Water Quality Program Guidance

Draft: Guidance for TMDL Implementation Plan Development for Urban/Rural Residential Land Uses within the Coastal Nonpoint Management Area

State of Oregon
Department of
Environmental
Quality

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Water Quality Program Guidance

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1. Introduction

1.1 Purpose

This document provides guidance to Designated Management Agencies (DMAs) for TMDL Implementation Plan development. Specifically, the guidance reminds DMAs that they are required under the existing provisions in OAR 340-042-0080 to develop TMDL Implementation Plans in accordance with the applicable Water Quality Management Plan (WQMP). The guidance recommends, but does not require, that DMA's expand their TMDL Implementation Plans to include control measures applicable to operators of regulated small MS4 sources and the control measures recommended by EPA in the "CZARA New Development Management Measure."

This Guidance serves as a supplement to DEQ's May 2007 TMDL Implementation Plan Guidance – for State and Local Government Designated Management Agencies available at http://www.deq.state.or.us/WQ/TMDLs/docs/impl/07wq004tmdlimplplan.pdf.

The purpose of this Guidance is:

- Provide information on how to prepare a TMDL Implementation Plan for DMAs located within the Coastal Nonpoint Management Area (Figure 1) and that would include control measures applicable for the:
  - Oregon TMDL Rule (Oregon Administrative Rules (OAR) 340-042-008);
  - National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Permit Requirements;
  - National Coastal Nonpoint Pollution Control Program Section 6217 of the Coastal Zone Act Reauthorization Amendments (CZARA) which is administered by NOAA and EPA, (16 U.S.C. §1455b);

This Guidance was prepared by DEQ as a commitment to assist urban and rural residential DMAs, such as cities, counties or special districts, in their efforts to develop successful TMDL Implementation Plans. The development of a single plan by DMAs to address TMDL, MS4, and CZARA water quality issues should avoid duplication and redundancy and be more efficient. For questions or comments on this document please contact your DEQ basin coordinator (http://www.deq.state.or.us/WQ/TMDLs/TMDLs.htm).

The Guidance outlines the rationale, steps, and issues that could be considered during the development of a TMDL Implementation Plan. The Guidance document is organized into three sections:

Section 1: Overview of TMDL, MS4 stormwater, and CZARA 6217 programs;

Section 2: Concepts for how a DMA that wants to voluntarily expand the TMDL Implementation Plan could include control measures applicable to operators of regulated small MS4 sources and the control measures recommended by EPA in the "CZARA New Development Management Measure."

Section 3: Components of a TMDL Implementation Plan to address post construction sediment and hydrology.

Figure 1. Coastal Nonpoint Management Area Boundary.

1.2 Background

The State of Oregon has developed and maintained a coastal management program since the early 1970's to address competing uses and resource impacts occurring in the state's coastal areas. Similarly, the development and implementation of TMDLs has occurred since the 1980's, including watersheds within coastal areas, to restore waters of the state that are water quality impaired. These programs are often complementary, and with this guidance, DEQ is further aligning the programs to improve the efficiency and effectiveness of water quality management in coastal areas.

Oregon relies on: the development and implementation of TMDLs; storm water control measures and CZARA 6217 management measures as tools to restore and protect the water quality of the state.

The TMDL provides the pollutant load reductions needed for 303(d) listed pollutant(s) and their source(s). Activities that can be sources of these TMDL pollutants in urban and rural residential areas include:

- Runoff from existing residential, commercial, industrial, roads, and other impervious land uses.
- Runoff from where construction activities are occurring.
- Runoff from proposed and future construction areas.
- Runoff from developing areas.
- Runoff from On-site disposal systems.
- Runoff from Roads, highways, and bridges.
- Runoff from General sources (households, commercial, and landscaping).

Pollution reduction is largely dependent upon having adequate pollution prevention mechanisms in place. Examples of pollution prevention mechanisms are: erosion control BMPs, riparian protection strategies, stormwater management strategies, and a well-defined adaptive management process.

TMDL Regulatory Authority

DEQ is authorized by the Environmental Quality Commission (EQC) to develop under the federal Clean Water Act (CWA) (CFR40§130 Total Maximum Daily Loads (TMDL) and individual water quality-based effluent limitations. http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&rgn=div8&view=text&node=40:21.0.1.1.17.0.16.8&idno=40) and Oregon statute (ORS468B.110 (1)) to develop and implement TMDLs according to Oregon Administrative Rule (OAR 340-042) for water bodies designated as impaired and listed on the 303(d) list.

TMDL Program

TMDLs are used to manage water quality so that impaired water bodies on the 303(d) list will meet water quality standards. DEQ's TMDL development schedule is annually reviewed and established by the regional and headquarters TMDL program managers. These decisions are prioritized based on funding, available resources, water quality impairment, available data, and local and EPA interests.

The Oregon TMDL rules (OAR 340-042) specify the elements that are to be included in a TMDL, WQMP, and a TMDL Implementation Plan. The TMDL includes allocations that when met the impaired water body would meet water quality standards. Allocations are established for both nonpoint sources (Load Allocations or LA) and for point sources (Waste Load Allocations or WLAs). WLAs are implemented by setting appropriate effluent limits in NPDES permits. LAs are met by DMAs implementing their programs or TMDL implementation plans.

An urban or rural residential DMA may be identified as a source of stormwater and non-stormwater pollutants (e.g. temperature), or both, and therefore given a TMDL WLA or LA for that pollutant. An urban and rural residential entity should use this Guidance if they are identified as a DMA in a TMDL and the entity is located within the Coastal Nonpoint Management Area (Table 1).

MS4 Stormwater Program Overview

Phase I or II MS4 permitted communities that are named as a DMA, and when stated in the WQMP, are required to prepare a TMDL Implementation Plan. In the case of Phase I MS4 permits, a Storm Water Management Plan (SWMP) is required to be written and sent to DEQ for approval. The SWMP must include benchmarks (or BMPs) for TMDL impairments and listed pollutants necessary to achieve TMDL load allocations. In addition, for those waterbodies located within a MS4 community that do not yet have a TMDL, the permit requires that all 303(d) listed pollutants must be evaluated to determine whether the SWMP reduces the 303(d) listed pollutant (Table 1).

EPA's NPDES Phase I or Phase II Stormwater rules (http://cfpub.epa.gov/npdes/stormwater/munic.cfm) require the MS4 permitted community to implement a stormwater management program and to prepare a SWMP in order to reduce the discharge of pollutants into the storm sewer system to the maximum extent practicable. Stormwater runoff may discharge into a municipal system, such as a stormwater pipe, ditch within an MS4 public right-of-way, or other conveyance system that collects and discharges into a waterbody.

CZARA Section 6217 – Coastal Nonpoint Management Area Post Construction New Development Management Measure Overview

TMDL implementation plans developed by urban and rural residential DMAs to meet CZARA Section 6217should address the post construction new development management measure that includes post construction total suspended solids (TSS) and pre-development hydrology targets (Table 1). These are contained in one of the 15 Urban Management Measures for areas within the Coastal Nonpoint Management Area boundary as identified in the NOAA and EPA "Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, issued under the authority of Section 6217 (g) of The Coastal Zone Act Reauthorization Amendments of 1990 http://www.epa.gov/owow/nps/MMGI/.

The components of the CZARA Section 6217(g) Post Construction New Development Management Measure are, to the maximum extent practicable:

- Practices that will reduce post-construction development TSS loadings by 80%; or
- Reduce TSS loadings so that the average annual TSS loads are no greater than pre-development loadings; and
- Maintain post-construction development peak runoff rate and average volume to pre-development levels.

Table 1. TMDL Implementation Plan Concepts to Address TMDL, MS4 Stormwater, and CZARA Programs

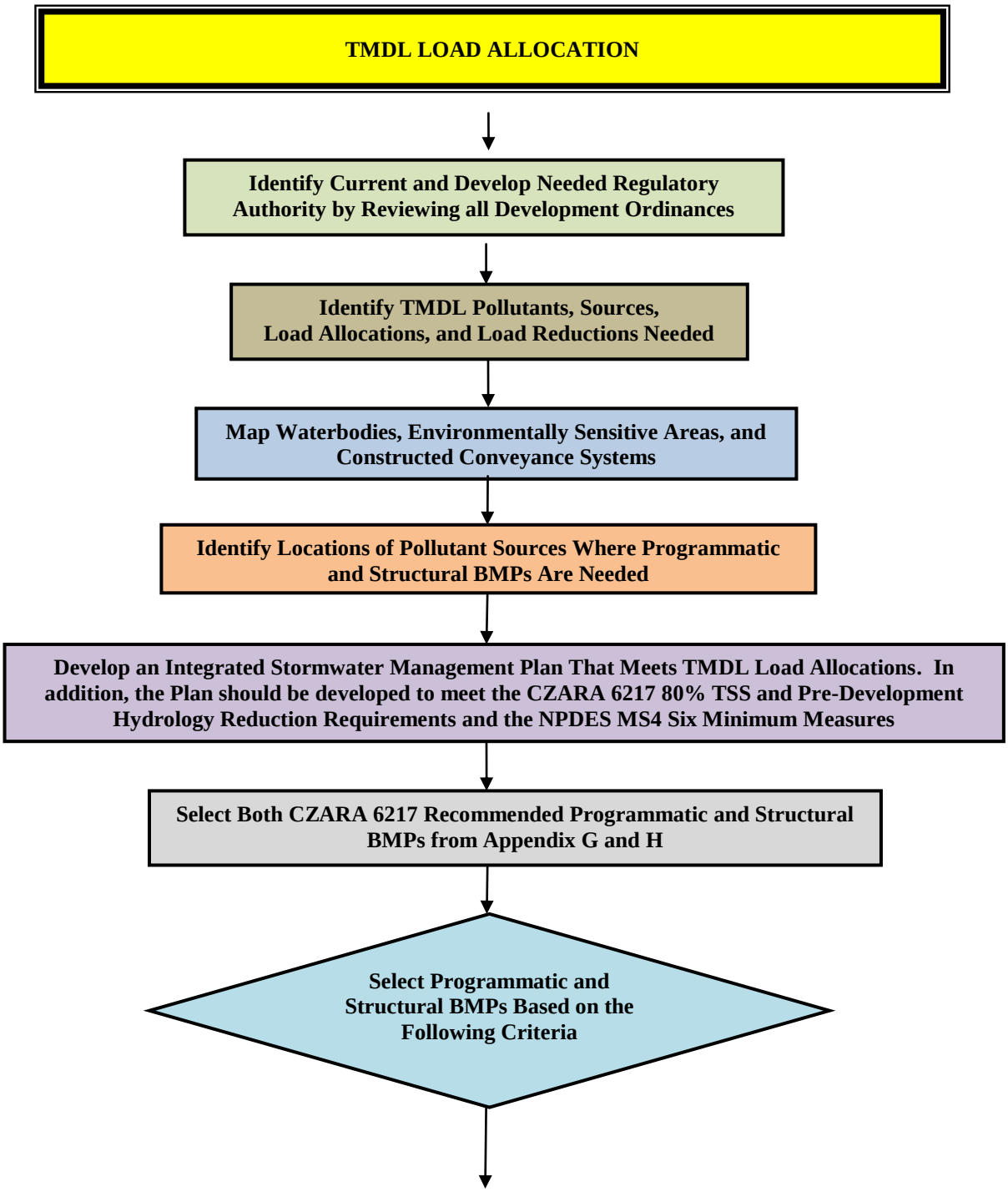
PROGRAM	REQUIREMENTS
Oregon TMDL Rule (OAR 340-042-008)	• **Meet the TMDL Rule regarding TMDL Implementation Plan development and implementation requirements.**
NPDES MS4 Stormwater Permit Requirements, if a MS4 Community	• **If a Phase I or II MS4 community, prepare a TMDL Implementation Plan to meet the requirements of the Water Quality Management Plan (WQMP).**
Coastal Zone Act Reauthorization Amendments (CZARA) Section 6217	• **Reduce the post construction average annual total suspended solid (TSS) loadings by 80 percent or** • **Reduce the post-development loadings of TSS so that the average annual TSS loadings are no greater than predevelopment loadings by design or performance, and** • **Maintain post development peak runoff rate and average volume at levels that are similar to pre-development levels.**

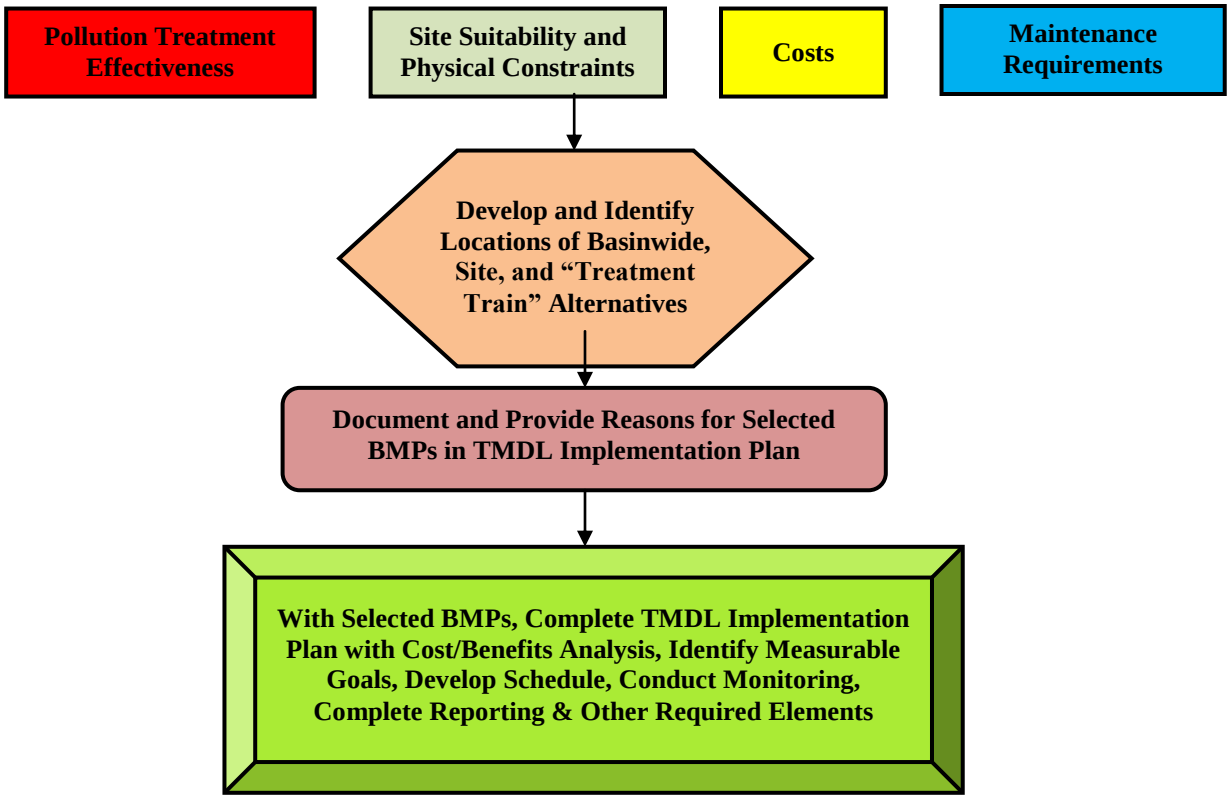
Local code amendments can be used to meet load reductions as well as new development management measure goals for post construction sediment and hydrology. The application of Goal 5 and Goal 6 land use laws in Oregon and the intersection with water quality rules to address the CZARA new development management measures are described in Appendix A.

2. Concepts for Development of a TMDL Implementation Plan

In Figure 2, are the concepts to consider for developing TMDL Implementation Plans in accordance with OAR 340-042 and to include control measures applicable to operators of regulated small MS4 sources and the control measures recommended by EPA in the "CZARA New Development Management Measure".

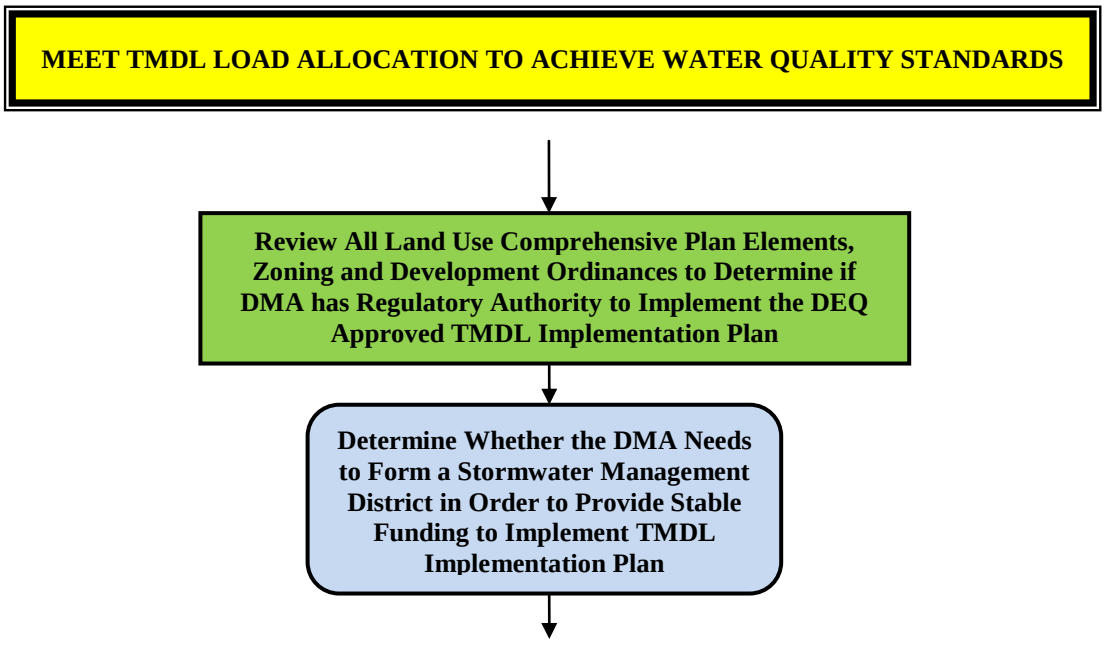
Figure 2. Process for TMDL Implementation Plan Development

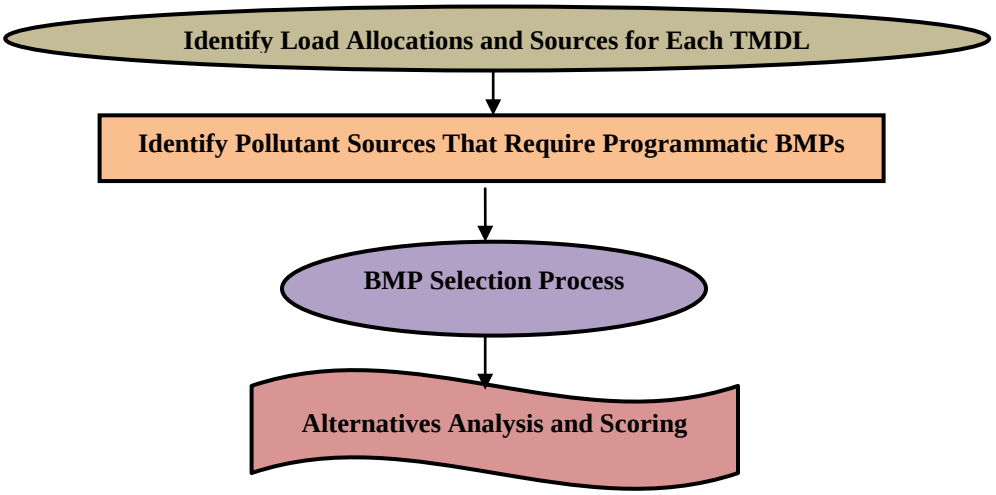




An important part of the above TMDL Implementation Plan process includes selecting programmatic BMPs for inclusion in the TMDL Implementation Plan. This selection process can be further expanded (Figure 3).

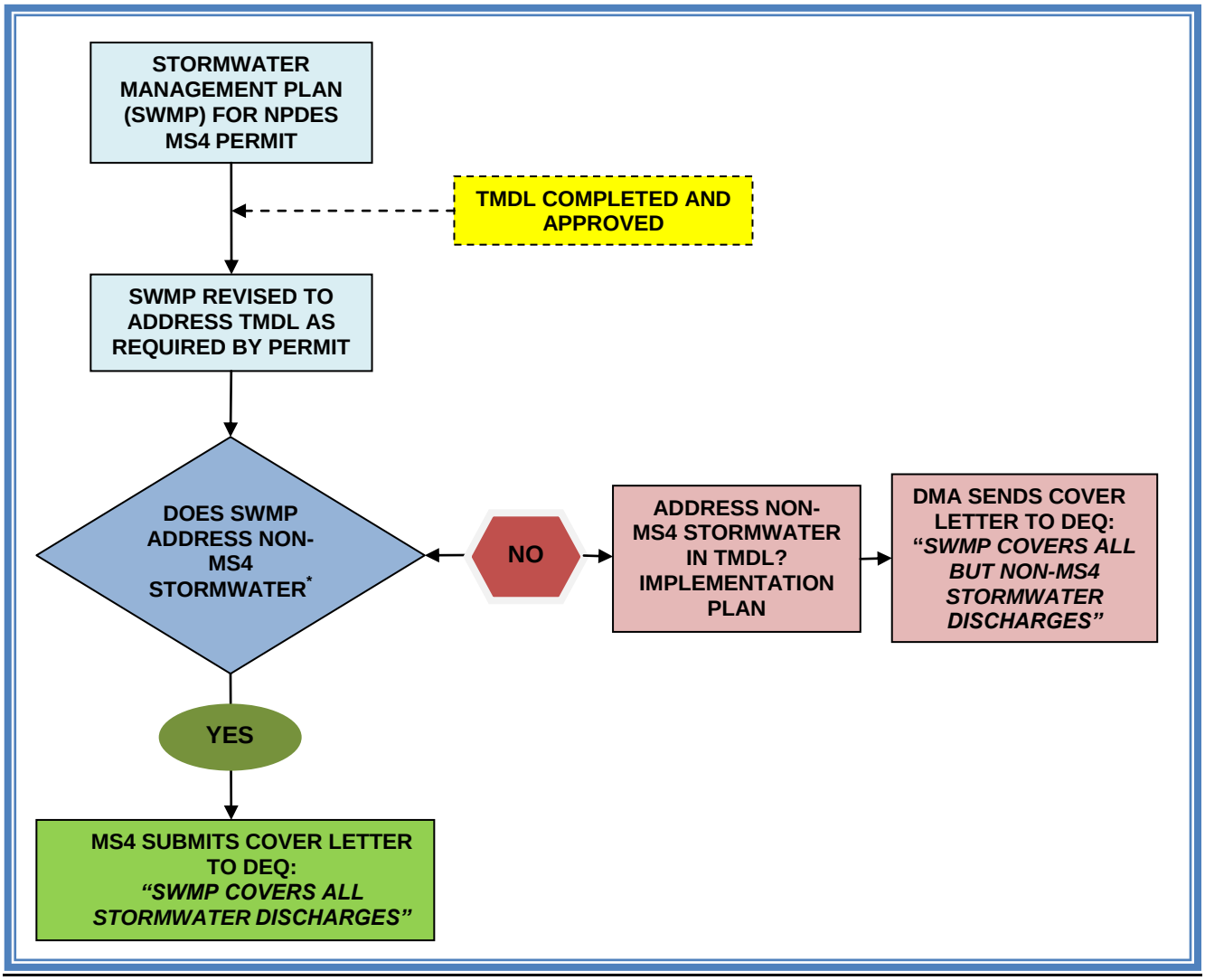
Figure 3. Process for Programmatic BMP Selection for TMDL Implementation Plans





The development of the TMDL Implementation Plan should be coordinated with requirements of the MS4 Stormwater Program (Figure 4).

Figure 4. Process for Addressing Stormwater NPDES Permitted Phase I or II MS4 and TMDL Load Allocation



* Non-MS4 stormwater discharges are those that are within the MS4 permitted geographically jurisdiction's boundaries but flow directly to surface waters without being conveyed through the jurisdiction's MS4.

2.1 Examples of Where Information Can Be Found To Build Upon other Water Quality Protection Efforts

Many of the urban and rural residential DMAs already have water quality plans or strategies in place that help prevent or control water pollution, such as stormwater management plans, local land use plans, zoning, and development ordinances, or road maintenance plans, but these plans may not address all of the TMDL pollutants or cover all relevant sources of pollution. TMDL Implementation Plans should *build* upon these efforts.

Plans should reference existing activities and describe any additional strategies that will be undertaken in order to achieve the pollution reductions described in the TMDL. DEQ has prepared the "Inventory of Water Resource Management Activities" in Appendix A that provides a questionnaire to identify planning and management activities already underway that might support the TMDL implementation effort. These are recommended to be incorporated as actions within the TMDL Implementation Plan.

The TMDL Implementation Plan is recommended and encouraged to build upon previous water quality related work including structural and programmatic measures completed or planned by cities and counties.

Note: These plans do not substitute for the TMDL Implementation Plan itself.

Water quality programs with applicable plans may include the following water quality, land use, habitat management, and other programs within a particular watershed:

1. ***Local***
   - Comprehensive Land Use Plan
   - Zoning Plan
   - Water Quality Related Development Ordinances
   - Stormwater Plan
   - Water Quality related Capital Improvement Plan
2. ***State***
   - DEQ Onsite Septic Systems Permit
   - DEQ NPDES 1200-C Construction Stormwater Permit and Plan
   - DEQ 401 Water Quality Certification Program (with required Stormwater and Erosion Control Plans)
   - DEQ Underground Injection Control (UIC) Program (with required Stormwater Management Plan)
   - State Drinking Water Source Water Protection Program Source Water Assessments and Protection
   - DEQ Air and Land Quality Programs
   - Watershed Council's OWEB funded Watershed Management Plan
   - State Land Use Planning Program Goals and Guidelines Compliance (DLCD)
   - Department of State Lands Oregon's Removal-Fill Permit and Wetlands Planning
3. ***Federal***
   - EPA NPDES Stormwater Phase I and II Permit Stormwater Management Plans (SWMP)
   - NMFS Endangered Species Act (ESA), Section 4(d) Rule

The following are a few examples of those program that share similar water quality protection goals, as does the TMDL program:

- **Oregon Plan for Salmon and Watersheds**

  In 1997, the Oregon Legislature and Governor established the Oregon Plan for Salmon and Watersheds, http://www.oregon-plan.org/, in order to protect populations of various salmonid species with the support and participation of a wide spectrum of stakeholders and tribal nations from all sectors and regions of the state. The effort is still being made today.

- **Oregon Conservation Strategies**

  Oregon Conservation Strategy, http://www.dfw.state.or.us/conservationstrategy/, provides information on at-risk species and habitats, identifies key issues affecting them, and recommends actions. The Strategy could be considered when identifying priority areas for TMDL implementation.

- **Integrated Water Resource Strategy**

  In 2009, State legislature directed the Oregon Water Resources Department to develop a statewide, Integrated Water Resources Strategy (IWRS), http://www.wrd.state.or.us/OWRD/LAW/Integrated_Water_Supply_Strategy.shtml to better understand and meet Oregon's water quantity, water quality, and ecosystem needs by the end of 2012. DEQ is a partner in the effort, and once finalized, the strategy should be considered when planning TMDL implementation.

- **Watershed Council Action Plans**

Watershed councils are locally organized, voluntary, non-regulatory groups established to improve the condition of watersheds in their local area. Many of the watershed councils, http://www.oregon.gov/OWEB/watershed_council_contacts.shtml, in Oregon have developed and are implementing action plans.

2.2 Adopt a Long Term Vision with Adaptive Management

DEQ expects that the strategies and timelines in a TMDL Implementation Plan will ultimately be successful in meeting the pollution reduction goals. DEQ recognizes, however, that pollution prevention at times can be an uncertain science and the pathway to implementing some of these strategies may be uncertain due to availability of funds, level of public support, etc. As such, DEQ expects that the DMA will implement the plan to the best of its abilities but acknowledges that reasonable and prudent judgment will make adjustments or revisions necessary from time to time.

Natural systems are complex and dynamic. The way a system will respond to human management activities is often unknown and can only be described as probabilities or possibilities. Adaptive management involves testing, monitoring, evaluating applied strategies, and incorporating new knowledge into management approaches that are based on scientific findings. In the case of TMDLs, adaptive management is used to assess whether the actions identified as necessary to solve the identified pollution problems are the correct ones and whether they are working.

DEQ expects many of the water pollution problems being addressed through TMDLs will take several years or decades to be resolved. The TMDL Implementation Plan must indicate how the DMA will continue efforts over the long term to further reduce pollution contributions in order to fully achieve the TMDL requirements and ensure the desired levels of protection will be maintained. Long-term success is largely dependent upon having adequate pollution prevention mechanisms in place [e.g., erosion control BMPs, riparian protection strategies, stormwater management strategies] and a well-defined process for adaptive management.

Adaptive management allows us to fine-tune our actions to make them more effective, and to try new strategies if we have evidence that a new approach could help us to achieve compliance. Partners will work together to monitor progress towards these goals, evaluate successes, obstacles, and changing needs, and make adjustments to the implementation strategy as needed.

Pollution reduction plans, whether for a broad area or specific site, tend to have an opportunistic component. That is, for reasons of practicality and efficiency, the TMDL Implementation Plans adapt to the realities on the ground, such as the willingness of particular property owners to participate, the availability of particular funding, or physical constraints. The greater the investment in advance planning, the greater the certainty of the final result.

Where implementation of the TMDL Implementation Plan or effectiveness of management techniques is found to be inadequate, DEQ expects DMAs to revise the components of the implementation plan to address these deficiencies. Through adaptive management, DEQ expects that the adequacy of these activities will be monitored and modified over time as needed.

When DEQ, in consultation with the DMAs, concludes that all feasible steps have been taken to meet the TMDL and attainment of water quality standards, the TMDL, or the associated surrogates is not practicable, it will reopen the TMDL and revise it as appropriate. DEQ would also consider re-opening the TMDL should new information become available indicating that the TMDL or its associated surrogates should be modified.

There are possible restrictions due to regulatory responsibilities of DEQ and other state, local, and federal agencies that make some changes in implementation actives not possible. These restrictions should be determined, documented, and provided to the DMA during the management plan development.

2.3 TMDL Implementation Plan Approval

TMDL implementation plans are developed by the DMAs and submitted to DEQ for review and approval. EPA's timeline for approving a TMDL does *not* affect the TMDL implementation plan timeline. DEQ may extend a deadline required in the WQMP if there is sufficient justification.

Notification of DMA requirements for TMDL Implementation Plan development and submittal are in the WQMP:

- The due date for submitting completed TMDL Implementation Plans are in the WQMP and is usually between 12 – 18 months after TMDL/WQMP issuance;
- DEQ is required to notify DMAs, affected parties, and others by letter of the plan due date within 20 days of TMDL issuance;
- After DEQ receives the plan, DEQ will acknowledge receipt of the plan by letter and will strive to review it within 60 days;
- If the plan cannot be reviewed within 60 days, DEQ will let the DMA know when the review will occur.

Once the TMDL Implementation Plan has been received, DEQ will use the following criteria to determine the adequacy of the plan for approval:

- The TMDL implementation plan will be reviewed to ensure that it includes all TMDL WQMP required components.
- Addresses all the known or suspected sources of pollution within the DMA's jurisdiction of the plan (or referenced in other plans and/or permits).
- The DMA selected BMPs are reasonably expected to be effective.
- The DMA demonstrates how the TMDL load allocations will be achieved.
- If the plan is found to be unsatisfactory, DEQ will identify which portions of the plan are considered inadequate and require revision, return the plan, and identify a timeframe for resubmitting the plan. (To the extent possible, DEQ will provide resource materials and technical assistance to those needing help to complete the plan).
- After receiving a satisfactory plan, DEQ will send the DMA a letter of approval.
- The approval letter may also include recommendations for additional actions the DMA should consider or undertake or DEQ's expectations of things to be addressed in a future update of the plan.

2.4 Plan Implementation

TMDL implementation typically requires effort by point sources and DMAs to achieve the goals of the TMDL. TMDL implementation is accomplished through: renewal and meeting permits that reflect wasteload allocations; and, DMAs enacting or continuing various land and water management strategies, and restoration and pollution prevention efforts that contribute to pollutant load reductions to meet LAs.

DMAs are required to implement their approved TMDL implementation plans. Failure to implement an approved TMDL implementation plan could be a violation according to DEQ's Enforcement Guidance. In addition, Oregon's TMDL rule requires DEQ and the DMA to review, and if necessary, revise the TMDL Implementation Plan every 5 years. DEQ will make every attempt to work collaboratively with DMAs to help them achieve compliance.

DEQ expects that the DMA will implement the plan to the best of its abilities but acknowledges that reasonable and prudent judgment will make adjustments or revisions necessary from time to time. The DMA should keep DEQ apprised of the changes. In most instances, it will be adequate to wait for the next 5-year review of the plan to revise it to reflect the changes.

DEQ has prepared the TMDL Implementation Tracking Matrix, which is a template for DMAs to describe and report management activities in their annual reports to DEQ. DEQ encourages the use of this matrix for organizing the implementation plan and tracking progress of the management measures. Additional details on each strategy can be included in a narrative portion of the plan.

Generally, two reports are recommended to be submitted to DEQ on a regular basis, the TMDL implementation plan annual progress report and the 5-year TMDL implementation plan review report. The Annual Progress Report tracks implementation of the TMDL Implementation Plan and the BMPs. Typically, the TMDL WQMP specifies the

frequency of reporting. If there is no frequency specified in the WQMP, it is recommended that a progress report should be submitted to DEQ ***once a year***. Check with your Basin Coordinator for annual reporting requirements.

Every fifth year, DMAs are required to submit a 5-Year TMDL Implementation Plan Review Report which is a more thorough evaluation report than the TMDL Implementation Plan Annual Progress Report. The report should describe the effectiveness of the BMPs and other management strategies identified in the DEQ approved DMA's TMDL Implementation Plan that was put into place during the preceding four years. Check with your DEQ Basin Coordinator for your reporting requirements.

2.5 Compliance and Enforcement

The TMDL is issued as an Order and identifies the DMAs required to submit a TMDL Implementation Plan to DEQ for approval. When a DMA fails to develop and submit a TMDL Implementation Plan as required in the TMDL or WQMP, or for failure to implement an approved TMDL Implementation Plan (OAR 340-042-0080(3)), DEQ may take enforcement action as directed by DEQ's Enforcement Procedure and Civil Penalties Rules and Guidance (340-012-0026) http://arcweb.sos.state.or.us/pages/rules/oars_300/oar_340/340_012.html.

However, DEQ's intent is to work cooperatively with DMAs, including assisting them in developing their plans and working through implementation issues. It is DEQ's goal that this partnership approach will create incentives for DMAs to implement the TMDL. Enforcement should be used as a measure of last resort when cooperative endeavors are not successful.

2.6 Technical, Outreach Assistance, and Funding

DEQ is aware of the difficulty that many communities, particularly the smaller communities, will have in developing and implementing the TMDL implementation plan. DEQ staff will continue to provide assistance to DMAs in the development and implementation of the TMDL Implementation Plan. The form of this assistance includes technical, funding, and public education, and involvement.

It is the responsibility of the DMAs to fund the development and implementation of the implementation plan. As resources allow, DEQ will provide staff time and funds to DMAs for development and implementation of the TMDL Implementation Plan. There are several funding sources available for cities and counties:

- Oregon DEQ - 319 Nonpoint Source Grants
- Oregon DEQ - Clean Water State Revolving Fund
- Oregon Health Authority, Public Health Division, Office of Environmental Public Health, Drinking Water Program and the Oregon Business Development Department - Safe Drinking Water Revolving Loan Fund (SDWRLF)
- Department of Land Conservation and Development (DLCD) - Oregon Coastal Management Program (OCMP)
- Oregon Watershed Enhancement Board (OWEB) – Grants
- Oregon Department of Fish and Wildlife (ODFW) - Access and Habitat
- ODFW - The Riparian Tax Incentive Program
- U.S. Fish and Wildlife Service - Partners for Fish and Wildlife Program

3. Content of the Implementation Plan

The elements of a TMDL Implementation Plan can be found in OAR 340-042-0040(l) and explained in the TMDL Implementation Plan Guidance – for State and Local Government Designated Management Agencies (May 2007).

Figure 5. Elements of a TMDL Implementation Plan

ELEMENTS OF A TMDL IMPLEMENTATION PLAN

1. Table of Contents
2. Figures
3. Tables
4. Acknowledgments
5. Executive Summary
6. Introduction
7. Public Participation
8. Geographic Extent of the Watershed(s) Map
9. Causes and Sources of Pollutants
10. Pollutant Load Reductions Needed
11. Best Management Practices to Achieve Allocations
    a. Basin Scale – Programmatic
    b. Project Scale - Structural
12. Cost and Benefits Analysis
13. Reasonable Assurance, Measurable Goals, and Milestones for Attaining Water Quality Standards and Beneficial Uses
14. Performance Monitoring
15. Develop an Evaluation Framework
16. Compliance with Land Use Requirements
17. Information/Education for Implementing the Plan
18. Provide Analyses or Information in the TMDL WQMP

3.1 ELEMENT 6 -- Introduction

What information should be provided?

The reasons for the TMDL Implementation Plan, its goals and purpose, and other background information.

Why should this be included?

Although not required, it is helpful to provide this information in order for people who read the TMDL Implementation Plan to understand the reason for its development and implementation.

Where can this information be found?

This information can be drawn directly from the TMDL and customized for the DMA's jurisdiction.

Example

(based on the Willamette TMDL WQMP, http://www.deq.state.or.us/wq/tmdls/docs/willamettebasin/willamette/chpt14wqmp.pdf):

The (name of the entity) was named by DEQ as a DMA (reference page # in TMDL)for the pollutants #### because the (name of the entity) has legal authority over a sector or source contributing pollutants(specify the reason as state din the TMDL). The [name of DMA] is required to develop a TMDL implementation plan for review and approval by DEQ. The TMDL implementation plan will specify the (name of the entity)actions, timelines, milestones, and other responsibilities to be implemented by the (name of the entity) to fulfill our responsibility under the TMDL.

3.2 ELEMENT 7 -- Public Participation

What information should be provided?

An essential step in the development and implementation of a TMDL Implementation Plan is developing and implementing a public participation plan. This plan should include the input from a broad range of individuals, agencies, businesses, watershed councils and other organizations. Their involvement is important due to their interest and familiarity with local water quality needs and conditions.

Why should this be included?

An essential step in implementing and developing a TMDL Implementation Plan is the input from a broad range of individuals, agencies, organizations, and businesses because of their interest and familiarity with local water quality needs and conditions. Public participation facilitates dialogue between individuals, watershed councils and other non-profits, community, and government groups to commit resources to implementation, such as funding and technical support.

Where can this information be found?

The public participation process for the implementation plan in many cases may be identifying and describing the ongoing partnerships and public review and input that the DMA currently uses in the watershed on a much smaller geographical scale.

Public participation facilitates dialogue between local stakeholders and government agencies to commit resources to TMDL implementation, such as funding and technical support. Community members are best suited to identify and resolve sources of water quality problems. In many watersheds in Oregon there are a number of diverse watershed planning activities already in place, such as watershed and/or basinwide water quality management plans by watershed council and other non-profit organizations. Some cities and counties may have already developed water quality management plans or stormwater management plans and government agencies, such as Water Quality Restoration Plans completed by the U.S. Forest Service and Bureau of Land Management.

THINGS TO CONSIDER IN FORMULATING A PUBLIC PARTICIPATION PROCESS

- **What partnerships currently exist in the watershed that could enhance public participation?**
- **What media campaigns are currently in place that could enhance public understanding?**
- **What are the target audiences in the watershed?**
- **What are the concerns and priorities of the target audiences?**
- **Which strategies are best suited for reaching and engaging the public in this watershed?**

Source: Guidance Manual for Total Maximum Daily Load Implementation Plans, The Commonwealth of Virginia: Department of Conservation and Recreation, Department of Environmental Quality, July 2003.

The public participation section of the implementation plan is recommended to describe the approaches, which will be used to inform the public and to solicit input.

Public participation in the development of TMDL Implementation Plan may be facilitated through:

- Local Advisory Group
- Focus Groups
- Steering Committees
- Public Meetings

Local Advisory Group is required to be established by DEQ to assist in developing a TMDL (OAR 340-042-0050(1)). The local advisory group is the primary method for building partnerships in the watershed for TMDL implementation. The local advisory group should include interested parties for each sector such as agriculture, forestry, local government, environmental groups/NGOs, watershed councils, point sources, other nonpoint sources, planning agencies, state agencies, federal agencies, tribal nations, and funding agencies and entities (could be any of the above).

The role of the local advisory group is to advise and provide input to DMAs on:

- Sources of pollution
- Local conditions
- Priority areas
- Types of implementation measures
- Identifying collaborations and opportunities for leveraging available resources for implementation
- Identifying issues and making connections to other important local efforts that could affect water quality or the beneficial uses

1. Focus Groups

They provide a way for a smaller numbers of individuals within the community to come together to address specific implementation issues. The membership of such groups should be generally made up of key individuals who are local leaders and are knowledgeable about the specific issue the focus group is to address. The objective of such groups is to provide input on what is needed to obtain participation in carrying out the TMDL Implementation Plan.

For example, the urban and rural residential focus group may deal with ways to address pollutant loadings from septic tank failures, straight pipes, and pets for bacteria TMDLs, and even stormwater issues in some of the urbanized watersheds for bacteria and benthic TMDLs. The government focus group could consider what financial and technical resources can be brought to bear to address the TMDL, as well as existing local, state, and federal regulatory authorities. The environmental focus groups could address what their membership may be able to

contribute in regards to TMDL implementation. The implementation plan should summarize the input from each of the focus groups and document recommendations.

2. Steering Committees

They can consider recommendations that are formulated by the focus groups and to provide overall oversight to the process is also recommended. The formation of a steering committee is to provide overall oversight in the TMDL implementation process. Membership on this committee should be comprised of stakeholders from the various focus groups as well as personnel from the key agencies involved in the plan development. This committee would review the recommendations that come forward from the various groups and comments from the public meetings, and provide overall guidance.

3. Public Meetings

They provide a forum whereby the general public can be informed as to the TMDL requirements, how the TMDL Implementation Plan will be developed, and what actions the implementation plan will require. It is suggested that a minimum of two public meetings be held during development of the TMDL Implementation Plan.

The first meeting should provide a general description of what a TMDL is, a more detailed description of the TMDL and implementation plan development processes, and a solicitation for participation in focus groups. The primary purpose of the second public meeting would be to present the draft TMDL Implementation Plan for public comment. This meeting should be held early enough in the IP development process to allow a 30-day public comment period after the draft plan is presented. Finally, the implementation plan should document the location(s) and attendance at any public meetings and summarize the content of the comments provided.
Another important coordination issue is the need for multi-jurisdictional coordination. Begin engaging neighboring jurisdictions on these issues through your steering committee framework. Finally, solicit early DEQ facilitation of inter-jurisdictional dialogue on complex implementation issues. Failure to bring the state in early could result in time-sensitive decisions being made in a crisis mode, which is likely to result in less than ideal outcomes.

Things to consider in formulating a public participation process:

- What partnerships currently exist in the watershed that could enhance public participation?
- What media campaigns are currently in place that could enhance public understanding?
- What are the target audiences in the watershed?
- What are the concerns and priorities of the target audiences?
- Which strategies are best suited for reaching and engaging the public in this watershed?

Example

This example is based on Fanno and Tryon Creeks Watershed Management Plan, Chapter 22 Tryon Creek Watershed Strategies and Actions, by City of Portland, Bureau of Environmental Services, 2005:

"Public Involvement
Active neighborhood groups provide collaborative restoration, education and technical assistance opportunities for local area residents. Partners include SW Neighborhoods, Inc (SWNI), Crestwood Neighborhood Association, Friends of Woods Park, Portland Parks and Recreation, and BES Community Watershed Stewardship Grants and Watershed Revegetation programs.

Active stewardship sites include Woods Park. BES' revegetation program has active sites at April Hill and Woods Park and in cooperation with homeowners just downstream of April Hill. Free programs such as Naturescaping for Clean Rivers are available to raise awareness about how individual actions, such as landscaping practices and pesticide use, influence watershed health. Additional public outreach steps could include placing curb markings to discourage dumping in storm drains."

3.3 ELEMENT 8 -- Geographic Extent of Watershed(s) Covered by the Plan Map (Map and Description)

What information should be provided?

Provide a map of waterbodies and constructed conveyance systems such as pipes, drainage ditches, open channels, etc. within or near the DMA's jurisdiction that may be affected by activities within the jurisdiction, including waterbodies receiving runoff from the jurisdiction.

Why should this be included?

Having a description of the geographic extent of the watershed(s) covered by the plan with a map is helpful to provide this context so that a reader of the plan understands its purpose. These map(s) will be helpful for determining the BMPs needed to meet the TMDL. Knowing and mapping both the natural and manmade systems are important to identifying the streams, wetlands, ponds, and groundwater areas to protect and to restore back to a healthy system.

Where can this information be found?

This information can be drawn directly from the TMDL WQMP and other federal, state, and local natural resource agencies, customized for the DMA's jurisdiction.
For most urban and rural residential areas, there may be some mapping of local streams, wetlands, and other natural water areas.

Map all natural drainage/conveyance systems and other environmentally sensitive areas such as:

- Rivers and Streams
- Riparian Areas
- Floodplains
- Springs and Seeps
- Wetlands
- Tidal and Non-Tidal Wetlands
- Forests
- Steep Slopes
- Highly Erodible Soils
- Topography

Some might have maps identifying human constructed water systems, such as ditches, stormwater drainage pipes, floodwater detention or drainage/conveyance systems such as ponds, dikes, etc.

Map manmade drainage/conveyance systems including the type and location of stormwater discharges either directly or through municipal conveyance systems:

- Discharges from MS4 drainage and conveyance systems into receiving waters
- Discharges from non-MS4 drainage and conveyance systems into receiving water
- Stormwater discharged directly to receiving waters (e.g., runoff from a parking lot that flows overland)
- Discharges from on-site sewage systems
- Seepage into ground water that flows into surface waters

3.4 ELEMENT 9 -- Causes and Sources or Groups of Similar Sources that Need to be Controlled to Achieve the Water Quality Standards

What information should be provided?

List of TMDL pollutant(s) and potential source(s) that are under the DMA's jurisdiction, including a description of why these pollutants are of concern, and the water bodies affected or potentially affected.

Why should this be included?

Including this information in the plan will help to explain the selection of management strategies and prioritization of these strategies.

Where can this information be found?

This information can be drawn from the TMDL WQMP and other assessments of water quality resources for the area in question. The WQMP will list the specific pollutants that need to be addressed, potential sources of those pollutants, and the pollutant loads by TMDL listed pollutant(s). However, the list of sources may not cover all source categories or specificity on sources that fall within the DMA's jurisdiction, therefore, it is important to assess whether other sources are likely to exist.

3.4.1 Principal Pollutants in Urban and Rural Residential Runoff

Table 2 identifies the principal pollutants found in urban and rural residential runoff. These were the type of pollutants found in any city or county that has residential, commercial, industrial, roads, and other impervious areas. These pollutants were found through extensive sampling by EPA, U.S. Geological Survey (USGS), DEQ, and some cities and counties in Oregon.

Table 2. Categories of Principal Pollutants in Urban and Rural Residential Runoff.

CATEGORIES OF PRINCIPAL POLLUTANTS IN URBAN AND RURAL RESIDENTIAL RUNOFF	
CATEGORY	**EXAMPLES**
METALS	Zinc, Cadmium, Copper, Chromium, Arsenic, Lead
ORGANIC CHEMICALS	Pesticides, Oil, Gasoline, Grease
PATHOGENS	Viruses, Bacteria, Protozoa
NUTRIENTS	Nitrogen, Phosphorus
BIOCHEMICAL OXYGEN DEMAND (BOD)	Grass Clippings, Fallen Leaves, Hydrocarbons, Human, And Animal Waste
SEDIMENT	Sand, Soil, And Silt
SALTS	Sodium Chloride, Calcium Chloride

3.4.2 List of TMDL Pollutant(s), Source(s), and Concern(s)

The TMDL and WQMP will identify the source(s) of TMDL pollutant(s) on a basin-wide scale. It will be necessary for a DMA to survey, map, and describe each local source or sources of the TMDL impairments and listed pollutants. This will include identification of sources by each watershed and site(s) within the of the city, county, or other jurisdictional boundary.

Uncontrolled or untreated runoff from urban and rural residential land uses can run off the landscape or infiltrate into groundwater areas that eventually flow into surface waters. Impervious surface areas, in addition to being sources of pollutants, increase runoff volumes that rapidly flow into waters of the state. This increase in volume and velocity of runoff often causes stream bank erosion, channel incision and sediment deposition in stream channels. In addition, runoff from these developed areas can increase stream temperatures, that along with the increase in flow rate and pollutant loads, negatively affect water quality and aquatic life. Warmer instream temperatures could be caused by historic removal of shade-producing vegetation along streams.

Common sources of urban and rural residential pollution come from the following activities and areas:

- Reduced tree canopy and open space
- Runoff from pre-developed areas
- Runoff from construction sites
- Runoff from existing development
- Impervious surfaces such as streets, roadways, highways, bridges, parking lots, driveways, cul de sacs, compacted areas, rooftops, etc.
- Improperly sited, designed, and maintained onsite wastewater treatment (septic) systems
- Illicit cross connections between sanitary and wastewater systems
- Pet and waterfowl wastes
- Lawn and garden fertilizers and pesticides
- Household chemicals that are improperly disposed of
- Vehicle emissions
- Automobile fluids and road deicing/anti-icing chemicals,
- Commercial/industrial sites
- Sites known to be contaminated by hazardous substances, and
- Other sources, depending on the type of land uses and activities

The following **Table 4** identifies the impacts and concerns of TMDL listed pollutants or impairments on the beneficial uses and water quality caused by urban and rural and rural residential areas:

Table 3. Impacts And Concerns Of TMDL Listed Pollutants Or Impairments On The Beneficial Uses And Water Quality Caused By Urban And Rural Residential Runoff.

POLLUTANT/ IMPAIRMENT	SOURCES	CONCERN / IMPACTS

HYDROLOGY (VOLUME REDUCTION)	• Impervious surfaces directly connected to the stormwater system or overland flow • Destruction of natural drainage systems • Development, site clearing, and grading • Maintained landscapes • Creeks “channelized” or ”piped”	• Increased peak discharges compared to predevelopment levels • Temperature increase • Riparian and wetlands areas loss • Freshwater impact on estuaries • Increased pollutant loads • Greater flood risk • Disruption of natural water balance • Lower dry weather flow • Changes in species diversity and abundance of benthic communities • Changes in stream physical structures, incl. stream bank erosion and down cutting • Loss of recreational opportunities • Wetlands water levels reduced affecting aquatic flora and fauna
TEMPERATURE	• Loss of aquatic habitats • Riparian vegetation cleared • Unrestricted access • Creeks “channelized” or ”piped” • Impervious surfaces	• Increased water temperature • Loss of riparian function • Changes in species diversity and abundance • Reduced fish population • Fish kills and widespread destruction of benthic habitats • Impaired or destroyed fish and wildlife habitat • impairment of commercial and recreational fishing resources

Table 4. Impacts and Concerns of TMDL Listed Pollutants or Impairments on The Beneficial Uses and Water Quality Caused By Urban and Rural Residential Runoff. (Cont.)

POLLUTANT/ IMPAIRMENT	SOURCES	CONCERN / IMPACTS

SEDIMENT / TURBIDITY	• Home landscaping and public grounds maintenance • Erosion from building sites • Erosion from bare earth areas e.g.: unsealed roads, driveways and car parks, poorly maintained lawns • Impervious surfaces • Washing cars in the street • Air pollution carried by rain into stormwater systems	• Smothering of plants and animals that live on the bottom of ponds lakes and streams • Impairment of commercial and recreational fishing resources • Reduced aesthetic value (water looks "muddy") • Reduced aquatic plant growth • Clogging of fish gills prevents breathing • Fish cannot see food • Loss of aquatic habitat: "Properly Functioning Conditions" • Hinders the ability of aquatic predators (e.g. certain fish species) to see their prey • Temperature Increase • Flow Alterations • Changes in stream physical structures, incl. stream bank erosion and down cutting
BACTERIA (E COLI AND FECAL COLIFORM)	• Animal (dog, cat, horse) faeces • Leaky or overflowing onsite septic systems • Illicit cross connections between sanitary and wastewater systems • Impervious surfaces	• Contaminates shellfish -- Closed shellfish beds • Bacteria in drinking water from surface water sources • Potential for ground-water contamination. • Makes contact with water unsafe for humans • Causes disease in aquatic organisms • impairment of commercial and recreational fishing resources

Table 3. Impacts and Concerns of TMDL Listed Pollutants or Impairments on the Beneficial Uses and Water Quality Caused By Urban and Rural Residential Runoff. (Cont.)

POLLUTANT/ IMPAIRMENT	SOURCES	CONCERN / IMPACTS

NUTRIENTS (NITRATES AND PHOSPHORUS)	• Impervious surfaces • Vegetation washed into waterways • Air pollution carried by rain into stormwater systems • Washing cars with detergent containing phosphorous • Excessive use of fertilizers, which is washed off lawns • Decay of plant material • Leaky or overflowing sewerage systems • Bank erosion	• Nitrogen and phosphorous stimulates the growth of algae and aquatic plants • Decay of algae and plant matter reduces dissolved oxygen levels • Excessive growth of algae and aquatic plants reduces waterway aesthetic values • Diminished fish and wildlife habitat • Eutrophication and depressed dissolved oxygen • Impairment of commercial and recreational fishing resources • Potential for ground-water contamination.
AQUATIC WEEDS OR ALGAE (CHLOROPHYLL A)	• Impervious surfaces directly connected to the stormwater system or overland flow • Vegetation washed into waterways • Bank erosion • Excessive use of fertilizers • Decay of plant material	• Nitrogen and phosphorous stimulates the growth of algae and aquatic plants • fish kills and widespread destruction of benthic habitats • impairment of commercial and recreational fishing resources • Loss of recreational opportunities
DISSOLVED OXYGEN	• Vegetation washed into waterways • Impervious surfaces	• Oxygen dissolved in the water is depleted when plant matter decays. • Not enough dissolved oxygen for Fish and other water life • fish kills and widespread destruction of benthic habitats • impairment of commercial and recreational fishing resources

Table 3. Impacts and Concerns of TMDL Listed Pollutants or Impairments on the Beneficial Uses and Water Quality Caused By Urban and Rural Residential Runoff. (Cont.)

POLLUTANT/ IMPAIRMENT	SOURCES	CONCERN / IMPACTS
TOXICS: METALS	• Impervious surfaces • Vehicle fluids, deterioration of parts, and vehicle exhaust. • Washing cars in the street • Air pollution carried by rain into stormwater systems • Deterioration of building surfaces	• Contaminated food chain and water supplies • Bioaccumulation of toxics • Toxic to aquatic life at low concentrations • Impairment of commercial and recreational fishing resources • Potential for ground-water contamination.
OTHER TOXICS SUCH AS PESTICIDES (ATTACHED TO SEDIMENTS)	• Impervious surfaces • Home Landscaping and Public Grounds Maintenance • Tire ware is a substantial source of cadmium and zinc	• Bioaccumulation of toxics • Toxic to aquatic life at low concentrations impairment of commercial and recreational fishing resources • Potential for ground-water contamination.
OTHER TOXICS SUCH AS PESTICIDES (IN WATER)	• Impervious surfaces directly connected to the stormwater system or overland flow • Home Landscaping and Public Grounds Maintenance • Driving a car or truck contributes a number of different types of pollutants to urban runoff. Pollutants are derived from automotive fluids, deterioration of parts, and vehicle exhaust. • Tire ware is a substantial source of cadmium and zinc; concentrations at outfalls often exceed acute toxicity levels • Used on gardens	• Bioaccumulation of toxics • known to be toxic to aquatic life at low concentrations impairment of commercial and recreational fishing resources • Potential for ground-water contamination.

Table 3. Impacts and Concerns of TMDL Listed Pollutants or Impairments on the Beneficial Uses and Water Quality Caused By Urban and Rural Residential Runoff. (Cont.)

POLLUTANT/ IMPAIRMENT	SOURCES	CONCERN / IMPACTS
OIL & GREASE	• Leaks from vehicles • Car washing or maintenance • Impervious surfaces directly connected to the stormwater system or overland flow • Illegal dumping of waste lubricating or food oils	• Known to be toxic to aquatic life at low concentrations • Widespread destruction of benthic habitats • Can kill some marine aquatic life (e.g. Fish, turtles, sea birds) • Impairment of commercial and recreational fishing resources • Reduces aesthetic appeal of waterways • Decay of some hydrocarbons can decrease dissolved oxygen levels • Potential for ground-water contamination.

The following **Table 4** provides an example of the 303(d) listings addressed by a TMDL, the TMDL pollutants, and their sources from an example TMDL WQMP:

Table 4. Example 303(d) Listings within Each TMDL Subbasin and Waterbody Addressed by a TMDL, the TMDL Pollutants, and Their Sources
(based on the Willamette TMDL WQMP): http://www.deq.state.or.us/wq/tmdls/willamette.htm)

TMDL Pollutant(s), Source(s), And Concern(s)

The Coast Fork of the Willamette River is currently listed by DEQ as water quality limited due to elevated summer temperatures, elevated bacteria levels, and mercury. The watersheds are drained by X, Y, and Z. City stormwater drains to all these waterbodies and the wastewater treatment plant discharges to X. The table below identifies waterbodies within or near the [name of DMA] that may be affected by activities within the [name of DMA]'s jurisdiction, and indicates the river miles affected, the TMDL parameter, and the season affected by the listing.

Subbasin	Waterbody Name	River Miles	Parameter	Season
Coast Fork	Coast Fork Willamette R.	0 to 31.3	Temperature	Summer
Coast Fork	Coast Fork Willamette R.	0 to 31.3	Fecal Coliform	W/S/F
Coast Fork	Coast Fork Willamette R.	0 to 31.3	Fecal Coliform	Summer
Coast Fork	Coast Fork Willamette R.	0 to 31.3	Mercury	All year

TMDL Pollutants and Potential Sources of Pollutants within [name of DMA's] Jurisdiction

TMDL pollutants in the vicinity of [name of DMA]'s jurisdiction as well as the primary suspected sources of the pollutants are:

• *Warmer Instream Temperatures - Caused by historic removal of shade-producing vegetation along streams.*

• *Fecal Coliform - Likely sources include domestic animal waste carried in stormwater runoff and illicit cross connections between sanitary and wastewater systems.*

• *Mercury - Found in sediments; likely source is erosion from construction sites not covered by DEQ permit (i.e., sites with disturbed ground surface area of less than 1 acre).*

Concerns Associated with Pollutants:

• *Temperature - At times, the Willamette River and its tributaries are too warm to support healthy salmon and trout. Some of these cold-water fish including lower Columbia Coho, spring Chinook, winter steelhead, and bull trout are threatened with extinction and elevated stream temperatures have contributed to their decline. Warm water interferes with adult salmon and trout migration and spawning. Warm water also decreases chances of juvenile survival, affects egg and embryo development, alters juvenile fish growth rates, and decreases their ability to compete with temperature-tolerant fish species for habitat and food. Salmon and trout are also more susceptible to disease when water temperatures are warmest.*

• *Bacteria - People can be affected by bacteria present in water when enjoying water activities such as swimming, wading, wind surfing, water skiing, boating, or fishing. Ingestion or contact with water contaminated with bacteria can cause skin and respiratory ailments, gastroenteritis and other illnesses in humans.*

• *Mercury - The accumulation of mercury in fish is a well-recognized environmental problem throughout the United States. Mercury is a potent toxin that can cause damage to the brain and nervous system. Small children and the developing fetus are most sensitive to mercury's toxic effects. The primary way that humans are exposed to mercury is through the consumption of fish or seafood containing elevated levels of mercury.*

3.5 ELEMENT 10 -- Pollutant Load Reductions Needed to Meet the Water Quality Goals

What information should be provided?

Identify the specific pollutant loads reductions by pollutant and source needed to meet the TMDL LAs, if applicable.

Why should this be included?

Including this information in the plan will help to explain the selection of management strategies and prioritization of these strategies.

Where can this information be found?

This information can be drawn from the TMDL/WQMP. The WQMP will provide the pollutant loads reduction needed by TMDL listed pollutant(s) and source(s) and the estimated pollutant load reduction by recommended most effective and other recommended BMPs in order to meet the TMDL load allocations.

Some activities and suggested roles/responsibilities for developing pollution reduction strategies may include:

- To reduce pollutant loads for nonpoint sources, the local partners and DMAs will identify strategies for meeting their load allocations.
- DEQ with the local partner or DMA will evaluate strategy effectiveness for meeting TMDL load allocations.
- DEQ with the local partner or DMA will attempt to quantify strategies into acres, units, and/or design specification that are needed to meet LAs. Strategies should be quantified by DMA and watershed.
- DEQ with the stakeholder group including the local partners and DMAs will identify priority areas for strategy implementation– consideration should be given to pollution reduction per unit of investment, existing local priorities or restoration plans, local capacity and willingness for implementation, or other key considerations.

The following is an example simple equation for determining the number and types of BMPs needed to meet a TSS load allocation:

XX Pounds of TSS [Equals] XX Pounds/Linear Foot [Times] XX Number of BMPs

(TSS Load Allocation) = (Load Reduction Est. per BMP) X (Number of Needed BMPs)

The following **Table 5** provides an example of how to describe Pollutant Load Reductions and BMPs to Meet Load Allocations from an example TMDL WQMP:

Table 5. Example Pollutant Load Reductions and BMPs to Meet Load Allocations. (Based on the Willamette TMDL WQMP)

POLLUTANT LOAD REDUCTIONS NEEDED TO MEET LOAD ALLOCATIONS

*The Coast Fork of the Willamette River is currently listed by DEQ as water quality limited due to elevated summer temperatures and elevated bacteria levels. The watersheds are drained by X, Y, and Z. City stormwater drains to all these waterbodies. The table below identifies Load Reductions estimated by Pollutant for the selected BMPs within the [name of DMA]'s jurisdiction in order to meet the TMDL load allocations. (*Note: This is just an example. The DMA is recommended to include all TMDL pollutants and BMPs needed in this section and table.)

POLLUTANT	BMP TYPE		LOAD REDUCTION
	PROGRAMMATIC	STRUCTURAL	
Temperature (Percent Effective Shade Target Surrogate)	**Riparian Protection Ordinance w/ XXX Foot Buffer Width**		**XX Percent Effective Shade**
TSS		**Grassed Swales**	**XX Pounds Per Linear Foot**
Sediment (TSS)		**High Efficiency Street Sweeping**	**XX Pounds Per Curb Mile**
Bacteria		**Onsite System Repair or Replacement**	**XX E. Coli Organisms Per 100 Milliliters (MPN)**
Bacteria		**Infiltration Basin Facility**	**XX E. Coli Organisms Per 100 Milliliters (MPN)**

3.6 ELEMENT 11 -- Management Strategies to Achieve Load Allocations

What information should be provided?

The DMAs TMDL Implementation Plan should identify the management strategies the DMA will use to achieve load allocations. DMAs will need to identify the selected most effective and other recommended BMPs by pollutant and source. This section of the TMDL Implementation Plan will also need to include a description of how the DMA will manage the known or suspected sources of pollution.

Note: The DMA is not responsible for pollution arising from activities that occur outside of the DMA's jurisdiction.

In some instances, it may be necessary to prioritize among the strategies if resources are limited. This may mean addressing some sources of pollution before others or focusing implementation efforts in a particular geographic area. To the extent possible, the selection of priorities should be driven by the greatest opportunities for achieving pollutant reductions.

Why should this be included?

Including this information in the plan will help to explain the selection of management strategies needed to meet the TMDL LAs and WLAs, if applicable.

Where can this information be found?

The WQMP will list the specific most effective and other recommended BMPs by pollutant and source, which the DMA will include in this section of the TMDL Implementation Plan. This guidance will supplement and add to what is already in the TMDL WQMP.

This section of the guidance document provides for each TMDL listed pollutant and source:

- Important factors to consider in selecting BMPs
- Importance of land use planning process in meeting TMDL Load Allocations
- Impacts of impervious surfaces percent on urban areas runoff volume
- Reducing impervious surfaces with low impact development BMPs
- Selecting BMPs for multiple pollutants
- BMPs "Treatment Train" concept that in combination with other practices can better achieve TMDL
- BMPs selection process
- Why BMPs are required?
- BMP selection process for inclusion in the TMDL Implementation Plan
- Relationship of TMDL Implementation Plan Elements to the NPDES MS4 Stormwater Permit Requirements
- CZARA Post Construction New Development Management Measure
- DEQ's Recommended most effective and other recommended programmatic and structural BMPs to meet TMDL Load Allocation
- A description of the BMP's purpose, cost effectiveness, and effectiveness of BMP by pollutant to achieve TMDL Load Allocation

In **Appendix ##,** DEQ has provided a table of recommended Programmatic BMPs by TMDL listed pollutant and source and in **Appendix ##** a table of the Structural BMPs by TMDL listed pollutant, source, estimated load reduction, costs, and what is included in the costs. **Appendix ##** identifies those structural BMPs that are or are not Underground Injection Controls (UICs). The DEQ recommended structural BMPs generally are not UICs.

For small and medium sized communities this table is designed to be used as a toolbox to easily select those management measures that the city or county DMA does not already have available or in use. An example, is that for some small DMAs they could require that developers provide proof of NPDES 1200-C Permit coverage for development and redevelopment that disturbs one acre or more, or less than one acre if part of a larger common plan of development or sale. In addition, the DMA should include a process to inform DEQ of erosion and sedimentation problems on construction sites in their jurisdiction.

DEQ's goal is that current city or county planning and public works staff will be able to select the BMPs from the programmatic and structural BMPs tables without having to hire consultants or additional staff.

3.6.1 Important Factors to Consider in Selecting BMPs

Importance of Land Use Planning Process in Meeting TMDL Load Allocation

Goal 5 requires local governments to inventory and evaluate specific types of resources, and develop land use ordinances with clear and objective standards to conserve and protect the subset of each of those resource types identified as significant. Many jurisdictions do not have inventories and protection ordinances consistent with the Goal 5 rule for riparian, wetland and wildlife protection. This is because amendments to the rule adopted in 1996 required cities and counties to conduct inventories for these resources and adopt ordinances to protect significant resources by the time of their next periodic review. Subsequent changes to the statute governing periodic review

decreased the frequency of periodic review and mandated that state resources be focused on a list of goals that did not include Goal 5. Counties with population under 15,000 and cities with population under 2,500 (unless in close proximity to a large city) no longer are required to conduct periodic reviews. Goal 5 compliance may be triggered by a comprehensive plan amendment such as a change in the UGB. A local jurisdiction may also decide to revise their strategy for managing resources covered by Goal 5, in which case Goal 5 rule will need to be taken into consideration.

Goal 5 resources that require local inventories are:

- riparian corridors, including water and riparian areas and fish habitats;
- wetlands;
- wildlife habitat

Other Goal 5 resources related to water quality protection are:

- federal Wild and Scenic Rivers;
- Oregon Scenic Waterways;
- groundwater resources;
- natural areas; and
- other resources not related to water quality

The Goal 5 process differs for each Goal 5 resource, and the Administrative Rule is very detailed and confusing in places. Requirements for addressing riparian areas, wetlands, and wildlife habitat are among the most cumbersome. One reason for this is that Oregon's land use program has a primary intent of avoiding urban sprawl. Lands within UGBs and urban incorporated communities that are protected for natural objectives can not be used for residential, commercial or industrial development. Protection of land within a UGB often necessitates expansion of the UGB to accommodate projected need for developable land. There is also the risk of conflict with expectations of private property owners if development is restricted to protect a Goal 5 resource.

The Goal 5 process consists of an inventory and assessment phase and protection phase. A local jurisdiction must either carefully justify its decision to protect or not protect a resource, or follow an inventory process and protection strategy described in the Goal 5 rule. (Some Goal 5 resources, like Wild and Scenic Rivers and ground water resources are defined by a state or federal process, so local inventories are not necessary.) The Goal-prescribed strategies for inventory and assessment or for protection are known as "safe harbors." Safe harbors are intended to streamline the process of deciding which land, if any, should have restrictions placed on its use in order to protect the resource. A jurisdiction may chose to use the safe harbor option for the inventory and assessment, but use the standard process for the determining appropriate protection of significant resources. Conversely, a jurisdiction could determine their own inventory process, and choose to use the safe harbor protection strategy.

When taking the standard approach for a resource inventory a local government must demonstrate that the inventory process was "adequate" and justify the decision to identify some resources as "significant." When taking the standard approach for developing a protection strategy, a local government must conduct an "ESEE" analysis, evaluating the environmental, social, energy and economic consequences of allowing, limiting or prohibiting uses that conflict with a significant resource. A local government's strategy for managing significant resources must be based on the ESEE analysis. Goal 5 requirements are met when local governments have adopted "clear and objective standards" in their comprehensive plans that define the degree of protection for each Goal 5 resource.

It is important to remember that a safe harbor sometimes sets both a minimum and maximum threshold for determining significance and protecting a resource. The safe harbors represent compromises between environmental, social, energy, and economic objectives that have been worked out at the state level. Because of this, it is possible to comply with Goal 5 by using a safe harbor without providing sufficient protection of surface water, groundwater and wetlands to meet specific environmental goals.

Further information on Goal 5 as it applies to riparian, wetland, and drinking water resources is included in Chapter Four. See the discussion section for each of the model codes designed to protect these resources.

Goal :

To protect natural resources and conserve scenic and historic areas and open spaces.

Findings:

Natural drainageways are an important natural resource. They provide protection from flooding, treatment of stormwater, and help to maintain stream morphology.

Fish and other wildlife, some of which are endangered or threatened, depend on the excellent water quality and functional, available habitat.

Groundwater is an important natural resource. The Source Water Assessment for [jurisdiction] delineates the significant groundwater resources in this area and this resource must be protected from contamination.

The storage capacity for stormwater provided by soil and its filtering function are essential to maintaining ground and surface water resources. These functions must be preserved or their loss mitigated.

Goal 6 – Air, Water and Land Resources Quality

Unlike Goal 5, Goal 6 does not have administrative rules to set standards for meeting the goal. Instead, it relies entirely on other state and federal regulations for direction and implementation. However, for water quality purposes, Goal 6 has the potential for being the most important land use planning goal. The Goal requires that "all waste and process discharges from future development, when combined with such discharges from existing developments shall not threaten to violate, or violate applicable state or federal environmental quality statutes, rules and standards." The Goal includes a series of "guidelines" for developing comprehensive plans such as designating sites for controlling pollution, buffering and separating land uses that lead to impacts upon water resources, and considering the planning area's carrying capacity for water resources.

State definitions for wastewater and pollutants include pollutants carried by stormwater and impacts on habitat that result from stormwater flows. Goal 6 requires jurisdictions to integrate compliance with federal and state water quality regulations with their comprehensive planning process.

Goal 6 can be used to justify local actions or possibly require local actions when development activity or allowed land uses pose a threat to federal or state protected water resources. Examples of federal and state designations and requirements that could trigger local action include:

- Phase I and Phase II Stormwater NPDES permit requirements;
- Total Maximum Daily Load (TMDL) limits and associated requirement;
- State designation of a "high or exceptional water quality" water body requiring special water quality protection (OAR 340-04-0002(44);
- State's water quality anti-degradation policy;
- State designated Groundwater Management Areas.

Under these situations, local jurisdictions could adopt measures that address water quality threats or violations or both under Goal 6. The relationship between Goal 6 implementation measures and Goal 5 resources is described in OAR 660-023-0240(1). The rule states that, "The requirements of Goal 5 do not apply to the adoption of measures required by Goal 6. . ." A local government must make findings specifying what is required to meet the objectives of Goal 6. Such findings can be informed by the standards and objectives within the federal and state programs listed above.

Goal:

To maintain and improve the quality of the air, water and land resources of the state.

Findings:

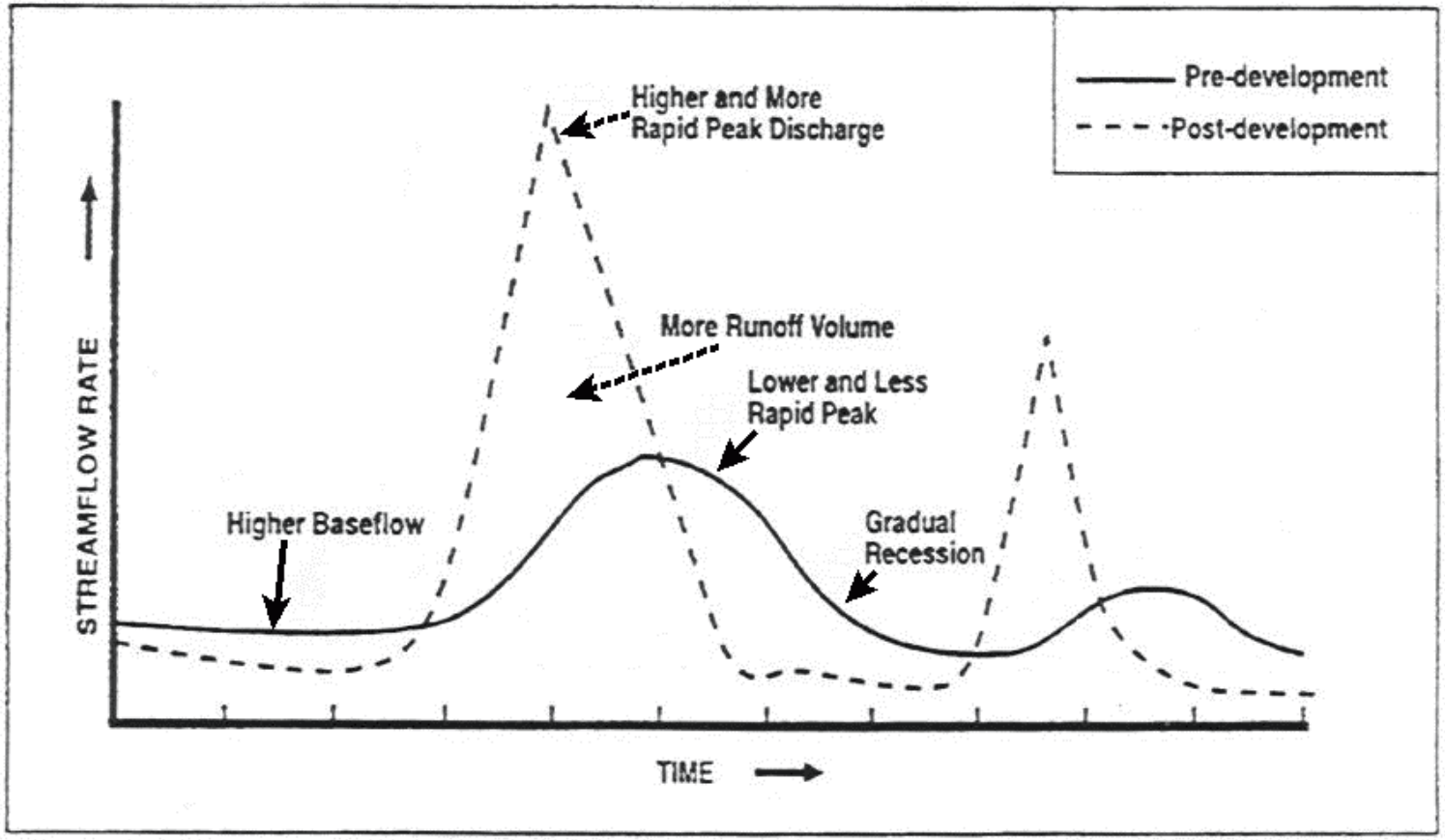
The water resources and associated riparian vegetation in the jurisdiction contribute to the health, safety, and general welfare of the area. The effectiveness of these resources to trap and remove pollutants from runoff; to stabilize stream banks and reduce channel erosion; and to moderate water temperature contributes to the maintenance and protection of the community's water quality.

Impacts of Impervious Surfaces Percent on Urban Areas Runoff Volume

Once development occurs, the natural surface water systems are replaced by stormwater infrastructure. These once natural systems are now draining runoff from all developed/impervious areas. This runoff can pick up pollutants, increases the volume of runoff, (that once infiltrated into the ground), and therefore increases unstable stream banks, and flooding.

Urban development increases the peak discharge rate associated with a given design storm because impervious surfaces generate greater runoff volumes and drainage systems deliver it more rapidly to a stream. **Figure 10** profiles the change in the receiving water due to post-development peak discharge rates that accompany development.

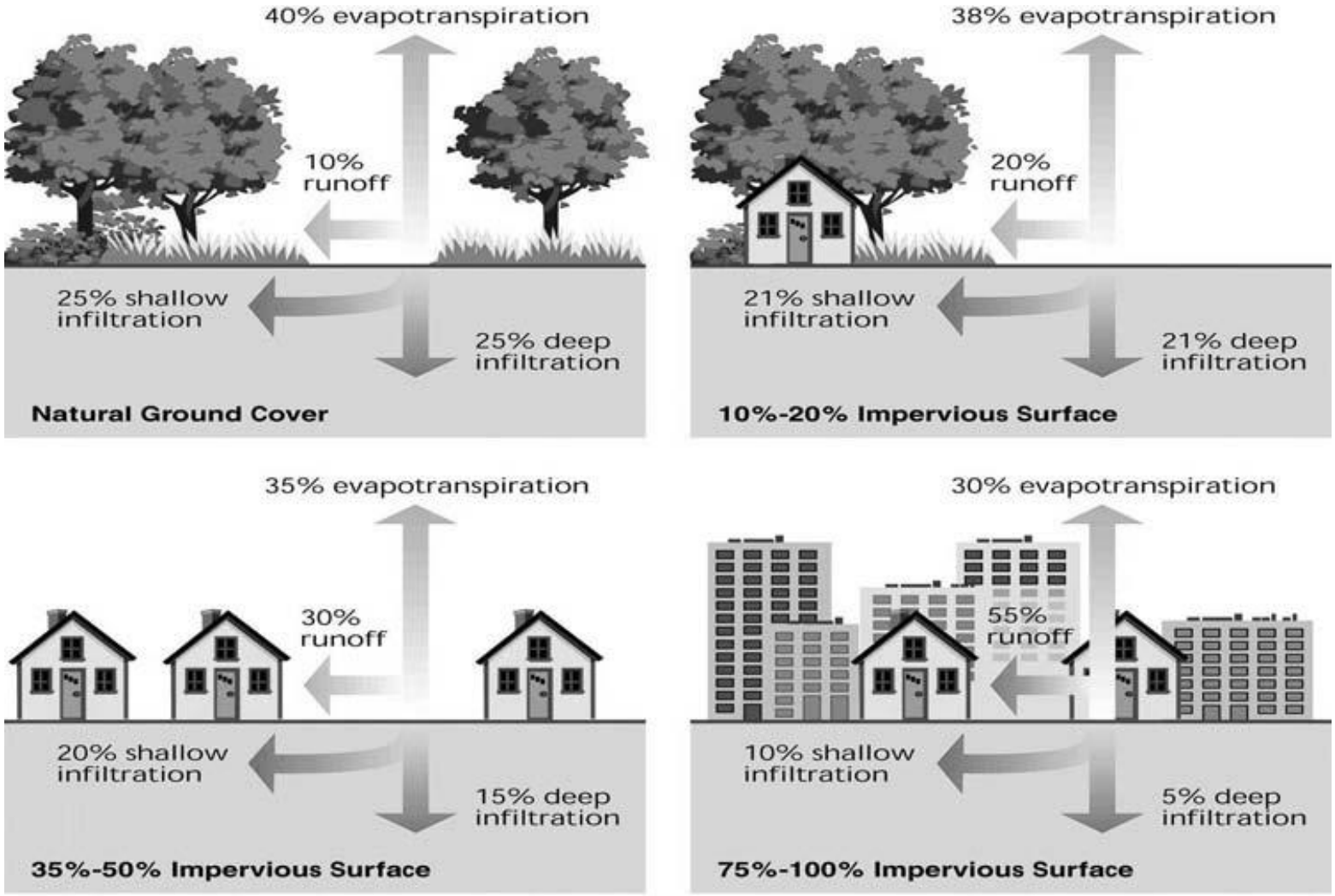
Figure 8. Pre- and Post-Development Peak Discharge Rates.



Source: Maryland Department of the Environment (MDE), 2000, Maryland Stormwater Design Manual: Volume 1 and 2, Maryland Department of the Environment, Annapolis, Maryland. http://www.mde.state.md.us/assets/document/sedimentstormwater/Introduction.pdf

Moreover, **Figure 9:** identifies the impacts of various development intensity, expressed as impervious surfaces percent, on the hydrology of urban areas.

Figure 9. Impact of Impervious Surfaces Percent on Urban Areas Runoff.



Source: EPA Stormwater Best Management Practice Design Guide: Volume 1, General Considerations, EPA/600/R-04/121, September 2004
http://www.epa.gov/nrmrl/pubs/600r04121/600r04121.pdf

Reducing Impervious Surfaces with Low Impact Development BMPs

"Given the direct relationship between imperviousness and stormwater generation, reduction in imperviousness can be expected to result in comparable reduction in stormwater generation, both total volume and rate."

"Conservation design approaches reflect a totally different philosophy towards site design which integrates stormwater management into the very core of site design, as opposed to being considered an afterthought to site design."

Source: Conservation Design for Stormwater Management. A Design Approach to Reduce Stormwater Impacts from Land Development and Achieve Multiple Objectives Related to Land Use, A Joint Effort Between the Delaware Department of Natural Resources and Environmental Control and The Environmental Management Center of the Brandywine Conservancy September 1997

Many of the BMPs recommended in this Guidance document are designed to capture and infiltrate runoff from the impervious surfaces in urban and rural residential areas. These BMPs are sometimes referred to as Low Impact Development (LID) BMPs. They emphasize replicating pre-development hydrology with respect to runoff volume, temperature, rate, and duration.

Reducing Impervious Surfaces

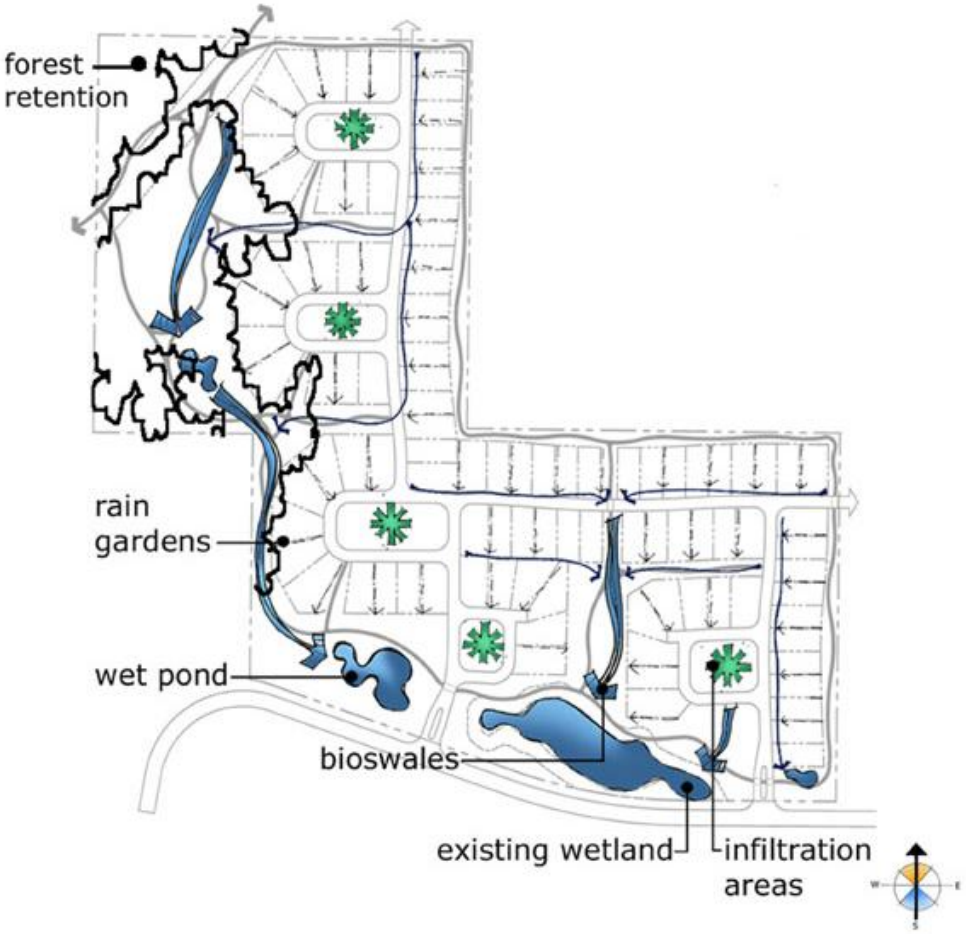
- **Constructing Biofiltration Practices**
- **Creating Natural Areas**
- **Leaving Areas Undisturbed**
- **Clustering Development**

These BMPs are a more reliable and effective stormwater management practice than traditional approaches that focus on pollutants without addressing hydrology. In addition, LID BMPs treat many urban and rural pollutants and help to reduce flooding impacts. These benefits are already expressed in a number of recent EPA documents and numerous states, cities, and expert groups, including the National Academy of Sciences Low Impact Development (http://www.epa.gov/owow/NPS/lid/#guide) and EPA's Green Infrastructure Reports http://epa.gov/greeninfrastructure).

EPA defines **Low Impact Development (LID)** as *"A comprehensive stormwater management and site-design technique. Within the LID framework, the goal of any construction project is to design a hydrologically functional site that mimics predevelopment conditions. This is achieved by using design techniques that infiltrate, filter, evaporate, and store runoff close to its source. Rather than rely on costly large-scale conveyance and treatment systems, LID addresses stormwater through a variety of small, cost-effective landscape features located on-site. LID is a versatile approach that can be applied to new development, urban retrofits, and revitalization projects. This design approach incorporates strategic planning with micro-management techniques to achieve environmental protection goals while still allowing for development or infrastructure rehabilitation to occur."*

Figure 10 provides an example LID/Green Infrastructure development:

Figure10. Pierce County, Washington LID/Green Infrastructure Design.



Selecting BMPs for Multiple Pollutants

There are many types of pollutants found in urban and rural residential runoff. However, many waterbodies within a city or county have only a few of these pollutants on DEQ's 303(d) list. Then only a few of the 303(d) listed pollutants have TMDLs developed by DEQ. However, based on many local, regional, and national water quality studies, most communities will have many if not all of these pollutants in their waterbodies that pose a risk to water quality.

Therefore, it is very important for an urban and rural residential DMA to include BMPs for all known or suspected pollutants within in their jurisdiction into their TMDL Implementation Plan.

This is particularly applicable for the larger and medium sized communities or those that have the following land uses that would contribute many of the urban related pollutants:

- Major highway running through their community
- Industrial or commercial land uses
- Other land uses that create impervious surfaces

Best Management Practices "Treatment Train" Concept

A very important design practice is to have a series of different BMPs that would treat the many known or suspected pollutants. This would be done on-site first. If the polluted runoff cannot be completely treated on-site, then treat off-site in a BMPs "treatment train". The treatment trains are independent of where the BMP is located and should follow a progression of different unit processes to address different pollutants or factions of the target pollutant.

Projects are most successful when LID practices and BMPs are integrated into a site design and are used in a "treatment train" approach. In such an approach, any runoff that cannot be treated on-site would flow from one practice into a second or third practice, such as a green roof followed by a cistern, with the overflow to a planter box with its own overflow and under drain. Site conditions, applicable performance requirements, and cost typically influence the selection of appropriate LID practices.

Stormwater treatment via multiple, consecutive BMPs can significantly improve the quality of water discharged to urban rivers, lakes, streams, wetlands, and coastal waters. In general, stormwater treatment trains should seek to address source controls and infiltration, evapotranspiration and reuse first, then large particles, and, finally, small particles. The specific pollutant removal role of the second or third facility in a treatment train often assumes that significant settling or removal of solids has already occurred.

For example, phosphorus removal using a two-facility treatment sequence relies on the second facility (e.g., sand filter) to remove a finer fraction of solids than those removed by the first facility. It is recommended that oil control facilities be upstream of treatment facilities and as close to the source of oil-generating activities as possible. They should also be upstream of detention facilities, if possible. However, not all treatment facilities can function effectively if located downstream of detention facilities. Those facilities that treat unconcentrated sheet flows, such as filter strips and narrow biofilters, are usually not practical downstream of detention facilities because of a variety of factors, including the sheer volume that may need to be treated.

This is important given that many BMPs are only effective for a selected number of pollutants. In the end, a city or county will find it more cost effective and efficient to construct multiple BMPs in what is called a "treatment train" as outlined in **Figure 13.**

Figure11. Best Management Practices "Treatment Train" Concept.

Reduce Runoff Generation	→	**On-Site Treatment And/or Conveyance, Pretreatment and Infiltration**	→	**Additional Treatment and Reduction**	→	**Final Treatment and Reduction**	→	**Discharge to Receiving Waters if Necessary**
Pollution prevention & minimize DCIA to reduce runoff		**First on-site treatment and then capture runoff for, retention, evaporation, infiltration, reuse and treatment**		**Surplus runoff to bioretention or infiltration BMPs**		**Direct remaining runoff to regional treatment BMPs**		**Discharged water meets water quality standards**

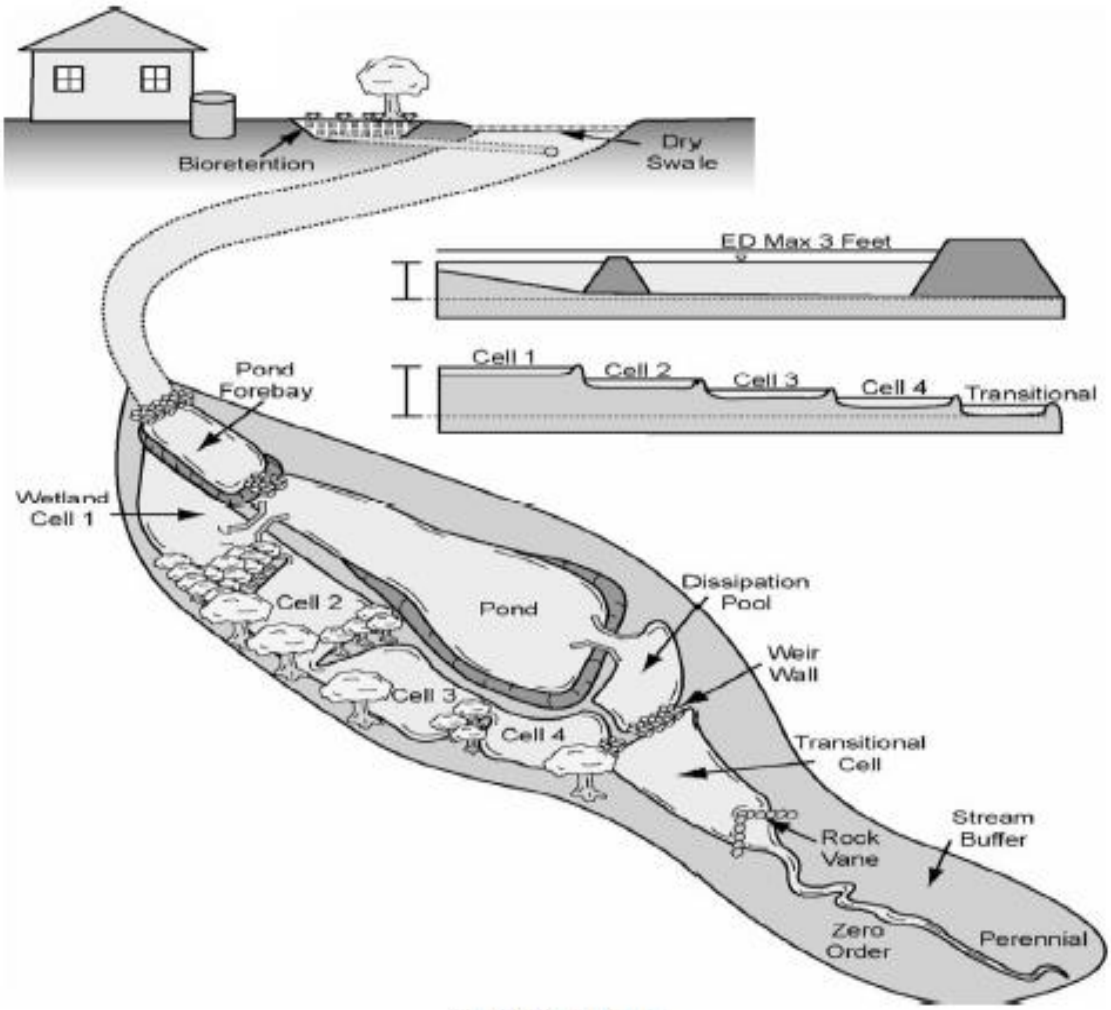
Notes:
1. DCIA is directly connected impervious area.
2. Recharge/infiltration should be attained wherever possible.
3. Multi-step treatment maximizes removal of both suspended and dissolved pollutants.

Source: As Modified - *Tertiary Treatment of Urban Stormwater,* University of Newcastle, Australia, Posted 11-12-99 by Nigel Bosworth.

Figure 12 provides an example "Treatment Train" design.

Figure12. An Example "Treatment Train" Design.

(based on VADCR (Virginia Department of Conservation and Recreation). 2009. Draft VA DCR Stormwater Design, Specification No. 13: Constructed Wetlands Version 1.5, July 2, 2009, http://www.vwrrc.vt.edu/swc/July2009Updates/VASWMBMPSpec13CONSTRUCTEDWETLAND.html)



Source: VA DCR 2009

Figure 3A1-24. Pond/wetland combination.

3.6.2 Best Management Practice Selection (BMP) Selection Process

BMP Selection Process for Inclusion in the TMDL Implementation Plan

The process of selecting the most effective and appropriate programmatic or structural BMPs is guided by the types, amount of acreage, and locations of land use development (residential, commercial, industrial, roads, etc.) in the urban and rural residential areas. Identifying the sources and amount of pollutants affecting the water quality of waters of state within the DMAs jurisdiction is the first step in the selection process. In addition, in order to select BMPs it is important to understand the basic steps of controlling, reducing, and treating stormwater runoff in order to meet TMDL load allocations and water quality standards of water entering into waters of the state.

Oregon's TMDL Rule requires DMAs to identify the management strategies the DMA or other responsible person will use to manage the known or suspected sources of pollution. These management strategies or BMPs are selected and implemented for use on a basin scale or project scale. Basin scale BMPs are Programmatic BMPs and Project Scale are Structural BMPs.

Programmatic BMPs are intended to direct or encourage activities that will result in reduced pollutant loading, such as the adoption of ordinances that protect sensitive environmental areas, prevent pollutants from entering waters of the state (e.g. erosion and sediment control), or require infiltration and/or treatment of runoff. Land use planning (as described above) is a Programmatic BMP, which is one of the most important first steps in meeting an urban and rural residential TMDL Load Allocation. They focus on reducing impervious surfaces and dispersing instead of collecting stormwater.

Structural BMPs are design features and facilities that physically manage the water to remove and treat pollutants and attenuate flows. These may include detention basin, or simply the direction of stormwater to natural or modified landscape features.

In **Appendix D** of this Guidance, DEQ has provided a table of the recommended Programmatic BMPs by TMDL listed pollutant and source and **Appendix E** includes a table of the structural BMPs by TMDL listed pollutant, source, estimated load reduction, costs, and what is included in the costs. **Appendix F** identifies those Structural BMPs that are or are not Underground Injection Controls (UICs). The recommended structural BMPs generally are not UICs.

DEQ's selection of recommended programmatic and structural BMPs is based on NOAA and EPA and other technical sources that are identified in the tables. These are the most cost effective in reducing pollutant loads to meet the TMDL LAs. The tables in **Appendix D and E** are designed for a DMA to easily identify for their local community the source or condition causing the TMDL listed pollutant and the programmatic and structural BMPs that are effective in controlling or treating it. Many of these BMPs are also defined by EPA as Low Impact Development (LID). Both the research and application of these BMPs is constantly changing as new BMPs are developed and tested on the ground. DEQ staff is committed to providing to local communities the best available science.

For small and medium sized communities these tables are designed to be used as a toolbox to easily select those management measures that the city or county DMA does not already have available or in use. The aim is that this list of management measures be used by current city or county planning and public works staff without having to hire consultants or additional staff.

Prior to selecting BMPs, the DMA should review the TMDL WQMP for a list of BMPs that are recommended to be used to control sources of pollution. The WQMP may list recommended BMPs by pollutant and source and the estimated pollutant load reduction by BMP.

Note: The DMA is not responsible for pollution arising from activities that occur outside of the DMA's jurisdiction.

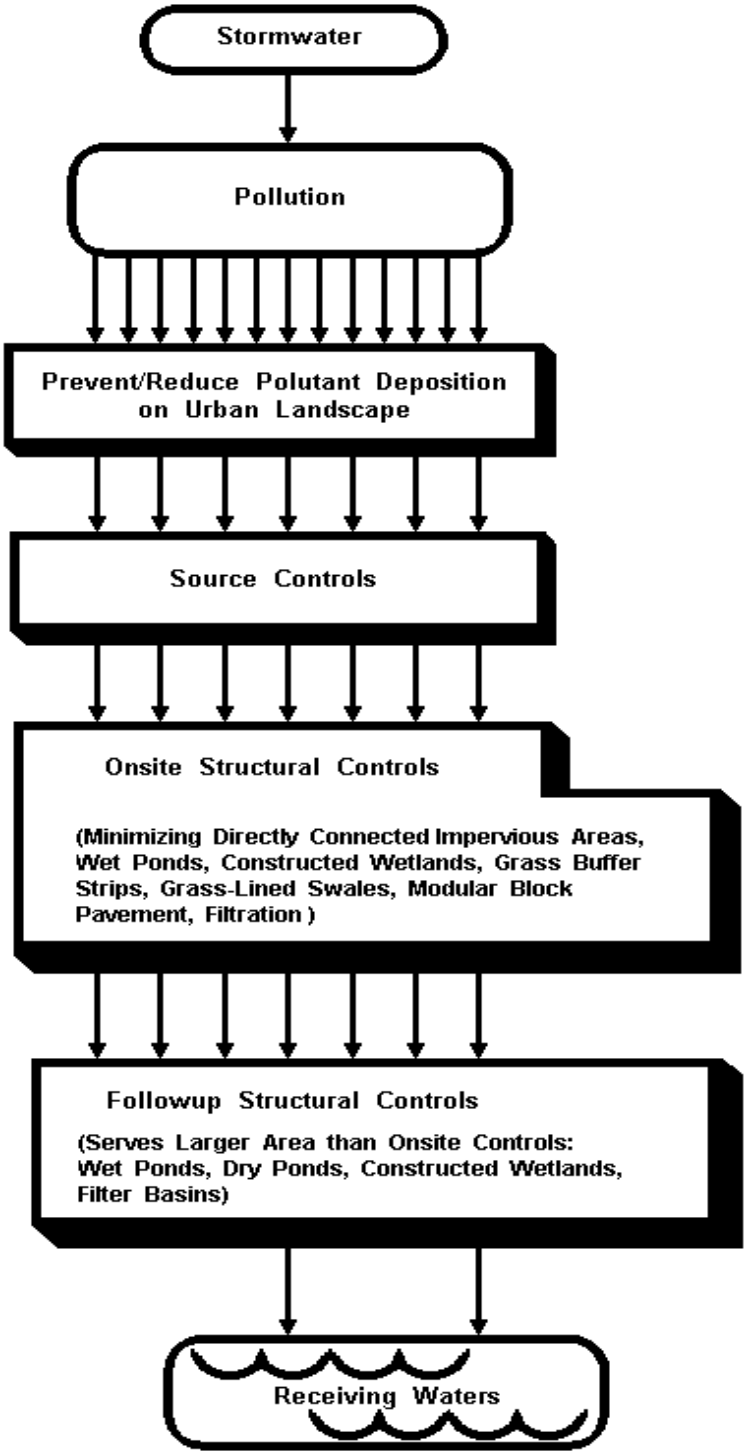
The TMDL WQMP provided information is just the beginning of the preparation of the DMA's TMDL Implementation Plan. The DMA will need to prepare a plan that provides a more site-specific description of the management measures necessary to prevent, control, and/or treat specific sources of the TMDL pollutant.

The TMDL Implementation Plan must include the estimated BMP load reduction by pollutant and indicate how the urban and rural residential DMA will reduce pollution and the BMPs it will use to meet load allocations. In addition, the plan must describe the selected Programmatic and Structural BMPs in sufficient detail with the technical design, implementation, operation and maintenance, and effectiveness monitoring over time. The plan should also include the estimated costs for implementation and/or construction, administration, education/outreach, operation and maintenance, and monitoring. Likewise, specific timelines should be identified for each of these actions to ensure that TMDL LA is met within a reasonable timeframe.

DMAs may adjust the number and timing of the individual BMPs based on the size of the DMA, population density, high growth or growth potential, and other applicable local factors such as infrastructure age and design or percentage of high pollutant loading land use types. In some instances, it may be necessary to prioritize among the strategies if resources are limited. This may mean addressing some sources of pollution before others or focusing implementation efforts in a particular geographic area. To the extent possible, the selection of priorities should be driven by the greatest opportunities for achieving pollutant reductions.

The following flowchart in **Figure 13** outlines the basic steps of controlling, reducing, and treating stormwater runoff in order to meet TMDL load allocations. Note that most of the Programmatic BMPs would be applied during the prevent/reduce pollutant deposition and the next step, source controls. Structural BMPs would mostly be applied in all steps of the stormwater process in order to meet the TMDL load allocations and water quality standards.

Figure 13. Steps to Control, Reduce, and Treat Stormwater Runoff.



Relationship of TMDL Implementation Plan Elements to the NPDES MS4 Stormwater Permit Requirements

The Oregon TMDL rule requires that all communities, whether a Phase I or II Municipal Separated Storm Sewer Systems (MS4) permitted community or not, to prepare a TMDL Implementation Plan. Moreover, for those waterbodies located within a MS4 community that do not yet have a TMDL, the permit requires that all 303(d) listed pollutants be evaluated to determine whether the SWMP reduces the 303(d) listed pollutant. In the case of Phase I MS4 permitted communities, a Stormwater Management Plan (SWMP) is required to be written and sent to DEQ for approval. The SWMP must include benchmarks (or BMPs) for TMDL impairments and listed pollutants necessary to achieve TMDL load allocations.

EPA's NPDES Phase I or Phase II Stormwater rules (http://cfpub.epa.gov/npdes/stormwater/munic.cfm) require the (MS4) permitted community to implement a stormwater management program and to prepare a SWMP in order to reduce the discharge of pollutants into the storm sewer system to the maximum extent practicable. Stormwater runoff may discharge into a municipal system, such as a stormwater pipe, ditch within an MS4 public right-of-way or other conveyance system that collects and discharges into a waterbody.

The SWMP should include a full range of strategies including regulations, financial incentives, technical assistance, and education. For that reason, MS4 communities (some with population of only several hundred) are required to use their regulatory authority granted by state statutes and rules.

Within the Coastal Nonpoint Management Area, there are no Phase I communities. The State of Oregon Department of Transportation (ODOT) has a Phase I Permit that includes the Coastal Nonpoint Management Area. For Phase II, the Medford Urbanized Area, which includes the communities of Medford, Ashland, Central Point, Phoenix, Jacksonville, Talent, and a Portion of Jackson Co. (incl. White City) is a MS4 **(Table 6)**. So far, the communities of Coos Bay, Roseburg, and Grants Pass are the only communities within the Coastal Nonpoint Management Area boundary that are MS4s to be evaluated by DEQ.

Table 6. Communities within the Coastal Nonpoint Management Area Designated as a Phase II MS4 Stormwater NPDES Community.

PHASE II MS4 COMMUNITY (IN URBANIZED AREA)
Medford Urbanized Area
• **Medford**
• **Ashland**
• **Central Point**
• **Phoenix**
• **Jacksonville**
• **Talent**
• **Portion of Jackson Co. (incl. White City)**

One of the questions that is usually asked by many urban and rural residential DMAs is the relationship of the NPDES MS4 Stormwater Permit six minimum control measures requirements (http://cfpub.epa.gov/npdes/stormwater/menuofbmps/) to the TMDL Implementation Plan requirements. All of the six minimum control measures are required elements to be included in the TMDL Implementation Plan.

Under MS4 permits, DEQ requires local governments to use their regulatory authority to adopt ordinances to address the following six minimum stormwater control measures:

1. ***Public Education and Outreach.***

   Distributing educational materials to inform citizens about the impacts polluted stormwater runoff discharges can have on water quality.

2. ***Public Participation/Involvement.***

   Providing opportunities for citizens to participate in program development and implementation.

3. ***Unlawful Discharge Detection and Elimination.***

   Implementing a plan to detect and eliminate unlawful discharges to the storm sewer system (includes developing a system map and informing the community about unlawful discharges and improper disposal of waste).

4. ***Construction Site Runoff Control.***

   Implementing an erosion and sediment control program for construction activities that disturb one or more acres of land.

5. ***Post-Construction Runoff Control.***

   Implementing a program to address stormwater discharges from new development and redevelopment areas. Applicable controls could include preventive actions such as protecting sensitive areas or the use of structural controls such as grassed swales or porous pavement.

6. ***Pollution Prevention/Good Housekeeping.***

   Implementing a program aimed at preventing or reducing pollutant runoff from municipal operations. The program must include municipal staff training on pollution prevention measures.

The following **Table 7** identifies where the NPDES MS4 Stormwater Permit six minimum control measures are included in the TMDL Implementation Plan. Note that most; four of the six minimum management measures, are addressed in **Section 3.11, Management Strategies to Achieve Load Allocations.**

Table 7. Sections of a TMDL Implementation Plan that Addresses the NPDES MS4 Stormwater Permit Requirements.

RELATIONSHIP OF NPDES MS4 PERMIT REQUIREMENTS TO THE TMDL IMPLEMENTATION PLAN ELEMENTS	
NPDES MS4 Required Six Elements	**TMDL Implementation Plan Section***
1. Public Participation/Involvement	**3.7 Public Participation**
2. Public Education and Outreach	**3.17 Information/Education for Implementing the Plan**
3. Unlawful Discharge Detection and Elimination	**3.11 Management Strategies to Achieve Load Allocations**
4. Construction Site Runoff Control	**3.11 Management Strategies to Achieve Load Allocations**
5. Post-Construction Runoff Control	**3.11 Management Strategies to Achieve Load Allocations**
6. Pollution Prevention/Good Housekeeping	**3.11 Management Strategies to Achieve Load Allocations**

***** *Note:* Section numbers refer to the TMDL Implementation Plan outline in this Guidance Document.

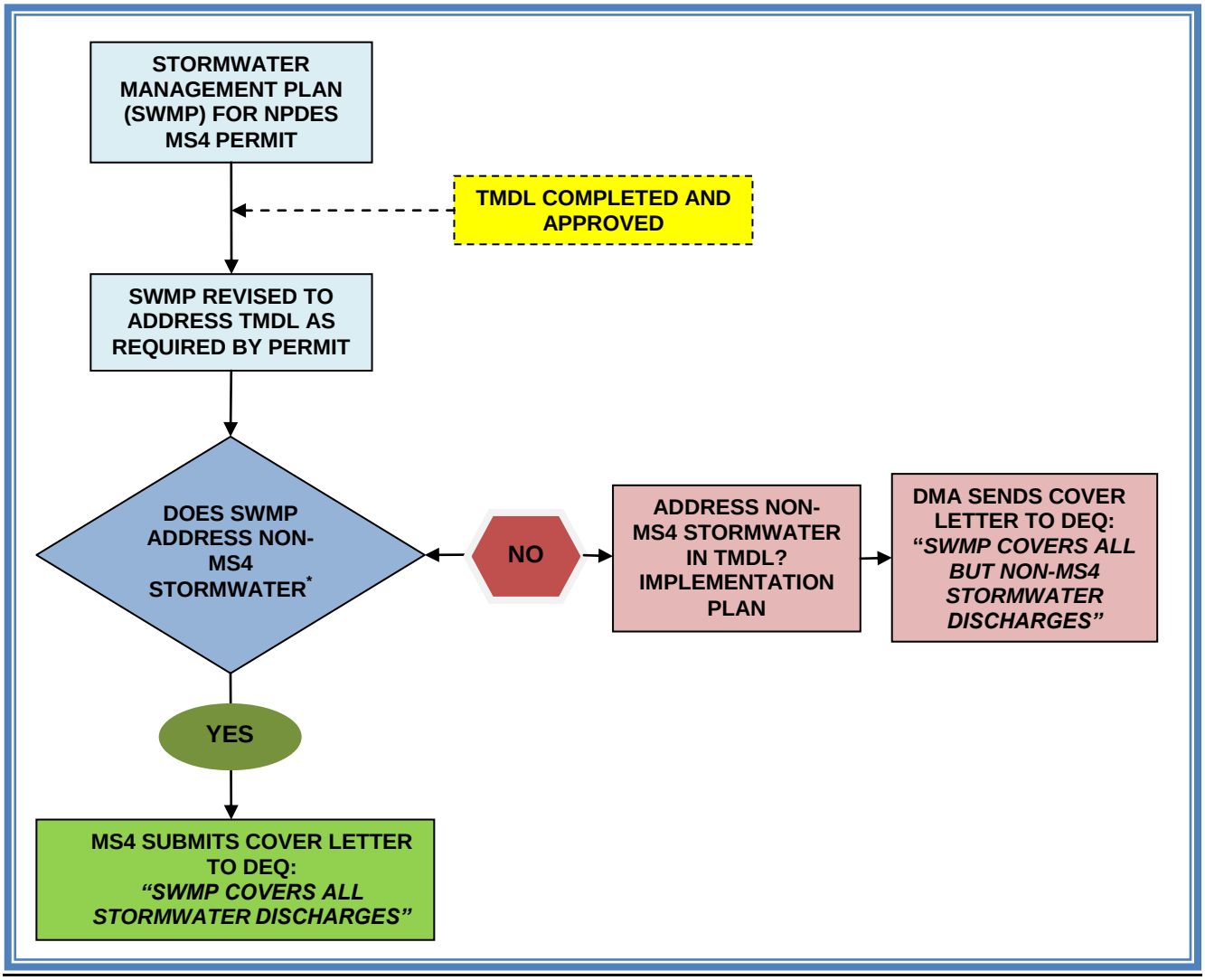
See the following **Table 8** for a description of those sources of pollutants that are covered in an MS4s' SWMP and need to be covered in a TMDL Implementation Plan.

Table 8. Permitted MS4s, NPDES Plan vs. TMDL Implementation Plan.

Type of Discharge or Environmental Concern	Addressed by NPDES SWMP?	Addressed by TMDL Implementation Plan?
Stormwater Discharges From Municipal System*	**Yes**	**No (refer to SWMP)**
Stormwater Discharged Directly To Receiving Waters (For Example Runoff From a Parking Lot that Flows Overland or Through a Private Pipe)	**No**	**Yes**
Discharges From On-Site Sewage Systems • **Discharges Into MS4** • **Seepage Into Ground Water or Direct to Surface Waters**	**Yes (through MS4 illicit discharge program)** **Unlikely**	**No (refer to SWMP)** **Yes (unless addressed in SWMP)**
Stream Temperature Reduction *(As an example of a pollutant, there may be many others)* • **BMPs To Reduce Temperature of Stormwater Runoff** • **Need For Shading and Riparian Habitat Restoration**	**No**	**Yes**

The following **Figure 14** identifies the steps a Phase I or II stormwater NPDES permitted community would follow in determining the process of meeting TMDL rule requirements.

Figure 14. Stormwater NPDES Permitted Phase I and II MS4 Communities and TMDL Rule Process Flow Chart.



* Non-MS4 stormwater discharges are those that are within the MS4 permitted geographically jurisdiction's boundaries but flow directly to surface waters without being conveyed through the jurisdiction's MS4.

Example

(based on the DEQ Issued MS4 NPDES Stormwater Permit and the TMDL WQMP Requirements):

The Coast Fork of the Willamette River is currently listed by DEQ as water quality limited due to elevated bacteria levels. The watersheds are drained by X, Y, and Z. City stormwater drains to all these waterbodies.

*"[Name of DMA] submits the attached MS4 NPDES Stormwater permit required SWMP that already addresses the assigned WLAs and other requirements outlined in the **DEQ TMDL Implementation Plan Guidance.** [Name of DMA] states that the SWMP Covers All Stormwater Discharges"*

CZARA Post Construction New Development Management Measure

The Coastal Zone Act Reauthorization Amendments (CZARA) Section 6217[1] includes 15 Urban Management Measures that need to be addressed in Oregon's Coastal Nonpoint Pollution Control Plan within the Coastal Nonpoint Management Area boundary. DEQ has completed 14 of the 15 Urban Management Measures under CZARA Section 6217. The last remaining is the Post Construction New Development Management Measure.

The CZARA Section 6217(g) Post Construction New Development Management Measure states:

"By design or performance:

After construction has been completed and the site is permanently stabilized, reduce the average annual total suspended solid (TSS) loadings by 80 percent. For the purposes of this measure, an 80 percent TSS reduction is to be determined on an average annual basis, or reduce the post development loadings of TSS so that the average annual TSS loadings are no greater than predevelopment loadings.

To the extent practicable, maintain post development peak runoff rate and average volume at levels that are similar to pre-development levels."

The CZARA 6217(g) Post Construction New Development Management Measure for the 80 percent TSS reduction and pre-development hydrology volume reduction can be addressed by adopting a Post-Construction Stormwater Runoff Control Ordinance with a required Stormwater Management Plan, described as follows:

1. Post-Construction Stormwater Runoff Control Ordinance

Appendix N has a DEQ developed Example **Post-Construction Stormwater Runoff Control Ordinance** and **Appendix O** has an EPA developed example ordinance; both of which requires the development of a **Stormwater Management Plan** (SWMP) for new development, redevelopment, and retrofits. The required SWMP must include all necessary BMPs and other required elements of the ordinance in order to meet TMDL load allocations and meet water quality standards.

This ordinance provides standards for addressing infiltration, treatment, and detention of stormwater separately as well as an option for a combined approach to mitigating the water quality impacts of developments. It includes standards for conveyance of surface water in streams, creeks, channels, and ditches and other waters of the state that exist on a site at the time of development. It also addresses pollution reduction, treatment, and flow control for stormwater generated from new development, redevelopment, or retrofit.

For the purpose of this ordinance, "new" and "redevelopment" refers to any man-made change to improved or unimproved real estate including, but not limited to the placement of buildings or other structures, dredging, filling, grading, or paving.

The purpose of the Post-Construction Stormwater Runoff Control Ordinance is to establish minimum stormwater management requirements and controls and to meet the following objectives:

- Minimize increases in stormwater runoff from any development in order to reduce flooding, siltation, increases in stream temperature, streambank erosion, and to maintain the integrity of stream channels;
- Minimize increases in nonpoint source pollution caused by stormwater runoff from development which would otherwise degrade local water quality;
- Minimize the total annual volume of surface water runoff which flows from any specific site during and following development to not exceed the pre-development hydrologic regime to the maximum extent practicable; and
- Reduce stormwater runoff rates and volumes, soil erosion and nonpoint source pollution, wherever possible, through stormwater management controls and to ensure that these management controls are properly maintained and pose no threat to public safety.

1 *"Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, issued under the authority of Section 6217 (g) of The Coastal Zone Act Reauthorization Amendments of 1990"*, http://www.epa.gov/owow/nps/MMGI/

2. Stormwater Management Plan

Both of the DEQ and EPA example model ordinances require a SWMP for new development, redevelopment, and retrofits. The required SWMP in the Post-Construction Stormwater Runoff Control Ordinance requires identifying a DMA's entire stormwater drainage system, including both the open and piped systems, their connections to the rivers, and the overall condition of the system. The plan should also include all existing surface water or groundwater releases from a constructed water quality treatment facility or other constructed facility or structure, e.g., settling pond, lake, reservoir, swimming pool, etc. and include actions to control and treat sediment-laden runoff from new development, redevelopment, and retrofits.

The SWMP should include identifying the source of pollution and develop controls to prevent polluted stormwater runoff. Stormwater BMPs should improve the quality of water resources including groundwater recharge, channel protection, flood control and pollutant reduction. The BMPs should be used at a specific site where this is physical suitability, such as topographic, slope, and soil conditions.

The SWMP should identify the size and location of the most effective BMPs by pollutant in a drainage (watershed) area that can effectively remove pollutants. This area is represented as a percentage of the impervious land area draining to the BMP. In addition, the SWMP should ensure there is sufficient hydraulic head (elevation) difference needed at a site (from the inflow to the outflow) to allow for gravity operation within the practice.

The SWMP should establish goals, policies, and implementation actions that will achieve the DMA's long-term objectives in a way that is understandable to the public, usable by City or County staff, and meets regulatory needs. Finally, the SWMP establishes a means for measuring, reporting, and adaptively managing the DMA's water resources, by presenting benchmarks that will ensure meaningful progress toward a community objectives, as well as ensuring compliance with applicable laws and permit requirements.

The SWMP should include stormwater quality management policies and management practices that are, and/or will be implemented in the DMA's jurisdictional area. Concurrent with the development of the Stormwater Plan, a DMA should prepare a Stormwater Facilities Master Plan, which will update the Capital Improvement Program (CIP) for future drainage infrastructure. The SWMP will support development and implementation of the Stormwater Facilities Master Plan and CIP in a manner that helps meet the DMA's water quality objectives.

The plan should also include a description of the DMA's authorities and plans for implementing surface water management activities within its boundaries, including the planning, design, construction, operation, and maintenance of the stormwater drainage system.

Example SWMP Development Guidance:

San Bernardino County Stormwater Program, Model Water Quality Management Plan Guidance, Revised June 09, 2005 (http://www.waterboards.ca.gov/santaana/water_issues/programs/stormwater/docs/sbpermit/wqmpguide60905.pdf)

New Jersey Stormwater Best Management Practices Manual, APPENDIX C, Sample Municipal Stormwater Management Plan February 2004. (http://www.nj.gov/dep/stormwater/bmp_manual/NJ_SWBMP_C.pdf)

Example SWMPS:

City of Springfield (Oregon) Stormwater Management Plan, Prepared by: City of Springfield, Public Works Environmental Services Division, January 2004. (https://scholarsbank.uoregon.edu/xmlui/bitstream/handle/1794/5828/Springfield_Stormwater_Master_Plan.pdf?sequence=1)

Greenville Stormwater Management Plan 2007, Prepared by City of Greenville Public Works Department, Engineering Division. (http://www.greenvillesc.gov/PublicWorks/forms/StormwaterManagementPlan/Greenville_Stormwater_Management_Plan.pdf)

3.6.3 Types and Description of Best Management Practices

There are primarily two types of BMPs; ones that are implemented on a basin scale or on a project scale. Basin scale BMPs are Programmatic BMPs and project scale BMPs are Structural BMPs. It is recommended that a DMA select Programmatic BMPs first, since they direct or mandate the implementation of the Structural BMPs.

Both types of BMPs should be selected to prevent, control, and treat runoff for all phases of development, redevelopment, and retrofits:

- Pre-Construction
- Construction
- Post-Construction

Programmatic BMPs are typically passive and tend to be source control or pollution prevention BMPs that reduce pollution in runoff by reducing the opportunity for the stormwater runoff to be exposed to the pollutants. In many cases, it may be easier and less costly to prevent the pollutants from entering the stormwater runoff than to control with structural BMPs. In addition, programmatic BMPs tend to be easier to design and implement. Typically, the measures do not require maintenance but do require administrative resource commitments to ensure that they are continually implemented. Programmatic BMPs normally do not have technical or engineering designs associated with them.

Programmatic BMPs are intended to direct or encourage activities that will result in the following:

- Develop, if needed, a Stormwater Management District or some other method to develop and adopt a stable funding source
- Develop, if needed, the authority to implement the TMDL Implementation Plan
- Develop and implement Capital Improvement Projects (CIP) plans to implement the TMDL Implementation Plan
- Review and update Comprehensive Land Use Plan and Zoning Maps in order to prevent pollution by locating or relocating land use activities away from mapped environmentally sensitive and hazard areas.
- Review and update Zoning Map and Ordinance to control land use activity to limit production of polluted runoff that would require structural BMPS to control and treat.
- Adoption of ordinances that are recommended to protect, prevent, reduce, and treat pollutants
- Reduce the location and amount of impervious surfaces
- Require infiltration and/or treatment of runoff
- Match pre-development hydrology
- Collect and treat stormwater runoff to meet TMDL LAs and water quality standards

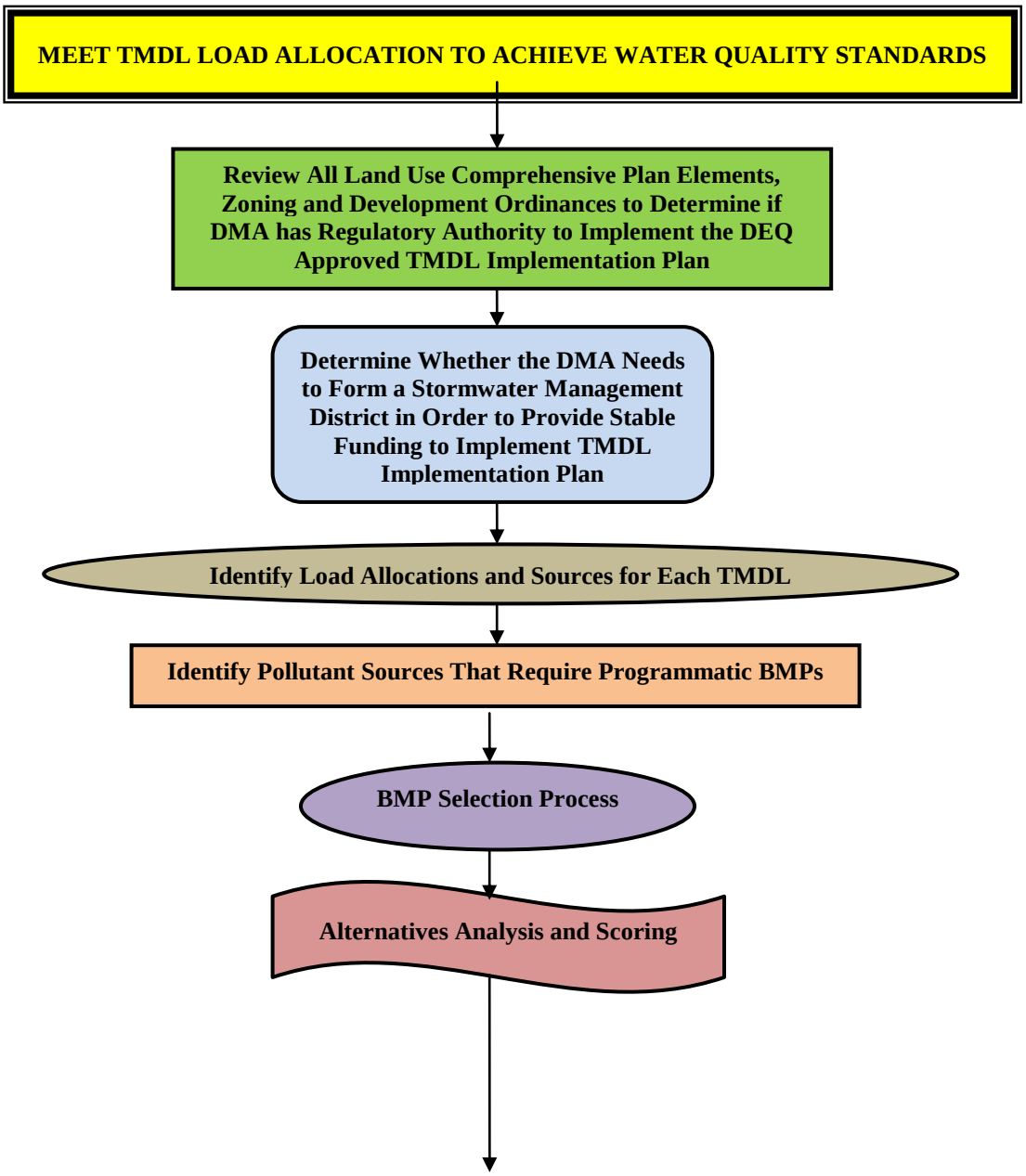
Land use planning is a Programmatic BMP that should be selected and implemented first in order to meet the TMDL Load Allocation. They usually require the updating or development of new rules, regulations, and ordinances, which would mandate structural BMPs that focus on reducing impervious surfaces and dispersing instead of collecting and treating stormwater by Structural BMPs. Some example ordinances are in **Appendix L** through **Appendix O.**

There are four major groups of programmatic BMPs:

1. Land Use Planning BMPs
2. Source Control BMPs
3. Pre, During, And Post-Construction BMPs
4. Maintenance BMPs

The following **Figure 15** identifies the Programmatic BMP selection process:

Figure 15. BMP Selection Process for Programmatic BMPs.



(Continues Next Page)

Figure 15. BMP Selection Process for Programmatic BMPs (Cont.).

Structural BMPs are site design features and facilities that physically manage the water to remove and treat pollutants, infiltrate runoff to meet pre-development hydrology volume, reduce downstream erosion, provide flood control, and promote groundwater recharge and attenuate flows in waters of the state to meet water quality standards. They range from highly engineered facilities to preserved, unmodified landscape features. Structural BMPs may be temporary, intended for use during construction or permanent for ongoing use once development is completed.

Many structural BMPs are considered Low Impact Development (LID) or Green Infrastructure BMPs. These BMPs rely on infiltration, evaporation, and capture and/ reuse.

The majority of the DEQ most effective and other recommended structural BMPs in **Appendix E** are taken directly from **EPA's National Pollutant Discharge Elimination System (NPDES) Stormwater BMP website**: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm or from other sources. The effectiveness of each BMP by pollutant type is included in the structural BMPs tables in **Appendix E**, which are based on either EPA's collected studies or the **International Stormwater Best Management Practices (BMP) Database (Appendix C,** http://www.bmpdatabase.org/BMPPerformance.htm).

1. Structural BMPs Factors

Many factors contribute to selecting the best Structural BMP for a site. Designers need to select BMPs that meet the water quality and quantity goals, and that are physically feasible. Other factors, such as maintenance requirements, cost and aesthetics of these BMPs influence choice. Following is a simple process designed to narrow down the choice of BMPs at a site.

The framework for selecting a BMP is based on answering a series of questions, including:

- What is the land use in the drainage area?
- What is goal of the BMP (e.g., water quantity control, water quality control, both)?
- What physical constraints exist at the site?
- Which BMPs require supplemental water?
- What other benefits and costs (e.g., aesthetics, cost) do the remaining BMP options have?
- What size should the BMP be to protect for water quality?
- Can the designer incorporate nonstructural components into a design to reduce this volume?

Structural BMPs typically require engineering design and engineered construction. The several types of structural BMPs vary greatly in their design and they each have advantages and disadvantages relative to each other. Some structural BMPs provide considerable stormwater quantity handling capability with LID BMPs, such as infiltration and/or detention/retention facilities (e.g. infiltration devices, stormwater wetlands, wet detention basins) and pollutant removal ability.

Others provide many types of pollutant removal mechanisms such as sedimentation, filtration, microbial action, and plant uptake (e.g. bioretention, stormwater wetlands). In addition, structural BMPs can be divided into those that help reduce the pollutants or quantity of stormwater entering a collection system (e.g. permeable pavement, filter strips, rooftop runoff management), and those that treat the stormwater before entering into waters of the state (e.g. sand filter, stormwater wetlands, wet detention basins).

Note: For design purposes, post development peak runoff rate and average volume is recommend on the 2-year/24-hour storm.

2. Major Types of Structural BMPs Pollutant Removal Mechanisms

Each structural BMP processes pollutants differently. The effectiveness of each structural BMP in treating or reducing pollutants differs by BMP. There have been many research studies completed throughout the United States and regionally in Portland and Seattle. The **International Stormwater Best Management Practices (BMP)**

Database Project, http://www.bmpdatabase.org/BMPPerformance.htm, has collected research data on the effectiveness of stormwater BMPs from throughout the Unites States over many years.

The following are the major types of structural BMPs and their pollutant removal process and function. Any given BMP may be a hybrid of several types:

- **Infiltration BMPs.** This type of BMPs is intended to infiltrate all or most of the stormwater into the ground and minimize discharges to surface waters. The most common infiltration facilities are bio-infiltration ponds, bio-infiltration rain gardens, and natural dispersion in vegetated filter strips.

- **Biofiltration BMPs.** Biofiltration facilities are flow-through BMPs intended to maximize the amount of stormwater that flows through dense vegetation, compost or soil, and to increase the potential for infiltration as compared to standard conveyance systems. Included in this class are Biofiltration Swales, and Vegetated Filter Strips.

  Biofiltration Swales are linear features that take collected stormwater and provide treatment as the water flows along the length of the swale. Bioretention facilities vary greatly in size, from small Rain Gardens to large Retention Ponds. They are designed to hold the water until it can filter through the media on the bed of facility. Those that are designed to discharge all or some treated stormwater to the surface have under drains. Vegetated filter strips manage stormwater as sheet flow across sloping ground. They are usually parallel to the edge of the pavement, but can be put in place where collected stormwater is discharged through a flow spreader.

- **Media Filtration BMPs.** Media filtration facilities direct stormwater flows through soil, amended soil, compost or a special mix of materials, maximizing absorption of dissolved pollutants, as well as physically trapping particles. Media filtration BMPs may infiltrate stormwater into the soil all, some or none of the stormwater they treat.

  Media Filter Drains, also known as bioslopes, are linear facilities parallel to the pavement. Stormwater is directed as sheet flow into the subsurface and through a special media before being collected in a perforated pipe and discharged to surface water. Media filter drains may allow for some, but usually limited, infiltration. There are several proprietary media filter systems. These are generally intended for use in developed areas where space for other media filter BMPs is not available.

- **Density Separation BMPs.** These BMPs rely on the difference in density between pollutants and water to allow the collection and trapping of the pollutants. In this category are detention ponds, retention (wet) ponds, stormwater treatment wetlands, and oil/water separators. All of these BMPs discharge all or most of the treated stormwater to surface waters. The ponds may also facilitate media filtration and infiltration. Bioretention facilities and infiltration ponds both facilitate sedimentation, but because fine sediments can clog the beds, sediment removal is best done as pre-treatment for these BMPs.

  Detention ponds are designed to draw down the captured stormwater at a rate slow enough to allow most of the sediment in the water to deposit on the bed. They are intended to release all of the stormwater. Retention ponds hold all of the stormwater quiescent until the next storm, when the inflow of new water forces out the treated water from the previous storm. Where these are constructed in areas of high groundwater they may have permanent standing water, otherwise they may dry out by infiltration and evaporation. Stormwater Treatment Wetlands are a special case of wet ponds, including dense wetland vegetation to increase the treatment capability of the facility.

  There are multiple proprietary sedimentation BMPs available. These are generally intended for use in developed areas where space is too limited for other BMPs that remove sediment.

- **Oil control Structure BMPs.** These are used to remove free, dispersed, and sorbed oil. This type of treatment is most effective in situations where relatively high concentrations of oil and grease occur in storm runoff such as in parking lots, high traffic areas and spill response activities. They do not function well at low concentrations of oil. Oil/water separators are usually underground vaults that take advantage of

density differences to separate light oil and dense sediment from stormwater. The two most common types are Baffle Oil/water separators, and Coalescing Plates.

For those that want more information in helping to select the most effective BMPs to include in their TMDL Implementation Plan, **Appendix C** contains excerpts from the International Stormwater Best Management Practices (BMP) Database Project of Recommendations for BMP Selection and Design for the following pollutants: Nutrients, Solids, Metals, Fecal Indicator Bacteria, and Runoff Volume.

3. Structural BMP's Estimated Load Reductions

The structural BMP's estimated load reductions will be provided in the "Implementation Ready" TMDL WQMP. DEQ has also provided for most of the TMDL and 303(d) listed pollutants within the Coastal Nonpoint Boundary in the recommended structural BMPs tables located in **Appendix E.** For each pollutant category analyzed, the median influent and effluent concentrations, and estimated load reductions in percent are included. Most of the load reduction estimates are taken from the *International Stormwater Best Management Practices (BMP) Database Project* or from EPA data.

4. Structural BMPs Selection Process

The following **Figure 16** identifies the Structural BMPs selection process to meet TMDL load allocations and achieve water quality standards.

The selection process provided is based on the following major methods of pollutant removal, treatment, and volume reduction to meet pre-development hydrology volume and TMDL LAs:

- Source Reduction (Pollution Prevention/Good Housekeeping) BMPs
- Flow Control (Volume Reduction) BMPs
- Detention (Volume Reduction and Sediment Removal) BMPs
- Retention (Volume Reduction) BMPs
- Filtration (Pollutant Removal) BMPs
- Infiltration (Volume Reduction and Pollutant Removal) BMPs
- Treatment (Pollutant Removal) BMPs

Figure 16. Structural BMPs Selection Process.

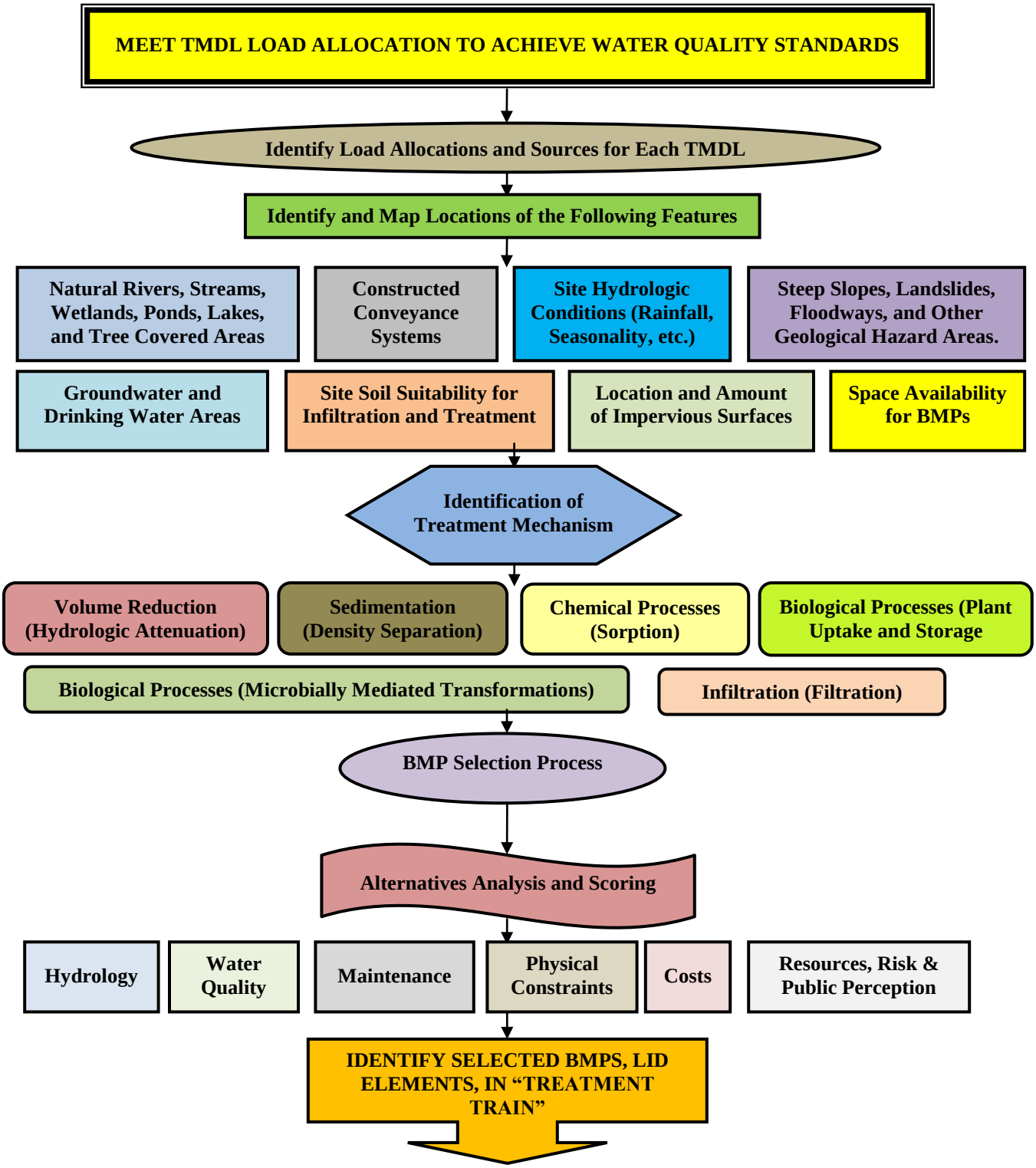
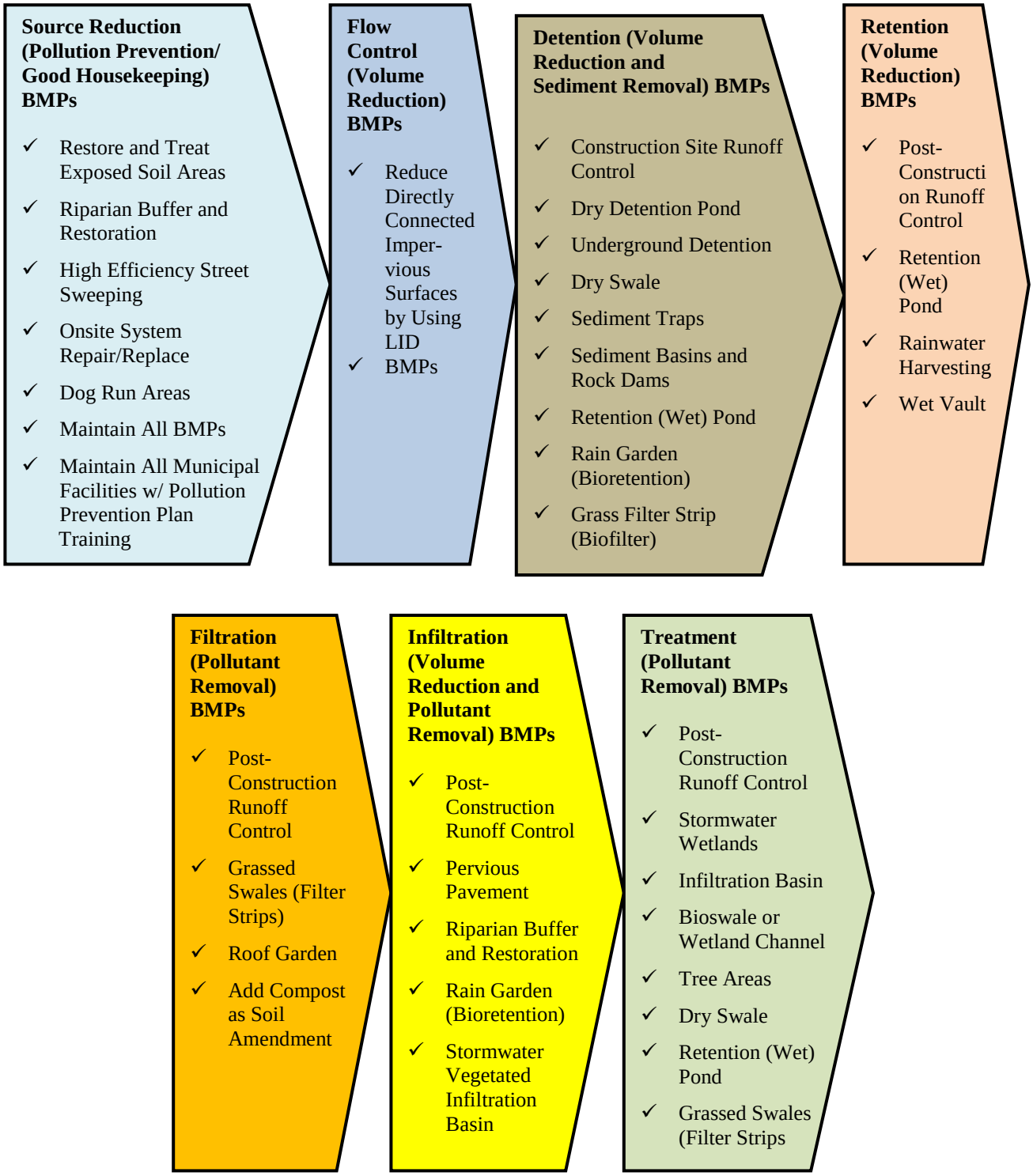


Figure 16. Structural BMPs Selection Process (Cont.).



3.6.4 DEQ's Recommended Most Effective and Other Recommended Programmatic and Structural BMPs to Meet TMDL

DEQ's selection of recommended programmatic and structural BMPs is based on NOAA and EPA and other technical sources that are identified in the tables. These are the most cost effective in reducing pollutant loads to meet the TMDL LAs and WLAs.

The tables in **Appendix G and H** are designed for a DMA to easily identify for their local community the source or condition causing the TMDL listed pollutant and the programmatic and structural BMPs that are effective in controlling or treating it. Many of these BMPs are also defined by EPA as Low Impact Development (LID).

For small and medium sized communities the table are designed to be used as a toolbox to easily select those management measures that the city or county DMA does not already have available or in use. The aim is that this list of management measures be used by current city or county planning and public works staff without having to hire consultants or additional staff.

Both the research and application of these BMPs is constantly changing as new BMPs are developed and tested on the ground. DEQ staff is committed to providing to local communities the best available science.

In **Table 7,** DEQ recommends for urban and rural residential DMAs, the following Programmatic and Structural BMPs (using the data from **Appendix D and E)** as the most effective in meeting TMDL LAs:

Table 7. DEQ Recommended Most Effective and Other Cost Effective Programmatic and Structural BMPs List.

DEQ RECOMMENDED PROGRAMMATIC AND STRUCTURAL BMPS FOR URBAN AND RURAL RESIDENTIAL DMAS BY POLLUTANT				
TMDL IMPAIRMENT OR POLLUTANT	PROGRAMMATIC BMPS		STRUCTURAL BMPS	
	MOST EFFECTIVE	OTHER RECOMMENDED	MOST EFFECTIVE	OTHER RECOMMENDED
HYDROLOGY (Pre-Development)	Low Impact Development (LID) Ordinance	Stormwater Management Plan	Detention Ponds	Riparian Restoration
	Stormwater Management Ordinance	Tree Protection Ordinance	Infiltration Facilities	Tree Planting
	Riparian Protection Ordinance	Floodway and Floodplain Overlay District Ordinance		Vegetated Filter Strips
	Wetland Protection Ordinance	Acquisition Of In-Stream Flow Rights		Retention (Wet) Ponds
				Bioretention Facilities
				Stormwater Treatment Wetlands
				Pervious Pavement
SEDIMENTATION (Turbidity)	Erosion and Sediment Control Ordinance	Riparian Protection Ordinance	Construction Sediment Control Facilities	Riparian Restoration
	Low Impact Development (LID) Ordinance	Hillside Development (Steep Slopes) Protection Ordinance	Construction Erosion Control BMPs (Source Control)	High Efficiency Street Sweeping (Source Control)
	Stormwater Management Ordinance	Floodway and Floodplain Overlay District Ordinance	Biofiltration Swales	Stormwater Wetland
			Detention Ponds	Pervious Pavement

Table 7. DEQ Recommended Most Effective and Other Cost Effective Programmatic and Structural BMPs List. (Cont.)

DEQ RECOMMENDED PROGRAMMATIC AND STRUCTURAL BMPS FOR URBAN AND RURAL RESIDENTIAL DMAS BY POLLUTANT				
TMDL IMPAIRMENT OR POLLUTANT	PROGRAMMATIC BMPS		STRUCTURAL BMPS	
	MOST EFFECTIVE	OTHER RECOMMENDED	MOST EFFECTIVE	OTHER RECOMMENDED
SEDIMENTATION (Turbidity) (cont.)			Infiltration Facilities	Sedimentation Devices (May Be Proprietary)
			Vegetated Filter Strips	
			Bioretention Facilities	
			Retention (Wet) Ponds	
			Restore and Treat Exposed Soil Areas (Source Control)	
AQUATIC WEEDS OR ALGAE (Chlorophyll a)	Erosion and Sediment Control Ordinance	Protecting Surface Water Sources of Drinking Water Ordinance	Pond/Wetland System	High Efficiency Street Sweeping
	Low Impact Development (LID) Ordinance	Protecting Groundwater Sources of Drinking Water Ordinance	Biofiltration Swale	Erosion Control BMPs
		Public Areas Fertilization Policy	Infiltration Facilities	
BACTERIA (E coli and Fecal Coliform)	Onsite Inspection and Maintenance Ordinance	Riparian Protection Ordinance	Septic Systems Repair or Replacement	Riparian Restoration
	Local Community Loan Program	No Wildlife Feeding Ordinance	Stormwater Control and Treatment Facilities	Dog Run Parks

Table 7. DEQ Recommended Most Effective and Other Cost Effective Programmatic and Structural BMPs List (Cont.).

DEQ RECOMMENDED PROGRAMMATIC AND STRUCTURAL BMPS FOR URBAN AND RURAL RESIDENTIAL DMAS BY POLLUTANT				
TMDL IMPAIRMENT OR POLLUTANT	PROGRAMMATIC BMPS		STRUCTURAL BMPS	
	MOST EFFECTIVE	OTHER RECOMMENDED	MOST EFFECTIVE	OTHER RECOMMENDED
BACTERIA (E coli and Fecal Coliform) (Cont.)	Low Impact Development Ordinance	Illicit Discharge and Connection Ordinance		
	Pet Waste Pick-Up Ordinance			
DISSOLVED OXYGEN	Same Programmatic BMPs Listed Below For Nutrients (Nitrates and Phosphorus)	Same Programmatic BMPs Listed Below For Nutrients (Nitrates and Phosphorus)	Same Programmatic BMPs Listed Below For Nutrients (Nitrates and Phosphorus)	Same Programmatic BMPs Listed Below For Nutrients (Nitrates and Phosphorus)
NUTRIENTS (Nitrates and Phosphorus)	Erosion and Sediment Control Ordinance	Protecting Surface Water Sources of Drinking Water Ordinance	Stormwater Wetland	High Efficiency Street Sweeping
	Low Impact Development (LID) Ordinance	Protecting Groundwater Sources of Drinking Water Ordinance	Erosion Control BMPs (Source Control)	Biofiltration Swale
	Onsite Inspection and Maintenance Ordinance	Public Areas Fertilization Policy	Riparian Restoration	Dry Detention Ponds
	Local Community Loan Program		Bioretention Facilities	Vegetated Filter Strip
			Infiltration Facilities	
			Media Filter Drain	

Table 7. DEQ Recommended Most Effective and Other Cost Effective Programmatic and Structural BMPs List (Cont.).

DEQ RECOMMENDED PROGRAMMATIC AND STRUCTURAL BMPS FOR URBAN AND RURAL RESIDENTIAL DMAS BY POLLUTANT				
TMDL IMPAIRMENT OR POLLUTANT	PROGRAMMATIC BMPS		STRUCTURAL BMPS	
	MOST EFFECTIVE	OTHER RECOMMENDED	MOST EFFECTIVE	OTHER RECOMMENDED
TEMPERATURE	Riparian Protection Ordinance	Stormwater Management Ordinance	Riparian Restoration	Instream Restoration
	Wetland Protection Ordinance	Instream Flow Purchased	Infiltration Facilities	Stormwater Wetlands
	Stormwater Management Plan	Tree Protection Ordinance		Tree Planting
TOXICS (Attached to Sediments)	Same Programmatic BMPs Listed Above For Sedimentation (Turbidity)	Same Programmatic BMPs Listed Above For Sedimentation (Turbidity)	Same Structural BMPs Listed Above For Sedimentation (Turbidity)	Same Structural BMPs Listed Above For Sedimentation (Turbidity)
TOXICS (Dissolved)	Integrated Pest Management Ordinance (IPM) Ordinance	Same Programmatic BMPs Listed Above For Nutrients (Nitrates and Phosphorus)	Infiltration Facilities	Biofiltration Swales
	Same Programmatic BMPs Listed Above For Nutrients (Nitrates and Phosphorus)	Same Programmatic BMPs Listed Above For Nutrients (Nitrates and Phosphorus)	Bioretention Facilities	Media Filtration Devices (May Be Proprietary)
			Vegetated filter strips	Retention (Wet) Ponds
			Media Filter Drains	
			Stormwater Wetlands	

Identify, Map, And Provide A List of Selected Structural BMPs, Restoration, And Land Acquisition Areas

The TMDL Implementation Plan should describe the DMA selected most effective and other recommended programmatic and structural BMPs. DMAs are recommended to focus on identifying the most appropriate geographic location for siting and installing structural BMPs or conducting nonstructural BMPs. Factors affecting BMP siting decisions might include local conditions such as slopes, soils, and critical areas; historical, current, and future land uses; property ownership; cost; site access; infrastructure considerations; and social acceptance.

In addition, DMAs should consider recommending areas where BMPs can result in the greatest pollutant load reduction. These critical areas are at or near pollutant source areas. They could include places with severe upland or channel erosion, sites generating oil and grease or other toxics, extensively paved sub watersheds or small catchments requiring runoff volume controls, areas with a high density of illicit connections, parks that generate significant bacteria loads from pets, industrial facilities generating high pollutant loads, and similar locations.

A map should also be included that identifies where the structural BMPs will be implemented over time. The following maps are examples. **Figure 17** provides an example structural stormwater BMP site location map. **Figure 18** provides another example structural stormwater BMP site location by drainage subbasin map. **Figure 19** is an example schematic of BMP flow network. In addition, **Figure 20** is an example structural BMPs and restoration watershed location map.

Finally, all of the proposed structural BMPs, restoration, and land acquisition for preservation sites that are displayed on the maps can be converted into tables that provide information that is more detailed. This includes providing an identification number, name, and a detailed description of the proposed projects. **Table 8** provides an example structural BMPs, restoration, and land acquisition for preservation list taken from the City of Portland Fanno and Tryon Creeks Watershed Management Plan.

Figure 17. Example Structural Stormwater BMP Site Location Map.

(based on Stormwater BMP Performance Assessment and Cost-Benefit Analysis, by Capitol Region Watershed District, St. Paul, MN, January 22, 2010 http://www.capitolregionwd.org/documents/BMP_Report_Main_Body_View.pdf)

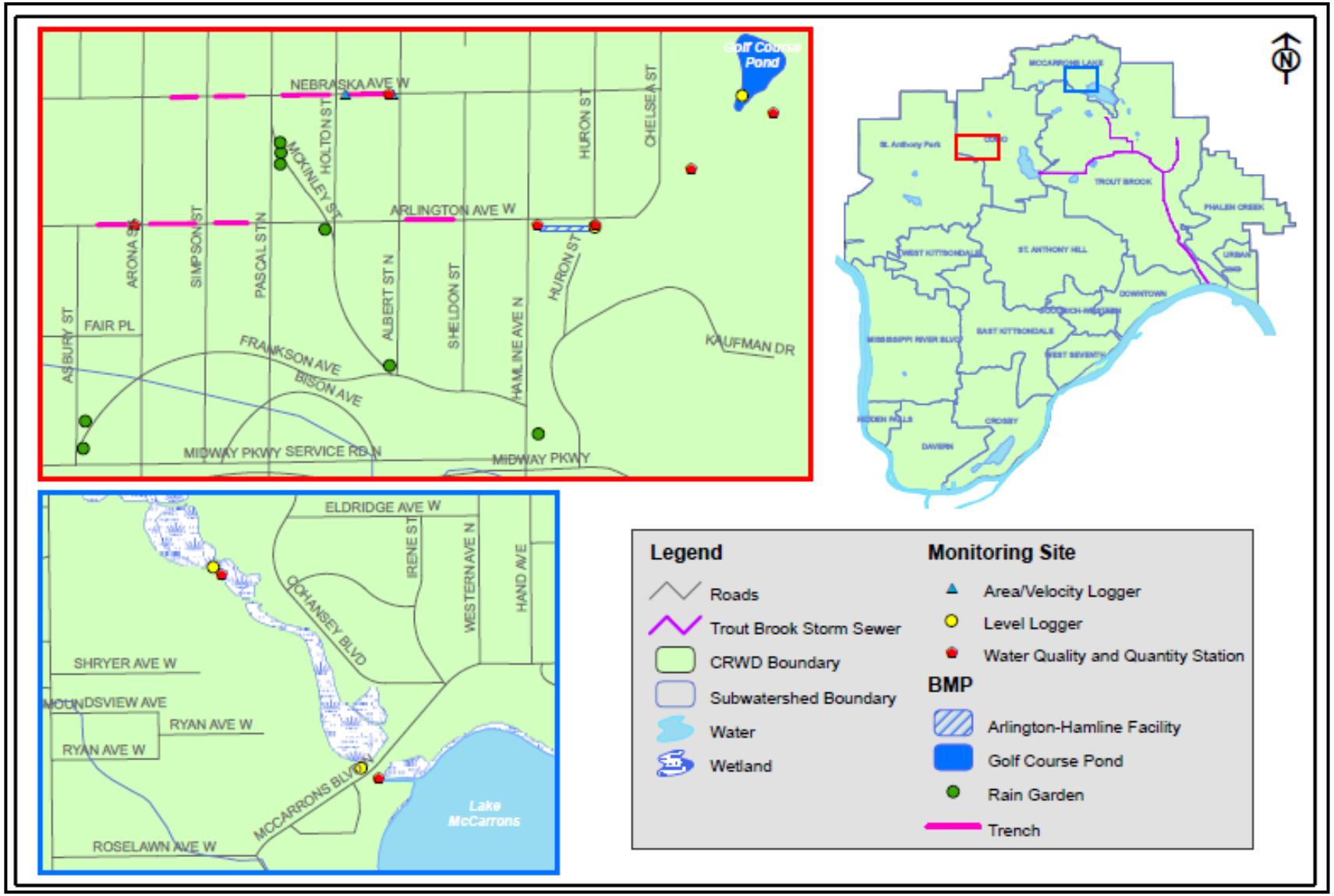


Figure 18. Example Structural Stormwater BMP Site Location by Drainage Subbasin Map.

(based on Stormwater BMP Performance Assessment and Cost-Benefit Analysis, by Capitol Region Watershed District, St. Paul, MN, January 22, 2010, http://www.capitolregionwd.org/documents/BMP_Report_Main_Body_View.pdf):

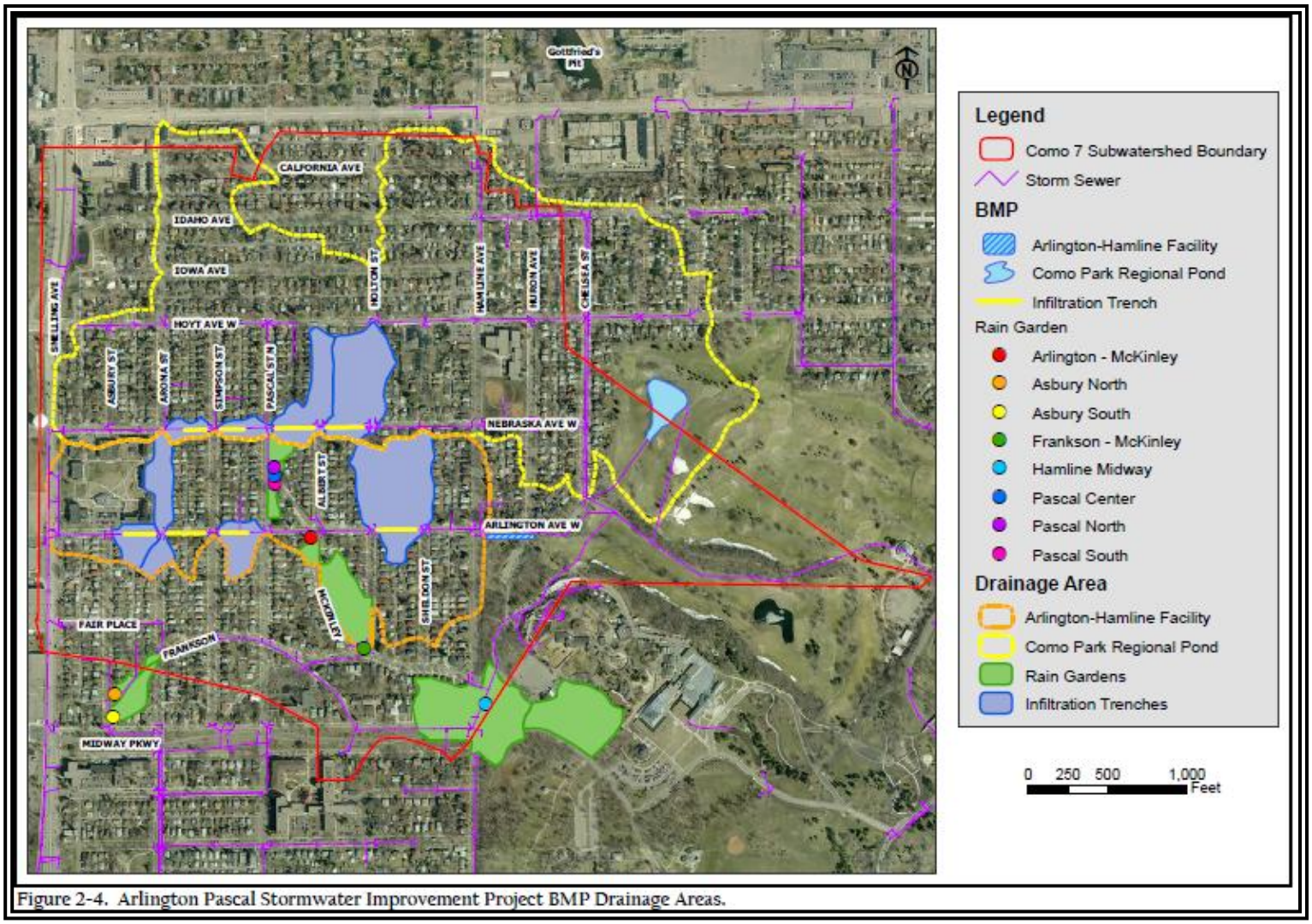


Figure 2-4. Arlington Pascal Stormwater Improvement Project BMP Drainage Areas.

Figure 19. Example Schematic of BMP Flow Network.

(based on Stormwater BMP Performance Assessment and Cost-Benefit Analysis, by Capitol Region Watershed District, St. Paul, MN, January 22, 2010, http://www.capitolregionwd.org/documents/BMP_Report_Main_Body_View.pdf):

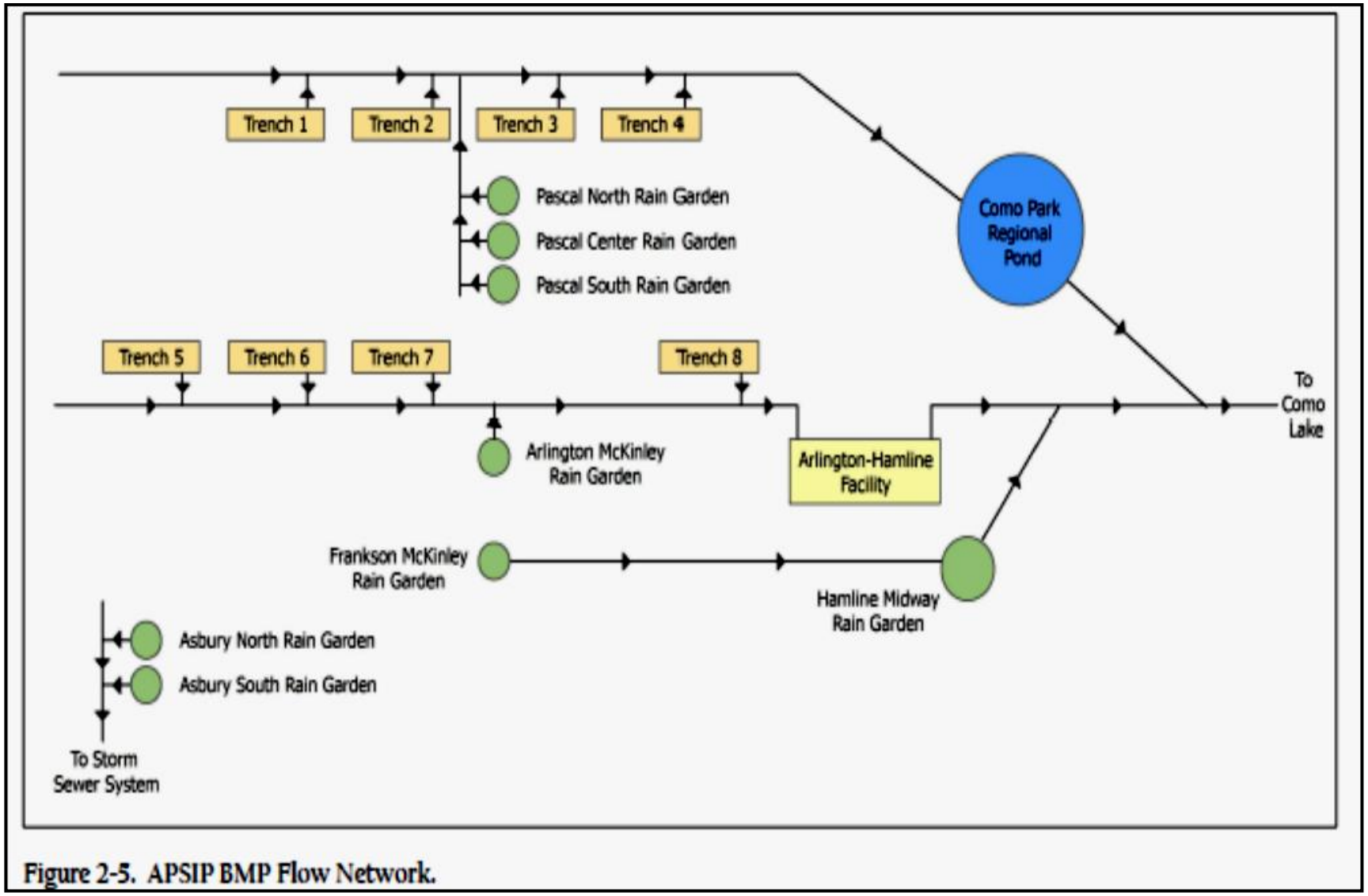


Figure 20. Example Structural BMPs and Restoration Watershed Location Map.

(based on Fanno and Tryon Creeks Watershed Management Plan, Chapter 22 Tryon Creek Watershed Strategies and Actions, by City of Portland, Bureau of Environmental Services, 2005, http://www.portlandonline.com/bes/index.cfm?c=43097&a=128526):

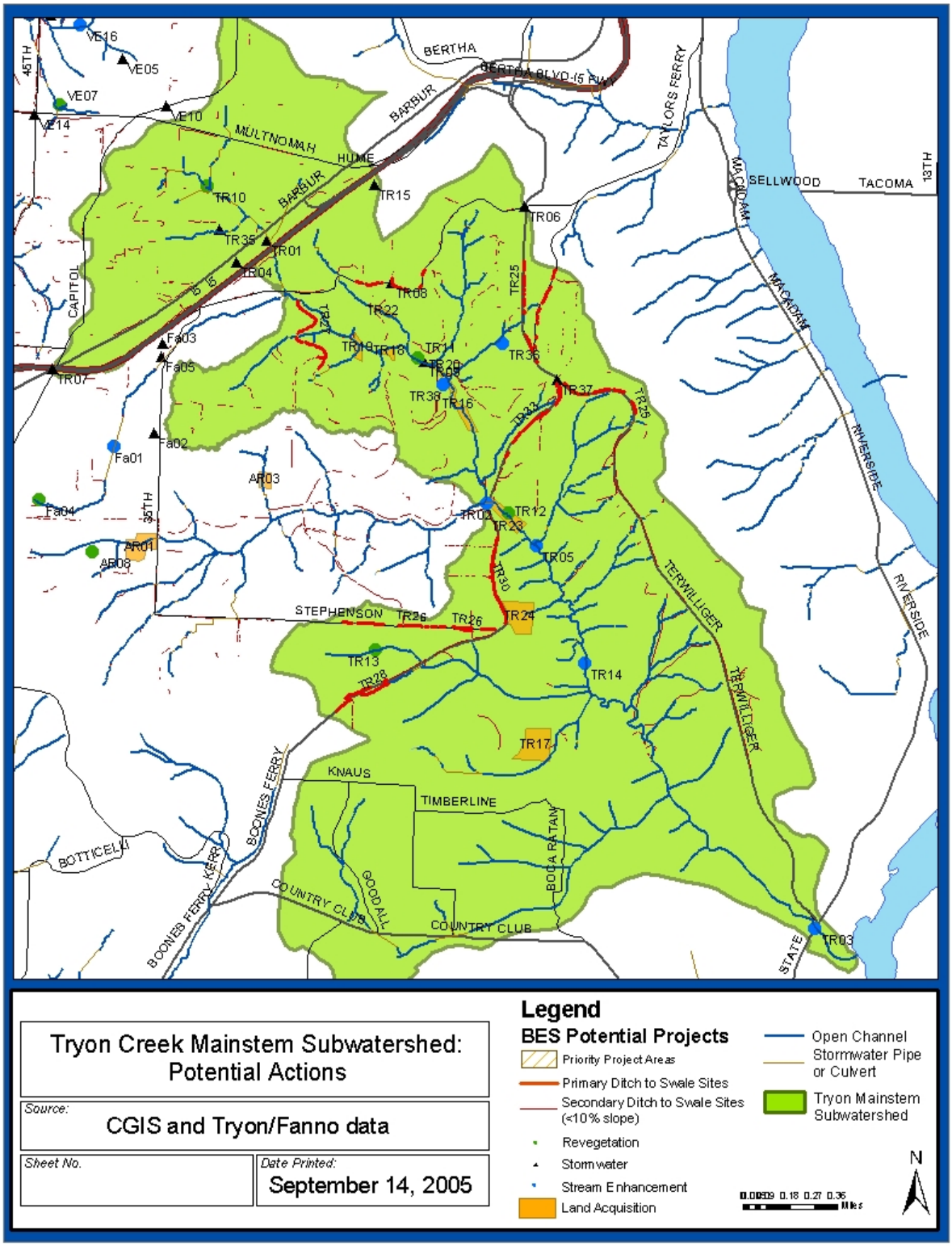


Table 8. Example Structural BMPs, Restoration, and Land Acquisition for Preservation List.

(based on Fanno and Tryon Creeks Watershed Management Plan, Chapter 22 Tryon Creek Watershed Strategies and Actions, by City of Portland, Bureau of Environmental Services, http://www.portlandonline.com/bes/index.cfm?c=43097&a=128526):

Action ID	Name	Description
TR01	I-5 and Barbur Blvd Retrofit	Stormwater: retrofit the impervious parking areas to reduce runoff and improve water quality.
TR02	Boones Ferry Rd Culvert	Aquatic restoration: retrofit the culvert to improve fish passage.
TR03	Highway 43 Culvert	Aquatic restoration: retrofit the culvert to improve fish passage.
TR04	Upper Tryon Creek Commercial Area Retrofit	Stormwater: retrofit the impervious parking areas to reduce runoff and improve water quality.
TR05	NOAA Tryon Creek Enhancement	Stream Enhancement: Improve aquatic habitat complexity and protect sanitary sewer.
TR06	Burlingame Mall Retrofit	Stormwater: retrofit the impervious parking areas to reduce runoff and improve water quality.
TR07	Capitol Hwy West Portland Center Retrofit	Stormwater: retrofit the impervious parking areas to reduce runoff and improve water quality.
TR08	17th and Taylor's Ferry Rd	Stormwater: retrofit the impervious parking areas to reduce runoff and improve water quality.
TR09	Marshall Park impervious area removal	Stormwater: retrofit the impervious parking areas to reduce runoff and improve water quality.
TR10	Windgate	Revegetation: plant trees to provide habitat, stabilize soils, and intercept rainfall.
TR11	Marshall Park South Basketball Court area	Revegetation: plant trees to provide habitat, stabilize soils, and intercept rainfall.
TR12	Boones Ferry Rd Crossing	Revegetation: plant trees to provide habitat, stabilize soils, and intercept rainfall.
TR13	Meadowview	Revegetation: plant trees to provide habitat, stabilize soils, and intercept rainfall.
TR14	Tryon Creek State Natural Area Stream Restoration	Stream Enhancement: Improve aquatic habitat complexity and protect sanitary sewer.
TR15	Capitol Hill Elementary School	Stormwater: retrofit the impervious parking areas to reduce runoff and improve water quality.
TR16	East of Marshall Park	Land Acquisition: procure land of high resource value for preservation.

Table 8. Example Structural BMPs, Restoration, and Land Acquisition for Preservation List (Cont.).
(based on Fanno and Tryon Creeks Watershed Management Plan, Chapter 22 Tryon Creek Watershed Strategies and Actions, by City of Portland, Bureau of Environmental Services, 2005, http://www.portlandonline.com/bes/index.cfm?c=43097&a=128526):

Action ID	Name	Description
TR17	Englewood	Land Acquisition: procure land of high resource value for preservation.
TR18	Extension Near Stream	Land Acquisition: procure land of high resource value for preservation.
TR19	Jensen Foley Connection	Land Acquisition: procure land of high resource value for preservation.
TR20	Marshall Park Connection N Maplecrest	Land Acquisition: procure land of high resource value for preservation.
TR21	Maricara Park Riparian Extension	
TR22	Marshall Park North Extension	Land Acquisition: procure land of high resource value for preservation.
TR23	Tryon Creek State Natural Area Connection	Land Acquisition: procure land of high resource value for preservation.
TR24	Tryon Life Farm	Land Acquisition: procure land of high resource value for preservation.
TR25	Along Terwilliger	Stormwater: Implement Ditch to Swale retrofits to improve water quality and public safety.
TR26	Along Stevenson	Stormwater: Implement Ditch to Swale retrofits to improve water quality and public safety.
TR27	Along Lancaster North	Stormwater: Implement Ditch to Swale retrofits to improve water quality and public safety.
TR28	Boones Ferry Rd Southwest	Stormwater: Implement Ditch to Swale retrofits to improve water quality and public safety.
TR29	Boones Ferry Rd South	Stormwater: Implement Ditch to Swale retrofits to improve water quality and public safety.
TR30	Boones Ferry Rd South 2	Stormwater: Implement Ditch to Swale retrofits to improve water quality and public safety.
TR31	Boones Ferry Rd North	Stormwater: Implement Ditch to Swale retrofits to improve water quality and public safety.
TR32	Boones Ferry Rd Mid Southwest	Stormwater: Implement Ditch to Swale retrofits to improve water quality and public safety.

Table 8. Example Structural BMPs, Restoration, and Land Acquisition for Preservation List (Cont.).
(based on Fanno and Tryon Creeks Watershed Management Plan, Chapter 22 Tryon Creek Watershed Strategies and Actions, by City of Portland, Bureau of Environmental Services, 2005. http://www.portlandonline.com/bes/index.cfm?c=43097&a=128526):

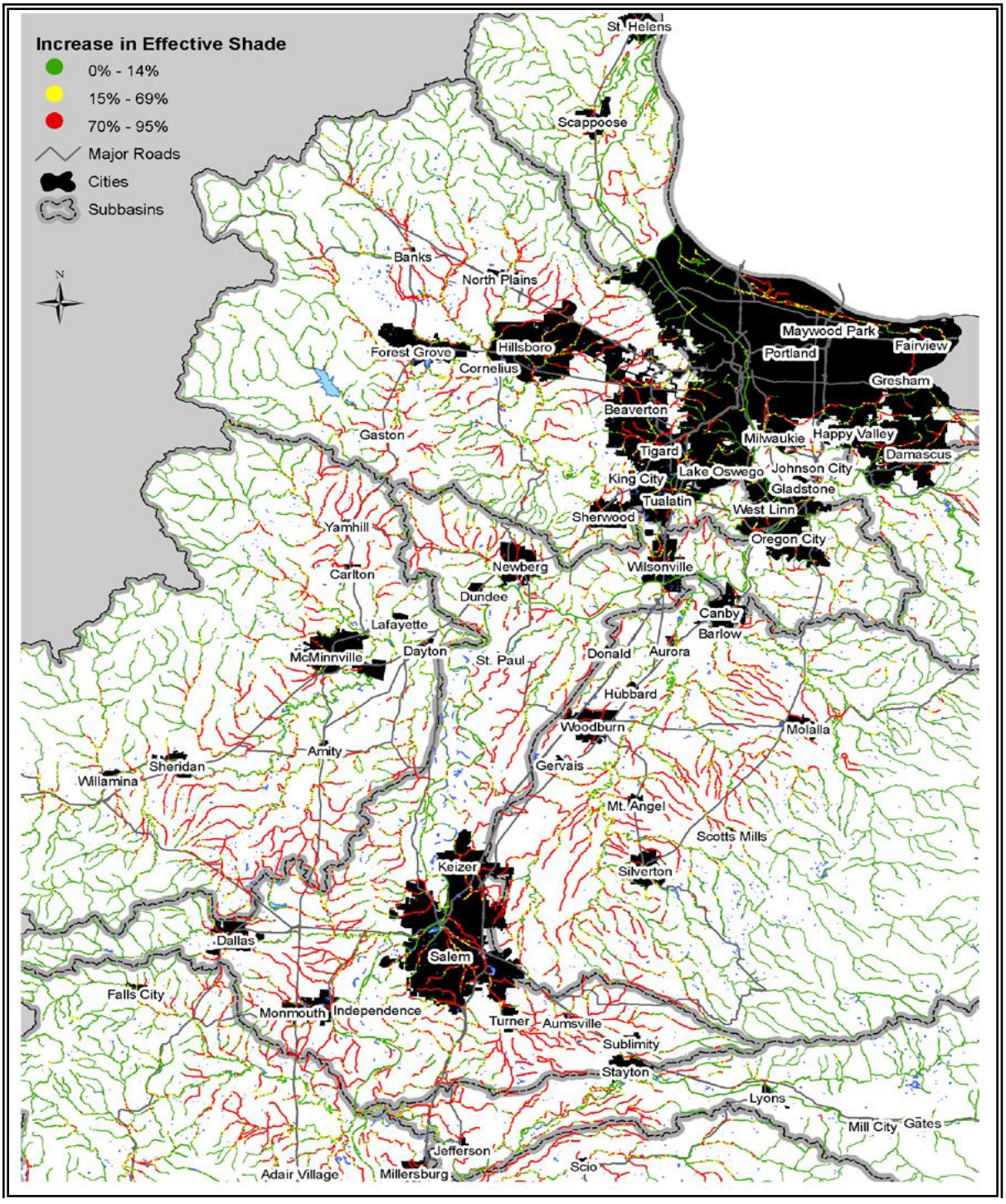
Action ID	Name	Description
TR33	**Boones Ferry Rd Mid**	**Stormwater: Implement Ditch to Swale retrofits to improve water quality and public safety.**
TR34	**Near 17th on Taylor's Ferry Rd**	**Stormwater: Implement Ditch to Swale retrofits to improve water quality and public safety.**
TR35	**Headwaters Project**	**Stormwater: retrofit the impervious parking areas to reduce runoff and improve water quality.**
TR36	**Plum Pocket Project (SW 6th and Lucille)**	**Revegetation: plant trees to provide habitat, stabilize soils, and intercept rainfall.**
TR37	**Terwilliger and Boones Ferry Rd Intersection**	**Stormwater: retrofit, as part of PDOT projects, to reduce runoff and improve water quality.**
TR38	**Marshall Park Trails**	**Stream Enhancement: retrofit trail system to decrease erosive impacts to stream banks.**

The following **Figure 21** identifies those critical areas in which a specific BMP is needed. This example is for constructing streamside fences to protect riparian areas from grazing or other land use activities. Other critical or environmentally sensitive areas or sites, such as wetlands, steep slopes, highly erosive soils, etc. could also need specific BMPs, including restoration.

Figure 21. Example Critical Areas Riparian Areas Restoration Map.

(based on Cost Estimate to Restore Riparian Forest Buffers and Improve Stream Habitat in the Willamette Basin, Oregon Report, BY Oregon DEQ, Water Quality Division, Watershed Management Section, March 2010 http://www.deq.state.or.us/wq/tmdls/docs/WillametteRipCost030310.pdf):

Increase in Effective Shade after Restoration of System Potential Vegetation (N. Willamette Basin)



3.7 ELEMENT 12 -- Cost and Benefit Analysis

What information should be provided?

Estimate the Costs to Implement the Plan, Including Management Measures, Administration, Information/Education Activities, and Monitoring. In addition, identify the Sources, Amounts of Financial, Technical Assistance, and Associated Authorities Available to Implement the Management Measures.

DMAs are recommended to conduct a fiscal analysis to determine what resources are necessary to develop, implement, and maintain the structural and programmatic BMPs, and where and how these resources will be obtained.

Why should this be included?

Including this information in the plan will help to select the most cost effective and other recommended BMPs needed to meet the TMDL LAs and WLAs, if applicable.

Where can this information be found?

The WQMP will list the specific most effective and other recommended BMPs by pollutant and source. Most of the structural BMPs in the tables included in **Appendix H** have estimated costs. For programmatic BMPs, **Appendix G** includes cost estimates for a few BMPs.

3.12.1 Estimate the Costs to Implement the Plan, Including Management Measures, Administration, Information/Education Activities, and Monitoring

Identify and quantify the following costs to implement the Plan:

LIST OF COST ELEMENTS TO CALCULATE FOR PLAN IMPLEMENTATION

a. Selected Most Effective and Other Recommended BMPs
  i. Research the Unit Costs
  ii. Multiply the Unit Costs by the Number of Units Required
  iii. Translate Structural BMPs into Capital Improvement Plans
b. Ongoing Maintenance
c. Technical Assistance
d. Administrative
e. Information/Education Activities
f. Monitoring

Source: As Modified from *Guidance Manual for Total Maximum Daily Load Implementation Plans*, The Commonwealth of Virginia: Department of Conservation and Recreation, Department of Environmental Quality, July 2003 http://www.deq.state.va.us/tmdl/implans/ipguide.pdf.

DMAs will need to calculate the costs to implement and maintain the most effective and other recommended structural and programmatic BMPs identified in their TMDL Implementation Plan. Most of the structural BMPs tables in **Appendix E** have estimated costs that may include construction, planting, operation, maintenance, technical assistance, administrative, information/education activities, monitoring, and recurring payments for lease, where applicable. For programmatic BMPs, **Appendix D** includes cost estimates for a few BMPs.
It may be necessary to utilize other cost estimate references, identified below, including talking with local estimates from contractors and builders, and estimates from stakeholders, to fully develop all cost elements. As stated in the ***Guidance Manual for Total Maximum Daily Load Implementation Plans***, The Commonwealth of Virginia, Department of Conservation and Recreation, Department of Environmental Quality, July 2003: "*some management measures might be more*

diffusely implemented across the watershed, and therefore the costs might be difficult to quantify. For example, developers across the watershed are encouraged to use fencing to prevent sediment runoff on their construction sites, and homeowners are encouraged through educational outreach to keep their neighborhood storm drains free of debris. These actions are voluntary, and therefore no specific operational costs are associated with them. However, costs would be associated with Information/Education activities."

Type and Number of BMPs To Meet the TMDL Load Allocation

In order to calculate the costs of implementing the plan requires determining the type and number of BMPs to be selected to meet the TMDL load allocation identified in the TMDL WQMP. In order to determine this, the following method is recommended:

XX Pounds of TSS [Equals] XX Pounds/Linear Foot of TMDL Pollutant Removed per BMP [Times] XX Number of BMPs

_____

(TSS Load Allocation) = (WQMP Provided Load Reduction Est. per BMP) X (No. of Needed BMPs)

The TMDL WQMP will provide the pollutant reduction amount per structural and programmatic BMPs identified to meet the TMDL load allocation. DMAs can use this load reduction estimate to calculate the number of needed BMPs.

The following **Table 9** provides an example estimate of the type and number of BMPs needed:

Table 9. Example Estimated Type And Number of BMPs Recommended To Meet The TMDL Load Allocation.
(based on A Total Maximum Daily Load Implementation Plan for Knox Creek and Pawpaw Creek Prepared for: Virginia Department of Environmental Quality Submitted September 10, 2007, http://www.deq.virginia.gov/export/sites/default/tmdl/implans/knoxpawip.pdf)

Estimated Residential Waste Control Measures Needed in the Knox Creek and Pawpaw Creek Watersheds						
CONTROL MEASURE	VA COST-SHARE PRACTICE NUMBER	KNOX CREEK		PAWPAW CREEK		
		EXISTING BMPS	UNITS NEEDED	EXISTING BMPS	UNITS NEEDED	TOTAL UNITS NEEDED
Septic System Pump-out Program	RB-1	2	158	1	42	200
Sewer Connection	RB-2	0	0	0	0	0
Septic System Repair	RB-3	22	80	6	20	100
Septic System Installation/ Replacement	RB-4	6	374	2	82	456
Alternative Waste Treatment System	RB-5	0	24	0	6	30

BMPs Cost Estimates

Most of the structural BMPs in the tables included in **Appendix E** have estimated costs. For programmatic BMPs, **Appendix D** includes cost estimates for a few BMPs.

DMAs are recommended to multiply the total number of needed most effective and other recommended structural and programmatic BMPs identified in their implementation plan by all costs by the total number needed. These costs may include construction, planting, operation, maintenance, technical assistance, administrative, information/education activities, monitoring, and recurring payments for lease, where applicable.

The following tables taken from State of Virginia TMDL Implementation Plan provide example structural and programmatic BMPs costs estimate for residential areas. This includes construction, installation, operation, maintenance, education/information, and administration costs. **Table 10** provides example structural and education BMPs costs estimate for residential areas. **Table 11** gives example structural BMPs capital costs estimate. While, **Table 12** presents example structural BMP (rain gardens) operation and maintenance capital costs estimate.

Table 10. Example Structural And Education BMPs Costs Estimate For Residential Areas.

(based on A Total Maximum Daily Load Implementation Plan for Knox Creek and Pawpaw Creek. Prepared for Virginia Department of Environmental Quality Submitted September 10, 2007, http://www.deq.virginia.gov/export/sites/default/tmdl/implans/knoxpawip.pdf)

RESIDENTIAL CONTROL MEASURE COSTS AND NEEDS

Residential Control Measure	Unit	Unit Cost	Knox Units	Knox Cost	Pawpaw Units	Pawpaw Cost
Septic Systems Pump-out Program (RB-1)	System	$250	158	$39,500	100	$25,000
Septic System Repair (RB-3)	System	$3,000	80	$240,000	30	$90,000
Septic System Installation/Replacement (RB-4)	System	$6,000	374	$2,244,000	105	$630,000
Alternative Waste Treatment System Installation (RB-5)	System	$11,400	24	$273,600	15	$171,000
Residential Education Program	Program	$3,750	0.75	$2,813	0.25	$938
Infiltration Trench	Acre-Treated	$5,285	12	$63,420	0	$0
Erosion and Sediment Control	Acre-Treated	$2,000	20	$40,000	3	$6,000
Vegetated Stream Buffer	Acres	$700	37	$25,900	6.6	$4,620

Table 11. Example Structural BMPs Capital Costs Estimate.

(based on Stormwater BMP Performance Assessment and Cost-Benefit Analysis by Capitol Region Watershed District, St. Paul, MN, January 22, 2010, http://www.capitolregionwd.org/documents/BMP_Report_Main_Body_View.pdf)

Table 4-1. Total Capital Cost of the APSIP.

	Total Cost	Design	Construction	Bond Interest*
Arlington-Hamline Facility	$799,087	$86,636	$487,488	$224,963
Como Park Regional Pond	$1,364,346	$147,926	$832,357	$384,063
Infiltration Trenches	$400,060	$47,904	$239,521	$112,635
Trench 1	$20,039	$2,400	$11,998	$5,642
Trench 2	$29,807	$3,569	$17,846	$8,392
Trench 3	$88,383	$10,583	$52,916	$24,884
Trench 4	$86,595	$10,369	$51,845	$24,380
Trench 5	$25,812	$3,091	$15,454	$7,267
Trench 6	$34,766	$4,163	$20,815	$9,788
Trench 7	$29,058	$3,479	$17,397	$8,181
Trench 8	$85,599	$10,250	$51,249	$24,100
Rain Gardens	$160,244	$19,193	$95,966	$45,085
Arlington-McKinley	$4,116	$494	$2,471	$1,150
Asbury North	$9,246	$1,106	$5,532	$2,607
Asbury South	$11,970	$1,433	$7,164	$3,374
Frankson-McKinley	$10,921	$1,309	$6,545	$3,067
Hamline Midway	$103,172	$12,365	$61,824	$28,983
Pascal Center	$5,421	$648	$3,239	$1,533
Pascal North	$6,750	$806	$4,028	$1,917
Pascal South	$8,648	$1,032	$5,162	$2,454
APSIP Total:	$2,723,737	$301,659	$1,655,332	$766,746

*Does not include bond interest paid by project partners.

Table 12. Example Structural BMP (Rain Gardens) Operation And Maintenance Capital Costs Estimate.

(based on Stormwater BMP Performance Assessment and Cost-Benefit Analysis, by Capitol Region Watershed District, St. Paul, MN, January 22, 2010, http://www.capitolregionwd.org/documents/BMP_Report_Main_Body_View.pdf)

Table 4E-8. 2008 Total Operation and Maintenance Costs for the Rain Gardens.

	Staff Hours[a]	Labor	Equipment and Materials	Contract Service	Total
Arlington-McKinley	41.0	$462	$186	$0	$649
Asbury North	57.6	$698	$204	$0	$902
Asbury South	56.8	$1,071	$401	$0	$1,472
Frankson-McKinley	91.8	$1,149	$402	$0	$1,551
Hamline Midway	18.6	$188	$60	$648	$896
Pascal Center	54.6	$529	$184	$0	$713
Pascal North	51.6	$517	$112	$0	$628
Pascal South	33.8	$527	$205	$0	$732
Total:	405.6	$5,142	$1,755	$648	$7,544

[a]Includes both staff and volunteer hours.

Technical Assistance Cost Estimates

The following **Table 13** identifies the amount of agricultural and residential full time equivalent (FTE) technical assistance needed to implement the Total Maximum Daily Load Implementation Plan for Knox Creek and Pawpaw Creek in Virginia. One FTE is equal to one full-time staff member. The estimate of technical assistance should take into account the following: administration and management services, including salaries, regulatory fees, and supplies, as well as in-kind services efforts, such as the work of volunteers and the donation of facility use. This will include Information and education efforts.

Table 13. Example Technical Assistance Needs (based on A Total Maximum Daily Load Implementation Plan for Knox Creek and Pawpaw Creek.

(prepared for Virginia Department of Environmental Quality Submitted September 10, 2007, http://www.deq.virginia.gov/Portals/0/DEQ/Water/TMDL/ImplementationPlans/knoxpawip.pdf)

RECOMMENDED TECHNICAL ASSISTANCE NEEDS FOR IMPLEMENTATION IN THE KNOX CREEK AND PAWPAW CREEK WATERSHEDS.							
IMPAIR-MENT	YEARS 1-5				YEARS 6-10		
	FTE	FTE	FTE	FTE	FTE	FTE	FTE
	Estimated Agricultural	Recom-mended Agricultural	Estimated Residential	Recom mended Residential	Estimated Agricultural	Estimated Residential	Recommended Agricultural/ Residential
KNOX CREEK	1.22	1	2.32	2.5	1.22	0.13	1
PAWPAW CREEK	0.41	0.5	0.54	0.5	0.41	0.02	0.5
TOTAL	1.63	1.5	2.86	3.0	1.63	0.15	1.5

Monitoring Cost Estimates

The TMDL Implementation Plan is recommended to include both implementation monitoring and effectiveness monitoring elements. Implementation monitoring involves developing a set of criteria to determine whether loading reductions are being achieved and progress is being made toward attaining (or maintaining) water quality goals, and specify what measures will be taken if progress has not been demonstrated. Effectiveness monitoring involves determining whether the plan is being implemented appropriately and whether progress toward attainment or maintenance of water quality goals is being achieved.

The cost to implement the DMA proposed monitoring program elements are recommended to be provided in this section of the implementation plan. Elements to consider for inclusion as recommended in the *"Urban Stormwater BMP Performance Monitoring, A Guidance Manual for Meeting the National Stormwater BMP Database Requirements, April 2002 http://water.epa.gov/scitech/wastetech/guide/stormwater/upload/2006_10_31_guide_stormwater_montcomplete.pdf" are* as follows:

- Number of years in which monitoring will be conducted
- Implementation monitoring is data collected to account for work done and the success of the project such as the type of activity, the location of the activity (latitude and longitude or other appropriate description), a measure of the size of the project, the date project was done, and project success (yes/no, percentage, etc. as appropriate
- Qualitative monitoring which may include:
    - Photo documentation of improvement in stream bank vegetation/cover for residential properties or vegetated stormwater containment/collection swales (i.e., photos before planting, shortly after planting, and after plant maturation)
    - Documentation of relative sediment volume (i.e., high, medium, or low) collected from detention ponds or filters in stormwater treatment systems
- If applicable, quantitative monitoring of any fixed or temporary monitoring instrumentation purchase, installation, and maintenance; and
- If applicable, quantitative monitoring of any annual sampling and laboratory costs

Final Costs Estimate

The following **Table 14** provides an example final costs estimate for all BMPs needed to meet a TMDL.

Table 14. Example Final Costs Estimate for All BMPs Needed to Meet A TMDL.

(based on A Total Maximum Daily Load Implementation Plan for Knox Creek and Pawpaw Creek. Prepared for Virginia Department of Environmental Quality Submitted September 10, 2007, http://www.deq.virginia.gov/Portals/0/DEQ/Water/TMDL/ImplementationPlans/knoxpawip.pdf).

TOTAL ESTIMATED COSTS TO MEET THE KNOX CREEK AND PAWPAW CREEK TMDLS IMPAIRMENT						
	Agricultural BMPs ($)	Residential BMPs ($)	Industrial BMPs ($)	Streambank Stabilization ($)	Tech. Assist. ($)	Total ($)
Knox Creek	$467,556	$2,929,240	$17,465,200	$0	$1,125,000	$21,986,995
Pawpaw Creek	$27,700	$642,458	$5,718,000	$3,286,800	$375,000	$10,049,958
Total	$495,256	$3,571,698	$23,183,200	$3,286,800	$1,500,000	$32,036,953

The total cost to implement the BMPs needed in this watershed is estimated at $32 million. However, $23 million, or 72%, of the total cost is estimated for the industrial BMPs, which will largely be covered by these industries.

Benefit/Costs Estimate

The following **Table 14** provides an example BMPs cost/benefit summary for meeting a TMDL.

Table 14. Example Cost/Benefit Summary.

(based on Moore's Creek Fecal Coliform TMDL Implementation Plan, Thomas Jefferson Planning District Commission. Prepared by the Thomas Jefferson Planning District Commission for the Virginia Department of Environmental Quality and the Virginia Department of Conservation and Recreation, http://www.deq.virginia.gov/Portals/0/DEQ/Water/TMDL/ImplementationPlans/mooresip.pdf)

MOORE'S CREEK FECAL COLIFORM TMDL IMPLEMENTATION PLAN COST BENEFIT/SUMMARY				
Measure	Reduces Input From	Reduction (Bacterial cfu/yr)	Cost	Reduction/$
Animal Exclusion And Buffers	Cattle And Grasslands	$1.024 * 10^{14}$	$325,000	$3.151 * 10^{8}$
Streambank Protection And Stabilization	Grasslands And Residential	$2.346 * 10^{12}$	$730,905	$3.210 * 10^{6}$
Maintenance And Repairs For Sanitary Sewer	Sewer Leakage	$7.239 * 10^{12}$	$8,900,000	$8.134 * 10^{5}$
Connection Of Oak Hill To Public Sewer	~20 Leaking Septic Systems	$3.059 * 10^{12}$	$1,210,000	$2.528 * 10^{6}$

Other Public Sewer Connection Projects	**~96 Leaking Septic Systems + 1 Mass Drain Field**	**$1.172 * 10^{13}$**	**$4,257,525**	**$2.753 * 10^{6}$**
Repair/Replace Other Septic Systems/Educate Owners	**Straight Pipes And ~118 Leaking Septic Systems**	**$4.244 * 10^{13}$**	**$733,000**	**$5.790 * 10^{7}$**
Education, Planning And Maintenance Activities	**Urban Land Uses**	**$1.148 * 10^{14}$**	**$3,804,550**	**$3.017 * 10^{7}$**

From Table 6.10, it is clear that animal exclusion and buffers are likely to offer the greatest reduction in bacterial populations in Moore's Creek, and should be a very high priority. Repair or replacement of septic systems appears to be more cost-effective than public sewer connection, although in neighborhoods with small lots, public sewer connection may be the only option. The residential programs will play an important role in improving water quality, since human waste can carry with it human viruses in addition to the bacterial and protozoan pathogens that all fecal matter can potentially carry. In terms of economic benefits to homeowners, an improved understanding of on-site sewage treatment systems, including knowledge of what steps can be taken to keep them functioning properly and the need for regular maintenance, will give homeowners the tools needed for extending the life of their systems and reducing the overall cost of ownership. The average septic system will last 20 to 25 years if properly maintained. Proper maintenance includes: knowing the location of the system components and protecting them (e.g., not driving or parking on top of them), not planting trees where roots could damage the system, keeping hazardous chemicals out of the system, and pumping out the septic tank every three to five years. The cost of proper maintenance, as outlined here, is relatively inexpensive in comparison to repairing or replacing an entire system. Additionally, the repair/replacement and pump-out programs will benefit owners of private sewage (e.g., septic) systems, particularly low-income homeowners, by sharing the cost of required maintenance. In addition to the benefits to individual landowners, the economy of the local community will be stimulated through expenditures made during implementation, and the infusion of dollars from funding sources outside the impaired areas. Building contractors and material suppliers who deal with septic system pump-outs, private sewage system repair and installation, fencing, and other BMP components can expect to see an increase in business during implementation. Additionally, income from maintenance of these systems should continue long after implementation is complete.

3.7.2 Identify the Sources and Amounts of Financial and Technical Assistance and Associated Authorities Available to Implement the Management Measures

Legal Authorities

One of the most important first tasks that an urban and rural residential DMA should do is to review all city, county, or other applicable jurisdiction's rules, regulations, comprehensive land use plans, and zoning and development ordinances. This is to identify existing or lack of legal authorities to develop and implement water quality improvements in order to meet the TMDL requirements. In addition, all municipal road, parks, public works, stormwater, and other master plans and Capital Improvement Projects should be analyzed to determine the existing or lack of authorities to develop and implement the TMDL Implementation Plan and BMPs.

TMDL implementation activities will be carried out under existing or developed regulatory authorities, programs, and water quality restoration plans as well as by sector or source specific plans that DMAs will develop in fulfillment of the requirements of this TMDL. The DMA should include citation and brief descriptions in the TMDL Implementation Plan of legal authorities used to carry out the management strategies. For example, cite and describe the ordinances that prohibit illegal dumping to the storm drainage system, require erosion control for grading projects, etc.

Specifically, for a MS4 permitted community, DMAs will have identified the legal authorities to meet alternative minimum requirements for on-site management of stormwater discharges. These authorities may have been established in a SWMP that has been approved by the jurisdictional stormwater authority. The implementation of the SWMP may be required through the adoption of a local ordinance. There should also be a legally obligated entity responsible for long-term operation and maintenance of the stormwater practice.

Financial and Technical Assistance

DMAs will also need to conduct a fiscal analysis to determine what financial and technical assistance resources are necessary to develop, implement, and maintain the BMPs, and how these resources will be obtained. Forming a Stormwater Management District may be the best way to provide a stable funding source. EPA has developed a factsheet on the alternatives available to fund a stormwater program http://water.epa.gov/lawsregs/lawsguidance/cwa/tmdl/upload/region3_factsheet_funding.pdf. The results of this analysis should be described in the TMDL Implementation Plan.

DMAs will most likely use a combination of funding sources including general funds, stormwater district fees (if in existence), and other local federal, state, and private sources. EPA's *Guidebook of Financial Tools: Paying for Sustainable Environmental Systems*, which is available for download at www.epa.gov/efinpage/guidbkpdf.htm can be used as a resource. This guidebook identifies the following ways to fund the implementation of the TMDL Implementation Plan:

The amount and timing of funding of BMPs will depend upon the pollutant source being addressed, when BMPs are needed to be implemented. Some BMPs will require immediate financing because they can be implemented immediately (e.g., changing BMPs for maintaining roadside ditches) while others will require more evaluation before an effective strategy can be determined (e.g., determining whether bacteria is coming from failing septic systems). Some BMPs may require a significant public process (e.g., adopting a new ordinance or including stormwater management facilities in a capital improvement plan) while others can be undertaken relatively quickly (e.g., information/education efforts or changes in road maintenance programs).

In some instances, it may be necessary for DMAs to prioritize among the strategies, if resources are limited. This may mean addressing some sources of pollution before others or focusing implementation efforts in a particular geographic area. To the extent possible, the selection of priorities should be driven by the greatest opportunities for achieving pollutant reductions.

Some of the costs of implementing your TMDL Implementation Plan can be defrayed by leveraging existing efforts and seeking in-kind services.

Some examples follow:

1. ***Use existing data sources***

   Most geographic areas have some associated background spatial data in the public domain, such as digital elevation models, stream coverage, water quality monitoring data, and land cover data in the form of imagery like orthophotos quads or raster satellite image files.

2. ***Use existing studies***

   Many agencies have reports of previous analyses, providing useful baseline information and data, such as delineated sub watersheds or a historical stream monitoring record.

3. ***Use partnerships***

   State, county, or federal agencies working as technical assistance providers and implementing natural resource program initiatives can offer computer services and expertise, such as performing GIS analysis or weaving together elements of different programs that might apply to the local area. They might be in a position to write part of the overall watershed plan if they have existing generalized watershed characterization studies.

4. ***Cover incidental/miscellaneous costs through contributions***

   For example, staff time to assemble needed elements, supplies, and meeting rooms for a stakeholder or scoping meeting can all be donated.

Example Funding Strategy:

(based on City of Springfield (Oregon) Stormwater Management Plan, 8.0 Financial Strategy, Prepared by: City of Springfield, Public Works Environmental Services Division, January 2004. (https://scholarsbank.uoregon.edu/xmlui/bitstream/handle/1794/5828/Springfield_Stormwater_Master_Plan.pdf?sequence=1)

Operations within the City's stormwater management program, including development and implementation of the … plan is completely funded by "drainage user fees," which are billed on a monthly basis. Drainage user fees are made up of a base fee plus a fee calculated on impervious surface areas, including roofs and paved areas (such as parking lots and roads). Single family and duplex residences are charged a flat fee based on average amounts of impervious area. The stormwater drainage system Capital Improvements Program (CIP) is funded, in part, by user fees, and, in part by stormwater drainage system development charges (SDCs).

3.8 ELEMENT 13 -- Reasonable Assurance, Measurable Goals, and Milestones for Attaining Water Quality Standards and Beneficial Uses

What information should be provided?

Develop interim, measurable milestones for determining whether management measures are being implemented and develop a schedule for implementing the Plan. The way to determine if the objectives of the implementation plan are being met is to develop measurable goals and milestones. By developing interim and long-term measurable milestones on the implementation of the implementation plan, reasonable assurance can better be obtained.

Why should this be included?

Including this information in the plan will help to ensure, provide reasonable assurance, that the TMDL Implementation Plan is implemented to ultimately meet water quality standards within the TMDL basin(s). In addition, both the DMA and DEQ can determine whether the BMPs are being implemented to meet the load allocation.

Where can this information be found?

The selected most effective and other recommended programmatic and structural BMPs are provided by the DMA in **Section 3.11;** the cost and benefits of implementing the BMPs is in **Section 3.12**, the schedule is in **Section 3.13**, and the results of implementation and effectiveness monitoring have been developed in **Section 3.14.**

3.13.1 Develop Interim, Measurable Milestones for Determining Whether Management Measures are Being Implemented To Provide Reasonable Assurance

The purpose of implementing the TMDL Implementation Plan is to ultimately meet water quality standards.

There are three elements of this objective:

1. ***Protection***

   Prevent the degradation of healthy waters.

2. ***Restoration***

   Develop and implement plans to treat and reduce pollutants.

3. ***Maintenance of Reductions***

   Institutionalize technical and administrative procedures to offset the introduction of new pollutants.

Measurable Goals

Measurable Goals are generally defined as objective markers or milestones that DMAs will use to track the progress and effectiveness of selected BMPs in reducing pollutants to meet TMDL LAs. The TMDL Implementation Plan is recommended to include a variety of short- and long-term goals. At a minimum, measurable goals are recommended to contain descriptions of actions DMAs will take to implement each BMP, what is anticipated to be achieved by each goal, and the frequency and dates for such actions to be taken.

This section of the implementation plan is recommended to address the following questions:

- Who will be responsible for tracking BMP installations, operation, and maintenance?
- What are the implementation milestones?
- What type of water quality monitoring will be continued during implementation?
- What annual goals are to be achieved during implementation?
- What are the methods to be used to assess "reasonable assurance" of successful implementation?

- What methods will be used during implementation for evaluating progress?
- What actions will be taken if water quality standards are not attained?

Reasonable Assurance

Reasonable Assurance means the TMDL Implementation Plan should include adequate information to ensure the plan will be implemented and changes made as necessary to provide reasonable assurances that BMPs and other strategies will be implemented, monitored, and adjusted to meet TMDL LAs and achieve water quality standards. Without a demonstration that the LAs will be met, there is no assurance that the TMDL equation will add up to a sum that does not exceed a level necessary to implement the applicable water quality standards.

To ensure the LAs are met, DMAs will need to clearly identify strategies to reduce pollutant loads from the identified pollutant sources. The TMDL Implementation Plan must explain the process used to estimate the expected LAs reductions by source. This would include providing the rationale for selection of both the number and type of Programmatic and Structural BMPs to be implemented within its jurisdiction, how many will be applied, priority areas where they will be applied, their pollutant reduction efficiencies, etc.).

The plan should quantify strategies into acres, units, and/or design specification that are needed to meet LAs. In addition, consideration should be given to pollution reduction per unit of investment, existing local priorities or restoration plans, local capacity and willingness for implementation, or other key considerations.

The TMDL Implementation Plan should provide an overall schedule for implementation of BMPs along with an adaptive management procedure for reviewing key milestone progress and revising BMPs, if necessary, to meet the TMDL target loads. The plan should identify the percentage of implementation actions installed within certain timeframes. (For example, 50% of riparian area restoration within first two years, or 75% of all streets receiving high efficiency street sweeping within the first year.)

The TMDL Implementation Plan should include a monitoring and reduction tracking system in order to facilitate adjustments to selected BMP and to track the progress of their implementation. In addition, the plan should describe potential follow-up actions if there is insufficient progress in meeting LAs and water quality standards.

It is difficult to ensure, based on prior knowledge, that implementing nonpoint source controls will achieve expected load reductions. BMPs may fail to achieve projected and planned pollution load reductions due to inadequate selection of BMPs (practices not applicable to a particular watershed), inadequate design or implementation, or lack of full participation by all contributing sources of nonpoint pollution.

Reasonable assurance could be provided through a variety of ways through voluntary and regulatory programs. When a voluntary approach is used to meet TMDLs, the TMDL Implementation Plan must identify measurable milestones and timeline for meeting those milestones. In order to ensure that TMDL goals will be met, voluntary measures must be accompanied with a plan for regulatory measures that will be implemented when voluntary measure milestones are not met according to the timelines.

Table 15 provides an example of BMPs implementation and percentage of load reduction goals (water quality milestones) met to meet TMDL Load Allocations.

Table 16 provides an additional different example.

Table 15. Example Implementation and Water Quality Milestones.

(Based on A Total Maximum Daily Load Implementation Plan for Dumps Creek, Submitted by: MapTech, Prepared for Virginia Department of Environmental Quality Submitted April 2008, http://www.deq.state.va.us/tmdl/implans/ccbrip.pdf)

Table 6.2 Proposed milestones for implementation of control measures.

	Implementation Milestones				Water Quality Milestones: Percentage of Load Reduction Goals	
Date	Reclamation of AML (acres)	Haul Road Stabilization (acres)	Vegetated Buffers (acres)	Streambank Stabilization (feet)	TDS (%)	Sediment (%)
1/1/2008		Current Implementation			9	24
1/1/2009	10	8	0	500	14	30
1/1/2010	25	17	0	500	22	34
1/1/2011	45	27	0	500	33	38
1/1/2012	60	38	0	500	41	41
1/1/2013	100	50	0	500	63	50
1/1/2014	150	63	0	500	89	60
1/1/2015	200	77	5	1,000	100	76
1/1/2016	250	91	5	1,500	100	90
1/1/2017	273	106	5	2,000	100	99
1/1/2018	273	123	5	2,640	100	100
1/1/2023		De-listing from 303(d) List			100	100

Table 16. **Additional Example Implementation and Water Quality Milestones.**

(Based on A Total Maximum Daily Load Implementation Plan for Knox Creek and Pawpaw Creek Prepared for Virginia Department of Environmental Quality Submitted September 10, 2007, http://www.deq.virginia.gov/export/sites/default/tmdl/implans/knoxpawip.pdf)

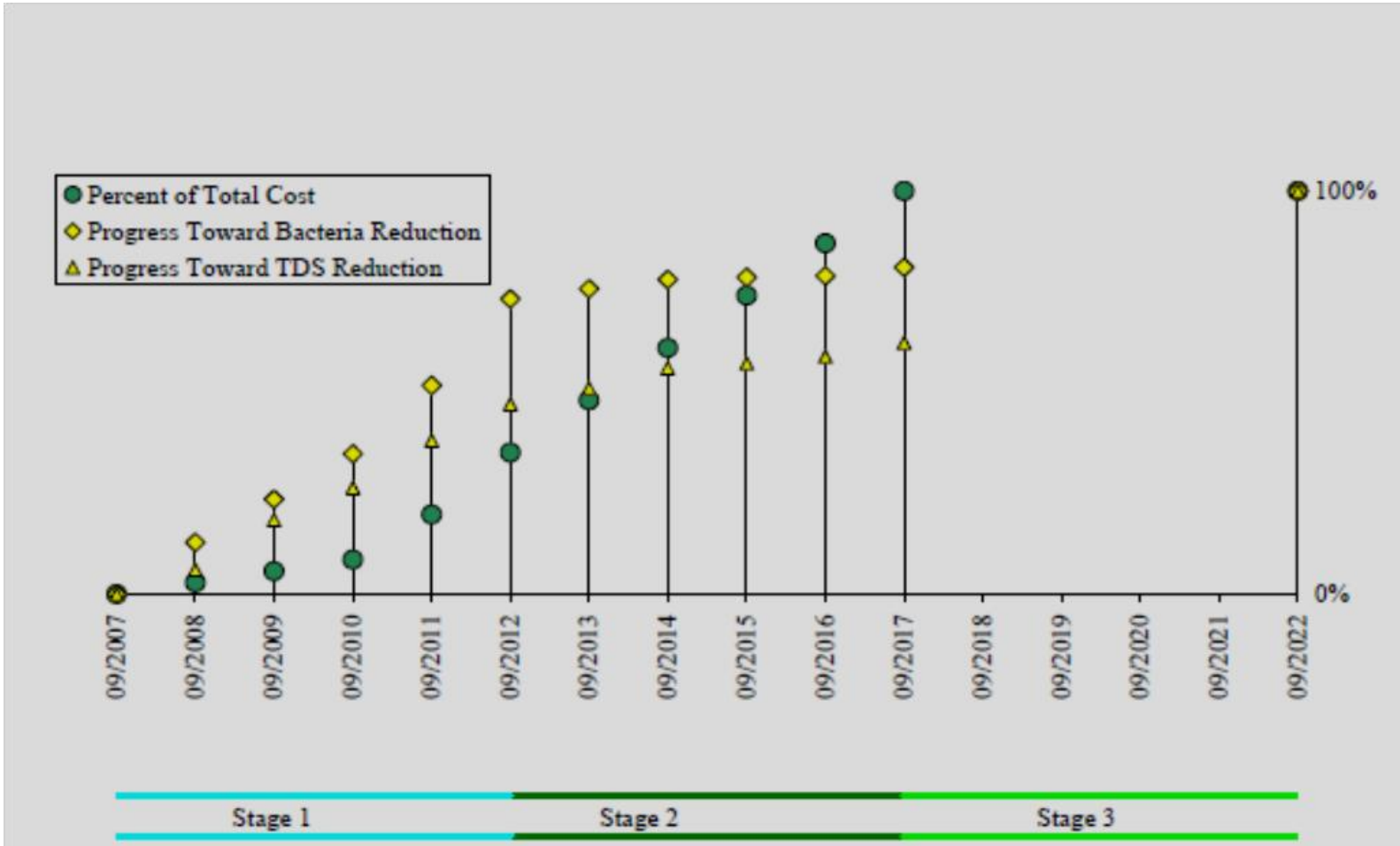


Figure 6.1 Timeline for implementation in the Knox Creek watershed.

3.13.2 Develop a Schedule for Implementing the Plan

Setting timelines and milestones is critical to having a successful program. A schedule for completing measurable milestones should be included. For example, if the adoption of an ordinance is proposed to require pet owners to pick up their pet waste, measurable milestones may include dates for public review of the proposed ordinance and ordinance adoption.

TMDL WQMPs will include specific implementation timelines and associated milestones for the development and implementation of TMDLs. Development of the implementation timeline turns goals and objectives into specific tasks. The timeline specifies when each management action change occurs and who is responsible for implementing the change. The timeline is broken down into increments to track and review progress. The duration of the increments could vary for the life of the project (e.g. months in beginning, then years, and later to decades).

Some of the specific components of timeline development are:

- Timelines and milestones will be determined with a DMA and local input during the TMDL development process.
- Milestones will be set for both instream water quality and BMP implementation.
- Administrative capacity and resources will be considered.
- Timelines should be developed for meeting interim goals, benchmarks, and meeting load allocation. Goals and benchmarks need to be measurable.
- The WQMP timelines should be used by DMAs to develop their sector or source specific TMDL Implementation Plans.
- Include a clear goal under timeline element, e.g., a water quality target to achieve at a designated time.
- Break down long-term goals, such as meeting temperature criteria, into intermediate benchmarks to achieve (e.g., meeting shade targets in priority watersheds).
- Include clear milestones under timeline element. Milestones are the end of a stage that marks the completion of a work package.
- Include timelines for approval of TMDL Implementation Plans and required permits.

The first step in producing a TMDL Implementation Plan schedule is to know the steps and timeline for development, submittal, and approval by DEQ of the plan.

The following **Table 17** provides a recommended timeline:

Table 17. TMDL Implementation Plan Recommended Timeline.

DATE	ACTION
BEGINNING	**DEQ Sends TMDL and WQMP with Cover Letter to DMA.**
Specified in the WQMP but typical ranges are 12 – 18 months	**DMA Begins from Date of Letter Receipt to Prepare TMDL Implementation Plan and Submits to DEQ.** **DMA Conducts Public Review Opportunities for Review and Comment on Draft Plan**
WITHIN 90 DAYS	**DEQ Receives and Reviews Implementation Plan and Provides Comments to DMA.**
2nd YEAR	**DMA Secures Funding and Begins to Implement TMDL Implementation Plan.**
4th YEAR	**DMA Conducts Program Implementation Plan Effectiveness Monitoring and Annual Reporting to DEQ.**
5th YEAR	**Program Monitoring Data Shows Need to Revise Implementation Plan and TMDL– DMA Revises Implementation Plan and Submits to DEQ.**
5th YEAR, 2nd MONTH	**DEQ Provides Comments on Revised Implementation Plan.**
5th YEAR, 6th MONTH	**DMA Implements Revised Implementation Plan and Conducts Program Effectiveness Monitoring and Reporting to DEQ.**
6th YEAR	**DMA and/or DEQ Conducts Ambient (In -Stream) Monitoring to Determine if Water Quality Standards are Met.**
VARIES	**When Ambient (In -Stream) Monitoring Data by Pollutant Shows Trend of Compliance, DEQ Sends Letter to DMA Stating that for Now DMA Meets TMDL and / or Standard for Pollutant.**

As part of the TMDL Implementation Plan schedule, timelines for implementing management strategies are recommended to be included. The following programmatic and structural BMPs implementation timelines **(Tables 18 and 19)** are provided as examples.

Table18. Example Implementation Timeline.

(Based on A Total Maximum Daily Load Implementation Plan for Dumps Creek, Submitted by: MapTech, Prepared for Virginia Department of Environmental Quality Submitted April 2008, http://www.deq.state.va.us/tmdl/implans/ccbrip.pdf)

Table 6.2 Timeline for implementation in the Knox Creek watershed – Stage I.

Knox Creek Implementation Milestones	Existing	Year 1	Year 2	Year 3	Year 4	Year 5
Cumulative Progress Toward BMP Installation						
Agricultural:						
Grazing Land Protection System (SL-6)	0%	10%	20%	30%	40%	50%
Stream Protection System (WP-2T)	0%	10%	20%	30%	40%	50%
Improved Pasture Management	0%	10%	20%	30%	40%	50%
Waste Storage Facilities (WP-4) - Horses	0%	10%	20%	30%	40%	50%
Manure Incorporation	0%	10%	20%	30%	40%	50%
Vegetated Stream Buffer	0%	10%	20%	30%	40%	50%
Residential:						
Septic Systems Pump-out Program (RB-1)	0%	20%	40%	60%	80%	100%
Septic System Repair (RB-3)	0%	20%	40%	60%	80%	100%
Septic System Installation/Replacement (RB-4)	0%	20%	40%	60%	80%	100%
Alternative Waste Treatment System Installation (RB-5)	0%	20%	40%	60%	80%	100%
Residential Education Program	0%	20%	40%	60%	80%	100%
Infiltration Trench	0%	0%	0%	0%	0%	0%
Erosion and Sediment Control	0%	0%	0%	0%	0%	0%
Vegetated Stream Buffer	0%	10%	20%	30%	40%	50%
Industrial:						
Reclamation of Abandoned Mine Land	0%	0%	0%	0%	10%	25%
Dirt Road Stabilization	0%	0%	0%	0%	10%	25%
Forest Harvesting BMPs	0%	0%	0%	0%	10%	25%
Exceedance of Endpoints (%)						
Instantaneous EC Standard (235 cfu/100mL)	47.8%	41.7%	36.6%	31.2%	23.0%	12.8%
Geometric Mean EC Standard (126 cfu/100mL)	91.7%	86.1%	83.3%	63.9%	47.2%	25.0%
TDS Endpoint (369 mg/L)	16.2%	15.3%	13.2%	12.0%	10.0%	8.6%
Cost (% of Total)	0%	3.0%	6.0%	9.0%	20.3%	35.7%

Table 19. Additional Example Implementation Timeline.

(Based on A Total Maximum Daily Load Implementation Plan for Dumps Creek, Submitted by: MapTech, Prepared for Virginia Department of Environmental Quality, Submitted April 2008, http://www.deq.state.va.us/tmdl/implans/ccbrip.pdf)

Table 6.3 Timeline for implementation in the Knox Creek watershed – Stages II and III.

Knox Creek Implementation Milestones	Year 6	Year 7	Year 8	Year 9	Year 10	Year 15
Cumulative Progress Toward BMP Installation						
Agricultural:						
Grazing Land Protection System (SL-6)	60%	70%	80%	90%	100%	100%
Stream Protection System (WP-2T)	60%	70%	80%	90%	100%	100%
Improved Pasture Management	60%	70%	80%	90%	100%	100%
Waste Storage Facilities (WP-4) - Horses	60%	70%	80%	90%	100%	100%
Manure Incorporation	60%	70%	80%	90%	100%	100%
Vegetated Stream Buffer	60%	70%	80%	90%	100%	100%
Residential:						
Septic Systems Pump-out Program (RB-1)	100%	100%	100%	100%	100%	100%
Septic System Repair (RB-3)	100%	100%	100%	100%	100%	100%
Septic System Installation/Replacement (RB-4)	100%	100%	100%	100%	100%	100%
Alternative Waste Treatment System Installation (RB-5)	100%	100%	100%	100%	100%	100%
Residential Education Program	100%	100%	100%	100%	100%	100%
Infiltration Trench	20%	40%	60%	80%	100%	100%
Erosion and Sediment Control	20%	40%	60%	80%	100%	100%
Vegetated Stream Buffer	60%	70%	80%	90%	100%	100%
Industrial:						
Reclamation of Abandoned Mine Land	40%	55%	70%	85%	100%	100%
Dirt Road Stabilization	40%	55%	70%	85%	100%	100%
Forest Harvesting BMPs	40%	55%	70%	85%	100%	100%
Exceedance of Endpoints (%)						
Instantaneous EC Standard (235 cfu/100mL)	11.6%	10.5%	10.2%	10.1%	9.1%	0%
Geometric Mean EC Standard (126 cfu/100mL)	25.0%	25.0%	25.0%	25.0%	22.2%	0%
TDS Endpoint (369 mg/L)	7.9%	7.1%	6.9%	6.7%	6.1%	Healthy Aquatic Life
Cost (% of Total)	48.6%	61.4%	74.3%	87.1%	100.0%	100%

3.9 ELEMENT 14 -- Performance Monitoring

What information should be provided?

Provide for performance monitoring with a plan for periodic review and revision of the implementation plan. Performance Monitoring means monitoring implementation of management strategies, including sector-specific and source-specific implementation plans, and resulting water quality changes. Therefore, performance monitoring needs to include tracking of implementation as well as monitoring to track progress towards meeting water quality standards. This monitoring should be designed to answer the question, "Were the original assumptions we made correct?" During a TMDL process, assumptions about how a watershed functions are often made based on available data and best professional judgment. Collection of additional data helps to increase our understanding of environmental processes and can be used to better inform the original assumptions.

Why should this be included?

Including this information in the plan will help to ensure that the TMDL Implementation Plan is implemented to ultimately meet water quality standards within the TMDL basin(s). In addition, both the DMA and DEQ can determine whether the BMPs are being implemented to meet the load allocation.

Where can this information be found?

DMAs need to identify in the TMDL Implementation Plan their proposed monitoring with a plan for periodic review and revision of the implementation plan. There are two types of monitoring required. The first is Monitoring Implementation of management strategies, including sector-specific and source-specific implementation plans. The second type of monitoring is Effective Monitoring, which involves the collection of data to track progress toward meeting water quality standards by measuring the resulting water quality changes caused by implementation actions. Therefore, there needs to be included tracking of implementation as well as monitoring of water quality indicators.

The tables in **Appendix I** identify the recommended implementation and effectiveness monitoring by pollutant.

3.9.1 Implementation Monitoring

DMAs must monitor implementation of management strategies by tracking the progress and accomplishments of each activity. Implementation monitoring includes monitoring that is designed to answer the question: "Did we accomplish what we said we would in the manner, time, and budget proposed?" This type of monitoring is generally directed toward specific management changes or implementation activities. Implementation monitoring is data collected to account for work done and the success of the project in meeting its design target. This type of monitoring is recommended to be done for each project.

Implementation Monitoring plans are recommended to:

- Estimate the targeted amount of work to be done (examples: miles of stream fencing, number of sediment retention ponds).
- Describe some criteria for determining successful implementation (example tree survival after 8 years).
- Define what management measures will be monitored (can add over time).
- Define parameters to track for each management strategy.
- Develop data collection and storage methods.
- Assign responsibility to parties who will collect, store, and report data.
- Develop project management charts to assess workflows.
- Riparian restoration data should be entered by the DMAs in The Oregon Watershed Restoration Inventory (OWRI), http://www.oregon.gov/OWEB/MONITOR/OWRI.shtml, as administered by OWEB.
- Select analysis methods to assess if milestones are met.
- Describe some criteria for determining successful implementation (example tree survival after 8 years).

- Monitoring will continue throughout the life of the implementation efforts and afterward to confirm attainment of water quality targets.

Reporting is recommended to include the amount of work done and the amount of completed work that is on target to be successful. Critical data includes the type of activity, the location of the activity (latitude and longitude or other appropriate description), a measure of the size of the project, the date project was done, and project success (yes/no, percentage, etc. as appropriate.) A robust system for tracking implementation is recommended in order to describe the role of management actions on water quality changes.

3.9.2 Effectiveness Monitoring

Effectiveness monitoring is conducted to evaluate pollutant load reductions achieved by a particular management strategy or a collection of strategies - data collected to measure the change caused by implementation actions.

Successful effectiveness monitoring depends on drawing the connection between causes (implementing a management activity) and resulting effects (changes in water quality indicators). The relationship between the management activities and the measured indicator is recommended to be explicitly identified either in a sampling design that isolates the cause and effect relationship (Before, After, Control, Impact (BACI) or through modeled relationships that identify any actions, natural or anthropogenic, that might influence the indicator. Using trends in water quality or compliance with TMDL targets can be used as effectiveness monitoring if sufficient documentation exists to tie changes in water quality to management activities.

Effectiveness monitoring can be conducted at different scales ranging from at an individual project, to across the entire jurisdiction. Each scale has its own advantages and challenges. Measuring at the project scale gives you data on actual pollutant reductions; but monitoring the effectiveness of every implementation action is often impractical. Monitoring for changes at the jurisdiction scale may reduce the number of monitoring locations; but a number of confounding impacts across a jurisdiction makes measuring the effect of localized restoration actions at the larger landscape scale difficult.

Appropriate monitoring indicators, spatial scale, and time scale depend on the type of implementation action. For example, the most sensitive indicator to measure the effectiveness of a riparian fencing project would be different from the indicator used for riparian restoration projects. Likewise, the appropriate temporal and spatial scales for measuring changes in an indicator would be different for these two project types with changes from the riparian planting taking place over the scale of 5-50 years but changes from riparian fencing project being measureable within 1-5 years.

DMAs should consult with DEQ to ensure that their monitoring and evaluation strategies are adequate and do not duplicate other efforts or involve unnecessary data collection. For practical reasons, there is not a one-size-fits-all expectation for monitoring effectiveness. DEQ will be available to work directly with DMAs to establish a mechanism for monitoring effectiveness.

Many larger DMAs are already conducting water quality monitoring that can be used to evaluate the effectiveness of their pollution reduction efforts. These quantitative activities may have been undertaken voluntarily or required as part of an NPDES permit or other regulatory requirement. These jurisdictions are expected to describe the effectiveness of their TMDL implementation efforts in reducing pollutant loads.

While quantitative monitoring methods are preferred in most cases, qualitative methods may provide an effective measurement of implementation progress in some instances. Examples may include photo documentation of improvement in stream bank vegetation/cover for residential properties or vegetated stormwater containment/ collection swales (i.e., photos before planting, shortly after planting, and after plant maturation), or the documentation of relative sediment volume (i.e., high, medium, or low) collected from detention ponds or filters in stormwater treatment systems. While these methods do not provide quantitative information on the effectiveness of the projects, they do illustrate progress, and can be combined with other monitoring efforts to show success of implementation activities.

As mentioned previously, DEQ does not expect each DMA, particularly smaller jurisdictions, to implement its own water quality monitoring program. DMAs that are not able to undertake an evaluation of effectiveness on their own are expected to participate in discussions with DEQ and other entities in the area (e.g., watershed councils, Soil and

Water Conservation Districts, other municipalities). These discussions will help identify effectiveness monitoring needs and discuss how resources could be pooled to implement an effectiveness evaluation strategy for the area.

The tables in **Appendix I** identify the recommended implementation and effectiveness monitoring by BMP and by pollutant.

Effectiveness monitoring – within the context of TMDLs, should include details such as:

- Locations of potential monitoring sites
- Conditions (hydrologic, seasonal, land management) when samples will be collected
- Minimum sample size needed to assess if goal is met
- Technical needs for collection and analysis of samples
- Responsibility to parties for collecting, storage, and transfer of samples for analysis
- Who is responsible for analysis of sample results
- Data analysis methods to be used to assess if goal is met

3.10 ELEMENT 15 -- Develop an Evaluation Framework to Meet Plan Review, Revision, and Reporting Requirements

What information should be provided?

Generally, two reports are recommended to be submitted to DEQ on a regular basis. These reports are recommended to include descriptions of DMA's intention to review its implementation plan and report to DEQ on the frequency specified in the TMDL WQMP. Generally, the implementation plan review should be conducted once every five years and results of that review submitted to DEQ. In addition, a report should be submitted to DEQ on an annual basis describing the progress of the DMA's management strategies.

Why should this be included?

Including this information in the plan will help to ensure that implementation of the TMDL Implementation Plan is being tracked and reported to DEQ. In addition, reporting of any necessary changes to the plan and specifically BMPs being implemented is important to ensure the plan will meet TMDL load allocations.

As identified in OAR 340-042-0080, TMDL Implementation Plan acceptance by DEQ was based on the TMDL Implementation Plan containing and acknowledging the following reporting and performance components:

- Reasonable assurance that plan will be implemented.
- Developed timeline, with reference to costs and funding, for implementing TMDL management strategies (implementation and completion dates).
- Proposed performance monitoring plan for confirming implementation of strategies and success of strategies in meeting TMDL reductions for applicable parameters (ex., temperature, mercury, and bacteria).
- Submittal of annual reports for describing progress on implementing strategies that were selected for pollutant load allocations/reductions in the TMDL Implementation Plan.
- Submittal of 5 year evaluation report for describing implementation progress and the effectiveness of the strategies implemented during the preceding 4 years in meeting the parameter reductions.
- Plan adaptation and revisions based on the annual and 5^{th} year periodic reviews if it is determined that the plan is not effective in meeting parameter load allocations/reductions.

Where can this information be found?

The TMDL WQMP will provide further guidance on how and what to report.

3.10.1 Annual Progress Report

The Annual Progress Report tracks implementation of the TMDL Implementation Plan and the BMPs. Typically, the TMDL WQMP specifies the frequency of reporting. If there is no frequency specified in the WQMP, it is recommended that a progress report should be submitted to DEQ ***once a year***.

Check with your Basin Coordinator for annual reporting requirements.

3.10.2 Five (5)-Year Implementation Plan Review Report

Every fifth year, DMAs are required to submit a 5-Year TMDL Implementation Plan Review Report which is a more thorough evaluation report than the TMDL Implementation Plan Annual Progress Report. The report should describe the effectiveness of the BMPs and other management strategies identified in the DEQ approved DMA's TMDL Implementation Plan that was put into place during the preceding four years.

Check with your DEQ Basin Coordinator for your reporting requirements.

3.11 ELEMENT 16 -- Evidence of Compliance with Land Use Requirements

What information should be provided?

To provide evidence that a TMDL Implementation Plan is in compliance with local land use requirements, in most cases, the plan should:

1. Identify applicable acknowledged local comprehensive plan provisions and land use regulations, and

2. Explain how the implementation plan is consistent with these local planning requirements or what steps will be taken to make the local planning requirements consistent with the implementation plan.

3. Some programmatic BMPs may require amendments to comprehensive plans and development codes. Such changes require public notice and notice to DLCD and must be consistent with land use goals, statutes and rules.

Another important requirement is that the DMA's planning director will need to send a letter to DEQ, certifying that their Comprehensive Plan and implementing ordinances comply or will comply by a given timeline with the applicable management measures identified in their TMDL Implementation Plan and their compliance with applicable statewide land use compliance. This letter will most likely be added with transmittal of the TMDL Implementation Plan.

Why should this be included?
Including this information in the plan will help to ensure that implementation of the TMDL Implementation Plan meets the state land use rules and regulations.

Where can this information be found?
A city or county will need to review, and if required, update their comprehensive plan and applicable implementing ordinances.

To meet this land use requirement, a city or county may determine it is necessary to amend their comprehensive plan and applicable implementing ordinances.

Specifically, revising or adopting the following development ordinances:

- Erosion and Sediment Control.
- Stormwater Quantity and Quality Management Control and Treatment.
- Wetland, Riparian, and Other Environmentally Sensitive Areas Protection.
- Hillside Development.

- Floodway and Floodplain Protection.
- Drinking Water Protection (DWP) Overlay Zone for Groundwater Wells.

Urban and rural nonpoint contributing sources will likely need development-related controls administered through local land use ordinances.

It is essential that city and county land use related TMDL Implementation Plan measures are enforced through the local plan.

It is however important to note that a DMA will still need to meet both the TMDL load allocations and the state land use-planning goals individually. For example, even if a local jurisdiction has adopted a Goal 5 "safe harbor" for riparian and wetland areas protection, the DMA will need to analyze the adequacy of their Goal 5 program in meeting their TMDLs, particularly the shade requirements with a temperature TMDL. For most urban areas, the riparian areas are degraded and may contain very few trees. In addition, the "safe harbor" buffer widths may not provide sufficient shade to meet the temperature TMDL shade surrogates in some instances. A local jurisdiction may determine that they are in compliance with Goal 5 and not ~~Goal 6 or~~ their TMDL.

The land use Goals that interface with the urban management measures most directly are Goals 5, 6, and 7.

Goal 5 requires the inventory of riparian areas, wetlands, open space, wildlife habitat, and groundwater resources. Once local governments have identified significant resources in these categories, generally they will develop a program to protect the significant resources. See http://www.lcd.state.or.us/LCD/docs/goals/goal5.pdf for Goal 5 rules.

Goal 6 provides a context through which water quality protection objectives can be integrated into a local government's comprehensive plan and development ordinances. Local governments can adopt local measures to protect ground and surface water from development impacts as long as they demonstrate a connection between the local measure and efforts to achieve or maintain water quality standards

Goal 6 states that local government comprehensive plans must be compliant with state and federal water quality laws and standards. A TMDL and the associated order issued by DEQ identify local governments as a DMA and set a schedule for compliance with a pollutant load allocation. This action on the part of DEQ clearly defines the local government's obligation for complying with water quality standards. Once this is established.

At the time of a comprehensive plan amendment, a local government must demonstrate compliance with all goals. A finding of compliance with the water quality provisions of Goal 6 can only be made if the local government is compliant with the schedule laid out in the TMDL order. See http://www.lcd.state.or.us/LCD/docs/goals/goal6.pdf for Goal 6 rules.

Goal 7 requires local governments to adopt plan policies to reduce risk to people and property from natural hazards. DLCD revised Goal 7 in 2002. The revised Goal requires updates of local plans to address new hazards information. The goal also encourages local governments to reduce hazard risks by keeping those areas in open space or low-density uses. Local government strategies to address known hazards can include restrictions for development activities in the flood plain and on steep slopes that are prone to erosion and landslides. See http://www.lcd.state.or.us/LCD/docs/goals/goal7.pdf for Goal 7 rules.)

The State Land Use Planning Goals and program is an integral part of ensuring state water quality rules and regulations are met. In addition, the comprehensive plan provides the framework for protecting and enhancing water quality. All water quality provisions in the land development code should be supported by the appropriate comprehensive plan goals and policies.

Oregon Statewide Planning Goal 2: Land Use Planning indicates that, *"all land use plans shall include identification of issues and problems, inventories and other factual information for each applicable statewide planning goal, evaluation of alternative courses of action and ultimate policy choices…"* Many comprehensive plans already have provisions that support water quality ordinances, particularly if any Goal 5 work has been completed. In addition to Goal 5, there are a number of Statewide Planning Goals that have water quality components to them. Perhaps the

best way to address water quality is not to rely on one or two goals, but to recognize that most of the goals are in some way related to water quality, and when used in concert, they form a powerful basis for water quality ordinances.

3.11.1 DMA's Planning Director Letter to DEQ.

The DMA's planning director will need to send a letter to DEQ, certifying that their Comprehensive Plan and implementing ordinances comply or will comply by a given timeline with the applicable management measures identified in their TMDL Implementation Plan and their compliance with applicable statewide land use compliance. This letter will most likely be added with transmittal of the TMDL Implementation Plan.

3.12 ELEMENT 17 -- Information/Education Component that Identifies the Information/Education Activities Needed for Implementing the Plan

What information should be provided?

Provide in the TMDL Implementation Plan a description of the DMA's proposed information/education activities needed for implementing the plan.

Why should this be included?

Although it is important to let people know about the water quality problems in the watershed, sometimes simply informing and educating people on the issues is not enough to initiate behavior change. Behavior change occurs over time. First, audiences may need to be made aware of the issue or problem. Then they may need to be educated on the problems facing the watershed. Finally, they need to know what actions they could take to help address those problems.

Where can this information be found?

EPA has developed many excellent information and education guidebooks for the NPDES Stormwater Phase II and Watershed/Nonpoint Source programs. The following three EPA documents are the most helpful in both developing and implementing an information/education component that identifies the information/education activities needed for implementing the plan:

- **Getting In Step, A Guide for Conducting Watershed Outreach Campaigns,** December 2003 EPA 841-B-03-002, http://www.epa.gov/owow/watershed/outreach/documents/getnstep.pdf

- **EPA NPDES Stormwater Phase II Final Rule Public Education and Outreach Minimum Control Measure Factsheet,** http://www.epa.gov/npdes/pubs/fact2-3.pdf

- **EPA NPDES Stormwater Phase II Final Rule Public Education and Outreach on Stormwater Impacts - Developing an Outreach Strategy Factsheet,** http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=115&minmeasure=1

The EPA guidance document, **Getting In Step, A Guide for Conducting Watershed Outreach Campaigns,** December 2003 EPA 841-B-03-002, http://www.epa.gov/owow/watershed/outreach/documents/getnstep.pdf, provides the following six steps in developing an effective information/education program:

- Define information/education goals and objectives.
- Identify and analyze the target audiences.
- Create the messages for each audience.
- Package the messages for various audiences.
- Distribute the messages.
- Evaluate the information/education program.

This guide provides a brief description of the activities that occur in each of these steps:

Step 1. Define information/education goals and objectives

The outreach goals and objectives will reinforce the overall watershed goals and objectives and should be specific, measurable, action-oriented, and time-focused. Keep the desired outcome in mind when developing your objectives. Do you want to create awareness, provide information, or encourage action among your target audience? It is very important to make your objectives as specific as possible and to include a time element as well as a result. This approach will make it easier to identify specific tasks and will enable you to evaluate whether you have achieved the objectives.

Step 2. Identify and Analyze the Target Audience

Next, you should identify the audiences you need to reach to meet your objectives. The target audience is the group of people you want to reach with your message. You should break down your target audience into smaller segments using demographics, location, occupation, watershed role, and other factors. If your target audience is too broad, chances are you will not be able to develop a message that engages and resonates with the entire audience. Be creative in defining and developing perspectives on your target audiences and in finding out what makes them tick.

Step 3. Create the Message

After gathering information on members of the target audience, you are ready to create a message that will engage them and help achieve your watershed planning objectives. To be effective, the message must be understood by the target audience and appeal to people on their own terms. The message should articulate what actions the audience should take. These actions might include letting vegetation grow taller along a stream, pumping septic tanks, or conducting soil tests before fertilizing lawns. The actions should tie directly back to the goals of the watershed plan because one of the goals of your information/education program will be to help implement the watershed plan. In addition, your message should be clear, specific, and tied directly to something the target audience values, such as:

- *Money savings*
- *Time savings*
- *Convenience*
- *Health improvement*
- *Efficiency*
- *Enhancing public values*
- *Improving ecosystem function*
- *Enhancing quality of life and environmental amenities*
- *Economic development benefit*

Step 4. Package the Message

Now it is time to determine the best package or format for the message for eventual delivery to the target audience. The information you collected in Step 2 while researching the audience will help to determine the most appropriate format. When selecting your message format, think about where the target audience gets its information. A farming community might respond more positively to door-to-door visits or articles in farm publications than to an Internet and e-mail campaign.

- *Work with the Media*

  If your message needs to be understood and embraced by the public, it should be covered by the mass media. The media can be a very cost-effective and efficient way to get your message delivered. Formats using the mass media can be broken down into two major categories—news coverage and advertising.

News coverage includes interviews, news stories, letters to the editor, and event coverage. Advertising includes the development of public service announcements (PSAs). Publicity generated from news coverage is dependent on the news organization, whereas you create radio, TV, and newspaper advertising yourself. In many cases, the advertising you do can be leveraged later into news coverage. For example, one state bought informational ads on agriculture-related water quality issues from a radio station and received as a benefit some free news coverage of the issues during the year.

- *Develop Effective Print Materials*

  By far the most popular format for outreach campaigns is print. Printed materials include fact sheets, brochures, flyers, booklets, posters, bus placards, billboards, and doorknob hangers. These materials can be created easily, and the target audience can refer to them repeatedly. The Texas Commission on Environmental Quality (TCEQ) launched a nonpoint source outreach campaign in 2001 that targeted watersheds with water quality problems where the causes were known. In watersheds where pet waste was identified as contributing to these problems, TCEQ developed a full-color billboard display of a dog with the message, "Please pick up my poop". The billboards served as prompts to encourage behavior change. For more information, visit www.tceq.state.tx.us/assistance/education/nps.html .

- *Hold Events*

  Also, consider using activities to spread your message. A watershed event can be one of the most energizing formats for distributing messages targeted at awareness, education, or direct action. A community event plays into the desire of audience members to belong to a group and have shared goals and visions for the community. In urban areas, where knowing your neighbors and other members of your community is the exception rather than the rule, community events can help to strengthen the fabric of the community by creating and enhancing community relationships, building trust, and improving the relationships between government agencies and the public. In addition, if such events are done well, they are just plain fun.

- *Leverage Resources*

  If resources are limited and the message is fairly focused, try to piggyback onto an existing event that involves the target audience. Trade shows and other events for farmers, developers, boaters, fishers, the automobile industry, and other groups can often be accessed with a little research and a few phone calls. As in all outreach, you cannot deliver a message to the target audience if you do not have access to it. Approaches for generating interest and attention are limited only by your creativity. Watershed groups have used bands, balloons, face painting, mascots, interactive displays, video games, giveaways, clowns, jugglers, and celebrities to draw crowds. You can also increase the exposure of your event by inviting local TV and radio stations to cover it.

Step 5. Distribute the Message

Once the message has been packaged in the desired format, you can proceed with distribution. Fortunately, you have already considered distribution mechanisms somewhat while researching the target audience and selecting a format. Common means of distribution are by direct mail, door-to-door, by phone, through targeted businesses, during presentations, etc…."

3.13 ELEMENT 18 -- Provide Any Other Analyses or Information Specified in the TMDL Water Quality Management Plan (WQMP)

What information should be provided?

If DEQ identifies any additional requirements such as *any other analyses or information* for DMAs in the WQMP, these requirements must be addressed in the DMA's TMDL Implementation Plan.

Why should this be included?

Oregon's TMDL rule states: "*Provide any other analyses or information specified in the WQMP*. Moreover, *"For sources subject to permit requirements in ORS 468B.050, wasteload allocations, and other management strategies will be incorporated into permit requirements."*

Where can this information be found?

The TMDL WQMP will identify the needed additional information needed.

For example, the Willamette TMDL WQMP requires that DMAs:

- *"Include citation and brief descriptions in the implementation plan of legal authorities used to carry out the management strategies. For example, cite and describe the ordinances that prohibit illegal dumping to the storm drainage system, require erosion control for grading projects, etc.*

- *If located along the main stem Willamette River from river mile 50 downstream to the confluence with the Columbia River, address cold-water refugia in the implementation plan. This would be accomplished by identifying these areas and exploring opportunities to restore or enhance these areas whenever feasible. The results of this effort should be summarized in the plan."*

Appendices

Appendix A: Application of Oregon's Goal 5 and Goal 6 Land Use Laws and Water Quality Rules for Post Construction Sediment and Hydrology

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Appendix A: Application of Oregon's Goal 6 and Goal 5 Land Use Laws and Water Quality Rules for Post Construction Sediment and Hydrology

Information from Oregon's "Water Quality Model Code and Guidebook" was used to develop the following information on Goal 6 and Goal 5 and the application with Oregon water quality rules to meet new development management measures for post construction hydrology.

(Green highlight indicates text that needs to be customized by jurisdiction.)

(Blue highlight indicates a note to the user of the model code that identify issues needing consideration or points where choices need to be made about the appropriate strategy for meeting specific local objectives.)

Goal 6 – Air, Water and Land Resources Quality

Unlike Goal 5, Goal 6 does not have administrative rules to set standards for meeting the goal. Instead, it relies entirely on other state and federal regulations for direction and implementation. However, for water quality purposes, Goal 6 has the potential for being the most important land use planning goal. The Goal requires that "all waste and process discharges from future development, when combined with such discharges from existing developments shall not threaten to violate, or violate applicable state or federal environmental quality statutes, rules and standards." The Goal includes a series of "guidelines" for developing comprehensive plans such as designating sites for controlling pollution, buffering and separating land uses that lead to impacts upon water resources, and considering the planning area's carrying capacity for water resources.

State definitions for wastewater and pollutants include pollutants carried by stormwater and impacts on habitat that result from stormwater flows. Goal 6 requires jurisdictions to integrate compliance with federal and state water quality regulations with their comprehensive planning process.

Goal 6 can be used to justify local actions or possibly require local actions when development activity or allowed land uses pose a threat to federal or state protected water resources. Examples of federal and state designations and requirements that could trigger local action include:

- Phase I and Phase II Stormwater NPDES permit requirements;
- Total Maximum Daily Load (TMDL) limits and associated requirement;
- State designation of a "high or exceptional water quality" water body requiring special water quality protection (OAR 340-04-0002(44);
- State's water quality anti-degradation policy;
- State designated Groundwater Management Areas.

Under these situations, local jurisdictions could adopt measures that address water quality threats or violations or both under Goal 6. The relationship between Goal 6 implementation measures and Goal 5 resources is described in OAR 660-023-0240(1). The rule states that, "The requirements of Goal 5 do not apply to the adoption of measures required by Goal 6. . ." A local government must make findings specifying what is required to meet the objectives of Goal 6. Such findings can be informed by the standards and objectives within the federal and state programs listed above.

Goal
To maintain and improve the quality of the air, water and land resources of the state.

Findings
The water resources and associated riparian vegetation in the jurisdiction contribute to the health, safety, and general welfare of the area. The effectiveness of these resources to trap and remove pollutants from runoff; to stabilize stream banks and reduce channel erosion; and to moderate water temperature contributes to the maintenance and protection of the community's water quality.

The municipal water supply is drawn from [Name groundwater and/or surface water source] and care must be taken to preserve the quality of this/these resource/s.

The Federal Clean Water Act requires streams, rivers, lakes, and estuaries that appear on the 303(d) list be managed to meet State water quality standards. According to the most recent Section 303(d) List of Water Quality Limited Water bodies published by DEQ, the following waterways within [jurisdiction] are water quality limited for the parameter(s) listed and, therefore, do not comply with State water quality standards:
Jurisdiction has been named as a Designated Management Agency (DMA) in the [name TMDL document] and given a pollutant load allocation for [name pollutant]. This load allocation represents a [state percentage] reduction from current levels. A significant portion of this load reduction must be achieved through changes in development practices. [Repeat finding as necessary for each pollutant].

According to the US Fish & Wildlife Service, [name species] is listed as [threatened/endangered]. [Spawning/rearing/migration] habitat for [name species] is found within [jurisdiction].

Development activities permitted by [jurisdiction] which result in harm to threatened or endangered species and fall outside the provisions for incidental take allowed by section 4(d), a Section 7 consultation or a Section 10 permit of the ESA, could result in the [jurisdiction] being held liable for a take under the ESA.

The DEQ definition of wastewater includes both point and non-point sources. Wastewater from a point source comes from a discernable or discrete conveyance such as a pipe, ditch, or channel. Non-point source wastewater is from overland flow, which does not generally follow a defined channel, and includes stormwater. Water pollution in the [jurisdiction] results from both point sources and non-point sources.

Reduction of open space, removal of vegetative cover, and development that increases the amount of impervious surfaces can contribute significantly to increases in the volume and peak flows of stormwater and decreases in water quality.

Offsetting measures can reduce the negative effects of urban development on water quality and quantity. Examples include reduction of stormwater runoff or maximization of infiltration, inclusion of landscaped buffer strips adjacent to new development, protection of floodplains, preservation and improvement of streamside vegetation along watercourses and in wetlands, and other development best management practices (BMPs).

Policies
All development within the [jurisdiction] shall comply with applicable state and federal water quality regulations.

[Groundwater/surface water] resources used to supply domestic drinking water shall be mapped and protected from potential pollution through a variety of measures relating to land use, transportation and hazardous substance management.

If waterways or lakes within the [jurisdiction] are declared water quality limited by the DEQ, the [city/county] will respond to directives issued in a TMDL Water Quality Management Plan.

Development practices that eliminate, reduce or contain potential drinking water pollutants shall be utilized within current and potential Source Water Protection areas to avoid contamination of [name drinking water source].

All development within the [jurisdiction] shall be constructed to preserve the quality and quantity of groundwater and surface water resources.

To protect and enhance water quality in [jurisdiction], as required by state and federal laws, the [jurisdiction] will manage non-point pollutants by:

- Regulating new development, re-development, and construction to better control drainage and erosion and to reduce, treat, and retain stormwater;
- Establishing riparian area buffers where appropriate to address Total Maximum Daily Load (TMDL) requirements and other state and federal requirements;
- Regulating the location of permitted uses that may have higher than ordinary impacts on water quality, particularly those that generate, store or use hazardous waste or materials;
- Reducing street-related water quality and quantity impacts;
- Increasing public awareness of techniques and practices private individuals can employ to help prevent and correct water quality and quantity problems;

- Offering information and technical assistance on the appropriate use and encouraging the appropriate disposal of polluting substances that affect surface and groundwater resources;
- Regulating the cutting of trees and encouraging the reforestation and re-vegetation of appropriate areas in the [jurisdiction]; and
- Requiring erosion and sediment control practices to protect water quality for activities that result in soil disturbance.

The [jurisdiction] recognizes the detrimental effect of stormwater on water quality and shall establish building and design standards that support the reduction of impervious surfaces and mitigate the impact of impervious surfaces on the watershed. ↑top↑

Goal 7 – Areas Subject to Natural Disasters and Hazards

While Goal 7 is not directly concerned with water quality, Goal 7 compliance entails measures that will protect and help improve water quality. In protecting against floods local governments may jointly address issues of water quality, such as limiting development within floodways and floodplains, preserving the natural drainage features and reducing impervious surfaces to reduce runoff and flooding potential. When managing hillside development and its potential for increasing landslide risks, local governments can also prevent impacts to water quality from excess erosion and sedimentation.

Goal
To protect life, property from natural disasters and hazards.

Findings
Hillside development changes the landscape and results in increased runoff, increased downstream peak flows and decreased water quality. Changes generally include the loss of vegetation, which intercepts rainfall, stabilizes soil, and hillside cuts, which can interrupt the flow of groundwater. Poor development practices on hillsides can require increased public expenditures for flood and erosion control, landslide clean up, stormwater management, and water quality treatment.

Increased amounts of stream sedimentation lead to a loss of in-stream storage of floodwater, leading to widening of stream/river banks and more flooding.

The [jurisdiction] includes slopes above [X%] that are considered steep and are not suitable for building. Other slopes between [X and X%] are considered constrained and require special consideration before, during and after development.

Urban development, without stormwater runoff mitigation techniques, can significantly increase stream flooding frequency and peak flows and may enlarge the 100-year floodplain areas.

To maintain habitat for many species, the natural hydrology of the stream should be maintained; meaning that annual flow patterns should remain the same after development as before development.

The natural sinuosity of a stream and its associated wetlands provide essential flood storage capacity and valuable aquatic habitat.

Many portions of the *floodway fringe* contain natural assets such as significant vegetation, wildlife, etc. and are valuable for water quality, open space and recreation purposes.

Filling in designated floodplain areas can increase flood elevations above the elevations predicted by FEMA models. This poses risks to other properties in or adjacent to floodplains and can change the hydrograph of the waterway.

Policies
Development on hillsides shall not endanger life and property nor land and aquatic resources determined to be environmentally important.

Natural vegetation and tree cover shall be preserved where possible to retain stormwater and to provide soil stability on slopes.

The development code will define steep and constrained slopes.

The [jurisdiction] shall require certain land disturbing activities associated with construction and improvements to employ erosion and sediment control practices to prevent increased stream sedimentation.

Steep and constrained slopes will be mapped by the [jurisdiction] for the purpose of creating a hillside protection overlay zone.

Standards for the hillside protection overlay will require:

- Geotechnical reports, as appropriate, to assess risk of slope instability that may result from development
- Utilization of stormwater management practices that reduce sediment transport and peak storm flows by minimizing erosion and surface water runoff.

Development in the floodway and floodway fringe (100 year floodplain excluding the floodway) shall be controlled by local regulations in order to minimize potential damage (on-site, upstream and downstream) to life and property, to allow for transport of flood waters; to protect and enhance water quality, and to protect the economic, environmental, and open space qualities of the land and adjacent water bodies.

To the extent possible, significant drainage ways shall be kept in a natural state to provide flood storage and conveyance, protect and enhance water quality, and protect and enhance native species.

Standards for new development will be developed that emphasize stormwater infiltration and detention on site or detention by a regional facility to preserve the natural hydrograph and water quality of the receiving stream.

Maintain flood storage capacity within the floodplain, to the maximum extent practicable, through measures that may include reducing impervious surface in the floodplain and adjacent areas.

Open space designation will be considered for high risk, steep slope areas with low potential for development.

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The following was developed from Chapter 4.3.7 Stormwater Management of Oregon's "Water Quality Model Code and Guidance"

Problem

Stormwater runoff from developed areas can alter natural stream flows, cause increased erosion and lead to downstream flooding. Where stormwater comes into contact with pollutants, such as oil, pesticides, solvents and other materials used in the urban environment, pollutants can be carried into surface or groundwater. Many communities manage stormwater by channeling and diverting it into the storm sewer system and moving it off site as quickly as possible. Stormwater plans and development codes often deal only with the conveyance of stormwater, and do not include standards for stormwater retention and treatment. Without adequate mitigation of stormwater impacts, water quality and aquatic habitat is likely to be degraded by urban development.

Objective

To reduce the amount of stormwater leaving a site to the greatest extent possible, and to treat and, when appropriate, detain the stormwater that cannot be infiltrated on-site.

Strategy

Implementing the zoning code changes suggested throughout this guidebook will lead to a significant reduction in the amount of stormwater flowing from a site. It is unlikely that all stormwater can be eliminated and therefore, a zoning code should contain adequate stormwater provisions to address both the quality and quantity of stormwater leaving a site. The *Model Development Code and User's Guide for Small Cities* includes some language for storm drainage, but does not adequately address both the quantity and quality of stormwater leaving a site. Use the model code language that follows as a template for drafting a code to mitigate stormwater impacts on water quality. Carefully consider the costs and benefits of each requirement and set criteria that make sense for your jurisdiction. An engineer or hydrologist will need to be consulted in order to effectively modify the model code to meet local objectives.

Discussion
Many of the model ordinances found in this guidebook are designed to minimize the amount of runoff generated by new development by increasing infiltration opportunities and decreasing impervious surfaces where possible. Where it is not feasible to eliminated runoff, it is important that local jurisdictions allow or require developers to treat and/or store stormwater on-site and/or provide for regional treatment and storage. The best method to ensure such provisions is to prepare a local stormwater or surface water master plan that shows the jurisdiction's method for dealing with stormwater. Stormwater Master Plans can specify BMPs to be used, to mitigate stormwater impacts on surface and ground water and the rationale (nexus) for requiring new development to manage stormwater. They can also identify the need for regional and sub-regional treatment and storage facilities. Absent a stormwater plan, language in the comprehensive plan can help support a stormwater ordinance (See Chapter 3).

When developing a strategy for stormwater management it is important to select an appropriate size of storm for which to design your BMP's. Many jurisdictions require treatment facilities to be designed for large storms, such as a twenty-year storm. In western Oregon most of the rain falls in many small storms. While you may need to require conveyance facilities to handle large storms, designing infiltration and treatment facilities for smaller storms will allow many more options and may provide sufficient protection for water quality and aquatic habitat. The objective, often called "low impact development" is to allow rainwater to flow through a development in a manner that most closely mimics the pre-development condition, or in other words, preserve the natural hydrology of the site.

Much of this objective can be achieved by eliminating barriers that exist in local drainage ordinances. Many cities and counties require gutters, storm drains and storm sewers. Some have mandatory system development charges for storm sewers that provide no incentive to reduce stormwater flow. If developers are given the freedom to reduce the amount of stormwater generated on the site through landscaping techniques, the use of porous paving materials and/or improving infiltration on site, impacts to the natural hydrology and downstream water ways will be reduced. Code improvements to promote stormwater mitigation strategies can be made within a drainage ordinance and supported through education, technical assistance and incentive programs. Sections one through five of the following ordinance provides code language to facilitate this type of approach.

For a more aggressive approach to stormwater management a local jurisdiction can adopt specific requirements for treatment, infiltration, and possibly detention of stormwater. Such requirements may be necessary in high impact areas (i.e., downtown, or industrial parks), or when the jurisdiction has water quality or salmon protection obligations under state or federal law (See Chapter Two). Section six, "Pollution Reduction and Flow Control", provides a framework for specific infiltration, treatment and detention requirements that could apply to high risk areas in the jurisdiction or for all development. It is important to remember, however, that the development of such standards is an engineering exercise that is difficult to generalize for a model code. Each jurisdiction needs to research appropriate standards for their local area.

Green highlight indicates text that need to be customized by jurisdiction.

Blue highlight indicates a note to the user of the model code that identify issues needing consideration or points where choices need to be made about the appropriate strategy for meeting specific local objectives.

Model Code Requiring a Stormwater Management Plan for New Development and Redevelopment

Storm and Surface Water Management Standards

I. Statement of Purpose

This ordinance includes standards for conveyance of surface water in streams, creeks and channels that exist on a site at the time of development. It also addresses pollution reduction and flow control for stormwater generated from new and redevelopment. For the purpose of this ordinance, "new" and "redevelopment" refers to any man-made change to improved or unimproved real estate including, but not limited to the placement of buildings or other structures, dredging, filling, grading, or paving.

The ordinance provides performance standards for addressing infiltration, treatment and detention of stormwater as well as design standards for facilities that serve to mitigate the water quality impacts of developments that fall below a certain size threshold.

II. Applicability

No permit for construction of new development or tenant improvements within the [jurisdiction] shall be issued until a stormwater management plan is approved. Separate applicability thresholds for Pollution Reduction and Flow Control Standards are listed in section IV. Development projects shall not be phased or segmented in such a manner to avoid the requirement of these rules and regulations.

III. Stormwater Management Plan Submittal

A. Preconstruction Submittal Requirements
   1. An analysis of stormwater mitigation strategies to increase infiltration and evapotranspiration (use of water by plants) and reduce the amount of stormwater runoff generated from the site. (*Note: rainwater can soak into the ground where it falls or it can accumulate on a non-pervious surface, flow to a pervious area and then infiltrate into the ground. The former scenario is stormwater mitigation, while the latter scenario requires stormwater management.)*
   2. Calculations of the amount of impervious surface before development and the amount of impervious surface after development. Impervious surface refers only to strictly impervious surfaces including roofs of buildings, impervious asphalt and concrete pavements, and other specifically impervious pavement materials such as mortared masonry and compacted gravel.
   3. An analysis of vegetative and other treatment methods used to reduce pollutants.
   4. An analysis of flow reduction methods including, infiltration, and detention and techniques.
   5. Statement of consistency with [jurisdiction] stormwater management objectives stated in section [appropriate reference] and, if applicable, the watershed management plan for the basin and/or requirements of a pollutant load reductive plan for a water quality limited stream.
   6. When the amount of impervious surface created is less than [1,000 square feet] responses required by 3-5 above are waved, and of the following sections of this code only Section V., Surface Water Conveyance Standards, apply.
   7. When the amount of impervious surface created is less than [10,000 square feet] and use of the design standards specified in [name document] is proposed, responses required by 3-5 above are waived.

B. Post Construction Submittal Requirements
   1. As-built plans, [stamped by a qualified professional] indicating all storm water mitigation and management strategies are installed per approved plans and approved changes.
   2. Maintenance plans for all stormwater facilities installed to comply with this ordinance. The maintenance program must be approved by the [Jurisdiction]. Proof of maintenance shall be submitted [annually]. A signed maintenance agreement with a local contractor or city/county public works department can serve to meet this requirement.
   3. When the amount of impervious surface created is less than [10,000 square feet] and use of the design standards specified in [name document] is proposed, the requirement of 1 above is waived.

IV. General Requirements

A. All development shall be planned, designed, constructed and maintained to:
   1. Provide a system by which storm/surface water within the development will be managed without causing damage or harm to the natural environment, or to property or persons.
   2. Protect property from flood hazards.
   3. Removal of 80% of suspended solids from stormwater.

B. Plan Review Standards

   Plans shall be submitted to the [Jurisdiction] for review. Plan approval will be based on the following criteria:
   1. Plans and calculations for development proposals resulting in more than [10,000 square feet] of impervious surface and proposals not using treatment facilities built to the design criteria specified in [name document] must be stamped and signed by a [qualified professional].
   2. Design, construction and maintenance of proposed stormwater management practices will result in post construction stormwater volumes flowing off site which are substantially the same as preconstruction volumes for all storms less than or equal to the [two-year] design storm. (*Note to local jurisdiction: Although water quality and aquatic habitat benefit from preservation of the natural hydrology, small jurisdictions that anticipate the cumulative impacts of development to be small over time might consider less stringent criteria. The consideration of volume, not flow-rate, is important. Simply reducing the flow-rate to discharge increased stormwater volume over a longer period of time can still result in bank erosion and loss of habitat function. On the other hand, retention of volume may be very difficult in areas with high ground water, and tidally influenced stream, have their own in-stream flow*

considerations. An engineer or consultant can help a jurisdiction address these considerations when drafting code language.)

3. Where required due to presence of fish, culvert installations must allow fish passage in accordance with Department of State Lands (DSL) and the U.S. Army Corps of Engineers (COE) and any other authorized federal, state, or local agency.
4. Installation of culverts, spans or stormwater outfalls along natural water features shall be designed to emphasize preservation of natural flow conditions, allow for natural obstructions and pursue stream enhancement opportunities.
5. Stormwater mitigation strategies, such as retention of existing trees, and use of porous paving surfaces, as well as stormwater treatment and flow control facilities used to meet the requirements of this code must be included in the plans.
6. Stormwater management plan shall be consistent with [State applicable basin or sub basin watershed management plan and/or pollutant load reduction plan].
7. In areas of high pollutant load, stormwater infiltration shall incorporate, or be preceded by treatment as necessary to prevent siltation of the infiltration facility, protect ground water, and prevent toxic accumulations of pollutants in the soil. (*It is preferable to eliminate pollutant contact with stormwater where possible.*)
8. All vegetation used for the installation and landscaping of stormwater facilities shall be selected from plants listed in [name of document, listing approved native plants] available from the [Jurisdiction or other source]. [Optional – Trees which are preserved or planted on site for stormwater mitigation credit, do not need to meet this criteria.] Planting schedule and maintenance of vegetation shall be approved by the [local official].
9. All storm conveyance pipes and vaults shall be built to specifications of the [Jurisdiction], as described in [reference standards document]. See Section VI for Pollution Reduction and Flow Control standards.
10. [All stormwater infiltration, treatment and detention facilities shall be built to the specifications of [Jurisdiction] as described in [reference standards document]. See Section VI for Pollution Reduction and Flow Control Standards.]

(*Note to local jurisdiction: As described in the discussion prior to this model code, the code is written to provide for two approaches to local regulation. If the specifics for meeting the general standards described in Section IV(A) and IV(B)(2) are to be left to the applicant and their consultant, Section VI is not needed. If the local jurisdiction wants to set specific standards to achieve flow and pollutant reduction targets then Section IV (B) (10) provides a link to this path. In either case, the jurisdiction is encouraged to adopt a design manual for treatment facilities, such as vegetated swales, and infiltration planter, so that developers do not have to bear the cost of hiring an engineer to design each facility.*)

C. The [jurisdiction] reserves the right to restrict the use of infiltration facilities in high risk areas including those with steep slopes, unstable soils, high water tables, or sites known to be contaminated by hazardous substances.
D. Infiltration facilities which fall under the jurisdiction of DEQ's Underground Injection Control (UIC) Program must be registered with the state and meet the requirements of the UIC Program.
E. Bonds: Applicants shall provide a performance bond, similar surety, or irrevocable petition for public improvement acceptable to the [Jurisdiction] to assure successful installation and initial maintenance of surface pollution reduction and flow control facilities. During construction and for a period of one year thereafter, the bond shall be in favor of the [Jurisdiction] and in an amount of the anticipated construction cost. [Reference existing local practice for administering performance bonds.]
F. Contingency for system failure: If the storm management system fails due to lack of maintenance or breakage, and causes impacts to downstream water quality or flooding as a result of the failure, the [Jurisdiction] may perform the maintenance or repair and charge the owner of the facility.

V. Surface Water Conveyance Standards

A. Culverts and/or spans of streams, creeks, gulches and other natural drainage channels shall maintain a single channel conveyance system.
B. Culverts and/or spans are to be sized for the 24-hour post-developed tributary conditions of the [100 year storm]. (*Note to local jurisdiction: In drafting the code, a local jurisdiction may want to allow culverts under small local streets and driveways to be designed to a lower standard, provided thought is given to assure safe overland flow of flood water.*)
C. Conveyance calculations shall use [state method desired by jurisdiction, i.e., the Rational Method or the Santa Barbara Urban Hydrograph Method (SBUH) for analysis]. Exceptions must be documented and

approved by the [Jurisdiction].

D. In-stream detention is not allowed.

E. It shall be the responsibility of the owner that the new drainage system shall not negatively impact any natural waters, upstream or downstream from the site. The owner is responsible for providing a drainage system for all surface water, springs, and groundwater on site for water entering the property as well as management of springs and groundwater that surface during construction.

VI. Pollution Reduction and Flow Control Standards

A. Applicability

1. *(Note to local jurisdiction: Applicability should be determined by the local jurisdiction. It could include just commercial and industrial, or commercial, industrial and high density residential, or all development. Alternatively, a size threshold could be set for new impervious surface areas. At a minimum, it is recommended that pollution reduction and flow control standards be applied to new development ≥1 acre. Parking lots could be addressed under this ordinance, or addressed separately – see section 4.4.5 of this guidance. Jurisdictions that are working to encourage in-fill and redevelopment in core areas should select applicability thresholds for redevelopment such that they do not impose a disincentive for redevelopment and in-fill efforts. Different applicability thresholds for specific treatment criteria than for infiltration and detention may best suit the objective of a jurisdiction.)*

B. Infiltration, Treatment and Detention

1. Infiltration

a. Infiltration systems are to infiltrate a minimum of [one inch] of rainfall in 24 hours]. (*Note to local jurisdiction: The rainfall is that incident on the impervious areas of the development. Where there are no other constraints, this criterion should be set to reflect the size of storm that delivers 80-90% of the annual rainfall. Most of the annual rainfall is delivered in many small storms.*)

b. A facility designed to temporarily hold standing water shall drain at a rate sufficient to empty its capacity volume in [30 hours].

c. Stormwater treatment, in accordance with Subsection B.2 of this Section, shall occur prior to or concurrent with infiltration.

d. Infiltration systems shall be designed to overflow to conveyance systems in accordance with Subsection D of this Section.

e. Infiltration may be waived, or reduced, if it can be demonstrated by a registered professional engineer that infiltration will destabilize the soil, cause structural problems, or provide negative impacts to the environment, or is not feasible due to site constraints such as high groundwater or soil contamination.

2. Treatment

a. Water quality facilities shall be designed to capture and treat runoff for all flows up to [one half of a two-year, post-developed, 24-hour storm]. (*Note to local jurisdictions: This standard should be set to capture about 90% of the average annual rainfall.*)

b. The water quality system shall use vegetation for treatment. Accepted types of vegetated treatment facilities and sizing criteria are described in [name document]. Alternative systems may be used with approval of [local official] and shall be designed to provide equivalent treatment as is provided with a vegetated system.

c. A facility designed to temporarily hold standing water shall drain at a rate sufficient to empty its capacity volume in [30 hours].

d. Systems treating stormwater from over [10,000] square feet of impervious area and all systems that deviate from the sizing and design criteria in [name document] must be designed by a registered engineer and be approved by [local official].

3. Detention

Onsite storm quantity detention facilities shall be designed to capture and detain runoff as follows:

a. [Two-year, 24-hour post-developed runoff rate to the two year, 24-hour pre-developed discharge rate];

b. A facility designed to temporarily hold standing water shall drain at a rate sufficient to empty its capacity volume in [30 hours].

c. Sites with infiltration systems designed to handle storms in excess of that specified by Subsection (1) of this Section will be permitted to reduce on-site detention requirements by a volume equal to [100%] of the excess infiltration capacity.

(*The following provisions, d and e, should be added when jurisdictions have areas of known flooding/conveyance problems. The standards contained in the brackets must be tailored to meet the specific needs and watershed conditions of your jurisdiction.*)

d. In areas with limited downstream capacity, [reference map or other document specifying areas], detention shall be designed for a [25-year, 24-hour, post-developed runoff rate to a two-year, 24-hour pre-developed discharge rate, and, from the two-year, 24-hour pre-developed discharge rate.]

e. Downstream analysis shall be provided to assure sufficient capacity for new development. Downstream analysis shall occur to the distance downstream where the project site contributes less than 15% of the upstream drainage area OR a minimum of 1,500 feet downstream of the project. (*Note to local jurisdiction: Meeting this requirement can be very costly to a developer. The requirement should be imposed only when the need is justified. It is best to establish capacity estimations through a stormwater master planning exercise, initiated by the city or county).*

C. Combine stormwater infiltration, treatment and detention.
(*Note to local jurisdiction: Design standards should be developed by each jurisdiction to reflect rainfall patterns, soils and other factors specific to the jurisdiction. An overlay area can be established and/or a percolation test required to identify where soil and topographical conditions are conducive to infiltration. In locations where infiltration is not advisable, combined facilities can still be use to achieve treatment and detention standards. City of Portland Bureau of Environmental Services is a good source for sizing and construction standards.*)

Facilities receiving stormwater from impervious areas less than [10,000 square feet] and designed in accordance with the sizing and construction standards contained in [name document] are presumed to comply with the [Jurisdiction] infiltration, treatment and detention requirements of this code.

D. Conveyance
Infiltration, treatment and detention facilities shall be constructed to convey stormwater that exceeds their design capacity. Conveyance systems shall be sized to meet the following conditions:
1. Storm sewer conveyance facilities draining [less than 640 acres], [25-year, 24-hour design storm].
2. Storm sewer conveyance facilities draining [greater than 640 acres], [50-year, 24-hour design storm].

Goal 5 – Natural Resources, Scenic and Historic Areas, and Open Spaces

Goal 5 – Natural Resources, Scenic and Historic Areas, and Open Spaces
Goal 5 requires local governments to inventory and evaluate specific types of resources, and develop land use ordinances with clear and objective standards to conserve and protect the subset of each of those resource types identified as significant. Many jurisdictions do not have inventories and protection ordinances consistent with the Goal 5 rule for riparian, wetland and wildlife protection. This is because amendments to the rule adopted in 1996 required cities and counties to conduct inventories for these resources and adopt ordinances to protect significant resources by the time of their next periodic review. Subsequent changes to the statute governing periodic review decreased the frequency of periodic review and mandated that state resources be focused on a list of goals that did not include Goal 5. Counties with population under 15,000 and cities with population under 2,500 (unless in close proximity to a large city) no longer are required to conduct periodic reviews. Goal 5 compliance may be triggered by a comprehensive plan amendment such as a change in the UGB. A local jurisdiction may also decide to revise their strategy for managing resources covered by Goal 5, in which case Goal 5 rule will need to be taken into consideration.

Goal 5 resources that require local inventories are:
- riparian corridors, including water and riparian areas and fish habitats;
- wetlands;
- wildlife habitat

Other Goal 5 resources related to water quality protection are:
- federal Wild and Scenic Rivers;
- Oregon Scenic Waterways;

- groundwater resources;
- natural areas; and
- other resources not related to water quality

The Goal 5 process differs for each Goal 5 resource, and the Administrative Rule is very detailed and confusing in places. Requirements for addressing riparian areas, wetlands, and wildlife habitat are among the most cumbersome. One reason for this is that Oregon's land use program has a primary intent of avoiding urban sprawl. Lands within UGBs and urban incorporated communities that are protected for natural objectives can not be used for residential, commercial or industrial development. Protection of land within a UGB often necessitates expansion of the UGB to accommodate projected need for developable land. There is also the risk of conflict with expectations of private property owners if development is restricted to protect a Goal 5 resource.

The Goal 5 process consists of an inventory and assessment phase and protection phase. A local jurisdiction must either carefully justify its decision to protect or not protect a resource, or follow an inventory process and protection strategy described in the Goal 5 rule. (Some Goal 5 resources, like Wild and Scenic Rivers and ground water resources are defined by a state or federal process, so local inventories are not necessary.) The Goal-prescribed strategies for inventory and assessment or for protection are known as "safe harbors." Safe harbors are intended to streamline the process of deciding which land, if any, should have restrictions placed on its use in order to protect the resource. A jurisdiction may chose to use the safe harbor option for the inventory and assessment, but use the standard process for the determining appropriate protection of significant resources. Conversely, a jurisdiction could determine their own inventory process, and choose to use the safe harbor protection strategy.

When taking the standard approach for a resource inventory a local government must demonstrate that the inventory process was "adequate" and justify the decision to identify some resources as "significant." When taking the standard approach for developing a protection strategy, a local government must conduct an "ESEE" analysis, evaluating the environmental, social, energy and economic consequences of allowing, limiting or prohibiting uses that conflict with a significant resource. A local government's strategy for managing significant resources must be based on the ESEE analysis. Goal 5 requirements are met when local governments have adopted "clear and objective standards" in their comprehensive plans that define the degree of protection for each Goal 5 resource.

It is important to remember that a safe harbor sometimes sets both a minimum and maximum threshold for determining significance and protecting a resource. The safe harbors represent compromises between environmental, social, energy, and economic objectives that have been worked out at the state level. Because of this, it is possible to comply with Goal 5 by using a safe harbor without providing sufficient protection of surface water, groundwater and wetlands to meet specific environmental goals.

Further information on Goal 5 as it applies to riparian, wetland, and drinking water resources is included in Chapter Four. See the discussion section for each of the model codes designed to protect these resources.

Goal

To protect natural resources and conserve scenic and historic areas and open spaces.

Findings
Natural drainageways are an important natural resource. They provide protection from flooding, treatment of stormwater, and help to maintain stream morphology.

Fish and other wildlife, some of which are endangered or threatened, depend on the excellent water quality and functional, available habitat.

Groundwater is an important natural resource. The Source Water Assessment for [jurisdiction] delineates the significant groundwater resources in this area and this resource must be protected from contamination.

The storage capacity for stormwater provided by soil and its filtering function are essential to maintaining ground and surface water resources. These functions must be preserved or their loss mitigated.

The Local Wetlands Inventory, published [X, X, 200X] describes locally significant wetlands.

Policies
Significant natural features within the [jurisdiction] shall be identified and inventoried by the [jurisdiction]. These shall include:

- Seasonal and perennial streams and other natural drainageways, wetlands, and flood plains;
- Lands abutting any significant rivers or streams (list significant rivers and/or streams)
- Lands with significant native vegetation as defined in the Oregon Natural Heritage Plan (1998), which may include certain woodlands, grasslands, wetlands, riparian vegetation, and plant species;
- Significant hillsides;
- Groundwater and surface water areas used for drinking water; and
- Areas used as wildlife habitat

Rivers, streams and lakes shall be preserved and buffered as needed to protect their function.

Significant natural drainage features and wetlands shall be preserved or have their losses mitigated.

Site-specific buffering, setback requirements and best management practices may be required, as necessary, to enhance and protect resources.

To minimize the negative impacts of development, stormwater should be infiltrated on site to the greatest extent possible. Runoff that cannot be infiltrated shall be managed so that the hydrograph of the receiving stream is not significantly impacted and treated so water quality is maintained.

Locally significant wetlands mapped in the Local Wetlands Inventory shall be protected to preserve habitat and protect and enhance water quality.

The [jurisdiction] will identify highly sensitive habitat areas and areas that are important for the protection of water quality for public purchase and ownership or for purchase and protection through existing conservancy programs.

4.2.9(a) Riparian Protection Overlay

Problem

Local jurisdictions must address their riparian and wetland resources per Goal 5 requirements. In addition, the presence of a stream on DEQ's 303(d) list, or liability concerns resulting from an ESA listing may necessitate more stringent riparian protection (see Chapter 2 for more details). In some cases the riparian buffer required by the Goal 5 safe harbor provision may be adequate to address the water quality impact issues that led to a 303(d) listing. In other cases, such as when temperature is a factor, a Goal 5 buffer, especially the safe harbor buffer, may not provide enough protection for the riparian area.

Objective

Promote stream health and protect and enhance water quality by establishing riparian protection areas along streams that have been identified through a Goal 5 process, are listed on DEQ's 303(d) list, or are within a watershed affected by an ESA listing for an aquatic species.

Strategy

Identify significant riparian resources by conducting an inventory process described by the standard Goal 5 rule or apply the safe harbor inventory provision under the rule for fish-bearing lakes and streams. Conduct an analysis of conflicting uses and the consequences of prohibiting, limiting, or allowing these conflicting uses as described in the Goal 5 rule and develop a program to protect the resource based on the findings of this analysis. Alternatively, implement the following Goal 5 safe harbor model ordinance for the areas identified as a Goal 5 significant riparian resource. If a greater level of management is required to meet water quality regulations, develop findings under Goal 6 and implement the supplemental provisions found after the safe harbor model code.

Discussion

The Goal 5 rule separates the identification of the significant riparian resource, from the process of determining the appropriate protection for that identified resource. For each item the state gives two options: The Goal 5 standard process that allows a lot of flexibility but requires more work; and a safe harbor process that allows no flexibility, but is often a faster and less expensive approach to complying with Goal 5. The safe harbor options were developed at the state level. They represent one approach to finding a compromise between protecting natural resources and pursuing other urban development objectives. A local government may divide the riparian corridor into a series of stream reaches and regard these as individual Goal 5 resource sites. A standard process could then be applied to some reaches and the safe harbor process to other reaches.

Resource inventory – The standard inventory process described in the Goal 5 rule for riparian areas requires that certain sources of information be consulted, but otherwise provides few parameters. Identification of the safe harbor significant riparian resource area requires that information be gathered on fish-bearing lakes and streams, using documents listed in the Goal 5 rule (ORS 660-23-0090). The safe harbor inventory specifies that the significant riparian resource will be defined by a boundary extending 50 feet from the banks of lakes and streams with an average annual stream flow less than 1,000 cubic feet per second. The safe harbor significant area boundary for streams with an average annual stream flow of 1,000 feet per second and greater is 75 feet from top of bank

Program to protect - The standard process for determining a program to protect the resource allows for the valuable functions of riparian areas to be considered along side other priority policy issues for the local government. This process is referred to as the ESEE process, since the (E)conomic, (S)ocial, (E)nvironmental and (E)nergy consequences of protecting or not protecting the resource must be the bases for a local program to manage the resource. The safe harbor program to protect riparian resources specifies activities to be allowed or not allowed in the resource area.

The safe harbor ordinance in conjunction with the safe harbor inventory of significant riparian areas will meet the requirements of Goal 5, but may not be sufficient to fully protect water quality from the impacts of urban development. A jurisdiction interested in protecting water quality to meet requirements of a TMDL management plan, protect salmon habitat, or pursue local priorities for resource protection will want to consider the standard process option. Goal 6 can also be used as a justification for riparian protection since a link between a healthy riparian area and healthy stream is well established. Although Goal 6 does not require the ESEE process, a similar process will be needed to establish findings that support limiting development in riparian areas.

RIPARIAN PROTECTION OVERLAY (RP) –

Two model codes are provided below. The first walks through a direct application of the Goal 5 safe harbor provisions. The second incorporates the provisions within a format that may be more usable for local government. Both codes assume that a safe harbor inventory is used (50' from fish bearing streams of less than 1000 cfs and 75' from fish bearing streams less than 1000 cfs and is inclusive of locally significant wetlands). These codes can be modified to incorporate a standard inventory by redefining the area for which the overlay applies. Any variation from the development standards within the overlay would need to be justified through a Goal 5 ESEE process.

Following the model codes are guidelines for approaching riparian protection from a more water quality centric approach.

Sample Ordinance to Implement Goal 5 "Safe Harbor" Riparian Corridors

This ordinance was developed to specifically implement the safe harbor alternatives outlined in the Riparian Corridor rules. The model is a strict interpretation of the safe harbor provisions, and reflects feedback from DLCD staff. There are three sections: Definition and Inventory, Protecting the Resource, and Hardship Variances and Restoration Provisions. Each of the first three sections states the rule requirements and draft ordinance language.

One: Purpose, Definitions and Inventory
Requirement: OAR 660-230-090 (5) and (4)

(5) As a safe harbor in order to address the requirements under OAR 660-23-030, a local government may determine the boundaries of significant riparian corridors within its jurisdiction using a standard setback distance from all fish-bearing lakes and streams shown on the documents listed in subsections (a) through (f) of Section (4) of this rule, as follows:

(a) Along all streams with average annual stream flow greater than 1,000 cubic feet per second (cfs) the riparian corridor boundary shall be 75 feet upland from the top of each bank.

(b) Along all lakes, and fish-bearing streams with average annual stream flow less than 1,000 cfs, the riparian corridor boundary shall be 50 feet from the top of bank.

(c) Where the riparian corridor includes all or portions of a significant wetland as set out in OAR 660-23-100, the standard distance to the riparian corridor boundary shall be measured from, and include, the upland edge of the wetland.

(d) In areas where the top of each bank is not clearly defined, or where the predominant terrain consists of steep cliffs, local governments shall apply OAR 660-23-030 rather than apply the safe harbor provisions of this section.

The Documents referred to in Section (4) of this rule are:

(4) At a minimum, local governments shall consult the following sources, where available, in order to inventory riparian corridors along rivers, lakes, and streams within the jurisdiction:

(a) Oregon Department of Forestry stream classification maps;

(b) United States Geological Service (USGS) 7.5 minute quadrangle maps;

(c) National Wetlands Inventory maps;

(d) Oregon Department of Fish and Wildlife (ODFW) maps indicating fish habitat;

(e) Federal Emergency Management Agency (FEMA) flood maps; and

(f) Aerial photographs.

Draft Safe Harbor Ordinance Language:

I. Purpose

The purpose of this ordinance is to protect and restore water bodies and their associated riparian areas, thereby protecting and restoring the hydrologic, ecological and land conservation functions these areas provide. Specifically, this ordinance is intended to protect habitat for fish and other aquatic life, protect habitat for wildlife, protect water quality for human uses and for aquatic life, control erosion and limit sedimentation, and reduce the effects of flooding. This ordinance attempts to meet these goals by excluding structures from areas adjacent to fish-bearing lakes and streams, and their associated wetlands, and by prohibiting vegetation removal or other alterations in those areas.

II. Definitions

(A) "Fish Use" means inhabited at any time of the year by anadromous or game fish species or fish that are listed as threatened or endangered species under the federal or state endangered species acts. Fish use is determined from Oregon Department of Forestry Stream Classification maps.

(B) "Impervious surface" means any material which reduces or prevents absorption of storm water into previously undeveloped land.

(C) "Lawn" is grass or similar materials maintained as a ground cover of less than 6 inches in height, and generally managed to restrict the growth of shrubs and trees that inhibit the growth of grasses and forbs. For purposes of this ordinance, lawn is not considered native vegetation regardless of the species used.

(D) "Mitigation" A means of compensating for impacts to a Significant Riparian Resource including: restoration, creation, or enhancement. Some examples of riparian impact mitigation actions are

replanting trees, removal of nuisance plants, and restoring streamside vegetation where it is disturbed or were it has been degraded due to past practices.

(E) "Net Loss" means a permanent loss of riparian functions provided by riparian structure and vegetation that results from a development action despite mitigation measures having been taken.

(F) "Off-Site Mitigation" means mitigation undertaken on a lot or parcel adjacent to or distant from the lot or parcel affected by a development action.

(G) "On-Site Mitigation" means mitigation undertaken within the lot or parcel affected by a development action.

(H) "Ordinary high water level" shall be regarded as the 2-year recurrent flood elevation.

(I) "Riparian area" is the area adjacent to a river, lake, or stream, consisting of the area of transition from an aquatic ecosystem to a terrestrial ecosystem.

(J) "Riparian corridor" is a Goal 5 resource that includes the water areas, fish habitat, riparian areas, and adjacent wetland and upland areas that serve to protect water quality and the habitat functions of the water body.

(K) "Stream" is a channel such as a river or creek that carries flowing surface water, including perennial streams and intermittent streams with defined channels, and excluding man-made irrigation and drainage channels.

(L) "Structure" is a building or other major improvement that is built, constructed or installed, not including minor improvements, such as fences, utility poles, flagpoles, or irrigation system components that are not customarily regulated through zoning ordinances.

(M) "Substantial Improvement" is any repair, reconstruction, or improvement of a structure, the cost of which equals or exceeds 50 percent of the market value of the structure either:

(a) Before the improvement or repair is started, or if the structure has been damaged and is being restored, before the damage occurred.

(b) For the purposes of this definition "substantial improvement" is considered to occur when the first alteration of any wall, ceiling, floor, or other structural part of the building commences, whether or not that alteration affects the external dimensions of the structure.

The term does not, however, include either:

(c) Any project for improvement of a structure to comply with existing state or local health, sanitary, or safety code specifications which are solely necessary to assure safe living conditions, or

(d) Any alteration of a structure listed on the National Register of Historic Places or a State Inventory of Historic Places.

(N) "Top of Bank" means a distinct break in slope between the stream bottom and the surrounding terrain which corresponds with the bankfull stage (the two-year recurrence interval flood elevation) of the stream.

III. Riparian Corridors (Based on Goal 5 safe harbor inventory.)

The inventory of riparian corridors contained in the Comprehensive Plan specifies which streams and lakes are fish-bearing, and the stream-size category. Based on the classification contained in this inventory, the following significant riparian resource shall be established:

(A) Along all fish-bearing lakes, and fish-bearing streams with average annual stream flow less than 1,000 cfs, the significant riparian resource shall extend 50 feet from the top of bank, except as identified in III(C).

[*Local streams in this category should be named or mapped, and the map incorporated by reference.*]

(B) Along all streams with average annual stream flow greater than 1,000 cubic feet per second (cfs) the significant riparian resource shall extend 75 feet upland from the top of each bank except as identified in III C.

[*Local streams in this category should be named or mapped, and the map incorporated by reference.*]

(C) Where the riparian corridor includes all or portions of a significant wetland as identified in the Goal 5 element of the Comprehensive Plan, the distance to the significant riparian corridor boundary shall be measured from, and include, the upland edge of the wetland.

(D) Except as provided for in III(C), the measurement of distance to the significant riparian corridor boundary shall be from the top of bank. In areas where the top of the bank cannot be clearly determined, the significant riparian corridor boundary shall be measured from the ordinary high water level,

[*Alternatively, use this section to define the significant riparian corridor determined using a standard inventory process.*]

Two: Protecting the Resource

Requirement: OAR 660-230-090 (8) (a - c)

(8) As a safe harbor in lieu of following the ESEE process requirements of OAR 660-23-040 and 660-23-050, a local government may adopt an ordinance to protect a significant riparian corridor as follows:

(a) The ordinance shall prevent permanent alteration of the riparian area by grading or by the placement of structures or impervious surfaces, except for the following uses provided they are designed to minimize intrusion into the riparian area:

(A) Streets, roads, and paths;

(B) Drainage facilities, utilities, and irrigation pumps;

(C) water-related and water-dependent uses;

(D) Replacement of existing structures with structures in the same location that do not disturb additional riparian surface area.

(b) The ordinance shall contain provisions to control the removal of riparian vegetation, except that the ordinance shall allow:

(A) Removal of non-native vegetation and replacement with native plant species;

(B) Removal of vegetation necessary for the development of water-related or water-dependents uses;

(c) Notwithstanding subsection (b) of this Section, the ordinance need not regulate the removal of vegetation in areas zoned for farm or forest uses pursuant to statewide Goals 3 or 4;

Draft Ordinance Language

IV. Activities Within the Significant Riparian Corridor

(A) The permanent alteration of the significant riparian corridor by grading or by the placement of structures or impervious surfaces is prohibited, except for the following uses, provided they are designed to minimize intrusion into the significant riparian corridor, and no other options or locations are feasible:

(1) Streets, roads, and paths;

(2) Drainage facilities, utilities, and irrigation pumps;

(3) Water-related and water-dependent uses

[For cities or counties with estuaries, this should read, "Water-related and water-dependent uses, except within the designated coastal shorelands boundary where alterations may be allowed only for water-dependent uses"]

(4) Replacement of existing structures with structures in the same location that do not disturb additional surface area;

(5) Non-conforming uses existing fully or partially within the significant riparian corridor may be expanded, provided the expansion does not occur within the significant riparian corridor. Substantial improvement of a non-conforming structure in the significant riparian corridor shall comply with the standards of this ordinance.

(6) Shoreline stabilization and flood control structures that legally existed on the effective date of this ordinance may be maintained. Any expansion of existing structures or development of new structures shall be evaluated by the Director and appropriate state natural resource agency staff. Such alteration of the significant riparian corridor shall be approved only if less-invasive or non-structural methods will not adequately meet the stabilization or flood control needs.

(B) Removal of vegetation is prohibited, except for:

(1) Removal of non-native vegetation and replacement with native plant species. The replacement vegetation shall cover, at a minimum, the area from which vegetation was removed, and shall maintain or exceed the density of the removed vegetation.

(2) Removal of vegetation necessary for the development of approved water-related or water-dependents uses. Vegetation removal shall be kept to the minimum necessary to allow the water-dependent or water-related use.

[For cities or counties with estuaries, this should read: "Removal of vegetation necessary for the development of approved water-related or water-dependents uses, except within the designated coastal shorelands boundary where removal may be allowed for only water-dependent uses. Vegetation removal shall be kept to the minimum necessary to allow the water-dependent or water-related use."]

(3) Trees in danger of falling [as determined by a certified arborist] and thereby posing a hazard to life or property may be felled, following consultation and approval from [the Director]. [The Director] may require these trees, once felled, to be left in place in the riparian corridor.

(4) Existing lawn within the significant riparian corridor may be maintained, but not expanded to further intrude into the resource.

(C) Exceptions: The following activities are not required to meet the standards of this section.

(1) Commercial forest practices regulated by the Oregon Forest Practices Act.

(2) Normal and accepted farming practices other than the construction of buildings, structures, or paved roads.
[This exclusion is allowed under safe harbor, but not required. However, SB 1010 does not allow local governments to regulate farming practices to protect water quality, and it would be hard to argue that riparian protection is not connected to water quality, unless it was done to protect wildlife.]

Three: Hardship Variances and Restoration Provisions

Requirement: 660-230-090 (8)(d) and (e)

(d) the ordinance shall include a procedure to consider hardship variances, claims of map error, and reduction or removal of the restrictions under subsections (a) and (b) of this Section for any existing lot or parcel demonstrated to have been rendered not buildable by application of the ordinance; and

*(e) The ordinance **may** authorize the permanent alteration of the riparian area by placement of structures or impervious surfaces within the riparian corridor boundary established under*

subsection (5)(a) of this rule upon a demonstration that equal or better protection for identified resources will be ensured through restoration of riparian areas, enhanced buffer treatment or similar measures. In no case shall such alterations occupy more than 50% of the width of the riparian area measured from the upland edge of the corridor.

Draft Ordinance Language:

V. Alteration Requiring Mitigation

(A) Permanent alteration of the significant riparian corridor by placement of a structure or impervious surface not provided for under Section IV may be allowed adjacent to streams with over 1,000 cfs average annual flow and having a significant riparian corridor as established under section II (B) of this ordinance under the following conditions

(1) Placement of fill, impervious services (including structures), and removal of vegetation shall be limited to the minimum amount necessary to accommodate the use. Any vegetation removed in excess of this standard shall be non-native species, and the proposal shall specify replacement of that vegetation with native species.

(2) The applicant shall provide sufficient information regarding the proposed development, the impacts to resources in the riparian corridor, and mitigation measures to allow the [Director], in consultation with the Oregon Department of Fish and Wildlife, to determine if the proposal will provide equal or better protection of riparian resources within the designated corridor through, provision of additional buffer along other portions of the reach, or enhancement and restoration of degraded riparian resources within the designated corridor. This information shall include at least a plot plan showing the top of bank, the extent of development within the significant riparian corridor, uses that are proposed to occur in association with the development, the extent of vegetation removal proposed, characteristics of the existing vegetation (types, density), proposed riparian enhancement or restoration measures, proposed alterations of topography or drainage patterns, and existing uses on the property.

(3) Proposals for development activities within the significant riparian corridor permitted under this section shall be subject to review by the Oregon Department of Fish and Wildlife (ODFW), according to OAR 635-415, the Fish and Wildlife Habitat Mitigation Policy. Proposed alterations of the riparian corridor shall result in at least no net loss of riparian values or functions.

(4) In no case shall a structure or impervious surface intrude more than 37.5 feet into the significant riparian corridor as measured from the significant Riparian area boundary established under section II B of this ordinance.

VI. Variance

In cases where the limitations on activities within the significant riparian corridor unduly restricts the development of a lot or parcel legally created before the effective date of this ordinance, a property owner may request a variance. Granting of a variance requires findings that:

(A) The proposed development represents a reasonable and legal use of the lot or parcel, considering the zoning;

(B) Strict adherence to the applicable standards of the significant Riparian Corridor overlay would effectively preclude a use of the parcel that could be reasonably expected to occur in similarly zoned parcels; and

(C) The property owner would be precluded a substantial property right enjoyed by the majority of landowners in the vicinity.

(D) The variance is the minimum necessary to retain a use of the property.

(E) Granting the variance will not be materially detrimental to the public welfare or be injurious to property or improvements in the neighborhood of the premises.

(F) The variance will be in general harmony with the intent and purpose of this ordinance, and will not adversely affect any officially adopted comprehensive plan provision.

Another Sample Ordinance for Goal 5 Riparian Protection

Riparian Resources Overlay Zone

I. PURPOSE

The Riparian Resources Overlay Zone is intended to provide protection for significant riparian resources within the [Jurisdiction] as designated under Statewide Planning Goal 5. These resources have been inventoried within the [Jurisdiction] according to procedures, standards and definitions established under Goal 5 and are identified on the Significant Riparian Resources Map as adopted in the Comprehensive Plan.

The Significant Riparian Resource Overlay Zone is intended to ensure reasonable economic use of property while protecting valuable natural resources within the [City of] Urban Growth Boundary. This ordinance establishes clear and objective standards to protect these resources.

Significant riparian areas support valuable fish and wildlife habitat, including habitat for anadromous salmonids; improve water quality by regulating stream temperatures, trapping sediment, and stabilizing streambanks; can be effected by floodwaters; and provide educational and recreational opportunities. It is recognized that not all resources will exhibit all of these functions and conditions.

II. DEFINITIONS

Bankfull Stage: The two-year recurrence interval flood elevation.

Bioengineering: A method of erosion control and landscape restoration using live plants, such as willows.

Building Envelope: The land area, outside of all required setbacks, which is available for construction of a primary structure on a particular property.

Delineation: An analysis of a resource by a qualified professional that determines its boundary according to an approved methodology.

Excavation: Removal of organic or inorganic material (e.g. soil, sand, Sediment, muck) by human action.

Fill: Deposition of organic or inorganic material (e.g. soil, sand, sediment, muck, debris) by human action.

Impervious Surface: Any material (e.g. rooftops, asphalt, concrete) which reduces or prevents absorption of water into soil.

Lawn: Grass or similar materials usually maintained as a ground cover of less than 6 inches in height. For purposes of this ordinance, lawn is not considered native vegetation regardless of the species used.

[Major Marsh: A wetland designated as significant under Statewide Planning Goal 17.]

Mitigation: A means of compensating for impacts to a Significant Natural Resource or its buffer including: restoration, creation, or enhancement. Some examples of mitigation actions are construction of new wetlands to replace an existing wetland that has been filled, replanting trees, removal of nuisance plants, and restoring streamside vegetation where it is disturbed.

Native Vegetation: Plants identified as naturally occurring and historically found within the City of Reedsport.

Natural Resource Enhancement: A modification of a natural resource to improve its quality.

Natural Resource Overlay: Designation given to all Significant Wetlands and Riparian Corridors indicated on the Significant Natural Resources Map.

Non-conforming: A structure or use that does not conform to the standards of this ordinance but has been in continuous existence from prior to the date of adoption of this ordinance up to the present. Non-conforming uses are not considered violations and are generally allowed to continue, although expansion, re-construction, or substantial improvements are regulated.

Non-Significant Wetland: A wetland mapped on the [Jurisdiction's] Local Wetlands Inventory that does not meet the primary criteria of the Oregon Division of State Lands Administrative Rules, OAR Chapter 141 (July, 1996 or as amended), for Identifying Significant Wetlands. For additional criteria information please refer to Statewide Planning Goal 5 and [Goal 17] [Jurisdiction's Report including findings on local wetlands inventory]

Qualified Professional: An individual who has proven expertise and vocational experience in a given natural resource field. A qualified professional conducting a wetland delineation must have the delineation approved by the Oregon Division of State Lands.

Review Authority: [Jurisdiction]

Riparian Area: The area adjacent to a river, lake, or stream, consisting of the area of transition from an aquatic ecosystem to a terrestrial ecosystem.

Riparian Corridor: Goal 5 Resource that includes the water areas, fish habitat, riparian areas, and adjacent wetland and upland areas that serve to protect the water quality and habitat functions of a water body.

Shrubs: Woody vegetation usually greater than 3 feet but less then 20 feet tall, including multi-stemmed, bushy shrubs and small trees and saplings.

Significant Riparian Resource: The portion of the riparian corridor determined to be a significant natural resource through an inventory conducted in compliance with State Land Use Goal 5 for riparian areas [and Goal 17 (*This is a consideration for jurisdictions within the Coastal Zone*)]. For purposes of this ordinance the Significant Riparian Resource is identified on the Significant Riparian Resource Overlay Zone Maps [*Reference location within the comp Plan of maps and report containing findings on riparian resource inventory*] and incorporated by this reference. The specific location of the resource boundary on a given property is determined by a distance from the top-of-bank, or from the upland edge of an associated significant wetland, as specified in this ordinance.

Significant Wetland: A wetland mapped on the [Jurisdiction's] *Local Wetlands Inventory* which meets the primary criteria of the Oregon Division of State Lands Administrative Rules, OAR Chapter 141 (July 1996. or as amended), for Identifying Significant Wetlands. For additional criteria information refer to Statewide Planning Goal 5 [and Goal 17(*This is a consideration for jurisdictions within the Coastal Zone*)] [*Reference report containing findings on significant resource inventories*].

State and Federal Natural Resource Agency: Oregon Division of State Lands, Oregon Department of Fish and Wildlife, U.S. Army Corps of Engineers, U.S. Department of Agriculture Natural Resources Conservation Service, U.S. Fish and Wildlife Service, U.S. Environmental Protection Agency, and Department of Environmental Quality.

Stream: A channel such as a river or creek that carries flowing surface water, including perennial streams and intermittent streams with defined channels, and excluding man-made irrigation and drainage channels. For purposes of this ordinance, streams are identified on [Reference appropriate Comp Plan map], as set forth by the Statewide Planning Goal 5 [and Goal 17(*This is a consideration for jurisdictions within the Coastal Zone*) [*Reference location of inventory*] and incorporated by this reference.

Structure: A building or other major improvement that is built, constructed or installed, not including minor improvements, such as fences, utility poles, flagpoles, or irrigation system components that are not customarily regulated through zoning ordinances.

Substantial Improvement: Any repair, reconstruction, or improvement of a structure, the cost of which equals or exceeds 50 percent of the market value of the structure either:

(a) Before the improvement or repair is started, or if the structure has been damaged and is being restored, before the damage occurred.

(b) For the purposes of this definition "substantial improvement" is considered to occur when the first alteration of any wall, ceiling, floor, or other structural part of the building commences, whether or not that alteration affects the external dimensions of the structure.

The term does not, however, include either:

(c) Any project for improvement of a structure to comply with existing state or local health, sanitary, or safety code specifications which are solely necessary to assure safe living conditions, or

(d) Any alteration of a structure listed on the National Register of Historic Places or a State Inventory of Historic Places.

Trees: A woody plant 5 inches or greater in diameter at breast height and 20 feet or taller.

Top-of-Bank: A distinct break in slope between the stream bottom and the surrounding terrain which corresponds with the bankfull stage (the two-year recurrence interval flood elevation) of the stream.

Variance: A grant of relief from the requirements of this ordinance which permits activity in a manner that would otherwise be prohibited by this ordinance.

Wetland: Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Based on the above definition, three major factors characterize a wetland: hydrology, substrate, and biota. For purposes of this ordinance, wetlands are identified on the Significant Natural Resource Overlay Zone Maps 1-3, as set forth by the Statewide Planning Goal 5 and Goal 17 [City of] Periodic Review Report (date) and incorporated by this reference.

Wetland Boundary*:* The edges of a wetland as delineated by a qualified professional.

III. APPLICABILITY

A. Affected Property

The procedures and requirements of the Significant Riparian Resource (SRR) Overlay Zone:

(a) apply to any parcel designated as having a Significant Riparian Resource as mapped in the comprehensive plan;

(b) apply in addition to the standards of the property's underlying zone;

(c) supersede the property's underlying zone where the underlying zone does not provide the level of resource protection afforded by the SRR Overlay Zone.

B. Activities Subject to Review

Activities subject to the review shall include all development on properties outlined in

III.A. and not specifically exempted from review as outlined in Section III.C, including:

1. Partitioning and subdividing of land.

2. New structural development.

3. Exterior expansion of any building or structure, or increases in impervious surfaces or storage areas.

4. Site modifications including grading, excavation or fill (As regulated by the Oregon Division of State Lands and the Army Corps of Engineers), installation of new above or below ground utilities, construction of roads, driveways, or paths.

5. Removal of trees or the cutting or clearing of any native vegetation within the Significant Natural Resource beyond that required to maintain landscaping on individual lots existing on the effective date of this ordinance, and removal of diseased or damaged trees that pose a hazard to life or property.

6. Planting of native plants only within the Significant Natural Resource Area and related setbacks. A list of native plants can be obtained at City Hall and/or from a source approved by the Planning Commission.

C. Exemptions

Activities exempt from this ordinance include:

1. The sale of property.

2. Temporary emergency procedures necessary for the safety or protection of property.

3. Commercial forest practices regulated by the Oregon Forest Practices Act.

4. Normal and accepted farming practices other than the construction of buildings, structures, or paved roads.

5. All water-related and water-dependent uses as described respectively in Section [reference section] of the Zoning Ordinance.

D. Agency Review

Decisions made by the [City of] under this ordinance do not supersede the authority of the state or federal agencies which may regulate or have an interest in the activity in question. It is the responsibility of the landowner to ensure that any other necessary state or federal permits or clearances are obtained. In particular, state and federal mitigation requirements for impacts associated with approved water-related or water-dependent uses may still be required.

IV. GENERAL DEVELOPMENT STANDARDS

A. The [Jurisdiction] has adopted the safe harbor setback methodology for the identification of the riparian boundary. Properties adjacent to significant Riparian Corridors and properties through which a significant Riparian Corridor passes are subject to setback requirements. The property owner is responsible for securing a qualified professional, as necessary, to conduct a delineation to determine the riparian boundary. Where a riparian corridor includes all or portions of a significant wetland, as identified on [Reference local wetland inventory map and

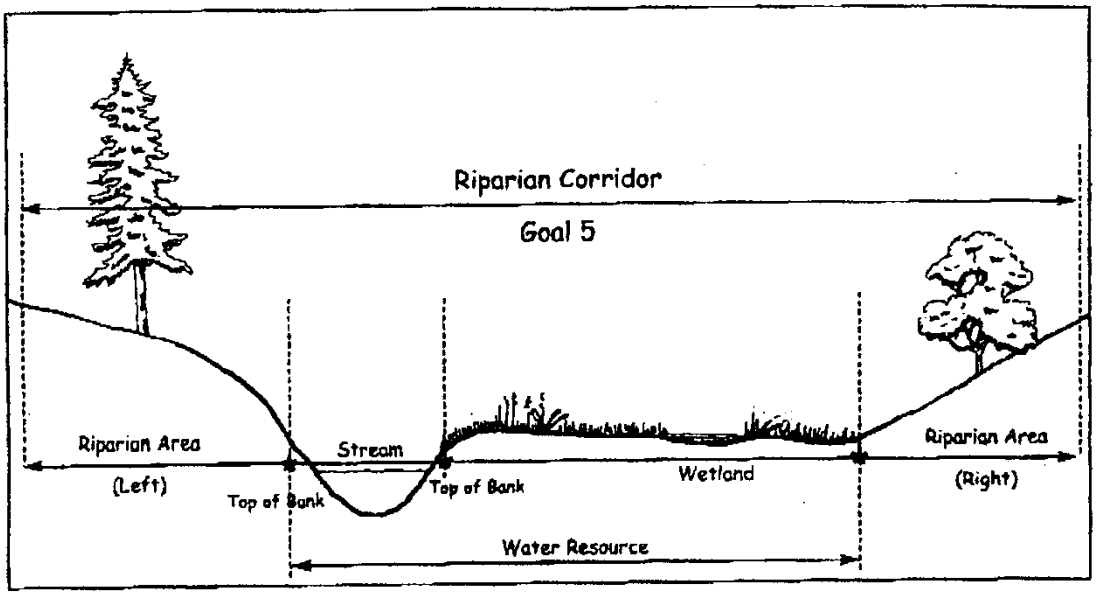


Figure 1: Cross section illustrating terms used in Statewide Planning Goal 5.

Source: Urban Riparian Inventory and Assessment Guide. Oregon Division of State Lands 1998

appropriate Comp Plan section] a professional certified in wetland delineation methods and certified by the Department of State Lands will be required. Significant riparian resources are identified on the Significant Riparian Resource Overlay Zone Maps [Reference riparian inventory maps and comp Plan sections] and incorporated by this reference. Figure 1 below is a cross section illustrating how the riparian protection area is determined when a significant wetland exists within a riparian corridor. The safe harbor setback is measured from the upland edge of the wetland.

B. The permanent alteration of the Significant Riparian Resource by grading, by excavation or fill, by the placement of structures or impervious surfaces, or by the removal of native vegetation is prohibited, except for the following uses provided they are designed to minimize intrusion into the significant natural resource, and no other options or locations are feasible: [Minimized intrusion – intrusion into the Significant Riparian Resource that can not be avoided and which is designed to achieve the smallest footprint practicable and constructed in a manor to mitigate short and long term impacts to the surrounding resource.]

1. Streets, roads, paths, and driveways;

Public or private streets, driveways, or paths may be placed within a Significant Riparian Resource to access development activities if it is shown to the satisfaction of the reviewing authority that no other practicable method of access exists. If allowed, the following standards shall apply:

i. To achieve minimum intrusion into the Significant Riparian Resource, design roads, driveways, and paths to be the minimum width necessary to allow for safe passage of vehicles and/or pedestrians consistent with the [Cite appropriate local standards for road and path construction];

ii. Bridges, arched culverts, or box culverts with a natural bottom shall be used for crossing of a Significant Riparian Resource. The lower lip of any culvert must meet the channel bed at or below grade. The number of channel crossings shall be minimized through use of shared access for abutting lots and access through easements for adjacent lots;

iii. Consider site plan elements that could facilitate access to potential new building sites and help reduce the need for subsequent encroachments into the Significant Riparian

Resource. (A statement by the applicant that such elements have been considered shall satisfy this provision);

iv. During construction, no stockpiling of fill materials, parking, or storage of equipment shall be allowed within the Significant Riparian Resource;

v. Erosion control measures, such as mulching, straw waddles, silt fences and biofilter bags, shall be used to reduce the likelihood of sediment and untreated stormwater entering surface water. [If local government has standards for erosion prevention and sediment control, replace this statement with one that coordinates with those standards.]

2. Utilities and drainage facilities;

Public and private utilities or drainage facilities may be placed within a Significant Riparian Resource if it is shown to the satisfaction of the reviewing authority that no other practicable alternative exists. If allowed the following standards shall apply:

i. The corridor necessary to construct utilities shall be the minimum width practical to minimize intrusion into the Significant Riparian Resource. Removal of trees and native vegetation shall be avoided unless absolutely necessary. The existing grade of the land shall be restored after construction. Native vegetation shall be used to restore the vegetative character of the construction corridor;

ii. No stockpiling of fill materials, parking, or storage of equipment shall be allowed within the Significant Riparian Resource.

3. Replacement of existing structures with structures in the same location that do not disturb additional surface area.

4. Structures or other non-conforming alterations existing fully or partially within the Significant Riparian Resource may be expanded provided the expansion occurs outside of the Significant Riparian Resource. Substantial improvement of a non-conforming structure in the Significant Riparian Resource shall require compliance with the standards of this ordinance.

5. Existing lawn within the Significant Riparian Resource may be maintained, but not expanded within the limits of the Significant Natural Resource. Development activities shall not justify the planting of non-native vegetation such as lawn and ornamental shrubs, nor the removal of vegetation except as provided by subsection IV(C).

6. Existing shoreline stabilization and flood control structures may be maintained. Any expansion of existing structures or development of new structures shall be evaluated by the Planning Department and appropriate state or federal natural resource agency. Such alteration of Significant Natural Resources shall be approved only if less-invasive or non-structural methods, such as bioengineering, will not adequately meet stabilization or flood control needs.

C. Removal of vegetation from the Significant Riparian Resource is prohibited, except for:

1. Removal of non-native vegetation and replacement with native plant species. The replacement vegetation shall cover, at a minimum, the area from which vegetation was removed, shall maintain or exceed the density of the removed vegetation, and shall maintain or improve the shade provided by the vegetation.

2. Removal of vegetation necessary for the development of approved water-related or water-dependent uses or for the continued maintenance of dikes, drainage ditches, or other stormwater or flood control facilities. Vegetation removal shall be minimized to avoid intrusion and impact to the riparian area.

3. Trees in danger of falling [as determined by a certified arborist] and thereby posing a hazard to life or property may be **felled**, following consultation and approval from the [Community Development Director]. If no hazard will be created, the [city/county] may require such trees, once felled, to be left within the Significant Riparian Resource.

4. The control or removal of nuisance plants should primarily be by mechanical means (e.g. hand-pulling). If mechanical means fail to adequately control nuisance plant populations, a federally approved herbicide technology for use in or near open water is the only type of herbicide that may be used in a Significant Riparian Resource area. No herbicide shall not be used were there is risk of contaminating the surface water due to over-spraying, wind-drift, migration through the soil, or erosion and transport of soil containing persistent forms of an herbicide. Herbicide applications are preferred to be made early in the morning or during windless periods at least 4 hours before probable rainfall. Any herbicide use must follow the label restrictions, especially the cautions against use in or near open water.

Note to planners on herbicide use in riparian areas – *Local governments are not allowed to regulate pesticide/herbicide use, but can provide information to improve compliance with state and federal law See list of pesticides prohibited for use near salmon bearing streams: http://www.pesticide.org/finalproductslist.pdf*

V. NATURAL RESOURCE ENHANCEMENT

Enhancement of natural resources, such as riparian enhancement, in-channel habitat improvements, non-native plant control, and similar projects which propose to improve or maintain the quality of a Significant Natural Resource is encouraged; however, no enhancement activity requiring the excavation or filling of material in a wetland shall be allowed unless all applicable State and Federal wetland permits have been granted.

VI. VARIANCES TO [reference for this code]

A variance to the provisions of [reference for this code] is permitted only as a last resort and may be considered only if necessary to allow reasonable economic use of the subject property. The property must be owned by the applicant and not created after the effective date of this Section.

A. A variance shall only apply to:

1. Lots on which the location of a Significant Riparian Resource results in a building area depth for a single-family dwelling of [50 feet] or less; or a building envelope of [1,600 square feet] or less;

2. Lots where strict adherence to the standards and conditions of Section IV would effectively preclude a use of the parcel that could be reasonably expected to occur in the zone, and that the property owner would be precluded a substantial property right enjoyed by the majority of landowners in the vicinity.

B. Permanent alteration of the Significant Natural Resource by an action requiring a variance is subject to the procedures and criteria of [reference code section addressing variance procedures] and the mitigation requirements of Section VII.

VII. Alterations Requiring Mitigation

Permanent alteration of the Significant Riparian Resource zone in areas that are not also designated as locally significant wetlands [Reference local comprehensive plan inventory] by placement of a structure or impervious surface not provided for under Section IV may be allowed adjacent to streams with over 1,000 cfs average annual flow and having a 75-ft riparian corridor established under this ordinance under the following conditions:

A. Alteration of the Significant Riparian Resource zone shall not be allowed in areas that are also identified as locally significant wetlands on [Reference local comprehensive plan inventory.

B. When mitigation for impacts to the Significant Riparian Resource is proposed, a mitigation plan prepared by a qualified professional shall be submitted to the review authority. The mitigation plan shall meet the following criteria:

1. The proposal will provide equal or better protection of riparian resources within the designated corridor through, provision of additional buffer along other portions of the reach, or enhancement and restoration of degraded riparian resources within the designated corridor. The mitigation plan shall document the location of the impact, the existing conditions of the resource prior to impact, the location of the proposed mitigation area, a detailed planting plan of the proposed mitigation area, as appropriate, with species and density, and a narrative describing how the resource will be replaced;

2. Mitigation shall occur on-site and as close to the impact area as possible. If this is not feasible, mitigation shall occur within the same drainage basin as the impact;

3. Setbacks for the placement of structures and hard surfaces and restrictions on vegetation removal in addition to that specified by this ordinance that are approved as part of a mitigation plan shall be recorded on the deed for the parcel.

4. All vegetation planted within a mitigation area shall be native to the region. Species shall be selected based on the composition of native plants in the impact area.

5. Trees shall be planted at a density of [not less than 5 per 1,000 square feet.] Shrubs shall be planted at a density of [not less than 10 per 1,000 square feet,] and shall be maintained as necessary to promote successful growth and establishment. [Note: Planting densities should be based on the plant composition of natural, healthy riparian areas in your jurisdiction, with a margin to allow for die-off.]

6. When restoration or enhancement is approved as mitigation, a report on the survival and health of planted vegetation shall be provided to [the review authority] in 18 to 24 months of the initial planting. If survival rate for tree or shrub species is below 80%, a replanting strategy shall be prepared and executed within six months of the report, with a subsequent report on survival provided to [the review authority] 12 to18 months from the time of the second planting.

VIII. PLAN AMENDMENT OPTION

Any owner of property affected by the Significant Riparian Overlay Zone within the Goal 5 planning area, as designated in the comprehensive plan, may apply for a quasi-judicial comprehensive plan amendment. This amendment must be based on a specific development proposal. A change in the boundary of the Significant Riparian Overlay Zone or a change in the allowed uses within a given reach of the Significant Riparian Resource must be adopted through a plan amendment process. To amend the program to protect the Significant Riparian Resource, which specifies uses allowed in the zone, the applicant shall demonstrate that such an amendment is justified by completing an Environmental, Social, Economic and Energy (ESEE) consequences analysis prepared in accordance with OAR 660-23-040. If the application is approved, then the revised inventory and/or the ESEE analysis shall be incorporated by reference into the [Jurisdiction] Comprehensive Plan, and the [Jurisdiction] Significant Riparian Resources Map

Plan amendment applications shall adhere to the following requirements:

A. The ESEE analysis must demonstrate to the ultimate satisfaction of the [jurisdiction] City/County Council that the adverse ESEE consequences of not allowing the conflicting use are sufficient to justify the loss, or partial loss, of the resource;

B. The ESEE analysis must demonstrate why the use cannot be located on buildable land outside of the Significant Riparian Resource and that no other sites within the [Jurisdiction] that can meet the specific needs of the proposed use;

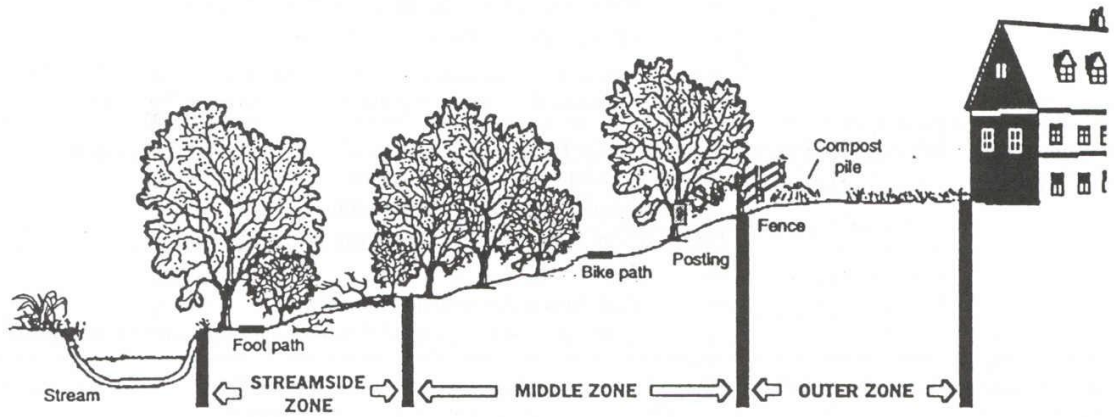
C. Proposed amendments to the Significant Riparian Resource inventory and shall be prepared by a qualified professional experienced in the execution of such inventories, with review by ODFW and DLCD;

D. ESEE analyses shall be prepared by a qualified professional experienced in the preparation of Goal 5 ESEE analyses, with review by DLCD.

Guidelines for incorporating water quality protection and maintenance of riparian function into protection strategies

Gradated management zones

A riparian code can be written to provide a wide management area, with fewer restrictions on development as you move away from the waters edge. The following code language was modified from a Center for Watershed Protection publication.



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

The water quality protection overlay shall be composed of three distinct zones, with each zone having its own set of allowable uses and vegetative targets as specified in this ordinance. In addition to the requirements of the underlying zone, the following limitations and exceptions shall apply:

Zone 1: Streamside Zone. The goal for the Streamside Zone is undisturbed native vegetation and is regulated as follows:

(i) Protects the physical and ecological integrity of the stream ecosystem.
(ii) Begins at the edge of the stream bank of the active channel and extends a minimum of [25] feet from the top of the bank.
(iii) Allowable uses within this zone are highly restricted to
1. Flood control structures

2. Unpaved footpaths
3. Road crossings, where permitted
4. Utility rights of way as part of allowed road crossings

Zone 2: Middle Zone. The goal of the Middle Zone is to maintain and enhance mature native vegetation adapted to the region and is regulated as follows:

(i) Protects key components of the stream and provides distance between upland development and the streamside zone.
(ii) Begins at the outer edge of the streamside zone and extends a minimum of [50] feet plus any additional buffer width as specified in this section.
(iii) Allowable uses within the middle zone are restricted to
1. Biking or hiking paths
2. Structural and nonstructural stormwater management facilities, with the approval of [planning official]
3. Recreational uses as approved by [planning official]
4. Tree removal limited to safety and necessary for construction of uses allowed in the Middle Zone. Tree removal requires approval from [planning official]
5. Utility rights of way

Zone 3: Outer Zone. The goal of the Outer Zone is to provide a gradual transition between development and the water quality protection overlay and is regulated as follows:

(i) Prevents encroachment into the water quality buffer and provides an opportunity for treatment of stormwater where pollutant loads are low and water enters the buffer as sheet flow.
(ii) Begins at the outward edge of the middle zone and provide a minimum width of [25] feet between Zone 2 and the nearest permanent structure.
(iii) Prohibits, permanent structures, or impervious cover, with the exception of paths.
(iv) Encourages the planting of native vegetation to increase the total width of the buffer.

Riparian management area varies with topography

Since the functions provided by a riparian may vary with topography, some jurisdictions use topography to define the extent of the management area. Inclusion of the entire 100 year flood plane is a common approach. The steepness and extent of the slop adjacent to the river is another consideration since potential for erosion increases on steep slopes. The following table is an example of how a riparian management area can be defined based on adjacent topography:

The water quality protection overlay width shall be modified if steep slopes are within [50 feet] of the stream and drain into the stream system. In those cases, the water quality protection overlay width shall be adjusted as follows:

Percent Slope	Width of Buffer
15%-17%	add 10 feet
18%-20%	add 30 feet
21%-23%	add 50 feet
24%-25%	add 60 feet

Appendix B: Inventory of Water Resource Management Activities

The following questions are intended to help local governments identify things they are already doing that may help address some of the Water Quality Implementation Plan requirements.

Planning

1. Identify which part(s) of your Comprehensive Plan address water quality, non-point source pollution, stormwater, riparian zones, or water pollution control.

2. What steps has your jurisdiction taken to enact and/or comply with Statewide Land Use Planning Goals 5, 6, and 7?

3. What zoning ordinances and/or overlays has your jurisdiction enacted that relate to water quality? This may include, but is not limited to, ordinances that address any of the following:

- Erosion and/or sediment control requirements at construction sites
- Retention of vegetation and/or re-planting requirements at construction sites
- Impervious surfaces limitations for new development
- Development limitations in floodplains
- Septic system inspection and maintenance requirements
- Riparian area protections

4. Has your jurisdiction participated in any of the following planning efforts?

- Source Water Assessment
- Drinking Water Protection Plan
- Watershed Management Plan (may be in partnership with a local watershed council)
- Other--Please

Specify _____

Stormwater

1. Does your jurisdiction have an NPDES municipal separate storm sewer system (MS4) permit?

2. Does your jurisdiction have any underground injection control (UIC) facilities (e.g., sumps)? If so, are they covered under a UIC general or individual permit?

3. Does your jurisdiction have any stormwater treatment facilities? If yes, what kind and how many?

4. Has your jurisdiction completed a SWMP?

5. Has your jurisdiction's public works or parks department constructed any swales, detention or retention ponds/basins, or artificial wetlands for managing stormwater? If yes, please specify.

6. Does your jurisdiction encourage or require private developers to construct swales, detention ponds/basins, or artificial wetlands?

Pollution Control

1. Does your jurisdiction have any voluntary or mandatory inspection or maintenance programs for onsite septic systems?

2. Does your jurisdiction have a program to detect illegal discharges into waterways?
3. Has your jurisdiction implemented any projects intended to help control nonpoint source pollution?

Outreach and Education

1. What resources does your jurisdiction provide that encourages pet owners to "pick up" after their pets (waste bags, educational materials, dog parks in environmentally friendly areas)?

2. What guidance or training programs exist for municipal employees that address pollution prevention in regards to municipal sources, i.e. maintenance of vehicles, buildings, roads, parks and open space or the stormwater system?

3. Does your jurisdiction offer yard waste collection services and/or recycling programs?

Regional Coordination

Which watershed councils, soil and water conservation districts (SWCDs), or other groups do you work with to address watershed restoration needs? Describe the types of cooperative efforts undertaken with them.

Monitoring

Does your jurisdiction monitor water quality (surface water, groundwater, or stormwater)? Has the data been analyzed?

Appendix C: International Stormwater Best Management Practices Recommendations for BMP Selection and Design

Source: International Stormwater Best Management Practices (BMP) Database, (http://www.bmpdatabase.org/BMPPerformance.htm) Pollutant Category Summary: Fecal Indicator Bacteria, Prepared by Wright Water Engineers, Inc. Geosyntec Consultants Under Support From Water Environment Research Foundation, Federal Highway Administration, Environment and Water Resources Institute of the American Society of Civil Engineers, December 2010, pages 5, 12, 21, 22, 25, and 26.

Bacteria

"Table 2. EPA's Summary of Bacteria Sources, Possible Management Activities and Transport Processes[2] (Source: EPA 2001)

SOURCE/ LAND USE	OPERATION/ ACTIVITY	SAMPLES OF MANAGEMENT ACTIVITY	FREQUENCY	TRANSPORT PROCESS(S)
Urban/Residential	Domestic Pets	Waste Pickup Law	Variable	Runoff; Erosion
	Wildlife	Management; Population Control	Constant	Runoff; Direct
	Septic Systems	Pump-out; Education; [Maintenance; Fixing; Replacement]2	Annual	Leaching; Interflow
	Illicit Discharge	Compliance	Constant	Direct
	Landfills	Disposal	Constant	Runoff; Leaching

[2] *Additional sources not explicitly included in the EPA (2001) table include sediments and litter within storm sewer systems that can provide environments where bacteria can persist and be resuspended during runoff and/or potentially reproduce/grow. Researchers have not reached consensus on the relative roles of regrowth versus resuspension of bacteria deposited in sediments (WERF 2007).*

2.3 BMP Design Considerations

In summary, BMP designs that maximize exposure to sunlight, provide habitat-enabling predation by other microbes, provide surfaces for sorption, provide filtration, and/or allow sedimentation should reduce bacteria concentrations in the water column. Practices that infiltrate stormwater will reduce bacteria loading (flow x concentration) by reducing the volume component of the load. Practices that infiltrate stormwater also typically provide treatment processes enabling sorption and filtration. Where infiltration is used, it is important to recognize that groundwater pollution can also occur, if adequate sorption and filtration do not occur prior to the infiltrated flows reaching groundwater.

4.1 Recommendations for BMP Selection

Based on the performance data available to date in the BMP Database, only general inferences regarding BMP selection are appropriate at this time.

General recommendations include:

2 (Editor Note: Added Maintenance; Fixing; Replacement

- *Those working to address pathogen impairments on streams should focus first and foremost on source controls. This requires clear identification of the primary sources of fecal indicator bacteria relative to site-specific conditions. Focusing on controllable sources of bacteria, particularly those of human origin, is believed to be the most important first step in protecting human health (Pitt 2004; Clary et al. 2009) although source control alone may not be sufficient to meet ambient water quality standards.*

- *The majority of conventional stormwater BMPs in the BMP Database do not appear to be effective at reducing fecal indicator bacteria concentrations to primary contact stream standards, which is the ultimate target of TMDLs. Because the data are limited, both in the number of data points and the representativeness of the data (i.e., grab samples, bias from quantitation limits, etc.), rigorous statistical conclusions cannot be drawn based on the available data. Significantly more studies and more representative data (i.e., flow-weighted composites and/or multiple grab samples during an event) are needed for all BMP types to increase the confidence of performance estimates with regard to bacteria.*

- *In terms of reducing overall bacteria loads to receiving waters, site designs and individual BMPs that reduce runoff volumes should reduce bacteria loading from urban runoff. (However, this does not necessarily mean that the receiving waters will attain stream standards if runoff is retained onsite.) BMP performance with regard to volume reduction is discussed separately in a companion technical summary.*

- *At the BMP category level, retention (wet) ponds, and various types of media filters may help to reduce bacteria concentrations, although not necessarily to instream standards. Individual bioretention studies also appear to reduce bacteria concentrations, but more studies are needed for this category of BMPs to draw category-level conclusions. Based on the unit treatment processes provided in retention ponds, media filters, and bioretention, bacteria reductions are expected, so the data, for the most part, support the theory.*

- *In general, grass swales/strips and detention basins do not appear to provide meaningful reduction in bacteria concentrations and often show net export of indicator bacteria. These BMP types may require enhancements to improve specific additional treatment processes such as filtration and sedimentation. However, it should be noted that volume reductions might be significant, so these BMPs may be effective at reducing bacteria loadings to receiving waters.*

- *The manufactured devices in the BMP Database include a range of unit treatment processes, requiring case-by-case evaluation of performance. As an overall category, the individual studies currently included in the Database do not demonstrate significant fecal indicator bacteria removal, regardless of the unit treatment process.*

- *Various individual BMPs may provide reductions in bacteria. Representative examples include individual bioretention studies, a wetland basin and a few detention basins. Care should be taken to understand both site-specific and BMP design characteristics in these studies before assuming that similar performance will occur at other locations."*

Table 5. Percent of Inflow and Outflow Values Greater than Primary Contact Recreation Standard for Fecal Coliform.

BMP CATEGORY	THRESHOLD (PRIMARY CONTACT STD.)	% INFLOW VALUES GREATER THAN THRESHOLD	% OUTFLOW VALUES GREATER THAN THRESHOLD
Detention Basin	200/100 ml	83% CI: 77% -90%	65% CI: 57% -73%
Grass Swale		85% CI: 77% -94%	93% CI: 87% -99%
Manufactured Device		98% CI: 94% -100%	99% CI: 97% -100%
Media Filter		74% CI: 65% -83%	59% CI: 49% -69%
Retention Pond		61% CI: 49% -74%	36% CI: 24% -48%

Key findings include:

- *The results indicate that all of the BMP categories analyzed exceed the 200/100 ml threshold (shown as a vertical red dashed line in the figures) for the majority of stormwater inflows and outflows, with the exception of retention ponds. Retention ponds have the lowest overall effluent concentrations with approximately two-thirds of the effluent values meeting the threshold value. However, it should be noted that influent data for retention ponds tended to be lower than many BMP types.*

- *Detention basins show statistically significant reductions in the frequency of exceedances of the 200/100 ml threshold, but the median effluent frequency of exceedance is still relatively high (65%). At higher thresholds, the frequencies of exceedance do not significantly change between inflow and outflow (Figure 13). This suggests that detention basins may be effective at reducing fecal coliform exceedances when the thresholds are low (e.g., 200/100 ml), but may be unable to reduce exceedances when thresholds are high (e.g., 2000/100 ml). Additional analysis is needed to further evaluate the causes of the trends shown in Figure 13. For example, the flow conditions under which high bacteria concentrations are observed could be a confounding variable affecting the appropriateness of this type of conclusion. Additionally, as an overall BMP category, the detention basin data set is expected to include a wide range of BMP designs. For example, some of the detention basins may function primarily for flood control, with little control (detention) of smaller events. Better performing detention basins may be enhanced with design features that promote infiltration, as well as detention (e.g., Pond D, as shown in Figure 5). As the BMP database grows, researchers may choose to sub-categorize detention basins with similar designs and unit processes.*

- *Figure 13 shows little overlap in the 95% confidence limits for the inflows and outflows for media filters, indicating that reductions in fecal coliform outflow concentrations are occurring relative to inflow concentrations. A different confidence limit (e.g., 90%) may have resulted in statistically significant differences.*

- *Grass swales and manufactured devices have significant overlap of confidence intervals, indicating that these overall categories of BMPs are not demonstrating significant bacteria removal. In fact they appear to*

frequently cause increases in exceedances indicating these BMP types may be exporting fecal coliform bacteria either from entrainment of previously deposited bacteria or from new sources (e.g., animal excrement). Also, even at higher thresholds (e.g., 2,000/100 ml), grass swales and manufactured devices typically have high exceedances of water quality standards at the outflow (i.e., ~85% for swales and ~55% for manufactured devices)."

Solids (TSS, TDS and Turbidity)

Source: International Stormwater Best Management Practices (BMP) Database, Pollutant Category Summary: Solids (TSS, TDS and Turbidity), Prepared by Wright Water Engineers, Inc. Geosyntec Consultants Under Support From Water Environment Research Foundation, Federal Highway Administration, Environment and Water Resources Institute of the American Society of Civil Engineers, May 2011, pages 3 and 23.

"1.2 Typical Sources and Composition of Sediment
Sediment is naturally present to varying degrees in receiving waters and runoff; however, both urban and agricultural human activities can increase sediment loads to levels that impact aquatic life and other beneficial uses of waterbodies. Sources of sediment in urban runoff include construction activities, denuded landscape areas, road sanding, decaying leaves or other organic matter (detritus), metallic dust from car brakes or engines, erosion of hill slopes, dust from atmospheric deposition (either directly deposited or carried by rain), and a variety of other human and natural sources. Accelerated stream channel erosion is also common in urban areas due to increased flow rates, durations and volumes from urban runoff, with the extent of erosion varying based on site-specific factors.

4.1 Recommendations for BMP Selection and Design
All of the BMPs included in the sediment analysis generally performed well with respect to TSS, both in terms of statistically significant pollutant removal and relatively low effluent concentrations. Similar findings were present for BMPs with turbidity data available for analysis, although this data set was more limited. Conversely, no BMPs showed statistically significant removal of TDS, with filter strips, media filters and retention ponds showing increases in TDS effluent concentrations.

As this analysis shows, stormwater managers have a broad range of options for reducing TSS concentrations in urban runoff. BMPs that provide sedimentation and filtration processes and are well designed, installed and maintained are expected to provide good removal of TSS. The lowest effluent concentrations achieved based on the available data set include bioretention, detention basins, media filters, retention ponds, and wetland basins. In general, these mechanisms are anticipated to be more effective as the hydraulic residence time increases.

Hydraulic residence can be increased in wetlands and ponds by increasing flow paths through the use of berms, baffles, and dense vegetation. In media filters and bioretention, increasing bed thickness and evenly distributing flows would likely improve performance. For infiltration oriented BMPs, maintenance is critical to prevent clogging from sediment build-up. Designing BMPs to minimize scour and resuspension of deposited sediment is important, along with ensuring appropriate long-term maintenance to remove accumulated sediment.

As would be expected, TDS data available in the BMP Database to date (which are relatively limited) indicate that TDS removal in stormwater BMPs is challenging; therefore, BMPs that provide volume reduction benefits may be the best general strategy for reducing TDS. In this regard, it is noteworthy that neither bioretention nor porous pavement had adequate data sets for inclusion in performance analysis for TDS.
The focus of this technical summary is sediment in urban runoff that is treated and managed with BMPs prior to discharge to reaching receiving waters. Note that instream channel processes that are impacted by urban runoff can be significant sources of sediment in urban areas and are not addressed in this summary. Channel stabilization and/or flow duration or volume management or combinations of these are also often necessary in urbanized areas to mitigate bed and bank erosion and should be considered as part of strategies for controlling sediment impacts to receiving waters."

Metals

Source: International Stormwater Best Management Practices (BMP) Database, Pollutant Category Summary: Metals, Prepared by Wright Water Engineers, Inc. Geosyntec Consultants Under Support From Water Environment Research Foundation, Federal Highway Administration, Environment and Water Resources Institute of the American Society of Civil Engineers, August 2011, Pages 18, 19, 51, 52, 53, and 54.

"1.2 Typical Sources of Metals in Urban Runoff

Metals concentrations above natural background levels in urban stormwater are often associated with automobile-related sources such as roads and parking lots and from building materials exposed to rain. Treated wood and tires are also common sources of metals in residential and commercial areas. Industrial areas may be "hot spots" for certain metals, depending on the industrial process and materials management practices. Other sources may include landfill leachate, soil erosion, household chemicals, and pesticides (Shaver et al. 2007).

***Table 3** summarizes key sources of selected metals in urban runoff:*

***Table 3. Common Sources of Metals in Urban Runoff** (Source: Shaver et al. 2007)*

COMMON SOURCES OF METALS IN URBAN RUNOFF	
METAL	**SOURCE**
COPPER	***Building Materials***
	Paints And Wood Preservatives
	Algaecides
	Brake Pads
ZINC	***Galvanized Metals***
	Paints And Wood Preservatives
	Roofing And Gutters
	Tires
LEAD	***Gasoline (Particularly Prior To Leaded Gasoline Phase-Out)***
	Paint
	Batteries
CHROMIUM	***Electro-Plating***
	Paints And Preservatives
CADMIUM	***Electro-Plating***
	Paints And Preservatives

2.3 BMP Design Considerations

2.3.1 General Guidance

For effective removal of metals, BMPs should be designed to address the characteristics of the metal(s) of interest, often requiring a "treatment train" approach that integrates sedimentation and filtration components for most effective removal of metals. Pitt and Clark (2010) provide these specific design recommendations based on results of extensive research related to optimization of BMP performance to remove metals to low levels:

- ***Design to the Pollutant of Interest****: For most BMPs, treatment effectiveness varies depending on the pollutant of interest and the influent characteristics of the targeted pollutants (e.g., filterable fraction, ionic forms, associations with different particle sizes, etc.). BMPs selections and design features should be targeted to these characteristics.*

- ***"Treatment Train"****: In many cases, a combination of treatment processes is needed. A "treatment train" incorporating different unit processes that target different pollutant characteristics can be designed as separate units dispersed throughout a drainage area, or they can be adjacent. In the cases of strict numeric discharge limits, redundancy is often necessary to provide the most robust control. In many cases, and similar to wastewater treatment facilities, an effective "treatment train" is composed of sedimentation unit processes followed by filtration unit processes (media filtration, infiltration through amended soils, bioretention/biofiltration devices, etc.) with the logic being to remove first the particles that will interfere with and/or shorten the life of the filtration devices.*

- ***Sedimentation****: Well-designed sedimentation practices typically are effective in removing particulates and associated particulate-bound pollutants down to approximately 5 to 10 µm for properly sized facilities (i.e., low surface overflow rates).*

- ***Filtration/Sorption****: Even though sedimentation may remove particles smaller than 10 µm, the reliable removal of pollutants and their associated particulates with diameters smaller than about 10 to 25 µm is typically accomplished using filtration techniques (such as biofiltration or bioretention BMPs), where particles as small as 1-2 µm may be removed. The removal of "dissolved" metals depends on the metal form (ionic, complexed, etc.) and on the chemical composition of the sorption/ion-exchange media.*

Other treatment processes that have been shown to be effective by enhancing sedimentation include chemical precipitation and coagulation, particularly for copper, lead and zinc. Wetlands may provide additional benefits through biologically mediated control processes (WERF 2003).

Although most metals migrate poorly through soils, infiltration of stormwater may be a concern in industrial areas that have high concentrations of dissolved metals and in areas with shallow groundwater (particularly areas with sandy soils). Amended soils have been shown to substantially reduce the migration of metals to groundwater and may enable use of infiltration in areas with sandy soils, depending on site-specific circumstances (WERF 2003).

5.0 RECOMMENDATIONS AND LIMITATIONS

<u>Key findings and observations related to BMP performance include</u>:

- *Large percentages of values below detection limits hamper the statistical performance analysis for some BMP-constituent combinations, particularly for dissolved cadmium, chromium, lead and nickel, as well as total cadmium. Total and dissolved copper and zinc are least affected by non-detects. As an overall BMP category, porous pavement is most affected by large percentages of non-detects.*

- *Arsenic: Detention basins and retention ponds demonstrated reductions in total arsenic concentrations. No BMP categories indicated reductions in dissolved arsenic. Levels of arsenic in runoff in the BMP Database are very low compared to EPA's aquatic life criteria (Table 1), with median total arsenic results approximately two orders of magnitude lower than EPA criteria.*

- *Cadmium: Bioswales, filter strips, media filters and retention ponds demonstrated reductions in total and dissolved cadmium concentrations. Analyses for both forms of cadmium were hampered by large numbers of non-detects for several BMP categories.*

- *Chromium: Reductions in total chromium were evident for detention basins, filter strips, media filters, retention ponds and manufactured devices. Retention ponds also showed reductions for dissolved chromium. Performance analysis for dissolved chromium was hampered by a large number of non-detects and reductions in dissolved chromium were not evident with the exception of retention ponds. The porous pavement data set was limited by large percentages of influent non-detects for both dissolved and total*

chromium. Influent and effluent chromium concentrations were generally low relative to EPA's aquatic life criteria for chromium, with both dissolved and total chromium below the chromium-VI criteria.

- *Copper: All BMP categories demonstrated significant reductions in effluent total copper concentrations, with the exception of wetland channels. (Median effluent total copper concentrations for wetland channels were lower than the influent, but not at a statistically significant level.) Effluent concentrations for total copper ranged from approximately 4 to 11 µg/L. Detention basins, filter strips and retention ponds showed reductions for dissolved copper, but performance for other BMP types was less clear, as evidenced by overlapping confidence intervals in the box plots. Median effluent concentrations for all BMP types for dissolved copper were similar, ranging from 4.2 to 7.9 µg/L.*

- *Iron: Data for iron are relatively limited, with the majority of BMP types having inadequate data sets for analysis. This is likely due to the fact that iron is not considered a "priority pollutant." For BMP types with dissolved iron data, reductions in dissolved iron are not evident, with influent and effluent distributions overlapping. Retention ponds and filter strips show reductions in total iron concentrations; whereas, other BMP categories have overlapping influent and effluent concentrations. Several BMP types suggest increased effluent concentrations for total and/or dissolved iron, particularly bioretention for total iron and filter strips for dissolved iron. Native soils and placed media mixes may have high iron content, which may be mobilized under reduced conditions. Both influent and effluent total iron concentrations varied substantially among the BMP categories analyzed. Median influent and effluent total iron results are generally below the aquatic life criteria of 1,000 µg/L; however, somewhat elevated total iron concentrations are present at the bioretention sites in this analysis.*

- *Lead: Total lead concentrations are reduced by all BMP categories. Filter strips, manufactured devices and media filters demonstrate reductions in median dissolved lead concentrations. The manufactured device and wetland channel data sets in the database have higher influent concentrations than other BMP categories. Comparison of effluent lead data to water quality criteria will vary based on waterbody-specific hardness conditions.*

- *Nickel: Bioswales, detention basins, filter strips, media filters, porous pavement and retention ponds show reductions in total nickel concentrations. Analysis of dissolved nickel data is hampered by large numbers of non-detects in both influent and effluent concentrations; nonetheless, bioswales and filter strips show reductions in dissolved nickel. Although current nickel criteria are calculated based on hardness and will vary by waterbody, both influent and effluent nickel values contained in this analysis are expected to be below most stream standards.*

- *Zinc: All BMP categories analyzed demonstrate reductions in total zinc, with most effluent concentrations in the 15-30 µg/L range. The broad category of manufactured devices showed higher effluent concentrations at approximately 60 µg/L, although removal of total zinc was still evident. Bioswales, filter strips, media filters, porous pavement, retention ponds and wetland basins all showed reductions for dissolved zinc, as well. Median effluent concentrations for dissolved zinc for most BMP types were in the 8-25 µg/L range, with the exception of manufactured devices, which had a median effluent concentration of 54 µg/L.*

Detention basins and wetland channels had relatively low influent concentrations of dissolved zinc, which may help to explain why differences between median inflow and outflow concentrations were not evident for this BMP category. Although zinc water quality standards are calculated based on waterbody-specific hardness concentrations, most influent and effluent dissolved zinc values in this analysis would be expected to be below most calculated zinc standards."

Nutrients

Source: International Stormwater Best Management Practices (BMP) Database, Pollutant Category Summary: Nutrients, Prepared by Wright Water Engineers, Inc. Geosyntec Consultants Under Support From Water Environment Research Foundation, Federal Highway Administration, Environment and Water Resources Institute of the American Society of Civil Engineers, December 2010, Pages 13, 14, 32 and 33.

"3.4 BMP Design Considerations

Because the various forms of nitrogen are removed through different processes, the most important consideration for BMP design is the dominant form of nitrogen that the system is designed to treat, based on loading sources and downstream impairments. The factors affecting removal of various nitrogen forms, as summarized in Table 4, should be taken into account in selecting BMP(s) for a particular site. As previously noted, nitrogen in stormwater runoff is predominantly organic nitrogen (e.g., leaves and other organic debris) and nitrate. For removal of organic nitrogen (which is predominantly particulate matter), BMPs that facilitate settling and filtration, as well as biological activity under aerobic conditions, will be the most effective. Conversely, for removal of nitrate (which is soluble), treatment processes conducive to biological activity under anaerobic conditions (e.g., surface or subsurface flow wetlands) will be most effective. Wetlands are ideal for nitrogen removal due to the variable depth zones that provide a diversity of oxidation-reduction potential conditions and the shallow depths and long residence times that allow microbial transformation processes to occur. Filtration processes are not expected to be effective for nitrate (Davis et al., 2006) except in special circumstances such as with engineered bioretention designed to incorporate a continuously submerged anoxic zone with an over drain (Kim et al., 2003). Ammonia, which occurs at relatively low levels in typical urban runoff, would be effectively removed in wetlands and other long residence time treatment BMPs through volatilization and microbially mediated oxidation/nitrification processes.

5.1 Recommendations for BMP Selection and Design
The analysis of BMP performance data aligns relatively well with observed urban runoff concentration characteristics and theoretical background of unit treatment processes and transport mechanisms for phosphorus and nitrogen. Key findings include:

- *Phosphorus in stormwater runoff is generally highly particulate-bound. As a result, BMPs with unit processes for removing particulates (i.e., sedimentation and filtration), will generally provide good removal for total phosphorus. In particular, BMPs with permanent pools appear to be effective at reducing the major forms of phosphorus. Leaching of phosphorus from soils/planting media and resuspension of captured particulate phosphorus may be a cause of phosphorus increases observed in vegetated BMPs such as bioretention, swales, and filter strips. Vegetated BMPs should be designed with adequate inlet protection, dense vegetation, and drop structures or check dams to minimize resuspension of particulates. The use of virgin compost or chemical fertilizers should be avoided and planting media within BMPs should be tested for phosphorus content if phosphorus is a constituent of concern.*

- *BMPs with permanent pools (i.e., retention ponds and wetlands) appear to be able to reduce nitrate concentrations, but may increase organic nitrogen. The opposite appears to be true for biofilters and media filters. Based on the theory of unit processes and knowledge of the nitrogen cycle, it is hypothesized that retention ponds and wetlands sequester nitrate in wetland sediments and vegetation during the growing season and then release nitrogenous solids during vegetation die-off periods. As indicated by the relatively high TKN removal and low NOx removal for media filters, inert filtration appears capable of capturing nitrogenous solids, but the conditions are not as conducive for significant denitrification or nitrogen uptake as compared to bioretention or BMPs with permanent pools (retention ponds and wetland basins). Therefore, a BMP designed for permanently reducing nitrogen may include a permanent wet pool followed by a vegetated swale or media filter. Alternatively, a bioretention cell with pore storage above and below the under drain may provide aerobic and anaerobic zones for nitrification/denitrification processes. Harvesting of vegetation and removal of captured sediment may also be key maintenance practices for reliable removal of nitrogen.*

Less is known about the fate and transport of organic carbon in BMP systems, but the performance results indicate that retention ponds may be capable of reducing concentrations of this constituent, presumably due to the sequestration of organic carbon into biota. Additional organic carbon data are needed to adequately evaluate BMP performance with regard to this constituent. When selecting BMPs to reduce nutrient loading, volume reduction

should also be considered. This analysis focuses only on the effluent concentrations achieved for nutrients. Volume reduction analysis for BMPs in the BMP Database is provided in a separate technical summary (see www.bmpdatabase.org)."

Volume Reduction

Source: International Stormwater Best Management Practices (BMP) Database, Pollutant Category Summary: Volume Reduction, Prepared by Wright Water Engineers, Inc. Geosyntec Consultants Under Support From Water Environment Research Foundation, Federal Highway Administration, Environment and Water Resources Institute of the American Society of Civil Engineers, January 2011, pages 30-31.

"6.2 Recommendations for BMP Selection

Based on the performance data available to date in the BMP Database, only general inferences regarding BMP selection are appropriate at this time. General recommendations include:

- *Normally-dry vegetated BMPs (filter strips, vegetated swales, bioretention, and grass lined detention basins) appear to have substantial potential for volume reduction on a long-term basis, on the order of 30 percent for filter strips and grass-lined detention Basins, 40 percent for grass swales, and greater than 50 percent for bioretention with under drains. Therefore, these BMPs can be an important part of an overall strategy to manage site hydrology and control pollutant loading via volume reduction.*

- *Normally-dry vegetated BMPs also tend to provide better volume reduction for smaller storms, which tend to occur more frequently than larger storms; this can lead to reduced frequency of discharges or much smaller discharge volumes. Both of these would tend to reduce the frequency of water quality impairments. Developers of BMP design and performance criteria may want to consider the role of BMP volume reduction in reducing pollutant loadings when developing design requirements.*

- *Retention ponds and wetland basins and channels do not appear to provide substantial volume reduction on average and should not be selected to achieve volume reduction objectives. In some cases, normally wet BMPs can be designed to provide some incidental volume reduction. Climate and other site-specific characteristics will also affect incidental volume reduction. For example, evaporation will tend to be more significant in arid areas.*

- *Variability in volumetric performance between studies indicates that design attributes and site conditions likely play keys role in performance. Therefore, when using categorical analysis results to select BMPs to maximize volume reduction, it is important to also ensure that design features to promote volume reduction are explicitly included in design and the site characteristics are conducive to allow volume reduction. For example, where facilities will likely be lined to prevent infiltration or soils are poor, volume reduction would likely be lower on average than observed in the BMP Database studies. Conversely, for sites with soils conducive to infiltration and design characteristics provided to promote infiltration (e.g., storage volume below the lowest outlet, etc.), volume reduction would likely be higher on average than observed in the BMP Database studies."*

Appendix D: Recommended Programmatic BMPs By TMDL Impairment or Pollutant And Source

Recommended Programmatic BMPs By TMDL Impairment or Pollutant And Source

TMDL IMPAIRMENT OR POLLUTANT	SOURCE OF POLLUTANT	PROGRAMMATIC BMPS	SOURCE(S)
HYDROLOGY VOLUME REDUCTION	**Reduced Summer and Late Fall Instream Flow and Stormwater Runoff**	**Stormwater Management Ordinance** *Adopt a **Stormwater Management Ordinance** that requires all new, redevelopment, and retrofit projects to establish minimum stormwater management requirements and controls and to meet the following objectives:* 1. *Minimize increases in stormwater runoff rates and volumes from any development in order to reduce flooding, siltation, increases in stream temperature, streambank erosion, and to maintain the integrity of stream channels;* 2. *Minimize increases in pollution caused by stormwater runoff which would otherwise degrade local water quality;* 3. *Maintain post development peak runoff rate and average volume at levels that are similar to pre-development levels; and* 4. *Ensure that these management controls are properly maintained and pose no threat to public safety.*	Source: *EPA Stormwater Management Model Ordinance* *http://water.epa.gov/polwaste/nps/mol6.cfm*
	Reduced Summer and Late Fall Instream Flow	**Instream Flow Purchased** ***Purchase of Permanent Instream Transfers,** particularly during the summer and late fall flow periods. Oregon law allows for the permanent change of 'beneficial use' from an out-of-stream use such as irrigation or municipal, to an instream use to benefit habitat, water quality, and/or recreation. Details of instream transfers depend on stream conditions, water availability, and OWRD regulation patterns. Payments to landowners for permanent water ranges from $300 to $1,200 per acre-foot of water.*	Source: *The Freshwater Trust, Flow Restoration Program, Portland, Oregon* *http://www.thefreshwatertrust.org/conservation/stream-flow*

Recommended Programmatic BMPs By TMDL Impairment or Pollutant And Source (Cont.)

TMDL IMPAIRMENT OR POLLUTANT	SOURCE OF POLLUTANT	PROGRAMMATIC BMPS	SOURCE(S)
HYDROLOGY VOLUME REDUCTION (Cont.)	**Reduced Summer and Late Fall Instream Flow and Stormwater Runoff**	**Low Impact Development (LID) Ordinance** *Adopt a **Low Impact Development (LID) Ordinance** that requires all new, redevelopment, and retrofit projects to reduce impervious surfaces and use LID and other BMPs to infiltrate, filter, retain, evaporate, and slow down runoff close to its source to treat sediment from impervious surfaces.*	Source: *Puget Sound Partnership, 2012, Integrating LID into Local Codes: A Guidebook for Local Governments, prepared by AHBL for the Puget Sound Partnership, Tacoma, WA, July 2012. http://www.psp.wa.gov/downloads/LID_Guidebook/20120731_LIDguidebook.pdf* *See http://water.epa.gov/polwaste/green/index.cfm for more information on Low Impact Development.*
	Reduced Summer and Late Fall Instream Flow and Stormwater Runoff	**Riparian Protection Ordinance** *Adopt a **Riparian Protection Ordinance** that provides a "no touch" riparian buffer on both sides of a waterbody with the width (in feet) based on the TMDL effectiveness shade and buffer width figures provided in the Implementation Ready TMDL WQMP in order to protect and maintain stream hyporheic flow and large woody debris.*	Source: *EPA Model Ordinances Language Website http://www.epa.gov/owowwtr1/nps/ordinance/mol1.htm The Stormwater Manager's Resource Center (SMRC) http://www.stormwatercenter.net/Model%20Ordinances/buffer_model_ordinance.htm*
	Reduced Summer and Late Fall Instream Flow and Stormwater Runoff	**Wetland Protection Ordinance** *Adopt a **Wetland Protection Ordinance** that includes protection of headwaters and other groundwater resources that provide cool water inflow from groundwater, hyporheic (near surface), wetland, or other sources into waterbody during the hottest time of year.*	Source: *Oregon Department of Land Conservation and Development and Department of Environmental Quality Water Quality Model Code and Guidebook, October, 2000, Chapter 4 Zoning, Section 4.3.9(e) Wetland Protection Overlay Ordinance, Pages 4.47 to 4.54 http://www.deq.state.or.us/wq/nonpoint/links.htm*
	Reduced Summer and Late Fall Instream Flow and Stormwater Runoff	**Tree Protection Ordinance** *Adopt a **Tree Protection Ordinance** that retains at least 60% canopy coverage, which will hold water and reduce temperature increases on impervious surfaces.*	Source: *Oregon Department of Land Conservation and Development and Department of Environmental Quality Water Quality Model Code and Guidebook, October, 2000, Chapter 4 Zoning, Section 4.4.8 Tree Preservation Ordinance, Pages 4.73 to 4.79 http://www.deq.state.or.us/wq/nonpoint/links.htmF*

Recommended Programmatic BMPs By TMDL Impairment or Pollutant And Source (Cont.)

TMDL IMPAIRMENT OR POLLUTANT	SOURCE OF POLLUTANT	PROGRAMMATIC BMPS	SOURCE(S)
HYDROLOGY VOLUME REDUCTION (Cont.)	**Reduced Summer and Late Fall Instream Flow and Stormwater Runoff**	**Stormwater Management Plan** *Develop a **Stormwater Management Plan** that requires specific actions for pollution reduction, treatment, and flow control of runoff from new development, redevelopment, and retrofits and includes standards for conveyance of surface water in streams, creeks, channels, and ditches and other waters of the state. An operation and maintenance schedule shall be provided for all proposed stormwater facilities and BMPs, and the party (or parties) responsible for maintenance and operation shall be identified. In general, stormwater management measures are called upon to meet one or more of four major watershed planning objectives, including:* 1. *Promoting groundwater recharge* 2. *Reducing pollutant loading to receiving waters* 3. *Minimizing or eliminating accelerated stream channel erosion* 4. *Minimizing or eliminating flooding*	Source: *City of Springfield (Oregon) Stormwater Management Plan, Prepared by: City of Springfield, Public Works Environmental Services Division, January 2004. (https://scholarsbank.uoregon.edu/xmlui/bitstream/handle/1794/5828/Springfield_Stormwater_Master_Plan.pdf?sequence=1)* *Greenville Stormwater Management Plan 2007, Prepared by City of Greenville Public Works Department, Engineering Division. (http://www.greenvillesc.gov/PublicWorks/forms/StormwaterManagementPlan/Greenville_Stormwater_Management_Plan.pdf*
TEMPERATURE	**Lack of Shading**	**Riparian Protection Ordinance** *Adopt a **Riparian Protection Ordinance** that provides a "no touch" riparian buffer on both sides of a waterbody with the width (in feet) based on the TMDL effectiveness shade and buffer width figures provided in the Implementation Ready TMDL WQMP in order to protect and maintain stream hyporheic flow and large woody debris.*	Source: *EPA Model Ordinances Language Website http://www.epa.gov/owowwtr1/nps/ordinance/mol1.htm The Stormwater Manager's Resource Center (SMRC) http://www.stormwatercenter.net/Model%20Ordinances/buffer_model_ordinance.htm*
	Lack of Wetlands, Headwaters, and Groundwater	**Wetland Protection Ordinance** *Adopt a **Wetland Protection Ordinance** that includes protection of headwaters and other groundwater resources that provide cool water inflow from groundwater, hyporheic (near surface), wetland, or other sources into waterbody during the hottest time of year.*	Source: *City of Springfield (Oregon) Stormwater Management Plan, Prepared by: City of Springfield, Public Works Environmental Services Division, January 2004. (https://scholarsbank.uoregon.edu/xmlui/bitstream/handle/1794/5828/Springfield_Stormwater_Master_Plan.pdf?sequence=1* *Greenville Stormwater Management Plan 2007, Prepared by City of Greenville Public Works Department, Engineering Division. (http://www.greenvillesc.gov/PublicWorks/forms/StormwaterManagementPlan/Greenville_Stormwater_Management_Plan.pdf)*

Recommended Programmatic BMPs By TMDL Impairment or Pollutant And Source (Cont.)

TMDL IMPAIRMENT OR POLLUTANT	SOURCE OF POLLUTANT	PROGRAMMATIC BMPS	SOURCE(S)
TEMPERATURE (Cont.)	**Constructed Facility Outflow**	**Stormwater Management Plan** *Develop a **Stormwater Management Plan** that requires specific actions for pollution reduction, treatment, and flow control of runoff from new development, redevelopment, and retrofits and includes standards for conveyance of surface water in streams, creeks, channels, and ditches and other waters of the state. An operation and maintenance schedule shall be provided for all proposed stormwater facilities and BMPs, and the party (or parties) responsible for maintenance and operation shall be identified. In general, stormwater management measures are called upon to meet one or more of four major watershed planning objectives, including:* 1. *Promoting groundwater recharge* 2. *Reducing pollutant loading to receiving waters* 3. *Minimizing or eliminating accelerated stream channel erosion* 4. *Minimizing or eliminating flooding*	Source: *Oregon Department of Land Conservation and Development and Department of Environmental Quality Water Quality Model Code and Guidebook, October, 2000, Chapter 4 Zoning, Section 4.3.9(e) Wetland Protection Overlay Ordinance, Pages 4.47 to 4.54* *http://www.deq.state.or.us/wq/nonpoint/links.htm*
	Lack of Forest Canopy	**Tree Protection Ordinance** *Adopt a **Tree Protection Ordinance** that retains at least 60% canopy coverage, which will hold water and reduce temperature increases on impervious surfaces.*	Source: *Oregon Department of Land Conservation and Development and Department of Environmental Quality Water Quality Model Code and Guidebook, October, 2000, Chapter 4 Zoning, Section 4.4.8 Tree Preservation Ordinance, Pages 4.73 to 4.79 http://www.deq.state.or.us/wq/nonpoint/links.htmF*
SEDIMENTATION (Turbidity)	**Lack of Riparian Areas**	**Riparian Protection Ordinance** *Adopt a **Riparian Protection Ordinance** that provides a "no touch" riparian buffer on both sides of a waterbody with the width (in feet) based on the TMDL effectiveness shade and buffer width figures provided in the Implementation Ready TMDL WQMP in order to protect and maintain hyporheic flow and Large Woody Debris to the stream.*	Source: *EPA Model Ordinances Language Website http://www.epa.gov/owowwtr1/nps/ordinance/mol1.htm The Stormwater Manager's Resource Center (SMRC) http://www.stormwatercenter.net/Model%20Ordinances/buffer_model_ordinance.htm*

Recommended Programmatic BMPs By TMDL Impairment or Pollutant And Source (Cont.)

TMDL IMPAIRMENT OR POLLUTANT	SOURCE OF POLLUTANT	PROGRAMMATIC BMPS	SOURCE(S)
SEDIMENTATION (Turbidity) (Cont.)	**Stormwater Runoff**	**Low Impact Development (LID) Ordinance** *Adopt a **Low Impact Development (LID) Ordinance** that requires all new, redevelopment, and retrofit projects to reduce impervious surfaces and use LID and other BMPs to infiltrate, filter, retain, evaporate, and slow down runoff close to its source to treat sediment from impervious surfaces.*	Source: *Puget Sound Partnership, 2012, Integrating LID into Local Codes: A Guidebook for Local Governments, prepared by AHBL for the Puget Sound Partnership, Tacoma, WA, July 2012.* *http://www.psp.wa.gov/downloads/LID_Guidebook/20120731_LIDguidebook.pdf* *See http://water.epa.gov/polwaste/green/index.cfm for more information on Low Impact Development.*
	Exposed Soil	**Erosion and Sediment Control Ordinance** *Adopt an **Erosion and Sediment Control Ordinance** that controls soil erosion either during construction or by other land use activities. Violation is soil visible (turbid water) in waters of the state originating from the site.*	Source: *EPA Erosion and Sediment Control Model Ordinance* *http://water.epa.gov/polwaste/nps/mol2.cfm*
	Stormwater Runoff	**Stormwater Management Ordinance** *Adopt a **Stormwater Management Ordinance** that requires all new, redevelopment, and retrofit projects to establish minimum stormwater management requirements and controls to treat stormwater runoff containing sediment and to meet the following objectives:* 1. *Minimize increases in stormwater runoff rates and volumes from any development in order to reduce flooding, siltation, increases in stream temperature, streambank erosion, and to maintain the integrity of stream channels;* 2. *Minimize increases in pollution caused by stormwater runoff which would otherwise degrade local water quality;* 3. *Maintain post development peak runoff rate and average volume at levels that are similar to pre-development levels; and* 4. *Ensure that these management controls are properly maintained and pose no threat to public safety.*	Source: *EPA Stormwater Management Model Ordinance* *http://water.epa.gov/polwaste/nps/mol6.cfm*

Recommended Programmatic BMPs By TMDL Impairment or Pollutant And Source (Cont.)

TMDL IMPAIRMENT OR POLLUTANT	SOURCE OF POLLUTANT	PROGRAMMATIC BMPS	SOURCE(S)
SEDIMENTATION (Turbidity) (Cont.)	**Stormwater Runoff**	**Stormwater Management Plan** *Develop a **Stormwater Management Plan** that requires specific actions for pollution reduction, treatment, and flow control of sediment-laden runoff from new development, redevelopment, and retrofits and includes standards for conveyance of surface water in streams, creeks, channels, and ditches and other waters of the state. An operation and maintenance schedule shall be provided for all proposed stormwater facilities and BMPs, and the party (or parties) responsible for maintenance and operation shall be identified. In general, stormwater management measures are called upon to meet one or more of four major watershed planning objectives, including:* 1. *Promoting groundwater recharge* 2. *Reducing pollutant loading to receiving waters* 3. *Minimizing or eliminating accelerated stream channel erosion* 4. *Minimizing or eliminating flooding*	Source: *City of Springfield (Oregon) Stormwater Management Plan, Prepared by: City of Springfield, Public Works Environmental Services Division, January 2004. (https://scholarsbank.uoregon.edu/xmlui/bitstream/handle/1794/5828/Springfield_Stormwater_Master_Plan.pdf?sequence=1)* *Greenville Stormwater Management Plan 2007, Prepared by City of Greenville Public Works Department, Engineering Division. (http://www.greenvillesc.gov/PublicWorks/forms/StormwaterManagementPlan/Greenville_Stormwater_Management_Plan.pdf)*
	Soil Erosion form Slopes	**Hillside Development (Steep Slopes) Protection Ordinance** *Adopt a **Hillside Development (Steep Slopes) Protection Ordinance** to minimize or stop soil erosion from steep slopes that are eroding (or subject to erosion from disturbance) causing sediment to enter into a waterbody.*	Source: *Oregon Department of Land Conservation and Development and Department of Environmental Quality Water Quality Model Code and Guidebook, October, 2000, Chapter 4 Zoning, Section 4.3.9(c) Hillside Development (Steep Slopes), Pages 4.36 to 4.43* *http://www.deq.state.or.us/wq/nonpoint/links.htm*
	Floodways/ Floodplains Erosion	**Floodway and Floodplain Overlay District Ordinance** *Adopt a **Floodway and Floodplain Overlay District Ordinance** that protects the floodway and floodplain from development and requires that any new, redevelopment, and retrofit projects to maintain post development peak runoff rate and average volume at levels that are similar to pre-development levels.*	Source: *Oregon Department of Land Conservation and Development and Department of Environmental Quality, Water Quality Model Code and Guidebook, October, 2000, Chapter 4 Zoning, Section 4.3.9(d) Floodway and Floodplain Overlay District, pages 4.44 to 4.47 and Appendix, Additional Model Ordinances, Oregon Model Flood Damage Prevention Ordinance, pages A.13 to A.30* *http://www.deq.state.or.us/wq/nonpoint/links.htm*

Recommended Programmatic BMPs By TMDL Impairment or Pollutant And Source (Cont.)

TMDL IMPAIRMENT OR POLLUTANT	SOURCE OF POLLUTANT	PROGRAMMATIC BMPS	SOURCE(S)
BACTERIA (E coli and Fecal Coliform)	**Failing Onsite Sewage Disposals Systems**	**Local Community Onsite Loan Program** *Develop a **Local Community Loan Program** to provide low-cost financial assistance to individual homeowners to repair or replace substandard and failing on-site systems. A county or city may contract with DEQ to borrower funds through the agency's Clean Water State Revolving Fund (CWSRF) to establish a "local loan".*	Source: *Oregon DEQ, Clean Water State Revolving Fund (CWSRF) Loan Program, Description of the Components of a Proposed Local Community Loan Program Fact Sheet, http://www.deq.state.or.us/wq/loans/docs/srfforms/apps/lclprojdesc.pdf; and Local Community Loan Application Form, http://www.deq.state.or.us/wq/loans/docs/srfforms/apps/lclapp.pdf*
	Failing Onsite Sewage Disposals Systems	**Onsite Inspection and Maintenance Ordinance** *Develop an **Onsite Inspection and Maintenance Ordinance** to require onsite system inspection and maintenance to repair or replace substandard and failing on-site systems.*	Source: *Washtenaw County, Michigan Regulation for Inspection of Residential Onsite Disposal Systems at Property Transfer Ordinance, http://www.epa.gov/owow/nps/ordinance/documents/WashtenawCounty.pdf* University of Rhode Island, Water Quality Resource Center, Onsite Wastewater Resource Center, Kingston, RI *http://www.uri.edu/ce/wq/RESOURCES/wastewater/Management/PDFs/Model%20OWM%20Ordinance.pdf*
	Lack of Riparian Areas	**Riparian Protection Ordinance** *Adopt a **Riparian Protection Ordinance** that provides a "no touch" riparian buffer on both sides of a waterbody with the width (in feet) based on the TMDL effectiveness shade and buffer width figures provided in the Implementation Ready TMDL WQMP in order to protect and maintain hyporheic flow and Large Woody Debris to the stream.*	Source: *EPA Model Ordinances Language Website http://www.epa.gov/owowwtr1/nps/ordinance/mol1.htm The Stormwater Manager's Resource Center (SMRC) http://www.stormwatercenter.net/Model%20Ordinances/buffer_model_ordinance.htm*
	Wildlife Waste	**No Wildlife Feeding Ordinance** *Adopt a **No Wildlife Feeding Ordinance** to limit the amount of wildlife waste entering waters of the state, including lakes, reservoirs, ponds, and other impoundments. (e.g., some communities patrol swimming beaches with dogs to keep waterfowl away during high recreational use times.*	Source: *New Jersey Department of Environmental Protection, Division of Water Quality, Municipal Stormwater Regulation Program Tier A Municipal Stormwater Guidance Document, April 2004, Chapter 7 – Model Ordinances, Model Ordinance - Wildlife Feeding, page 69 http://www.anjec.org/pdfs/ModelOrd-PetWaste.pdf*

Recommended Programmatic BMPs By TMDL Impairment or Pollutant And Source (Cont.)

TMDL IMPAIRMENT OR POLLUTANT	SOURCE OF POLLUTANT	PROGRAMMATIC BMPS	SOURCE(S)
BACTERIA (E coli and Fecal Coliform) (Cont.)	**Pet Waste**	**Pet Waste Pick-Up Ordinance** *Adopt a **Pet Waste Pick-Up Ordinance** to encourage pet owners to pick up pet waste at home and in public area.*	Source: *New Jersey Department of Environmental Protection, Division of Water Quality, Municipal Stormwater Regulation Program Tier A Municipal Stormwater Guidance Document, April 2004, Chapter 7 – Model Ordinances, Model Ordinance - Pet Waste, page 64 http://www.anjec.org/pdfs/ModelOrd-PetWaste.pdf*
	Bacteria Runoff From Impervious Surfaces	**Low Impact Development (LID) Ordinance** *Adopt a **Low Impact Development (LID) Ordinance** that requires all new, redevelopment, and retrofit projects to reduce impervious surfaces and use LID and other BMPs to infiltrate, filter, retain, evaporate, and slow down runoff close to its source to treat sediment from impervious surfaces.[3]*	Source: *Puget Sound Partnership, 2012, Integrating LID into Local Codes: A Guidebook for Local Governments, prepared by AHBL for the Puget Sound Partnership, Tacoma, WA, July 2012. http://www.psp.wa.gov/downloads/LID_Guidebook/20120731_LIDguidebook.pdf* *See http://water.epa.gov/polwaste/green/index.cfm for more information on Low Impact Development.*
	Stormwater Runoff	**Stormwater Management Ordinance** *Adopt a **Stormwater Management Ordinance** that requires all new, redevelopment, and retrofit projects to establish minimum stormwater management requirements and controls and to treat stormwater runoff containing bacteria and meet the following objectives:* 1. *Minimize increases in stormwater runoff rates and volumes from any development in order to reduce flooding, siltation, increases in stream temperature, streambank erosion, and to maintain the integrity of stream channels;* 2. *Minimize increases in pollution caused by stormwater runoff which would otherwise degrade local water quality;* 3. *Maintain post development peak runoff rate and average volume at levels that are similar to pre-development levels; and* 4. *Ensure that these management controls are properly maintained and pose no threat to public safety.*	Source: *EPA Stormwater Management Model Ordinance http://water.epa.gov/polwaste/nps/mol6.cfm*

[3] See www.epa.gov/nps/lid for more information on Low Impact Development.

Recommended Programmatic BMPs By TMDL Impairment or Pollutant And Source (Cont.)

TMDL IMPAIRMENT OR POLLUTANT	SOURCE OF POLLUTANT	PROGRAMMATIC BMPS	SOURCE(S)
BACTERIA (E coli and Fecal Coliform) (Cont.)	**Stormwater Runoff**	**Stormwater Management Plan** *Develop a **Stormwater Management Plan** that requires specific actions for pollution reduction, treatment, and flow control of runoff from new development, redevelopment, and retrofits and includes standards for conveyance of surface water in streams, creeks, channels, and ditches and other waters of the state. An operation and maintenance schedule shall be provided for all proposed stormwater facilities and BMPs, and the party (or parties) responsible for maintenance and operation shall be identified. In general, stormwater management measures are called upon to meet one or more of four major watershed planning objectives, including:* *1. Promoting groundwater recharge* *2. Reducing pollutant loading to receiving waters* *3. Minimizing or eliminating accelerated stream channel erosion* *4. Minimizing or eliminating flooding*	Source: *City of Springfield (Oregon) Stormwater Management Plan, Prepared by: City of Springfield, Public Works Environmental Services Division, January 2004. (https://scholarsbank.uoregon.edu/xmlui/bitstream/handle/1794/5828/Springfield_Stormwater_Master_Plan.pdf?sequence=1)* *Greenville Stormwater Management Plan 2007, Prepared by City of Greenville Public Works Department, Engineering Division. (http://www.greenvillesc.gov/PublicWorks/forms/StormwaterManagementPlan/Greenville_Stormwater_Management_Plan.pdf)*
	Illegal or Illicit Discharges[4]	**Illicit Discharge and Connection Ordinance** ***Adopt and Implement an Illicit Discharge and Connection Ordinance.** The objectives of this ordinance are: (1) To regulate the contribution of pollutants to the stormwater system by any user. (2) To prohibit illicit connections and discharges to the stormwater system. (3) To establish legal authority to carry out all inspection, surveillance, monitoring, and enforcement procedures necessary to ensure compliance with this ordinance.*	Source: *EPA National Pollutant Discharge Elimination System (NPDES) Illicit Discharge Detection and Elimination Program Development BMP Fact Sheet: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=111&minmeasure=3 and EPA's Illicit Discharge and Connection Model Ordinance http://water.epa.gov/polwaste/nps/mol5.cfm*

[4] Means an illegal and/or improper waste discharges into storm drainage systems and receiving waters.

Recommended Programmatic BMPs By TMDL Impairment or Pollutant And Source (Cont.)

TMDL IMPAIRMENT OR POLLUTANT	SOURCE OF POLLUTANT	PROGRAMMATIC BMPS	SOURCE(S)
NUTRIENTS (Nitrates and Phosphorus)	**Over Fertilization**	**Public Areas Fertilization Policy** *Adopt a **Public Areas Fertilization Policy** to prevent over-application of fertilizers to public lawn and landscaped areas. Fertilizers applied to lawns are roughly equivalent to the application rates for row crops (Barth, 1995a).*	Source: *New Jersey Department of Environmental Protection, Division of Water Quality, Municipal Stormwater Regulation Program Tier A Municipal Stormwater Guidance Document, April 2004, Chapter 7 – Model Ordinances, Fertilizer Application Model Ordinance* http://www.nj.gov/dep/watershedmgt/DOCS/TMDL/Fertilizer%20Application%20Model%20Ordinance.pdf
	Stormwater Runoff	**Stormwater Management Ordinance** *Adopt a **Stormwater Management Ordinance** that requires all new, redevelopment, and retrofit projects to establish minimum stormwater management requirements and controls to treat stormwater runoff containing sediment and to meet the following objectives:* 1. *Minimize increases in stormwater runoff rates and volumes from any development in order to reduce flooding, siltation, increases in stream temperature, streambank erosion, and to maintain the integrity of stream channels;* 2. *Minimize increases in pollution caused by stormwater runoff which would otherwise degrade local water quality;* 3. *Maintain post development peak runoff rate and average volume at levels that are similar to pre-development levels; and* 4. *Ensure that these management controls are properly maintained and pose no threat to public safety.*	Source: *EPA Stormwater Management Model Ordinance* http://water.epa.gov/polwaste/nps/mol6.cfm

Recommended Programmatic BMPs By TMDL Impairment or Pollutant And Source (Cont.)

TMDL IMPAIRMENT OR POLLUTANT	SOURCE OF POLLUTANT	PROGRAMMATIC BMPS	SOURCE(S)
	Stormwater Runoff	**Stormwater Management Plan** *Develop a **Stormwater Management Plan** that requires specific actions for pollution reduction, treatment, and flow control of runoff from new development, redevelopment, and retrofits and includes standards for conveyance of surface water in streams, creeks, channels, and ditches and other waters of the state. An operation and maintenance schedule shall be provided for all proposed stormwater facilities and BMPs, and the party (or parties) responsible for maintenance and operation shall be identified. In general, stormwater management measures are called upon to meet one or more of four major watershed planning objectives, including:* • *Promoting groundwater recharge* • *Reducing pollutant loading to receiving waters* • *Minimizing or eliminating accelerated stream channel erosion* • *Minimizing or eliminating flooding*	Source: *City of Springfield (Oregon) Stormwater Management Plan, Prepared by: City of Springfield, Public Works Environmental Services Division, January 2004. (https://scholarsbank.uoregon.edu/xmlui/bitstream/handle/1794/5828/Springfield_Stormwater_Master_Plan.pdf?sequence=1)* *Greenville Stormwater Management Plan 2007, Prepared by City of Greenville Public Works Department, Engineering Division. (http://www.greenvillesc.gov/PublicWorks/forms/StormwaterManagementPlan/Greenville_Stormwater_Management_Plan.pdf)*
	Nutrient Runoff From Impervious Surfaces	**Low Impact Development (LID) Ordinance** *Adopt a **Low Impact Development (LID) Ordinance** that requires all new, redevelopment, and retrofit projects to reduce impervious surfaces and use LID and other BMPs to infiltrate, filter, retain, evaporate, and slow down runoff close to its source and treat nutrients from impervious surfaces.*	Source: *Puget Sound Partnership, 2012, Integrating LID into Local Codes: A Guidebook for Local Governments, prepared by AHBL for the Puget Sound Partnership, Tacoma, WA, July 2012. http://www.psp.wa.gov/downloads/LID_Guidebook/20120731_LIDguidebook.pdf* *See http://water.epa.gov/polwaste/green/index.cfm for more information on Low Impact Development.*
	Exposed Soil	**Erosion and Sediment Control Ordinance** *Adopt an **Erosion and Sediment Control Ordinance** that controls soil erosion either during construction or by other land use activities. Violation is soil visible (turbid water) in waters of the state.*	Source: *EPA Erosion and Sediment Control Model Ordinance http://water.epa.gov/polwaste/nps/mol2.cfm*

Recommended Programmatic BMPs By TMDL Impairment or Pollutant And Source (Cont.)

TMDL IMPAIRMENT OR POLLUTANT	SOURCE OF POLLUTANT	PROGRAMMATIC BMPS	SOURCE(S)
NUTRIENTS (Nitrates and Phosphorus) (Cont.)	**Nutrient Runoff**	**Protecting Surface Water Sources of Drinking Water Ordinance** *Adopt a **Protecting Surface Water Sources of Drinking Water Ordinance** to protect drinking water obtained from surface water sources.*	Source: *Oregon DEQ, Water Quality Division, Model Ordinance: Protecting Surface Water Sources of Drinking Water Fact Sheet* http://www.deq.state.or.us/wq/pubs/factsheets/drinkingwater/ModelOrdinanceSurfaceWater.pdf
	Nutrient Runoff	**Protecting Groundwater Sources of Drinking Water Ordinance** *Adopt a **Protecting Groundwater Sources of Drinking Water Ordinance** to protect drinking water obtained from groundwater sources.*	Source: *Oregon DEQ, Water Quality Division, Model Ordinance: Protecting Groundwater Sources of Drinking Water Fact Sheet* http://www.deq.state.or.us/wq/pubs/factsheets/drinkingwater/ModelOrdinanceGroundwater.pdf
	Air Deposition	**Low Impact Development (LID) Ordinance** *Adopt a **Low Impact Development (LID) Ordinance** that requires all new, redevelopment, and retrofit projects to reduce impervious surfaces and use LID and other BMPs to infiltrate, filter, retain, evaporate, and slow down runoff close to its source to treat nitrogen or phosphorus from air deposition onto impervious surfaces.*	Source: *Puget Sound Partnership, 2012, Integrating LID into Local Codes: A Guidebook for Local Governments, prepared by AHBL for the Puget Sound Partnership, Tacoma, WA, July 2012.* http://www.psp.wa.gov/downloads/LID_Guidebook/20120731_LIDguidebook.pdf *See http://water.epa.gov/polwaste/green/index.cfm for more information on Low Impact Development.*
DISSOLVED OXYGEN	**Same Sources Listed Above For Nutrients (Nitrates and Phosphorus)**	**Same Programmatic BMPs Listed Above For Nutrients (Nitrates and Phosphorus)**	***Same Source(s) Listed Above For Nutrients(Nitrates and Phosphorus)***
TOXICS (Attached to Sediments)	**Same Sources Listed Above For Sedimentation (Turbidity)**	**Same Programmatic BMPs Listed Above For Sedimentation (Turbidity) and Nutrients(Nitrates and Phosphorus)**	***Same Source(s) Listed Above For* Sedimentation (Turbidity)**

Recommended Programmatic BMPs By TMDL Impairment or Pollutant And Source (Cont.)

TMDL IMPAIRMENT OR POLLUTANT	SOURCE OF POLLUTANT	PROGRAMMATIC BMPS	SOURCE(S)
TOXICS (In Water)	**Pesticides**	**Integrated Pest Management (IPM) Ordinance** *Adopt an **Integrated Pest Management (IPM) Ordinance** to develop effective plans, programs, and policies. Urban lawns receive an estimated five to seven pounds of pesticides per acre annually (Schueler, 1995b).*	Source: *Marin County, California Integrated Pest Management Ordinance (IPM) Ordinance* http://www.up3project.org/documents/Marin-IPM-Ordinance.pdf
	Same Sources Listed Above For Nutrients (Nitrates and Phosphorus)	**Same Programmatic BMPs Listed Above For Nutrients (Nitrates and Phosphorus)**	***Same Source(s) Listed Above For Nutrients (Nitrates and Phosphorus)***

Appendix E: Recommended Structural BMPs By TMDL Impairment or Pollutant, Source, Estimated Load Reduction and Costs

(International Stormwater Best Management Practices (BMP) Database project website, http://www.bmpdatabase.org/BMPPerformance.htm.)

TMDL IMPAIRMENT OR POLLUTANT	SOURCE OF POLLUTANT	STRUCTURAL BMPS	MEDIAN INFLOW AND OUTFLOW	ESTIMATED LOAD REDUCTION5	ESTIMATED COSTS	COSTS INCLUDED
HYDROLOGY VOLUME REDUCTION	**Stormwater Runoff**	**Porous Concrete and/or Asphalt Roads**	**NA**	**90% to 100%**	**$1.09 to $2.18 per ft^2**	• Do not install in areas where hazardous materials are loaded, unloaded, or stored. • Avoid high sediment loading areas. • Do not use sand for snow or ice treatment. • Periodic maintenance to remove fine sediments from paver surface will optimize permeability. • Annual maintenance cost are $0.16 per ft^2 to remove fine sediments from paver surface
		*Require construction of **Porous Concrete and/or Asphalt Roads** when constructing new roads or re-construction of a road.*	**NA**			Source: *EPA National Pollutant Discharge Elimination System (NPDES) Stormwater Pervious Concrete Pavement BMP Fact Sheet, http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=137&minmeasure=5*
		Riparian Restoration	**NA**	**100%**	**$10,000 to $15,000 per acre**	• Site Preparation • Planting • Maintenance • Program Costs • Recurring Payment for Lease
		***Restore Riparian Area** to **150-foot buffer on both sides** with native shrubs and trees that would grow and restore stream conditions to natural conditions.*	**NA**			Source: *Oregon DEQ, Cost Estimate to Restore Riparian Forest Buffers and Improve Stream Habitat in the Willamette Basin, Oregon, March 2010* (http://www.deq.state.or.us/wq/tmdls/docs/WillametteRipCost030310.pdf)

5 Load reduction is highly variable, and is related to how dirty the incoming water happens to be.

Recommended Structural BMPs By TMDL Impairment or Pollutant, Source, Estimated Load Reduction and Costs (Cont.)

TMDL IMPAIRMENT OR POLLUTANT	SOURCE OF POLLUTANT	STRUCTURAL BMPS	MEDIAN INFLOW AND OUTFLOW	ESTIMATED LOAD REDUCTION	ESTIMATED COSTS	COSTS INCLUDED
HYDROLOGY VOLUME REDUCTION (Cont.)	**Stormwater Runoff**	**Grassed Swales (Filter Strips)**	**NA**	**34%**	**$0.50 per**	• Design less than 4 percent slope; 1 to 2 percent slope is recommended • Small fore-bay should be used at the front of the swale to trap incoming sediments • Construction • Planting • Maintenance costs approximately $1.09 per linear foot
		*Require construction of onsite or construct regional non-UIC **Grassed Swales** (a.k.a. grassed channel, dry swale, wet swale, biofilter, or bioswale) that infiltrates stormwater and maintains dry weather flow.*	**NA**			*Sources: EPA National Pollutant Discharge Elimination System (NPDES) Stormwater Grassed Swales BMP Fact Sheet, (http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=75&minmeasure=5) and EPA, National Management Measures to Control Nonpoint Source Pollution from Urban Areas, EPA-841-B-05-004, November 2005 http://www.epa.gov/owow/nps/urbanmm/index.html*
	Stormwater Runoff	**Rain Gardens (Bioretention)**	**NA**	**57%**	**Residential Rain Gardens Average $3 to $4 per ft^2** **Commercial, Industrial and Institutional Site Costs Between $10 to $40 per ft^2**	• Bioretention areas best used on small sites (i.e., 5 acres or less). • Sized between 5 and 10 percent of the impervious area. • Designed to pond a small amount of water (6-9 inches) above the filter bed. • Costs include control structures, curbing, storm drains, under drains, and plants that can vary. • Bioretention requires landscaping maintenance.
		***Install Rain Gardens (Bioretention) with under drains** to infiltrate stormwater*	**NA**			Sources: *EPA National Pollutant Discharge Elimination System (NPDES) Bioretention (Rain Gardens) BMP Fact Sheet: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=72&minmeasure=5 and Low Impact Development (LID) Urban Design Tools Website: http://www.lid-stormwater.net/index.html*

Recommended Structural BMPs By TMDL Impairment or Pollutant, Source, Estimated Load Reduction and Costs (Cont.)

TMDL IMPAIRMENT OR POLLUTANT	SOURCE OF POLLUTANT	STRUCTURAL BMPS	MEDIAN INFLOW AND OUTFLOW	ESTIMATED LOAD REDUCTION	ESTIMATED COSTS	COSTS INCLUDED
HYDROLOGY VOLUME REDUCTION (Cont.)	**Stormwater Runoff**	**Stormwater Vegetated Infiltration Basins**	**NA**	**100%**	**$2 per ft^3**	• Design 0.25-acre basin with 2 to 3 percent of the site runoff infiltrates • Construction • Planting • Maintenance costs are estimated at 5 to 10 percent of construction costs.
		Require construction of onsite or construct regional non-UIC[6] Vegetated Infiltration Basins *that infiltrates stormwater and maintains dry weather flow.*	**NA**			Source: *EPA National Pollutant Discharge Elimination System (NPDES) Stormwater Infiltration Basin BMP Fact Sheet*, (http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=69&minmeasure=5)
TEMPERATURE	**Lack of Shading**	**Riparian Restoration**	**NA**	**100%**	**$10,000 to $15,000 per acre**	• Site Preparation • Planting • Maintenance • Program Costs • Recurring Payment for Lease
		Restore Riparian Area *to* ***150-foot buffer on both sides*** *with native shrubs and trees that would grow and restore stream conditions to natural conditions.*	**NA**			Source: *Oregon DEQ, Cost Estimate to Restore Riparian Forest Buffers and Improve Stream Habitat in the Willamette Basin, Oregon, March 2010* (http://www.deq.state.or.us/wq/tmdls/docs/WillametteRipCost030310.pdf)
	Lack of Cold Water Refugee	**Instream Restoration**	**NA**	**Not Available**	**$10,000 to $15,000 per acre**	• Placement of Large Woody Debris • Placement of gravel, rocks, etc.
		Restore *instream habitat complexity with placement of Large Woody Debris, and bed and bank material (e.g. gravel).*	**NA**			Source: *Oregon DEQ, Cost Estimate to Restore Riparian Forest Buffers and Improve Stream Habitat in the Willamette Basin, Oregon, March 2010* (http://www.deq.state.or.us/wq/tmdls/docs/WillametteRipCost030310.pdf)

[1] See **Appendix G**

Recommended Structural BMPs By TMDL Impairment or Pollutant, Source, Estimated Load Reduction and Costs (Cont.)

TMDL IMPAIRMENT OR POLLUTANT	SOURCE OF POLLUTANT	STRUCTURAL BMPS	MEDIAN INFLOW AND OUTFLOW	ESTIMATED LOAD REDUCTION	ESTIMATED COSTS	COSTS INCLUDED
TEMPERATURE (Cont.)	**Reduced Summer and Late Fall Instream Flow**	**Stormwater Vegetated Infiltration Basins**		**100%**	**$2 per ft^3**	• Design 0.25-acre basin with 2 to 3 percent of the site runoff infiltrates • Construction • Planting • Maintenance costs are estimated at 5 to 10 percent of construction costs.
		*Require construction of onsite or construct regional non-UIC[7] **Vegetated Infiltration Basins** that infiltrates stormwater and maintains dry weather flow.*				Source: *EPA National Pollutant Discharge Elimination System (NPDES) Stormwater Infiltration Basin BMP Fact Sheet*, (http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=69&minmeasure=5)
	Reduced Summer and Late Fall Instream Flow	**Grassed Swales (Filter Strips)**	**Inflow** **7.7^o C (Ptld.)** **11.5^o C (Ptld.)** **11.7^o C (Sea)** **Tempt.**	**2.5%** **8%** **51%**	**$0.50 per ft^2**	• Design less than 4 percent slope; 1 to 2 percent slope is recommended • Small fore-bay should be used at the front of the swale to trap incoming sediments • Construction • Planting • Maintenance costs approximately $1.09 per linear foot
		*Require construction of onsite or construct regional non-UIC **Grassed Swales** (a.k.a. grassed channel, dry swale, wet swale, biofilter, or bioswale) that infiltrates stormwater and maintains dry weather flow.*	**Outflow** **7.5^o C** **10.55^o C** **11.1^o C**			*Sources: EPA National Pollutant Discharge Elimination System (NPDES) Stormwater Grassed Swales BMP Fact Sheet, (http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=75&minmeasure=5) and EPA, National Management Measures to Control Nonpoint Source Pollution from Urban Areas, EPA-841-B-05-004, November 2005 http://www.epa.gov/owow/nps/urbanmm/index.html*

[1] See **Appendix G**

Recommended Structural BMPs By TMDL Impairment or Pollutant, Source, Estimated Load Reduction and Costs (Cont.)

TMDL IMPAIRMENT OR POLLUTANT	SOURCE OF POLLUTANT	STRUCTURAL BMPS	MEDIAN INFLOW AND OUTFLOW	ESTIMATED LOAD REDUCTION	ESTIMATED COSTS	COSTS INCLUDED
TEMPERATURE (Cont.)		**Rain Garden (Bioretention)**	**Inflow 10.8° C Tempt. (Ptld.) ISBMPD #00048**	**18%**	**Residential Rain Gardens Average $3 to $4 per ft²** **Commercial, Industrial and Institutional Site Costs Between $10 to $40 per ft²**	• Bioretention areas best used on small sites (i.e., 5 acres or less). • Sized between 5 and 10 percent of the impervious area. • Designed to pond a small amount of water (6-9 inches) above the filter bed. • Costs include control structures, curbing, storm drains, under drains, and plants, which can vary. • Bioretention requires landscaping maintenance.
		Install Rain Gardens (Bioretention) *to infiltrate stormwater*	**Outflow 8.85° C Tempt. (Ptld.) ISBMPD #00048**			Sources: *EPA National Pollutant Discharge Elimination System (NPDES) Bioretention (Rain Gardens) BMP Fact Sheet:* http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=72&minmeasure=5 *and Low Impact Development (LID) Urban Design Tools Website:* *http://www.lid-stormwater.net/index.html*
SEDIMENTATION (Turbidity)	**Lack of Riparian Areas**	**Riparian Restoration**	**NA**	**80% for 100 Foot Buffer Width[8]** **95% for 200 Foot Buffer Width[9]**	**$10,000 to $15,00 per acre**	• Site Preparation • Planting • Maintenance • Program Costs • Recurring Payment for Lease
		Restore Riparian Area *and exposed soils with native shrubs and trees in order to restore natural conditions.*	**NA**			Source: *Oregon DEQ, Cost Estimate to Restore Riparian Forest Buffers and Improve Stream Habitat in the Willamette Basin, Oregon, March 2010* http://www.deq.state.or.us/wq/tmdls/docs/WillametteRipCost030310.pdf

8 Source: Washington Ecology, LLC, Christopher W. May, *Stream-Riparian Ecosystems In The Puget Sound Lowland Eco-Region, A Review of Best Available Science*
9 Source: Washington Department of Ecology, *Wetlands in Washington State, Volume 1 – A Synthesis of Science*, March 2005.

Recommended Structural BMPs By TMDL Impairment or Pollutant, Source, Estimated Load Reduction and Costs (Cont.)

TMDL IMPAIRMENT OR POLLUTANT	SOURCE OF POLLUTANT	STRUCTURAL BMPS	MEDIAN INFLOW AND OUTFLOW	ESTIMATED LOAD REDUCTION	ESTIMATED COSTS	COSTS INCLUDED
SEDIMENTATION (Turbidity) (Cont.)	**Exposed Soil**	**Restore and Treat Exposed Soil Areas**	**NA**	**50% to 90% Seeding** **53% to 99% Mulching** **70% to 93% Erosion Control Blankets**	**$0.05 to $0.25/yd^2 Seeding** **$0.21 to $0.87/ yd^2 Mulching** **$0.05 to 4.50/ yd^2 Erosion Control Blankets**	• Installation • Maintenance is 5% to 15% of the selected BMP installation costs
		Restore and Treat Exposed Soil Areas *with erosion control BMPs to prevent and control erosion.*	**NA**			Source: *EPA, National Management Measures to Control Nonpoint Source Pollution from Urban Areas, EPA-841-B-05-004, November 2005* (http://www.epa.gov/owow/nps/urbanmm/index.html)
	Construct-ion Runoff	**Sediment Traps**	**NA**	**60% TSS**	**$0.20 to $2.00 per cubic foot of storage (about $1,100 per acre of drainage).**	• Installation • Traps that provide pools with large length-to-width ratios have a greater chance of success • Maintenance costs are minimal
		Install Onsite or Regional Sediment Traps *to settle sediment.*	**NA**			Source: *EPA National Pollutant Discharge Elimination System (NPDES) Sediment Traps BMP Fact Sheet http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=59&minmeasure=4*

Recommended Structural BMPs By TMDL Impairment or Pollutant, Source, Estimated Load Reduction and Costs (Cont.)

TMDL IMPAIRMENT OR POLLUTANT	SOURCE OF POLLUTANT	STRUCTURAL BMPS	MEDIAN INFLOW AND OUTFLOW	ESTIMATED LOAD REDUCTION	ESTIMATED COSTS	COSTS INCLUDED
SEDIMENTATION (Turbidity) (Cont.)	**Construct-ion Runoff (Cont.)**	**Sediment Basins and Rock Dams**	**NA**	**55% to 100% TSS**	**$0.20 to $1.30 per cubic foot of storage (about $1,100 per acre of drainage) for less than 50,000 ft^3 of storage** **$0.30 per cubic foot of storage for basins with greater than 50,000 ft^3 of storage**	• Installation • Maintenance costs are minimal • Can be converted to a **Stormwater Wetland** for post-construction treatment. • The detention time should be at least 8 hours. • Remove sediment from the basin when the storage capacity has reached approximately 50 percent.
		Install Onsite or Regional Sediment Basins and Rock Dams *to settle sediment.*	**NA**			Source: *EPA National Pollutant Discharge Elimination System (NPDES) Sediment Basins and Rock Dams BMP Fact Sheet* *http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=57&minmeasure=4*
	Stormwater Runoff	**Infiltration Basin Facilities**	**NA**	**75% TSS**	**$2 per ft^3 of storage for a 0.25-acre basin**	• Installation • Infiltration basin is sized to treat the runoff from a 1-inch storm • Maintenance is 5% to 15% of the selected BMP installation costs
		Install Onsite and/or Regional Infiltration Basin Facilities *to control and treat turbid runoff*	NA			Source: *EPA National Pollutant Discharge Elimination System (NPDES) Infiltration Basin BMP Fact Sheet:* *http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=69&minmeasure=5*

Recommended Structural BMPs By TMDL Impairment or Pollutant, Source, Estimated Load Reduction and Costs (Cont.)

TMDL IMPAIRMENT OR POLLUTANT	SOURCE OF POLLUTANT	STRUCTURAL BMPS	MEDIAN INFLOW AND OUTFLOW	ESTIMATED LOAD REDUCTION	ESTIMATED COSTS	COSTS INCLUDED
SEDIMENTATION (Turbidity) (Cont.)	**Stormwater Runoff (Cont.)**	**Dry Detention Ponds**	**Inflow 64.0 mg/L TSS**	**62.5% TSS**	**$41,600 for a 1 acre-foot pond** **$239,000 for a 10 acre-foot pond**	• Installation • Designed to detain stormwater runoff for some minimum time (e.g., 24 hours) • Maintenance is typically estimated at about 3% to 5% of the construction cost
		Install Onsite and/or Regional Dry Detention Ponds *to control and treat turbid runoff*	**Outflow 24.0 mg/L TSS**			Source: *EPA National Pollutant Discharge Elimination System (NPDES) Dry Detention Ponds BMP Fact Sheet: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=57&minmeasure=4*
	Stormwater Runoff (Cont.)	**High Efficiency Street Sweeping**	**NA**	**51% to 87% TSS**	**$150,000 per Street sweeper**	• Purchase a high efficiency vacuum sweeper • Annualized monthly sweeper costs per curb mile per year is $218 • For weekly sweeping, it is $946 per curb mile per year. • Operation & maintenance costs are approximately $15/curb mile.
		*Conduct **Regular High Efficiency Street Sweeping** of streets, parking lots, and other impervious surfaces with high-efficiency sweepers for removing the smallest possible particles.*	**NA**			Sources: *EPA, National Management Measures to Control Nonpoint Source Pollution from Urban Areas, EPA-841-B-05-004, November 2005 http://www.epa.gov/owow/nps/urbanmm/index.html; and EPA's Preliminary Data Summary of Urban Stormwater Best Management Practices, EPA-821-R-99-012, August 1, 1999 http://www.epa.gov/npdes/pubs/usw_a.pdf*

Recommended Structural BMPs By TMDL Impairment or Pollutant, Source, Estimated Load Reduction and Costs (Cont.)

TMDL IMPAIRMENT OR POLLUTANT	SOURCE OF POLLUTANT	STRUCTURAL BMPS	MEDIAN INFLOW AND OUTFLOW	ESTIMATED LOAD REDUCTION	ESTIMATED COSTS	COSTS INCLUDED
SEDIMENTATION (Turbidity) (Cont.)	**Stormwater Runoff (Cont.)**	**Rain Gardens (Bioretention)**	**Inflow 50.0 mg/L TSS**	**80% TSS**	**Residential Rain Gardens Average $3 to $4 per ft^2** **Commercial, Industrial and Institutional Site Costs Between $10 to $40 per ft^2**	• Bioretention areas best used on small sites (i.e., 5 acres or less). • Sized between 5 and 10 percent of the impervious area. • Designed to pond a small amount of water (6-9 inches) above the filter bed. • Costs include control structures, curbing, storm drains, under drains, and plants, which can vary. • Bioretention requires landscaping maintenance.
		Install Rain Gardens (Bioretention)*to control and treat turbid runoff*	**Outflow 10.0 mg/L TSS**			Sources: *EPA National Pollutant Discharge Elimination System (NPDES) Bioretention (Rain Gardens) BMP Fact Sheet:* http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=72&minmeasure=5 *and Low Impact Development (LID) Urban Design Tools Website:* *http://www.lid-stormwater.net/index.html*
	Stormwater Runoff (Cont.)	**Retention (Wet) Pond**	**Inflow 60.0 mg/L TSS**	**80% TSS**	**1996 Dollars** **$45,700 for a 1 acre-foot facility** **$232,000 for a 10 acre-foot facility** **$1,170,000 for a 100 acre-foot facility**	• Wet ponds need sufficient drainage area to maintain the permanent pool. In humid regions, this is typically about 25 acres. • Design features should include pretreatment, treatment, conveyance, maintenance reduction, and landscaping. • Ponds should always be designed with a length-to-width ratio of at least 1.5:1. • For ponds, the annual cost of routine maintenance is typically estimated at about 3 to 5 percent of the construction cost.
		Require construction of onsite or construct regional ***Retention (Wet) Ponds*** *that provide infiltration and removal of stormwater pollutants.*	**Outflow 12.0 mg/L TSS**			Source: *EPA National Pollutant Discharge Elimination System (NPDES) Wet Ponds (Retention) BMP Fact Sheet*, http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=68&minmeasure=5

Recommended Structural BMPs By TMDL Impairment or Pollutant, Source, Estimated Load Reduction and Costs (Cont.)

TMDL IMPAIRMENT OR POLLUTANT	SOURCE OF POLLUTANT	STRUCTURAL BMPS	MEDIAN INFLOW AND OUTFLOW	ESTIMATED LOAD REDUCTION	ESTIMATED COSTS	COSTS INCLUDED
SEDIMENTATION (Turbidity) (Cont.)	**Stormwater Runoff (Cont.)**	**Dry Swale**	**NA**	**87% - 99% TSS**	**$0.50 per ft^2**	• Design less than 4 percent slope; 1 to 2 percent slope is recommended • Small forebay should be used at the front of the swale to trap incoming sediments • Construction • Planting • Maintenance costs approximately $1.09 per linear foot
		Construct Onsite and/or Regional Non UIC Dry Swale *that will infiltrate and treat turbid waters.*	**NA**			Source: *EPA National Pollutant Discharge Elimination System (NPDES) Grassed Swales BMP Fact Sheet: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=75*
	Soil Erosion from Road Ditches	**Grass Filter Strip (Biofilter)**	**Inflow 50.5 mg/L TSS**	**64% TSS**	**$0.50 per ft^2**	• Design less than 4 percent slope; 1 to 2 percent slope is recommended • Small forebay should be used at the front of the swale to trap incoming sediments • Construction • Planting • Maintenance costs approximately $1.09 per linear foot
		Convert road ditches to ***Grassed Swales*** *(a.k.a. grassed channel, dry swale, wet swale, or biofilter,) that to infiltrate and capture sediment.*	**Outflow 18.0 mg/L TSS**			Sources: *EPA National Pollutant Discharge Elimination System (NPDES) Stormwater Grassed Swales BMP Fact Sheet, (http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=75&minmeasure=5); and EPA, National Management Measures to Control Nonpoint Source Pollution from Urban Areas, EPA-841-B-05-004, November 2005 http://www.epa.gov/owow/nps/urbanmm/index.html*

Recommended Structural BMPs By TMDL Impairment or Pollutant, Source, Estimated Load Reduction and Costs (Cont.)

TMDL IMPAIRMENT OR POLLUTANT	SOURCE OF POLLUTANT	STRUCTURAL BMPS	MEDIAN INFLOW AND OUTFLOW	ESTIMATED LOAD REDUCTION	ESTIMATED COSTS	COSTS INCLUDED
BACTERIA (E coli and Fecal Coliform)	**Failing Onsite Sewage Disposals Systems**	**Onsite Systems Repair or Replacement**	**NA**	**99% to 99.99%**	**$2,500 to $12,565 (Depending on Onsite System)**	• Material and Installation • Operation and Maintenance costs are between $6,845 to $36,406 over the design life of 20 to 30 years depending on onsite system • Maintenance costs are between $20 to $100 per month
		*For onsite systems, conduct an inspection and **Repair or Replace** substandard and failing on-site systems.*	**NA**			*Source: EPA Onsite Wastewater Treatment Systems Manual Chapter 3, February 2002 EPA/625/R-00/008 http://www.epa.gov/owm/septic/pubs/septic_2002_osdm_all.pdf*
	Wildlife, Pet, And Human Waste	**Riparian Restoration**	**NA**	**Approximately 80% (100 foot buffer width on each side)**	**$10,000 to $15,00 per acre**	• Site Preparation • Planting • Maintenance • Program Costs • Recurring Payment for Lease
		***Restore Riparian Area** with native shrubs and trees that would grow and restore stream conditions to natural conditions.*	**NA**			*Source: Stream-Riparian Ecosystems In The Puget Sound Lowland Eco-Region, A Review of Best Available Science, Christopher W. May, Watershed Ecology LLC, 2003 (Percent load reduction); and Oregon DEQ, Cost Estimate to Restore Riparian Forest Buffers and Improve Stream Habitat in the Willamette Basin, Oregon, March 2010* (http://www.deq.state.or.us/wq/tmdls/docs/WillametteRipCost030310.pdf

Recommended Structural BMPs By TMDL Impairment or Pollutant, Source, Estimated Load Reduction and Costs (Cont.)

TMDL IMPAIRMENT OR POLLUTANT	SOURCE OF POLLUTANT	STRUCTURAL BMPS	MEDIAN INFLOW AND OUTFLOW	ESTIMATED LOAD REDUCTION	ESTIMATED COSTS	COSTS INCLUDED
BACTERIA (E coli and Fecal Coliform) (Cont.)	**Wildlife Waste**	**Riparian Restoration**	**NA**	**Same As Above**	**Same As Above**	**Same As Above**
		Restore Riparian Area *with native shrubs and trees that would grow and restore stream to natural conditions to capture bacteria.*	**NA**			**Same As Above**
	Dog and Cat Waste	**Dog Run Parks**	**NA**	**Varies According to Participation**	**Varies**	• Installation of public education signage, free “pooper scooper” bags, and sanitary trash receptacles • Adoption of a "pooper-scooper" ordinance
		Establish ***Dog Run Areas*** *in a dog park that is sited away from environmentally sensitive features, waters of the state, and provides a safe off-leash fenced area.*	**NA**			*Source: EPA National Pollutant Discharge Elimination System (NPDES) Pet Waste Management BMP Fact Sheet, http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=4&minmeasure=1*
	Bacteria Runoff From Impervious Surfaces	**Non UIC Infiltration Basin Facilities**	**NA**	**Approximately 90%**	**$2 per ft^3 of storage for a 0.25-acre basin**	• Installation • Infiltration basin is sized to treat the runoff from a 1-inch storm • Maintenance is 5% to 15% of the selected BMP installation costs
		Install Onsite and/or Regional Non UIC Infiltration Basin Facilities *to control and treat runoff*	**NA**			Source: *EPA National Pollutant Discharge Elimination System (NPDES) Infiltration Basin BMP Fact Sheet: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=69&minmeasure=5*

Recommended Structural BMPs By TMDL Impairment or Pollutant, Source, Estimated Load Reduction and Costs (Cont.)

TMDL IMPAIRMENT OR POLLUTANT	SOURCE OF POLLUTANT	STRUCTURAL BMPS	MEDIAN INFLOW AND OUTFLOW	ESTIMATED LOAD REDUCTION	ESTIMATED COSTS	COSTS INCLUDED
BACTERIA (E coli and Fecal Coliform) (Cont.)		**Retention (Wet) Pond**	**Inflow 1971 Fecal Coliform Count**	**93%**	**1996 Dollars** **$45,700 for a 1 acre-foot facility** **$232,000 for a 10 acre-foot facility** **$1,170,000 for a 100 acre-foot facility**	• Wet ponds need sufficient drainage area to maintain the permanent pool. In humid regions, this is typically about 25 acres. • Design features should include pretreatment, treatment, conveyance, maintenance reduction, and landscaping. • Ponds should always be designed with a length-to-width ratio of at least 1.5:1. • For ponds, the annual cost of routine maintenance is typically estimated at about 3 to 5 percent of the construction cost.
		*Require construction of onsite or construct regional **Retention (Wet) Ponds** that provide infiltration and removal of stormwater pollutants.*	**Outflow 133 Fecal Coliform Count**			Source: *EPA National Pollutant Discharge Elimination System (NPDES) Wet Ponds (Retention) BMP Fact Sheet*, http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=68&minmeasure=5
NUTRIENTS (Nitrates and Phosphorus)	**Nutrient Runoff From Impervious Surfaces**	**Stormwater Wetland**	**Inflow 0.12 mg/L TP** **0.21 mg/L NOx**	**33% TP** **62% NOx**	**$57,100 for a 1 acre-foot facility** **$289,000 for a 10 acre-foot facility**	• Construction, design, and permitting cost • Stormwater runoff flows through the wet pond and into the shallow marsh • Maintenance is 3% to 5% of the selected BMP installation costs
		***Construct Onsite and/or Regional Stormwater Wetland** that will infiltrate and treat nutrient laden waters.*	**Outflow 0.08 mg/L TP** **0.08 mg/L NOx**			Source: *EPA National Pollutant Discharge Elimination System (NPDES) Stormwater Wetland BMP Fact Sheet: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=74&minmeasure=5*

Recommended Structural BMPs By TMDL Impairment or Pollutant, Source, Estimated Load Reduction and Costs (Cont.)

TMDL IMPAIRMENT OR POLLUTANT	SOURCE OF POLLUTANT	STRUCTURAL BMPS	MEDIAN INFLOW AND OUTFLOW	ESTIMATED LOAD REDUCTION	ESTIMATED COSTS	COSTS INCLUDED
NUTRIENTS (Nitrates and Phosphorus) (Cont.)	**Nutrient Runoff From Impervious Surfaces (cont.)**	**Dry Swale**	**NA**	**18% - 83% TP** **84% - 99% TN** **45% - 99% NOx**	**$0.50 per ft^2**	• Design less than 4 percent slope; 1 to 2 percent slope is recommended • Small forebay should be used at the front of the swale to trap incoming sediments • Construction • Planting • Maintenance costs approximately $1.09 per linear foot
		Construct Onsite and/or Regional Non UIC Dry Swale *that will infiltrate and treat nutrient laden waters.*	**NA**			Source: *EPA National Pollutant Discharge Elimination System (NPDES) Grassed Swales BMP Fact Sheet: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=75*
		Retention (Wet) Pond	**Inflow 0.27 mg/L TP** **0.40 mg/L NOx**	**59% TP** **62.5% NOx**	**1996 Dollars** **$45,700 for a 1 acre-foot facility** **$232,000 for a 10 acre-foot facility** **$1,170,000 for a 100 acre-foot facility**	• Wet ponds need sufficient drainage area to maintain the permanent pool. In humid regions, this is typically about 25 acres. • Design features should include pretreatment, treatment, conveyance, maintenance reduction, and landscaping. • Ponds should always be designed with a length-to-width ratio of at least 1.5:1. • For ponds, the annual cost of routine maintenance is typically estimated at about 3 to 5 percent of the construction cost.
		Require construction of onsite or construct regional ***Retention (Wet) Ponds*** *that provide infiltration and removal of stormwater pollutants.*	**Outflow 0.11 mg/L TP** **0.15 mg/L NOx**			Source: *EPA National Pollutant Discharge Elimination System (NPDES) Wet Ponds (Retention) BMP Fact Sheet*, http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=68&minmeasure=5

Recommended Structural BMPs By TMDL Impairment or Pollutant, Source, Estimated Load Reduction and Costs (Cont.)

TMDL IMPAIRMENT OR POLLUTANT	SOURCE OF POLLUTANT	STRUCTURAL BMPS	MEDIAN INFLOW AND OUTFLOW	ESTIMATED LOAD REDUCTION	ESTIMATED COSTS	COSTS INCLUDED
NUTRIENTS (Nitrates and Phosphorus) (Cont.)	**Nutrient Runoff From Impervious Surfaces (cont.)**	**High Efficiency Street Sweeping**	**NA**	**51% to 87% TSS**	**$150,000**	• Purchase a high efficiency vacuum sweeper • Annualized monthly sweeper costs per curb mile per year is $218 • For weekly sweeping, it is $946 per curb mile per year. • Operation & maintenance costs are approximately $15/curb mile.
		*Conduct **Regular High Efficiency Street Sweeping** of streets, parking lots, and other impervious surfaces with sweepers that have good efficiencies for removing the tiniest particles.*	**NA**			Sources: *EPA, National Management Measures to Control Nonpoint Source Pollution from Urban Areas, EPA-841-B-05-004, November 2005 http://www.epa.gov/owow/nps/urbanmm/index.html; and EPA's Preliminary Data Summary of Urban Stormwater Best Management Practices, EPA-821-R-99-012, August 1, 1999 http://www.epa.gov/npdes/pubs/usw_a.pdf*
	Exposed Soil	**Erosion Control BMPs**	**NA**	**50% to 90% Seeding** **53% to 99% Mulching** **70% to 93% Erosion Control Blankets**	**$0.05 to $0.25/yd^2 Seeding** **$0.21 to $0.87/yd^2 Mulching** **$0.05 to 4.50/yd^2 Erosion Control Blankets**	• Installation • Maintenance is 5% to 15% of the selected BMP installation costs
		***Restore Exposed Soil Areas** with erosion control BMPs to prevent and control erosion.*	**NA**			Source: *EPA, National Management Measures to Control Nonpoint Source Pollution from Urban Areas, EPA-841-B-05-004, November 2005 (http://www.epa.gov/owow/nps/urbanmm/index.html)*

Recommended Structural BMPs By TMDL Impairment or Pollutant, Source, Estimated Load Reduction and Costs (Cont.)

TMDL IMPAIRMENT OR POLLUTANT	SOURCE OF POLLUTANT	STRUCTURAL BMPS	MEDIAN INFLOW AND OUTFLOW	ESTIMATED LOAD REDUCTION	ESTIMATED COSTS	COSTS INCLUDED
AQUATIC WEEDS OR ALGAE (Chlorophyll a)	**Same Sources Listed Above For Nutrients**	**Same Structural BMPs Listed Above For Nutrients**	**NA**	**Same Load Reductions Listed Above For Nutrients**	**Same Costs Listed Above For Nutrients**	***Same Costs Included Listed Above For Nutrients***
			NA			***Same Sources Listed Above For Nutrients***
DISSOLVED OXYGEN	**Same Sources Listed Above For Nutrients (Nitrates and Phosphorus)**	**Stormwater Wetlands**	**Inflow 6.7 mg/L (FL) DO ISBMPD #00173**	**79%**	**$57,100 for a 1 acre-foot facility** **$289,000 for a 10 acre-foot facility** **$1,470,000 for a 100 acre-foot facility**	• Grading • Planting of wetland plants • Wetlands consume about 3 to 5 percent of the land that drains to them • Wetland volume needed to control the 10-year storm (ft^3). • Annual maintenance is 3% to 5% of the construction cost
		*Require construction of onsite or construct regional **Stormwater Wetlands** that provide infiltration and flow into receiving waterbody.*	**Outflow 1.4 mg/L (FL) DO ISBMPD #00173**			Source: *EPA National Pollutant Discharge Elimination System (NPDES) Stormwater Wetlands BMP Fact Sheet*, (http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=74&minmeasure=5)

Recommended Structural BMPs By TMDL Impairment or Pollutant, Source, Estimated Load Reduction and Costs (Cont.)

TMDL IMPAIRMENT OR POLLUTANT	SOURCE OF POLLUTANT	STRUCTURAL BMPS	MEDIAN INFLOW AND OUTFLOW	ESTIMATED LOAD REDUCTION	ESTIMATED COSTS	COSTS INCLUDED
TOXICS: METALS **TOTAL ARSENIC**	**Stormwater**	**Dry Detention Ponds**	**Inflow 2.5 ug/L Total Arsenic**	**28%**	**41,600 for a 1 acre-foot pond** **$239,000 for a 10 acre-foot pond**	• Installation • Designed to detain stormwater runoff for some minimum time (e.g., 24 hours) • Maintenance is typically estimated at about 3% to 5% of the construction cost
		Install Onsite and/or Regional Dry Detention Ponds *to control and treat stormwater runoff*	**Outflow 1.8 ug/L Total Arsenic**			Source: *EPA National Pollutant Discharge Elimination System (NPDES) Dry Detention Ponds BMP Fact Sheet, http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=57&minmeasure=4*
TOTAL CADMIUM	**Stormwater**	**Bioswale or Wetland Channel**	**Inflow 2.4 ug/L Total Cadmium**	**79%**	**1994 Dollars** **$16,000 per 2.5 acres**	• Designed to convey flow very slowly, often less than 2 ft/sec at the 2-year flood peak flow rate. • Designed to support dense wetland vegetation on its bottom.
		Install ***Bioswale or Wetland Channels*** *to infiltrate and treat stormwater*	**Outflow 0.5 ug/L Total Cadmium**			Source: *International Stormwater BMP Database, Cost Data Included in July 2007 Database Release, by Wright Water Engineers, Inc. and GeoSyntec Consultants, http://www.bmpdatabase.org/Docs/Cost%20Data%20Contained%20in%202007%20Release%20of%20BMP%20Database.xls, and International Stormwater, 2010 BMP Database Data Entry Spreadsheets User's Guide, by Wright Water Engineers, Inc. and GeoSyntec Consultants' http://www.bmpdatabase.org/Docs/2010%20BMP%20Database%20User's%20Guide.pdf*

Recommended Structural BMPs By TMDL Impairment or Pollutant, Source, Estimated Load Reduction and Costs (Cont.)

TMDL IMPAIRMENT OR POLLUTANT	SOURCE OF POLLUTANT	STRUCTURAL BMPS	MEDIAN INFLOW AND OUTFLOW	ESTIMATED LOAD REDUCTION	ESTIMATED COSTS	COSTS INCLUDED
TOXICS: METALS (Cont.) **TOTAL CADMIUM**	**Stormwater**	**Grassed Swales (Filter Strips)**	**Inflow 0.5 ug/L Total Cadmium**	**60%**	**$0.50 per ft^2**	• Design less than 4 percent slope; 1 to 2 percent slope is recommended • Small forebay should be used at the front of the swale to trap incoming sediments • Construction • Planting • Maintenance costs approximately $1.09 per linear foot
		*Install **Grassed Swales** (a.k.a. grassed channel, dry swale, wet swale, or biofilter) to infiltrate and treat stormwater*	**Outflow 0.2 ug/L Total Cadmium**			*Sources: EPA National Pollutant Discharge Elimination System (NPDES) Stormwater Grassed Swales BMP Fact Sheet, (http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=75&minmeasure=5); and EPA, National Management Measures to Control Nonpoint Source Pollution from Urban Areas, EPA-841-B-05-004, November 2005 http://www.epa.gov/owow/nps/urbanmm/index.html*
TOTAL CHROMIUM	**Stormwater**	**Retention (Wet) Pond**	**Inflow 5.0 ug/L Total Chromium**	**60%**	**1996 Dollars** **$45,700 for a 1 acre-foot facility** **$232,000 for a 10 acre-foot facility** **$1,170,000 for a 100 acre-foot facility**	• Wet ponds need sufficient drainage area to maintain the permanent pool. In humid regions, this is typically about 25 acres. • Design features should include pretreatment, treatment, conveyance, maintenance reduction, and landscaping. • Ponds should always be designed with a length-to-width ratio of at least 1.5:1. • For ponds, the annual cost of routine maintenance is typically estimated at about 3 to 5 percent of the construction cost.
		*Require construction of onsite or construct regional **Retention (Wet) Ponds** that provide infiltration and removal of stormwater pollutants.*	**Outflow 2.0 ug/L Total Chromium**			Source: *EPA National Pollutant Discharge Elimination System (NPDES) Wet Ponds (Retention) BMP Fact Sheet*, http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=68&minmeasure=5

Recommended Structural BMPs By TMDL Impairment or Pollutant, Source, Estimated Load Reduction and Costs (Cont.)

TMDL IMPAIRMENT OR POLLUTANT	SOURCE OF POLLUTANT	STRUCTURAL BMPS	MEDIAN INFLOW AND OUTFLOW	ESTIMATED LOAD REDUCTION	ESTIMATED COSTS	COSTS INCLUDED
TOXICS: METALS (Cont.) **TOTAL COPPER**	**Stormwater**	**Grassed Swales (Filter Strips)**	**Inflow 23.5 ug/L Total Copper**	**69%**	**$0.50 per ft^2**	• Design less than 4 percent slope; 1 to 2 percent slope is recommended • Small forebay should be used at the front of the swale to trap incoming sediments • Construction • Planting • Maintenance costs approximately $1.09 per linear foot
		*Install **Grassed Swales** (a.k.a. grassed channel, dry swale, wet swale, or biofilter) to infiltrate and treat stormwater pollutants*	**Outflow 7.3 ug/L Total Copper**			*Sources: EPA National Pollutant Discharge Elimination System (NPDES) Stormwater Grassed Swales BMP Fact Sheet, (http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=75&minmeasure=5); and EPA, National Management Measures to Control Nonpoint Source Pollution from Urban Areas, EPA-841-B-05-004, November 2005 http://www.epa.gov/owow/nps/urbanmm/index.html*
TOTAL IRON	**Stormwater**	**Retention (Wet) Pond**	**Inflow 1160 ug/L Total Iron**	**76%**	**1996 Cost Estimate:** **$45,700 for a 1 acre-foot facility** **$232,000 for a 10 acre-foot facility** **$1,170,000 for a 100 acre-foot facility**	• Wet ponds need sufficient drainage area to maintain the permanent pool. In humid regions, this is typically about 25 acres. • Design features should include pretreatment, treatment, conveyance, maintenance reduction, and landscaping. • Ponds should always be designed with a length-to-width ratio of at least 1.5:1. • For ponds, the annual cost of routine maintenance is typically estimated at about 3 to 5 percent of the construction cost.
		*Require construction of onsite or construct regional **Retention (Wet) Ponds** that provide infiltration and removal of stormwater pollutants.*	**Outflow 227 ug/L Total Iron**			Source: *EPA National Pollutant Discharge Elimination System (NPDES) Wet Ponds (Retention) BMP Fact Sheet*, http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=68&minmeasure=5

Recommended Structural BMPs By TMDL Impairment or Pollutant, Source, Estimated Load Reduction and Costs (Cont.)

TMDL IMPAIRMENT OR POLLUTANT	SOURCE OF POLLUTANT	STRUCTURAL BMPS	MEDIAN INFLOW AND OUTFLOW	ESTIMATED LOAD REDUCTION	ESTIMATED COSTS	COSTS INCLUDED
TOXICS: METALS (Cont.) **TOTAL LEAD**	**Stormwater**	**Grassed Swales (Filter Strips)**	**Inflow 8.6 UG/l Total Lead**	**77%**	**$0.50 per ft^2**	• Design less than 4 percent slope; 1 to 2 percent slope is recommended • Small forebay should be used at the front of the swale to trap incoming sediments • Construction • Planting • Maintenance costs approximately $1.09 per linear foot
		*Install **Grassed Swales** (a.k.a. grassed channel, dry swale, wet swale, or biofilter) to infiltrate and treat stormwater pollutants*	**Outflow 2.0 ug/L Total Lead**			*Sources: EPA National Pollutant Discharge Elimination System (NPDES) Stormwater Grassed Swales BMP Fact Sheet, (http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=75&minmeasure=5); and EPA, National Management Measures to Control Nonpoint Source Pollution from Urban Areas, EPA-841-B-05-004, November 2005 http://www.epa.gov/owow/nps/urbanmm/index.html*
TOTAL LEAD	**Stormwater**	**Retention (Wet) Pond**	**Inflow 10.0 ug/L Total Lead**	**70%**	**1996 Dollars** **$45,700 for a 1 acre-foot facility** **$232,000 for a 10 acre-foot facility** **$1,170,000 for a 100 acre-foot facility**	• Wet ponds need sufficient drainage area to maintain the permanent pool. In humid regions, this is typically about 25 acres. • Design features should include pretreatment, treatment, conveyance, maintenance reduction, and landscaping. • Ponds should always be designed with a length-to-width ratio of at least 1.5:1. • For ponds, the annual cost of routine maintenance is typically estimated at about 3 to 5 percent of the construction cost.
		*Require construction of onsite or construct regional **Retention (Wet) Ponds** that provide infiltration and removal of stormwater pollutants.*	**Outflow 3.0 ug/L Total Lead**			Source: *EPA National Pollutant Discharge Elimination System (NPDES) Wet Ponds (Retention) BMP Fact Sheet*, http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=68&minmeasure=5

Recommended Structural BMPs By TMDL Impairment or Pollutant, Source, Estimated Load Reduction and Costs (Cont.)

TMDL IMPAIRMENT OR POLLUTANT	SOURCE OF POLLUTANT	STRUCTURAL BMPS	MEDIAN INFLOW AND OUTFLOW	ESTIMATED LOAD REDUCTION	ESTIMATED COSTS	COSTS INCLUDED
TOXICS: METALS (Cont.) **TOTAL NICKEL**	**Stormwater**	**Bioswale or Wetland Channel**	**Inflow 6.9 ug/L Total Nickel**	**56.5%**	**2000 Dollars** **$133,077 per 2.5 acres**	• Average Annual Revegetation Costs equals $300 • Designed to convey flow very slowly, often less than 2 ft/sec at the 2-year flood peak flow rate. • Designed to support dense wetland vegetation on its bottom.
		*Install **Bioswale or Wetland Channels** to infiltrate and treat stormwater*	**Outflow 3.0 ug/L Total Nickel**			Source: International Stormwater BMP Database, Cost Data Included in July 2007 Database Release, by Wright Water Engineers, Inc. and GeoSyntec Consultants, http://www.bmpdatabase.org/Docs/Cost%20Data%20Contained%20in%202007%20Release%20of%20BMP%20Database.xls, and International Stormwater, 2010 BMP Database Data Entry Spreadsheets User's Guide, by Wright Water Engineers, Inc. and GeoSyntec Consultants' http://www.bmpdatabase.org/Docs/2010%20BMP%20Database%20User's%20Guide.pdf
TOTAL ZINC	**Stormwater**	**Grassed Swales (Filter Strips)**	**Inflow 99.0 ug/L Total Zinc**	**76%**	**$0.50 per ft^2**	• Design less than 4 percent slope; 1 to 2 percent slope is recommended • Small forebay should be used at the front of the swale to trap incoming sediments • Construction • Planting • Maintenance costs approximately $1.09 per linear foot
		*Install **Grassed Swales** (a.k.a. grassed channel, dry swale, wet swale, or biofilter) to infiltrate and treat stormwater pollutants*	**Outflow 24.0 ug/L Total Zinc**			*Sources: EPA National Pollutant Discharge Elimination System (NPDES) Stormwater Grassed Swales BMP Fact Sheet, (http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=75&minmeasure=5); and EPA, National Management Measures to Control Nonpoint Source Pollution from Urban Areas, EPA-841-B-05-004, November 2005 http://www.epa.gov/owow/nps/urbanmm/index.html*

Recommended Structural BMPs By TMDL Impairment or Pollutant, Source, Estimated Load Reduction and Costs (Cont.)

TMDL IMPAIRMENT OR POLLUTANT	SOURCE OF POLLUTANT	STRUCTURAL BMPS	MEDIAN INFLOW AND OUTFLOW	ESTIMATED LOAD REDUCTION	ESTIMATED COSTS	COSTS INCLUDED
TOXICS: METALS (Cont.) **TOTAL ZINC**	**Stormwater**	**Porous Concrete and/or Asphalt Roads**	**Inflow 62.1 ug/L Total Zinc**	**71%**	**$1.09 to $2.18 per ft^2**	• Do not install in areas where hazardous materials are loaded, unloaded, or stored. • Avoid high sediment loading areas. • Do not use sand for snow or ice treatment. • Periodic maintenance to remove fine sediments from paver surface will optimize permeability. • Annual maintenance cost are $0.16 per ft^2 to remove fine sediments from paver surface
		*Require construction of **Porous Concrete and/or Asphalt Roads** when constructing new roads or re-construction of a road.*	**Outflow 17.8 ug/L Total Zinc**			Source: *EPA, National Management Measures to Control Nonpoint Source Pollution from Urban Areas, EPA-841-B-05-004, November 2005 http://www.epa.gov/owow/nps/urbanmm/index.html*
TOTAL ZINC	**Stormwater**	**Rain Gardens (Bioretention)**	**Inflow 74.0 ug/L Total Zinc**	**73%**	**Residential Rain Gardens Average $3 to $4 per ft^2** **Commercial, Industrial and Institutional Site Costs Between $10 to $40 per ft^2**	• Bioretention areas best used on small sites (i.e., 5 acres or less). • Sized between 5 and 10 percent of the impervious area. • Designed to pond a small amount of water (6-9 inches) above the filter bed. • Costs include control structures, curbing, storm drains, under drains, and plants, which can vary. • Bioretention requires landscaping maintenance.
		***Install Rain Gardens (Bioretention)**to control and treat turbid runoff*	**Outflow 30.0 ug/L Total Zinc**			Sources: *EPA National Pollutant Discharge Elimination System (NPDES) Bioretention (Rain Gardens) BMP Fact Sheet: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=72&minmeasure=5 and Low Impact Development (LID) Urban Design Tools Website: http://www.lid-stormwater.net/index.html*

Recommended Structural BMPs By TMDL Impairment or Pollutant, Source, Estimated Load Reduction and Costs (Cont.)

TMDL IMPAIRMENT OR POLLUTANT	SOURCE OF POLLUTANT	STRUCTURAL BMPS	MEDIAN INFLOW AND OUTFLOW	ESTIMATED LOAD REDUCTION	ESTIMATED COSTS	COSTS INCLUDED
OTHER TOXICS: Such As Pesticides (Attached to Sediment)	**Same Sources Listed Above For Sedimentation (Turbidity)**	**Same Structural BMPs Listed Above For Sedimentation (Turbidity)**		**Same Load Reductions Listed Above For Sedimentation (Turbidity)**	**Same Costs Listed Above For Sedimentation (Turbidity)**	***Same Costs Included Listed Above For Sedimentation (Turbidity)***
						Same Sources Listed Above For Sedimentation (Turbidity)
OTHER TOXICS: Such As Pesticides (In Water)	**Same Sources Listed Above For Nutrients (Nitrates and Phosphorus)**	**Same Structural BMPs Listed Above For Nutrients (Nitrates and Phosphorus)**		**Same Load Reductions Listed Above For Nutrients (Nitrates and Phosphorus)**	**Same Costs Listed Above For Nutrients (Nitrates and Phosphorus)**	***Same Costs Included Listed Above For Nutrients (Nitrates and Phosphorus)***
						Same Sources Listed Above For Nutrients (Nitrates and Phosphorus)
OIL AND GREASE	**Stormwater**	**Stormwater Wetlands**	**Inflow 10.15 mg/L Oil and Grease (Ptld.) ISBMPD #00048**	**75%**	**$57,100 for a 1 acre-foot facility** **$289,000 for a 10 acre-foot facility** **$1,470,000 for a 100 acre-foot facility**	• Grading • Planting of wetland plants • Wetlands consume about 3 to 5 percent of the land that drains to them • Wetland volume needed to control the 10-year storm (ft^3). • Annual maintenance is 3% to 5% of the construction cost
		*Require construction of onsite or construct regional **Stormwater Wetlands** that provide infiltration and flow into receiving waterbody.*	**Outflow 2.5 mg/L Oil and Grease (Ptld.) ISBMPD #00048**			Source: *EPA National Pollutant Discharge Elimination System (NPDES) Stormwater Wetlands BMP Fact Sheet*, (http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=74&minmeasure=5)

Recommended Structural BMPs By TMDL Impairment or Pollutant, Source, Estimated Load Reduction and Costs (Cont.)

TMDL IMPAIRMENT OR POLLUTANT	SOURCE OF POLLUTANT	STRUCTURAL BMPS	MEDIAN INFLOW AND OUTFLOW	ESTIMATED LOAD REDUCTION	ESTIMATED COSTS	COSTS INCLUDED
OIL AND GREASE	**Stormwater**	**Grassed Swales (Filter Strips)**	**Inflow 6.6 mg/L Oil and Grease (Ptld.) ISBMPD #00403**	**62%**	**$0.50 per ft^2**	• Design less than 4 percent slope; 1 to 2 percent slope is recommended • Small forebay should be used at the front of the swale to trap incoming sediments • Construction • Planting • Maintenance costs approximately $1.09 per linear foot
		*Install **Grassed Swales** (a.k.a. grassed channel, dry swale, wet swale, or biofilter) to infiltrate and treat stormwater pollutants*	**Outflow 2.5 mg/L Oil and Grease (Ptld.) ISBMPD #00403**			*Sources: EPA National Pollutant Discharge Elimination System (NPDES) Stormwater Grassed Swales BMP Fact Sheet, (http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=75&minmeasure=5); and EPA, National Management Measures to Control Nonpoint Source Pollution from Urban Areas, EPA-841-B-05-004, November 2005 http://www.epa.gov/owow/nps/urbanmm/index.html*

Appendix F: When Stormwater Best Management Practices (BMPs) That Are or Are Not Underground Injection Controls (UICs)

Guidelines in the use of this table: When stormwater BMPs are UICs numerous factors are evaluated as noted in this table. For a stormwater BMP to be granted Rule Authorization depends on the type of pre-treatment being used, land use(s), risk, likely quality and quantity of the discharge, required buffers/distance to water wells and sensitive areas, soils type and depth, confinement barrier, and local groundwater flow and depth to groundwater.

Disclaimer: A person that owns or operates stormwater BMPs is responsible for its performance and meeting all local, state, and federal regulations and design standards. If properly designed, installed and maintained, stormwater BMPs for infiltration (not injection) are advantageous for stormwater quality and quantity management considerations for preservation or reestablishment of the hydrologic cycle. However, owners/operators of stormwater infiltration BMPs must be careful to not cause the pollution of aquifers.

Stormwater BMPs That Are or Are Not UICs

STORMWATER BMP[10]	POSSIBLE WPCF PERMIT	POSSIBLE RULE AUTHORIZED	LIKELY NOT UIC	DESIGN NOTES
Dry Well/Drill Hole	**X**	**X**		
French/Trench Drain	**X**	**X**		
Infiltration Drain Field	**X**	**X**		Large domestic on-sites under WPCF permit. If any used for (non-human use), e.g., kennels may be Rule Authorized if pre-treated.

10 Note: nomenclature of structural stormwater BMPs varies.

Stormwater BMPs That Are or Are Not UICs (Cont.)

STORMWATER BMP[11]	POSSIBLE WPCF PERMIT	POSSIBLE RULE AUTHORIZED	LIKELY NOT UIC	DESIGN NOTES
Infiltration Trench (a.k.a. Infiltration Gallery)	**X**	**X**		Capped, Covered, or installed underground.
Infiltration Trench (without subsurface)			**X**	Open to surface **without** subsurface fluid distribution system (e.g., perforated pipes, drain tiles, membrane, drip, trench drain, etc.).
Infiltration Trench (with subsurface)	**X**	**X**		Open to surface **with** subsurface fluid distribution system (e.g., perforated pipes, drain tiles, membrane, drip, trench drain, etc.).
Infiltration Basin/Pond			**X**	Open to the surface **without** subsurface fluid distribution system (e.g., perforated pipes, drain tiles, membrane, drip, trench drain, etc.).
Infiltration Basin/Pond	**X**	**X**		**With** subsurface fluid distribution system (e.g., perforated pipes, drain tiles, membrane, drip, trench drain, etc.).
Sump/Tank/Vault	**X**			**With** subsurface discharge.
Sump/Tank/Vault			**X**	**Without** subsurface discharge or with discharge to surface or to municipal storm sewer.
Sand Filter and/or Organic Material	**X**	**X**		**With** subsurface fluid distribution system (e.g., perforated pipes, drain tiles, membrane, drip, trench drain, etc.).

11 Note: nomenclature of structural stormwater BMPs varies.

Stormwater BMPs That Are or Are Not UICs (Cont.)

STORMWATER BMP[12]	POSSIBLE WPCF PERMIT	POSSIBLE RULE AUTHORIZED	LIKELY NOT UIC	DESIGN NOTES
Sand Filter and/or Organic Material			X	**Without** subsurface fluid distribution system (e.g., perforated pipes, drain tiles, membrane, drip, trench drain, etc.). (Note: Sand Filters are poor for metals removal).
Roof Downspouts/ Drains for a Single Residential site/building			X	**With** subsurface discharge. Single residential sites may register on volunteer basis.
Roof Downspouts/Drains for Commercial, industrial/residential sites and complexes.		X		**With** subsurface discharge. Commercial, industrial, and residential sites/ complexes/buildings required to register.
Porous Pavement (porous concrete and asphalt, pavers, etc.)			X	Generally for small parking and overflow parking area, flag lots, etc. that have minimal traffic. Requires vacuuming to prevent clogging and impacts to groundwater.
Wet Extended Detention Pond/Basin (a.k.a. Retention Pond)			X	
Constructed Stormwater Wetland			X	For water quality treatment only (not a created wetland per CWA Section 404 or 10.)
Dry Extended Detention Pond/Basin			X	

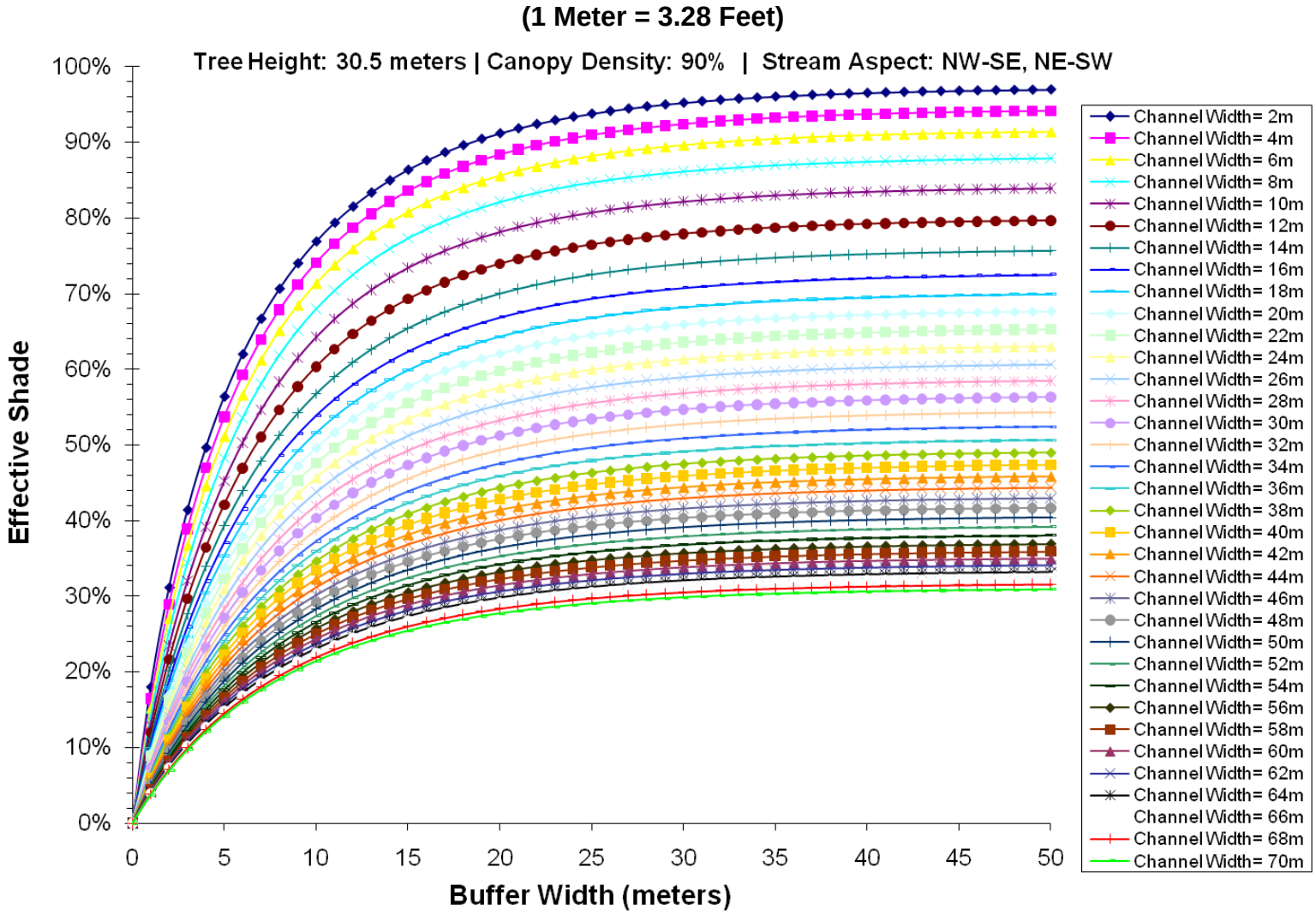
12 Note: nomenclature of structural stormwater BMPs varies.

Stormwater BMPs Stormwater BMPs That Are or Are Not UICs (Cont.)

STORMWATER BMP[13]	POSSIBLE WPCF PERMIT	POSSIBLE RULE AUTHORIZED	LIKELY NOT UIC	DESIGN NOTES
Catch Basin/Inlet			**X**	
Proprietary Stormwater Treatment Systems			**X**	**Without** subsurface discharge. Examples: "Swirl Separator", "Hydro-Dynamics Structure", "StormTreat", etc.).
Swale, Vegetated and other covers	**X**			**With** subsurface fluid distribution system (e.g., perforated pipes, drain tiles, membrane, drip, trench drain, etc.).
Swale, Vegetated and other covers		**X**		Used in series **with** UIC or fluid distribution system (e.g., perforated pipes, drain tiles, membrane, drip, trench drain, etc.) for flood control or any other purpose.
Swale, Vegetated and other covers			**X**	**Without** subsurface fluid distribution system (e.g., perforated pipes, drain tiles, membrane, drip, trench drain, etc.)
Vegetated Filter Strip			**X**	
Bio-Retention			**X**	
Catch Basin Inserts			**X**	Usual proprietary systems.
Oil and Water Separators			**X**	Usual proprietary systems.

13 Note: nomenclature of structural stormwater BMPs varies.

Appendix G: Example Riparian Buffer Widths Determination



Appendix H: Example Low Impact Development (LID) Ordinance, DEQ Model Low Impact Development Ordinance

Low Impact Development Ordinance

Problem

Local jurisdictions must address their stormwater per state land use planning Goal 6 requirements. In addition, the presence of a river, lake, or stream on DEQ's 303(d) list or an Environmental Protection Agency (EPA) approved Total Maximum Daily Load (TMDL), or liability concerns resulting from an Endangered Species Act (ESA) listing may necessitate more stringent stormwater management plans and implementation. The water quality impact issues that led to a 303(d) listing or an EPA approved TMDL are from both stormwater and nonpoint source pollutants such as temperature, nutrients, pesticides, metals, PAHs, etc. Protecting, enhancing, and treating for water quality program needs and other requirements are covered under Goal 6.

Many communities deal with stormwater by channeling and diverting it into the storm sewer system and moving it off site as quickly as possible. Stormwater plans and zoning codes often deal only with the conveyance of stormwater, and not the retention, treatment, infiltration, and prevention of water quality impacts. Stormwater runoff can alter natural stream flows and cause increased erosion and lead to downstream flooding. Where stormwater encounters pollutants, such as oil, pesticides, solvents, and other materials used in the urban environment, pollutants can be carried into surface or groundwater. These issues must be adequately considered during the land use review process.

Strategies for treating, retaining, infiltrating, and detaining stormwater as it flows across the ground are being used in many cities in an effort to achieve this ideal. Using Low Impact Development (LID) practices protects and reduces the impact of development on water quality and natural systems. LID practices look beyond the building envelope and focus on land development and site design that mimic nature's processes that conserve the natural systems and hydrologic functions of a site.

The goal of LID is to manage stormwater generated from new development and redevelopment so there will be no negative impacts to adjacent and/or downstream property owners and no degradation to groundwater, surface waters, or other "waters of the state" such as streams, ravines, wetlands, potholes, and rivers. In addition, LID is designed to provide water quality treatment control for the duration storm runoff from impervious areas using retention practices that will provide certainty to land developers and federal and state agencies in terms of performance measures and compliance with Federal Clean Water Act and specifically, the National Pollutant Discharge Elimination System (NPDES) requirements.

Objective

Conserve and use existing natural site features, to integrate distributed, small-scale stormwater controls, and to prevent measurable harm to streams, lakes, wetlands, and other natural aquatic systems from commercial, residential, or industrial development sites by maintaining a more hydrologically functional landscape.

Strategy

Implement the following Low Impact Development (LID) model code to encourage low impact development practices and projects within the community.

Discussion

Low impact development (LID) is a new approach and set of tools to help communities better protect Oregon's water quality, habitat, and biological resources from the harmful effects of land development and stormwater runoff. The low impact development approach to developing land and managing stormwater is to imitate the natural hydrology (or movement of water) of the site. In a mature Pacific Northwest forest, for example, almost all the rainfall (or snowmelt) disperses along the forest floor, where it infiltrates into the ground, is taken up by the roots of plants and trees, or evaporates. Researchers estimate that about less than one percent becomes surface runoff.

However, when forests and natural open spaces are cleared, and buildings, roads, parking areas and lawns dominate the landscape, rainfall becomes stormwater runoff, carrying pollutants to nearby waters. Much less water infiltrates

and is taken up by plants, less evaporates back to the atmosphere, and much more (about 20-30 percent in a suburban neighborhood) becomes surface runoff or stormwater runoff.

Low impact development (LID) techniques offer many benefits for managing stormwater. However, most local government regulations in Oregon still discourage or even prohibit the use of many LID techniques in development projects. For example, many local regulations require curbs and gutters along streets, or prohibit the use of permeable pavement. This is largely because traditional stormwater management practices have long relied on storm drains, pipes, and ponds to manage stormwater. Yet many builders, developers and other professionals are eager to incorporate LID techniques in their projects. Citizens who want their communities to grow more attractively—while protecting natural resources—also appreciate the potential of LID.

Low Impact Development (LID) Model Code Provisions

LOW IMPACT DEVELOPMENT (LID)

Sections:

I. Purposes.

All projects are encouraged [not required] to use some or all of LID techniques.

The goal of low impact development is to conserve and use existing natural site features, to integrate distributed, small-scale stormwater controls, and to prevent measurable harm to streams, lakes, wetlands, and other natural aquatic systems from commercial, residential, or industrial development sites by maintaining a more hydrologically functional landscape. The purpose of this chapter is to establish the development guidelines, requirements, and standards for low impact development projects. As part of meeting these purposes and goals, this chapter is intended to fulfill the following purposes:

A. Manage stormwater through a land development strategy that emphasizes conservation and use of on-site natural features integrated with engineered, small-scale hydrologic controls to more closely mimic predevelopment hydrologic conditions.
B. Encourage creative and coordinated site planning, the conservation of natural conditions and features, the use of appropriate new technologies and techniques, and the efficient layout of streets, utility networks and other public improvements.
C. Minimize impervious surfaces.
D. Encourage the creation or preservation of permanent forested open space.
E. Encourage development of industrial, commercial, and residential environments that are harmonious with on-site and off-site natural and built environments.
F. Further the goals and the implementation of the policies of the comprehensive land use plan.
G. Encourage infiltration as the preferred method of stormwater drainage.

II. Design and Development Standards.

Conformance to the following criteria is required for all development reviewed under the provisions of this chapter:

A. LID projects shall meet the water quality design and performance standards of Chapter 4.3.1.
B. Water quality treatment BMPs shall be provided to treat [95] percent of the annual runoff volume.
C. All areas subject to clearing and grading that have not been covered by impervious surfaces, incorporated into a drainage facility or engineered as structural fill or slope shall comply, at project completion, with section VIII of this chapter.
D. After certificate of occupancy is issued, there shall be no net increase in effective impervious surfaces for any LID project. The maximum impervious surfaces allowed for each lot shall be added to the face of the plat.
E. All projects shall provide a maintenance plan/program that has been approved by the [jurisdiction] including source control BMPs.
F. LID projects shall reduce the size of conventional detention facilities (e.g., ponds) as follows:
    1. Calculate the pond volume of a conventional project by using the conventional modeling assumptions in Table [X]: Impervious Surface Maximum Limits and Modeling Assumptions.
    2. Reduce the conventional volume by the percentage shown in Table [X]: Pond Reduction and Native Vegetation Requirements to find the allowed LID pond size.
    3. Apply sufficient LID techniques to the project so that the conventional pond volume is reduced to the required pond reduction percentage found in Table [X]. LID projects shall preserve native vegetation area according to the percentages shown in Table [X]. If the site has already been disturbed, the site shall be revegetated to meet the percentages shown in [X].

H. LID projects shall not exceed the maximum impervious surface limits shown in Table [X] under the column "LID Project".

TABLE [X]: Pond Reduction and Native Vegetation Requirements	Required Pond Reduction (Infiltration < 0.30 in/hr or less) [1,2]	Required Pond Reduction (Infiltration of ≥ 0.30 in/hr or more) [1,2]	Native Vegetation Area[3]
Residential < 6.1 Dwelling Units per Acre	50%	60%	35%
Residential ≥ 6.1 Dwelling Units per Acre	50%	60%	20%
Multi-Family[4,5]	40%	80%	20%
Commercial[5]	40%	80%	10%

1 The pond volume of a LID project must be reduced from conventional development volumes by the percentages listed in Table [X] while still meeting the required flow control standards.
2 Infiltration rates are as measured in the field at the proposed LID location using techniques recommended in Chapter 4.3.1.
3 Native vegetation areas shall comply with the standards established in Section VII of this chapter.
4 Multi-family projects are those projects containing more than four dwelling units attached in a single structure, regardless of ownership mechanism.
5 Multi-family and commercial projects must use pervious pavement for at least 20 percent of all paved surfaces.

Table [X]: Impervious Surface Maximum Limits and Modeling Assumptions[1]			
Dwelling Units Per Acre[2]	**Maximum Percent Impervious:** *LID Project*	**Conventional Percent Impervious:** *Modeling Assumption*	**Conventional Percent Turf:** *Modeling Assumption*
Non-Multifamily Residential ≤1.4 du/ac	10%	15%	85%
Non-Multifamily Residential 1.5-2.4 du/ac	15%	25%	75%
Non-Multifamily Residential 2.5-3.4 du/ac	20%	35%	65%
Non-Multifamily Residential 3.5-4.9 du/ac	30%	40%	60%
Non-Multifamily Residential 5.0-6.9 du/ac	35%	50%	50%
Non-Multifamily Residential 7.0-9.9 du/ac	40%	60%	40%
Non-Multifamily Residential ≥10.0 du/ac	60%	80%	20%
Multifamily Residential	70%	90%	10%
Commercial	70%	90%	10%

1 Impervious area includes all hard surfaces that impede infiltration of rainfall into the underlying soil profile. Many LID techniques improve the ability of water to infiltrate into the soil.
2 Dwelling units per acre is based on gross density.

III. Permitted uses.

Uses allowed in a low impact development shall include permitted, accessory, and conditional uses allowed in and subject to the conditions of the underlying zone district(s).

IV. Conformance.

All uses and development shall conform to all relevant requirements and standards of:
A. The zone district(s) within which the low impact development is located, except as may be modified by this chapter;
B. The International Building and Fire Codes; and
C. Other applicable official controls.

V. General design criteria.

A. The location of all streets, buildings, parking areas, pedestrian, bicycle and vehicular ways, and utility easements shall be designed to promote public safety, compatibility of uses, minimize effective impervious surface, preserve forested open space, and complement predevelopment site characteristics such as topography, soils, hydrology, and other natural features.
B. LID projects that are not accompanied by a concurrent subdivision or short subdivision approval, shall record an easement or covenant against the land title to ensure that the low impact development features are protected.

VI. Site assessment.

Low impact development site design is intended to mimic the predevelopment hydrologic conditions on the site. The development context shall be established by an initial site assessment. The initial inventory and assessment process will provide the baseline information necessary to design strategies that preserve natural resources, preserve areas most appropriate to evaporate, transpire, and infiltrate stormwater, and achieve the goal of maintaining pre-development natural hydrologic conditions on the site. The assessment will result in a series of maps identifying streams, lakes, wetlands, and buffers; steep slopes and other hazard areas; significant wildlife habitat areas; and permeable soils offering the best available infiltration potential. Maps can be combined as hard copies or as GIS layers to delineate the best areas to direct development. Designated development areas, which will contain all impervious surfaces and landscaped areas on the site, should be configured to minimize soil and vegetation disturbance, buffer critical areas, and take advantage of a site's natural stormwater processing capabilities. Designated development area boundaries shall be delineated on site plans and identified on the site during site preparation and construction. Areas outside of the designated development area envelope shall be designated Native Vegetation Areas or reserve areas.

VII. Native Vegetation Areas.

A. For the purposes of calculating required area, inundated lands shall not be included; however, other sensitive areas and their buffers may be included within the Native Vegetation Area boundaries.
B. Portions of a designated Native Vegetation Area without sufficient existing tree canopy shall be planted with a minimum of one native tree for every [600 or xxx] square feet. This requirement does not apply to wetlands or delineated wetland boundaries.
C. Native vegetation shall consist of plants that are indigenous to the Pacific Northwest or near natives that are suitable for the Pacific Northwest climate. A survey of existing trees and a tree planting plan shall be submitted for review and approval by the Planning Director as required under section XXII of this chapter.
D. Development within Native Vegetation Area shall be limited to stormwater dispersion facilities, pervious pedestrian trails, and approved surface water restoration projects. Activities within the Native Vegetation Areas shall be limited to passive recreation, removal of invasive species, amendment of disturbed soils consistent with all applicable regulations, and planting of native vegetation. Development shall be consistent with critical areas requirements and restrictions in [jurisdiction] development code.
E. A permanent protective mechanism shall be legally established to ensure that the required Native Vegetation Area is preserved and protected in perpetuity in a form that is acceptable to both the applicant and the [jurisdiction] and filed with the County Auditor's office. A permanent Native Vegetation Area shall be established using one of the following mechanisms.
    1. Placement in a separate non-building tract owned in common by the owners of the other buildings/lots of the project;
    2. Covered by a protective easement or public or private land trust dedication;
    3. Preserved through an appropriate permanent protective mechanism that provides the same level of permanent protection as subsection (1) of this section as determined by the approval authority.
F. Restrictions on the future use of the Native Vegetation Area shall be recorded on the face of the final plat or short plat.

VIII. Native Soil Protection and Amendment.

The duff layer and native topsoil should be retained in an undisturbed state to the maximum extent practicable. In any areas requiring grading, remove and stockpile the duff layer and topsoil on site in a designated, controlled area, not adjacent to public resources and critical areas, to be reapplied to other portions of the site where feasible.

A. Soil quality. All areas subject to clearing and grading that have not been covered by impervious surface, incorporated into a drainage facility or engineered as structural fill or slope shall, at project completion, demonstrate the following:
   1. An uncompacted topsoil layer, with a minimum organic matter content of ten percent dry weight in planting beds, and 5% organic matter content in turf areas, and a pH from 6.0 to 8.0 or matching the pH of the original undisturbed soil. The topsoil layer shall have a minimum depth of eight inches except where tree roots limit the depth of incorporation of amendments needed to meet the criteria. Subsoil's below the topsoil layer should be scarified at least 4 inches with some incorporation of the upper material to avoid stratified layers, where feasible.
   2. Planting beds must be mulched with 2 inches of organic material.
   3. Quality of compost and other materials used to meet the organic content requirements:
      a. The organic content for "pre-approved" amendment rates can be met only using compost that meets the definition of "composted materials" in OAR 340-093-0030.
      b. The compost must also have an organic matter content of 35% to 65%, and a carbon to nitrogen ratio below 25:1. The carbon to nitrogen ratio may be as high as 35:1 for plantings composed entirely of plants native to the [jurisdiction].
      c. Calculated amendment rates may be met through use of composted materials as defined above; or other organic materials amended to meet the carbon to nitrogen ratio requirements, and meeting the contaminant standards of Grade A Compost. The resulting soil should be conducive to the type of vegetation tobe established.

B. Implementation Options: The soil quality design guidelines listed above can be met by using one of the methods listed below:
   1. Leave undisturbed native vegetation and soil, and protect from compaction during construction
   2. Amend existing site topsoil or subsoil either at default "preapproved" rates, or at custom calculated rates based on specifier's tests of the soil and amendment
   3. Stockpile existing topsoil during grading, and replace it prior to planting. Stockpiled topsoil must also be amended if needed to meet the organic matter or depth requirements, either at a default "pre-approved" rate or at a custom calculated rate.
   4. Import topsoil mix of sufficient organic content and depth to meet the requirements.

   More than one method may be used on different portions of the same site. Soil that already meets the depth and organic matter quality standards, and is not compacted, does not need to be amended.

IX. Clustering.

A. To achieve the goals of low impact development, lots shall be clustered within the designated development area of the site. Clustering is intended to preserve open space, reduce total impervious surface area, and minimize development impacts on critical areas and associated buffers, as defined in [jurisdiction Chapter X] of the development code. Preservation of open space reduces potential stormwater runoff and associated impacts and provides area for dispersion, filtration and infiltration of stormwater.
B. The arrangement of clustered building lots shall be designed to avoid development forms commonly known as linear, straight-line or highway strip patterns.

X. Lot size, lot width, building height, impervious coverage.

A. **Lot size.** Design objective: Minimize area of site disturbance. The minimum lot size of the underlying zone district may be modified to achieve the goals in Section I of this chapter.
B. **Lot width.** Design objective: Minimize street length. The minimum lot width of the underlying zone district may be modified to achieve the goals in Section I of this chapter.
C. **Building height.** Design objective: Minimize building footprint. Building height may exceed the standard in the underlying zone to a maximum of 35 feet; provided that the project design protects adjacent uses both

inside and outside of the LID from adverse impacts on privacy, light, air and significant public views. If in excess of 35 feet, the maximum height in the underlying zoning shall apply.

D. **Building setbacks.** Design objective: Minimize impervious surfaces. The zoning setbacks may be modified to achieve the goals in Section I of this chapter.

XI. Street and Parking.

Use the street and parking design standards in the following three Metro (Portland area) design manuals, available at **http://www.oregonmetro.gov/index.cfm/go/by.web/id=235**:

- Creating livable streets: Street design guidelines for 2040, June 2022;
- Green streets: Innovative solutions for stormwater and stream crossings, June 2002; and
- Trees for green streets: An illustrated guide, June 2002.

A. **Alternative surfacing methods.**

Alternative surfacing for pedestrian facilities including, but not limited to: paving blocks, bark or wood mulch, turf block, pervious concrete, porous asphalt, plastic or other material grid systems, and other similar approved materials are encouraged. Alternative surfacing methods may also be approved for parking areas, emergency parking areas, private roads, fire lanes, road shoulders, bike paths, walkways, patios, driveways, and easement service roads unless site constraints make use of such materials detrimental to water quality. Utilization of alternative surfacing methods shall be subject to review and approval by the [jurisdiction] Park Public Works Department and Fire Marshal for compliance with other applicable regulations and development standards.

B. **Drainage and land alteration.**

1. Land alteration may commence when in compliance with [jurisdiction] site development regulations.
2. Drainage plans and improvements shall be in compliance with [jurisdiction] drainage standards. Alternative BMPs not specifically referenced in the [jurisdiction] standards may be considered subject to approval by the [jurisdiction] Public Works Department.

C. **Site assessment and concept plan.**

The site design process for a Low Impact Development begins with an in-depth site assessment. The site assessment shall be a component of the project submittal. The site assessment shall include, at a minimum, the following:

1. A survey prepared by a registered land surveyor, registered civil engineer or other professional licensed to conduct surveys showing existing public and private development, including utility infrastructure, on and adjacent to the site, major and minor hydrologic features, including seeps, springs, closed depression areas, drainage swales, and contours as follows:
   a. Up to 10 percent slopes, two-foot contours.
   b. Over 10 percent to less than 20 percent slopes, five-foot contours.
   c. Twenty percent or greater slopes, 10-foot contours.

   Spot elevations shall be at 25 foot intervals.
2. B. Location of all existing lot lines, lease areas and easements, and the location of all proposed lot lines, lease areas, and easements.
3. C. A soils report prepared by a licensed geotechnical engineer or licensed engineering geologist. The report shall identify:
   a. Underlying soils on the site utilizing soil pits and soil grain analysis to assess infiltration capability on site. The frequency and distribution of soil pits shall be adequate to direct placement of the roads and structures away from soils that can most effectively infiltrate stormwater.
   b. Topologic features that may act as natural stormwater storage or conveyance and underlying soils that provide opportunities for storage and partial infiltration.
   c. Depth to groundwater.
   d. Geologic hazard areas and associated buffer requirements as defined in [jurisdiction] Chapter [X].

4. A survey of existing native and non-native vegetation cover, including any heritage trees, by a licensed landscape architect, arborist, qualified biologist identifying any forest areas on the site, species and condition of ground cover and shrub layer, and tree species, and canopy cover.

5. A survey of wildlife habitat by a qualified biologist.
6. A streams, wetland, and water body survey and classification report by a qualified biologist showing wetland and buffer boundaries consistent with the requirements of [jurisdiction] Chapter [X], if present.
7. Flood hazard areas on or adjacent to the site, if present.
8. Aquifer and wellhead protection areas on or adjacent to the site, if present.
9. Any known historic, archaeological, and cultural features located on or adjacent to the site, if present.

D. **Preliminary meeting.**

Following completion of the site assessment and concept plan and prior to a pre-application conference, applicants are encouraged to meet with [jurisdiction] staff to discuss existing conditions and conceptual plans for designated development areas, Native Vegetation Areas, proposed lot and roadway configurations, and preliminary stormwater management design.

E. **Information submittal.**

The information required in the following sections shall be submitted with low impact development applications.

F. **General provisions.**

1. Information submitted for initial review can be an approximate description indicating the general nature of the proposal. Data shall be based on the applicant's best knowledge or intent of the proposal and shall be sufficiently clear to demonstrate how the project complies with the provisions of this chapter.
2. The [jurisdiction] shall have the authority to waive any portion of the information requirements herein; provided, that the information has been included with a previous rezone request, approved permit or concept plan, and the present LID application is consistent with the previous action to the extent that the subject data is applicable.

G. **Textual information.**

The applicant must respond to each of the items below but the response may include estimates or approximations where exact figures are not known at the time of the pre-application conference. All estimates should be based on the applicant's best knowledge and intent of the proposal. When estimates or approximations are used they must be identified as such. The applicant should be aware that any estimates or approximations provided may be used to set development conditions or thresholds.

1. The title and location of the proposed development, together with the names, addresses and telephone numbers of the record owner or owners of the land and the application, and, if applicable, the names, addresses and telephone numbers of any architect, planner, designer or engineer responsible for the preparation of the plan, and of any authorized representative of the applicant.
2. The legal description of the subject property.
3. Identify, if known, all special service districts, including fire, school (for residential projects only), drainage and flood control in which the site is located.
4. Documentation of site conditions of all applicable areas reviewed in the site assessment.
5. Description of the proposed LID including:
    a. Project narrative showing how the project fulfills the overall goals and each purpose statement in Section I of this chapter;
    b. Total gross area of the site;
    c. Total area of reserve area;
    d. Total project area;
    e. Total area of designated development area;
    f. Total area of Native Vegetation Areas;
    g. Total units proposed;
    h. Proposed number of structures by type;
    i. Conventional impervious surface assumptions used for pond reduction calculations;
    j. Maximum impervious surfaces proposed for each lot;
    k. Lot sizes and dimensions;

l. Total area of impervious surfacing;
m. Proposed ownership of land areas within the LID both during and after construction;
n. Gross density of structures;
o. Requested dimensional modifications;
p. Development schedule indicating the approximate date when construction of the LID or stages of the LID can be expected to begin and be completed.

6. Copy of all existing deeds, restrictive covenants, or other legal restrictions, which apply to the project site. The applicant may submit a copy of any proposed restrictive covenants that have been drafted.
7. The names and addresses of all property owners within 300 feet of the site taken from the latest equalized tax roles.
8. Preliminary drainage report as described in the [jurisdiction] site development standards. The report should clearly state the assumed conventional storage volume and LID storage volume in the introduction.

H. **Site plan and supporting maps and graphics.**

An initial site plan and any supporting graphics, narrative descriptions and maps to show existing conditions and major details of the proposed LID. The initial site plan and supporting graphics and maps in combination shall provide a level of detail appropriate to the scale of the project and sufficient to demonstrate how the project complies with the provisions of this chapter.

1. Proposed name of the development, north point, scale, date and address, and telephone number of the preparer of the site plan/supporting maps.
2. All information included in the site assessment in Section XV of this chapter, shall be provided at a legible scale appropriate to the area covered by the proposal, at the discretion of the [jurisdiction].
3. Designated development areas.
4. Native Vegetation Areas.
5. Reserve areas.
6. Areas of disturbed soils to be amended.
7. The existing and proposed circulation system of arterial, collector and/or local streets, including right-of-way street widths, off-street parking areas, and major points of access to public rights-of-way (including major point of ingress and egress to the development). Notations of proposed ownership, public or private, shall be included where appropriate.
8. Location and width of existing and proposed sidewalks and trails.
9. Proposed lots and dimensions.
10. For residential structures, provide the types and number of residential units in each structure or the range of residential structures proposed together with the range of the type and number of units per structure.
11. For nonresidential buildings, the gross floor area of each building.
12. The location and square footage or approximate location and square footage or acreage of all areas of all areas to be conveyed, dedicated or reserved as common open spaces, public parks, recreational areas, school sites, and similar public and semi-public uses with notations of proposed ownership included where appropriate.
13. Landscaping and open space improvements plan or concept.
14. The proposed treatment of the perimeter of the LID, including materials and techniques used such as screens, fences and walls.
15. The location of existing and proposed utilities including sanitary sewers, water lines and storm drainage facilities intended to serve the development.
16. Existing zoning and Comprehensive Plan boundaries for the site and adjacent property.
17. Information of contiguous properties within 300 feet of the proposed LID including:
    a. Existing and, if known, proposed land use and streets; and
    b. Existing structures excluding accessory buildings, ownership tracts and unique natural features of the landscape, if readily accessible.
18. A vicinity map showing the location of the site and its relationship to surrounding areas, including existing streets, major physiographic and cultural features such as railroads, lakes, streams, shorelines, schools, parks or other prominent features.
19. Landscape plan consistent with the requirements of Chapter [X] of the [jurisdiction] development code.
20. Tree survey and planting plan for Native Vegetation Areas, as required under Section VII of this chapter.

I. **Supplemental information.**

1. The proposed method of providing long-term maintenance of improvements or facilities, including roads and sidewalks, drainage, on-site fire protection improvements, water and sanitation systems, and community or public open space. The purpose of this paragraph is to generally identify the method of maintenance and not to require detailed agreements.
    a. If to be maintained by a governmental jurisdiction or existing water association, a letter from the jurisdiction or association shall be submitted specifying acceptance of maintenance responsibility and indicating the conditions, if any, upon which the acceptance is contingent.
    b. If the maintenance is to be provided privately, the developer shall indicate the organization to provide the maintenance and the method and approximate amount of funding required therefore.
2. Draft instruments for permanent preservation of Native Vegetation Areas and maintenance of low impact drainage facilities.

J. **Scope of initial low impact development approval.**

1. LID project approval must include findings that the purpose statements of Section I and the applicability requirements of Section II have been met.
2. Once the low impact development receives initial LID project approval, all persons and parties, their successors, heirs, or assigns, who own, have, or will have by virtue of purchase, inheritance or assignment, any interest in the real property within the proposed LID, shall be bound by the conditions attending the approval of the development and the provisions of this chapter.
3. Minor adjustments may be approved, and are those adjustments which may affect the dimensions, location and type of improvements of facilities; provided, the amendment maintains the basic character of the LID project approval including general type and location of land use activities, arrangement of buildings, density of the development, and provisions of the project to meet open space requirements; and provided further, the standards of this chapter are met.
4. Major adjustments are those, which, in the opinion of the [jurisdiction], substantially change the basic design, density, open space or other requirements of the low impact development. When a change constitutes a major adjustment, no building or other permit shall be issued without prior review and approval by the [jurisdiction].

K. **Control of the development after completion.**

The final development plan shall continue to control the low impact development after it is completed and the following shall apply:

1. The building official in issuing a certificate of completion of the low impact development shall note the issuance on the filed final development plan.
2. After the certificate of completion has been issued, the use of the land and the construction, modification or alteration of a building or structure within the low impact development shall be governed by an approved final development plan.
3. After the certificate of completion has been issued, no change shall be made in development contrary to the approved final development plan without approval of an amendment to the plan except as follows:
    a. Minor modifications of existing buildings or structures or the creation of additional impervious surface may be authorized by the [jurisdiction], if they are consistent with the purposes, intent and restrictions of the final plan.
    b. A building or structure that is totally or substantially destroyed may be reconstructed without approval of an amended low impact development if it is in compliance with the purpose and intent of the final development plan.
4. An amendment to a completed low impact development may be approved if it is consistent with the low impact development, or if it is appropriate because of changes in conditions that have occurred since the final development plan was approved or because there have been changes in the development policy of the community as reflected by the Comprehensive Plan or related land use regulations.
5. No modification or amendment to a completed low impact development is to be considered as a waiver of the covenants limiting the use of the land, buildings, structures and improvements within the area of the

low impact development and all rights to enforce these covenants against any change permitted by this section are expressly reserved.

6. In the event the applicant seeks an amendment to an approved final development plan, and it is the determination of the [jurisdiction], that such amendment exceeds the scope of final approval, the applicant shall submit to the [jurisdiction] all of the application materials and fees that would accompany the original application.

Appendix I: Implementation and Effectiveness Monitoring by Pollutant

Implementation and Effectiveness Monitoring by TMDL Pollutant								
BMP	Programmatic	Structural	Most Effective	Recommended	Implementation Monitoring		Effectiveness Monitoring	
					Project Implementation Tally	Project Implementation Performance	Project Effectiveness	Program Effectiveness Performance
TEMPERATURE								
Riparian Protection Ordinance	X		X		Y/N	% of riparian area meeting buffer width target.	NA	Long term (10+ year) stream temperature and stream flow monitoring at jurisdictional boundaries; 5 year shade and % site potential assessments from aerial photos or instream assessments
Wetland Protection Ordinance	X		X		Y/N	% of relevant area compliant, non-compliant, or unknown	NA	Low flow analysis from continuous stream discharge and precipitation data; Long term (10+ year) stream temperature and stream flow monitoring at jurisdictional boundaries
Stormwater Management Ordinance	X			X	Y/N	% of relevant area compliant, non-compliant, or unknown	Comparison of post development and pre-development peak and average volume levels at project level	Low flow analysis from continuous stream discharge and precipitation data; trends in peak and average stream flow; Long term (10+ year) stream temperature and stream flow monitoring at jurisdictional boundaries

Implementation and Effectiveness Monitoring by Pollutant (Cont.)

Implementation and Effectiveness Monitoring by TMDL Pollutant								
BMP	Programmatic	Structural	Most Effective	Recommended	Implementation Monitoring		Effectiveness Monitoring	
					Project Implementation Tally	Project Implementation Performance	Project Effectiveness	Program Effectiveness Performance
TEMPERATURE (Cont.)								
Instream Flow Purchased	X			X	# of purchases, quantity of water at critical periods	Volume of accumulated instream flow purchases	BACI comparison of stream flow above and below acquired instream flow.	Critical low flow period comparison from continuous stream discharge and precipitation data; Long term (10+ year) stream temperature and stream flow monitoring at jurisdictional boundaries
Stormwater Management Plan	X			X	Y/N	% of relevant area compliant, non-compliant, or unknown	NA	Long term (10+ year) stream temperature and stream flow monitoring at jurisdictional boundaries
Tree Protection Ordinance	X			X	Y/N	% canopy cover estimate	NA	Long term (10+ year) stream temperature and stream flow monitoring at jurisdictional boundaries; 5 year % canopy cover from aerial photos
Riparian Restoration		X	X		# of projects; area restored, area maintained	% survival estimates of native shrubs and trees	Solar pathfinder and densitometer shade measurements in project reach	Long term (10+ year) stream temperature and stream flow monitoring at jurisdictional boundaries; 5 year shade and % site potential assessments from aerial photos or instream assessments

Implementation and Effectiveness Monitoring by Pollutant (Cont.)

Implementation and Effectiveness Monitoring by TMDL Pollutant								
BMP	Programmatic	Structural	Most Effective	Recommended	Implementation Monitoring		Effectiveness Monitoring	
					Project Implementation Tally	Project Implementation Performance	Project Effectiveness	Program Effectiveness Performance
TEMPERATURE (Cont.)								
Stormwater Wetlands		X	X		# of projects; total catchment area draining to wetlands; # projects maintained	% of wetlands estimated to be operating as designed with vegetation and infiltration	% infiltration; BACI groundwater level and downstream stream discharge	Low flow analysis from continuous stream discharge and precipitation data; Long term (10+ year) stream temperature and stream flow monitoring at jurisdictional boundaries
Instream Restoration		X		X	# of different projects completed, river miles restored, area restored	% of projects still in place and % which visually appear to be performing as designed	BACI comparison of local stream temperature or benthic macro invertebrate communities.	Benthic stream macro invertebrate community health assessment and long-term (10+ year) stream temperature and stream flow monitoring at jurisdictional boundaries
Stormwater Vegetated Infiltration Basins		X		X	# of projects completed and maintained; catchment area draining to basin	% of projects maintaining design criteria in volume and vegetation	BACI comparison of groundwater levels and stream recharge below project	Low flow analysis from continuous stream discharge and precipitation data; Long term (10+ year) stream temperature and stream flow monitoring at jurisdictional boundaries

Implementation and Effectiveness Monitoring by Pollutant (Cont.)

Implementation and Effectiveness Monitoring by TMDL Pollutant								
BMP	Programmatic	Structural	Most Effective	Recommended	Implementation Monitoring		Effectiveness Monitoring	
					Project Implementation Tally	Project Implementation Performance	Project Effectiveness	Program Effectiveness Performance
TEMPERATURE (Cont.)								
Grassed Swales		X		X	# of projects completed and maintained; catchment area draining to swales	% of projects maintaining design criteria in volume and vegetation	BACI comparison of groundwater levels and stream recharge below project	Low flow analysis from continuous stream discharge & precipitation data; Long term (10+ year) stream temperature and stream flow monitoring at jurisdictional boundaries
Tree Planting		X		X	# of different projects completed, area planted, area maintained	Tree survival (visual estimate) at 1, 5, and 8 years, photo documentation	Solar pathfinder and densitometer shade measurements in project reach	Long term (10+ year) stream temperature and stream flow monitoring at jurisdictional boundaries; 5 year % shade estimates from aerial photos
SEDIMENT (Turbidity)								
Erosion and Sediment Control Ordinance	X		X		Y/N	% of inspected sites compliant or non-compliant	NA	Trends in macro invertebrate fine sediment stressor scores, TSS or turbidity monitoring at jurisdictional boundaries
Low Impact Development (LID) Ordinance	X		X		Y/N	% of inspected sites compliant or non-compliant; drainage area and type of LID practices installed	NA	Trends in macro invertebrate fine sediment stressor scores, TSS or turbidity monitoring at jurisdictional boundaries

Implementation and Effectiveness Monitoring by Pollutant (Cont.)

Implementation and Effectiveness Monitoring by TMDL Pollutant								
BMP	Programmatic	Structural	Most Effective	Recommended	Implementation Monitoring		Effectiveness Monitoring	
					Project Implementation Tally	Project Implementation Performance	Project Effectiveness	Program Effectiveness Performance
SEDIMENT (Turbidity) (Cont.)								
Stormwater Management Ordinance	X		X		Y/N	% of relevant area compliant, non-compliant, or unknown	NA	Trends in macro invertebrate fine sediment stressor scores, TSS or turbidity monitoring at jurisdictional boundaries
Riparian Protection Ordinance	X			X	Y/N	% of riparian area meeting buffer width target.	NA	Trends in macro invertebrate fine sediment stressor scores, TSS or turbidity monitoring at jurisdictional boundaries
Hillside Development (Steep Slopes) Protection Ordinance	X			X	Y/N	% of inspected sites compliant or non-compliant	NA	Trends in macro invertebrate fine sediment stressor scores, TSS or turbidity monitoring at jurisdictional boundaries
Floodway and Floodplain Overlay District Ordinance	X			X	Y/N	% of sites compliant or non-compliant	NA	Trends in macro invertebrate fine sediment stressor scores, TSS or turbidity monitoring at jurisdictional boundaries
Construction Runoff Control/ Treatment Facilities		x	x		# of facilities; area of drainage treated	estimated % facilities properly installed and maintained	% TSS removal by facility or turbidity reduction; % removal of visible suspended soil particles from runoff	Trends in macro invertebrate fine sediment stressor scores, TSS or turbidity monitoring at jurisdictional boundaries or integrator sites below intensive development areas

Implementation and Effectiveness Monitoring by Pollutant (Cont.)

Implementation and Effectiveness Monitoring by TMDL Pollutant								
BMP	Programmatic	Structural	Most Effective	Recommended	Implementation Monitoring		Effectiveness Monitoring	
					Project Implementation Tally	Project Implementation Performance	Project Effectiveness	Program Effectiveness Performance
SEDIMENT (Turbidity) (Cont.)								
High Efficiency Street Sweeping		X	X		miles swept	volume of debris swept	Before vs. after sweeping comparisons of runoff turbidity or TSS corrected for covariates like rainfall intensity, catchment gradient, others using multiple linear regression or other statistical methods.	Trends in macro invertebrate fine sediment stressor scores, TSS or turbidity monitoring at jurisdictional boundaries or integrator sites below intensively swept areas
Grassed Lined Swales		X	X		# of swales; # maintained; total catchment area draining to swales	visual estimate of % swales properly functioning	BACI comparisons of development runoff turbidity or TSS corrected for covariates like rainfall intensity, catchment gradient, others using multiple linear regression or other statistical methods.	Trends in macro invertebrate fine sediment stressor scores, TSS or turbidity monitoring at jurisdictional boundaries
Riparian Restoration		X		X	# of projects; area restored, area maintained	% survival estimates of native shrubs and trees	Before and after restoration comparisons of estimates of exposed soil and unstable banks.	Trends in macro invertebrate fine sediment stressor scores, TSS or turbidity monitoring at jurisdictional boundaries

Implementation and Effectiveness Monitoring by Pollutant (Cont.)

Implementation and Effectiveness Monitoring by TMDL Pollutant								
BMP	Programmatic	Structural	Most Effective	Recommended	Implementation Monitoring		Effectiveness Monitoring	
					Project Implementation Tally	Project Implementation Performance	Project Effectiveness	Program Effectiveness Performance
SEDIMENT (Turbidity) (Cont.)								
Erosion Control BMPs		X		X	# of facilities; area of drainage treated	estimated % facilities properly installed and maintained	% TSS removal by facility or turbidity reduction; % removal of visible suspended soil particles from runoff	Trends in macro invertebrate fine sediment stressor scores, TSS or turbidity monitoring at jurisdictional boundaries or integrator sites below intensive development areas
Stormwater Control/ Treatment Facilities		X		X	# of facilities; area of drainage treated	estimated % facilities properly installed and maintained	% TSS removal by facility or turbidity reduction; % removal of visible suspended soil particles from runoff	Trends in macro invertebrate fine sediment stressor scores, TSS or turbidity monitoring at jurisdictional boundaries or integrator sites areas with known stormwater problems
Stormwater Wetland		X		X	# of projects; total catchment area draining to wetlands; # projects maintained	% of wetlands estimated to be operating as designed with vegetation and infiltration	% infiltration and removal of TSS or turbidity reduction; BACI groundwater level and downstream stream discharge	Trends in macro invertebrate fine sediment stressor scores, TSS, turbidity, and storm response (flashiness) monitoring at jurisdictional boundaries or integrator sites areas with significant wetland installation.

Implementation and Effectiveness Monitoring by Pollutant (Cont.)

Implementation and Effectiveness Monitoring by TMDL Pollutant								
BMP	Programmatic	Structural	Most Effective	Recommended	Implementation Monitoring		Effectiveness Monitoring	
					Project Implementation Tally	Project Implementation Performance	Project Effectiveness	Program Effectiveness Performance
SEDIMENT (Turbidity) (Cont.)								
Porous Concrete and/or Asphalt Roads		X		X	# of projects; total catchment area draining to wetlands; # projects maintained	% of wetlands estimated to be operating as designed with vegetation and infiltration	BACI comparison of % infiltration and reduction of TSS or turbidity reduction in small drainages with porous surfaces installed	Trends in macro invertebrate fine sediment stressor scores, TSS, turbidity, and storm runoff response (flashiness) monitoring at jurisdictional boundaries or integrator sites areas with significant wetland installation.
BACTERIA (E coli and Fecal Coliform)								
Onsite Inspection and Maintenance Ordinance	X		X		Y/N	% failure of inspected systems	NA	Trends in fecal indicator bacteria concentrations at jurisdictional boundaries
Local Community Loan Program	X		X		Y/N	# of loans to fix failing systems	NA	Trends in fecal indicator bacteria concentrations at jurisdictional boundaries

Implementation and Effectiveness Monitoring by Pollutant (Cont.)

Implementation and Effectiveness Monitoring by TMDL Pollutant								
BMP	Programmatic	Structural	Most Effective	Recommended	Implementation Monitoring		Effectiveness Monitoring	
					Project Implementation Tally	Project Implementation Performance	Project Effectiveness	Program Effectiveness Performance
BACTERIA (E coli and Fecal Coliform) (Cont.)								
Low Impact Development Ordinance	X		X		Y/N	drainage area and type of LID practices installed	NA	Trends in fecal indicator bacteria concentrations at jurisdictional boundaries and comparison of pre/post development storm runoff response
Pet Waste Pick-Up Ordinance	X		X		Y/N	% of parks and other high use areas with sign postings	Trends in fecal indicator bacteria concentrations at boundaries of high use pet areas. Covariates including use and precipitation.	Trends in fecal indicator bacteria concentrations at jurisdictional boundaries
Riparian Protection Ordinance		X		X	Y/N	% of riparian area meeting buffer width target.	NA	Trends in fecal indicator bacteria concentrations at jurisdictional boundaries
No Wildlife Feeding Ordinance		X		X	Y/N	% of parks and other high use areas with sign postings	Trends in fecal indicator bacteria concentrations at boundaries of high use pet areas. Covariates including use and precipitation.	Trends in fecal indicator bacteria concentrations at jurisdictional boundaries

Implementation and Effectiveness Monitoring by Pollutant (Cont.)

Implementation and Effectiveness Monitoring by TMDL Pollutant								
BMP	Programmatic	Structural	Most Effective	Recommended	Implementation Monitoring		Effectiveness Monitoring	
					Project Implementation Tally	Project Implementation Performance	Project Effectiveness	Program Effectiveness Performance
BACTERIA (E coli and Fecal Coliform) (cont.)								
Illicit Discharge and Connection Ordinance		X		X	Y/N	# and location of inspections; # of illicit discharges identified	Before and after/ above and below fecal indicator sampling	Trends in fecal indicator bacteria concentrations at jurisdictional boundaries
Stormwater Control/ Treatment Facilities		X	X		# of facilities; area of drainage treated	estimated % facilities properly installed and maintained	% fecal bacteria indicator removal by facility; % removal of visible suspended soil particles from runoff	Trends in fecal indicator bacteria concentrations at jurisdictional boundaries
Public Onsite Systems Repair or Replacement		X	X		# of systems in need of repair or replacement	# of systems repaired or replaced	Before and after dye tests or fecal bacteria indicator tests before and after/ above and below system	Trends in fecal indicator bacteria concentrations
Riparian Restoration		X		X	# of projects; area restored, area maintained	% survival estimates of native shrubs and trees	Before and after restoration comparisons of estimates of exposed soil and unstable banks.	Trends in fecal indicator bacteria concentrations at jurisdictional boundaries

Implementation and Effectiveness Monitoring by Pollutant (Cont.)

Implementation and Effectiveness Monitoring by TMDL Pollutant								
BMP	Programmatic	Structural	Most Effective	Recommended	Implementation Monitoring		Effectiveness Monitoring	
					Project Implementation Tally	Project Implementation Performance	Project Effectiveness	Program Effectiveness Performance
BACTERIA (E coli and Fecal Coliform) (cont.)								
Dog Run Parks		X		X	# of designated parks	estimates of park use	BACI fecal indicator organism monitoring bracketing dog run parks	Trends in fecal indicator bacteria concentrations at jurisdictional boundaries
Nutrients								
Erosion and Sediment Control Ordinance	X		X		Y/N	% of inspected sites compliant or non-compliant	NA	Trends in nitrate and phosphorus monitoring at jurisdictional boundaries
Low Impact Development (LID) Ordinance	X		X		Y/N	drainage area and type of LID practices installed	NA	Trends in nitrate and phosphorus concentrations at jurisdictional boundaries and comparison of pre/post development storm runoff response
Protecting Surface Water Sources of Drinking Water Ordinance	X			X	Y/N		NA	Trends in nitrate and phosphorus monitoring at jurisdictional boundaries

Implementation and Effectiveness Monitoring by Pollutant (Cont.)

Implementation and Effectiveness Monitoring by TMDL Pollutant								
BMP	Programmatic	Structural	Most Effective	Recommended	Implementation Monitoring		Effectiveness Monitoring	
					Project Implementation Tally	Project Implementation Performance	Project Effectiveness	Program Effectiveness Performance
Nutrients (Cont.)								
Protecting Groundwater Sources of Drinking Water Ordinance	X			X	Y/N		NA	Trends in nitrate and phosphorus monitoring at jurisdictional boundaries
Public Areas Fertilization Policy	X			X	Y/N	annual quantity of fertilizer applied	BACI comparison of nitrogen or phosphorus in runoff from public areas	Trends in nitrate and phosphorus monitoring at jurisdictional boundaries
Pond/ Wetland System		X	X		# and drainage area of systems; number of systems maintained	Estimate of % of systems appearing to work as designed	Above vs. below % reductions in nitrogen and phosphorus concentrations	Trends in nitrate and phosphorus monitoring at jurisdictional boundaries or integrator sites below intensive development areas

Implementation and Effectiveness Monitoring by Pollutant (Cont.)

Implementation and Effectiveness Monitoring by TMDL Pollutant								
BMP	Programmatic	Structural	Most Effective	Recommended	Implementation Monitoring		Effectiveness Monitoring	
					Project Implementation Tally	Project Implementation Performance	Project Effectiveness	Program Effectiveness Performance
Nutrients (Cont.)								
Dry Swale		X	X		# and drainage area of systems; number of systems maintained	Estimate of % of swales functioning properly	BACI comparisons of development runoff nitrogen and phosphorus concentrations corrected for covariates like rainfall intensity, catchment gradient, others using multiple linear regression or other statistical methods.	Trends in nitrate and phosphorus monitoring at jurisdictional boundaries or integrator sites below intensive development areas
High Efficiency Street Sweeping		X		X	miles swept	volume of debris swept	Before vs. after sweeping comparisons of runoff nitrate and phosphorus concentrations.	Trends in nitrate and phosphorus monitoring at jurisdictional boundaries or integrator sites below intensive development areas
Erosion Control BMPs		X		X	# of facilities; area of drainage treated	estimated % facilities properly installed and maintained	% nitrate and phosphorus removal by facility; % removal of visible suspended soil particles from runoff	Trends in nitrate and phosphorus monitoring at jurisdictional boundaries or integrator sites below intensive development areas

Appendix J: Glossary

Best Management Practice
Means "...a practice or combination of practices considered by a State [or authorized Tribe] to be the most effective means (including technological, economic and institutional considerations) of preventing or reducing the amount of pollution by nonpoint sources to a level compatible with water quality goals." (40 CFR 130.2(Q))

Designated Management Agency (DMA)
Means a federal, state, or local governmental agency that has legal authority over a sector or source contributing pollutants, and is identified as such by the Department of Environmental Quality in a TMDL.

Director
Means the Director of the Department of Environmental Quality or the Director's authorized designee.

Floodplain
Means a generally flat, low-lying area adjacent to a stream or river that is subjected to inundation during high flows. The relative elevation of different floodplains determines their frequency of flooding, ranging from rare, and severe storm events to flows experienced several times a year. For example, a "100-year floodplain" would include the area of inundation that has a frequency of occurring, on average, once every 100 years.

Hydrologic Unit Code (HUC)
Means a multi-scale numeric code used by the U.S. Geological Survey to classify major areas of surface drainage in the United States. The code includes fields for geographic regions, geographic sub regions, major river basins, and subbasins. The third field of the code generally corresponds to the major river basins named in OAR chapter 340, division 41. The fourth field generally corresponds to the subbasins typically addressed in TMDLs.

Illicit Connections
Means an illegal and/or improper waste discharges into storm drainage systems and receiving waters.

Impervious Cover
Means any surface in the urban landscape that cannot effectively absorb or infiltrate rainfall; for example, sidewalks, rooftops, roads, and parking lots.

Imperviousness
Means the percentage of impervious cover by area within a development site or watershed, often calculated by identifying impervious surfaces from aerial photographs or maps.

Local Advisory Group
Means a group of people with experience and interest in a specific watershed or subbasin that is designated by the Department to provide local input during TMDL development.

Low Impact Development
LID is an approach to land development (or re-development) that works with nature to manage stormwater as close to its source as possible. LID employs principles such as preserving and recreating natural landscape features, minimizing effective imperviousness to create functional and appealing site drainage that treat stormwater as a resource rather than a waste product.

Management Strategies
Means measures to control the addition of pollutants to waters of the state and includes application of pollutant control practices, technologies, processes, siting criteria, operating methods, best management practices or other alternatives.

National Pollutant Discharge Elimination System (NPDES)
Means, as established by Section 402 of the Clean Water Act, this federally mandated permit system is used for regulating point sources, which include discharges from industrial and municipal facilities and stormwater discharges from discrete conveyances such as pipes or channels.

Performance Monitoring

Means monitoring implementation of management strategies, including sector-specific and source-specific implementation plans, and resulting water quality changes.

Pollutant
Has the meaning provided in the Federal Water Pollution Control Act Section 502 (33 USC Section 1362).

Reasonable Assurance
Means a demonstration that a TMDL will be implemented by federal, state, or local governments or individuals through regulatory or voluntary actions including management strategies or other controls.

Riparian Buffer
Means an area of land and water that is important to the integrity and quality of a stream, river, lake, wetland, or other body of water where a) critically important ecological processes and water pollution control functions take place, and b) development may be restricted or prohibited for these reasons.

Sector
Means a category or group of similar nonpoint source activities such as forestry, agriculture, recreation, urban development, or mining.

Sector-Specific Implementation Plan or Source-Specific Implementation Plan
In the context of a TMDL means a plan for implementing a Water Quality Management Plan for a specific sector or source not subject to permit requirements in ORS 486.050.

Source
Means any process, practice, activity, or resulting condition that causes or may cause pollution or the introduction of pollutants to a waterbody.

Subbasin
Means the designation in the fourth field of the U.S. Geological Survey Hydrologic Unit Code.

Surrogate Measures
Means substitute methods or parameters used in a TMDL to represent pollutants.

Total Maximum Daily Load (TMDL)
Means a written quantitative plan and analysis for attaining and maintaining water quality standards and includes the elements described in OAR 340-042-0040. These elements include a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet state water quality standards, allocations of portions of that amount to the pollutant sources or sectors, and a Water Quality Management Plan to achieve water quality standards.

TMDL Implementation Plan
The elements of an implementation plan are described in OAR 340-042-0080.

Waterbody
Means any surface waters of the state.

Watershed
Means an area of land that drains water, sediment and dissolved materials to a common receiving body or outlet. The term is not restricted to surface water runoff and includes interactions with subsurface water. Watersheds vary from the largest river basins to just acres or less in size. In urban watershed management, a watershed is seen as all the land that contributes runoff to a particular water body.

Water Quality Management Plan (WQMP)
Means the element of a TMDL describing strategies to achieve allocations identified in the TMDL to attain water quality standards. The elements of a WQMP are described in OAR 340-042-0040(4) (l).

Zoning

Means a set of local government regulations and requirements that govern the use, placement, spacing and size of buildings and lots (as well as other types of land uses) within specific areas designated as zones primarily dedicated to certain land use types or patterns.