# Chapter 5
# Stormwater Design Considerations

**Issues Requiring Design Consideration:**

- Minimize Runoff Before Treatment
- Incorporate Reasonable Runoff Calculation Assumptions
- Provide & Size Pretreatment to Hold Annual Sediment Loadings - Accounting for Sanding
- Avoid Bypasses that allow Stormwater to Pass Untreated
- Use BMPs that Fit the Site
- Keep Snow Cover & Plowing in mind when siting BMPs
- Design for Maintenance making Access Readily Available and Frequency Realistic

Chapter 2 discussed the problems associated with traditional treatment designs and introduced the BMPs that DEP is recommending for use to meet water quality and quantity objectives. The design and installation of these BMPs, when sized correctly, will ensure that DEP's objectives are met. However, there are other stormwater design aspects that should be considered and incorporated into the planning and design process.

The following guidelines are recommended to address some of the issues found in traditional designs and site development, building on the existing successful techniques and improving many aspects of current stormwater handling and management.

## 5.1. Incorporate Low Impact Development (LID)

Many impervious areas are directly connected to drainage systems, increasing the volume and rate of runoff leaving a site. As discussed in Chapter 3, LID practices can be used to minimize the volumes and rates of runoff leaving a site, by handling it at the source, allowing for smaller 'end of pipe' treatment structures. LID practices should be encouraged as an alternative to or in combination with traditional techniques. Traditional treatment components are still important parts of the nation's infrastructure, and provide a major benefit to the communities using them, but the fact is that they are just trying to approximate the efficiency of natural systems. These stormwater control practices focus on mitigation, not prevention. Traditional designs are now put in place as development occurs, but they are designed for anticipated problems with the development. These systems are still treating the symptom rather than the source.

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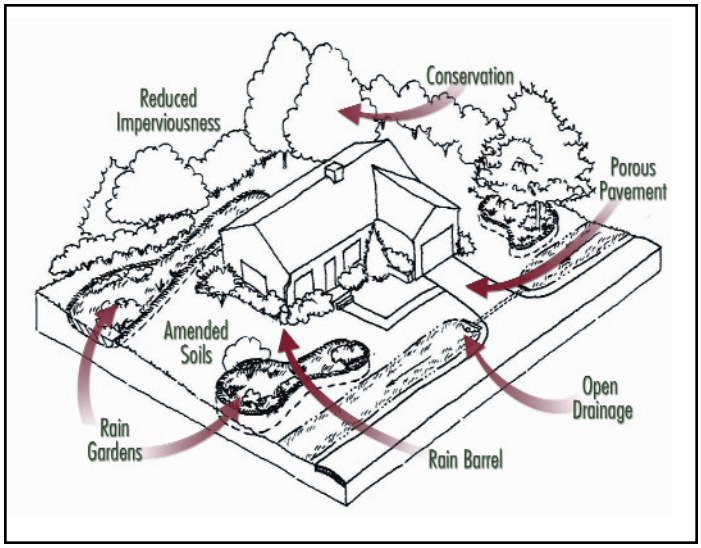
The LID methods and techniques introduced in Chapter 3 and further provided in Volume III, are examples of improvements that can be integrated into future design work to control flow generation at the source and prevent the production of large volumes of stormwater runoff in the first place. Designing a development to prevent the stormwater from concentrating will reduce the magnitude of the problem before designing costly systems to deal with it. This proactive approach will enable creative developers and homeowners to draft more alternatives for renovations and new development.




Drawing Courtesy of Puget Sound Action Team

*This drawing reflects how LID can be incorporated into renovations or new development projects. This example shows how multiple LID techniques can be used to minimize runoff from a site. Ideally, LID should be incorporated at the design stage to most closely mimic predevelopment conditions, but many of the features could also be incorporated into a redevelopment project.*

## 5.2. Sizing and Siting of Drainage Controls

The model TR-55, a runoff calculation model, is commonly used by developers and others to estimate pre and post runoff volumes and size drainage structures. TR-55 requires knowledge of the soil type and groundcover on the site and leaves it to the user's discretion to determine whether the existing and proposed cover types are in good, fair or poor condition. More information on hydrologic modeling can be found in Volume III.

In Maine, all pre-development conditions should be assumed to have good condition groundcover, and all post-development conditions should be assumed to have poor condition groundcover. Afterall, there is no guarantee that the property owner will maintain their property in the best possible condition. Additionally, any site that was wooded within the last five years should be considered undisturbed woods for all pre-construction runoff conditions, regardless of clearing or cutting activities that may have occurred on the site during that pre-application period.

Further, all stormwater controls should be sized assuming annual maintenance only. Sizing assumptions should not be based on more frequent maintenance since it rarely happens.

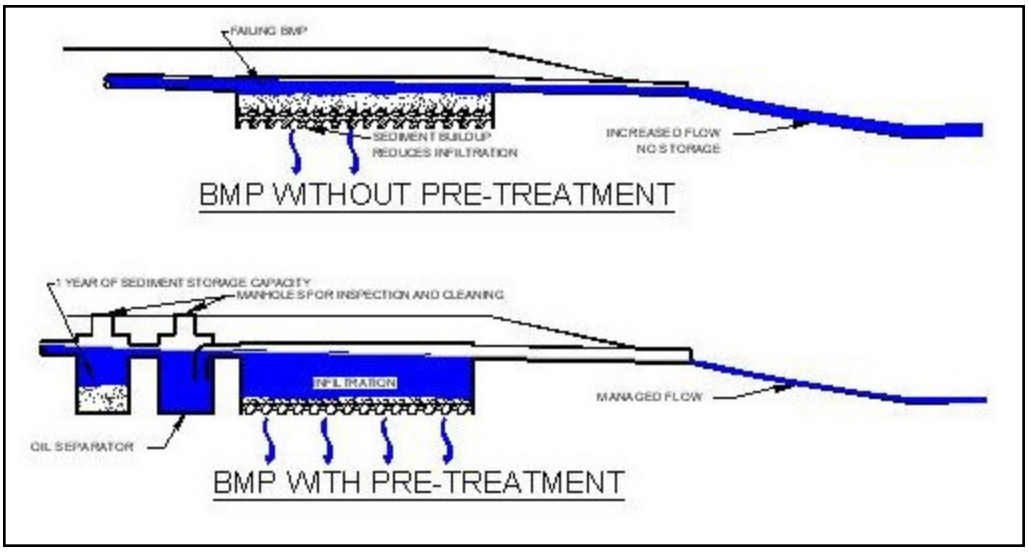
## 5.3. Provide Pretreatment on all BMPs

All stormwater treatment designs should include a mechanism to remove unwanted materials from the stormwater runoff prior to its entrance into the treatment unit. This is particularly important for infiltration systems. Except for rooftop runoff, stormwater contains sand and silt particles that can fill in detention structures and clog infiltration devices over time. One of the leading causes of failure in stormwater infiltration devices is clogging due to silts and sediments.

*This pretreatment basin or sediment forebay has simple construction using a gabion (rock filled wire basket) berm. This helps reduce the velocity of the flows and settle out some sediments before the water is treated further.*

To avoid premature failure, pretreatment must be installed to remove these particles. This can be done through an upfront settling basin, a deep sump catch basin not in series, a maintainable filter or some other appropriate device. The system should be designed such that when the pre-treatment unit requires maintenance the unit will start to fail. It should not just stop collecting sediment but should also stop passing water, without a bypass.

Surface infiltration devices such as raingardens and other LID techniques discussed in Chapter 3 and Volume III, typically provide pretreatment in the upper layers of the structure before it enters the infiltration reservoir area. Most use a




*Pretreatment to remove coarse sediments is critical to the life of a stormwater treatment system, particularly infiltration and filtration systems. Without it, systems will quickly clog with the sand and silt particles carried by stormwater. This drawing shows how an infiltration system will function with and without pretreatment. Without pretreatment, as shown on the top figure, sand and silt in the stormwater deposit in the infiltration system, causing it to clog. This results in the discharge of untreated stormwater to the nearby stream. In the bottom figure, pretreatment is provided, allowing for greater infiltration of stormwater and less water being discharged to the stream..*

layer of non-woven filter fabric in the upper profiles of the device. Regardless of the material used to provide pretreatment, its placement should allow for easy access to clean accumulated sediments that may build up over time.[1]

In areas where petroleum byproducts or other chemical spills could occur, such as gas stations, additional pretreatment should be added to remove the anticipated contaminants. However, infiltration should not be used at these sites.

All stormwater controls should have easily accessible, preferably visible, pre-treatment as a key feature of the design. The pre-treatment unit should be easily maintained and readily monitored for performance. An O&M plan with maintenance schedules and observable triggers identifying when maintenance is needed should be provided.

## 5.4. No Bypasses

Bypasses are used on some treatment systems that allow the stormwater control device to be bypassed if not maintained. In particular, some underground units are designed with bypasses should they fill with sediment or otherwise fail. In underground structural units, this failure is invisible so a bypass capability essentially renders the unit useless. Bypass capabilities should be prohibited so that at least water backing up in the unit will signify the need for maintenance. An exception to this would be in the case of a combined sewer, in which the back up of raw sewage would not be desired.

## 5.5. Adapt to Site-Specific Conditions

Some special site conditions may initially seem to preclude the use of infiltration techniques, including LID practices, but there are methods that may be used to adapt infiltration or LID practices to these sites. For example, sites with shallow groundwater suggest the use of wetlands treatment techniques since infiltration will not work seasonally. Similarly, organic absorption infiltration layers can be added where bedrock is shallow.

All sites can benefit from increasing the organic content of the onsite soils. In particular, the organic content of soils used in LID practices such as bioretention cells and raingardens is extremely important to the functioning of these systems. Not only do the soils promote the removal of pollutants in the water, but also provide absorption of runoff. The organic soils act as a sponge to retain water, providing more storage capacity than would normally occur. These systems can be modified to include underdrains that will carry excess water away from the site, after it has passed through the soil media. Underdrains may also be used to route stormwater flows to an area of more native soil material or sand that can be used for infiltration.

[1]Some techniques may need little or no maintenance over time if the size of the infiltration area is large enough in comparison to the drainage received. Most will need simple landscape type maintenance such as spring and fall cleanup. However, the filter fabric keeps fines from clogging the infiltration media (usually crushed stone) and provides an easily maintainable surface should further restoration be needed. The fabric can be cleaned with a vacuum unit or "vac truck" without major reconstruction. Similar to an engine without oil, the treatment will fail if not maintained. If pre-treatment fails, water will backup but the primary system is protected and it will start working again when it is maintained.

## 5.6. Consider Northern Climate Issues

Maine experiences very cold winters and the effects of our northern climate on BMP design should be considered. Some considerations include:

- Avoidance of curbing that could cause ice jamming by plows;
- Design of infiltration systems assuming storage only and no exfiltration (as could occur under winter conditions);
- Use of traditional overflows to municipal system in case of freezing and snow cover;
- Avoidance of the use of permeable pavers in areas where plows could hit and dislodge pavers;
- Separation of infiltration BMPs from roads by more than 10 feet and use of small volume BMPs only where infiltration might seep under the roadway;
- Fencing to protect vegetation from vehicles plowing snow.


Photo courtesy of http://www.massport.com/logan/pic/c_1176b_plow2.jpg

*Maine experiences very cold winters, with a lot of snow. Plowing, like shown on the left, is necessary to keep roads clear for safe passage. Stormwater treatment devices need to be designed with consideration to cold weather and plowing.*

In all cases, these designs will not create flooding issues as they are designed with overflows in the unlikely event that the unit ices completely over.

## 5.7. Insure Continuing Maintenance of All Stormwater Controls

Maintenance of BMPs is essential for them to perform as designed. There is widespread failure of traditional stormwater controls such as detention basins and other sediment containing controls. The good news is that they work well to remove sediments and the associated pollutants for a time, otherwise they would not fill up. The bad news is that they cease to function properly if not maintained and many are difficult to impossible to renovate and restore to original function. Some designs are too demanding for reasonable cost-effectiveness and continued attention. Issues include:

- Difficult access for equipment;
- Difficult to clean without complete renovation;
- Lack of maintenance easement or method for access;

*The detention area upgradient of this wetland was not properly maintained, causing large amounts of sediment to deposit in the wetland and the downstream pond. The cost to retrofit this BMP will be more costly than performing periodic maintenance originally specified.*

- Lack of ability to see if unit is full;
- Lack of understanding of maintenance needs;
- Problems with owner knowledge of system;
- Inability to backcharge owner if municipality must do the work;
- Too frequent maintenance because of undersizing of unit;
- Proposed maintenance burden on owner too great.

All BMP designs should comply with the following:

1. Formal equipment access
2. Ease and minimal cost of cleaning
3. Permanent maintenance easement
4. Method and easy access for evaluation of maintenance
5. Provisions for groundwater monitoring and assessment of the quantities of sediment removed, along with estimates in the design of expected annual sediment quantities.

A detailed and reasonable Operations & Maintenance plan should be developed, including manpower and budget needs.

## References

Comprehensive Environmental Inc. March 2003. *City of Nashua, New Hampshire Alternative Stormwater Management Methods, Part 1 – Planning & Guidance.*