Appendix B
Best Management Practices

Best Management Practices Categorization

The BMPs were classified into the following eight categories. Each category represents a different degree of pollutant removal and a different cost. As the degree of treatment increases, both the capital and operation and maintenance costs increase. The BMPs in each category are presented below and listed in the attached table.

Institutional Source Controls: Implementation of institutional source controls prevents pollutants from entering the stormwater flows through the adoption and enforcement of local ordinances, the expansion of existing recycling programs, and implementation of public education programs. Many of these programs, such as recycling programs, may need to be implemented to comply with other regulations. Therefore, the costs can be applied to two or more programs. This type of cost allocation may improve the feasibility of the program.

Nonstructural Source Controls: These controls also prevent pollutants from entering the stormwater flows through the expansion of cleanup programs, such as street sweeping, sidewalk sweeping, cleaning of storm drains, and enforcement actions against illicit dischargers. These controls could be implemented without construction of new facilities.

Minor Structural Source Controls: These controls provide for a reduction in sediment loads and associated pollutants that enter the receiving waters. The controls include improved diversion channels, grass swales, and grass lined channels, improved natural channel banks, and planting of vegetation on exposed soils. These minor structural source controls could be included as part of development projects or when other improvements are being completed.

Most of these controls have been implemented by communities throughout the United States as part of flood control projects. However, the level of maintenance required to ensure flood control capacity is generally less than the level of maintenance required to improve stormwater quality. Therefore, for many communities, new facilities would not need to be constructed. However, the level of maintenance for existing facilities may need to be increased to improve stormwater quality.

Minor Structural Discharge Elimination Methods: These methods will eliminate stormwater discharges, and thereby reduce the levels of pollutants discharged to the receiving waters. These controls, including recharge areas and porous pavement, have been installed by many communities throughout the United States as part of flood control projects or water augmentation projects.

However, to provide water quality improvements, many facilities would require increased maintenance to prevent pollutants from being discharged.

Moderate Structural Controls for Floatables and Oils Removal: Moderate structural controls provide for pollutant removal from stormwater which flows from local areas, such as parking lots. The controls, such as parking lot oil and grease separators, generally are constructed close to the pollutant source, and therefore, treat a small volume of stormwater with a concentrated pollutant level. These controls have been constructed in manufacturing sections of many metropolitan areas. However, increased maintenance may be required to ensure continued performance. To improve water quality further, these facilities could be constructed throughout all light industrial and commercial areas of the communities.

Major Structural Controls for Solids Removal: Major structural controls, such as detention basins or wetlands, remove solids, oils, and greases of large stormwater flows prior to discharge into receiving waters. These controls would require construction of major facilities to remove solids as well as floatables, oils, and greases. These controls also may remove nutrients associated with solids, such as animal droppings or litter. Operation and maintenance costs for these facilities are higher than for the Minor or Moderate Structural Controls. These facilities generally are designed to be operated passively, and therefore do not require expensive instrumentation equipment.

Major Structural Controls for Microorganism Removal: These controls provide for removal of microorganisms in large stormwater flows prior to discharge into receiving waters. Implementation would require construction of major sedimentation facilities and disinfection facilities. The most widely used disinfection method is chlorination followed by dechlorination prior to discharge. However, chlorination will require large storage facilities to provide adequate contact time prior to discharge. Dechlorination also may be required to protect fishery resources in the receiving waters. Operation and maintenance costs for these facilities are high. The facilities must be designed to treat flows which occur almost spontaneously and have a short duration. Therefore, the treatment facilities must be able to be operated remotely or automatically.

Major Structural Controls for Metals Removal: These controls remove metals in large stormwater flows prior to discharge into receiving waters. These controls would require construction of sedimentation facilities followed by either wetlands or lime precipitation. Operation and maintenance costs for these facilities are high. The facilities must be designed to treat flows which occur almost

spontaneously and have a short duration. Therefore, the treatment facilities must be able to be operated remotely or automatically.

Best Management Practices for Construction Erosion and Sediment Control Plans

1. During construction where grading involves more than 200 cubic yards of cut or fill, or disturbs more than 10,000 square feet, an Erosion Control Plan shall meet the standards given in Protecting Water Quality in Urban Areas (MPCA, 1989).

2. Erosion control plans submitted for review shall show proposed methods of retaining waterborne sediments on-site during the period of construction, and shall specify methods and schedules to determine how the site will be restored, covered, or revegetated after construction.

3. In addition, the project proposer shall:

    a. Provide specific measures to control erosion based on the grade and length of the slopes on the site, as follows:

        (1) Silt fences shall be placed along the toe of the slopes that have a grade of less than 3 percent and are less than 400 feet long from top to toe. The silt fences shall be supported by sturdy metal or wooden posts at intervals of 4 feet or less.

        (2) Flow lengths up-slope from each silt fence shall not exceed 400 feet for slopes that have a grade of less than 3 percent.

        (3) Silt fences shall be placed along the toe of the slopes that have a grade of 3 to 10 percent and are less than 200 feet long from top to toe. These fences shall be supported by sturdy metal or wooden posts at intervals of 4 feet or less.

        (4) Flow lengths up-slope from each silt fence shall not exceed 200 feet for slopes that have a grade of 3 to 10 percent.

        (5) Diversion channels or dikes and pipes shall be provided to intercept all drainage at the top of slopes that have a grade of more than 10 percent and are less than 100 feet long from top to toe. Silt fence shall be placed along the toe of said slopes, and shall be supported by sturdy metal or wooden posts at intervals of 4 feet or less.

(6) Diversion channels or dikes and pipes shall be provided to intercept all drainage at the top of slopes that have grades of more than 10 percent. Also, diversion channels or diked terraces and pipes shall be provided across said slopes if needed to ensure that the maximum flow length does not exceed 100 feet. Silt fence shall be placed along the toe of said slopes, and shall be supported by sturdy metal or wooden posts at intervals of 4 feet or less.

b. Require that silt fences or hay bales, staked with at least two sturdy metal or wooden posts per bail, be installed around each catch basin inlet on the site and that this barrier remain in place until pavement surfaces have been installed.

c. Ensure that flows from diversion channels or pipes are routed to sedimentation basins or appropriate energy dissipators in order to prevent transport of sediment to outflow conveyors and to prevent erosion and sedimentation when runoff flows into the conveyors.

d. Provide that site-access roads be graded or otherwise protected with silt fences, diversion channels or dikes and pipes to prevent sediment from leaving the site via the access roads. Each site-access road shall have coarse aggregate filter berms with a minimum height of 2 feet above the adjacent roadway and with maximum side slopes of 4:1.

e. Require that soils tracked from the site by motor vehicles be cleaned daily (or more frequently, as necessary) from paved roadway surfaces throughout the duration of construction.

f. Assure that silt fences and diversion channels or dikes and pipes be deployed and maintained for the duration of site construction. If construction operations interfere with these control measures, the silt fences, diversion channels or dikes and pipes may be removed or altered as needed but shall be restored to serve their intended function at the end of each day.

g. Specify that disturbed areas be revegetated or mulched permanently or temporarily if it can be reasonably anticipated that significant additional grading will not occur within 30 calendar days. A schedule of significant grading work will be required as part of the erosion and sedimentation control plan.

h. Require that temporary or permanent mulch be disc-anchored and applied at a uniform rate of not less than 2 tons per acre.

i. Provide a temporary vegetative cover consisting of a suitable, fast-growing, dense grass-seed mix spread at 1.5 times the usual rate per acre. If temporary cover is to remain in place beyond the present growing season, two-thirds of the seed mix shall be composed of perennial grasses.

j. Provide a 4-foot-wide sodded area along the curb line of all streets adjacent to the site and along all property boundaries where runoff could leave the site.

k. Specify a permanent vegetation cover consisting of sod, a suitable grass-seed mixture, or a combination thereof. Seeded areas shall be either mulched or covered by fibrous blankets to protect seeds and limit erosion.

l. Provide temporary on-site sedimentation basins whenever other erosion and sedimentation control practices are inadequate. On-site detention basins shall be designed to achieve pollutant removal efficiencies equal to or greater than those obtained by implementing the criteria set forth by the Nationwide Urban Runoff Program (NURP), and Protecting Water Quality in Urban Areas (MPCA, 1989).

Table B-1 Best Management Practices

Type of Practice	Area of Benefit	Storm Protection Benefit	Pollutants Controlled	Construction Requirements
Institutional Source Controls				
Public Education (Billing inserts, news releases, radio public service announcements, school programs, and pamphlets)	Not applicable.	Reduced pollutant load to storm drain system.	Can reduce improper disposal of paints, varnishes, thinners, pesticides, fertilizers, and household cleansers, and chemicals, etc.	None.
Litter Control	Site dependent.	Reduced potential for clogging and discharge.	Household and restaurant paper, plastics, and glass.	Increase number of trash receptacles.
Recycling Programs	Site dependent.	Reduction in potential for clogging and harmful discharge.	Household paper, glass, aluminum, and plastics. Oil and grease from auto maintenance.	Collection and sorting stations.
"No Littering" Ordinance	Storm drain system and receiving water.	Prohibits littering and prevents litter from entering storm drains.	Paper, plastics, glass, food wrappers, and containers.	None.
"Pooper Scooper" Ordinance	Storm drain system and receiving water.	Requires animal owners to clean up and properly dispose of animal wastes.	Coliform bacteria and nitrogen/urea.	None.
Develop and Enact Spill Response Plan	Site dependent.	Prevent pollutants from entering storm drain.	Hazardous chemical, harmful chemicals, oil, and grease.	None.
Require Tow Truck Drivers to Clean Up Chemical Spills from Accident Sites	Site dependent.	Prevent hazardous or harmful pollutants from entering storm drain.	Hazardous chemical, harmful chemicals, oil, and grease.	None.
Clean Up Vacant Lots	Site dependent.	Prevent debris from accumulating on lot. Prevent site from appearing as a "dump" for others to use for disposal. Eliminate sources of hazardous waste.	Hazardous and/or harmful chemicals, wind blown for water borne debris.	None.
Prohibit Illegal and Illicit Connections and Dumping into Storm Drain System	Storm drain system and receiving water.	Reduces pollutant load entering storm drains.	Coliform bacteria, nitrogen, contaminants, and toxic or harmful chemicals.	None.

Table B-1 Best Management Practices (continued)

Type of Practice	Area of Benefit	Storm Protection Benefit	Pollutants Controlled	Construction Requirements
Identify, Locate, and Prohibit Illegal or Illicit Discharge to Storm Drain System	Area-wide.	Halt hazardous and harmful discharges, whether intentional or negligent.	Sewage from cross connections, oil, grease, direct disposal of pesticides and fertilizers, contaminated water, paint, varnish, solvents, water from site dewatering, swimming pool and spa water, flushing water from radiators and cooling systems, and hazardous or harmful chemicals.	Monitor storm drain system for flows and water quality.
Require Proper Storage, use, and Disposal of Fertilizers, Pesticides, Solvents, Paints and Varnishes, and Other Household Chemicals (oil, grease, and antifreeze, etc.)	Site dependent (City, State, or County-wide).	Reduce pollutant load to storm system.	Household hazardous materials.	None.
Restrict Paving and Use of Nonporous Cover Materials in Recharge Areas	Recharge area site.	Promotes infiltration to groundwater and reduces runoff volume and velocity. Filters pollutants.		Establishment of vegetation or use of recharge/infiltration materials.
Nonstructural Source Controls				
Street Sweeping Daily—commercial areas Weekly—residential areas	Street right-of-way.	Reduction in potential for clogging storm drains with debris. Some oil and grease control possible.	Paper and plastics, leaves and twigs, dust, and oil and grease.	Acquire street sweeping equipment.
Sidewalk Cleaning	Sidewalk right-of-way in areas of heavy foot traffic.	Reduction in pollutants entering storm drain.	Oil and dirt.	None.
Clean and Maintain Storm Drain Channels Annually	Channel capacity and receiving water. Upstream flood control benefits. Includes benefits to channel wildlife habitat and vegetation.	Prevent erosion in channel. Improve capacity by removing silt and sedimentation. Remove debris that is habitat destroying or toxic to wildlife.	Silt and sediment and the contaminants contained therein. Plastic, glass, paper, and metal thrown or washed in channel.	None.
Clean and Inspect Storm Inlets and Catch Basins Annually	Site dependent flood control benefits.	Allows proper drainage to prevent flooding and continued proper operation of facilities.	Silt and sediment and the contaminants contained therein. Plastic, glass, paper, and metal thrown or washed into facilities.	None.

Table B-1 Best Management Practices (continued)

Type of Practice	Area of Benefit	Storm Protection Benefit	Pollutants Controlled	Construction Requirements
Clean and Inspect Debris Basins Annually	Site dependent flood control benefits.	Allows proper drainage to prevent flooding and continued proper operation of facilities.	Silt and sediment and the contaminants contained therein. Plastic, glass, paper, and metal thrown or washed into facilities.	None.
Storm Drains Cleaned and Maintained Every 3 to 6 Years	Flood control and water quality benefits.	Allows proper drainage to prevent flooding and continued proper operation of facilities.	Silt and sediment and the contaminants contained therein. Plastic, glass, paper, and metal thrown or washed into facilities.	None.
Storm System Pump Stations Cleaned and Maintained Annually	Site dependent flood control and water quality benefits.	Prevents flooding and allows continued proper operation of facilities.	Silt and sediment and the contaminants contained therein. Plastic, glass, paper, and metal thrown or washed into facilities.	None.
Inspect and Maintain Sewer System	Storm drain system and receiving water.	Prevents and eliminates sewer system surcharges.	Contaminants, toxics, and coliform bacteria.	None.
Minor Structural Source Controls				
Storm Drain Inlet Protection	Storm drain drainage area.	Prevent debris from entering storm drain.	Dirt, leaves, twigs, paper, plastic, and other incidentals.	Not available.
Outlet Protection	Storm drain receiving water.	Prevent erosion at the outlet of pipes or paved channels and protect downstream water quality.	Turbidity and sediment.	Structural apron lining at the outlet location. Made of riprap, grouted riprap, concrete, or other structural materials.
Slope Stabilization and Erosion Control Measures	Site and topography dependent.	Reduce silt and sediment load to storm drains.	Silt and sediment and the contaminants therein.	None.
Interceptor Swale	Dependent of flow velocity. Maximum velocity for earth channel is 6 fps. Maximum velocity for vegetated or riprap channel is 8 fps.	Shorten length of exposed slopes and intercept and divert storm runoff from erodible areas.	Sediment and silt and the contaminants contained therein.	Excavation drainageway across disturbed areas or rights-of-way.
Improve and Maintain Natural Channels	Channel capacity and receiving water. Upstream flood control benefits. Includes benefits to channel wildlife habitat and vegetation.	Prevent erosion in channel. Improve capacity by removing silt and sedimentation. Remove debris that is habitat destroying or toxic to wildlife.	Silt and sediment and the contaminants contained therein. Plastic, glass, paper, and metal thrown or washed in channel.	None.

Table B-1 Best Management Practices (continued)

Type of Practice	Area of Benefit	Storm Protection Benefit	Pollutants Controlled	Construction Requirements
Diversion Channel	Dependent of flow velocity. Maximum velocities: 5 fps for vegetated channel and 8 fps for riprap channel. Not for use on slopes greater than 15%. Drainage area should be 5 acres or less.	Intercept and convey runoff to outlets at nonerosive velocity.	Sediment and erosion controls.	Lined drainageway of trapezoidal cross section.
Grass-Lined Channel	Site dependent but of larger capacity than interceptor or perimeter swales.	Intercept runoff and convey runoff from site.	Sediment and silt and the contaminants contained therein.	Excavation of channel or improvements to natural channel. Stabilization with vegetation.
Storm Drain Drop Inlet Protection	Areas less than 1 to 2 acres.	Filters sediment from runoff before it enters inlet. Provides relatively good protection.	Sediment and the contaminants contained therein.	Barrier around storm drain inlet. Useful for areas where storm drain is operational before area runoff area is stabilized.
Riprap	Site dependent	Provides stabilization and erosion control for stream banks and channels, outlet, and slopes.	Erosion and sediment.	Placement of rock on area to be stabilized. May also require use of filter fabric liner.
Gabions	Site dependent	Provides stabilization and erosion control for stream banks, outlet, and slopes.	Erosion and sediment.	Placement of wire cage will with rocks over area to be stabilized. May also require use of filter fabric liner.
Vegetative Control	Applicable and effective for most sites.	Provides stabilization and erosion control for streambanks, swales, channels, outlets, slopes, open disturbed areas. Can be up to 99% effective with established cover. Temporary seeding can be up to 90% effective.	Erosion and sediment.	Site preparation (can include land leveling and installation of irrigation system), seeding or planting, and netting or mulching to establish seed. Can also include other sodding, ground cover, shrubs, trees, and native plants.
Filter Strips	Site dependent.	Receives overland flow slowing runoff and trapping particulates. Can be 30 to 50% effective for sediment control.	Silt, sediment, trash, organic matter, and to an extent, soluble pollutants through infiltration.	Grading and vegetative establishment. Should have a minimum width of 15 to 20 feet. Good performance is achieved with a 50- to 75-foot width.
Fence Open Channels	Site dependent.	Prevent windblown trash from entering channel. Prevents illegal dumping in channel.	Trash and pollutants.	Construction of fences.

Table B-1 Best Management Practices (continued)

Type of Practice	Area of Benefit	Storm Protection Benefit	Pollutants Controlled	Construction Requirements
Discharge Elimination Methods				
French Drains and Subsurface Drains	Dependent on site topography and soil permeability.	Provides drainage of "wet" soils to allow establishment of vegetation. Can reduce runoff.	Sediment.	Underground perforated pipe leading to a surface water outlet. Pipe size, bedding and depth is dependent on site conditions.
Infiltration Trench and Dry Well	Small drainage areas. Runoff from rooftops, parking lots, residential, etc.	Provides temporary storage of runoff and infiltration to soil. Not for use in areas where groundwater could become contaminated.	Prevents 100% of pollutants from entering surface water. Oil, grease, floating organic matter, and settleable solids should be removed before water enters trench.	Excavation of a shallow trench 2' to 10' deep. Backfilled with coarse stone aggregate.
Exfiltration Trench	Site dependent.	Prevent silting on underlying filter gravel or rock bed. Retain first flush, reduce runoff volume and peak discharge rate and promote water quality improvement.	Prevents pollutants from entering surface water. Oil, grease, floating organic matter, and settleable solids should be removed before water enters trench.	Uses perforated pipe with suitable membrane filter material. Installed before receiving water outlet or in groundwater recharge area.
Porous Pavement	Site dependent. Requires relatively flat surface.	Allow infiltration of surface runoff. Reduce runoff volume and pollutant loading from low volume traffic areas.	Oil and grease.	Install porous pavement. May require twice as much paving material as standard asphalt to achieve same strength.
Retention Basin	Best for sites of 5 to 50 acres.	Promotes infiltration to groundwater and reduces runoff volume and velocity. Filters pollutants.	Sediment, trace metals, nutrients, and oxygen-demanding substances.	Excavation of a basin over permeable soils. Size is site dependent. Depth is 3 to 12 feet.
Floatables and Oil Removal				
Clarifies and Oil and Water Separators on Parking Structures	Parking lot structure and receiving water.	Collect debris before it can enter storm drain.	Oil, grease, and antifreeze from vehicles and foods and food wrappers.	Install grit and separators.
Oil and Grit Separators	Site dependent. For heavy traffic areas or areas with high potential for oil spills.	Remove pollutants.	Sediments and hydrocarbons.	Install oil and grit separators on storm drains.
Sediment/Grease Tarp	Installed on storm drain inlets.	Intercept and trap sediment and grease from runoff.	Sediment, oil, and grease.	Install sediment and grease traps.

Table B-1 Best Management Practices (continued)

Type of Practice	Area of Benefit	Storm Protection Benefit	Pollutants Controlled	Construction Requirements
Solids Removal				
Detention Basin	Four acres of drainage area for each acre/foot of storage provided to retain a permanent pool of water.	Temporary storage of storm runoff until release. Can also improve water quality.	Sediment, trace metals, hydrocarbons, nutrients, and pesticides.	Excavation of a basin over soils which will cause excessive seepage. May require a liner. Can be used aesthetically as a small pond in landscaping.
Extended Detention Basin	Size for a minimum detention time of 24 hours.	Temporary storage of runoff for an extended period of time. Can improve water quality.	Sediment, trace metals, hydrocarbons, nutrients, and pesticides.	Excavation of a basin over soils which will cause excessive seepage. May require a liner. Can be used aesthetically as a small pond in landscaping.
Bar Screens	Site dependent.	Restrict passage objects which may obstruct pump station suction bays.	Large debris.	Install bar screens before pump station suction bays.
Wetlands	Requires large area, 3% of the watershed area.	Remove pollutants. Provide habitat and recreational area.	Hydrocarbons, silt and sediment, oxygen-demanding substances, bacteria, and nutrients.	Create a new wetlands area or use existing wetlands.
Microorganism Removal				
Conversion of Wastewater Treatment Plants to Wet Weather Facilities	Site dependent. Is abandoned treatment facility available?	Treats stormwater flows prior to discharge.	Process dependent. Chlorination facilities may be added to remove microorganisms.	Treatment conversion.
Install Treatment Facilities on "Dirty" Storm Drains	Site and need dependent.	Treats stormwater flows. Dry weather flows should be halted or routed to existing wastewater treatment facility if possible.	Microorganisms.	Site specific.
Swirl Concentrators and Chlorination/Dechlorination	Site and need dependent.	Treats stormwater flows prior to discharge.	Floatables, settleable solids, suspended solids, and coliform bacteria.	Install concentrators.
Chlorination/Dechlorination Facilities	Site and need dependent.	Treats stormwater flows prior to discharge.	Microorganisms.	Install chlorination/ dechlorination facilities.
Primary Clarifiers	Site and need dependent.	Treats stormwater flows prior to discharge.	Floatables, settleable solids, suspended solids, and coliform bacteria.	Install primary clarifiers.

Table B-1 Best Management Practices (continued)

Type of Practice	Area of Benefit	Storm Protection Benefit	Pollutants Controlled	Construction Requirements
Primary Clarifiers and Filters	Site and need dependent.	Treats stormwater flows prior to discharge.	Suspended solids, nutrients and coliform bacteria.	Construct sedimentation basins and filters.
Metals Removal				
Primary Clarifiers and Lime Precipitation	Site and need dependent.	Treats stormwater flows prior to discharge.	Floatable, settleable solids, suspended solids, coliform bacteria, and metals.	Install primary clarifiers and lime precipitation facilities.
Detention Basin and Wetland Treatment	Requires large area, 3% of the watershed area.	Remove pollutants. Provide habitat and recreational area.	Hydrocarbons, silt and sediment, oxygen-demanding substances, bacteria, metals, and nutrients.	Create a new wetlands area or use existing wetland.

Source: ENR 4900