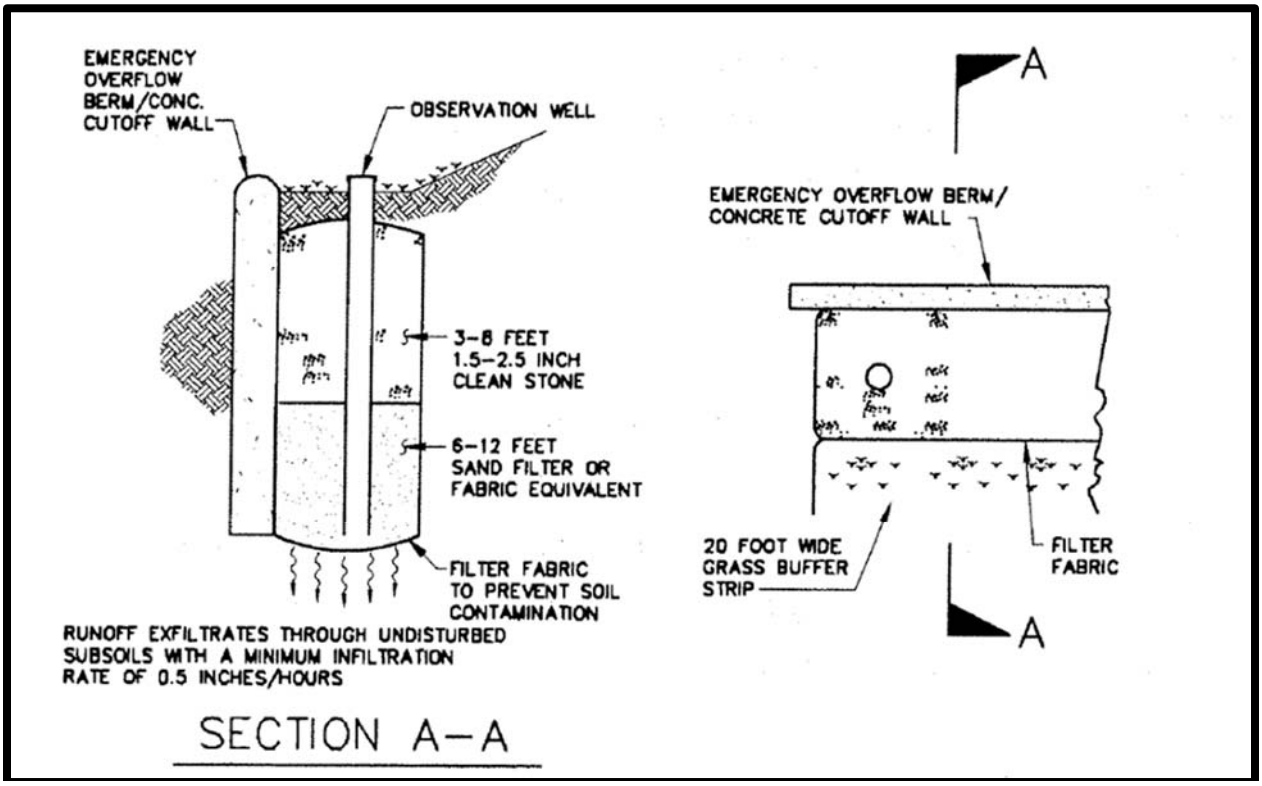
Effectiveness and Cost: Infiltration basins effectively remove soluble and fine-particle pollutants in captured water and the coarse-grained pollutants should be removed before entering the basin proper to keep it from clogging. Actual removal rates in soil will depend on the solubility and chemistry of the pollutant.

This is a high-cost BMP. The cost of infiltration basins is directly related to the size of the area draining to

it.

Limitations: Infiltration basins can cause groundwater contamination, have fairly high failure rates, and can breed mosquito and create undesirable odors if not adequately maintained. Infiltration basins cannot be used while construction is underway in the watershed. Infiltration basins should not be used in sandy soils located adjacent to water bodies.

BMP 106 - CONSTRUCT INFILTRATION TRENCHES



Description of Potential Pollutant and Source: Infiltration trenches may be appropriate for sites where sources of pollution are dispersed and cannot be adequately controlled by source control BMPs.

Description of BMP: Construct infiltration trenches. These are shallow excavated holes or ditches that have been backfilled with stone to form an underground reservoir. Runoff is temporarily stored in the trench as it percolates into the soil through the trench's bottom and sides. Infiltration trenches should drain within seventy-two hours. Infiltration trench systems must be designed to trap coarse sediment before it enters the trench proper and close the soil pores.

Application Guidance: Infiltration trenches are typically used for drainage areas of less than five acres. There must be at least four feet of permeable soil between the bottom of the trench and bedrock or high-water table. There must be a low potential for long-term erosion in the watershed.

Operation and Maintenance: Routine maintenance requirements include inspecting the basin after every major storm for the first few months after construction and annually thereafter, mowing the filter strips frequently enough to prevent woody growth and removal of sediment form the pretreatment device. Despite careful design, construction, and maintenance, trenches eventually clog.

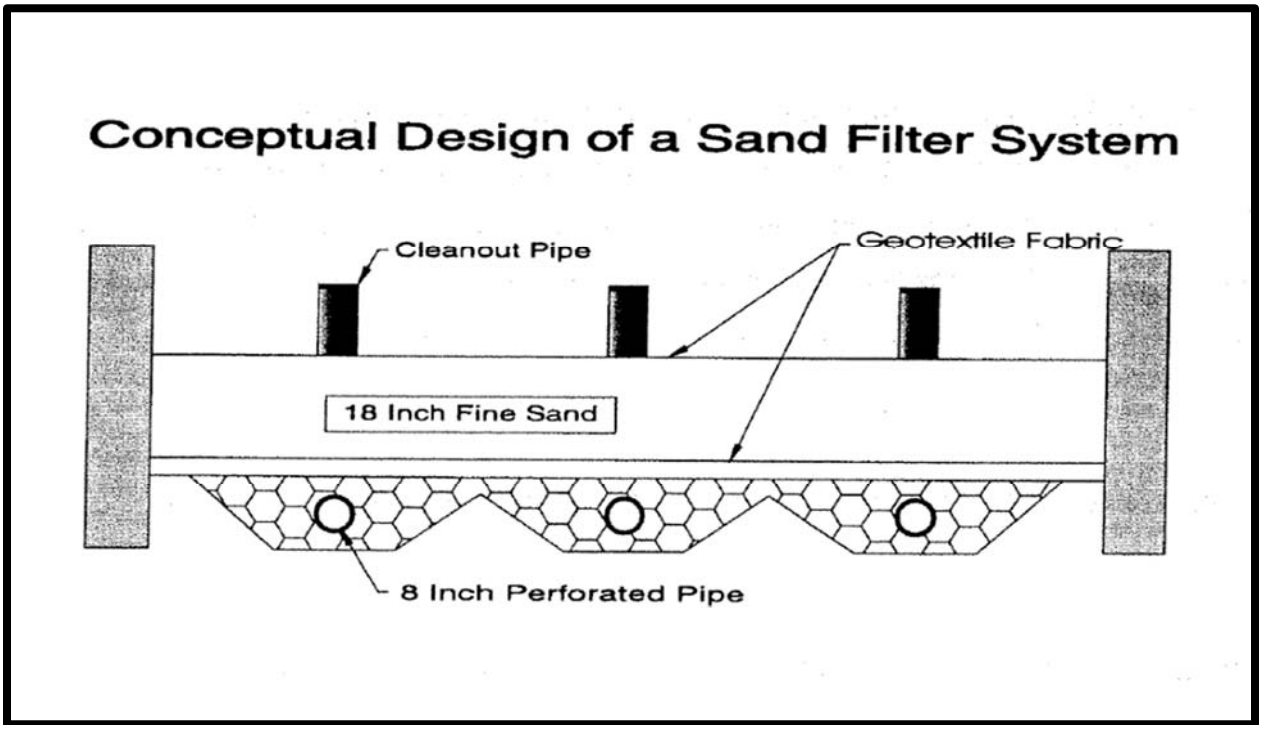
Effectiveness and Cost: Infiltration trenches have approximately the same pollutant removal effectiveness as infiltration basins. Infiltration basins effectively remove soluble and fine particle pollutants in captured water. Coarse grained pollutants should be removed before entering the trench proper to keep it from clogging. Actual removal rates in soil will depend on the solubility and chemistry of the pollutant.

This is a high-cost BMP. The cost of infiltration trenches is directly related to storage volume. As the storage volume increases, cost per unit volume decreases.

Limitations: Infiltration trenches can cause groundwater contamination and have fairly high failure

rates. Because infiltration trenches are not as visible as other BMPs, they are less likely to be maintained. Infiltration trenches cannot be used while construction is underway in the watershed. Infiltration trenches should not be used in sandy soils located adjacent to water bodies.

BMP 107 - CONSTRUCT FILTRATION BASINS



Description of Potential Pollutant and Source: Filtration basins may be appropriate for large sites (over three acres) where sources of pollution are dispersed and cannot be adequately controlled by source control BMPs.

Description of BMP: Construct filtration basins. The basins are lined with a filter media (such as sand and gravel). Storm water runoff drains through the filter media and into perforated pipes that are located in the filter media. Detention time is typically four to six hours. The runoff typically requires some form of preliminary treatment such as sedimentation. Hence, sediment trapping structures (such as a forebay) are required for sedimentation to prevent premature clogging of the filter media.

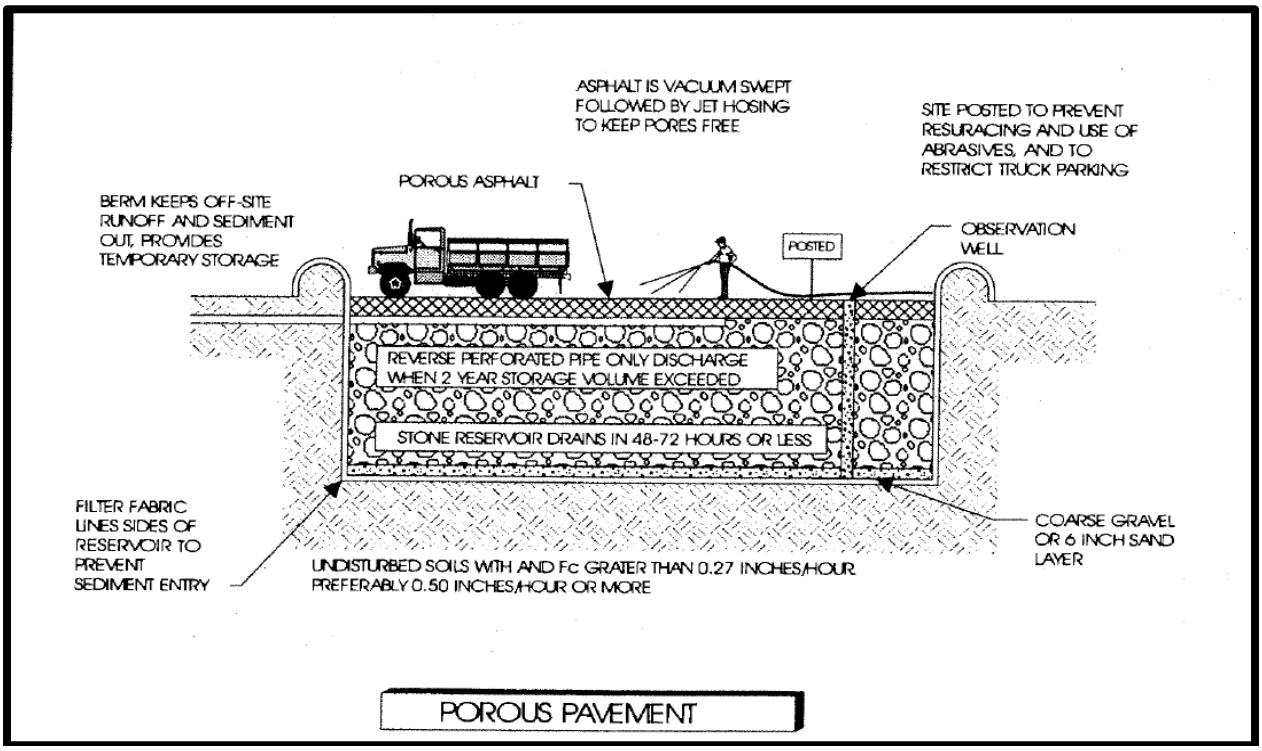
Application Guidance: Filtration basins have been used for drainage areas of three to eighty acres. Filtration basins may be used on sites with impermeable soils since the runoff filter through specially placed filter media, not native soils. Filtration basins can be used where unavailability of water prevents the use of wet ponds, wetlands, or biofilters. There must be an open space available to construct a filtration basin.

Operation and Maintenance: Maintenance requirements include inspecting the basin after every major storm for the first few months after construction and annually thereafter, removing litter and debris and re-vegetating eroded areas. In addition, the accumulated sediment should be periodically removed and the filter media with sediment depositions removed and replaced. The sediment removed during maintenance must be tested; if it is a hazardous waste, it must be properly disposed.

Effectiveness and Cost: This practice has a relatively moderate pollutant removal rate and high cost.

Limitations: Do not use filtration basins while construction is underway in the watershed.

BMP 108 - CONSTRUCT POROUS PAVEMENT



Description of BMP: Construct porous pavement. Some porous pavement has a layer of porous top course covering an additional layer of gravel. A crushed rock-filled groundwater recharge bed is typically installed beneath these top layers. Runoff infiltrates through the porous asphalt layer and into the underground recharge bed. The runoff then exfiltrates from the recharge bed into the underlying soils or into a perforated pipe system. Other types of porous pavement include a geocomposite backfilled with soil and planted with grass. The geocomposite overlies a crushed rock recharge bed.

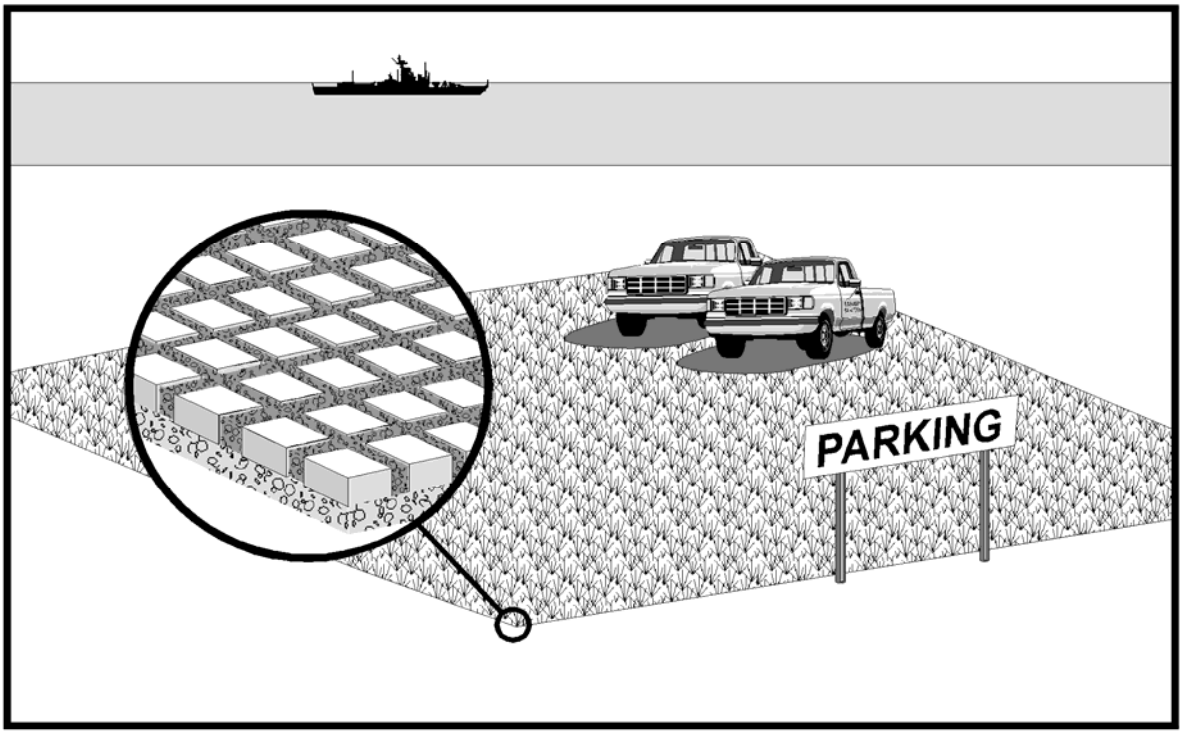
Application Guidance: Porous pavement can be used in parking areas which do not serve a high volume of traffic or heavy traffic. Porous pavement is only used to treat runoff from parking lots or other small areas.

Operation and Maintenance: Routine maintenance of porous pavement includes having the surface vacuum swept followed by high pressure jet hosing at least four times per year to keep the asphalt pores open. In addition, the site should be inspected after every major storm event replaced using conventional asphalt if the replaced area does not exceed ten percent of the total area. Spot clogging can be treated by drilling holes into the asphalt layer. However, if the facility becomes completely clogged it must be completely replaced.

Effectiveness and Cost: Porous pavement provides moderately effective pollutant removal. However, the life span can be shortened due to clogging of the surface from sediment. The use of porous pavement as a retrofit at an existing facility would require the removal of the existing pavement and its replacement with porous pavement. This would be a higher cost application than in new construction.

Limitations: Porous pavement is appropriate for areas that do not have high-volume traffic, such as parking lots. Porous pavement must be maintained to prevent clogging of the surface.

BMP 109 - CONSTRUCT CONCRETE GRID PAVEMENT



Description of Potential Pollutant and Source: Concrete grid pavement can be used to treat rainfall runoff from parking areas with low-volume traffic.

Description of BMP: Construct concrete grid pavement. This type of pavement consists of concrete blocks with regularly interspersed void areas which are filled with pervious materials such as gravel, sand or grass. The blocks are typically placed on a sand and gravel base and designed to provide a load-bearing surface that is adequate to support vehicles, while allowing infiltration of surface water into the underlying soil.

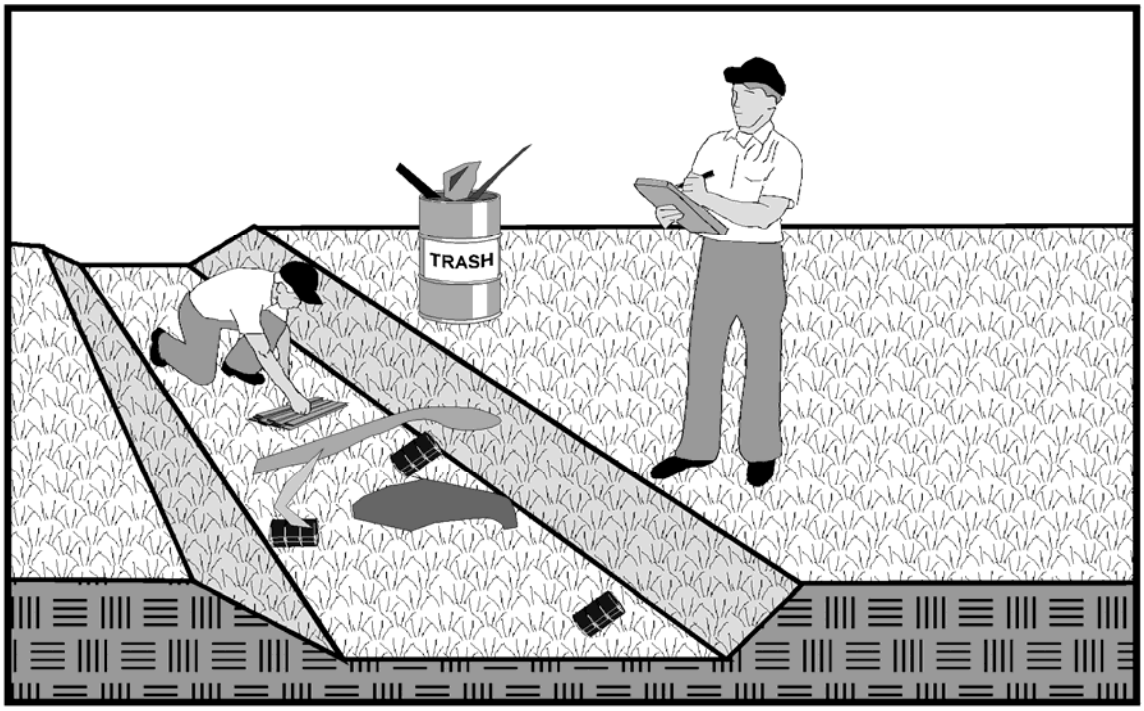
Application Guidance: Concrete grid pavement can be used in areas with low traffic volume. Suggested uses are low volume parking spaces, multi-use open space, fire lanes, and stream banks/lakeside erosion protection. Concrete grid pavement is only used to treat the runoff from the rainfall falling directly on it.

Operation and Maintenance: Concrete grid pavement offers an alternative means to providing a load-bearing surface without greatly increasing the impervious areas. Like all infiltration practices, they require maintenance to prevent clogging of the system. In addition, concrete grid pavement with grass requires additional "normal" grass maintenance, such as mowing, watering, and fertilizing. Extra care should be taken when applying fertilizers and pesticides that may have an adverse effect on concrete products.

Effectiveness and Cost: Concrete grid pavements provide moderately effective removal of fine particle pollutants. This is a relatively high-cost BMP.

Limitations: Concrete grid pavement can cause groundwater contamination and is not suitable for areas with high-volume traffic.

BMP 110 - REGULARLY INSPECT AND MAINTAIN STORM WATER CONVEYANCE SYSTEMS



Description of Potential Pollutant and Source: Over time, storm water conveyance systems may fill up with sediments and clog. Also, drainage swales may erode and be a source of sediment pollution to storm water.

Description of BMP: Inspect and maintain storm water conveyance systems on a regular basis. This will include inspection of drainage swales and outfall pipes to ensure that the area is not eroding.

Other storm water conveyance systems, such as oil/water separators, catch basins, and detention ponds, will be inspected and properly maintained.

Application Guidance: Storm water conveyance systems will be inspected monthly. The frequency for implementing of the BMP has been provided as general guidance. However, a facility operator may wish to establish a more suitable frequency. This will require SWPCP implementors to make judgements based on facility operations and conditions. To assign a frequency other than what has been suggested (i.e., more or less frequent), the following criteria will be considered and rated either High, Medium or Low. If many of the criteria are assigned a High rating, the frequency may be increased. Similarly, if many criteria are assigned a Low rating, the frequency may be decreased. The goal of implementing this BMP is to minimize exposure of pollutants to storm water.

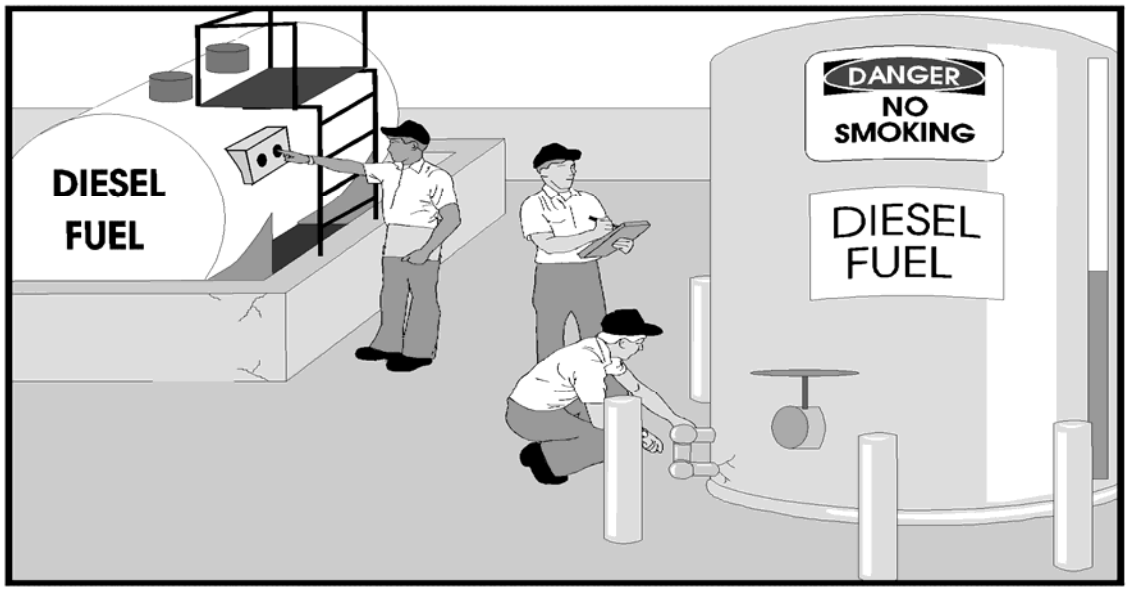
CRITERIA	RATING H=High M=Meum L=Low
Probability of exposure of significant materials to storm water in area draining to storm water conveyance system	
Quantity of significant materials potentially exposed in area draining to storm water conveyance system	
Toxicity of significant materials potentiality exposed in area draining to storm water conveyance system	
Frequency of use of significant materials potentially exposed in area draining to storm water conveyance system	
Evident of exposure (e.g., stains on pavement, evidence of significant materials in drainage system)	
Proximity of source area to outfall or receiving water	
Sensitivity of receiving water to potentially exposed significant materials (e.g., waters with beneficial uses such as human contact, recreation, significant species habitat, etc.)	

Training: The Storm Water Pollution Prevention Personnel will assign personnel responsible for inspections. Personnel will be provided a copy of a site plan showing the location of all storm water conveyance systems which need to be inspected.

Effectiveness and Cost: This is a moderately effective, low-cost BMP.

Limitations: None

BMP 111 - REGULARLY INSPECT AND TEST EQIDPMENT



Description of Potential Pollutant and Source: Regular inspection and testing of equipment will prevent breakdowns and failures, which can result in the exposure of significant materials to storm water.

Description of BMP: Regularly inspect and test equipment. Inspections will uncover conditions such as cracks or slow leaks which could cause breakdowns or failures that result in discharges of chemicals to storm sewers or surface waters.

The following is a list of some of the equipment that will be included in the inspection and testing program:

- Aboveground storage tanks
- Machinery
- Material storage areas
- Pressure release valves
- Process and material handling equipment
- Pumps and piping
- Sumps
- Wastewater treatment plants

Application Guidance: Equipment will be inspected and tested monthly.

The frequency for implementing of the BMP has been provided as general guidance. However, a facility operator may wish to establish a more suitable frequency. This will require SWPCP implementors to make judgements based on facility operations and conditions. To assign a frequency other than what has been suggested (i.e., more or less frequent) the following criteria will be considered and rated either High, Medium or Low. If many of the criteria are assigned a High rating, the frequency may be increased. Similarly, if many criteria are assigned a Low rating, the frequency may be decreased. However, the goal of implementing the BMP will be to minimize exposure of pollutants to storm water.

CRITERIA	RATING H=High M=Medium L=Low
Probability of exposure of significant materials to storm water	
Frequency of use of equipment	
Intensity of use of equipment	
Old age or poor condition of equipment and systems	
Evidence of exposure (e.g., stains on pavement, etching of concrete)	
Proximity of source area to outfall or receiving water	
Sensitivity of receiving water to potentially exposed significant materials (e.g., waters with beneficial uses such as human contact, recreation, significant species habitat, etc.)	

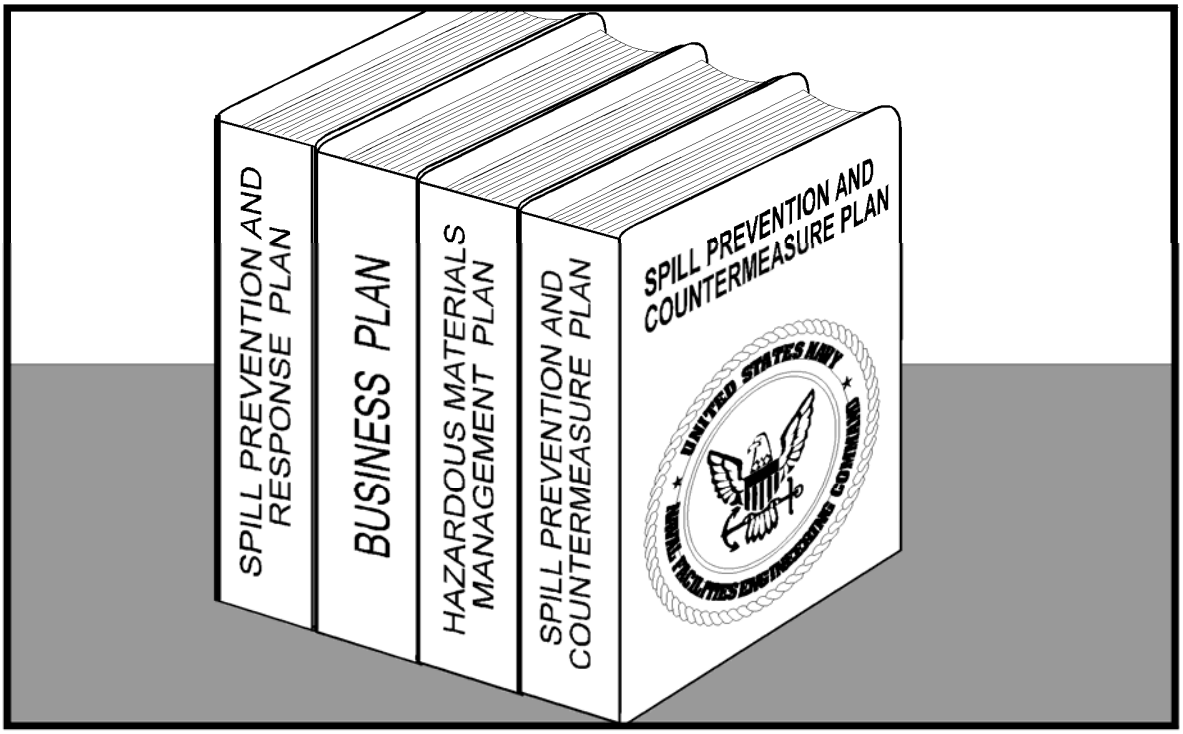
Training: An effective preventive maintenance program will include the following:

- Identification of equipment, systems, and facility areas that will be inspected.
- Schedules for periodic inspections or tests of these equipment and systems.
- Appropriate and timely adjustment, repair, or replacement of equipment and systems.
- Maintenance of complete records on inspections, equipment and system.

Effectiveness and Cost: This is a highly effective, low-cost BMP.

Limitations: None

BMP 112- PREPARE APPROPRIATE SPILL PREVENTION AND RESPONSE PLANS



Description of Potential Pollutant and Source: Spills of significant materials may be exposed to storm water and transported to storm drains and/or receiving waters.

Description of BMP: Prepare the appropriate plans to comply with all local, state and federal regulations related to spill prevention and response. The plans may include a Spill Prevention, Control, and Countermeasure (SPCC) Plan, Business Plan, Hazardous Materials Management Plan, and others. The plans will cover all industrial activities involving material handling and storage. 40 CFR 300 requires that sites which store or dispense petroleum products have an SPCC plan.

The plans address actions that will be taken in the event of a spill of hazardous materials. The plans will include the location of necessary equipment (e.g., absorbent material, fire extinguishers), and internal and external reporting procedures including the names and phone numbers of the appropriate people to notify in the event of a spill. In addition, the plans will describe specific material handling procedures and storage requirements.

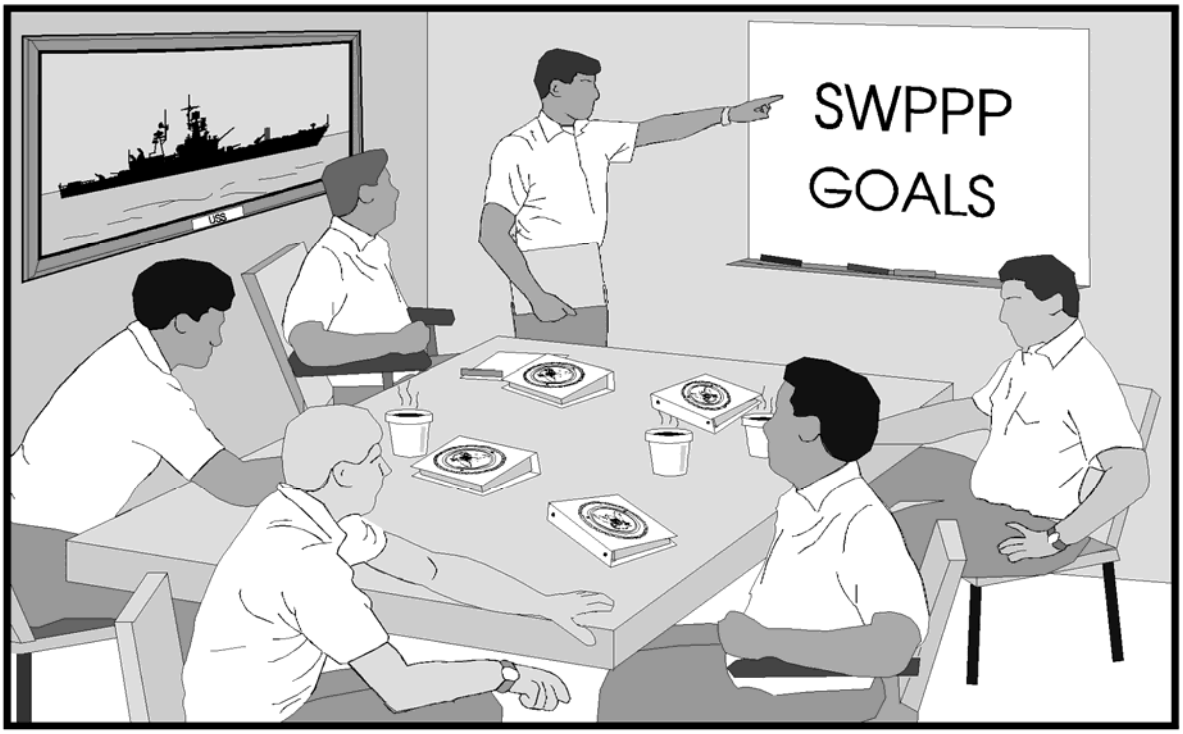
Application Guidance: N/A

Training: Personnel will be trained in the appropriate procedures for all spill prevention and response.

Effectiveness and Cost: This is an effective, low-cost BMP.

Limitations: None

BMP 113 - CONDUCT PERSONNEL TRAINING REGARDING THE SWPCP



Description of Potential Pollutant and Source: When properly trained, personnel are more capable of preventing spills, responding safely and effectively to an accident when it occurs, and recognizing situations that could lead to storm water contamination.

Description of BMP: Train personnel at all levels of responsibility in the components and goals of the SWPCP.

Application Guidance: Training will be conducted quarterly and at new personnel orientations.

Training: Training will address each component of the SWPCP, including how and why tasks are to be implemented. Topics will include:

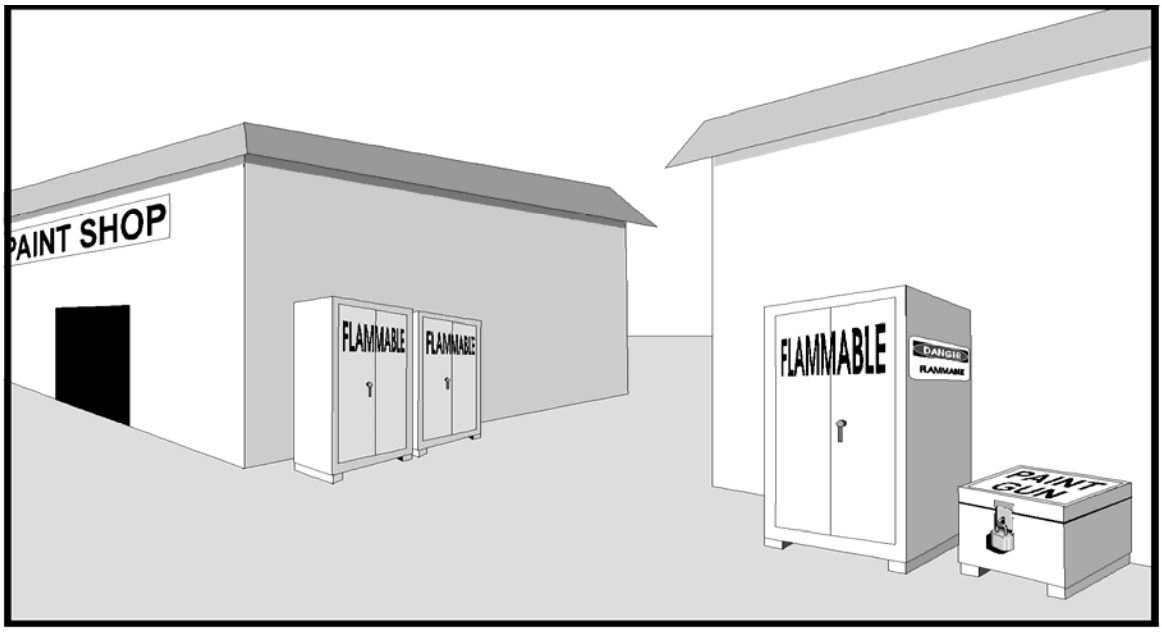
- Good housekeeping
- Material management practices Spill prevention and response

Effectiveness and Cost: This is a highly effective, moderate-cost BMP.

Limitations: None

PLACEHOLDER

BMP 115 - STORE CONTAINERS INSIDE SECONDARY CONTAINMENT



Description of Potential Pollutant and Source: Improper storage of containers of significant materials can result in the release of materials and chemicals that can cause storm water runoff pollution. Secondary containment can prevent storm water runoff pollution.

Description of BMP: Provide secondary containers for significant materials. Containers of significant materials will be stored inside secondary containment cabinets appropriate to the size and quantity of the substances stored. Cabinets will have covered shelves and provide secondary containment for spills of the substances that spill inside the cabinets. In many instances the cabinets will be locked to restrict access to the substances. Metal lockers typically used to store flammable substances are usually appropriate for preventing contact between significant materials and storm water.

The secondary containment will be placed away from vehicle traffic routes to reduce the potential for mechanical impact and accidental spills. A manifest list of the materials stored inside the locker will be posted on or inside the locker.

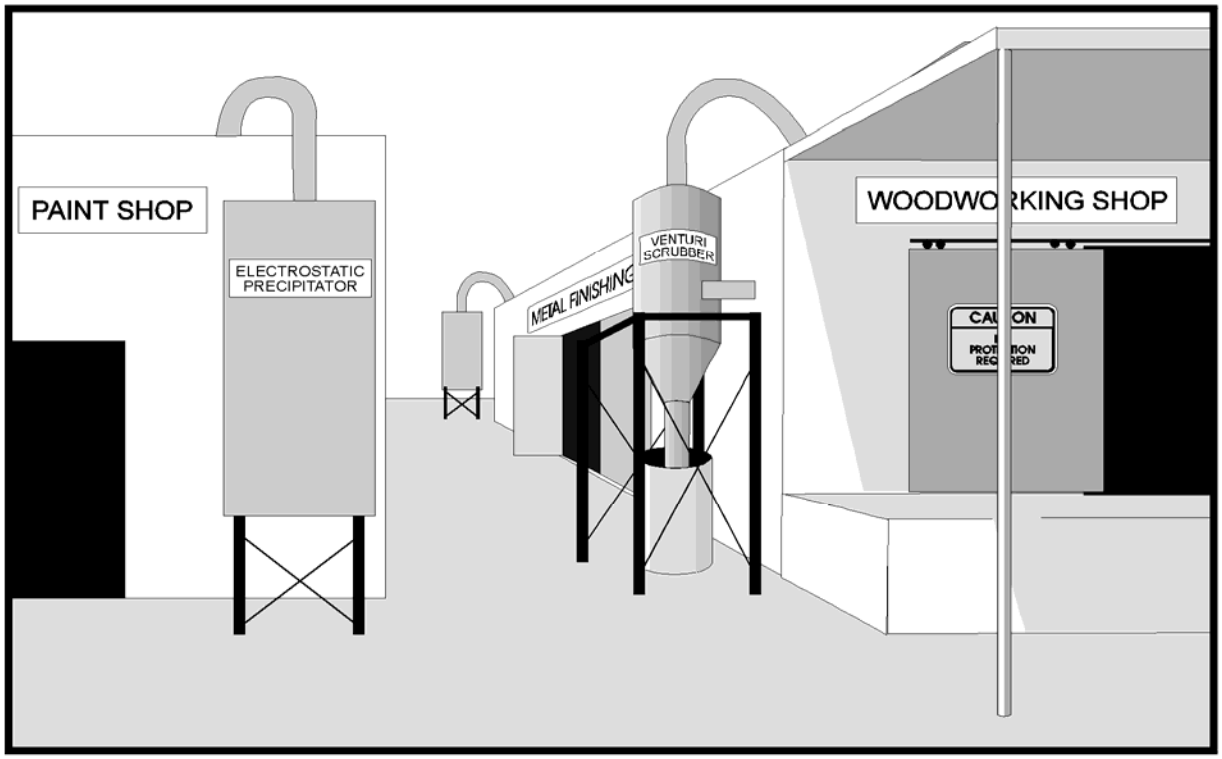
Application Guidance: Containers will always be properly stored.

Training: Personnel will be trained in preventing substances stored outside from entering the storm water and storing substance effectively.

Effectiveness and Cost: This is a moderately effective, low-cost BMP.

Limitations: None

BMP 116- CONTROL DUST AND PARTICULATES



Description of Potential Pollutant and Source: Many indoor and outdoor industrial processes can generate significant quantities of dust and particulates. These materials contain pollutants that can be exposed to storm water if uncontrolled. Examples of industrial processes which generate significant quantities of dust and particulates include metal finishing, painting, sanding, grinding, sawing, milling, sandblasting, welding and cement manufacture.

Description of BMP: Control dust and particulates. The emission of dust and particulates from indoor and outdoor industrial processes will be controlled. Control measures include the use of filters, baghouses, electrostatic precipitators, cyclone concentrators, waterwalls and other measures.

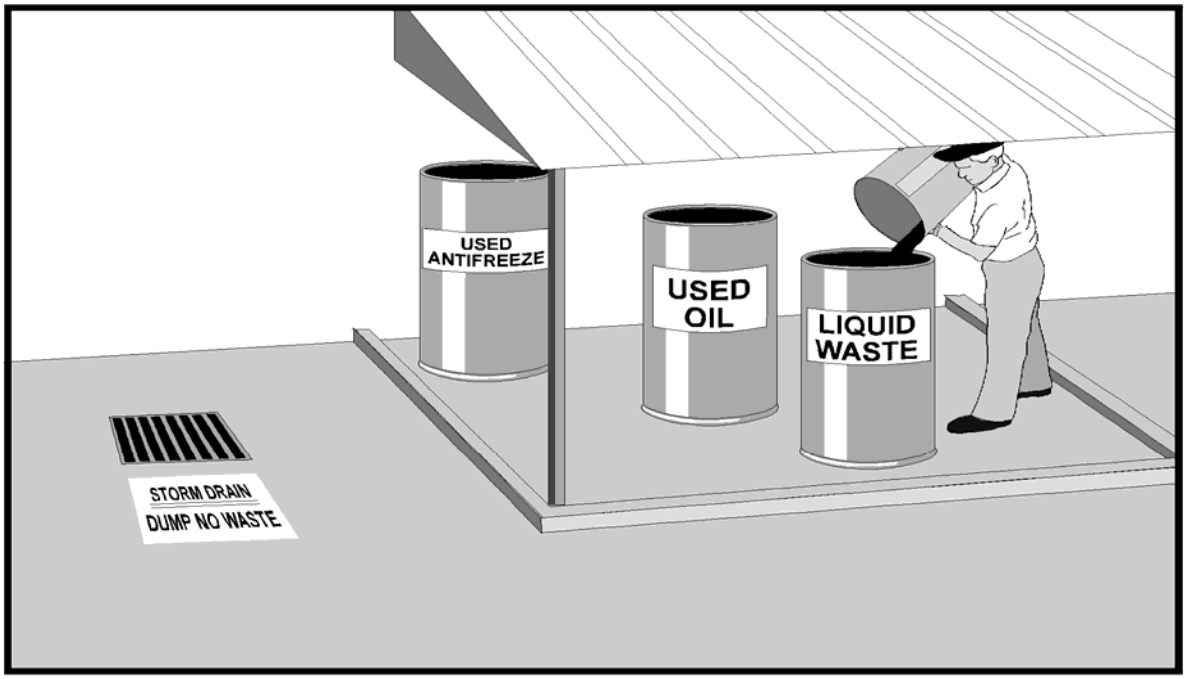
Application Guidance: All industrial processes which generate dust and particulates will be fitted with dust control devices.

Training: Personnel will be trained to properly use and maintain dust and particulate control equipment.

Effectiveness and Cost: This is an effective, moderate-cost BMP.

Limitations: It may not be possible to control outdoor processes.

BMP 117 - DO NOT POUR OR DEPOSIT WASTE INTO STORM DRAINS



Description of Potential Pollutant and Source: Waste poured or deposited into storm drains contains pollutants that can enter the storm drain system and receiving waters without treatment.

Description of BMP: Do not pour or deposit waste into storm drains or storm drain connections. All wastes will be disposed properly or recycled. Refer also to BMP 027, "Stencil Signs On Storm Drain Inlets."

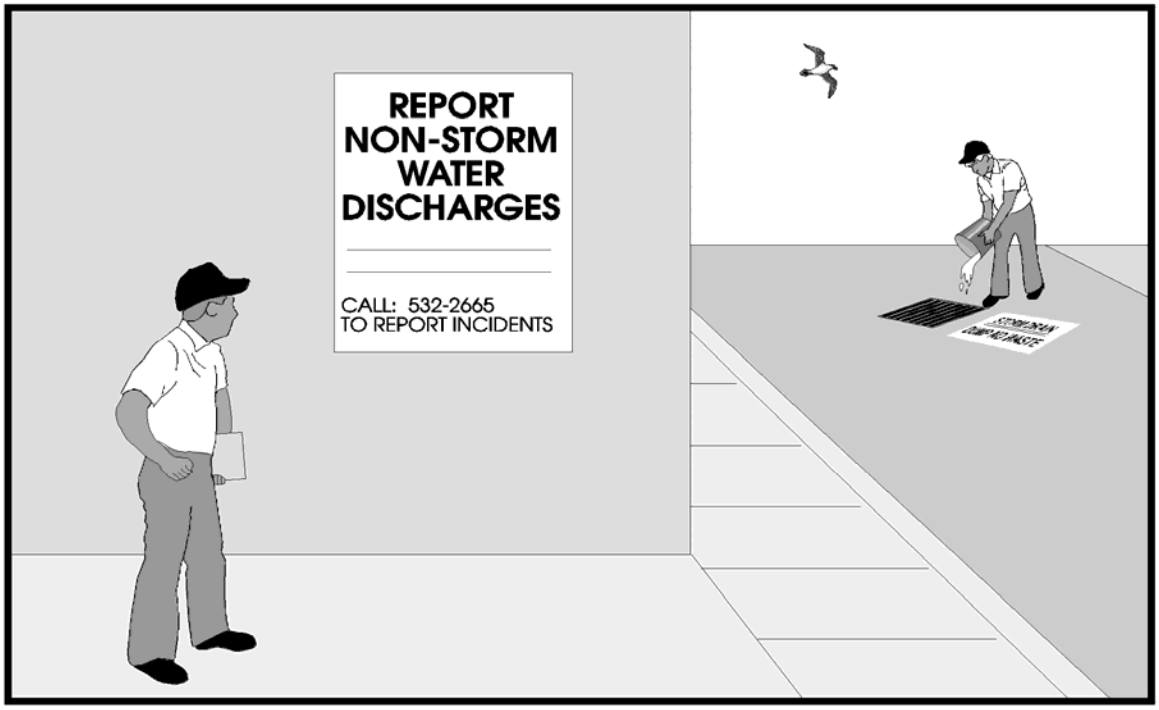
Application Guidance: Wastes will always be properly disposed.

Training: Personnel will be trained in proper disposal procedures. Signs will be posted at storm drain inlets.

Effectiveness and Cost: This is a highly effective, low-cost BMP.

Limitations: None

BMP 118 – ROUTINELY REPORT ANY OBSERVED NON-STORM WATER DISCHARGES



Description of Potential Pollutant and Source: Unknown significant materials may be present in non-storm water discharges resulting from improper disposal of wastes or illicit connections to the storm drain system. These non-storm water discharges drain to receiving waters without treatment.

Description of BMP: Develop adequate routine reporting procedures and make them available to all personnel who may observe either an act of illegal dumping or an unexplained non-storm water discharge. Information regarding reporting procedures will be posted in all industrial facilities. A member of the pollution prevention team will be designated to respond to reports.

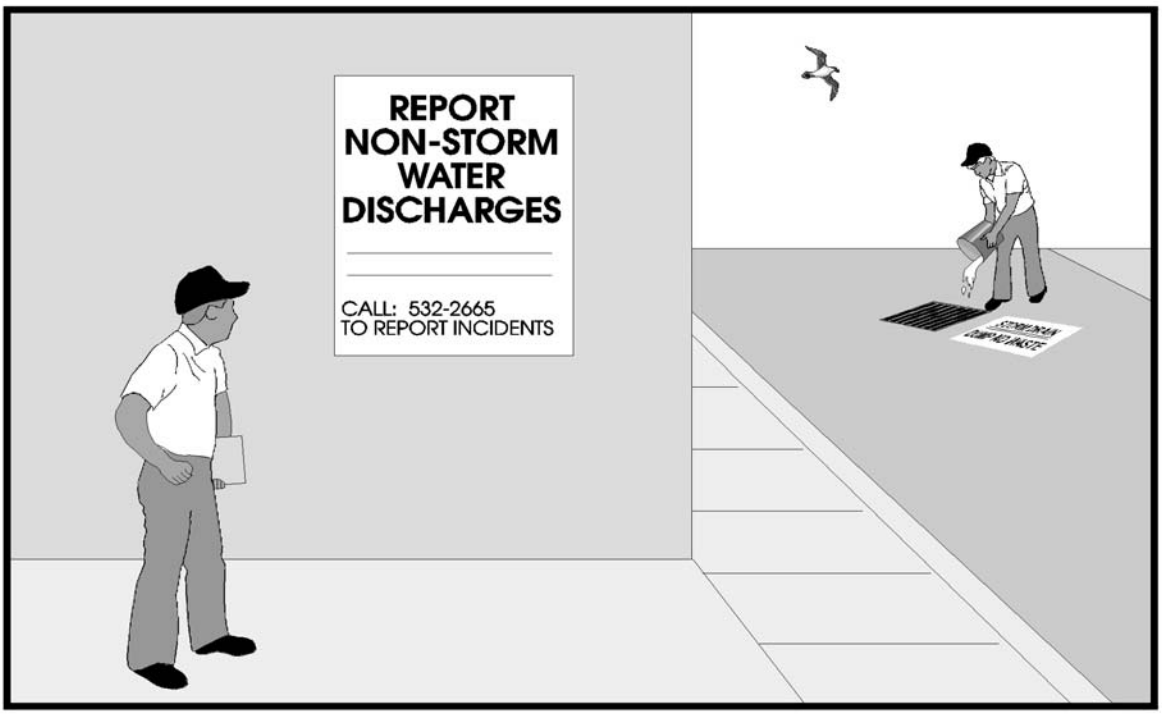
Application Guidance: Reporting forms will be made available at all times.

Training: Training will be performed as part of BMP 009 training.

Effectiveness and Cost: This is an effective BMP, and the costs are low.

Limitations: None

BMP 104 - Routinely Report Any Observed Non-Storm Water Discharges



Description of Potential Pollutant and Source: Unknown significant materials may be present in non-storm water discharges resulting from improper disposal of wastes or illicit connections to the storm drain system. These non-storm water discharges drain to receiving waters without treatment.

Description of BMP: Adequate routine reporting procedures will be developed and made available to all personnel who may observe either an act of illegal dumping or an unexplained non-storm water discharge. Information regarding reporting procedures will be posted in all industrial facilities. A member of the pollution prevention team will be designated to respond to reports.

Application Guidance: Reporting forms will be made available at all times.

Training: Training will be performed as part of BMP 008 training.

Effectiveness and Cost: This is an effective BMP, and the costs are low.

Limitations: None

BMP #110 - Timing of Construction

DESCRIPTION

Schedule and sequence construction work and erosion control applications so that they occur under optimal conditions--that is, during periods when the potential for erosion is lowest. Proper timing will minimize erosion and also maximize the effectiveness of control methods.

Targeted Pollutants

- (●) Sediment
- ( ) Nutrients
- ( ) Trace metals
- ( ) Bacteria
- ( ) Petroleum hydrocarbons

APPLICATIONS

This measure applies to almost any ground-disturbing activity, but it is especially relevant to large construction projects and any areas where work activities can be planned to coincide with periods of low erosion potential, such as during dry weather.

When construction during the wet season is unavoidable, use other BMPs described in this Catalog to control erosion, such as any of the slope protection techniques.

Physical Limits

Drainage area	unlimited
Max slope	unlimited
Min bedrock depth	N/A
Min water table	N/A
SCS soil type	ABCD
Freeze/Thaw	Good
Drainage/flood control	no

LIMITATIONS

None.

DESIGN PARAMETERS

- Construction work involving soil disturbance or exposure should be scheduled during seasonal low-runoff periods under favorable soil moisture conditions whenever possible.
- Erosion controls should be installed in stages to protect completed work and minimize exposed soils.
- Sediment collection systems should be installed prior to activities expected to produce sediment.
- Slope stabilization measures should be initiated within 14 calendar days after construction activities in that portion of the site where earthmoving activities have temporarily or permanently ceased.
- Consider site characteristics and permit conditions when deciding what kind of erosion control devices to incorporate into a construction project. Select measures that can be installed without disrupting critical timing or sequencing of other construction or erosion control activities.

- Identify the locations and dimensions for all erosion control and storm water management measures as clearly as possible on the site plans. This will help ensure effectiveness and proper timing of installation or implementation.

CONSTRUCTION GUIDELINES

Develop a scheduling/sequencing plan that addresses the following timing considerations. If using a Critical Path Method (CPM) for scheduling, incorporate the erosion control and storm water management practices into the CPM.

- Work activities that leave a site most susceptible to erosion should be scheduled for periods when the potential for erosion is lowest.
- Allow time to install sediment collection systems, drainage systems, and runoff diversion devices before beginning ground-disturbing work in a given area.
- Plan to install and maintain effective soil stabilization measures as work progresses, not just at the completion of all construction.
- Conduct work in units or stages so that some portions of the project site are final-graded and ready for seeding each time an approved season of seeding arrives. (See BMP # 111-Staging Areas).

MAINTENANCE

- Continually monitor site conditions and progress of work. Update the project work schedule to maintain appropriate timing and sequencing of construction and control applications.

BMP #111 - Staging Areas

DESCRIPTION

Targeted Pollutants

- ◒ Sediment
- ○ Phosphorus
- ○ Trace metals
- ○ Bacteria
- ○ Petroleum hydrocarbons

Physical Limits

Drainage area	unlimited
Max slope	15 %
Min bedrock depth	NA
Min water table	NA
SCS soil type	ABCD
Freeze/Thaw	good
Drainage/Flood control	yes

This BMP includes measures for collecting runoff from a staging area, materials storage site, or industrial activity area or for diverting water flow away from such areas so that pollutants do not mix with clean stormwater runoff. Various flow diversion structures, called stormwater conveyances, can be used to contain runoff on site, to channel it around the industrial area, or to carry pollutant-laden water directly to a treatment device or facility. Several options are available:

Stormwater Conveyances: This term includes many kinds of channels, gutters, drains, and sewers. Stormwater conveyances can be either temporary or permanent. They are constructed or lined with many different materials, including concrete, clay tiles, asphalt, plastics, metals, riprap, compacted soils, and vegetation. The type of material used depends on the use of the conveyance.

Dikes or Berms: Diversion dikes or berms are ridges built to block runoff from passing beyond a certain point. Temporary dikes are usually made with compacted soil. More permanent ones are constructed out of concrete, asphalt, or other durable materials.

Graded Areas and Pavement: Land surfaces can be graded, or graded and paved, so that stormwater runoff is directed away from construction activity areas. The slope of the grade allows the runoff to flow, but keeps it from washing over areas that may be contaminated with pollutants. Like conveyances and dikes, grading can prevent runoff from entering construction areas and becoming contaminated with pollutants from these areas. Grading can be a permanent or temporary control measure.

APPLICATIONS

Stormwater Conveyances: Stormwater conveyances can be used for two different purposes. The first is to keep uncontaminated stormwater from getting into areas of a construction site where it may become contaminated. This can be accomplished by collecting the stormwater in a conveyance and directing the flow away from those areas. Secondly, conveyances can be used to collect stormwater downhill from construction areas and keep it separate from runoff that has not been in contact with those areas. When potentially contaminated stormwater is collected in a conveyance like this, it can be directed to a treatment device or another facility on the site if desired.

Other beneficial aspects of stormwater conveyances include:

- Prevention of temporary flooding at industrial sites.

- Low maintenance.
- Erosion-resistant conveyance of stormwater runoff.
- Long-term control of stormwater flows.

Dikes or Berms: Diversion dikes are used to prevent the flow of stormwater runoff onto construction or staging/storage areas. Limiting the flow across these areas reduces the volume of stormwater that may carry pollutants from the area and which may require treatment. This method is suitable for sites where significant volumes of stormwater runoff tend to flow onto active materials handling or equipment staging sites and other construction areas. Typically, dikes are built on slopes just uphill from an active construction area together with some sort of a conveyance, such as a swale. The conveyance is necessary to keep the water away from the dike so that the water will not pool and seep through the dike. See BMP #140-Earth Dike.

Some advantages of diversion dikes are that they:

- Effectively limit stormwater flows over industrial site areas.
- Can be installed at any time.
- Are economical, temporary structures when built from soil on site.
- Can be converted from temporary to permanent at any time.

Graded Areas and Pavement: Grading is appropriate for any construction site where outdoor activities may pollute stormwater runoff--parking lots or outdoor storage areas, for example. Grading is often used in conjunction with coverings, buffer zones, and other practices to reduce the runoff velocity, increase infiltration of uncontaminated runoff, or direct pollutant-laden runoff to stormwater treatment facilities. Grading and paving are relatively inexpensive and easy to implement.

LIMITATIONS

Stormwater Conveyances

- Once the stormwater is concentrated in conveyances, it must be routed through stabilized structures all the way to its discharge to a receiving water or other stormwater BMP.
- May increase flow rates.
- May be impractical if there are space limitations.
- May be expensive to install, especially for small facilities or after a site has already been constructed.

Dikes and Berms

- Are not suitable for large drainage areas unless there is a gentle slope.
- May require maintenance after heavy rains.

Graded Areas and Pavement

- May be uneconomical to regrade and resurface large areas.
- May not be effective during heavy precipitation.

DESIGN PARAMETERS

Stormwater Conveyances: In planning for stormwater conveyances, consider the amount and speed of the typical stormwater runoff. Also, consider the stormwater drainage patterns, so that channels may be located to collect the most flow and can be built to handle the amount of water they will receive. When deciding on the type of material for the conveyance, consider the resistance of the material, its durability, and its compatibility with any pollutants it may carry.

Conveyance systems are most easily installed when a facility is first being 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 create an increase in velocity that causes an increase in erosion. Consider the materials used for lining the conveyance and the types of outlet controls provided.

Dikes and Berms: In planning for the installation of dikes, consider the slope of the drainage area, the height of the dike, the amount of runoff it will need to divert, and the type of conveyance that will be used with the dike. Steeper slopes result in higher volumes of runoff and higher velocities which the dike must be capable of handling. Remember that dikes are limited in their ability to manage large volumes of runoff. See BMPs #140-Earth Dike for additional parameters.

Graded Areas and Pavement: When designing graded and paved areas, be sure to consider both control and containment of runoff flows. The grading should control the uncontaminated flow by diverting it around areas that may have pollutants. The grading should also contain the contaminated flows or divert them to treatment facilities.

CONSTRUCTION GUIDELINES

Stormwater Conveyances: Specific construction methods apply to the type of conveyance being used.

Dikes and Berms: Ideally, dikes are installed before construction activity begins. However, dikes can be easily constructed at any time. Temporary dikes (usually made of dirt) generally only last for 18 months or less, but they can be made into permanent structures by stabilizing them with vegetation. Slope protection such as vegetation is crucial for preventing the erosion of the dike.

Graded Areas and Pavement: Staging/storage areas should be designated prior to the start of construction.

MAINTENANCE

It is best to inspect stormwater conveyances within 24 hours of a rainstorm and remove debris promptly. Make daily inspections during periods of prolonged rainfall, since heavy storms may clog or damage the conveyances. It is important to repair damage to these structures as soon as possible.

Dikes should be inspected regularly for damage. This is especially important after storm events since a heavy rain may wash parts of a temporary dike away. Any necessary repairs should be made immediately to make sure 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. Also, check to make sure that the 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.

BMP #112 - Preservation of Existing Vegetation

DESCRIPTION

Protect existing vegetation (including trees, grasses, and other plants) by preventing disturbance or damage to specified areas of a construction site or right-of-way. Preserving natural vegetation provides buffer zones and stabilized areas which help control erosion, protect water quality, and enhance aesthetic benefits. This practice minimizes the amount of bare soil exposed to erosive forces.

Targeted Pollutants

- ● Sediment
- ○ Phosphorus
- ○ Trace metals
- ○ Bacteria
- ○ Petroleum hydrocarbons

APPLICATIONS

This technique is applicable to all types of sites. Areas where preserving vegetation can be particularly beneficial are floodplains, wetlands, stream banks, steep slopes, and other areas where other structural erosion controls would be difficult to establish, install, or maintain. Compared to newly planted or seeded areas, preserving natural vegetation has many advantages:

Physical Limits

Drainage area	unlimited
Max slope	unlimited
Min bedrock depth	N/A
Min water table	N/A
SCS soil type	ABCD
Freeze/Thaw	good
Drainage/Flood control	no

- It can handle higher quantities of storm water runoff than newly seeded areas.
- It does not require time to establish (it is effective immediately).
- It has greater filtering capacity because the vegetation and root structure are usually denser in preserved natural vegetation than in newly seeded or base areas.
- It usually requires less maintenance, watering, and chemical application (e.g., fertilizer, pesticides) than planting new vegetation.

It also:

- Enhances aesthetics.
- Provides areas for infiltration, thus reducing the quantity and velocity of storm water runoff.
- Allows areas where wildlife can remain undisturbed.
- Provides noise buffers and screens for on-site operations.

LIMITATIONS

Preservation of natural vegetation may be impractical in some situations because:

- It may constrict the area available for construction activities.

- It may not be cost-effective in areas with high land values.

DESIGN PARAMETERS

- Successful preservation of vegetation requires good planning and site management to minimize the impact of construction activities on existing vegetation. The areas to be preserved should be identified in the plans and clearly marked in the field before any site disturbance begins. Clearly

  mark all trees to be preserved, and protect against ground disturbance within the dripline of each marked tree as shown on the attached figure. The dripline marks the edge of the tree's foliage where drips from rainfall would drop. Most of the tree's roots lie within the dripline and are vulnerable to damage.

- Preserving natural vegetation may affect some aspects of staging, work sequencing, and construction cost. In addition, control measures may be needed around the perimeter of the preserved area to maintain adequate water flow and drainage and to prevent damage from excessive erosion or sedimentation. Be sure to consider these and related factors when preparing the project site plan and project cost estimates.

- Consider the use of design exceptions to enable preservation of natural vegetation in certain areas where it would typically be removed and where its preservation would not pose safety problems.

CONSTRUCTION GUIDELINES

- Check the project plans for areas designated for preservation of natural vegetation. Keep all construction equipment, materials, and waste out of the designated areas.

- Do not modify existing drainage patterns through or into any preservation area unless specifically directed by the plans or approved by the local permitting authority.

- Perform maintenance activities as needed to ensure that the vegetation remains healthy and able to aid in erosion control and sediment collection.

MAINTENANCE

Inspect at regular intervals to make sure the preserved vegetated areas remain undisturbed and are not being overwhelmed by sediment. Implement maintenance or restorative actions as needed. Proper maintenance is important to ensure healthy vegetation that can control erosion. Different species, soil types, and climatic conditions will require different maintenance activities such as mowing. Maintenance should be performed regularly, especially during construction.

BMP #113 - Clearing Limits

DESCRIPTION

Minimize the total amount of bare soil exposed to erosive forces by (1) controlling the amount of ground that is cleared and grubbed at one time in preparation for construction, and (2) limiting the amount of time that bare ground may remain exposed before slope protection or stabilization measures are put into place. This measure, in conjunction with appropriate timing (avoiding the rainy season) , can reduce erosion and sedimentation.

Targeted Pollutants

- ● Sediment
- ○ Phosphorus
- ○ Trace metals
- ○ Bacteria
- ○ Petroleum hydrocarbons

APPLICATIONS

Any areas where vegetation must be removed to facilitate construction. This practice should be a design consideration of all projects. It may be necessary to carefully coordinate land clearing, grading, and erosion control measures--see BMP #110-Timing of Construction.

Physical Limits

Drainage area	unlimited
Max slope	unlimited
Min bedrock depth	N/A
Min water table	N/A
SCS soil type	ABCD
Freeze/Thaw	good
Drainage/Flood control	no

LIMITATIONS

None.

DESIGN PARAMETERS

- Evaluate the erosion potential of the project site (based on slope, soil type, intended season of work, use of heavy equipment).
- Based on the above analysis, establish the maximum allowable area that may be exposed at one time. The project site plan should clearly specify the maximum allowable exposure area.
- Initiate slope protection and reclamation as work progresses to help minimize the amount of disturbed soil.
- In all cases, stabilization measures should be initiated within 14 days after ceasing work in a given area or as soon as practicable during seasonally arid periods.

CONSTRUCTION GUIDELINES

- Do not disturb any areas that are not actually needed for the specified construction or related staging activities. See BMP #112-Preservation of Existing Vegetation.

- Conduct work in units or stages so that construction and stabilization take place promptly after clearing and grubbing and as much of the site as possible is ready for seeding each time the specified seeding season arrives.
- Implement soil stabilization measures concurrently with the progress of clearing and grading work to minimize the length of time that bare ground lies exposed to erosion.
- At the approach of a designated seeding season, be prepared to seed all portions of the project that are ready for seeding (as required).

MAINTENANCE

Conduct periodic inspections to check for unnecessary ground disturbance. Also check for clearing and grubbing beyond the contractor's capability and progress in keeping grading and pollution control measures current (in accordance with accepted work schedule).

BMP #114 - Stabilization of Construction Entrance and Roads

DESCRIPTION

A temporary sediment removal device--normally a pad of crushed rock or stone-can be installed at the approach from a construction site to a public roadway, to stabilize the road. This BMP is used to limit sediment tracking from vehicles and equipment leaving the construction site onto public rights-of-way and streets.

Targeted Pollutants

- Sediment
- Phosphorus
- Trace metals
- Bacteria
- Petroleum hydrocarbons

Physical Limits

Drainage area	unlimited
Max slope	15 %
Min bedrock depth	3 feet
Min water table	NA
SCS soil type	ABCD
Freeze/Thaw	good
Drainage/Flood control	no

APPLICATIONS

A stabilized construction entrance (SCE) is appropriate 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 there is risk of transporting mud or sediment onto paved roads.

LIMITATIONS

This control measure is not necessarily needed for temporary roads within the construction site (see BMP #115-Erosion Prevention on Temporary Roads).

DESIGN PARAMETERS

Width: The width should be at least 10 ft (3 meters) 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 turning radius.

Length: The minimum length should be 50 ft (15 meters) except on a single residence lot where a 30 ft minimum would apply.

Depth: Total depth of rock should be at least 6 inches (385 mm).

Aggregate: Fractured stone 2 to 8 in (50 to 200 mm) in diameter (for the base layer) and crushed stone 2 in (50 mm) in diameter or, reclaimed or recycled concrete equilavent.

Geotextile (filter fabric): Most installations will include geotextile (filter fabric) with the properties listed in the table below, to be placed over the entire area to be covered with aggregate. Work on single residential lots will generally not need

geotextile unless there's potential for excessive erosion, a high water table or other risk factor.

Stabilization of Construction Entrance/Roads/Driveways

The geotextile shall be a woven or nonwoven fabric consisting only of continuous chain polymeric filaments or yarns of polyester. The geotextile shall be inert to commonly encountered chemicals, hydro-carbons, mildew, rot resistant, and conform to the properties of the following table:

Geotextile Properties	Light Duty[1] Roads Grade Subgrade	Heavy Duty[2] Haul Roads Rough Graded	Test Method
Grab Tensile Strength (lbs)	200	220	ASTM D1682
Elongation at Failure (%)	50	60	ASTM D1682
Mullen Brust Strength (lbs)	190	430	ASTM D3786
Puncture Strength (lbs)	40	125	ASTM D751 modified
Equivalent Opening Size	40-80	40-80	US Std Sieve CW-02215
Aggregate Depth (in)	6	10	--

[1]Light Duty Road: Are sites that have been graded to subgrade and where most travel would be single axle vehicles and an occasional multi-axle truck. Trevira Spunbond 1115, Mirafi 100X, Typar 3401, or equivalent.

[2]Heavy Duty Road: Are sites with only rough grading, and where most ravel would be multi-axle vehicles. Trevira Spunbond 1135, Miraft 600X, or equivalent.

[3]Geotextiles not meeting these specifications may be used only when design procedure and supporting documentation are supplied to determine aggregate depth and fabric strength.

Drainage: Runoff from a stabilized construction entrance should drain to a sediment trap or a sediment basin. Piping of surface water under the entrance shall be provided as needed. If piping is impossible, install a mountable berm with 5:1 slopes.

Dust Control: Dust control should be provided at all times (see BMP #116-Dust Control).

CONSTRUCTION GUIDELINES

- Clear all vegetation, roots, and all other obstructions in preparation for grading.
- Prior to placing geotextile (filter fabric), make sure that the entrance is properly graded and compacted.
- To reduce maintenance and loss of aggregate, place geotextile over the existing ground before placing the stone for the entrance.
- Place a 1 ft (300 mm) layer of fractured stone over the entire width and length of the entrance.
- Place a 4 in layer of 2 in (100 mm layer of 50 mm) crushed stone over the base layer.

MAINTENANCE

The entrance must be maintained in a condition which will prevent tracking or flow of mud onto public rights-of-way. This may require periodic top dressing with additional 2 in (50mm) stone (as conditions demand) and repair or clean-out of any structures used to trap sediment.

All materials spilled, dropped, washed, or tracked from vehicles onto roadways or into storm drains must be removed immediately. When necessary, vehicle wheels must be cleaned to remove sediment prior to entrance onto public rights-of-way. When washing is required, it shall be done on an area stabilized with aggregate which drains into an approved sediment trap.

Trapped sediment shall be removed from the site or stabilized on site and prevented from entering storm drains, ditches or watercourses. Disturbed soil areas resulting from removal shall be permanently stabilized.

The stabilized construction entrance may be removed after final site stabilization is achieved or after the temporary BMPs are no longer needed.

BMP #115 - Erosion Prevention on Temporary and Private Roads

DESCRIPTION

Targeted Pollutants

- Sediment
- Phosphorus
- Trace metals
- Bacteria
- Petroleum hydrocarbons

Physical Limits

Drainage area	unlimited
Max slope	15%
Min bedrock depth	3 ft
Min water table	N/A
SCS soil type	ABCD
Freeze/Thaw	good
Drainage/Flood control	no

Any of several measures can be used to control erosion and sedimentation originating with haul roads, detours, access roads, and other unpaved or temporary roadbeds associated with a construction project. Possible measures include :

Road Placement: Place temporary roads as far as possible away from streams, surface waters or wetlands .

Open-Top Box Culvert: A wooden culvert installed across the road grade to convey surface runoff and roadside ditch flows to the downslope side. Open-top box culverts are useful for collecting surface runoff and ditch flows and channeling this water across the road without eroding the drainage system or road surface.

Waterbar (or Cross Ditch): A cut and berm built at a downward angle across the roadway, extending from the cutbank to the opposite fill shoulder. Waterbars reduce erosion by diverting storm water runoff from the road surface and directing it to a safe discharge area.

Road Sloping: Constructing the road with an outward slope of 1 to 2 percent from the cut slope to the fill slope. Sloped roads are designed to divert surface water off the entire road surface so that water does not concentrate in any specific location.

Rolling Dip: Constructing the road with shallow, outward-sloping dips or undulations to collect surface runoff and convey it away from the road surface.

Level Spreader: A drainage outlet constructed by cutting a shallow trench at zero grade across a slope to disperse concentrated runoff. Level spreaders convert concentrated flow into sheet flow for discharge at nonerosive velocities onto areas stabilized by vegetation. By reducing runoff velocity, they help reduce erosion, enable sediment to settle out, and enhance infiltration.

APPLICATIONS

Open-Top Box Culvert: Used, as a substitute for pipe culverts, for cross drainage on lightly used, unpaved roads on steep grades (greater than 6 percent).

Waterbar: Used as a temporary or permanent drainage facility on light-use, low-maintenance, unpaved roads. Waterbars should be placed above grade changes to prevent water from flowing down steeper portions of roads or skid trails. Bars may also be placed above intersections of roads, skid trails, or landings to protect these disturbed areas.

Road Sloping: Used as a drainage measure on temporary or low-traffic haul roads where erosion of the roadbed and fill slope is unlikely due to low runoff volume or intensity.

Rolling Dip: Used as a runoff diversion measure to prevent erosion of the road surface. Rolling dips are effective on long inclines to keep storm water from flowing directly down the road, where it may cause gullying and other damage to the road surface and grade.

Level Spreader: Useful where concentrated runoff from bare ground or other unstabilized areas can be diverted onto stabilized areas under sheet flow conditions. Level spreaders are often placed at the outlets of diversion dikes or runoff interception trenches to control runoff, dissipate water velocity, and disperse the water over a broad surface area. Level spreaders are relatively inexpensive to install. They may be used on slopes of 3:1 or flatter.

LIMITATIONS

Open-Top Box Culvert: Generally, box culverts are not required on grades of 6 percent or less and are ineffective under continuous or recurrent use where cleaning is sporadic.

Waterbar: Suitable only for light-use, low-maintenance, unpaved roads.

Road Sloping: Suitable only for low-traffic haul roads where runoff volume and intensity are low.

Rolling Dip: Not suitable on road grades steeper than 5 percent.

Level Spreader: Level spreaders are not recommended for use in most situations. They are not suitable on slopes steeper than 3:1 or where the soils are easily erodible. They should be constructed only on natural soils, not on fill material. Level spreaders cannot handle large quantities of sediment-laden storm water. If altered by erosion or other disturbance, they may "short circuit" and actually concentrate flows into small streams instead of spreading the flows into sheet flow.

DESIGN PARAMETERS

Open-Top Box Culvert: Box culverts can be built from logs; lumber; discarded guardrail; or commercial, corrugated steel. They are installed at a skewed angle downgrade across the roadway, with the discharge end extending 6 to 12 in (150 to 300 mm) beyond the surface of the roadbed.

Spacing between culverts should be in accordance with recommended cross drainage spacing in Table 1. Where recommended spacing is less than 33 ft (10 meters), the road should be paved with gravel or crushed rock.

Waterbar: Waterbars are generally constructed using a blade-equipped tractor or by hand. The size of the waterbar depends on the amount of precipitation in the area, the soil erodibility, and anticipated traffic.

- The waterbar should extend from the cutbank side of the road completely across to the fillslope side.
- Cut dimensions: Up to 16 in (400 mm) deep across road, 8 to 16 in (200 to 400 mm) deep at outlet, 3 to 4 ft (1.0 to 1.2 meters) wide.
- Berm dimensions and orientation: 1 to 2 ft (300 to 600 mm) high 5 in (150 mm) minimum height, skewed at angle of 30^{o} to 40^{o} across road.
- Spacing between bars: Use Table 1, for recommended cross drain spacing on low to relatively moderately steep topography.
- Discharge: Runoff should not be directed onto fill material without proper energy dissipation and drainage away from the fill.

Road Sloping:

- The slope should be approximately 1 to 2 percent from the cut slope outward to the fill slope.
- Berms on the outside of the road should be limited or removed to allow water to flow off the road surface.
- Provide sediment collection or erosion-control measures at the toe of the fill slope to prevent excessive erosion and sediment transport.

Rolling Dip: (applies to roads greater that 150 ft long only)

- The dip should be approximately 1 ft (0.3 meter) below the surface plane of the road. The upgrade approach to the bottom of the dip should be approximately 66 ft (20 meters) long. The downgrade approach to the bottom of the dip should be approximately 23 ft (7 meters) long.
- Align the dip across the road at nearly a 90-degree angle and slope it outward approximately 5 percent.

Table 1. Recommended Cross Drain Spacing (Source: ITD, 1994)

Road Grade (percent)	Spacing Between Open-Top Culverts, feet (meters)
2 to 5	300 to 500 (90 to 150)
6 to 10	200 to 300 (60 to 90)
11 to 15	100 to 200 (30 to 60)
16 to 20	<100 (<30)

CONSTRUCTION GUIDELINES

Open-Top Box Culvert: Construct a box-like frame (three-sided, open-topped) of logs; lumber; discarded guardrail; or commercial, corrugated steel. Install it flush with the road surface, skewed at an angle downgrade across the roadway. Set the inflow end at the same grade as the side ditches on the road and extend it into the cut bank. The discharge end should extend 6 to 12 in (150 to 300 mm) beyond the surface of the roadbed and should be directed onto vegetated ground or riprap or into another erosion-control structure such as a sediment trap or catch basin.

Waterbar: Cut each waterbar into solid soil to a minimum depth of 6 in (150 mm) next to the cutbank and 8 in (200 mm) at the road shoulder, with an adverse grade on the downroad or downgrade side of the waterbar. Build a continuous, firm berm of soil, at least 6 in (150 mm) above normal grade, parallel to the waterbar cut on its downhill side. Include a bank tie-in point, cut 6 to 12 in (150 to 300 mm) into the roadbed. For added stability, the bar may be compacted with a nonerosive fill material. The completed waterbar must extend across the full roadway width, aligned at an angle of 30^{o} to 40^{o} relative to the roadway. A dissipation or filter device (such as riprap or silt fence) may be needed below the waterbar to control erosion and trap sediment.

Road Sloping: Road sloping is built into the road during construction. Install erosion- and sediment-control measures downslope before completing the finish grade of the sloped road. Then construct the outward slope of 1 to 2 percent, as specified in the contract plans.

Rolling Dip: Rolling dips are built into the road, during construction, following the natural contours of the land. Install erosion and sediment measures at the low point of the dip (drainage outfall to fillslope) before final grading to direct storm water discharge from the dip. Construct the dip according to the specifications shown in the contract plans. If not specified, make the dip 1 ft (300 mm) deep, with a 23 ft (7-meter)-long approach on the downgrade side and a 66 ft (20-meter)-long approach on the upgrade side.

MAINTENANCE

Inspect all devices regularly according to provisions of the contract or project site plan. Make repairs promptly to avoid progressive damage. Remove accumulated sediments as necessary to ensure proper functioning.

Open-Top Box Culvert: Clean and repair the culverts on a regular basis. Remove sediments and other debris which may block drainage flow or decrease structural efficiency.

Waterbar: Properly constructed bars should require little or no maintenance. However, all waterbars need to be open at the lower end so water can easily flow away from the roadway. Hand shovel work may be necessary following high runoff periods or severe storms to ensure unrestricted flow.

Road Sloping: Minor regrading may be required to maintain slope angle.

Rolling Dip: Outflows should be kept free of debris to prevent ponding.

BMP #116 - Dust Control

DESCRIPTION

This fact sheet describes products or measures used for reducing or preventing wind erosion by protecting the soil surface, roughening the surface reducing the surface wind velocity. Several dust control treatments are described below. Other methods are also available .

Vegetative Cover: For disturbed areas not subject to traffic, vegetation provides the most practical method of dust control (see BMP #145-Seeding and BMP #146-Sodding).

Mulch (including gravel mulch): When properly applied, mulch offers a fast, effective means of controlling dust (see BMP#121-Mulching).

Spray-On Adhesive: Asphalt emulsions, latex emulsions, or resin in water can be sprayed onto mineral soil to prevent their blowing away (see BMP #122-Hydromulching).

Sprinkling: The site may be sprinkled with water until the surface is wet. Sprinkling is especially effective for dust control on haul roads and other traffic routes.

Stone: Stone or gravel used to stabilize construction roads and disturbed soils can also be effective for dust control and reduce soil losses from those areas by up to 80 percent.

Surface Roughening: Tilling or discing the surface of disturbed soils to produce a rough surface or ridges which when perpendicular to prevailing winds can reduce soil losses due to wind by 80 percent (see BMP #126-Slope Roughening).

Targeted Pollutants

- ● Sediment
- ○ Phosphorus
- ◒ Trace metals
- ○ Bacteria
- ◒ Petroleum hydrocarbons

Physical Limits

Drainage area	N/A
Max slope	5%
Min bedrock depth	N/A
Min water table	N/A
SCS soil type	N/A
Freeze/Thaw	N/A
Drainage/Flood control	no

Barriers: A board fence, wind fence, sediment fence, or similar barrier can control air currents and blowing soil. All of these fences are normally constructed of wood. Perennial grass and stands of existing trees may also serve as wind barriers. Barriers prevent erosion by obstructing the wind near the ground and preventing the soil from blowing off-site.

APPLICATIONS

The above measures for dust control should be used when open dry areas of soil are anticipated on the site. Clearing and grading activities create the opportunity for large amounts of dust to be blown. Therefore, one or several dust control measures should be considered prior to clearing and grading. In many cases, water erosion control measures incorporated into the project will indirectly prevent wind erosion.

As a standard practice, any exposed area should be stabilized using vegetation to prevent both wind and water erosion. When rainfall is insufficient to establish vegetative cover, mulching is an effective way of conserving moisture, preventing

surface crusting, reducing runoff and erosion, and helping to establish vegetation. It is a critical treatment on sites with erosive slopes.

LIMITATIONS

Vegetative measures may not be practical during dry periods unless a reliable supply of establishment water is available. Other methods should be stipulated in the project contract to ensure that dust control is not overlooked.

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.

DESIGN PARAMETERS

Dust Prevention: The best method of controlling dust is to prevent dust production. This can best be accomplished by limiting the amount of bare soil exposed at one time. In project design, identify all areas where ground disturbance will not be allowed. Design and locate haul roads, detours, and staging areas to avoid unnecessary exposure of bare ground and avoid using areas that are the most susceptible to wind erosion.

In the stormwater site plan, specify staging or work sequencing techniques that minimize the risk of wind erosion from bare soil. In most cases, this will require a change from traditional construction techniques that allow large areas to be disturbed at the outset of construction and to remain exposed for long periods of time.

Vegetative Cover: Follow recommended seeding and planting specifications. If site conditions are favorable, use an extended seeding season to ensure that seeding becomes established over as much of the project as possible before winter shutdown or substantial completion. Specify the use of establishment water to accelerate vegetative stabilization if other means of long-term slope protection are not feasible.

Mulch: Apply according to the design parameter for BMP #121.

Sprinkling: Apply at a rate of 3.2 gallons per acre (35 liters per hectare) so that the soil is wet but not saturated or muddy and so that air quality requirements are maintained.

Stone: At ingress/egress to public highways, apply as indicated in BMP #114-Stabilization of Construction Entrance. For detours, haul roads, or temporary traffic routes through the construction site, provide a 2.4 in (60 mm) minimum thick layer of fractured stone 1 to 2 in (25 to 50) mm in diameter. Also see BMP#115-Erosion Prevention on Temporary Roads.

Surface Roughening: Tilling or discing should leave 6 in (150 mm) (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 in (150mm) irregular surface.

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 in conjunction with the barrier.

CONSTRUCTION GUIDELINES

Site Assessment: Assess the potential problem of wind erosion and dust generation at the project site. Consider the soil type, prevailing wind direction, and the effect of other prescribed erosion control measures.

Use Preventive Strategies Wherever Possible:

- Minimize amount of bare ground exposed at one time.
- Minimize amount of ground disturbance occurring when wind erosion is highest.

Implement Dust Control Measures as Needed:

- Provide stabilized roadway to minimize amount of dust generated by construction vehicles and highway traffic (gravel, pave or moisten the bare areas of the highway or detour route).
- Apply protective materials to exposed areas (e.g., stone, mulch, adhesive/ emulsions).
- Install barriers to prevent dust from blowing off site.
- Establish vegetation at the earliest possible opportunity (using establishment water if necessary to ensure viability).
- Keep haul roads, detours, and other bare areas moist by sprinkling them with water.

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 set forth in the stormwater plan. Remove sediments that accumulate behind any sediment fence or barrier when the accumulation reaches one half the height of the barrier. Dispose of the sediments only in an approved location (not in wetlands or where they will contribute to pollution at the disposal site).

Apply chemical controls (emulsions and resins) at the manufacturer's specified rates and in accordance with all federal, state, and local regulations governing their use. Chemical products must be stored, handled, and disposed of in accordance with all applicable regulations and department policies.

BMP #117 - Cover for Materials and Equipment

DESCRIPTION

This BMP includes partial or total physical enclosure of materials, equipment, process operations, or activities. Covering prevents stormwater from coming into contact with potential pollutants and reduces material loss from wind blowing. Tarpaulins, plastic sheeting, roofs, buildings, and other enclosures are examples of covering that are effective in preventing stormwater pollution. Covering can be temporary or permanent.

Targeted Pollutants

- ● Sediment
- ○ Phosphorus
- ● Trace metals
- ○ Bacteria
- ● Petroleum hydrocarbons

APPLICATIONS

Covering is a simple, effective, and usually inexpensive way of reducing or preventing pollution. It is appropriate for outdoor material storage piles, such as stockpiles of dry materials, topsoil, spoils piles, gravel, sand, compost, sawdust, wood chips, and building materials. It is also effective where containers of liquids or solids are stored or transferred. Although it may be too expensive to cover or enclose all construction activities, the high-risk parts of a site can often be separated and covered. For example, chemical preparation areas, vehicle maintenance and washing areas, storage areas for chemically treated products and toxic wastes (e.g., used oils).

Physical Limits

Drainage area	N/A
Max slope	N/A
Min bedrock depth	N/A
Min water table	N/A
SCS soil type	N/A
Freeze/Thaw	N/A
Drainage/Flood control	no

LIMITATIONS

- Covering alone may not protect exposed materials from contact with stormwater runoff/run-on.
- Requires frequent inspections. Consider curbing or an elevated platform to prevent pollution from run-on water.

DESIGN PARAMETERS

In selecting an appropriate covering, evaluate the strength and longevity of the covering, as well as its compatibility with the materials or items being enclosed. Cost, aesthetics, weather conditions, drainage patterns, and size of the stockpiles or storage area are other factors affecting the choice of covering.

- In designing a covering for materials, remember to provide adequate access for loading, handling, and transfer. Cost considerations may justify a less-than-optimum access arrangement in some cases. For instance, tarpaulins and plastic sheeting have to be removed or rearranged to allow continued access as materials are depleted, but they are less expensive than a permanent structure such as a roof or shed.

- Climate or weather conditions also influence the choice or design of a covering. Tarpaulins and sheeting may be difficult to keep secured in extremely windy areas.

- Where a permanent structure is indicated for a particular area or activity, consider building a roof instead of a complete enclosure. This will reduce costs and may also eliminate the need for ventilation and lighting systems that could be needed in a building.

- Consider the nature of the materials being enclosed, especially if they pose environmental or safety dangers. Materials that are biological, flammable, explosive, or chemically reactive require special ventilation and temperature control measures.

- Covering alone may not protect exposed materials from stormwater contact. Where stormwater runon is a potential problem, place the material on an elevated, impermeable surface or build curbing around the outside of the materials to prevent poluution of stormwater from adjacent areas.

CONSTRUCTION GUIDELINES

Tarpaulins and 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 one meter along the border of separate sheets and securely anchor the overlap area so that it does not separate (through wind or other causes), allowing water to leak into the protected materials.

Roofs, Sheds, and Buildings: Construct according to plans or drawings in accordance with existing building codes and departmental standards for such construction.

MAINTENANCE

Frequently inspect coverings for damage and general wear. Repair or replace them immediately, as needed.

BMP #118 - Spill Prevention and Control

DESCRIPTION

Targeted Pollutants

- ○ Sediment
- ○ Phosphorus
- ◒ Trace metals
- ○ Bacteria
- ◒ Petroleum hydrocarbons

Physical Limits

Drainage area	N/A
Max slope	N/A
Min bedrock depth	N/A
Min water table	N/A
SCS soil type	N/A
Freeze/Thaw	N/A
Drainage/Flood control	no

This fact sheet describes methods of minimizing exposure of pollutants to storm water runoff by enclosing any drips, overflows, leaks, and other liquid material releases or by isolating pollutant spills from stormwater runoff.

There are numerous spill containment methods, ranging from large structural barriers to simple, small drip pans. The benefits vary based on cost, maintenance requirements, and the size of spill control. Three possible options are discussed below:

Containment Diking: Temporary or permanent earth berms, concrete berms, or retaining walls designed to hold spills. Diking is one of the best protective measures against stormwater pollution because it surrounds the area of concern and holds the spill, keeping spill materials separated from the storm water outside of the diked area. Diking is one of the most common types of spill containment. Also see BMP #140-Earth Dike and BMP #142-Temporary Berms.

Curbing: Like containment diking, curbing is a barrier that surrounds an area of concern. It prevents spills or leaks from being released to the environment by routing runoff to treatment or control areas. The terms "curbing" and "diking" are sometimes used interchangeably, but curbing is usually small scale and cannot contain large spills like diking can.

As with diking, common materials for curbing include earth, concrete, synthetic materials, metal, or other impenetrable materials. Asphalt is also a common material used in curbing.

Drip Pans: Pans used to contain very small volumes of leaks, drips, and spills. Drip pans can be depressions in concrete, asphalt, or other impenetrable materials, or they can be made of metals, plastic, or any material that does not react with the dripped chemicals. Empty or discarded containers may be used as drip pans. Catch drips so that the materials or chemicals can be cleaned up easily or recycled before they can contact stormwater. Drip pans can be a temporary or permanent measure.

APPLICATIONS

Containment Diking: Diking can be used at any construction site, but it is most commonly used for controlling large spills or releases from liquid storage areas and liquid transfer areas. It is an effective containment method around tank truck loading and unloading areas. Proper diking contains spills, leaks, and other releases and prevents them from flowing into runoff conveyances, nearby streams, or infiltration

into groundwater. It also allows for proper disposal and/or recycling of materials captured within the dike.

Curbing: Curbing is usually small scale; it cannot contain large spills like diking can. However, many facilities use curbing to contain small areas used for handling and transferring liquid materials.

Curbing is already a common practice. It is inexpensive, easy to install, and provides excellent control of run on. As with diking, materials spilled within a curbed area can be collected for proper disposal and/or recycling.

Drip Pans: Drip pans can be used at any site where valves and piping are present and the potential for small-volume leakage and dripping exist. Although leaks and drips should be repaired and eliminated as part of preventive maintenance programs, drip pans can provide a temporary solution where repair or replacement must be delayed. In addition, drip pans can be an added safeguard when they are positioned beneath areas where leaks and drips may occur.

Drip pans are inexpensive, easy to install, and simple to operate. They allow for reuse or recycling of the collected material.

LIMITATIONS

Containment Diking:

- May be too expensive for some smaller facilities.
- Requires maintenance.
- Could collect polluted stormwater, with possibe infiltration to ground water.

Curbing:

- Not effective for holding large spills.
- May require more maintenance than diking.

Drip Pans:

- Suitable only for small volumes.
- Must be inspected and cleaned frequently.
- Must be secured during poor weather conditions.
- Requires that personnel are trained in proper disposal methods so that contents are not disposed of improperly.

DESIGN PARAMETERS

Containment Diking:

- Size: For tank truck loading and unloading operations, the diked area should be capable of holding an amount equal to any single tank truck compartment.
- Materials: Materials used to construct the dike should be strong enough to safely hold spilled materials. The materials used usually depend on what is available on site and the substance to be contained. Dikes may be made of earth (i.e., soil or clay), concrete, synthetic materials (liners), metal, or other impervious materials. Containment dikes may need to be designed with impervious materials to prevent leaking or pollution of stormwater, surface water, and ground water supplies.
-
- In general, strong acids and bases may react with metal containers, concrete, and some plastics. So where spills may consist of these substances, other alternatives should be considered. Some of the more reactive organic chemicals may also need to be contained with special liners. If uncertain about the suitability of certain dike construction materials, refer to the *Material Safety Data Sheet* (MSDS) for the chemical being contained.

Curbing: When using curbing for runoff control, protect the berm by limiting traffic and installing reinforced berms in areas of concern.

Materials spilled within a curbed area can be tracked outside of that area when personnel and equipment leave the area. This tracking can be minimized by grading within the curbing to direct the spilled materials to a downslope side of the curbed area. This will keep the materials away from personnel and equipment that pass through the area. It will also allow the materials to accumulate in one area, making cleanup much easier.

Manual or mechanical methods, such as those provided by sump systems, can be used to remove accumulated material from a curbed area.

Drip Pans: When using drip pans, consider local weather conditions, the location of the drip pans, materials used for the drip pans, and how the pans will be cleaned.

The location of the drip pan is important. Because drip pans must be inspected and cleaned frequently, they must be easy to reach and remove. Take special care to avoid placing drip pans in precarious positions such as next to walkways or on an uneven surface. Drip pans in these locations are easily overturned and may present a safety or environmental hazard.

Weather is also an important factor. Heavy winds and rainfall can move or damage drip pans because the pans are small and lightweight. To prevent this, secure the pans by installing or anchoring them. Drip pans may be placed on platforms or behind wind blocks or may be tied down.

MAINTENANCE

Containment Diking: Inspect containment dikes during or after significant storms or spills to check for washouts or overflows. In addition, regular testing to ensure that

dikes are capable of holding spills is recommended. Soil dikes may need to be inspected on a more frequent basis.

Changes in vegetation, inability of the structure to retain stormwater dike erosion, or soggy areas indicate problems with the dike's structure. Damaged areas should be patched and stabilized immediately, where necessary. Earthen dikes may require special maintenance of vegetation, such as mowing and irrigation.

When evaluating the performance of the containment system, pay special attention to the overflow system, since it is often the source of uncontrolled leaks. If overflow systems do not exist, accumulated stormwater should be released periodically. Polluted stormwater should be treated prior to release. Mechanical parts (such as pumps) or manual systems (slide gates, stopcock valves) may require regular cleaning and maintenance.

Curbing: Since curbing is sized to contain small spill volumes, frequent maintenance is needed to prevent overflow of any spilled materials. Inspect all curbed areas regularly and clean clogging debris. Repair the curb by patching or replacing it as needed to ensure effective functioning. Inspections should be conducted before forecasted rainfall events and immediately after storm events. If spilled or leaked materials are observed, cleanup should start immediately to allow space for future spills. In addition, prompt cleanup of spilled materials will prevent dilution by rainwater, which can adversely affect recycling opportunities.

Drip Pans: For drip pans to be effective, site operators must pay attention to the pans and empty them when they are nearly full. Because of their small holding capacities, drip pans will easily overflow if not emptied. Also, recycling efforts can be affected if stormwater accumulates in drip pans and dilutes the spilled material. It is important to have clearly specified and easily followed practices of reuse/recycle and/or disposal, especially the disposal of hazardous materials. Consider dumping the drip pan contents into a nearby larger-volume storage container and periodically recycling the contents of the storage container.

Frequent inspection of the drip pans is necessary due to the possibility of leaks in the pan itself. Also check for random leaking of piping or valves and for irregular, slow drips that may increase in volume. Conduct inspections before forecasted rainfall events to remove accumulated materials. Empty accumulations immediately after each storm event.

BMP #119 - Vehichle/Equipment Washing and Maintenance

DESCRIPTION

A typical system is a lined, depressed area that collects the water used in washing off the trucks, cars, or other construction vehicles/machinery, and drains it into a collection or treatment system.

Targeted Pollutants

- ● Sediment
- ● Phosphorus
- ● Trace metals
- ○ Bacteria
- ● Petroleum hydrocarbons

APPLICATIONS

A wash down area is used on projects where the soil is silty or heavy in clay, and has the likelihood of transporting dirt and mud offsite. Projects that will take place over the course of the rainy season, and areas where water is expected to be encountered (high ground water table) in the normal course of the project should be considered as candidates.

Physical Limits

Drainage area	N/A
Max slope	5%
Min bedrock depth	N/A
Min water table	N/A
SCS soil type	N/A
Freeze/Thaw	N/A
Drainage/Flood control	no

LIMITATIONS

Washing vehicles generates liquid, semi-solid and solid wastes. These wastes must be contained on-site or treated to prevent pollution of surface and ground water.

Off-site: Treatment is required for all discharges to waters of the State since it could be contaminated with degreasers, hydrofluoric acid, hydrochloric acid, nitric acid, phosphoric acid, oil, hydraulic fluids, lubrication, and engine cleaning solvents. Waters of the State are all surface waters (canals, rivers, ponds, streams and lakes), and all ground water.

Contact the local permitting authority to determine proper disposal methods.

On-site: If wash water discharge to a sediment pond is the system of choice, sufficient acreage is required for the operation.

DESIGN PARAMETERS

Detergents used for vehicle washing should not contain phosphates. Phosphates are a plant nutrient that can cause excessive growth of aquatic plants when discharged into a stream or lake.

A stabilized construction entrance and road (BMP #114), to reduce off-site tracking of mud, dirt and rocks, should be installed at the vehicle wash/maintenance area. Washing and maintenance should be conducted in disturbed areas (staging area), but not in a cut or fill area until grading has been performed, and not where there

will be a high volume of construction traffic. Highly erodible soils or frequently wet areas should be avoided.

Off-site discharge options:

- Lagoon: Pond-like structure that works on the principle of evaporation, is easy to install and requires low maintenance. There is a need to be aware of safety issues (fencing the area from the public).
- Land application system: Large land area is required. This alternative is the lowest in out-of-pocket cost.
- Filtering and recycling of wash water: A good option for conservation measures. Initially, expense would be high. Monitoring of the operation would be more intensive.
- Municipal waste water treatment plant: This option is available only in areas where a municipal waste water treatment plant exists and the operation is capable of handling the load. This is the best option for limiting liability for larger construction projects.

CONSTRUCTION GUIDELINES

Designate an area that can be graded and bermed. The design should collect waste water for evaporation or direct it to an off-site containment or treatment system. A lined pond should be used where pollutants such as oil, grease, fuels, etc., may reach the high ground water table.

MAINTENANCE

Check system for integrity. Are the controls working as designed? Clean up sediments that have been tracked by vehicles onto nearby roadways.

BMP #120 - Waste Management

DESCRIPTION

This BMP entails meeting the regulatory requirements of hazardous waste management which includes hazardous waste determination; acquiring an EPA identification number; accumulation; record keeping reporting; and transportation manifesting. Good housekeeping will minimize the contribution of pollutants to stormwater discharges by handling and storing hazardous materials onsite in a clean and orderly manner.

Targeted Pollutants

- Sediment
- Phosphorus
- Trace metals
- Bacteria
- Petroleum hydrocarbons

APPLICATIONS

Compliance with applicable regulations will protect human health and the environment from hazardous waste generated by construction activities, reduce liability, and prevent unnecessary interruptions to schedules (i.e., project shut down due to environmental investigations/enforcement actions). The first step in preventing pollution of stormwater runoff is to maintain a clean and orderly work environment. This will reduce the possibility of accidental spills. Common sense is the simplest, inexpensive method to utilize. Improving the operation and maintenance of industrial machinery; material storage practices; material inventory controls; routine and regular clean-up; maintaining well organized work areas; and educational programs for employees regarding these practices will assist in reaching these goals.

Physical Limits

Drainage area	N/A
Max slope	N/A
Min bedrock depth	N/A
Min water table	N/A
SCS soil type	N/A
Freeze/Thaw	N/A
Drainage/Flood control	no

LIMITATIONS

Carelessness and poor judgment often result in problems associated with the disposal of hazardous materials. Not being fully aware of all the hazards at the site could increase the potential for mishandling of such wastes, resulting in stormwater contamination.

DESIGN PARAMETERS

Select a designated waste collection area on-site. Secure an adequate number of containers with lids or covers. If possible provide a covered area or spill containment pallets. Arrange for waste collection before containers overflow (additional containers and more frequent pick-ups will be needed during the demolition phase). Provide immediate cleanup in case of a spill. Assure waste is transported and disposed of at an approved facility. A liner, concrete pad, berm, etc., should be utilized to keep waste separated and contain accidental spills, so they do not pollute stormwater

runoff. Provide labels and signs for the area to educate contractors about proper storage and handling, and to comply with regulatory requirements.

CONSTRUCTION GUIDELINES

The best way to avoid polluting runoff from outside material storage areas is to prevent stormwater run-on or rain from coming in contact with the materials. Methods that can be utilized to accomplish this are

- Identifying, controlling, and enforcing storage and disposal/stockpile areas
- Providing a barrier such as a liner, concrete pad or berm
- Protecting the storage area by:
- storing the material indoors
- covering the area with a roof
- covering the material with a temporary covering
- Engineering safeguards such as:
- overflow protection devices
- protective guards around tanks, storage area, etc.

MAINTENANCE

- Regularly pick up and dispose of all garbage and waste material.
- Make sure equipment is working properly.
- Routinely inspect for leak or conditions that could lead to discharges of chemicals or contact of stormwater:
- external corrosion and structural failure
- installation problems
- evidence of spills or overfills
- Locate storage areas away from direct traffic routes.
- Stack according to directions to avoid damage due to improper weight distribution.
- Store likes together, separate incompatible wastes.
- Assign hazardous material inventory to a limited number of people.
- Keep up-to-date inventory of all hazardous materials and wastes.

- Identify all chemical substances present at the work site.
- Label all containers with name, hazards, handling, and first aid information.
- Mark those that require special instructions.
- Cleanup of liquid or dry material spills.
- Provide initial and annual training for employees on the hazards and the proper handling procedures.
- Do not mix products together unless specifically recommended.
- Use all the product before disposing of container.
- Do not remove original product label from container until container has been completely emptied.

BMP #121 - Mulching

DESCRIPTION

Mulching is a temporary soil stabilization or erosion control practice where materials such as straw, grass, grass hay, compost, wood chips or wood fibers are placed on or incorporated into the soil surface. In addition to stabilizing soils, mulching can reduce the speed of stormwater runoff over an area. When used together with seeding or planting, mulching can aid in plant growth by holding the seed, fertilizers, and topsoil in place, by helping to retain moisture, and by insulating against extreme temperatures.

Targeted Pollutants

- ● Sediment
- ◒ Phosphorus
- ○ Trace metals
- ○ Bacteria
- ○ Petroleum hydrocarbons

Physical Limits

Drainage area	2 ac
Max slope	50%
Min bedrock depth	N/A
Min water table	N/A
SCS soil type	ABCD
Freeze/Thaw	fair
Drainage/Flood control	no

Mulching protects the soil surface from splash erosion. It retards runoff, traps sediment, and creates more favorable conditions to assist germination and the early development of plants. Common natural and synthetic (stabilizers) mulches suitable for use at construction sites include:

Vegetative materials: wheat straw, rye straw, barley straw, grass hay

Wood products: wood cellulose fibers, wood chips, bark, sawdust

Other organic materials: leaves, peat, manure, compost

Rock products: gravel, slag, crushed stone

Fabricated mulch: jute, burlap, coconut (coir), excelsior, Kraft paper string

Synthetic mulch: asphalt, vinyl, plastics, latex, rubber, adhesives or "tackifiers".

APPLICATIONS

Mulch is an immediate, effective, and inexpensive means of controlling dust and erosion and aiding revegetation of construction sites. It provides immediate protection to soils that are exposed and that are subject to heavy erosion; it retains moisture (which may minimize the need for watering); and it requires no removal because of natural deterioration of most mulching materials.

Mulching is often used alone in areas where temporary seeding cannot be used because of the season or climate. It may be used in conjunction 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 anchoring to hold it in place.

- To aid in establishing vegetation, mulch seeded and planted areas where slopes are steeper then 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 three 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, but they must be treated with nitrogen to prevent nutrient deficiency. 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 six percent because they tend to wash down slopes.

- Bark mulch is suitable for areas planted to 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.

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 the period of decomposition. Therefore, prescribed application rates of both the straw mulch and the specified fertilizer should be strictly followed. The use of 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 with other BMPs, such as BMP #127-Gradient Terracing, or BMP #132-Check Dams.

DESIGN PARAMETERS

GUIDE TO MULCH MATERIALS, RATES, AND USES				
Mulch Material	**Quality Standards**	**Application Rate 1100 ft^2 (per 100 m^2)**	**Depth and Coverage**	**Remarks**
Gravel, slag,	Washed, 3/4 to 11/2 in (20	280 ft^3 (8 m^3) (or more to ensure	2.75 to 3.1 in (70 to 80	Excellent mulch for short slopes

or crushed stone	to 40 mm) diameter with at least 30% of it larger than 3/4 in (20 mm) diameter.	90% coverage at 2.5 tons/1100 ft^2(2.3 metric tons/100 m^2).	mm uniform covering.	around woody plants and ornamentals. Use where subject to foot traffic. Approximately 42.5 lb/ft (660 $kg/m^{3)}$.
Hay or straw	Air dried, free of unwanted seeds and coarse material. Fibers should not be chopped or ground to reduce fiber length. Minimum fiber length - 8 in (200 mm).	88 TO 110 lb (40 to 50 kg) (2 to 3 bales).	50 to 80 mm to form a uniform mat through which 20 to 40% of the original ground surface can be seen.	Use where the mulching effect is to be maintained for >3 months. Subject to blowing unless kept moist, punched, or tacked down. Most common and widely used mulching material. Can be used in critical erosion areas.
Wood fiber cellulose	Dyed material should not contain any growth inhibiting factors.	22 to 33 lb (10 to 15 kg)		If used on critical areas, double the normal application rate. Apply with hydromulch. No tie-down required. Packaged in 110 lb (50 kg) bags.
Wood chips	Do not use kiln-dried or air-dried material. Chip size 1/2 x 1 1/2 in (15 x 40 mm) diameter and 1/10 to 1/2 in (3 to 15 mm thick.		2.75 to 3.1 in (70 to 80 mm) uniform depth	Applying at over the specified thickness may markedly reduce soil nutrients for a long time. Increase fertilizer 25 percent with wood chip mulch on revegetation sites.
Compost	Odorless or earthy smell	5.3 to 53 ft^3 (0.15 to 1.5m^3)	2 to 3.1 in (50 to 80 mm) uniform depth	Inexpensive, but may not be available in some areas.

Stone and gravel:

- After the gravel or stone is applied, construction traffic may move over it. Areas which 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.
- Upon completion of activities on the 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, it should be stabilized by covering it with netting, such as jute, or by spraying it with a tacking agent. See construction guidelines for more information.
- 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
- The straw fibers should be applied to form a uniform cover of loose straw through which 20 percent 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 3.1 in (50 to 80 mm). On larger slopes, straw can be blown onto the slope to achieve a uniform cover of 2 to 3.1 in (50 to 80 mm).

Wood chips:

- Due to bacterial action during decomposition, nutrient concentrations in the soil may be depressed under a layer of wood chips. Because of this, applications should not exceed the specified thickness which 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 percent to replenish soil nutrients lost due to breakdown of wood chips.

Effectiveness of mulches:

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

- Straw mulches react similarly to hydromulches, as they break down fairly rapidly. However, straw is twice as effective and at about half the cost of hydromulches. Sediment reduction by straw mulch without vegetation is 90 to 95 percent for a few months. It drops to 70 to 90 percent in 6 months, and further to 40 to 60 percent in 2 years, and 10 to 30 percent after that. Nutrient reductions are estimated at 60 to 80 percent for a few months, 50 to 70 percent in 6 months, 20 to 50 percent up to 2 years, and 0 to 10 percent beyond 2 years.

- Wood chips deteriorate more slowly than wood fiber and therefore retain their effectiveness longer. Sediment reductions of 90 to 95 percent can be expected for a year, 80 to 90 percent up to 2 years, and 50 to 60 percent beyond 2 years. Nutrient reductions of 60 to 80 percent, 50 to 70 percent, and 30 to 50 percent are estimated for the same period.

CONSTRUCTION GUIDELINES

Seeding (temporary or permanent) can take place prior to or concurrent with mulching. Other surface runoff control measures should be installed prior to seeding and mulching. If seeding is prior to mulching, mulches must 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 must be stabilized to prevent it from being damaged by water or wind (blown away). Use one of the following methods:

- Hand punching can be used on small sites, sites with rock and stone on the surface, sites with slopes which are steeper than 3:1, or sites which 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 in (100 mm)

into the slope. The bunches of straw should resemble the tufts of a toothbrush.

- Roller punching can be used on large, gently sloping sites without significant outcroppings of rock and stone. Roller punching should not be used on sites which have been wattled (unless there is adequate space between lines of wattling) or on planted sites. A roller equipped with straight studs not less than 6 in (150 mm long), from 4 to 6 in (100 to 150 mm) wide, and approximately 3/4 in (20 mm) thick, will best accomplish the desired effect. Studs should stand approximately 8 in (200 mm) 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. These are suitable for use wherever roller punching can be used. The crimpers consist of serrated disk blades, set 4 to 8 in (100 to 200 mm) 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 ft^3/ac (2.0 cubic meters per hectare) of the tacking agent or its equivalent over the straw mulch. Agents which are neutral or nearly neutral in color and of demonstrated effectiveness for the soils and climate of the application area are acceptable.

- Matting may be used on large, steep areas which cannot be punched with a roller. Jute or wood excelsior on plastic netting shall be applied over unpunched straw according to BMP #124-Matting.

MAINTENANCE

Inspect all mulched areas periodically (according to the inspection interval prescribed in the project site stormwater plan and after runoff-producing storm events. Repair damaged areas of the mulch immediately. 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.

BMP #122 - Hydromulching

DESCRIPTION

Hydraulic mulching is a process where wood fiber mulch, processed grass, hay or straw mulch are applied with a tacking agent in a slurry with water to provide temporary stabilization of bare slopes or other bare areas. This mulching method provides uniform, economical slope protection. It may be combined with hydroseeding as a revegetation method (see BMP #145-Seeding).

Targeted Pollutants

- ● Sediment
- ◒ Phosphorus
- ○ Trace metals
- ○ Bacteria
- ○ Petroleum hydrocarbons

Physical Limits

Drainage area	2 ac
Max slope	15 %
Min bedrock depth	N/A
Min water table	N/A
SCS soil type	ABCD
Freeze/Thaw	fair
Drainage/Flood control	no

APPLICATIONS

Hydraulic mulching is an effective way to increase water retention (thereby reducing erosion) for six months or up to one year. Beyond one year, the effectiveness drops off.

Hydraulic mulching can be applied to areas that are within about 200 feet (60 meters) 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 (see BMP #112-Preservation of Existing Vegetation). The mulch usually lasts about a year. The growing vegetation is needed to provide continued stabilization.

LIMITATIONS

- Loses effectiveness after one year.
- Only suited for physically stable slopes (at natural angle of repose, or less).
- Avoid hyrdraulic mulching on long uninterrupted slopes. Break up concentrated flows with other BMPs, such as BMP #127-Gradient Terracing or BMP #132-Check Dams.

DESIGN PARAMETERS

Effectiveness: Hydraulic mulching initially reduces sediment generation by 70 to 80 percent as compared to sediment production off bare slopes. Within two years, the breakdown of wood fiber will have reduced its effectiveness to 40 to 60 percent. Beyond that time, only 10 to 30 percent effectiveness can be expected, and the mulch should be replaced. Nutrient generation is typically reduced 50 to 70 percent for six months, 20 to 50 percent up to two years, and 0 to 10 percent beyond two years.

Equipment: 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 must be sufficient to produce a homogeneous slurry of tacking agent and mulch (and seed fertilizer, if used).

Application rates: Apply the water at a minimum rate of 3000 gallons per acre (28 cubic meters per hectare). Tacking agent should be applied at 28.5 ft^3 (2.0 m^3) of wet ingredients per acre (hectare) or 90 kilograms of dry ingredients per hectare.

When seeding is combined with hydraulic mulching, be sure to include an appropriate specified formulation at the specified rate. Legume seeds should be pellet inoculated with the appropriate bacteria. Inoculation rates should be four times that required for dry seeding.

CONSTRUCTION GUIDELINES

- The time allowed between placement of seed in the hydraulic mulcher and the emptying of the hydraulic mulcher tank should not exceed 30 minutes.
- Wood fiber may be dyed to aid in uniform placement. Dye 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 a period of time or the applied water will cause erosion.

MAINTENANCE

Hydraulically-mulched slopes should be inspected periodically for damage due to wind, water, or human disturbance. Repair all damaged areas immediately using hydraulic mulching at the original specifications or straw mulch.

BMP #123 - Geotextile

DESCRIPTION

Targeted Pollutants

- ● Sediment
- ○ Phosphorus
- ○ Trace metals
- ○ Bacteria
- ○ Petroleum hydrocarbons

Geotextiles are porous fabrics known in the construction industry as filter fabrics, road rugs, synthetic fabrics, construction fabrics, or simply fabrics. Geotextiles are manufactured by weaving or bonding fibers made from synthetic materials such as polypropylene, polyester, polyethylene, nylon, polyvinyl chloride, glass, and various mixtures of these materials.

The material is applied from a roll and anchored into place to provide a continuous sheet over the exposed slope or surface. This sheeting reduces raindrop impact and surface erosion on disturbed soils. It can also protect new vegetation and aid in growth and establishment of vegetation by retarding evaporation of soil moisture. They can also be used on benched slopes.

Physical Limits

Drainage area	100 ac
Max slope	100%
Min bedrock depth	N/A
Min water table	N/A
SCS soil type	ABCD
Freeze/Thaw	good
Drainage/Flood control	no

Geotextiles are used for a variety of purposes as separators or reinforcement, for filtration and drainage, and for erosion control on slopes or stream banks.

Matting or netting made of biodegradable materials (such as jute, wood fiber, straw, coconut, paper, or cotton) can be used for many of these same purposes, but is not as durable. These products are discussed separately under BMP #124-Matting.

APPLICATIONS

Geotextiles are an effective tool to prevent surface erosion and promote rapid establishment of a permanent (or temporary) vegetative cover. The two main applications are for slope protection and as a flexible channel lining. For slope protection applications, the fabrics are useful in preventing the loss of top soil, thereby reducing surface erosion and promoting establishment of vegetative cover. They should be given serious consideration where slope, high flows, or other factors prevent use of organic matting.

Used alone, geotextiles can function as erosion control matting to stabilize channels and swales or to protect recently-planted seedlings until they become established. They may be placed in ditches or along stream banks to protect new plantings if more elaborate measures such as riprap or rock revetments are not appropriate. The purpose of this application is to protect the integrity of the ditch or stream while permanent vegetative cover becomes established.

Geotextiles are also used as separators. An example of such a use is geotextile as a separator between riprap and soil. This "sandwiching" prevents the soil from being eroded from beneath the riprap.

The primary advantages of geotextiles are:

- Relatively low cost for many applications.

- Ease and convenience for many applications.
- Quick and effective protection against erosion problems.
- Design methodologies are available for many uses.
- A wide variety of geotextile products is 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 must be protected prior to installation.
- Geotextiles that are not biodegradable should not be used where their presence or appearance is aesthetically unacceptable.
- Should not be placed on 1:1 (50%) slopes if they are to be covered with overlying material.

DESIGN PARAMETERS

Maximum slope steepness: Products are available for up to 1:1 steepness.

Durability/decomposition: Some synthetic geotextiles persist a very long time and should be considered a permanent measure. Others remain effective for less than a year. Those types designed to assist in establishment of vegetation will eventually photodegrade or decompose. If a short-term, degradable product is needed, see BMP #124-Matting.

Materials: In determining how much fabric is needed, allow for an overlap of 4 in (100 mm) on both sides of each roll and 3 ft (1 m) at the ends of rolls. Also, the fabric should extend beyond the edge of the exposed area at least 1 ft (300 mm) at the sides and 3 feet (1 m) at the top and bottom. Staples should be of 1/10 in (3 mm) diameter (or heavier) steel wire. Allow for a spacing of approximately 5 ft (1.5 m) apart along the sides and center of each roll and not more than 1 ft (300 mm) apart along upper end of a roll or at the overlap of two rolls.

CONSTRUCTION GUIDELINES

- The soil must 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 rolls at least 4 in (100 mm), and make sure there is at least a 3 ft (1 m) overlap when an uphill roll joins to 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 300 mm at the sides and 3 ft (1 m) 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 in (200 mm) deep. The trench should then be backfilled and tamped.
- Staples should be driven perpendicularly into the slope face. Place them approximately 5 ft (1.5 m) apart down the sides and center of the roll, and not more than 1 ft (300 mm) apart at the upper end of a roll or at the end overlap of two rolls.
- Be sure the fabric makes uniform contact with the slope face underneath. No "bridging" of rills or gullies should be allowed.

MAINTENANCE

Inspect weekly or monthly and within 24 hours after each runoff-producing storm. To assure proper functioning, complete one inspection during the first runoff-producing event after installation. If fabric sheeting is damaged or missing, replace it immediately to restore full protection. Also inspect to ensure that channelization and erosion is not occurring underneath fabric (sediment outwash is the most visible sign of this.)

Products used for temporary control may be removed and reused, if this can be done without leaving the area susceptible to erosion.

BMP #124 - Matting

DESCRIPTION

A porous net or fibrous sheet that is laid over the ground surface for slope stabilization and erosion control, or to hold a mulch in place and protect it against wind or water damage. Matting and netting are sometimes classified as geotextiles (see BMP #123), but in this catalog, matting is considered to be materials made from biodegradable materials including straw, coconut (coir), jute, wood fiber (excelsior), paper, and cotton. Some of these organic materials may be held in place by plastic netting.

Targeted Pollutants

- ● Sediment
- ○ Phosphorus
- ○ Trace metals
- ○ Bacteria
- ○ Petroleum hydrocarbons

APPLICATIONS

A wide variety of matting materials may be used for erosion control. Most are of two main types: woven—such as jute, or bonded to plastic—such as excelsior. Application examples for these two types are listed below.

Physical Limits

Drainage area	100 ac
Max slope	100%
Min bedrock depth	2 ft
Min water table	N/A
SCS soil type	ABCD
Freeze/Thaw	good
Drainage/Flood control	no

Jute matting: Jute matting or netting is available as a heavy fiber net which is generally purchased in rolls and is stapled/anchored to slopes to provide a uniform covering. This covering protects mulches, provides additional water-holding capacity, and aids in moderating environmental fluctuations near the ground surface (as does a mulch).

Jute matting can be applied over straw, grass hay, wood fiber, or manure mulches when wind or water damage would occur without a protective net. Matting is the best single method for protecting the integrity of a mulched area. It may be applied alone as an alternative to straw or wood fiber mulches on flat sites for dust control and seed germination enhancement, but should not be applied alone where runoff quantities are significant.

Wood fiber (Excelsior) matting: Wood fiber matting is made by bonding wood excelsior fibers to a paper or plastic reinforcing net. The matting is generally purchased in rolls and stapled to slopes to provide a uniform covering which can protect mulches, provide enhanced water-holding capacity, and aid in moderating environmental fluctuations near the ground surface.

Matting can be useful in the following circumstances:

- Construction sites becoming temporarily inactive (inactive period greater than two weeks and less than one year).
- Graded areas receiving permanent revegetation treatment by seeding.
- Bare areas receiving permanent revegetation treatment by seeding.

Plastic netting: Plastic netting (photo/biodegradable) is a monolithic plastic clothlike material. It is used primarily to hold straw and other materials in place. Plastic netting is more durable than jute or wood fiber matting. It is much easier to handle and requires less labor, but has no mulch capabilities itself. Plastic netting alone provides no soil stabilization or erosion control. It is best used to hold down mulches until vegetation becomes established.

LIMITATIONS

- Should not be used where overland water flow will exceed 6.5 ft/s (2 m/s). Because of the following characteristics of plastic netting and wood fiber matting, jute matting, straw or straw coconut matting are preferred.
- Plastic netting does not function as a mulch (as does jute matting) since it does not absorb water. When plastic netting is used to anchor straw mulch, it increases the effectiveness of the mulch, but does not provide direct control of erosion and sedimentation or nutrient generation. Straw mulch rates should be increased 25 percent when plastic netting is used instead of jute or straw.
- Wood fiber matting is more difficult to put in place than jute, and is less predictable in controlling erosion. Properly applied, it can be as effective as jute matting at sediment and nutrient reduction. However, it is often 10 to 20 percent less effective.

DESIGN PARAMETERS

- Jute matting should be fiber cloth of a uniform plain weave, undyed and unbleached single jute yarn, 3 to 4 ft (1.0 to 1.2 m) wide and weighing an average 0.4 lb per linear foot (600 grams per linear meter) of cloth with a tolerance of plus or minus 5 percent. It should have approximately 78 warp ends per width of cloth and 45 weft ends per linear meter of cloth. The yarn shall be of a loosely twisted construction having an average twist of not less than 6.3 turns per 4 in (100 mm) and should not vary in thickness by more than half of its normal diameter.
- Wood fiber matting should consist of machine-produced mats of curled wood excelsior, of which 80 percent have a 8 in (200 mm) or longer fiber length. It should be of consistent thickness with the fiber evenly distributed over the entire area of the blanket (backing). The top side of each blanket should be covered with a 1 x 3 in (25 x 75 mm) weave of twisted Kraft paper or biodegradable plastic mesh that has a high wet strength. Blankets should be fire and smolder resistant and contain no chemical additives. Blankets shall be in rolls 3 to 4 ft (1.0 to 1.2 m) wide and 130 to 200 ft (40 to 60 m) long.
- Plastic netting with mesh opening from 1/10 x 1/10 in (3 x 3 mm) to 1/5 x 1/5 in (6 x 6 mm) should be applied over straw mulch similarly to the method specified below for jute matting.

Effectiveness: Jute matting acts similarly to straw mulch or hydromulch. Sediment reduction is typically 70 to 90 percent for up to 6 months, 40 to 60 percent for up to 2 years, and 10 to 30 percent beyond 2 years. Nutrient reduction is estimated at 50

to 70 percent for 6 months, 20 to 50 percent for up to 2 years, and 0 to 10 percent beyond 2 years.

Due to the difficulty of proper application, wood excelsior matting has a more variable effectiveness than straw, jute, or hydromulch. Properly applied, it can be as effective. Sediment reduction should range from 50 to 90 percent, 20 to 60 percent, and 0 to 30 percent in 6 months, 2 years, and beyond 2 years, respectively. Nutrient reductions for the same time periods are estimated to be 30 to 70 percent, 10 to 50 percent, and 0 to 10 percent.

CONSTRUCTION GUIDELINES

The following guidelines apply to all matting and netting installations.

- The soil must be reasonably smooth. Fill and compact any gullies and rills. Rocks, vegetation or other obstructions which rise above the level of the soil should be removed.
- After site preparation and seeding (if any), the rolls of netting or matting should be rolled onto the surface from the top of the slope to the bottom of the slope. It is preferred that rolls are not constructed in a horizontal direction across the slope face. The rolling should follow water flow direction.
- At the top of the area, bury the end of each roll in a trench at least 8 in (200 mm) deep. The trench should then be backfilled and tamped.
- Overlap the sides of rolls at least 4in (100 mm), and make sure that there is at least a one-meter overlap when an uphill roll joins to a downhill roll. The uphill roll should overlie the downhill roll.
- Extend the matting beyond the edge of the mulched or seeded area at least 1 ft (300 mm) at the sides and one meter at the top and bottom of the area. If existing vegetation or structures mark the boundaries of the area, the matting should continue into the stable vegetated area or to the edge of the structure.
- Staples should be driven perpendicularly into the slope face. Place them approximately 3 ft (1.0 m) apart down the sides and center of the roll, and not more than 1 ft (300 mm) apart at the upper end of a roll or at the end overlap of two rolls.
- Staples should be of heavy gauge wire 7/100 in (2 mm in diameter or greater), bent into a "U" shape, with legs at least 6 in (150 mm) long, and a 1 in (25 mm) crown. Use longer staples and greater frequency in loose or sandy soil.
- Be sure the matting makes uniform contact with the slope face underneath. No "bridging" of rills or gullies should be allowed.
- If wood fiber matting is to be applied without other mulches, the minimum thickness of mat should be 1.5 (40 mm). If the mat is to be applied over other mulches, the minimum mat thickness shall be 0.6 (15 mm).

MAINTENANCE

Inspect at regular intervals and after each runoff-producing storm event. Make repairs as necessary to restore complete coverage and full effectiveness of the matting or netting.

BMP #125 - Pipe Slope Drain

DESCRIPTION

A pipe slope drain is a device used to carry concentrated runoff from the top to the bottom of a slope that has already been damaged by erosion or is at high risk for erosion. It may be used to convey runoff from offsite around a disturbed portion of the site. It may also be used to drain saturated slopes that have the potential for soil slides. Pipe slope drains can be either temporary or permanent, depending on the method of installation and the material used.

Pipe slope drains are made of flexible tubing or rigid pipe with a prefabricated entrance section. Other temporary slope drains may use plastic sheeting, stone gutters, fiber mats, riprap, concrete or asphalt ditches, or half-round pipe. Outlet protection such as riprap must be provided for velocity dissipation at the drain outlet.

Targeted Pollutants

- ● Sediment
- ○ Phosphorus
- ○ Trace metals
- ○ Bacteria
- ◒ Petroleum hydrocarbons

Physical Limits

Drainage area	5 ac
Max slope	50%
Min bedrock depth	2 ft
Min water table	5 ft
SCS soil type	ABCD
Freeze/Thaw	good
Drainage/Flood control	yes

APPLICATIONS

Pipe slope drains are used whenever it is necessary to convey water down a slope without causing erosion. They are especially effective before a slope has been stabilized or before permanent drainage structures are ready for use. Pipe slope drains may be used with other devices, including sediment traps (BMP #137), and vegetative buffer strips (BMP #136).

Temporary pipe slope drains, usually flexible tubing or conduit, may be installed prior to the construction of permanent drainage structures. Permanent slope drains may be placed on or beneath the ground surface; pipes, sectional downdrains, paved chutes, or clay tiles may be used.

Pipe slope drains are appropriate in the following general locations:

- On cut or fill slopes before permanent storm water drainage structures have been installed.
- Where earth dikes or other diversion measures have been used to concentrate flows.
- On any slope where concentrated runoff crossing the face of the slope may cause gullies, channel erosion, or saturation of slide-prone soils.
- As an outlet for a natural drainageway.

The drainage area may be up to 10 acres (4 hectares).

LIMITATIONS

Not suitable for drainage areas greater than 10 acres (4 hectares).

DESIGN PARAMETERS

Pipe sizing: Typical relationships between area and pipe diameter are shown below:

RELATIONSHIP BETWEEN AREA AND PIPE DIAMETER	
Maximum Drainage Area acres (hectares)	Pipe Diameter in (millimeters)
0.5 acres (0.2)	12 in (300)
1.5 acres (0.6)	18 in (450)
2.5 acres (1.0)	21 in (525)
3.5 acres (1.4)	24 in (600)
5.0 acres (2.0)	30 in (750)

Spacing: For a two-lane highway construction project, experience has shown that temporary slope drains should be spaced at a longitudinal interval of 500 ft (150 meters) on a 2 percent grade, 200 ft (60 meters) on a 4 percent grade, and as may be dictated by field conditions on a grade of 5 percent or greater.

Materials: Pipe may be any heavy-duty, flexible tubing designed for this purpose, including nonperforated, corrugated plastic pipe; corrugated metal pipe; bituminous fiber pipe; or specially designed flexible tubing.

A standard flared end section secured with a watertight fitting should be used for the inlet. A standard T-section fitting may also be used. Extension collars should be 1 ft (300 mm) long segments of corrugated pipe. All fittings must be watertight.

Slope of drain: Try for a 3 percent minimum.

CONSTRUCTION GUIDELINES

Temporary slope drains should be installed with inlets at points where water is discharged from ditches, berms, or other points of concentrated flow. All drains should be anchored to the slope to prevent disruption by water or other forces. The inlet section of the drain should be properly installed to funnel the flow into the drain. It is often necessary to construct cross berms to direct flow into the inlet.

- Place the pipe slope drain on undisturbed or well-compacted soil.

- Soil around and under the entrance section must be hand tamped in 4 to 8 in (100- to 200-mm) lifts to the top of the dike to prevent piping failure around the inlet.
- Place filter cloth under the inlet, extend it 3 to 5 ft (1 to 2 meters) in front of the inlet, and key it in 6 in (150 mm) on all sides to prevent erosion. A 6 in (150-mm) metal toe plate may also be used for this purpose.
- Securely stake the pipe slope drain to the slope at intervals of 10 ft (3 meters) or less, using grommets provided for this purpose.
- Make sure that all slope drain sections are securely fastened together and have watertight fittings.
- Extend the pipe beyond the toe of the slope and discharge at a nonerosive velocity into a stabilized area or to a sedimentation trap or pond. Use rock outlet protection if necessary.
- The pipe slope drain should have a slope of 3 percent or steeper.
- The height at the centerline of the earth dike should range from a minimum of 1 ft (300 mm) over the pipe to twice the diameter of the pipe measured from the invert of the pipe. It should also be at least 6 in (150 mm) higher than the adjoining ridge on either side.
- At no point along the dike will the elevation of the top of the dike be less than 6 in (150 mm) higher than the top of the pipe.
- Immediately stabilize all areas disturbed by installation or removal of the pipe slope drain.

MAINTENANCE

- Inspect the slope drain regularly and after every storm. Make any necessary repairs within 7 days or before the next storm (whichever comes first).
- Check to see that water is not bypassing the inlet or undercutting the inlet or pipe. If necessary, install headwalls or sandbags to prevent bypass flow.
- Check for erosion at the outlet point and check the pipe for breaks or clogs. Install additional outlet protection if needed and immediately repair the breaks and clean any clogs.
- Do not allow construction traffic to cross the pipe slope drain and do not place any material on it.
- If a sediment trap has been provided, clean it out when the sediment level reaches one-third to one-half the design volume.
- A temporary slope drain should remain in place up to 30 days after slopes have been completely stabilized.

BMP #126 - Slope Roughening

DESCRIPTION

Targeted Pollutants

- ● Sediment
- ○ Phosphorus
- ○ Trace metals
- ○ Bacteria
- ○ Petroleum hydrocarbons

This BMP entails establishing a rough soil surface by creating horizontal grooves, furrows, depressions, or steps running parallel to the slope contour over the entire face of a slope. This reduces the speed of runoff, increases infiltration, and traps sediment. It also helps establish vegetative cover by reducing runoff velocity and providing stable, level areas where seedlings can take hold and grow. This measure may be used prior to seeding/planting and should be applied using appropriate machinery.

Alternately, in some cases, leaving the slope in a roughened condition will control erosion and provide suitable rooting areas for plant seedlings better than a finely-graded slope. Other measures, such as flow diversion must be used to keep erosion from occurring while vegetation is being established.

Physical Limits

Drainage area	1 ac
Max slope	20%
Min bedrock depth	3 ft
Min water table	5 ft
SCS soil type	BCD
Freeze/Thaw	good
Drainage/Flood control	no

APPLICATIONS

Slope and surface roughening provide simple, inexpensive, and immediate short-term erosion control for bare soil where vegetative cover is not yet established. The practice is appropriate for all slopes, although different methods are used depending on the steepness of the slope, the type of slope (cut or fill), soil and rock characteristics, future mowing and maintenance requirements, and type of equipment available. All slopes steeper than 3:1 and greater than 5 ft (1.5 meters) vertical height require roughening and may also require terracing, grooving, or furrowing prior to seeding.

LIMITATIONS

This BMP is limited to slopes in medium to highly cohesive soils or in soft rock which can be excavated without ripping. Slope angle must be gentle enough to permit access to heavy equipment. The method is not applicable for use in moraines and other depositional soils. In addition, serration is of limited effectiveness in anything more than a gentle rain, and it is only a temporary measure. If the roughening is washed away in a heavy storm, the surface will have to be reroughened and reseeded.

This BMP is not a stand-alone measure, it must be implemented in conjunction with other BMPs.

DESIGN PARAMETERS

Slope roughening can be used with seeding, planting, and temporary mulching to stabilize an area. For steeper slopes and slopes that will be left roughened for longer period of time, try a combination of surface roughening and vegetative stabilization. Surface roughening should be applied immediately after grading activities have ceased (temporarily or permanently) in an area.

Different methods can be used to roughen the slope surface. They include stair-step grading, grooving (using disks, spring harrows, or teeth on a front-end loader), and tracking (driving a crawler tractor up and down a slope, leaving the cleat imprints perpendicular to the slope). The selection of an appropriate method depends on the grade of the slope, mowing requirements after vegetative cover is established, whether the slope was formed by cutting or filling, and type of equipment available.

Slopes steeper than 2:1: Any slope steeper than 2:1 should be terraced or stair-step graded, with benches wide enough to retain sediment eroded from the slope above. See BMP #127 (Gradient Terracing).

Slopes between 3:1 and 2:1: Cut slopes with a gradient steeper than 3:1 but less than 2:1 should be stair-step graded or groove cut. Stair-step grading works well with soils containing large amounts of small rock. Each step catches material discarded from above and provides a level site where vegetation can grow. Stairs should be wide enough to work with standard earth-moving equipment. Grooving can be done by any implement that can be safely operated on the slope, including those described above. Grooves should not be less than 3.1 in (80 mm) deep or more than 16 in (400 mm) apart.

Fill slopes with a gradient steeper than 3:1 but less than 2:1 should be compacted every 12 in (300 mm) of depth. The face of the slope should consist of loose, uncompacted fill 4 to 6 in (100 to 150 mm) deep that can be left rough or can be grooved as described above, if necessary.

It is important to avoid excessive compacting of the soil surface, especially when tracking, because soil compaction inhibits vegetation growth and causes higher runoff speed. Therefore, it is best to limit roughening with tracked machinery to sandy soils that do not compact easily and to avoid tracking on clay soils.

Slopes flatter than 3:1: Any cut or filled slope that will be mowed should have a gradient less than 3:1. Such a slope can be roughened with shallow grooves parallel to the slope contour by using normal tilling. Grooves should be close together (less than 10 in (250 mm)) and not less than 1 in (25 mm) deep.

CONSTRUCTION GUIDELINES

Timing of work: To slow erosion, slope or surface roughening should be done as soon as possible after the vegetation has been removed from the slope. The roughened areas should be seeded as quickly as possible, preferably within seven days after serration/roughening if weather conditions or water availability permits. In material that ravels or sloughs readily, delay the revegetation effort until at least 30 days after slope serration.

On slopes composed of material that weathers rapidly, slope roughening should be completed early in the summer. This will allow material to slough off the step face prior to fall seeding or planting so it does not smother the seeds or seedlings.

Equipment: Various types of heavy equipment of various kinds can be successfully used for slope roughening:

- A front-end loader equipped with disks, harrows, or teeth can make grooves across the slope.
- Driving a crawler tractor up and down the slope will make cleat imprints perpendicular to the slope.
- A dozer, equipped with a special blade containing a series of square grooves and positioned at the same angle as the cut, can serrate the slope along the contours.

Methods:

- Fill slopes constructed with highly erodible soils or soils containing high-clay contents shall be minimally compacted prior to establishing a roughened surface. However, excessive compaction of the surface soil is undesirable because of reduction in infiltration and suppression of vegetation rooting.
- Make the grooves or depressions approximately horizontal (or parallel the roadway grade if its profile grade is less than 2 percent).
- Excavate each series of grooves in the opposite direction from the preceding series to minimize buildup of loose material at the ends of the steps or cuts.
- Loose material collected at the ends of steps should be removed and the ends blended into the natural ground surface.
- If encountering rock that is too hard to rip, try to blend the grooves into the rock.
- Remove materials which fall into the ditchline or roadway and any rock fragments larger than one-third the shelf width.
- Construct a slope bench at the bottom of the slope face.

MAINTENANCE

Inspect the slopes periodically for damage from surface runoff and seepage and inspect after each runoff-producing storm. Damage caused by construction-related activities should be repaired as soon as possible. If rills appear (small watercourses that have steep sides and are usually less than 100 mm deep), they should be immediately filled, and the slope should be promptly regraded and adequately protected.

BMP #127 - Gradient Terracing

DESCRIPTION

Gradient terracing is a term used to describe an earth embankment or ridge-and-channel arrangement constructed along the face of a slope at regular intervals. Gradient terraces are constructed at a positive grade. They reduce erosion damage by capturing surface runoff and directing it to a stable outlet at a speed that minimizes erosion.

Targeted Pollutants

- ● Sediment
- ○ Phosphorus
- ○ Trace metals
- ○ Bacteria
- ○ Petroleum hydrocarbons

APPLICATIONS

Gradient terraces are usually limited to use on long, steep slopes that have a water erosion problem or where it is anticipated that water erosion will be a problem. They are used for reducing runoff velocity and increasing the distance of overland runoff flow. They hold moisture better than do smooth slopes, and they minimize sediment loading of surface runoff.

Physical Limits

Drainage area	10 ac
Max slope	50%
Min bedrock depth	6 ft
Min water table	8 ft
SCS soil type	BCD
Freeze/Thaw	good
Drainage/Flood control	Yes

LIMITATIONS

Gradient terraces should not be constructed on excessively steep slopes or in areas with sandy or rocky soils. They will be effective only where suitable runoff outlets will be available. Gradient terraces may significantly increase cut and fill costs and cause sloughing if too much water infiltrates the soil.

DESIGN PARAMETERS

Gradient terraces should be designed and installed according to a plan determined by an engineering survey and layout. It is important that gradient terraces are designed with adequate outlets, such as a grassed waterway, vegetated area, or tile outlet. In all cases, the outlet should direct the runoff from the terrace system to a point where the outflow will not cause erosion or other damage. Vegetative cover should be used in the outlet where possible. The design elevation of the water surface of the terrace should not be lower than that at the junction of the outlet area when both are operating at design flow. Terraces can be constructed with linings to carry water to the outlet and can be used with a dike or similar measure above the terrace to divert runon from reaching the terraced slope.

CONSTRUCTION GUIDELINES

Construction of gradient terraces should be completed using equipment that is capable of meeting the specification established in the construction plans.

MAINTENANCE

Inspect the gradient terraces regularly during project construction and inspect them after any major storm. If used as a permanent BMP, inspect at least once a year after project completion and after major storms. Evaluate whether the terrace is functioning effectively as a runoff collection and diversion device and note whether other stabilization measures (including vegetation) are performing effectively. Take prompt action as needed to ensure proper drainage and slope stability.

BMP #128 - Retaining Walls

DESCRIPTION

Walls constructed against a slope or stream bank to prevent slope erosion or slope failure, or undercutting of the bank. Examples of retaining wall materials include: concrete, concrete masonry, rock, wood planking or railroad ties, and metal bins. Also see BMP #129- Gabions.

Targeted Pollutants

- ● Sediment
- ○ Phosphorus
- ○ Trace metals
- ○ Bacteria
- ○ Petroleum hydrocarbons

Physical Limits

Drainage area	unlimited
Max slope	67 %
Min bedrock depth	N/A
Min water table	3
SCS soil type	ABCD
Freeze/Thaw	fair
Drainage/Flood control	no

APPLICATIONS

For slope protection or stabilization under extreme conditions or to protect erodible, unstable stream banks.

Concrete retaining wall: An engineered concrete wall which is designed to stabilize a slope and retain the rock or soil behind it. In addition to a solid concrete wall, precast, interlocking concrete blocks could be used.

Masonry retaining wall: An engineered structure similar to a concrete retaining wall but using masonry blocks, usually of specific design for aesthetic appeal.

Native rock retaining wall: A low-gravity wall constructed of rock materials native to the construction site. It provides an aesthetically attractive method of stabilizing a slope. Native rock is suitable for walls up to about 6.5 feet (2 meters) in vertical height where the slope is steeper than 2:1 behind the wall. They can be higher on slopes of 2:1 (or flatter) gradient with proper engineering design.

Redwood (wood planking) retaining wall: A retaining wall constructed of redwood planking and posts. Redwood retaining walls are useful for relatively small slopes of loose material which are underlain by a rigid rock base material or a firm, non-plastic subsoil with high shear strength. The firm foundation is necessary to securely anchor the wall. Can construct in poorer foundation soils by using longer posts and closer spacing, 3 feet (1.0 meter) maximum. Redwood will generally last longer than other woods.

Railroad tie retaining wall: A retaining wall constructed of railroad ties. These are useful for relatively small slopes of loose material which are underlain by a rigid base of rock or a firm, non-plastic subsoil. The wall must be securely anchored to the rock base or firm subsoil.

Mechanically stabilized earth (MSE) retaining walls: The following are considered MSE walls: reinforced earth, retained earth, Hilfiker, Genesis (Keystone/Tensar), and T-wall. All of those designs use some type of anchored structure to retain earthen materials behind a wall.

LIMITATIONS

Retaining walls should be considered a permanent measure only. Cost and site-specific design requirements limit their use to situations where other stabilization measures would be ineffective or aesthetically unacceptable.

- Native rock retaining walls have a maximum height of about 6.5 feet (2 meters).
- Redwood retaining walls require a firm foundation to anchor the wall.
- Wood treated with creosote or other chemicals to retard decay may leach out and cause toxic effects. Treated railroad ties should not be used along sensitive streams for instance.

DESIGN PARAMETERS

Retaining walls require a site-specific design. Wall heights, requirements for drainage, and suitable materials must be determined through on-site inspections. Listed in this fact sheet are some suggestions of appropriate applications of retaining walls for erosion control. All types of retaining walls should conform to local building codes and ordinances. Plans and specifications should be prepared by professional engineers for most installations, including all that fall outside the parameters listed under the physical limits.

CONSTRUCTION GUIDELINES

Concrete retaining walls: Construct as designed by a professional engineer or as shown on the plans.

Masonry retaining walls: Construct as designed by a professional engineer or as shown on the plans.

Native rock retaining walls:

- Remove all large rocks from the eroding slope face and stockpile on site.
- Excavate a footing trench along the toe of the slope.
- Place the largest rocks in the footing trench with their longitudinal axis normal to the embankment face. Arrange subsequent rock layers so that each rock above the foundation course has a three-point bearing on the underlying rocks.
- The slope of the wall should be between 1/2:1 and vertical, depending upon the height of the wall, the height of the slope, the width of the right-of-way, or other limitations on space.
- Obtain fill material from the slope and place it behind the rock wall. Slope above the wall should be maintained at 2:1 or less with a slope bench at the toe. Backfill the footing trench with excavated material.
- If a roadway is located at the toe of the wall, pave the roadway up to the base of the rock wall and provide roadway curb for water transport. If a

roadway is not located at the toe of the retaining wall, slope the backfilled material away from the wall at 2 percent and stabilize it.

- Revegetate the stabilized slope immediately with a method applicable to the particular site. (See Sections 4.5 and 5.2 of this manual.)

Redwood (wood planking) retaining wall:

- Prepare the site by rough grading the slope surface, then work from the bottom of the slope towards the top.
- Set the bottom course of redwood posts into rigid base foundation material and secure with a concrete collar.
- Install planking on the upslope side of the posts. Provide sufficient vertical spacing to allow drainage at the base of the wall and between planks.
- Backfill behind the wall with material from the slope above. Slope the backfill material between redwood walls at 2 percent toward the top of the lower wall.
- Proceed in a similar fashion up the slope to the desired height.
- Revegetate the backfilled benches behind the walls according to procedures applicable to the specific site (see Sections 4.5 and 5.2 of this manual).

Railroad tie retaining wall:

- Prepare the site by rough grading the slope surface, then work from the bottom of the slope toward the top.
- Set the bottom course of railroad ties onto a rigid base foundation material and secure with pinning or metal collars.
- Backfill behind the wall with material from the slope above. Slope the backfill material between the tiers of railroad ties at 2 percent toward the top of the lower wall. If the engineered wall requires deadmen, install in accordance with the design drawing.
- Proceed in a similar fashion up the slope to the desired height. If the total height exceeds 2 meters, the wall must be designed and approved by a registered engineer.
- Revegetate the backfilled benches behind the walls according to procedures applicable to the specific site (see Sections 4.5 and 5.2 of this manual).

MSE retaining wall:

- Prepare the site and construct as shown on the plans.

MAINTENANCE

Retaining walls must be inspected periodically on regular intervals to detect signs of structural failure, and to check for damage caused by subsurface drainage or

material sloughing. In stream bank installations, inspect for signs of undercutting and other instability. Make all repairs promptly, as needed.

BMP #129 - Gabions

DESCRIPTION

Rectangular wire-mesh cages that are filled with rock and wired together to form a protective but permeable structure for slope stabilization and erosion control .

Targeted Pollutants

- ● Sediment
- ○ Phosphorus
- ○ Trace metals
- ○ Bacteria
- ○ Petroleum hydrocarbons

APPLICATIONS

Gabions can be used as retaining walls to mechanically stabilize steep slopes, or for revetments, weirs, channel linings, culvert headwalls, and culvert outlet aprons. They are particularly useful where seepage is anticipated. For related information, refer to BMP #128 (Retaining walls).

Physical Limits

Drainage area	unlimited
Max slope	40%
Min bedrock depth	N/A
Min water table	2 ft
SCS soil type	ABCD
Freeze/Thaw	good
Drainage/Flood control	no

LIMITATIONS

Materials costs and professional design requirements may make use of gabions impractical. Gabions may alter stream dynamics or adversely affect wildlife habitat. When used in channels with high sediment loads, the galvanizing wire on the cages quickly wears off, causing rusting and the premature failure of the cages.

DESIGN PARAMETERS

- Construction plans and specifications should be prepared by professionals familiar with the use of gabions. The structure must be able to handle expected storm and flood conditions.
- On streambank applications, the foundation is an important design feature of the structure. Consider the potential for the stream to erode the sides and bottom of the channel and make sure the gabions will be supported properly.
- The gabion structure must be securely "keyed" into the foundation and abutment surfaces. The rock filling holds the gabions in place by gravity, but tie-backs may be used if conditions warrant additional structural strength.
- Gabions are usually placed on a filter blanket (gravel layer of filter cloth) or both.

Materials

Gabions should be fabricated in such a manner that the sides, ends, lids, and diaphragms can be assembled at the construction site into a rectangular basket of required sizes. Gabions should be of single unit construction -- the base, ends, and sides should either be woven into a single unit or one edge of these members connected to the base section of the gabion in such a manner that strength and flexibility at the point of connection is at least equal to that of the mesh.

Where the length of the gabion exceeds its horizontal width, the gabion should be equally divided by diaphragms, of the same mesh and gage as the body of the gabions, into cells whose length does not exceed the horizontal width. The gabion should be furnished with the necessary diaphragms secured in proper position on the base section in such a manner that no additional tying at this juncture will be necessary.

All perimeter edges should be securely selvedged or bound so that the joints formed by tying the selvedges have the same strength as the body of the mesh.

The fill material for the wire gabions should be rock ranging in size from a minimum of 4 inches (100 mm) to a maximum of 8 inches (200 mm), both measured in the greatest dimension. Rock should be sound, durable, well graded, and should be obtained from a source approved by the Engineer.

See the ITD Catalog of Best Management Practices (July 1994) for additional detailed design criteria for gabions.

CONSTRUCTION GUIDELINES

Empty gabion baskets should be placed on a smooth, firm foundation excavated as directed by the plans. Each row, tier, or layer of baskets should be reasonably straight and should conform to the line and grade shown on the plans or established by the Project Engineer. The empty gabion baskets should be fastened to the adjacent baskets along the top and vertical edges. Each layer should be fastened to the underlying layer along the front, back and ends. Fastening should be performed in the same manner as provided for assembling the gabion units.

Unless otherwise indicated on the plans, the vertical joints between basket units of adjacent tiers or layers, along the length of the structure, should be staggered by at least one cell.

Before filling each gabion with rock, all kinks and folds in the wire mesh should be removed and all baskets should be properly aligned. A standard fence stretcher, chain fall or steel rod may be used to stretch the wire baskets and hold alignment.

The gabion cells should be carefully filled with rock placed by hand/machine in such a manner that the alignment of the structure will be maintained and so as to avoid bulges and to minimize voids. All exposed rock surface should have a reasonably smooth and neat appearance. No sharp rock edges should project through the wire mesh.

The gabion cells in any row or layer should be filled in stages so that local deformations may be avoided. At no time should any cell be filled to a depth exceeding 12 inches (305 mm) more than any adjacent cell.

The layer of rock should completely fill the gabion basket so that the lid will bear on the rock when it is secured. The lid should be joined to the sides, ends, and diaphragms in the same manner as specified for joining the vertical edges. The gabion basket lid should be secured so that no more than 1 inch (25 mm) gap remains at any connection.

Gabion rows or layers not completed at the end of each shift should have the last gabion filled with rock tied internally as an end gabion.

The area behind the gabion structure should be backfilled with granular material. Geotextile, if required, should be spread uniformly over the back of the gabion structure as shown on the plans. Joining edges of the geotextile should be overlapped a minimum of 12 inches (305 mm) and should be anchored in position with approved anchoring devices. The Contractor should place the backfill material in a manner that will not tear, puncture, or shift the geotextile.

See the ITD Catalog of Best Management Practices (July 1994) for additional detailed design criteria for gabions.

MAINTENANCE

Inspect regularly and after each major storm. Check for signs of undercutting or other instability. Repair damaged areas immediately to restore designed effectiveness and to prevent damage or erosion of the slope or streambank.

Check wire of cages for rusting and wear. Repair where possible or replace.

BMP #130 - Riprap Slope and Outlet Protection

DESCRIPTION

An arranged layer or pile of rock placed over the soil surface on slopes and at or below storm drain outfalls or temporary dikes.

Riprap used as slope protection protects against erosion and dissipates the energy of runoff or surface water flow. Outlet protection reduces the speed of concentrated storm water flows and thereby reduces erosion or scouring at storm water outlets. In addition, outlet protection lowers the potential for downstream erosion. This type of protection can be achieved through a variety of techniques, including stone or riprap outlet structures and armored scour holes installed below the storm drain outlet.

Targeted Pollutants

- ● Sediment
- ○ Phosphorus
- ○ Trace metals
- ○ Bacteria
- ○ Petroleum hydrocarbons

Physical Limits

Drainage area	5 ac
Max slope	40%
Min bedrock depth	N/A
Min water table	N/A
SCS soil type	ABCD
Freeze/Thaw	good
Drainage/flood control	no

APPLICATIONS

For slope protection, use riprap or blanketed slopes. Outlet protection should be installed at the outlets of all pipes, culverts, catch basins, sediment basins, ponds, interceptor dikes, and swales or channel sections where the velocity of flow may cause erosion in the receiving channel. Outlet protection should also be used at outlets where the velocity of flow at the design capacity may result in plunge pools (small, permanent pools located at an inlet or outfall).

Outlet protection should be installed early during construction activities, but may be added at any time, as necessary.

LIMITATIONS

The minimum particle size of the rock must be sized for the maximum expected velocity of flow out of the outlet and the soil conditions where the outlet will be located.

DESIGN PARAMETERS

The design of rock outlet protection depends entirely on the location. Pipe outlets at the top of cuts or on slopes steeper than 10 percent, cannot be protected by rock aprons or riprap sections due to reconcentration of flows and high velocities encountered after the flow leaves the apron.

Tailwater depth: The depth of tailwater immediately below the pipe outlet must be determined for the design capacity of the pipe. If the tailwater depth is less than half

the diameter of the outlet pipe and the receiving stream is wide enough to accept divergence of the flow, it shall be classified as a Minimum Tailwater Condition. If the tailwater depth is greater than half the pipe diameter and the receiving stream will continue to confine the flow, it shall be classified as a Maximum Tailwater Condition. Pipes which outlet onto flat areas with no defined channel may be assumed to have a Minimum Tailwater Condition.

Apron Size: The apron length and width shall be determined according to the tailwater condition.

If the pipe discharges directly into a well-defined channel, the apron shall extend across the channel bottom and up the channel banks to an elevation one foot above the maximum tailwater depth or to the top of the bank, whichever is less.

The upstream end of the apron, adjacent to the pipe shall have a width two (2) times the diameter of the outlet pipe, or conform to pipe end section if used.

Bottom Grade: The outlet protection apron shall be constructed with no slope along its length. There shall be no overfall at the end of the apron. The elevation of the downstream end of the apron shall be equal to the elevation of the receiving channel or adjacent ground.

Alignment: The outlet protection apron shall be located so that there are no bends in the horizontal alignment.

Materials: The outlet protection may be done using rock riprap, grouted riprap or gabions (BMP #129). Riprap size shall be based on calculated shear stress. It shall be composed of a well graded mixture of stone size so that 50 percent of the pieces, by weight, shall be larger than the d50 size determined by using the charts. A well graded mixture as used herein is defined as a mixture composed primarily of larger stone sizes but with a sufficient mixture of other sizes to fill the smaller voids between the stones. The diameter of the largest stone size in such a mixture shall be 1.5 times the d50 size. Thickness: The minimum thickness of the riprap layer shall be 1.5 times the maximum tone diameter for d50 of 15 inches or less; and 1.2 times the maximum tone size for d50 greater than 15 inches. The following chart lists some examples:

ROCK RIPRAP SIZES AND THICKNESS

Unit shear stress (lb/ft^2)	d_{50} (inches)	d_{max} (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

Unit shear stress calculated as T = yds

where:

T = shear stress in lb/ft^2

y = unit weight of water, 62.4 lb/ft^3

d = flow depth in ft

s = channel gradient in ft/ft

Stone Quality: Stone for riprap shall consist of field stone or rough unhewn quarry stone. The stone shall be hard and angular and of a quality that will not disintegrate on exposure to water or weathering. The specific gravity of the individual stones shall be at least 2.5.

Recycled concrete equivalent may be used provided it has a density of at least 150 pounds per cubic foot, and does not have any exposed steel or reinforcing bars.

Filter: A filter is a layer of material placed between the riprap and the underlying soil surface to prevent soil movement into and through the riprap. Riprap shall have a filter placed under it in all cases.

A filter can be of two general forms: A gravel layer or a plastic filter cloth. The plastic filter cloth can be woven or non-woven monofilament yarns, and shall meet these base requirements: thickness 10-60 mils, grab strength 90-120 lbs; and shall conform to ASTM D-1777 and ASTM D-1682.

Gravel filter blanket, when used, shall be designed by comparing particle sizes of the overlying material and the base material. Design criteria is available in any soils or civil engineering reference or from the National Resources Conservation Service (formerly the Soil Conservation Service).

DESIGN PROCEDURE AND EXAMPLES

1. Investigate the downstream channel to assure that non-erosive velocities can be maintained.

1. Determine the tailwater condition at the outlet to establish which curve to use.

2. Enter the appropriate chart with the depth of flow and discharge velocity to determine the riprap size and apron length required. It is noted that references to pipe diameter in the charts are based on full flow. For other than full pipe flow, the parameters of depth of flow and velocity must be used.

3. Calculate apron width at the downstream end if a flared section is to be employed.

Example 1: ***Pipe Flow (full) with discharge to unconfined section***

A circular conduit is flowing full:

Q = 280 cfs, diam. = 66", tailwater (surface) is 2 ft. above pipe invert, (minimum tailwater condition)

Read d_{50} = 1.2', and apron length 38'

Apron width = diam. + L_a = 5.5 + 38 = 43.5'

Example 2: ***Box Flow (partial) with high tailwater***

A box conduit discharging under partial flow conditions. A concrete box 5.5' x 10' is flowing 5.0' deep, Q = 600 cfs and tailwater surface is 5' above invert (Max. tailwater condition).

$V = \underline{Q} = \underline{600} = 12$ fps

A 5x10

At the intersection of the curve d = 60" and V = 12 fps, read d_{50} = 0.4'

Then reading to the d = 60" curve, read apron length = 40'

Apron width, W = conduit width + 0.04 L_a = 10+(0.4) (40) = 26'

Example 3: ***Open Channel Flow with Discharge to Unconfined Section***

A trapezoidal concrete channel 5' wide with 2:1 side slopes is flowing 2' deep, Q = 180 cfs (velocity = 10 fps) and the tailwater surface downstream is 0.8' (minimum tailwater condition).

At intersection of the curve d-24' and V = 10 fps, read d_{50} = 0.7'

Then reading up to the d = 24" curve, read apron length = 22'

Apron width, W = bottom of width of channel + L_a = 5 + 22 = 27'

Example 4: ***Pipe flow (partial) with discharge to a confined section***

A 48" pipe is discharging with a depth of 3', Q = 100 cfs, and discharge velocity of 10 fps (established from partial flow analysis) to a confined trapezoidal channel with a 2' bottom, 2:1 side slopes, n = .04, and grade of 0.6%.

Calculation of the downstream channel (by Manning's Equation) indicates a normal depth of 3.1' and normal velocity of 3.9 fps.

Since the receiving channel is confined, the maximum tailwater condition controls.

At the intersection of d = 36" and v = 10 fps, Read d_{50} = 0.3'

Reading up to the d = 36" curve, read apron length = 30'

Since the maximum flow depth in this reach is 3.1', that is the minimum depth of riprap to be maintained for the entire length.

CONSTRUCTION GUIDELINES

- The subgrade for the filter, riprap or gabion shall be prepared to the required lines and grades. Any fill required in the subgrade shall be compacted to a density of approximately that of the surrounding undisturbed material.
- The rock or gravel shall conform to the specified grading limits when installed respectively in the riprap or filter.
- Filter cloth shall be protected from punching, cutting, or tearing. Any damage other than an occasional small hole shall 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 shall be a minimum of one foot.
- Stone for the riprap or gabion outlets may be placed by equipment. Both shall be constructed to the full course thickness in one operation and in such a manner as to avoid displacement of underlying materials. The stone for riprap or gabion outlets shall be delivered and placed in a manner that will insure that it is reasonably homogenous with the smaller stones and spalls filling the voids between the larger stones. Riprap shall be placed in a manner to prevent damage to the filter blanket or filter cloth. Hand placement will be required to the extent necessary to prevent damage to the permanent works.
- Complete construction of the outlet protection before allowing erosive flows to pass through the outlet.

MAINTENANCE

Once a riprap outlet has been installed, the maintenance needs are relatively low. Inspect after heavy storms and high flows for scouring under the outlet and dislodged stones, and repair damage promptly. For dikes, maintain the area upstream of the outlet structure so that accumulated sediments can be removed when they reach a depth of one-third the height of the dike, or 12 inches (300 mm), whichever is less.

BMP #131 - Inlet Protection

DESCRIPTION

Targeted Pollutants

- ● Sediment
- ○ Phosphorus
- ○ Trace metals
- ○ Bacteria
- ○ Petroleum hydrocarbons

Inlet protection consists of a filtering measure placed around an inlet or drain to trap sediment and prevent the sediment from entering the storm drain system. Additionally, it serves to prevent the silting-in of inlets, storm drainage systems, or receiving channels. Inlet protection may be composed of gravel and stone with a wire mesh filter, block and gravel, filter fabric, or sod. Care must be taken not to cause flooding with diverted flow.

APPLICATIONS

Physical Limits

Drainage area	1 ac
Max slope	5%
Min bedrock depth	2 ft
Min water table	2 ft
SCS soil type	ABCD
Freeze/Thaw	good
Drainage/Flood control	no

Inlet protection is appropriate for small drainage areas (less than 1 acre) where storm drains will be ready for use before the drainage area reaches final stabilization. Storm drain inlet protection is also used where:

- A permanent storm drain structure is being constructed on site and there is danger of sediment silting it in before permanent site stabilization.
- There is a threat of sediment silting in an inlet which is in place prior to permanent stabilization.
- Ponding around the inlet structure could be a problem to traffic on site.

Filter fabric is used for inlet protection when storm water flows are relatively small, with low velocities. Filter fabric inlet protection is appropriate for most types of inlets where the drainage area is 1 acre or less.

Block and gravel filters can be used where velocities are higher. They may be used with most types of inlets where overflow capability is needed and in areas of heavy flows (238 gal/min (15 liters/second) or greater).

Gravel and mesh filters can be used where flows are higher and in locations subject to disturbance by site traffic. This type of protection may be used with most inlets where overflow capability is needed and in areas of heavy flows (238 gal/min (15 liters/second) or greater).

Sod inlet filters are usually used where sediments in the storm water runoff are low.

LIMITATIONS

Filter fabric inlet protection cannot be used where inlets are paved because the fabric must be staked.

Straw bales (BMP #134) are not recommended for inlet protection when the area adjacent to the inlet is paved. Additionally, the bales must be anchored. Consider sandbags (BMP #142) in situations where anchoring of straw bales is not possible (e.g., paved road surfaces).

Inlet protection is a high maintenance item compared with other more permanent measures.

DESIGN PARAMETERS

Several different designs are in use and the configurations vary. Most of the following design considerations apply to all three main types of inlet protection (filter fabric, gravel and mesh, and block and gravel). Some additional concerns apply to only one or two of the types.

Drainage area: Not to exceed 1 acre. Overland flow to the inlet should be no greater than 15 liters/second.

Slope gradient: The drainage area should be fairly flat, with slopes of 5 percent or less. With filter fabric designs, the area immediately surrounding the inlet should not exceed a slope of one percent.

Height of filter fabric: To avoid failure caused by pressure against the fabric when overtopping occurs, it is recommended that the height of the filter fabric be limited to 16 in (0.4 meters) above the crest of the drop inlet.

Sump: Where possible, a filter fabric or block-and-gravel protection device should be provided with a sediment trapping sump 12 to 20 in (300 to 500 mm) deep as measured from the crest of the inlet. Side slopes should be 2:1. The recommended volume of excavation is 860 ft^3/acre (60 cubic meters/hectare) of ground disturbed.

Orientation: To achieve maximum trapping efficiency in gravel-and-mesh or block-and-gravel traps, the longest dimension of the basin should be oriented toward the longest inflow area.

Materials for filter fabric inlet protection:

- Filter fabric (see the fabric specifications for silt fence, BMP #135)
- Wooden stakes 2x2 in (50 mm x 50 mm) (or 2x4 in (50 mm x 100 mm)), with a minimum length of 3 ft (1.0 meter)
- Heavy-duty wire staples at least 45 in (10 mm) long
- Washed gravel 0.8 to 1.2 in (20 to 30 mm) in diameter, with less than 5 percent fines

Materials for excavated gravel inlet protection:

- Hardware cloth or wire mesh with 2/5 to 3/5 in (10 to 15 mm) openings
- Filter fabric (see the fabric specifications for silt fence, BMP #135)
- Washed gravel 0.8 to 4 in (20 mm to 100 mm) in diameter

Materials for block and gravel inlet protection:

- Hardware cloth or wire mesh with 2/5 to 3/5 in (10 to 15 mm) openings
- Filter fabric (see the fabric specifications for silt fence, BMP #135)
- Concrete blocks 4 to 12 in (100 mm to 300 mm) wide
- Washed gravel 0.8 to 4 in (20 mm to 100 mm) in diameter

CONSTRUCTION GUIDELINES

Filter fabric:

- Place a stake at each corner of the inlet and around the edges at no more than 3 ft (1 meter) apart. Drive the stakes into the ground 20 in (500 mm) if possible, or a minimum of 8 in (200 mm).
- For stability, install a framework of wood strips around the stakes at the crest of the overflow area, 20 in (500 mm) above the crest of the drop inlet.
- Excavate a trench 8 to 12 (200 to 300 mm) deep around the outside perimeter of the stakes. If a sediment trapping sump is being provided, then the excavation may be as deep as 2 ft (600 mm).
- Staple the filter fabric to the wooden stakes with heavy-duty staples, overlapping the joints to the next stake. Ensure that 12 to 32 in (300 to 800 mm) of filter fabric extends at the bottom so it can be formed into the trench.
- Place the bottom of the fabric in the trench and backfill the trench all the way around, using washed gravel to a minimum depth of 4 in (100 mm). Use enough gravel to ensure contact between the filter fabric and the underlying surface.

Gravel and mesh:

- 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 300 mm 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 it at least 500 mm 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 a depth of at least 300 mm.

Block and gravel:

- 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 in (300 mm to 500 mm) 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 in (500 mm) beyond the inlet structure.
- Place concrete blocks over the filter fabric in a single row lengthwise on their sides along the sides of the inlet. Excavate the foundation a minimum of 2 in (50 mm) below the crest of the inlet. The bottom row of blocks should be against the edge of the structure for lateral support.
- The open ends of the block should face outward, not upward, and the ends of adjacent blocks should abut. Lay one block on each side of the structure on its side to allow for dewatering of the pool.
- The block barrier should be at least 12 in (300 mm) high and may be up to a maximum of 24 in (600 m) high. It may be from 4 to 12in (100 mm to 300 mm) deep, depending on the size of block used.
- Prior to 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.

Swale, ditch line or yard inlet protection:

- Excavate completely around inlet to a depth of 18" below notch elevation.
- Drive 2 x 4 post 1' into ground at four corners of inlet. Place nail strips between posts on ends of inlet. Assemble top portion of 2 x 4 frame using overlap joint shown. Top of frame (weir) must be 6" below edge of roadway adjacent to inlet.
- Stretch wire mesh tightly around frame and fasten securely. Ends must meet at post.
- Stretch filter cloth tightly over wire mesh, the cloth must extend from top of frame to 18" below inlet notch elevation. Fasten securely to frame. Ends must meet at post, be overlapped and folded, then fastened down.
- Backfill around inlet in compacted 6" layers until layer of earth is even with notch elevation on ends and top elevation on sides.
- If the inlet is not in a low point, construct a compacted earth dike in the ditch line below it. The top of the dike is to be at least 6" higher than the top of frame (weir).
- This structure must be inspected frequently and the filter fabric replaced when clogged.

Curb Inlet Protection:

- Attach a continuous piece of wire mesh (30" min. width by throat length plus 4') to the 2" x 4" weir (measuring throat length plus 2') as shown on the standard drawing.
- Place a piece of approved filter cloth (40-85 sieve) of the same dimensions as the wire mesh over the wire mesh and securely attach to the 2" of 4" weir.
- Securely nail the 2" x 4" weir to 9" long vertical spacers to be located between the weir and inlet face (max. 6' apart).
- Place the assembly against the inlet throat and nail (minimum 2') lengths of 2" x 4" to the top of the weir at spacer locations. These 2" x 4" anchors shall extend across the inlet top and be held in place by sandbags or alternate weight.
- The assembly shall be placed so that the end spacers are a minimum 1' 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" stone over the wire mesh and filter fabric in such a manner as to prevent water from entering the inlet under or around the filter cloth.
- This type of protection must be inspected frequently and the filter cloth and stone replaced when clogged with sediment.

Assure that storm flow does not bypass inlet by installing temporary earth or asphalt dikes directing flow into inlet.

MAINTENANCE

- Inspect regularly and after every storm. Make any repairs necessary to ensure the measure is in good working order.
- Remove accumulated sediment and restore the trap to its original dimensions when sediment has accumulated to half the design depth of the trap. All sediments removed must be disposed of properly.
- On gravel-and-mesh devices, clean (or remove and replace) the stone filter or filter fabric if it becomes clogged.
- On filter fabric devices, replace the fabric immediately if it becomes clogged. Make sure the stakes are firmly in the ground and that the filter fabric continues to be securely anchored.
- Inlet protection should remain in place and operational up to 30 days after the drainage area is completely stabilized.

Inlet protection (IDT, 1994)

Straw Bale Inlet Protection (Minnesota Pollution Control Agency, 2000; based on Michigan Soil Erosion and Sediment Control Guidebook

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Curb Inlet Sediment Barrier (Woodward-Clyde Consultants, 1994)

Inlet protection Detail

BMP #132 - Check Dams

DESCRIPTION

A small dam constructed in an open channel, swale, or drainageway. Check dams may be temporary or permanent barriers made of logs and brush, straw bales, stone, or other materials. They are used to reduce or prevent excessive bank and bottom erosion by reducing the gradient or runoff velocity.

Targeted Pollutants

- ● Sediment
- ○ Phosphorus
- ○ Trace metals
- ○ Bacteria
- ○ Petroleum hydrocarbons

APPLICATIONS

Check dams are often used in natural or constructed channels or swales where adequate vegetation cannot be established promptly. They are used below small drainage structures (smaller than 36 inch (900 mm) pipe culverts) but may be used below large structures if a diversion ditch cannot be used. Log and brush check dams should be placed where they will not cause flooding and where they can be left in place.

Physical Limits

Drainage area	10 ac
Max slope	50%
Min bedrock depth	2 ft
Min water table	N/A
SCS soil type	ABCD
Freeze/Thaw	good
Drainage/Flood control	yes

LIMITATIONS

Check dams should never be placed in live streams unless approved by appropriate local, state and/or federal authorities.

DESIGN PARAMETERS

Drainage area: The drainage area above the check dam should be between 1 and 4 hectares.

Spacing: The dams must be spaced so that the toe of the upstream dam is never any higher than the top of the downstream dam. Excavating a sump immediately upstream from the check dam improves its effectiveness.

Height: Maximum height should be 2 feet (600 mm). The center of the dam must be 16 to 10 inches (50 to 250 mm) lower than either edge, to form a weir for the outfall.

Width: The check dam should be as much as 20 inches (500 mm) wider than the banks of the channel to prevent undercutting as overflow water re-enters the channel.

Stabilization: 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 plastic sheeting or riprap where there may be significant erosion or prolonged submergence.

Materials:

- Stone 2 to 16 inches (50 to 400 mm) in diameter
- Logs 6 to 8 inches (150 to 200 mm) in diameter
- Sandbags filled with pea gravel
- Filter fabric meeting the standard specifications (see BMP #135, Silt Fence)

Embedding: The logs should be driven into the ground a minimum of 28 inches (700 mm).

CONSTRUCTION GUIDELINES

Rock check dams: Place the stones on filter fabric either by hand or using appropriate machinery; do not simply dump them in place. Keep the side slopes 1:2 or flatter.

Lining the upstream side of the dam with a layer of 0.8 to 1.1 inch (20 to 30 mm) gravel 12 inches (300 mm) deep is a suggested option for additional channel protection.

Log check dams: Logs must be firmly embedded in the ground. Intermingled brush and logs or filter cloth may be attached to the upstream side of the dam to retard the flow and trap additional sediment. If a filter cloth is used, it should be securely stapled to the top of the dam and adequately anchored in the streambed.

Sandbag check dams: Be sure that all bags are securely sealed. Place the bags by hand or use appropriate machinery to place them in an interlocking pattern.

Gravel-filled burlap bags: Gravel-filled burlap bags may be used for temporary check dams in areas of concentrated flow. Fold the burlap bag flaps under the bags in a direction away from the water flow. Construct gravel bag check dams such that the crest of the downstream check dam is approximately level with the toe of the upstream check dam. Install check dams so the side end points are higher than the centerline crest. Erosion caused by high flows around the edges should be corrected immediately.

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

MAINTENANCE

Inspect the check dams regularly and after every runoff-producing storm. Make any repairs necessary to ensure the measure is in good working order.

Remove accumulated leaves and sediments from behind the dam when they reach a depth of one-half the original height of the dam. Dispose of all materials properly so they don't contribute to pollution problems at the disposal site.

Restore stone as necessary for the dams to maintain their correct height. On sandbag dams, inspect the sandbag fabric for signs of deterioration.

Check dams (Portland and USA, 1994)

Gravel-filled sandbag check dams (Woodward-Clyde Consultants, 1994)

BMP #133 - Temporary Stream Crossing

DESCRIPTION

A temporary stream crossing is a bridge or culvert across a stream or watercourse for short-term use by construction vehicles or heavy equipment. Vehicles moving over unprotected stream banks will damage the bank, thereby releasing sediments and degrading the stream bank. A stream crossing provides a means for construction vehicles to cross streams or watercourses without moving sediment to streams, and without damaging the streambed or channel, or causing flooding.

Targeted Pollutants

- ● Sediment
- ○ Phosphorus
- ○ Trace metals
- ○ Bacteria
- ◒ Petroleum hydrocarbons

APPLICATIONS

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 period of time. Temporary stream crossings should be installed only when it is necessary to cross a stream and a permanent crossing is not feasible or not yet constructed.

Physical Limits

Drainage area	N/A
Max slope	N/A
Min bedrock depth	2 ft
Min water table	N/A
SCS soil type	ABCD
Freeze/Thaw	good
Drainage/Flood control	yes

The specific loads and the stream conditions will dictate what type of stream crossing to employ.

Bridges: Where available materials and designs are adequate to bear the expected loadings, bridges are the preferred method to cross a stream as they provide the least obstruction to flows and fish migration.

Culverts: Culverts are the most common type of stream crossings and are relatively easy to construct. A pipe (to carry the stream flow) is laid into the channel and covered by gravel (simply put--backfill, density, bedding and galvanized headwall).

LIMITATIONS

Bridges are expensive to design and install. These costs may make it difficult to justify using a bridge as a temporary crossing in some situations.

Culverts cause greater disturbance during installation and removal. In sensitive stream systems, these impacts may not be justifiable.

Always attempt to minimize or eliminate the need to cross streams. Temporary stream crossings are a direct source of pollution; therefore, every effort should be made to use an alternate method such as a longer detour. When it is absolutely necessary to cross a stream, a well-planned approach will minimize damage to the stream bank and reduce erosion.

Use of the following stream crossing measures below the high water mark of a stream or other water body (waters of the U.S.) should be carefully evaluated due to Section 404 permit requirements. If the project will remain a Categorically Excluded (Cat-Ex) project, you may proceed if the situation is discussed in the Cat-Ex. Otherwise, Section 404 permitting (401 Certification)/a Water Resources, Stream Alteration Permit, may be required. The design of temporary stream crossings involves extensive knowledge of hydrologic processes, and therefore must be designed by a Professional Engineer.

DESIGN AND PLANNING PARAMETERS - GENERAL

In-Stream Excavation - In-stream excavation shall be limited to only that necessary to allow installation of the temporary bridge or culvert as described below.

Elimination of Fish Migration Barriers - Temporary bridges pose the least potential for creating barriers to aquatic migration. The construction of a temporary bridge or culvert shall not cause a significant water level difference between the upstream and downstream water surface elevations.

Crossing Alignment - The temporary waterway crossing shall be at right angles to the stream. Where approach conditions dictate, the crossing may vary 15 degrees from a line drawn perpendicular to the centerline of the stream at the intended crossing location.

Road Approaches - The centerline of both roadway approaches shall coincide with the crossing alignment centerline for 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, a shorter distance may be provided. All fill materials associated with the roadway approach shall be limited to a maximum height of 2 feet above the existing flood plain elevation.

Surface Water Diverting Structure - A water diverting structure such as a swale shall be constructed (across the roadway on both roadway approaches) 50 feet (maximum) on either side of the waterway crossing. This will prevent roadway surface runoff from directly entering the waterway. The 50 feet is measured from the top of the waterway bank. Design criteria for this diverting structure shall be in accordance with the BMP fact sheet in this Catalog for the individual design standard of choice. If the roadway approach is constructed with a reverse grade away from the waterway, a separate diverting structure is not required.

Road Width - All crossings shall have one traffic lane. The minimum width shall be 12 feet with a maximum width of 20 feet.

Time of Operation - All temporary crossings shall be removed within 14 calendar days after the structure is no longer needed. Unless prior written approval is obtained from the Water Resources Administration, all structures shall be removed within one year from the date of the installation.

Materials:

- Aggregate - There shall be no earth or soil materials used for construction within the waterway channel. (3/4" to 4") also referenced as AASHTO

designation No. 1 shall be the minimum acceptable aggregate size for temporary crossings. Larger aggregates will be allowed.

- Filter Cloth - Filter cloth is a fabric consisting of either woven or nonwoven plastic, polypropylene, or nylon used to distribute the load, retain fines, allow increased drainage of the aggregate and reduce mixing of the aggregate with the subgrade soil. Filter cloths such as Mirafi, Typar, Adva Filter, Polyfilter X, or approved equivalent shall be used, as required by the specific method.

Considerations for Choosing a Specific Method (Bridge or Culvert): The following criteria for erosion and sediment control shall be considered when selecting a specific temporary access waterway crossing standard method:

- Site aesthetics - Select a standard design method that will least disrupt the existing terrain of the stream reach. Consider the effort that will be required to restore the area after the temporary crossing is removed.

- Site location - Locate the temporary crossing where there will be the least disturbance to the soils of the existing waterway banks. When possible locate the crossing at the point receiving minimal surface runoff.

- Physical site constraints - The physical constraints of a site may preclude the selection of one or more of the standard methods.

- Time of year - The time of year may preclude the selection of one or more of the standard methods due to fish spawning or migration restrictions.

- Vehicular loads and traffic patterns - Vehicular loads, traffic patterns, and frequency of crossings should be considered in choosing a specific method.

- Maintenance of Crossing - The standard methods will require various amounts of maintenance. The bridge method should require the least maintenance, whereas the ford method will probably require more intensive maintenance.

- Removal of the structure - Ease of removal and subsequent damage to the waterway should be primary factors in considering the choice of a standard method.

DESIGN PARAMETERS - TEMPORARY BRIDGE

This is the preferred method for temporary access waterway crossings. Normally, bridge construction causes the least disturbance to the waterway bed and banks when compared to culverts.

Most bridges can be quickly removed and reused.

Temporary access bridges pose the least chance for interference with fish migration when compared to the other temporary access waterway crossings.

CONSTRUCTION GUIDELINES - TEMPORARY BRIDGE

Restriction: 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.

Bridge Placement: A temporary bridge structure shall be constructed at or above bank elevation to prevent the entrapment of floating materials and debris.

Abutments: Abutments shall be placed parallel to and on stable banks.

Bridge Span: Bridges shall be constructed to span the entire channel. If the channel width exceeds 8 feet (as measured from top-of-bank to top-of-bank) then a 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. However, no footing, pier or bridge support will be permitted within the channel for waterways less than 8 feet wide.

Stringers: Stringers shall either be logs, sawn timber, prestressed concrete beams, metal beams, or other approved.

Deck Material: Decking materials shall be of sufficient strength to support the anticipated load. All decking members shall be placed perpendicular to the stringers, butted tightly, and securely fastened to the stringers. Decking materials must be butted tightly to prevent any soil material tracked onto the bridge from falling into the waterway below.

Run Planks (optional): Run planking shall be securely fastened to the length of the span. One run plank shall be provided for each track of the equipment wheels. Although run planks are optional, they may be necessary to properly distribute loads.

Curbs or Fenders: Curbs or fenders may be installed along the outer sides of the deck. Curbs or fenders are an option which will provide additional safety.

Bridge Anchors: Bridges shall be securely anchored at only one end using steel cable or chain. Anchoring at only one end will prevent channel obstruction in the event that floodwaters float the bridge. Acceptable anchors are large trees, large boulders, or driven steel anchors. Anchoring shall be sufficient to prevent the bridge from floating downstream and possibly causing an obstruction to the flow.

Stabilization: All areas disturbed during installation shall be stabilized within 14 calendar days of that disturbance.

MAINTENANCE - TEMPORARY BRIDGE

Inspection - Periodic inspection shall be performed by the user to ensure that the bridge, streambed, and stream banks are maintained and not damaged.

Maintenance: Maintenance shall be performed, as needed to ensure that the structure complies with the standard and specifications. This shall include removal and disposal of any trapped sediment or debris. Sediment shall be disposed of outside of the flood plain and stabilized.

Removal: When the temporary bridge is no longer needed, all structures including abutments and other bridging materials shall be removed within 14 calendar days. In all cases, the bridge materials shall be removed within one year of installation.

Final Clean-Up: Final clean-up shall consist of removal of the temporary bridge from the waterway, protection of banks from erosion, and removal of all construction materials. All removed materials shall be stored outside the waterway flood plain.

Equipment: Removal of the bridge and clean up of the area shall be accomplished without construction equipment working in the waterway channel.

Final Stabilization: All areas disturbed during removal shall be stabilized within 14 calendar days of that disturbance.

DESIGN PARAMETERS - TEMPORARY CULVERT

A temporary access culvert is a structure consisting of a section(s) of circular pipe, pipe arches, or oval pipes of reinforced concrete, corrugated metal, or structural plate, which is used to convey flowing water through the crossing.

Temporary culverts are used where (1) the channel is too wide for normal bridge construction, or (2) anticipated loading may prove unsafe for single span bridges.

Temporary culverts can be salvaged and reused.

CONSTRUCTION GUIDELINES - TEMPORARY CULVERT

Culvert Strength - All culverts shall be strong enough to support their cross sectional area under maximum expected loads.

Culvert Size - The size of the culvert pipe shall 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 percent of the cross sectional area of the existing channel. The minimum size culvert that may be used is a 12" diameter pipe.

Culvert Length - The culvert(s) shall extend a minimum of one foot beyond the upstream and downstream toe of the aggregate placed around the culvert. In no case shall the culvert exceed 40 feet in length.

Filter Cloth - Filter cloth shall be placed on the streambed and streambanks prior to placement of the pipe culvert(s) and aggregate. The filter cloth shall cover the streambed and extend a minimum six inches and a maximum one foot beyond the end of the culvert and bedding material. Filter cloth reduces settlement and improves crossing stability.

Culvert Placement - The invert elevation of the culvert shall be installed on the natural streambed grade to minimize interference with fish migration (free passage of fish).

Culvert Protection - The culvert(s) shall be covered with a minimum of one foot of aggregate. If multiple culverts are used they shall be separated by at least 12" of compacted aggregate fill. At a minimum, the bedding and fill material used in the construction of the temporary access culvert crossings shall conform with the aggregate requirements cited in Section I.H. 1. above.

Stabilization - All areas disturbed during culvert installation shall be stabilized within 14 calendar days of the disturbance.

MAINTENANCE - TEMPORARY CULVERT

Inspection - Periodic inspection shall be performed to ensure that the culverts, streambed, and streambanks are not damaged, and that sediment is not entering the stream or blocking fish passage or migration.

Maintenance - Maintenance shall be performed, as needed in a timely manner to ensure that structures are in compliance with this standard and specification. This shall include removal and disposal of any trapped sediment or debris. Sediment shall be disposed of and stabilized outside the waterway flood plain.

Removal - When the crossing has served its purpose, all structures including culverts, bedding and filter cloth materials shall be removed within 14 calendar days. In all cases, the culvert materials shall be removed within one year of installation.

Final Clean-up - Final clean-up shall consist of removal of the temporary structure from the waterway, removal of all construction materials, restoration of original stream channel cross section, and protection of the steam banks from erosion. Removed material shall be stored outside of the waterway flood plain.

Equipment - Removal of the structure and clean up of the area shall be accomplished without construction equipment working in the waterway channel.

Final Stabilization - All areas disturbed during culvert removal shall be stabilized within 14 calendar days of the disturbance.

Temporary stream crossing (North Carolina, 1988)

Temporary stream crossing (California, 1993)

Temporary Access Bridge

Temporary Access Culvert

BMP #134 - Straw Bales/Biofilter Bags

DESCRIPTION

Temporary sediment barriers, consisting of a row of entrenched or anchored straw bales and/or biofilter bags, reduce the transport of sediment from a construction site by providing a temporary physical barrier to sediment and reducing runoff velocities. The barriers can be placed in various combinations to construct the required structure, as shown on the attached figures. They may also be used as a barrier to divert or direct small amounts of runoff around active work areas or to a slope drain, sediment trap or other filtration/sedimentation BMP. Both biofilter bags (plastic mesh bags filled with wood chips) and straw bales are temporary measures. They have a limited life span and must be regularly inspected and replaced when damaged.

Targeted Pollutants

- ● Sediment
- ○ Phosphorus
- ○ Trace metals
- ○ Bacteria
- ○ Petroleum hydrocarbons

Physical Limits

Drainage area	1 ac/400ft bales
Max slope	2% for bales; 10% for biobags
Min bedrock depth	2 ft
Min water table	2 ft
SCS soil type	ABCD
Freeze/Thaw	fair
Drainage/Flood control	no

APPLICATIONS

The barriers are effective at storm drain inlets, across minor swales and ditches, as diversion dikes and berms, along property lines, and for other applications where the need for a barrier is temporary and structural strength is not required. For instance:

- At the toe of embankment slopes
- At the outlet of slope drains
- As filter cores for log check dams
- In front of silt fences
- To protect inlets along paved streets

LIMITATIONS

These types of barriers are only suitable where flow rates are low (475 gal/min (30 liters per second) or less). They require regular inspections and repair, and periodic replacement (about 3 months maximum usefulness).

Do not use straw bale barriers for drainage areas greater than 1 acre (0.5 hectare). Straw bale barriers often prove ineffective at erosion control if poorly installed and maintained. Even when properly installed, temporary barriers are not usually as effective as silt fences (see BMP #135) or gravel berms see BMP# 142). Straw bales used in conjunction with either of these controls may improve effectiveness and durability. Certified weed-free straw bales must be used instead of hay bales.

DESIGN PARAMETERS

Constructed Slope	Percent Slope	Slope Length Feet
2:1	50	25
2.5:1	40	50
3:1	33	75
3.5:1	30	100
4:1	25	125

Where slope gradient changes through the drainage area, steepness refers to the steepest slope section contributing to the straw bale dike.

The practice may also be used for a single-family lot if the slope is less than 15 percent. The contributing drainage area in this instance shall be less than one acre and the length of slope above the dike shall be less than 200 feet.

Concentrated flows: No greater than 475 gal/min (30 liters) per second.

Useful life: 3 months maximum, depending on site conditions.

Buffer zone: An undisturbed buffer zone of 3 to 6.5 ft (1-2 meters) is necessary between the barriers and surface waters to allow safe removal of the barrier and of accumulated sediments.

Embedding: The barrier must be embedded to a minimum depth of 6 in (150 mm) and backfilled for the entire length of the barrier. Each bale or bag should be securely anchored with two stakes 2 in X 2 in X 3 ft (50 mm x 50 mm x 1 meter) or steel drift pins driven at least 20 in (500 mm) into the ground.

CONSTRUCTION GUIDELINES

Barriers used for sediment control at the toe of slopes must be in place prior to disturbing the slope. Install the bales a short distance away from the toe of the slope to increase the effective area but outside of any ditch channel.

Place the barriers in a single row lengthwise on the contour for sheet flow applications, or perpendicular to the contour in concentrated flow applications. When flows are expected to be high enough to surpass the infiltration capacity of the devices, the center (low point) bales shall be wrapped in filter fabric with a 3 ft (1 meter) tail stapled securely and extending from the down gradient side of the barrier to prevent scouring. The ends of the adjacent barriers must tightly abut one another.

Any gaps between barriers should be filled with tightly wedged straw. For concentrated flow applications, extend the end of the barrier so that the bottoms of the end units are at a higher elevation than the top of the lowest middle unit to

assure that sediment laden water flows through or over the barrier instead of around the ends.

MAINTENANCE

Perform one inspection during the first runoff producing event after the installation of the barriers to assure proper functioning. No more than one foot depth of sediment should be allowed to accumulate behind either bales or biofilter bags. Damaged barriers, undercutting, or end runs must be repaired immediately. Bales should be replaced as needed due to disintegration or rotting.

If approved, straw bales or biofilter bags may be used after project completion as mulch. Temporary sediment barriers should be removed within 30 days of final stabilization of the site. If rebar is used it must be removed.

Straw Bale Dike

Biobag placement for overland flow (Portland and USA, 1994)

Biobag placement for ditches and swales (Portland and USA, 1994)

BMP #135 - Silt Fence

DESCRIPTION

A silt fence is a temporary sediment barrier consisting of a filter fabric stretched and attached to supporting posts. (Wire fence backing is necessary with several types of filter fabric commonly used.) Silt fences assist in sediment control by retaining some of the eroded soil particles and slowing the runoff velocity to allow particle settling.

Targeted Pollutants

- ● Sediment
- ○ Phosphorus
- ○ Trace metals
- ○ Bacteria
- ○ Petroleum hydrocarbons

Physical Limits

Drainage area	1 ac/100 ft
Max slope	33%
Min bedrock depth	2 ft
Min water table	2 ft
SCS soil type	ABCD
Freeze/Thaw	good
Drainage/Flood control	no

APPLICATION

Silt fences can be used near 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, and at natural drainage areas to reduce the quantity of sediment and to dissipate flow velocities to downstream areas.

Also use at grade breaks on cut/fill slopes and above interceptor dikes.

The silt fence should be constructed after the cutting and slashing of trees and before excavating haul roads, fill benches, or any soil disturbing construction activity in the drainage areas.

LIMITATIONS

Silt fences should not be used where there is a concentration of water in a 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, take corrective action by placing rock berms or other corrective measures in the areas of concentrated flow.

DESIGN PARAMETERS

Maximum allowable slope lengths: Maximum allowable slope lengths contributing runoff to a silt fence are listed in the table below:

Slope Steepness	Maximum Slope Length (Feet)

2:1	50
3:1	75
4:1	125
5:1	175
Flatter than 5:1	200

Maximum drainage area: Maximum drainage area for overland flow to a silt fence shall not exceed ½ acre per 100 feet of fence

Design Calculations: Design computations are not required. All silt fences shall be placed as close to the contour as possible, and the area below the fence must be undisturbed or stabilized.

Site Plan Details: A detail of the silt fence shall be shown on the plan, and contain the following minimum requirements:

- The type, size, and spacing of fence posts.
- The size of woven wire support fences.
- The type of filter cloth used.
- The method of anchoring the filter cloth.
- The method of fastening the filter cloth to the fencing support.

Joining Filter Fabric: Where ends of filter fabric come together, they shall be overlapped, folded and stapled to prevent sediment bypass.

Materials:

Silt Fence Fabric**:** The fabric shall meet the following specifications unless otherwise approved by the appropriate erosion and sediment control plan approval authority. Such approval shall not constitute statewide acceptance. Statewide acceptability shall depend on in-field and/or laboratory observations and evaluations.

Fabric Properties	Value	Minimum Acceptable Test Method
Grab Tensile Strength (lbs)	90	ASTM D1682
Elongation at Failure (%)	50	ASTM D1682
Mullen Burst Strength (PSI)	190	ASTM D3786
Puncture Strength (lbs)	40	ASTM D751 (modified)
Equivalent Opening Size	40-80	US Std Sieve CW-02215

Ultraviolet Radiation Stability %	90	ASTM-G-26

Fence Posts (for fabricated units): The length shall be a minimum of 36 inches long. Wood posts will be of sound quality hardwood with a minimum cross sectional area of 3.0 square inches. Steel posts will be standard T and U section weighing not less than 1.00 pound per linear foot.

Wire Fence (for fabricated units): Wire fencing shall be a minimum 14¼ gage with a maximum 6" mesh opening, or as approved.

Prefabricated Units: Envirofence or approved equal may be used in lieu of the above method providing the unit is installed per manufacturer's instructions.

CONSTRUCTION GUIDELINES

- Posts should be spaced 10 ft (3 meters) apart when a wire mesh support fence is used and no more than 6.5 ft (2 meters) apart when using extra-strength filter fabric (without a wire fence). The posts should extend at least 16 in (0.4 meter) into the ground.
- If standard strength filter fabric filter is to be 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. The filter fabric should then be stapled or wired 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 joints in the fabric are required, splice it together only at a support post, with a minimum 6 in (150 mm) overlap, and securely seal the joint.
- Embedded filter fabric should extend in a flap which is anchored by backfill, to prevent fabric from pulling out of ground.

MAINTENANCE

Silt fences should be inspected periodically for damage (such as tearing by wind, animals, or equipment) and for the amount of sediment which has accumulated. Remove the sediment when it reaches one-half the height of the silt fence. In situations where access is available, machinery can be used. Otherwise, the silt must be removed manually. The key elements to remember are:

- The sediment deposits should be removed when heavy rain or high water is anticipated.
- The sediment deposits should be placed in an area where there is little danger of erosion.

- The silt fence should not be removed until adequate vegetative growth ensures no further erosion of the slopes. Generally, the fabric is cut at ground level, the wire and posts are removed, then the sediment is spread, seeded, and protected (mulched) immediately.

BMP #136 - Vegetative Buffer Strip

DESCRIPTION

Targeted Pollutants

- ● Sediment
- ○ Phosphorus
- ○ Trace metals
- ○ Bacteria
- ○ Petroleum hydrocarbons

Physical Limits

Drainage area	unlimited
Max slope	20%
Min bedrock depth	5 ft
Min water table	3 ft
SCS soil type	ABCD
Freeze/Thaw	fair
Drainage/Flood control	no

A vegetative buffer strip is a gently sloping area of vegetative cover that runoff water flows through before entering a stream, storm sewer, or other conveyance. The buffer strip may be an undisturbed strip of natural vegetation or it can be a graded and planted area .

Vegetative buffer strips act as living sediment filters that intercept and detain storm water runoff. They reduce the flow and velocity of surface runoff, promote infiltration, and reduce pollutant discharge by capturing and holding sediments and other pollutants carried in the runoff water. Vegetative buffer strips function much like vegetated or grassed swales. Buffer strips, however, are fairly level and treat sheet flow across them, whereas grassed swales are indentations that treat concentrated flows running along them (see treatment BMP #5 - vegetated swale).

APPLICATIONS

- Used for temporary or permanent control, usually in conjunction with other sediment collection and slope protection practices. Consider use with level spreaders (treatment BMP #21) or diversion measures such as earth dikes (BMP #140) and slope drains (BMP #125). Also, silt fences (BMP #135) installed up-gradient can prevent overloading of the buffer strip.
- May be placed at many locations between the source of sediment (road surface, side slopes) and a natural or constructed waterway. They are inexpensive and easily constructed, and can be put into place at any time if climatic conditions allow for planting.
- May be used at almost any site that can support vegetation, but is best suited for areas where the soils are well drained or moderately well drained and where the bedrock and the water table are well below the surface.
- Provides low to moderate treatment of pollutants in storm water while providing a natural look to a site.
- Can provide habitat for wildlife.
- Can screen noise and views if trees or high shrubs are planted on the filter strips.

LIMITATIONS

- Not effective for filtering high velocity flows from large paved areas, steep slopes, or hilly areas. Consider other measures if slopes exceed 15 percent.
- Requires significant land space.
- May have a short useful life due to clogging by sediments and oil and grease.
- Do not use planted or seeded ground as a buffer strip for sediment trapping until the vegetation is well established.

DESIGN PARAMETERS

Width and length: A buffer strip must be at least 20 ft (6 meters) wide to function well. Along live streams or above wetlands, the minimum width should be 100 ft (30 meters). The length of the strip should be approximately 50 to 82 ft (15 to 25 meters). Where slopes become steeper, increase the length of the strip.

Plant materials: Tall, dense stands of grass form good sediment traps, as do willows and alder. The willows and alder can be native or planted. A combination of grasses with willows or alder is also effective. Any planted species should be deep rooted and able to adjust to low oxygen levels. Vegetative cover should be at least 75 percent to assure adequate removal of sediments. Forested strips are always preferred to vegetated strips, and existing vegetation is preferred to planted vegetation. In planning for vegetated strips, consider climatic conditions, since vegetation may not take hold in especially dry and/or cold regions.

Effectiveness: In many cases, a vegetative buffer strip will not effectively control runoff and retain sediments unless employed in conjunction with other control measures. Where heavy runoff or large volumes of sediment are expected, provide diversion measures or other filtering measures above or below the buffer strip.

CONSTRUCTION GUIDELINES

- Try to direct sediment-laden water onto naturally vegetated or stabilized planted ground.
- Fertilizing seeded or planted ground may enhance growth (and improve its effectiveness as a buffer strip).
- Do not place any equipment, construction debris, or extra soil in the buffer strip (or the strip will be damaged).

MAINTENANCE

Inspections: Inspect the buffer strip at regular intervals to ensure proper functioning. Check for damage by equipment and vehicles. In newly planted areas, check the progress of germination and plant growth, and arrange for fertilizing, if needed, to enhance growth and establishment. (Planted ground must not be used for a sediment trap until the vegetation is well established.) Make sure that water flowing

through the buffer strip is not causing additional erosion nearby, and not forming ponds due to erosion within the buffer strip.

Maintenance: Buffer strips in natural vegetation do not generally require maintenance; however, on some sites it may be necessary to remove sediments and replant on a regular basis. Promptly repair any damage from equipment, vehicles, or erosion.

BMP #137 - Sedimentation Trap (Basin)

DESCRIPTION

A temporary or permanent dam or basin used to collect, trap, and store sediment produced by construction activities, or as a flow detention facility for reducing peak runoff rates. Sediment basins can be designed to maintain a permanent pool or to drain completely dry. Either way, the basin detains sediment-laden runoff long enough to allow most of the sediment to settle out.

A sediment basin can be constructed by excavation or by placing an earthen embankment across a low area or drainage swale. The pond has a riser and pipe outlet with a gravel outlet or spillway to slow the release of runoff and provide some sediment filtration.

Targeted Pollutants

- ● Sediment
- ○ Phosphorus
- ◒ Trace metals
- ○ Bacteria
- ○ Petroleum hydrocarbons

Physical Limits

Drainage area	5 ac
Max slope	10%
Min bedrock depth	3 ft
Min water table	2 ft
SCS soil type	BCD
Freeze/Thaw	good
Drainage/Flood control	no

APPLICATIONS

Sediment traps are appropriate where physical site conditions or land ownership restrictions preclude the effective use of barrier-type erosion control measures. It may be used below construction operations which expose critical areas to soil erosion.

A temporary sediment basin used in combination with other control measures, such as seeding or mulching, is especially effective for removing sediments.

Note that the use of sedimentation basins on construction sites greater than or equal to 5 acres with an NPDES stormwater permit has special requirements. Refer to Part IV.D.2.a.(2)(a) of the NPDES stormwater general permit for onsite activities.

LIMITATIONS

- May not be feasible downstream of narrow right-of-way due to lack of space.
- May not be practical in highly erodible soil types (0.01 and smaller, very fine sand, silt and clay) due to extremely large basin size requirements.
- May not remove enough of the fine silts. Additional control measures such as filter cloth around riser should be used to minimize release of fine silts. If filter cloth is used, regular inspection and replacement is required to deal with clogging.
- Should not be located in any active stream channel.

DESIGN PARAMETERS

Design of the basin should be based upon the total drainage area lying upstream and (if permanent) on the future use of such lands. Design should be approved by a professional engineer.

The volume of the sediment basin should be at least 1800 ft^3 /acre (125 cubic meters per hectare) of total drainage area (about 1/2 in (13 mm) over the watershed). Disturbed areas greater than 10 acres (4 hectares) within the same drainage basin should be provided a basin with a capacity of 3600 ft^3 (250 cubic meters) per hectare of total drainage area (1 in (25 mm) over the watershed) to meet the NPDES regulations.

The basin should be designed with baffles or other deflectors to spread the flow throughout the basin. It should also include an emergency spillway and riser pipe(s). These structures must be designed on a site-specific basis using standard engineering practices. The basin pond must be sized by calculating the settling zone volume and adding the necessary sediment storage volume. The settling zone volume is determined by the pond surface area calculated using the following equation:

$SA = 1.2Q_x / V_{sed}$

Where:

SA = the pond surface area in square meters

Q_x = the design inflow (in cubic meters per second) based on the runoff from the design storm event for the drainage area.

V_{sed} = the settling velocity for the design soil particle in meters per second. The following table lists theoretical settling velocities for different particle sizes (#200 sieve=0.074 mm).

Size in (mm)	V_{sed} in/sec (m/sec.)
0.02 (0.5)	0.0023 (0.058)
0.008 (0.2)	0.00079 (0.020)
0.004 (0.1)	0.00028 (0.007)
0.002 (0.05)	0.000079 (0.002)
0.0008 (0.02)	0.000012 (0.0003)
0.0004 (0.01)	0.0000028 (0.00007)
0.0002 (0.005)	0.00000079 (0.00002)

For particle sizes of 0.01 and smaller, the V_{sed}'s are so low that the SA becomes extremely large, often making the overall basin size requirement too large to be practical. In this case, extra protection

measures should be taken to negate the need for the basin.

The settling volume requirement is then calculated by multiplying the surface area by the settling depth. The settling depth must be a minimum of 1 ft (0.6 meter) and a maximum of 4 ft (1.2 meters) and is governed by a relationship with the basin length (distance from the inlet to the outlet). The ratio of length to settling depth should be greater than 200. For example, if the length was (120 meters), the settling depth must be less than 2 ft (0.6 meters) to achieve the ratio of greater than 200.

Typically, a sediment storage depth of 3 ft (1.0 meter) is appropriate unless large volumes of soil are expected from highly erodible site conditions. In this case use the "universal soil loss equation" or other applicable estimating methods to design the storage depth on a site-specific basis.

Determine the final pond dimensions and volume as follows:

1) Determine the pond geometry for the sediment settling volume calculated above by adding a sediment storage depth of 3 ft(1.0 meter) and 3:1 side slopes from the bottom of the basin. The bottom must be level.

2) Extend the side slopes (at 3:1) as necessary to obtain the settling zone volume at the settling zone depth determined above.

3) Adjust the geometry of the basin to effectively combine the settling zone volume and sediment storage volume while preserving the depth and side slope criteria listed above.

Sediment basins covered by this standard should be limited to the following category:

The water surface at the crest elevation of the pipe spillway should not exceed 10 ft (3 meters) measured upward from the original stream bed to the crest elevation of the pipe spillway; and the drainage area should not exceed 150 acres (60 hectares).

Because finer silts may not settle out completely, additional erosion control measures should be used to minimize release of the fine silt. Runoff should enter the basin as far from the outlet as possible to provide maximum retention time.

CONSTRUCTION GUIDELINES

The temporary sediment basin should be installed before clearing and grading is undertaken. It should not be built within an active stream channel. Putting a dam in such a site could destroy aquatic habitat, and failure of the dam could result in flooding. A temporary sediment basin should be constructed only if there is sufficient space and appropriate topography. The basin should be made large enough to handle the maximum expected amount of site drainage. Fencing around the basin may be necessary for safety reasons or to discourage vandalism.

The following general construction criteria are critical to successful installation and operation of sediment basins.

- Locate the dam to provide maximum volume capacity for silt behind the structure.

- Prepare the dam site by clearing vegetation and removing topsoil before beginning dam construction. Areas under the embankment and any structural works should be cleared and grubbed, and the topsoil stripped to remove all trees, vegetation, roots and other objectionable material. To facilitate cleanout and restoration, the pool area (measured at the top of the pipe spillway) should be cleaned of all brush, trees or other debris.

- Level the bed for the pipe spillway to provide uniform support through its entire length under the dam.

- Construct an emergency spillway (as per design) on undisturbed soil--not on fill. The design width and entrance/exit channel slopes are critical to the spillway's ability to successfully protect the dam with a minimum of erosion hazard in the spillway channel. The spillway should be lined with

  4 in (100 mm) of concrete, reinforced with 6 X 6 in (150 mm x 150 mm) 10/10 wire mesh extending to a minimum of 36 in (900 mm) down each face of the embankment. The spillway should be at least 20 in (500 mm) deep with 1:1.5 slide slopes.

- All pipe joints must be securely fastened and watertight. The riser should be rigidly and securely fastened to the barrel and the bottom of the riser should be sealed (watertight). The barrel should be placed on a firm foundation according to the lines and grades shown on the plans.

- Place at least 1 ft (600 mm) of hand-compacted backfill (maximum 6 in (150 mm) lifts) over the pipe spillway before crossing it with construction equipment. The movement of the hauling and spreading equipment over the fill should be controlled so that the entire surface of each lift will be traversed by not less than one tread tract of the equipment.

- The pipe spillway should discharge at ground elevation below the dam, and not more than 12 in (300 mm) above any streambed.

- Fill material should be taken from approved designated borrow areas, and should be of the type and quality conforming to that specified for the adjoining fill material. It should be free of roots, woody vegetation, oversize stones, rocks exceeding 6 in (150 mm) diameter, or other objectionable materials. Do not use frozen material.

- Areas on which fill is to be placed should be scarified prior to placement of fill. Fill materials should be placed in 6 in (150 mm) maximum lifts, compacted by construction equipment. The embankment should be raised and compacted to an elevation which provides for anticipated settlement to design elevation (allow at least 10 percent for settlement). Lifts should be continuous over the entire length of the fill and approximately horizontal.

- Stabilize the embankment and emergency spillway with revegetation or other stabilization measures.

MAINTENANCE

Sediment basins should be readily accessible for maintenance and sediment removal. They should be inspected after each rainfall and be cleaned out when about half the volume has been filled with sediment. Poorly draining basins require maintenance to clean clogged riser or filter cloth. Removed sediment should be disposed of and stabilized in an approved location such that spoils do not re-enter waters of the state. Sediment may not be dumped into any water of the U.S. without appropriate permitting.

The sediment basin should remain in operation and be properly maintained until vegetation or other measures permanently stabilize the drainage area. A well built temporary sediment basin that is large enough to handle the post-construction runoff volume may later be converted to use as a permanent storm water management structure.

If the pond is located near a residential area, it is recommended for safety reasons that a sign be posted and that the area be secured by a fence.

BMP #138 - Portable Sediment Tank

DESCRIPTION

A sediment tank is a compartmented tank container through which sediment laden water is pumped to trap and retain the sediment prior to pumping the water to drainageways, adjoining properties, and rights-of-way below the sediment tank site.

Targeted Pollutants

- ● Sediment
- ○ Phosphorus
- ◒ Trace metals
- ○ Bacteria
- ○ Petroleum hydrocarbons

APPLICATIONS

A sediment tank should be used on sites where excavations are deep, and space is limited, such as urban construction, where direct discharge of sediment laden water to stream and storm drainage systems is to be avoided.

Physical Limits

Drainage area	5
Max slope	NA
Min bedrock depth	NA
Min water table	NA
SCS soil type	NA
Freeze/Thaw	good
Drainage/Flood control	no

DESIGN PARAMETERS

Location: The sediment tank shall be located for ease of clean-out and disposal of the trapped sediment, and to minimize the interference with construction activities and pedestrian traffic.

Tank Size: The following formula should be used in determining the storage volume of the sediment tank: Pump Discharge (G.P.M.) x 16 = Cubic Foot Storage.

An example of a typical sediment tank is shown in on the attached drawing. Other container designs can be used if the storage volume is adequate and approval is obtained from the local approving agency.

INSTALLATION GUIDELINES

Follow manufacturer's specifications.

VARIATION WITH FLOCCULATION

The pollution removal efficiency of the sediment tank can be considerably increased by using flocculation chemicals, such as alum (aluminum sulfate) in the tank. Flocculation will allow some very small suspended solids to settle that otherwise would never be removed. The time it takes to settle out larger particulates will also decrease. However, a flocculation tank setup is considerably more complicated as the rate of flocculant addition must be carefully monitored.

BMP #139 - Temporary Swale

DESCRIPTION

A temporary excavated drainage way designed to prevent runoff from entering disturbed areas by intercepting and diverting it to a stabilized outlet. Another purpose of a temporary swale is to intercept sediment laden-water and divert it to a sediment trapping device.

Targeted Pollutants

- ● Sediment
- ○ Phosphorus
- ◒ Trace metals
- ○ Bacteria
- ○ Petroleum hydrocarbons

Physical Limits

Drainage area 10

Max slope 14 %

Min bedrock depth 5 ft

Min water table 3 ft

SCS soil type BCD

Freeze/Thaw fair

Drainage/Flood control yes

APPLICATIONS

Temporary Swales are constructed:

- To divert flows from a disturbed area
- Intermediately across disturbed areas to shorten overland flow distance.
- To direct sediment laden water along the base of slopes to a trapping device.
- To transport offsite flows across disturbed areas such as rights-of-way.

Swales collecting runoff from disturbed areas shall remain in place until the disturbed areas are permanently stabilized.

DESIGN PARAMETERS

Design Criteria. The following design criteria should be met, depending on the drainage area served by the swale:

	Swale A	Swale B
Drainage Area	5 ac or less	5-10 ac
Bottom Width of Flow Channel	4 feet	6 feet
Depth of Flow Channel	1 foot	1 foot
Side Slopes	2:1 or flatter	2:1 or flatter
Grade	0.5% min, 20% max	0.5% min, 20% max

Outlet.

- The temporary swale shall be designed with an outlet that functions with a minimum of erosion, and dissipates runoff velocity prior to discharge off the site.
- Runoff shall be conveyed to a sediment trapping device such as a sediment trap or sediment basin until the drainage area above the swale is adequately stabilized.
- The on-site location may need to be adjusted to meet field conditions in order to utilize the most suitable outlet condition.
- If a swale is used to divert flows from entering a disturbed area, a sediment trapping device may not be needed.

CONSTRUCTION GUIDELINES

Stabilization of the swale shall be completed within 10 days of installation with proper seeding or mulching techniques (see BMP #145-Seeding or BMP #121-Mulching). The flow channel shall be stabilized according to the following criteria:

Type of treatment	Channel grade (percent)	Flow Channel A (less than 5 acres)	Flow Channel B (5-10 acres)
1	0.5-3.0	Seed and Straw Mulch	Seed and Straw Mulch
2	3.1-5.0	Seed and Straw Mulch	Seed and cover with Jute or Excelsior; Sod, or line with 2" stone
3	5.1-8.0	Seed and cover with Jute or Excelsior; Sod, or line with 2" stone	Line with 4-8"stone or Recycled Concrete Equivalent[a]
4	9.1-20	Line with 4-8"stone or Recycled Concrete Equivalent[a]	Engineering Design

[a] Recycled Concrete Equivalent shall be concrete broken into the required size, and shall contain no steel reinforcement.

In highly erodible soils, as defined by the Soil Survey (NRCS/SCS) of the project's county, refer to the next higher slope grade for type of stabilization.

Also see Treatment BMP #1 - Vegetated Swale, for additional construction guidelines for swales.

MAINTENANCE

See treatment BMP #1 - Vegetated Swale.

BMP #140 - Earth Dike

DESCRIPTION

An earth dike is a temporary berm or ridge (or ridge-and-channel combination) of compacted soil located in a manner to channel water to a desired location. Earth dikes are used to protect work areas from upslope runoff and to divert sediment-laden water to appropriate traps or stable outlets. The channel portion (if used) generally has a lining of stone, riprap, or vegetation for stabilization.

Targeted Pollutants

- ● Sediment
- ○ Phosphorus
- ◒ Trace metals
- ○ Bacteria
- ○ Petroleum hydrocarbons

Physical Limits

Drainage area	10 ac
Max slope	10%
Min bedrock depth	5 ft
Min water table	5 ft
SCS soil type	ABC
Freeze/Thaw	Fair
Drainage/Flood control	yes

APPLICATIONS

Earth dikes are used in construction areas to control erosion, sedimentation, or flood damage. Earth dikes can be used in the following situations:

- Across unprotected slopes, as slope breaks, to reduce length.
- Below slopes to divert excess runoff to stabilized outlets.
- At or near the perimeter of the construction area to keep sediment-laden runoff from leaving the site.
- To protect cut or fill slopes by diverting upslope flows away from disturbed areas to a stabilized outlet.
- To direct any sediment-laden runoff to a sediment-trapping device.
- To direct clean water away from disturbed areas

LIMITATIONS

- Despite an earth dike's simplicity, improper design can limit its effectiveness.
- Frequent inspection and maintenance are essential to the proper performance of this BMP.
- When the drainage area above the earth dike is greater than 10 acres (4 hectares), consult the United States Department of Agriculture - Soil Conversation Service (USDA-SCS) standards and specifications for diversions.

DESIGN PARAMETERS

The earth dike shall be constructed of compacted soil or coarse aggregate according to the following criteria:

SUGGESTED DIKE DESIGN CRITERIA		
Criteria	**Drainage area under 5 acres (2 hectares)**	**Drainage area between 5 to 10 acres (2 to 4 hectares)**
Dike Height	18 in (.53 m)	3 ft (1.0 m)
Dike Width	2 ft (0.6 m)	3 ft (1.0 m)
Flow Width	4 ft(1.3 m)	6 ft (2.0 m)
Flow Depth in channel	8 in (0.2 m)	15 in (0.4 m)
Side Slopes	2:1 or flatter	2:1 or flatter
Grade	0.5% - 20%	0.5% - 20%

The channel formed behind the dike should have a positive grade to a stabilized outlet. The channel should be stabilized with vegetation or other stabilization measures.

Grades over 10 percent may require site-specific design developed or approved by a registered engineer.

CONSTRUCTION GUIDELINES

Some general considerations include proper compaction of the earth dike, appropriate location to divert the intercepted runoff, and proper ridge height and thickness. Earth dikes should be constructed along a positive grade. Other than the discharge point, there should be no dips or low points where stormwater will collect.

Runoff intercepted from disturbed areas should be diverted to a sediment-trapping device. Runoff from undisturbed areas can be channeled to an existing swale or to a level spreader. Stabilization for the dike and flow channel (or drainage swale) should be stabilized as soon as possible. Stabilization materials can include vegetation, stone, or riprap.

Where: Construct the dike where it will not interfere with major areas of construction traffic so that vehicle damage to the dike will be kept to the minimum.

When: Install the dike prior to the majority of soil disturbing activity. The dike may be removed when stabilization of the drainage area and outlet are complete.

Site preparation: Clear the area of all trees, brush, stumps, or other obstructions.

Construction: Construct the dike to the designed cross-section, line and grade making sure that there are no irregularities or bank projections to impede the flow. Construct the connecting portion to any stream channel last.

Compaction: The dike should be compacted using earth moving equipment (to prevent failure of the dike).

Stabilization: The dike must be stabilized at least 10 days after installation. The flow channel shall be stabilized according to the following criteria:

Type of treatment	Channel grade (percent)	Flow channel A (less than 5 acres)	Flow channel B (5-10 acres)
1	0.5-3.0	Seed and Straw Mulch	Seed and Straw Mulch
2	3.1-5.0	Seed and Straw Mulch	Seed and cover with Jute or Excelsior; Sod, or line with 2" stone
3	5.1-8.0	Seed and cover with Jute or Excelsior; Sod, or line with 2" stone	Line with 4-8"stone or Recycled Concrete Equivalent
4	8.1-20	Line with 4-8"stone or Recycled Concrete Equivalent	Engineering Design

[a] Recycled Concrete Equivalent shall be concrete broken into the required size, and shall contain no steel reinforcement.

In highly erodible soils, as defined by the Soil Survey (NRCS/SCS) of the project's county, refer to the next higher slope grade for type of stabilization.

Outlet: Earth dikes shall have an outlet that functions with a minimum of erosion. Runoff shall be conveyed to a sediment trapping device until the drainage area above the dike is adequately stabilized. The on-site location may need to be adjusted to meet field conditions in order to utilize the most suitable outlet.

MAINTENANCE

- Inspect diversion dikes regularly and after every storm. Make any repairs necessary to ensure they are in good working order.
- Inspect the dike, flow channel and outlet for deficiencies or signs of erosion.
- If material must be added to the dike, be sure it is properly compacted.
- Reseed/stabilize the dike as needed to maintain its stability regardless if there has been a storm event or not.

BMP #141 - Perimeter Dike/Swale

DESCRIPTION

A temporary ridge of soil excavated from an adjoining swale located along the perimeter of the site or disturbed area. The purpose of a perimeter dike/swale is to prevent off-site storm runoff from entering a disturbed area and to prevent sediment laden storm runoff from leaving the construction site or disturbed area.

Targeted Pollutants

- ● Sediment
- ○ Phosphorus
- ◒ Trace metals
- ○ Bacteria
- ○ Petroleum hydrocarbons

APPLICATIONS

A perimeter dike/swale is constructed to divert flows from entering a disturbed area, or along top of slopes to prevent flows from eroding the slope, or along base of slopes to direct sediment laden flows to a trapping device.

The perimeter dike/swale shall remain in place until the disturbed areas are permanently stabilized.

Physical Limits

Drainage area 2 acres

Max slope 10 %

Min bedrock depth 5 ft

Min water table 5 ft

SCS soil type ABC

Freeze/Thaw fair

Drainage/Flood control yes

DESIGN PARAMETERS

The perimeter dike/swale shall not be constructed outside the property lines without obtaining legal easements from effected adjacent property owners.

A detailed design is not required for the perimeter dike/swale. However, the following criteria shall be used:

Drainage area: Less than 2 acres (for drainage areas larger than 2 acres, but less than 10 acres, see BMP #140 - earth dike; for drainage areas larger than 10 acres, see BMP #143 - storm drain diversion).

Height: 18 inches minimum from bottom of swale to top of dike evenly divided between dike height and swale depth.

Bottom width of dike: 2 feet minimum.

Width of Swale: 2 feet minimum.

Grade: Dependent upon topography, but shall have positive drainage

(sufficient grade to drain) to an adequate outlet. Maximum

allowable grade not to exceed 20 percent.

Outlet

- The perimeter dike/swale shall have an outlet that functions with a minimum of erosion.

- Diverted runoff from a protected or stabilized upland area shall outlet directly onto an undisturbed stabilized area.
- Diverted runoff from a disturbed or exposed upland area shall be conveyed to a sediment trapping device such as a sediment trap (BMP #137), or to an area protected by any of these practices.
- The on-site location may need to be adjusted to meet field conditions in order to utilize the most suitable outlet.

CONSTRUCTION GUIDELINES

The disturbed area of the dike and swale shall be stabilized within 10 days of installation, in accordance with the guidelines seed and straw mulch or straw mulch only if not in the seeding season. (See BMPs #143 and #121).

MAINTENANCE

See BMP #140 - Earth Dike, or treatment BMP #1 - Vegetated Swale.

BMP #142 - Temporary Berms (Sandbags)

DESCRIPTION

A temporary berm is a ridge of compacted soil, or sandbags which intercepts and diverts runoff from small construction areas. Temporary berms are often constructed along the top edge of fill slopes but may also be constructed across the roadway (as a transverse berm) at a slight angle with the centerline.

Berms are used to prevent runoff onto newly constructed slopes until vegetation is established or until permanent measures are in place. They intercept flow from the construction area and direct it to temporary slope drains or to outlets where it can be safely discharged.

Targeted Pollutants

- ● Sediment
- ○ Phosphorus
- ○ Trace metals
- ○ Bacteria
- ○ Petroleum hydrocarbons

Physical Limits

Drainage area	5 ac
Max slope	50%
Min bedrock depth	N/A
Min water table	N/A
SCS soil type	ABCD
Freeze/Thaw	good
Drainage/Flood control	yes

APPLICATIONS

Temporary berms are used to direct or divert runoff flows, or as barriers to collect and store runoff. They are used at storm drain inlets, across minor swales and ditches, and for other applications where the structure is of a temporary nature.

LIMITATIONS

Temporary berms do not provide filtration. Therefore, they can only be used for minor flows.

DESIGN PARAMETERS

Soil berm: A berm of soil with an approximate height of 12 to 20 in (300 to 500 mm) with a minimum top width of 2 to 2.3 ft (600 to 700) mm and side slopes of 2:1 or flatter. Berms should be high enough to prevent flow from overtopping. Berms are normally constructed from embankment materials.

Sandbag berm: The following dimensions are suitable for sandbag berms.

- Height - 20 in (0.5 meter) minimum
- Top width - 20 in (0.5 meter) minimum
- Bottom width - approximately 4.25 to 5 ft (1.3 to 1.5 meters)
- Sandbag size - length 2 to 2.6 ft (0.6 to 0.8 meters), width 16 to 20 in (0.4 to 0.5 meters), depth or thickness 6 to 8 in (150 to 200 mm), and weight 88 to 132 lb (40-60 kg)

CONSTRUCTION GUIDELINES

Soil berm: All berms should be graded to drain to a slope drain inlet. When practical, embankments should be constructed with a gradual slope to one side of the embankment. This will permit the placement of all temporary berms and slope drains on one side of the embankment. When fills are constructed on sidehill slopes, the top surface should slope toward the inside so that surface runoff will be away from the fill slope.

- Compact the entire width of the berm. This can be accomplished with the track of a bulldozer or, preferably, with a grader wheel (rubber).

Sandbag berm:

- Install so that flow under or between bags is prevented.
- Stack the sandbags in an interlocking fashion to provide additional strength for resisting the force of the flowing water. However, do not stack them more than three high without broadening the foundation using additional sandbags, or providing additional stability.
- Sandbag sediment barriers should store the runoff from design storm as specified.

MAINTENANCE:

Temporary berms should be inspected and repaired periodically as well as after each significant rainfall.

Sandbags should be reshaped or replaced as needed during inspection. Additional inspections should be made daily during wet weather. When silt reaches 6 inches (150 mm), the accumulated silt should be removed and disposed of at an approved site in a manner that will not contribute to additional siltation. The sandbag berm should be left in place until all upstream areas are stabilized and accumulated silt has been removed. Removal of bags should be done by hand.

BMP #143 - Temporary Storm Drain Diversion

DESCRIPTION

The re-direction of a storm drain line or outfall channel so that it may temporarily discharge into a sediment trapping device. The purpose is to prevent sediment laden water from entering a watercourse, public or private property through a storm drain system, or to temporarily provide underground conveyance of sediment laden water to a sediment trapping device.

Targeted Pollutants

- ● Sediment
- ○ Phosphorus
- ○ Trace metals
- ○ Bacteria
- ○ Petroleum hydrocarbons

APPLICATIONS

One of the following practices or procedures shall be used whenever the off-site drainage area is less than 50 percent of the on-site drainage area to that system. A special exception may be given, at the discretion of the local permitting authority, where site conditions make this procedure impossible.

Physical Limits

Drainage area 5 ac

Max slope 50%

Min bedrock depth NA

Min water table NA

SCS soil type ABCD

Freeze/Thaw good

Drainage/Flood control yes

DESIGN METHODS FOR TEMPORARY DIVERSION

- Construction of a sediment trap (basin) (see BMP #137) below a permanent storm drain outfall: Temporarily divert storm flow into the basin or trap constructed below permanent outfall channel.
- In-line diversion of storm drain at an inlet or manhole: Achieved by installing a pipe stub in the side of a manhole or inlet and temporarily blocking the permanent outfall pipe from that structure. A temporary outfall ditch or pipe may be used to convey storm flow from the stub to a sediment trap or basin. This method may be used just above a permanent outfall or prior to connecting into an existing storm drain system.
- Delay completion of the permanent storm drain outfall and temporarily divert storm flow into a sediment trap: Earth dike (BMP #140), swale (BMP #139) or designed diversion is used, depending on the drainage area, to direct flow into a sediment trap. The trap should be constructed to one side of the proposed permanent storm drain location whenever possible.
- Installation of a stormwater management basin early in the construction sequence: Install temporary measures to allow use as a sediment basin. Since these structures are designed to receive storm drain outfalls, diversion should not be necessary.

COMPLETION AND DISPOSITION

When the areas contributing sediment to the system have been stabilized procedures can be taken to restore the system to its planned use.

The following removal and restoration procedure is recommended:

1. Flush the storm drain system to remove any accumulated sediment.

1. Remove the sediment control devices, such as traps, basins, dikes, swales, etc.

2. For sites where an inlet was modified, brick shut the temporary pipe stub and open the permanent outfall pipe.

3. Establish permanent stabilized outfall channel as noted on the plans.

4. Restore the area to grades shown on the plan and stabilize with vegetative measures.

5. For basins that will be converted to stormwater management, remove the accumulated sediment, open the low flow orifice, and seed all disturbed areas to permanent vegetation.

BMP #144 - Topsoiling

DESCRIPTION

This BMP includes the placement of topsoil or other suitable plant growth material over disturbed lands to provide a suitable soil medium for vegetative growth and a supply of native or locally occurring seeds and propagules. Topsoiling may involve bringing in soils from off site or merely replacing fertile topsoils that were stripped and stockpiled during earlier site development activities.

Targeted Pollutants

- ● Sediment
- ○ Phosphorus
- ○ Trace metals
- ○ Bacteria
- ○ Petroleum hydrocarbons

APPLICATIONS

Topsoiling is recommended on slopes 2:1 or flatter where the native soil is unsuitable for vegetative growth. It is an effective way of improving plant establishment on sites where moisture, nutrients, or pH levels are low, or where the remaining soil is too shallow to support root systems.

Physical Limits

Drainage area	unlimited
Max slope	50%
Min bedrock depth	3 ft
Min water table	2 ft
SCS soil type	N/A
Freeze/Thaw	fair
Drainage/Flood control	no

LIMITATIONS

Be careful not to apply topsoil over a subsoil of contrasting texture. For instance, a clay-like topsoil placed over a sandy soil may cause the topsoil to slough as water flows between the two soil layers of different permeability. Also, topsoil should not be applied when the subsoil is frozen or extremely wet.

DESIGN PARAMETERS

Plan to maintain the existing or established grade of the subsoil. The topsoil should be uniformly distributed at a minimum compacted depth of 2 inches (50 mm) on slopes 3:1 or steeper, and 4 inches (100 mm) deep on flatter slopes. The soil should be a loam, sandy loam, clay loam, silt loam, sandy clay loam, or other mixture approved by an agronomist. It should be free of subsoil, refuse, sticks, noxious weed seeds, other extraneous materials, and stones larger than 1.5 inches (40 mm) diameter.

Topsoil can either be obtained commercially or stripped, stockpiled, and replaced on the construction site. Stockpiled topsoils should undergo a laboratory analysis to determine organic content, pH, and soluble salts. A pH of 6.0 to 7.5 and organic content of not less than 1.5 percent by weight is recommended. Where soil pH is less than 6.0, lime may be applied to adjust pH to 6.5 or higher. Any soils having soluble salt content greater than 500 parts per million should not be used.

If desired, it is possible to place a thin layer of topsoil 1.2 to 2 inches (30 to 50 mm) thick on benched slopes. In such applications, it is important not to apply so much topsoil that the value of the benches is destroyed. This method is especially valuable

on rocky benches, especially on south- or west-facing slopes, however, proper placement of the soil is often a problem. In some cases, soil has been bucketed onto slopes. This produces an uneven spread and the quantity is hard to control. Soil can also be blown onto the slope using a snow blower. In that case, organic matter can be mixed with the soil, but the soil should be screened to remove any rocks larger than 2 inches (50 mm). The advantage is that the amount of soil needed is much less and it can be spread very rapidly on the horizontal surfaces. The soil may need some form of stabilization before the next rain event. Consider whether mulch, matting, geotextiles or seeding is required and when.

CONSTRUCTION GUIDELINES

The following guidelines apply to the placement of topsoil:

- The existing or established grade of subsoil should be maintained.
- Lime may be uniformly applied over designated areas where subsoil is highly acidic or heavy in clay content.
- Prior to spreading topsoil, loosen the subgrade by discing (or other method) to a depth of 2 inches (50 mm) to permit bonding of subsoil to topsoil. Tracking a bulldozer vertically over the slope will pack the soil and create horizontal erosion check slots to prevent topsoil from sliding down the slope.
- Spread the topsoil uniformly at a minimum compacted depth of 2 inches (50 mm) on 1:3 or steeper slopes and 4 inches (100 mm) on flatter slopes. A depth of 6 to 12 inches (150 to 300 mm) is preferred. Any surface irregularities should be corrected in an effort to prevent formation of water-holding depressions.
- Where quantities of stockpiled topsoil on site are limited, it is more desirable to cover all areas of exposed subsoil to a lesser depth than to cover partial areas to the suggested minimum depth of 3.1 inches (80 mm).
- Topsoil should not be placed when the subgrade is frozen, excessively wet or in a condition that may otherwise be detrimental to proper grading or proposed sodding or vegetation establishment.

MAINTENANCE

Periodically and after major storm events, inspect, repair, and reseed as necessary to control slope erosion and subsequent topsoil losses.

BMP #145 - Seeding

DESCRIPTION

Permanent Seeding means growing a long-term or permanent vegetative cover (plants) on disturbed areas or areas that need assistance in revegetation. The purpose of permanent seeding is to reduce erosion and sedimentation and to establish desirable competitive ground cover for wildlife habitat and ease of roadside maintenance. This practice uses prescribed perennial grasses, legumes and native shrubs or wild flowers that will hold the soils, reduce storm water runoff and act as a bio-filtering system on long term basis.

The guidelines given in this fact sheet for design, construction and maintenance can also be used to install temporary seeding on construction sites.

Targeted Pollutants

- Sediment
- Phosphorus
- Trace metals
- Bacteria
- Petroleum hydrocarbons

Physical Limits

Drainage area	unlimited
Max slope	5%
Min bedrock depth	2 ft
Min water table	2 ft
SCS soil type	ABCD
Freeze/Thaw	fair
Drainage/Flood control	no

APPLICATIONS

Temporary seeding should be considered as slope protection and erosion control practice for construction sites. Permanent seeding should be considered for any disturbed area where all construction or maintenance activities have ceased or been finalized and is now ready for permanent vegetative cover. Typical areas subject to permanent vegetative cover are all areas disturbed by new construction, reconstruction, maintenance, materials source site and areas in need of revegetation.

The primary advantages of seeding are:

- It establishes good soil stabilization.
- It prevents soil erosion and sedimentation.
- It contains and filters storm water runoff.

Additional advantages specific to permanent seeding are:

- It provides wildlife ground cover and habitat.
- It competes with undesirable vegetation and noxious weeds.
- It provides aesthetic qualities.
- It reduces the cost of maintenance.

LIMITATIONS

Permanent vegetative ground cover will take several years before sufficient establishment takes place. Establishment will occur quicker in high precipitation areas, usually over 20 inches (500 mm), as opposed to the arid or semi-arid regions of the state. Permanent seeding should be conducted in conjunction with various forms of mulching, matting and annual grass (cereal grain) as a nurse crop.

Other factors that contribute to the success or failure of permanent seeding are:

- Seeding should be done at the proper time of year.
- Proper application of fertilizers as prescribed will contribute to the success of the seeding.
- Once seeded, the site should not be disturbed.
- Irrigation may have to be used in low precipitation area (arid/semi-arid) for establishment.

DESIGN PARAMETERS

Conduct all permanent seeding and fertilizing in accordance with local requirements. See Appendix F in this manual for additional guidelines.

CONSTRUCTION GUIDELINES

- Permanent seeding is the last phase of reclaiming any disturbed soils.

MAINTENANCE

- Inspect all seeded 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 or where other remedial actions are necessary to assure establishment of permanent seeding.
- Continue monitoring of the site/area until permanent vegetation is established.

BMP #146 - Sodding

DESCRIPTION

This BMP entails the placement of rolls or strips of sod as a landscape planting or erosion control measure. Sod is a layer of soil bound by grass and plant roots into a thick mat. It is commercially available in rolled strips that are laid over an area of exposed soil. Sod stabilizes the area by immediately covering the surface with vegetation and enabling storm water to infiltrate into the ground.

Targeted Pollutants

- Sediment
- Phosphorus
- Trace metals
- Bacteria
- Petroleum hydrocarbons

APPLICATIONS

Sodding is appropriate for any graded or cleared area that might erode and where a permanent, long-lived plant cover is needed immediately. It can be a temporary or permanent BMP. Possible uses for sod include buffer zones, stream banks, dikes, swales, slopes, outlets, level spreaders, and filter strips.

Physical Limits

Drainage area	unlimited
Max slope	14%
Min bedrock depth	2 ft
Min water table	2 ft
SCS soil type	ABCD
Freeze/Thaw	fair
Drainage/Flood control	no

Primary advantages of sod are:

- Provides immediate dense vegetative cover and erosion control.
- Provides more stabilizing protection than initial seeding.
- Generates less weed growth than seeded vegetation does.
- Can be available for site activities (open to foot traffic) within a shorter time than can seeded vegetation.
- Can be placed at any time of the year as long as water is available and moisture conditions in the soil are favorable.

LIMITATIONS

- Purchase and installation costs are higher than for seeding.
- Continued irrigation may be required if the sod is placed during dry seasons or on sandy soils. Watering may be necessary after planting and during periods of drought or intense heat.
- Sod should not be installed during very hot or wet weather.

DESIGN PARAMETERS

Materials: Use grasses that require little or no maintenance (watering or fertilizing). This may require advance planning to obtain grasses that are desirable for the location.

Site preparation: The soil surface should be find graded before laying down the sod. Topsoil may be needed in areas where soil textures or conditions are inadequate (such as dense or impermeable soils). Add lime and fertilizers as needed to promote good plant growth conditions.

Slope: Do not place sod on slopes greater than 3:1 if slopes are to be mowed. If placed on steep slopes, the sod should be laid with staggered joints or be pegged down (or both).

Installation methods: Sod can be applied in strips or other patterns, or alternate areas can be seeded to reduce expense. If placed on steep slopes or next to running waterways, consider placing chicken wire, jute, or other matting over the sod for extra protection against lifting. See BMP #124-Matting and Netting or BMP #123-Geotextiles.

CONSTRUCTION GUIDELINES

- Spread and grade the topsoil (if used). Sod may be placed directly on the ground (without topsoil) only if it has been specifically grown for sites with no topsoil.
- Prepare the soil surface by fine-grading the surface before laying sod. Sodding should then take place immediately after the soil bed is established.
- Lay the sod in a staggered pattern, as shown. Sod in waterways must be laid parallel to the flow.
- Sod can be laid in strips on the contour to reduce effective slope length.
- Roll or compact the sod immediately after installation to ensure firm contact with the underlying soil.
- Water to a depth of 4 inches (100 mm), as needed.

MAINTENANCE

- Inspect the sod frequently after it is first installed, especially after large storm events, until it is established as permanent cover. Remove and replace any dead sod.
- Once the sod is established, mow the area as needed.
- Water as often as necessary during periods of intense heat or lack of rain.
- Sodding usually serves as both a temporary and permanent measure and therefore does not require removal.

BMP #147 - Planting

DESCRIPTION

This BMP fact sheet describes the process of establishing vegetation by setting out plants that have been grown to a specified size or age. The plants may be potted in plastic tubes or in containers of various sizes, or root wrapped, or may be bare root stock .

Plantings are often specified for aesthetic purposes (landscaping) but can serve various erosion control functions as well. The living trees and shrubs in a planted area will grow large enough to provide soil stabilization and erosion control benefits sooner than the seeds of woody species can germinate and grow to effective size.

The use of trees and shrubs also provides greater aesthetic and biological diversity and, in many areas, is more compatible with vegetation on lands adjoining the planted site.

Also refer to Appendix F for additional design guidance regarding using landscaping to maximize water quality benefits.

Targeted Pollutants

- Sediment
- Phosphorus
- Trace metals
- Bacteria
- Petroleum hydrocarbons

Physical Limits

Drainage area	unlimited
Max slope	50%
Min bedrock depth	3 ft
Min water table	3 ft
SCS soil type	ABCD
Freeze/Thaw	fair
Drainage/Flood control	no

APPLICATIONS

Planting is the preferred method of revegetation in many situations where seeding and other slope treatments are either not effective or not appropriate as permanent measures. Such areas may include:

- Any finished slope that will remain undisturbed for at least ten years, especially if the area is bordered by forests, wetlands or other naturally occurring woody vegetation. On such sites, trees and shrubs may be the desirable vegetation from a long-term perspective, but may be very difficult or unreliable to establish from seed.
- Extremely rocky slopes or sites. If natural vegetation is present in significant amounts, such areas are difficult to seed and mulch effectively. Plantings can be used to provide additional stabilization.
- Streets or materials source sites that have been abandoned permanently.
- All types of landscaping, including urban thoroughfares and interchanges, and residential streets where landscape aesthetics are a concern.
- Wetlands and wildlife habitat areas: in such areas, 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.

- Areas where the higher rate of transpiration for trees and shrubs (compared to grasses and forbs) helps remove excess moisture from the soil.

LIMITATIONS

- Purchase and installation costs are higher than for seeding.
- Continued or periodic irrigation may be required if planting occurs during dry season or on sandy soils. Watering may also be necessary up to two years after planting and during periods of drought or intense heat.
- Specific seasons of work apply for planting. Planting outside the designated season should not be allowed unless provisions for special care and maintenance of the plants are enforceable.

DESIGN PARAMETERS

Advantages of Planting: Many shrubs and trees are difficult to establish from seed in natural environments and natural seed crops vary widely from year to year. Rapid invasion from native vegetation and rapid establishment of sown seed of woody species is therefore unreliable. Vegetative plantings are used to provide living shrubs and trees that will grow to adequate size to provide soil stabilization and erosion control faster than seeds of woody species can germinate and grow to these dimensions.

Materials: 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 root stock. Some species are successfully planted as sprigs or tubelings.

Use of Native Species: If possible, use species that are native to the area. Native species provide long-term soil stabilization which is aesthetically harmonious with natural vegetation and which requires little long-term maintenance. Short-term maintenance is necessary to ensure the establishment of the vegetation.

Maximizing Effectiveness: Successful planting projects depend on selecting suitable plant species, using healthy planting stock, and planting when the season and weather conditions are favorable. The site must be properly prepared for planting, and must be properly maintained after planting to ensure long-term survival of the plants. Make sure the contract and plans include adequate provisions for all aspects of the planting process.

Since vegetative planting places living plants on a site, thus decreasing the length of time necessary to establish a complete revegetation project, it is more effective than seeding methods for revegetation. Adequate maintenance is absolutely necessary to achieve this effectiveness since vegetative planting require irrigation for at least the first year, and will benefit from irrigation for two or more years.

Vegetative planting may be combined with seeded grasses and legumes which provide immediate surface coverage (see BMP #145-Seeding).

CONSTRUCTION GUIDELINES

Make sure that planting site is adequately graded and that tree locations and planting areas (for shrubs, vines, and ground covers) are marked and approved before planting begins.

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

- Tree species may be of bare root stock or of potted stock. Pots should be one gallon (4 liter) size or larger.
- Shrub species may be of bare root stock or of potted stock. The preferred planting pot is a tube of woven plastic that is planted with the plant contained in it. The pot deteriorates over time. The pots should be 2 inches (50 mm) long, with both ends open.
- Paper pots must be 2 to 3.1 inches (50 to 80 mm) square and 8.5 to 12 inches (220 to 300 mm) long. The paper around the rim should be removed to ground level at planting.
- Peat pots are not recommended since research has shown greater mortality of plantings in peat pots due to drying. If peat pots are used, any exposed peat pot material showing after planting should be removed.
- In general, no container should be less than 2 inches (50 mm) wide and 6 inches (150 mm) deep.

Plant storage: 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 planting stock in shade, out-of-doors, and kept lightly sprinkled with water to maintain a moist soil from the time of receipt to the time of planting. This time should not exceed 30 days.

Planting procedures:

- Plant the mixture of trees and shrubs that has been prescribed. In no case should this be less that 690 plants per acre (1,700 plants per hectare). If bare root stocks are used, planting rates should be increased by 1.25 times the stated rate.
- Voluntary or unskilled labor may be used in planting. However, a supervisor who is skilled in the techniques being used should direct the labor.
- Construct a basin 12 inches (300 mm) in diameter and depressed no more than 2 inches (50 mm) from the elevation of the downslope lip.
- Open the planting hole with a planting bar or shovel. Then place the plant near the downslope lip of the basin. This allows sloughing from the slope to fall in to the basin without burying the young plant.

- Carefully remove plants from their containers, if any, and place them in the planting holes so that the crown of the plant is at the surface of the soil. No air space should be allowed around the roots, nor should the roots be folded under. Plants in individual containers made of decomposable material are planted without removing them from the container.

- Apply fertilizer at the rate specified, and place wood chip or wood fiber mulch to a depth of 2 inches (50 mm) around each plant.

- The soil should be wetted to field capacity to a depth of 3.1 to 4 inches (80 to 100 mm) at the time of planting and each time the soil moisture level drops below the permanent wilting percentage.

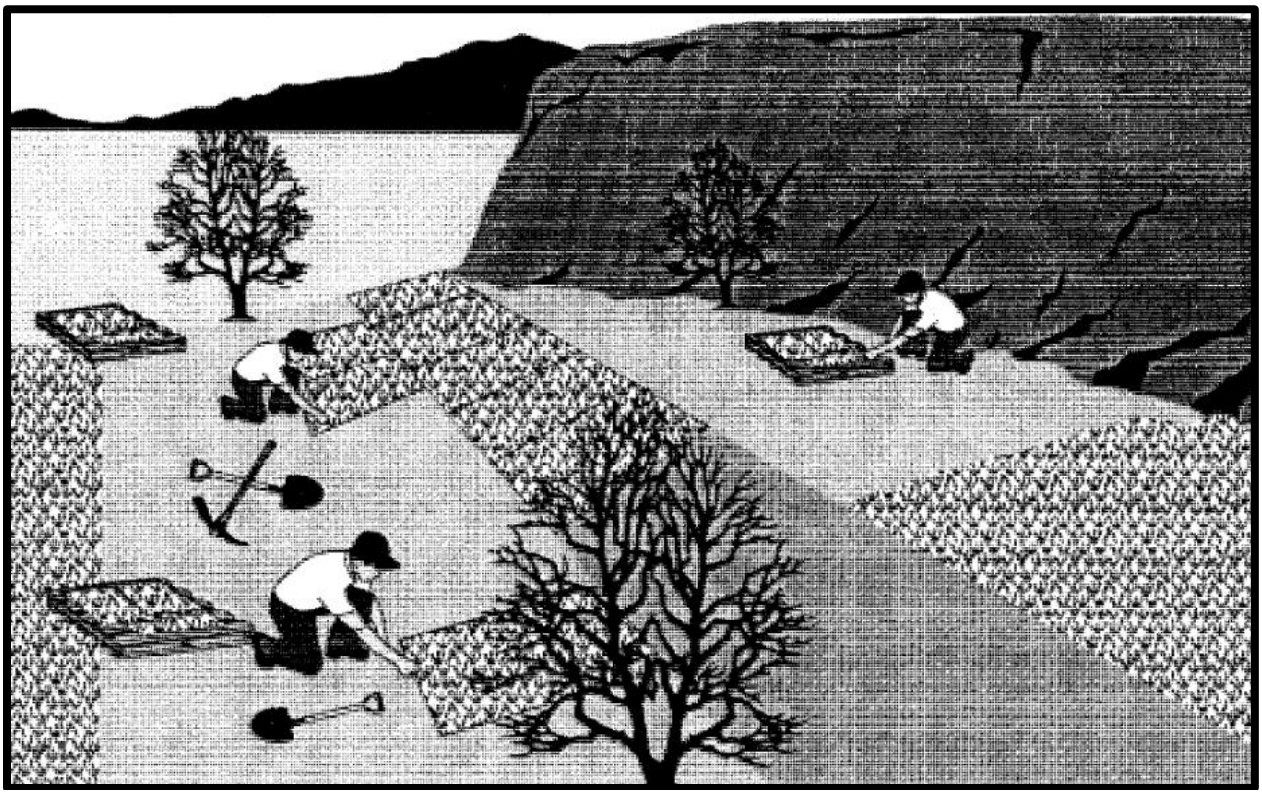
MAINTENANCE

- Irrigation of vegetative plantings during the first two years following planting is required to increase the survival rate. Water as often as necessary during periods of intense heat or lack of rain.

- Inspect plantings frequently after first installed to see if plants are thriving. Remove and replace dead plants to restore the prescribed number of living plants per hectare.

- After storm events, examine the planting basins and mulch cover and make any needed repairs.

BMP A - REVEGETATE BARREN AREAS



Description of Potential Pollutant and Source: Barren areas are typically sources of erosion-related pollutants.

Description of BMP: Seeding, sodding and planting shrubs and trees can be used to revegetate a barren area. It is usually necessary to fertilize and water in order to establish new vegetation. Native plants should be used wherever possible to reduce water demands. The local Soil and Water Conservation District and the Board of Water Supply have information regarding appropriate native plants and seed mixes. See BMPs B and C for information on mulches and soil binders.

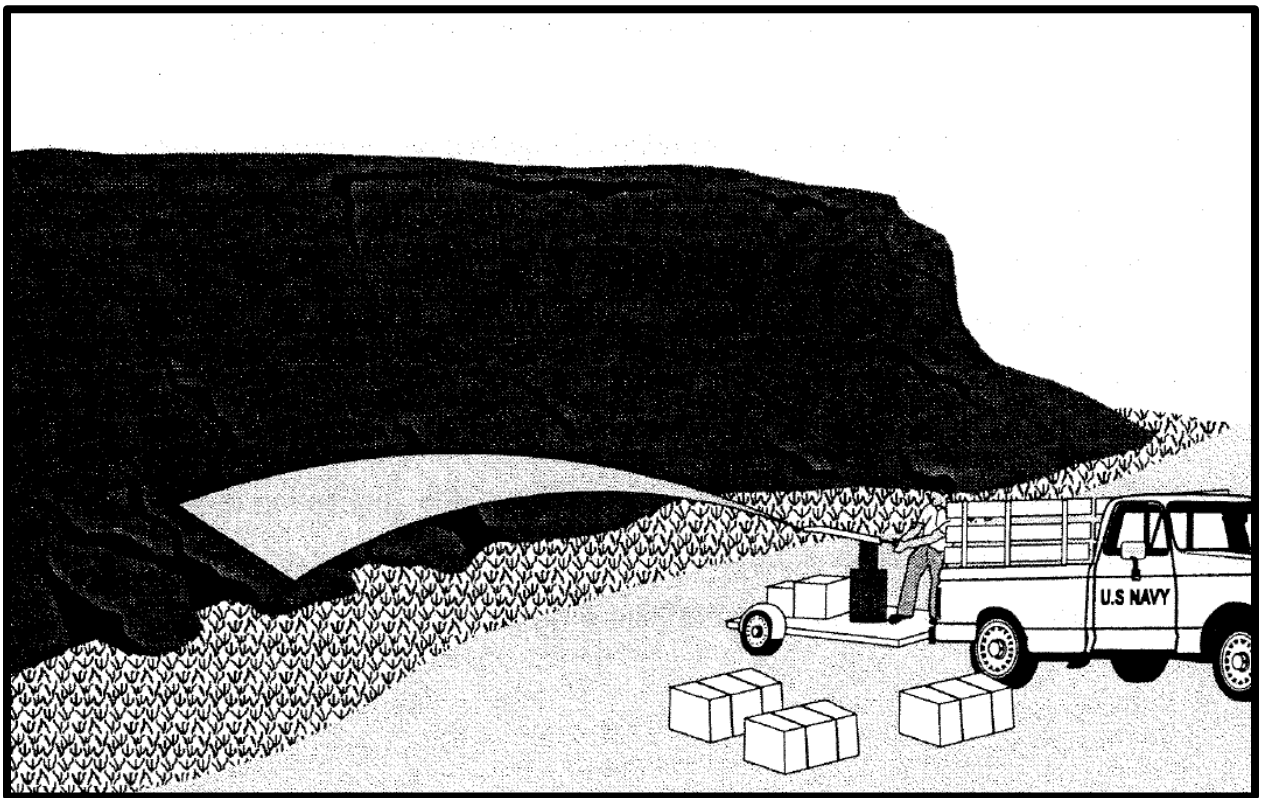
Application Guidance: Sites which are eroding due to lack of vegetation will be revegetated.

Maintenance: Maintenance activities may include fertilizing, irrigation, pruning, and weed and pest control.

Effectiveness and Cost: Establishing vegetation is very effective in reducing erosion. The cost of revegetation will vary depending on the method used, the availability of water, and size of area.

Limitations: It may be difficult to establish vegetation in areas which are heavily used, lack sufficient water, or have poor soils. Irrigation is required for revegetation until plants are established.

BMP B - MULCH EXPOSED AREAS



Description of Potential Pollutant and Source: Exposed areas are sources of erosion-related pollutants.

Description of BMP: Mulch exposed areas. Organic mulching is used to provide temporary erosion control, moisture, and shade to areas being revegetated. Organic mulches include hay, straw, wood fiber, and recycled paper. Mulches must be crimped or netted into the soil. Inorganic mulches, such as gravel, cobbles, and decomposed granite can be used for permanent protection of exposed soil from raindrop impact and runoff in areas where the establishment of new vegetation is not feasible.

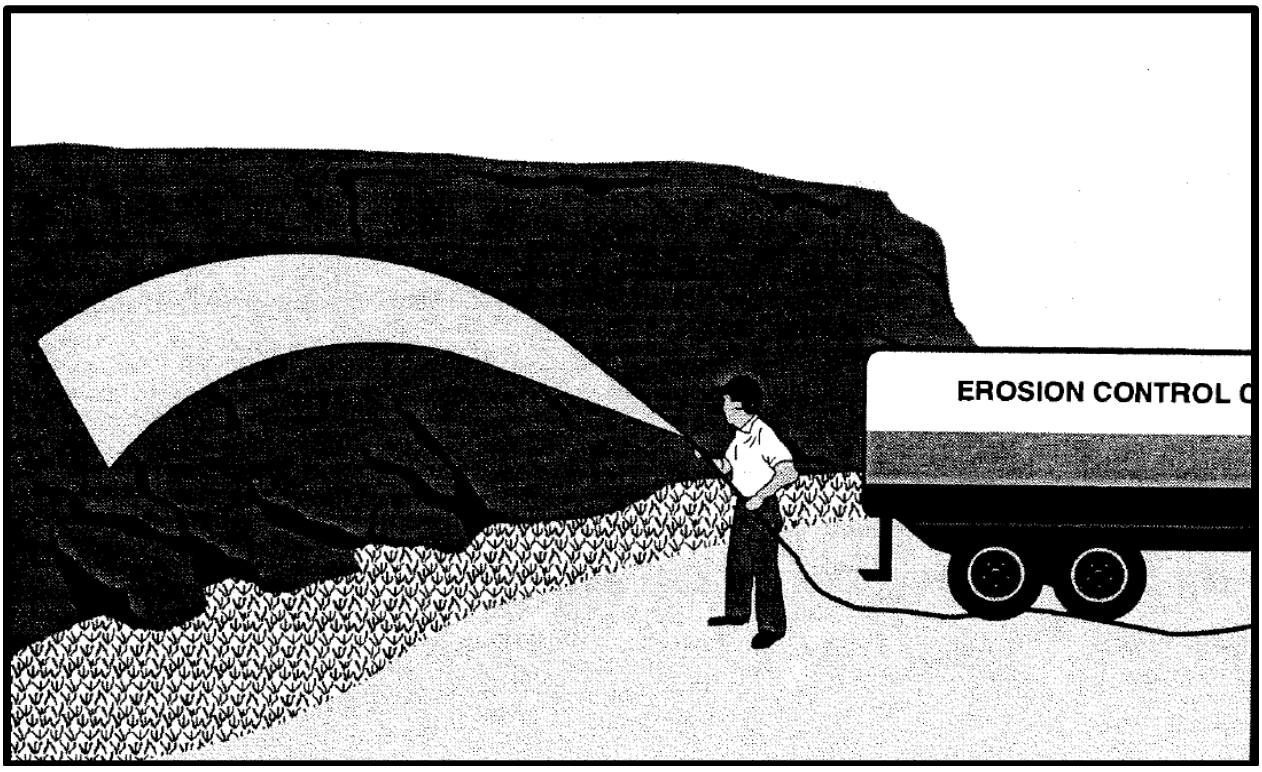
Application Guidance: Organic mulching will be used to provide temporary erosion control and to enhance the establishment of new vegetation. Inorganic mulches can be used to stabilize areas that cannot be seeded or planted, such as areas that are heavily trafficked or have insufficient rainfall.

Maintenance: Areas that have been mulched will be periodically inspected, and any damaged areas will be re-mulched. Organic mulches will be inspected weekly and after every rainfall.

Effectiveness and Cost: Organic mulches are relatively ineffective in reducing erosion but are highly effective in the establishment of new vegetation. The cost varies with the size of area and type of mulch selected. Inorganic mulches are highly effective in reducing erosion provided the soil is adequately covered. The cost varies with the size of the area and the availability and type of mulch selected.

Limitations: Mulches are applied hydraulically and are limited in application to slopes adjacent to areas accessible by large equipment. Mulches provide limited temporary erosion control and are intended primarily to enhance the establishment of vegetation.

BMP C - USE SOIL BINDERS



Description of Potential Pollutant and Source: Exposed areas are sources of erosion-related pollutants.

Description of BMP: Use soil binders. These are also known as chemical mulches, chemical stabilizers, or soil palliatives. Binders made of acrylic co-polymers, emulsifications, and other materials are sprayed onto the surface of the soil to hold the soil in place and provide short-term protection against erosion from storm water runoff and wind. Soil binders can be used alone, as temporary "bare earth" erosion control, or with seed and mulch as temporary erosion control until the new vegetation is established. Some soil binders are completely biodegradable.

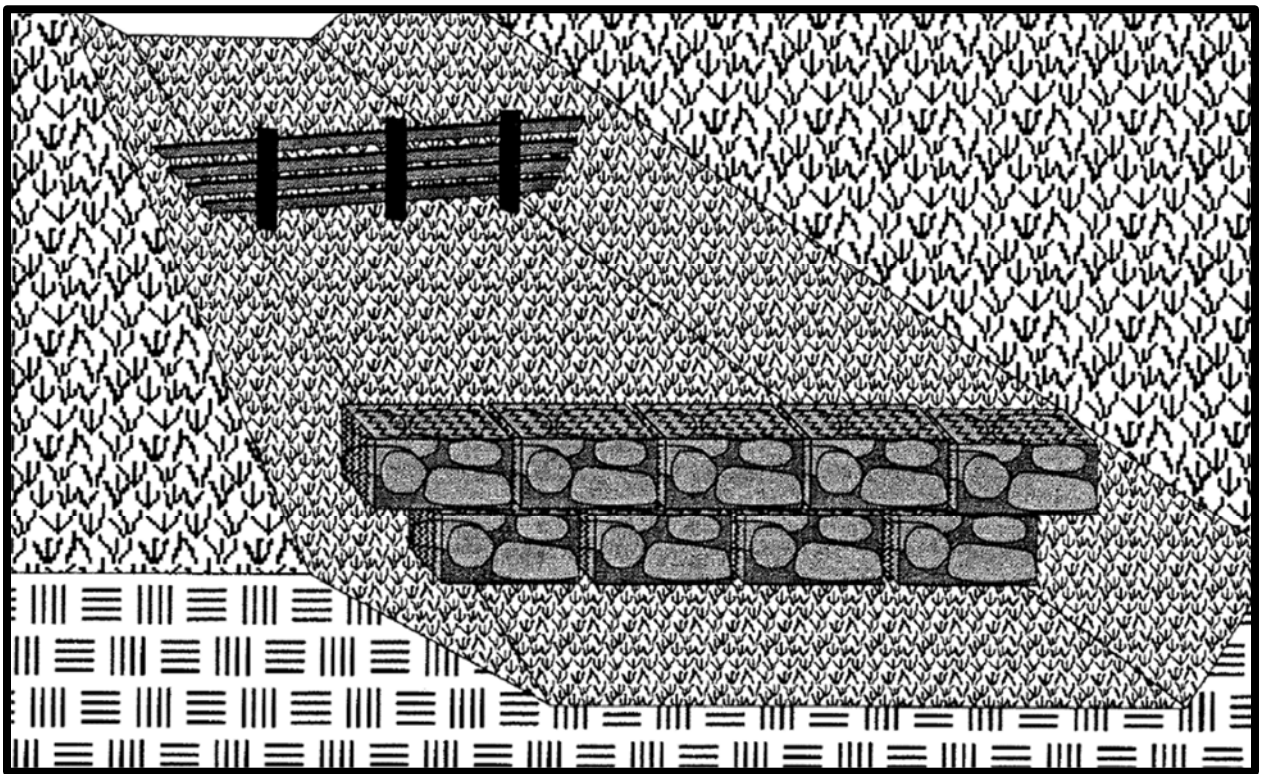
Application Guidance: Soil binders will be used in eroding areas where temporary seeding practices cannot be used because of season, or where more effective erosion control is needed until the vegetation is established. Soil binders provide immediate protection to soils that are in danger of erosion. Soil binders are not a long-term solution to erosion.

Maintenance: Soil binders are a temporary practice and must be periodically reapplied to be effective. Some soil binders can last twelve to eighteen months on bare earth when applied at the appropriate rate.

Effectiveness and Cost: Soil binders, when applied with seed and mulch, can provide immediate and inexpensive short-term erosion control that is more effective than seeding and mulching without binders. Soil binders used alone can provide effective, relatively inexpensive, short-term erosion control.

Limitations: The use of soil binders is a temporary erosion control practice. The application rates and procedure recommended by the manufacturer of the soil binder product must be followed. Soil binders are applied with large spray equipment and are limited to readily accessible areas.

BMP D - USE CHECK DAMS TO REDUCE RUNOFF VEWCITY



Description of Potential Pollutant and Source: Water in an unlined channel or swale which flows at a high velocity can cause erosion and transport of sediment downstream.

Description of BMP: Use check dams to reduce runoff velocity. Check dams are small dams constructed across a swale or drainage channel. Check dams can be built from logs, stones, or gabions. Check dams are used to reduce the velocity of the flow, which reduces the amount of erosion caused by the flow.

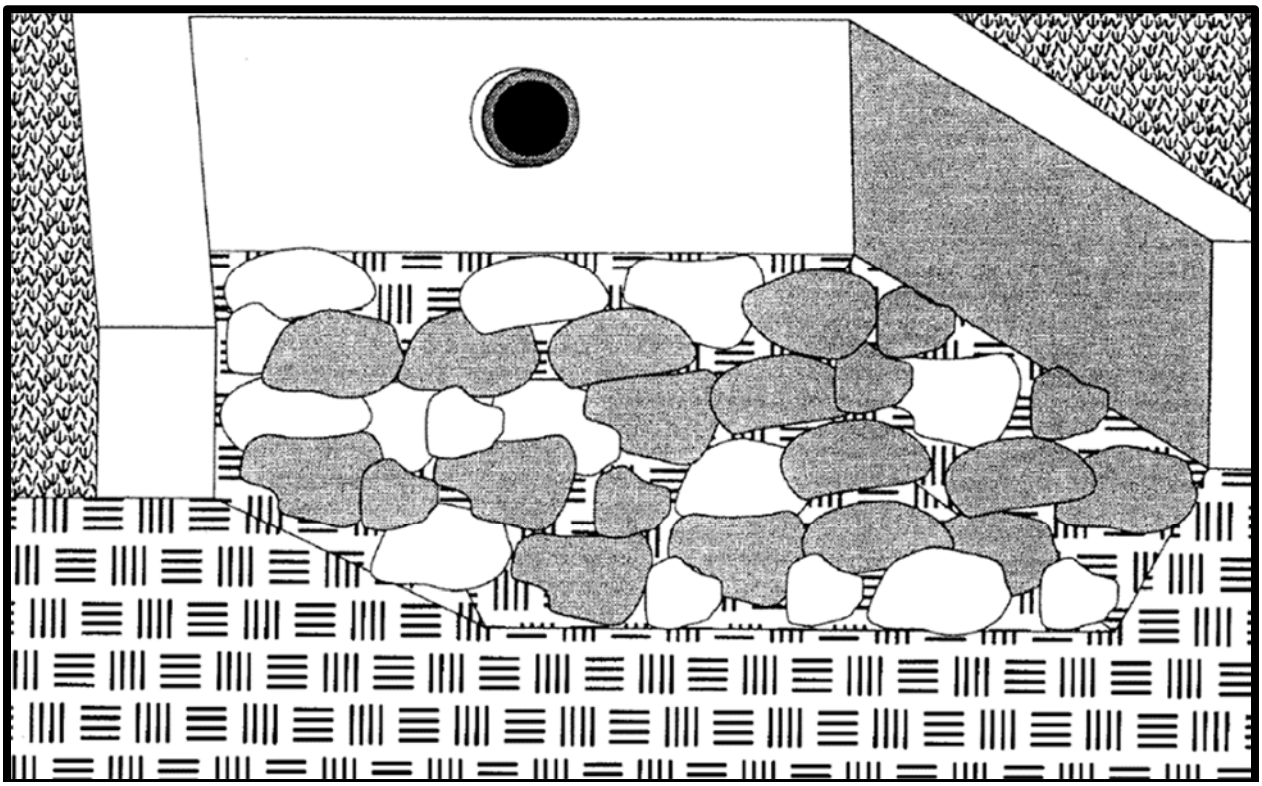
Application Guidance: Check dams will be used when erosion is caused by high velocities in a swale or drainage channel. This will typically occur in a steeply sloped swale. Check dams will only be used in small ditches and swales that drain ten acres or less.

Maintenance: Check dams will be inspected for sediment and debris accumulation after every major storm event. The accumulated sediment must periodically be removed.

Effectiveness and Cost: Check dams can provide effective, inexpensive erosion control for stream banks.

Limitations: Check dams should not be placed in streams.

BMP E - REDUCE FWW VELOCITY AT OUTLET



Description of Potential Pollutant and Source: Concentrated storm water runoff exiting a pipe or swale outfall can cause erosion and transport of sediment downstream.

Description of BMP: Use outlet protection to reduce the velocity of storm water flowing out of storm water pipe outlets or the end of channels. Stone, riprap, pavement, or concrete can be used for outlet protection.

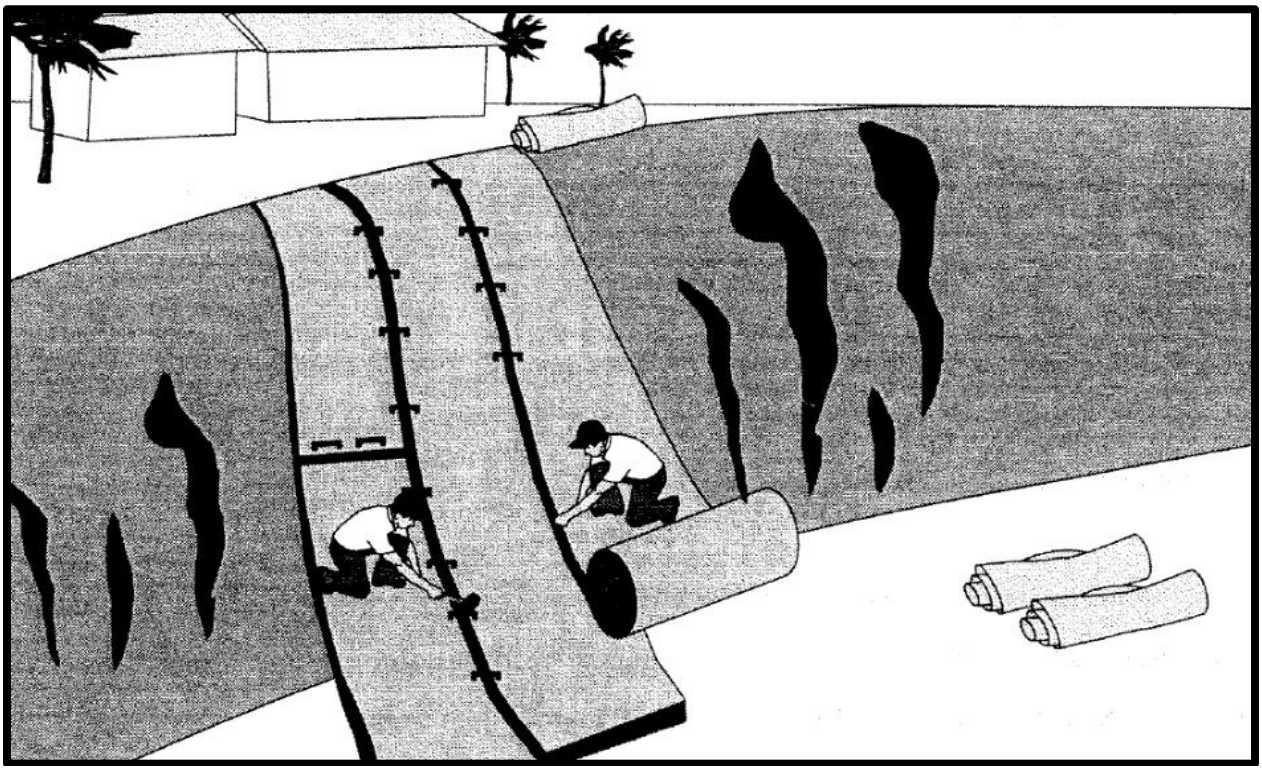
Application Guidance: Outlet protection will be used whenever there is erosion at storm water pipe or channel outlets.

Maintenance: Outlet protection will be periodically inspected for erosion and scouring.

Effectiveness and Cost: Outlet protection can provide effective, inexpensive erosion control.

Limitations: None

BMP F - USE EROSION CONTROL BLANKETS



Description of Potential Pollutant and Source: Exposed areas are sources of erosion-related pollutants.

Description of BMP: Use erosion control blankets. These are used with seeding to provide temporary and/or permanent erosion control, depending on the type of blanket. Biodegradable blankets made of wood fiber, straw, coconut, or combinations are used in conjunction with seeding for short-term erosion control on steep or rapidly eroding areas where mulches or binders would not be effective enough. Synthetic blankets made of vinyl, rigid nylon, or flexible polypropylene are used with seeding for long-term erosion control in swales, ditches, channels or other areas of concentrated flow. Turf reinforcement mats are three dimensional mats that are soil filled and seeded to provide a permanent reinforces soil-map-vegetation matrix. Soil fibers, either individual or continuous fibers (roving), are sprayed on the soil with seed to provide an in-place matrix for short-term or long-term erosion control, depending on whether organic or synthetic fibers are used.

Application Guidance: Erosion control blankets will be used in critical (steep or rapidly eroding) areas or areas of concentrated flow in conjunction with seeding for the establishment of vegetation.

Maintenance: Maintenance activities include inspection after major storms for securing or damage.

Effectiveness and Cost: Erosion control blankets are highly effective for short-term and long-tern erosion control. Costs are higher initially than mulches or binders, erosion control blankets but can be cost-effective in the long-term.

Limitations: Erosion control blankets are placed by hand and, therefore, are not limited in application; they also may be applied on slopes steeper than one to one. In contrast, soil fibers are placed with equipment and are limited to readily accessible area