CITY OF LAREDO

STORM WATER MANAGEMENT

GUIDANCE MANUAL

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SECTION 1

DESIGN CRITERIA
and
SUPPLEMENTAL INFORMATION

1. RAINFALL INTENSITY AND MAXIMUM DURATION DETERMINATION

a. Rainfall Intensity (i)

Rainfall intensity (i) is the average rainfall rate in inches per hour, and is selected on the basis of design rainfall duration and design frequency of occurrence. The design duration is equal to the time of concentration for the drainage area under consideration. The design frequency of occurrence is a statistical variable which is established by design standards or chosen by the engineer as a design parameter.

The rainfall intensity used in the rational method is read from the intensity-duration-frequency curves based on the selected design frequency and design duration.

The following equation represents mathematically the City of Laredo intensity-duration-frequency curves:

$$i = \frac{b}{(t + d)^e} \qquad (Eq.\ 1)$$

where:

i = Average rainfall intensity, inches per hour
t = Storm duration, minutes
b,d & e = Coefficients for different storm frequencies

The values for b,d and e as published in TXDOT Hydraulics Manual, 1987, are:

City of Laredo
Intensity-Duration-Frequency Curve Coefficients

Area	2-Year		5-Year		10-Year		25-Year		50-Year		100-Year		All
Webb													Frequencies
County	e	b	e	b	e	b	e	b	e	b	e	b	d
	0.83	66	0.812	81	0.801	90	0.781	95	0.781	103	0.77	110	9.6

b. Maximum Expected Rainfall:

MAXIMUM EXPECTED RAINFALL AMOUNTS (INCHES) PER DURATION FOR RECURRENCE INTERVALS							
Rainfall	Rainfall Recurrence Interval (Years)						
Duration (Hours)	1	2	5	10	26	50	100
½	1.3	1.6	2.1	2.4	2.7	3.0	3.3
1	1.7	2.1	2.5	3.0	3.5	3.8	4.3
2	1.9	2.4	3.1	3.6	4.2	4.7	5.3
3	2.1	2.6	3.3	3.9	4.6	5.2	5.8
6	2.3	3.0	4.0	4.7	5.5	6.2	7.1
12	2.7	3.4	4.6	5.5	6.6	7.4	8.3
24	3.0	3.8	5.3	6.5	7.6	8.6	9.8

2. RUNOFF COEFFICIENTS

a. Recommended Rational Method "C" Values

Average Runoff Coefficient for "C" in formula Q = CIA				
TYPE AREA OR LAND USE	HYDROLOGIC SOIL GROUPS			
Area Use or (Zoning Classification)	Deep Sand, Aggregated Silts	Sandy & Silty Loams	Clay Loam, Shallow Sandy Loams	Heavy Plastic Clays
Parks & permanent open space (AG)	0.35	0.37	0.39	0.41
Single-family (R- S, R- 1)	0.50	0.52	0.55	0.58
Multi-Family (RSM, R-2, R-3, B-1)	0.65	0.71	0.87	0.90
Commercial (B-3, B-4, M- 1, M-2)	0.95	0.96	0.98	1.00
Central Business District (B-2)	1.00	1.00	1.00	1.00

b. Recommended SCS Method "CN" Values

SCS Runoff Curve Numbers For Urban Areas and Agricultural Lands					
Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Average % impervious area[1]	A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc).					
Poor condition (grass cover 50%).....		68	79	86	89
Fair condition (grass cover 50% to 75%).....		49	69	79	84
Good condition (grass cover 75%).....		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right of way).....		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right of way).....		98	98	98	98
Paved; open ditches (including right of way).....		83	89	92	93
Gravel (including right of way).....		76	85	89	91
Dirt (including right of way).....		72	82	87	89
Urban districts:					
Commercial and business.....	85	89	92	94	95
Industrial.....	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses).....	65	77	85	90	92
1/4 acre.....	38	61	75	83	87
1/3 acre.....	30	57	72	81	86
1/2 acre.....	25	54	70	80	85
1 acre.....	20	51	68	79	84
2 acres.....	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation).....		77	86	91	94
Agricultural Lands	Poor	68	79	86	89
Grassland, or range-continuous forage for grazing	Fair	49	69	79	84
	Good	39	61	74	80
Meadow-continuous grass, protected from grazing and generally mowed for hay.		30	58	71	78
Brush-weed-grass mixture with brush the major element [3]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30	48	65	73
Woods--grass combination (orchard or tree farm) [4]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods [5]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30	55	70	77

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Average % impervious area[1]	A	B	C	D
Farmsteads--buildings, lanes, driveways and surrounding lots.		59	74	82	86

[1] The average percent impervious area shown was used to develop the composite curve numbers. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a curve number of 98 and pervious areas are considered equivalent to open space in good hydrologic condition.

[2] Poor: less than 50 percent ground cover or heavily grazed with no mulch.
Fair: 50 to 75 percent ground cover and not heavily grazed.
Good: greater than 75 percent ground cover and lightly or only occasionally grazed.

[3] Poor: less than 50 percent ground cover.
Fair: 50 to 75 percent ground cover.
Good: greater than 75 percent ground cover.

[4] Curve numbers shown were computed for areas with 50 percent woods and 50 percent grass (pasture) cover. Other combinations of conditions may be computed from the curve numbers for woods and pasture.

[5] Poor: Forest litter, small trees and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

Source: Soil Conservation Service. TR-55: Urban Hydrology for Small Watersheds

3. ALLOWABLE MANNING'S "n" COEFFICIENTS

Type of channel and description	**Minimum**	**Normal**	**Maximum**
A. Closed Conduits Flowing Partly Full			
A-1. Metal			
a. Brass, smooth	0.009	0.010	0.013
b. Steel			
1. Lock bar and welded	0.010	0.012	0.014
2. Riveted and spiral	0.013	0.016	0.017
c. Cast iron	0.010	0.013	0.014
1. Coated			

Type of channel and description	Minimum	Normal	Maximum
2. Uncoated	0.011	0.014	0.016
d. Wrought iron			
1. Black	0.012	0.014	0.015
2. Galvanized	0.013	0.016	0.017
e. Corrugated metal			
1. Subdrain	0.017	0.019	0.021
2. Storm Drain	0.021	0.024	0.030
A-2. Non Metal			
a. Lucite	0.008	0.009	0.010
b. Glass	0.009	0.010	0.013
c. Cement			
1. Neat, surface	0.010	0.011	0.013
2. Mortar	0.011	0.013	0.015
d. Concrete			
1. Culvert, straight and free of debris	0.010	0.011	0.013
2. Culvert with bends, connections and some debris	0.011	0.013	0.014
3. Finished	0.011	0.012	0.014
4. Sewer with manholes, inlet, etc., straight	0.013	0.015	0.017
5. Unfinished, steel form	0.012	0.013	0.014
6. Unfinished, smooth wood form	0.012	0.014	0.016
7. Unfinished, rough wood form	0.015	0.017	0.020
e. Wood			
1. Stave	0.010	0.012	0.014
2. Laminated, treated	0.015	0.017	0.020
f. Clay			
1. Common drainage tile	0.011	0.013	0.017
2. Vitrified sewer	0.011	0.014	0.017
3. Vitrified sewer with manholes, inlet, etc.	0.013	0.015	0.017
4. Vitrified subdrain with open joint	0.013	0.015	0.017
g. Brickwork			
1. Glazed	0.011	0.013	0.015
2. Lined with cement mortar	0.012	0.015	0.017
h. Sanitary sewers coated with sewage slimes, with bends and connections	0.012	0.013	0.016
i. Paved invert, sewer, smooth bottom	0.016	0.019	0.020
j. Rubble masonry, cemented	0.018	0.025	0.030

Type of channel and description	Minimum	Normal	Maximum
B. Lined or Built-up Channels			
B-1. Metal			
a. Smooth steel surface			
1. Unpainted	0.011	0.012	0.014
2. Painted	0.012	0.013	0.017
b. Corrugated			
B-2. Nonmetal			
a. Cement			
1. Neat, surface	0.010	0.011	0.013
2. Mortar	0.011	0.013	0.015
b. Wood			
1. Planed, treated	0.010	0.012	0.014
2. Planed, creosoted	0.011	0.012	0.015
3. Unplaned	0.011	0.013	0.015
4. Plank with battens	0.012	0.015	0.018
5. Lined with roofing paper	0.010	0.014	0.017
c. Concrete			
1. Trowel finish	0.011	0.013	0.015
2. Float finish	0.013	0.015	0.016
3. Finished, with gravel on bottom	0.015	0.017	0.020
4. Unfinished	0.014	0.017	0.020
5. Gunite, good section	0.016	0.019	0.023
6. Gunite, wavy section	0.018	0.022	0.025
7. On good excavated rock	0.017	0.020	-
8. On irregular excavated rock	0.022	0.027	-
d. Concrete bottom float finished with sides of			
1. Dressed stone in mortar	0.015	0.017	0.020
2. Random stone in mortar	0.017	0.020	0.024
3. Cement rubble masonry, plastered	0.016	0.020	0.024
4. Cement rubble masonry	0.020	0.025	0.030
e. Gravel bottom with sides of			
1. Formed concrete	0.017	0.020	0.025
2. Random stone mortar	0.020	0.023	0.026
3. Dry rubble or riprap	0.023	0.033	0.036
f. Brick			
1. Glazed	0.011	0.013	0.015
2. In cement mortar	0.012	0.015	0.018

Type of channel and description	Minimum	Normal	Maximum
g. Masonry			
1. Cemented rubble	0.017	0.025	0.030
2. Dry rubble	0.023	0.032	0.035
h. Dressed ashler	0.013	0.015	0.017
i. Asphalt			
1. Smooth	0.013	0.013	-
2. Rough	0.016	0.016	-
j. Vegetal lining	0.030	-	0.500
C. Excavated or Dredged			
a. Earth, straight and uniform			
1. Clean, recently completed	0.016	0.018	0.020
2. Clean, after weathering	0.018	0.022	0.025
3. Gravel, uniform section, clean	0.022	0.025	0.030
4. With short grass, few weeds	0.022	0.027	0.033
b. Earth, winding and sluggish			
1. No vegetation	0.023	0.025	0.030
2. Grass, some weeds	0.025	0.030	0.033
3. Dense weeds or aquatic plants in deep channels	0.030	0.035	0.050
4. Earth bottom and rubble sides	0.028	0.030	0.035
5. Stony bottom and weedy banks	0.025	0.035	0.040
6. Cobble bottom and clean sides	0.030	0.040	0.050
c. Dragline-excavated or dredged			
1. No vegetation	0.025	0.028	0.033
2. Light brush on banks	0.035	0.050	0.060
d. Rock cuts			
1. Smooth and uniform	0.025	0.035	0.040
2. Jagged and irregular	0.035	0.040	0.050
e. Channels not maintained, weeds and brush uncut			
1. Dense weeds, high as flow depth	0.050	0.080	0.120
2. Clean bottom, rush on sides	0.040	0.050	0.080
3. Same, highest stage of flow	0.045	0.070	0.110
4. Dense brush high stage	0.080	0.100	0.140
D. Natural Streams			
D-1. Minor streams (top width at flood stage <100 ft)	0.250	0.030	0.033
a. Streams on plain			
1. Clean, straight, full stage, no rifts or deep pools	0.025	0.030	0.033

Type of channel and description	Minimum	Normal	Maximum
2. Same as above, but more stones and weeds	0.030	0.035	0.040
3. Clean, winding, some pools and shoals	0.033	0.040	0.045
4. Same as above, but some weeds and stones	0.035	0.045	0.050
5. Same as above, lower stages, more ineffective slopes and sections	0.040	0.048	0.050
6. Same as 4, but more stones	0.045	0.050	0.060
7. Sluggish reaches, weedy, deep pools	0.050	0.070	0.080
8. Very weedy reaches, deep pools, or floodways with heavy stand of timber and underbrush	0.075	0.100	0.150
b. Mountain streams, no vegetation in channel, banks usually steep, trees and bush along banks submerged at high stages			
1. Bottom: gravels, cobbles, and few boulders	0.030	0.040	0.050
2. Bottom: cobbles with large boulders	0.040	0.050	0.070
D-2. Flood plains			
a. Pasture, no brush			
1. Short grass	0.025	0.030	0.035
2. High grass	0.030	0.035	0.050
b. Cultivated areas			
1. No crop	0.020	0.030	0.040
2. Mature row crops	0.025	0.035	0.045
3. Mature field crops	0.030	0.040	0.050
c. Brush			
1. Scattered brush, heavy weeds	0.035	0.050	0.070
2. Light brush and trees, in winter	0.035	0.050	0.060
3. Light brush and trees, in summer	0.040	0.060	0.080
4. Medium dense brush, in winter	0.045	0.070	0.110
5. Medium dense brush, in summer	0.070	0.100	0.160
d. Trees			
1. Dense willows, summer straight	0.110	0.015	0.200
2. Cleared land with tree stumps, no sprouts	0.030	0.040	0.050
3. Same as above, but with heavy growth of sprouts	0.050	0.060	0.080
4. Heavy stand of timber, a few down trees, little undergrowth, flood stage below branches	0.080	0.100	0.120
5. Same as above, but with flood stage reaching branches	0.100	0.120	0.160

Type of channel and description	Minimum	Normal	Maximum
D-3 Major streams (top width at flood stage >100 ft). The "n" value is less than that for minor streams of similar description, because banks offer less effective resistance.			
a. Regular section with no boulders or brush	0.025	-	0.060
b. Irregular and rough section	0.035	-	0.100

4. FREEBOARD AND SUPERELEVATION REQUIREMENTS

a. Freeboard: Adequate channel freeboard shall be provided for the 100-year storm in reaches flowing at critical depth by using Equation 2 or the elevation of the energy grade line, whichever is less.

$$H_{FB} = 2.0 + 0.025\ V\ (d)^{\frac{1}{3}} \qquad (Eq.\ 2)$$

where,

H_{FB} = Freeboard height, ft
V = Velocity, ft/sec
d = Depth of flow, ft

Freeboard shall be in added to superelevation, standing waves and/or other water surface disturbances. Concrete side slopes shall be extended to provide freeboard. Freeboard shall not be obtained by the construction of levees. Minimum freeboard for all channels shall be 1' above the 100-year water surface elevation.

b. Superelevation: Superelevation of the water surface shall be determined at all horizontal curves which deviate more than 45 degrees off the projected centerline. An approximation of the superelevation at a channel bend can be obtained from the following equation:

$$h = \frac{V^2\ T_w}{g\ r_c} \qquad (Eq.\ 3)$$

where h = Superelevation, ft
V = Flow velocity, ft/sec
T_w = Top width of channel, ft
r_c = Centerline radius of curvature, ft
g = Acceleration due to gravity, ft/sec^2

The freeboard shall be measured above the superelevation water surface.

5. STORM WATER RUNOFF CALCULATION METHODS

Storm Runoff Calculation Methods	
Contributing Area	Runoff Methods*
Less than 100 Acres	Rational or VRIM [1] SCS Tabular/Graphical [2]
100 Acres-400 Acres	SCS Tabular/Graphical [3] TR-20 or HEC-1
400 Acres - 15 mi^2	SCS TR-20 or HEC-1
Greater than 15 mi^2	SCS TR-20 or HEC-1

[1] VRIM, Variable Rainfall Intensity Method
[2] SCS, Tabular/Graphical and TR-20 Methods
[3] It is recommended that the hand calculated SCS Tabular Method not be used for areas greater than 400 acres due to the rigorous nature of the calculations and likelihood of error.
* Other model methodologies may be used if pre-authorized by the City Engineer.

6. DESIGN GUIDELINES FOR WATER QUALITY CONTROL BASINS

Storm water can have significant impact on the water quality of Laredo's creeks and on the Rio Grande. Treatment of this storm water by filtration and/or sedimentation improves water quality by removing suspended particulate matter and associated constituents such as bacteria, nutrients and metals.

Filtration systems are the primary water quality control structures. In order to ensure the long-term effectiveness of these systems, it is necessary to protect the filter media from excessive sediment loading. Typically a sediment trapping structure is required to be located prior to the filtration basin.

The sedimentation basin consists of an inlet structure, outlet structure and basin liner. The sedimentation basin design should maximize the distance from where the heavier sediment is deposited near the inlet to where the outlet structure is located. This will improve basin performance and reduce maintenance requirements.

a. Water Quality Volume

The primary control strategy for water quality basins is to capture and isolate the "first flush" volume of storm water runoff for treatment. This "first flush" volume is outlined in section 24.59.5.4.1 of the Storm Water Management Ordinance for the three water quality treatment options. The water quality volume must consist of runoff from all impervious surfaces such as roadways, parking areas and roof tops; additionally, runoff from all pervious areas which provide contributing drainage to impervious areas must also be included in the water quality volume. Water quality treatment is not required for runoff from lands left in their natural

state, e.g., greenbelts and open spaces; natural state may include areas restored to natural state. Runoff from these areas must be routed around the water quality basin or it must be included in the water quality volume. Off-site contributing drainage should be routed around the water quality basin. If this is not done, off-site contributing areas must be included in the water quality volume.

b. Storm Water Quality Treatment Options - Off-Line, On-Line and Wet Detention

i. Off-Line detention

Off-line detention is the capture and isolation of the water quality volume typically achieved by using isolation and diversion baffles and weirs. A typical approach for achieving isolation of the water quality volume is to construct an isolation/diversion weir in the storm water channel such that the height of the weir equals the height of water in the water quality basin when the entire water quality volume is being held. When additional runoff greater than the water quality volume enters the storm water channel it will spill over the isolation/diversion weir and mixing with the already isolated water quality volume shall be minimal.

Because travel time from distant contributing areas reduces the effectiveness of the water quality volume in capturing all of the first flush runoff, a maximum contributing drainage area of 50 acres per filtration basin system is recommended.

ii. On-Line detention:

On-line detention consists of providing the water quality volume within the storm water management facility, below the storm water outflow invert. This volume is to be discharged slowly (>24 hrs) to increase the potential for sedimentation.

iii. Wet Detention

Wet detention is a treatment system that utilizes water-tolerant vegetation and which removes pollutants through settling, absorption by soils, and nutrient uptake by vegetation, and in which a design water pool is normally maintained which has a capacity to provide extended detention for the required storm water treatment volume above a permanent water level.

7. EASEMENTS

All channel easements should be a minimum of 15' on either side of the channel measured from the 100 year water surface elevation plus 1' of freeboard. All closed drainage easements shall meet the following minimum standards, unless special circumstances warrant additional or reduced easements, as determined by the City Engineer:

Pipe Size (in inches)	**Minimum Easement Width (in feet)**
36" and under	15'
42" through 54"	20'
60" through 66"	25'
72" and above	30'

8. RETAINING WALL DESIGN

Retaining walls shall be designed using the best available information and current acceptable level of practice in the field of structural engineering. The design should refer to the appropriate ACI manuals for concrete design and ASHTO standards for anticipated loadings where applicable.

SECTION 2

BEST MANAGEMENT

PRACTICES

The Best Management Practices (BMPs) in this manual provide environmental protection measures for the majority of situations experienced on a construction site. It is intended to provide the Contractor/Engineer with information concerning the application and effectiveness of various BMPs. It is important to note that this manual does not provide an exhaustive list of BMPs. There are many new publications and studies being conducted into the designing and testing of new BMPs. If there is any unique construction activity not covered by this manual, other design manuals should be reviewed.

The structural BMPs contained within this manual, in large part, address the protection of the environment from contaminants already borne by storm water runoff. The following is a list of Preventive Maintenance/Good Housekeeping activities that, if followed, limit the potential for pollutants to be present in the environment and available for uptake by runoff. These Preventive Maintenance/Good Housekeeping activities should be followed in conjunction with the structural BMPs to limit the possibility of storm water contamination:

Preventive Maintenance

Do not connect floor drains in potential pollutant source areas to storm drains, surface water conveyance systems, receiving water bodies, or to the ground.

Cover and contain materials, equipment, waste and compost piles that could cause leachate contamination of storm water.

Conduct all oily parts cleaning, steam cleaning, or pressure washing of equipment or containers inside a building, or on an impervious contained area, such as a concrete pad. These areas should be drained to appropriate BMPs and/or the sanitary sewer system where allowed by the local sewer authority.

Use drip pans to collect leaks and spills from equipment and vehicles that are stored outside.

For the storage of liquids use containers, such as steel and plastic drums, that are rigid and durable, corrosion resistant to the weather and fluid content, non-absorbent, water tight, rodent-proof, and equipped with a close-fitting cover.

For the temporary storage of solid wastes contaminated with liquids or other potential pollutant materials use dumpsters, garbage cans, drums and comparable containers, which are durable, corrosion resistant, non-absorbent, non-leaking, and quipped with either a solid cover or screen cover to prevent littering. If covered with a screen, the container must be stored under a lean-to or equivalent structure.

Where feasible store potential storm water pollutant materials inside a building or under a cover and/or containment.

Minimize use of toxic cleaning solvents, such as chlorinated solvents, and other toxic chemicals.

Recycle waste materials such as solvents, coolants, oils, degreasers, and batteries to the maximum extent feasible.

Empty drip pans immediately after a spill or leak is collected in an uncovered area.

Stencil warning signs at storm water catch basins and drains indicating not to discharge waste to a receiving water body.

Good Housekeeping:

Promptly contain and clean-up solid and liquid pollutant leaks and spills, including oils, solvents, fuels, and dust on any exposed soil, vegetation, or paved area.

Sweep paved material handling and storage areas monthly, or more frequently, if needed, for the collection and disposal of dust and debris that could contaminate storm water.

Do not hose down pollutants from any area to the ground, a storm drain, conveyance ditch, or receiving water.

Clean oils, debris, sludge, etc. from all BMP systems, including catch basins, settling/detention basins, oil/water separators, boomed areas, and conveyance systems, regularly.

Promptly repair or replace all substantially cracked or otherwise damaged paved process, secondary containment, high-intensity parking and any other drainage areas, which can be contaminated by pollutant material leaks or spills.

Promptly repair all leaking connections, pipes, hoses, valves, etc. which can contaminate storm water.

Clean up pollutant liquid leaks and spills in impervious uncovered containment areas at the end of each working day.

Use solid absorbents, e.g., clay and peat absorbents and rags for cleanup of liquid spills/leaks, where practicable.

Intentionally
Blank

INTERCEPTOR SWALE

APPLICATIONS

Perimeter Control

Slope Protection

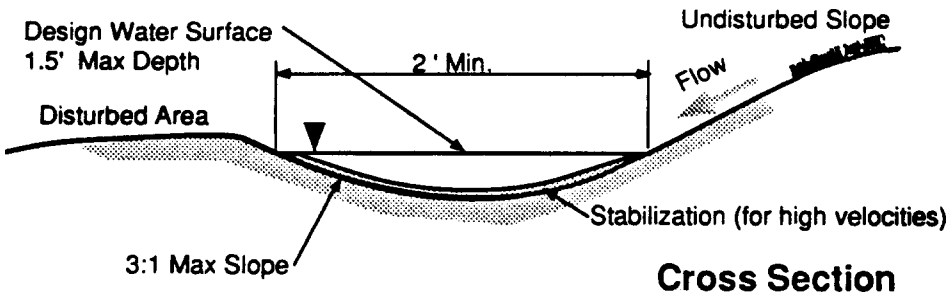
POLLUTANT REMOVAL

HI	Sediment
LO	Oil & Grease
LO	Nutrients & Toxics
HI	Floatables
MED	Other Construction Wastes

IMPLEMENTATION REQUIREMENTS

MED	Capital Costs
MED	Maintenance
LO	Training
HI	Suitability to slopes >5%

BMP - 1



Cross Section

DESCRIPTION

An interceptor swale is a trapezoidal or parabolic channel which collects water and directs it to a desired location. The interceptor swale can be lined with native vegetation or a protective lining, depending upon the slope and design velocities.

APPLICATIONS

Interceptor swales are used to reduce the amount and speed of flow and convey it to a stabilized outfall. Placement at the top of a sloping disturbed area keeps runoff from crossing disturbed areas where there is a high risk of erosion. Placement at the toe of slopes from disturbed areas allows the collection of sediment-laden runoff for treatment prior to discharge from the site.

Interceptor swales are commonly installed prior to commencement of major soil disturbing activities. Temporary swales are useful in protecting specific areas, such as staging, storage or fueling areas, and smaller disturbed areas during phased construction.

Vegetated interceptor swales are also effective as permanent storm water controls. To remain in place as permanent controls, the swales must be designed to handle post-construction runoff, must be permanently stabilized, and should be routinely inspected and maintained.

DESIGN CRITERIA

- Depth of flow in the swale shall be based on a 2-year design storm peak flow. Positive overflow must be provided to accommodate larger storms.
- Side slopes of the swale shall not exceed 3:1.
- Minimum design channel freeboard shall be 6 inches.
- The minimum required channel stabilization shall be grass, erosion control mats, or mulching. For grades in excess of 2 percent or velocities exceeding 6 feet per second, stabilization consisting of high velocity erosion control mats, or a 3-inch layer of crushed stone or riprap is required. Velocities exceeding 8 feet per second are discouraged.

INTERCEPTOR SWALE

DESIGN CRITERIA (CONT.)

- Swales must be designed for flow capacity based on Manning's Equation to ensure proper channel section.
- Check dams can be used to reduce velocities in steep swales. Refer to the Check Dam BMP sheet for additional information.
- Possible impacts to upstream or downstream stream reaches should be considered.
- Swales must maintain a positive grade to an acceptable outlet.
- Swales which will remain in place longer than 15 days should be stabilized.
- Swales should remain in place until the area being protected has been permanently stabilized.

MAINTENANCE REQUIREMENTS

Interceptor swales must be inspected once each week and following a storm event of 0.5 inches or greater. Repairs to the swales must be made promptly to ensure continued protection of the site.

ADVANTAGES

+ Simple and effective for channeling runoff away from areas subject to erosion
+ Can handle flows from large drainage areas
+ Inexpensive

DISADVANTAGES

- Cause erosion and sediment transport due to concentrated flows if constructed improperly
- Discourages vegetation growth if velocities too high
- Require ongoing maintenance, inspections and repairs

DIVERSION DIKE

APPLICATIONS

Perimeter Control

Slope Protection

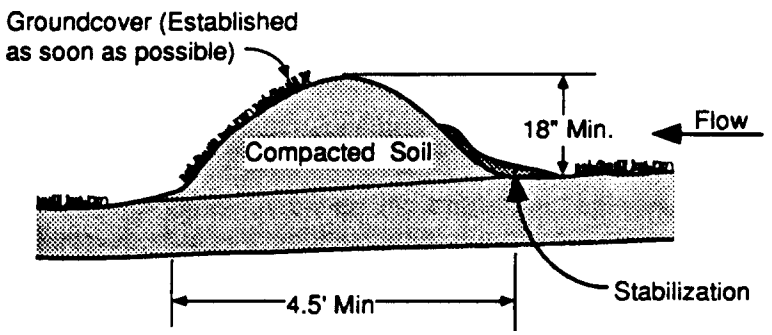
POLLUTANT REMOVAL

HI	Sediment
LO	Oil & Grease
LO	Nutrients & Toxics
MED	Floatables
MED	Other Construction Wastes

IMPLEMENTATION REQUIREMENTS

MED	Capital Costs
MED	Maintenance
LO	Training
HI	Suitability to slopes >5%

BMP - 2



DESCRIPTION

A diversion dike is a ridge constructed of earth which is used to protect work areas from up slope runoff and to divert sediment-laden runoff to stabilized discharge outlets. The dike consists of compacted soil stabilized either with native vegetation for low velocity flows or with riprap or erosion control mats for higher velocity flows.

APPLICATIONS

Diversion dikes are used in construction areas to control erosion, sedimentation or flood damage. Placement at the top of a sloping disturbed area prevents runoff from crossing disturbed areas where there is a high risk of erosion. Placement at the toe of slopes from disturbed areas allows the collection of sediment-laden runoff for treatment prior to discharge from the site.

Diversion dikes are commonly installed at the perimeter of construction sites which are subject to large quantities of runoff from neighboring sites. Used in combination with drainage swales, the diversion dike can be quickly installed with a minimum of equipment and costs, using the swale excavation as the dike. Use of diversion dikes can reduce the costs associated with structural controls not only by reducing the quantity of flow but also by directing runoff to a central location for treatment.

DESIGN CRITERIA

- The maximum contributing drainage area should be less than 10 acres depending upon site conditions.
- The dike shall have capacity for the 2-year design storm peak flow.
- The maximum width of the flow at the dike shall be 20 feet.
- Side slopes of the diversion dike shall not exceed 3:1.
- Minimum width of the embankment at the top shall be 2 feet.
- Minimum embankment height shall be 18 inches as measured from the toe of the slope.

DIVERSION DIKE

DESIGN CRITERIA (cont.)

- Where velocities are less than 6 feet per second, the minimum stabilization for the dike and adjacent flow areas is grass, erosion control mats, or mulch. Where the velocities exceed 6 feet per second, crushed stone, riprap or high velocity erosion control mats should be used. Velocities greater than 8 feet per second are discouraged.
- Possible impacts to upstream or downstream conditions should be considered.
- The flow line at the dike must be maintained on a positive grade to an acceptable outlet.
- Dikes should remain in place until the area being protected has been permanently stabilized.
- Due to potential interference with movement of construction equipment, dike locations should be carefully considered prior to installation.

MAINTENANCE REQUIREMENTS

Diversion dikes must be inspected once each week and following a storm event of 0.5 inches or greater. Repairs must be made promptly to ensure continued protection of the site.

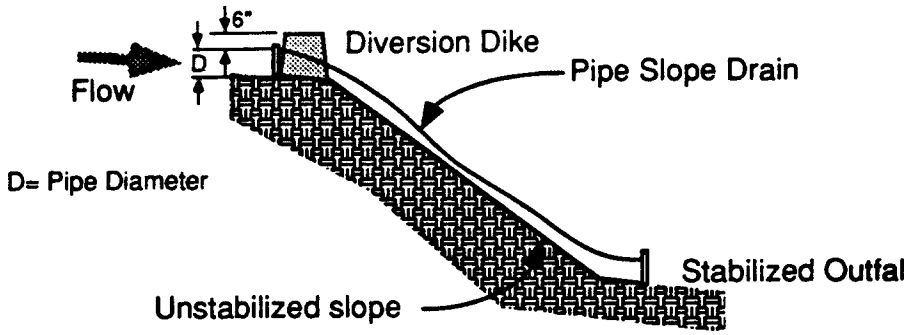
ADVANTAGES

+ Simple and effective for channeling runoff away from areas subject to erosion
+ Inexpensive due to readily available construction materials

DISADVANTAGES

- Effectiveness limited by improper design and construction
- Require ongoing maintenance, inspections and repairs

PIPE SLOPE DRAIN



APPLICATIONS

Slope Protection

POLLUTANT REMOVAL

MED	Floatables
LO	Oil & Grease Sediment Nutrients & Toxics Other Construction Wastes

IMPLEMENTATION REQUIREMENTS

HI	Capital Costs
HI	Maintenance
LO	Training
HI	Suitability to slopes >5%

BMP - 3

DESCRIPTION

A pipe slope drain is a temporary pipe installation which conveys water down a disturbed slope to the outfall. Pipe slope drains are typically constructed from flexible piping with stabilized areas at the top and toe of the slope. Often a temporary headwall is constructed at the top of the slope to anchor the pipe and prevent undercutting.

APPLICATIONS

Pipe slope drains are used on sites with long, unstabilized, steep slope areas which are disturbed and subject to erosion from sheet flow. Interceptor swales or diversion dikes are commonly used to divert flow into the pipe slope drain. Pipe slope drains can service relatively large drainage areas, but do not provide any pollutant removal. Discharges from pipe slope drains must, therefore, be directed to a treatment BMP prior to discharge from the site.

Pipe slope drains are also effective as permanent storm water controls. To remain in place as permanent controls, the drains must be designed to handle post-construction runoff, must be permanently stabilized, and should be routinely inspected and maintained. Permanent pipe slope drains are often installed below grade.

DESIGN CRITERIA

- A standard corrugated metal pipe with a prefabricated flared end section and integral toe plate which extends a minimum of 6 inches from the bottom of the end section may be used as the entrance. The grade of the entrance shall not exceed 3%.
- The berm/diversion dike at the entrance shall have a minimum height of the pipe diameter plus 6 inches and a minimum width of 3 times the pipe diameter.
- Watertight collars or gasketed watertight fittings shall be used to connect all sections of the pipe slope drain.
- All sediment-laden runoff conveyed by the pipe slope drain shall be directed to a sediment trapping facility.

PIPE SLOPE DRAIN

DESIGN CRITERIA (CONT.)

- Maximum drainage area for individual pipe slope drains shall be 5 acres. For areas larger than 5 acres, multiple pipe slope drains shall be used.
- Temporary pipe slope drains are to be sized to accommodate runoff flows equivalent to a 10-year storm as calculated using the Rational Method and Manning's Equation, but in no case shall pipes be sized smaller than is shown in the following table:

Minimum Pipe Size	Maximum Contributing Drainage Area
12"	0.5 Acres
18"	1.5 Acres
21"	2.5 Acres
24"	3.5 Acres
30"	5.0 Acres

- Both the inlet and outfall of the pipe slope drain should be properly stabilized. Grass can typically be used for the inlet, but the outlet, at a minimum, will require the use of crushed stone or riprap to protect against the high velocities.
- Drains must be located away from construction areas to avoid damage from construction equipment.
- The area upstream of the pipe slope drain typically must be graded to direct flow into the inlet.

MAINTENANCE REQUIREMENTS

Pipe slope drains must be inspected once each week and following every storm event of 0.5 inches or greater. Damage to joints or clogging of pipe must be repaired promptly to ensure continued protection of the site. Where the diversion dike at the top of the slope has eroded, the dike must be reinforced with sandbags or a concrete collar to prevent failure. Erosion around the pipe drain should be stabilized with erosion control mats, crushed stone, riprap, concrete pavement, or other acceptable methods.

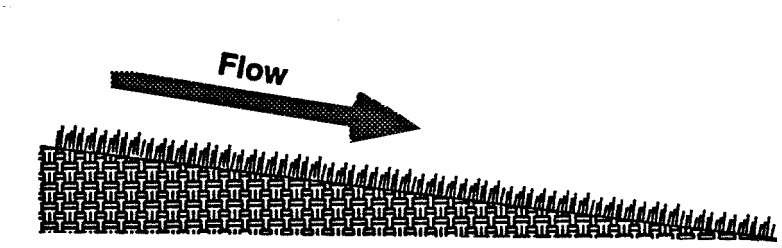
ADVANTAGES

+ Reduces or eliminates erosion by transporting water down steep slopes or by draining saturated soils
+ Easy to install and require little maintenance if installed properly.

DISADVANTAGES

- May require ongoing maintenance, inspections and repairs
- Requires stabilization of the area disturbed by installation to prevent erosion
- May clog during large storm event

VEGETATION



APPLICATIONS

Slope Protection

Channel Protection

Temporary Stabilization

Permanent Stabilization

POLLUTANT REMOVAL

HI	Sediment
MED	Nutrients & Toxics
LO	Oil & Grease Floatables Other Construction Wastes

IMPLEMENTATION REQUIREMENTS

HI	Suitability to slopes >5%
MED	Capital Costs Maintenance
LO	Training

DESCRIPTION

The use of vegetation as a Best Management Practice consists of installing grasses or groundcovers to prevent erosion of topsoil. Vegetation can be used alone or as a protective lining for other BMPs.

APPLICATIONS

Vegetation effectively reduces erosion from swales, stock piles, berms and along roadways and therefore has a wide range of applicability. Leaving vegetative strips around a site is an excellent means of protecting an area disturbed by utility or site development construction.

Vegetation has applicability for both temporary and permanent erosion control. Temporarily vegetating stockpiles may have a higher initial cost, but, depending on the length of time the cover will remain in place, may be cost-effective when compared to the expense of maintaining tarps or covers.

Vegetation is not an appropriate erosion control measure in areas which are subject to heavy pedestrian or vehicular traffic.

DESIGN CRITERIA

- Interim or final grading must be completed prior to seeding. Steep slopes should be eliminated.
- Other erosion control structures, such as dikes, swales, diversions, etc., should be installed prior to seeding.
- Groove or furrow slopes steeper than 3:1 on the contour line before seeding.
- Provide 4-6 inches of topsoil over rock, gravel or otherwise unsuitable soils. The seed-bed should be well pulverized, loose and uniform.
- Use only high quality, USDA certified seed.

BMP - 4

VEGETATION

DESIGN CRITERIA (CONT.)

- Select an appropriate species or species mix adapted to local climate, soil conditions and season according to the following table. Consult with the local office of the U.S. Soil Conservation Service (SCS) or other local sources for selection of proper species and application techniques.
- The seeding application rate should be in accordance with that recommended by the SCS or other local expert.
- Fertilizer should be applied according to manufacturer's recommendation with proper spreading equipment. The typical application rate for a 10-10-10 grade fertilizer is 700-1000 lb/acre. DO NOT APPLY EXCESS FERTILIZER.
- If hydro-seeding, do not mix seed and fertilizer more than 30 minutes prior to application.
- Apply seed using a cyclone seeder, seed drill, cultipacker or hydroseeder.
- Provide adequate hydration to aid in establishment of vegetation.
- Use appropriate mulching techniques where necessary.

MAINTENANCE REQUIREMENTS

Protect newly seeded area from excessive runoff and traffic until vegetation is established. A watering and fertilizing schedule should be developed and implemented to assist in establishment of the vegetation. Once established, maintain as necessary to address erosion.

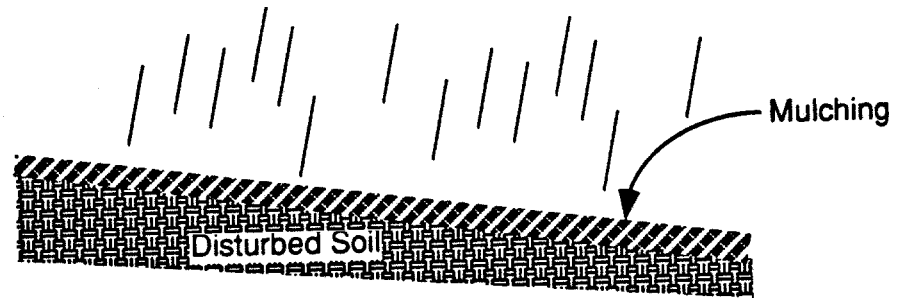
ADVANTAGES

+ Simple and effective stabilizing areas
+ Inexpensive

DISADVANTAGES

- Erosion and sediment transport from concentrated flows can occur if seed does not take
- Significant watering may be required during dry season to establish vegetation

MULCHING



APPLICATIONS

Slope Protection

Temporary Stabilization

POLLUTANT REMOVAL

HI	Sediment
LO	Oil & Grease
	Nutrients & Toxics
	Floatables
	Other Construction Wastes

IMPLEMENTATION REQUIREMENTS

MED	Capital Costs
	Maintenance
LO	Training
	Suitability to slopes >5%

BMP - 5

DESCRIPTION

Mulching is the application of a protective layer of material on bare areas to reduce erosion caused by the impact energy of rainfall. The types of material which can be used for mulching include organic materials such as hay, wood chips, or pine bark and inorganic materials.

APPLICATIONS

Mulching is used for either temporary or permanent stabilization of areas which have been cleared of vegetation. Mulching is also used to protect areas which have been seeded until the grass has established itself. Both the risk of erosion and moisture loss due to the action of rain, wind and sunlight are reduced by the application of mulch. In addition, mulch slows runoff from disturbed areas and allows for the deposition of previously entrained sediments.

Mulching can be used alone or in combination with other techniques. Netting or other means of anchoring the mulch may be used to assist in stabilization of disturbed areas. Some manufacturers produce pre-packaged mulching material (for instance, hay inside biodegradable netting) which reduce the labor requirements for placing mulch.

DESIGN CRITERIA

- If using a prepackaged mulch material, follow the manufacturers installation instructions.
- The selection of mulch material depends largely on the slope, climate, and soil type. Cost and availability of materials are also considerations. Straw or hay are recommended due to low cost, wide availability and biodegradability.
- Mulch should be applied uniformly and evenly over areas without concentrated water flow.
- Typical application rates are approximately two tons per acre of dry straw or hay. For other materials coverage should be based on the manufacturers instructions or such that 25% of the soil is visible through the mulching.
- On slopes exceeding 3-5%, anchoring may be required to keep the mulch in place.
- Organic mulches typically biodegrade over time. Reapplication may be required to provide adequate protection.

MULCHING

MAINTENANCE REQUIREMENTS

Mulched areas must be inspected weekly and following storm events of 0.5 inches or greater. Thin or bare areas should be covered with fresh mulch material. High traffic areas will require application of fresh mulch on a routine basis to provide adequate protection.

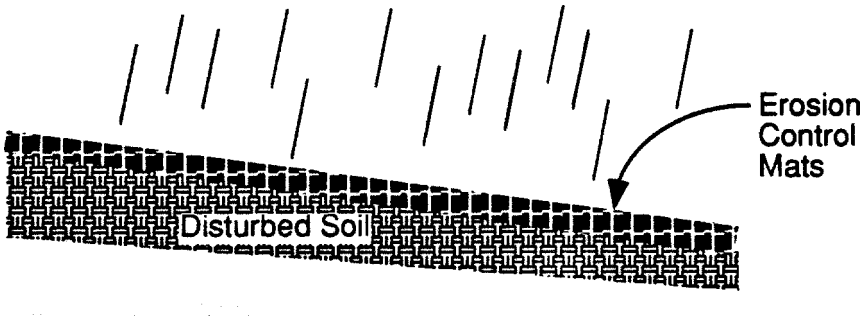
ADVANTAGES

+ Provides immediate protection to exposed soils.
+ Retains moisture which may reduce watering requirements for vegetation establishment.
+ Does not require removal due to natural biodegradation.
+ Inexpensive.

DISADVANTAGES

- May delay germination of seeds due to reduction in soil surface temperature.
- May be easily blown or washed away if not properly anchored.
- Mulch materials such as wood chips may absorb nutrients required for plant growth.
- Mulch materials that are washed off may clog other site BMPs.

EROSION CONTROL MATS



APPLICATIONS

Slope Protection

Sediment Trapping

Temporary Stabilization

Permanent Stabilization

POLLUTANT REMOVAL

MED	Sediment
LO	Oil & Grease
LO	Nutrients & Toxics
LO	Floatables
LO	Other Construction Wastes

IMPLEMENTATION REQUIREMENTS

HI	Capital Costs
MED	Maintenance
MED	Training
MED	Suitability to slopes >5%

BMP - 6

DESCRIPTION

Erosion control mats are manufactured geomembranes or biodegradable fabrics which are placed over disturbed areas to provide protection from erosion. A wide variety of vendors produce erosion control mats to promote vegetation establishment and protect banks from high velocity flows.

APPLICATIONS

Erosion control mats provide temporary or permanent stabilization protection to barren or disturbed areas. Erosion control mats are particularly helpful in areas that are difficult to stabilize such as steep slopes, drainage swales, embankments, or high pedestrian traffic areas.

DESIGN CRITERIA

- Erosion control mats should be installed in accordance with the manufacturer's instructions.
- After installation the matting should be checked to ensure that the matting is in uniform contact with the soil, that lap joints are well secured, and that anchor staples are flush with the ground.

MAINTENANCE REQUIREMENTS

Installations of erosion control matting must be inspected weekly and following significant storm events of 0.5 inches or greater. Missing or loose mats must be replaced or reanchored promptly to ensure continued protection of the site.

EROSION CONTROL MATS

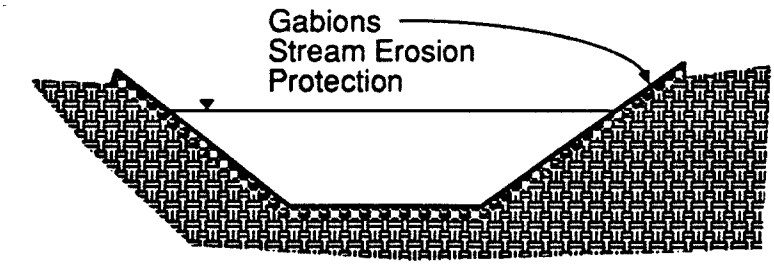
ADVANTAGES

+ Relatively inexpensive for certain applications.
+ Easy to install.
+ Wide variety of materials available for many uses.

DISADVANTAGES

- Effectiveness is highly dependent upon selection of proper material and correct installation.

PERMANENT STRUCTURAL CONTROLS



APPLICATIONS

Perimeter Control
Slope Protection
Channel Protection
Temporary Stabilization
Permanent Stabilization

POLLUTANT REMOVAL

LO	Oil & Grease
I	Sediment
	Nutrients & Toxics
	Floatables
	Other Construction Wastes

IMPLEMENTATION REQUIREMENTS

HI	Capital Costs
MED	Maintenance
	Training
HI	Suitability to slopes >5%

BMP - 7

DESCRIPTION

Permanent structural controls consist of gabions, retaining walls, riprap, non-bioderadeable geotextile and geoweb products. These controls are designed to provide permanent stabilization of slopes and channels that will continue to experience erosive velocities following construction. These controls can be designed to provide erosion protection (gabion mats, rock riprap, geotextile, etc.) and/or structural slope control (gabions, retaining walls, geo web, etc.).

APPLICATIONS

Permanent erosion control devices should only be used to stabilize areas with a high potential for erosion at the conclusion of the contruction phase. Areas with a high potential for erosion include any channel section with velocities greater than 6 fps as well as localized obstructoins to the natural channel flow regime (crossings, culverts, discharge pipes, etc.) that may cause localized erosion. Due to the complex nature of the flow regime requiring permanent structural controls, these controls should be engineered.

DESIGN CRITERIA

- Manufacturers design guidelines should be followed in all permanent structural control applications.
- Permanent structural controls may need to be provided at localized obstructions to the flow regime.
- Design of structural slope controls should consider area soils, wall height and groundwater conditions and should be engineered.
- When using permanent erosion structural controls the channel side slopes shall not exceed 3:1.
- Anchoring of the permanent control is critical as undermining of the foundation and washout of sediments at the edges can cause catastrophic failure of the structural control.
- Impacts to upstream and downstream conditions should be considered.
- Check dams may be used to reduce velocities in steep swales. Refer to the Check Dam fact sheet for additional information.

PERMANENT STRUCTURAL CONTROLS

DESIGN CRITERIA (cont.)

- Anchoring of the permanent controls is critical as undermining of the foundation and washout of sediments at the edges can cause catastrophic failure of the structure.
- Swales must be designed for flow capacity based on Manning's Equation to ensure proper channel section.
- Check dams can be used to reduce velocities in steep swales. Refer to the Check Dam fact sheet for additional information.
- Impacts to upstream or downstream conditions should be considered.
- Swales must maintain a positive grade to an acceptable outlet.

MAINTENANCE REQUIREMENTS

Permanent structural controls must be inspected annually to ensure that the BMP is providing adequate protection and has not been washed away or undermined by flows to ensure continued protection of the site. Any damage to the permanent structural control should be repaired immediately

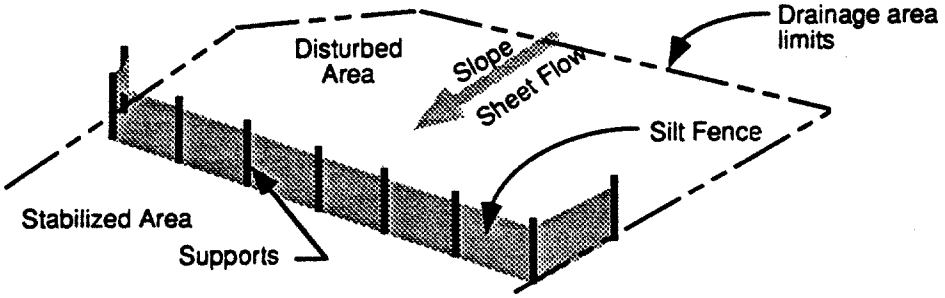
ADVANTAGES

+ Can provide structural stability to steep channel slopes.
+ Can provide long term effective erosion and slope control.
+ Able to handle high velocity flows

DISADVANTAGES

- Cause erosion and sediment transport due to concentrated flows if constructed improperly.
- Discourages vegetation growth if the velocities are too high
- Requires ongoing maintenance, inspections and repairs.
- Expensive to design and construct.
- May require additional state and federal permitting.

SILT FENCE



APPLICATIONS

Perimeter Control

Slope Protection

Sediment Trapping

POLLUTANT REMOVAL

HI	Sediment
MED	Floatables
LO	Oil & Grease Nutrients & Toxics Other Construction Wastes

IMPLEMENTATION REQUIREMENTS

MED	Capital Costs
HI	Maintenance
LO	Training
MED	Suitability to slopes >5%

BMP - 8

DESCRIPTION

Silt fencing consists of filter fabric stretched between support posts to catch sheet flow drainage from disturbed areas. The filter fabric is supported by chicken wire or other backing material and is toed in with an anchor trench at the base. Properly designed and installed silt fence can be very effective and economical because it can be re-located on the current construction site, and/or re-used at other construction sites.

APPLICATIONS

Silt fences are used to treat overland, non-concentrated flows from disturbed areas. Silt fences are used most often as perimeter control for both site development projects and linear (roadway) projects. Most effective with coarse to silty soil types, silt fences are subject to clogging when used with clay soil types. Silt fences are not appropriate for treating concentrated flows.

DESIGN CRITERIA

- Silt fences should be located along a line of constant elevation where possible.
- The maximum slope permissible adjacent to the fence is 1:1.
- Maximum distance of flow to the silt fence should be less than 200 feet.
- Maximum concentrated flow to the silt fence should be no greater than 1 cubic foot per second per 20 feet of fence.
- If 50% or less of the soil to be contained, by weight, passes the U.S. Standard Sieve No. 200, select the equivalent opening size (EOS) to retain 85% of the soil.
- The maximum opening size shall be 70 (#70 sieve) and the minimum opening size shall be 100 (#100 sieve).
- If 85% or more of the soil to be contained, by weight, passes the U.S. Standard Sieve No. 200, silt fencing shall not be used due to clogging potential.
- Provide sufficient room between the silt fence and other obstructions for the operation of the sediment removal equipment to properly maintain the fence.
- The ends of the fence should be turned upstream to prevent bypass of sediment-laden flow.

SILT FENCE

MAINTENANCE REQUIREMENTS

Silt fencing runs must be inspected weekly and following significant storm events of 0.5 inches or greater. Routine removal of sediment must be performed to ensure continued successful operation of the fencing. The sediment should be removed when it reaches a depth of approximately one-half the height of the fence. If the fabric becomes clogged, either clean or replace the filter fabric.

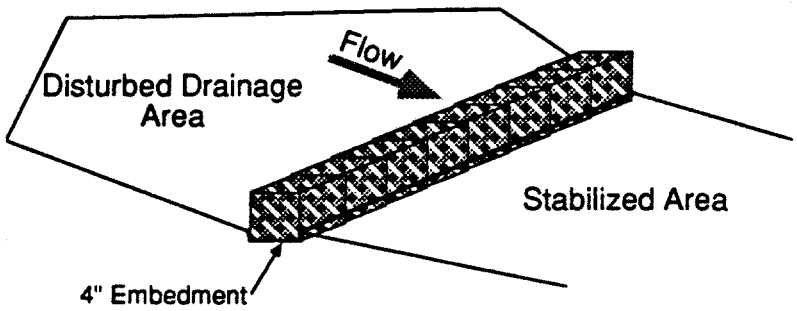
ADVANTAGES

+ Removes sediment and prevents downstream damage from sediment deposits.
+ Reduces the speed of runoff flow.
+ Minimal clearing and grubbing required for installation.
+ Inexpensive.

DISADVANTAGES

- May result in failure from improper choice of pore size in the filter fabric or improper installation.
- Should not be used in streams.
- Is only appropriate for small drainage areas with overland flow.
- Frequent inspection and maintenance is necessary to ensure effectiveness.

HAY BALE DIKE



APPLICATIONS

Perimeter Control

POLLUTANT REMOVAL

MED Sediment
Floatables

LO Oil & Grease
Nutrients & Toxics
Other Construction Wastes

IMPLEMENTATION REQUIREMENTS

MED Capital Costs

HI Maintenance

LO Training

MED Suitability to slopes >5%

BMP - 9

DESCRIPTION

A hay bale dike is a temporary barrier constructed of hay bales which have been anchored in place. Most commonly, wooden stakes or steel rebar is used to anchor the straw bales. Hay bales are used either to intercept and redirect flow or to serve as a filtration device.

APPLICATIONS

Hay bale dikes are typically only used on small residential sites since they are limited to controlling runoff from small drainage areas on relatively flat slopes.

Hay bales can also be used as check dams but are limited to small water-courses due to problems with adequately securing the bales.

DESIGN CRITERIA

- Hay bale dikes should be placed along a line of constant elevation.
- Hay bale dikes are only suitable for treating sheet flows across grades of 2% or less.
- Maximum contributing drainage area shall not exceed 0.25 acre per 100 linear feet of dike.
- Maximum distance of flow to the hay bale dike should not exceed 100 feet.
- Minimum dimensions for individual bales shall be 30 inches long, 18 inches high, 24 inches wide, and shall weigh no less than 50 pounds when dry.
- Each hay bale shall be placed into an excavated trench, having a minimum depth of 4 inches and a width to accommodate the bales.
- To prevent seepage or bypass, hay bales shall be positioned so that there is no gap between bales.
- Each individual bale shall be held in place by a minimum of 2 stakes, driven to a depth 6 inches below the bottom of the 4 inch trench (10 inches minimum). The first stake shall be driven at an angle to the previously installed bale.
- The ends of the dike shall be angled up-slope to prevent bypass of storm water.
- Place bales on sides so that bindings are not buried for future disposal.

HAY BALE DIKE

MAINTENANCE REQUIREMENTS

Hay bale dikes should be inspected weekly for missing or deteriorated bales which should be replaced promptly. Sediment should be removed from behind the bales when it reaches a depth of approximately 6 inches. Due to natural decomposition of the hay bales, the bales must be replaced at intervals no less than every three months.

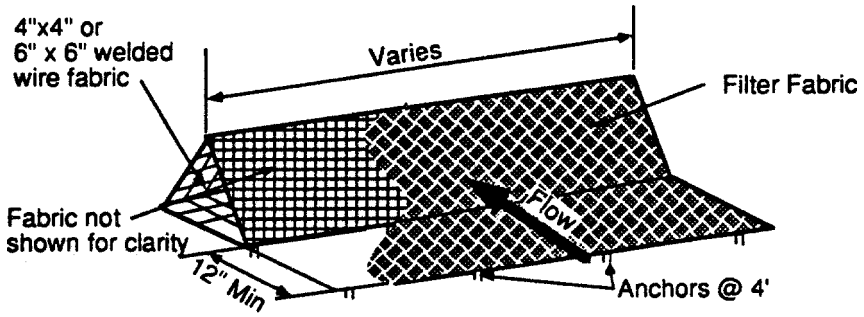
ADVANTAGES

+ Simple and inexpensive.
+ Will biodegrade on site.

DISADVANTAGES

- Nonrecyclable.
- Installation with wooden stakes or rebar may create maintenance nuisance after completion of project if not removed.
- Effectiveness of straw bales is limited and may be further reduced by failure to maintain the hay bales.
- Require frequent inspections to ensure continued sediment removal.

TRIANGULAR SEDIMENT FILTER DIKE



APPLICATIONS

Perimeter Control
Slope Protection
Sediment Trapping
Channel Protection

POLLUTANT REMOVAL

HI	Sediment
MED	Floatables
LO	Oil & Grease Nutrients & Toxics Other Construction Wastes

IMPLEMENTATION REQUIREMENTS

MED	Capital Costs
MED	Maintenance
LO	Training
MED	Suitability to slopes >5%

BMP - 10

DESCRIPTION

A triangular sediment filter dike is a self contained silt fence consisting of filter fabric wrapped around a wire mesh frame which has a triangular cross section. The triangular sediment filter dike when weighted with rock or sand bags, is useful on pavements and in other areas where it is impractical to install the posts or to entrench the fabric. This dike is sturdier and can be reused.

APPLICATIONS

As noted above, triangular sediment filter dikes are useful in paved areas or where stakes and entrenchment are impractical. They are used to provide perimeter control by detaining sediment-laden flow and can be used to prevent sediment-laden flow from entering streams or storm sewers. Triangular sediment filter dikes can be used to control more concentrated and higher velocity flows than silt fences.

DESIGN CRITERIA

- Dikes shall be installed along a line of constant elevation.
- Maximum slope perpendicular to the dike shall be less than 1:1.
- Maximum drainage flow to the dike shall be 11 cubic feet per second per 100 linear feet of dike.
- Maximum distance of flow to the dike shall be less than 200 feet.
- Maximum concentrated flow to the dike shall be 1 cubic foot per second or less.
- If 50% or less of the soil to be contained, by weight, passes the U.S. Standard Sieve No. 200, select the equivalent opening size (EOS) to retain 85% of the soil.
- The maximum opening size shall be 70 (#70 sieve) and the minimum opening size shall be 100 (#100 sieve).
- If 85% or more of the soil to be contained, by weight, passes the U.S. Standard Sieve No. 200, a triangular sediment filter dike should not be used due to clogging potential.
- Provide sufficient room between the filter dike and other obstructions for the operation of the sediment removal equipment to properly maintain the dike.
- The ends of the dike should be turned upstream to prevent bypass of sediment-laden flow.

TRIANGULAR SEDIMENT FILTER DIKE

MAINTENANCE REQUIREMENTS

Triangular sediment filter dikes must be inspected weekly and following storm events of 0.5 inches or greater. Repairs must be made promptly to ensure continued protection of the site. Sediment should be removed when it has reached a depth of approximately 6 inches. As with silt fence, the integrity of the filter fabric is important to the effectiveness of the dike. Overlap between dike sections should be checked on a regular basis and repaired if deficient.

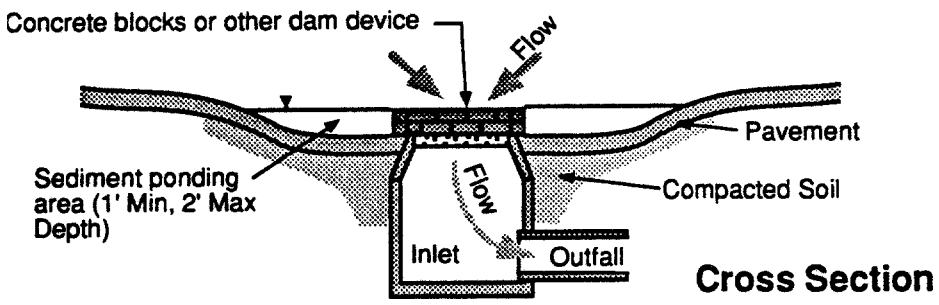
ADVANTAGES

+ Removes sediment and prevents downstream damage from sediment deposits.
+ Reduces the speed of runoff flow.
+ Minimal clearing and grubbing required for installation.
+ Inexpensive.

DISADVANTAGES

- May result in failure from improper choice of pore size in the filter fabric or improper installation.
- Should not be used in streams.
- Is only appropriate for small drainage areas with overland flow.
- Frequent inspection and maintenance is necessary to ensure effectiveness.

INLET PROTECTION



APPLICATIONS

Sediment Trapping

POLLUTANT REMOVAL

MED Sediment
Floatables

LO Oil & Grease
Nutrients & Toxics
Other Construction Wastes

IMPLEMENTATION REQUIREMENTS

HI Capital Costs

HI Maintenance

LO Training

LO Suitability to slopes >5%

DESCRIPTION

Inlet protection includes a variety of techniques used for intercepting sediment at low point inlets through the use of stone, concrete blocks, filter fabric and other materials. Normally located at an inlet to the storm drainage system, these techniques work by providing either detention or filtration to prevent sediment and floatable materials from entering the drain.

APPLICATIONS

Due to limited effectiveness, inlet protection is typically used as a secondary defense in site erosion control to prevent the introduction of sediment or floatables to the storm drain system. A common usage is in new residential or commercial developments where roadways and storm inlets are installed prior to development of individual lots. Inlet protection is also useful during repairs on existing roadways although care must be taken to avoid the potential for flooding, traffic or pedestrian safety or maintenance problems.

Different configurations of inlet protection are used depending upon site conditions and the desired results. Some of these include:

- Filter barrier protection (similar to silt fencing) is appropriate around an inlet when the drainage area is less than one acre and the basin slope does not exceed 5 %. This type of protection is not applicable to paved areas.
- Block and gravel protection (crushed stone or recycled concrete are also appropriate) is used for flows exceeding 0.5 cubic feet per second. An allowance for overtopping should be provided to prevent flooding problems.
- Wire mesh and gravel protection is used when flows exceed 0.5 cubic feet per second and when construction traffic will occur over the inlet. This technique is useful for both curb and drop inlets.
- Excavated impoundment protection around a drop inlet may be used to protect against sediment entering a storm drain system. It is necessary to install weep holes in order for the impoundment to drain completely.

BMP - 11

INLET PROTECTION

DESIGN CRITERIA

- Filter fabric protection shall be designed and maintained in a manner similar to silt fencing. For instance:
  - If 50% or less of the soil to be contained, by weight, passes the U.S. Standard Sieve No. 200, select the equivalent opening size (EOS) to retain 85% of the soil.
  - The maximum opening size shall be 70 (#70 sieve) and the minimum opening size shall be 100 (#100 sieve).
  - If 85% or more of the soil to be contained, by weight, passes the U.S. Standard Sieve No. 200, silt fencing shall not be used due to clogging potential.
- The maximum depth of flow shall not exceed 8 inches depending upon vehicular and pedestrian traffic.
- Positive drainage is critical in the design of inlet protection. If overflow is not provided at the inlet, flows which exceed the capacity of the inlet protection system should be routed to established swales, streets or other watercourses to minimize potential for damage due to ponding or flooding.
- Inlet protection is only viable at low point inlets. Inlets which are on a slope cannot be effectively protected because storm water will bypass the inlet and continue downstream, causing potential overload conditions at the downstream inlets.

MAINTENANCE REQUIREMENTS

Inlet protection systems should be inspected on a weekly basis and especially following significant storm events of 0.5 inches or greater. If filter fabric is a component of the system and becomes clogged, it should be cleaned or replaced, as necessary. Sediment should be removed when it reaches a height approximately one-half the inlet opening height. If a sump is used, the sediment should be removed when the volume of the sump has been reduced by half.

If the inlet protection system includes stone filters, the stones must be pulled away from the inlet and cleaned or replaced when the stone filter becomes clogged. Since cleaning the clogged stone may be difficult, the clogged stone can be used for fill material on the construction site and new stone placed around the inlet for protection.

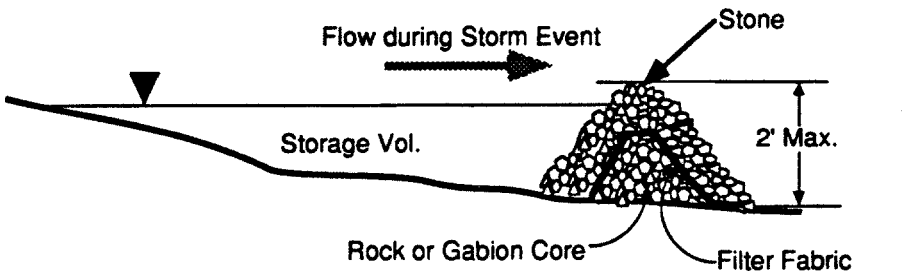
ADVANTAGES

+ Prevents clogging of existing storm drainage systems and the siltation of receiving water.
+ Reduces the amount of sediment leaving the site.

DISADVANTAGES

- May be difficult to remove the collected sediment.
- May cause erosion elsewhere as clogging occurs.
- Is practical only for low sediment, low volume flows (disturbed areas less than one acre).

STONE OUTLET SEDIMENT TRAP



APPLICATIONS

Sediment Trapping

POLLUTANT REMOVAL

HI	Sediment
MED	Floatables
LO	Oil & Grease
	Nutrients & Toxics
	Other Construction Wastes

IMPLEMENTATION REQUIREMENTS

HI	Capital Costs
MED	Maintenance
LO	Training
HI	Suitability to slopes >5%

BMP - 12

DESCRIPTION

A stone outlet sediment trap consists of the formation of a small ponding area (sediment trap) behind a stone and filter fabric berm which allows sediment deposition from the collected runoff. The stone and filter fabric berm has a stone filter outlet at the top to allow passage of treated water. This is used for treatment of concentrated flows which are collected in drainage swales or channels.

APPLICATIONS

Stone outlet sediment traps are used to reduce the velocity of runoff flow and capture entrained sediments. These are typically used for long term (up to 18 months) applications where a sediment basin would not be feasible due to site or construction method restrictions. The use of a stone and filter fabric berm rather than compacted earth provides additional filtration and aids in preventing overtopping of the stone filter.

DESIGN CRITERIA

- Maximum drainage area contributing to the trap shall be 3 acres or less. For larger drainage areas, a sediment basin should be used.
- The minimum length (in feet) of the crest of the stone outlet shall be equal to 6 times the size (in acres) of the contributing drainage area.
- Deposited sediment shall be removed when the depth of sediment is equal to one-third of the height of the outlet structure as measured from the original toe of the slope to the crest of the outlet, or has reached a depth of one foot, whichever is less.
- The minimum width of the embankment at the top shall be 3 feet.
- The maximum slope of the embankment shall be 3:1.
- The maximum height of the embankment shall be 2 feet as measured from the toe of the slope to the crest of the stone outlet. The height of the compacted earth embankment (adjacent to the sides of the stone outlet sediment trap) shall be one foot higher than the crest.
- The effective life of the stone outlet sediment trap is approximately 18 months.

STONE OUTLET SEDIMENT TRAP

MAINTENANCE REQUIREMENTS

Stone outlet sediment traps should be inspected routinely, and immediately following significant storm events of 0.5 inches or greater for accumulation of sediment. Sediment shall be removed and the area directly behind the berm regraded to its original dimensions when the capacity of the impoundment has been reduced by one-half of its original storage capacity. The removed sediment shall be stockpiled or redistributed across the site in areas which are protected from erosion.

The stone outlet should be inspected for clogging of the void spaces between the stones. If the aggregate appears to be clogged such that efficiency has been reduced, the stone should be replaced.

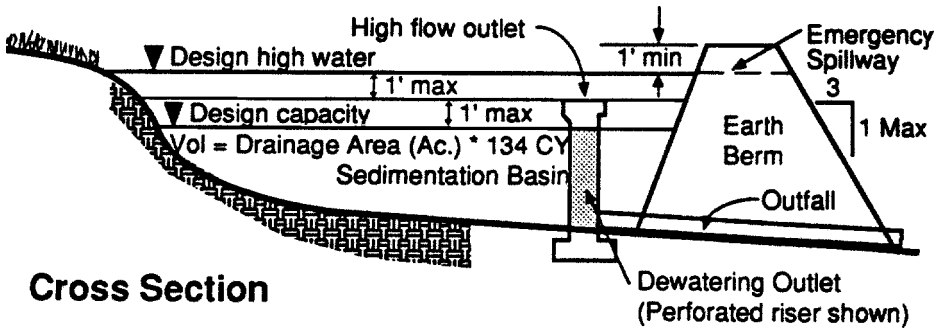
ADVANTAGES

+ Simple and inexpensive to install.
+ Protects downstream areas from clogging or damage due to sediment deposits.
+ Can simplify the drainage design process by trapping sediment at specific spots onsite.

DISADVANTAGES

- Is suitable only for limited areas.
- Is effective only if properly maintained.
- Will not remove fine silts and clays.

SEDIMENT BASIN



Cross Section

APPLICATIONS

Sediment Trapping

POLLUTANT REMOVAL

HI	Sediment
MED	Nutrients & Toxics
MED	Floatables
LO	Other Construction Wastes
	Oil & Grease

IMPLEMENTATION REQUIREMENTS

HI	Capital Costs
MED	Maintenance
LO	Training
HI	Suitability to slopes >5%

BMP - 13

DESCRIPTION

A sediment basin is a settling pond with a controlled outlet used to collect and store sediment produced by construction activities. Sediment-laden runoff is directed to the basin to allow settling of the suspended sediment. It provides treatment for the runoff as well as detention and controlled release of runoff, minimizing potential flood impacts downstream.

APPLICATIONS

Sediment basins can be used at sites with adequate open space to place the basin and the ability to direct a majority of the site drainage to the basin. For sites with disturbed areas of 10 or more acres that are part of a common drainage area, sediment basins should be used for temporary or permanent control of storm water runoff, unless specific site conditions limit their usefulness.

Sediment basins are highly effective in reducing sediment and other types of pollutants for design storm conditions. They also reduce maintenance requirements due to the central location of the sediment and the minimal structural requirements of the basin.

DESIGN CRITERIA

- Maximum drainage area contributing to the basin should be 10 acres or less. Larger sediment basins will require specific measures to address the potential for overtopping the basin and possible failure of the berm.
- Minimum capacity of the basin shall be 3600 cubic feet per acre of disturbed, contributing drainage area.
- Deposited sediment shall be removed when the storage capacity has been reduced to 20% of the original capacity.
- The minimum embankment width at the top shall be 8 feet.
- The maximum embankment slope shall be 3:1.
- The maximum embankment height shall be 6 feet as measured from the toe of the slope on the downstream side.
- The basin outlet shall be designed to accommodate the 10-year design storm without causing damage to the containment structure.
- Minimum outlet capacity shall be 0.2 cubic feet per second per acre of contributing drainage area.

SEDIMENT BASIN

DESIGN CRITERIA (cont.)

- The sediment basin shall have a minimum design dewatering time of 36 hours.
- The basin must be laid out such that the effective flow length of the basin should be at least twice the effective flow width.
- The sediment basin outfall pipe discharge point shall be stabilized with riprap or other form of stabilization for design flows and velocities based on the 25-year design storm peak flows. For velocities in excess of 5 feet per second, velocity dissipation measures should be used to reduce outfall velocities.
- Fencing around the basin may be required to prevent vandalism or unauthorized entry.

MAINTENANCE REQUIREMENTS

Sediment shall be removed and the basin regraded to its original dimensions at such point that the capacity of the impoundment has been reduced to 20% of its original storage capacity. The removed sediment shall be stock-piled or redistributed in areas which are protected from erosion.

The basin outlet structure and emergency spillway (if applicable) should be inspected frequently and after each significant storm event 0.5 inches or greater to check for damage and to ensure that obstructions have not diminished the effectiveness of the structure.

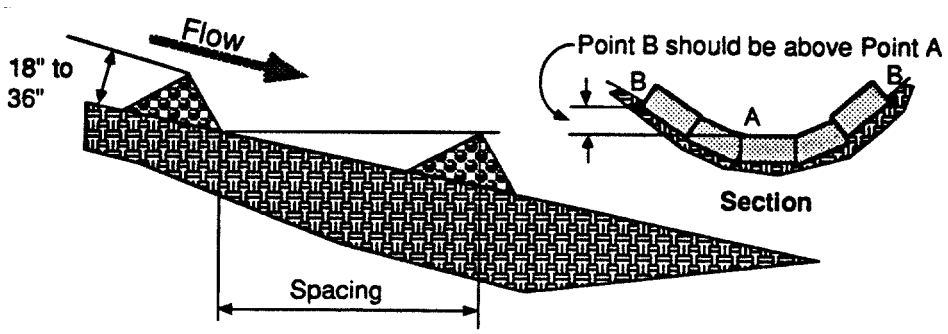
ADVANTAGES

+ Protects downstream areas from clogging or damage due to sediment deposition during construction activities.
+ Can trap smaller sediment particles than sediment traps because of the longer detention time.
+ Can be converted to a permanent storm water detention structure, once construction is completed.

DISADVANTAGES

- Is generally suitable for small areas (less than 10 acres).
- Requires regular maintenance and cleaning.
- Will not remove very fine silts and clays unless used in conjunction with other measures.
- Requires careful adherence to safety practices since ponds are attractive to small children.

CHECK DAMS



APPLICATIONS

Sediment Trapping

Channel Protection

POLLUTANT REMOVAL

MED	Sediment
MED	Floatables
LO	Oil & Grease
	Other Construction Wastes
	Nutrients & Toxics

IMPLEMENTATION REQUIREMENTS

MED	Capital Costs
HI	Maintenance
LO	Training
MED	Suitability to slopes >5%

BMP - 14

DESCRIPTION

A check dam is a small, temporary or permanent, barrier constructed across a drainage ditch, swale, or channel to reduce the velocity of concentrated flows. Check dams are constructed of straw bales, logs, stone, pea gravel-filled sandbags, or earth berms. Reduced velocity reduces the potential for erosion in the channel and allows time for some deposition of sediment.

APPLICATIONS

Check dams are used to protect long drainage swales where protective vegetation has not been established and where erosive velocities are present. Because check dams offer limited treatment, they are used in conjunction with other treatment techniques such as inlet protection, riprap, or other sediment-reducing treatments. Check dams are frequently used early in construction to protect swales in linear projects such as roadway construction. They are also useful in short swales which are located on steep slopes to reduce unacceptable flow velocities.

DESIGN CRITERIA

- Check dams shall be placed at a distance and height to allow small pools to form between each one. Typically the dam height should be between 18 and 36 inches. On steep slopes, the dams should be spaced such that the top of the downstream dam should be at the same elevation as the toe of the upstream dam.
- See design criteria for straw bale and sand bag berms for specific design criteria. Maximum allowable flow shall be based on the specific technique used and the velocity of flow.
- Major flows (greater that the 2-year design storm) must pass the check dam without causing excessive upstream flooding.
- Check dams should be used in conjunction with other sediment reduction techniques prior to releasing the flow offsite.

CHECK DAMS

MAINTENANCE REQUIREMENTS

The maintenance requirements for check dams depend upon the maintenance requirements of the management practice used for the dam. In general, however, the check dams should be inspected weekly and following any significant storm events greater than 0.5 inches for damage and excessive clogging. Repairs should be undertaken in a timely manner to prevent the potential for upstream flooding.

ADVANTAGES

+ Are inexpensive and easy to install.
+ May be used permanently if designed properly.
+ Allow a high proportion of sediment in runoff to settle out.
+ Reduce the velocity and may provide aeration of the water.
+ May be used where it is not possible to divert the flow or otherwise stabilize the channel

DISADVANTAGES

- May kill grass linings in channels if the water level remains high after storm events or if there is significant sedimentation.
- Reduces the hydraulic capacity of the channel.
- May create turbulence which erodes the channel banks.

STABILIZED CONSTRUCTION ENTRY

APPLICATIONS

Temporary Stabilization

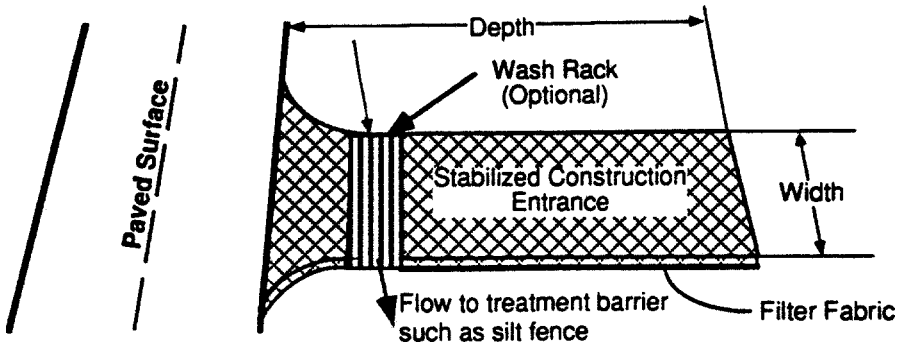
POLLUTANT REMOVAL

MED	Sediment
LO	Oil & Grease
	Nutrients & Toxics
	Floatables
	Other Construction Wastes

IMPLEMENTATION REQUIREMENTS

HI	Capital Costs
MED	Maintenance
LO	Training
LO	Suitability to slopes >5%

BMP - 15



DESCRIPTION

A stabilized construction entrance is used to facilitate the wash down and removal of sediment and other debris from construction equipment prior to exiting the construction site. The entrance typically consists of a gravel, crushed stone, recycled concrete or other rock material pad underlain by a filter fabric. For improved effectiveness, a washdown rack can be incorporated into the design. A stabilized construction entrance specifically addresses the problem of silt and mud deposition in roadways used for construction site access.

APPLICATIONS

Usually used for sites with significant daily truck traffic, stabilized construction entrances shall be a required part of an erosion control plan for all site developments greater than 5 acres in size. These are not suitable for use in long linear projects. When used properly, construction entrances also direct the majority of traffic to a single location, reducing the number and quantity of disturbed areas on the site and providing protection for other structural controls onsite.

DESIGN CRITERIA

- Stabilized construction entrances are to be constructed such that drainage across the entrance is directed to a controlled, stabilized outlet on-site with provisions for storage, proper filtration and removal of washwater.
- The entrance must be properly graded so that storm water is not allowed to leave the site and enter roadways.
- The minimum width of the entrance shall be 15 feet, but in no case shall the width be less than that of the entryway to be used.
- The minimum sediment depth of the entrance shall be 8 inches for the entire length of the control.

STABILIZED CONSTRUCTION ENTRY

DESIGN CRITERIA (cont.)

- Minimum dimensions for the entrance shall be as follows:

Tract Area	Avg. Lot Depth	Min Width of Entrance	Min Length of Entrance
< 1 acre	100 feet	15 feet	20 feet
< 5 acres	200 feet	20 feet	30 feet
<10 acres	>200 feet	20 feet	40 feet
>10 acres	> 200 feet	25 feet	50 feet

- Selection of the location for the construction entrance is critical. It must be used exclusively in order to be effective in controlling tracking of sediments offsite.
- Construction entrances may be more cost-effective than labor-intensive street cleaning.

MAINTENANCE REQUIREMENTS

The construction entrance must be inspected daily to determine if sediment and other materials are being effectively detained onsite. When sediment has substantially clogged the void area between the rocks, the aggregate mat must be washed down or replaced. Periodic regrading and top dressing with additional stone will be required to keep the efficiency from being diminished.

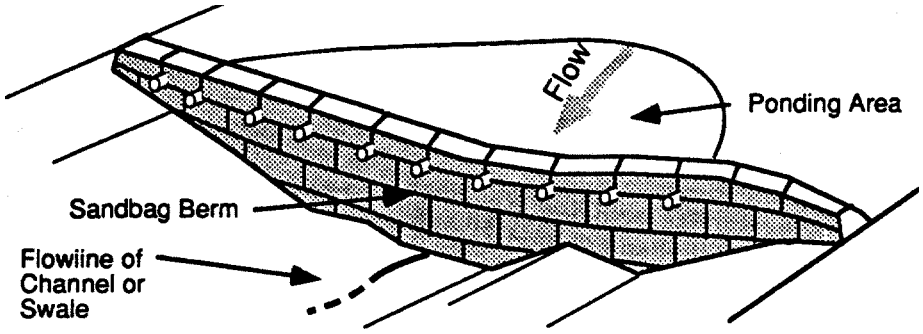
ADVANTAGES

+ Simple and effective for preventing silt and sediment deposition on adjacent roadways by construction traffic.
+ Protects other structural controls by channeling construction traffic to one exit location.
+ Cost-effective when compared to labor-intensive street cleaning.

DISADVANTAGES

- Moderate initial expense.
- Reduced effectiveness if not maintained properly or if bypassed.
- Requires ongoing maintenance, inspections and repairs.

SANDBAG BERM



APPLICATIONS

Sediment Trapping

Channel Protection

POLLUTANT REMOVAL

MED	Sediment
LO	Oil & Grease
LO	Nutrients & Toxics
MED	Floatables
LO	Other Construction Wastes

IMPLEMENTATION REQUIREMENTS

HI	Capital Costs
HI	Maintenance
LO	Training
HI	Suitability to slopes >

BMP - 16

DESCRIPTION

A sandbag berm consists of stacked sandbags installed across a watercourse or channel to direct flow around construction or to allow sedimentation to occur for flows downstream of disturbed areas. There are overflow pipes located in the top of the berm to allow controlled outflow of water after sedimentation occurs.

APPLICATIONS

A sandbag berm is a temporary sediment control method that addresses the problem of construction in creeks, channels and other watercourses which carry a constant flow and are subjected to high, concentrated flows. Sandbag berms can also be used to create a small sedimentation pond prior to completion of a permanent detention basin.

Sandbag berms can also be used as check dams in temporary swales or borrow ditches. Another useful application is the installation of sandbag berms parallel to a roadway providing a corridor of control similar to that provided by a silt fence or straw bales. The sandbag berm, however, is capable of controlling much higher flows and is more durable.

DESIGN CRITERIA

- Berms are to be constructed along a line of constant elevation for use as perimeter control devices.
- The maximum flow through rate shall be 0.1 cubic feet per second per square foot of berm surface.
- The minimum width of the berm shall be 18 inches at the top and 54 inches measured at the bottom
- The maximum side slopes shall be 2:1.
- The maximum design freeboard shall be 0.3 feet.
- Sandbags shall be made of jute, polypropylene, polyethylene or polyamide fabric. Jute shall be composed of a uniform weave of undyed and un-bleached single jute yarn weighing an average of 1.2 pounds per linear yard of cloth with approximately 78 warp ends per width of cloth. Polypropylene, polyethylene or polyamide fabric shall have a minimum unit weight of 4 ounces per square yard, a mullen burst strength of 300 psi minimum and ultraviolet stability exceeding 70 percent. The bags shall be filled with coarse sand or pea gravel.

SANDBAG BERM

DESIGN CRITERIA (cont.)

- To provide flowthrough capability, 4 inch diameter Schedule 40 or greater PVC pipe segments approximately 24 inches long shall be installed immediately below the top layer of sandbags.
- For severe velocities or high flows, woven wire mesh can be used to maintain the integrity of the berm.
- Sufficient room for the operation of sediment removal equipment shall be provided between the berm and other obstructions in order to properly move the sediment.
- The ends of the berm shall be turned upgrade or shall tie into natural grades to prevent bypasses of stormwater.
- For applications within the flow path of channels, the center of the berm must be lower than the outside ends to prevent bypass around the berm.

MAINTENANCE REQUIREMENTS

Sandbag berms must be inspected daily and following each significant rain event 0.5 inches or greater. The sandbags shall be reshaped or replaced as necessary during the inspection. Sediment shall be removed when it reaches a depth of 6 inches. In addition, the PVC overflow pipes shall be inspected weekly to ensure unobstructed flow.

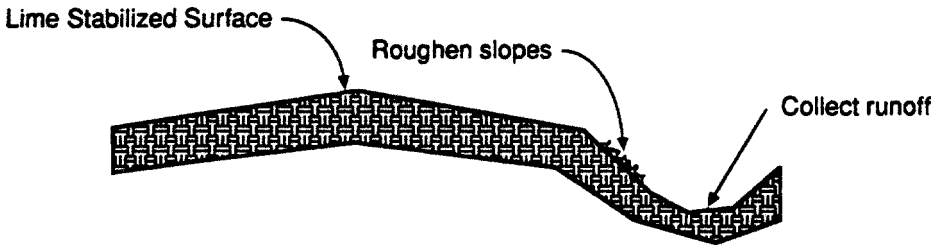
ADVANTAGES

+ Materials readily available on construction sites.

DISADVANTAGES

- Expensive and labor-intensive.
- Require ongoing maintenance, inspections and repairs

LIME STABILIZATION CONTROL BMP



APPLICATIONS

Housekeeping Practices

POLLUTANT REMOVAL

MED Nutrients & Toxics

LO Oil & Grease
Sediment
Floatables
Other Construction Wastes

IMPLEMENTATION REQUIREMENTS

MED Maintenance

LO Capital Costs
Training
Suitability to slopes >5%

BMP - 17

DESCRIPTION

Lime stabilization is used to treat high plasticity soils such as clay to limit the future impacts on shrink-swell potential on the constructed project, particularly roadways, parking lots and other paved surfaces. During lime stabilization, hydrated lime is applied to the soil, disked into the soil and then allowed to cure. This BMP is used to reduce the potential impacts to aquatic life caused by changes in water pH due to the introduction of lime entrained in site runoff.

APPLICATIONS

These techniques are applicable to a wide variety of sites and the engineer will determine which technique to apply based on site conditions such as the amount of available open space, the size of the area being stabilized, and proximity of nearby water courses. The engineer will also take into account the other BMPs already in use on-site. The use of diversion dikes and interceptor swales to redirect upslope water away from the area being stabilized will also reduce potential lime impacts to water bodies.

DESIGN CRITERIA

- The contractor shall limit lime operations to those which can be thoroughly mixed and compacted by the end of each work day.
- No traffic other than the water trucks and mixing equipment shall be allowed to pass over the spread lime until after completion of mixing and curing.
- Areas adjacent and downslope of stabilized areas shall be roughened to intercept lime from runoff and to reduce runoff velocity.
- Geotextile fabrics should not be used to control lime since the grain size of the lime is significantly smaller than the equivalent opening size of the fabric.
- For areas where phasing of lime stabilization is impractical, a curing seal such as Liquid Asphalt, Grade MC-250 or MC-800, shall be applied at a rate of 0.15 gallons per square yard of surface to protect the base.
- Use of a sediment basin with a significant (>36 hours) drawdown time is encouraged for large stabilized areas.

MAINTENANCE REQUIREMENTS

There are generally no maintenance requirements for this BMP. If excess lime appears in the roughened areas, swales or sedimentation basins in use, however, the lime shall be removed and disposed of properly.

ADVANTAGES

+ Protects nearby water courses from harmful impacts of chemical construction practices.
+ Inexpensive and easy to implement.

DISADVANTAGES

- May not provide adequate protection during heavy rain events.

SOLID WASTE MANAGEMENT

APPLICATIONS

Waste Management

Housekeeping Practices

POLLUTANT REMOVAL

LO Sediment
Oil & Grease

HI Nutrients & Toxics
Floatables
Other Construc-
tion Wastes

IMPLEMENTATION REQUIREMENTS

MED Capital Costs
Maintenance
Training

LO Suitability to
slopes >5%

BMP - 18

DESCRIPTION

Large quantities of solid waste are generated at construction sites and include such items as: packaging, pallets, wood waste, concrete waste, soil, electrical wiring, cuttings, and a variety of other material. This BMP addresses techniques which can be used to minimize the potential for storm water contamination from solid waste through appropriate storage and disposal practices.

APPLICATIONS

The solid waste management practice for construction sites is based on proper storage and disposal practices by construction workers and supervisors. Key elements of the program are education and modification of improper disposal habits. Cooperation and vigilance is required on the part of supervisors and workers to ensure that the recommendations and practices are followed. The following list describes the targeted materials:

- Paper and cardboard containers
- Plastic packaging
- Styrofoam packing and forms
- Insulation materials (non-hazardous)
- Wood pallets
- Wood cuttings
- Pipe and electrical cuttings
- Concrete, brick and mortar waste
- Shingle cuttings and waste
- Roofing tar
- Steel (cuttings, nails and rust residue)
- Gypsum board cuttings and waste
- Sheathing cutting sand waste
- Miscellaneous cuttings and waste
- Food waste
- Demolition waste

STORAGE PROCEDURES

- ♦ Wherever possible, minimize the production of solid waste materials.
- ♦ Designate a foreman or supervisor to oversee and enforce proper solid waste procedures.
- ♦ Instruct construction workers in proper solid waste procedures.
- ♦ Segregate potentially hazardous waste from non-hazardous construction site debris.
- ♦ Keep solid waste materials under cover in either a closed dumpster or other enclosed trash container that limits contact with rain and runoff.
- ♦ Store waste materials away from drainage ditches, swales, and catch basins.
- ♦ Prohibit littering by workers and visitors.

SOLID WASTE MANAGEMENT

STORAGE PROCEDURES (cont.)

- Police site daily for litter and debris.
- Enforce solid waste handling and storage procedures.
- Do not allow trash containers to overflow.
- Do not allow waste materials to accumulate on the ground.

DISPOSAL PROCEDURES

- If feasible, segregate recyclable wastes from non-recyclable waste materials and dispose of properly.
- General construction debris may be hauled to a licensed construction debris landfill (typically less expensive than a sanitary landfill).
- Use waste facilities approved by local jurisdiction.
- Runoff which comes into contact with unprotected waste material shall be directed into a structural treatment unit such as silt fencing to remove debris.

EDUCATION

- Educate ALL workers on solid waste storage and disposal procedures.
- Instruct workers in differentiation between solid and hazardous waste.
- Have regular meetings to discuss and reinforce disposal procedures (incorporate into regular safety seminars).
- Clearly mark all solid waste containers to indicate which materials are acceptable for placement into the container.

QUALITY CONTROL

- Foreman and/or construction supervisor shall monitor onsite solid waste storage and disposal procedures.
- Discipline workers who repeatedly fail to follow proper procedures.

REQUIREMENTS

- Jobsite waste handling and disposal education and awareness program.
- Commitment by management to implement and enforce Solid Waste Management Program.
- Compliance by workers.
- Sufficient and appropriate waste storage containers.
- Timely removal of stored solid waste materials.
- Possible modest cost impact for additional waste storage containers.
- Small cost impact for training and monitoring.
- Minimal overall cost impact.

HAZARDOUS WASTE MANAGEMENT

APPLICATIONS

Waste Management

Housekeeping Practices

POLLUTANT REMOVAL

LO Sediment
Floatables

HI Oil & Grease
Nutrients &
Toxics
Other Construc-
tion Wastes

IMPLEMENTATION REQUIREMENTS

MED Capital Costs
Maintenance
Training

LO Suitability to
slopes >5%

BMP - 19

DESCRIPTION

The hazardous waste management BMP addresses the problem of storm water polluted with hazardous waste through spills or other forms of contact. The objective of this BMP is to minimize the potential of storm water contamination from common construction site hazardous wastes through appropriate recognition, handling, storage and disposal practices.

It is not the intent of this BMP to supersede or replace normal site assessment or remediation procedures. Significant spills and/or contamination warrant immediate response by trained professionals. Suspected jobsite contamination should be immediately reported to regulatory authorities and protective actions taken. The Construction General Permit requires reporting of significant spills to the National Response Center at 800/424-8802.

APPLICATIONS

The hazardous waste management techniques presented here are based on proper recognition, handling, and disposal practices by construction workers and supervisors. Key elements of the program are education, proper disposal practices, as well as provisions for safe storage and disposal. The following list describes the targeted materials:

- Paints
- Solvents
- Stains
- Wood preservatives
- Cutting oils
- Greases
- Roofing tar
- Pesticides
- Fuels and lube oils
- Lead based paints and asbestos (demolition)

STORAGE PROCEDURES

- ♦ Wherever possible, minimize the use of hazardous materials.
- ♦ Minimize the generation of hazardous wastes on the jobsite.
- ♦ Segregate potentially hazardous waste from non-hazardous construction site debris.
- ♦ Designate a foreman or supervisor to oversee hazardous materials handling procedures.
- ♦ Keep liquid or semi-liquid hazardous waste in appropriate containers (closed drums or similar) and under cover.
- ♦ Store waste materials away from drainage ditches, swales and catch basins.
- ♦ Use containment berms in fueling and maintenance areas and where the potential for spills is high.
- ♦ Ensure that adequate hazardous waste storage volume is available.

HAZARDOUS WASTE MANAGEMENT

STORAGE PROCEDURES (cont.)

- Ensure that hazardous waste collection containers are conveniently located.
- Do not allow potentially hazardous waste materials to accumulate on the ground.
- Enforce hazardous waste handling and disposal procedures.
- Clearly mark all hazardous waste containers to indicate which materials are acceptable.

DISPOSAL PROCEDURES

- Regularly schedule hazardous waste removal to minimize onsite storage.
- Use only reputable, licensed hazardous waste haulers.

EDUCATION

- Instruct workers in identification of hazardous waste.
- Educate workers of potential dangers to humans and the environment from hazardous wastes.
- Instruct workers on safety procedures for common construction site hazardous wastes.
- Educate all workers on hazardous waste storage and disposal practices.
- Have regular meetings to discuss and reinforce identification, handling and disposal procedures (incorporate into regular safety seminars).
- Establish a continuing education program to indoctrinate new employees.

QUALITY CONTROL

- Foreman and/or construction supervisor shall monitor on-site hazardous waste storage and disposal procedures.
- Educate and if necessary, discipline workers who repeatedly fail to follow proper procedures.
- Ensure that the hazardous waste disposal contractor is reputable and licensed.

REQUIREMENTS

- Jobsite hazardous waste handling and disposal education and awareness program.
- Commitment by management to implement and enforce Hazardous Waste Management Program.
- Compliance by workers.
- Sufficient and appropriate hazardous waste storage containers.
- Timely removal of stored hazardous waste materials.
- Possible modest cost impact for additional hazardous waste storage containers.
- Small cost impact for training and monitoring.
- Potential cost impact for hazardous waste collection and disposal by licensed hauler. The actual cost depends on the type of material and volume.

CONCRETE WASTE MANAGEMENT

APPLICATIONS

Waste Management

Housekeeping Practices

POLLUTANT REMOVAL

LO Sediment
Oil & Grease

HI Nutrients & Toxics
Floatables
Other Construction Wastes

IMPLEMENTATION REQUIREMENTS

MED Capital Costs
Maintenance
Training

LO Suitability to slopes >5%

BMP - 20

DESCRIPTION

Concrete waste at construction sites comes in two forms: (1) excess fresh concrete mix including truck and equipment washing residue, and (2) concrete dust and debris resulting from demolition. Both of these have the potential to impact water quality through storm water runoff contact with the waste materials.

APPLICATIONS

The introduction of concrete, especially fresh concrete, to a water body can impact a number of water quality parameters such as pH and suspended solids. Changes in pH and the amount of suspended solids significantly impacts the aquatic life.

UNACCEPTABLE DISPOSAL PRACTICES

- Dumping in vacant areas of the jobsite
- Illicit dumping off the jobsite
- Dumping into ditches or drainage facilities

DISPOSAL PRACTICES

- Avoid the unacceptable disposal practices listed above.
- Develop a pre-determined, safe concrete disposal area.
- Provide a truck washout area with a minimum of 6 cubic feet of containment volume for every 10 cubic yards of concrete poured.
- Never dump waste concrete illicitly or without the property owner's knowledge and consent.
- Treat runoff from storage areas through the use of structural controls as required.

EDUCATION

- Driver and equipment operators should be instructed on proper disposal and equipment washing practices (see above).
- Supervisors must be made aware of the potential consequences of improperly handled concrete waste.

ENFORCEMENT

- The construction site manager or foreman must ensure that employees and pre-mix companies follow proper procedures for concrete disposal and equipment washing.

CONCRETE WASTE MANAGEMENT

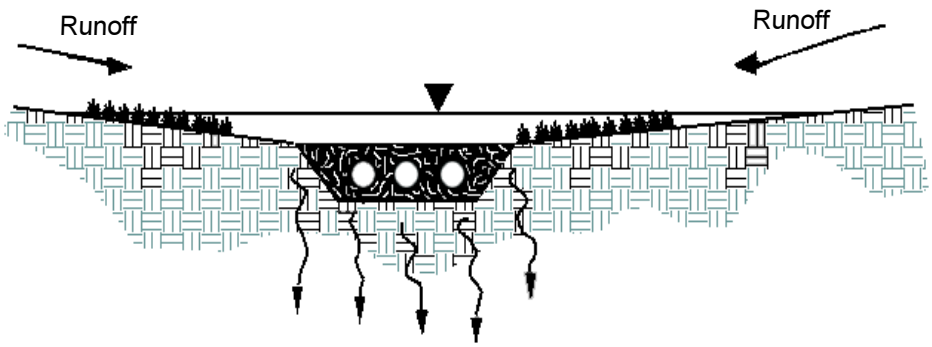
DEMOLITION PRACTICES

- Monitor weather and wind direction to ensure that concrete dust is not entering drainage structures or surface waters.
- Where appropriate, construct sediment traps or other types of sediment detention devices downstream or demolition activities.

REQUIREMENTS

- Use pre-determined disposal sites for waste concrete.
- Prohibit dumping waste concrete anywhere but at the pre-determined areas.
- Assign pre-determined truck and equipment washing areas.
- Educate drivers and operators on proper disposal and equipment cleaning procedures.
- Minimal cost impact for training and monitoring.
- Concrete disposal cost depends on availability and distance to suitable disposal areas.
- Additional costs involved in equipment washing could be significant.

INFILTRATION



APPLICATIONS

POLLUTANT REMOVAL

HI Heavy Metals, Bacteria and Viruses, Toxic Chemicals, Sediment, Oil and Grease, Oxygen Demanding Substances

MED Nutrients

IMPLEMENTATION REQUIREMENTS

MED Capital Costs, Operation and Maintenance Costs, Maintenance

BMP - 21

DESCRIPTION

Storm water infiltration involves a variety of systems where surface runoff is infiltrated into the ground rather than discharged to a surface water body. Infiltration systems typically include: ponds, basins, trenches, dry wells, buried perforated pipe, porous pavement, and concrete grids.

APPLICATIONS

Infiltration BMPs should be used as a final treatment for urban runoff following pretreatment for suspended solids and oil. Infiltration techniques are useful for ground water recharge. These BMPs have residential applications for removal of organic material and phosphates and are applicable in areas where land area is limited such as retrofits in existing developments in residential areas, commercial districts, and parking lots. Infiltration basins are typically used for areas less than 5 acres, but may handle up to 50 acres if the soil is very permeable. Other infiltration methods are applicable only for smaller sites.

DESIGN CRITERIA

- Should be sized to capture a particular fraction of the surface runoff.
- Should be located off-line from the primary detention / conveyance systems.
- A Darcy's Law approach should be considered when sizing the BMP.
- Pretreatment is required in areas where fine soils are present.
- An overflow should be provided with capacity to convey runoff from larger storms.

INFILTRATION

MAINTENANCE REQUIREMENTS
Remove sediment frequently to avoid build-up and clogging of infiltration surfaces.

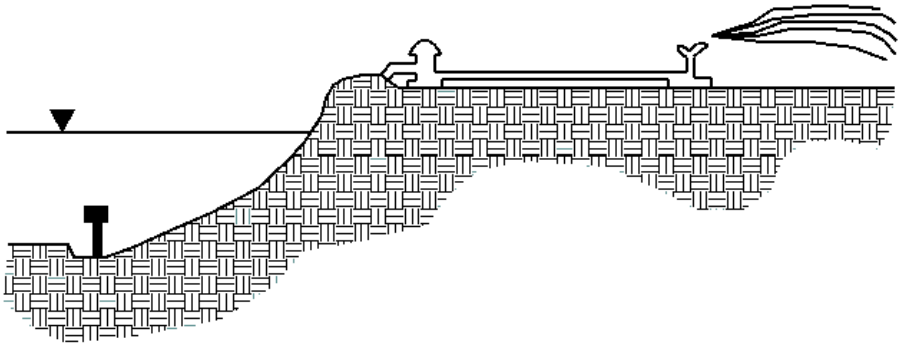
ADVANTAGES

+ Attenuate peak flows.
+ Provides a groundwater recharge.
+ Can effectively remove pollutants based on design and maintenance
+ Can reduce the size requirement of the storm drain system since less surface runoff is present.
+ Medium capital cost.

DISADVANTAGES

- Can result in infiltration of contaminated water.
- Poor pollutant removal during large storm events as a result of flows bypassing the BMP.
- High failure rates due to problems with site conditions, design, construction and lack of maintenance.
- Potentially high maintenance if fine silts affect infiltration.
- Moderate maintenance costs associated with sediment removal from the associated settling basin.
- May not be considered aesthetically pleasing.

RETENTION PONDS



APPLICATIONS

POLLUTANT REMOVAL

HI Sediment
Toxic Chemicals

MED Heavy Metals, Nurtients, Bacteria and Viruses, Oil and Grease, Oxygen Demanding Substances

IMPLEMENTATION REQUIREMENTS

MED Capital Costs,

O&M Costs

BMP - 22

DESCRIPTION

Retention ponds are designed to hold surface runoff for periods of days or weeks. Retention ponds are appropriate where storm water runoff from a relatively small area needs to be treated prior to its release or reuse. A continual flow of water should be provided in order to make up for loss due to evaporation and infiltration.

APPLICATIONS

Retention ponds work well in areas that receive urban runoff from roads, parking lots, residential neighborhoods, commercial areas, and industrial sites. Retention ponds can provide effective pretreatment for surface runoff prior to release or reuse. Retention ponds should not be utilized in areas where surface runoff may contain soluble metals or toxic organic material.

Retention is effective at reducing the size of oil/water separators because total suspended solids concentrations are reduced and flows are detained and may be passed through an oil/water separator at a lower rate of flow. When surface runoff from industrial areas is received in a retention pond and volatiles are in excess, adding aeration equipment to the retention pond can reduce the amount of volatiles discharged into the storm water. Application of this method to reduce volatiles should be coordinated with the Texas Air Control Board.

DESIGN CRITERIA

- The amount of directly connected impervious area in the contributing watershed will significantly impact the storage volume required and the time required to treat the captured runoff.
- Retention ponds should be located off-line from other controls.
- Ponds are typically sized for the one year storm event.
- A water budget analysis should be completed to ensure that available base flow will be greater than water losses.

RETENTION PONDS

MAINTENANCE REQUIREMENTS

Sediments, litter and trash must be removed regularly. Landscape surrounding the wet pond must be maintained. Control insect populations by installing predacious bird and bat nesting boxes. Outlet structures should be maintained regularly to prevent clogging.

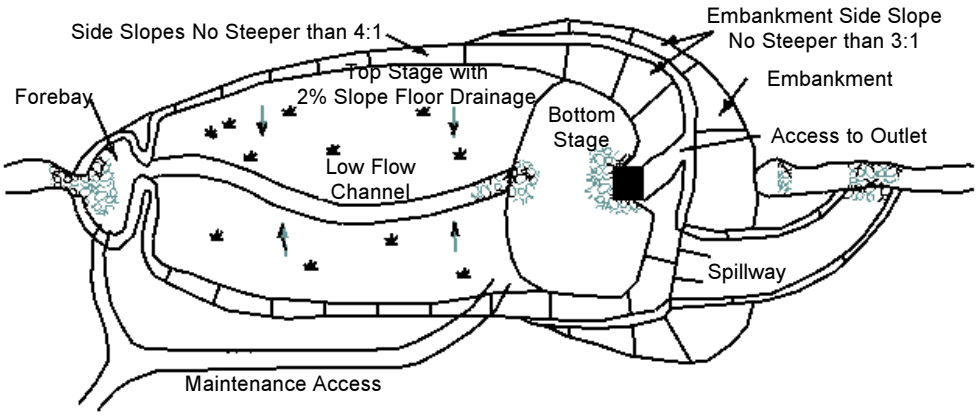
ADVANTAGES

+ Creates a permanent habitat supporting a wide range of species.
+ Attenuates peak flow.
+ Provides aesthetic benefits.
+ Potentially very effective in removal of pollutants and sediments.
+ Able to develop into diverse habitats supporting a wide range of species.
+ Able to be designed to capture the first flush.
+ Wetland vegetation is conducive to the uptake of contaminants and nutrients.

DISADVANTAGES

- Regular maintenance is required.
- Floating litter, scum and algal blooms, nuisance odors, and possible mosquito problems.
- Water fowl attracted to the pond may create nutrient imbalances.
- Regular maintenance will disturb biological communities that establish themselves in the pond.
- Safety concerns for the general public associated with bodies of deep water.
- Provides limited groundwater recharge
- May lead to contamination of fish and wildlife through bio-accumulation of metals and toxic chemicals in habitats.
- Can disrupt the existing habitat and alter the stream hydrology in an area.

EXTENDED DETENTION BASIN



APPLICATIONS

Perimeter Control

Slope Protection

POLLUTANT REMOVAL

HI Floatable Materials, Sediment

MED Heavy Metals, Nutrients, Toxic Chemicals, Oil and Grease, Oxygen Demanding Sub-stances

LO Bacteria and Viruses

IMPLEMENTATION REQUIREMENTS

MED Operation Maintenance, Maintenance Costs, Capital Costs

BMP - 23

DESCRIPTION

Extended detention basins are normally dry between storm events, however, water is detained in the pond from one to two days following a storm event. An outlet is located at the bottom of the pond that allows waters to be released slowly after a storm event and provide time for sediments to settle prior to discharge into receiving waters.

APPLICATIONS

Extended detention basins are applicable in areas where water availability is limited and unable to support a wet pond. Extended detention basins can be used to enhance storm water runoff quality and reduce peak storm water runoff rates. Existing detention basins can be retrofitted to extended detention basins through modification of the outlet structure to limit flows and extend the draw-down time.

DESIGN CRITERIA

- The extended detention basin is typically sized to capture the first inch of runoff.
- Soil maps and boring tests should be conducted prior to design/construction in order to establish geotechnical parameters.
- Perforated riser pipes or submerged orifices are typically used as outlet structures.
- An armored or geotextile reinforced embankment and overflow spillway must be incorporated in the basin to prevent catastrophic failure of the basin.
- A shallow basin with maximum surface area performs better than a deep basin with the same volume.
- The length of the basin should be greater than three times its width.
- Energy dissipators should be utilized at all inlets to the pond to minimize erosion in the pond.
- The length between inlets and outlets should be maximized to prevent short circuiting and encourage sedimentation in the basin.
- Inclusion of a small shallow wetland in the basin's bottom can improve nutrient removal rates.

EXTENDED DETENTION BASIN

MAINTENANCE REQUIREMENTS

Orifice and/or riser pipe should be checked regularly for clogging. The banks and the bottom should be checked for signs of erosion. Sediments should be removed when accumulation depths are greater than 6 inches or resuspension of sediments is observed. Landscape surrounding the facility must be maintained to meet aesthetically pleasing standards. Insect populations may be controlled through installation of predacious bird and bat nesting boxes.

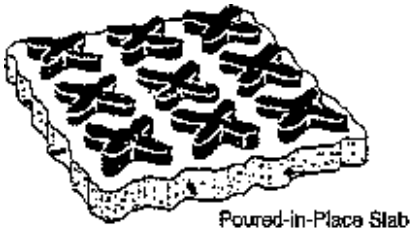
ADVANTAGES

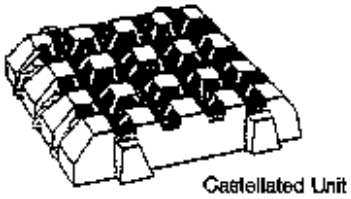
+ Provides flood control.
+ Reduces downstream erosion.
+ Effective removal rate of 70-80% of total suspended solids.
+ Can be designed to incorporate recreational and open space uses available for the general public.
+ Has the ability to capture and treat the first flush.
+ Shallow wetlands can be easily incorporated into the design to enhance the pollutant removal capabilities of the pond.

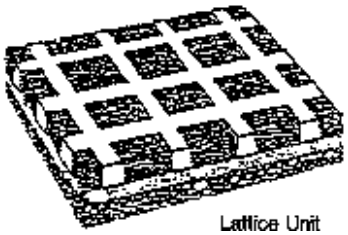
DISADVANTAGES

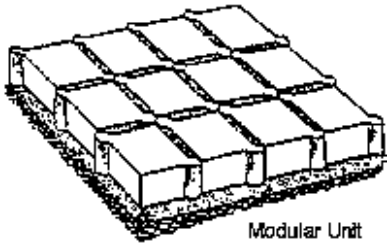
- Pollutant removal efficiency is dependent upon the designed detention period.
- Removal of soluble pollutants and bacteria may be poor.
- Has a limited groundwater recharge ability.
- Large tracts of land are required for the storage area.
- Floatables accumulate and require regular litter and trash pickups.
- Clogging can shorten the design life if not maintained.

POROUS PAVEMENT









APPLICATIONS

POLLUTANT REMOVAL

HI	Sediment
LO	Oil & Grease
MED	Other Construction Wastes

IMPLEMENTATION REQUIREMENTS

MED	Maintenance
LO	Training
HI	Suitability to slopes >5%

BMP - 24

DESCRIPTION
Porous pavements may consist of porous graded asphaltic concrete or interlocking paving blocks with open spaces.

APPLICATIONS
Porous pavements are often used in walkways, lightly traveled areas and as overflow parking in parking lots.

DESIGN CRITERIA
- A base course of graded gravel is often used that is typically capable of storing 0.25-inch of runoff from the paved surface.
- Underlying soil conditions should be investigated in order to determine the infiltrative properties of the subgrade and the effectiveness of the BMP.
- In high clay conditions, underdrain systems should be installed that will drain the base material and discharge as sheet flow through vegetated buffers or other on-site water quality treatment systems.

MAINTENANCE
Porous pavements should be routinely vacuumed and swept in order to remove sediments and debris that are too large to pass through the voids in the concrete. Use of a high pressure washing following vacuuming has been found to be effective in unclogging porous pavement. Other maintenance to porous pavements may be performed as with conventional pavements.

POROUS PAVEMENT

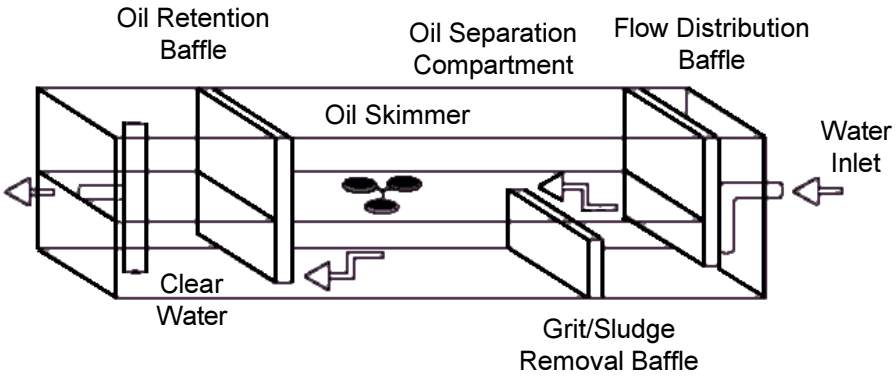
ADVANTAGES

+ Attenuates peak flow during small events.
+ Improves erosion control.
+ Provides some groundwater recharge.
+ May be able to reduce the size of storm drain systems as less water is to be conveyed through them.

DISADVANTAGES

- Does not create habitat.
- Risk of groundwater contamination.
- Improper installation can lead to structural failure of the pavement.
- Potentially high maintenance costs.
- Not suitable for large or heavily traveled areas.

OIL/WATER SEPARATORS



APPLICATIONS

POLLUTANT REMOVAL

LO	Sediment Floatable Materials
MED	Bacteria/viruses Heavy metals Nutrients Toxic chemicals Sediment Oxygen demanding substances
HI	Oil & Gas

IMPLEMENTATION REQUIREMENTS

MED	Capital Costs, Training
HI	O&M Costs Maintenance

DESCRIPTION

Oil/water separators are designed to remove oil, other water-insoluble hydrocarbons, and settleable solids from storm water runoff. Separators are also effective at removing floatable debris and settleable solids. Two general types of oil/water separators are the conventional gravity separator and the coalescing plate interceptor (CPI).

APPLICATION

Oil/water separators will be needed for industrial and commercial sites where activities result in abnormal amounts of petroleum products lost to exposed pavements, either by accidental small spills or normal dripping from vehicle undercarriages. Conventional separators are capable of removing oil droplets with diameters equal to or greater than 150 micrometers. Separators are often used in airfields, fleet vehicle maintenance, washing facilities and mass transit park-and -ride lots.

DESIGN CRITERIA

When designing, the sizing is related to anticipated influent flow rate, oil concentration, water temperature, and the effluent goal. To maintain reasonable separator size, it should be designed to bypass flows in excess of first flush and should avoid hydraulic overloading. Systems should have traffic rated lids, where appropriate.

Oil/water separators used in conjunction with and proceeded by retention basins can reduce the size of the oil/water separator because of the reduction in sediment loads and the slower rates.

Specify appropriate performance tests after installation and shakedown, and/or certification by a professional engineer that the separator is functioning in accordance with design objectives.

Do not use oil/water separators for the removal of dissolved or emulsified oils such as coolants, soluble lubricants, glycols, and alcohols.

BMP - 25

OIL/WATER SEPARATORS

MAINTENANCE REQUIREMENTS

Effectiveness depends on routine maintenance. Therefore, inspection of the facility should take place at least twice a year. Preferably more often after long dry periods, large storms, or spills. Maintenance involves the removal of accumulated oil, grease, and floating debris, and proper disposal.

ADVANTAGES

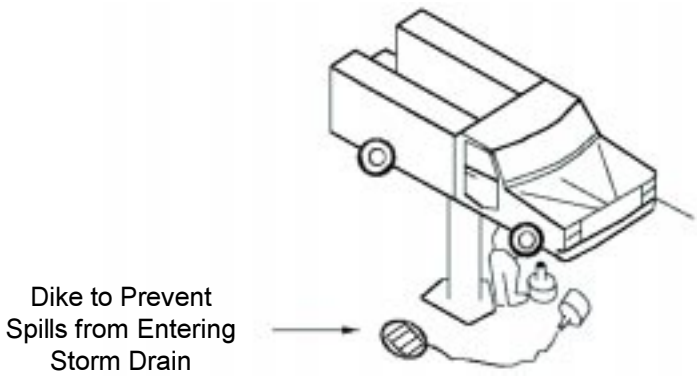
+ Provides pre-treatment of runoff before it is discharged into infiltration systems, retention/detention systems, or into sewers discharging directly into aquatic systems.
+ The design life is 20 plus years.

DISADVANTAGES

- No direct provision of a habitat.
- Little data on oil characteristics in storm water leads to considerable uncertainty about BMP performance
- High maintenance requirements
- Oil/water separators may not be suitable for large areas.
- Ineffective for erosion or flood control.

VEHICLE AND EQUIPMENT MAINTENANCE / REPAIR

APPLICATIONS



POLLUTANT REMOVAL

LO	Floatable Materials Bacteria & Viruses Nutrients Sediment
HI	Heavy metals Toxic chemicals Oil and grease Oxygen Demanding Substances

IMPLEMENTATION REQUIREMENTS

MED	Capital Costs (site specific) O&M Costs Training

BMP - 26

DESCRIPTION

The maintenance of vehicles and equipment is a potentially significant source of storm water pollution. Activities such as engine repair and service, replacement of fluids, and outdoor equipment storage and parking will contaminate storm water.

APPROACH

The discharge of pollutants into storm waters from vehicle and equipment maintenance can be prevented and reduced by observing some of the following procedures and techniques:

This practice involves using off-site facilities, performing work in designated areas only, providing cover for materials stored outside, checking for leaks and spills, containing and cleaning up spills immediately.

- Employees and subcontractors should be trained to use proper maintenance and spill cleanup procedures.
- Equipment should be kept clean in order to prevent the excessive build up of oil and grease.
- Use designated areas when performing maintenance work on equipment or when changing motor oil. Use drip pans, drop clothes or containers under the areas that might drip while working on a vehicle outdoors.
- Incoming vehicles should be checked for leaking oil and fluids. Wrecked vehicles should be kept in a covered area, all fluids should be drained, and cracked batteries should be stored in a secondary container.
- Maintain a yard storm drain inlet(s).
  - Clean regularly and especially after large storms.
  - Do not hose down work areas.
- Regularly inspect equipment and vehicles for leaks and repair immediately. Keep the equipment yard clean.
- Recycle greases, used oil or oil filters, antifreeze, cleaning solutions, automotive batteries, hydraulic and transmission fluids.
- Separate wastes such as hazardous and nonhazardous wastes, oils and solvents, chlorinated solvents and unchlorinated solvents. This allows for easier recycling and the reduction of disposal costs.

VEHICLE AND EQUIPMENT MAINTENANCE / REPAIR

APPROACH (cont.)

Make sure oil filters are completely drained and crushed before recycling or disposal.
Use recycled products and non-toxic chemicals.
Small spills should be cleaned-up with rags and without large amounts of water. Damp mops can be used for general cleanups, while larger spills will require dry absorbent materials.
Waste oil, antifreeze, detergents, solvents or other vehicle fluids should not be discharged into a storm drain.
Signs should be painted on storm drain inlets to indicate that they are not to receive liquid or solid waste.
Dumpsters that store items awaiting transfer to a landfill such as used oil filters should be covered or located in a lean-to and should not have the drain plug removed.

MAINTENANCE REQUIREMENTS

Inspection maintenance areas on a regular schedule.

ADVANTAGES

+ All of the application techniques listed above involve low cost measures depending on the size of the facility.
+ Maintenance should be low if the procedures as outlined above are properly followed.

DISADVANTAGES

- Inspections of maintenance areas are needed on a regular basis.
- Space and time limitations may preclude all work being conducted indoors. Vehicles/equipment brought on-site after working hours may not be able to have spills contained and cleaned-up.
- Drip pans (3-ft. x 3-ft.) should be purchased or fabricated in order to contain antifreeze.
- The identification of engine leaks may require the use of solvents.

VEHICLE AND EQUIPMENT WASHING, CLEANING

APPLICATIONS

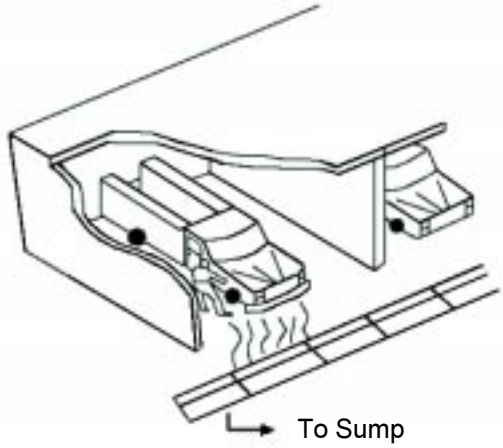
POLLUTANT REMOVAL

LO	Sediment Nutrients Heavy Metals Bacteria & Viruses
MED	Floatable Materials
HI	Toxic Materials Oxygen Demanding Substances Oil & Grease

IMPLEMENTATION REQUIREMENTS

MED	Capital Costs O&M Costs Maintenance Training

BMP - 27



DESCRIPTION

BMPs should be used wherever vehicles and equipment are washed. The washing of vehicles can contribute to the pollution of storm water if performed outdoors, or in areas where the wash is able to flow onto the ground. High concentrations of oil and grease, phosphates, surfactants, suspended solids, heavy metals and organics are contained within the wash water.

APPROACH

Employees should be educated on pollution prevention measures.

Use either a designated wash area or an off-sight commercial washing facility where the site is covered, paved, and runoff of storm water is prevented. Create a berm outside this area to contain wash water if needed.

Phosphate free detergents should be used.

Filter, recycle, or discharge wash water to a sanitary sewer, process treatment, or a dead-end sump.

Steam cleaning wash water should not be disposed of in a storm drain.

VEHICLE AND EQUIPMENT WASHING, CLEANING

DESIGN CRITERIA

- ♦ Wash water from vehicles and equipment cleaning should be discharged to the sanitary sewer whenever possible. The discharge pipe should have a positive control valve that can be shut when washing is not occurring in order to prevent the entry of storm water. If this is not possible and washing is conducted in an outside area, then this area should be designated as a wash zone, and the following elements should be incorporated in the wash area design:
  - Pave with Portland Cement
  - Berm the area to prevent runoff from entering the wash area
  - Slope wash area for wash water collection
  - discharge wash water to the sanitary sewer, process treatment , or a dead-end sump
  - Clearly mark the wash zone

MAINTENANCE REQUIREMENTS

Berms will need repair and patching.
Sumps will need to be cleaned-out.

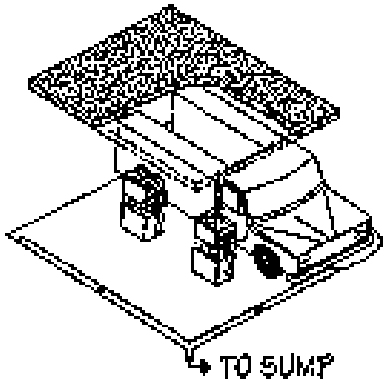
ADVANTAGES

+ The costs are low for the repair and patching of berms.

DISADVANTAGES

- Some municipalities may require pretreatment (such as sand and grit traps) and monitoring of wash water discharges to the sanitary sewer.
- Steam cleaning can generate significant pollutant concentrations requiring permitting, monitoring, pretreatment, and inspections.
- Generally a permit is required if wash water is discharged off the property.

VEHICLE AND EQUIPMENT FUELING



APPLICATIONS

POLLUTANT REMOVAL

LO	Sediment Nutrients Heavy Metals Bacteria & Viruses Floatable Materials
MED	Oil & Grease
HI	Toxic Materials Oxygen Demand-ing Substances

IMPLEMENTATION REQUIREMENTS

MED	Capital Costs O&M Costs Maintenance Training

BMP - 28

DESCRIPTION

Most transportation and repair facilities have to deal with fuel spills and leaks. Fuel spills and leaks contaminate storm water with sediment, toxic materials, floatable materials, oxygen-demanding substances, and oil/grease. BMP measures should be practiced.

APPROACH

- Use off-site fueling stations as much as possible. Performing this work off-site can also be economical by eliminating the need for a separate fueling area at your site.
- If fueling occurs on-site, use designated areas.
  Install spill overflow prevention equipment.
  Minimize exposure to storm water by covering fueling area.
  Install oil/water separators and/or grease traps in nearby storm drains.
  Locate designated area away from drainageways to prevent the runoff of storm water and the runoff of spills.
  Discourage “topping-off” of fuel tanks.
- Always use a secondary containment, such as a drain pan or drop cloth, to catch spills or leaks.
- Use dry cleanup methods instead of washing down or burying spills. Place a stockpile of spill cleanup materials where it will be readily accessible.
- Use absorbent materials on small spills. Remove the absorbent materials promptly and dispose of the materials properly.
- Comply with all federal and state requirements regarding stationary above ground storage tanks.
- If using underground storage tanks (US) then install US leak detection equipment or procedures.
- Educate employees and subcontractors in proper fueling and cleanup procedures and encourage them to participate.

VEHICLE AND EQUIPMENT FUELING

DESIGN CRITERIA

Install spill overflow prevention equipment, and US leak detection equipment.
Cover fueling area to minimize exposure to storm water. Install oil/water separators and/or grease traps in nearby storm drains.

MAINTENANCE REQUIREMENTS

Inspections of fueling areas and storage tanks should be carried out on a regular basis. Covered fueling areas require routine maintenance for oil/water separators and grease traps. For spill control maintenance, an ample supply of spill cleanup materials should be kept on-site.

ADVANTAGES

+ Costs of the above measures should be low except for cover installation. However, the costs for covering will vary depending on the size of the area.

DISADVANTAGES

- The capital costs of above ground tanks are higher. Above ground tanks are required to meet strict environmental, zoning, and fire code regulations.
- The oil/water separators associated with vehicle equipment fueling have to be maintained to prevent the pollution of storm water.

SPILL PREVENTION AND CONTROL

APPLICATIONS

POLLUTANT REMOVAL

LO Sediment, Nutrients, Floatable Materials, Other Construction Waste

MED Oil & Grease Toxic Materials

IMPLEMENTATION REQUIREMENTS

LO Capital Costs Maintenance

MED O&M Costs Training

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DESCRIPTION

In order to prevent and reduce the discharge of contaminants into storm water, leaks and spills can be reduced by making an effort to stop the source of spills, containing and cleaning up spills, properly disposing of spill materials, and training employees and subcontractors.

APPROACH

- General measures can be taken to reduce the impacts of leaks and spills to storm water. Such as:
  - Storing hazardous materials and wastes in covered containers and protecting them from vandalism.
  - Making spill cleanup materials easily accessible.
  - Training employees in spill prevention and cleanup techniques.
- In the case of a significant spill, different materials pollute at different levels. If employees are educated about the substances that they come in contact with they will be able to identify a “significant spill” versus an “insignificant spill” and react with the necessary appropriate response.
- Cleanup leaks and spills immediately. If spills occur on paved surfaces, use as little water as possible. A rag can be used for small spills, a damp mop for general cleanups, and absorbent materials for larger spills. If dealing with a hazardous material, cleanup materials must be disposed of as hazardous waste.
- Cleanup as much of the material as possible and dispose of properly. Dry materials spilled should never be hosed down or buried.
- In the case of a significant spill, a report should be made to local agencies, such as the Fire Department, who can assist in the cleanup.
- For any significant oil spill into a water body or onto an adjoining shoreline, federal regulations require that the National Response Center (NRC) be reported to at 800-424-8802 (24 hours).

Vehicle and Equipment Maintenance

- During on-site maintenance, maintain it away from drainage courses in a designated area and/or a secondary containment (drain pan or drop cloth), that is located away from drainage courses.
- Regularly inspect on-site vehicles and equipment. Repair leaks immediately. Check incoming vehicles and equipment for leaks.
- Place drip pans or absorbent materials under paving equipment when not in use.
- For small spills use absorbent materials. Never hose down or bury the spill.
- Remove the cleanup materials, used fluids, and other materials promptly and dispose of properly (Oil filters can be recycled).
- Keep cracked batteries in a secondary container. Do this with all cracked batteries, even if you think all the acid has drained out. If you drop a battery, treat it as if it is cracked. Put it into the containment area until you are sure it is not leaking.

SPILL PREVENTION AND CONTROL

APPROACH (cont.)

Vehicle Equipment Fueling
- For on-site fueling, use designated areas located away from drainage courses.
- Use a secondary containment, such as drain pan, when fueling to catch spills/leaks. Discourage "top-ping-off" of fuel tanks.

MAINTENANCE REQUIREMENTS

Keep ample supplies of spill control and cleanup materials on-site, near storage, unloading, and maintenance areas. Update your spill prevention and control plan and stock cleanup materials as changes occur in the types of chemicals on-site.

ADVANTAGES

+ Prevention of leaks and spills is inexpensive

DISADVANTAGES

- An experienced spill cleanup company may be required for certain types of spills.
- Treatment and/or disposal of contaminated soil or water can be quite expensive.