Nonpoint Source Environmental Monitoring Strategy

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NONPOINT SOURCE ENVIRONMENTAL MONITORING STRATEGY

List of Figures:

List of Tables:

Executive Summary

The sources and causative agents that result in nonpoint source (NPS) pollution are highly diverse and often occur across jurisdictional boundaries. The effects from multiple pollutants and pollution sources make problem identification and program effectiveness difficult to evaluate in complex aquatic ecosystems. These complexities frequently involve substantial interdisciplinary efforts and resources to identify and remedy NPS pollution. Accurate problem identification and effectiveness monitoring are necessary to link NPS activities with changes in water quality. In addition, organizations funding NPS control efforts desire more confirmation that these activities are making a difference in water quality, especially since significant amounts of money and time have been, and will continue to be, spent at the local, state, and federal levels to address NPS problems.

This *Nonpoint Source Environmental Monitoring Strategy* (*Strategy*) describes how Michigan's water monitoring programs support the pollution control efforts of the Michigan Department of Environmental Quality's (MDEQ's) NPS program. The *Strategy* describes how the MDEQ's NPS monitoring priorities are set, how monitoring is used to track improvements in water quality following implementation of NPS control actions, and how the monitoring results are communicated and used in program decisions. This document does not directly address social changes or MDEQ administrative measures.

The *Strategy* groups NPS monitoring into four broad categories for discussion purposes: statewide trend monitoring, problem identification monitoring, total maximum daily load (TMDL) development and effectiveness monitoring, and NPS control effectiveness monitoring. This *Strategy* also identifies and describes the various NPS monitoring tools used by the MDEQ and its contractors. The key part of this *Strategy* is Chapter II, which describes how NPS monitoring priorities are set, how appropriate methods and sites are chosen, how monitoring results are conveyed to resource managers and the public, and how study conclusions are used in NPS program decision making. This process is summarized in a flow chart that identifies critical steps and dates (Figure II-1).

The *Strategy* describes several significant changes in the way NPS monitoring is prioritized, conducted, and reported by the MDEQ. The changes are designed primarily to foster better communication throughout the process, ensure that monitoring priorities support the NPS program goals, ensure monitoring results are available at the appropriate times, and provide a way to most effectively utilize limited monitoring resources. The following are the most significant changes:

- The Water Bureau (WB) staff from the Surface Water Assessment Section (SWAS) currently solicit requests for monitoring from internal and external partners on an annual basis. This process will be expanded by requesting specific NPS monitoring sites and projects, and by convening meetings between NPS program and water quality monitoring program staff to discuss and identify watershed-specific monitoring needs. Following these meetings, the SWAS, in consultation with the Field Operation Sections (FOS) and other WB management units, as appropriate, will balance monitoring resources among watersheds and against other WB monitoring needs.

- The NPS monitoring priorities will be documented in the NPS program's Multi-Year Plan to help facilitate long-term planning. This document will be made available to all internal and external partners and published on the WB's Web site.

- Some form of effectiveness monitoring will be conducted following all NPS control actions funded by the MDEQ. Also, the WB will look for opportunities to "showcase" the effectiveness of certain NPS control actions by implementing intensive monitoring projects. The *Strategy* describes the types of effectiveness monitoring that could be conducted and identifies criteria that will be considered prior to selecting "showcase" monitoring projects.

- Short- and long-term NPS program and monitoring priorities will be described in an NPS Multi-Year Plan that will be made available to all external and internal partners. The WB will continue to release request for proposals (RFPs) for grant funding to implement Best Management Practices (BMPs) and conduct monitoring. The WB will use the RFPs to solicit proposals for work that is consistent with the priorities described in the NPS Program Multi-Year Plan.

- Monitoring reports prepared by the SWAS (including grantees or contractors) will highlight findings and data relevant to the NPS program to make it easier for resource managers and other interested parties to quickly locate and use NPS monitoring results.

- Brief annual updates on each monitoring program element will be provided to the NPS program for incorporation into the Annual NPS Program Report, which will also feed into the process of annually evaluating the NPS program priorities.

I. Introduction

A. Strategy Scope

The MDEQ has implemented a comprehensive statewide monitoring program to assess the quality of Michigan's surface waters (MDEQ, 1997). A key goal of the monitoring effort is to support and evaluate the effectiveness of water quality protection programs. This companion document was developed to describe in more detail how Michigan's water monitoring efforts support and evaluate the effectiveness of NPS pollution control efforts.

By March 1, 2004, each state was required to submit a *Nonpoint Source Management Program Evaluation Framework* to the United States Environmental Protection Agency (USEPA) describing how the state would evaluate the effectiveness of their NPS program with respect to new evaluation guidance provided by the USEPA in September 2003. That evaluation was to include a broad range of administrative, environmental, and social indicators. This *Strategy* covers the environmental components requested for the USEPA evaluation framework, but is much broader in scope, since it addresses all aspects of Michigan's NPS-related environmental monitoring (e.g., NPS monitoring conducted with Clean Michigan Initiative (CMI) funds, state general funds, or other sources), not just those applicable to NPS activities funded by the USEPA under Section 319 of the Clean Water Act (CWA).

Although this *Strategy* focuses on environmental monitoring, it was developed within the context of the administrative component needed for the USEPA's evaluation framework. One goal of the *Strategy* is to define how monitoring results will be conveyed to, and used by, the NPS program and USEPA, and how the NPS program will convey its needs back to the monitoring programs for incorporation into the environmental monitoring efforts. Although individual, corporate, and government behaviors are key to NPS pollution issues, societal assessments are not part of the MDEQ's water quality monitoring program and are not covered in this document. It is envisioned that societal assessments will be discussed in the broader evaluation framework, since societal surveys and assessments are done as part of select NPS program projects, as well as by numerous environmental organizations, local governments, and universities in Michigan.

For the purposes of this document, pollution is defined as any human-induced alteration of the chemical, physical, or biological integrity of state waters. NPS pollution to waters of the state will be generally defined as that originating from any pollution source that is not regulated by a National Pollutant Discharge Elimination System (NPDES) permit. For example, permit-required activities related to storm water runoff from a large urban area, covered by a Phase II storm water permit, will not be considered an NPS of pollution while non-permit-related storm water activities in Phase II communities, as well as storm water from small communities or agricultural operations, will be considered an NPS of pollution. In addition, atmospheric deposition of pollutants will be considered an NPS even if the pollutants originated from a facility with stack emissions controlled by an air permit.

The NPS pollutants addressed in this document include, but are not limited to sediments, nutrients, bacteria/pathogens, metals, petroleum products, other organic compounds, and thermal inputs. Many NPS pollutants are delivered to surface waters via storm water flow, so hydrologic conditions and factors contributing to changes in stream flow are important variables that are also covered.

In many cases, MDEQ staff, grantees, or contractors work closely with other federal, state, tribal, and local agencies or organizations. However, the *Strategy* focuses primarily on activities conducted by MDEQ staff, grantees, contractors, and volunteers.

B. Strategy Purpose and Organization

This *Strategy* is designed to strengthen the framework for defining how NPS-related monitoring priorities are set, how the monitoring is implemented, and how the monitoring results are used in program decisions to protect Michigan's water resources. This includes detailed descriptions of how the types of monitoring are selected, how monitoring sites are chosen, how measurement parameters are determined, how monitoring frequency is decided, how the data are reported and stored, and how the results are communicated.

Effective NPS program implementation depends on the availability of viable monitoring data to identify problems in a watershed, document accomplishments and failures, identify management and/or implementation problems, and support mid-course corrections and program level modifications. These information requirements support the need for four basic types of NPS monitoring within the scope of Michigan's NPS program. The four major categories of NPS monitoring are listed below and are discussed in this document starting with the most general and largest scale monitoring approach, then progressing to the more specific, smaller scale efforts.

1. Determine watershed and statewide water quality trends (Chapter III).
2. Identify and quantify NPS pollutant problems in Michigan's water bodies (Chapter IV).
3. Develop and evaluate the effectiveness of the TMDL pollutant control processes (Chapter V).
4. Evaluate NPS program, project, and BMP effectiveness (Chapter VI).

The key part of this *Strategy* (Chapter II) describes how NPS monitoring priorities are set, how study designs are determined, and how monitoring data are used to evaluate the effectiveness of NPS control efforts and determine future NPS program and monitoring priorities.

C. NPS Programs and Staff Organization

Michigan's NPS Program relies primarily on five activities to implement its NPS pollution reduction strategy. These five activities are grant administration, compliance and enforcement, information/education, technical assistance, and monitoring and field investigations.

The NPS Program is in the MDEQ, WB, SWAS (Figure I-1), although the centralized duties related to administration of the NPS <u>grant</u> program are now in the MDEQ, Environmental Science and Services Division. The NPS program supports approximately 17 full time employees (FTEs) in the field, 7.5 FTEs in the NPS Unit, 8.5 FTEs for statewide administrative/technical support, and 4.5 FTEs for NPS monitoring. The NPS program emphasis has been to minimize staffing and maximize financial support to local watershed planning and implementation activities. Approximately 60% of the NPS program's staff time is currently devoted to local watershed management planning and implementation grants. Compliance and enforcement activities occupy about 15% of NPS program staff time, with the majority of the effort addressing agricultural issues. About 10% of NPS program staff time is spent on technical assistance and another 5% on information and education activities. Monitoring and field investigations currently account for only about 10% of NPS program staff time since NPS-related monitoring is conducted primarily by other programs in the WB.

Three of the NPS monitoring FTEs are assigned to SWAS monitoring staff. The other 1.5 FTE dedicated to monitoring is used by the Land and Water Management Division (LWMD) for hydrologic studies. Hence the obvious need for continual, clear communication and reporting of needs and results between NPS and water quality monitoring staff. This is complicated by staff and projects being supported by various funding sources with different priorities, different data needs, and different reporting timelines. This *Strategy* has been developed partly to clarify the communication routes and timing of decision making among NPS and water quality monitoring staff and managers.

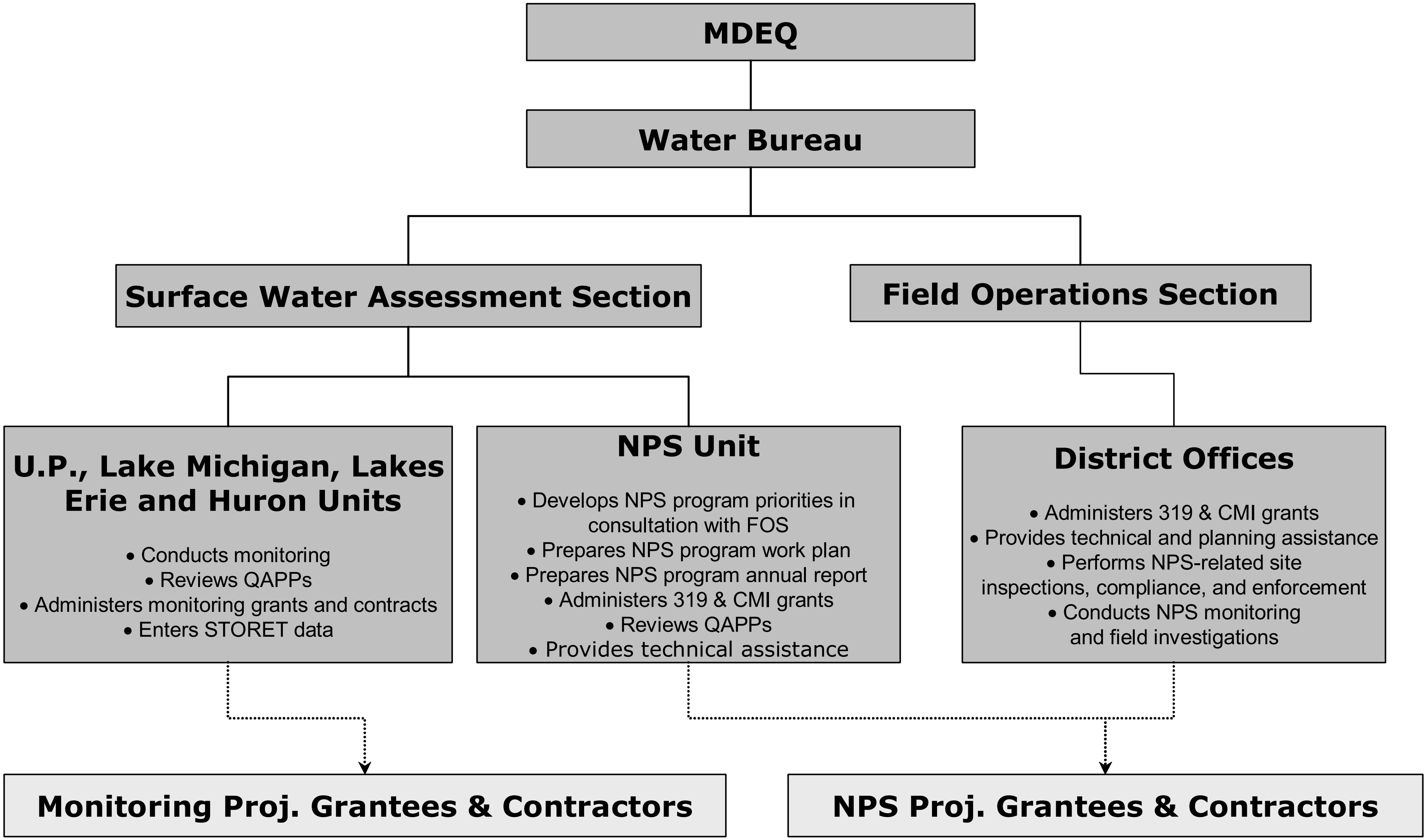

Figure I-1. Water Bureau sections and units involved with NPS program implementation or monitoring.

II. Water Quality Monitoring and NPS Program Integration

Water quality monitoring is necessary to determine the effectiveness of NPS control actions and support sound NPS related water quality management decisions. Therefore, it is imperative that the WB's water quality monitoring and NPS programs be effectively integrated in three key areas (Figure II-1):

1. Priority setting and planning;
2. Study design and implementation; and
3. Data management and reporting

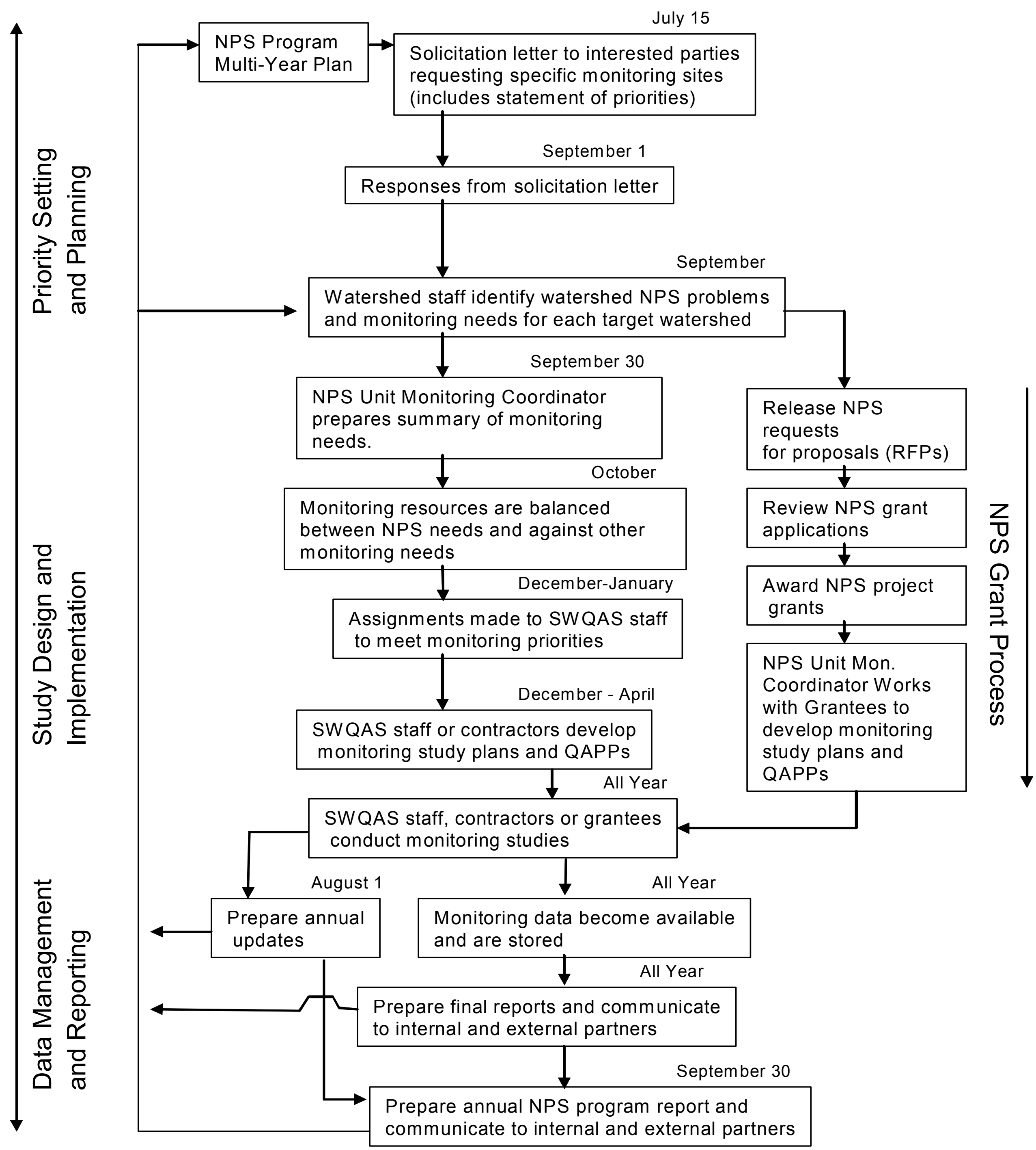

Figure II-1. Water Quality Monitoring and Nonpoint Source Program Integration.

Priority setting and planning activities include evaluating available resources, establishing NPS program and monitoring priorities, and determining monitoring needs. Study design and implementation includes selecting specific monitoring objectives, projects, and locations; developing monitoring plans for implementation by MDEQ staff; and, working with grantees and contractors to develop monitoring plans and Quality Assurance Project Plans (QAPPs). Data management and reporting includes storing data electronically and preparing final reports. The integration of these activities and the timing of key interactions between the water quality monitoring and NPS programs are described below.

The remainder of this chapter provides a more detailed description of the interaction between the WB's water quality monitoring staff and NPS program staff, which is necessary to prevent or reduce adverse water quality impacts caused by NPS pollution. The description includes some ongoing activities, as well as a number of new actions that will be taken by WB staff. Also, new and ongoing actions are described in more detail in Chapters III-VI.

A. Establishment of NPS Priorities and Allocation of Monitoring Resources

Before September of each year, the WB establishes program priorities and allocates resources for all monitoring conducted by WB staff and contractors. The priorities are based, in part, on the MDEQ's strategic plan, as well as division and section work plans and budget. The amount of water quality monitoring resources available to the WB in any given year to support and evaluate the effectiveness of the NPS program (as well as other WB water quality protection programs) is always dependent on the annual budget and available FTEs.

Annual NPS program and monitoring priority decisions will be guided by an NPS Program Multi-Year Plan. The NPS Program Multi-Year Plan will be developed by the NPS Unit and will identify short- and long-range program and monitoring priorities. Program priorities are established by the NPS Unit with input from the FOS and monitoring staff. Program and monitoring priorities will be described as specifically as possible to facilitate long-term planning. The NPS Program Multi-Year Plan will be updated annually by the NPS Unit and will cover a long-term, rolling time frame. The NPS Unit will revise the NPS Program Multi-Year Plan after reviewing program needs, TMDL schedules, the basin year monitoring plan, resources allocated, ongoing monitoring projects, and recent monitoring results. This plan will be reviewed by Michigan's Water Quality Monitoring Advisory Board annually. Also, the plan will be published on the WB's Web site and made electronically available to all internal and external customers including potential grantees and contractors. The NPS Program Multi-Year Plan should include the following:

1. NPS program priorities developed to date.
2. Key aspects of the NPS problem identification monitoring schedule developed to date, such as the TMDL problem identification monitoring schedule, the five-year monitoring schedule, and the five-year road stream crossing survey schedule.
3. A description of any multi-year effectiveness monitoring projects underway (including TMDL effectiveness monitoring projects) and a list of watersheds that may be targeted for short-term effectiveness monitoring projects.
4. A description of relevant trend monitoring activities that may be coordinated with NPS monitoring projects.

B. *Identification of Watershed-Specific NPS Monitoring Needs*

The WB intensively monitors each major watershed on a five-year cycle. The major watershed area boundaries are illustrated in Figure II-2. While the five-year cycle determines much of the monitoring focus, other watersheds may be targeted for monitoring if the objectives and priorities are consistent with the NPS Program Multi-Year Plan, the MDEQ's strategic plan, the WB's work plan, or the SWAS and FOS work plans.

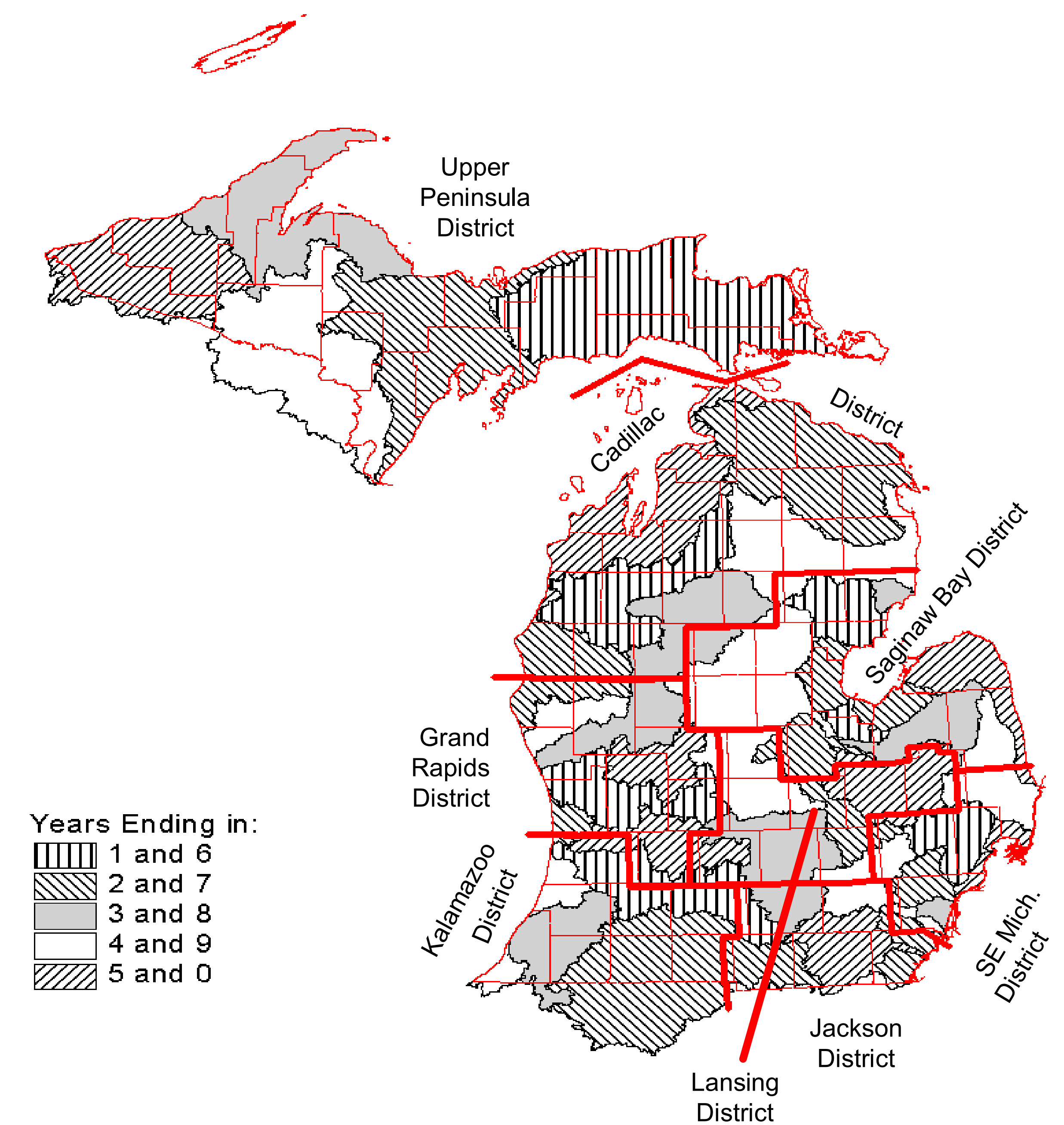

Figure II-2. Michigan's five-year rotating watershed monitoring cycle. Watersheds with similar shading are monitored in the same year.

By July 15th of each year, the SWAS will distribute a letter to internal and external partners seeking water quality monitoring recommendations. This letter will reflect current NPS program goals and water quality monitoring priorities, identify priority watersheds to be monitored as part of the five-year cycle, and emphasize the WB's interest in soliciting water quality monitoring recommendations that are consistent with those goals and priorities. All NPS monitoring recommendations received prior to September 1 of each year will be considered in the process of developing monitoring plans for the upcoming year.

During September of each year, the NPS monitoring coordinator will convene meetings to discuss monitoring needs in each of the major watersheds targeted as part of the WB's five-year basin monitoring strategy. Meeting participants will include NPS program staff, SWAS monitoring staff, and LWMD hydrologists. The NPS monitoring coordinator will be responsible for ensuring that monitoring needs in watersheds outside of the five-year cycle are discussed during each of the appropriate monitoring meetings.

Prior to the watershed monitoring meetings, the SWAS meeting participants will review the description and results of all previous or ongoing NPS-related water quality monitoring studies performed in the target watersheds. The SWAS monitoring staff will review TMDL development and effectiveness monitoring priorities, as well as water quality trend monitoring commitments that have already been established for the watershed. The FOS, NPS monitoring meeting participants are expected to be familiar with current land use activities in the target watersheds and possess considerable knowledge of previous, ongoing, and planned NPS projects in the watershed. The LWMD hydrologists will be familiar with past hydrologic studies, ongoing monitoring activities, and future monitoring needs. Prior to the meeting, participants will seek input from internal monitoring specialists or program staff, as well as other resource managers (including the appropriate Michigan Department of Natural Resources (MDNR) fisheries and wildlife monitoring staff, local health departments, and local watershed councils) concerning known or potential problematic NPS of pollution in the watershed and related water quality monitoring needs. All participants are encouraged to identify showcase NPS project effectiveness monitoring possibilities.

The watershed-specific NPS water quality monitoring needs discussed during each of the meetings will be summarized by the NPS monitoring coordinator. Water quality monitoring needs will be carefully described in each of the summaries to ensure that the exact monitoring questions to be answered are clear. This is especially important when communicating NPS project effectiveness water quality monitoring needs. The summaries will identify the entity expected to conduct the work, estimated time required to complete the work, and the estimated monitoring study cost (funding and FTEs). Draft meeting summaries will be distributed to the meeting participants for review and comment. Each of the final meeting summaries will be distributed to the SWAS and FOS Chiefs, SWAS Unit Chiefs, FOS District Supervisors, and all meeting participants.

C. Determination of NPS Monitoring Needs

In October of each year, the NPS program monitoring needs will be reviewed and balanced against each other and against other WB needs by the SWAS management, in consultation with other WB management units as appropriate. The SWAS management will evaluate all WB monitoring needs, including NPS watershed-specific and statewide needs, and allocate available monitoring FTEs and funding. After this meeting, the NPS monitoring coordinator is responsible for documenting the NPS monitoring decisions in the NPS Program Multi-Year Plan. Also, the NPS monitoring coordinator will develop a list of monitoring projects that will be conducted in the upcoming field season and a list of recommended projects that will not be conducted. The NPS monitoring coordinator will transmit these lists to NPS program and monitoring staff.

D. Design and Implementation of Water Quality Monitoring Studies

Before April of each year, the SWAS monitoring staff will develop monitoring study plans and QAPPs. These water quality monitoring efforts must be consistent with established NPS program priorities. The most complex monitoring designs (particularly designs for multi-year projects) may take over a year to develop and secure resource commitments, especially when multiple partners are involved in implementation of the project. Monitoring study plans and QAPPs are approved by SWAS unit chiefs after the plans and QAPPs are determined to be adequate to address the study objectives.

Some NPS monitoring priorities are addressed by grantees selected through an RFP process. The WB will release NPS RFPs each year. All NPS RFPs released by the WB will highlight the current NPS program goals and priorities consistent with the NPS Program Multi-Year Plan. Also, the RFPs will note that grant award decisions will be heavily weighted towards project proposals that address NPS program goals and priorities. Many of the grants will be funded with Section 319 money. These grants are reviewed and prioritized as follows:

1. Consistent with the annual proposal review schedule, the NPS monitoring coordinator will review all applications containing monitoring work (typically two-thirds or more of the proposals). The SWAS monitoring staff will be available to assist with the review of grantee monitoring proposals upon the request of the NPS monitoring coordinator. The review will focus on the appropriateness of the scope and scale of the proposed monitoring, as well as the following issues:

    a. Are monitoring objectives clearly defined and can these objectives be met?
    b. Do the proposed monitoring objectives duplicate ongoing (or completed) monitoring work?
    c. Are the proposed monitoring objectives consistent with NPS program goals and priorities?
    d. Should additional monitoring activities be conducted by the grantee?
    e. Does the grant application lack worthwhile monitoring activities that cannot be carried out by the grantee but could be performed the SWAS water quality monitoring staff or their contractors?

    Comments on the proposed monitoring schemes are considered in the NPS Unit's proposal evaluation process and could lead to the recommendation that the proposed monitoring be fully funded, partly funded, or deleted from the proposal.

2. Grantees conducting monitoring with Section 319 funds must develop a work plan and QAPP. These documents are typically submitted within six to nine months after the grantee receives notification of funding. The work plan and QAPP are reviewed and approved by the NPS Unit Chief. Monitoring staff from the SWAS or LWMD may assist with the review upon the request of the NPS monitoring coordinator.

E. Management and Reporting of Water Quality Data and Information

The overall value of NPS water quality monitoring is maximized when information is properly managed and effectively communicated to federal, state, local, and tribal resource managers, as well as other interested parties in the public and private sectors. All NPS-related monitoring data collected by the WB (including grantees and contractors) will be reported in some fashion. The WB's water quality data management and reporting processes relative to the NPS program are summarized below:

1. All water chemistry, sediment chemistry, and biological community assessment data collected by WB staff (or contractors and grantees) will be stored in the USEPA's Storage and Retrieval (STORET) database within one year of data collection. Any water quality data (i.e., channel morphology measurements) not entered in STORET are maintained in internal electronic databases and also made available to interested parties via the WB's Web site.

2. By August 1 of each year, SWAS, FOS, and LWMD staff (including contractors and grantees) will prepare brief summaries of all NPS-related monitoring conducted during the year. The summaries will be developed using a prescribed format and forwarded to the NPS monitoring coordinator. The NPS monitoring coordinator will use these summaries to develop the Annual NPS Program Report and include these summaries as appendices to the report.

3. In addition to the summaries described above, the SWAS monitoring staff and LWMD hydrologists (or their contractors) will continue to write staff reports describing the results of all monitoring. Staff reports that cover NPS-related topics will include sections specific to NPS problem identification and project effectiveness. This standard reporting format will allow interested readers to quickly locate and use NPS monitoring data and information.

4. Special technical reports will be prepared by SWAS monitoring staff (or their contractors) and the NPS monitoring coordinator whenever special projects are completed. Special projects could include multi-year intensive monitoring efforts intended to "showcase" the results of NPS controls in a particular watershed. These reports will be made available to interested parties.

5. The SWAS monitoring staff, LWMD hydrologists, and the NPS monitoring coordinator will give presentations at conferences and meetings, whenever possible, to communicate NPS-related water quality monitoring results to various audiences.

6. By September 30 of each year, the Annual NPS Program Report is prepared by the NPS Unit and communicated to internal and external partners (including the USEPA, Region 5). This annual report includes a section that summarizes major findings (or a description of monitoring that was conducted if the results are not yet available) of NPS studies conducted during the fiscal year. This section is prepared by the NPS monitoring coordinator using staff reports, technical reports, and annual summaries of studies performed by the SWAS monitoring staff or their contractors, FOS NPS staff, citizen volunteers, LWMD hydrologists, and NPS grantees.

7. The SWAS, NPS Unit updates the NPS Program Multi-Year Plan as necessary. This plan (described in Chapter II.A) is used to document NPS priorities and guide NPS monitoring activities and is intended to be flexible and provide long-range guidance to NPS monitoring and program staff.

F. Summary of Actions

This ***Strategy*** is designed to provide a more formal framework for defining how NPS-related monitoring is identified, conducted, and reported, to effectively address the complex NPS pollution issues. The ***Strategy*** identifies a number of actions intended to strengthen the lines of communication between water quality monitoring staff and NPS program staff and clearly define specific staff responsibilities. Appendix I includes a summary of these actions; many of which are new. In addition, new actions are summarized at the end of Chapters III-VI.

III. Statewide Trend Monitoring

A. Description

In 1998, the MDEQ began implementing a monitoring plan designed to provide a comprehensive assessment of the quality of Michigan's surface waters. The monitoring plan consists of nine program elements: fish contaminants, water chemistry, sediment chemistry, biological integrity, wildlife contaminants, beach monitoring, volunteer monitoring, inland lake quality and eutrophication, and stream flow (MDEQ, 1997). The monitoring plan is intended to assess environmental conditions, as well as measure temporal and spatial trends in the waters of the state. A portion of Michigan's CMI bond funds were allocated for the implementation of the activities outlined in the monitoring plan, resulting in an increase of approximately $3 million per year for surface water quality monitoring over the approximately $2 million per year in other state and federal sources of funding.

The NPS of pollution are a major source of contamination to the waters of the state. The trend monitoring elements of the MDEQ's water quality monitoring plan are an important part of Michigan's effort to assess the combined effectiveness of all point and NPS load reduction activities. In some cases, the relative contributions from point versus NPS may be obvious, but in many cases they are not. For example, declines in total phosphorous loads from monitoring stations located above all point source discharges can be attributed to declines in NPS while declines in total phosphorus loads measured at the mouth of most major tributaries could be attributable to reductions in either point or NPS or both. Monitoring staff generally assume that declines in contaminant concentrations in ambient water, sediments, or biota can be at least partly attributed to the success of NPS reduction activities. The major spatial and temporal trend elements of Michigan's water quality monitoring plan are briefly described below:

Michigan's Fish Contaminant Monitoring Program (FCMP) includes a fixed station trend monitoring element. Whole, adult fish are routinely collected from 26 fixed trend sites and analyzed for mercury, polychlorinated biphenyls (PCBs), and chlorinated pesticides such as Dichlorodiphenyltrichloroethane (DDT). Sites were selected based on geographical coverage, water body type (inland lakes, rivers, Great Lakes, and connecting channels), fish species, and site access. Locations also were selected to complement and avoid duplication with the USEPA's Great Lakes whole fish trend monitoring program. In addition, the FCMP includes edible portion and caged fish monitoring elements. The edible portion monitoring element is used primarily to assess human health impacts associated with consuming fish. However, edible portion samples are also used to identify toxic "hot spots" and are occasionally used to identify temporal trends and assess the effectiveness of pollution reduction efforts. Caged fish monitoring is used to identify spatial trends, identify sources of contaminants, and assess the effectiveness of pollution reduction efforts. An annual FCMP report is prepared to summarize trend, edible portion, and caged fish data from the previous year (the edible portion and caged fish elements of the FCMP are described in more detail in Appendix II).

The WB began implementing a redesigned fixed station trend monitoring network for water chemistry in 1998. This network includes sites near the mouth of 31 inland rivers, as well as sites on Saginaw Bay, Grand Traverse Bay, the St. Mary's, St. Clair, and Detroit Rivers. The locations were selected to ensure broad geographical coverage throughout the state, and in the case of the inland rivers, to sample the tributaries that contribute the highest pollutant loads to the Great Lakes. Samples are analyzed for suspended solids, nutrients, PCBs, mercury, and other trace metals (cadmium, chromium, copper, lead, nickel, and zinc). Annual reports for the inland rivers have been completed for 1998-99, 2000, 2001, and 2002. The focus of these reports has been on the analysis of spatial trends, while future reports will begin to incorporate analysis of temporal trends at specific sites. A contractor prepares separate annual reports for the connecting channels, Saginaw Bay, and Grand Traverse Bay, which include spatial and temporal trend assessments. The problem identification and effectiveness elements of the water chemistry monitoring program are described in Appendix II.

The WB and Michigan State University scientists began a project in 1999 to measure contaminant levels in the sediment core samples from selected inland lakes. Sediment core samples are collected intact and slices of the core are dated. As a result, contaminant concentrations can be assigned to a particular year, often going back 200 years. The resulting data are used to assess spatial and temporal trends in sediment contaminant levels. Twenty-two lakes have been monitored through 2003. Approximately 30 lakes will be assessed over the course of the project, after which some of the lakes will be revisited on a periodic basis. Sites are selected based on: 1) accessibility; 2) limnological character; 3) geographic location; 4) airshed location; and 5) watershed characteristics. Sediment samples are analyzed for nutrients, mercury, other trace metals, total PCBs, and organochlorine pesticides such as DDT.

An assessment of contaminant concentrations in bald eagles also began in 1999, and has continued each year since using nonlethal procedures. Eagle plasma and feathers are analyzed for mercury, PCBs, and chlorinated pesticides including DDT. Also, efforts are being made to expand the analyte list to include emerging contaminants such as brominated or fluorinated compounds. Watersheds with eagle nests and successful reproduction are assessed once every five years consistent with the NPDES five-year basin cycle. Nests associated with the Great Lakes and connecting channels are sampled annually because of the uncertainty of nesting success from year to year. Twelve inland territories with consistently high productivity also are sampled each year to track annual contaminant trends, assess concentration variability, and determine the optimum frequency of sampling necessary to measure trends. These inland territories are located in the Au Sable, Michigamme, Ontonagon, and Thunder Bay River watersheds. An annual report is prepared that describes spatial and temporal trends in productivity and contaminant levels.

Sample collection of herring gull eggs began in 2002, expanding an existing program carried out by the Canadian Fish and Wildlife Service. Herring gull eggs are excellent indicators of water quality for Great Lakes nearshore areas. The eggs are analyzed for mercury, PCBs, and chlorinated pesticides such as DDT. Also, efforts are being made to expand the analyte lists to include emerging contaminants such as brominated or fluorinated compounds. Eggs are collected from nine colonies throughout the state, with some located in each of Michigan's Great Lakes watersheds. An annual report is prepared that summarizes spatial and temporal contaminant trends.

The current biological assessment procedure used by WB monitoring staff is a qualitative tool designed to determine if aquatic life is affected by pollution. The WB is currently developing an aquatic life community temporal trend monitoring program. The objective is to develop a procedure that can be used to assess long-term aquatic community changes at specific locations, as a tool to evaluate impacts from NPS and to assess the effectiveness of BMPs. Reports will be prepared on a project-specific basis as appropriate.

As noted above, conclusions regarding temporal and spatial trends are an important measure of the effectiveness of NPS activities at a statewide scale. Key findings from the statewide trend monitoring activities described above will be incorporated into the Annual NPS Program Report as appropriate. The program coordinator for each of the trend monitoring activities, in consultation with the NPS monitoring coordinator, will be responsible for identifying information in the annual trend reports that are relevant to the NPS program. For example, there may be particular watersheds that have a larger number of NPS projects over a defined period, in which case, temporal trend data from those watersheds could be incorporated in the Annual NPS Program Report.

B. Integration of Water Quality Trend Monitoring and the NPS Program

The coordination and integration of water quality trend monitoring with other monitoring priorities and NPS program priorities is described in Chapter II. However, many of the actions described in Chapter II are reiterated here in more detail and with special emphasis on the inclusion of trend monitoring project plans in the priority setting, planning, and reporting process. The SWAS is responsible for overseeing implementation of the water quality monitoring plan and coordinates many of the elements of the plan. Staff (including contractors or grantees) ensures that monitoring plans are developed, samples are collected, data are properly stored, reports are written, and results are communicated to internal and external partners including NPS program staff. The SWAS NPS staff have primary responsibility for including the results of water quality trend monitoring in the Annual NPS Program Report and considering water quality trend monitoring priorities in the NPS Program Multi-Year Plan. The SWAS and FOS staff will be responsible for completing the following activities to ensure that water quality trend monitoring activities are integrated with the NPS program plan:

1. Priority Setting and Planning

a. Before September of each year, the SWAS monitoring staff will obtain trend monitoring plans from each of the trend monitoring project coordinators. The trend monitoring plans will be used by SWAS monitoring staff to prepare for their annual meetings with NPS program staff to discuss monitoring needs for target watersheds **(new action)**.
b. In October of each year, the NPS program monitoring needs will be reviewed and balanced against each other and against other WB needs (including trend monitoring needs) by SWAS management in consultation with other WB management units as appropriate.

2. Study Design and Implementation

a. By December of each year, the SWAS managers will communicate monitoring priorities to the trend monitoring project coordinators.
b. Trend monitoring project coordinators will develop monitoring work plans by April of each year.
c. Monitoring studies will be conducted throughout the year.

3. Data Management and Reporting

a. Trend monitoring project coordinators will ensure that data are entered into the appropriate electronic databases as the data become available (including STORET).

b. Trend monitoring project coordinators will complete reports as data become available.
c. Trend monitoring project coordinators will prepare annual updates to be submitted to the NPS monitoring coordinator by August 1 of each year. The annual updates will focus on NPS-related trend monitoring activities and conclusions **(new action)**.
d. The SWAS NPS staff will use relevant trend monitoring conclusions to help assess the overall NPS program effectiveness and prepare their Annual NPS Program Report **(new action)**.
e. The SWAS monitoring coordinator will assist the SWAS NPS staff with the development (and annual updates) of an NPS Program Multi-Year Plan by providing plans for trend monitoring **(new action)**.

IV. NPS Problem Identification

A. Description

Problem identification is the primary objective of many NPS pollution-related monitoring studies conducted by the MDEQ and its grantees or contractors. The MDEQ implements a number of routine monitoring activities (briefly described in Appendix II) designed to assess the waters of the state on a regular basis, respond to complaints about water quality, and monitor conditions at sites with known or suspected water quality problems. Much of the problem identification monitoring is conducted on a five-year rotating basin-year monitoring schedule.

Water quality measurements are compared to specific water quality standards (WQS) that have been established in Michigan to protect surface waters for certain designated uses (Administrative Rules, Part 4. WQS, promulgated pursuant to Part 31 of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended). The designated uses include industrial, agricultural, and public water supply; navigation; body contact recreation; and use by aquatic life and wildlife. The WQS specify minimum criteria that waters of the state must meet to support the designated uses.

Most of the routine water quality assessment monitoring conducted by WB staff includes rapid assessment techniques, such as the SWAS surveys or FOS road stream crossing surveys. The SWAS surveys include biological assessments, as well as water and sediment chemistry monitoring to identify impaired water bodies and causes of impairment. The FOS surveys are primarily visual assessments of stream conditions and nearby riparian land uses from road crossings over streams. Problematic NPS of pollution observed during the SWAS surveys and FOS road stream crossing surveys are reported to appropriate NPS program staff for additional monitoring or follow-up corrective action.

More quantitative procedures such as bacteria monitoring at beaches, edible portion fish contaminant monitoring, or caged fish contaminant monitoring are conducted routinely. The results of the bacteria monitoring are used to determine the need for beach closings or advisories, identify sources of bacteria, or identify water bodies that are not attaining WQS. Edible portion fish contaminant monitoring results are used primarily to determine the need for sport fish consumption advisories, but in some cases, results are used to identify trends. The primary objectives of caged fish monitoring are to identify sources of bioaccumulative pollutants or to assess the effectiveness of pollution control activities.

Local water quality monitoring grants or NPS grants are used in some cases to develop watershed plans that describe problems and identify NPS of pollution. These projects are often used to direct corrective actions and additional monitoring.

Stream hydrology studies are conducted to assess NPS pollution caused by or related to increasing flow variability.

The FOS staff respond to citizen complaints and the results of these actions are used to direct future NPS pollution control actions or additional monitoring.

Volunteer groups monitor inland lakes and wadeable streams and these data are used to help identify impaired water quality.

B. Integration of Problem Identification Monitoring and the NPS Program

The coordination and integration of problem identification monitoring with other monitoring priorities and NPS program priorities is described in Chapter II. However, many of the actions described in Chapter II are reiterated here in more detail and with special emphasis on the responsibilities of staff involved in problem identification monitoring. Problem identification monitoring priorities are determined in part by NPS program priorities, as well as the MDEQ's commitment to assess waters of the state on a five-year rotation. The SWAS monitoring staff and NPS program staff (including contractors and grantees) have some problem identification monitoring responsibilities and all are responsible for ensuring that problem identification monitoring and NPS monitoring priorities are coordinated to the maximum extent. The SWAS and FOS staff will either have direct responsibility or oversight responsibilities for preparing study designs, implementing studies, entering data in appropriate databases, preparing reports, and communicating results to internal and external partners. The NPS monitoring coordinator is responsible for including the results of problem identification monitoring in the Annual NPS Program Report and documenting problem identification monitoring priorities in the NPS Program Multi-Year Plan. The SWAS and FOS staff will be responsible for completing the following activities to ensure that problem identification monitoring activities are integrated with the NPS program plan:

1. Priority Setting and Planning

a. During September of each year, the SWAS monitoring staff and NPS program staff will meet to discuss NPS program priorities, NPS problems, and monitoring needs within target watersheds **(new action)**.
b. Before September 30 of each year, the NPS monitoring coordinator will prepare summaries of the meetings to discuss NPS watershed monitoring needs including NPS-related problem identification monitoring needs **(new action)**.
c. In October of each year, the NPS program monitoring needs (including NPS problem identification monitoring needs) will be reviewed and balanced against each other and against other WB needs by SWAS management in consultation with other WB management units as appropriate.

2. Study Design and Implementation

a. By December of each year, the SWAS managers will communicate the monitoring priorities to staff. The NPS monitoring coordinator will prepare lists of monitoring projects that will be conducted, and recommended monitoring projects that will not be conducted in the upcoming field season. These lists will be transmitted to NPS program and monitoring staff **(new action)**.
b. The SWAS monitoring staff will develop watershed monitoring plans by April of each year.
c. The SWAS and FOS project administrators will work with grantees and contractors to develop monitoring plans and QAPPs.
d. Monitoring studies will be conducted throughout the year.
e. An inventory of NPS studies will be maintained by the NPS monitoring coordinator. The SWAS monitoring staff and FOS project administrators will help maintain the list by providing information regarding the status of NPS problem identification projects **(new action)**.

3. Data Management and Reporting

a. The SWAS monitoring staff and NPS program staff will ensure that data are entered into the appropriate electronic databases (including STORET). The FOS and SWAS project administrators will ensure that grantees and contractors provide appropriate data in STORET-ready format. The SWAS STORET coordinator will enter grantee's and contractor's STORET-ready data into the database.

b. The SWAS staff will complete reports as data become available. The reports will include a section that highlights the NPS problem identification monitoring results. Also, the FOS and SWAS project administrators will ensure that grantees and contractors complete final reports in a timely manner and highlight all NPS problem identification monitoring results **(new action)**.
c. By August 1 of each year, SWAS staff, as well as FOS and SWAS project administrators will prepare annual updates to be submitted to the NPS monitoring coordinator. The annual updates will focus on NPS-related conclusions and follow the format outlined in Appendix III-1 **(new action)**.
d. The NPS monitoring coordinator will use reports and annual updates to develop the Annual NPS Program Report, revise the NPS Program Multi-Year Plan, help determine NPS program priorities, and develop priorities for future problem identification and effectiveness monitoring studies **(new action)**.

V. TMDL Development and Effectiveness Monitoring

A. Description

Section 303(d) of the federal CWA and the USEPA's Water Quality Planning and Management Regulations (Title 40 of the Code of Federal Regulations, Part 130) require states to develop TMDLs for water bodies that do not meet applicable WQS. Each TMDL must include waste load allocations for point sources and load allocations for NPS such that the sum of the allocations (plus a margin of safety) is not greater than the loading capacity of the water for the pollutants addressed by the TMDL. The MDEQ updates the list of water bodies (Section 303(d) list) that are not meeting applicable WQS every two years. This list is submitted to the USEPA along with a schedule for developing all TMDLs within 13 years of a water body being listed as not attaining standards.

The Section 303(d) list includes a number of water bodies with impairments caused either partially or entirely by NPS of pollutants. Examples of common impairments caused by NPS of pollution include sediment-related impacts to aquatic biological communities, elevated levels of bacteria, sport fish consumption advisories and/or impaired aquatic communities due to contaminated sediments, and sport fish consumption advisories due to atmospheric deposition of contaminants. In many cases, TMDLs will be the primary mechanism for reducing loads of NPS pollutants and attaining WQS in waters of the state.

Monitoring conducted to support TMDLs can be divided into two categories. The first category is TMDL development monitoring. This includes the monitoring necessary to define the extent of the impairment, causes or sources of pollution, contaminant loads, and reductions necessary to restore a degraded water body. The second category of TMDL monitoring is TMDL effectiveness monitoring. This category includes monitoring necessary to measure the impact of TMDL implementation and ultimately document that WQS are being met.

B. TMDL Development Monitoring

The TMDL development monitoring is similar to the problem identification monitoring described in Chapter IV and is often accomplished using the tools described in Chapter IV and Appendix II. The type, extent, and causes of impairments or sources of pollution all dictate the type of monitoring conducted. In addition, the spatial scale of the problem and causes, the nature of the sources (e.g., agricultural vs. urban), as well as logistical, technical, and resource constraints influence the type of monitoring conducted. Sites are typically selected based on a targeted design as opposed to a randomized design.

C. TMDL Effectiveness Monitoring

The TMDL effectiveness monitoring is similar to the effectiveness monitoring described in Chapter VI. The objectives of the effectiveness monitoring depend in part on the implementation of the TMDL. The primary objective is to document the restoration of designated uses in cases where the TMDL has been fully implemented. However, the objectives may include measuring trends, measuring reductions in pollutant loads, or documenting the elimination of pollutant sources.

D. Data Management and Reporting

Data collected as part of TMDL development or TMDL effectiveness monitoring will be stored in appropriate MDEQ databases. In addition, environmental data will be entered into STORET within one year of collection.

The TMDLs are developed by the SWAS staff. Also, the MDEQ provides a biennial report to the USEPA describing the quality of the waters of the state (required under Section 305(b) of the Federal CWA) and listing the water bodies that are not attaining WQS (Section 303(d) list). This biennial report is prepared by the SWAS staff and includes a list of approved TMDLs and a schedule for developing remaining TMDLs.

E. Integration of TMDL Monitoring and the NPS Program

The coordination and integration of TMDL monitoring with other monitoring priorities and NPS program priorities is described in Chapter II. However, many of the actions described in Chapter II are reiterated here in more detail. The SWAS staff (including contractors and grantees) have primary responsibility for developing TMDLs and reporting results. The SWAS NPS staff have primary responsibility for including the results of TMDL monitoring in the Annual NPS Program Report and documenting TMDL monitoring priorities in the NPS Program Multi-Year Plan. The SWAS and FOS staff will be responsible for completing the following activities to ensure that TMDL monitoring activities are integrated with the NPS program plan:

1. Priority Setting and Planning

a. Before September of each year, the SWAS staff and management will review the TMDL schedule, determine NPS-related TMDL monitoring needs, and forward TMDL monitoring priorities to SWAS monitoring staff **(new schedule)**.
b. During September of each year, the monitoring staff and NPS program staff will meet to discuss NPS program priorities and TMDL monitoring needs within target watersheds **(new action)**.
c. Before September 30 of each year, the NPS monitoring coordinator will prepare summaries of the meetings to discuss NPS watershed monitoring needs including NPS-related TMDL monitoring needs **(new action)**.
d. In October of each year, the NPS program monitoring needs will be reviewed and balanced against each other and against other WB needs (including TMDL monitoring needs) by SWAS management in consultation with other WB management units as appropriate.

2. Study Design and Implementation

a. In December of each year, the SWAS managers will communicate the monitoring priorities to staff. The NPS monitoring coordinator will prepare lists of monitoring projects that will be conducted, and recommended monitoring projects that will not be conducted in the upcoming field season. These lists will be transmitted to NPS program and monitoring staff **(new action)**.
b. The SWAS staff will develop TMDL monitoring plans by April of each year or work with contractors to develop TMDL monitoring plans.
c. Monitoring studies are conducted throughout the year.
d. An inventory of NPS studies will be maintained by the NPS monitoring coordinator. The SWAS monitoring staff and FOS project administrators will help maintain the list by

providing current information regarding the status of TMDL-related NPS monitoring projects **(new action)**.

3. Data Management and Reporting

a. The SWAS staff will enter data into the appropriate electronic databases as the data become available (including STORET).
b. The SWAS will provide the USEPA with the biennial report describing water quality in Michigan and specific water bodies that are or are not attaining standards.
c. The SWAS will prepare annual updates of TMDL-related monitoring activities. These summaries will be submitted to the NPS Unit by August 1 of each year. The annual updates will focus on NPS-related conclusions and will follow the format outlined in Appendix III-2 **(new action)**.
d. The NPS monitoring coordinator will use reports and annual updates of TMDL-related monitoring activities to prepare the Annual NPS Program Report. The Annual NPS Program Report will be submitted to the USEPA by September 30 of each year and other external or internal partners as appropriate **(new action)**.
e. The NPS monitoring coordinator will use reports and annual updates of TMDL-related monitoring activities to revise the NPS Program Multi-Year Plan, help determine NPS program priorities, and develop priorities for future monitoring studies **(new action)**.

VI. NPS Project Effectiveness Monitoring

A. Introduction

Documenting the effectiveness of NPS pollution control activities is essential to the long-term success of the NPS program. While the benefits of a particular BMP may be intuitive to those closest to the watershed, sound effectiveness monitoring strategies must be developed and implemented wherever necessary to provide objective assessments of the merits of NPS pollution control projects.

Developing a procedure for monitoring the effectiveness of NPS pollution control projects in Michigan is confounded by the complexity of aquatic ecosystems and pollution sources to be monitored. Effectiveness monitoring strategies that are appropriate for the largest lakes in the world may not be appropriate for an inland lake. Likewise, Michigan's rivers and streams range from relatively small, high energy event responsive systems to low energy connecting channel rivers, which rank among the largest rivers in the world by volume of discharge. Effectiveness monitoring activities are therefore highly diverse, often with little similarity between seemingly common NPS problems.

The intent of this chapter is to provide an overview of the essential elements that produce successful NPS effectiveness monitoring projects. Also, this chapter describes responsible entities within the MDEQ for the development and implementation of effectiveness monitoring plans, criteria considered during the development of study designs, and the procedures used to prioritize monitoring. This chapter is not a list of BMP monitoring options, but rather serves to communicate the MDEQ's expectations within the given range of monitoring options. All BMPs funded by the WB will be monitored in some fashion, regardless of the magnitude of the treatment. All groups that participate in funded NPS projects are encouraged to use this information in conjunction with more technical monitoring guidance documents developed by others (see examples: USEPA, 1997; USDA-NRCS, 1996; USDA-SCS, 1993; Kondolf and Micheli, 1995).

B. NPS Effectiveness Monitoring Objectives and Design Considerations

The NPS effectiveness monitoring methodologies will range along a continuum of monitoring techniques, from quantitative to qualitative (Table VI-1). The main factors in deciding whether a given BMP will be monitored qualitatively or quantitatively are:

1. The scale of the impairment's cause(s) (local or widespread);
2. The scale of an impairment's manifestation (local or widespread);
3. The characteristics of the watershed;
4. The size, scale, and type of the NPS pollution control effort;
5. The ability to control sources of variability, and;
6. Logistical considerations.

Table VI-1. Examples of monitoring methods arranged along a continuum from high to low precision. The examples represent a portion of available options and are presented to illustrate a range of potential options.

Quantitative	**Macroinvertebrates**	**Plants**	**Fish**	**Chemical Nutrient**	**Chemical Non-Nutrient**	**Sediment**	**Dissolved Oxygen (D.O.)**	**Flow**
High Precision ↕ **Low Precision**	Quantity/M^2 Biomass (g/M^2) Organism specific (quantity/M^2) Rapid bioassessment procedure (RBP) – (i.e., P-51) Genus/species resolution RBP – Family level of resolution RBP – Order level of resolution Presence/absence of indicator group	Quantity/M^2 Biomass (g/M^2) Chlorophyll a concentration Organism specific (quantity/M^2) Area of Coverage (M^2 of area covered) Indicator species (i.e., *Cladophora sp.*) Nuisance/non-nuisance concentrations Before/after photograph	Total biomass/ area (i.e., g/M^2) Diversity or community indices Catch per unit effort RBP – P-51 Species level resolution Presence/ absence of indicator species	Loadings (lbs/day) Concentrations Chlorophyll *a* concentrations Species composition Algae biomass diurnal D.O. Attached algae lengths Secchi depth Algae blooms or nuisance densities of macrophtyes	Concentrations within biota, sediment, or water Bioassays - water sediment Multiple grab samples Single grab sample	Loadings (lbs/day) TSS concentrations Geomorphic measurements Pin studies Bank erosion Hazard indices Erosion rates Pebble count Embeddedness Turbidity caused by suspended solids Dimensions – (e.g., area restored) Before/after photographs	Multiple diurnal measurements (continuous) Biochemical Oxygen Demand loadings Sediment Oxygen Demand Instantaneous measurements Anaerobic indicators (smell, black underside of rocks, facultative biota, etc.)	Measures of flow variability (e.g., CVLF5) Evidence of extreme flow variability (e.g., debris in trees)
Qualitative								

As previously noted, processes for developing NPS effectiveness monitoring studies have been described in many publications. Most of these procedures include a multi-step process that involves:

1. Problem identification (a measured or observed impairment or threat to water quality and identification of causes).
2. Definition of monitoring objectives (the question to be answered with monitoring data).
3. Experiment design (sites to be visited, variables to be measured, statistical analyses to be employed, and sample size estimation techniques).
4. Data management and reporting.

Some important considerations are highlighted below:

1. Problem Identification

Monitoring the effectiveness of an NPS pollution control project must begin with a clear understanding of the problem that is to be solved by the control actions. The MDEQ supports a number of programs specifically intended to identify impairments or threats to the waters of the state. Monitoring efforts focused partially or entirely on identifying threats or impairments caused by NPS of pollution are described in Chapter IV.

Evaluation of the Scale and Scope of Impacts and Causes

Understanding the relationship that scale has on monitoring effectiveness is critical in creating an appropriate monitoring design for any given treatment. The magnitude or relative size of a given area of perturbation and the scale of the causes and/or manifestation will influence the selection of monitoring objectives (Figure VI-1). The following examples illustrate the importance of understanding the scale of impairments and causes:

> **Example A, local impacts caused by a local source** (Figure VI-2): Assume that a benthic macroinvertebrate community is impaired in a riffle downstream of a road crossing but not above the crossing. The impairment is so severe that the aquatic life designated use (included in Michigan's WQS) is not being met. The cause of the impairment is sedimentation and the source of the sediment is bank erosion near the road crossing. Stabilizing the bank near the road crossing will reduce sediment loads to the impacted area and over time the sediments will be flushed from the riffle area. The effectiveness monitoring could include an assessment of the benthic macroinvertebrate community over time. In this example, the effect of the treatment should be relatively easy to measure in the stream.
>
> **Example B, widespread impacts caused by numerous sources** (Figure VI-2): Assume that impairments to the benthic macroinvertebrate community have been documented throughout the watershed. The impairments are caused primarily by sediments from numerous erosion sources. The watershed is also impacted by hydrologic dysfunction, which is contributing to bank erosion. A few BMPs or treatments have been funded but not enough to address the hydrologic dysfunction or every source of erosion. The effect of individual projects on the benthic macroinvertebrate community will be difficult to measure and the success of effectiveness monitoring projects will hinge on the ability to select appropriate surrogates of progress. For example, projects intended to control bank erosion by stabilizing banks, retaining storm water runoff, or increasing infiltration could

be monitored in the short term by measuring or modeling reductions in sediment inputs, measuring the volume of storm water detained, documenting bank stabilization with photographs, or other qualitative or semi-quantitative techniques.

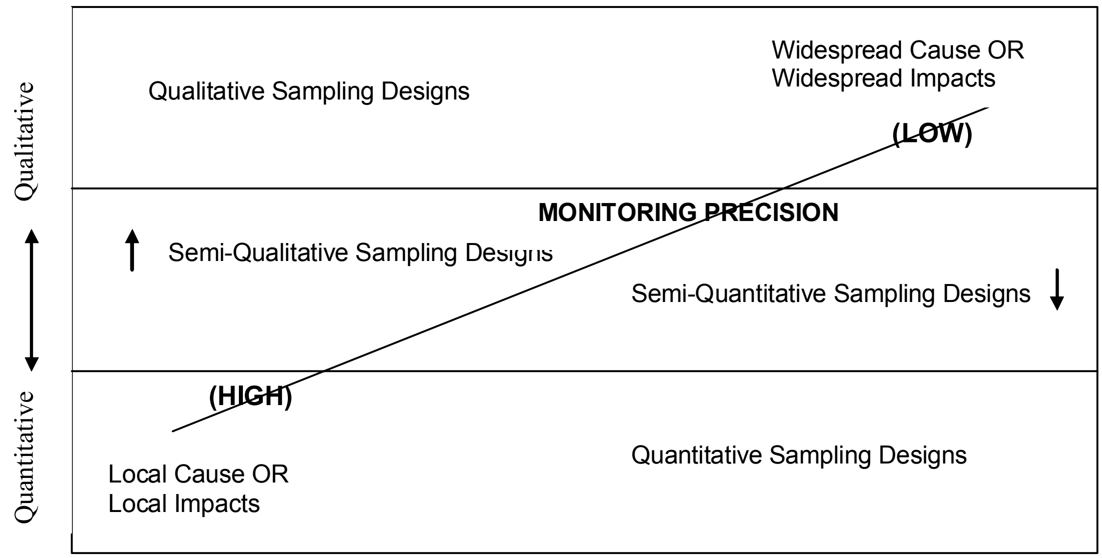

Figure VI-1. A description of monitoring precision capabilities when the causative agent(s) are localized or widespread throughout the watershed. The ability to "reasonably" monitor any given BMP or series of BMPs becomes less precise (less quantitative) as the causative agent moves from a single localized defective point towards many defective points in combination throughout the watershed.

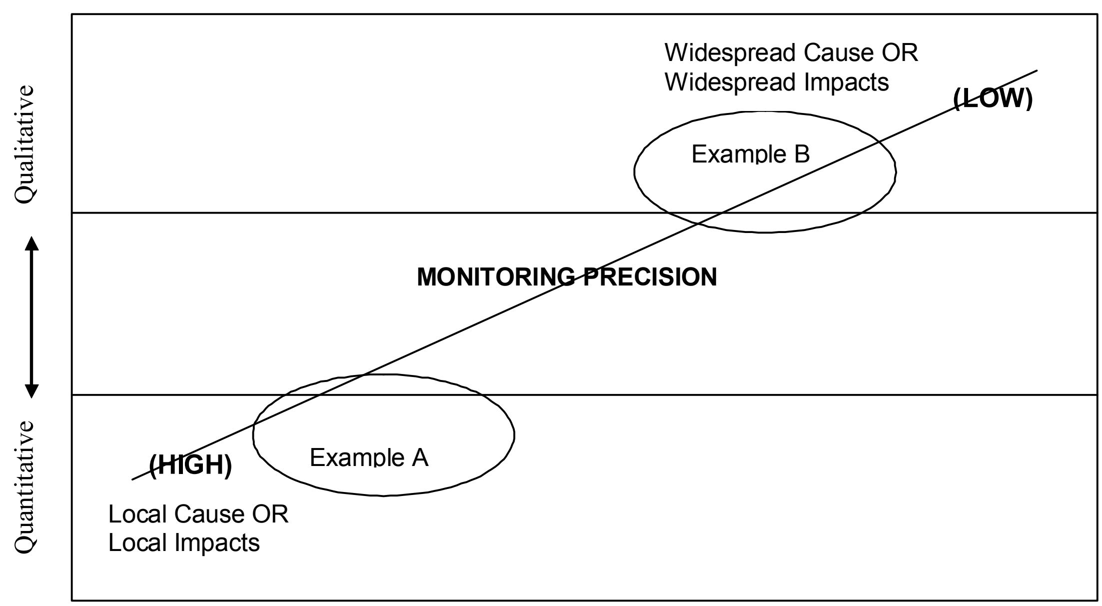

Figure VI-2. Example of scale illustrating the use of identical BMP(s) with a local cause or local impact (Example A) and a widespread cause or widespread impact (Example B). The potential monitoring precision changes from quantitative to qualitative as scale changes from local to widespread.

The level of monitoring effort devoted to assessing the effectiveness of a BMP, as described above, is largely determined by scale of the sources and problems being addressed. As such, the question of using quantitative versus qualitative sampling methods may or may not be an option for many BMP monitoring needs.

2. Defining Effectiveness Monitoring Objectives

Developing appropriate monitoring objectives is another essential element of a successful effectiveness monitoring project. All MDEQ-supported effectiveness monitoring efforts will have clearly articulated monitoring objectives and an assessment of the probability that the objectives can be achieved. The SWAS NPS and monitoring staff, as well as the FOS NPS staff will be responsible for developing specific monitoring objectives. Also, the NPS program staff will help determine the magnitude of change that should result from NPS controls while monitoring staff will help determine appropriate monitoring designs to detect changes in loads or ambient conditions.

The objective of NPS pollution control effectiveness studies should ideally be to document improvements in the aquatic environment (or no further degradation due to NPS pollution) that are a direct consequence of a specific NPS pollution control effort. In example A, the primary monitoring objective would be some measurement of restored designated use (e.g., restored benthic macroinvertebrate community) that resulted from the installation of BMPs designed to arrest sediment inputs. Other primary objectives for NPS projects could include efforts to assess changes in the status of a designated use impairment such as:

- Impaired fish communities;
- Excessive eutrophication;
- Fish consumption advisories;
- Beach closures or exceedences of bacteria standards; and/or
- Exceedences of WQS.

In many cases, measuring the change in the status of an impaired use may not be a realistic objective given the scale of the causes or magnitude of the treatments. In these cases, secondary or surrogate parameters that are closely associated with the source of the suspected pollutant may be used to demonstrate the effectiveness of a treatment. Examples of these types of surrogate measurements can include:

- Monitored changes in pollutant loads from an NPS;
- Modeled pollutant load reduction estimates;
- Monitored volumes of storm water retained or detained;
- Modeled volumes of storm water retained or detained;
- Changes in physical habitat;
- Changes in stream flow variability; or
- Reductions in the amount of gravel used to repair road side crossings.

Also, NPS effectiveness monitoring objectives may be qualitative. Qualitative effectiveness monitoring documents or describes the installation of specific BMPs and relies on previously established effectiveness studies to estimate environmental improvements rather than actual outcome monitoring. Qualitative effectiveness monitoring is most common when the scale of impairment and pollutant sources exceed a reasonable ability to document environmental change using more quantitative monitoring methods. Common examples of qualitative effectiveness monitoring include:

- Before and after photos documenting improvements at a site;
- A measurement (i.e., miles or square feet) of buffer strip added to a watershed; or
- Estimates of dollars saved (e.g., dollars saved detaining storm water as opposed to directing storm water to the nearest stream).

The relationship between primary, secondary or surrogate, and qualitative monitoring objectives is shown in m. The objectives in Table VI-2 are limited to monitoring studies intended to assess the effectiveness of efforts to restore benthic macroinvertebrate communities. In general, primary objectives should be a higher priority than secondary and qualitative objectives. However, these decisions are dependent on the scale of the problem, causes, and the magnitude of the treatments.

Table VI-2. Examples of the relationship between primary, secondary, and qualitative effectiveness monitoring objectives.

Impairment	Causes	Primary Monitoring Objective	Secondary Monitoring Objective	Qualitative
Biota – Macroinvertebrate Community	Sedimentation	Macroinvertebrate Community	Changes in: -sediment concentration or load -geomorphic measurements -pebble Counts -measures of embeddedness	Before/after photographs of sediment reduction BMPs Measure of treatment added to a watershed (e.g., miles of buffer strip)
Biota – Macroinvertebrate Community	Low D.O. levels	Macroinvertebrate Community	Changes in D.O. concentration(s)	Before/after photographs of treatment Sediment odor Blackened undersides of rocks
Biota – Macroinvertebrate Community	Chemical	Macroinvertebrate Community	Changes in chemical concentration or load Bioassays	Before/after photographs of treatment Description of chemical reduction activities.

Finally, it will sometimes be desirable to monitor the performance of an NPS BMP even if in-stream improvements are unlikely or are too difficult to measure. For example, measuring the phosphorus reduction between the inlet and outlet of an infiltration swale in the median of an urban boulevard may be desirable if the objective of the project is to evaluate the phosphorus removal potential of infiltration swales and determine the potential benefit of this particular BMP at other locations.

3. Experimental Design

The specific effectiveness monitoring study design, including measured parameters, station locations, sampling frequency, and data analysis techniques will be determined by WB staff, grantees, or contractors. Monitoring studies conducted by grantees or contractors will be reviewed and approved by WB staff. In some cases, grantee monitoring will be supplemented by SWAS monitoring projects, or SWAS monitoring could be supplemented with grantee monitoring. Study designs will be developed after reviewing the problem identification, purpose and scope of the NPS pollution control, purpose of the effectiveness monitoring, and determining the monitoring objectives. The following is a review of some of the key issues and criteria that will be considered by WB staff, contractors, and grantees.

Controlling Variability

Successfully detecting changes following an NPS pollution control action depends, in large, on identifying primary sources of variability and controlling those factors with the sampling design or post-hoc statistical analyses. Generally, as noted above, studies conducted in areas impacted by multiple sources of pollution will require more samples and more effort to control variability than studies conducted in an area where a single impact can be isolated and measured. In addition, the magnitude of change that might result from an individual NPS pollution control action may not be measurable without extraordinary expenditures of resources.

For example, measuring changes in pollutant loads in response to NPS pollution control activities may be very difficult given the variability associated with flow and concentration in most streams. Flow and suspended solid variability are such that detecting a real change of +/- 10% in annual suspended solids loads would require approximately 200 samples per year from streams with relatively stable flows to over 1,500 samples per year from streams with flashy flow regimes (Day, 1990). In addition, annual loads of suspended solids are quite variable with loads increasing by 100% or more or decreasing by 50% or more between years. Studies must be designed to control or minimize these sources of variation.

Parameter Selection

Parameter selection will be driven by the monitoring objectives. Generally, primary measurements of NPS effectiveness will yield data sufficient to determine whether or not corrective measures (BMP installation) have restored a designated use or improved water quality. Secondary or surrogate measures will yield data sufficient to assess load reductions or site improvements. Also, quantitative measures, such as ranks, concentrations, or densities will allow hypotheses to be tested statistically while qualitative measures, such as before and after photographs, will require more subjective assessments of project success.

It is beneficial to systematically record or monitor land use or land management parameters along with the water quality parameters when attempting to measure effects from BMP treatments that are implemented on a watershed scale. Understanding exactly where and when specific BMPs were implemented is essential when attempting to associate water quality effects with the implementation of specific BMPs. Planning for the collection of land management or land use data may be just as important as planning for the collection of the water quality data.

Station Locations
Monitoring stations are usually selected using probabilistic, systematic sampling, or targeted designs. Probabilistic methods involve selecting sites based on random or stratified random techniques to provide a statistically unbiased assessment of a larger population. Systematic sampling involves selecting stations in a manner (such as fixed intervals) that ensures that every sample has a defined probability of being selected. For example, targeting every fifth riffle pool sequence in a river reach ensures that samples along the entire reach are included. Targeted designs include monitoring sites that are selected based on specific criteria, such as road crossings or future installation of a BMP. Targeted designs are most commonly used to evaluate the impact or benefit of NPS pollution control projects (USEPA, 1997).

Properly designed studies that employ probabilistic or systematic sampling designs to select a subset of samples from a larger population allow conclusions to be extrapolated to the entire population with a known level of confidence. However, targeted sampling toward selected sites of interest can help to control extraneous sources of variation that unless otherwise controlled can overwhelm the ability to detect differences of interest.

Sampling Frequency
Determining the appropriate number of samples and appropriate design for collecting samples is important to control some sources of variability that would otherwise prevent trends or differences from being detected. The SWAS staff, contractors, and grantees will use sample size estimation techniques (when they exist) to ensure that study designs have sufficient power to detect trends or differences at levels of interest. Iterative approaches will be considered to estimate sample sizes when other more direct estimation techniques are not available. Effectiveness monitoring studies will not be initiated until the designers have some level of confidence that sufficient sampling effort can be maintained over the course of the study to achieve the stated objectives.

In addition to the total number of samples collected, the study designers will also consider collection schedules as a means to control some sources of variability. For example, studies intended to measure changes in loading rates from streams with variable flows should employ flow weighted sampling designs so that most of the samples are collected during the high flow periods when the magnitude of the loads and load variability are highest. Sampling designs that include measurements of biological communities need to consider temporal and spatial impacts on each respective population.

Randomized, systematic, or fixed approaches can also be used to determine sampling schedules. Randomized sampling designs are most appropriate when the population does not contain major trends, cycles, or patterns (USEPA, 1997) and stratified random sampling designs are most appropriate when the population can be divided into groups or strata based on similar variance (such as high flow and low flow) or similar characteristics (such as ecoregions). Systematic sampling can be used to ensure that sampling is evenly spread over time or space. Fixed sampling designs are often logistically easier to implement than random or systematic sampling designs. However, fixed sampling intervals will not be employed when the magnitude or variability of the measurement contains major trends, cycles, or patterns.

Statistical Designs

Selecting the proper statistical design is a key element of monitoring projects because selecting the appropriate design will ensure that the study is properly controlled. Several publications describe the advantages and disadvantages of various statistical designs as well as appropriate statistical analyses (see for example USDA-NRCS, 1996; USEPA, 1997). The SWAS staff, contractors, and grantees will determine appropriate statistical analyses, and the intent of this section, is to describe a few of the more commonly used alternatives and examples.

Plot Designs: Multiple plots within treatment groups have been used in Michigan to assess the effectiveness of agricultural NPS pollution control projects. For example, buffer strips were planted and surface runoff samples collected from plots near an agricultural ditch. Loads from plots "treated" with buffer strips can be compared to loads from a control plot without buffer strips. The advantage to this approach is that treatments are replicated and a control is available, which accounts for variables, such as soil type, slope, and weather.

Before and After Designs: Before and after studies are often used to assess the effectiveness of projects at a particular site or within a particular watershed. The success of this study design is dependent on the investigator's ability to control temporal variability (e.g., annual or seasonal variation in weather, benthic macroinvertebrate communities, flow variability, or land use). Before and after caged fish studies have been used to demonstrate reductions in NPS of bioaccummulative pollutants. Before and after load monitoring has been conducted where loads can be related to flow and corrected for differences in annual flow variability. In addition, before and after channel morphology and benthic macroinvertebrate community studies have been used to document improvements in water quality. Finally, before and after photos have been used extensively to document site-specific improvements.

Above and Below Watersheds and Paired Watersheds: A paired watershed or a nested paired watershed sampling design is very useful for assessing the effectiveness of BMPs. In a paired watershed sampling design, two watersheds are sampled; one is a control or reference watershed and the other is a treatment watershed. It is essential that the two watersheds be as similar as possible (other than the presence of the BMP in the treatment watershed) in terms of geology, hydrology, rainfall patterns, vegetation types, or other factors that may contribute uncertainty to the comparison.

Paired watershed studies have been used to demonstrate the effectiveness of urban or agricultural BMPs in Michigan. However, in some cases, studies have been impacted by the MDEQ's inability to manage all activities in the control watershed. Nested paired watershed designs have been used to assess differences in fish contaminants (caged fish and edible portion samples), benthic macroinvertebrate communities, and habitat quality as measures of NPS pollution control effectiveness.

Trend Stations: Fixed station trend designs offer advantages associated with controlling variability particularly when the trend monitoring objective is specific to a particular site. Trends determined using a fixed station design cannot be extrapolated to a larger population with defined confidence unless the stations are selected randomly. The MDEQ has used fixed station designs to document changes in water quality, sediment chemistry, and fish contaminant concentrations at individual stations.

4. Data Management and Reporting

The study plans and QAPPs will describe the types of data that will be collected and identify data storage procedures and data reporting formats. Monitoring data collected by SWAS (including contractors and grantees) will be stored in MDEQ databases and STORET.

All SWAS NPS effectiveness monitoring projects will be described in staff reports. Both the SWAS and FOS project administrators will be responsible for ensuring that grantees and contractors produce reports summarizing the results of NPS effectiveness monitoring projects. Staff will look for opportunities to develop technical articles describing the results of “showcase” NPS projects in peer-reviewed journals. Also, staff will look for opportunities to present the results of “showcase” monitoring projects at workshops or conferences.

The SWAS and FOS staff and project administrators will be responsible for producing annual updates of ongoing projects and projects completed within the current fiscal year. The SWAS NPS staff will use these updates in the Annual NPS Program Report developed for the USEPA and other external and internal customers. In addition, the results of NPS effectiveness monitoring projects will be used to update the NPS Program Multi-Year Plan, identify future monitoring efforts, and target future NPS pollution control activities.

C. Special NPS Effectiveness Monitoring Projects

The WB will look for opportunities to “showcase” the results of some NPS reduction efforts with intensive effectiveness monitoring projects. Although resource intensive, showcase projects will provide sound scientific evidence for improvements than can occur when NPS controls are implemented. These special projects will be long term and more intensive than typical effectiveness monitoring projects. It is anticipated that only one or two special projects will be ongoing at any one time given the considerable resource commitment. The following criteria will be assessed as the WB evaluates opportunities to implement special monitoring projects to “showcase” NPS projects:

<u>Technical Considerations</u>

Programmatic

Monitoring projects intended to answer program or policy questions in addition to site-specific questions will be a priority. For example, state and federal agencies spend considerable resources controlling agricultural NPS pollution as part of the Conservation Reserve Enhancement Program (CREP).

In addition, the SWAS or FOS staff may request that certain types of monitoring be conducted to help provide information necessary to guide decisions about the priority of future implementation projects. For example, monitoring the effectiveness of bank stabilization projects in large watersheds dominated by sandy soils may provide information that will help determine the priority of future bank stabilization projects or efficacy of future effectiveness monitoring projects in similar watersheds.

Design

Successfully detecting changes in response to NPS pollution control depends on identifying primary sources of variability and controlling for those factors with design or statistical methods. The WB will look for situations where all or most sources of variability can be controlled or appropriately considered. The criteria used to select monitoring projects based on design considerations could include an assessment of the scale of the impacts and causes as well as an evaluation of the potential to isolate changes in water quality following BMP implementation.

Project
Effectiveness monitoring conducted by the WB at a high profile site may be given a higher priority than monitoring conducted at other sites. High profile sites could include projects within Great Lakes Areas of Concern. Also, effectiveness monitoring projects within watersheds that have suffered high profile or catastrophic impacts may also be considered a priority. Examples of these types of areas could include the Dead River watershed downstream of the two dams that were breached in 2003.

Logistical Considerations
Several logistical criteria must be considered in addition to the more technical or policy-oriented criteria discussed above. These logistical criteria include the following:

Coordination of BMP implementation and monitoring activities: The success of many types of effectiveness monitoring studies is dependent on a high degree of coordination between the implementation phase and monitoring phase. For example, some studies require a pre-implementation or base line monitoring phase prior to implementing pollution control activities. Other effectiveness monitoring studies are dependent on season, such that the timing of the implementation phase must be closely coordinated with the monitoring phase.

Continuity of financial and logistical support: Some types of effectiveness monitoring projects may require several years to plan and complete. If a commitment is made to conduct a multi-year monitoring project, then adequate resources must be committed to ensure that projects and monitoring are completed as planned.

Capability: Effectiveness monitoring designs must be logistically achievable. Entities developing effectiveness monitoring projects must evaluate the objectives and determine whether or not the technical or logistical challenges can be met. For example, load monitoring projects often require an event monitoring strategy. If the sample collection cannot be automated and the monitoring entity is unable to respond quickly to high flow events, then the project should not be attempted.

D. Integration of NPS Effectiveness Monitoring and the NPS Program

The coordination and integration of NPS effectiveness monitoring with other monitoring priorities and NPS program priorities is described in Chapter II. However, many of the actions described in Chapter II are reiterated here in more detail and with special emphasis on the responsibilities of staff involved in effectiveness monitoring. Effectiveness monitoring priorities are determined, in part, by NPS program priorities, the quantity and nature of NPS pollution control projects being implemented, and the problems (and causes) that they are designed to address. The NPS effectiveness monitoring projects are prioritized first against other NPS monitoring priorities then against all of the WB's monitoring priorities before monitoring assignments are given to staff. The SWAS and FOS staff will be responsible for completing the following activities to ensure that NPS effectiveness monitoring activities are integrated with the NPS program plan:

1. Priority Setting and Planning

a. During September of each year, the SWAS monitoring staff will meet with the NPS program staff to discuss NPS program priorities and effectiveness monitoring opportunities within target watersheds **(new action)**.
b. Before September 30 of each year, the NPS monitoring coordinator will prepare summaries of the meetings to discuss NPS watershed monitoring needs including NPS-related effectiveness monitoring needs **(new action)**.
c. In October of each year, the NPS program monitoring needs (including effectiveness monitoring needs) will be reviewed and balanced against each other and against other WB needs (including TMDL monitoring needs) by SWAS management in consultation with other WB management units as appropriate.

2. Study Design and Implementation

a. The SWAS managers will communicate the monitoring priorities to staff in December of each year. The NPS monitoring coordinator will prepare lists of monitoring projects that will be conducted, and recommended monitoring projects that will not be conducted in the upcoming field season. These lists will be transmitted to NPS program and monitoring staff **(new action)**.
b. The NPS program staff will provide descriptions of BMPs or NPS treatments to SWAS monitoring staff. The descriptions will identify the types and magnitude of changes predicted to occur as a result of the treatment (e.g., expected sediment load reduction of 10%) **(new action)**.
c. The SWAS monitoring staff will develop watershed monitoring plans by April of each year. The watershed monitoring plans will include effectiveness monitoring studies.
d. The SWAS monitoring staff will develop effectiveness monitoring study designs (or work with contractors to develop monitoring designs) after reviewing available problem identification studies, BMP or treatment descriptions, and determining appropriate study objectives. The study designs will identify parameters, station locations, sampling frequency, data analysis techniques, and statistical methods. The SWAS Unit Chiefs will approve QAPPs developed for projects to be completed by the SWAS or SWAS contractors **(new actions)**.
e. The NPS monitoring coordinator (and SWAS or LWMD monitoring staff upon request) will work with grantees and project administrators to develop effectiveness monitoring study designs after reviewing available problem identification studies, BMP or treatment descriptions, and determining appropriate study objectives. The study designs will identify parameters, station locations, sampling frequency, data analysis techniques, and statistical methods. The NPS Unit Chief will approve grantee QAPPs **(new actions)**.
f. Monitoring studies are conducted throughout the year.
g. An inventory of NPS studies will be maintained by the NPS monitoring coordinator. The SWAS monitoring staff and FOS project administrators will help maintain the list by providing current information regarding the status of effectiveness monitoring projects **(new action)**.

3. Data Management and Reporting

a. The SWAS monitoring staff will enter data into the appropriate electronic databases as the data become available (including STORET).
b. The FOS and SWAS project administrators will ensure that grantees and contractors provide appropriate data in STORET-ready format **(new action)**.
c. The SWAS STORET coordinator will enter grantee's and contractor's STORET-ready data into the database **(new action)**.
d. The SWAS staff will complete reports as data become available. The reports will include a section that highlights the NPS effectiveness monitoring results. Also, the FOS and SWAS project administrators will ensure that grantees and contractors complete final reports in a timely manner and highlight all NPS effectiveness monitoring results **(new action)**.
e. Staff will look for opportunities to develop technical articles describing the results of "showcase" NPS projects in peer-reviewed journals. Also, staff will look for opportunities to present the results of "showcase" monitoring projects at workshops or conferences.
f. The SWAS staff as well as the FOS and SWAS project administrators will prepare annual updates of project effectiveness studies to be submitted to the NPS Unit by August 1 of each year. The annual project effectiveness study updates will focus on NPS-related conclusions and follow the format outlined in Appendix III-3 **(new action)**.
g. The SWAS NPS staff will use reports and annual updates of project effectiveness studies to prepare the Annual NPS Program Report and submit the report to the USEPA and other external or internal partners **(new action)**.

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VIII. List of Acronyms

BCC	Bioaccumulative Chemicals of Concern
BEACH Act	Beaches Environmental Assessment and Coastal Health Act
BMP	Best Management Practices
CMI	Clean Michigan Initiative
CREP	Conservation Reserve Enhancement Program
DCH	Department of Community Health
DDT	Dichlorodiphenyltrichloroethane
D.O.	Dissolved Oxygen
E. coli	*Escherichia coli*
FCMP	Fish Contaminant Monitoring Program
FOS	Field Operations Section
FTE	Full-time employees
HEC-HMS	Hydrologic Engineering Center's Hydrologic Modeling System
HEC-RAS	Hydrologic Engineering Center's River Analysis System
LWMD	Land and Water Management Division
MCWC	Michigan Clean Water Corps
MDEQ	Michigan Department of Environmental Quality
MDNR	Michigan Department of Natural Resources
mg/L	Milligrams per liter
ml	Milliliters
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source
PCB	Polychlorinated biphenyl
PEAS	Pollution Emergency Alert System
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
RFP	Request for Proposals
Section 303(d) List	List of water bodies that are not meeting designated uses. Required by Section 303(d) of the Federal CWA
Section 319 Grant	NPS grant funds provided by the federal government pursuant to Section 319 of the Federal CWA
SQL	Structured Query Language
STORET	The USEPA's data STOrage and RETrieval database
Strategy	Nonpoint Source Environmental Monitoring Strategy
SWAS	Surface Water Assessment Section
TMDL	Total Maximum Daily Load
USDA-NRCS	United States Department of Agriculture-Natural Resource Conservation Service
USDA-SCS	United States Department of Agriculture-Soil Conservation Service
USEPA	United States Environmental Protection Agency
WB	Water Bureau
WQS	Water Quality Standard

Appendix I. Summary of Actions.

	SWAS Monitoring Staff	SWAS NPS Staff	FOS Nonpoint Staff
Priority Setting and Planning	• By July 15 of each year, managers send a solicitation letter to interested parties requesting specific monitoring recommendations **(new schedule)**. • NPS program and monitoring priorities are communicated to staff via the NPS Program Multi-Year Plan **(new action)**. • Prior to September, monitoring staff review modeling priorities, trend program priorities, TMDL schedule, volunteer monitoring results, and priorities of other internal and external partners and prepare a list of monitoring priorities **(new action)**. • In September, monitoring staff meet with NPS program staff to identify NPS problems and monitoring needs in target areas **(new action)**. • In October, SWAS managers (in consultation with other WB management units) will balance monitoring resources between NPS needs and against other WB needs **(new action)**.	• The NPS monitoring coordinator documents program and monitoring priorities in NPS Program Multi-Year Plan. The NPS Program Multi-Year Plan is distributed to internal and external partners **(new action)**. • Prior to September, staff will meet with LWMD hydrologic studies staff, review grantee reports, review program priorities, and prepare a list of monitoring priorities **(new schedule)**. • During September, staff meet with FOS NPS and SWAS monitoring staff to identify NPS problems and monitoring needs in target areas. The NPS monitoring coordinator will prepare a summary of the meeting outcomes **(new action)**. • Before September 30, the NPS monitoring coordinator will prepare a statewide summary of all watershed meetings **(new action)**.	• NPS program and monitoring priorities are communicated to staff via the NPS Program Multi-Year Plan **(new action)**. • Prior to September, staff will review the results of stream crossing surveys, grantee projects, NPS program priorities, information from other internal and external partners, and prepare a list of monitoring priorities **(new schedule)**. • During September, staff meet with SWAS NPS, monitoring staff to identify NPS problems and monitoring needs in target areas **(new action)**.

Appendix I. Continued

	SWAS Monitoring Staff	SWAS NPS Staff	FOS Nonpoint Staff
Study Design and Implementation	• By December, the SWAS managers will communicate the outcomes of priority setting meetings to staff **(new action)**. • Staff will develop monitoring plans and QAPPs before April. • SWAS monitoring staff will assist with the review of grantee monitoring proposals upon the request of the NPS monitoring coordinator. • Staff will provide advice, technical assistance, and training to volunteer monitoring groups. • Staff will work with NPS and FOS project administrators, grantees, and contractors to develop monitoring plans and QAPPs upon request. • Monitoring studies are conducted throughout the year. • Staff will help the NPS monitoring coordinator maintain a list of ongoing studies by providing updates **(new action)**.	• By December, the SWAS managers will communicate the outcomes of priority setting meetings to staff **(new action)**. • The WB will release NPS RFPs, which reflect the program goals and monitoring priorities consistent with the NPS Program Multi-Year Plan. • Staff will forward requests for hydrologic watershed analysis to LWMD. Monitoring plans and QAPPs are developed before April. • The NPS monitoring coordinator will work with grantees and project administrators to develop monitoring plans and QAPPS (with assistance from SWAS or LWMD monitoring staff upon request). • Staff will provide descriptions of BMPs or NPS treatments to monitoring staff **(new action)**. • Project administrators will require grantees to develop study plans and QAPPs. • Monitoring studies are conducted throughout the year. • The NPS monitoring coordinator will maintain a list of ongoing NPS studies **(new action)**. • The NPS monitoring coordinator will prepare and transmit lists of monitoring projects to be conducted and recommended monitoring projects that will not be conducted **(new action)**.	• By December, the SWAS managers will communicate the outcomes of priority setting meetings to staff **(new action)**. • Staff will work with grantees and contractors to develop monitoring plans and QAPPs. • Monitoring studies are conducted throughout the year. • FOS staff will respond to citizen complaints, investigate, and forward information to monitoring staff for follow-up action as appropriate. • Staff will help the NPS monitoring coordinator maintain a list of ongoing studies by providing updates **(new action)**.

Appendix I. Continued

	• **SWAS Monitoring Staff**	• **SWAS NPS Staff**	• **FOS Nonpoint Staff**
Data Management and Reporting	• Staff will ensure that monitoring data are entered into appropriate MDEQ databases as data become available. • Project administrators will ensure that contractors and grantees provide monitoring data in STORET ready format **(new action)**. • The STORET coordinator will enter data into STORET as they become available. • Project administrators will ensure that grantee and contractor reports are completed in a timely manner. • Staff reports are prepared as data become available or annual monitoring reports are prepared. • Staff reports include sections highlighting NPS conclusions **(new action)**. • By August 1, summaries of NPS related monitoring projects are prepared and forwarded to the NPS monitoring coordinator **(new action)**. • Staff will review monitoring reports and summaries and work with NPS program staff to identify sites that are ideally suited for long-term effectiveness monitoring **(new action)**.	• Project administrators will ensure that contractors and grantees provide monitoring data in STORET ready format **(new action)**. • Project administrators will ensure that grantee and contractor reports are completed in a timely manner. • By August 1, summaries of NPS related monitoring projects are prepared (by project administrator or grantee) using a prescribed format and forwarded to the NPS monitoring coordinator **(new action)**. • Staff will use annual updates to help prepare the NPS Annual Report for USEPA as well as other internal and external partners **(new action)**. • By October 31, staff will review monitoring reports and summaries and work with monitoring staff and FOS staff to identify sites that are ideally suited for long-term effectiveness monitoring **(new action).** • Staff will use reports and annual updates to determine future program and monitoring priorities and revise the NPS Program Multi-Year Plan. **(new action)**. • Staff will use reports and annual updates to help prepare the Annual NPS Program Report **(new action)**.	• Project administrators will ensure that contractors and grantees provide monitoring data in STORET ready format **(new action)**. • Project administrators will ensure that grantee and contractor reports are completed in a timely manner. • By August 1, summaries of NPS related monitoring projects are prepared (by project administrator or grantee) using a prescribed format and forwarded to the NPS monitoring coordinator **(new action)**. • Staff will review monitoring reports and summaries and work with SWAS staff to identify sites that are ideally suited for long-term effectiveness monitoring **(new action)**. • Staff will enter stream crossing survey data into database throughout the field season and forward recommendations for more intensive monitoring. • Staff will complete stream crossing watershed reports and forwards to NPS monitoring coordinator and other partners. • Staff will investigate citizen complaints and forwards reports to appropriate monitoring staff.

Appendix II. Description of NPS Monitoring Options

NPS monitoring performed by the MDEQ (and its partners) falls into four major categories: Statewide trend monitoring, NPS problem identification monitoring, TMDL monitoring, and NPS project effectiveness monitoring.

Monitoring tools used by the MDEQ to measure temporal and spatial water quality trends are described in Chapter III. More detailed descriptions of the water quality trend monitoring tools can be found in the *Strategic Environmental Quality Monitoring Program for Michigan's Surface Waters* and the annual reports referenced in Chapter III. The remainder of this Appendix describes the different monitoring tools used by the MDEQ to identify NPS problems, develop and evaluate the effectiveness of TMDLs, and/or evaluate the effectiveness of specific NPS projects. All of these monitoring tools can serve multiple purposes (Table App. II-1). Specific MDEQ staff actions necessary to ensure effective communication, integration, and coordination occurs between the water quality monitoring and NPS programs are highlighted in each monitoring tool description.

Table App II-1. Water quality monitoring tools used by the MDEQ (and partners) to support and evaluate the effectiveness of the NPS program.

	NPS Monitoring Category		
Monitoring Tool	**NPS Problem Identification Monitoring**	**TMDL Monitoring**	**NPS Effectiveness Monitoring**
CMI Beach Monitoring Grants	x	x	x
Water and Sediment Chemistry Monitoring	x	x	x
Edible Portion Fish Contaminant Monitoring	x	x	x
Biosurveys	x	x	x
Caged Fish Contaminant Monitoring	x	x	x
Volunteer Monitoring	x	x	
Road Crossing Watershed Surveys	x	x	
CMI Local Monitoring Grants	x		x
Section 319 and CMI NPS Grants	x		x
Complaint Response	x		
Hydrologic Analysis and Modeling	x	x	x
Channel Morphology Monitoring		x	x

1. CMI Beach and BEACH Act Monitoring Grants

CMI beach monitoring grants and Beaches Environmental Assessment and Coastal Health Act (BEACH Act) grants are used to determine if public swimming beaches meet bacteriological WQS. The monitoring provides a basis for deciding to close or reopen swimming beaches. The data are also evaluated by WB staff for inclusion of impaired water bodies on the Section 303(d) lists, or for follow-up corrective action by NPS program staff.

<u>Site Selection</u>

The CMI and BEACH Act monitoring grants are only awarded for public beaches. Private beaches are ineligible for funding. Specific sampling points within the swimming area are determined by the grantee and documented in a QAPP. Grantees are required to submit a QAPP and have it approved by the SWAS prior to conducting any monitoring.

Parameters and Indicators
A minimum of three 100 milliliters (ml) samples are collected in three to six feet of water in swimming areas, and the samples are composited for *Escherichia coli (E. coli)* analysis. The USEPA approved methods are used to quantify *E. coli*. The WB is researching the possibility of using more rapid *E. coli* quantification methods to provide more timely results.

Data Management
Within 36 hours of sampling, grantees enter *E. coli* monitoring results directly into the WB's Web site. This allows timely Internet access to the data by persons interested in the monitoring results. The WB's STORET coordinator annually uploads all new *E. coli* data to the USEPA's STORET database.

Reporting and Data Utilization
Grantees send quarterly reports and a final report to the project administrator. The project administrator submits an annual report to the USEPA, which includes the *E. coli* monitoring data collected in the previous year. The project administrator also sends an annual summary of all NPS-related beach monitoring activities to the NPS monitoring coordinator for inclusion as an appendix in the Annual NPS Program Report. The NPS program staff use the beach monitoring results to target corrective actions.

2. Water and Sediment Chemistry Monitoring

Water and sediment chemistry monitoring is conducted by the WB (and its partners) to help identify NPS problems, develop and evaluate the effectiveness of TMDLs and evaluate the effectiveness of NPS projects. The chemical data collected are also used to determine whether or not the water body is attaining all designated uses (Section 303(d) listing process) and for follow-up corrective action by NPS program staff.

Site Selection
Water and sediment chemistry sampling locations are targeted to best satisfy the objective(s) of the specific monitoring project. When the purpose of the monitoring project is to evaluate the effectiveness of an implemented TMDL, water and sediment chemistry sampling stations are usually targeted. Upstream/downstream sampling designs are often used to evaluate the effectiveness of NPS projects. Randomized, systematic, or targeted sampling designs are used to identify NPS problems.

Parameters and Indicators
The specific chemicals or parameters analyzed in the water or sediment samples collected are dependent on the monitoring objectives. The USEPA approved analytical methods are used whenever possible.

Data Management

All NPS-related water and sediment chemistry data collected by the WB and its partners are entered into the USEPA's STORET within one year of collection.

Reporting and Data Utilization

Technical reports are prepared by the WB monitoring staff to communicate the results of all water and sediment chemistry monitoring projects to interested parties. The WB monitoring staff send annual summaries of their NPS-related water and sediment chemistry monitoring activities to the NPS monitoring coordinator. These summaries will be included as an appendix in the Annual NPS Program Report. Also, the NPS program staff use the water and sediment chemistry monitoring results to target corrective actions.

3. Edible Portion Fish Contaminant Monitoring

The WB collects approximately 700 edible portion fish tissue samples from 40 sites annually for contaminant analysis. Edible portion fish contaminant monitoring is used by the WB to identify water bodies contaminated with bioaccumulative chemicals of concern (BCCs), determine the need for sport fish consumption advisories or commercial fishing regulations, assess the effectiveness of implemented TMDLs, or evaluate the effectiveness of NPS projects.

Fish tissue samples are a particularly useful water quality monitoring tool because BCCs are often difficult to measure in ambient water at levels of concern. However, these contaminants accumulate in fish at levels that may be orders of magnitude above the concentrations in the ambient water. The relatively high concentrations in the fish tissue are easier and less expensive to measure than the relatively low concentrations typically found in the ambient water.

Site Selection

Fish contaminant monitoring sites are not selected randomly. Instead, the following factors are considered: known or suspected sources of contamination, public access, popularity with anglers, availability of species and sizes of interest, TMDL development needs, NPS effectiveness monitoring needs, and the ability to collect samples. The SWAS fish contaminant monitoring specialist is responsible for developing and communicating the annual site list. Monitoring recommendations from the public, local watershed groups, universities, other state and federal agencies, tribal organizations, and local units of government are considered in the site list development process.

Parameters and Indicators

The WB usually targets ten top predators and ten bottom fish from each location, but sample designs vary according to the circumstances or specific objectives of each study. Monitoring is usually limited to top predators when the samples are analyzed for mercury only.

Fish are collected using standard fish sampling techniques determined appropriate for individual water bodies. These techniques include electrofishing, trap nets, gill nets, and trawling. Standard edible portion samples are processed in accordance with the SWAS Procedure #31. Most of the edible portion samples are analyzed by the Michigan Department of Community Health Environmental Laboratory, with contract laboratories providing some additional analytical support. All contaminant analyses are conducted using peer-reviewed methods by laboratories with approved QAPPs.

Mercury and a suite of chlorinated organic contaminants are typically analyzed in each edible portion sample. However, samples from some locations are analyzed for mercury only. Dioxin and furan congeners are analyzed along with mercury and chlorinated organic contaminant concentrations in approximately 75 samples per year. The analyte lists for individual monitoring studies are expanded as needed to satisfy specific study objective(s).

Data Management

Fish contaminant data are stored in a structured query language (SQL) server database with a Microsoft Access interface and are available on the WB's Web site.

Reporting and Data Utilization

Annual reports are prepared by the SWAS fish contaminant monitoring specialist. These annual reports are also accessible through the WB's Web site. Edible portion fish contaminant data and conclusions that are relevant to NPS issues are noted in the annual report.

Edible portion fish contaminant monitoring projects that focus on individual NPS issues within an individual water body are either summarized in technical reports prepared by monitoring staff or summarized in the annual report.

The SWAS fish contaminant monitoring specialist sends annual summaries to the NPS monitoring coordinator for all edible portion fish contaminant monitoring activities, for inclusion as an appendix in the Annual NPS Program Report. The NPS project staff use the edible fish contaminant results to target corrective actions.

4. Biosurveys

The WB uses biosurveys to determine whether or not water bodies are attaining designated uses. These studies may also be used to identify problems caused by NPS of pollution, provide information necessary to develop and evaluate the effectiveness of TMDLs, and assess the effectiveness of specific NPS projects. A typical biosurvey includes a qualitative assessment of the macroinvertebrate (and in some cases, fish) community and habitat conditions at selected sampling sites in a river or stream system. Water and sediment samples are also routinely collected and analyzed to determine various chemical and physical characteristics.

Site Selection

Each major watershed in Michigan is surveyed at least once every five years according to the MDEQ's rotating watershed monitoring cycle. Deviation from the normal schedule may occur when biosurveys are needed to confirm water quality problems reported to the MDEQ, develop or evaluate the effectiveness of TMDLs, or assess the effectiveness of specific NPS projects.

The SWAS monitoring staff consider several factors when selecting biosurvey sampling sites, including physical, biological, and chemical watershed attributes; historical and current land use practices; reported water quality problems; TMDL development and effectiveness needs; NPS project effectiveness evaluation opportunities; and site accessibility. Census and/or targeted sampling designs are currently used for most biosurveys. However, randomized designs are being considered for certain biosurveys, particularly those that are conducted every five years to identify NPS problems.

The SWAS monitoring staff prepare detailed biosurvey study plans and obtain the approval of their supervisor prior to conducting field work. The study plans are based on input from the MDNR Fisheries Division, WB staff, (including NPS program staff), local watershed groups, and the public. These study plans clarify the monitoring objectives, identify the location of specific sampling sites, and document the types of monitoring to be performed at each site.

Parameters and Indicators
Qualitative biosurveys are performed in wadable streams by SWAS monitoring staff according to the SWAS Procedure #51. The analyses of fish and macroinvertebrate communities, along with habitat quality at a given sampling location, are made according to a set of predetermined metrics. These metrics were adopted specifically for Michigan's wadable streams and were chosen from rapid biological assessment protocols used by the USEPA, Ohio EPA, and Illinois EPA.

When necessary, quantitative biosurvey techniques are used to evaluate the effectiveness of specific NPS projects.

Data Management
All physical habitat data collected as part of the MDEQ biosurveys are stored in a Microsoft Access database maintained by the SWAS. All biosurvey-related environmental data are entered into the USEPA's STORET database within one year of collection.

Reporting and Data Utilization
The SWAS monitoring staff prepare technical reports to communicate their biosurvey data to interested parties. These staff reports will include subsections specific to NPS problem identification and project effectiveness to describe NPS problems observed in the watershed and highlight biosurvey findings that relate to NPS project effectiveness. All SWAS biosurvey reports are distributed to the SWAS NPS Unit and the FOS district offices. A current listing of all WB biosurvey reports is also maintained on the WB's Web site.

The SWAS monitoring staff send annual summaries to the NPS monitoring coordinator of their biosurvey monitoring activities for inclusion as an appendix in the Annual NPS Program Report. The NPS program staff use the biosurvey results to target corrective actions.

5. Caged Fish Contaminant Monitoring

The WB collects caged fish tissue samples from approximately 50 sites annually for contaminant analyses. Caged fish studies are used to identify point and NPS of BCCs, develop and evaluate the effectiveness of TMDLs, and assess the effectiveness of specific NPS projects. Caged fish studies are a particularly useful water quality monitoring tool because the test fish are exposed to the water column under relatively controlled conditions. Some contaminants accumulate in test fish at levels that may be orders of magnitude above the concentrations in the ambient water. The relatively high concentrations in the test fish tissue are easier and less expensive to measure than the relatively low concentrations typically found in ambient water.

Site Selection
Caged fish contaminant monitoring sites are not selected randomly. Instead, a number of factors are considered, including known or suspected sources of contamination, five-year rotating watershed monitoring cycle, TMDL development or effectiveness monitoring needs, NPS project effectiveness evaluation opportunities, and access. The SWAS fish contaminant monitoring specialist is responsible for developing and communicating the annual caged fish monitoring site list. Caged fish monitoring recommendations from the public, local watershed

groups, universities, other state and federal agencies, tribal organizations, and local units of government are considered in the site list development process.

Parameters and Indicators

The SWAS staff (or contractors) conduct caged fish studies in accordance with the SWAS Procedure #62. Control samples are obtained at the beginning of the test period by randomly selecting a subset of channel catfish and combining them into four composite samples of whole fish. The remaining channel catfish are held in stainless steel cages at the test site for 28 days. The fish are removed from the cages and divided into four composite samples of whole fish. Ideally, each composite sample will have a minimum total weight of 100 grams. The number of fish per composite is determined by the size of the fish and the number surviving to the end of the 28-day test. Caged fish studies are typically conducted between June and September to minimize exposure to spring or fall wet weather events that can negatively impact caged fish studies conducted in event responsive streams.

Net uptake of each contaminant is calculated based on the relationship between the concentrations in the control samples and the concentrations in the test samples. If contaminant concentrations in the control samples are below the quantification level, then these concentrations are assumed to be zero and the average concentration in the test fish is calculated and presented as the net uptake. However, if control sample concentrations are above the quantification level, then the difference between the test and control concentrations is evaluated statistically. If the test concentrations are statistically significantly higher than control concentrations ($p<0.05$), then net uptake is calculated by subtracting average concentrations in the control samples from average concentrations in the test samples.

Mercury and a suite of chlorinated organic contaminants are typically analyzed in each caged fish sample. Dioxin and furan congeners are also analyzed in some samples. Analyte lists for individual monitoring studies are expanded as needed to satisfy specific study objective(s).

All contaminant analyses are conducted by laboratories using peer-reviewed methods with approved QAPPs.

Data Management

Caged fish contaminant data are stored in a SQL server database with a Microsoft Access interface and are available on the WB's Web site.

Reporting and Data Utilization

The results and conclusions of caged fish studies are presented in the FCMP annual report. Technical reports may also be produced by SWAS monitoring staff to communicate the findings of individual caged fish studies.

6. Volunteer Monitoring

The WB strives to assess water quality conditions at a minimum of 80% of stream or river miles and public access lake acres over a five-year period. Monitoring partnerships with citizen volunteers are used to help achieve this goal. Since the 1970s, the WB has worked with volunteers to monitor inland lakes and in 1998 began working with volunteers to monitor rivers and streams. Twenty-nine volunteer groups are currently partnering with the WB to monitor water quality conditions in Michigan rivers, while approximately 200 inland lakes are monitored by volunteers. These volunteer groups are the foundation of the Michigan Clean Water Corps (MCWC) formed through an Executive Order issued by Governor Jennifer M. Granholm on September 30, 2003.

A key objective of the monitoring activities carried out by the MCWC is to identify problematic NPS of pollution for appropriate verification monitoring and corrective action by the WB. Volunteers are also encouraged to use their water quality data to influence local decisions and activities. One volunteer group routinely monitors Mill Creek (Lapeer and St. Clair Counties), in part, to assist an Intercounty Drain Board in determining the best way to ensure adequate drainage while still protecting stream habitat and water quality.

Site Selection

Monitoring sites are selected at the final discretion of the volunteers. However, SWAS monitoring staff responsible for the water bodies targeted for monitoring by the volunteers offer advice and recommendations relative to the positioning of specific sampling sites. Volunteer groups that receive CMI funds must prepare a QAPP. Each QAPP must be approved by the SWAS prior to sample collection and analysis. All sampling locations selected by a volunteer monitoring group are documented in the QAPP.

Parameters and Indicators

Most of the river and stream monitoring conducted by volunteers is focused on aquatic macroinvertebrate communities and physical habitat conditions. Some river and stream volunteer monitoring groups also collect water samples for chemical analysis.

Each lake volunteer sampler must demonstrate that they can collect consistent quality data before they can participate in the more complicated monitoring projects. Consequently, first-year lake volunteer monitoring groups may only register for the Secchi disk transparency, spring total phosphorus, and summer total phosphorus monitoring projects. After they have demonstrated a proficiency in these projects they may register for chlorophyll, D.O., and temperature monitoring or the pilot projects (aquatic plant mapping and fish age and growth).

The Great Lakes Commission has been contracted to assist the MCWC . The Great Lakes Commission (with assistance from the MDEQ WB) will provide sampling methods, conduct workshops and training, provide technical support and quality control assistance, maintain a volunteer monitoring database, and provide laboratory analysis support to some volunteer monitoring groups.

Visual observations are another important monitoring tool used by volunteers. The WB maintains a Pollution Emergency Alert System (PEAS) and all volunteers are instructed to report any pollution incidents (including those that involve NPS) that they observe to PEAS for follow-up MDEQ investigation.

Data Management

All river, stream, and lake volunteer water quality monitoring results and metadata will be held in a computerized database maintained by the MCWC contractor. These data will be accessible via the MCWC's and WB's Web sites.

Reporting and Data Utilization

Annual reports summarizing the water quality data or visual observation information collected by volunteers are not required unless the volunteer group is a recipient of a CMI grant. However, many of the volunteer groups do produce such reports on a regular basis.

The MCWC will publish a newsletter to highlight citizen volunteer monitoring activities. The newsletter will be distributed to interested parties.

The WB project administrator for the MCWC contract will inform appropriate SWAS water quality monitoring and FOS NPS program staff of NPS problems identified by volunteer groups to stimulate appropriate verification monitoring and necessary corrective action.

7. Road Stream Crossing Surveys

The WB uses road stream crossing surveys as a screening tool to help evaluate the general water quality of Michigan's rivers and streams and identify NPS of pollutants. The survey information is also used for local watershed planning or assessment efforts to help identify where BMPs could be implemented, and to track general land use changes in a watershed. The survey procedure uses standardized assessment and data recording practices and is primarily conducted by FOS staff and trained volunteers. Road stream crossing surveys consist of a visual assessment of stream conditions and nearby riparian land uses. Statewide implementation began in 2001.

Site Selection

The goal is to conduct road stream crossing surveys on at least 80% of the area within all Michigan watersheds over a five-year period. Road stream crossing surveys are performed in a specific watershed the year before that watershed is targeted for more comprehensive water quality monitoring by the SWAS.

The number and location of survey stations needed to effectively assess a watershed depends on a variety of factors, including the heterogeneity of land use, soils, topography, hydrology, water quality conditions, locations of pollutant source areas, and accessibility. At a minimum, 30% of the road crossings within a watershed should be surveyed, with the sites distributed such that each subwatershed is assessed with adequate geographic coverage to provide a representative depiction of conditions found throughout the watershed. If the intent of a particular road stream crossing survey is to obtain detailed information for implementing watershed BMPs, then most road crossings within the watershed need to be assessed.

Parameters and Indicators

The survey instrument consists of multiple forms, which can be completed on paper or on a series of pen tablet screens. There are two types of survey effort incorporated by the forms. The first form is a two-page visual assessment of stream conditions and watershed characteristics observed by the investigator. The investigator records any appropriate observations along the entire length of the stream visible from the road crossing (and takes upstream and downstream photos). General topics covered include:

- Site Identification (investigator name, location, date, time, global positioning system coordinates, etc.)
- Background Information (weather, stream width/depth/flow, water color, etc.)
- Physical Appearance (plants, algae, turbidity, foam, etc.)
- Substrate (cobble/gravel, sand, silt, etc.)
- Instream Cover (pools, woody debris, overhanging vegetation, etc.)
- River Morphology (riffle/pool, highest water mark, channel type, etc.)
- Stream Corridor (riparian vegetation width, streamside land cover, stream canopy, etc.)
- Adjacent Land Uses (crop land, impervious surfaces, forest, lawns/parks, wetlands, etc.)
- Road Crossing (crossing type/surface/ownership, culvert problems, crossing erosion, etc)
- Potential Sources (bank erosion, construction, agricultural crops/animals, recreation, etc.)

The investigator visually evaluates the general condition of various factors for the preceding topics and subjectively quantifies each factor using an appropriate scale for each included on the forms. The scales used include presence or absence, relative abundance, distance ranges, percent coverage, source severity estimates of slight/moderate/high, and others. Additionally, the investigator may collect optional water measurements of temperature, pH, and D.O.

The second one-page form is an optional form to be used at select stations where additional instream assessment work (primarily the characterization of benthic macroinvertebrate communities) is desired. These surveys are conducted by the FOS staff or volunteer groups that have received MDEQ training. The procedure for this assessment is the same as that used by the WB's volunteer river and stream monitoring program.

Data Management

All road stream crossing survey data are recorded on paper (or pen tablet) field sheets and then entered into a Microsoft Access database. The database is located on a Lansing WB server that is accessible from the FOS district offices. The paper forms are filed in the FOS district offices.

Two copies of each photo are maintained. One copy is stored on the Lansing WB server. Original photos are labeled and filed with the paper forms in the FOS district offices.

Reporting and Data Utilization

The road stream crossing survey relies primarily on visual observation; therefore, the data are inherently subjective. Additionally, to increase the amount of data that can be collected, the procedure was designed to be conducted by investigators with different knowledge levels of water quality, aquatic biology, and NPS issues. Consequently, road stream crossing surveys are useful for qualitative screening purposes to identify issues and the potential need for more rigorous studies. It is not intended to be used as a scientific quantification of water quality or watershed conditions.

The limitations of a procedure that relies primarily on visual observations were taken into account in establishing the objectives, the content and design of the forms, and the methods for conducting the assessments. There are a variety of quality assurance/quality control (QA/QC) activities implemented specifically to minimize subjective variation and account for different knowledge levels among the individuals conducting the survey. These QA/QC activities should facilitate the accurate collection of quality data on a statewide basis. Nevertheless, the numerous sources of data variability resulting from the assessment methodology are taken into account when drawing conclusions or making watershed management recommendations.

Technical reports are not prepared by the WB to communicate road stream crossing survey results. The computerized road stream crossing survey database is intended for internal use by the WB's NPS and water quality monitoring staff. However, the WB is currently developing ways to transfer road stream crossing survey results to local watershed groups and other external customers.

The FOS NPS staff will send annual summaries of road stream crossing survey work performed in their respective watersheds to the NPS monitoring coordinator for inclusion as an appendix in the Annual NPS Program Report.

8. CMI Local Monitoring Grants

The WB awards approximately $200,000 in CMI grants annually to local governments and other nonprofit entities to support local water quality monitoring projects. Grant applications are solicited by the WB through a standard RFP process. Fifteen CMI local monitoring grants have been awarded to date by the WB and many have focused on source identification for *E. coli*, nutrients, and other conventional pollutants.

<u>Site Selection</u>
Water quality monitoring sites are selected by the grantee and are documented in a QAPP. Grantees are required to submit a QAPP for SWAS approval prior to conducting any monitoring.

<u>Parameters and Indicators</u>
Water quality parameters and indicators monitored by the grantee are documented in a SWAS approved QAPP and are determined based on the objectives of the monitoring project. Wherever possible, USEPA approved analytical methods are required. If the grant project involves qualitative biosurveys, the grantee is directed to use the SWAS Procedure #51.

<u>Data Management</u>
Most grantees provide monitoring data with their quarterly status reports as the monitoring is completed. The grantee's final report must contain all monitoring data if not already provided in quarterly reports. These monitoring data, which are provided in mixed formats (some hard copy, some electronic) are sent to the project administrator. All *E. coli* data collected by the grantee are entered into the WB's *E. coli* database by the project administrator and subsequently uploaded to STORET by the WB's STORET coordinator. All other environmental data collected by the grantee are also entered into STORET by the WB's STORET coordinator. Efforts are underway to obtain all grantee data in electronic format.

<u>Reporting and Data Utilization</u>
Grantees provide quarterly status and final reports for their respective local water quality monitoring projects. These reports are available upon request from the SWAS NPS Unit.

The project administrators send annual summaries to the NPS monitoring coordinator of all NPS-related grantee local water quality monitoring activities for inclusion as an appendix in the Annual NPS Program Report.

The WB project administrators inform appropriate SWAS water quality monitoring and FOS NPS staff of NPS problems identified by the grantees to stimulate appropriate verification monitoring and necessary corrective action.

9. Section 319 and CMI NPS Grants

Monitoring may be performed (or subcontracted) by nonprofit entities that receive Section 319 or CMI NPS grant funds from the WB. Specific monitoring objectives are set by the grantees. Typical planning grant project objectives are to identify water quality impairments, identify NPS of pollution, and determine appropriate BMPs. The typical monitoring objectives of an implementation grant project are to determine the effectiveness of the BMPs implemented.

Site Selection

Specific water quality monitoring sites must be documented in a SWAS approved QAPP. A key goal of a typical planning grant project is to document every NPS water quality problem and source that exists in the targeted watershed. Therefore, site selection for planning project grants is based on covering the entire watershed. Site selection for implementation grant projects is targeted to cover BMP sites.

Parameters and Indicators

Specific water quality parameters and indicators monitored by the grantee are documented in a SWAS approved QAPP and are determined based on the objectives of the monitoring project. The USEPA approved analytical methods are required whenever possible. When the project involves qualitative biosurveys, the grantee is directed to use the SWAS Procedure #51.

Stream bank erosion site and road crossing inventories are common in planning grant projects. Water chemistry sampling and biosurveys are less common. BMP effectiveness monitoring may involve flow monitoring and water chemistry sampling of either BMP influent and effluent, or of ambient water, or both.

Data Management

Most grantees provide monitoring data with their quarterly status reports. The grantee's final report must contain all monitoring data, if not already provided in quarterly reports. These monitoring data, which are provided in mixed formats (some hard copy, some electronic) are sent to the project administrator. All *E. coli* data collected by the grantee are entered into the WB's *E. coli* database by the project administrator, and subsequently uploaded to STORET by the WB's STORET coordinator. All other environmental data collected by the grantee are also entered into STORET by the STORET coordinator. Efforts are underway to obtain all grantee data in an electronic format.

Reporting and Data Utilization

Grantees submit a quarterly status report and an end-of-project final report that contains all monitoring data collected by the grantee. Project administrators submit annual summaries to the NPS monitoring coordinator, of water quality monitoring activities conducted by their Section 319 and CMI NPS grantees, for inclusion as an appendix in the Annual NPS Program Report.

The WB project administrators inform appropriate SWAS water quality monitoring and FOS NPS staff of NPS problems identified by the grantees to stimulate appropriate verification monitoring and necessary corrective action. The WB NPS staff use the NPS project effectiveness monitoring results to direct future BMP development and implementation efforts.

10. Complaint Response

The WB FOS staff conducts limited environmental sampling in response to citizen complaints or concerns. This sampling is usually performed to verify the existence of reported problems. If a water quality problem is confirmed, additional samples may be collected to determine the extent, cause, and source of the problem. If the initial investigation reveals a significant or chronic water quality problem, the FOS requests monitoring assistance from the SWAS.

Site Selection

Usually the initial samples are collected by FOS staff at the site of the complaint. Depending on the nature and scope of the problem, additional upstream and downstream samples may be collected to evaluate the problem extent, cause, and source. The scale, type, timing, and intensity of this additional sampling are determined based on the nature of the problem and the water body size and characteristics. If SWAS water quality monitoring assistance is needed, the sampling may be done immediately if it is an acute problem, or deferred until the appropriate year of the WB's five-year rotating watershed monitoring cycle if it is a chronic problem.

Parameters and Indicators

The FOS staff collect water grab samples for visual and odor assessment to determine the reason for discolored water (e.g., algae, pollen, particulates). The FOS staff also may make direct water measurements of basic physical parameters, such as temperature, pH, and D.O. levels. Less frequently, FOS staff collect water grab samples or sediment samples for chemical or bacterial analysis. Benthic macroinvertebrate, fish, and macrophyte samples may also be collected on occasion.

Data Management

Data from general complaint investigations by FOS staff are stored in hardcopy form in district watershed or complaint files as appropriate. If the complaint investigation results in escalated enforcement action, the data may be stored in confidential enforcement files. If multiple sites are sampled, or sampling is conducted over numerous dates, the water quality data are forwarded to the SWAS for entry into appropriate internal databases or the USEPA's STORET when environmental data are involved.

Reporting and Data Utilization

Sample results are reported back to the person(s) who reported the complaint when the data are not part of an enforcement case. The results may also be discussed with local watershed groups, as appropriate, to help with watershed protection/restoration efforts. The data are also used by the FOS NPS staff to help identify possible locations for SWAS monitoring as part of the five-year rotating watershed monitoring cycle.

11. Hydrologic Analysis and Modeling

Hydrologic analysis and modeling of watersheds are conducted by LWMD hydrologists under a memorandum of understanding with the WB to help evaluate the effectiveness of NPS projects.

Hydrologic analysis and modeling are also performed by professional hydrologists subcontracted by NPS project grantees. Grantees who propose to conduct hydrologic analysis or modeling as part of their respective NPS projects must prepare QAPPs. All QAPPs must be reviewed by the LWMD and formally approved by the WB before field sampling can begin.

Site Selection

Suggestions of hydrologic monitoring or modeling sites can originate from the NPS Unit, FOS district offices, or the LWMD. Sites may be locations of anticipated projects, active projects, or completed projects. A hydrologic analysis is frequently required as a prerequisite for grant projects that are proposing to control stream bank erosion.

Parameters and Indicators

Common hydrologic parameters measured include stage, instantaneous flow, and rainfall. A Geographic Information System with data layers that include land use and soil type is critical to effective hydrologic modeling. Models used include the United States Army Corps of Engineers Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS) and the Hydrologic Engineering Center's River Analysis System (HEC-RAS).

Data Management

Flow measurements are sent to the United States Geological Survey Lansing Office and published in their annual report. All other data such as rainfall, stage, and continuous flow records are stored in electronic format on the LWMD server. Model input and output files are also stored on the LWMD server.

Reporting and Data Utilization

Reporting of hydrologic analysis or modeling results are accomplished through technical reports or memoranda prepared by the LWMD lead investigator or grantees. These reports/memos are sent to the SWAS NPS Unit, FOS NPS staff, and the NPS grantees. All reports/memos are filed in the appropriate NPS grant project file and are available upon request from the SWAS NPS Unit. The LWMD lead investigator or grantees also send annual summaries of projects to the NPS monitoring coordinator for inclusion as an appendix in the Annual NPS Program Report.

12. Channel Morphology Monitoring

The WB conducts three to five channel morphology studies annually to measure the effectiveness of specific NPS grant projects that involve erosion control and channel restoration activities. Channel morphology measurements are taken in targeted stream segments before and after BMP implementation according to a draft SWAS procedure (available upon request).

Channel morphology studies are also used to help develop and design effective restoration strategies for rivers or streams.

Site Selection

Channel morphology sampling locations are carefully situated to reflect physical improvements expected to occur in a river or stream system due to the implementation of an NPS project(s).

Parameters and Indicators

Parameters measured include longitudinal profiles, cross sectional dimensions at monumented sites, average cross sectional dimensions within a reach, pebble counts, erosion pins, scour chains, photographs, and stream bank recession rates.

These measurements are usually made before and after BMPs are implemented. Changes such as a coarser substrate particle size, deeper pools, or a narrower channel are generally considered to be improvements that are favorable to aquatic organisms, especially fish. If these changes occur downstream of management measures but not upstream of management measures then this is a good indicator that the treatment resulted in stream improvement.

Data Management

Channel morphology data are entered into a Microsoft Access database and paper copies are stored with the field notes in the SWAS water quality monitoring file. The electronic database is maintained on the SWAS server.

Reporting and Data Utilization

Technical reports are prepared by SWAS monitoring staff. These reports consist of all raw data and sufficient descriptions of locations and bench marks so that another person can repeat the measurements as they were performed originally. A current listing of all WB channel morphology reports is maintained on the WB's Web site.

The SWAS investigators send annual summaries of their channel morphology monitoring activities to the NPS monitoring coordinator. The summaries will be included as an appendix in the Annual NPS Program Report. The WB NPS staff use the results of channel morphology studies to target corrective actions, evaluate BMP performance, guide BMP design effort, and assist with the development of restoration strategies for rivers or streams.

Appendix III. Annual Reporting Format

One of the key aspects of this *Strategy* is the commitment to communicate monitoring data to NPS program staff. The communication of monitoring results is essential to ensure that NPS program staff know the status of NPS-related problem identification monitoring, effectiveness monitoring, and monitoring conducted to support NPS-related TMDL development and implementation. The NPS program staff will use this information to guide corrective actions, develop and update the NPS Multi-Year Plan, and communicate monitoring results to the USEPA, other partners, and interested parties. The WB staff will summarize NPS monitoring activities annually using a consistent format. Several examples of this format are presented in this appendix. A separate format is used for each of the types of NPS monitoring as follows:

1. Problem identification monitoring.
2. TMDL monitoring (development and effectiveness).
3. NPS project effectiveness monitoring.

A given watershed may appear twice in the problem identification section because both district staff and SWAS staff may conduct problem identification monitoring in a watershed. The NPS trend monitoring activities will not be reported this way because these activities tend to not vary much from year to year and so do not lend themselves to this reporting format.

Appendix III-1. NPS Problem Identification Monitoring Summaries

Water Body Name: Lake Creek (a tributary to the Grand River in Ionia County)

Hydrologic Unit Code: 04050007

Monitoring Agency/Group: MDEQ-FOS, Grand Rapids District

Monitoring Type/Frequency: Road Stream Crossing Survey/five-year

Monitoring Period: August 2003

Number of Stations: 12 road stream crossings

Number of Stream Miles/Lake Acres Monitored: 38 miles

Lead Investigator/Title/Phone: Janice Tompkins, Senior Environmental Quality Analyst, 616-356-0268

NPS Problems Identified:

- A high amount of sand and silt dominated substrate was observed.
- Forty-one percent of the sites exhibited filamentous algae.
- The majority of stream impacts appear to be from inadequate riparian buffer and stream canopy in some locations, as well as nutrient runoff from adjoining cropland and a golf course.

Data Availability:

The data are available in the NPS Road Stream Crossing database or from the lead investigator. The results are summarized in a 2003 report titled, "Summary of Lake Creek Watershed Assessment, Ionia County, Michigan" also available from the lead investigator.

Appendix III-2a. NPS-Related TMDL Development Monitoring Summaries

Name of TMDL Water Body: Rio Grande Creek

HUC: 4050006

Problem: *E. coli* WQS exceedances from Crockery Creek confluence upstream to Chester Township

Monitoring Agency/Group: MDEQ-WB Contractor (Great Lakes Environmental Center, Limno Tech.)

Monitoring Type/Frequency: Weekly *E. coli* grab samples

Monitoring Period: May through September 2002; May through September 2004

Stations: 7

Monitoring Staff/Title/Phone: Christine Alexander, MDEQ Aquatic Biologist, 517-373-6794

TMDL Development Monitoring Highlights:

All stations samples exceeded the total body contact *E. coli* standard. **2002 data:** Thirty-day geometric mean data ranged from 68 *E. coli*/100 ml to 1,064 *E. coli*/100 ml. Daily geometric means ranged from 2 *E. coli*/100 ml to 3,649 *E. coli*/100 ml. **2004 data:** Thirty-day geometric mean data ranged from 151 *E. coli*/100 ml to 1,617 *E. coli*/100 ml. Daily geometric means ranged from 20 *E. coli*/100 ml to 21,303 *E. coli*/100 ml.

The primary *E. coli* source identified appears to be agricultural. The 2004 data indicate exceedances are related to wet weather events.

Follow-up TMDL monitoring for *E. coli* occurred in Fiscal Year 2004.

Appendix III-2b. NPS-Related TMDL Effectiveness Monitoring Summaries

Names of TMDL Water Bodies: Sycamore Creek watershed (including Mud, Talmadge, and Willow Creeks and Havens Drain)

HUC: 04050004

Problem: D.O. WQS not attained in the Sycamore Creek watershed from the Grand River confluence upstream to the headwaters

Monitoring Agency/Group: MDEQ-WB

Monitoring Type/Frequency: D.O./continuously (15-minute intervals)

Monitoring Period: July 19 through August 23, 2001

Stations: 2

Lead Investigator/Title/Phone: David Trapp/MDEQ Environmental Engineer, 517-335-4180,

TMDL Effectiveness Monitoring Highlights:

Pre-BMP implementation monitoring was conducted in 1989. D.O. measurements showed periods of concentrations below the warmwater standard of 5 milligrams per liter (mg/l), as a minimum, at seven out of eight stations. The primary D.O. sink was determined to be sediment oxygen demand attributed to solids loading.

Post-BMP implementation monitoring took place in 2001 on Sycamore Creek at Harper Road and on Willow Creek near the terminus of West Eugenia Drive.

D.O. concentrations recorded at the Harper Road station ranged from 4.5 mg/l (50.8% saturation) to 10.3 mg/l (118.9% saturation). Readings were below the 5 mg/l warmwater standard for a period of approximately five consecutive hours at this station. Harper Road D.O. diurnal variation, daily average concentration minus daily minimum concentration, ranged from 0.7 mg/l to 2.1 mg/l. Comparison of 1989 data with 2001 readings at similar streamflows suggests no significant change in D.O. saturation at Harper Road.

West Eugenia Drive concentrations ranged from 5.2 mg/l (61.0% saturation) to 12.3 mg/l (151.4% saturation). Diurnal variation at this location ranged from 1.7 mg/l to 2.5 mg/l. Comparison of 1989 data with 2001 readings at similar streamflows suggests a D.O. saturation increase at West Eugenia Drive since BMP implementation.

A follow-up D.O. TMDL for the Sycamore Creek watershed is scheduled for Fiscal Year 2013.

Appendix III-3. NPS Project Effectiveness Monitoring Summaries

NPS Project Name: CREP

NPS Grant Project #: Not Applicable

Local Implementation Contact: Conrad Hayes, Gratiot Conservation District, 989-875-3050

Grantee Contact: Not Applicable, not a grant project

Status of Implementation Project: Original goal was 80,000 acres of practices, however more implementation was suspended at only 46,000 acres due to insufficient funds

Name of Water Body: Bullock and Busch Creek tributaries in Tittabawassee River Watershed

HUC: 4080201

Lead Investigator: John Suppnick, MDEQ-WB, 517-335-4192

Project Effectiveness Evaluation Data:

> Type and # of BMPs Implemented: Vegetative Filter Strips were implemented on 55-95% (average 77%) of eligible stream length in each of five subwatersheds in northeastern Gratiot County. These are compared to five nearby subwatersheds that have 0-29% (average 10%) of the eligible stream lengths treated with filter strips. Grab samples are collected during runoff events and analyzed for nutrients, suspended solids, and turbidity.
> Pollutant Reduction Data: Preliminary calculations indicate that an annual average of from 18,600 to 41,400 tons of sediment is being controlled by the filter strips overall in the Saginaw Bay watershed. Phosphorus reduction in the watershed is estimated at 31,800 to 69,800 pounds per year retained on the filter strip.
> Before and After Pictures: None available for these monitored sites, however photos are available for the CREP in the annual monitoring report: MI/DEQ/WD-03/118.

Additional Project Effectiveness Monitoring Data: Five runoff samples were collected in each of the watersheds during spring of 2004. Results of sampling so far are summarized in the table below:

	Suspended Solids (mg/l		Total Phosphorus (mg/l)		TKN (mg/l)		NO2+NO3 (mg/l)		Ortho-Phos. (mg/l)		Turbidity (mg/l)	
Treatment or Control	T	C	T	C	T	C	T	C	T	C	T	C
Median	49	110	0.25	0.33	1.50	1.50	20	18.2	0.05	0.06	100	96
Average	70	117	0.29	0.38	1.45	1.75	19.8	19.3	0.08	0.06	102	137