Chapter 6. Subwatershed Management Alternatives

6.1 The Complex Process of Selecting Best Management Practices

After there is an understanding of the sources and causes of the challenges in the subwatershed, it is important to understand the various management alternatives that exist to address those challenges. In the field of watershed management, these management alternatives are called Best Management Practices, or BMPs. BMPs cover a broad range of activities, as will be described in this chapter, that will vary in cost, effectiveness, and feasibility, depending on a host of complex factors. In order to determine which BMPs would be the most environmentally effective and most cost effective toward meeting the Lower One Subwatershed goals, the Lower One SWAG has taken several steps during the planning process:

- First, a broad list of possible BMPs was generated (see the Management Alternatives Menu in Appendix C). At a regular SWAG meeting, these possible BMPs – their potential effectiveness, cost, and feasibility - were discussed and additions were included based on ideas generated at that collaborative meeting.
- Second, communities and agencies held individual meetings with the subwatershed facilitators to look at this Menu and discuss which of those BMPs would: 1) best address their often unique priorities for the river in their locality, 2) be the most environmentally effective in their community, and 3) be most likely to be implemented as part of their community Storm Water Pollution Prevention Initiative (SWPPI).
- Third, communities and agencies began developing lists of short term (defined as those to be initiated by 2005) and long term (defined as those to be initiated after 2005) actions that would be recommended for the Subwatershed Action Plan and their individual SWPPI. These lists were shared among the subwatershed members at subsequent SWAG meetings in order to coordinate ideas and resources, as well as offer suggestions among participants, identify gaps and ensure that subwatershed-wide goals were being adequately addressed.
- Fourth, community and agency short term actions for the subwatershed were synthesized by the Rouge Program Office staff in order to develop a method of determining the relative environmental effectiveness of the proposed activities within their particular subwatershed. This analysis is summarized below or in Appendix H.
- Finally, communities were given the BMP Cost Estimating Guidelines, found in Appendix B, to use as a general guideline for judging the relative cost-effectiveness of their proposed actions.
- These steps have resulted in the development of the Subwatershed Action Plan, described in the following chapter, as well as the development of individual community and agency SWPPIs to be submitted to the MDEQ by December, 2001.

6.2 Description and performance of Stormwater Best Management Practices Considered

As the SWAG began the process described above, it was widely recognized that selecting management alternatives to manage stormwater across a subwatershed is a complex process. There are a number of competing factors that need to be addressed when selecting the appropriate structural and non-structural Best Management Practices (BMPs) or combinations of BMPs for an area or community. Without proper BMP selection, design, construction and maintenance, BMPs will not be effective in managing stormwater. For example, a particular combination of BMPs may be developed for use on construction sites and new land development, where opportunities exist for incorporating BMPs that are focused on runoff prevention, reducing impervious surfaces and maintaining natural drainage patterns. In established urban communities, however, other combinations of BMPs will be appropriate due to space constraints. In these developed areas, BMPs should focus on pollution prevention practices along with retrofit of the established storm drain system, if possible. Site suitability is key for selecting a particular BMP strategy. A few considerations to incorporate into BMP selection are: drainage area, land uses, soil types, runoff volumes and flow rates, site slopes, availability of land, safety and community acceptance, and maintenance accessibility and needs. The cost of designing, implementing and then maintaining a BMP is also a factor that needs to be weighed.

> **Figure 6.1: Stormwater BMP Resources online**
>
> Reports based on Rouge River watershed case studies of various BMP pilot projects: http://www.rougeriver.com
>
> Center for Watershed Protection (CWP): publications on BMP performance, design, maintenance, watershed planning: http://www.cwp.org/
>
> Created by the CWP, www.stormwatercenter.net provides a comprehensive library of articles about BMP performance and is designed specifically for stormwater practitioners, local government officials and others that need technical assistance on stormwater management issues.
>
> Stormwater BMP links for developed or developing communities, emphasizing documents and standards developed by other states: http://www.epa.gov/OST/stormwater/#nsbd
>
> Technical fact sheets on a number of BMPs are available on the USEPA website at: http://www.epa.gov/owm/mtbfact.htm.
>
> American Society of Civil Engineers National Stormwater Best Management Practices Database developed in partnership with the USEPA: http://www.asce.org/peta/tech/nsbd01.html
>
> An online BMP search engine to research 70 different studies in standardized format from over the past 15 years, this website is managed by the Urban Water Resources Council of the American Society of Civil Engineers and is sponsored under a cooperative agreement with the USEPA: http://www.bmpdatabase.org/
>
> Environmental Technology Evaluation Center (EvTEC) conducts independent evaluations of commercial stormwater BMP devices: http://www.cerf.org/evtec/

A stormwater best management practice (BMP) is a technique, measure or structural control that is used for a given set of conditions to manage the quantity and improve the quality of stormwater runoff in the most cost-effective manner. BMPs can be either engineered and constructed systems (“structural BMPs”) that improve the quality and/or control the quantity of runoff such as detention ponds and constructed wetlands, or institutional, education or pollution prevention practices designed to limit the generation of stormwater runoff or reduce the amounts of pollutants contained in the runoff (“non-structural BMPs”). No single BMP can address all stormwater problems. Each type has certain limitations based on drainage area served, available land space, cost, pollutant removal efficiency, as well as a variety of site-specific factors such as soil types, slopes, depth of groundwater table, etc. Careful consideration of these factors is necessary in order to select the appropriate BMP or group of BMPs for a particular location.

Non-Structural BMPs

Non-structural BMPs include institutional, educational, regulatory and pollution-prevention type practices designed to prevent pollutants from entering stormwater runoff or reduce the volume of stormwater requiring management. These BMPs include education programs, public involvement programs, land use planning, natural resource protection, regulations, operation and maintenance or any other initiative that does not involve designing and building a physical stormwater management mechanism. Although most of these non-structural BMPs are difficult to measure quantitatively in terms of overall pollutant reduction and other stormwater parameters, research demonstrates that these BMPs have a large impact on changing policy, enforcing protection standards, improving operating procedures and changing public awareness and behaviors to improve water quality and quantity in a watershed over the long term. Therefore, these BMPs should not be overlooked, and in some cases, should be the emphasis of a stormwater management program.

Structural BMPs

Structural stormwater BMPs are physical systems that are constructed for a development – new or existing – that reduce the stormwater impact of development. Such systems can range from underground, in line storage vaults to manage peak flows, to slightly graded swales vegetated with wildflowers to slow flows as well as treat pollutants. Structural BMPs can be designed to meet a variety of goals, depending on the needs of the practitioner. In existing urbanized areas and for new developments, structural BMPs can be implemented to address a range of water quantity and quality considerations. Because the effect of these physical systems can often be quantitatively measured by monitoring inflow and outflow parameters, recent studies have suggested certain pollutant removal efficiencies of various BMPs. These data are summarized in the table below.

Table 6.1: Structural BMP Expected Pollutant Removal Efficiency
Adapted from USEPA, 1993c., ND = No Data

Structural BMP	Solids and sediment removal	Nitrogen removal	Phosphorus removal	Longevity* and general comments
Constructed Wetland[47]	50-80%	<30%	45%	20+ yrs. Also effective at removing hydrocarbons (87%), lead (62%), and bacteria (77%). Requires monitoring and maintenance.
Retention Basins	50-80%	30-65%	30-65%	20 + yrs. Effective at attenuating peak flow, removing solids. Off-line RB used for combined sewer overflow control.
Extended Wet Detention Pond	90% if held for more than 24 hours[48]	ND	ND	20 + yrs. but more maintenance needed
Infiltration Basin	50-80%	50-80%	100%	60 – 100% failure rate within 5 yrs. if not maintained. Restricted to areas with permeable soils.
Dry Detention Basin[49]	30-65%	15-45%	15-45%	Does not handle first flush.
Infiltration Trenches[50], Dry wells	50-80%	50-80%	70%	50% failure rate within 5 yrs. if not maintained
Porous pavement	ND	ND	ND	75% failure rate within 5 yrs. if not maintained. Need appropriate soils, good maintenance plan. Study in Kinston, N. Carolina showed a 2/3 reduction in runoff from a permeable grid pavement[51].
Sand Filters	70%	21%	30-50%	20+ yrs. Begin clogging in 3-5 yrs., most effective at controlling TSS, BOD and Fecal coliform bacteria.[52]

[47] Urbanization and Water Quality: A Guide to Protecting the Urban Environment. 1994. The Terrene Institute, Washington, DC.
[48] Guidebook of Best Management Practices for Michigan Watersheds.
[49] "Impervious Reduction and Mitigation in Tributaries of the Huron River: a stormwater management study of Ann Arbor, Scio, and Superior Townships," p.19 (from Bown and Scheuler, 1997).
[50] Horner, Richard. 1994. Fundamentals of Urban Runoff Management, Terrene Institute, Washington, DC. P. 116.
[51] Bradfield, M. 2000. Permeable Pavements Reduce Runoff, *Concrete Masonry Designs*, p. 30.
[52] Galli, J. 1990. Peat Sand Filters: A Proposed Storm Water Management Practice for Urbanized Areas. Metropolitan Council of Governments.

Structural BMP	Solids and sediment removal	Nitrogen removal	Phosphorus removal	Longevity* and general comments
Grassed Swales	65-81%	15-45%	15-45%	20+ yrs. Works best as part of stormwater system with check dams. Might not be beneficial if flow exceeds 5cfs[53].
Vegetated Filter Strips	50-90%[54]	50-80%	50-80%	Unknown longevity, but may be limited. At least 100ft[55] wide recommended for effectiveness
High-powered street sweeping[56]	50-90%	ND	50-90%	Broom sweepers, 50% Vacuum sweepers, 90%[57]
Catch basin cleaning	ND	ND	ND	Recommended at least twice per yr. for effectiveness
Construction phasing	42%[58]	ND	ND	With effective phasing plan and inspection; most appropriate for sites 25 acres or more.
Stabilizing soils on construction sites[59]	80-90%	ND	ND	Establish grass or mulch cover within two weeks after exposure.
Silt fences	75-86% if properly installed and maintained[60], only 36-65% if at toe of slope[61]	ND	ND	Studies find that a majority of silt fences are improperly installed and maintained.[62]
Biofilters[63] (vegetated swale designed to treat stormwater)	100 ft. = 60% 200 ft. = 83%	ND	100 ft = 45% 200 ft = 29%	Should be shallow and broad with regular maintenance to remove sediments. Off-line is best.

[53] US Environmental Protection Agency, Office of Water, Washington, DC. 1999. Storm Water Technology Fact Sheet, Vegetated Swales, 832-F-99-006.
[54] Filliam, J.W. 1994. Riparian Wetlands and Water Quality. Journal of Environmental Quality. 23:896-900.
[55] Schueler, T. 1995. The Architecture of Urban Stream Buffers. Watershed Protection Techniques, Col. 1, No.4.
[56] Watershed Protection Techniques. 1999. Technical Note: 103. Vol. 3, No. 1, p. 601.
[57] Guidebook of Best Management Practices for Michigan Watersheds. Reprinted 1998. Michigan Department of Environmental Quality, Surface Water Quality Division.
[58] Claytor, Watershed Protection Techniques, Technical Note 80.
[59] Brown, W. and D. Caraco. 1996. Task 2 Technical Memorandum: Innovative and Effective Erosion and Sediment Control Practices for Small Sites. Center for Watershed Protection for the US EPA Office of Wastewater Management. Silver Spring, MD.
[60] Goldman, S.J., K. Jackson and T.A. Bursztynsky. 1986. Erosion and Sediment Control Handbook. McGraw-Hill Book Co. New York, NY.
[61] Harding, M.V. 1990. Erosion Control Effectiveness: Comparative Studies of Alternative Mulching Techniques, Environmental Restoration: Science and Strategies for Restoring the Earth. Island Press, Covello, CA, p. 149-156.
[62] Paterson, R.G. 1994. Construction Practices: The Good, the Bad and the Ugly. Watershed Protection Techniques, 1 (3):95-99.
[63] Reeves, E. 1994. Performance and Condition of Biofilters in the Pacific Northwest, Technical Note 30, Watershed Protection Techniques, Vol. 1, No. 3, p. 117-119.

Structural BMP	Solids and sediment removal	Nitrogen removal	Phosphorus removal	Longevity* and general comments
Grassed swales along highways[64]	65-98%	ND	12-41%	From study of three systems in VA, MD, and FL. Greater lengths, dense vegetation and checkdams increase effectiveness.
Sediment basins or traps at construction sites	65%	ND	ND	Measured 230 samples, 9 storms from 6 basins. More protection needed for larger storms.
Vegetated Roofs	ND	ND	ND	70-100% runoff reduction. 60% temperature reduction. Reduces combined sewer overflows.
Other media filters	65-100%	15-45%	<30%	Require regular maintenance.
Increasing/Improving Vegetation	ND	ND	ND	Vegetating an area with trees and native plants can improve infiltration and evapotranspiration.

*Based on current designs and prevailing maintenance practices (Metropolitan Council of Governments, 1992).

The Importance of Phasing or Sequencing BMPs

A key consideration when planning to implement BMPs to address various subwatershed goals is how the various BMPs will be phased or sequenced in relation to one another over time. Determining which actions will need to take place before other actions will be important in achieving the full potential of each activity. Which BMP is best to implement first, second or third can be based on a number of factors such as ecological factors, elements of cost, political realities, length of time for developing the BMP, and/or priority concerns within the watershed area. For example, in the Middle One subwatershed, increased flow variability is a major concern - causing bank erosion, loss of habitat and loss of aesthetic qualities in local streams. In addition to working toward a goal of reducing flow variability, however, the subwatershed also recognizes the need for habitat improvement and bank stabilization in receiving streams and the river. Implementing BMPs to address each of these concerns should follow a phased approach for ecological reasons whereby before streambank stabilization and vegetation projects get underway, the subwatershed will need to reduce the peak flow problems so that the newly stabilized banks are not destroyed by continued high storm water volumes and velocities. I.e., it is crucial to solve the cause or source of the problem (high peak flows) before an attempt is made to solve the actual problem (bank erosion and loss of habitat). The phasing of BMPs in this scenario might include first improving storm water source controls upstream by disconnecting downspouts at buildings and implementing a rain barrel promotion program; then, investigating existing detention basins to determine whether retrofitting outlets or vegetation could improve flow; then, if more detention/retention is necessary to reduce peak flows, a hydrologic study may be necessary to determine sites for additional detention construction; and finally, constructing new detention systems in the subwatershed might be the last phase in controlling flow before habitat improvements can be installed and expected to succeed.

Listed below are three major phases under which most BMPs can be categorized in terms of their dependence on various factors. Under section 6.3 that follows, a phase (I, II, or III) is indicated for each type of BMP. This phasing sequence is a recommendation only and individual circumstances may suggest alternative phasing, depending on various factors. As individual communities and agencies develop their Storm Water Pollution Prevention Initiatives (SWPPIs)

[64] Schueler, T. 1994. Performance of Grassed Swales Along East Coast Highways,

under their General Storm Water Permits, these phasing recommendations should be taken into consideration.

- **Phase I**: BMPs that can be initiated right away, require minimal cost or planning, address the upstream sources/causes of a downstream problem, usually non-structural BMPs (source controls, education programs, improving good housekeeping activities, etc.).
- **Phase II:** BMPs that require significant planning and development, design specifications, require major additional costs, address sources/causes of a problem, can be structural or non-structural BMPs (ordinances, new projects/programs, studies, pilot projects, design/construction of detention/wetland, etc.)
- **Phase III:** BMPs for which success may depend on the success of a previously implemented BMP, mostly structural BMPs (in-stream habitat improvements after flow improvements, pond/lake dredging after watershed-wide nutrient/sedimentation reduction efforts in place, etc.)

6.3 The Range of Recommended Management Alternatives

The subwatershed is comprised of diverse local communities, from rural townships to urban city centers. Subsequently, there are a variety of structural and non-structural management alternatives, or BMPs, that could be considered across the subwatershed. The alternatives listed below may apply to one community but not to another, and so it is important to note that each of the alternatives is a unique solution to a specific pollution source or problem. Although each of these alternatives will most likely apply to at least one of the communities or agencies in the subwatershed, not all of them apply to every community. This diversity of applications is described both in the Subwatershed Action Plan (Chapter 7) and in each individual SWPPI to be submitted after this plan is complete. Although it is not an exhaustive list of all of the possible management alternatives that could be considered, the range of recommended management alternatives for the subwatershed are summarized below.

6.3.1 Reduce Peak Flows

<u>Stormwater and Water Resource Protection Ordinances (Phase II)</u>

In undeveloped areas, or in area where redevelopment may occur, it is important to have regulations in place that can guide land development with regard to protecting the water quality, water quantity and biological integrity of the receiving surface water. This regulation can use existing data to determine the development impact that can be tolerated by the surface waters before that system will become degraded. Future development or redevelopment can be guided to control runoff so that local streams and water resources are not negatively affected by the development to the greatest extent practicable.

<u>Land Use Planning and Management (Phase I)</u>

Land use planning and management involves a comprehensive planning process to promote Low Impact Development (LID) and control or prevent runoff from certain developed land uses in areas where beneficial uses of receiving water are sensitive to development. Ideally this type of planning is most effective in undeveloped areas, although opportunities may be available in areas of existing development, or in instances of redevelopment. The land use planning process involves the following steps: 1) determine water quality and quantity goals with respect of human health, aquatic life and recreation; 2) identify planning area and gather pertinent hydrological, chemical and biological data; 3) determine and prioritize the water quality needs as they relate to land use and the proposed development; 4) develop recommendations for low impact development to address the problems and needs that have been previously determined; 5) present recommendations to a political body for acceptance and 6) implement adopted recommendations.

Reduce Directly Connected Impervious Surfaces (Phase I)
Utilizing a Low Impact Development (LID) Plan for new developments can reduce directly connected impervious surfaces. LID Plans combine a hydrologically functional site design with pollution prevention measures to compensate for land development impacts on hydrology and water quality. The result will be a reduction in storm water peak discharge, a reduction in runoff volume and the removal of storm water pollutants. This can apply to new residential, commercial and industrial developments. In urban communities, especially older areas, there may be opportunities to disconnect impervious areas through downspout disconnection and the disconnection of sump pumps to driveways and sewers systems.

Slow Storm water Runoff (Storm water Storage Facilities) in Urban Areas (Phase II)
In older urban areas where stormwater detention systems do not exist, storm water storage facilities are underground urban source control devices designed to retard flow sufficiently to reduce sewer overflows, prevent downstream flooding and/or reduce erosive velocities. These facilities consist of storage tanks connected to the existing drainage system, street storage and parking lot storage. Retrofitting storage into existing drainage systems is usually very expensive and therefore not recommended, except in the most severe cases. Improperly sized and sited storage facilities can also cause localized parking lot and street flooding, icing in winter months and increased downstream flooding.

Install/Maintain Storm water Retention/Infiltration Basins and other Infiltration Devices (Phase I or II)
Storm water infiltration basins are any storm water device or system, which causes the majority of runoff from small storms to infiltrate into the ground rather than be discharged to a stream. Most infiltration devices also remove waterborne pollutants by filtering the water through the soil. Storm water infiltration can provide a means of maintaining the hydrologic balance by reducing impervious areas. Infiltration devices could include any of the following: basins, trenches, permeable pavement, modular pavement or other systems that collect runoff and discharge it into the ground. Infiltration devices should only be used on locations with gentle slopes, permeable soils and relatively deep water tables and bedrock levels. Typical long-term pollutant removal rates for infiltration basins and trenches range from 75 to 90% for sediment, metals, bacteria and BOD, 50 to 70% for phosphorus, and 45 to 60% for nitrogen. The removal rates for porous pavement range from 80 to 99% for sediment, nitrogen, organic matter, zinc, and lead, and 65% for phosphorus. In new developments, permeable soil areas should be preserved and utilized as storm water infiltration areas.

Construct/Maintain Wet Detention Ponds and/or Constructed Wetlands (Phase I or II)
Wet detention ponds, or constructed wetlands, are small man-made ponds or shallower areas with emergent wetland vegetation around the banks designed to capture and remove particulate and certain dissolved constituents. Wet ponds and wetlands are ideal for large, regional tributary areas (10 to 300 acres) where there is a need to achieve high levels of particulate and some dissolved nutrient removal. The pond or wetland should be sized to treat runoff, accumulate sediment and route floods. The outlet should be sized based on the design method. The pond should be configured for aesthetics, safety and maintenance. Landscaping design requirements should include a natural vegetated buffer around the pond/wetland to reduce pollutants entering the area as well as decrease goose habitat, and increase aesthetics. Floating vegetation should be used in the pond to shade water and prevent algae blooms as opposed to chemical herbicides. It should be noted that the successful establishment of emergent and other wetland plants, and specific wetland hydrology, will only be achieved with proper monitoring and maintenance for approximately five to ten years after construction.

Construct/Maintain Dry Retention/Detention Ponds (Phase I or II)
A retention/detention basin is usually dry between storms. It is designed to capture runoff and release it slowly to allow most of the pollutant-laden sediments to settle. Dry retention/detention basins are used for tributary watersheds 10 acres and larger in size to attenuate peak flow and remove particulates. The basin should be designed to treat runoff, accumulate sediments and

route floods. The outlet should be sized to drawdown the first 50% of volume in 12 to 16 hours and the remaining water in 24 to 32 hours. The basin should be configured for aesthetics, safety and maintenance. Dry ponds are not as efficient at removing pollutants as wet ponds can be due to the re-suspension of settled solids during storm events and the lack of wetland vegetation.

Install/Maintain In-line Storm Sewer Treatment Devices (Phase I or II)
In urban areas, in-line sewer treatment devices perform primary treatment to remove grit, sediment and floatable material from storm sewer flows. These devices can take the form of catch basin inserts or swirl separators. Catch basin inserts are devices that are used to filter out grit and sediments, and filter and absorb hydrocarbon products from storm runoff before it can get into the storm sewer system. Inserts are installed in each catch basin as reusable cartridges or as disposable filters. The reusable cartridges are more expensive initially, but require less maintenance than the disposable filters, which must be changed frequently. Swirl separators are devices, which are placed in-line in the sewer system. During dry weather flow, water is allowed to flow into the unit and out through a foul sewer outlet, into the interceptor sewer. During wet weather conditions, flow enters the separator tangentially and begins to swirl. A flow director directs the flow toward the inside of the tank and does not allow it to remix with incoming flow. The concentrated slurry is allowed to flow to the interceptor, while the high volume of overflow is relatively clear and overflows into a center downshift that carries the water away for storage, treatment or discharge into a receiving water. Swirl separators are highly effective and require very little maintenance, because they have no moving parts.

6.3.2. Reduce Nutrient and Sediment Loads

Support Environmental Friendly Residential and Commercial Lawn and Garden Maintenance (Phase I)
Nitrogen, phosphorus, potassium and other nutrients are necessary to maintain optimum growth of lawns and most gardens. Nutrients that are applied beyond the plants needs on lawns and gardens may get washed off as stormwater runoff and end up in lakes, streams, and wetlands, or may leach into groundwater. When nutrients such as nitrogen and phosphorus run off into surface waters, they can cause algae blooms and excess nuisance aquatic plant growth. Fertilizer management addresses the proper selection, use, application, storage and disposal of fertilizers, as well as a combination of mechanical methods and careful application of chemicals. Mechanical methods include the proper selection of vegetation for various land uses; proper watering techniques to reduce runoff and excess transpiration; proper lawn mowing techniques to reduce the runoff rate and pollutant transport; proper organic debris disposal and proper pest control techniques to minimize the use of herbicides and pesticides. Particular maintenance techniques are required on steep slopes, in or around drainage channels, streams and detention basins, and adjacent to catch basins. This BMP could be carried out though public education efforts on non-point source pollution and/or through regulations requiring licensing for landscaping and lawn car professionals.

Street and Paved Area Sweeping (Phase I)
Another way to decrease the amount of sediments and nutrients discharging to the river is through a comprehensive street and parking lot sweeping program. When performed regularly, street sweeping can remove 50 – 90 % of street pollutants that can potentially enter surface waters through runoff. Street sweeping can also make road surfaces less slippery during light rains, improve aesthetics by removing liter and control pollutants which can be captured by the equipment. Street sweeping involves the use of specialized equipment to remove liter, loose gravel, soil, pet waste, vehicle debris and pollutants, dust and industrial debris form road surfaces. Street sweeping equipment consists of mechanical brooms, vacuum sweepers or a combination of both. Sweeping is recommended on high to medium traffic streets.

Control Soil Erosion (Phase I)
Soil erosion control is the process of stabilizing soils and slopes in an effort to prevent or reduce erosion due to storm water runoff. This is of most immediate concern on construction sites where soil has been disturbed and exposed. This is also a concern on streambanks that are eroding

due to lack of vegetation and an excess of peak flows during storm events. Soils on construction sites and stream banks can be stabilized by various physical or vegetative methods, while slopes are stabilized by reshaping the ground to grades, which will improve surface drainage and reduce the amount of soil eroding from a site. Streambank and soil stabilization methods have been described in separate BMPs. Other erosion control efforts can take the form of a soil erosion control ordinance that are often implemented on the county level. In areas where development activity is active, it is important to emphasize SESC ordinance inspection and enforcement, which often entails hiring an adequate number of field staff.

Perform Storm Sewer System Cleaning (Phase I)

Storm sewer system cleaning is particularly beneficial for pipes with grades, which are too flat for self-cleaning velocities to be achieved on a regular basis. Cleaning the systems helps to remove pollutants and will ensure that the pipes convey their intended design flow, as well as allowing the in-system storage capacity of the sewers to be fully utilized. The removal of deposited material can be accomplished with vactors, jetters, and scrapers or by flushing with water. It has been found that the removal efficiency for organics is between 65 and 75% and 55 to 65% for grit and non-organic material.

Perform Catch Basin Cleaning (Phase I)

When performed on a regular basis, catch basin cleaning removes pollutants from the storm drainage system, reduces the concentration of pollutants during the first flush of storms, prevents clogging of downstream systems, restores the catch basins sediment trapping ability and allows the in-system storage capacity of the sewers to be fully utilized. Catch basin cleaning requires the use of a vactor truck; and cleaning should be performed before it is 40% full.

Construct/Maintain Media/Sand Filters (Phase I or II)

A media filter is essentially a settling basin followed by a sand filter for particulate removal. Other filters may be used to provide dissolved pollutant removal. The most common media utilized is sand, while some use a peat/sand mixture. Media filters are used on sites with limited space or that are unsuitable for vegetation. Sand filters remove up to 90% of suspended materials.

Implement Streambank Stabilization Measures (Phase III)

Before implementing any streambank stabilization measure, it is important to first understand the cause of the streambank erosion problem. If the cause is extreme peak storm water flows, it is crucial to first address peak flow problems before stabilization measures can be expected to succeed. Streambank stabilization measures work by either reducing the force of flowing water and/or by increasing the resistance of the bank to erosion. Vegetating streambanks also provides important ecological benefits such as shading water and providing crucial habitat for both terrestrial and aquatic wildlife species. Three types streambank stabilization methods exist, they include engineered methods, bioengineered methods and biotechnical methods. Engineered structures include riprap, gabions, deflectors and revetments. Bioengineering refers to the use of live plants that are embedded and arranged in the ground where they serve as soil reinforcement, hydraulic drains, and barriers to the earth movement and/or hydraulic pumps. Examples of bioengineering techniques include: live stakes, live fascines, brush mattresses, live cribwall and branch packing. Biotechnical measures include the integrated use of plants and inert structural components to stabilize channel slopes, prevent erosion and provide a natural appearance. Examples of biotechnical techniques include: joint plantings, vegetated gabion mattresses, vegetated cellular grids and reinforced grass systems. Whenever possible bioengineered or biotechnical methods should be implemented in lieu of engineered methods so as to increase habitat and aesthetics.

Prevent and Remove Stream Obstructions (Phase I)

This BMP involves the detection of site-specific stream flow problems that are caused by blockages of debris, log jams, sediment islands, and branches or trees that have fallen into the river. It is important to realize that woody debris in the river is not always bad and, if managed appropriately, can actually provide bank protection against erosion and wildlife habitat. However, if removal is required to solve a flow, erosion or flooding problem, it is important to do so in an environmentally friendly manner, and keep disruptions to habitat to a minimum. Stream cleanup should always be considered before any drastic measures such as clearing and snagging, channelization or other severe modifications are taken. Both communities and individuals should be encouraged to get involved with the process of monitoring and maintaining stream flow conditions, checking for obstructions that are hindering the flow of the river and causing upstream ponding problems and removing smaller obstructions before they become a major problem. Dam or weir removal to improve fish migration may also fall under this category.

Utilize Soil Stabilization Measures for Construction Activities (Phase I)
Soil stabilization measures are any physical or vegetative method, which prevents or reduces soil erosion. Where possible, existing trees, vegetation in and along streams and vegetative slopes should be preserved during soil disruption activities. Attempts should be made to schedule clearing and grading for periods where erosion is least likely and construction should be performed in phases to minimize the amount of exposed area at any time. In addition, channels, stabilized dikes and swales, or slope drains can be utilized to divert runoff away from exposed areas such as at the top of a slope, across the slope face, at the site perimeter or for drainage areas greater than 10 acres.

Install/Maintain Sediment Trapping Devices (Phase I or II)
Sediment trapping devices such as a barrier, basin or other devices are designed to remove sediment from runoff. Sediment basins should be located at the downstream end of drainage areas larger than 5 acres, and before a treatment train of other BMPs such as a wet detention pond or constructed wetland that is built to treat excess sediments and other pollutants. Dikes, temporary channels and pipes should be used to divert runoff from disturbed areas into the basin and runoff from undisturbed areas around the basin. Simpler devices for areas less than 5 acres include a sediment trap and sand bag barrier, silt fences and straw bales. Silt fences and straw bales can be placed along level contours downstream of exposed areas where only sheet flow is anticipated. Sediment trapping devices can also be used on storm drain inlets and can include filter fabric, excavated drop traps, gravel filters and sandbags. Maintenance is a key requirement of any of these soil erosion control BMPs. Sediment traps, barriers, basins and filters should be inspected frequently for repairs and sediment removal.

6.3.3. Increase recreational opportunities, Reduce bacteria loads, Increase aesthetic quality

Identify and Eliminate Illicit Discharges (Phase I)
Illicit discharge detection and elimination requires 1) the prevention, detection and removal of all physical connections to the storm water drainage system that conveys any material other than storm water, 2) the implementation of measures to detect, correct and enforce against illegal dumping of materials into to streets, storm drains and streams, and 3) implementation of spill prevention, containment, cleanup and disposal techniques of spilled materials to prevent or reduce the discharge of pollutants into storm water. Crews must be trained on how to identify illicit discharges and locate illicit connections. Although this effort can be labor intensive, the pay off is a reduction in the amount sanitary sewage and chemical that enters surface waters.

Identify and Eliminate Failing OSDSs (Phase I)
Traditionally county health departments have permitted the design and installation of onsite sewage disposal systems (OSDSs), but no mechanism was in place to inspect these systems following installation. Unfortunately as urban sprawl occurs and homeowners move from sewered areas to unsewered areas, the knowledge of how to properly maintain OSDSs diminished. As these improperly maintained systems aged, they began failing and releasing untreated wastewater into ground water or surface water runoff. Identifying these failed systems can occur through regular inspections or by sampling. Inspections can occur during property transactions (at time-of-sale) or during septic tank pump outs. The method of surface water sampling to detect failing systems is being developed and tested by some communities. The small volume of untreated sewage created by failing systems is difficult to detect in surface

waters. Once sewage is detected in surface waters, dye testing has to be performed on homes to show which systems are failing. This requires homeowner cooperation, which is sometimes difficult to coordinate. Once identified, mechanisms are usually in place to correct system failures. Depending on local ordinances and sanitary sewer availability, homeowners may be allowed to fix their failing systems, but some may be required to hook up to the municipal system. This effort can be very costly especially if the systems are nontraditional or if sanitary sewers are not readily available.

Facilitate Agricultural Manure Management Practices (Phase I)
In rural areas, smaller agricultural establishments and small horse farms may contribute to higher bacteria concentrations if manure is not managed properly. State agencies have the authority to control agricultural practices through voluntary measures called Generally Accepted Agricultural Management Practices, or GAAMPs. GAAMPs provide agricultural landowners guidelines to follow with regard to nutrient and pesticide application and storage, manure management, groundwater protection, and a host of other agricultural BMPs to protect surface and groundwater as well as habitat. There are established outreach programs for landowners to educate about these recommended practices, which should be utilized as much as possible to control potential pollutants from this land use.

Perform Septic Tank/Sanitary Sewer Maintenance (Phase I)
Septic tank and sanitary sewer maintenance measures can be used to prevent, detect and control spills, leaks, overflows and seepage from occurring in the sanitary system. Identify dry weather inflow and infiltration problems first within the sanitary system. Wet weather flows, which are more difficult to locate, can then be located using smoke testing, sewer televising and/or dye testing. On-site sewage disposal systems should be designed, sited, operated and maintained properly to prevent nutrient/pathogen loadings to surface waters and to reduce loadings to groundwater. Septic tanks should be pumped at least every three years depending on the size of the family or group using the tank. Educational materials should be distributed to new and current homeowners that maintain septic tanks so that pollution prevention is emphasized.

Reduce Excessive Geese Populations (Phase I)
Society's desire for lush green lawns and the requirement of onsite storm water retention ponds has created attractive habitat for the goose and waterfowl population. Although whether goose feces is a large culprit of the bacterial problem in surface water still merits research, it is suspected at least as a smaller cause of the public health problem. The nutritional value of the geese's diet is very small therefore they require large quantities of food, which creates a large volume of feces, which is unattractive and unsanitary for human recreation. Geese populations can be controlled by a public education effort, landscape design with taller vegetation, egg replacement and/or goose relocation. The public education effort usually takes the form of "Don't Feed the Waterfowl" signs and has limited value. Landscape design involves creating an environment that is unfavorable to geese yet favorable to humans. Egg replacement involves the location of geese nests and the replacement of eggs before they are hatched, usually with plastic eggs. Goose relocation requires the corralling of geese into pens then hauling them off to other areas where they won't be considered a nuisance. Relocation requires more effort initially then less as the geese population decreases. Border collie programs, especially on larger areas such as golf courses, have proved effective as the dogs herd the animals off site and deter them from returning.

Maintain Infrastructure (Phase I)
Infrastructure maintenance includes the upkeep of sanitary sewer lines in order to prevent sewage from flowing into surface waters. Maintenance involves regular inspections of the piping to locate partial blockages before they backup wastewater into basements or onto the surface, to locate pipe failures, which could cause illicit discharges and/or locate cross connections between the sanitary and storm systems. Maintenance personnel can perform inspections by actually walking the sewers or using a video camera to document the sewer's condition.

Identify areas for recreation enhancement (Phase I or II)
In order to encourage public awareness and concern for rivers, streams and wetlands, it is important to increase opportunities for people to access these water resources. If provided aesthetic and accessible, well-advertised recreational areas - be it a canoe livery, a fishing pier, a trail system or other recreational opportunities - the public will be able to experience the human benefits that the water offers and in turn, may want to work to protect the resource. First, the designated and desired uses must be restored so that it is safe for the public to use the resource in the manner it is intended; i.e., first reduce bacteria to partial body contact limits in order to promote a canoe livery. Then, the recreational facility must be planned, built and promoted.

Continue and Expand Litter and Debris Cleanup (Phase I)
Litter and debris cleanup can be achieved through adopt-a-road, adopt-a-park, adopt-a-catch basin, and adopt-a-stream programs. Community organizations, schools, churches and private companies can pledge to collect debris along local, county and state roads, community parks, local catch basins and streambanks. This effort is coordinated with the local, county or state road agencies, who will remove the collected debris for proper disposal. Street sweeping can also improve aesthetics by removing liter and control pollutants, which can be captured by the equipment.

6.3.4. Preserve/Increase Habitat, Natural Features

Conduct Natural Features Inventory and Assessments (Phase I or II)
The first step in protecting a community's natural resources is identifying what resources should be protected, where they are located, and what benefits they provide to the community. After an inventory, it is often helpful to design an assessment of these natural features so that they can be prioritized in terms of their importance to the community and their relative Lack of preservation. It is often not feasible to protect all of the natural features in a community; however, an inventory and assessment can provide scientific rationale to support a local protection ordinance and/or the basis for avoiding the feature during site design and development. Community-wide inventories and assessments can also provide future opportunities to preserve greenways for wildlife as well as recreation.

Implement Natural Features Protection Ordinances (Phase II)
In order to direct development while protecting key local natural resources, it is often necessary to implement local ordinances that clarify why the protection of certain features is important and how they will be protected under the law. These local ordinances can be more protective than state or federal law and can better reflect the priorities of a local community. Examples include woodland, wetland, natural features setback, soil erosion and sedimentation control, and fertilizer application ordinances.

Preserve and Enhance Existing Wetlands (Phase II)
Wetlands serve as giant sponges, which soak up storm water during wet weather events allowing the water to infiltrate into the soil instead of running off directly to surface waters. As the storm water infiltrates into the soil, pollutants are filtered out before it reaches groundwater. Wetlands serve to reduce storm water velocities, reduce peak flows and to filter out storm water pollutants, they also provide habitat for numerous wildlife species. A wetland ordinance that is more protective than the state or federal government requires may be necessary to protect those wetlands deemed important to a community. Enhancing wetlands can be implemented through volunteers who can monitor the wetland and provide new habitat through plantings, bird nesting boxes, and other activities.

Preserve, Enhance and Support Wetland Mitigation Banking (Phase II)
While preserving existing wetlands in the landscape is of primary importance for protecting water resources, when a wetland fill is permitted, in-kind (type for type) wetland mitigation banking is an option that attempts to replace the functions of the filled wetland. Wetland mitigation is the replacement of wetland function that has been lost in a watershed through the creation or restoration of wetland in that same watershed. Mitigation is required as a condition of many

wetland fill permits issued under state law (Part 303, Wetland Protection of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended) and federal law (part 404 of the Clean Water Act). The goal of wetland mitigation is to replace wetland functions, which provide public benefits, such as flood storage, water quality protection, fish and wildlife habitat and groundwater recharge. Wetland mitigation banking can facilitate compliance with permit requirements by providing a mechanism for the establishment of new wetland areas or "bank", in advance of anticipated losses. Wetlands established in a mitigation bank provide "credits", which can be sold to permit applicants, or used by he bank sponsor to meet permit conditions. Support for wetland banking can come from community/county construction projects and from permits requiring such banks. An ecological benefit of banking is that the banked wetlands can be created where hydrology and other critical factors support their function and success, rather than to force mitigation of a wetland on a project site where a wetland creation might fail.

<u>Construct and Restore Wetlands (Phase II)</u>
A constructed wetland is a man-made wetland with over 50% of its surface area covered by wetland vegetation. It is ideal for large, regional tributary areas (10 to 300 acres) where there is a need to achieve high levels of particulate and nutrient removal. Wetland size and configuration, hydrologic sources, and vegetation selection must be considered during the design phase. Constructed wetlands provide a suspended solid removal of approximately 87%, while nutrient removal ranges widely due to a lack of standard design criteria, but is in the range of 60-90%. These wetlands also benefit the area by providing fish and wildlife habitat and aesthetic benefits.

<u>Utilize Instream Habitat Restoration Techniques (Phase III)</u>
Habitat restoration techniques include instream structures that may be used to correct and/or improve fish and wildlife habitat deficiencies over a broad range of conditions. Examples of these techniques include: channel blocks, boulder clusters, covered logs, tree cover, bank cribs, log and bank shelters, channel constrictors, cross logs and revetment and wedge and "K" dams. The majority of these structures are to be installed with hand labor and tools. After construction, a maintenance program must be implemented to ensure long-term success of the habitat structure. It should be noted that in areas that experience high stormwater peak flows, in-stream habitat restoration should be installed after desired flow target is reached so as to ensure the success of the habitat improvement project.

6.3.5. Reduce Chemical Pollutants

<u>Conduct Household Hazardous Waste Management (Phase I)</u>
The average American household contains 3 to 10 gallons of hazardous chemicals including items such as automotive wastes, cleaners and paints. In general the public is unaware of the problems associated with the over-use and improper disposal of these materials. In addition, the public generally does not recognize the toxicity of materials used in and around homes. The goal of a Household Hazardous Waste Program is to minimize the purchase and use, and properly store and dispose of household hazardous materials which exhibit characteristics such as: corrosivity, ignitability, reactivity, and/or toxicity, or as listed as hazardous materials by the EPA. The proper disposal of hazardous materials will minimize the amount of hazardous materials that will enter surface waters and groundwater supplies.

<u>Install/Maintain Oil and Grease Trap Devices (Phase I)</u>
Oil and grease traps remove abnormally high concentrations of petroleum products, grease and grit by gravity and coalescing plates. These devices are particularly useful on industrial sites, vehicle maintenance and washing facilities, areas where heavy mobile equipment is used, restaurant kitchens and restaurant dishwashing equipment. Conventional oil/water separators have the appearance of septic tanks, but are much longer in relationship to the width. Separators for large facilities have the appearance of a municipal wastewater primary sedimentation tank. These devices are only effective for reducing abnormally high concentrations of oils and greases. Their performance is unproven for urban storm water runoff.

6.3.6. Promote Watershed Stewardship

Public Participation/Education Programs (Phase I or II)

Public participation and education programs are activities where people learn about and/or work together to control storm water pollution. These programs are critical in urban and developing watersheds because pollution caused by the every day actions of the general public make up a good portion of pollution sources. These programs would be based on the following four objectives: 1) promote a clear identification and understanding of the problem and solutions, 2) identify responsible parties/target audiences, 3) promote community ownership of the problems and solutions and 4) integrate public feedback into program implementation. To achieve these objectives the audience needs to be identified, the program carefully designed and the program effectiveness periodically reviewed. Public participation/education programs can include the following activities:

- Adopt-a-stream programs – utilizing citizen volunteers to conduct benthic macroinvertebrate, aesthetics, or other monitoring on a regular basis to reflect changes
- Program planning and tracking – public surveys and database
- Program identity – program message, logo and tag line
- Collateral material – newsletters, fact sheets, brochures, posters
- Coordinating committees – focus groups, stewardship/protection groups that meet regularly
- Residential programs – storm drain stenciling, home toxics checklist/alternatives and other neighborhood specific projects, demonstration lawns and gardens, rainbarrels, etc.
- Presentations – environmental booths, speakers bureau and special events
- Business programs – workshops, publications and green business projects, recognition programs
- Construction programs – workshops, educational materials and certification, recognition programs
- Consumer programs – point of purchase displays and printed grocery bags
- School education – facility tours, contests and curriculum, outdoor education, schoolyard habitats

Highlight Watershed Issues in the Media (Phase I)

Watershed education studies show that the public generally receives their environmental information from the major media – television, newspapers, and radio. Various popular marketing and advertising techniques to take advantage of these media have been tested in the Chesapeake Bay Watershed area as well as the neighboring Huron River Watershed area. Creative, visual, and targeted messages in the major media via press releases, advertisements, and public service announcements - can go a long way toward creating an aware and educated public.

6.3.7. Integrate Stormwater Management into Operating Procedures

Implement creative financial solutions (Phase II)

Integrating stormwater management programs into the daily procedures of a community will most likely incur new costs. In many cases, communities and agencies will need to explore creative solutions to finance new staff, new programs, new requirements in their stormwater program. Grants may be available, often with a local match involved, but these are short term solutions for one time projects. Long terms solutions that have been tested include implementing a stormwater utility fee, incurred by users of the stormwater system; use impervious cover as basis for user fees; give credits to fees if private detention/retention practices exist; create habitat stamps patterned after duck stamp program; one-time septic system installation fee; establish forest and wetland mitigation banking system; Restore Buffer Incentive Program to $500/acre payment to landowners; purchase of environmental easements by the private sector; adopt-a-stream/fish giving programs; statewide Purchase/Transferable Development Right Bank (PDR/TDR); lawn and garden fertilizer surcharge; charge per day per exposed acre of land on construction sites.

Implement institutional framework to carry out watershed actions (Phase I or II)
Watersheds are a hydrologic boundary, not a political boundary. Therefore, some level of institutional arrangements must be established so that the various local, county, state and federal jurisdictions, which fall into the watershed boundary, are coordinated. It is recommended that the coordination of the watershed level be tiered as it is in government. Watersheds are often broken down into subwatersheds or tributary groups that consist of 10-15 parties so as to have a more manageable working group. These subwatersheds then have a representative at the watershed level to coordinate watershed-wide initiatives and decisions. Often, at the watershed level, there is a working group dedicated to watershed issues. This may be a council where member communities and agencies sit on the board. It may be an independent research group that is contracted by the communities and agencies to provide data and information about the watershed. It may be a county or state agency who takes the lead on coordinating watershed issues in and outside of its political jurisdiction. In the Rouge, the Rouge Program Office has been working as a watershed-wide research assistance organization coordinated under Wayne County, the Rouge Steering Committee includes representatives from seven subwatershed groups to take care of watershed-wide decisions, and the seven Subwatershed Advisory Groups (SWAGs) include representatives from each of the associated communities and agencies. As the Rouge program evolves and funding sources change, it will be up to these groups to decide how institutional arrangements will work best to continue restoration and protection efforts.

Integrate stormwater management into community planning (Phase I or II)
In every community, and most importantly in less developed communities, it is important to have a strong and defensible plan for the community and the protection of its natural resources. As new information becomes available about watershed management, communities will need to stay informed. Planning commissions and departments, as well as boards and councils, who are responsible for recommending how the land is developed need to have a master plan, zoning ordinance and other ordinances that reflect how their community will be shaped and what natural resources will be preserved. Since these decision-makers may not have knowledge about stormwater practices and the benefits of natural resources, it may be important to keep new members informed about the community's resources and priorities on a regular basis so that they are able to make informed decisions in the site plan review process and larger environmental issues.

Increase enforcement capacities (Phase I)
After ordinances and regulations are in place, there can often be a lack of resources and personnel to enforce the ordinance. Since many natural features protection ordinances deal with preserving certain features on the site of a development, careful and regular inspection during the design and construction process is necessary in order to ensure that the ordinance requirements are being followed appropriately. Sometimes this means increasing the number of personnel dedicated to inspection and enforcement, and/or the increase of enforcement follow-through and fines. Just as important in ensuring ordinance compliance is implementing an educational component that will explain the requirements of the ordinance and the different acceptable ways that the contractor can comply with the requirements. Put in plain terms, and with illustrations, this education process, both for compliance personnel and developers/contractors, can go a long way toward decreasing the amount of non-compliance issues.