Detroit Water and Sewerage Department

Wastewater Master Plan

DWSD Project No. CS-1314

Review of Source Water Protection and Related Watershed Management Regulations and Programs

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Acronyms

AGNPS	Agricultural Non-point Source Pollution Model
ANSWERS	Areal Non-point Source Watershed Environment Response Simulation Model
BCCs	bioaccumulative chemicals of concern
CE-QUAL-ICM	Three-dimensional Time-variable, Integrated-compartment Eutrophication Model
CE-QUAL-RIV1	Hydrodynamic and Water Quality Model for Streams
CE-QUAL-W2	Two-dimensional Laterally Averaged Hydrodynamic and Water Quality Model
CH3D-WES	Curvilinear Hydrodynamics in Three-Dimensions-Waterways Experiment Station
CMI	Clean Michigan Initiative
CORMIX	Cornell Mixing Zone Expert System
CSO	Combined sewer overflow
CSWS	City of Charlotte Stormwater Services
CWA	Clean Water Act
D/DBPR	disinfection/disinfection by-product rule
DECAL	Simplified Deposition Calculation for Organic Accumulation Near Marine Outfalls
DEP	Department of Environmental Protection
DO	dissolved oxygen
DR3M-QUAL	Multi-event Urban Runoff Quality Model
DWRPD	Drinking Water and Radiological Protection Division
DWSD	Detroit Water and Sewer Department
DWSRF	Drinking Water State Revolving Fund
DYNHYD5	Link-node Tidal Hydrodynamic Model
DYNTOX	Dynamic Toxics Wasteload Allocation Model
EFDC	Environmental Fluid Dynamics Computer Code
ESA	Endangered Species Act
EUTROMOD	Watershed and Lake Modeling Software
EXAMSII	Exposure Analysis Modeling System
FWHA	Federal Highway Administration
GIS	geographic information system
GLI	Great Lakes Water Quality Initiative

Acronyms

GWLF	Generalized Watershed Loading Functions
HEA	Habitat Equivalency Analysis
HSPF	Hydrological Simulation Program – FORTRAN
IOCs	inorganic contaminants
IPP	Industrial Pretreatment Program
LaMPs	Lakewide Management Plans
LAs	load allocations
MCDEP	Mecklenburg County Department of Environmental Protection
MCL	maximum contaminant levels
MDEQ	Michigan Department of Environmental Quality
MOA	Memorandum of Agreement
MOS	margin of safety
MOU	Memorandum of Understanding
NEBA	Net Environmental Benefits Analysis
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRLAM	Natural Resource Liability and Asset Management
PCBs	polychlorinated biphenyls
PCPs	pentachlorophenols
PHOSMOD	Seasonal and Long-Term Trends of Total Phosphorus and Oxygen in Stratified Lakes
POTWs	publicly owned treatment works
PWS	public water systems
QUAL2E	Enhanced Stream Water Quality Model
RAP	remedial action plans
RIVMOD-H	River Hydrodynamics Model
SDWA	Safe Drinking Water Act
SEMCOG	Southeast Michigan Council of Government
SITEMAP	Stormwater Intercept and Treatment Evaluation Model for Analysis and Planning
SIUs	Significant Industrial Users
SLAMM	Source Loading and Management Model
SLOSS-PHOSPH	Simplified Pollutant Yield Approach

Acronyms

SMPTOX4	Simplified Method Program – Variable Complexity Stream Toxics Model
SOCs	synthetic organic contaminants
SSA	Sole Source Aquifer
SSO	Sanitary sewer overflow
STORM	Storage, Treatment, Overflow Runoff Model
SWAP	source water assessment program
SWIM	Surface Water Improvement and Management
SWMM	Stormwater Management Model
SWP	source water protection
SWQD	Surface Water Quality Division
SWRRBWQ	Simulation for Water Resources in Rural Basins – Water Quality
SWTR	surface water treatment rule
TCDD	tetrachlorodibenzo-p-dioxin
TMDL	Total Maximum Daily Load
TPM	Tidal Prism Model
UIC	underground injection wells
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VOCs	volatile organic compounds
WASP6	Water Quality Analysis Simulation Program
WCA	Water Catchment Area
WET	whole effluent toxicity
WHP	wellhead protection programs
WLAs	wasteload allocations
WQBEL	water quality-based effluent limitation
WQS	Water Quality Standards
WRDA	Water Resources Development Act
WTP	water treatment plants
WWMP	Wastewater Master Plan
WWTP	Wastewater Treatment Plant

Review of Source Water Protection and Related Watershed Management Regulations and Programs

1. Introduction

1.1 Purpose

Before embarking on any capital improvement plan for Detroit Water and Sewer Department's (DWSD) Wastewater Treatment Plant (WWTP) and collection system infrastructure, DWSD needs to understand the current and future regulations and trends affecting wastewater discharge. In recent years, there has been an increasing emphasis on non-point source pollution control and a watershed approach to protecting waterways. Under the watershed protection concept, the drinking water and wastewater regulations intersect. Source water protection (SWP), with its aim to protect drinking water source quality, can be viewed as an integral part of a watershed management plan. For waters designated as drinking water sources, future SWP regulations could likely affect the regulations of wastewater discharge because they may both fall under the same umbrella of a watershed management plan.

The 1996 Safe Drinking Water Act (SDWA) amendments require states to develop programs for assessing potential contamination threats to the watersheds or groundwater protection areas of drinking water sources. States are currently compiling basic location and identification information on such threats (under the source water assessment effort that is due in May 2003). The next steps (developing and implementing individual SWP plans) are the most important to realizing the U.S. Environmental Protection Agency's (USEPA's) goal of having functional water quality protection programs for all of the nation's drinking water suppliers by 2005.

There are many other Clean Water Act (CWA) programs and coming regulations, particularly those related to watershed management, that can help support this goal. Total maximum daily load (TMDL) program managers, for example, can give drinking water sources a higher priority when developing TMDLs for threatened or impaired waters. Likewise, stormwater program managers can choose control strategies that also protect drinking water sources.

The relationships between watershed management, water quality, SWP, and wastewater management are intensifying. In the current climate where active citizen groups are encouraged and regulations are quickly evolving, the DWSD should consider these areas during the long-range planning process for their wastewater program. How might watershed management programs in the Great Lakes involve their wastewater infrastructure? What source water regulations and programs exist and how might these affect planning and operations? What programs exist that may help with regulatory compliance?

In preparing the DWSD's 50-year Wastewater Master Plan (WWMP), it is imperative that the WWMP address the protection of the watershed and drinking water source supplies. This document seeks to provide background information to help the DWSD answer such questions. Through education and a proactive program, the DWSD is best positioned to continue meeting the needs of its wastewater customers while complying with the water quality and quantity needs of its watersheds.

The goals of this technical memorandum are to:

- Provide regulatory background on SWP, and discuss other watershed management components that are related to SWP.
- Summarize the results and conclusions of the SWP report under the water master plan.
- Discuss how SWP regulations and related watershed management programs might affect the existing and future wastewater discharges.

1.2 Background

This document is part of the overall 50-year WWMP. Within the context of a WWMP, it is necessary to be aware of the impact (either direct or indirect) that SWP or other similar watershed programs or regulations might have on the wastewater discharge, and how the inevitable future increase of wastewater discharge can fit into this picture. Also useful is information on alternatives available to WWTPs for meeting SDWA regulations.

1.2.1 Source Water Protection and Related Watershed Management Programs

Programs such as the Michigan Department of Environmental Quality's (MDEQ's) Source Water Assessment Program (SWAP), and the SWP plan described in the 50-year Water Master Plan may not seem at first glance to affect the wastewater component of operations. However, with the placement of DWSD wastewater outfalls upstream of drinking water intakes, the water quality and quantity relationship has already been established. By providing a summary of such source water programs, the wastewater audience should understand the story of SWP and alert them to the drinking water programs in existence.

There are applications/tools available that would empower DWSD to be proactive in supporting source water/watershed protection programs. This document intends to provide the DWSD with a general awareness of the topics covered, and may spur an interest in future studies to investigate how the topic may directly affect wastewater operations. The applications discussed in this document include TMDL trading, water quality trading, net environmental benefits analysis (NEBA), and the new concept of watershed-wide permitting. Each of these applications can be integrated into source water/watershed protection as it relates to wastewater and drinking water treatment.

1.2.2 The Watershed Management Approach

One important trend that unites all users of a water source, including drinking water and wastewater facilities, is the concept of watershed management. Reaching beyond the TMDL program, the USEPA announced at the Water Environment Federation's

Watershed 2002 Conference that it would like to adopt a holistic approach to watershed management. The concept would integrate all the permitting programs, TMDL programs, and any program related to water quality and quantity together under one umbrella. With this in mind, the relationship between source water programs and wastewater discharge is even more important to understand so that they can be managed together in the future.

The MDEQ also heralds the watershed management approach, and its suggested programs are discussed in more detail in later sections of this document.

1.2.3 Wastewater Master Plan Overview

The DWSD serves approximately 77 communities, including Detroit. The 904-square-mile service area serves about 3.2 million people. The population is concentrated in the City of Detroit and Wayne, Southern Macomb, and Southeastern Oakland Counties. This technical memorandum is part of an overall WWMP that serves as a planning document encompassing the following:

- Wastewater collection and treatment
- Onsite sewerage disposal
- Sanitary sewer overflow (SSO) control
- Combined sewer overflow (CSO) management
- Collaboration with other wastewater treatment providers

The planning area for the DWSD WWMP has been delineated based on a watershed approach. The watershed boundaries for the planning area include the existing contract service area and surrounding communities extending out to natural drainage boundaries. The existing service area lies within the watersheds of Lake St. Clair, the Clinton River, the Rouge River, and the Detroit River. The WWMP includes an estimated 124 municipalities within the planning area.

The total number of industrial and commercial discharges within DWSD service areas is estimated to be about 12,000. In comparison, during the past 10 years, Significant Industrial Users (SIUs) have been estimated to be between 400 and 500. SIUs discharge the pollutant types and loadings of most concern to the DWSD. In addition, information and monitoring data are readily available only for SIUs and their discharge is estimated to be about half the total industrial flow.

The WWMP identifies limits and constraints pertinent to the expansion of existing treatment facilities and/or the construction of new treatment facilities in the DWSD service area. This includes determining the following:

- The pretreatment rules and procedures applied by DWSD to the SIUs of the wastewater collection system.
- Statistical information on the pollutants monitored as part of the Industrial Pretreatment Program (IPP).
- Comparison of the quantities of these pollutants discharged to the sewer system over the years.

2. Regulatory Background

2.1 Summary of the Safe Drinking Water Act 1996 Amendments

2.1.1 Introduction

On August 6, 1996, President Clinton signed the 1996 SDWA Amendments. These amendments brought substantial changes to the national drinking water program for water utilities, states, and USEPA, as well as greater protection and information to the 240 million Americans served by public water systems (PWSs).

These changes will correct problems and help the USEPA, states, and water systems prepare for future drinking water safety challenges and assure the sustainable availability of safe drinking water. The amendments increased state flexibility, provided for more efficient investments by water systems, gave better information to consumers, and strengthened the USEPA's scientific work, including the use of risk and cost-benefit considerations in setting drinking water standards.

Four themes characterized the areas of greatest change. Together, they comprised a balanced, integrated framework of reform, and represented a major national commitment to:

- New and stronger approaches to prevent drinking water contamination
- Better information for consumers, including the "right to know"
- Regulatory improvements, including better science, effort prioritization , and risk assessment
- New funding for states and communities through a Drinking Water State Revolving Fund (DWSRF)

2.1.2 New and Stronger Prevention Approaches

The 1996 SDWA Amendments emphasized preventing contamination problems through SWP and enhanced water system management. This emphasis transformed the previous law, with its largely after-the-fact, regulatory focus, into a truly environmental statute that can better provide for the sustainable use of water by our nation's PWSs and their customers. The states are central to this process: they create and focus prevention programs, and help water systems improve operations and avoid contamination problems.

The 1996 SDWA Amendments introduced the WHP, Sole Source Aquifer (SSA) program, public water monitoring waivers and treatment exemptions, and Comprehensive State Grant Water Protection programs. While building on existing programs, the 1996 SDWA Amendments also established several new program opportunities:

- A new, optional program to allow drinking water suppliers to petition to receive a portion of a state's grant for technical assistance.
- Authority for states to use DWSRF funds to administer or provide technical assistance through SWP programs, except for enforcement actions.

- New authority to give local communities DWSRF loans that may be used to purchase land or easements if the purpose is to protect source water or ensure drinking water standards compliance.
- New authority to provide loans to communities to implement local, voluntary, incentive-based SWP measures.

The 1996 SDWA Amendments do not confer any new regulatory or enforcement authorities for drinking water SWP upon states. However, many provisions require the USEPA to incorporate SWAP into drinking water regulations. Both the required SWAP and the optional individual source water protection programs completed by or for drinking water suppliers can aid in obtaining relief from or assist in complying with certain regulatory requirements.

2.2 Source Water Assessment and Protection Regulations

2.2.1 The Safe Drinking Water Act Amendments of 1996 and Source Water Protection

Under the 1996 SDWA Amendments, the states must develop and implement SWAP programs with technical and financial assistance from the federal government in the form of a DWSRF to provide ongoing support for drinking water technical assistance and infrastructure improvement. In addition, approximately 10 percent of the 1997 appropriation to the DWSRF was set aside to support the state SWAPs. In August 1997, the USEPA published its final guidance on state SWAPs, which describes the elements that a state's submittal must contain to be approved by the USEPA.[1] Each state was required to submit an intended use plan along with its application for the set-aside funds and was required to submit a SWAP plan to the USEPA by February 1999. The plans included a description of the manner in which the state would complete the three key components of a source water assessment: delineation of the assessment area, contamination source inventory, and water supply susceptibility assessment. Once the SWAP was approved, a state had 2 years to complete the source water assessment for all of its PWSs, with the provision that an additional 18-month extension might be required. The state also had to report the results to the public.

The specific language mandating the SWAP appears in Section 1453 of the SDWA. Section 1453(a)(1) mandates that assessments be accomplished "for the protection and benefit of PWSs and for the support of monitoring flexibility." Section 1453(a)(2)(A) requires states to delineate boundaries of the source water areas for each PWS, using all reasonable available hydrogeologic information. Section 1453(a)(2)(B) requires states to identify contaminants regulated under the SDWA for which monitoring is required and any unregulated contaminant the state has added to the list and, to the extent practical, to determine the sources of the contaminants and the susceptibility of the PWS to contamination. Section 1453(a)(3) requires that the assessments be completed within 2 years after the approval of the state's SWAP, with a possible 18-month extension.

[1] USEPA. "State Source Water Assessment and Protection Programs." EPA 816-R-97-009. Office of Water: Washington, D.C. August 1997.

Water utilities, local governments, state governments, and the federal government share the responsibility for developing measures and programs to protect drinking water quality. Drinking water suppliers have been guided in their efforts primarily due to the drinking water quality provisions of the SDWA. The SDWA requires the USEPA to set standards for maximum contaminant levels (MCL) in public drinking water supplies, regulate underground injection of wastes into groundwater, and establish public water supply protection programs. The 1996 SDWA Amendments increased the authority and responsibility for drinking water protection by creating the Sole Source Aquifer

Demonstration Program and Wellhead Protection Program (WHP). Subsequent amendments in 1996 further strengthened drinking water protections with the establishment of the SWAP program.

The 1996 SDWA Amendments created the requirement that all 180,000 PWSs be covered under a SWAP. The basic assumption for the implementation of a SWAP program is that multiple-barrier protection of PWSs will provide high-quality water supplies and protect public health. The establishment of multiple barriers that include SWAP, treatment, distribution system maintenance, monitoring, and SWP is proposed to protect the quality and safety of drinking water supplies. The USEPA views source water assessment as the first step toward protecting the nation's water sources and encourages all water systems to enact protection programs, although the regulations do not yet require SWP.

2.2.2 Great Lakes Assessment Protocols

Source water assessments of intakes that extend into the Great Lakes present a unique challenge in determining the scope and magnitude of these assessments with limited resources. Some source water intakes extend far enough into a lake to receive no effects from specific shoreline contaminant sources (except possibly air borne contaminants), while others closer to shore do. To provide guidance on how source water assessments should be performed, it is necessary to address this very basic premise. Great Lakes states formed a workgroup to develop these parameters. This workgroup includes representatives of the Great Lake states, water utilities with intakes on the Great Lakes, USEPA Region V, and other interested parties.

The mission of the Great Lakes Protocol Workgroup (defined on June 16, 1999) is to develop a consensus amongst the states for a consistent procedure allowing the flexibility necessary to properly conduct source water assessments of the Great Lakes' drinking water sources. This flexibility will include the variability of these sources and site-specific concerns for determination of source sensitivity and susceptibility.

The protocol defines the requirements of an initial survey, using the "Great Lakes Surface Water Assessment Survey" form. The protocol also defines the "critical assessment zone" and the criteria to categorize it as high, medium, and low sensitivity. It also defines the common parameters for completing the assessment, spill assessment, and potential treatment impacts. The protocol provides an outline of the general methodology to be used for Great Lakes intakes, which should be a main part of the SWAP for states in the Great Lakes region.

2.2.3 Michigan Source Water Assessment Program

According to the Amendments, states must submit a program for delineating source water areas of PWSs, and for assessing the susceptibility of such source waters to contamination within 18 months after the USEPA publishes the guidance for state source water partnership programs. Results of completed source water assessments must be made available to the public. These results are a statutory prerequisite for state-tailored monitoring programs because they can provide a good scientific basis for such tailoring. The source water assessment results will also provide the information necessary for water systems to seek help from states in protecting source water or initiating local government efforts.

In addition to requirements for the completion of source water assessments, there are related requirements pertaining to the protection of source water. These requirements include wellhead protection, well abandonment, and underground injection wells (UIC). In addition, there are requirements pertaining to water treatment plants (WTPs) that are impacted by the quality of source water, such as the surface water treatment rule (SWTR), disinfection/disinfection by-product rule (D/DBPR), etc.

In 1998, Michigan amended its SDWA[2], which provides authority for the MDEQ to conduct a source water assessment. In October 1997, the SWAP Committee met and began developing the framework for Michigan's SWAP. In October 1998, the SWAP Committee approved the draft final version of the SWAP, which was submitted to the USEPA for approval. Michigan's SWAP was approved by the USEPA in October 1999 and is administered by the MDEQ's Drinking Water and Radiological Protection Division (DWRPD).[3] In January 2002, the U.S. Geological Survey (USGS) in Michigan completed a source water assessment report for the Belle Isle, Fighting Island, and Lake Huron intake water supplies.

SWP programs directed to Michigan surface water supplies include state regulations for proper placement and construction of water plant intakes and issuance of National Discharge Elimination System (NPDES) permits by the Surface Water Quality Division (SWQD) for point source discharges. The SWQD is also active in controlling non-point source discharges to surface waters through programs such as CWA, Section 319 projects.

Michigan voters passed a Clean Michigan Initiative (CMI) on November 3, 1998, which allocates bond funds for SWP activities such as controlling non-point source discharges to surface waters and abandonment of wells.

2.2.4 Monitoring Waiver

Although SWP programs are not mandated, there are programs that encourage their use. One in particular—the Monitoring Waiver—is of monetary interest to the drinking water planners through a reduction in monitoring requirements. The USEPA has allowed states to develop monitoring waiver programs for those utilities with source

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[2] Act 399 of 1976, Am. 1998, Act 56, Imd. Eff. Apr. 8, 1998.

[3] MDEQ. 1999. "Michigan Source Water Assessment Program." Drinking Water and Radiological Protection Division: Lansing, MI. Available at < http://www.deq.state.mi.us/dwr/GWS/SWA/swa.htm>.

waters that are not vulnerable to the following contaminants of concern: pesticides, volatile organic compounds (VOCs), synthetic organic contaminants (SOCs), and inorganic contaminants (IOCs). If a SWP program is in place and monitoring of the finished water shows no trace of the contaminants in question, the monitoring requirements of that contaminant may be reduced. This provides a cost savings to the water utility by reducing monitoring efforts and encourages a SWP plan.

Under Section 1418(a) of the SDWA, states may reduce monitoring requirements for most contaminants for an interim period for systems serving fewer than 10,000 people if an initial sample fails to detect, at the time of greatest vulnerability, the presence of the contaminant and the state determines that the contaminant is unlikely to be detected by further monitoring during the relief period. The interim monitoring relief period ended either when alternative monitoring is adopted and approved for the state or by August 1999, whichever came first. Interim monitoring relief does not apply to microbial contaminants, disinfection

by-products, or corrosion by-products. States may use any relevant information gleaned from source water assessments to help determine whether interim monitoring relief for given PWSs and contaminants is warranted.

Under Section 1418(b) of the SDWA, states with an approved SWAP may adopt "tailored alternative monitoring requirements" where the state concludes that (based on data available at the time of adoption concerning susceptibility, use, occurrence, or wellhead protection, or from the state's drinking water SWAPs) such alternative monitoring would provide assurance that it complies with the USEPA administrator's guidelines. Alternative monitoring does not apply to microbial contaminants, disinfection by-products, or corrosion by-products, but it does apply to all other chemical contaminants.

Under alternative monitoring, states may allow reductions in monitoring frequency for most chemical contaminants in accordance with the provisions of the USEPA's Alternative Monitoring Guidelines. Alternative monitoring provides one of the clearest benefits to PWSs for their participation in the state's SWAP. For a PWS to be eligible for alternative monitoring, the assessment for the delineated areas or areas from which the PWS derives its source water must be completed.

There is no time frame limiting the applicability of alternative monitoring relief.

2.3 Additional Watershed Related Regulations

2.3.1 Overview

Numerous federal and state statutes and local ordinances have been adopted that may directly or indirectly affect the WWMP effort. These include the CWA, Clean Air Act, SDWA, the Michigan Natural Resources and Environmental Protection Act (the Michigan "Environmental Code"), the Detroit City Charter, Annex 2001, and local ordinances and codes. Numerous state and federal regulations and rules have also been adopted to implement these laws, and these rules establish the regulatory framework for many programs.

The total population growth for this area is projected to be about 250,000 by 2030. This growth may warrant additional WWTP capacity. In addition to the existing WWTP, new plants will need to comply with an array of regulatory requirements. Water quality regulations and policies are critical with regard to the siting of a new WWTP in any watershed.

Water quality criteria are initially established by the USEPA, and adopted by MDEQ as water quality standards (WQS) to help protect the receiving water designated uses, either as stated by the USEPA or on a more stringent basis. Subsequently, discharge limitations for WWTPs are set under the NPDES Permit Program of the CWA. Pertinent policies, of interest to wastewater operations, reviewed in more detail in other sections of the Master Plan include:

- **Pollutant Total Maximum Daily Loads—**Pollutant TMDLs as per part of the Water Quality Planning and Management regulation at 40 CFR Part 130(b) and Section 303(d) of the CWA and Michigan Natural Resources and Environmental Protection Act, Act 451 of 1994.
- **NPDES Permits and Water Management—**NPDES Permits and Water Management as per Part 31 of the Michigan Natural Resources and Environmental Protection Act, Act 451 of 1994.
- **Water Quality-Based Effluent Limit Development for Toxic Substances—**Water Quality-Based Effluent Limit Development for Toxic Substances as per Part 8 of the Michigan Natural Resources and Environmental Protection Act, Act 451 of 1994.
- **Water Quality Guidance for the Great Lakes System—**Water Quality Guidance for the Great Lakes System as published by the USEPA on March 23, 1995.
- **Wastewater Discharge Permits—**Wastewater Discharge Permits as per Part 21 of the Michigan Natural Resources and Environmental Protection Act, Act 451 of 1994.
- **Land Application of Biosolids—**Land Application of Biosolids as per Part 24 of the Michigan Natural Resources and Environmental Protection Act, Act 451 of 1994.
- **The Federal Antidegredation Policy—**The Federal Antidegredation Policy (40 CFR Parts 122, 123, 124 and 131)
- **Water Quality Planning and Management Regulation—**Water Quality Planning and Management Regulation (40 CFR Part 130).
- **Surface Water Quality Standards**—Surface WQS and associated designated uses described in Part 4 of Part 31 Rules of the Natural Resources and Environmental Protection Act, Act 451 of 1994.
- **Areas of Concern and Remedial Action Plans**—Areas of concern and remedial action plans (RAP) through the Great Lakes Water Quality Agreement of 1978.

- **Protection of Species and Preservation of Critical Habitats—**Protection of species and preservation of critical habitats, designated as threatened or endangered as per the federal Endangered Species Act (ESA); the ESA of the State of Michigan, Part 365 of the Natural Resources and Environmental Protection Act, Act 451 of 1994; and the Memorandum of Agreement between the USEPA, the U.S. Fish and Wildlife Service (USFWS), and the National Marine Fisheries Service (NMFS), which consolidates Sections 7, and 9 of the ESA and water quality issues related to NPDES permitting in parts 303, 304, and 402 of the federal CWA.

Annex 2001

On June 18, 2001, the Great Lakes governors signed a supplementary agreement to the Great Lakes Charter known as "Annex 2001" or the "Great Lakes Charter Annex." This document articulates the governors' commitment to managing the Great Lakes ecosystem by implementing a system that is "simple, durable, efficient, retains and respects authority within the Basin, and most importantly, protects, conserves, restores, and improves the Waters and Water-Dependent Natural Resources of the Great Lakes Basin" (Annex, 2001).

To further these objectives over a 3-year period, the governors and premiers intend to create a series of binding agreements, including the establishment of a decision-making standard applicable to all new proposals to withdraw water or increase water withdrawals or existing water withdrawal capacity from the waters of the Great Lakes Basin. This resource-based standard would require all proposals to result in an improvement to the waters and water dependent natural resources of the Great Lakes Basin. Although the details have not yet been developed, this can affect in-basin withdrawals to the extent that they result in significant consumptive losses and/or discharges outside of the basin.

Annex 2001, scheduled for completion in late 2003 or early 2004, calls for conservation, reinforces the Great Lakes Charter and existing institutions, and calls for research into the relationship between groundwater, surface water, and the Great Lakes basin ecosystem. It proposes to do the following:

- Forge a new binding agreement to manage the Great Lakes waters
- Create a new standard requiring an improvement to the water and water-dependent natural resources of the Great Lakes before allowing new water uses
- Implement the new standard for interim decisions under the U.S. Water Resources Development Act (WRDA)
- Obtain better information so that the water is managed rationally
- Include the premiers in reviewing and consulting on all new proposed diversions subject to the WRDA
- Lower the "trigger level" for reviewing proposed diversions to include any proposed diversions that are subject to the governors' authority under the WRDA

Improvements to the waters of the Great Lakes under Annex 2001 will require not only the mitigation of adverse effects of a new water use by improving the resources of the Great Lakes, but will also include strong provisions for water conservation. Withdrawals that result in a net water loss of over 1 million gallons per day that meet criteria in the Annex will have to be reviewed. The proposals will be judged for conservation and impacts on natural resources. Pre-existing uses are exempted, but increases in water usage are not. To make any proposal for a Lake Michigan water withdrawal more attractive to the governing bodies, there are potential credits that can be explored to replace the withdrawn surface water and/or to improve the waters and water-dependent resources of the Great Lakes Basin. Such credits may include:

- Directly returning treatment plant effluent to the Great Lakes Basin
- Restoring historic diversion from the Mississippi Basin to the Great Lakes Basin
- Restoring the natural flow regime within the Great Lakes Basin
- Receiving credit for biological and environmental projects resulting in improvements to the environment

Such actions may be worthwhile to achieve related ecosystem improvement objectives in Michigan, including the implementation of best management practices (BMPs) and ecosystem restoration projects that provide SWP plans and/or surface water quality improvements (e.g., in lieu of costly WWTP upgrades). DWSD may be in a position to find a ready market for ecosystem improvement projects in Michigan that could generate credits to be banked and then drawn down to meet future credit demands (their own or others) for improving the waters and water dependent natural resources of the Great Lakes Basin. In particular, for projects that DWSD is likely to undertake for their own purposes, it may be important to try to obtain advance credit (e.g., by banking credits), because it may not be possible to receive credit retrospectively.

There are several water use and quality projects that are funded by the Great Lakes Protection Fund. Of particular relevance to the DWSD is an ecological currencies project. The results of this project (to be completed by March 2003) are expected to provide estimates of potential new water uses in the Great Lakes Basin and tools to build an ecological currency that will assist in the best allocation of resources in the basin.

2.3.3 Summary of the Great Lakes Water Quality Initiative

2.3.3.1 Background

In 1990, Congress amended Section 118 of the CWA to require the USEPA to publish "water quality guidance" for the Great Lakes system. Under Section 118, the Great Lakes Water Quality Initiative (GLI) must conform to the objectives and provisions of the Great Lakes Water Quality Agreement between the U.S. and Canada. Also, the GLI must be no less restrictive than the CWA's national water quality criteria.

2.3.3.2 Overview

The GLI is a set of regulations published by the USEPA on March 23, 1995, and codified in 40 CFR part 132 with the title of "Water Quality Guidance for the Great Lakes System". It identifies minimum WQS, antidegradation policies, and

implementation procedures for the Great Lakes System to protect human health, aquatic life, and wildlife.

The GLI for the Great Lakes System will help establish consistent, enforceable, long-term protection from all types of pollutants, but will place short-term emphasis on the types of long-lasting pollutants that accumulate in the food web and pose a threat to the Great Lakes System. It consists of water quality criteria for 29 pollutants and detailed methodologies to develop criteria for additional pollutants; implementation procedures to develop more consistent, enforceable water quality-based effluent limits in discharge permits, as well as TMDLs of pollutants that can be allowed to reach the lakes and their tributaries from all sources; and antidegradation policies and procedures.

The GLI provisions will also help establishing consistent goals or minimum requirements for RAPs and Lakewide Management Plans (LaMPs) that are critical to the success of international multi-media efforts to protect and restore the Great Lakes ecosystem.

Under the CWA, the states of Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, and Wisconsin had to adopt provisions into their WQS and NPDES permit programs by March 23, 1997, that are consistent with the GLI, or the USEPA would promulgate the provisions for them. The GLI was adopted by Michigan in July 1997.

2.3.3.3 GLI Details

40 CFR Part 132 includes the detailed methodologies, policies, and procedures for adoption of criteria by Great Lakes states and tribes, application of methodologies, and implementation of procedures for the USEPA review as described in its six appendixes (A through F). The GLI methodologies for development of aquatic life criteria and values; bioaccumulation factors; human health criteria and values; and wildlife criteria are described in Appendix A to D, respectively. Appendix E presents GLI antidegradation policy. The last appendix describes the GLI implementation procedures.

The following sections provide a brief summary for each of the water quality, implementation procedures, and antidegradation provisions in the GLI.

Water Quality Criteria and Methodologies.

Protection of Aquatic Life. The final guidance contains both acute and chronic water quality criteria for 15 pollutants to protect aquatic life from acute and chronic exposures to pollutants. Table 2-1 lists these 15 chemicals. They are derived to establish ambient concentrations for pollutants, which, if not exceeded in the Great Lakes System, will protect fish, invertebrates, and other aquatic life from adverse effects due to that pollutant.

TABLE 2-1 POLLUTANTS THAT HAVE WATER QUALITY CRITERIA TO PROTECT AQUATIC LIFE

Arsenic (III)	Endrin	Selenium	Nickel
Chromium (VI)	Lindane	Cadmium	Pentachlorophenol
Cyanide	Mercury (II)	Chromium (III)	Zinc
Dieldrin	Parathion	Copper	

A two-tiered methodology to derive Aquatic Life Criteria (Tier I) or Values (Tier II) for additional pollutants discharged to the Great Lakes System was described.

Protection of Human Health. The final guidance contains numeric human health criteria for 18 pollutants in ambient water, and includes Tier I and Tier II methodologies to derive cancer and non-cancer human health criteria for additional pollutants. Tier I human health criteria are derived to protect individuals from adverse health impacts due to consumption of aquatic organisms and water, including incidental water consumption related to recreational activities in the Great Lakes System. For each chemical, chronic criteria are derived to reflect long-term consumption of food and water from the Great Lakes System. Tier II values are intended to provide a conservative, interim level of protection in the establishment of a permit limit, and are distinguished from the Tier I approach by the amount and quality of data used for derivation. The 18 pollutants identified are listed in Table 2-2.

TABLE 2-2 POLLUTANTS IDENTIFIED TO PROTECT HUMAN HEALTH

Benzene	Dieldrin	Lindane	Toxaphene
Chlordane	2,4-Dimethylphenol	Mercury	Trichloroethylene
Chlorobenzene	2,4-Dinitrophenol	Methylene Chloride	
Cyanides	Hexachlorobenzene	2,3,7,8-TCDD	(Including Methylmercury)
DDT	Hexachloroethane	Toluene	

Protection of Wildlife. Numeric criteria of four pollutants to protect wildlife in ambient water and a methodology to derive Tier I criteria for additional bioaccumulative chemicals of concern (BCCs) are included. The four pollutants identified are DDT and metabolites; mercury including methylmercury; polychlorinated biphenyls (PCBs); and 2,3,7,8 -TCDD. Wildlife criteria are derived to establish ambient concentrations of chemicals, which, if not exceeded, will protect mammals and birds from adverse impacts from these chemicals due to consumption of food and/or water from the Great Lakes System.

Pollutants Subject to Federal, State, and Tribal Requirements. Table 2-3 lists the parameters that are subject to federal, state and tribal requirements.

Table 2-3 Pollutants Subject to Federal, State, and Tribal Requirements

Alkalinity	Chlorine	pH	Total and Suspended Solids
Ammonia	Color	Phosphorus	Turbidity
Bacteria	Dissolved Oxygen	Salinity	
BOD	Dissolved Solids	Temperature	

Bioaccumulation Methodology. Bioaccumulation refers to the uptake and retention of a substance by an aquatic organism from its surrounding medium and from food. The final guidance identifies 22 BCCs that are targeted for special controls. Table 2-4 tabulates these 22 BCCs.

Table 2-4 Bioaccumulative Chemical of Concerns

Chlordane	Hexachlorobutadiene	Mercury	1,2,3,4,-Tetrachlorobenzene
4, 4' - DDD	Hexachlorocyclohexane (BHC)	Mirex	1,2,4,5,-Tetrachlorobenzene
4, 4' - DDE	Alpha-BHC	Octachlorstyrene	Toxaphene
4, 4' - DDT	Beta-BHC	Pentachlorobenzene	Photomirex
Dieldrin	Delta-BHC	Polychlorinated biphenyls (PCBs)	Gamma - BHC
Hexachlorobenzene (HCB)	Lindane	2,3,7,8-TCDD (Dioxin)	

Implementation Procedures. This section of the final guidance contains nine specific procedures for implementing WQS and developing NPDES permits to attain the standards. The nine procedures are site-specific modifications; variances from WQS for point sources; TMDL and mixing zones; additivity; determining the need for water quality-based effluent limitation (WQBEL); intake pollutants; whole effluent toxicity (WET); loading limits; levels of quantification; and compliance schedules.

Antidegradation Provisions. The USEPA's existing regulations, at 40 CFR 131.6, establish an antidegradation policy as one of the minimum requirements of an acceptable WQS submittal. Section 131.12 describes the required elements of an antidegradation policy. These are protection of water quality necessary to maintain existing uses, protection of high quality, and protection of water quality in those water bodies identified as outstanding national resources.

The GLI provided detailed antidegradation procedures that were not part of the existing regulations. The detailed implementation procedures were intended to result in greater consistency in how antidegradation should be applied throughout the Great Lakes System. The guidance specified, among other things, how high quality waters should be identified,

what activities should and should not require review under antidegradation, and the information necessary to support a request to lower water quality and the procedures to be followed by a tribe or state in making a decision whether or not to allow a lowering of water quality. Meanwhile, it also allows tribes and states greater flexibility in how antidegradation is implemented.

2.3.3.4 Importance to Source Water Protection

The GLI provides for the development of uniform water quality criteria and implementation procedures for the Great Lakes. A major thrust of the initiative was to limit toxic discharges to the lakes. It is expected that criteria from the guidance will primarily affect effluent limitations for the point source discharges. Consequently, changes in the discharge limits will have a long-term beneficial effect on DWSD source water quality for the WTPs.

CSOs, one of the biggest contributors of toxic pollutants to the Great Lakes Basin, are not directly regulated under the GLI except that in procedure 3.B.8 of Appendix F, GLI requires that TMDLs must consider discharges from wet weather events where appropriate. CSOs occur when stormwater fills up sewers due to wet weather events. CSOs carry domestic and industry wastes and are dumped directly into waterways.

Chlorine and ammonia, common and highly toxic pollutants throughout the Great Lakes Basin, are excluded from the GLI's list of "Pollutants of Initial Focus" (GLI Table 6).

Implementation of GLI can improve the water quality in the Great Lakes. It is not likely that the drinking water standards will be affected.

2.3.4 MDEQ Watershed Management Program

Although watershed management is not a mandatory process, it is the modern approach to achieving water quality and quantity goals in a watershed. So many regulatory programs exist and often confuse those entities involved with them. The watershed management approach can join all entities under one umbrella and enact a collective approach to reaching water quality and quantity goals.

SWP is a subset of watershed management, but with a specific goal of protecting the drinking water supply and public health. It focuses on maintaining good quality source water. Its many advantages include minimizing treatment costs and maximizing the health of consumers. What is good for the watershed is generally good for the source water, and conversely, by accomplishing SWP, the watershed benefits.

3. Summary of Source Water Assessment and Protection Programs for the DWSD Drinking Water Intakes

3.1 Source Water Assessment Program Summary

3.1.1 Overview

The goal of a SWAP, as required by the USEPA through the MDEQ, is to provide information to the water utility and general public about potential sources of contamination within their drinking water watersheds. The hope of the USEPA is that

this information would spur public involvement and support for watershed protection plans, which are not yet mandatory. The USEPA is considering mandating SWP plans in the future.

Source water assessments for Belle Isle, Fighting Island, and Lake Huron intakes were completed by the USGS for the MDEQ in 2002. These assessments define a watershed area, identify existing and potential contaminant problems in the watersheds, describe how each problem is relevant to drinking water treatment, and suggest possible solutions to each. Only watershed areas within the U.S. were examined. For each assessment, the sensitivity and susceptibility of each intake to contamination is estimated. These assessments provide background information useful in the development of SWP plans.

By their nature, all surface waters are susceptible to contamination. They are open to atmospheric deposition and can easily be the recipient of spills and discharges of contaminants into their receiving waters. Across the U.S., any surface water watershed is labeled as "sensitive." If at least one potential source of contamination exists in the watershed, it is also labeled as susceptible to contamination. Potential sources of contamination are locations, such as gas stations or chemical plants, where problems may or may not exist today, but have the potential of occurring because of onsite contaminants.

3.1.2 Assessment Projects

Two of the three source water assessment reports compiled by the USGS for DWSD drinking water watersheds involve source water watersheds that contain DWSD WWTP outfalls. The results of these two SWAPS are discussed briefly here.

3.1.2.1 Belle Isle Intake

According to the USGS report, "[t]he Belle Isle source water is categorized as highly susceptible [to contamination], given land uses and potential contaminant sources within the source water area."[4] This assessment identifies the following:

- 321 listed potential contaminant sources within the watershed
- Two known combined sewer drainage areas
- Potential urban combined sewers along Lake St. Clair
- Urban and agricultural runoff from the Saint Clair River, Clinton River and Lake Saint Clair watersheds

[4] U.S. Geological Survey, Water Resources Division, Michigan District. *Working Draft Source Water Assessment Report for the City of Detroit—Belle Isle Intake Water Supply*. Michigan Source Water Assessment Report 9. January 2002.

Executive Summary: Belle Isle Water Intake

The purpose of the Source Water Assessment is to analyze the sensitivity and determine susceptibility of a community's source of drinking water to potential sources of contamination.

Sensitivity is determined from the natural setting of the source water (raw water to the WTP), and indicates natural protection afforded the source water. Using procedures established in the Great Lakes Protocol, the Michigan SWAP, results of a two-dimensional hydrodynamic model of the St. Clair River-Lake St. Clair-Detroit River Waterway, considering the effects of winds and circulation patterns in Lake St. Clair, and the influence of the Detroit River, the Belle Isle intake for the DWSD WTPs has a high degree of sensitivity to potential contaminants.

Susceptibility identifies factors within the community's source water area that may pose a risk to the water supply. The susceptibility determination provides information with respect to listed facilities and land areas within the source water area that should be given greater priority and oversight in implementing a source water protection program. The source water area for the Belle Isle intake includes 321 listed potential contaminant sources in the United States and 24 listed potential contaminant sources within the susceptible area; two known combined sewer drainage areas in the United States; potential urban combined sewers along Lake St. Clair; and urban and agricultural runoff from the Saint Clair River, Clinton River and Lake Saint Clair watersheds. In Canada, the source-water area includes 5 National Pollutant Release Sites, and 18 permits for 28 sewage treatment and storage facilities. These potential contaminant sources, in combination with the highly sensitive intake, indicate that the Belle Isle source water is highly susceptible to potential contamination.

The Belle Isle source water is categorized as highly susceptible, given land uses and potential contaminant sources within the source water area. However, it is noted that historically, the DWSD WTPs have effectively treated this source water to meet drinking water standards. The City of Detroit has instituted pollution prevention programs, but should be cognizant of additional potential threats to its source of drinking water that are identified in this report. This report explains the background and basis for these determinations.

Source: U.S. Geological Survey, Water Resources Division, Michigan District. January 2002. "Working Draft Source Water Assessment Report for the City of Detroit—Belle Isle Intake Water Supply." Michigan Source Water Assessment Report 9.

3.1.2.2 Fighting Island Intake

According to USGS report, "[t]he Fighting Island source water is categorized as highly susceptible [to contamination], given land uses, potential contaminant sources, and commercial and transportation activities within the source water area."[5] This assessment identifies the following:

- 189 listed potential contaminant sources within the susceptible area
- 67 known CSOs and SSOs in the U.S.
- Urban and agricultural runoff from the Rouge and Ecorse River watersheds in the U.S., and from the Little River and Turkey Creek watersheds in Canada and shipping on the Detroit River.

[5] U.S. Geological Survey, Water Resources Division, Michigan District. *Working Draft Source Water Assessment Report for the City of Detroit—Fighting Island Intake Water Supply*. Michigan Source Water Assessment Report 31. January 2002.

Executive Summary: Fighting Island Intake

The purpose of the Source Water Assessment is to analyze the sensitivity and determine susceptibility of a community's source of drinking water to potential sources of contamination.

Sensitivity is determined from the natural setting of the source water (raw water to the WTP), and indicates natural protection afforded the source water. Using procedures established in the Great Lakes Protocol, the Michigan SWAP and the results of a two-dimensional hydrodynamic model of the St. Clair River-Lake St. Clair-Detroit River Waterway, and considering the effects of flow and mixing in the Detroit River, the Fighting Island intake for the DWSD WTPs has a high degree of sensitivity to potential contaminants.

Susceptibility identifies factors within the community's source water area that may pose a risk to the water supply. The susceptibility determination provides information with respect to listed facilities and land areas within the source water area that should be given greater priority and oversight in implementing a source water protection program. The source water area for the Fighting Island intake included 4,102 listed potential contaminant sources in the United States and 189 listed potential contaminant sources within the susceptible area; 67 known combined-sewer and storm-sewer outfalls in the United States; urban and agricultural runoff from the Rouge and Ecorse river watersheds in the U.S., and from the Little River and Turkey Creek watersheds in Canada; and shipping on the Detroit River. In Canada, the source-water area includes no National Pollutant Release Sites, and one permit for a sewage treatment and storage facility. These potential contaminant sources and commercial and transportation activities, in combination with the moderately sensitive intake, indicate that the Fighting Island source water is highly susceptible to potential contamination.

The Fighting Island source water is categorized as highly susceptible, given land uses, potential contaminant sources, and commercial and transportation activities within the source water area. However, it is noted that historically, the DWSD WTPs have effectively treated this source water to meet drinking water standards. The City of Detroit has instituted pollution prevention programs, but should be cognizant of additional potential threats to its source of drinking water identified in this report. This report explains the background and basis for these determinations.

Source: U.S. Geological Survey, Water Resources Division, Michigan District. January 2002. "Working Draft Source Water Assessment Report for the City of Detroit—Fighting Island Intake Water Supply." Michigan Source Water Assessment Report 31.

3.1.3 Additional Scopes to be Considered in the Future

The USGS/MDEQ SWAP reports on DWSD intake watersheds provide a basis for understanding potential sources of contamination to source water. However, there are many aspects of source water assessment that were not included and could be of interest to DWSD in the future. DWSD is encouraged to look into potential options to complete the "broad term" assessment evaluation. These options have been accomplished in other SWAPs in the U.S., and are described in the Source Water Protection section of the 50-year Water Master plan.

Examples not included in the SWAP report that should be investigated include:

- Non-point source pollution, characterization and load quantification
- Pollution sources (both point and non-point) from the Canadian side
- A comprehensive list of all potential contaminant sources (this can be accomplished through private, yellow pages-type data base searches with Standard Industrial Classification Codes)

- Storage of the contaminant information in a GIS-based data base system that can be used in SWP for public outreach programs and for real time identification and data retrieval of contaminant sources during a spill, which has also been done elsewhere

3.2 DWSD Comprehensive Water Master Plan Source Water Protection Task Report Summary

3.2.1 Purpose

The purpose of this section is to summarize the content and framework of the DWSD SWP Plan contained in the 50-year Water Master Plan. This framework consists of a feedback model that encompasses research and data collection, problem identification, plan development, implementation, program monitoring, and program modification. Specific SWP plan implementation measures are preliminary, but are summarized in this section.

3.2.2 Report Outline

3.2.2.1 Regulatory Background

This section provides a summary of current and upcoming regulations that are relevant to source water assessment and watershed protection. This section also includes the requirements of non-regulatory local programs concerning the Great Lakes.

3.2.2.2 Watershed Protection Background

This section presents issues affecting the source water indirectly by affecting the contributing watershed. The discussion of these issues helps shape the context of a SWP program based on a watershed approach.

3.2.2.3 Detroit Source Water Assessments

This section describes the intake watersheds and their potential sources of contamination. Included are summaries of the information gained from the SWAPs performed by the USGS for the MDEQ. This section also lists existing and potential contaminant problems in the watersheds (including TMDL information), describes how each problem is relevant to drinking water treatment, and suggests possible solutions to each.

3.2.2.4 Review of Source Water Assessment and Protection Programs Nationwide

This section showcases source water assessment and protection programs for nine metropolitan areas across the U.S. The information contained here may be of interest to DWSD as they develop a SWP program for Detroit.

3.2.2.5 Monitoring for Contaminants in Source Water

Monitoring for contaminants in the source water is not only a requirement of the SDWA for specific pollutants, but also a prudent measure to defend the water system from sudden entry of dangerous contaminants. Both current monitoring programs and the future use of early warning systems are discussed.

3.2.2.6 Vulnerability Assessments

This section discusses recent regulatory requirements in the wake of the events of September 11, 2001, and provides a summary of what a vulnerability assessment should contain. An appropriate assessment encompasses the entire water system, from the source of supply through the distribution system. The *Risk Assessment Methodology for Water Utilities*, developed by Sandia National Laboratories, is the USEPA-preferred method of vulnerability assessment analysis.

3.2.2.7 Emergency Supply Strategies

Many hazards, from vandalism to contaminant spills, can require a change in the daily supply and distribution of water to Detroit. This section suggests avenues for emergency supply planning.

3.2.2.8 Source Water Protection Tools

This section describes several tools and technologies that should be considered by DWSD for use in a SWP program. Pertinent reference documents are also summarized.

3.2.2.9 Source Water Protection Framework

This section builds upon the discussion from the previous sections in the report and presents a framework for developing and implementing a SWP plan.

3.2.3 Key Components of a Source Water Protection Framework

The DWSD encompasses a geographical diverse area with many land uses. Therefore, a framework for a SWP plan should cover the prevention and mitigation of both point and non-point source pollution. Key components of the SWP plan include the following:

- Public education and involvement to establish support for SWP within the community and among stakeholders
- Establishing protection goals and objectives that prioritize a schedule of actions for the development/implementation of programs
- Establishing funding and coordination plans
- Implementing the plan
- Contingency planning
- Considering and resolving conflicts in SWP plan implementation
- Evaluating and revising the plan

3.2.4 Detailed Components of a Source Water Protection Framework

The key components identified above can be expanded further into a detailed framework. This detailed framework is a feedback model that evaluates the scientific understanding of watersheds and SWP, the cost effectiveness and funding for SWP programs, and the political and social acceptance of policies on SWP. The following sections provide a discussion of the detailed components, and the model framework is illustrated in Figure 1.

3.2.4.1 Establish Stakeholders and Identify Issues and Goals

Close coordination with stakeholders will help identify the problems within the watershed. This step identifies stakeholders and the underlying issues associated with SWP. Stakeholders will help focus attention on identifying key problem areas, alternative management options, and a detailed management option. In addition, the stakeholders will identify SWP goals.

3.2.4.2 Conduct Background Research on Source Water and Water Quality

This step in the DWSD framework summarizes the source water assessment completed by the USGS for the MDEQ. Based on interviews with municipalities nationwide, summaries are provided for source water assessments and protection programs nationwide. In addition, this section provides a summary of local programs and initiatives related to SWP. Last, this section summarizes federal, state, and local regulations related to SWP.

3.2.4.3 Gather Data

This step summarizes the data-gathering activities necessary for SWP. Sources may include historical data from state and national databases or data generated by models. To improve upon source assessment and protection efforts, a geographic information system (GIS) can graphically illustrate the spatial attributes of a watershed related to source water.

3.2.4.4 Identify Key Water Quality Problems

This step draws upon the background information to provide an image of the state of the watershed and will help in developing objectives related to SWP goals. Because sources and causes of pollutants on a watershed basis are diverse and each has a cumulative effect, it is important to address the most significant problems first. The priority of addressing sources and cause of pollutants is influenced by the proximity of the source, relative contribution of pollutants, and likelihood of a successful remedy. This will help to efficiently allocate resources and maximize the net benefits of water quality protection.

3.2.4.5 Consider Source Water Protection Options

This section summarizes the development of alternatives for identifying the key problem areas. It is critical to develop alternative management options that look at short- and long-term conditions. This may include BMP identification, emergency water supply strategies, emergency spill response protocols, and other technologies that could be implemented to meet the objectives of water protection goals. Identification of alternative management options will emerge out of the planning sessions conducted by a DWSD technical committee. The review of the alternative management options will consider the scientific validity, economic efficiency, and socio-political acceptance.

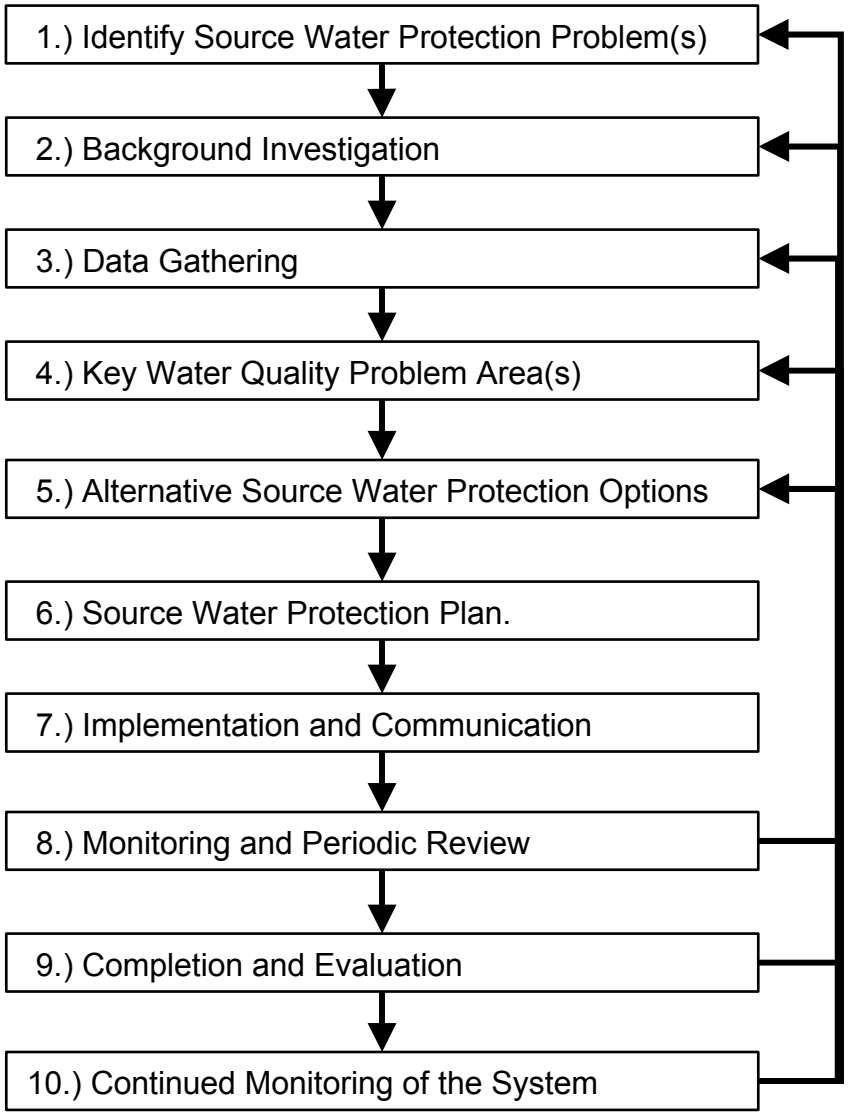

Figure 1. Ten Step Source Water Protection Plan Framework

3.2.4.6 Establish Source Water Protection Plan

This step summarizes the development of a plan that identifies a systematic, chronological order of activities for SWP. This includes implementing protocols for evaluating and reporting the progress of the plan. This plan is a guide that can be used as a basis for developing a plan that is acceptable to the DWSD and other stakeholders through a unified workshop process. Executing a detailed management plan involves scheduling projects and identifying funding sources. A program evaluation and review technique can be used to assess progress and modify the plan accordingly.

3.2.4.7 Implement Plan and Communicate

This step outlines the implementation of the SWP plan and a public education strategy. Implementation would involve developing programs to put the SWP plan into action. As part of the plan, the public education strategy identifies necessary steps for educating the public about SWP.

3.2.4.8 Monitor and Periodically Review Plan

Monitoring and periodic review of the plan is needed to demonstrate the progress toward achieving plan objectives. This includes reviewing the plan on the basis of before, during, and after monitoring data. Such data helps establish a benchmark for evaluating progress and program success. Seasonal or other periodic data assessments help watershed managers respond to changing circumstances, modifications, or schedules.

3.2.4.9 Complete and Evaluate Plan

Through the review of progress reports, goals and objectives, and monitoring data, watershed managers can identify if the source water and/or watershed protection projects are complete and successful.

3.2.4.10 Continued Monitoring of the System

Although future years will show the successful completion of many SWP projects, protocols for continued monitoring of the overall SWP plan will help watershed managers identify if corrective measures are required.

3.2.5 Source Water Protection Plan Recommendations

This section is pending the completion of the draft SWPP task report, which is estimated to be completed by September 2002, under the CS-1278 water master plan project.

The draft report will have (to be updated when the draft report is issued):

- Conclusions
- Conditions of Current Watershed
- Recommendations
- Immediate Actions (within 2 years)
- Short-term Actions (3 to 5 years)
- Long-term Actions (5 to 10 years)
- Long-range Planning (beyond 10 years)

4. Related Programs and Tools in Watershed Management and Source Water Protection

4.1 Purpose

Management and protection of source waters are the next logical steps after the source water assessment programs specified in The 1996 SDWA Amendments. Local governments and water utilities should develop management strategies once delineation of watershed areas has been completed and potential sources of contamination identified.

Watershed management in the Great Lakes watershed is an active arena filled with many players. Programs that can and will involve the DWSD span several organizations in the Great Lakes. This section identifies a handful of programs and tools that may be of particular interest to DWSD wastewater operations. The exact application of each tool to DWSD wastewater situations may not yet be determined, but examples of tools used in other areas of the country are provided in this section as a starting point for the master plan process.

4.2 Summary of MDEQ Watershed Guide

MDEQ published a document in February 2000, entitled "Developing a Watershed Management Plan for Water Quality: An Introductory Guide." The guide was written to help local units of government, nonprofit organizations, and citizens to develop watershed management plans for the specific watershed of concern. It outlines a process for gathering people, information, and resources together to protect and improve Michigan's water resources. It also represents the position of MDEQ and the experience the state has gathered in addressing the watershed management issues, which should be valuable for DWSD when it plans for its water and WWMP.

Almost every activity that takes place on land has the potential to affect the quality of water within a community. Watershed planning brings together the people within an affected community to address those activities, regardless of existing political boundaries. By working together, individuals within a watershed area can design a coordinated watershed management plan that builds upon the strengths of existing programs and resources, and addresses water quality concerns in an integrated, cost-effective manner.

The MDEQ Watershed Guide assists the development of watershed management plans submitted to MDEQ for approval under the CMI. The CMI is a multi-million dollar environmental bond initiative that received an overwhelming vote of approval from Michigan residents in 1998. The CMI designates $165 million toward quality projects, including implementing approved watershed management plans.

The Guide also includes 11 steps that have been used successfully by MDEQ non-point source grant recipients since 1995. Watershed planning and implementation are iterative processes— while all steps in the planning process are important, the order in which the steps are completed varies.

These steps are outlined in the tables below.

STEP 1
Identifying and Networking with Local Agencies and Citizens

Objectives	Potential Stakeholders
Identify water quality concerns Identify other groups or individuals with similar concerns Form a steering committee Identify a lead organization Discuss all existing and perceived concerns Define the geographic scope of the watershed based on the concerns Modify committee membership based on the geographic scope of the watershed Begin to develop a resource library	County/Regional Representatives Local Government (municipality/township) Personnel State and Federal Agencies (local representatives) Business Representatives Citizen Groups Universities, Colleges, and Schools Environmental and Conservation Groups
Detail guidance discussed includes:	
How to begin a watershed project	
How to conduct a stakeholder meeting	
Who should be on the watershed steering committee, who should lead the committee, and how should the committee be operated	
Defines the role of a technical committee	
Details how to determine the geographic scope of a watershed, how to develop a watershed map and describe a watershed, and what to do with information collected	

STEP 2
Getting to Know your Watershed

Objectives	Product
Identify designated and desired uses for your watershed Identify pollutants in your watershed Identify sources of pollutants in your watershed Identify causes of pollutants Develop goals based on uses Develop an initial water quality summary	A water quality summary of designated and desired uses, known and suspected pollutants, sources and causes, and overall goals
Detail guidance discussed includes:	
Types of designated uses and associated water quality concerns	
Determining whether the water body meets the designated uses in the present and in the future; provides contact information for assistance	
What are the desired uses for the watershed and how are they determined	
Lists how to identify known or suspected pollutants, and how to identify sources of pollutants	
Details how to identify the causes of each source of pollution	
Specifies how to develop goals for watershed, and what should be included in a water quality summary	

STEP 3
Defining a Critical Area

Objectives	Product
Identify critical areas for a watershed	Designation of a critical area that geographically narrows the scope of your watershed project by focusing attention on the portions of the watershed that contribute the greatest pollution to the water body

STEP 4
Surveying the Watershed to Inventory your Critical Area

Objectives	Product
Conduct an inventory of the watershed	A list of sources and causes for each pollutant
Use the data collected to modify the list of known and suspected pollutants, sources, and causes	The location of sources for each pollutant
	A brief summary of the method(s) used to conduct your inventory

STEP 5
Prioritizing Pollutants, Sources, and Causes

Objectives	Product
Prioritize pollutants for your watershed based on the designated uses	A prioritized list of pollutants, sources, and causes for your watershed
Prioritize sources and causes of pollutants	

STEP 6
Determining Objectives for your Watershed Goals

Objectives	Product
Determining objectives for each of your watershed goals	A table showing objectives for each of your watershed goals

STEP 7
Identifying the Systems of Best Management Practices Needed

Objectives	Product
Identify the Best Management Practices (BMPs) for each source or cause of pollution in your watershed Combine BMPs into systems	A table showing the systems of BMPs needed for each source or cause of pollution, and estimated costs
A Best Management Practice is a land management practice that a landowner implements to control sources or causes of pollution. There are three types of BMPs that treat, prevent, or reduce water pollution: **Structural BMPs**—"brick and mortar" practices that require construction activities for installation, such as stormwater basins, grade stabilization structures, and rock rip-rap **Vegetative BMPs**—use plants, including grasses, trees, and shrubs, to stabilize eroding areas **Managerial BMPs**—involve changing the operating procedures at a site	
Detail guidance discussed includes: BMP manuals from MDEQ's Non-point Source Program Details how to identify appropriate managerial, structural, and vegetative BMPs Describes what is involved in estimating the costs of BMPs Lists how to organize and describe the BMPs selected for your watershed Specifies when and how to select specific systems of BMPs	

STEP 8
Identifying and Analyzing Existing Local Projects, Programs, and Ordinances

Objectives	Product
Identify the local programs, projects, and ordinances that currently impact water quality Evaluate the local programs, projects, and ordinances that currently impact water quality to see whether they are consistent with the goals of the watershed plan Identify opportunities to coordinate with or improve upon existing programs	A summary of existing local projects, programs, and ordinances, and any modifications needed to meet the watershed goals

STEP 9
Identifying and Analyzing Existing Local Projects, Programs, and Ordinances

Objectives	Product
Identify the local programs, projects, and ordinances that currently impact water quality Evaluate the local programs, projects, and ordinances that currently impact water quality to see whether they are consistent with the goals of the watershed plan Identify opportunities to coordinate with or improve	A summary of existing local projects, programs, and ordinances, and any modifications needed to meet the watershed goals

STEP 9
Identifying and Analyzing Existing Local Projects, Programs, and Ordinances

Objectives	Product
upon existing programs	

STEP 10
Informing and Involving the Public

Objectives	Product
Identify target audiences Develop messages for the target audiences Select delivery mechanisms for disseminating the messages Use this information to develop an information/education strategy for the watershed	An information and education strategy for the watershed that involves the public and stakeholders

STEP 11
Developing an Evaluation Process

Objectives	Product
Understand why evaluation is important Understand methods of evaluation Select an evaluation method or methods for the watershed	An evaluation process based on the goals, objectives, and tasks of the watershed plan

STEP 12
Assembling your Watershed Plan

Objectives	Product
Add any missing tasks Refine the water quality summary Assemble the watershed plan	The watershed management plan document, including the final water quality summary

4.3 SEMCOG Regional Water Quality Management Plan

Southeast Michigan Council of Government (SEMCOG) is a regional planning partnership in southeast Michigan. The partnership's principal activities support local planning through the use of SEMCOG's technical, data, and intergovernmental resources. In collaboration with local government, SEMCOG has the responsibility of adopting region-wide plans and policies for community and economic development, water and air quality, and land use and transportation.

In 1978, SEMCOG published its first Water Quality Management Plan for southeastern Michigan. In 2000, the new Water Quality Management Plan was updated to focus on restoration and maintenance of "designated uses" for surface waters, such as supporting aquatic life, wildlife, agriculture, industrial and municipal water supplies; navigation; and swimming. This new plan advocates an inter-municipal approach for protecting water quality so that issues can be addressed on a watershed basis.

The new plan also focuses on current challenges posed by growth and urban redevelopment. It sets regional goals, and identifies policies for achieving these goals. The revised plan also recognizes the major role that local governments play in water quality management. Strong emphasis on home rule means that major responsibilities and choices for plan implementation now rest at the local level, with an increasing focus on intergovernmental cooperation.

SEMCOG's plan is particularly important when considering the watershed management and SWP efforts in southeast Michigan. It represents the local-specific concerns and action recommendations. It also emphasizes local government responsibilities that DWSD should be aware of. The plan also clearly states that the future trend is for multi-government and multi-agency cooperation, in which DWSD should seek an active role.

The following table briefly highlights the issues discussed in the plan.

Table 4-1 Summary of the SEMCOG Water Quality Plan

Issue	Action Steps	Related Plan Policies
Stormwater Runoff: Precipitation that travels over the surface of the land to a stream or lake, in contrast to that which infiltrates into the ground. The stormwater carries a variety of pollutants such as fertilizers, pesticides, oil and bacteria from animal waste.	Identify the non-point source pollution within the community Apply best management practices for stormwater management Emphasize preservation of open space, farmland, and natural areas through master plan, zoning ordinance, and site plans Learn how other communities are reducing impervious surface Initiate programs to prevent pollutants from entering the water resources Prepare a benefit and loss analysis of applying Michigan General Stormwater Permit	Communities are responsible for the quality and quantity of stormwater that is generated within and leaves their jurisdiction. Communities should work together and with other agencies in development of watershed management plans. Communities should identify a combination of preventative and remedial measures that take into account the land and water features within their jurisdiction. The primary goal of these measures is to control runoff rates, volumes and pollutant loadings to levels that result in achieving and/or preserving designated uses of surface waters within the community's jurisdiction, as well as avoiding negative downstream impacts.

Table 4-1 Summary of the SEMCOG Water Quality Plan

Issue	Action Steps	Related Plan Policies
Erosion and Sedimentation: Particulate matter in the waterbody, chemical pollution. Much of this problem is from new construction	Inform and educate builders Educate citizens Establish a call-in number for complaints Soil erosion protection requirement in development approval Act as or work with the enforcing agency Incorporate a buffer system into master plans and zoning ordinances	Public education on the benefits of erosion control Communities should develop and enforce a feasible erosion control plan and inspect the compliance appropriately, while encouraging BMP. Maintain a strong buffer system and reducing the amount of impervious surfaces around the water resource.
Septic Systems: Wastewater treatment that uses septic tanks and drainfields to dispose of sewerage in soil Illicit Connections: When a sanitary pipe is hooked into the storm sewer, one of the most visible impacts of it is beach closing	Siting of septic systems should be an integral part of community land use planning and zoning practice Identify areas in which the septic systems should be prohibited and limited Educate and train the cross connection identification Work with health department on an illicit discharge correction program Apply for a Michigan stormwater general permit and develop a program to identify and correct illicit discharges	Identify areas unsuitable for septic system Plan and enforce Educate public Ensure that building inspectors are adequately trained Community health departments should develop and implement illicit discharge identification and elimination program
Protection of habitat: The potential loss of habitat could be exacerbated by major land use and demographic changes occurring in the developing areas of Southeast Michigan. SEMCOG forecasts that 235,000 additional acres will become urbanized between 2000 and 2025, which will be an impediment to reaching the regional water quality goals.	Inventory habitat on communities' preserved land and assess the importance of land conservation Inventory the types of natural vegetation Mechanisms in master plan, zoning ordinances for conservation subdivisions Educate residents about the importance of habitat protection Advocate the use of natural vegetation and backyard conservation program	Communities should strive for a balance between protecting habitat and changing land use patterns Communities, state and federal agencies should support the work of land conservancies Communities should encourage preservation and restoration of natural areas through open space ordinances, and other policies

Table 4-1 Summary of the SEMCOG Water Quality Plan

Issue	Action Steps	Related Plan Policies
Protection of Wetlands: Wetlands provide many benefits, including water quality improvement, food and habitat for fish and wildlife, flood control, shoreline erosion control and recreation. Degradation of these resources will also result in more costly programs to remediate pollution problems.	Inventory wetland areas Research the needs for a wetland ordinance Incorporate provisions in the master plan, zoning ordinances to protect wetlands Educate residents Ensure the wetland areas are not overly stressed by stormwater runoff	A "no net loss of wetlands" policy should be the minimum Using proven, cost-effective techniques
Protecting Stream corridor and Floodplain: Riparian land plays an essential role in protecting water quality, avoiding flood damages, maintaining wildlife habitat and access to water-related recreation.	Cost benefit analysis of adding a buffer zone vs. flooding damages Develop a floodplain ordinance or regulation in zoning ordinance if applicable Include an assessment of the impacts on riparian areas as part of the site plan review process	Local government should incorporate measures to protect 100-year floodplain. Local floodplain regulatory ordinances should go beyond federal and state floodplain minimum standards. Local ordinances should require 100-foot development or riparian buffer where there are low-to-moderate slopes.

Table 4-1 Summary of the SEMCOG Water Quality Plan

Issue	Action Steps	Related Plan Policies
Water Quality Infrastructure: Wastewater Treatment Capacity. WWTPs in Southeast Michigan are operating at or near design capacity, and cannot properly treat additional wastewater discharges. In addition, most of the facilities were built 25 years ago and many require significant retrofitting.	Identify future wastewater infrastructure needs and costs based on residential, industrial and commercial growth, local zoning and master plans Develop a master plan and capital improvement plan for the wastewater system Develop and adopt a capital improvements program for financing maintenance and replacement based on the schedule	An inventory of the capacity of existing and planned wastewater systems should be conducted. Wastewater infrastructure needs should be based on maintaining the existing capacity, adding capacity to meet future growth, and assessing the capacity of land to support on-site systems. Combined sewer overflows should be mitigated MDEQ should work with local governments to develop policies to address overflows from separate sanitary systems
Water Quality Infrastructure: Sanitary Sewer Services. As state and federal grant programs for sewer construction were phased out, providing sewer service often became the responsibility of the land developer. This has resulted in an incremental approach to extending sewer lines, often on a subdivision-by-subdivision basis. This incremental approach to sewer extension has resulted in lost opportunities to attain more cost effective and environmentally sound practices that could be achieved from a more holistic approach.	Communities should create forums to work with neighboring communities to collaborate on sewer planning Evaluate adequacy of sewer capacity to transport flow to treatment facilities Develop a sewer system master plan and capital improvement plan Identify areas experiencing septic failures and make them a high priority for remediation	Local sewer planning should consider the plans and growth patterns of adjoining municipalities, as well as county and regional plans Sewer services planning should be an element of the community master planning process. Identify short-term needs (5-20 years). Plan should address the impacts of infiltration and inflow, stormwater and CSOs, as well as dry-weather flow. The master plans should also identify areas that are unsuitable for on-site systems and those that should not be sewered

Table 4-1 Summary of the SEMCOG Water Quality Plan

Issue	Action Steps	Related Plan Policies
Watershed Management: Rivers and watersheds do not stop at municipal boundaries. Often, national or state strategies are too "global" and not applicable for the watershed. A balance between a national, state and community-by-community approach is needed. The action of one community may have either beneficial or negative effects on neighboring communities. As a result, multi-community approaches to water quality management need to be identified and utilized. Planning and management at the watershed level helps ensure that appropriate upstream and downstream activities are coordinated to address water quality concerns unique to that watershed efficiently and effectively.	List issues and activities dealing with water quality protection. Identify what can be done on a community, subwatershed or watershed level. Share the ideas with other communities and use this as a basis to start a collaborative process. Contract neighboring communities concerning interest in watershed-wide and subwatershed planning Prepare pro/con analysis of whether to apply for the Michigan General Stormwater Permit. Present this information to various leaders in the community. This will assist in making an informed decision about applying for the permit. Consider using the RAPs as references when developing master plans, ordinances and sub-watershed plans	Watershed management must be built on partnerships identified and designed by local governments. Local governments should exercise their responsibility for water quality protection by engaging in watershed and subwatershed planning and implementation. Communities have primary responsibility for ensuring that planning and implementation of the various remedial and preventative actions identified occur within their jurisdictions. Local government should be protective of water quality and quantity. Specifically, communities need to accomplish the following: review of subwatershed plans for consistency; provide for integration, coordination and sharing of information; provide advice on distribution of grant funds; identify a mechanism for dispute resolution; and establish new mechanisms to address unsolved issues using existing institutions of government. Comprehensive watershed-wide coordination is essential to successful watershed management and must be designated by, and accountable to, the local governments and other entities within the watershed, consistent with local home rule. Communities and agencies within a watershed need to determine how they will accomplish those activities that must be addressed for the entire watershed.

Table 4-1 Summary of the SEMCOG Water Quality Plan

Issue	Action Steps	Related Plan Policies
Water Quality Trading: Allows pollution control of sources beyond regulatory requirements, which can be used in a voluntary framework, such as watershed management, to optimize the cost of achieving and maintaining water quality improvements. It allows market forces to create non-regulatory incentives for pollution reductions and to develop more efficient pollution control technologies.	Use locally initiated watershed/subwatershed planning and management groups to identify water quality goals and establish pollutant load allocations For pollutants that are problematic to the community, assess opportunities to use water quality trading to achieve needed reductions more cost-effectively Monitor trades within the municipality/watershed via MDEQ's web site	Public and private entities in southeast Michigan should consider water quality trading as another mechanism for achieving, protecting and maintaining designated uses of surface waters. Local government should generate and use credits as a means of cost-effectively achieving, protecting, and maintaining designated uses of Southeast Michigan's surface waters.
Environmental Indicators: One understandable measure on the condition of a region's water resources is the use of indicators, such as the percent of impervious surface, land use, and vehicle miles traveled.	Work with the planning commission and the public in developing indicators Utilize selected indicators in developing monitoring programs and subwatershed plans	Subwatershed planning groups need to identify specific environmental indicators as part of their planning process. Indicator information should be used by communities to formulate environmental protection laws and regulations and develop resource protection and education programs.
Pollution Prevention: Many pollutants that have entered the region's waters have accumulated among sediments. Remediation of contaminated sediments can be extremely costly and beyond the financial resources of local government.	Inventory potential sources in your community that could result in contaminated sediments Identify known areas of contaminated sediments in the community master plan and watershed planning activities Identify impacts of contaminated sediments on water resources and the community Cost benefit analysis of remediation	Impacted localities and other appropriate parties should cooperate to prioritize and remediate known areas of contaminated sediments that impair the designated uses.

Issues not summarized in Table 4-1 include

- Allocation of limited state and federal funding
- Public education and participation
- Water quality monitoring
- Groundwater

5. Tools and Future Trends in Source Water Protection, Watershed Management, and NPDES Permitting

SWP, watershed management, and NPDES permitting are all related within the wastewater treatment and discharge context. Here are some tools that can assist the DWSD in putting the issues into perspective.

5.1 Total Maximum Daily Loads and Trading Issues

5.1.1 Overview of Total Maximum Daily Loads and the 303(d) List of Impaired Waterbodies

The 303(d) list identifies those waterbodies that are not meeting surface WQS for one or more pollutants. The 303(d) list provides the DWSD with a good indication of what its future wastewater control and watershed management responsibilities might be, identifies other sources that may also face future water quality improvement responsibilities, and provides a sense of the DWSD's relative contribution to the water quality problems compared to other sources. So, a review of the 303(d) list provides an important resource to help assess future effluent limits and opportunities for watershed improvements.[6]

When a state lists a waterbody on its 303(d) list, the state must then develop a TMDL for the pollutant(s) causing the water quality problem. The TMDL analysis establishes the total assimilative capacity of the segment(s). The analysis then allocates pollutant loading caps to all permitted point sources—formally called wasteload allocations (WLAs), and to all non-point sources—formally called load allocations (LAs). A margin of safety (MOS) is also established to account for any uncertainty.

Each individual NPDES permit holder generally receives its own WLA. This may be in the form of a loading limit, as implied by the term TMDL, or it may be converted to a water quality-based effluent limit. With respect to non-point sources, the state may develop LAs for non-point sources by tributary, political jurisdiction, other area, or in rare cases individual landowners. Following completion of the TMDL and LAs, many states and communities are preparing, voluntarily or as part of a state requirement, a TMDL implementation plan that spells out roles, responsibilities, schedules, and often funding sources necessary to implement the TMDL.[7]

5.1.2 Using the Michigan 303(d) List for Strategic Planning

Michigan's 1998 and 2000 303(d) lists contemplate a 10-year schedule. This remains the case with the recently released draft 2002 303(d) list (MDEQ, 2002). It may be that some currently listed waters will be delisted, while other impaired waterbodies could be added to the list. The DWSD could establish a process to evaluate potential future liabilities and opportunities associated with TMDL development and implementation on and around

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[6] As of July 2002, USEPA and the states are considering changing the structure of the 303(d) list so that potentially only Category 5 listed waters would need TMDLs. This section should reflect or address such changes to the extent possible before it is finalized.

[7] As of July 2002, the new TMDL rule, or "watershed rule" as it is now called, is still in draft form and is expected to be released for comment sometime in the late summer or early fall 2002. This section should reflect or address such changes to the extent possible before it is finalized.

the DWSD's receiving watershed. Such an evaluation should be performed each time the state issues a new 303(d) list.

The steps outlined below would provide the DWSD with a strategic evaluation of TMDL-related responsibilities and opportunities.

1. Identify 303(d) listed segments on, above, and below the receiving water
2. For those listed segments, identify pollutant(s) causing impairment
3. Identify sources of impairment by category
4. Determine when the TMDL(s) is scheduled for development
5. Evaluate the quality of the available data that was used to list the water, and that will be used for the TMDL (also, identify who will do the TMDL—state staff, state contractor, other)
6. Assess the DWSD's contribution to impairments in and below its receiving water
7. Assess contributions from upstream sources that limit the assimilative capacity in and below the DWSD's receiving water
8. Estimate the relative contribution of the DWSD's loading to the water quality problem compared to other sources
9. Evaluate whether the DWSD's additional responsibilities for additional treatment, pollutant load reductions, or other water quality improvements are likely to be proportional, less than, or greater than its relative contribution
10. Develop an appropriate action plan and repeat steps 1 through 8 as needed in greater detail as information becomes available and the TMDL process approaches

Going through this type of evaluation ahead of TMDL development will help the DWSD determine the optimal level of its involvement and participation in TMDLs in and around its receiving water. This type of analysis can also help identify early opportunities to avoid or mitigate undesirable TMDL outcomes, including the possibility of relying on water quality trading—as a buyer or a seller—under any TMDL implementation plan.

Under certain circumstances, an active role may be the best strategy to protect the DWSD's interests and best serve its ratepayers and stakeholders. Such a strategy may include, for example, participation in TMDL workgroup meetings, financial and/or in-kind contributions to the TMDL modeling, offers for additional data collection and analysis, etc. If all watershed stakeholders are not taking a cooperative approach, the DWSD may wish to maintain a lower profile during the process.

5.1.3 A Preliminary Analysis of DWSD's Total Maximum Daily Load-Related Risks and Opportunities

The DWSD's main outfalls are located on the Rouge River Lower Branch near its confluence with the Detroit River and on the Detroit River. Michigan's 1998 and 2002 303(d) lists identify the following impairments as shown in Table 5-1.

Table 5-1 DWSD WWTP Discharge Receiving Stream TMDL Identification

Rouge River Impairments	Detroit River Impairments
• CSO/Pathogens • Low dissolved oxygen (DO) • Poor fish and macroinvertebrate communities • Sediment FCA-PCBs	• CSO/Pathogens • Sediment FCA-PCBs • Sediment TCCD (dioxin) • Sediment—mercury • Mercury in the water column

Currently, Michigan's WQS do not directly establish criteria for nutrients. The current WQS include phosphorus limits for discharge directly to a Great Lake as well as indirect nutrient limits as they effect stimulation of aquatic rooted, attached, suspended, and floating plants, fungi, or bacteria that may negatively impact the uses of a waterbody.

The DWSD's biggest challenges and opportunities may arise in two areas.

1. The WWTP expansion will significantly increase the DWSD's future flow and it is not yet clear whether pollutant loadings at the higher volumes and current treatment levels can be assimilated by the receiving water without causing or contributing to a water quality impairment for one or more pollutants.

2. The state of Michigan must establish nutrient criteria by 2004 (or possibly later) under a USEPA mandate with a possible result being new discharge limits for the DWSD's WWTP even before TMDLs are developed for the currently listed impaired segments (this is important because a WQS is the combination of the water quality criteria with the designated use).

The DWSD could take several immediate steps to better ascertain its TMDL-related risks and opportunities. First, managers could conduct an assessment to determine the assimilative capacity of the receiving waters both in terms of plant expansion and in terms of declining water quality values. This should include an analysis of the receiving waters and pertinent upstream and downstream segments for declining water quality trends, particularly in parameters that are currently not on the 303(d) list. This will help identify potential problems that can be tracked. As part of this effort, each new 303(d) and 305(b) list should be analyzed in both draft and final form. This will indicate new listings, delisted segments, and state perceived trends.

For example, according the MDEQ (MDEQ, 2002), CSO/Pathogen listings are "scheduled for TMDL development based on the scheduled implementation of the approved long-term CSO Control Programs for these facilities". For the moment, this issue needs to be monitored. If the correction of all CSOs within the watershed fails to improve WQS for pathogens, the corresponding stream segments will probably be listed again. Delisting, i.e., CSO correction, is not scheduled to occur until at least 2007.

Toxics may be another concern since outfalls 049F and 050A both have monthly discharge limits for PCBs and total mercury and several segments are 303(d) listed for toxics in the sediment, including PCBs, dioxins, and mercury. It needs to be determined if the mercury and PCBs have contributed or are contributing to the toxics in the sediment. If DWSD's discharges are not contributing to the toxics in the sediment, this information will help establish fair and equitable allocations when the TMDLs are eventually developed.

5.1.4 Overview of Water Quality Trading Options in Watershed Management Plans

Environmental credit trading represents a new, incentive-based vision for more efficient and effective watershed management plans. Credit programs supplement existing regulations by offering incentives and rewards for actions that go beyond compliance. Credit trading and banking options provide stakeholders with opportunities to expedite restoration and reduce overall costs.

After a relatively slow start compared to air emissions trading and wetland mitigation banking, the number of efforts to explore how watershed-based trading could help achieve local water quality objectives has grown in the U.S. from about five in 1990 to

over 45 today. These initiatives are in various stages of development, ranging from feasibility studies to full-blown implementation. Almost a dozen are well into the implementation phase, with trades underway or completed.

A trading program provides a framework for stakeholders to evaluate how cost effective different control options or BMPs are across all sources and all types of regulatory and voluntary programs. With a trading option, people can prioritize actions and implement the most cost-effective projects first. Sometimes, this will mean someone does more than they are required to do and sells or banks pollutant reduction credits. Other times, this will mean someone makes an equivalent or greater contribution to pollution reduction "offsite" by buying credits. Federal policies and local trading rules prevent anyone from "turning off" pre-existing controls, and prevent trades that might lead to localized "hot spots" occurring or persisting.

Properly designed and implemented trading programs—like those that conform to Michigan's draft trading rules (as summarized in Appendix A) and to USEPA's new trading policy (May 2002 Draft)—provide incentives for businesses, utilities, and municipalities to act in ways that further not only their own financial goals, but also improve environmental quality. Trading may encourage pollution prevention, promote the development and installation of more efficient abatement technologies, and reduce pollutant loading from previously unregulated sources. Doing this through a stakeholder-driven watershed management plan creates a vehicle for sustainable watershed management in the region.

Watershed trading projects in place or under development today are being designed to achieve an array of goals and objectives related to environmental and economic concerns. Examples include:

- Least-cost wastewater treatment costs

- Equitable shares of the treatment costs between point sources and non-point sources
- Optimizing resource allocation to maximize environmental returns on investments
- Economic development without major capacity limitations due to TMDLs
- Incentives for faster implementation of needed improvement projects—including for listed waters where the TMDL has not yet been developed

The success of innovative, market-based solutions to complex problems depends on many factors. Experience to date with watershed trading has shown that several characteristics and conditions can be critical to achieving the goals and objectives stakeholders establish for the trading program.

For example, an evaluation of trading programs prepared for the Washington State Departments of Ecology and Transportation by CH2M HILL (Bacon, Girts, and Derry, 2001) identified the conditions and characteristics listed below as important lessons learned.

- **Leadership and Involvement—Champions are Persistent, Stakeholders Must Have Access and Role.** A core group with consensus building skills and technical expertise is needed to educate participants and other stakeholders, answer critical procedural and scientific questions, and drive the design and implementation process forward. Most often, it is best to engage as many stakeholders as appropriate from the beginning. It is incumbent upon the leaders to issue broad invitations for participation. Exclusion generally carries greater risks down the road than inclusion. Even if inclusion makes the road longer, it will more likely lead to success, buy-in, acceptance, ownership, endorsement, and participation.

- **Specific Environmental Objectives—A Target and a Baseline.** Whether in the form of a TMDL or similar analysis, the environmental objective must be articulated in clear and measurable terms. Some programs have established a loading cap that they are now under and want to remain below, while others have set loading targets that they must achieve significant reductions in order to meet. A clear baseline sets in motion incentives to trade and the benchmark from which equity is measured.

- **Sufficient Reduction Capacity in Alternative Sources—Provides Tradable Reductions.** Loading reductions must be available for which trading is a politically feasible activity. These tradable options may be the only reductions being implemented in the area. More commonly, tradable options supplement ongoing pollutant control efforts (i.e., technology-based controls). Such loading reduction capacity typically is found among non-point sources, but several programs are examining ways to take advantage of temporary or purposeful point source loading reductions, such as from industries that are changing processes or turning to reuse. To date, agriculture is the most common source of tradable options.

- **Favorable Economics—Creates Incentives to Trade.** To generate interest in trading and design a workable program, the relative difference in control costs among some sources must be significantly different—significant enough so that when transaction costs and any operation and maintenance costs are factored in, the trade is still a good deal. Point sources have typically found such differentials with non-point source partners. While significant differentials between point sources have not been identified to date, point-non-point trading can offer opportunities to take advantage of timing and scheduling differentials, which translate into better financing deals and cost-savings.

- **Strong Data Collection and Monitoring Program—Measurable and Verifiable Results.** Sufficient data and monitoring are critical to establishing a baseline and evaluating the potential and actual impacts of trades on water quality. The baseline may be set by WQS and by site-specific criteria, such as determined by use attainability studies. It is important to quantify non-point source loadings and BMP effectiveness rates in order to provide sufficient assurance that environmental benefits will result from point-non-point source trades. From the very beginning, a trading initiative that includes the performance criteria and program evaluation process to review effectiveness, document results, and adjust rules or policies if necessary, is more likely to document environmental improvements. Developing a data system to record and track trades is a key part of this process.

- **Workable Regulatory Framework—Flexible but Firm.** Especially for point-non-point source trading, accountability and enforceability have been sticking points and deal breakers. The programs examined represent several different approaches to solving this problem. Some rely on permit-based provisions, alone or in combination with other mechanisms. Contracts and other binding agreements that specify roles, responsibilities, and recourse also are gaining acceptance.

- **State Buy-In—As an Active or Passive Participant.** Regardless of whether the state actively participates in program design and implementation, or plays a narrower role as regulator and observer, state acceptance has been a key component in each program examined. In many instances, state staff played a critical part in conducting technical analysis and crafting viable solutions. In others, they reviewed proposals through the existing permitting process. Resource allocations to state regulatory authorities, including legislative appropriations and direction and federal grants, have greatly facilitated the implementation of such programs—especially when they involve multiple agencies.

- **Point Source Must See Benefits—Outweighing Political and Technical Obstacles.** So far, most trading has involved point sources "buying" reductions from non-point sources that do not face nearly the same regulatory requirements, relatively speaking, that point sources operate under. Politically, then, many point sources are reluctant to come to the table and discuss trading opportunities when they feel non-point sources have not been held accountable for "their fair share." Most point sources that have come forward have done so because of compelling economic opportunities, or because they believe that if something doesn't get

done, regulatory requirements are likely to become more stringent and new sources may be disallowed.

- **Resources to Support Design and Piloting—Also Implementation.** So far, no one can really say that getting a trading program off the ground is inexpensive. Most of the programs discussed here have, or will have, spent somewhere between several hundred thousand and $1 million on data collection, technical analysis, development, and design efforts (including workshops, education, and alternatives analysis) to support trading. As more trading programs come on-line, significantly more information and models will be available to interested parties, and development costs should begin to decrease.

5.1.5 Evaluating the Potential Benefits of the DWSD's Participation in a Trading Program

Several future situations could lead the DWSD to consider whether trading would be a good business decision, including new state nutrient criteria, TMDLs and LAs, and additional requirements associated with the pending expansion—any or all of which could lead to more stringent effluent limits and/or loading caps for selected pollutants.

In these situations, DWSD may have following basic choices when trading is an option:

- Upgrade technology to meet the new effluent limit or loading cap;
- Stay with current technology and create or purchase credits to offset loadings above a cap;
- Upgrade technology beyond that required to meet a cap and sell surplus reductions to other sources; or
- Appeal or litigate the allocation and delay action

Thus, the DWSD could find itself considering trading either as a buyer or a seller of credits. It also is possible that not trading may be the best solution. It will then be necessary to evaluate the potential economic and environmental benefits of becoming a buyer or a seller.

Economic benefits may include:

- Increasing flexibility and expanding the range of watershed improvement options
- Reducing cost by taking advantage of differences in control costs among sources, saving anywhere from 10 to 50 percent or even more
- Generating market demand for new innovative technologies
- Providing additional benefits such as greater and improved recreation and tourism opportunities

Environmental benefits may include:

- Sellers going beyond minimum requirements to create credits that can be sold, banked, or retired
- Targeting locations of reductions to priority areas
- Getting reductions in nutrients sooner
- Providing broader environmental benefits such as ecological restoration, ecosystem protection, improved wildlife habitat, recreation, and aesthetic amenities
- Increasing the overall health of waterways

Many communities implement trading programs for two primary reasons:

- Supporting development of an equitable and environmentally successful watershed management plan by relying in part on market-based approaches, including environmental credit trading
- Arriving at results-oriented solutions that will enable utilities, industries, states, local governments, and land owners to economically meet water quality objectives through community-based partnerships

Many resources are available to help utilities that are interested in exploring how trading can help them meet their water quality-related responsibilities. For example, in 1996, the USEPA published a *Draft Framework for Watershed-Based Trading*, and has recently issued an updated policy (May 2002) and expects to issue updated guidance in 2003 or 2004. The Water Environment Research Foundation has published five studies of trading demonstration programs in Colorado, Connecticut, Maryland, Michigan, and Wisconsin. Lessons learned in the Michigan study, *Phosphorus Credit Trading in the Kalamazoo River Basin: Forging Nontraditional Partnerships* (Kieser et al., 2000) served as the basis for the draft Michigan rules. The Association of Metropolitan Sewerage Agencies and the Water Environment Federation also have several trading-related resources. When DWSD becomes interested in exploring trading further, it can contact one of these organizations or an engineering consultant with practices and in-house experts devoted to evaluating, designing, and implementing watershed-based trading programs, such as CH2M HILL or Kieser & Associates. See Appendix A, *Summary of Michigan's Draft Water Quality Trading Rules*.

5.2 Net Environmental Benefit Analysis

5.2.1 Summary

NEBA is a set of techniques for quantifying and comparing the benefits of alternative actions that affect the environment. In NEBA, only environmental effects are considered. Ecological changes like improved wildlife habitat, nutrient uptake capacity, and stream integrity benefit humans indirectly through the functions and services that they provide to and through the ecosystem. To make improved decisions about such ecosystem function, it is often advantageous to quantify the ecological

changes using an ecological metric. This quantification improves decision-making on ecological tradeoffs because it enables the systematic identification, evaluation, ranking, and selection of alternatives on the basis of net ecological benefits.

The primary NEBA tool for quantifying ecological benefits using an ecological metric is called Habitat Equivalency Analysis (HEA). It is used to identify least-cost options for producing an environmental improvement (e.g., as a result of a stormwater BMP) and for mitigating any environmental harm (e.g., wetland mitigation). This approach, known as the *service-to-service* approach, is supported by many federal agencies (DOI, 1997; NOAA, 1997; USEPA, 1999) and in federal court rulings (U.S. vs. M. Fisher et al., 1997) as a valid approach for determining compensation for habitat impacts. The *service-to-service* approach has also been used in multiple states across the U.S. (California, Texas, New Jersey, South Carolina, Virginia, Indiana, Louisiana, Florida, Oregon, Idaho, Alabama, plus others). Several peer-reviewed journal articles and federal government reports discuss the merits of this approach (King and Adler, 1991; Unsworth and Bishop, 1994; NOAA, 1995; NOAA, 1997; NOAA, 1998; Fonseca, et al., 2000).

The application of NEBA tools to assist in developing least-cost environmental solutions has extended to a broad range in federal and state regulatory contexts. For example, recent regulatory drivers in the state of Florida have opened the door to the consideration and implementation of NEBA strategies. In 1993, as part of the Ecosystem Management Initiative, the Florida Department of Environmental Protection (DEP) developed a new agency culture to support a systems approach to environmental protection and sustainability. The new ecosystem management approach that sprung from this culture change includes a cooperative teaming procedure in project permitting under the Florida state law and regulations. A major—and overriding—consideration in the team permitting concept is that in return for the expedited regulatory procedures, there will be a net environmental benefit from the activity after it is permitted. (www.leg.state.fl.us/Statutes/index.cfm; www.wri.org.incentives/barnett.html).

5.2.2 Benefits to DWSD

This evaluation tool has potential applicability to DWSD for identifying, evaluating, ranking, and selecting ecosystem management alternatives for SWP/water treatment and wastewater treatment. From the wastewater treatment perspective, ecosystem management measures can be undertaken in lieu of costly abatement technologies. A potential role of the NEBA tool is to determine the water quality improvements that would be achieved by the various ecosystem management measures and determine their equivalence to the water quality improvements that the WWTP upgrades would accomplish. Such measures would not necessarily be limited to reducing pollutant loadings, but can include positive modifications to non-pollutant stressors. Depending upon the factors limiting attainment of water quality goals, these actions can include increasing fish habitat and restoring the natural flow regime, for example. The DWSD objective would be to modify their NPDES permit to reflect the water quality impacts of their discharges given the improvements achieved by other means.

The application of the tool is similar for situations where the DWSD needs to expand wastewater treatment capacity and will require a new NPDES permit. It may be difficult to obtain such a permit unless the DWSD can demonstrate that their discharge will not lead to or increase an impairment. The DWSD may find it advantageous, or even necessary to include ecosystem restoration projects and/or BMPs as part of the conditions of their NPDES permit, as these could be more cost-effective and technically feasible than more stringent effluent limitations. Together with the appropriate water quality modeling, the NEBA tool can be used to identify, evaluate, and rank alternative actions in terms of their impact on water quality and thus provide a defensible and verifiable basis for less stringent effluent limitations.

Extending this concept to 303(d) listed waters and TMDLs, the NEBA tool can similarly be used to potentially bypass the TMDL by demonstrating alternative pathways to attainment, or decrease the cost of TMDLs by facilitating pollutant trades. For point sources, the NPDES permits would be written based upon the conditions of the trade.

Finally, the DWSD will want to consider the potential of SWP measures to generate water quality credits for their wastewater discharges. If the market institution will allow, it can be important to register these credits in advance rather than try to use them "after the fact". This can only be done, if the DWSD can demonstrate how the actions improve water quality and would offset their discharges. The NEBA tool can be used to take a water quality-based approach toward quantifying credits and the credit ratios that would produce equivalent water quality gains.

In summary, ecosystem management measures can be a source of cost savings for the DWSD. The NEBA tools assist in choosing the mix of ecosystem management measures (e.g., stormwater BMPs, ecosystem restoration, and offsite treatment wetlands) that produces the desired net environmental benefit at least cost. The tools can be applied separately to address SWP/water treatment or wastewater treatment objectives or they can assist with taking a more comprehensive approach that looks for synergies in the two programs. The next section provides additional details on NEBA approaches and includes a few project descriptions illustrating the tools. A brief discussion of how these tools have been applied in other contexts is included.

5.2.3 How and Where the Tools Have Been and Could Be Applied

5.2.3.1 Innovative Watershed-Based Programs Involving Ecosystem Restoration and Net Environmental Benefit Analysis

Watershed management tradeoffs using net environmental benefit analysis, whether they occur in the context of a formal trading institution or result from one-on-one negotiations with the regulatory authorities, are decisions that take advantage of opportunities to maximize water quality and achieve ecological improvements at least cost.

An evolving and innovative concept is that of multi-credit or multi-stressor tradeoffs. An important issue in making such tradeoffs relates to understanding how the proposed alternatives compare in the nature and extent (i.e., spatial and temporal) of their impact on attaining water quality goals. This can be accomplished using water

quality modeling methodologies and NEBA to quantify the water quality improvements using performance-based measures that are tied directly to the relevant ecological goals (e.g., designated use attainment, improvement to the waters and water-dependent natural resources of the Great Lakes Basin). In the trading context, such an approach is used to ensure trades result in at least equivalent gains in water quality as would occur without the trade or result in even greater improvements with the appropriate MOS, as required by the trading rules.

One NEBA approach uses HEA. This approach has broad applicability to a wide variety of tradeoff contexts from single point sources conducting BMPs and instream habitat enhancements in lieu of costly plant upgrades, to multiple sources making credit purchases from a mitigation bank. In between are same pollutant trades between two trading partners as well as multi-stressor trades including point to non-point trades or non-point-to-non-point trades.

Although fairly straightforward in situations involving same pollutant loads from multiple sources distributed to the same water segment at roughly the same intervals, determining appropriate trading credits can be complicated by spatial and temporal differences in water quality improvements as well as the nature (i.e., pollutant versus non-pollutant stressor) and magnitude of the differences. HEA is a tool for organizing the basic ecological information relating stressors to water quality improvements and designated use attainment that will provide fair and consistent computations for water quality credits. The trading ratio must be set to recoup all lost ecosystem services (that is, designated uses) resulting from the trade. This requires taking into consideration spatial and temporal differences in water quality improvements as well as the nature and magnitude of the changes. For example, instream enhancements may only accrue credits for improvements to impaired sections of the stream even if reaches upstream of the impaired water segment are also improved. Also, if the enhancements are likely to remain effective for a limited number of years, that too, can be factored into the credit calculations. The relative uncertainty related to the magnitude of the water quality improvements resulting from different actions can affect the trading ratio as well.

The HEA tool is routinely used by the National Oceanic and Atmospheric Administration (NOAA) to standardize the process of determining the quality and quantity of restoration actions necessary to offset impacts to their trust resources. Other federal agencies, including the USFWS and several states, have applied the tool similarly. The USEPA has suggested this tool for determining wetland mitigation ratios and for quantifying mitigation for unavoidable impacts under the CWA Section 316(b) regulations involving fish impingement and entrainment from cooling water intake structures. The HEA approach has withstood court challenges in natural resource damage assessment cases.[8]

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[8] National Oceanic and Atmospheric Administration (NOAA). *Habitat Equivalency Analysis: An Overview*, U.S. Department of Commerce, National Oceanic and Atmospheric Administration - Damage Assessment and Restoration Program. 1997a.
National Oceanic and Atmospheric Administration (NOAA). *Scaling Compensatory Restoration Actions.* U.S. Department of Commerce, National Oceanic and Atmospheric Administration - Damage Assessment and Restoration Program, 1997b.

Habitat Equivalency Analysis Project Descriptions

Ecological Restoration of Sugarland Run, Virginia

CH2M HILL is providing oversight and management of the wetland restoration associated with an oil spill in Reston, Virginia. The restoration serves as the required compensation as part of a Natural Resource Damage Assessment (NRDA) case and includes the development of both ecological and recreational enhancements. The restoration program, which was designed primarily to manage stormwater to improve water quality, was scaled using a net environmental benefit analysis approach and the HEA tool. Application of this tool was to ensure that the environmental objectives and regulatory requirements were met at least cost.

Fishing Point Risk Assessment and Wetland Compensation Using Habitat Equivalency Analysis

CH2M HILL provided ecological risk assessment services for 2.5 acres of freshwater emergent marsh that were impacted by a landfill, and is in the process of preparing a design to compensate for wetlands filling that occurred as a result of a remedial landfill cover installed for the protection of human health. Based on successful negotiations and a teaming relationship with the regulators and trustee organizations, a natural resource economic model (the HEA tool) is being used to design compensation for the wetland filling incurred as part of cover construction. The benefit of this approach is that compensation is scaled based on lost ecological services, rather than the traditional approach of scaling compensation solely based on area lost. A pre-construction functional analysis of the wetlands indicated that the most valuable features related directly to water quality benefits (that is, contaminant retention and flood storage). As such, the currency being used to link lost ecological service to ecological services gained through compensation is changes in water quality due to improved stormwater management. This approach will enable the organization to obtain full credit for water quality services created as part of the compensation package.

The HEA approach can apply to a single point source discharger's NPDES permit written to reflect some combination of traditional treatment and natural treatment systems/ecosystem restoration/BMPs or to develop a consistent approach toward performance-based credits to support trading. In either case, NPDES permits for point sources would be written to reflect the conditions of the trade. Descriptions of two real world CH2M HILL stormwater BMP projects using HEA are included in the project descriptions on the next page.

The NEBA technology is closely tied to ecosystem restoration, BMPs, and natural treatment systems. When these approaches make sense (best thing for environment and least cost), the NEBA provides the quantitative justification and demonstration of the win-win for the environment and the bottom line, respectively. Thus, there are several innovative ways of using these ecological technologies in a watershed/NPDES context:

National Oceanic and Atmospheric Administration (NOAA). *Oil Pollution Act Regulations.* 15 CFR part 990. National Oceanic and Atmospheric Administration. 1996.
Unsworth, R.E. and R. Bishop, *Assessing Natural Resource Damages Using Environmental Annuities*, Elsevier Science, Ecological Economics, 11(1994) 35-41. October 1993.

- Demonstrate progress toward achieving designated uses (water quality goals) by altering multiple stressors (chemical and non-chemical)
- Create habitat for fish, wildlife, and endangered species (and thus generate potential revenue stream from wetland or stream mitigation banks or habitat conservation banks)
- Create revenue stream from sales of harvestable products
- Provide open space or park and recreation amenities

Off-set other environmental liabilities; NEBA tools and concepts can also be used in identifying potential supplemental environmental projects for NPDES noncompliance and thus can assist the DWSD in agency negotiations over determining how much credit against the cost of the penalty to assign to a supplemental environmental project.

5.3 Best Management Practices for Non-point Source Pollution

5.3.1 Watershed Approach—Ecosystem Restoration and Best Management Practices

Ecosystem restoration tools address chemical, physical, and/or biological components of a degraded natural system to produce improvements in the quality of water resources, to support diverse, productive communities of plants and animals, and to otherwise achieve the designated uses of the watershed. Ecosystem restoration plays a special role in developing TMDL alternatives, for example, because this tool impacts both chemical and non-chemical stressors. Common stressors that degrade ecosystem function include point and non-point sources of pollution, habitat alteration and disruption, and hydrological alteration (that is, stream integrity). For cost-effective CWA compliance, it can be important to restore the natural dynamics of the watershed prior to developing TMDLs. In addition, as ecosystem restoration projects can simultaneously improve water quality, habitat, and stream integrity, it can be important to allow multi-stressor trading to provide credits based upon relative contribution toward designated use attainment, rather than based simply on pollutant load reduction. Failure to give credit for reducing both pollutant and non-pollutant stressors will lead to inefficient (that is, more costly) TMDLs and/or will result in failure to meet designated uses.

A second feature that distinguishes ecosystem restoration tools, BMPs, and natural treatment systems from other technologies to improve water quality are their multiple benefits and contributions toward achieving other environmental, economic, and societal goals. Examples include wetland mitigation credits, habitat conservation credits, ESA compliance, harvestable crops, carbon sequestration, open space preservation, parklands for recreation, etc.). These benefits can be ancillary to the TMDL but can nonetheless assist with that goal by providing additional sources of revenue or credit to share in the cost of achieving designated use attainment. Thus, it

can be important to consider TMDLs in a broader context of watershed management that takes other stakeholder goals into consideration.

Like trading concepts, the earlier that ecosystem restoration and natural treatment systems can be introduced in the process, the greater are the opportunities for developing a watershed management approach or individual NPDES permit that achieves cost-effective CWA compliance.

5.4 Potential Uses of Ecosystem Restoration and Non-point Source Best Management Practices to DWSD

5.4.1 Introduction and Background

This section presents an overview of using BMPs for non-point sources of contaminants to potentially address DWSD's future NPDES requirements. As such, this section will focus on those non-point source BMPs that may help address mercury, pentachlorophenols (PCPs), and pathogen removal. PCPs and pathogens are closely tied to organic sedimentation. To the degree that organic sedimentation is controlled, so, too, potentially will be those contaminants.

Southeast Michigan is a densely populated urbanized region, which includes the cities of Detroit and Mt. Clemens as well as several "upriver" and "downriver" communities. Land uses include industry, residential, and in the northern counties, agriculture. Most of the new development is in the outlying suburban communities, with a loss of populations from the core urban areas[9].

Based upon the MDEQ report, this region continues to see a significant loss of population from the Detroit Metro area and high growth rates in undeveloped areas of adjacent and coastal counties. It is projected that the population in Wayne County and the city of Detroit will decrease between 2000 and 2020. While the population in the urban core communities continues to decline, outlying counties are expected to grow. Concurrently, while the average population growth for the region is 15 percent, the amount of developed land outside of the metro area is projected to increase by 40 percent (Southeast Michigan Council of Governments)[10].

The MDEQ report identifies the primary cumulative and secondary impacts for this region:

- Local water pollution problems from stressed or inadequate septic and sewer systems. Beach closings due to large masses of decaying plants and elevated levels of fecal coliform, which are attributed to inadequate septic and sewer systems and high levels of nutrients.
- Increased development in coastal hazard areas. As more and more of the shoreline becomes developed, there is increased pressure to develop coastal hazard areas such as flood risk areas and wetlands.

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[9] MDEQ. Michigan Coastal Management Program Draft Section 309 Enhancement Grants Assessment. Michigan Coastal Management Program Land And Water Management Division, Michigan Department Of Environmental Quality P.O. Box 30458.Lansing, Michigan 48909-7958, 75pp. February 2001.

[10] Ibid.

- An increase in vacant industrial properties. As industries leave the waterfront, they leave behind large, and sometimes contaminated industrial sites. Expensive clean-up costs of contaminated industrial sites may discourage redevelopment in brownfields.

The report's findings outline the challenges facing DWSD as well as some potential opportunities to use BMPs to address specific contaminants from non-point sources to be used as offsets in lieu of using expensive effluent abatement equipment to satisfy NPDES requirements. For the purposes of this discussion, it is assumed that such offsets will be allowed under future regulatory requirements germane to DWSD's interests.

The report helps identify potential point and non-point sources of contaminants: inadequate septic systems, increased development in rural areas and in coastal areas, and current and vacant industrial areas.

There are two areas where non-point source BMPs may be relevant to DWSD. The first area relates to the non-point sources associated with urban runoff for both industrial and residential/commercial areas. The urban runoff and its associated pollutants are primarily from streets, building roofs and parking lots that may collect in natural (e.g., depressions, ponded areas, streams) or manmade (e.g., catch basins) areas before entering into the combined sewer systems of DWSD or being discharged directly into adjoining waterbodies within the watershed through surface sheet flow and groundwater flow. The sources of the pollutant loadings associated with these discharges can be through current atmospheric deposition (mercury, PCPs, tetrachlorodibenzo-p-dioxin [TCDD]), legacy (e.g., contamination from past industrial practices or spills, lead-based paint from aging housing stock), ignorance or malfeasance (deliberate dumping) and current practices (e.g., winter salt/sand applications).

The second area involves the non-point source discharges associated with rural runoff. This primarily includes discharges from agriculture operations (concentrated runoff from feedlots, sediment erosion and pollutant loadings from crop fields) into adjoining waterbodies within the watershed through sheet surface flow and groundwater flow.

5.4.2 Types of Non-Point Source Best Management Practices

There are a variety of non-point source BMPs and most relate to controlling nutrients. Most non-point source BMPs require a relatively large area to be effective, which can become cost prohibitive in an urban area with high real estate values. However, given the projected trend from MDEQ within the DWSD area, opportunities may exist to locate and cost-share some non-point source BMPs in urban land reuse plans (e.g.,

industrial shoreline redevelopment[11]), as part of industrial site remediation activities and as part of a larger restoration effort such as the Rouge River Restoration. Those with potential application to DWSD are listed below.

5.4.2.1 Bioretention, Infiltration Best Management Practices, Stream Bank and Shoreline Restoration Best Management Practices

These BMPs primarily contain and trap sediment. The literature on metal removal rates is mixed, but nutrient removal rates can be high. Examples include:

- Bioretention areas (e.g., filter strips) and swales
- Infiltration trenches and tubes
- Infiltration basins
- Rain gardens in neighborhood areas to catch pollutants from roof runoff
- Grass swales
- Porous Pavement
- Riparian buffers
- Acquisition, preservation and enhancement of rural areas
- Soil bioengineering
- Native shoreland revegetation

Urban BMPs are identified next, including brief discussions of their potential effectiveness at treating metals and at controlling non-point sources of pollution. These BMPs are divided into two groups. The first group includes BMPs that have an open water component to their design and the second group includes the other types of primarily urban BMPs.

5.4.2.2 Detention and Extended Detention Ponds and Wetland Treatment Systems (i.e., Including Offsite Wetland Treatment Systems)

These BMPs primarily control urban runoff. Typically a National Urban Runoff Program pond design criterion rule-of-thumb is that a 1 percent pond to watershed area ratio results in a predicted 65 percent removal for total phosphorus and 95 percent removal for total suspended solids. Options include:

- Modification of existing flood control basin
- Conversion of open areas or wet ponds to treatment wetlands
- The feasibility of a wetlands solution would depend upon the concentration of the contaminant, discharge requirements, flow volume and range, and available land area.
- PCPs are included in a group of aromatic hydrocarbons that have been shown to be treatable with wetlands at rates that conform to first-order reaction kinetics similar to what we see for BOD and COD (e.g., 50 to 90 percent with a limit of 2 to 10 mg/L).

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[11] See "Best Management Practices for Soft Engineering of Shorelines." Based on a Binational Conference held November 23, 1999. Sponsored by the Greater Detroit American Heritage River Initiative and Partners. Edited by: Andrew D. Caulk, Wayne State University, John E. Gannon, United States Geological Survey, John R. Shaw, Environment Canada and John H. Hartig, Greater Detroit American Heritage River Initiative.

- Fecal coliform removal can be 80 to 99 percent with a limit of less than 100 to 1,000 col/100 ml.
- If designing a wetland for organic contaminant removal, one would want to consider a series of wetlands ranging from subsurface to surface flow wetlands, or else consider oversizing a surface flow wetland to distribute the effluent over a large area.
- Methyl mercury has been detected in these wetlands but risk assessments indicate that exposures are low and not hazardous, but a few treatment cells have proven to be exceptions. (See the final section in Chapter 4 A, which describes the mercury results by Everglades Stormwater Treatment Area[12]).
- CH2M HILL recently conducted a study of mercury bioaccumulation in wildlife inhabiting Hayward Marsh, a constructed treatment wetland that receives secondary effluent from a municipal treatment plant and inflow from San Francisco Bay. The study was requested by the San Francisco Bay Regional Water Quality Control Board because measurable levels of mercury were detected in water. The endpoints defined for this study focused on protection of aquatic wildlife from adverse effects of mercury through dietary exposure. The study examined levels of mercury in various components of the food chain and in bird eggs as well as muskrats to evaluate the probability of adverse effects on wildlife. Results of the study were compared to levels of mercury bioaccumulation in other freshwater and estuarine environments. Conclusions were that mercury was not accumulating to significant levels in wildlife using the marsh. These results allowed the client to reduce further sampling to periodic monitoring, rather than conducting more intensive studies of potential impacts of mercury. Thus, the definition of ecological endpoints and the design of the study plan provided a cost-effective evaluation of the Regional Board's concerns.
- In a study at a Savannah River treatment wetland the authors concluded that mercury contained in the effluent should exist as elemental (Hg0) and mercuric ions (Hg2+)[13]. The constructed wetland system was designed to precipitate mercury in the wetland hydrosoil as cinnabar (HgS). In such systems, binding to organic ligands will also contribute to transfers of mercury from the water to the hydrosoil. The mercury in watersheds bound to humic and other organic materials is very stable. The organic bound mercury will settle in the constructed wetlands and decrease mercury concentrations in the effluent. Mercury in bottom sediments is strongly held by the following binding mechanisms: (1) sorption on hydrated ferric oxides, (2) surface sorption or ion exchange on mineral ion exchangers such as montmorillonite, or (3) sorption and/or chemical binding with organic material and sulfur-containing matter. The fundamental principle for sequestering mercury from the effluent in the constructed wetland system is via

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12 http://www.sfwmd.gov/koe_section/2_everglades.html

13 "Wetlands For Industrial Wastewater Treatment At The Savannah River Site: A Case Study" Roger W. Lehman, John H Rodgers, Jr., F. Douglas Mooney, John B. Gladden, and James R. Bell. http://www.rfweston.com/Publications/LehmanWEFTEC01.doc

formation of relatively insoluble HgS and precipitation in hydrosoil. The authors state it will be important to avoid methylation of mercury in these constructed wetlands by regulation of water depth and flows to maintain the desired reduction-oxidation (redox) potential in the hydrosoil.

- Biological controls can be a necessary component of any BMP that contains open water in order to prevent increases in nutrient loads from waterfowl and mammals and potentially to interrupt the pathways of metals accumulation. Such controls can include for example:
  - Beetle propagation and wetland release for control of Purple Loosestrife.
  - Control of nuisance geese by roundup and exportation or shoreline plantings to discourage use.

5.4.2.3 Other Non-point Source Urban Best Management Practices and Their Metal Removal Potential

- Street storage[14] refers to the technology of temporarily storing stormwater in urban areas on the surface (off-street and on-street) and, as needed, below the surface close to the source. The term, "close to the source", is meant where the water falls as precipitation prior to its entry into the combined, sanitary, or storm sewer system. The concept is to accept the full volume of stormwater runoff into the sewer system but greatly reduce the peak rate of entry of stormwater into the system. System components include street berms, flow regulators, and surface and subsurface stormwater storage sites. By eliminating or greatly reducing surcharging in combined sewer systems, street storage has the potential to cost effectively and simultaneously mitigate basement flooding and CSOs. Other possible benefits of street storage are mitigating SSOs, eliminating surface flooding, reducing peak flows at WWTPs, and controlling non-point source pollution.

  The potential to manage non-point source pollution is based on the premise that suspended solids are a major component of non-point source pollution and that other potential pollutants tend to be absorbed onto or adsorbed into the solids. The numerous well-maintained sumps in a street storage system provide a means for removing solids and other pollutants in stormwater. When the street storage approach is planned early and carefully tied to water quality and health benefits, state revolving fund (low interest loan) eligibility can be obtained.

- Reconstruction designs and site planning techniques that incorporate BMPs
- Removal of unused impervious surfaces
- Operation and maintenance BMPs

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[14]This discussion is taken from Walesh, Stuart G. Street Storage System for Control of Combined Sewer Surcharge Retrofitting Stormwater Storage Into Combined Sewer Systems. Contract No. 8C-R416-NTSX. National Risk Management Research Laboratory Office of Research and Development U.S. Environmental Protection Agency Cincinnati, OH 45268. 1999.

- These BMPs can remove contaminants before they are discharged in CSSs and adjoining waterbodies. Of particular consideration are the cold climate considerations particularly as they relate to spring thaw and snowmelt where a large loading of contaminants can be discharged[15]. Examples of operation and maintenance BMPs include:
  - Street sweeping
  - Sand and salt application limits
  - Snow storage
  - Erosion and sediment control
  - Catch basin, outlet and culvert cleaning
  - Pond cleaning
- Education can play an important role in enhancing water quality as individuals contribute to residential and business property management practices that reduce the concentrations of pollutants in urban runoff.
  - Properly dispose of used motor oil
  - Limit the application of lawn fertilizers
  - Avoid unnecessary construction of paved surfaces

5.4.3 Case Studies

5.4.3.1 Ecological Restoration Projects with Water Quality Goals

Charlotte-Mecklenburg County Watershed Enhancement at Edwards Branch; North Carolina. The Edwards Branch Water Quality Enhancement Project will be the county's first Surface Water Improvement and Management (SWIM) project to actually implement water quality improvements in a small, urbanized watershed. The project will allow assessment of a variety of stormwater BMPs (for example, wet and dry extended detention, bioretention, and stream restoration) including constructed stormwater treatment wetlands. The project was conceived in 1996 when the Board of County Commissioners issued a policy statement supporting the cleanup of surface waters within the county.

The City of Charlotte Stormwater Services (CSWS) and Mecklenburg County Department of Environmental Protection (MCDEP) developed, implemented, and evaluated a comprehensive, watershed-wide water quality enhancement plan. This work included the following:

- Classification of streams using the Rosgen Stream Classification System.
- Selection of type and location of a variety of BMPs to be retrofitted into a fully developed, dense, urban watershed.
- Hydrologic and hydraulic modeling to determine the impacts of a variety of proposed BMP combinations.

[15] See Center for Watershed Protection, Stormwater BMP Design Supplement for Cold Climates, 1997.

- Development of conceptual plans, preliminary plans, final plans and specifications, with steps in each part of the process to evaluate the plan's ability to meet or exceed project goals.
- Development of a Mitigation Credit Proposal for a "watershed approach" rather than on a per BMP basis (as a result CSWS will receive approximately 4,300 linear feet of stream mitigation credit for only 1,200 linear feet of actual stream restoration).
- Hydrologic and hydraulic modeling to determine the impacts of the BMPs on the watershed floodplain boundaries.

Wake County Watershed Management Plan; North Carolina. The Wake County Watershed Management Plan will serve as the county's strategic plan for protecting and restoring the designated uses of Wake County's streams, which is critical to the community's desire to remain recognized as one of the U.S.'s "Best Places" to live, work and raise a family. CH2M HILL is providing fully integrated services that will culminate in the provision of recommended strategies and best management practices for controlling the hydrologic changes caused by impervious surfaces as well as the increased pollutant loads associated with changes in land use anticipated for the county. This project exemplifies an approach to watershed strategic planning that combines stakeholders' vision for water quality, aquatic habitat, and stream integrity with good science to develop an efficient and lawful implementation plan. Ecosystem restoration plays a key role to the extent that non-pollutant stressors play a primary role in the failure to meet and maintain designated uses and other water quality goals.

Specifically, the plan will be based upon a thorough understanding of the condition of Wake County streams, as well as an understanding of the causes of stream degradation in Wake County. Stream aquatic integrity in urban settings is directly affected by the physical changes in the watershed, some of which result in the degradation of the chemical and/or physical condition of the stream. Habitat information is extremely important for discriminating between physical and chemical effects. A holistic approach of integrating stream habitat and riparian zone information with biological and chemical data provides a comprehensive stream assessment. This approach provides a means to assess the impacts of watershed changes and stormwater infrastructure on the riparian corridor and stream integrity. In addition, the stream assessment information will be used to identify and prioritize streams and watersheds for protection and restoration, as well as the locations for BMP implementation that will be most effective in minimizing the effects of watershed development on stream integrity.

A range of protection and improvement strategies for each of the Wake County subwatersheds will be identified. These strategies will be evaluated in the context of the assessment and modeling results to determine appropriate strategies for inclusion in the Wake County Watershed Management Plan. In addition, a funding program that will generate sufficient revenue to support the implementation, operation, maintenance, and management requirements of the Wake County Watershed Management Plan will be researched. Finally, the plan will include organizational and institutional

recommendations that will allow the Wake County Watershed Management Plan to meet or exceed the defined watershed protection goals and objectives at the lowest possible cost to the citizens of Wake County.

Ecosystem Restoration and Water Management Plan; CalFed Bay-Delta Program; Sacramento and San Joaquin River Basins; California. The CalFed Bay-Delta Program has become a collaborative effort among a wide variety of stakeholders (including urban and agricultural water users, fishing interests, environmental organizations, and businesses) who contribute to program design and to the problem-solving, decision-making process. Public participation and input have been essential throughout the process.

The Bay-Delta is the largest estuary on the West Coast. It is a varied ecosystem that includes a maze of tributaries, sloughs, and islands that encompass 738,000 acres. It is a haven for plants and wildlife, including 70,000 acres of wetlands. The Bay-Delta is critical to California's economy, supplying drinking water for two-thirds of California's population, industrial water to multiple industries, and irrigation water for crops that represent 45 percent of America's produce.

For decades, the Bay-Delta has been the focus of competing interests (economic and ecological, urban and agricultural) and the area has suffered. Habitats are declining, several native species are endangered, the system is no longer a reliable source of high-quality water, and area levees face an unacceptably high risk of breaching. In May 1995, the CalFed Bay-Delta Program was established as a cooperative effort among a number of state and federal agencies to develop a long-term, comprehensive plan to restore the Bay-Delta System's ecological health and improve water management for its beneficial uses.

Watershed Planning/Management. This evaluation is a programmatic approach to watershed analysis for the Sacramento and San Joaquin river basins. The program used a wide variety of scientific, technological, and decision-making tools to develop long-term solutions to problems related to water quality, fish and wildlife viability, water supply reliability, and the dependability of the Delta levees and channels during natural disasters. Phase 1 of the program identified three basic alternatives to provide a long-term solution for the Delta. In the current Phase II, detailed alternatives are being evaluated. This evaluation includes modeling studies, impact analyses, common program development, pre-feasibility studies, 404(b)1 assessment, early project implementation, decision analysis, selection of a preferred alternative, and Environmental Impact Statement/Environmental Impact Report preparation.

The study evaluated water supplies, sustainable habitat and habitat restoration, agricultural and municipal water supply economics, recreation and recreational economics, cultural resources, fishery resources, and vegetation and wildlife resources, including water birds. The analysis identified more than 25 separate alternatives through a multi-phase screening process.

Environmental Restoration. The CalFed analysis includes a significant component related to stream restoration. The activities considered in CalFed include improvement in water quality such as the reduction of toxics in point and non-point

source discharges; reduction of entrainment conditions at diversions; removal of structures that serve as barriers or lead to straying of anadromous fish; wetlands restoration; and channel reconfiguration.

***Federal Planning Studies/NEPA*.** This program is jointly prepared by federal and state agencies. The federal agencies involved at this time include the U.S. Bureau of Reclamation, the USFWS, and the USEPA. The Environmental Impact Statement will be developed to respond to the U.S. Bureau of Reclamation's National Environmental Policy Act (NEPA) guidelines.

***Public Information*.** The program consists of 16 state and federal agencies and is administered through indefinite quantities contracts with the Bureau of Reclamation and a contract with the California Department of Water Resources. Multiple workshops, advisory committees, and public forums are being used to respond to stakeholder concerns.

5.4.3.2 Watershed Management Mitigation Bank and Conservation Bank Projects

City of West Palm Beach Regional Mitigation Bank; Florida. CH2M HILL has provided Natural Resource Liability and Asset Management (NRLAM) services to the City of West Palm Beach, Florida, for several years. The City is at the permitting stage for a mitigation bank within its Water Catchment Area (WCA), which is a surface water supply and a regionally significant wetland and aquatic system. The development of the bank is part of the city's overall program to integrate management of water supply, watershed protection, wetland restoration, wetland reuse of reclaimed water, and aquifer recharge. The sale of credits from the bank will provide a funding source for wetland restoration efforts within the bank and for some of the city's watershed management activities. The bank will generate mitigation credits through restoration of hydrologically altered wetlands adjacent to the WCA.

Ongoing efforts demonstrate that mitigation banking is a means to assess opportunities for ecological restoration within a watershed. Secondly, mitigation banking can provide a funding source to accomplish ecological restoration and provide a trust fund for long-term land management. A banker is free to use profits from credit sales for any legal purpose. For banks created by water resources managers, profits can be used to fund other watershed management activities.

5.5 Watershed Permit: An Innovative Concept and Future Tool for Integrated Action

This innovative framework and implementation tool could become a key component of a successful watershed management approach in selected communities. A watershed permit is a mechanism that focuses on ambient water quality goals and addresses multiple pollutant sources and stressors in a watershed, including increasing the level of non-point source control where needed. A USEPA internal work group has developed the watershed permit concept and three alternative permit models. This section summarizes the work group's progress to date.

5.5.1 Watershed Permits Provide New Opportunities for Effective, Efficient, and Flexible Attainment of Water Quality Goals

Communities around the country are seeking new opportunities to implement water resource management actions through a watershed approach. Many use a watershed approach as a framework to *plan* management actions but are limited in taking full advantage of it as a framework to *implement* management actions. Communities commonly develop pollution control strategies in a watershed planning process that considers point and non-point sources, multi-media, and interactive or cumulative effects. But, when it comes to implementing those strategies, the various agencies and programs involved more often than not carry out specific elements of the management plan independently of each other.

The lack of integrated action is partly the result of the patchwork of agencies and regulatory programs that tend to focus exclusively on a single source category, media, or land use activity. Integrated implementation also is hampered by difficulty coordinating multiple jurisdictions and agencies and by a lack of important links between controls that are installed and evaluated using serial or parallel approaches. Additionally, mismatches between loading contributions and control responsibilities further constrain a watershed community's ability to reduce pollution and improve water quality and limit opportunities to maximize the cost-effective use of finite fiscal resources.

Many communities have taken the watershed management approach as far as they can, despite such hindrances**.** Communities need a regulatory framework that can provide options for addressing multiple pollutant sources and stressors through a single environmental management mechanism and provide the flexibility to achieve WQS and other watershed goals in a cost-effective manner. Watershed permitting meets this objective by offering implementation options that allow communities to take advantage of many of the opportunities presented by a watershed approach.

5.5.2 Watershed Permits Are a Tool for Integrating Pollution Prevention and Control Actions and Implementing a Watershed Approach

A watershed permit is a regulatory and administrative mechanism that may be used to address point sources, non-point sources, and other stressors in a defined geographic area with the goal of achieving WQS and locally defined watershed objectives. A watershed permit is an implementation tool, not a planning tool, but its effectiveness depends on it being informed by a successful watershed planning process. Watershed permitting integrates flexible point source regulation and control with enforceable controls on selected non-point sources in a single regulatory framework.

A watershed permit has four distinguishing characteristics:

- **It is *voluntarily* selected—**Watershed permitting enhances rather than replaces the existing NPDES regulatory framework and is applied in places that select a watershed approach to meeting WQS and other watershed objectives; point source dischargers covered under a watershed permit would continue to have individually determined technology-based requirements.

- **It is *geographically-* or *place-*based**—Watershed permitting can be applied to an entire watershed, a subwatershed, a county, or a community depending upon specific circumstances.
- **It is *enforceable*** – Watershed permits are regulatory mechanisms that are enforceable by both federal and state authorities, but also may rely on local enforcement authorities for many non-point sources (see Attachment A).
- **It represents an "*outside the box*" approach to source control**—Watershed permitting moves the USEPA, states, and watershed communities beyond the current source-by-source permitting framework to facilitate consideration and management of all pollutant sources and stressors in a watershed, including multi-media sources such as air deposition to waterbodies.

A watershed permit may take a variety of forms (see hypothetical cases below) and could cover multiple municipal and industrial point source facilities and an array of non-point sources (e.g., runoff, air deposition) as selected by local stakeholders and the permittee(s) and identified in the permit. The ultimate objective of implementing a watershed permit is to enhance both the environmental and cost-effectiveness of watershed management by providing more options and greater flexibility to communities in meeting WQS and watershed goals.

5.5.3 Three Watershed Permit Models Provide Flexibility and Accountability for Different Situations

A USEPA work group has identified three conceptual watershed permit models, representing different signatory or permittee arrangements. The work group has not endorsed or expressed a preference for any of the three models. For any given set of local water quality conditions, source mixes, and management preferences, it is expected that one of the models may be more effective in meeting environmental objectives and stakeholders' needs than the others are.

The three models, listed in order from greatest to least departure from the current source-by-source permitting framework are:

- Single Entity Watershed Permit
- Multi-party Watershed Permit
- Common Watershed Conditions

Each model is briefly described below.

5.5.3.1 Single Entity Watershed Permit

In this model, a single entity—e.g., a municipality or multi-jurisdictional basin authority, or a newly created umbrella organization—is the permit holder and is the sole party legally responsible for complying with the terms of the permit. Permit requirements are oriented toward ambient results; thus, the permit holder becomes a "regulator" and must ensure that the participating sources take actions that will allow it to meet its permit requirements. The terms and conditions of the agreement between the permittee and participating sources should grant the entity authority over its members and specify enforcement powers and processes. The watershed

permit itself may also specify the permitted entity's responsibilities with respect to enforcement against its members. If permit conditions are not met, an authorized state or USEPA takes enforcement action against the single permit holder. Federal and state enforcement authority stops at the permitted entity (unless specific conditions on an individual discharger are established in such a manner that regulations are "deemed" to be federally enforceable). This model is somewhat similar to the pretreatment program where publicly owned treatment works (POTWs) are responsible for administering national general pretreatment regulations, national categorical standards, and if necessary, more stringent locally-derived limits.

5.5.3.2 Multi-Party Watershed Permit

In this model, two or more dischargers jointly hold a single permit. Some permit conditions may specify joint and several liability for compliance. Other provisions may be written to apply to a subset of signatories or an individual source. Some conditions and responsibilities may vary across signatories in some other way. For example, the group may be held to an overall loading target, selected dischargers may face more stringent mercury limits than others. Some groups may be responsible for achieving non-point source reductions while others are not. In this model, individual responsibilities may be specified in the permit, and an authorized state or USEPA can take enforcement actions directly against individual signatories, or multiple signatories, depending on the provisions of the permit. Point sources may or may not continue to hold individual NPDES permits in addition to the multi-party watershed permit, depending on whether the watershed permit covered all parameters that would otherwise be regulated through individual permits.

5.5.3.3 Common Watershed Conditions

In this model, point sources would still hold individual NPDES permits, but all participating point sources would share a common or related set of conditions, applicable to one or more parameters, that would be specified in their NPDES permits. Individual NPDES permits are the only regulatory mechanisms that exist in this model. The individual sources may or may not have a Memorandum of Understanding (MOU) specifying any other agreements among them, or documenting any negotiations leading up to the permit conditions.

5.5.4 How Do the Different Watershed Permit Models Compare?

Table 5-2 provides an at-a-glance comparison of the three watershed permit models described above. As is evident, the models are similar in many respects and represent successive steps away from the current "single point source permit holder" approach of the NPDES program. They differ primarily in the number of parties involved, the manner in which non-point source coverage can be enhanced, and in the roles and responsibilities among participating sources. They also differ with respect to the type and number of permit holders with whom the USEPA and authorized states would be primarily involved.

Table 5-2 Comparison of Conceptual Models for Watershed Permits

Permit Characteristic	Common Conditions	Multi-Party	Single Entity
"Who" holds the permit?	Two or more NPDES permittees share common or contingent conditions in individual permits.	Two or more sources jointly hold a single permit; point sources may continue to hold individual permits.	Single "permit" holder is responsible for meeting ambient water quality standards in watershed.
What sources are covered?	Expected to vary by watershed and will be specified in the permit.		
What geographic area is covered?	Geographic area determined by locations, numbers, and types of sources covered. Permit specifies its geographic jurisdiction. Waterbody size (river miles, lake acres, estuary square miles) and watershed or drainage area covered could vary dramatically across watershed permits.		
What parameters are covered?	One or more relevant parameters.	One or more parameters with ambient targets and/or effluent limits.	All relevant parameters; permittee responsible for meeting water quality stds.
What is the water quality goal?	Water quality goals include water quality standards and other applicable watershed goals specified through local, state, tribal, or regional watershed planning processes. The permit specifies such goals as ambient water quality requirements or effluent limits for all parameters covered under the permit. Regardless of how the water quality goal is implemented, a characteristic of the watershed permit is that it is *ambient results oriented*.		
Will all covered sources have some type of numeric target or limit?	Participating sources assigned a total loading. Group requirement specified in a condition common to each individual permit or individual effluent limits that reflect agreed upon allocation of total loading.	Participating sources assigned a total loading. Group requirement specified as a permit condition or individual effluent limits that reflect agreed upon allocation of total loading.	Permittee must meet ambient conditions. Permit likely does not include effluent limits for individual dischargers. Agreements between permittee and its members may contain such limits for some or all sources.

Table 5-2 Comparison of Conceptual Models for Watershed Permits

Permit Characteristic	Common Conditions	Multi-Party	Single Entity
Do technology-based requirements still apply?	Technology-based requirements currently applicable to point sources will still apply. In some cases, non-point sources may be held to minimum requirements to implement specific BMPs or select appropriate BMPs from among an "approved" or recommended set.		
How is flexibility provided for point sources?	Flexibility provided in allocating loadings and selecting controls to meet individual/group target(s).	Flexibility provided in allocating loadings and selecting controls to meet individual/ group targets.	Individual point sources benefit from permittee's flexibility in establishing individual responsibilities and may face lower overall requirements since more sources are addressed.
How is accountability established and how is the permit enforced?	Permit holder accountable to an authorized state or USEPA for all permit conditions. Participating point sources may have side agreements with other point sources and or non-point sources.	Permit holder accountable to an authorized state or USEPA for all permit conditions. Participating point sources may have ordinances, contracts, MOUs, or other legally binding authorities or agreements with each other and/or with participating non-point sources.	USEPA and state enforcement is directed at the single permittee. The permittee "regulates" members — point and non-point sources — via ordinances, contracts, MOUs, or other legally binding authorities or agreements.
What monitoring requirements are in place?	Permittees responsible for demonstrating that ambient water quality standards, or sufficient progress toward meeting ambient water quality standards, are met as specified in a TMDL, other watershed goals, and through individual effluent limits. Dischargers with individual effluent limits and other individual permit conditions will continue to have effluent monitoring requirements. Location, number, and frequency of ambient and effluent monitoring and sampling and reporting are specified in the permit(s).		

5.5.5 Watershed Permits Offer Environmental and Economic Benefits to Watershed Communities

The specific incentives to hold or be a signatory to a watershed permit will vary depending on the local political, economic, regulatory, and water quality conditions, as well as with respect to the model selected. In general, some or all of the incentives listed below will draw dischargers and communities to a watershed.

- A watershed community can bring many sources under one umbrella and increase opportunities to achieve water quality objectives—reaching the same goal for less money, reaching a higher quality for the same money, or getting improvements that might not have otherwise been possible without a broad, ecological, "watershed" approach.
- An entity currently holding several NPDES permits can use a watershed permit to capture cost-savings by consolidating permit application and implementation activities, at a minimum streamlining administrative functions, but, perhaps, streamlining planning and control activities as well.
- Some dischargers could gain a degree of control or influence over other sources that might not be subject to the same regulatory scrutiny and control under the current implementation approach.
- Some point source dischargers end up with less stringent effluent limits with the same or better environmental result than they otherwise would have had under the current implementation approach.
- Non-point sources may be compensated or receive some other benefit, such as technical assistance, from taking actions not required of them now.

5.5.6 Watershed Permitting: A Framework for Innovative Environmental Protection

In summary, watershed permitting presents the USEPA, states, and communities a unique framework to achieve the goals of the CWA and objectives of local watershed management initiatives. By focusing on ambient or watershed goals in a watershed permit, regulatory agencies, regulated dischargers, and non-regulated sources have an opportunity to meet watershed objectives potentially at savings relative to source-by-source permitting.

5.5.6.1 Hypothetical Examples of Model Applications

The following cases provide hypothetical examples of how a watershed-permitting framework could be applied under a specific set of circumstances. There is one example of each watershed permit model. Each example examines the signatories and scope of the permit(s), the water quality goals and permit requirements, and the benefits to participants in the watershed-permitting framework. These examples further illustrate how watershed permits could be used to successfully implement a watershed approach in some watershed communities.

Plum Creek Basin Water Quality Agency: A Single Entity Watershed Permit.
Signatory and Scope (Who and What). The Plum Creek Basin Water Quality Authority—a quasi-municipal corporation comprised of the 13 counties, cities, and special sanitation districts surrounding Plum Creek and the Plum Creek Reservoir—is the single permit holder of a watershed permit that covers all previously NPDES-regulated discharges of its members and addresses previously unregulated non-point sources.

The Authority is a political subdivision of the state and is empowered to levy a limited tax on watershed residents, charge recreationists using the reservoir, and collect fees from WWTPs and non-point sources. It is governed by a Board of Directors comprised of a representative from each of the member jurisdictions. The Authority was created by the state legislature and has been operating continuously for about 10 years.

The 13 members are "regulated" by the Authority through several vehicles, including: a formal intergovernmental agreement that created the Authority and governs its activities and member roles and responsibilities; the Plum Creek Basin Water Quality Master Plan, which has been formally adopted as an MOU; a TMDL for the reservoir, which was incorporated into the Master Plan; and the Plum Creek Control Regulation, a state regulation adopted by the State Water Quality Control Commission, which sets forth the basic elements of the TMDL and Master Plan. The 13 members do not hold NPDES permits.

Water Quality Goals (How). The permit establishes federally enforceable ambient water quality targets in two different ways. For phosphorus, the permit implements a TMDL (based on a total phosphorus standard expressed as a concentration) and makes specific allocations to the following source categories: point sources; non-point sources; septic systems; industrial sources; and background sources. Phosphorus loading allocations (i.e., caps) for specific sources in each category are made in the locally enforceable Master Plan. For other parameters, the permit establishes water quality-based effluent limits or loading contributions for point sources and selected non-point sources, expressed as concentrations. Notably, prior to implementation of the watershed permit, the reservoir was not, and is not now, water quality-limited.

Benefits to Participants (Why). The Authority and its members determined that a single entity watershed permit, together with existing locally-enforceable intergovernmental agreements, local ordinances covering non-point sources, and state oversight, would greatly increase the cost-effectiveness and environmental-effectiveness of Master Plan implementation. The permit has motivated the Authority and its members to identify, list, and prioritize phosphorus loading reduction options—both point and non-point source—according to environmental and economic criteria established by the Authority and its members. Further, the permit has enabled the Authority to implement management actions in an order that results in the greatest benefit for the resources expended and targets projects to locations in the basin where they are most needed. The phosphorus reduction option list is broad and includes POTW upgrades, large non-point source control projects, smaller BMPs, as well as an array of stream and habitat restoration initiatives.

Prior to applying for and receiving a watershed permit, the Authority had been implementing a watershed-based trading program that involved both point-point and point-non-point source trades. While the program was running relatively smoothly and water quality objectives were being met, the traditional NPDES regulatory framework was cumbersome, required numerous permit re-openings to track trades, and frequently involved state and USEPA regional staff. The watershed-permit has obviated the need for formal "trading," as all reduction negotiations, including compensation arrangements, occur under a single permit. The watershed-permit also greatly streamlined implementation of the watershed approach in the Plum Creek Basin.

Orange Bay: A Multi-party Watershed Permit.
Signatories and Scope (Who and What). Six governmental units—three counties and three cities—together hold a single, multi-party watershed permit. The permit covers all discharges and parameters previously regulated under individual NPDES permits that the six jurisdictions once held for POTWs and stormwater sources.

Water Quality Goals (How). The permit establishes federally enforceable ambient water quality targets in two different ways. For nitrogen, the permit assigns an annual nitrogen loading cap to each of the jurisdictions for each bay segment into which they discharge (there are seven bay segments and 14 jurisdiction-segment combinations). The permit also identifies total annual nitrogen loading caps by jurisdiction, by segment, and overall. Using this approach, the permit effectively implements selected allocations of the seven TMDLs developed for each bay segment. Other WLAs and LAs for non-signatory jurisdictions and unregulated sources (including three other counties as well as atmospheric deposition, springs/septic systems, and industrial sources) are implemented through traditional means. For other parameters, the permit establishes water quality-based effluent limits for point sources, expressed as concentrations. The permit is supplemented by several MOUs with key state agencies as signatories and the Orange Bay Management Plan, which together govern how jurisdictions go about meeting their nitrogen allocations.

Benefits to Participants (Why). The permit holders determined that a multi-party watershed permit, structured as described above, would provide a more flexible and cost-effective means of meeting environmental objectives for water quality and living resources than available under a traditional, NPDES-focused approach. Under the loading cap for each bay segment into which it discharges, a jurisdiction has a great deal of flexibility in selecting loading reductions: it may select from an array of controllable point or non-point sources, so long as it can demonstrate reductions and compliance with ambient standards. Jurisdictions on the same segment may "trade" with each other to take advantage of cost-savings opportunities or to maximize the improvements from environmental restoration projects. Additionally, the permit facilitates in-fill economic development in urban areas by enabling, for example, one city to relax previously required stormwater retrofit requirements for new construction in exchange for contributions to its "stormwater" bank.

Sunnyside County and Lake Frank: Common Watershed Conditions.
Signatories and Scope (Who and What). Four NPDES permit holders—three municipal POTWs and a stormwater management agency—share a set of common, jointly contingent conditions that establish individual and group standards for copper loadings. The common conditions effectively create a "bubble" for the four permittees that covers only copper discharges. All other parameters are regulated in each of the four NPDES permits, independently of other permits. With the exception of the conditions pertaining to copper, which are water-quality based, the permits contain technology-based standards only.

Water Quality Goals (How). The three POTWs involved already had individual effluent limits for copper in their NPDES permits that were inserted after development of a TMDL for copper. The regional state water quality agency subsequently determined, however, that copper loadings must be reduced an additional 600 pounds per year, from the current 1,200 lb./yr. to 600 lb./yr., to achieve WQS. The common conditions section of the four permits establishes a federally enforceable copper loading cap *for the group* of 1,000 lbs./yr. for 1998, 800 lbs./yr. for 1999, and 600 lbs./yr. for 2000, 2001, and 2002. So long as the total copper discharged by the group falls below the cap, all four permittees are considered in compliance with their common conditions. The permits also establish individual caps that become effective if permit holders fail to meet their group target.

Individual responsibilities are established in a separate Memorandum of Agreement (MOA). The Agreement stipulates roles and responsibilities among the four parties, lays out LA negotiation procedures, intra-group reporting requirements, and accountability and enforcement mechanisms to ensure individual and group responsibilities are fulfilled. The MOA also establishes a "copper reduction bank" whereby the group members make separate financial contributions to a local environmental non-profit and its technical contractor to pay for non-point source BMPs and restoration/remediation projects that result in copper loading reductions. Under the MOA and the NPDES permits, these non-point source reductions can be credited toward the group's reduction target. The projects include stormwater controls that are not otherwise required and highway runoff abatement measures, as well as stream and wetlands restoration.

Benefits to Participants (Why). The four permittees determined that by acting together they could more quickly meet the overall loading reduction target at a lower cost to each than if individual WLAs had been ratcheted down. By asking to be treated as a single discharger—the bubble approach—for copper, the POTWs were able to broaden the range of reduction options that would "count" toward their requirements. Bringing the stormwater management agency to the table and creating the copper bank did the most to broaden reduction opportunities. Providing an easy means to accommodate point-point source trades within the group (through allocation negotiations and MOA mechanisms for transfer payments) is another important way that the bubble-common conditions approach has increased opportunities for cost-effective environmental improvements.

Moreover, regulations, politics, and regulatory staff resources were such that it was unlikely that the stormwater management agency would have been given an individual copper allocation for at least 3 years. An options analysis had shown that the first 200 to 300 pounds of additional reductions could be achieved at least cost through minor stormwater control and treatment upgrades. Furthermore, the municipalities running the three POTWs were dues-paying members of the stormwater management agency and successfully made the case that by coming to the table early, the agency (and its members) could avoid a future, more stringent allocation that would likely be more costly than the approach implemented in the MOA and the common conditions.

Watershed Permitting: Moving Forward from Concept to Implementation

The watershed permitting concept paper represents the first step in describing the objectives, characteristics, applications, and benefits of a watershed permit. Several activities are necessary to move the USEPA forward in its examination of watershed permitting: ·

- Investigate Regulatory and Legal Issues at the Federal and State Level;
- Link the WSP Concept to "Influence Opportunities";
- Develop Case Examples, Pilot Test Sites, and Demonstration Projects; and
- Develop a Watershed Permitting Framework.

Ideally, these steps will occur in parallel and in concert. They all can begin right away and should proceed with the ultimate objective of supporting the development of a watershed permitting policy and framework or "guidance" document and implementation of the framework at specific sites.

Link the WSP Concept to Influence Opportunities

In recent years, USEPA, other Federal agencies, and a number of states have undertaken a major effort to organize their water programs within a watershed management framework and watershed permits could be potentially powerful tools to successfully implement these initiatives.

The Office of Water's 1996 Watershed Framework and the 1994 NPDES Watershed Strategy encourage federal, state, and tribal water programs to organize their work around watersheds and actively involve public and private interests at all levels in their watershed management activities. Simultaneously, the NPDES program is continuing with its regulatory "streamlining" efforts in both the base program and pretreatment program. The Agency also is placing renewed emphasis on "reinvention" with its creation of the Office of Reinvention. Both streamlining and reinvention initiatives present opportunities to consider innovative, creative mechanisms for implementing watershed management actions.

Also, USEPA has convened two Federal Advisory Committees that are addressing water quality issues in a watershed context. One committee is advising the Agency on program direction for the national Total Maximum Daily Load (TMDL) program and the other is addressing USEPA's urban wet weather discharge program. Program implementation through watershed management is a core principle in the discussions of both of these advisory committees and watershed permits could provide a mechanism to more effectively implement TMDLs and urban runoff management actions.

There are several ongoing programs and developing initiatives where a watershed-permitting framework could facilitate achieving environmental objectives and where a WSP might be the missing key component in a watershed protection and management strategy. For example, there may be opportunities to integrate a WSP framework and WSPs into the following initiatives and positively influence the innovations already being considered:

- Watershed-Based Trading (which was discussed briefly above);
- CZARA implementation;
- NEP implementation;
- Great Lakes and Chesapeake Bay Programs; and

Great Waters Initiative.

Case Examples, Pilot Test Sites, and Demonstration Projects

Within the watershed-permitting framework, stakeholders will want and need to tailor an acceptable watershed permit model to best match local watershed conditions and fit with existing institutional roles and responsibilities. In practice, there may be as many variations of implementation arrangements as there are watersheds where WSPs are issued. In this initial concept paper, or other early guidance, the USEPA cannot solve all the implementation challenges potential permittees might face without lessons from actual experiences. We will need to rely on pilots and demonstrations to provide additional details about holding, implementing, and overseeing WSPs.

Attached to the concept paper are six illustrations of why and how a watershed permit might be implemented because it is important for the USEPA and other stakeholders to "see" how WSPs might work as they are considering and further developing the concept. With this in mind, OWM plans to sponsor development of several detailed "case examples" to describe how actual stakeholders in real watersheds think they would go about selecting a specific WSP model, tailoring it to their unique institutional arrangements and water resource conditions, and implementing management actions under the permit. These examples could be developed and completed within the next several months.

As discussed above, it also will be important for the USEPA to support and document early WSP initiatives so that the Agency, states, and other communities that might benefit from WSP approaches can learn from these first efforts. The USEPA policy and guidance alone will not be enough to encourage watershed permitting and assist states and communities in designing and implementing WSP programs. Consistent and comprehensive information about implementation experiences, including documented case examples with analysis and evaluation, will help the USEPA and states refine regulations and policies governing watershed permitting and will assist stakeholders by showing how a WSP program might work. The USEPA recognizes that stakeholder input and shared experiences will be critical to resolving a number of watershed permitting issues and developing successful WSP initiatives.

Develop a Watershed Permitting Framework

Based upon the concept paper and what is learned through case examples and pilot test sites, the USEPA can establish a regulatory and policy framework for issuing and implementing watershed permits. This framework could accompany or follow a general policy statement of USEPA support for the concept of watershed permitting. This framework may consist of detailed policy and guidance documents and, if needed, regulations to support a watershed permitting program. The framework would include an explication of minimum required permit conditions, acceptable and preferred permitting arrangements, and a minimum set of mechanisms that must be in place to meet federal enforcement requirements and provide satisfactory accountability.

5.6 Modeling Tools

5.6.1 Source Loading Estimation Tools

The USEPA classifies loading and receiving water models mainly in three categories: watershed scale loading models, receiving water models, and ecological assessment techniques and models.

5.6.1.1 Watershed Scale Loading Models

Watershed scale loading models are used to evaluate the effects of land uses and practices on pollutant loading to surface waters. The USEPA classifies these models as simple models, mid-range models, or detailed models. In general, simple models require the least amount of data, are quicker to set up and obtain results, and can be used to assess the relative contributions of various land use types and practices within a watershed. They can be typically used on an annual basis. Simple models are not continuous simulations; that is to say, they lack the capability to assess a time series of storm events. This also means that they lack the capability to transport pollutants and to transform pollutants. Many of these models are based on empirical relationships. Simple models include the following:

- USEPA Screening Procedures
- Simple Method/PLOAD
- USGS Regression Approach
- Simplified Pollutant Yield Approach (SLOSS-PHOSPH)
- Watershed
- Federal Highway Administration (FHWA) Model
- Watershed Management Model

Mid-range models are more complex than their simple model counterparts without the in-depth reams of data required by the detailed models. The mid-range models offer the capability of continuous simulation, point source contributions, and pollutant transport and transformation. Generally, this class of models offers a greater range of output options, both in terms of quantity and quality. They are designed to estimate the importance of different pollutant contributions within a watershed from multiple land uses and other contributors. In general, mid-range models offer a better assessment of BMPs within a watershed. Mid-range models include the following:

- Stormwater Intercept and Treatment Evaluation Model for Analysis and Planning (SITEMAP)
- Generalized Watershed Loading Functions (GWLF) Model
- Urban Catchment Model (P8 – UCM)
- Automated Q-ILLUDAS (AUTO-QI)
- Agricultural Non-point Source Pollution Model (AGNPS)
- Source Loading and Management Model (SLAMM)

Detailed models are the most complex, requiring the greatest amount of data and time to run. They portray current understanding of pollutant loading, fate, and transport. More often than not, this level of models is the most likely to be periodically revised. These models are not meant to be used as casual planning tools. Detailed models include the following:

- Storage, Treatment, Overflow Runoff Model (STORM)
- Areal Non-point Source Watershed Environment Response Simulation Model (ANSWERS)
- Multi-event Urban Runoff Quality Model (DR3M-QUAL)
- Simulation for Water Resources in Rural Basins – Water Quality (SWRRBWQ)
- Stormwater Management Model (SWMM)
- Hydrological Simulation Program – FORTRAN (HSPF)

5.6.1.2 Receiving Water Models

Receiving water models are used to predict the response of a water body (or bodies) to different pollutant loadings. They examine water body response, calculate capacities, and test various scenarios. As with the watershed scale models, receiving water models range from the simple to the complex. Most deal primarily with mass balance equations, taking into account three factors: transport, reactions, and inputs. The USEPA classifies receiving water models as hydrodynamic, steady-state water quality, dynamic water quality, or mixing zone. Hydrodynamic models are those that use a mathematical formulation to describe transport, circulation, and deposition within a water body. Water bodies can include streams and rivers, impoundments (lakes and reservoirs), wetlands, estuaries, and near-coastal waters. Spatial simulation can be in 1-D longitudinal, 2-D vertical, 2-D horizontal, or 3-D. Stand alone hydrodynamic models that can be also externally coupled to water quality models include the following:

- River Hydrodynamics Model (RIVMOD-H)
- Link-node Tidal Hydrodynamic Model (DYNHYD5)
- Environmental Fluid Dynamics Computer Code (EFDC)
- Curvilinear Hydrodynamics in Three-Dimensions-Waterways Experiment Station (CH3D-WES)

Water quality models simulate chemical and biological processes within a waterbody. They can be either steady state of hydrodynamic. Steady state water quality models determine the fate and transport of pollutants using constant input values and predicting constant output values. Steady state models include the following:

- Watershed and Lake Modeling Software (EUTROMOD)
- Seasonal and Long-Term Trends of Total Phosphorus and Oxygen in Stratified Lakes (PHOSMOD)
- BATHTUB
- Enhanced Stream Water Quality Model (QUAL2E)
- Exposure Analysis Modeling System (EXAMSII)
- TOXMOD
- Simplified Method Program – Variable Complexity Stream Toxics Model (SMPTOX4)
- Tidal Prism Model (TPM)
- Simplified Deposition Calculation for Organic Accumulation Near Marine Outfalls (DECAL)
- Dynamic Toxics Wasteload Allocation Model (DYNTOX)

More complex are the dynamic water quality models. As the name implies, they can utilize time varying inputs and create time varying results. Dynamic water quality models require more time to prepare and to calibrate. Most are internally coupled models (CE-QUAL-RIV1, CE-QUAL-W2, and HSPF). Dynamic water quality models include the following:

- Water Quality Analysis Simulation Program (WASP6)
- Hydrodynamic and Water Quality Model for Streams (CE-QUAL-RIV1)
- Two-dimensional Laterally Averaged Hydrodynamic and Water Quality Model (CE-QUAL-W2)
- Three-dimensional Time-variable, Integrated-compartment Eutrophication Model (CE-QUAL-ICM)
- HSPF

The final category of receiving water models is the mixing zone models. They are used to approximate a limited volume of water, usually in the vicinity of a single discharge. They include two models: Cornell Mixing Zone Expert System (CORMIX) and PLUMES.

6. Impacts of Additional Wastewater Discharge on Source Water Protection

6.1 Purpose

This section will identify SWP considerations relevant to the potential expansions planned in the DWSD WWMP.

6.2 Future Additional Wastewater Discharges to the Watershed of Drinking Water Interest

The technical memorandum entitled Technical Feasibility of Satellite Treatment identified the following alternatives to address the future increased wastewater treatment needs within the DWSD sewer service area: construction of four WWTPs and/or expansion of the two existing suburban WWTPs.

The sites of these future facilities and their receiving waters and the DWSD drinking water intakes are shown in Figure 4.

6.2.1 Alternative Satellite New Wastewater Treatment Sites

Table 6-1 lists the four potential satellite WWTPs to be constructed, and their discharge receiving waters, and the potential design average and maximum treatment flow rates.

Table 6-1 Alternative Satellite Wastewater Treatment Plants

Site Number	Site Name	Receiving Water	Avg./Max. Capacity
1	Oakland University area	Clinton River	21/45 mgd
2.	Ford Motor Co Proving Grounds	Clinton River Middle Branch	56/104 mgd
3	East of Macomb/Oakland (South of M-59)	Clinton River Lower Branch	62/113 mgd
4	Conner Creek	Detroit River	125/200 mgd

The expected treated effluent concentrations from the future discharges at Site Nos. 1 through 3 are: $CBOD_5$ (< 4 mg/L), TSS (< 10 mg/L), Ammonia Nitrogen (<0.5 mg/L), and Total Phosphorus (< 1 mg/L). The Connor Creek site would discharge to the Detroit River, which has a much higher base flow than the Clinton River. As a result, the discharge requirements to the Detroit River are not as strict. The expected treated effluent concentrations from the future discharges at the Connor Creek site are: $CBOD_5$ (< 20 mg/L), TSS (< 25 mg/L), Ammonia Nitrogen (not regulated), and Total Phosphorus (< 1 mg/L).

6.2.2 Potential Additional Discharges from Existing Suburban Wastewater Treatment Plants

The City of Pontiac's WWTP, which is located south of M-59, east of Opdyke Road, has a current capacity of 25.5 mgd. The alternatives study report evaluates the option of upgrading the plant up to 74.2 mgd capacity – an increase of 39 mgd. The effluent is discharged to Clinton River.

Due to the low flow and protected uses of Clinton River, the wastewater discharge has stringent existing NPDES limits on NH4-N (0.5 mg/L monthly, 2 mg/L daily), phosphorus (1 mg/L monthly average), $CBOD_5$ (4 mg/L monthly average and 10 mg/L maximum daily) and WET. The expected discharge after expansion will be in compliance with all current NPDES limits.

City of Warren WWTP, located in the northeast corner of the City Warren, has a present total capacity of 36 mgd. The alternatives study report evaluates an upgrade of the plant up to 76 mgd capacity – an increase of 40 mgd. The effluent is discharged to Red Run Drain, which is a tributary to the Clinton River.

Due to the low flow and protected uses of Red Run Drain, the wastewater discharge has stringent current NPDES limits on NH4-N (0.5 mg/L monthly, 2 mg/L daily), phosphorus (1 mg/L monthly), $CBOD_5$ (4 mg/L monthly, 10 mg/L daily). It is expected the future discharge after expansion will be in compliance with all current NPDES limits.

The maximum additional future wastewater discharges from the evaluated four new WWTPs and potential expansion of the two existing WWTPs is about 340 mgd average flow. The future discharges are expected to have equal to or better water quality than the current discharges based on the existing regulated pollutants.

6.3 Source Water Protection Considerations

The above proposed additional wastewater discharges will have an effect on the receiving water quality and thus impact on the future SWP programs. The impact have the following effects: a net increase of the pollutant mass discharged to the water body, and an impact on DWSD and other municipalities drinking water intakes downstream of the evaluated discharge points.

6.3.1 Total Maximum Daily Load Impacts

One future regulation that would impact the potential new discharges is the TMDL regulation to be developed by the USEPA and MDEQ, as discussed in the Technical Feasibility of Satellite Treatment technical memorandum.

The MDEQ compiles a list of water quality-limited or threatened waters requiring the establishment of pollutant TMDLs. These TMDLs are for water bodies that are not presently attaining WQS and waterbodies that are presently attaining WQS, but are expected not to meet WQS by April 2004. There are currently no TMDLs in effect on the Clinton or Detroit Rivers. However, several TMDLs are scheduled to be developed affecting these water bodies over the next 10 years. Table 6-2 (from the Technical Feasibility of Satellite Technical Memorandum) lists the sections of the Clinton and Detroit Rivers that would be impacted by expansion of a current WWTP or the construction of a new WWTP, the date the TMDL is scheduled to be developed, and the WQS that is non-attainment.

Table 6-2 TMDL Schedule for Proposed Receiving Streams

Water Body	Location	Distance	Problem	Year of TMDL Development
Clinton River				
Bear Creek	Red Run Drain confluence upstream to Mound Road in the vicinity of Warren	2.5 miles	Pathogens	2006
Main Branch	Yates Dam upstream to Pontiac WWTP outfall	10.7 miles	Fish community rated poor	2006
Main Branch	Lake St. Clair confluence upstream to Yates Dam	25 miles	Pathogens	2006
Red Run Drain	Clinton River confluence upstream including all tributaries to Warren, Center Line, Madison Heights, Troy and Clawson	6 miles	Pathogens, Macroinvertabrate community rated poor	2006
Main Branch	Lake St. Clair confluence upstream to Yates Dam	25 miles	PCBs	2010
Main Branch	Northbound Gratiot Ave (S. Broadway St), Mt. Clemens. One mile total reach (upstream and downstream of Gratiot Ave)	1 mile	Mercury	2011
Detroit River	Entire river from Lake St. Clair downstream to Lake Erie	28 miles	Pathogens	2007
	Entire river from Lake St. Clair downstream to Lake Erie	28 miles	PCBs, Dioxin	2008
	Entire river from Lake St. Clair downstream to Lake Erie	28 miles	Mercury	2011

Depending on the specific TMDL study results and future regulations, there may be issues requiring additional efforts to address concerns of one or more specific pollutants from TMDL perspectives. Depending on these pollutants' impacts on drinking water quality and WTP operations, there might be additional efforts in SWP to minimize the impact on the downstream drinking water supply.

Figures 2 and 3 show the TMDL conditions in the watershed for two DWSD source water intakes in which WWTP outfalls exist within the watersheds: Belle Isle and Fighting Island.

6.3.2 Locations of the Potential Additional Discharges Relative to the DWSD Intakes

Figure 4 shows the relative locations of the four potential new WWTPs and the two existing plants with potential to be expanded. Three potential new WWTPs and two potential expansions of existing plants would discharge to the Clinton River and its tributary. Clinton River flows into Lake St. Clair, which is upstream of the Detroit River. Therefore, two DWSD drinking water intakes (Belle Isle and Fighting Island intakes) are downstream of these discharges. However, there are substantial travelling distances from the discharging points to the intakes. The massive volume of the Lake St. Clair and complex hydraulics in the lake and river makes the assessment on its true impact very difficult at this point.

The likely concerns from these new discharges are:

- The increased flow (particularly wet weather discharges) on the Drain and River – whether it could cause erosion and sediment resuspension.
- The persistent species of pathogens and bacteria that could be present in the wastewater discharge and that escape the wastewater treatment processes.
- The trace organic/inorganic compounds that are not currently being regulated or monitored, but might have an impact on the drinking water quality that could be discovered in the future. These include the endocrine disrupters, antibiotics, and pharmaceutically active compounds that have raised concerns recently.

Overall, it is difficult to foresee the true impact that the future TMDL regulation and SWP program will have on the evaluated new discharges, mainly because neither regulation is finalized nor has clear guidance been given by the USEPA or MDEQ. Experiences with the

watershed management and strategies on SWP have just started. Therefore, issues like these have to be revisited often in the future. Any program and recommendations that have been developed are subject to future modifications and updates. Therefore, it will be an evolving and dynamic process for developing a SWP program.

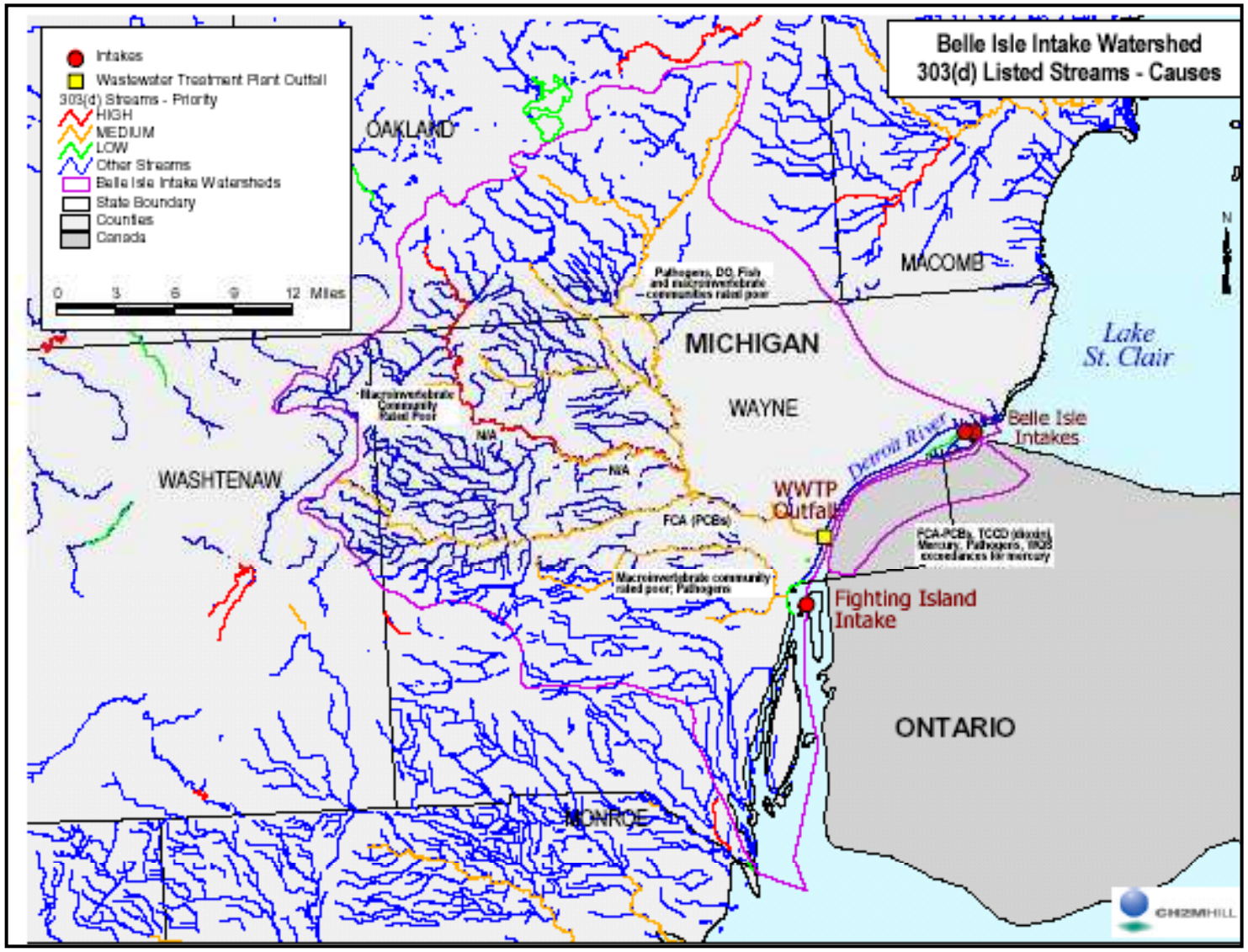

Figure 2. TMDL Conditions at Belle Isle Intake Watershed

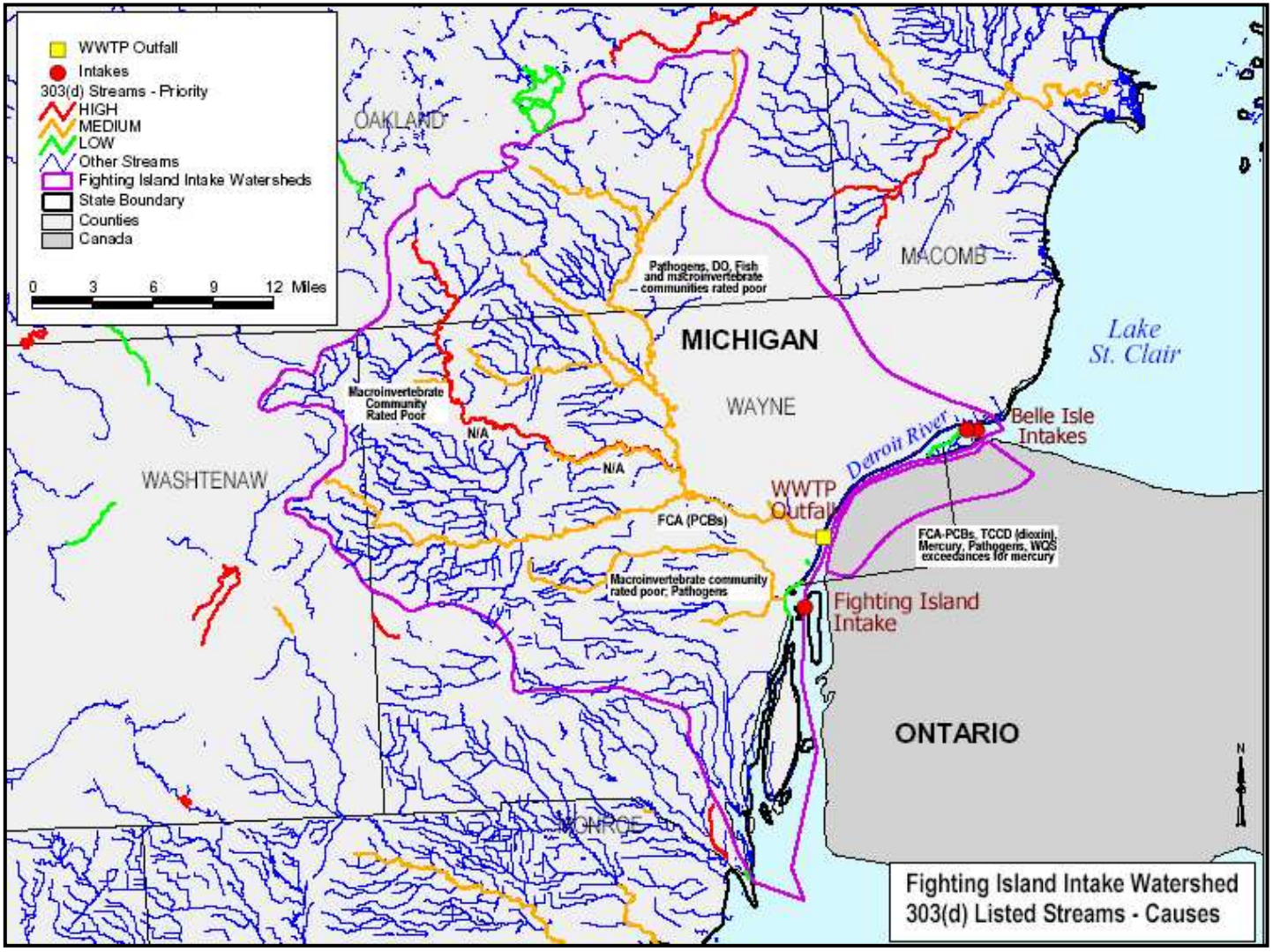

Figure 3. TMDL Conditions at Fighting Island Intake Watershed

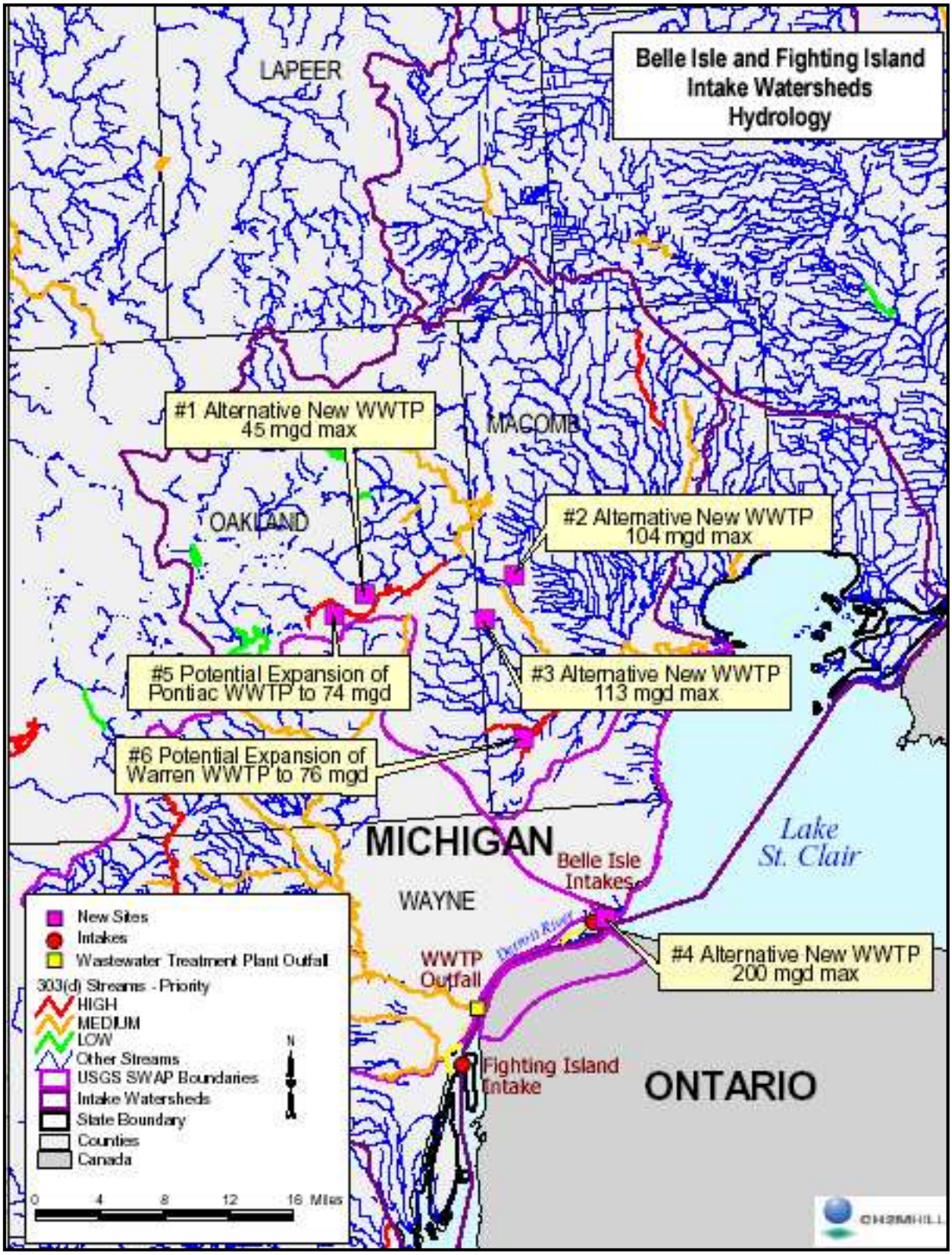

Figure 4. Locations of the Potential New or Expansion WWTP Sites

7. Recommendations

The DWSD is a unique organization with the ability to work with both drinking water and wastewater concerns under the same umbrella. This provides a strong advantage to both the water and wastewater functions of DWSD—issues that involve both sides can be addressed in concert.

The expanding wastewater needs of the Detroit area are apparent. A commitment to regular communication between both the wastewater and water components of the organization is the most important step that DWSD can take to ensure that wastewater needs are met with a minimal effect on the source water and watershed needs within the same watershed.

With the theme of communication and proactive management in mind, the following are recommended:

1. Get involved in regional watershed and source water programs that are within water/wastewater service area watershed boundaries. Work with state, SEMCOG, communities, and other watershed stakeholders in developing such programs.

- Anticipate and study the future regulations as opportunities to protect the environment through means beyond WWTP point source control. Consider the following watershed alternatives for complying with the future regulations on WWTP discharge:
  - Habitat Equivalency Analysis
  - Water Quality Trading
  - Net Environmental Benefit Analysis
  - BMP initiatives
  - Future watershed-wide permit concept
  - TMDL efforts in WWTP discharge receiving streams
  - Further reduction and control of point sources such as CSOs, SSOs, and WWTP wet weather effluent

2. Establish and develop a Watershed Protection Program. The program is envisioned to consists of at least these five major elements for implementation:
   - Working with stakeholders such as MDEQ, SEMCOG, and local communities to build a watershed team and establish public support
   - Defining the program issues
   - Establishing program goals and selecting measures
   - Implementing program activities
   - Measuring success and adjusting the program

3. Update the source water protection, watershed management regulations and programs regularly, and modify the source water protection framework

accordingly. National guidance and formal regulations on source water protection remain to be finalized, as do numerous future watershed regulations and programs. Therefore, the source water protection framework and program will be subjected to future changes. The development of a source water protection plan, and watershed management plan in general, will be a dynamic and evolving process. It is beneficial to DWSD to look into the alternative methods of protecting the water supply by using a watershed approach.

Appendix A

Summary of Michigan's Draft Water Quality Trading Rules

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Summary of Michigan's Draft Water Quality Trading Rules

Prepared by David Batchelor, Market-Based Environmental Program Specialist, Michigan Department of Environmental Quality, 2000.

Purpose. The proposed rules provide legal authority for a voluntary statewide Water Quality Trading Program. Nutrient trading among and between point and non-point sources may be done by rule. Other types of trades may occur on a case by case basis. All trading is watershed-based.

Water Quality Benefit. A percentage of all credits traded are retired to achieve a net loading reduction and water quality improvement. The program will reduce the cost of improving water quality, create incentives for non-point source reductions and facilitate implementation of total maximum daily loads (TMDLs) and urban stormwater control programs.

Restrictions. Any use of credits that would cause a violation of water quality standards is prohibited. Credits can not be used to comply with a federal technology-based effluent limitation unless allowed under federal regulations. The use of credits to increase the discharge of listed bioaccumulative chemicals of concern is restricted.

Eligibility. Reductions to generate credits must occur after the effective date of the rules. All reductions must be real, surplus and quantifiable. Actual changes must be made to reduce point discharges or non-point source loadings. This will maintain the margin of safety achieved in practice by point sources. Agricultural management practices or control structures to eliminate manure runoff or abate a nuisance under the Michigan Right to Farm Act and non-point source reductions funded under Section 319 of the federal Clean Water Act (CWA) or the Clean Michigan Initiative (CMI) are not eligible to generate credits.

Open and Closed Trading. All trading is water quality-based. Open nutrient trading can occur in any of Michigan' Major Watersheds where water quality standards are being met; and, in impaired waters pending the development of a TMDL (Figure 1). Open trading has directional and temporal components to be consistent with the states antidegradation regulations.

Closed nutrient trading may occur where a pollutant-specific cap and point and non-point source allocations have been established by a TMDL, remedial action plan (RAP), lakewide management plan (LaMP) or a watershed management plan (WSMP) approved by the department for the purposes of trading. Trading areas are delineated in the RAP/LaMPs that have been developed for each area of concern (Figure 2). Watersheds for which a WSMP has been prepared locally and approved by the department will be established on a case-by-case basis. The cap, point source waste load allocations and non-point source loading allocations establish the baseline for closed trading to occur.

Pollutants Traded. Nutrient (total phosphorus and total nitrogen) trading occurs by rule. Point source permit modifications are not required before trading can occur and non-point source reduction requirements are not incorporated in point source permits. Trading for pollutants other than nutrients, cross-pollutant trading, the use of banked nutrient credits, intra-plant trading and other types of trades must be approved before they occur. Most of these trades will occur in the context of national pollutant discharge elimination system (NPDES) permits. Discount factors different from and in addition to those specified for nutrients in the rules may be required to protect water quality.

Baselines. Baselines are the point source discharge and non-point source loading levels below which reductions must be made to generate a credit. They are established using the most accurate information available for a 3-year period representative of source operation. A different time period may be used if approved by the department. Non-point source baselines for agricultural, industrial, urban and residential stormwater runoff must use meteorological data for the prior 10-years or period of record, whichever is longer. Quantification procedures established by an applicable requirement must be used if they are available.

The point source baseline is the actual discharge level that complies with the most protective applicable requirement. This prevents credits being created by the issuance of a permit and requires a period of operation to establish the level of control achieved by proper operation and maintenance. The point source baseline equation is B (Baseline)= F (Flow) x C (Concentration) x K (a unit conversion factor of 8.346). The baseline for permitted stormwater sources with numerical limits is calculated using the same equation.

The baseline for permitted stormwater sources for which a numerical limit has not been established is the pollutant-specific loading reduction achieved through complete implementation of the management practices specified by a permit. This baseline is calculated by determining a pollutant-specific loading factor for each land use in a watershed and multiplying it by the average annual surface runoff for each land use times the number of acres for each land use. The baseline is the sum of the pollutant loadings from each area.

Sources of stormwater runoff that are not required to be permitted may subject to other applicable requirements (TMDL, RAP, LaMP or WSMP) or they may be completely unregulated. The baselines for unpermitted sources of stormwater that are not regulated are the pollutant-specific loading associated with existing land uses and any existing management practices. Changes in land use and the implementation of additional management practices can generate credits. The baseline for regulated non-point stormwater sources is the level of control required by the most protective applicable requirement. The baselines for all stormwater sources that are not permitted are calculated by using the same equations that are used for permitted stormwater sources that are controlled by management practices.

The baseline for regulated agricultural operations is the pollutant loading achieved after the implementation of management practices specified by a regulation or the cap and loading allocation specified in a TMDL, RAP, LaMP or a WSMP approved for trading by the department. The baseline for unregulated agricultural operations is the pollutant loading associated with existing operations. The baseline must be established in a plan prepared by a certified planner under the United States Department of Agriculture, Natural Resource Conservation Service (NRCS). The plan documents existing operations and management practices, calculates baseline loadings, recommends operational changes and management practices and estimates reduced loadings. Once the plan has been prepared the grower or producer has the option to implement any of the management practices in the plan. The methods and procedures used to quantify sediment, sediment-borne phosphorus, sediment-borne nitrogen and animal feedlot runoff are specified in "Pollutants Controlled Calculation and Documentation" (MDEQ 1999). The department must approve methods and procedures for commercial fertilizer and manure runoff.

Credits Generated. Point source *discharge reductions* or non-point source *loading reductions* that result after controls or management practices have been implemented are subtracted from the point source or non-point source baseline to determine the *reduced discharge level for point source* or the *reduced loading level for non-point sources*. Each point source is required to contribute 10% of its discharge reduction to provide a direct water quality benefit. The total number of credits that are generated and may be registered by the point source is equal to the reduced discharge level minus 10% of the discharge reductions. Non-point sources must contribute 50% of all loading reductions made to generate credits. The department does not certify credits that are generated and registered by point or non-point sources.

Discount Factors. Discount factors are applied to the use of credits to provide an additional margin of safety and water quality benefit. A quantity of credits 10% greater than necessary to meet a water quality-based effluent limitation is required where an impoundment is located between the sources that generate and use credits and where pre-TMDL trading occurs in impaired waters. The department may establish different discount factors to assure that water quality standards are not violated.

Banking. Banking of nutrient credits is allowed to encourage early reductions. They have a 5-year credit life from the date of generation. Point and non-point source reductions made after the date a regulation is proposed but before the date by which final compliance must be attained can also be banked. They may be used for a period of 5 calendar years after they are generated or 1 year after the final compliance date, whichever occurs first. The use of banked nutrient credits is subject to trade-specific approvals and conditions as necessary to protect water quality. All banked nutrient credits that are not used are retired to provide a water quality benefit.

Notice Requirements. Notices of credit generation and use certified by a responsible official are required for all trades. They may be submitted by mail or electronically. The department must review all notices for completeness within 30 days. Administrative reviews for completeness may lead to more detailed technical reviews

if the department determines that additional information is needed to verify credit generation or that the proposed use of credits is consistent with the rules and water quality standards. Department determinations are final and subject to judicial review.

The point and non-point source operational changes and management practices specified in notices of generation are legally enforceable on the date that the department issues a determination of completeness. For point sources this constitutes a permit modification by rule. For non-point sources this establishes direct accountability under the rules. Rule violations are enforceable under Part 31 of Public Act 451 of 1994.

The use of credits specified by notice also becomes legally enforceable when the department determines the notice is complete. For point sources this constitutes a permit modification by rule. The department is prohibited from approving a notice of use that is inconsistent with the rules or water quality standards. Sources that generate and use credits are required to submit compliance reports. Point sources will use discharge-monitoring reports. Non-point sources may use forms provided by the department.

Registry. The department must establish and maintain a water quality trading registry to record and monitor all trading activity. The department must make registry information electronically available to the public. This will allow potential traders and citizens to evaluate trading opportunities and track the generation and use of credits from cradle to grave. The registry will provide real time information and discharge/loading data for all sources that trade, descriptions of how credits are generated and used, and the type and quantity of credits traded and retired in each watershed where trading occurs. The department must enter the information in the notices of generation and use in the registry within 5 days of making a completeness determination, and update it daily. A 10-day period is provided for sources to identify and correct any data entry errors.

Watershed Plans. Local watershed management plans approved by the department can be used for trading. The plans would establish where trading may occur, the pollutants to be traded and the baselines (caps and allocations) for point and non-point sources that trade. Trading must be consistent with plans that have been approved by the department.

Plans approved by the department for TMDL, RAP or LaMP implementation, Clean Water Act 319 projects, permitted watershed-based stormwater management programs and stormwater pollution prevention initiatives, and nonpoint source watershed management plans developed under the Clean Michigan Initiative, Public Act 287 of 1998 may be used for trading. They must include, or be amended to include a statement of purpose, a delineation of the trading area, a pollutant-specific cap and loading allocations for all sources that may trade; and, a demonstration that the use of credits would be consistent with the state's antidegradation regulations.

In addition to using existing plans, the rules allow any 'person' to develop a comprehensive watershed management plan that would improve water quality, encourage environmentally sound land use practices, create parks and natural areas;

or, establish other programs consistent with water quality standards. These plans must include a process for public involvement, written agreement from each person or source included in the plan and all other approvals required by law. The department must public notice each plan prior to approval or disapproval. Action by the department is final and subject to judicial review. Plans approved by the department are effective for a period of up to 5 years and are binding on the department and the parties thereto.

Program Evaluations. The department is required to conduct periodic program evaluations every 5 years to assess the environmental and economic performance of the program. The department must conduct ambient monitoring to assess water quality and quantify actual nonpoint source loading reductions. The department must also determine whether trading has been consistent with water quality standards, there has been a net loading reduction between sources that trade, there have been any localized adverse effects, and if the program has achieved a sufficient level of accountability and compliance. Transaction costs and agency costs for administration of the program must be documented and the department may conduct a comparison of the cost of reducing pollutant loadings through trading to achieving equivalent reductions without trading where adequate information is available. A report of the departments findings must be public noticed with an opportunity for a hearing. After public notice, comment and opportunity for hearing, the department may modify the program as necessary to achieve the stated purposes of the program.

Compliance and Enforcement. The rules establish a dual liability scheme. A person or source that uses credits is solely responsible for complying with all discharge standards and limitations. A person or source that generates credits is strictly liable for assuring that reductions are real, surplus, quantifiable and equal to the number credits that are registered. This creates an incentive for users of credits to exercise care when purchasing credits, to purchase extra credits as insurance and to obtain credits from more than one source.

Credit generators are subject to 'treble damages' if they register invalid credits that are used and later discovered by the department. The generator must obtain and donate three times the amount of bad or insufficient credits. These credits are retired to benefit water quality. The treble damage provision is supplemental to enforcement remedies established in Part 31 of Public Act 451 of 1994. A reconciliation true-up period of 30 days is provided a person or source that discovers and provides notice of insufficient credits *without receiving notice* from the department. The rules also establish a 90-day reconciliation true-up period for a source that uses credits that are not to be real, surplus, quantifiable or sufficient.

In any enforcement actions initiated by the department under the rules, a person or source that generates credits will have the burden of proof that the reductions generated and credits registered are real, surplus, quantifiable and sufficient. A person that uses credits will have the burden of proof of due diligence to comply with discharge standards and limits and the trading rules.

Citizen Petitions. Citizens may petition the department seeking enforcement action to enjoin, abate or correct a violation of the trading program rules. The petition must be submitted by certified mail and include the name, location and description of the source and alleged violation, a reference to applicable rules and the corrective action desired. The department must acknowledge receipt and provide a copy of the petition to the person or source named in the petition within 10 days. Within 30 days, the department must initiate appropriate enforcement action, provide a schedule for taking enforcement or provide an explanation of why enforcement is not appropriate r has not been taken. The petitioner may file a contested case hearing or initiate a civil action in a court of competent jurisdiction if the department's is not timely or the petitioner is not satisfied by the enforcement action taken or the explanation why enforcement has not been taken.