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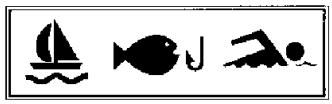

BRINGING OUR RIVER BACK TO LIFE

Rouge River National Wet Weather Demonstration Project

Wayne County, Michigan

Planning and Cost Estimating Criteria for Best Management Practices

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Planning and Cost Estimating Criteria for Best Management Practices

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Introduction

This is a general appendix to the Subwatershed Management Plans for the Rouge River subwatersheds. It is primarily based on *'Cost Estimating Guidelines – Best Management Practices (BMP) and Engineered Controls'*, (Rouge Program Office, 1997), a manual published by the Rouge Program Office (RPO) as a technical tool for use in choosing and costing **Stormwater Best Management Practices** (Stormwater BMPs) for use in the Rouge River watershed. A list of other references follows this section. This document is intended to focus and update the cost estimating manual to make the material more directed, more accessible and more useful in the implementation of the Subwatershed Management Plans.

Background

The original manual was written mainly to help community planning and public works managers develop storm water runoff control programs in the most effective manner for their specific concerns. **Combined Sewer Overflow** (CSO) controls were also briefly addressed. The bulk of the manual consisted of a series of three to four page information sheets on each stormwater BMP. The original manual was published in 1997.

Update

Since 1997, new material has been published on the experience that many agencies throughout the United States have had with Stormwater BMPs. This document uses new information on BMPs (for example: manuals, reports, web sites) and combines it with the original material in a simpler format to be more accessible to planners and other potential users of it. The list of BMPs included is focussed on those for which cost and performance data is available. In general techniques that have not been reliably evaluated have been excluded from the update. In addition the number of BMPs presented is reduced to those considered to be the most useful to planners engaged in using the Subwatershed Management Plans.

Format

Table A.1 on page 3 shows the Stormwater BMPs summarized in this manual, organized according to application and then by technique. The table is organized as a matrix with the techniques along one axis and the stormwater quality or quantity aspect to be controlled along the other. Following the table are a series of single sheets on each BMP, which summarizes the available information and gives cost guidelines.

The table is organized by eight categories of watershed improvements.

There are two major categories of Stormwater BMPs. The first is non-structural BMPs. These are measures to reduce the conversion of rainfall to runoff and to reduce pollutants at the source before they can get into the runoff. These Stormwater BMPs are a combination of education, information, management and development practices, which achieve these objectives. The second category is structural BMPs, which are techniques that treat stormwater runoff to reduce the impact of peak flow quantities and remove pollutants from runoff. They are called structural because they all require physical structures or modifications to achieve their objectives.

There is a second important distinction between Stormwater BMPs, which affects their application. This distinction is between those that can be incorporated into new developments and those that can be retrofitted to existing development. All communities will look at a combination of controlling stormwater from new development and correcting the problems caused by stormwater from existing development. Each community's emphasis will depend on the age of development within the community and the extent to which existing or new development has the greatest potential for stormwater pollution.

General Budgeting Considerations

Basic Subwatershed Budgeting is a topic, which is not covered, in the following sheets. A good reference for this activity is the Center for Watershed Protection's **Rapid Watershed Planning Manual** published in October 1998.

TABLE A.1

APPLICABILITY OF BMPs

Best Management Practice Category and Technique	Page Number	To Control: Increased Flow/Velocity	Floatable Materials	Particulate Materials	Dissolved Oxygen	Eutrophication & Nutrients	Toxics	Oil/Petroleum products	Pathogens
Public Education and Participation BMPs									
Information Pamphlets	4	X	X	X	X	X	X	X	X
Technical Manuals	5	X	X	X	X	X	X	X	X
Catchbasin and Curb Stenciling	6		X		X		X	X	
Media Relations	7	X	X	X	X	X	X	X	X
Business Education	8	X	X	X	X	X	X	X	X
Program Planning and Administration	10	X	X	X	X	X	X	X	X
Urban Source Control BMPs									
Low Impact Development Plans	11	X							
Ordinances	12	X	X	X	X	X	X	X	X
Pavement Deicing	13						X		
Street Sweeping	14		X	X	X	X	X	X	X
Catch Basin Cleaning	15			X			X	X	
Septic System Maintenance	16				X	X			X
Illicit Connection Surveys	17		X	X	X	X			X
Illicit Connection Investigation and Elimination	18		X	X	X	X			X
Downspout Disconnection	20	X		X					
Treatment Control BMPs									
Wet Detention/Retention Ponds	22	X		X		X			
Dry Detention/Retention Ponds	24	X							
Constructed Wetlands	26	X				X			
Vegetated Swales	28			X					
Stormwater Filters	29			X					
Oil and Grease Trap Devices	31							X	
Channel Restoration/Stabilization BMPs									
Streambank Stabilization Measures	32	X				X			
Construction Erosion and Sediment Control BMPs									
Erosion Control Measures	33	X	X	X				X	

Information Pamphlets

Type:	Non-structural, Public Education and Participation
Description:	Composition and printing of information pamphlets on stormwater and watershed management for distribution to the public in a given watershed or community. The pamphlets should be short, eye-catching (colors, graphics) and pitched at a general level of knowledge to ensure that they are read at least once and preferably kept for reference.
Function:	Dissemination of information to the general public. By informing the public it is hoped to influence personal behavior in the activities that have an impact on stormwater quality and quantity.
Application:	Distributed to households, school groups, service groups, etc.
Site Requirements:	None.
Effectiveness:	Difficult to measure in terms of reduction of pollutants or other environmental benefits. The objective is to raise public awareness and thereby produce long-term improvements.
Who Does It?	This can be done by a local group (e.g. local environmental or conservation club), by municipal staff or by a consultant.
Design Requirements:	Public Relations or Marketing Consultant or by local public interest group.
Basis for Cost Estimate:	Time to research and compose the information pamphlets. Using existing sources as much as possible. Printing cost per pamphlet. Expect to use letter size sheet. Color printing is more expensive, but more effective at getting information across. Distribution costs may be negligible if the pamphlets can be coordinated with another mailing such as a municipal information newsletter or with a sewer or water utility billing. Another low cost method of distribution is to use non-profit groups such as environmental groups or conservancy and nature clubs.
Cost (1000 $s):	$100/hour for development (Consultant cost. This can be reduced if agency staff or local non-profit groups are used). 160-320 hours for development. $0.10-$0.20/pamphlet for black and white printing. (Varies depending on volume, size and quality) $0.30/pamphlet for mailing.
Who Pays For It?	Paid for by municipality
Reference:	*Chapter 4, Source Control BMPs*, Municipal Best Management Practice Handbook, (California State Water Resources Control Board, 1993).

Technical Manuals

Type:	Public Education and Participation
Description:	Manuals providing information, guidance and local rules for professionals involved in activities impacting stormwater quantity and quality.
Function:	Dissemination of information to the professional community. Allows designers and developers to work within established standards and guidelines.
Application:	Distributed to the design professionals working in a community or watershed.
Site Requirements:	None.
Effectiveness:	Difficult to measure in terms of reduction of pollutants. Should produce long-term improvements in water quality and reduction of stormwater quantity.
Who Does It?	This can be done by municipal staff or by a consultant. For municipalities that do not have the expertise in-house, the county level engineering departments may be able to provide assistance and guidance.
Design Requirements:	Design professional either municipal staff or consultant.
Basis for Cost Estimate:	Time to develop content and research sources. Printing cost per manual. Expect to use letter size sheet. Color printing more expensive.
Cost (1000 $s):	$100/hour for development. 160-480 hours for this task. $100.00/manual for printing. (Varies depending on volume, size and quality)
Who Pays For It?	Paid for by municipality
Reference:	**Guidebook of Best Management Practices for Michigan Watersheds**, (Michigan Department of Natural Resources, 1993). **Wayne County Storm Water Management Ordinance Package (Draft)**, (Wayne County Department of Environment, 2000). **Internet Based Manual Builder**, (Center For Watershed Protection, available January 2001). This is a tool which will be available at the CWP website at www.cwp.org in early January 2001.

Catchbasin and Curb Stenciling

Type:	Non-Structural, Urban Source Control BMP.
Description:	Painting of signs beside inlets to the drainage system, e.g. catchbasins and curbs, to discourage illegal dumping into surface waters. This is a good volunteer activity for homeowners associations, scout troops, and school groups.
Category:	Existing Development
Function:	Removal of Stormwater Pollutants.
Application:	To discourage dumping into surface waters.
Site Requirements:	None.
Effectiveness:	No detailed studies available yet. However, this is intended to raise public awareness and should give long-term improvements in water quality.
Who Does It?	This can be done by municipal staff, by volunteers or by a contractor.
Design Requirements:	If volunteers are to be used, coordination and planning must be done, and materials must be supplied.
Basis for Cost:	Coordination Cost: $3,500 Cost per applied stencil (Crew of two persons, pickup truck, paint, stencils, assumes 10 stencils per hour). Crew cost assumed to be $60/hour. Cost of maintaining applied stencil (Inspections twice yearly, touch-up paint).
Who Pays For It?	Paid for by municipality or watershed NGO.
Cost (1000 $s):	Application: $6/stencil (This cost can be reduced by using volunteers). Inspection: $1/stencil (Assumes two inspections per year, one spring, one fall). Maintenance: $2/stencil (Assumes one stencil in three will require touch up).
Reference:	***Urban Source Control BMPs-Pavement Cleaning*, Cost Estimating Guidelines–Best Management Practices and Engineered Controls**, (Rouge Program Office, Wayne County, Michigan, 1997).

Media Relations

Type: Non-Structural, Urban Source Control BMP.

Description: Using the media to make the public aware of how their actions affect the quantity and quality of stormwater.

Category: Existing and New Development

Function: Reduction of Stormwater Peak Discharge and Runoff Volume.
Removal of Stormwater Pollutants.

Application: Public Information.

Site Requirements: None.

Effectiveness: No detailed studies available yet. Objective is to promote public awareness and thereby have a long-term effect.

Who Does It? This can be done by watershed volunteer and non-profit groups or contracted to a media consultant. The first group can be less costly and often as effective.

Design Requirements: Need an experienced consultant or municipal employee to design a program. Time needs to be spent developing relations with the local reporters to get stories aired by local media.

Basis for Cost: Cost of municipal employee or public relations consultant to disseminate information to the media. Cost of radio or television airtime (if purchased). Cost of production crew for Cable TV Access program.

Who Pays For It? Paid for by municipality

Cost (1000 $s): Media/Public Relations Consultant $100/hour. 100-200 hours for developing media relations plan. Costs for radio, TV and cable TV vary greatly. Consult with local media outlets.

Reference: **NPDES Phase II Cost Estimates**, (in *National Conference on Tools for Urban Water Resource Management and Protection*, Environmental Protection Agency, February 2000).
***Public Information and Participation BMPs – Public Participation,* Cost Estimating Guidelines–Best Management Practices and Engineered Controls**, (Rouge Program Office, Wayne County, Michigan, 1997).

Business Education

Type:	Non-Structural, Urban Source Control BMP.
Description:	Providing information to industrial and commercial operations on how to conduct their business without adverse effect on the stormwater quality and quantity.
Category:	Existing and New Development
Function:	Reduction of Stormwater Peak Discharge and Runoff Volume. Removal of Stormwater Pollutants.
Application:	Use to impact existing and future land uses.
Site Requirements:	Require access to meeting room for presentations to businesses. Need access to work areas to demonstrate how good practices impact stormwater pollution.
Effectiveness:	No detailed studies available yet. Long-term impact expected through owner and employee awareness and long-term reduction of pollution.
Who Does It?	This can be done by municipal staff, in particular a business outreach coordinator.
Design Requirements:	Materials to be designed by marketing and education professionals. Presentations to be made by municipal employees at work sites. This requires that an outreach program be undertaken to identify and contact businesses that would benefit – from a presentation to employees. Lists of business premises ordered by type of activity in the municipality must be compiled. The type of activity should be organized by potential stormwater impact. Contacting and making presentations to local business organizations such as the Chamber of Commerce should also be part of this effort. The program requires regular follow-up and retraining of new staff in local businesses every few years to allow for staff turnover.
Basis for Cost Estimate:	Time to research and compose the information pamphlets. Using existing sources as much as possible. The pamphlets are dependent on the activities at a given business site. Printing cost per pamphlet. Expect to use letter size sheet. Color printing is more expensive but also more effective. Cost of municipal employee to compile lists of business premises ordered by type of activity in the municipality.
Who Pays For It?	Paid for by municipality.
Cost (1000 $s):	$50/hour for business/activity list. 40-80 hours for compilation. $100/hour for development. 80-160 hours for development. $0.10 - $0.20/pamphlet for black and white printing. (Varies depending on volume, size and quality) $50/hour for employee presentation. 8 hours for presentation, including prep time.

Reference: ***Urban Source Control BMPs-Pavement Cleaning*****, Cost Estimating Guidelines–Best Management Practices and Engineered Controls**, (Rouge Program Office, Wayne County, Michigan, 1997).

Program Planning and Administration

Type:	Non-Structural, Urban Source Control BMP.
Description:	Personnel to oversee and coordinate the public education and public participation programs.
Category:	Existing and New Development
Function:	Oversight and coordination of public education/information program.
Application:	Overall program coordination.
Site Requirements:	None.
Effectiveness:	This is an adjunct to the other activities in the public education and information program. No specific effectiveness can be assigned to this activity.
Who Does It?	Can be done by municipal staff or by watershed organization on contract.
Design Requirements:	Formulation and coordination of other activities to ensure the best impact on stormwater pollution.
Basis for Cost:	Use of a municipal employee part-time to coordinate the stormwater programs. One employee one day per week. Watershed organizations may be less costly.
Who Pays For It?	Paid for by Municipality
Cost (1000 $s):	$10,000/year, i.e. 0.2 Full Time Equivalents (FTE) per year. (FTE assumed to be $50,000 per year)
Reference:	***Urban Source Control BMPs-Pavement Cleaning*, Cost Estimating Guidelines–Best Management Practices and Engineered Controls**, (Rouge Program Office, Wayne County, Michigan, 1997).

Low Impact Development Plans

Type:	Non-Structural, Urban Source Control BMP.
Description:	Combining a hydrologically functional site design with pollution prevention measures to compensate for land development impacts on hydrology and water quality.
Category:	New Development
Function:	Reduction of Stormwater Peak Discharge and Runoff Volume. Removal of Stormwater Pollutants.
Application:	Use for design of new developments: residential, commercial, industrial.
Site Requirements:	None.
Effectiveness:	No detailed studies available yet. Should produce long-term improvements.
Who Does It?	Can be done by municipal staff or by consultant on contract.
Design Requirements:	Design manual to be made available to development design professionals.
Basis for Cost Estimate:	Time to develop content and research sources. Cost of adapting existing manual to community requirements. Printing cost per manual. Site Planning Roundtable.
Who Pays For It?	Paid for by municipality
Cost (1000 $s):	$100/hour for development. 1000-2000 hours for this task. $100.00/manual for printing. (Varies depending on volume, size and quality) Site Planning Roundtable; $25,000 - $40,000
Reference:	**Low-Impact Development Strategies – An Integrated Design Approach**, (Department of Environmental Resources, Prince George's County, Maryland, 2000). **Watershed Protection Techniques Vol.3, No.2, Better Site Design Feature Article**, (Center for Watershed Protection, January 2000).

Ordinances

Type:	Non-Structural, Urban Source Control BMP.
Description:	A consistent set of municipal ordinances to regulate activities under the municipality's jurisdiction affecting storm water.
Category:	Existing or New Development
Function:	Reduction of Stormwater Peak Discharge. Removal of Pollutants
Application:	To apply a uniform standard to the implementation of stormwater BMPs in a community.
Site Requirements:	None.
Effectiveness:	No studies yet available. Long-term improvements expected with the consistent application of the ordinances.
Who Does It?	Can be done by municipal staff or by watershed organization or consultant on contract. Municipal staff or watershed organization will probably be less costly.
Design Requirements:	Ordinances need to be implemented in accordance with an overall plan for stormwater management in the community/municipality.
Basis for Cost Estimate:	Time to develop content and research sources. Cost of adapting existing ordinances to community requirements. Legal review by municipalities legal representatives. Public meetings to make the public aware and to get feedback on draft ordinance.
Who Pays For It?	Paid for by municipality
Cost (1000 $s):	$150/hour for development including review of existing ordinances in neighboring communities. 160-320 hours for this task. (Can vary widely). $200/hour for legal review. 80-200 hours for each ordinance. (Can vary widely). $500.00/public meeting. (Varies depending on volume, size and quality) Publishing and distribution cost can vary widely by community.
Reference:	*Chapter 2, Financial, Legal and Regulatory Concerns*, **Design and Construction of Urban Stormwater Management Systems**, (American Society of Civil Engineers/Water Environment Federation, 1992). **Wayne County Storm Water Management Ordinance Package (Draft)**, (Wayne County Department of Environment, 2000). **Model Ordinances**, (Center For Watershed Protection, available January 2001). These are available at the CWP website at www.cwp.org.

Pavement De-icing

Type: Non-Structural, Urban Source Control BMP.

Description: Limiting the application of salt, de-icing chemicals and abrasives to the minimum necessary for effective snow and ice control. Reviewing storage and handling practices to minimize the amount entering the stormwater system. Also looking at alternatives to using conventional deicing materials.

Category: Existing Development

Function: Removal of Stormwater Pollutants.

Application: Public Works Department Maintenance Practice.

Site Requirements: Examine storage practices in public works yards to ensure the minimum contamination of the stormwater system.

Effectiveness: A properly designed program can save money and reduce de-icing compound runoff.

Who Does It? Can be done by municipal staff.

Design Requirements: Prepare a de-icing plan that more closely matches weather conditions and application rates. Look at de-icing practices. For example the -city of Windsor and the -city of Detroit do not salt and plow residential side streets after every snowstorm, whereas many suburban communities do. Studies have shown that application rates vary between 300 and 800 lbs. per mile of two-lane highway.

Basis for Cost Estimate: Assumes that all equipment is already available in the public works department.
Extra cost of using alternatives compared with conventional salt. Salt costs about $25/ton, alternatives from $200 to $650/ton. Application rates are assumed to be approximately 200-lbs./lane mile.
Cost of inspecting storage facilities.

Who Pays For It? Paid for by municipality

Cost (1000 $s): $100/hour for storage review. 40-80 hours for this task.
$20/lane mile for Calcium Chloride in addition to conventional salt.
$65/lane mile for CMA in addition to conventional salt.

Reference: ***Urban Source Control BMPs-Pavement De-icing*, Cost Estimating Guidelines–Best Management Practices and Engineered Controls**, (Rouge Program Office, Wayne County, Michigan, 1997).
***Minimizing Effects from Highway De-icing*, Stormwater Management Fact Sheet**, (Environmental Protection Agency, September 1999).

Street Sweeping

Type: Non-Structural, Urban Source Control BMP.

Description: A program of scheduled curb sweeping and cleaning. Reduce pollutant discharges to storm water by cleaning gutters regularly with a combination of mechanical broom sweepers and vacuum sweepers. Also known as curb cleaning.

Category: Existing and New Development

Function: Removal of Particulate Matter.
Removal of Stormwater Pollutants.

Application: All roadside gutters.

Site Requirements: None.

Effectiveness: Depends on the number of times sweeping is done and the average interval between storms.

Who Does It? Can be done by municipal staff.

Design Requirements: Determine the average interval between storms to determine the best cleaning interval and schedule to be adhered to by maintenance crews.

Basis for Cost: Equipment Cost.
Labor Cost.
Disposal Cost per mile. (Based on the weight of debris collected per mile)
Disposal Cost per cubic yard. (Depends on the frequency of cleaning.)
Miles per day cleaned. Local rates are approximately 10 miles per day.

Who Pays For It? Paid for by municipality

Cost (1000 $s): Maintenance: $65/curb mile (excluding disposal costs)
$150/curb mile for contractor (including disposal costs)

Reference: ***Urban Source Control BMPs-Pavement Cleaning*****, Cost Estimating Guidelines–Best Management Practices and Engineered Controls**, (Rouge Program Office, Wayne County, Michigan, 1997).

Catch Basin Cleaning

Type: Non-Structural, Urban Source Control BMP.

Description: A program of scheduled inspections of catch basins and of cleaning the contents out of catch basins. Regular removal of sediment from catch basins to reduce pollutant slugs during the first flush and prevent downstream clogging and restore sediment-trapping capacity of catch basin.

Category: Existing and New Development

Function: Removal of Particulate Matter.
Removal of Stormwater Pollutants

Application: Maintenance practice.

Site Requirements: None.

Effectiveness: Depends on the number of times cleaning is done and the average interval between storms. Local studies suggest that a 3-year cleaning cycle is adequate on average. An important part of the program is inspecting to determine how often cleaning is required and to identify any areas where -- increased incidence of polluting material or particulates. May make accelerated cleaning programs necessary.

Who Does It? Can be done by municipal staff.

Design Requirements: Review of catch basin layout to identify most efficient routing.
Review of cleaning records to identify problem areas.

Basis for Cost: Cost of spot inspections of catch basins assuming 2 days of inspection per month. Assume 16 catch basins can be inspected per hour with a crew of 1 person with a pickup.
Cost per catch basin for cleaning including disposal in an approved landfill.

Who Pays For It? Paid for by municipality

Cost (1000 $s): Inspection: $3/catchbasin, 10 catch basins per hour
Cleaning: $10-$40/catch basin (including disposal in an approved landfill)

Reference: ***Urban Source Control BMPs-Catch Basin Cleaning*, Cost Estimating Guidelines–Best Management Practices and Engineered Controls**, (Rouge Program Office, Wayne County, Michigan, 1997).
Catch Basin Cleaning Study (Draft), (City of Farmington Hills/TetraTech MPS, May 2000).

Septic System Maintenance

Type: Non-Structural, Urban Source Control BMP.

Description: Periodic inspection of on-site sewage disposal systems (OSDS) and regular pumping of septic tanks will prevent, detect and control spills, leaks, overflow and seepage from on-site sewage disposal systems.

Category: Existing and New Development

Function: Prevents premature failure of on-site sewage disposal systems and detects problems that will minimize pollution.

Application: Maintenance practice.

Site Requirements: Availability of a plan showing the location of the on-site sewage disposal systems.

Effectiveness: Pumping of septic tanks on a regular basis and inspection of the on-site sewage disposal system can prevent premature failure and detect problems so that repairs can be less costly. An inspection of the on-site sewage disposal system is recommended every 5 years. Health Departments recommend a 3-year cleaning cycle for septic tanks.

Who Does It? Can be done by municipal staff or by county health agency.

Design Requirements: Risers on septic tanks make location, inspection and pumping easier. Pumping must be done by a Licensed Septage Waste Servicer. A Registered Sanitarian should perform inspections or a person certified as a septic system evaluator by the local health department or NSF International.

Basis for Cost: Cost of regular inspections of on-site sewage disposal systems. Assumes 20% of a community's septic tanks are inspected each year so that a five-year cycle is maintained. Time for inspection usually takes 1 to 3 hours, but can take much longer if the location is not well defined.
Cost per septic tank for pumping and proper disposal of the contents.

Who Pays For It? Paid for by municipality

Cost (1000 $s): Inspection: $100/hour, 3 hours per site including reporting and travel time. (This time can be substantially more if the on-site sewage disposal system is difficult to locate.)

Pumping: $100-$150/septic tank including disposal.

Reference:

***Urban Source Control BMPs-Septic Tank/Sanitary Sewer Maintenance*, Cost Estimating Guidelines–Best Management Practices and Engineered Controls**, (Rouge Program Office, Wayne County, Michigan, 1997).

Strategies to Address On-site Sewage System Problems, (Rouge Program Office, Wayne County, Michigan, 1998).

Illicit Connection Surveys

Type: Non-Structural, Urban Source Control BMP.

Description: Survey of open channel to determine if storm sewer outfalls have a sanitary sewer discharging to them. Prevent, detect and remove all physical connections to the stormwater drainage system that discharge any material other than storm water. The process requires a follow up to identify the exact source and to remove it from the storm sewer system.

Category: Existing Development

Function: Removal of Particulate Matter.
Removal of Stormwater Pollutants.
Removal of Floatable Materials.
Removal of Pathogens.

Application: Investigation program.

Site Requirements: None.

Effectiveness: Depends on the actions taken to follow up survey results and to identify and remove actual sources.

Who Does It? Can be done by municipal staff or by contractor or county agency.

Design Requirements: Identify the watercourses that have indicators of the most illicit discharges.

Basis for Cost: Cost per lineal mile of open channel. This cost includes outfall identification, laboratory work and illicit discharge follow-up. It assumes one mile per day. Sewer system investigations are costed by lineal mile. Building investigations are costed by site.

Who Pays For It? Paid for by -municipality

Cost (1000 $s): Survey: $2,000/lineal mile of open channel.
$2,800/lineal mile of closed sewer (visual inspection not TV).
$660/individual building.
$1-$2/lineal foot for TV inspection.

Reference: ***Urban Source Control BMPs-Illicit Connection Control,*** **Cost Estimating Guidelines–Best Management Practices and Engineered Controls**, (Rouge Program Office, Wayne County, Michigan, 1997).

Illicit Connection Investigation and Elimination

Type:	Non-Structural, Urban Source Control BMP.
Description:	Follow up to illicit connection surveys (see above). This is to focus on the storm sewer system parts identified as having illicit connections and to identify and remove the specific sources. Detect and remove all physical connections to the stormwater drainage system that discharge any material other than storm water.
Category:	Existing Development
Function:	Removal of Particulate Matter. Removal of Stormwater Pollutants. Removal of Floatable Materials. Removal of Pathogens.
Application:	Investigation program.
Site Requirements:	None.
Effectiveness:	Depends on the size of the system contributing to an outfall identified as having an illicit connection. The larger the system, the more effort required to locate the source.
Who Does It?	Can be done by municipal staff or by county agency.
Design Requirements:	None.
Basis for Cost:	Cost per 8-hour day of investigation, assuming a two-person crew. Cost per site for dye testing, including collection and lab work. Enforcement cost per connection (disconnecting of illicit connection)
Who Pays For It?	Paid for by municipality
Cost (1000$s):	$800/day of investigation $600/ per dye test sample. $5,000-$15,000/Enforcement cost per property
Reference:	***Urban Source Control BMPs-Illicit Connection Control,*** **Cost Estimating Guidelines–Best Management Practices and Engineered Controls**, (Rouge Program Office, Wayne County, Michigan, 1997).

Downspout Disconnection

Type: Non-Structural, Urban Source Control BMP.

Description: Disconnection of roof rainwater downspouts from the storm or sanitary sewer system.

Category: Existing Development

Function: Reduction of peak flows in stormwater system.
Reduction of sewer overflows.

Application: Removal of stormwater from the sewer system by directing it on to the lot for temporary storage. This increases the time of entry, allows infiltration and ponding and therefore reduces - peak flow into the stormwater system. Reduced peak will reduce the amount of flooding from a given storm event and reduce the damage to a stream from high flows. Reduction of peak will also reduce the number of Combined Sewer and Sanitary Sewer overflows which will improve water quality.

Site Requirements: None.

Effectiveness: Properly designed program can remove significant amounts of stormwater runoff. The effectiveness is enhanced by the availability of a grassed or vegetated area to which the flow is directed.. If the flow is directed to a paved area, no advantage is gained.

Who Does It? Can be done by municipal staff.

Design Requirements: Requires survey of (missing information here)

Basis for Cost: Cost per downspout disconnection (including cost of plugging underground leader, new downspout elbow and splash pad to direct flow away from the building).

Who Pays For It? Paid for by municipality

Cost (1000 $s): $50 per house

Reference: ***Urban Source Control BMPs-Illicit Connection Control,*** **Cost Estimating Guidelines–Best Management Practices and Engineered Controls**, (Rouge Program Office, Wayne County, Michigan, 1997).

Wet Retention Pond

Type: Structural, Treatment Control BMP.

Description: A small man-made lake or basin with emergent wetland vegetation around the bank designed to capture and remove particulate and certain dissolved pollutants. There is an important distinction between retention pond and detention ponds in stormwater BMPs. Retention ponds are designed to retain the runoff from a storm event until it is displaced by a subsequent event. In the interval between events the retention pond allows infiltration, evaporation and removal of pollutants by aquatic vegetation. Sediment washout is also less likely than with a dry pond or basin.

Category: Existing or New Development

Function: Reduction of Stormwater Peak Discharge.
Removal of Suspended Solids.
Removal of Metals and Nutrients.

Application: Generally used for drainage areas in excess of 5 acres (Wayne County Guidelines), especially where there is a need to control nutrients.
At outfall from existing or proposed pipe system to natural channel.
At discharge point of large commercial and industrial sites to natural channel.

Site Requirements: Open space, size related to catchment area.
Permanent pool of water.
Regular maintenance (For example, grass cutting, sediment removal, planting and harvesting of aquatic plants)

Effectiveness: Good removal of suspended solids (SS) with proper maintenance.
Based on references, SS removal of 75% can be achieved.
Limited removal of nutrients and metals through biological uptake.
Based on references, 60% of nutrients can be removed.
Can be used for passive recreation.

Who Does It? Designed by consultant or municipal staff. Installed by contractor, developers in the case of new development and municipalities in case of retrofit.

Design Requirements: Design of pond size is based on the size of the upstream watershed. Design for removal of pollutants is difficult. Extensive design required to ensure safety and to ensure blending with landscape.

Basis for Cost Estimate:

Depth of pond in feet (This can affect cost in that it is a reflection of site configuration).
Area of contributing watershed in impervious acres.
Volume of pond in million gallons or cubic feet.
Landscaping in square yards
Outlet and inlet structures
The single most important determinant of cost is the pond volume. Volume is generally determined (Wayne County Standards) for a 24-hour Soil Conservation Service storm distribution. A typical volume is 7000 cubic feet (0.05 MG) per impervious acre for a 1-hour, 100-year event.

Who Pays For It?

Construction and design costs paid for by developer in installation for new development and by municipality for retrofit. Maintenance paid for by municipality when on public property and by property owner when on private property and serving private property alone.

Cost (1000 $s):

Design & Permits: 30% of construction cost estimated for this task.

Construction:	$160,000/MG for 1 MG pond to $52,000/MG for 10 MG pond or $0.50 to $1.00/ ft3 excluding land purchase (Land Purchase can be negligible if constructed as part of new development or if incorporated into existing parklands.)
Maintenance:	$10,000/year

Reference:

Chapter 11, Design of Stormwater Impoundments, **Design and Construction of Urban Stormwater Management Systems**, (American Society of Civil Engineers/Water Environment Federation, 1992).
Chapter 5.0, Description and Performance of Storm Water Best Management Practices, **Preliminary Data Summary of Urban Stormwater Best Management Practices**, (Environmental Protection Agency, August 1999).
Wayne County Storm Water Management Ordinance Package (Draft), (Wayne County Department of Environment, 2000).

Dry Detention Pond or Basin

Type: Structural, Treatment Control BMP.

Description: A pond or basin that is usually dry between storms that captures runoff and releases it slowly enough to allow most sediment to settle. The capture area can be earth-lined or concrete-lined and, unlike a wet retention pond, can have a cover. This type of BMP is less effective than a wet pond at removing pollutants and there is more likelihood of sediment washout also. Therefore, dry detention basins require careful maintenance in the form of sediment removal between events to ensure that they achieve their design objectives.

Category: Existing or New Development

Function: Reduction of Stormwater Peak Discharge.
Removal of Suspended Solids.

Application: Use for tributary watersheds 10 acres and larger to remove particulates.
At outfall from existing or proposed pipe system to natural channel.
At discharge point of large commercial and industrial sites to natural channel.

Site Requirements: Open space, size related to catchment area.
Regular maintenance (For example, grass cutting [r an open earthlined basin], sediment removal)

Effectiveness: Good removal of suspended solids with proper maintenance.
Based on references, SS removal of 75% can be achieved.
Poor removal of nutrients because no vegetation present.

Who Does It? Designed by consultant or municipal staff. Installed by contractor, developers in the case of new development and municipalities in case of retrofit.

Design Requirements: Design for removal of pollutants is difficult. Extensive design required to ensure safety and to ensure blending with landscape.

Basis for Cost Estimate: Depth of basin in feet. (Indicates the site configuration).
Volume of basin in million gallons or cubic feet.
Area of contributing watershed in impervious acres.
The single most important determinant of cost is the pond volume. Volume is generally determined (Wayne County Standards) for a 24-hour SCS storm distribution. A typical volume is 7000 cubic feet (0.05 MG) per impervious acre for a 1-hour, 100-year event.

Who Pays For It? Construction and design costs paid for by developer in installation for new development and by municipality for retrofit. Maintenance paid for by municipality when on public property and by property owner when on private property and serving private property alone.

Cost (1000 $s): Design & Permits: 30% of construction cost estimated for this task.
Construction: $125,000/MG for 1 MG pond to $40,000/MG for 10 MG pond or $0.40 to $0.80/ ft^3 excluding land purchase.
Maintenance: $10,000/year

Reference: *Chapter 11, Design of Stormwater Impoundments*, **Design and Construction of Urban Stormwater Management Systems**, (American Society of Civil Engineers/Water Environment Federation, 1992).
Chapter 5.0, Description and Performance of Storm Water Best Management Practices, **Preliminary Data Summary of Urban Stormwater Best Management Practices**, (Environmental Protection Agency, August 1999).
Wayne County Storm Water Management Ordinance Package (Draft), (Wayne County Department of Environment, 2000).

Constructed Wetlands

Type:	Structural, Treatment Control BMP.	
Description:	A man-made basin with a significant percentage covered by wetland vegetation.	
Category:	Existing or New Development	
Function:	Reduction of Stormwater Peak Discharge. Removal of Suspended Solids. Removal of Metals and Nutrients. Removal of Pathogens.	
Application:	At outfall from existing or proposed pipe system to natural channel. At discharge point of large commercial and industrial sites to natural channel.	
Site Requirements:	Open space, size related to catchment area. Regular maintenance (For example, wetland vegetation harvesting, sediment removal)	
Effectiveness:	Good removal of suspended solids with proper maintenance. Based on references, SS removal of 75% can be achieved. Limited removal of nutrients and metals through biological uptake. Based on references, 60% of nutrients can be removed. Can be used for passive recreation.	
Who Does It?	Can be done by municipal staff.	
Design Requirements:	Extensive design required to ensure safety and to ensure blending with landscape.	
Basis for Cost Estimate:	Area of contributing watershed in acres (This will determine the wetland size). Area of wetland in acres. Permitting, design and contingency assumed at 25% of construction cost. Maintenance assumed to be 2% of construction per year. Typical area is 0.1 acres per impervious acre for a 1-hour, 100-year event.	
Who Pays For It?	Paid for by municipality	
Cost (1000 $s): .	Design: Construction: Maintenance:	$7,000-$14,000/acre (Permitting, design and contingency). $26,000-$55,000/acre excluding land purchase. (Land Purchase can be negligible if constructed as part of new development or if incorporated into existing parklands.) $600-1,100/acre/year

Reference: *Chapter 4, Wetlands*, **Stormwater BMP Design Supplement for Cold Climates**, (U.S. EPA/Center for Watershed Protection, 1997)

Storm Water Wetlands, **Storm Water Technology Fact Sheet**, (U.S. EPA, September 1999)

Vegetated Swales

Type:	Structural, Treatment Control BMP.
Description:	Channels or flat surfaces lined with vegetation that filters flow depths are shallower than vegetation height.
Category:	New Development
Function:	Removal of Nutrients. Removal of Suspended Solids.
Application:	At outfall from existing or proposed pipe system to natural channel.
Site Requirements:	Open space, size related to catchment area. Regular maintenance (For example, vegetation harvesting, sediment removal)
Effectiveness:	Available data does not permit good assessment of pollutant removal efficiency. Good removal of suspended solids with proper maintenance. Based on references, Suspended Solids removal of 66% can be achieved. Limited removal of nutrients and metals through biological uptake. Based on references, 10-15% of nutrients can be removed.
Who Does It?	Can be done by municipal staff.
Design Requirements:	Extensive design required to ensure safety and to ensure blending with landscape.
Basis for Cost Estimate:	Area of vegetated swale.
Who Pays For It?	Paid for by municipality
Cost (1000 $s):	Construction: $0.30/ square foot. Maintenance: $0.02/square foot/year
Reference:	*Chapter 5.0, Description and Performance of Storm Water Best Management Practices*, **Preliminary Data Summary of Urban Stormwater Best Management Practices**, (Environmental Protection Agency, August 1999).

Stormwater Filters

Type: Structural, Treatment Control BMP.

Description: A stormwater filter is a system that uses a filter medium (such as sand, gravel, peat or compost) or surface vegetation to remove a fraction of the polluting constituents in stormwater runoff. The first broad category of stormwater filters that uses a filter medium has limitations in cold climates because of freezing of the medium during cold winters. In addition, neither category has any effect on stormwater flow attenuation.

Category: Existing or New Development

Function: Removal of Nutrients.
Removal of Suspended Solids.
Removal of Pesticides.

Application: Surface vegetation stormwater filters are used for reducing sediment, fertilizers, pesticides and other pollutants from drainage areas up to 5 acres (2.5 hectares) with slopes up to 2 percent, for example along roadways, around parking lots, as buffers along larger bodies of water. Filter media stormwater filters are used mostly for particulate removal of runoff from large paved areas.

Site Requirements: Open space for vegetative filters, size related to catchment area.

Effectiveness: Regular maintenance (For example, cleaning/replacing filter medium, vegetation harvesting, and sediment removal) determines the effectiveness.
Based on references, SS removal of 50-80% can be achieved.
Surface vegetation filters can remove over 50% of nutrients and over 30% of metals. Media filters can remove less than 0% of nitrogen.
Media filters can remove over 50% of metals.

Who Does It? Can be done by municipal staff.

Design Requirements: Extensive design required to ensure efficient performance, safety and to ensure blending with landscape.

Basis for Cost Estimate: Size of filter in cubic feet.
Size of filter is determined by the watershed area and the landuse.
Typical filter size is 10 cubic feet per impervious acre.

Who Pays For It? Paid for by municipality

Cost (1000 $s):	Construction:	$3.00-$6.00/cubic foot for media filter $5.30/cubic foot for vegetated filter
	Maintenance:	$0.36-$0.72/cubic foot/year

Reference: *Chapter 6, Filtering BMPs***, Stormwater BMP Design Supplement for Cold Climates**, (U.S. EPA/Center for Watershed Protection, 1997)

Chapter 5.0, Description and Performance of Storm Water Best Management Practices, Preliminary Data Summary of Urban Stormwater Best Management Practices**, (Environmental Protection Agency, August 1999).**

Oil and Grease Trap Devices

Type:	Structural, Treatment Control BMP.
Description:	A device that removes abnormally high concentrations of petroleum compounds, grease and grit by gravity or coalescing plates.
Category:	Existing or New Development
Function:	Removal of Petroleum or Grease. Removal of Suspended Solids.
Application:	At commercial or industrial facilities that generate high levels of oil products or grease. In medium to large parking or motor vehicle storage areas.
Site Requirements:	Open space, size related to catchment area or to volume of runoff. Regular maintenance (For example, vegetation harvesting, sediment removal)
Effectiveness:	Removal of oil and grease depends on proper maintenance.
Who Does It?	Can be done by municipal staff or by contractor.
Design Requirements:	Design required based on pass-through volume and droplet size. Volume is typically 400 cubic feet per trap device. There should be a maximum area of one acre tributary to each device.
Basis for Cost Estimate:	Pass-through volume in cubic feet.
Who Pays For It?	Paid for by municipality. It may be possible to recover costs from property owners by passing a bylaw or entering into a maintenance agreement.
Cost (1000 $s):	Construction: $100/cubic foot. Maintenance: $10/year/cubic foot
Reference:	*Chapter 5, Description and Performance of Storm Water Best Management Practices*, **Preliminary Data Summary of Urban Storm Water Best Management Practices**, (U.S. EPA, Office of Water, 1999)

Streambank Stabilization Measures

Type: Structural, Channel Restoration/Stabilization BMPs.

Description: Use of structures that stabilize streambanks and slopes that cannot be stabilized by vegetation.

Category: Existing or New Development

Function: Repair of erosion.
Streambank Stabilization.

Application: Applicable to a wide range of channel conditions from steep gradients to low gradients with shifting substrates.

Site Requirements: Existing natural channel.

Effectiveness: Repair and arrest of streambank erosion.

Who Does It? Can be done by municipal staff.

Design Requirements: Design required based on slope, soil type and extent of erosion.

Basis for Cost Estimate: The costs of engineered streambank stabilization measures are very site specific and difficult to estimate. Therefore, the approach has been to give a few key costs that can be used to build a cost for a specific project.

Who Pays For It? Paid for by municipality

Cost (1000 $s):

Construction:
- $1.50-$3.50/live stake (2 - 3 feet spacing in a grid pattern)
- $2.00-$9.00/joint planting stake (2 - 3 feet spacing in a grid pattern)
- $5.00-$9.00/foot of live facsine (spaced at 3 - 5 feet up the slope, i.e. require a fascine for every 4 - feet of slope perpendicular to the stream flow direction)
- $10.00-$25.00/square foot of live cribwall (typically requires 4 square feet per lineal foot of streambank)
- $25-$35/sq. yd. (For plain 8" Rip-rap)
- $30-$45/sq. yd. (For plain 16" Rip-rap)
- $20-$30/ft. (For 3ft by 1 ft gabion baskets)

Reference: *Chapter 16, Hydraulic Design of Flood Control Channels*, **Hydraulic Design Handbook**, (McGraw-Hill, New York, 1999).
Chapter 16, Streambank and Shoreline Protection, **Engineering Field Handbook**, (U.S. Department of Agriculture, Natural Resources Conservation Service, 1996)

Erosion Control Measures

Type: Structural, Construction Erosion and Sediment Control BMPs.

Description: Providing a barrier, basin or other device to remove sediment from stormwater runoff.

Category: New Development

Function: Reduction of stormwater pollution especially sediment runoff.

Application: Construction Sites.

Site Requirements: Site Specific.

Effectiveness: If properly installed and maintained, up to 80% of site sediment can be removed.

Who Does It? Can be done by municipal staff or by watershed organization on contract.

Design Requirements: Design required based on drainage pattern of site, soil type and nature of construction. Types of BMP include Geotextile, Straw Erosion and Wood Fiber Blanket, Silt Sack, Beaver Dam, Monofilament Wrap, Plastic or Wooden Snow Fence and Sediment Logs.

Basis for Cost Estimate: Requirements are site specific and are generally not a direct cost to the municipality. The costs must be borne by the contractor involved in the construction. The costs to the municipality involve plan review at the building permit stage and site inspection and enforcement during construction.

Who Pays For It? Paid for by municipality

Cost (1000 $s): Plan Review: $100/hour, typically requires a minimum of 4 hours plus 4 hours per acre of site.

Geotextile	$0.80/ sq.yd.
Straw Erosion Blanket	$0.50/lin.ft.
Wood Fiber Blanket	$0.55/lin.ft.
Silt Sack	$130/sack
Beaver Dam	$60/sack
Monofilament Wrap	$2.70/sq.yd.
Plastic Snow Fence	$0.80/lin.ft. (Including posts)
Wood Snow Fence	$0.80/lin.ft. (Including posts)
Sediment Log	$2.50/lin.ft.

Reference:

***Construction Erosion and Sediment Control BMPs-Sediment Trapping Devices*, Cost Estimating Guidelines–Best Management Practices and Engineered Controls**, (Rouge Program Office, Wayne County, Michigan, 1997).

Pebble Creek Erosion and Sedimentation Control Study, (City of Farmington Hills, Wayne County, Michigan, 1998).

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