Storm Water Management

One of the challenges to local governments in protecting water quality is preventing and treating storm water runoff. Storm water runoff is one of the major sources of pollution degrading our water resources. This is largely due to the early focus on and success in reducing pollution from point sources (e.g., industrial plants) and the growing number of impervious surfaces such as roads, parking lots, and buildings. Impervious surfaces add to the amount and rate of storm water entering our surface waters. This storm water carries a variety of pollutants such as fertilizers, pesticides, oil, bacteria from animal waste, and increased flow into the system. This results in degradation to our water resources, increases in the magnitude and frequency of flood events, reductions in fish and other aquatic species diversity, increases in streambank erosion, and decreases in infiltration into the groundwater. As a result, new regulatory requirements are evolving that will affect the planning practices of local government.

In response, SEMCOG's *Water Quality Management Plan for Southeast Michigan* (Water Quality Plan) includes a framework for managing storm water runoff and encourages local land use decision making that is compatible with sustainable water quality. The tools in this section expand on the framework in the Water Quality Plan. They provide the information necessary to begin to incorporate water quality protection into local plans and ordinances.

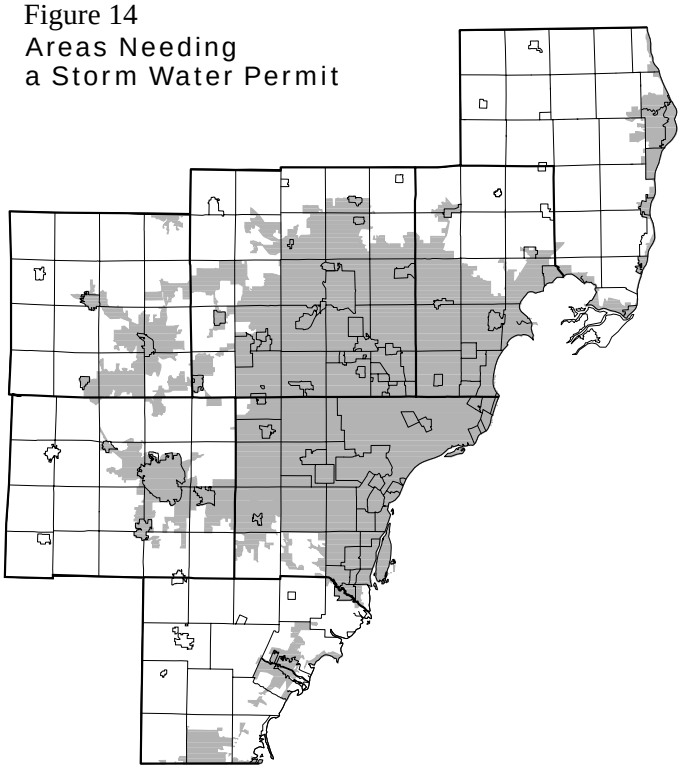
Keeping It Connected

Storm water management can go hand-in-hand with traffic calming. Both roundabouts and adding curves to straight roads are traffic calming techniques that offer storm water management opportunities. For example, bioretention areas with low, native plants could be placed at the center of roundabouts, in road medians, and along the curves of roads.

Planning and Regulatory Considerations

Initial efforts to improve water quality at the federal level primarily focused on reducing pollutants in industrial process wastewater and discharges from municipal sewage treatment plants. But as pollution control measures for these sources were implemented and refined, studies showed that more diffuse sources of water pollution were also significant causes of water quality impairment. Of specific concern was storm water runoff draining off large surface areas, such as agricultural and urban land.

Figure 14
Areas Needing
a Storm Water Permit



Source: SEMCOG.

Beginning in 1991, the federal Clean Water Act required communities with populations over 100,000 served by separate storm sewer systems to obtain a National Pollutant Discharge Elimination System (NPDES) permit to discharge storm water to creeks, streams, and rivers. Under this program, construction sites greater than five acres also are required to obtain storm water discharge permits.

Beginning in 1999, Phase II of the federal storm water program was implemented. Phase II requires permits for communities in urbanized areas with populations under 100,000 and for construction sites greater than one acre in size. In accordance with this rule, over 175 Southeast Michigan communities must receive a storm water permit from the Michigan Department of Environmental Quality.

The tools listed below are a starting point in meeting these storm water requirements.

Tools to Implement Storm Water Management

Land use tools can be utilized to aid storm water management in three ways:

- Incorporating storm water into the master plan.
- Reducing and preventing storm water runoff.
- Managing storm water runoff once it has occurred.

Incorporating storm water into the master plan

Community plans also need to acknowledge the importance of storm water management and relate it to the health, safety and welfare of its residents. Managing storm water protects water quality, reduces flooding, and preserves water features such as lakes, streams and wetlands so that they can continue to perform the functions that people depend on.

Storm water management goals within the master plan should not only address *quantity* of storm water, but *quality* as well. For example, an overabundance of nutrients in a lake will cause algae growth, which is a water quality problem for both people and the environment. Therefore, the goals for storm water management should include elements that:

1) Protect the land's natural ability to absorb, clean, and store storm water.
2) Minimize impervious surfaces in new construction and redevelopment projects to reduce the amount of runoff and improve infiltration.
3) Use Best Management Practices (BMPs) throughout the community to handle storm water.
4) Implement community programs that improve water quality and educate the public about their role in water quality.
5) Link protection of water quality through storm water management, impervious surface reduction, and erosion and sedimentation control, to the protection of residents' health, safety, and welfare.

Example goals

Goal: Storm drainage systems shall manage storm water runoff in a manner that allows as much water as possible to naturally infiltrate into the ground. Any water that does not infiltrate should be stored in a safe and environmentally sound manner, and released from the site at the same volume, velocity, and water quality as under pre-development conditions. Storm water shall not leave a site without sediments being allowed to settle out, and allowing the water to be filtered through an above-ground system to remove pollutants.

Goal: To the maximum extent possible, Best Management Practices (BMPs) shall be used to capture, store, and filter storm water runoff before release into any natural system. If possible, above-ground structures, such as vegetated swales, manufactured wetlands, and other similar BMPs shall be used. If necessary, a combination of above-ground and below-ground BMPs shall be used.

Goal: Improve storm water quality by implementing programs throughout the community that remove pollutants from storm water, and educate the public about ecologically safe practices to follow around their homes and businesses.

Storm water management incorporated into a local park in St. Clair Shores.

Policies pertinent to storm water management should address:

1) Storm water quantity: Limiting the amount of storm water that can enter natural systems from developed sites is important to the preservation of the community's natural features.
2) Storm water quality: Water quality from developed areas is dependent on the storm water systems ability to allow water to infiltrate into the ground, as well as filter the water leaving developed sites.
3) Community actions: These policies work to improve water quality by emphasizing actions that the community and its residents can take to protect water resources.

Example policies

Policy 1: Manage storm water *quantity* so that it leaves a developed site at the same volume and velocity as under pre-developed conditions.

- Minimize impervious surfaces in new construction and in redevelopment projects.
- Build infiltration areas into new development and redevelopment projects.
- Preserve open spaces in a natural condition as mechanisms for storm water *infiltration*.

Policy 2: Manage storm water *quality* so that it leaves a developed site at the same or better quality as under pre-developed conditions.

- Use Best Management Practices (BMPs) that minimize, collect, and treat storm water.
- Use BMPs that pre-treat or filter storm water of pollutants and sediments before it reaches natural water features.
- Maintain BMPs according to a pre-determined schedule that addresses the following:
  - Regular clean-out, maintenance, and/or inspection of structural controls (such as catch basins, vegetated swales, infiltration basins, etc.).
  - Label outfall structures that discharge runoff to natural systems.
  - Identify the funding source for the schedule of maintenance activities.
  - Monitor the maintenance program for effectiveness.

Policy 3: Develop and implement community programs that address storm water quality.

- Initiate a household hazardous waste clean-up day.
- Produce and distribute educational materials for residents that discuss the impacts of their actions on storm water quality.
- Commit to using lands owned and maintained by the community as demonstrations for desirable storm water management practices.
- Augment the county's street sweeping efforts to smaller, local roads. Strive to sweep these streets monthly in high construction areas.
- Work to (or coordinate with the county to) evaluate the amount of salt and/or sand that is applied to roads in the winter. Implement procedures to keep, as much as possible, salt/sand out of storm water systems.
- Collect leaves in the fall and compost them for use in community landscaping projects.
- Develop and follow building and vehicle maintenance procedures that keep hazardous substances out of storm drainage systems.

Reducing and preventing storm water runoff

Utilize low-impact development

Preventing storm water runoff from residential, industrial, and commercial property can result from efforts at the local planning and zoning level. One technology being utilized is low-impact development (LID). In LID technology, the traditional approach to site drainage is reversed to mimic the natural drainage functions. Instead of rapidly and efficiently draining the site, low-impact development relies on various planning tools and control practices to preserve the natural hydrologic functions of the site. Two important aspects of LID are minimizing impervious surfaces and preserving existing natural features.

Auburn Hills is managing parking lot runoff by capturing and treating the runoff instead of directing it to the storm drain.

Minimize impervious surfaces

Local ordinances and regulations can be passed minimizing impervious surfaces, resulting in less storm water runoff. Consider reviewing:

Parking standards

- The required parking ratio governing a particular land use or activity should be enforced as both a maximum and a minimum in order to curb excess parking space construction.
- Develop parking standards that reflect average parking needs instead of single peak day projections.
- Parking lots can be made more attractive at the same time they treat storm water. Bioretention areas, dry swales, perimeter sand filters, and filter strips are all effective at treating storm water within the parking lot.

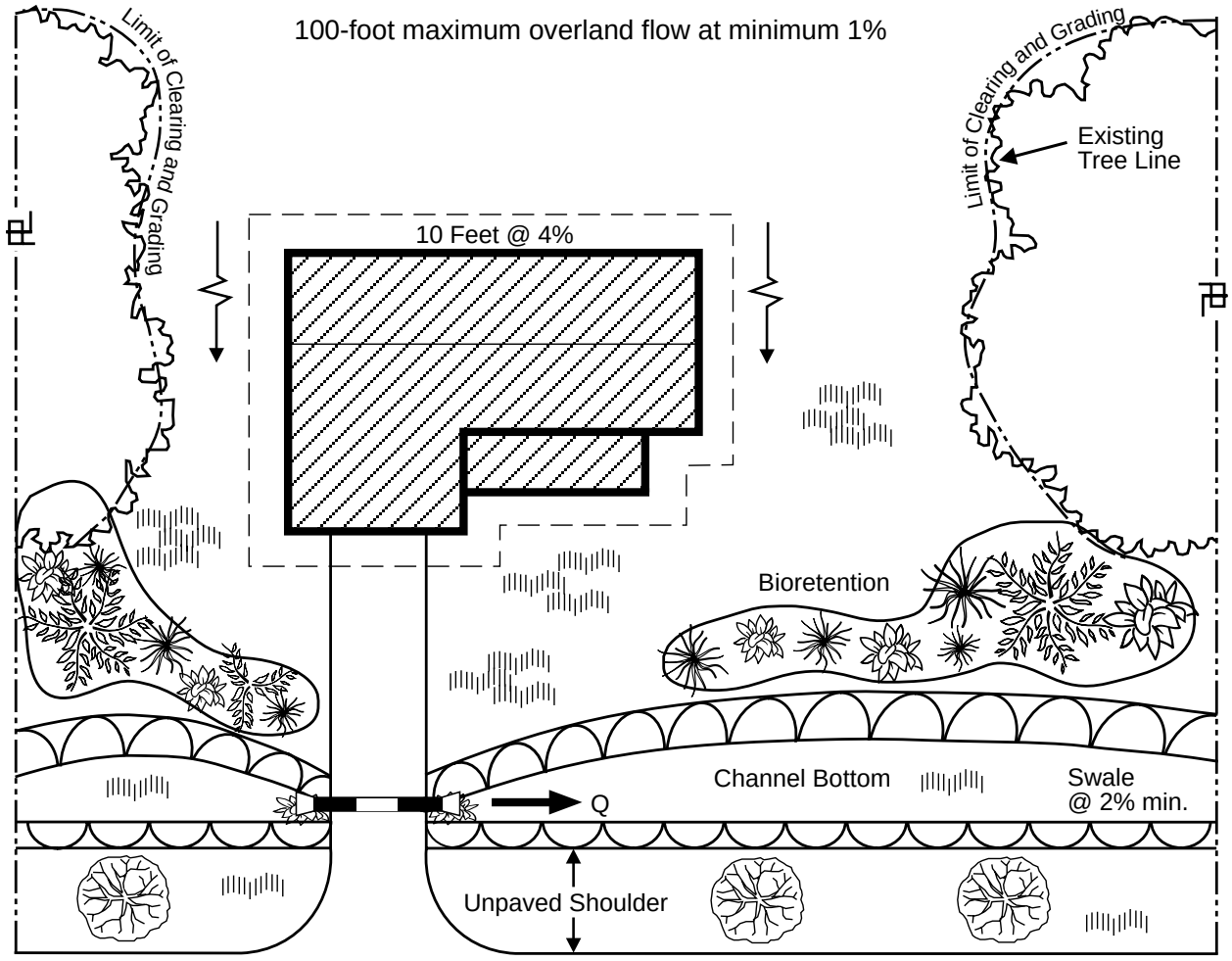
Lot setbacks/Lot width

- Relax side yard setbacks and allow narrower frontages. This reduces total road length in the community (and overall site imperviousness) and can be used to encourage traffic calming.
- Relax front setback requirements to minimize driveway lengths and reduce overall lot imperviousness.

Miscellaneous

- Retrofit existing cul-de-sacs with depressed vegetated islands or rain gardens designed to hold and treat storm water.

Figure 15
A Low-Impact Development: Residential Lot



Swale roadside drainage, storm water storage "bioretention" basins, and undisturbed areas are typical features of a low-impact lot.

Prepared by: Ron Struss, MN Board of Water and Soil Resources/U-M Extension Service.

Source: Dakota Soil and Water Conservation District and the Protecting Water Quality Through Low-Impact Development Workshop Handbook, May 14-15, 2001, Eagan, MN.

- Include in subdivision codes that downspouts should not be connected to the storm sewer.
- Reduce road lengths and widths. Not only does this reduce impervious surfaces, but can also be a traffic calming technique.

Preserve and restore natural features

Preservation and restoration of natural features is another practice that reduces storm water runoff in your community. Wetlands, woodlands, and open spaces allow precipitation to infiltrate into the ground. This not only reduces runoff, but replenishes the groundwater supply.

Use open space development

(See also section on Managing Residential Development.)

- Implementing open space design subdivisions incorporates smaller lot sizes which minimizes total impervious area, reduces total construction costs, conserves natural areas, provides community recreational space, and promotes watershed protection. These designs should be considered an option in a residential district.
- Leave as much open space as possible in its natural condition. This provides storm water infiltration and has a minimal annual maintenance cost.

- Link open space to existing wetlands, river systems, and other open space areas. This provides a buffer to these sensitive areas, allows scenic recreational opportunities for residents, provides a wildlife corridor, and could provide a location for nonmotorized transportation opportunities in the community.
- Minimize the amount of clearing and grading on a site. This will preserve natural areas and reduce soil erosion and compaction.

Managing storm water runoff

Initiate a storm water ordinance

A storm water management ordinance can be used to communicate to developers how storm water quality and quantity are viewed by the community, and can give them guidance to how they should approach storm water management on site through their designs. Storm water runoff is one of the major sources of pollution degrading our water resources. This is due, in part, because we have become very efficient at collecting runoff, and carrying it off site through underground pipes. These pipes, however, do not filter the storm water of pollutants before it reaches a stream or wetland.

Under the new federal Phase II storm water regulations, permitted communities are required to include provisions for developing, implementing, and enforcing programs to manage storm water from new development and redevelopment. Storm water ordinances are one mechanism to ensure not only that these requirements are satisfied, but that your community's storm water goals are being met.

A storm water ordinance regulates storm water runoff for the purpose of protecting local water resources from degradation, preventing flooding, and meeting other water quality and quantity goals. Regulating storm water runoff minimizes runoff rates and volumes, soil erosion, stream channel erosion, and nonpoint source pollution. This regulation falls under protecting the public interest and preventing threats to public health and safety.

Consider the following when developing a storm water ordinance:

- Require development and redevelopment projects to meet both flood control and water resource protection performance standards.
- Ensure that the storm water outlet does not exceed its reasonable share of the maximum capacity of the downstream watercourse or closed conduit.
- Limit land disturbance and grading.
- Require that storm water drainage improvements follow the natural drainage pattern of the land to the fullest extent possible.

Incorportating storm water standards into local ordinances is one mechinism local communities can utilize in managing storm water runoff.

- Manage storm water for the 100-year storm, bank full conditions and first flush volume. For stream channel protection, require that bank full volumes are managed on site and released gradually into the stream.
- Require that the first flush volume (approximately 35 percent of the bank-full flood storage volume) cannot be discharged until it is treated by capture and gradual release over a period of at least 24 hours.
- Maintain or establish buffer strips (minimum of 30 feet) from the top of bank of any watercourse or surface water.
- Ensure that the applicants demonstrate that storm water management systems will be maintained in perpetuity.
- Require that soils be aerated/decompacted after construction is complete. Compacted soils reduce infiltration and can cause storm water management practices to be ineffective. In fact, storm water best management practices should be clearly labeled on grading plans and flagged in the field to ensure heavy construction equipment avoids these areas.
- Rather than place specific storm water design criteria into an ordinance, it is often preferable to fully detail these requirements in a storm water design manual. This allows specific design information to change over time as new information or techniques become available without requiring the formal process needed to change ordinance language.

Use Best Management Practices

Communities should have policies and standards in place that encourage the use of Best Management Practices (BMPs) whenever possible to minimize, collect and treat storm water. Storm water BMPs consist of methods or a combination of methods that prevent or reduce water pollution generated from

nonpoint sources. In general, BMPs can be structural, or they can be non-structural policies that help protect water resources. Structural BMPs are most often described in a community's Engineering Design Standards, which provides minimum standards on how each type of facility is to be built. BMPs should function together as a system to ensure that the volume, rate, timing, and pollutant load of runoff remains similar to that which occurred under natural conditions.

Structural Best Management Practices. Structural BMPs are physical means of accomplishing the above goals and can be divided into four categories:

1) Detention structures. Structures that "detain water, and let it out slowly until the pond is dry.
2) Retention structures. Structures that "retain" water, holding it until it infiltrates into the ground or evaporates.
3) Vegetated swales and strips.
4) Other. Practices to reduce accumulated pollutants picked up by runoff, regulate the amount of impervious areas, and eliminate inappropriate discharges to drains and storm sewers.

Examples of various structural BMPs are listed below. Please note that some examples may fall under more than one category.

Detention structures

- detention ponds
- wet ponds
- storm water wetlands
- multiple pond systems

Retention Structures

- wet ponds
- infiltration trenches
- infiltration basins
- storm water wetlands
- multiple pond systems
- rain gardens

Vegetated swales and strips

- grassed swales
- filter strips

Other practices

- porous pavement
- grass pavers
- water quality inlets (e.g., oil/grit separators)

Where each of these structural BMPs can be used is site specific and dependent on soil type, infiltration rate of soil, the level of the water table at the particular location, amount of sediment at the site, thermal impacts, space constraints, drainage area, and cost. Therefore, a particular BMP should be selected based on the water quality needs as well as cost, drainage area, land use, soil and topography. Consideration should also be given to addressing maintenance and inspection of BMPs to ensure that they are functioning properly.

Storm water management in Northville Township.

Policy (non-structural) Best Management Practices. Prevention and/or reduction of pollution generated from nonpoint sources can also be accomplished through the use of a community's policy BMPs, standards or programs. These tools can be described in the community's property/facilities management manual, master plan, and/or zoning ordinance. Examples of policy BMPs are:

Storm water system maintenance

- street sweeping
- catch basin cleaning
- outfall inventory/inspection
- woody debris management
- stream bank stabilization
- floodplain/wetland management
- household hazardous waste disposal
- equipment/storage area maintenance
- fertilizer management

Site development

- cluster housing
- minimize street parking
- minimum/maximum parking space criteria
- lot coverage requirements
- open space requirements
- require use of structural BMPs
- enforce soil erosion and sedimentation control (SESC) practices
- development and maintenance agreements

Public education/outreach

- display boards

Table 17
Planning Criteria for Best Management Practices

BMP	Description	Function	Application
Extended wet detention pond	Small constructed lake or basin with emergent wetland vegetation around the bank.	Designed to detain runoff from storm events until it is displaced by subsequent events. Reduction of storm water peak discharge. Removal of suspended solids. Removal of metals and nutrients.	Generally used for drainage areas in excess of five acres.
Extended dry detention pond	A pond or basin that is usually dry between storms that captures runoff and releases it slowly enough to allow most sediment to settle.	Less effective than wet retention pond at removing pollutants. Reduction of storm water peak discharge. Removal of suspended solids.	Used for tributary watersheds 10 acres and larger to remove particulates.
Constructed wetlands	Constructed basin with a significant percentage covered.	Reduction of storm water. peak discharge.	Removal of suspended solids. Removal of metals and nutrients by wetland vegetation. Removal of pathogens.
Vegetated swales	Channels or flat surfaces lined with vegetation that filters flow.	Removal of nutrients.	Removal of suspended solids.
Storm water filters	System that uses a filter medium (sand, gravel, peat or compost) or surface vegetation to remove a fraction of the polluting constituents in runoff. Limitations in cold climates because of freezing of medium.	No affect on storm water flow attenuation. Removal of nutrients. Removal of suspended solids. Removal of pesticides. Used for reducing sediment, fertilizers, pesticides, etc. from drainage areas up to five acres with slopes up to two percent (e.g., along roads, around parking lots).	Used mostly for particulate removal of runoff from large paved areas.
Oil and grease separators	A device that removes abnormally high concentrations of petroleum compounds, grease, and grit.	Removal of petroleum or grease. Removal of suspended solids.	At commercial/industrial facilities that generate high levels of oil products or grease. In medium to large parking or motor vehicle storage areas.

Source: *Planning and Cost Estimating Criteria for Best Management Practices*, Rouge River National Wet Weather Demonstration Project, April 2001.

- cable programming
- fliers/brochures/newsletters
- public meetings/workshops
- volunteer opportunities
- website
- river/creek signage

BMP selection. Selecting the BMP for your site is an imperative step in meeting your community's storm water goals. The Center for Watershed Protection (CWP) has developed a Web site called Storm Water Manager's Resource Center to assist communities in this process. CWP provides a series of matrices that can be used as a screening process for selecting the correct BMP for a development site. Screening factors include:

- land use (practices best suited for the proposed land use at a site),
- physical feasibility (physical constraints that may restrict or preclude a BMP),
- climate/regional factors (regional characteristics that restrict or modify the use of certain BMPs),
- watershed factors (which BMP helps meet watershed protection goals),
- storm water management capability (which BMP or combination of BMPs are needed to meet storm water sizing criteria),
- pollutant removal (how does each BMP compare in terms of pollutant removal), and
- community and environmental factors (decide if the BMPs have any important community or environmental benefits or drawbacks that might influence the selection).

Case Example

Storm Water Management Program

Community: Canton Township

Contact: Tom Casari, (734) 394-5150

Canton Township developed a storm water manual in March 1997 to assist in implementing their storm water ordinance. Specifically, the purpose of the manual is to help property developers understand storm water management standards for new construction projects. Design guidelines for new storm water management facilities are detailed in this manual along with Best Management Practices (BMPs) which address both water quality and quantity issues.

Topics in the manual include:

- design runoff rates
- downstream improvement requirements
- enclosed systems design criteria
- outlet sizing
- road culverts
- open channel modifications
- BMPs (such as wet detention ponds, streambank stabilization, oil/water separators, extended detention basins, sand filters, constructed wetlands, and vegetated swales)

Procedures and Design Criteria for Storm Water Management Systems

Community: Washtenaw County

Contact: Janis Bobrin, (734) 994-2525

Washtenaw County's storm water program embodies a shift in storm water management philosophy from a flood control perspective to include design standards that provide more sophisticated quantity control and directly address water quality.

The office of the Drain Commissioner exercises authority over the design and construction of structural facilities that convey and treat stormwater runoff that will be generated from a site as a result of its design. The Drain Commissioner's Rules will govern the design of such management facilities with the following objectives:

- Incorporate design standards that control both water quantity and quality.
- Encourage innovative stormwater management practices that meet the criteria contained within these rules.
- Place greater emphasis on the maintenance of facilities.
- Make the safety of facilities a priority.
- Strengthen the protection of natural features.
- Encourage more effective soil erosion and sedimentation control measures.

Following is a sample of the hierarchy for structural controls that positively influences both water quantity and quality:

- In general, the most effective storm water quality controls are infiltration practices, which reduce both the runoff peak and volume. But, to date, structural infiltration devices such as basins and, to a lesser degree, trenches have suffered extremely high failure rates due to clogging. Therefore, an aggressive maintenance program must be incorporated into these controls. In addition, these practices are only feasible on small sites, with suitable soils and no potential for groundwater contamination.

- The next most effective storm water site controls reduce the runoff peak and involve storage facilities such as retention and detention ponds. In selecting an appropriate storm water pond design, wet ponds are generally preferable to detention ponds, since they hold storm water much longer, allowing more particulates to settle out. In addition, the aquatic plants and algae within wet ponds take up soluble pollutants (nutrients) from the water column. These ponds must manage storm water for the 100-year storm, bank-full conditions, and first-flush volume.

Additional Resources

Canton Township. *Canton Storm Water Management Manual*.

Center for Watershed Protection. *Better Site Design: A Handbook for Changing Development Rules in Your Community*. Ellicott City, MD: Center for Watershed Protection, 1998.

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United States Environmental Protection Agency. Office of Wastewater Management. Post-Construction Storm Water Management in New Development and Redevelopment. www.epa.gov/OW/index.html