Chapter 2

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2.00 BEST MANAGEMENT PRACTICES

2.10 BMP SELECTION

WHAT IS A BMP?

The following definitions are taken from Minn. Stat. §103F.711, Minnesota Clean Water Partnership Act:

> "**Best Management Practices**" are practices, techniques, and measures that prevent or reduce water pollution from nonpoint sources by using the most effective and practicable means of achieving water quality goals. Best management practices include, but are not limited to, official controls, structural and nonstructural controls, and operation and maintenance procedures.
>
> "**Official Controls**" are ordinances and regulations that control the physical development of the whole or part of a local government unit or that implement the general objectives of the government unit.

BMP SYSTEMS

A treatment system consists of a series of best management practices (BMPs). Such systems may include multiple management options, ranging from street sweeping and structures to open space and litter control laws. Although stormwater ponds and wetland-treatment systems are most often the tools for treatment and storage of urban runoff, they are only some of the tools in this process.

PRIORITIES

Address the appropriate BMPs by priority:

1. Avoid adverse impacts.
2. Minimize unavoidable adverse impacts.
3. Mitigate unavoidable adverse impacts.

AVOIDANCE

It is generally the policy of this manual that the first and best BMP is to avoid impacts.

Avoid development-related construction activity in the most sensitive areas. For example, avoid development along the shorelines of lakes or streams, in natural drainageways, or in areas dominated by steep slopes, dense vegetation, porous soils, scientific and natural areas, or other identified resources. Implementing avoidance measures may require zoning and development policies that specifically limit these options.

MINIMIZATION

As development occurs, there is a need to develop policies that reproduce predevelopment hydrologic conditions. This implies looking at reproducing the full spectrum of hydrologic conditions, including peak discharge, runoff volume, infiltration capacity, base flow levels, ground water recharge and maintenance of water quality.

A comprehensive approach to hydrology involves the entire context of site planning. The issues of runoff volume, infiltration recharge, and water quality revolve around the amount of impervious surface required by development and its configuration in terms of its relationship to drainage paths and vegetative cover.

One goal should be to preserve and utilize the natural drainage system. Keep pavement and other impervious surfaces out of low areas, swales and valleys. For example, a site plan should keep roads and parking areas high in the landscape and along ridges wherever possible.

Try to avoid connecting streets, roofing and parking areas with pipes or other structures. Utilize natural topography and vegetated waterways to convey acceptable levels of runoff.

Fit development to the terrain by choosing road patterns that provide access schemes that match the land form. For example, in rolling or dissected terrain (typical in much of Minnesota), use strict street hierarchies with local streets branching from collectors in short loops and cul-de-sacs along ridge lines. This approach results in a road pattern that resembles the branched patterns of ridge lines and drainage ways in the natural landscape. Road patterns like these facilitate the development of plans, which work with the land form and minimize disruption of existing grades and natural drainage. For more information, see chapter 3 and Figure 3.30-1.

These measures are more difficult to achieve than it appears, because they go against long-established policies, which too often increase flows and destroy the waterways we wish to utilize.

MITIGATION

Treatment is mitigation for unavoidable impacts.

Any alteration of the drainage and ecological system can have positive and negative environmental impacts. As Schueler (Schueler *et al.*, 1992) points out: "…systems, which offer reliable pollutant removal and longevity, tend to be associated with the greatest number and strongest degree of secondary environmental impacts. Careful site assessment and design are often required to prevent stream warming, natural wetland destruction, and riparian and habitat modification."

The Metropolitan Washington Council of Governments (MWCG) studied temperature and dissolved oxygen effects from four BMPs: (1) infiltration dry pond, (2) extended-detention artificial wetland, (3) extended-detention dry pond and (4) wet pond (Galli, December 1990).

The MWCG researchers concluded that none of the four BMPs was "thermally neutral." All four BMPs caused a rise in temperature and each violated Maryland standards some of the time. Temperature-standard violations occurred under both base-flow and storm-flow conditions. The infiltration dry pond produced the smallest temperature increases, whereas the wet pond had the highest recorded maximum change in temperature.

The MWCG recommends a long-term, holistic approach to watershed management. Its BMP design recommends increasing the performance of infiltration devices by improving the infiltration design capacity and intentionally oversizing the basins. The design also recommends buffer strips and shading of pilot and riprap outflow channels by landscaping or other means.

The MWCG recommends carefully examining long periods of extended detention control. It recommends a six- to 12-hour detention-period limit be established for sensitive areas, and that shading in the storage pool be required. In addition, the MWCG recommends more research on the case-specific effects of BMPs and their effectiveness at controlling temperature increases; water temperature monitoring for thermally sensitive areas should be greatly increased.

Even if a constructed system of BMPs functions as expected in terms of pollutant removal, other potential impacts could result.

BMP SELECTION OPTIONS

Select and implement BMP options on a system-wide, regional, and waterbody basis, as appropriate to meet the system goals. Also, determine the appropriate measures after considering a variety of factors, including:

- the characteristics of the resource to be protected,
- the feasibility of implementation,
- public demands and
- governmental requirements.

An application for a National Pollutant Discharge Elimination System (NPDES) permit by the City of Minneapolis (Minneapolis, City of, 1991) utilized a tiered or prioritized process for evaluating pollutant management in its stormwater-treatment system (Table 2.10-1). Many of these BMPs can be implemented through education or regulation. Six groups of BMPs listed here are based on the primary implementation method that is likely to be effective. In general, the least-impacting level that will solve the problem should be used.

Note in Table 2.10-1 that structural methods and treatment were in the last tier level. This prioritization is due to the expense and physical alteration necessitated by treating runoff after it is generated. If it is feasible to meet the project objectives, including protection of downstream water-quality characteristics, without structural methods, such as construction of stormwater ponds, this is usually more cost effective and creates less disruption of the community.

SELECTION CONSIDERATIONS

Temperature

Ponds designed to hold large volumes of water to settle solids have a tendency to raise water temperatures. This can lower the concentration of dissolved oxygen in a pond and release phosphorus and toxics that are sensitive to pH and other chemical changes due to low oxygen. Anaerobic conditions or excess production of algae could be other secondary impacts from the construction of ponds.

Table 2.10-1 A list of potential best management practices

Information and Education
- Catch basin stencils
- Erosion control information
- Fertilizer and pesticide application
- Illicit dumping and littering information
- Landscaping information to reduce runoff
- Maintenance of lots (parking and vacant)
- Proper storage of chemicals
- Proper yard waste disposal
- Information on hazardous waste and used motor oils

Ordinances and Regulations
- Erosion-control ordinances
- Comprehensive management plans for developments
- Elimination of illegal connections
- Fertilizer and pesticide licensing
- Illicit dumping and littering enforcement
- Land use controls
- Landscaping requirements to reduce runoff
- Special commercial or industrial requirements
- Pet ordinances

Elimination of Discharges
- Infiltration basins
- Pervious structures
- Diversion or off-line infiltration devices

Source Controls by the City
- Limiting infiltration to storm sewers
- Effective use of deicing chemicals
- Management of hazardous waste and used motor oils
- Management of commercial and residential yard wastes
- Monitoring programs
- Storm sewer outlet and streambank erosion prevention and maintenance
- Spill response and prevention
- Street cleaning
- Storm sewer maintenance

Minor Structural Controls
- In-line sediment traps
- Skimmers and separators

Treatment Measures
- Detention basins
- Stormwater-treatment facilities
- Swirl concentrators
- Alum treatment

Modified from: City of Minneapolis, 1992

Aesthetics

The appearance of stormwater ponds varies tremendously depending upon the desires of the local community, the amount of money available for aesthetic work, such as landscaping, and the intended function of the pond or system of ponds. The trend in the Twin Cities area is to incorporate stormwater ponds into parks and recreational areas. Safety and aesthetic concerns can often be addressed together through appropriate use of vegetation.

There are many good examples of multiple-use facilities that incorporate stormwater detention into the provision of accessible recreation. Recent projects have created permanent areas of open water in wet ponds that are integrated into walking trail systems and other features.

The development of multiple-use facilities depends upon the support of local government and the availability of funds.

Effect on Other Resources

When planning a BMP, consider the effect it will have on other resources. Without proper design and planning, your BMP may simply shift a water-quality problem elsewhere. Improperly designed BMPs can adversely affect stream temperature, peak-flow timing, aesthetics, and ground water. Fish and wildlife can also be adversely affected. Studies have shown that pollutants, such as trace metals, can bioaccumulate in plants and fish that live where sediment from urban storm water is trapped. Many BMPs trap pollutants that need to be disposed of in an environmentally sound manner.

The potential for odor, insects, weeds, turbidity and trash are also important to residents who live near structural BMPs. With regular maintenance, these problems can usually be overcome or be made very temporary.

Physical Site Suitability

BMPs should only be used in areas where the physical site characteristics are suitable. Some of the important physical site characteristics are soil type, watershed area, water table, depth to bedrock, site size and topography. If these conditions are not suitable, a BMP can lose effectiveness, require excessive maintenance or stop working after a short while.

Unfavorable site conditions can often be overcome with special design features. For example, the bottom of a detention pond can be sealed to prevent seepage at a site where a permanent pool is desired. In other cases, a practice will be excluded from consideration when a site presents impractical conditions. An example would be where a high water table or clay soils eliminate an infiltration basin from consideration. The physical site conditions must be examined for each practice.

Maintenance Requirements

Stormwater ponds, as well as wetlands or other areas that receive stormwater flows, require periodic maintenance, such as disposal of trash and sediment. In fact, maintenance is an important part in the operation of any BMP. The initial design of a BMP should take maintenance requirements into account. A feature, such as a forebay in a detention pond, may increase annual maintenance costs slightly, but the interval between costly sediment cleanouts of the whole pond may be extended significantly. Locations for disposal of material should be taken into account during this phase of planning a BMP.

Cost Effectiveness

A continuous tradeoff exists between building ponds and other land and resource commitments. Pond construction and maintenance can be expensive and may reduce the availability of development sites. This is a frequent concern of real-estate interests.

Conversely, stormwater ponds may increase property value as well as aesthetic amenities to the neighborhood. These same ponds may reduce the cost of constructing downstream storm sewers or providing flood-prevention measures.

Economics is an important consideration in the selection of BMPs that will achieve the water-quality goal at the least cost. This should be considered when selecting BMPs and deciding how they will be implemented. To properly compare alternatives, all costs for the design life of a BMP should be included. These include expected maintenance costs as well as the initial costs for land, engineering and construction.

To create a true economic picture of a BMP, benefits other than water quality and flood prevention should also be considered. Some benefits, such as increases in land values for property next to an attractive detention pond, are direct economic benefits. Other benefits, such as incidental recreation or wildlife benefits, may be more difficult to quantify.

2.20 BMP SYSTEMS

It is very important to adopt an interdisciplinary approach when designing BMP systems. Create a design team as an integral part of this approach. Members of the team should have expertise in stormwater engineering, wetland ecology and other natural-resource-management skills, such as landscaping and construction of BMPs. The design team should work together through a four-stage process that begins with a watershed assessment and ends with site management. The entire sequence may take several years.

Table 2.20-1 outlines the tasks required for each stage of BMP-system planning and construction. These tasks are suggested with the realization that designing a BMP system is too complex and site-specific to be reduced to a "cookbook" guidance. Rather, the tasks are intended to help the design team adopt and modify the process to meet local conditions and plan-review requirements.

Table 2.20-1 Stages of stormwater-treatment system design and construction

1. **Develop the watershed plan for stormwater-treatment systems**
   - Inventory wetlands, lakes, flowages and streams.
   - Consider potential BMP sites.
   - Establish management goals for waters.
   - Determine growth rates and ultimate development.
   - Design a system that accommodates this plan without resource destruction.
   - Establish a funding mechanism to fund studies and implement a plan.
2. **Develop the on-site concept plan for the BMP system.**
   - Locate flow patterns and discharge points from the area.
   - Protect local resources and unique features.
   - Locate potential treatment options.
3. **Refine the BMP system design for each site.**
   - Design the BMP system for maximum pollutant removal.
   - Incorporate standard design features into the system.
   - Develop a plan for the BMP system and its aesthetic and habitat components.
4. **Implement and maintain the system.**
   - Prepare the site and construct the treatment system.
   - Establish and maintain the site and surrounding areas.
   - Inspect, manage, monitor and maintain the treatment system after construction.
   - Re-evaluate and adapt the system as needed.

Stage 1: Watershed Plans

Inventory and analyze the physical and natural features of the watershed to determine which treatment system is realistic. Plan to meet stormwater and water-quality goals. This should be accomplished as soon as possible. Key feasibility factors include:

Inventory. The location and quality of all aquatic systems, including lakes, streams, springs and wetlands, and important upland features, such as mature forests, should be carefully delineated. Potential BMP sites should be identified.

Management Goals. Establish goals and functions for significant water bodies, such as lakes or wetlands. Goals should be based on the characteristics of the water bodies. For example, the influx of phosphorus and total suspended solids (TSS) to lakes may require treatment to prevent eutrophication, while wetland vegetation may need to be protected from drainage and inundation. Streams may require erosion-control measures to protect the banks.

BMPs should generally not be constructed in natural wetlands. The exceptions to this rule should be based on plans that protect the wetland functions and values. Stormwater-wetland conflicts can often be avoided if overlay maps are developed that show all existing wetlands and other pertinent features, such as existing and proposed drainage systems.

Assess Environmental Constraints. BMP systems should not overload the hydraulic or nutrient capacity of natural stream or wetland systems.

Protect Unique Systems. Streams capable of supporting trout may require special protection from suspended solids and increased temperature. Infiltration may be required.

The use of shade strips along a stream will help maintain lower water temperatures. For example, the Minnesota Department of Natural Resources Forestry guidelines for trout streams suggest a 50-foot-wide filter strip along streams where the slope exceeds 10%. The strip not only shades the stream surface, but allows the overland flow to be cooled as it passed under the forest canopy.

Control runoff from industrialized areas or areas with a potentially significant loading of pollutants, such as road salts and deicing compounds.

If the contributing drainage area to a proposed stormwater-control system is larger than 100 acres, flow-control and channel-protection measures should be seriously considered.

Determine Ultimate Development. Zone and restrict uses that are clearly not compatible with the stormwater-management and water-quality goals for the system.

Design a System. The system should meet all management objectives, not just stormwater control.

Establish a Funding Mechanism. Establish and maintain a reliable and effective funding system. Area charges or utility assessments for storm water have been shown to be an effective method to finance new systems, maintain existing systems and fund system improvements. We recommend a “surface water utility” or other permanent mechanism be implemented.

Stage 2: On-site Assessment Plan

The second design stage involves the selection and adaptation of basic BMP designs to a specific area.

Staking the Site. The team should visit the site to locate unique features, flow patterns and discharge points from the area. An attempt should be made to identify and protect local resources and unique features.

Consider Potential Treatment Options. The design team reviews the overall development plan to find opportunities to make the BMP system easier to establish. For example, the possibility of regional ponds or construction of new wetlands might be explored. Similarly, the site plan can be adapted to designate protected areas, such as extending "tree-save" areas to retain forest cover, wetland buffers, or provide buffer-area links to increase contiguous habitat area.

Assess Your Opportunities. The concept design for the BMP system should explicitly consider the method of runoff conveyance to the stormwater-treatment system. Decide whether the treatment system will be on-line or off-line, and how it will manage large- and small-design storms.

Stage 3: Refine the Stormwater-Treatment-System Design

Stage 3 is the design stage, where the design team refines the plans, including the geometry and volume of the stormwater ponds, hydraulics of the conveyance systems and other BMPs, to optimize pollutant-removal performance.

The design team should select the most appropriate BMP-system design, based upon the results of the feasibility analysis conducted in Stage 1. The basic design is adapted to a concept plan, which is submitted to the appropriate agencies for preliminary approval.

Design features intended to accommodate operation and maintenance activities should be incorporated into the final design.

Permanent easements should be obtained to provide access for activities, such as removal of sediment removal and maintenance of pond outlets.

Stage 4: Implementation and Maintenance

A plan outlining operation and maintenance activities for the site should be developed. Site-specific BMPs should be developed, especially for projects proposing to discharge stormwater runoff to waterways or wetlands. Often, these BMPs should include a schedule for removing sediment from retention basins and other maintenance measures.

Projects that require a NPDES permit may require specific BMPs during construction. A stormwater-management plan is generally required under the permit to manage pollutants in runoff from the site during and after construction. Federal, state and local units of government may require other permits also.

Design needs to be continued through the operation-and-maintenance phase. Measures that need to be addressed include:

- establishing and maintaining the site and surrounding areas;
- inspecting, managing, monitoring and maintaining the treatment system; and
- re-evaluating and adapting the system as needed.