5.0 TMDL IMPLEMENTATION

Once the TMDL development process is complete, an implementation plan is developed to ensure that appropriate management actions are taken to remove impairments. Management actions typically include identifying specific control measures (e.g., installing BMPs) that will be taken to reduce pollutant loadings and monitoring to assess water quality improvements. Sources of stormwater impairments are typically many and diffuse. As a result, phased TMDL implementation using adaptive management techniques will likely be required to remove impairments from streams.

A description of the phased TMDL implementation approach is provided below, followed by an introduction to management actions designed to reduce stormwater impacts to streams. A detailed Stormwater TMDL Implementation Support Manual for Stakeholders is presently under development and will soon be available to support TMDL implementation actions.

5.1 TMDL Implementation Approach

The TMDL implementation strategy should be part of a comprehensive watershed-specific management program. Recommended steps for developing and applying phased TMDL implementation for each watershed are as follows:

1. Review available watershed data and reports, including TMDLs and watershed assessment documents;
2. Conduct a detailed source identification and characterization program:
    - Use local knowledge (e.g., from local Department of Public Works, Boards of Health, and watershed groups) and draw on other ongoing programs (e.g., NPDES Phase 2 Municipal Separate Storm Sewer System (MS4) stormwater discharge inventories and illicit discharge inspection programs)
    - Conduct on-the-ground reconnaissance to identify potential sources;
    - Review infrastructure maps (e.g., storm sewer, sanitary sewer, and CSO maps) to identify potential sources; and
    - Review other available information to identify potential sources.
3. Prioritize sources for mitigation. High priority should be assigned to the sources that can be addressed most cost effectively;

4. Identify specific management techniques to mitigate or remove each source or type of source;
5. Develop detailed site-specific designs and programs for each local management practice;
6. Obtain funding to remediate highest priority sources;
7. Implement management practices to mitigate sources;
8. Monitor changes in receiving waters as management practices are implemented (including pre-implementation monitoring) and re-evaluate sources; and
9. Revisit and/or repeat Steps 3 through 8, as needed until TMDLs are attained.

In most watersheds, sources of stormwater impairments are many and diffuse. As a result, appropriate management practices must be selected, designed, and implemented at numerous locations in each watershed to mitigate adverse impacts and control impairments. The most appropriate suite of management practices vary depending on land use and impairment cause. The implementation strategy is an iterative process where data are gathered on an ongoing basis, sources are identified and eliminated if possible, and control measures including Best Management Practices (BMPs) are implemented, assessed, and modified as needed.

5.2 Evaluation of Alternative Management Actions

This section provides an introduction to stormwater management actions. A detail stormwater TMDL implementation support manual for stakeholders is presently under development. The management practices outlined below are designed to address a wide range of impacts associated with different types of land use. When these practices are implemented, major improvements in watershed health, well beyond reductions in loadings, will be realized, including improvements in stream physical, hydrologic, water quality, and biologic characteristics. Thus, development and application of the TMDL implementation plan will have far reaching benefits to the watershed.

Table 5-1 provides a matrix of management practices vs. mitigation provided and land use applicability. This matrix is intended to assist resource managers in evaluating the suitability of each management practice at specific locations. Various stormwater BMP options are identified and their ability to mitigate hydrologic, sediment, and pollutant impacts are rated. Also, the applicability of each BMP to various land use conditions is rated. The ratings for applicability and mitigation are color coded in the table and are subjective.

Stormwater BMPs to mitigate impacts in urban and suburban areas, defined as residential, commercial, and industrial areas are emphasized in Table 5-1. Agricultural land uses and other land-modifying uses can also contribute significantly to stormwater impairments. Stormwater

BMPs to mitigate impacts in these areas are also important and are described in a companion stormwater TMDL implementation support manual (under development).

Practices which mitigate for multiple impervious cover impacts are preferred over those which mitigate for a single impact. For example, stormwater retention/recharge practices are preferable to stormwater detention practices. Retention/recharge practices mitigate peak rates of discharge, volume of discharge, and reduced baseflow, whereas detention only mitigates peak rates of discharge.

Priority should be given to management practices based on their ability to treat the causal factors of the impairment as opposed to the symptoms. Therefore, the following hierarchy of impacts should be used for evaluation of management scenarios, in descending order of priority:

- Hydrologic impacts
- Physical impacts
- Water quality and biological impacts

Since mitigating measures should be evaluated based on their ability to mitigate for all of the impacts of impervious cover (hydrologic, physical, biological, and water quality), the most effective best management practices (BMPs) have the following characteristics

- Designed for very small events and large events (traditional BMPs were only designed for large events),
- Provide for significant recharge of runoff, and
- Provide enhanced pollutant removal using biofiltration

Sub-watersheds with BMPS that meet the above criteria could be considered effectively pervious for evaluation of existing and future conditions. BMPs that do not meet the critera for full treatment will still provide some pollutant reduction, but may not mitigate as well for hydrologic and physical impacts. Since many of these BMPs do not reduce runoff volumes, pollutant loads will still be elevated compared with more pervious conditions. According to the Impacts of Impervious Cover document, approximately 140 monitoring studies were evaluated by R. Winer as part of the *National Pollutant Removal Performance Database for Stormwater Treatment Practices, 2nd Edition* in 2000. This study summarized the effectiveness of stormwater treatment practices in removing pollutants. Removal rates, such as those developed in the Winer study, can be used in developing pollutant loading rates from sites with BMPs that do not render their watersheds as effectively pervious.

One important BMP concept for consideration with the IC model is disconnection of impervious areas. One of the most effective low-impact development strategies (LIDS) for retrofits is to "disconnect" impervious areas. Impervious areas that drain directly to closed drainage systems produce runoff in all but the smallest of rain events. If runoff from paved surfaces is allowed to flow over pervious/vegetated surfaces before entering a drainage collection system, some or all of the runoff from small storm events will be intercepted and percolated into the ground. Disconnecting impervious areas from storm sewer systems can have significant benefits for small storm events, which make up the majority of all storm events. Methods of disconnecting impervious areas include:

- Removing curbs on roads and parking lots;
- Locating catch basins in pervious areas adjacent to (rather than in) parking lots; and
- Adding gravel or vegetated strips adjacent to roof areas.

LIDS can be an effective component of a comprehensive stormwater TMDL implementation plan.

5.3 Summary

Stormwater TMDL implementation plans and actions will likely be costly and time-consuming to complete. It is critically important to move forward with a phased implementation approach to removing stormwater impairments. A detailed stormwater TMDL support manual will soon be available to support stakeholders in mitigating stormwater impacts to New England's streams.

Table 5-1. Management Practices, Mitigation Provided, and Land Use Applicability Matrix

Management Practice	Mitigation Provided					Applicability							
	Runoff Volume (↑)	Peak Flow Rates (↑)	Baseflow (↓)	Sediment concentration (↑)	Pollutant concentration[1] (↑)	New Development	Retrofit	Urban	Sub-Urban	Agricultural	Residential Sub-Division	Commercial	Industrial
Stormwater Infiltration/Retention													
Infiltration Basin	Good	Good	Good	Good	Good	Well Suited	Moderately Suited	Moderately Suited	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited
Infiltration Trench	Good	Good	Good	Good	Good	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited
Infiltration/Biofilter Swale	Good	Good	Good	Good	Good	Well Suited	Moderately Suited	Moderately Suited	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited
Vegetated Filter Strip	Good	Moderate	Moderate	Moderate	Moderate	Well Suited	Well Suited	Moderately Suited	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited
Stormwater Detention													
Created Wetland	Moderate	Good	Not Applicable	Moderate	Moderate	Well Suited	Moderately Suited	Moderately Suited	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited
Extended Detention Ponds	Not Applicable	Good	Not Applicable	Moderate	Moderate	Well Suited	Moderately Suited	Moderately Suited	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited
Vegetated Riparian Buffer Zones	Moderate	Moderate	Not Applicable	Moderate	Moderate	Well Suited	Moderately Suited	Moderately Suited	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited
Swales	Moderate	Good	Not Applicable	Moderate	Moderate	Well Suited	Moderately Suited	Moderately Suited	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited
Other Stormwater Treatment													
Sand Filter/Filter Beds	Not Applicable	Not Applicable	Not Applicable	Moderate	Moderate	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited
Oil and Grit Chambers	Not Applicable	Not Applicable	Not Applicable	Moderate	Not Applicable	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited
Catchbasins with Sumps & Hoods	Not Applicable	Not Applicable	Not Applicable	Moderate	Not Applicable	Well Suited	Well Suited	Well Suited	Well Suited	Moderately Suited	Well Suited	Well Suited	Well Suited
Combined Sewer Overflow													
Combined Sewer Separation	Not Applicable	Not Applicable	Not Applicable	Moderate	Good	Not Applicable	Well Suited	Well Suited	Well Suited	Not Applicable	Not Applicable	Well Suited	Well Suited
CSO Prevention Practices	Not Applicable	Not Applicable	Not Applicable	Moderate	Good	Not Applicable	Well Suited	Well Suited	Well Suited	Not Applicable	Not Applicable	Well Suited	Well Suited
Low Impact Development Practices													
Disconnecting Impervious Area	Good	Moderate	Moderate	Moderate	Moderate	Well Suited	Well Suited	Moderately Suited	Well Suited	Moderately Suited	Well Suited	Well Suited	Well Suited
Bioretention	Good	Moderate	Moderate	Good	Good	Well Suited	Well Suited	Well Suited	Well Suited	Moderately Suited	Well Suited	Well Suited	Well Suited
Soil Amendment	Moderate	Moderate	Moderate	Moderate	Moderate	Well Suited	Well Suited	Moderately Suited	Well Suited	Well Suited	Well Suited	Moderately Suited	Moderately Suited
Pervious Pavement	Good	Good	Good	Good	Good	Well Suited	Well Suited	Well Suited	Well Suited	Moderately Suited	Well Suited	Well Suited	Well Suited
Green Roof	Good	Good	Not Applicable	Good	Good	Well Suited	Moderately Suited	Well Suited	Well Suited	Moderately Suited	Moderately Suited	Well Suited	Well Suited
Rain Barrels/Cisterns	Good	Moderate	Moderate	Moderate	Moderate	Well Suited	Well Suited	Well Suited	Well Suited	Moderately Suited	Well Suited	Well Suited	Well Suited
Rain Garden	Good	Moderate	Moderate	Good	Good	Well Suited	Well Suited	Well Suited	Well Suited	Moderately Suited	Well Suited	Well Suited	Well Suited

Key

- Minimal Mitigation
- Moderate Mitigation
- Good Mitigation
- Not Applicable
- Moderately Suited
- Well Suited

[1]Pollutants mitigated include nutrients, metals, and other constituents