Monitoring and Assessing Water Quality in Massachusetts to Support Multiple Water Resource Management Objectives under the Clean Water Act
2026 – 2035

Commonwealth of Massachusetts
Executive Office of Energy and Environmental Affairs
Rebecca L. Tepper, Secretary
Massachusetts Department of Environmental Protection
Bonnie Heiple, Commissioner
Bureau of Water Resources
Kathleen M. Baskin, Assistant Commissioner

September 2025

CN 203.6

Monitoring and Assessing Water Quality in Massachusetts to Support Multiple Water Resource Management Objectives under the Clean Water Act
2026 – 2035

Prepared by:
Watershed Planning Program
Division of Watershed Management, Bureau of Water Resources
Massachusetts Department of Environmental Protection

September 2025

CN 203.6

Suggested Citation
MassDEP. 2025. Monitoring and Assessing Water Quality in Massachusetts to Support Multiple Water Resource Management Objectives under the Clean Water Act 2026 – 2035. CN 203.6, Massachusetts Department of Environmental Protection, Bureau of Water Resources, Division of Watershed Management, Watershed Planning Program. Worcester, MA.

Cover Photo
Backpack electrofishing at Still River, Lancaster, MA by WPP monitoring staff. Courtesy of Shervon De Leon.

Notice of Availability
This report is available on the Massachusetts Department of Environmental Protection website.

Watershed Planning Program

The mission of the Watershed Planning Program (WPP) in the Massachusetts Department of Environmental Protection is to protect, enhance, and restore the quality and value of the waters of the Commonwealth. Guided by the federal Clean Water Act, WPP implements this mission statewide through five Sections that each have a different technical focus: (1) Surface Water Quality Standards; (2) Surface Water Quality Monitoring; (3) Data Management and Water Quality Assessment; (4) Total Maximum Daily Load; and (5) Nonpoint Source Management. Together with other MassDEP programs and state environmental agencies, WPP shares the duty and responsibility of securing the environmental, recreational, and public health benefits of clean water for all people of the Commonwealth.

Acknowledgements

The preparation of the 2026-2035 ten-year monitoring strategy was a collaborative effort with input from multiple programs and offices within MassDEP. Many thanks to staff in the Watershed Planning Program (Richard Carey, Richard Chase, Padmini Das, Anna Mayor, Matthew Reardon, Suzanne Flint, James Meek), the Office of Research and Standards (Diane Manganaro, C. Mark Smith), and the Wetlands Program (Lisa Rhodes), whose experience and professional judgement were invaluable in the development of this document.

Disclaimer

References to trade names, commercial products, manufacturers, or distributors in this report constituted neither endorsement nor recommendation by MassDEP.

Contact Information

Watershed Planning Program
Division of Watershed Management, Bureau of Water Resources
Massachusetts Department of Environmental Protection
8 New Bond Street, Worcester, MA 01606
Watershed Planning Program website
Email address: dep.wpp@mass.gov

(This page intentionally left blank)

Table of Contents

List of Figures

List of Tables

I. Executive Summary

States are required to fulfill surface water quality monitoring requirements under the federal Clean Water Act (CWA) that are consistent with guidance provided by the U.S. Environmental Protection Agency (EPA) in *Elements of a State Water Monitoring and Assessment Program* (EPA 2003). To comply with these requirements, MassDEP, through its Watershed Planning Program (WPP), previously published ten-year monitoring strategies in 2005 (*A Water Quality Monitoring Strategy for the Commonwealth of Massachusetts;* the "2005 Monitoring Strategy"; MassDEP 2005*)* and 2018 (*A Strategy for Monitoring and Assessing the Quality of Massachusetts' Waters to Support Multiple Water Resource Management Objectives 2016 – 2025;* the "2016 Monitoring Strategy"; MassDEP, 2018). The updated monitoring strategy presented here (the "2026 Monitoring Strategy") describes how MassDEP will acquire and use monitoring data from various water types within the context of multiple water resource management programs throughout the next ten years (i.e., 2026 – 2035).

The overall need for credible scientific water quality monitoring data has not changed fundamentally since the publication of the 2016 Monitoring Strategy. However, to ensure monitoring activities provide the data and information needed to support ongoing and emerging water management issues, MassDEP periodically examines monitoring initiatives relative to shifts in program priorities. A comprehensive water resource monitoring program for Massachusetts must address core CWA requirements while maintaining flexibility to respond to new water quality challenges. Environmental data are needed to identify and characterize water pollution problems, support water quality criteria development, set priorities for water resource protection and restoration activities, support proactive decision-making on existing and emerging issues, and evaluate the effectiveness of past and ongoing measures undertaken to improve water quality.

The 2026 Monitoring Strategy describes a comprehensive monitoring program for Massachusetts that serves multiple water resource management needs and addresses all surface waters. As such, the monitoring program is designed to provide data and information from streams, rivers, lakes, reservoirs, estuaries, coastal areas, and wetlands to support the five major objectives listed below.

1) Develop policies, water quality standards, and identify emerging issues
2) Assess the status or condition of Massachusetts' surface waters
3) Develop, implement, and evaluate pollution control strategies
4) Measure the effectiveness of water quality management programs
5) Maintain reserve monitoring capacity to respond to unforeseen data needs

Massachusetts intends to allocate approximately 20 percent of its total monitoring capacity over the next ten years to address each monitoring objective. However, it is unlikely that monitoring resources will be evenly distributed among all five objectives in any given year. The overall resource allocation will be achieved over the ten-year planning period.

MassDEP has identified a number of themes or principles to guide the strategic water monitoring plan for the next ten years, as reflected in the overall design of the water monitoring program elements. Major themes, inherent to both MassDEP's water management programs and associated monitoring elements, are as follows: 1) the focus on the watershed as the fundamental planning unit for water quality management; 2) the assessment of biological communities, such as aquatic macroinvertebrates, fish, or algae as reliable indicators of water quality conditions and ecosystem health; 3) the application of new technology and streamlined systems for data processing and analysis to support monitoring and assessment activities; and 4) the formation and reliance on partnerships and collaboration to meet water quality goals.

Eighteen monitoring program elements are included in the 2026 Monitoring Strategy to meet the defined monitoring objectives. These monitoring elements include both deterministic (targeted) and probabilistic (random) sampling networks. Furthermore, these designs encompass both rotating watershed monitoring cycles as well as non-rotating, priority-driven schedules.

EPA encourages states to adopt networks of randomly selected sampling sites that will allow for statistically unbiased assessments that can be applied at larger scales (e.g., statewide). Because statistically valid inferences can be drawn for an entire population of waterbodies by sampling a set of sites randomly selected from that population, a probabilistic design can, with a single sample, provide a snapshot of the percentage of waters attaining water quality standards and supporting designated uses. A single sample, however, does not allow for the assessment of individual waterbodies. Therefore, WPP has added adequate spatial, temporal and analytical coverage to its random survey designs to assess the designated use support status, and identify causes and sources of impairment, for individual waterbodies. WPP previously completed a five-year probabilistic survey of wadeable rivers and streams (2011 – 2015), a three-year probabilistic survey of lakes and ponds (2016 – 2018), and a four-year probabilistic survey of estuaries and coastal waters (2020 – 2023). For 2025 – 2028, WPP is currently conducting a four-year probabilistic survey of wadeable rivers and streams.

Several targeted monitoring networks are also planned to obtain the data and information needed to identify causes and sources of impairments, and to develop and implement pollution control strategies, such as total maximum daily loads (TMDLs), National Pollutant Discharge Elimination System (NPDES) permits, watershed-based plans, and best management practices (BMPs). Furthermore, targeted monitoring will provide data to define issues related to emerging concerns and to support the development of surface water quality standards and policies.

MassDEP will continue to employ new technologies and enhance monitoring functions through the deployment of multiparameter sondes and data loggers, as well as the use of telemetry. Ongoing efforts will be maintained to automate data validation as well as enhance data flows. The application of geospatial and statistical software will be used to

evaluate data and inform watershed assessment and listing decisions. MassDEP also intends to continue to improve its electronic data management systems. To that end, MassDEP has procured a commercially available water data storage and retrieval system that will manage data from multiple water monitoring program elements and facilitate the transfer of MassDEP data and information to EPA's Water Quality Exchange (WQX).

Monitoring resource needs are summarized following the description of each individual program element throughout this report. These needs generally fall into four categories: 1) staffing; 2) funding for equipment and supplies; 3) funding for contractual services; and 4) training. Long-term staffing and funding support are critical to the implementation of the 2026 Monitoring Strategy.

The demand for scientifically valid water quality information is expanding. At the same time, numerous external entities are collecting and submitting water quality data to MassDEP to inform water resource management objectives, such as water quality assessments and designated use attainment decisions. MassDEP has expanded its outreach activities to leverage these external data sources, as appropriate, by developing the infrastructure required to review sampling protocols and project plans, and to accept, validate, and analyze data from an increasing number of new sources.

List of Acronyms

ATTAINS	Assessment TMDL Tracking and Implementation System
BMP	Best Management Practice
CALM	Massachusetts Consolidated Assessment and Listing Methodology
CAPS	Conservation Assessment and Prioritization System
CSO	Combined Sewer Overflow
CWA	Clean Water Act
DCR	Massachusetts Department of Conservation and Recreation
DER	DFG Division of Ecological Restoration
DFG	Massachusetts Department of Fish and Game
DMF	DFG Division of Marine Fisheries
DPH	Massachusetts Department of Public Health
DQO	Data Quality Objective
DWP	MassDEP Drinking Water Program
WPP	MassDEP Watershed Planning Program
EOEA	Massachusetts Executive Office of Environmental Affairs
EOEEA	Massachusetts Executive Office of Energy and Environmental Affairs
EPA	U.S. Environmental Protection Agency
GIS	Geographic Information System
IEI	Index of Ecological Integrity
ITFM	Intergovernmental Task Force on Monitoring
MAP2	Massachusetts Probabilistic Monitoring and Assessment Program
MassDEP	Massachusetts Department of Environmental Protection
MDWPC	Massachusetts Division of Water Pollution Control
MEP	Massachusetts Estuaries Project
NARS	National Aquatic Resource Surveys
NGO	Non-governmental Organization
NHD	National Hydrography Dataset
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source
NRCS	Natural Resources Conservation Service
N-STEPS	Nutrient Scientific Technical Exchange Partnership & Support
NWQI	National Water Quality Initiative
ORS	MassDEP Office of Research and Standards
PCB	Polychlorinated Biphenyls
PPA	Performance Partnership Agreement
QA/QC	Quality Assurance/Quality Control

QAPP	Quality Assurance Project/Program Plan
QMP	Quality Management Plan for Federally Funded Programs
RBP	Rapid Bioassessment Protocols
RSN	Reference Site Network
SAP	Sampling and Analysis Plan
SDWA	Safe Drinking Water Act
SOP	Standard Operating Procedure
SRF	Massachusetts Clean Water State Revolving Fund
SWQS	Surface Water Quality Standards
TALU	Tiered Aquatic Life Use
TMDL	Total Maximum Daily Load
USGS	U.S. Geological Survey
WES	MassDEP William X. Wall Experiment Station
WET	Whole-effluent Toxicity
WLA	Wasteload Allocation
WPDG	Wetland Program Development Grant
WQX	Water Quality Exchange

Foreword

This report updates and expands on the document *A Strategy for Monitoring and Assessing the Quality of Massachusetts' Waters to Support Multiple Water Resource Management Objectives 2016 – 2025* (the 2016 Monitoring Strategy), published in 2018. Major components of the monitoring program outlined in this report, the 2026 Monitoring Strategy, fulfill requirements of the federal Clean Water Act (CWA) and are consistent with design and implementation guidance from EPA provided in *Elements of a State Water Monitoring and Assessment Program* (EPA 2003). EPA acknowledges that the status of state monitoring programs varies with respect to satisfactorily meeting all program elements outlined in the guidance, and personnel and other resources are a significant constraint for all states. Therefore, EPA has provided these elements as overarching goals to be periodically reviewed and updated.

II. Introduction

The Federal Water Pollution Control Act of 1972 and subsequent amendments in 1977, 1981 and 1987 are collectively known as the Clean Water Act (CWA). The objective of this statute is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters. MassDEP, and its precursor agencies, have been administering a multi-faceted water quality management program for Massachusetts' rivers, lakes, wetlands and coastal waters that includes:

- Establishing water-use goals through the implementation of surface water quality standards;
- Monitoring and assessing to determine if waters are meeting their goals, and to identify those in need of restoration and protection;
- Making recommendations for restoring waters through the development of total maximum daily loads (TMDLs) to be used in setting wastewater effluent limits and as targets for ameliorating stormwater and nonpoint sources of pollution; and
- Providing financial grants and (later) loans for the construction of wastewater treatment facilities, sewerage systems and pollution controlling infrastructure, as well as funds for implementing best management practices (BMPs) for the control of nonpoint sources of pollution.

Each of the program elements listed above relies on credible water monitoring data and information. Water quality data inform a wide range of decision-making, from identifying outstanding resource waters for special protection to assessing and prioritizing impaired waters for corrective actions. Monitoring data are also indispensable for the development of water quality criteria, the calibration and verification of predictive models for TMDL analyses, and the evaluation of the effectiveness of pollution control and watershed restoration measures. In short, the basis for making scientifically defensible decisions with respect to water resource management rests with the availability of sufficient valid environmental monitoring data. With passage of the CWA, Congress acknowledged the importance of water quality monitoring and assessment by requiring states to report on the quality of their waters (§305(b)) and to identify and prioritize impaired waters for corrective actions (§303(d)).

EPA has provided federal guidance for meeting the monitoring objectives of the CWA. However, individual states were allowed flexibility to design and implement their monitoring programs. While this offered the states considerable flexibility to determine where, what, and how much to monitor within their borders, there was little or no comparability between state monitoring programs, and any efforts to assemble data and information across states into a comprehensive assessment of the nation's waters were seriously compromised. Not surprisingly, water monitoring programs differed substantially from state to state, both in their design and character, as well as in the amount and sources of funding.

A brief history of water quality management in Massachusetts will serve to illustrate how the monitoring program was adapted over time in response to changing water quality problems and issues. During the 1970s the Massachusetts Division of Water Pollution Control (MDWPC) published river basin plans for over twenty river basins and coastal drainage areas. As part of this planning process, low-flow steady-state simulation models were developed for those watersheds where wasteload allocations were needed to determine the level of wastewater treatment required and to derive wastewater effluent limits for permitting under the National Pollutant Discharge Elimination System (NPDES). For several years, the MDWPC designed and conducted intensive water quality surveys on mainstem rivers to obtain the hydrological measurements, reaction rate coefficients, and other input parameters that were needed to execute these models. Data from these surveys were also used for reporting the use support status of assessed waters pursuant to §305(b) of the CWA.

Monitoring of lakes and ponds was initiated in 1974 and expanded in 1979 to provide data and information in support of the federal Clean Lakes Program authorized by §314 of the CWA, as well as the subsequent Massachusetts Clean Lakes and Great Ponds Act (Chapter 628, Acts of 1981). The MDWPC carried out both baseline surveys to provide the data needed to classify lakes according to their trophic status, as well as a smaller number of more intensive year-round lake studies. Limited grant monies were available for eligible lake restoration projects through both federal and state programs. This program has not received funding since 1995 although today §319 funds may be used to support selected activities that were originally eligible for clean-lakes funding.

The 1980s saw an increased emphasis on the identification and control of toxic pollutants in the aquatic environment. The EPA announced the publication of individual ambient water quality criteria documents for pollutants listed as toxic in the CWA, and these, along with subsequent criteria, were used to screen ambient water quality and wastewater discharge data for potential toxic effects. Furthermore, revisions to the Massachusetts Surface Water Quality Standards (MA SWQS) included the adoption by reference of EPA's National Recommended Water Quality Criteria. Waterbodies impacted by toxic pollutants and wastewater discharges in need of "individual control strategies" for toxic pollutants were identified and prioritized for implementation. Most of these control strategies involved the issuance of NPDES permits with whole-effluent toxicity (WET) testing requirements and, in some cases, individual numerical effluent limits for toxic contaminants. Also at this time, an inter-agency task force was formed to assess and manage toxic contaminants in fish, and a monitoring program was initiated to measure the levels of polychlorinated biphenyls (PCBs) and heavy metals, including mercury, in the edible portions of fish. Data were provided to the Massachusetts Department of Public Health (DPH) for risk assessment and, where necessary, the release of fish edibility advisories.

By the mid-1980s most municipal wastewater treatment plants were providing a minimum of secondary treatment, and some included further removal of biochemical oxygen demand and/or various degrees of nitrification and phosphorus removal. Older urban centers in

Massachusetts, however, were still served by complex combined sewer collection systems that date back to the late 1800s. Combined sewer overflows (CSOs) continued to contribute significant loadings of solids, nutrients, and bacteria to receiving waters during storm events. Although limited in scope, the MDWPC initiated wet-weather monitoring upstream and downstream from CSOs to document the magnitude and extent of these discharges. Both CWA construction grants and the Massachusetts Clean Water State Revolving Fund (SRF) have been utilized over the years to develop and implement strategies to control CSOs.

Massachusetts continued to rely on the use of intensive surveys for assessing and reporting on the condition of its waters; however, this monitoring was supplemented by more site- or issue-specific project-level investigations. For example, targeted sampling upstream and downstream from wastewater discharges served to evaluate the impacts of those discharges on the quality of their receiving waters. Rapid bioassessment techniques were developed that provided information pertaining to the effects of water quality conditions on instream macroinvertebrate and fish communities, and more emphasis was placed on the use of biological monitoring as a direct measure of the aquatic life use support status of Massachusetts' waters.

While water quality management programs in Massachusetts always focused on the river basin, (i.e., watershed) as the fundamental assessment and planning unit, in 1993 MassDEP placed the 27 major watersheds and coastal drainage areas in Massachusetts on a rotating five-year schedule to synchronize monitoring, assessment, and other components of its watershed management program. The goal was to allocate one year to each of five water management steps or phases (i.e., Year 1 – planning; Year 2 – monitoring; Year 3 – assessment; Year 4 – implementation of control strategies; and Year 5 – effectiveness evaluation), after which the process would begin again. Five years later the watershed approach to water quality management was formally adopted by the Massachusetts Executive Office of Environmental Affairs (EOEA), now the Executive Office of Energy and Environmental Affairs (EOEEA), through the implementation of its Watershed Initiative to include multiple organizations and interested parties. Fifteen watershed teams, consisting of representatives from state and federal agencies, municipalities, and non-governmental organizations (NGOs), such as watershed associations, were established to focus on the restoration and preservation of the Commonwealth's watersheds. MassDEP's monitoring program attempted to support the EOEA watershed teams in Year 2 of the management cycle. At the same time, however, the Watershed Initiative spurred the establishment or enhancement of several citizen monitoring programs throughout Massachusetts, and it became evident that state-citizen monitoring partnerships would be needed in the future to acquire adequate water quality data and information to support watershed management programs.

For the first several years following passage of the CWA, Massachusetts' water pollution abatement programs were focused on the control of point sources through wasteload allocation and NPDES permitting, and little emphasis was placed on the assessment and

control of nonpoint sources (NPS), although it could be argued (and was) that the Clean Lakes Program was, in effect, an NPS management program since there were no point discharges to Massachusetts' lakes. Nonetheless, NPS pollution is not easily assessed or controlled, for it is intricately linked with the use of the land, and land-use decisions are primarily made at the local level. The management and remediation of NPS pollution is typically accomplished through the implementation of BMPs. The CWA §319 provides grant funding for the implementation of BMPs. EPA has challenged states to design monitoring programs that will document improvement to water quality that may be realized through the implementation of individual BMPs and inform the preparation of water remediation "success stories."

Over the last 53 years, approximately $175 million in CWA §106 funding has been used to support MassDEP's monitoring and assessment work. Water quality monitoring throughout the 1990s and beyond indicated that, while significant progress had been made toward the abatement of the most obvious water pollution problems in Massachusetts, water quality standards were still not met in many of Massachusetts' waters. Excessive nutrients (nitrogen and phosphorus) and bacteria, particularly during wet weather, were identified as the most pervasive pollutants requiring further controls. The planning tool informing the management of these and other pollutants is the TMDL, which establishes the maximum allowable load of pollutants that waterbodies can receive and still meet the water quality standards established for protecting public health and maintaining the designated beneficial uses of those waters. The TMDL establishes allowable loadings from both point and nonpoint sources of pollution. TMDL implementation is accomplished through adherence to prevailing regulations and program requirements such as those governing the NPDES permits for point source control and the stormwater management performance standards maintained by conservation commissions under the Wetlands Protection Act. Furthermore, funding priority for CWA §319 grants and the SRF is given to watershed clean-up projects that are consistent with TMDL program requirements.

Similar to wasteload allocations (WLA) derived in the 1970s and 1980s, TMDLs are developed through the application of models that simulate waterbody conditions and predict the effects on the receiving water of a range of pollutant loading scenarios that are associated with various wastewater treatment options. Reliable environmental data and information are essential to the proper calibration and verification of these models, and their capacity to accurately predict future conditions is a direct reflection of the accuracy of underlying data and assumptions.

From the previous discussion, it can be seen that Massachusetts' water quality monitoring programs have adapted over the years to respond to new and emerging water quality problems and issues, and this capacity to change, as needed, to provide the environmental data and information that will inform water resource management decision-making in the future must be a theme of any strategic monitoring plan developed for Massachusetts. Furthermore, in recent years the number and type of water data collection activities have

expanded and dispersed beyond MassDEP, and this presents unique challenges to meeting CWA program objectives.

In 2003, the EPA published *Elements of a State Water Monitoring and Assessment Program* (EPA 2003) to increase consistency among state water monitoring programs and provide a framework for determining whether those programs meet the prerequisites of CWA §106(e)(1). This report called on each state to formulate a "comprehensive monitoring program strategy that serves all water management needs and addresses all state waters, including all waterbody types (e.g., streams, rivers, lakes, Great Lakes, reservoirs, estuaries, coastal areas, wetlands and groundwater)." In formulating this strategy, states were to incorporate the following ten basic elements of a water resource monitoring program:

- Long-term Monitoring Program Strategy
- Monitoring Objectives
- Monitoring Design
- Core and Supplemental Water Quality Indicators
- Quality Assurance
- Data Management
- Data Analysis/Assessment
- Reporting
- Programmatic Evaluation
- General Support and Infrastructure Planning

Additionally, this monitoring strategy was designed to identify technical issues and resource needs that address CWA monitoring objectives and formulate a long-term plan for addressing gaps and implementing the program. Finally, the monitoring strategy was intended to be a "working document" with periodic updates.

MassDEP published the 2005 and 2016 Monitoring Strategies in accordance with the aforementioned EPA guidelines. These Monitoring Strategies each covered ten-year periods (2005 – 2015 and 2016 – 2025, respectively) and consisted of a combination of probabilistic, fixed-site, and targeted sampling networks designed to provide data and information for better water resource management decision-making.

The 2026 Monitoring Strategy encompasses a planning horizon of approximately ten years (i.e., 2026 – 2035). *The ultimate goal of the Commonwealth is to implement a comprehensive monitoring program that serves all water quality management needs and addresses all waterbody types*. To this end, the 2026 – 2035 Monitoring Strategy re-examines program priorities and data needs and sets forth a plan for achieving a comprehensive water resource monitoring program that continues to embody EPA's fundamental ten elements and meets the prerequisites of §106(e)(1) of the CWA.

III. Monitoring Program Strategy

This planning document describes how monitoring data from various water types will be acquired and used within the context of MassDEP's water resource management programs. The overall need for credible scientific water monitoring data has not changed fundamentally since the publication of the 2016 Monitoring Strategy. However, to ensure monitoring activities provide the data and information needed to support ongoing and emerging water management issues, MassDEP periodically examines monitoring initiatives relative to shifts in program priorities. A comprehensive water resource monitoring program for Massachusetts must address core CWA requirements while maintaining flexibility to respond to new water quality challenges. Environmental data and information are needed to identify and characterize water pollution problems, set priorities for water resource protection and restoration activities, support proactive decision-making on existing and emerging issues, and evaluate the effectiveness of past and ongoing measures undertaken to improve water quality. Where necessary, this updated strategy will adjust the existing monitoring program to fulfill the informational needs of the various water management programs.

In the development of the 2026 Monitoring Strategy, MassDEP will, in addition to EPA's *Elements of a State Water Monitoring and Assessment Program,* continue to use the three guiding principles that were identified and implemented in the 2016 Monitoring Strategy. These three guiding principles are 1) the focus on the watershed as the fundamental planning unit for water quality management, 2) the formation and reliance on partnerships and collaboration to meet water quality goals, as set forth in the Massachusetts SWQS, TMDL implementation plans, and the Massachusetts NPS Management Plan, and 3) the application of new technology and streamlined systems for data processing and analysis to support monitoring and assessment activities.

Watershed protection is the dominant theme of many state water quality management programs, and EPA has endorsed this approach by providing financial and technical support for watershed-based water quality management activities. Although the Watershed Initiative was discontinued as a formal EOEA program in 2003, MassDEP continues to utilize the watershed as the focus for monitoring and other water management program elements. The completion of all the steps in the watershed management process within a five-year timeframe has proven to be impracticable, however. The practice of watershed management is inherently complex, resource-intensive, and time-consuming, and project demand often outpaces available funding and other resources. Therefore, while MassDEP's water management programs continue to progress in a stepwise fashion to restore impaired waters and protect waters that meet water quality standards, in practice these steps are typically not completed within a five-year timeframe as originally conceived. In 2010 the watersheds were regrouped on a regional basis to take advantage of potential benefits to monitoring survey logistics of more closely aligned watersheds, and to more equitably distribute Massachusetts' total river miles among the five groups. Finally, while some monitoring will be performed in accordance with the rotating watershed cycle, other

watersheds or individual waterbodies may be prioritized for monitoring separate from this schedule based on identified monitoring needs from year to year.

Although short-lived as a formal program, the Watershed Initiative established partnerships between a variety of government agencies, NGOs and other stakeholders, all focused on the restoration and protection of Massachusetts' watersheds. Because resources were limited across all state agencies, care was taken to avoid duplication of effort, and emphasis was placed on sharing environmental data and information among all interested parties. Over the years the number of external data providers has increased substantially, providing new and varying sources of data and information to support water management policy decision-making. For example, CWA §604(b) water quality planning and assessment grants to outside parties have substantially supported NPS management and other assessments. External data providers include volunteer monitoring organizations, academic institutions, government agencies, stream teams, watershed associations, NPDES permit holders, and environmental consultants. MassDEP continues to work collaboratively with these groups to optimize the utilization of their data. In doing so, MassDEP can focus its monitoring efforts in areas that are not covered by these external data providers. The acquisition of valid scientific data is achieved, in part, by ensuring that interested monitoring parties develop standard operating procedures (SOPs) and quality assurance project plans (QAPPs) that will increase the likelihood that these external data sources can be used to fulfill selected CWA requirements (e.g., §305(b)/303(d) assessment and listing functions). MassDEP has developed protocols for external data providers to follow when preparing and submitting their quality-assured surface water quality data for such uses and provides QAPP review and approval for groups who submit QAPPs for review. More information pertaining to the submittal of external water resources data to MassDEP is provided on the External Data Submittals to the Watershed Planning Program webpage.

MassDEP recognizes that the effectiveness of its monitoring program is not only contingent upon the successful implementation of field sampling operations but is equally dependent on the availability of essential laboratory analytical support, and the validation, quality, analysis, management and reporting of data (Figure 1). Annual reviews will be conducted to ensure that necessary resources and tools are in place to support all elements.

MassDEP will continue to employ technology and enhance monitoring functions through the use of multiparameter sondes and data loggers for continuous data collection, telemetry remote monitoring, and other emerging technologies. Laboratory and analytical resources will be adequately supported to ensure samples are analyzed in accordance with standard methods and established quality assurance protocols. Efforts to automate data verification and validation, data analysis, assessment reporting, and listing decisions are ongoing. MassDEP has improved its electronic data management systems and plans to implement more efficient measures for reporting and distributing water quality monitoring data and information to multiple end users in government, the private sector and the public. To that end, MassDEP has procured a commercially available, off-the-shelf water data storage and retrieval system to manage data from multiple water quality monitoring program elements

and facilitate the transfer of MassDEP data and information to EPA's Water Quality Exchange (WQX).

In addition to monitoring and managing water resources at the watershed level and relying increasingly on the development of partnerships to meet water quality objectives, several other program enhancements will be integrated in the design of the strategic monitoring plan. MassDEP's goal is to develop biocriteria for two different biological assemblages in streams: macroinvertebrates and diatoms. Biocriteria development for the initial assemblage, the macroinvertebrate community, was completed in 2021. It is anticipated that biocriteria development using the diatom community will be completed in 2027. MassDEP will continue to place emphasis on the use of biological communities, such as macroinvertebrates and fish, and eventually diatoms, as the most effective indicators of water quality conditions and ecosystem health.

The restoration of impaired waters and the preservation of healthy watersheds will remain a primary goal of MassDEP and its many partners. MassDEP's Watershed Planning Program will continue to identify impaired waters, support clean-up activities, and highlight high-quality waters in need of further measures to ensure their protection. Consistent with EPA's Healthy Watershed Initiative, protection measures may be implemented through the development of watershed-based plans and CWA §319 grant projects.

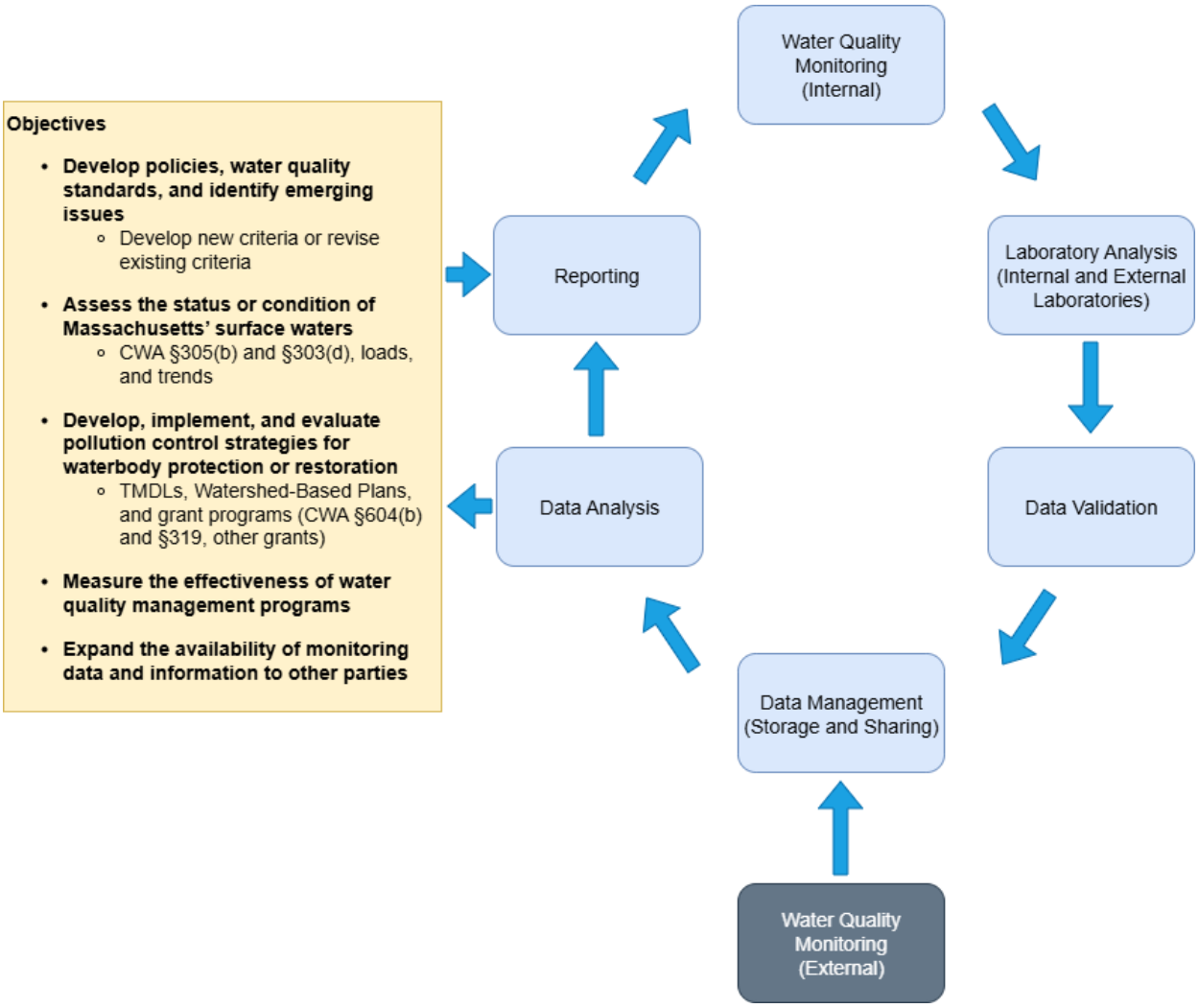

Figure 1. Elements of a Statewide Monitoring Strategy

IV. Monitoring Objectives

The identification of monitoring objectives is a critical first step in designing a monitoring program that is efficient and effective in generating data that supports important water quality management decisions. The monitoring program for Massachusetts is designed to provide data and information from streams, rivers, lakes, reservoirs, estuaries, coastal areas, and wetlands to support the major objectives described below. Massachusetts' goal is to allocate approximately 20 percent of its total monitoring capacity over the next ten years to address each of the five major monitoring objectives, while reserving additional capacity to meet unforeseen needs, such as technical support to other MassDEP programs. It is unlikely that monitoring resources will be evenly distributed among all five objectives in any given year. Rather, this overall resource allocation will be achieved over the ten-year planning period. MassDEP's monitoring data, as well as data from external sources, will be needed to meet these objectives.

MONITORING OBJECTIVE 1: Develop policies, water quality standards, and identify emerging issues – This objective is to conduct short-term investigations to support the development or revision of water quality standards and policies, and to identify and characterize emerging and ongoing water quality issues such as fish tissue contamination and toxic algae blooms. Monitoring to meet this objective may be triggered by the results of other monitoring programs or may be initiated in response to new information on potential risks to human or ecological health. For example, monitoring data collected for assessment purposes may be used to identify high-quality waters in need of protection from degradation, and additional monitoring data could be useful for defining the level of protection required. This objective will be achieved through the implementation of several targeted monitoring program elements.

MONITORING OBJECTIVE 2: Assess the status or condition of Massachusetts' waters – This objective is to determine the water quality status of the Commonwealth's waters relative to the attainment of their designated uses, as established in the MA SWQS (*Aquatic Life*, *Fish Consumption*, *Public Water Supply*, *Shellfish Harvesting*, *Primary* [e.g., swimming] *and Secondary* [e.g., boating] *Contact Recreation, and Aesthetics)*. Monitoring data are needed to assess and report on the designated use attainment status of waters pursuant to §305(b) of the CWA, and to list impaired waters in accordance with the requirements of CWA §303(d). In addition, these assessments should identify the causes and sources of those impairments. This objective will be realized by combining a probabilistic sampling design to estimate the percentage of waters that are impaired for each use statewide with targeted sampling to confirm impairment causes, identifying sources of pollution and, where uses are restored, removing waterbodies or applicable impairments from the 303(d) List.

Drinking Water: *While included as a designated use in the MA SWQS, MassDEP's Watershed Planning Program does not assess the designated use attainment status of public water supplies for the purpose of assessing and listing waters in accordance with §305(b) and §303(d) of the CWA. Public water supplies in Massachusetts are regulated by MassDEP's Drinking Water Program (DWP) which acts as EPA's Primacy Agent for administering the federal Safe Drinking Water Act (SDWA). DWP protects public health by implementing new source approvals, water supply treatment and distribution requirements, source water protection, emergency preparedness, and reporting raw and finished drinking water quality data. The 1996 amendments to the SDWA required every state to examine existing and potential threats to the quality of all its public water supply sources and to develop a Source Water Assessment and Protection (SWAP) Program. As part of this program, DWP: 1) delineated protection areas for all public ground and surface water sources; 2) inventoried uses in these areas that may present potential threats to water quality; 3) determined the susceptibility of water supplies to contamination from these sources; and 4) publicized the results in source water assessment reports. The top five potential threats to public water sources that were identified through the SWAP were: 1) residential lawn care/gardening; 2) residential septic systems and cesspools; 3) residential fuel oil storage; 4) stormwater discharge; and 5) state-regulated underground storage tanks.*

Selected data flows from DWP may be useful for focusing both regulatory and non-regulatory restoration and preservation measures, authorized by the CWA, in the watersheds of public water supplies. For example, such activities as NPDES permitting (including stormwater), §604(b) assessments, and §319 BMP implementation could be used to reduce or eliminate threats to water supplies identified during the SWAP process. In addition, monitoring proposed herein with the objective to identify emerging issues such as cyanobacteria blooms or new and unforeseen pollutants may have implications for many surface waters including, in some instances, public water supplies. It is a goal of MassDEP to continue to link data flows and information from SDWA and CWA program elements to better protect public health and the environment.

MONITORING OBJECTIVE 3: Develop, implement, and evaluate pollution control strategies – This objective is to provide data and information needed for the development and implementation of various measures to restore impaired waters. Such measures include, but are not limited to, the derivation and application of TMDLs to point and nonpoint sources of pollution, issuance of NPDES wastewater discharge permits, and installation of stormwater controls and BMPs. Targeted monitoring will be used to characterize and

quantify pollution sources as the first step toward their remediation. Limited fixed-site monitoring may be required to quantify pollutant loadings. Monitoring may also be needed to acquire input parameters for predictive water quality models to be used to derive WLAs and effluent limits for discharge permits, or to define NPS loading reduction goals to be included in NPS watershed-based plans.

MONITORING OBJECTIVE 4: Measure the effectiveness of water quality management programs – This objective is to identify, through monitoring, waters that exhibit measurable improvement in water quality as a result of the implementation of various water resource management activities and programs. Effectiveness monitoring can be designed and carried out at various scales ranging from the local, waterbody or segment-specific level to broader-scale watershed or statewide levels. Monitoring at broader scales will provide more comprehensive assessments of entire systems of control measures for improving water quality, such as the institution of a new water policy or regulatory program. In general, targeted monitoring designs will be most suitable for evaluating the effectiveness of waterbody and watershed restoration activities, such as the issuance of NPDES wastewater discharge permits. However, repeated statewide probabilistic surveys may also be useful in demonstrating, more holistically, the longer-term environmental benefits of Massachusetts' entire water resource management program. In any case, the efficacy of various water resource management activities in ameliorating water pollution will be reported through the preparation and release of water quality "Success Stories" for waters where monitoring data confirm the restoration of one or more beneficial uses, and results in the removal of segments from the 303(d) list.

MONITORING OBJECTIVE 5: Maintain reserve monitoring capacity to respond to unforeseen data needs – This objective is to set aside some field and lab resources each year to accommodate unforeseen monitoring projects or requests for assistance that may arise unexpectedly and outside of the normal program planning process.

V. Core and Supplemental Water Quality Indicators

EPA guidance calls for the state monitoring program to include "a core set of baseline indicators selected to represent each applicable designated use, plus supplemental indicators selected according to site-specific or project-specific decision criteria." These indicators or variables (e.g., water quality parameters) include physical/habitat, chemical/toxicological, and biological/ecological endpoints that impart information pertaining to the integrity of the water resource and provide the information-base for making water quality-related assessment and management decisions, such as determining the impairment status of the resource.

The Intergovernmental Task Force on Monitoring Water Quality (ITFM) defined an environmental indicator as "a measurable feature which singly or in combination provides managerial and scientifically useful evidence of environmental and ecosystem quality or reliable evidence of trends in quality" (ITFM 1995). Inherent in this definition is a hierarchy of indicator types ranging from those emphasizing program-focused activities, such as the *number of discharge permits issued*, to greater reliance on resource-focused measures, such as the assessment of *biological integrity*. Note that the former represents, at best, "managerial evidence of environmental quality" as defined above, whereas the latter provides direct "scientific evidence" of ecosystem quality (EPA 1995). The kinds of indicators comprising the hierarchy are:

- Response Indicators - Measures of integrated or cumulative reactions to exposure and stress, such as biological community indices.

- Exposure Indicators - Measures of environmental variables that suggest a degree of exposure to stressors, such as water-column pollutant levels or ambient toxicity.

- Stressor Indicators - Activities that impact the aquatic environment, such as pollutant discharges and changes in land-use and habitat.

- Administrative Indicators - Regulatory actions by the EPA, the state, and local entities and responses by the regulated community.

Each indicator type in this hierarchy represents a step closer to the direct measure of the integrity of the resource than does the category below it. For example, reliance on administrative and stressor indicators is presumptive - actual instream pollutant concentrations are estimated based on knowledge of the magnitude and quality characteristics of upstream discharges, or conditions are assumed to be improved if a regulatory action is taken. Exposure indicators, such as pollutant concentrations that can be compared to numerical criteria, provide more reliable evidence of instream conditions but still do not account for site-specific factors influencing the biological response to those pollutant concentrations. Therefore, the site-specific application of biological response indicators, such as macroinvertebrate or fish community analyses, allows for greater

confidence in the final water resource assessment. By focusing more in the future on indicators that reflect the actual condition of the resource, the §305(b) / §303(d) assessment and listing process will be strengthened and attention will be shifted toward solving the most important environmental problems.

In general, monitoring programs focus on measuring exposure, response and, to a lesser degree, stressor indicators. Administrative indicators, which are tracked by counting the number of permits issued or enforcement actions taken, are typically not the subject of environmental monitoring programs. Massachusetts' water monitoring programs feature a wide variety of water quality, habitat, and public health-related variables that represent the higher tiers in the hierarchy of indicators. For example, emphasis is placed on exposure and response indicators for assessing the attainment of water quality standards.

As outlined in *Elements of a State Water Monitoring and Assessment Program* (EPA 2003), EPA distinguishes between core indicators that are used routinely to assess use attainment for applicable water quality standards at a broader statewide or watershed scale, and supplemental indicators that are used when core indicators identify impairment, or when there is an expectation that a particular pollutant may be present. Supplemental indicators are often useful for identifying causes and sources of impairment and for targeting appropriate source controls.

EPA's suggested indicators for states to include in monitoring programs are presented in the tables below with slight modification to reflect Massachusetts' existing program elements. Table 1 provides a breakdown of core (statewide and watershed scale) and supplemental (impairment or pollutant specific) indicators used for assessing and managing the aquatic life and water contact recreational uses (including rivers, lakes, and coastal waters), as defined in the MA SWQS. Likewise, Table 2 provides a breakdown of core and supplemental indicators that can be used to assess and manage the human health-related designated uses in the MA SWQS.

Table 1**.** Core and supplemental indicators used for assessing the aquatic life and water contact recreational uses for rivers **(R)**, lakes **(L)**, and coastal waters **(C)**, as designated in the Massachusetts Surface Water Quality Standards.

INDICATOR CATEGORY	AQUATIC LIFE	RECREATION
Core	Macroinvertebrate community **(R, L, C)** Fish community **(R, L)** Periphyton/Phytoplankton blooms **(R, L, C)** Chlorophyll **(R, L, C)** Seagrasses (e.g., Eelgrass) **(C)** Habitat and Flow** **(R, L, C)** Dissolved oxygen **(R, L, C)** pH **(R, L, C)** Hardness **(R, L)** DOC **(R, L)** Temperature **(R, L, C)** Transparency (e.g. Secchi depth) **(L)**	*Escherichia coli* **(R, L)** *Enterococcus* **(R, L, C)** Transparency (e.g. Secchi depth) **(R, L, C)** Harmful algal blooms **(R, L, C)** Macrophyte density **(R, L)** Bathing beach closures **(R, L, C)**
Supplemental	Diatom community **(R, L)** Toxic pollutants in water (SWQS Table 29a) **(R, L, C)** Ammonia **(R, L, C)** Toxicity tests (water, sediment) **(R, L, C)** Tissue residue assays **(R, L, C)** Nutrients (nitrogen, phosphorus) **(R, L, C)** Turbidity **(R, L, C)** New and emerging contaminants in water **(R, L, C)** **New and emerging contaminants in macroinvertebrate tissue (R, L)** Sediment quality **(R, L, C)** Non-native species **(R, L)** Land-use/% impervious cover **(R, L, C)** Zooplankton **(L)**	Cyanotoxins **(R, L, C)** **Cyanobacteria I.D.s and cell counts (L, C)** Cyanobacteria visual assessments **(L, C)** Objectionable scums, sheens, debris, deposits **(R, L, C)** Flow/water level **(R, L)** Sediment chemistry **(R, L, C)** Toxic Pollutants **(R, L, C)** Turbidity **(R, L, C)** pH **(R, L, C)** New and emerging contaminants **(R, L, C)**

** Stream discharge/lake water level
Geomorphology (slope, bank stability, channel morphology)
Stream substrate (sediment type, embeddedness)
Riparian zone (shoreline vegetation, canopy)

Table 2. Core and supplemental indicators used to assess human health-related water uses for rivers **(R)**, lakes **(L)**, and coastal waters **(C)**, as designated in the Massachusetts Surface Water Quality Standards.

INDICATOR CATEGORY	FINFISH/SHELLFISH CONSUMPTION	DRINKING WATER*
Core	Mercury in fish tissue **(R, L, C)** PCBs in fish tissue **(R, L, C)** Pesticides in fish tissue **(R, L, C)** Shellfish bed closures (non-management) **(C)** **Toxic pollutants in water (MA SWQS Table 29b) (R, L, C)**	Primary drinking water standards (legally enforceable under the SDWA) Toxic pollutants in water (MA SWQS Table 29b) **(R, L, C)**
Supplemental	Other toxic pollutants in fish tissue **(R, L, C)** Fecal coliform bacteria in water **(C)** New and emerging contaminants in fish tissue **(R, L, C)** New and emerging contaminants in water **(R, L, C)**	Secondary drinking water standards or other health-based advisories (unenforceable guidelines)

*While included as a designated use in the MA SWQS, MassDEP does not assess the use attainment status of public water supplies for the purpose of assessing and listing waters in accordance with §305(b) and §303(d) of the CWA.

While the above indicators are typically used to assess the designated use attainment status of waters and to identify causes and sources of impairment, many of these same variables are measured when monitoring to meet other program objectives, such as developing pollution control strategies and policies, or evaluating the effectiveness of water quality management programs. In these cases, monitoring designs may be more site- or issue-specific, but the indicators are largely the same.

VI. Monitoring Design

EPA guidelines for the development of state monitoring programs call for the development of sampling networks that will provide comprehensive assessments of all waters and waterbody types (e.g., shallow streams, large rivers, lakes, wetlands, etc.) over time. To provide complete coverage, both spatially and temporally, states are encouraged to adopt networks of randomly selected sampling sites that will allow for statistically unbiased assessments that can be applied at larger scales. Because statistically valid inferences can be drawn for an entire population of waterbodies by monitoring a set of sites randomly selected from that population, a probabilistic design can provide, with a stated level of confidence, the percentage of waters attaining water quality standards and supporting designated uses. The actual number of sites chosen for monitoring will affect the overall confidence that can be placed in extrapolating up to a scale beyond the individual sites or waters sampled. These probabilistic monitoring designs are in contrast with deterministic, or targeted, designs that utilize non-random site selection based on previous knowledge of conditions at the sites.

Targeted monitoring networks will continue to be needed to identify causes and sources of impairments, and to develop and implement pollution control strategies, such as TMDLs, watershed-based plans, NPDES permits and BMPs. Furthermore, targeted monitoring may provide data to define emerging issues or to support the development of water quality standards and policies. MassDEP will conduct some targeted monitoring while also relying on partners to fulfill additional data needs.

In short, Massachusetts has selected a set of monitoring program components that utilize a combination of targeted and probabilistically derived sampling networks best suited to meet the monitoring objectives described in Section III. These monitoring elements incorporate different design components, such as intensive and screening-level targeted monitoring, and randomization. Furthermore, these designs encompass both rotating watershed monitoring cycles as well as non-rotating priority-driven schedules.

The existing and planned monitoring networks or program elements that will be needed to support Massachusetts' water resource management programs over the next ten years and beyond are presented here by monitoring objective. Some monitoring networks will yield data and information that may meet more than one objective. These are described under the monitoring objective that they are primarily designed to fulfill and other objectives that may, in part, be met are noted.

OBJECTIVE 1 – Support criteria calculation, development of policies and standards, and identification of emerging issues

Both long-term, consistent data collection of parameters to support calculation of site-dependent criteria, and short-term, project investigations to support potential regulatory and policy updates or potential new criteria adoption will be performed as needed. In the

next five years (2025 – 2030) monitoring is anticipated to identify and characterize emerging contaminants. Monitoring to meet this objective is ongoing and may also be triggered by the results of other monitoring programs, new EPA criteria recommendations, or information concerning emerging contaminants indicating potential risks to human or ecological health. In addition, monitoring data may be used to identify high-quality waters in need of protection and for defining the level of protection required. This objective will be achieved through the implementation of long-term data collection for existing criteria calculation and of targeted monitoring program elements for regulatory updates and emerging contaminants.

1.1 Monitoring to support criteria calculation and development *(Rivers, Lakes, Coastal waters)*

Criteria calculation. Continued sampling as needed for parameters required to calculate existing equation and model-based criteria in the MA SWQS will be necessary, such as dissolved organic carbon, pH, and temperature for freshwater aluminum criteria, and the ten parameters for the calculation of freshwater copper criteria using the copper biotic ligand model. EPA continues to develop additional site-dependent criteria; therefore, the monitoring program will maintain flexibility to add parameters required to calculate future complex criteria that may be adopted into the MA SWQS.

Criteria development. The Massachusetts Probabilistic Monitoring and Assessment Program (MAP2) project continues to provide phosphorus and nitrogen data from wadeable rivers and streams that support multiple water management objectives, including the derivation and refinement of nutrient criteria. For coastal waters, MassDEP has obtained support from EPA's Nutrient Scientific Technical Exchange Partnership & Support (N-STEPS) program to categorize coastal waters and develop potential numeric nutrient criteria. The overall objective of MassDEP's N-STEPS project is to develop nutrient concentration targets for classes of coastal waters that are not covered by TMDLs, as well as to develop target nutrient concentrations for rivers that discharge to those coastal ecosystems. Targets derived in this N-STEPS partnership may be used for water quality assessments and/or be adopted into the MA SWQS. To understand water quality conditions in Mount Hope Bay and the Taunton River Estuary, as well as Mattapoisett and Sippican harbors in Buzzards Bay, MassDEP, in partnership with the U.S. Geological Survey (USGS) will continue to collect data using one buoy located in Mount Hope Bay and two buoys in Buzzards Bay – one each in Mattapoisett and Sippican harbors. The buoys fill critical data gaps; for example, the buoy in Mount Hope Bay is an extension of the Narragansett Bay Fixed-Site Monitoring Network (NBFSMN). The buoys are used to collect continuous measurements of dissolved oxygen, temperature, salinity, pH, nitrate-nitrogen, and chlorophyll *a*. The information will be used to gain insight into water quality dynamics and support numeric nutrient criteria development for coastal and marine waters.

Within the next ten years, MassDEP may adopt numeric nutrient criteria for lakes in the MA SWQS. EPA finalized recommended numeric nutrient criteria (NNC) for lakes and reservoirs in 2019, and MassDEP initiated a project – *Development and Implementation of Numeric*

Nutrient Criteria for Massachusetts Lakes and Reservoirs – in 2024, which aimed to develop criteria using EPA models. The Lake NNC project also identified the need to collect data to support the development of Cold Water criteria for lakes. The existing Cold Water criteria in the MA SWQS were developed for stream assessments and do not apply to lakes. Maximum depth, thermocline depth, surface area, and other parameters of each lake are needed for criteria development. As resources allow, MassDEP will continue to collect and analyze nutrient and biological data from Massachusetts' waters to compare to future criteria and further refine guidance on the assessment of nutrients.

In addition to nutrients, MassDEP anticipates the need for data and analytical support for developing other pollutant criteria and indicators of water integrity for potential adoption into the MA SWQS. For example, MassDEP is reviewing EPA's recommended updated selenium criteria and PFAS criteria, as well as pursuing the further development of indices of biological integrity (IBIs), which will strengthen the process of Aquatic Life use attainment decisions. Biological monitoring will continue to be a critical component of the WPP surface water quality monitoring program, and will support the development of IBIs. The use of various techniques for interpreting biological data (e.g., biocondition gradients; tiered aquatic life use, etc.) will also be explored. These updated pollutant criteria and biological metrics may then be considered for adoption as criteria into the MA SWQS.

The above discussion presents examples of the issues confronting MassDEP over the next several years. To address these issues, partnerships with federal agencies (e.g., EPA and USGS) and/or other potential contractors will be needed for data exploration, analysis, modeling, and other technical support.

Resources needed to implement this monitoring element:

- *Funding to support full-time and seasonal monitoring staff*
- *Funding for equipment and supplies*
- *Expanded laboratory analytical capabilities at MassDEP's WES*
- *Funding for contractual support (e.g., Cold Water lakes, N-STEPS, biocriteria development, coastal and marine numeric nutrient criteria, etc.)*

1.2 Assessing and managing potentially toxic algae blooms *(Rivers, Lakes)*

MassDEP provides technical expertise and laboratory support to the investigation of potentially toxic algal (cyanobacteria) blooms. Working in collaboration with DPH, MassDEP performs cyanobacterial counts and identifications on water samples to determine whether cell counts exceed DPH's advisory levels for recreational waters, resulting in the issuance of public advisories against swimming or contact due to toxic cyanobacteria.
MassDEP intends to continue collaborating with its sister environmental agencies, public health officials, and other interested parties to develop a comprehensive program aimed at

monitoring and managing the human health and ecological risks associated with algal blooms in Massachusetts' waters.

In 2024, WPP initiated a pilot study examining cyanobacteria blooms in select Massachusetts lakes, including those with a history of bloom-based swimming advisories (posted by municipal Boards of Health) or that have experienced blooms in recent years. The study utilized EPA's new criteria recommendations for recreational waters, which include bloom duration as measured by three consecutive ten-day sampling periods. Values exceeding such criteria constitute public health concerns at (public) beaches, but bloom duration data are needed to evaluate surface waters for Integrated Report impairment decisions. MassDEP anticipates potentially adopting cyanotoxin criteria in the MA SWQS in the future, and these data will support criteria development, as well as the eventual evaluation of the data against the criteria.

In addition to the activities described above, MassDEP is participating in the EPA Region 1 Cyanobacteria Monitoring and Bloom Watch Program. This cyanobacteria monitoring program is designed to be integrated into existing monitoring programs and uses consistent sampling and analytical protocols to allow for region-wide data analysis and interpretation.

Resources needed to implement this monitoring element:

- *Funding to support full-time and seasonal monitoring staff*
- *Expanded laboratory, risk assessment, and data analysis capabilities at MassDEP's WES, WPP, and ORS*
- *Funding for equipment and supplies*

1.3 Monitoring to assess long-term change *(Rivers and Lakes)*

The Regional Monitoring Network (RMN) is a USEPA-guided, multi-State project designed to provide long-term ecological data for the purposes of trend analysis and comparison with other, more synoptic, datasets. The project design establishes sentinel sites that are monitored with a minimum of effort and expense across the nation. WPP has been a participant in the RMN Project since 2011 and currently monitors six streams and two lakes in Massachusetts.

WPP staff monitor air and water temperature, collect continuous conductivity and dissolved oxygen data, and nutrient (total phosphorous, total nitrogen, nitrate/nitrite, ammonia), chloride, and macroinvertebrate samples at the six stream sites in Massachusetts as part of an ongoing collaborative effort among multiple federal and state agencies, NGOs, and academic institutions across New York and New England to assess the effects of long-term change in the Northeast. Spearheaded by EPA, this effort is aimed at coordinating temperature and biological data collection across the region. Similar regional collaborations have been established across the country. The six Massachusetts sites are Hubbard River in Granville, Brown's Brook in Holland, Parker's Brook in Oakham, West Branch Swift River in Shutesbury, Avery Brook in Whately, and Cold River in Florida. UMass/Amherst and DFG's Division of Ecological Restoration (DER) are the other partners on the "Massachusetts Team."

In 2023, WPP established long-term monitoring sites on two Massachusetts lakes (Upper Spectacle Pond in Sandisfield and Russell Pond in Russell) as part of the Northeast RMN program. To support the objectives of the Northeast RMN program, WPP collects the following types of physical and chemical environmental data and information at each site to fulfill the goals of the Northeast RMN program:

- Discrete vertical profile (dissolved oxygen, temperature, pH, conductivity)
- Continuous vertical profile (dissolved oxygen, temperature)
- Secchi disk transparency
- Nutrients (total phosphorus, total nitrogen)
- Water chemistry (alkalinity, hardness, turbidity, chloride, dissolved organic carbon)
- Chlorophyll *a*
- Phytoplankton community
- Littoral macroinvertebrate community
- Water level
- Ice cover duration

Resources needed to implement this monitoring element:

- *Funding for equipment and supplies*
- *Funding for full-time and seasonal monitoring staff*

1.4 Monitoring new and emerging contaminants *(All water types)*

Monitoring data may be needed in the future to assess and manage currently unregulated and unforeseen contaminants. For example, the fate and transport of pharmaceuticals and personal care products in the environment and their potential effects on public health and aquatic life are emerging issues that need further investigation. Priority-driven targeted

monitoring of selected contaminants in water, sediments, or biota may be performed, in limited instances, to respond to emergency situations or to answer specific questions pertaining to the presence of new or unusual contaminants in selected waterbodies. This could include monitoring of emerging contaminants, such as perfluorinated compounds, in biota. MassDEP, through WPP, is in the process of developing a five-year monitoring plan targeting new and emerging contaminants. The planned sampling would be in addition to previously completed data collection efforts for emerging contaminants (see descriptions of previous WPP projects on MassDEP's PFAS in Surface Water and Fish Tissue webpage).

Table 3. Planned five-year timeline for monitoring emerging contaminants

Project Task	**July 2025 - June 2026**	**July 2026 – June 2027**	**July 2027 - June 2028**	**July 2028 - June 2029**	**July 2029 – June 2030**
6-PPD & 6-PPD-quinone (6-PPDq)	■				
Pesticides		■			
Microplastics			■		
PFAS (Per- and Polyfluoroalkyl Substances)				■	
Pharmaceuticals & Personal Care Products (PPCPs)					■

The introduction of non-native species to Massachusetts' waters, while not a new problem, continues to emerge as an issue of critical concern. Invasive, non-native species disrupt or displace indigenous species, reduce biological diversity, and impair aquatic life use support. MassDEP intends to work with other agencies and partners to document the presence of non-native species populations and, where applicable, develop strategies for their control.

Resources needed to implement this monitoring element:

- *Funding to support full-time and seasonal monitoring staff*
- *Funding for equipment and supplies*
- *Expanded laboratory risk assessment and data analysis capabilities at MassDEP's WES and ORS*
- *Funding for field sample collection and laboratory analyses*

OBJECTIVE 2 – Assess the status or condition of Massachusetts' waters

Monitoring Objective 2 is to assess the water quality status of Massachusetts' waters relative to the attainment of their beneficial uses, as designated in the MA SWQS. A monitoring program designed to assess the status of designated uses needs to be statewide in scale, comprehensive, and repeated at regular intervals. Furthermore, the design of this monitoring element should strengthen the §305(b) assessment process by increasing the number of stream miles and lake acres assessed and reducing the historical bias toward monitoring waters with known or suspected water quality problems. This expanded spatial coverage can be achieved using probabilistic sampling designs that provide for statistically valid estimates of the use support status of 100% of the waters in a target population (e.g., shallow streams, deep rivers, lakes, etc.) with data and information collected from a random sample of those waters. EPA strongly encourages all states, nationwide, to adopt this approach for one or more waterbody types and/or designated uses.

The following probabilistic and targeted monitoring networks will be used to assess the status of Massachusetts' waters for reporting in accordance with the requirements of §305(b) and §303(d) of the CWA. The data generated by the following networks do not constitute the only data and information used by MassDEP when assessing the condition of Massachusetts' waters. Depending upon the designated use under consideration, data and information from multiple sources may be used to make use assessment decisions. For example, bathing beach water quality is regulated by DPH under Massachusetts General Law and the Code of Massachusetts Regulations ("Beaches Bill"). These regulations require that all public and semi-public bathing beaches (e.g., beaches at camps, campgrounds, hotels, condominiums, country clubs) in the state be monitored for bacterial, and on occasion other environmental contamination, during the bathing beach season. If water samples from a beach are found to exceed regulatory standards, the beach waters must be closed, and beach closures are considered when assessing the primary contact recreational use. Likewise, the Massachusetts Division of Marine Fisheries (DMF) monitors water quality and classifies shellfish growing areas. This information is used to assess the support status of the shellfish harvesting use. Finally, water quality status and trend information are available from EPA's National Aquatic Resource Surveys and National Estuaries Program (see text boxes below). Additional information on data sources can be found in Section VIII (Data Analysis and Assessment).

The EPA National Aquatic Resource Surveys: *The EPA National Aquatic Resource Surveys (NARS) employ statistically valid, random sampling designs to assess the condition of aquatic resources on a national scale and track changes over time. Coastal waters, rivers, lakes, and wetlands are surveyed on a rotating schedule. Each survey uses standardized field and lab methods and is designed to yield unbiased estimates of the condition of the whole water resource under evaluation. This program has demonstrated the utility of these designs for inferring conditions on a watershed, ecoregion, state, or*

larger scale. The use of NARS results for assessing Massachusetts' waters has been limited by the small number of randomly chosen sites that fall within the Commonwealth, as well as some difficulty comparing NARS indicators and endpoints with the MA SWQS. For this reason, Massachusetts has not actively participated in the field or lab activities of the national surveys. However, Massachusetts has developed and implemented state-scale probabilistic sampling designs.

The EPA National Estuary Program: *The National Estuary Program (NEP) is a non-regulatory program, authorized by § 320 of the CWA, aimed at the protection and restoration of the water quality and ecological integrity of the estuaries of national significance, Currently, 28 estuaries nationwide ae included in this program. Each NEP study area encompasses the estuary and surrounding watershed. The NEPs develop and implement Comprehensive Conservation and Management Plans (CCMPs), which are long-term plans that contain actions to address water quality and living resource challenges and priorities that are defined by municipal, state, federal, private, and non-profit organizations. Each NEP has a Management Conference (MC) that consists of a diverse group of interested parties and uses a collaborative, consensus-building approach to implement the CCMP. Three NEP study units are focused entirely or partially in Massachusetts waters: 1) the Massachusetts Bays NEP (MassBays), which comprises 47 separate estuaries extending from the Merrimack/Black Rock Creek estuary near the New Hampshire boundary to Provincetown Harbor at the terminus of Cape Cod; 2) the Buzzards Bay NEP, which covers233 square miles of estuaries and open bay along the 350 miles coastline from the Rhode Island border to the tip of Cuttyhunk Island; and 3) the Narragansett Bay NEP, which is focused on 196 square miles of estuarine waters draining 1,700 square miles of watershed located in Massachusetts (60%) and Rhode Island (40%).*

2.1 The Massachusetts Probabilistic Monitoring and Assessment Program (MAP2) *(Rivers, Lakes, Coastal Waters)*

In 2011, MassDEP's surface water monitoring program initiated the implementation of the Massachusetts Probabilistic Monitoring and Assessment Program (MAP2). MAP2 uses statistically valid survey designs to provide unbiased condition assessments of Massachusetts waters (rivers, lakes, and coastal waters). The primary goals of MAP2 are to provide an unbiased assessment of aquatic life, recreational, fish consumption, and aesthetic uses in Massachusetts waters, and, over time, to provide trend analyses for those uses. Additionally, the MAP2 study was designed such that sufficient data would be

collected from each of the monitoring sites in the network to allow individual assessments of these same designated uses.

The random sampling design employed for MAP2 Rivers allows for the determination, with a known statistical confidence, of the percentage of wadeable stream miles supporting and not supporting their designated uses. The data collected allow for an assessment of the aquatic life, recreational, and aesthetic use-support status of all shallow streams in Massachusetts. MassDEP completed MAP2 Rivers monitoring over a period of five years (2010 – 2015). In 2025, MassDEP implemented its second MAP2 Rivers project, which will end in 2027.

The probabilistic sampling design for MAP2 Lakes provided an unbiased assessment of designated uses and water quality conditions in Massachusetts lakes over a period of three years (2016 – 2018) by surveying 75 lakes and ponds. MassDEP reviewed the elements of the EPA's National Lakes Assessment, along with its own data needs, to develop the monitoring objectives, select appropriate indicators, and define the sampling frame for the network. Adequate spatial, temporal, and analytical coverage was provided to assess the support status of designated uses at the individual lakes in the sampling network.

The Massachusetts Coastal Condition Assessment (MCCA) used a probabilistic survey design to provide an unbiased assessment of designated uses and water quality conditions in Massachusetts coastal and estuarine waters over a period of four years (2020 – 2023). The survey focused on a single designated use, Aquatic Life. Additionally, the MCCA established a baseline to measure trends in conditions in future surveys.

MassDEP will continue to employ random sampling designs to assess one or more designated uses in multiple waterbody types (Appendix 1) and report statewide survey results through the EPA's Assessment TMDL Tracking and Implementation System (ATTAINS) database.

Resources needed to implement this monitoring element:

- *Funding to support full-time and seasonal monitoring staff*
- *Funding for field and laboratory equipment and supplies*
- *Funding for contract laboratory services for bacteriological and other biological analyses, such as taxonomic identifications of macroinvertebrates and phytoplankton*
- *Collaboration with the Department of Fish and Game (DFG) for fish community assessments*

2.2 Targeted monitoring to support assessment and listing decisions *(Rivers, Lakes, Coastal waters)*

While the probabilistically derived sampling networks discussed above determine the percentage of stream miles, lake acres, or coastal waters that are meeting water quality standards, these networks are not as useful for identifying individual impaired waters for listing pursuant to §303(d) of the CWA. Targeted monitoring designs will be used to confirm causes and identify sources of impairment or, alternatively, demonstrate that previously impaired waters are now supporting their beneficial uses and can be removed from the 303(d) list. The need for further data and information from specific waterbodies will be identified as part of the watershed assessment process, and these waters will then be targeted for monitoring. This monitoring may be performed in rivers, lakes, or coastal waters, and can be conducted in accordance with a rotating watershed schedule such as the seven-year cycle (Appendix 2), or in selected watersheds in response to shifting program priorities.

Several water management functions rely on the availability of more directed and comprehensive sampling and analytical coverage. For this reason, MassDEP will continue to rely on deterministic monitoring to provide data in support of multiple watershed management objectives, as discussed later in this report. The scope of the targeted monitoring effort will depend upon the resources available and the prevailing water quality issues within each watershed.

Resources needed to implement this monitoring element:

- *Funding to support full-time and seasonal monitoring staff*
- *Expanded laboratory and data analysis capabilities at WES, including equipment and staff*
- *Funding for equipment and supplies*
- *Funding to support outreach staff to increase data flow of quality-assured external data along with management and validation of data*
- *Investment in resources for data analysis and reporting*

MassDEP started a seven-year Targeted Assessment Monitoring (TAM) cycle in 2021 (Appendix 2) and plans to transition to a four-year rotating basin cycle in 2029 (Appendix 1).

2.3 Targeted monitoring to assess the fish consumption use *(Rivers, Lakes)*

Two MassDEP programs monitor contaminant levels in the edible tissues of freshwater fish: a screening program to provide data for human health risk assessments associated with consumption of freshwater fish; and a research program designed to examine whether mercury levels in fish tissue are changing with time (i.e., trend analysis). The screening

surveys support the determination of the edibility of freshwater fish and, thus, allow for the assessment of the fish consumption use as designated in the MA SWQS. This screening program is described in further detail below. The research program measures the overall effectiveness of multiple programs aimed at eliminating or reducing releases of mercury to the environment throughout Massachusetts and New England. More information on the research program is presented under Monitoring Objective 4.

The program to assess fish edibility, known as the "Toxics-in-Fish" monitoring program, is a cooperative effort that began over 40 years ago with MassDEP (WPP and the Office of Research and Standards [ORS]), DPH, and the Department of Fish and Game (DFG). This effort is coordinated by the Interagency Fish Toxics Committee, chaired by the Director of ORS, or his/her designee. The goal of this monitoring element is to provide data for the assessment of the risk associated with human consumption of freshwater fish, and most of the fish are collected from waters requested by the public. Initially, fish collection efforts were generally focused on waterbodies where wastewater discharge data or previous water quality studies indicated potential toxic contamination problems. Fish were typically screened for the presence of mercury and other heavy metals, PCBs and organochlorine pesticides and their derivatives. Later, concerns about mercury contamination from both local and far-field sources led to a broader survey of waterbodies throughout Massachusetts. In both cases, the analyses have been restricted to edible fish fillets.

Uniform protocols, designed to assure accuracy and prevent cross-contamination of samples, are followed for fish collection, processing, and shipping. Fish are typically obtained with electrofishing gear or gill nets. Lengths and weights are measured, and fish are visually examined for tumors, lesions, or other indications of disease. Fish of the same species collected from the same location are typically analyzed as composites. DPH performs risk assessments and issues public health advisories.

MassDEP intends to continue to work cooperatively with DPH and DFG to sample 5 -10 waters each year in response to public requests and provide contaminant data to DPH for risk assessment and management. Over the next ten years, MassDEP anticipates that the list of contaminants currently monitored in Massachusetts freshwater fish will be expanded to include some of the additional compounds listed in US EPA's recommended 2024 list of Contaminants to Monitor in Fish and Shellfish Advisory Programs. MassDEP's WES is conducting proficiency testing for EPA Method 1633 for PFAS analysis and when completed, expanded analysis of PFAS in biota will begin. In addition, there exists a need to expand the scope of fish toxics monitoring to include previously monitored waters, particularly those for which site-specific edibility advisories have been issued, to assess whether those advisories are still appropriate. This latter goal will not be realized without expanding staff and analytical laboratory capacity.

Resources needed to implement this monitoring element:

- *Funding to support full-time and seasonal monitoring staff*
- *Expanded laboratory, risk assessment, and data analysis capabilities at WES and ORS, including equipment and staff*
- *Funding for equipment and supplies*

2.4 The Conservation Assessment and Prioritization System (CAPS) and Rotating Wetland Assessments *(Wetlands)*

Detailed information pertaining to MassDEP's Wetland Monitoring and Assessment Program can be found on the Wetlands Monitoring and Assessment: Research and Development webpage. MassDEP's Wetlands Program has been working collaboratively with the University of Massachusetts-Amherst (UMass) and the Massachusetts Office of Coastal Zone Management Program since 2006 to develop a strategy to monitor and assess wetlands for purposes of reporting on the status and trends of all wetlands across the state and for developing criteria to monitor and assess the physical, chemical, and biological integrity of wetlands for reporting under §305(b) of the CWA.

The central feature of the Massachusetts strategy is the CAPS, a landscape-level assessment model that has been under development by UMass since 2000. CAPS combines land-cover mapping derived from GIS and aerial photography with 26 inland and coastal stressors or resiliency metrics, each representing a stressor on the environment, to calculate a value between 0 and 1 for each 30 square meter plot on the landscape. A complete list of metrics is available on the CAPS website. The CAPS computer model can analyze individual or multiple metrics to derive an Index of Ecological Integrity, or IEI. Wetland IEI values generated from the CAPS model define a continuous gradient that is inversely proportional to the magnitude of stressors acting on those wetlands (generalized stressor gradient). High IEI scores (approaching 1.0) are indicative of communities that are relatively free from stressors. The IEI is a *predictor* of the capacity of a wetland to sustain its ecological condition in the long term and to recover from stress.

EPA Wetland Program Development Grants (WPDGs) to support MassDEP's Wetland Program monitoring and assessment strategy development has been discontinued. MassDEP continues to use the CAPS model in different capacities. For example, it forms the basis for important habitat maps that MassDEP developed for use with their wildlife habitat guidance. MassDEP is also currently working under WPDG funding to develop a statewide hydraulic model. This effort uses "critical linkages", a model developed by UMASS using CAPS that identifies which streams would benefit the most in stream miles from improvements in crossings. The statewide hydraulic model will facilitate improved stream crossings to benefit aquatic organism passage and thus, the aquatic life designated use.

Resources needed to implement this monitoring element:

- *Funding to support full-time staff for monitoring, data management and analysis, and reporting*
- *Funding to support seasonal monitoring staff*
- *In-house or contract laboratory resources for processing macroinvertebrate and other biological samples*
- *Investment in GIS, statistical, and other analytical capabilities*
- *Funding for equipment and supplies*

2.5 The MassDEP eelgrass mapping project *(Coastal Waters)*

The condition of seagrass meadows is a core indicator of the aquatic life designated use attainment status of Massachusetts' shallow marine and estuarine waters. Seagrass beds provide food and cover for important fauna and their prey. Their leaf canopy calms the water, filters suspended matter and, together with their extensive system of roots and rhizomes, stabilizes sediment. Eelgrass, *Zostera marina,* is the most common seagrass present on the Massachusetts coastline. Seagrasses are sensitive to degraded water quality, and the loss of seagrass beds has been linked to eutrophication resulting from excessive contributions of nitrogen from coastal watersheds. Therefore, the change in the distribution and abundance of seagrass over time is a sensitive indicator of environmental condition.

Changes in the spatial extent of the seagrass community are indicators of water quality conditions in coastal waters. Eelgrass is considered a sentinel species for embayment health and is an important species in the ecology of shallow coastal systems providing habitat structure and sediment stability. Losses of bed area and/or thinning of beds (decreases in density) are generally both linked to nutrient enrichment. The MassDEP Wetlands Program's Eelgrass Mapping Project routinely maps eelgrass beds statewide in comparison to historic records for determination of the stability of this resource and to measure temporal trends in habitat quality.

The primary biological information used to make assessment decisions for the aquatic life use in marine or estuarine waters is obtained from eelgrass bed maps based on surveys conducted by the Wetlands Conservancy Program (WCP) at MassDEP, as part of the Eelgrass Mapping Project. Currently, the best available information on the general eelgrass extent along the Massachusetts coastline comes from these various eelgrass (seagrass) mapping efforts, which are available as data layers through MassGIS.

Assessment decisions are based on a comparison between the data derived from the first phase of the Eelgrass Mapping Project (1995) with the most recently completed statewide dataset available to determine whether the eelgrass beds within an Assessment Unit (AU) are stable or are being lost. If the areal coverage of the beds is fairly stable or increasing (less than 10% or no loss), the AU is considered to be supporting the aquatic life use. Loss of

eelgrass beds equal to or exceeding 10% is considered to be a "substantial decline" and the aquatic life use is evaluated as not supporting.

Resources needed to implement this monitoring element:

- *Funding to support full-time staff for monitoring, data management and analysis, and reporting*

OBJECTIVE 3 - Develop, implement and evaluate pollution control strategies

Targeted monitoring of lakes, rivers, and estuaries is needed to provide data and information to support the development and implementation of various measures to restore impaired waters. These measures include the identification or verification of causes and sources of impairment, calculation and implementation of TMDLs and watershed-based plans to manage point and nonpoint sources of pollution, issuance of NPDES wastewater discharge permits, and installation of stormwater controls and BMPs. Monitoring to provide data to NPDES permit writers could be conducted on a rotating watershed basis if it adhered to the schedule for issuing those permits. Many NPDES permits require ambient monitoring for nutrients. In most cases, however, monitoring to develop and implement control strategies is more likely to be scheduled to address high-priority waters without regard to where they fall on a rotating monitoring plan.

In 2013, EPA announced a new framework for prioritizing and implementing TMDLs and related pollution control strategies. EPA guidance, entitled *A Long-Term Vision for Assessment, Restoration, and Protection under the Clean Water Act Section 303(d) Program* (Vision), allows states to adopt strategies for implementing the requirements of CWA §303(d) that are tailored to individual state water quality program goals and priorities. Furthermore, while the statutory and regulatory obligations to develop TMDLs for waters identified on the CWA §303(d) lists remain in place, and TMDLs will continue to be the prevailing mechanisms for addressing those waters, it is acknowledged in the Vision that under certain circumstances there are alternative restoration approaches that may be more immediately beneficial or practicable in achieving water quality standards than pursuing the TMDL approach from the beginning. EPA provided updated guidance as part of the 2022 - 2032 Vision for the Clean Water Act Section 303(d) Program (EPA 2022) that was incorporated into planning efforts by MassDEP. The *Massachusetts Vision 2.0: Clean Water Act Section 303(d) and Total Maximum Daily Load Development* (*TMDL Vision*) outlines MassDEP's approach to TMDL prioritization, including priority concerns based on impairments listed in the *Final Massachusetts Integrated List of Waters for the Clean Water Act 2018/2020 Reporting Cycle* (MassDEP 2021). Given these concerns, waterbodies were sorted by waterbody type to identify metrics best suited to create a prioritization framework. In addition to the core document describing the overall strategy, three appendices describe the prioritization approach for estuaries, lakes, and rivers.

3.1 Targeted monitoring to support TMDL development *(Rivers)*

The TMDL process establishes the maximum allowable loading of pollutants that a waterbody can receive and still meet the standards established for protecting public health and maintaining the designated beneficial uses of those waters. Targeted monitoring is needed to: 1) characterize pre-TMDL baseline conditions; 2) support the calibration and verification of predictive computer simulation models; 3) estimate pollutant loads; and 4) evaluate alternatives and recommend management strategies to address impaired waters. Furthermore, monitoring will be needed to evaluate the effectiveness of pollution control measures after implementation (see Monitoring Objective 4 – Effectiveness Monitoring).

Bacteria and nutrients (i.e., phosphorus and nitrogen) account for over 60 percent of the use impairment of Massachusetts' waters, and the development of TMDLs or alternative plans to restore water quality has been, and will continue to be, focused on these pollutants over the next several years. To date, nutrient loading estimates and/or TMDLs have been derived for the Assabet, Blackstone, Charles, Nashua, and Taunton watersheds, primarily, through collaboration with USGS and various other partners. Recent projects, also in collaboration with USGS, that include monitoring components to estimate nutrient loadings are underway or recently completed in the Merrimack, Connecticut, and Taunton River watersheds. Approved by the EPA in 2025, the Final Statewide Total Maximum Daily Load for Pathogen-Impaired Waterbodies ("Final Statewide Pathogen TMDL Report") is a restoration plan and pollution budget to restore pathogen impaired waters. The Final Statewide Pathogen TMDL Report consists of a core document that includes applicable water quality standards and numeric targets, TMDL calculation methodology, and development of load and wasteload allocations. Additionally, watershed specific appendices were developed to highlight detailed information on watershed characterization, existing water quality data, potential sources, and existing local management. The Final Statewide Pathogen TMDL Report includes 228 pathogen-impaired segments across 288 municipalities. This document will be updated based on future Integrated Lists as new pathogen-impaired waterbodies are identified.

There has been a decline in phosphorus concentrations in multiple rivers in the state, including a documented decline in several rivers in Central Massachusetts (Wong et al. 2018). This highlights the need for updated targeted monitoring efforts and assessments prior to TMDL development. One recent example of this effort has been targeted sampling in the Quinebaug River watershed conducted by both WPP (2024, 2025) and USGS (2024-2027) that will support updated water quality assessments as well as support CT DEEP efforts to develop a TMDL for an impoundment of the Quinebaug River, West Thompson Lake, located in Connecticut. The Nashua and Housatonic River watersheds are also strong candidates for targeted monitoring to support updated water quality assessments.

MassDEP will continue to review monitoring needs for watersheds requiring TMDL or alternative plan development. In addition, it is anticipated that monitoring resources may be needed to inform adaptive management decisions in areas where TMDLs have been

developed, and water quality has improved due to the implementation of restorative measures. For example, the Assabet and Charles River watersheds are considered potential candidates for intensive water quality surveys in the next few years. Surveys of all watersheds with TMDLs for rivers would provide measures of the effectiveness of TMDL implementation and/or NPDES permit issuance toward meeting water quality goals in these watersheds (see Monitoring Objective 4).

Resources needed to implement this monitoring element:

- *Funding to support full-time and seasonal monitoring staff*
- *Funding to support outreach staff to increase data flow of quality assured external data along with management and validation of data*
- *Expanded laboratory analytical capabilities at WES*
- *Funding to support nutrient loading studies*
- *Coordination on cross-border water quality investigations and monitoring*

3.2 Targeted monitoring to support TMDL development *(Lakes)*

Nutrients are a priority concern for lake TMDL development. There are approximately 43,660 acres of lakes impaired due to nutrient related causes, of which 7,172 acres have a TMDL, and 36,488 acres require a TMDL (MassDEP 2024b). The TMDL Vision document prioritized 212 lakes and ponds that are listed as impaired due to nutrient pollution related causes within the Massachusetts Integrated List of Waters for the Clean Water Act 2018/2020 Reporting Cycle (MassDEP 2021). Many of these impaired lakes have seen limited samplings. Monitoring of lakes and ponds to determine current baseline conditions and identify sources of impairment are needed. Lake Cochituate and Congamond Ponds are two potential candidates for targeted lake monitoring. Lake TMDL monitoring is often more involved and requires a significant amount of effort to sample. Over this planning period, MassDEP will continue to identify lakes for updated monitoring and assessments as well as source identification to support TMDL development efforts.

Resources needed to implement this monitoring element:

- *Funding to support full-time and seasonal monitoring staff*
- *Expanded laboratory analytical capabilities at WES*
- *Investment in outreach staff to increase data flow of quality assured external data along with management and validation of data*

3.3 Estuarine TMDL Development *(Coastal Waters)*

MassDEP has shown a long-term commitment to the restoration of impaired estuaries. Nutrients (phosphorus and nitrogen) support the growth of aquatic plants, which in turn

provide food for fish, shellfish, and other organisms. However, excess nutrients can negatively impact coastal ecosystems. In 2001, the Massachusetts Estuaries Project (MEP) was created to help determine current nitrogen loads to southeastern Massachusetts estuaries and evaluate reductions necessary to support healthy ecosystems. Through a collaborative effort with MassDEP, UMass-Dartmouth, and southeastern coastal communities, evaluations were completed for 68 coastal estuarine systems. EPA has approved nitrogen TMDLs for 51 of the estuarine systems, and seven nitrogen TMDLs are either in draft form or require additional information to complete the TMDLs. Ten of the technical evaluations determined that nitrogen concentrations and habitat health did not require development of TMDLs.

While the MEP has been completed, future coastal TMDL development efforts will continue as part of the Southeast Estuaries Project (SEEP). The TMDL Vision document has prioritized estuaries for future TMDL development (MassDEP 2024b, Appendix B). Recently, to understand the current conditions in Mattapoisset Harbor and Sippican Harbor, MassDEP has collaborated with USGS on synoptic surveys and a buoy deployment in each system. In addition, benthic macroinvertebrate sampling has been conducted in the Onset Bay and Buttermilk Bay System and the Weweantic River Estuary System. Given sufficient funding, additional efforts to more fully characterize other estuarine systems identified as high and medium priority for TMDL development will be completed.

OBJECTIVE 4 – Measure the effectiveness of water quality management programs

Working with its many and varied partners, MassDEP administers several water quality management programs and activities including, but not limited to, TMDL development, NPDES wastewater discharge permitting, and CWA §319 NPS management. Data and information are needed to assess the effectiveness of all these programs in restoring and protecting Massachusetts' water resources. Effectiveness monitoring can be designed and implemented at various scales ranging from the local, waterbody, or segment-specific level to broader-scale watershed or statewide levels of coverage. In any case, the need exists to periodically resurvey those waters that were originally determined to be impaired, and for which pollution abatement activities have been carried out, to document water quality improvements or demonstrate the need for further restoration through adaptive management.

Waters exhibiting improved water quality, whether fully restored or not, may be candidates for the preparation and release of water quality "Success Stories", as called for in CWA §319 guidance. The EPA's National Water Program Guidance has established performance measures to be used to report on waters that have been fully or partially restored (measures "L" and "Y", respectively), or that have exhibited demonstrable improvement in water quality (measure "W"). Monitoring program elements will be designed to assess the efficacy of Massachusetts' water resource management activities in ameliorating water pollution, and the findings will be reported to the EPA using the "L", "Y" and "W" performance

measures. While the goal is for all impaired uses associated with a particular waterbody to be fully restored, resulting in removal from the CWA §303(d) list, the use of these performance measures will demonstrate interim progress toward meeting that goal.

In general, targeted monitoring designs will be most suitable for evaluating the effectiveness of waterbody and watershed restoration activities, and feedback from the watershed assessment process may be useful for selecting waters for future investigation. Statewide probabilistic surveys, repeated every five or ten years, may also be useful in demonstrating, more holistically, the longer-term environmental benefits of Massachusetts' water resource management programs including, but not limited to, NPDES, TMDL implementation plans, watershed-based plans, and NPS implementation grants.

4.1 CWA Section 319 effectiveness monitoring

The demonstration of measurable improvements to water quality associated with the implementation of CWA §319-funded NPS pollution control projects is an important component of the Massachusetts Nonpoint Source Management Plan. EPA encourages states to identify waters impaired by NPS pollution that have been the focus of restoration activities, such as the installation of BMPs, and perform monitoring to demonstrate the resulting improvements. As described above, waters exhibiting improved water quality, whether fully restored or not, may be candidates for the preparation and release of "Success Stories."

Many of MassDEP's surface water monitoring program elements are aimed at collecting data to support assessment and listing decisions and to identify causes and sources of use impairment in accordance with the requirements of CWA §305(b) and §303(d), or to support TMDL development and implementation. Monitoring to detect changes in water quality due to the implementation of CWA §319-funded projects will likely need to be carried out at a smaller local scale than that performed to meet other CWA objectives. Even in a small watershed, a substantial amount of CWA §319-funded work will need to be completed (e.g., more than just a single BMP installation) to discern a measurable water quality response. Furthermore, CWA §319 effectiveness monitoring guidance from EPA calls for statistical sampling designs that will document, with a stated level of confidence, that water quality improvements have been achieved. Monitoring to meet the requirements of the NPS monitoring guidance will present a challenge to MassDEP over the next several years.

The National Water Quality Initiative (NWQI), administered by the Natural Resources Conservation Service (NRCS), provides financial assistance to farmers and ranchers for the application of conservation systems to reduce nitrogen, phosphorus, sediment, and pathogen contributions to surface waters from agricultural land. The NRCS has worked closely with its partners, including federal and state agencies, and soil and water conservation districts, to identify one to twelve priority watersheds in each state where on-farm conservation investments will result in the greatest water quality benefits. The Palmer

River Watershed was chosen as the pioneering priority watershed for NWQI funding in Massachusetts. MassDEP has since then completed monitoring activities in James Brook and Unkety Brook in the Nashua River Watershed and is currently collecting data from the upper Manhan River Watershed using NWQI funding.

EPA guidelines require the state water quality agency (i.e., MassDEP) to undertake monitoring to demonstrate the effectiveness of conservation practices implemented by NRCS in the Palmer River Watershed. EPA developed a monitoring plan that found significant challenges associated with this requirement. MassDEP, with EPA, has been conducting a bacteria source tracking program in the target watershed for several years, to provide adequate baseline data for the NWQI task. EPA found that significant additional sample collection over several years would be necessary to detect a meaningful signal, and only if conservation practices could be applied over a very large portion of the watershed using a carefully designed implementation plan. Furthermore, §1619 of the federal Farm Bill prohibits water quality regulatory agencies from accessing the location and details pertaining to BMP implementation or other farm practices that may have been implemented, and, therefore, monitoring cannot be designed to measure the effectiveness of those practices. Nonetheless, MassDEP will continue to explore various sampling designs that can be employed in waters where discernible water quality responses to conservation practices are anticipated. Where feasible, monitoring to evaluate the effectiveness of nonpoint source mitigation efforts will be prioritized and integrated with other targeted surface water monitoring elements to facilitate planning and the efficient use of existing monitoring resources and logistics.

Resources needed to implement this monitoring element:

- *Funding for equipment and supplies*
- *Expanded laboratory and data analysis capabilities at WES*
- *Funding to support outreach staff to increase data flow of quality assured external data, along with management and validation of data*
- *Funding for contractual support*

4.2 Monitoring trends in the mercury content in fish *(Lakes)*

Since 1994, MassDEP's Office of Research and Standards (ORS) has carried out a series of research projects designed to monitor, both spatially and temporally, the tissue burdens of mercury in fish as part of its larger efforts to understand and control the inputs and effects of mercury in the environment in Massachusetts. Furthermore, the use of statistically valid study designs allows for the determination of long-term trends in mercury concentration, thus providing a measure of the overall effectiveness of multiple programs aimed at the elimination or reduction of mercury releases to the environment. A statewide survey of mercury in freshwater fish was conducted in 1994, and this was followed in 1999 by an investigation of fish in a specific region of the state that was thought to receive greater

atmospheric deposition of mercury. In addition, seasonal variation in fish tissue mercury was examined in 2001 and 2002, and this led to the decision to limit future collections of fish for the assessment of trends in mercury content to the spring.

In 2001, MassDEP initiated long-term monitoring at several lakes to track temporal changes in the mercury contamination of fish. Since that time, the number of lakes monitored has ranged up to approximately 50, and while a subset of these lakes has been removed from the rotation due to access and/or fish yield issues, most of these waterbodies remain in the rotation. Due to resource constraints, current monitoring is focused on a subset of waterbodies with about seven to nine sampled each year on a rotating basis. A statistically valid sampling regimen is employed to determine, at a specified level of confidence, whether mercury concentrations in fish are significantly higher in some areas of the state than others and whether, over time, those concentrations are increasing, decreasing, or remaining constant. Lakes are sampled on a rotating schedule. During each sampling event an attempt is made to obtain edible muscle tissue samples from 30 yellow perch and 12-15 Largemouth bass, and each individual sample is assayed for total mercury. This sample size allows for a more rigorous statistical analysis of the data. Data on certain water quality parameters for sampled lakes are also collected. MassDEP intends to continue the long-term monitoring program and associated trends analysis as resources allow and is working to expand the range of contaminants assessed to include PFAS.

Resources needed to implement this monitoring element:

- *Expand laboratory and data analysis capabilities at WES and ORS*
- *Funding for equipment and supplies*
- *Expanded analytical staffing for contaminant sample processing and analysis, in particular for metals, PFAS, and other organic chemicals*
- *Funding for contracting services to conduct field sampling and sample analysis, pending expanded analytical capabilities at WES*

OBJECTIVE 5: Maintain reserve monitoring capacity to respond to unforeseen data needs

MassDEP has a goal to reserve some field and lab resources each year to accommodate unforeseen monitoring projects or requests for assistance that may arise unexpectedly and outside of the normal program planning process. Unanticipated data needs and emergencies can usurp monitoring resources and disrupt planned monitoring activities, particularly when monitoring resources have already been allocated to those planned activities. The goal is to devise an annual monitoring program that utilizes less than 100 percent of the available monitoring personnel resources and laboratory capacity to ensure that unforeseen monitoring needs are met with minimal impact on planned monitoring activities.

VII. Quality Assurance

A system for assuring the reliability of scientific data and related information is an essential component of any environmental monitoring program. It is an EPA requirement (EPA Classification No. CIO 2105) that any organization performing environmental information operations in cooperation with EPA needs to establish a quality system to support the development, review, approval, implementation, and assessment of data collection operations. MassDEP is committed to ensuring that the monitoring data used to support the various water quality management activities specified in the CWA are of known and documented quality. Fundamental support for MassDEP's quality system is the EPA-approved Quality Management Plan for Federally Funded Programs (QMP). The QMP describes each element of the total quality system employed by MassDEP, including the policies and procedures used by MassDEP to make certain that all data and information collected in support of programs to assess, protect, and improve the environment are sufficient for their intended purposes.

Within WPP, surface water monitoring is conducted under an EPA-approved, programmatic Quality Assurance Program Plan (QAPP). The 2025-2029 WPP programmatic QAPP is consistent with the intent of EPA's Quality Policies and guidance for non-EPA organizations. The programmatic QAPP documents in detail all aspects of the monitoring program, including goals and objectives, sampling design(s) and logistics, data quality objectives (DQO), equipment, personnel and training needs, quality control sampling data validation and management, and reporting elements. The programmatic QAPP and supporting documentation are typically submitted to EPA for review and approval before project work is initiated. In addition to this overarching QAPP, individual Sampling and Analysis Plans (SAPs) are prepared annually for each monitoring project. Standard Operating Procedures (SOPs) are maintained for all field and laboratory operations and are revised as needed to reflect changes in methodologies. All field and laboratory personnel receive periodic training in the execution of the SOPs. Monitoring SOPs include, but are not limited to, sampling and analysis for benthic macroinvertebrates, fish tissue toxics, ambient water chemistry and microbiology, benthic algae, fish communities, and aquatic plants. In addition to the WES laboratory, WPP often uses contract labs for sample analysis. All laboratories are evaluated for analytical accuracy and precision using double-blind QC samples, Proficiency Testing materials, and/or inter-laboratory comparison test samples.

WPP's commitment and strong emphasis on quality data and quality decision-making remains a core operating principle. Each WPP staff person is responsible for adhering to the requirements of WPP's QAPP and related SOPs, and ensuring that quality control processes, procedures, and policies are applied to the collection, management, and analysis of data. This includes becoming familiar with the QA/QC expectations, individual duties and responsibilities, QA/QC principles and practices, QA/QC-related training sessions, SOPs and guidelines for staff use, and approved QA/QC protocols (QAPPs, SOPs, etc.). WPP's QA Analyst oversees QAPP implementation for all WPP data operations.

To ensure a high degree of relevance and validity for computer modeling results, WPP also maintains an EPA-approved TMDL modeling QAPP. The modeling QAPP covers quality assurance and quality control aspects of water quality modeling, with specific emphasis on model applications related to TMDL development, and is intended to generally cover the most important factors that affect the credibility of model results, such as model selection, quality of input data, meeting data quality objectives (DQOs) for model parameterization (calibration), adherence to good modeling practices, sensitivity analyses, and overall uncertainty estimates for model output. The TMDL modeling QAPP is an appendix to the WPP programmatic QAPP.

In addition to WPP-generated data, WPP relies on data and information from outside or external groups to inform decision-making. Water quality data and information are collected by numerous parties and organizations in Massachusetts with the intent that WPP will use their information for making use assessments and other watershed management decisions. Specific WPP staff (e.g., QA Analyst, External Monitoring & Data Coordinator) support outreach activities and communication, review of external SOPs, SAPs, QAPPs, and related data validation and data submittal and scoring of data submittals for usability by WPP. Additional information can be found on the External Data Submittals to the Watershed Planning Program webpage.

Resources needed to implement this program element:

- *Funding for full-time staff resources to manage WPP QA/QC efforts*
- *Funding for full-time staff resources to assist with data validation of external data sources*

VIII. Data Management

WPP has customized and is maintaining a commercial database system for its chemical, physical, and biological data. A database system (Environmental Quality Information System, EQuIS) is being utilized to consolidate, streamline, and standardize data handling and QA/QC activities, as well as to provide tools for data sharing with the public and EPA via WQX. The primary purpose of implementing EQuIS is to provide secure, long-term storage of quality-assured chemical, physical, and biological sampling data and appropriate metadata for water quality assessments and other planning needs under the purview of WPP.

WPP's implementation of EQuIS includes the following data types (including associated metadata):

- Ambient surface water quality data (physical/chemical results, including continuous probe data)
- Benthic macroinvertebrate data
- Fish community data
- Fish toxics data

The data and information maintained in EQuIS enable MassDEP to meet its key obligations under the CWA by supporting statewide waterbody assessment and cleanup activities and production of the CWA §305(b) / §303(d) Integrated Report, development of TMDLs, and use of the EPA Assessment TMDL Tracking and Implementation System (ATTAINS) databases (see below).

As with sample collection and analysis, attention to quality is a fundamental principle applied to all phases of WPP's data systems, including raw data processing, validation procedures, data storage, and publication. Critically important functions supporting data management include QA/QC planning, documentation, data entry, waterbody identification, station registration using GIS, data validation, Laboratory Information Systems (LIMS) coordination, and the use of Electronic Data Deliverables.

WPP applies extensive standardized procedures to compile, automate, and validate data. These procedures are well documented in WPP SOPs and include review of both field-recorded data and laboratory analytical data for conformance with the DQOs established in project-specific or programmatic QAPPs and SAPs. Detailed analysis of all available information, such as field notes, survey conditions, field and lab QC data and audit results that could affect data quality is performed. WPP's data validation process is in addition to separate quality assurance and quality control activities performed at the WES laboratory and contract analytical laboratories. Using this system, WPP can accept, qualify, or censor data results. Qualified data are still considered usable, albeit with caveat. Once data are validated, they are batch-uploaded to EQuIS and transmitted to WQX. Biological data are finalized through separate QC review procedures and uploaded to EQuIS.

For external data, WPP maintains a separate database (EDB) to store data submitted to WPP by external parties. This system is also used to score the data for usability in assessment decision-making.

WPP stores the results of its watershed assessment decisions in ATTAINS, which is maintained by EPA. WPP data are made available to outside parties via MassDEP's Water Quality Monitoring Program Data webpage and WPP's Water Quality Data Viewer.

Resources needed to implement this program element:

- *Funding for EQuIS implementation and maintenance*
- *Funding for electronic field tablet upgrades (as needed)*
- *Funding for Exchange Network Grant and other projects to enhance WPP's data systems and reporting technologies*

IX. Data Analysis and Assessment

Results of WPP's water quality monitoring efforts, combined with other credible data and information, constitute the basis for making water quality assessments in accordance with the requirements set forth in §305(b) of the CWA. Use-attainment determinations are made for each waterbody Assessment Unit (AU) for which adequate data and information are available. In many cases, little or no data are available for particular AUs. In these cases, waters are not assessed for any designated uses or are assessed as having "insufficient information". In fact, many small and/or unnamed streams and ponds have never been monitored or assessed.

Historical Water Quality Assessment Reports are available for all of Massachusetts' watersheds and coastal drainage areas on MassDEP's Water Quality Assessments webpage.

In 2002, EPA published the *Consolidated Assessment and Listing Methodology – Toward a Compendium of Best Practices* or CALM Document (EPA 2002) aimed at improving states' monitoring and assessment programs and making data and information more available to the public. The CALM Document provided guidance to the states on how to update and clarify the decision-making process for assessing the attainment of water quality standards. Prior to the 2012 CWA integrated reporting cycle, WPP included its assessment procedures in individual watershed assessment reports. Since then, WPP has published stand-alone MA CALM Guidance Manuals for each two-year reporting cycle. The MA CALM Guidance Manuals contain a brief summary of the MA SWQS that define the goals for water quality in the state, the requirements for assessing the quality of data to be used for CWA reporting, the methods of reviewing water quality data and information used by WPP to make use assessment and listing decisions, and the use of the ATTAINS database system for storing and reporting those decisions. Recent improvements to the MA CALM Guidance Manual have included new evaluation methods for long-term, continuous monitoring datasets (e.g., dissolved oxygen, conductivity, and temperature); screening methods to determine whether or not conditions are naturally occurring; more detailed screening guidelines used to make nutrient enrichment decisions, procedures and schema for analyzing bacteria data for primary and secondary contact recreation decisions; and updated evaluation methods for toxic pollutants. The latest MA CALM Guidance Manual is available on MassDEP's Water Quality Assessments webpage.

The availability of appropriate and reliable scientific data and technical information is fundamental to the CWA §305(b) reporting and §303(d) listing process. Under the requirements of MassDEP's QMP and WPP's quality assurance program, environmental data of known and documented quality and suitable for their intended use are consistently generated, analyzed, and utilized for decision-making. WPP's most recently validated data are utilized for making use assessment decisions. Ideally, these data are five years old or less. Although WPP relies most heavily on "internal" data collected as part of WPP's

ambient water quality monitoring program, “external” data from other state and federal agencies, local governments, drinking water utilities, volunteer organizations and other sources are also solicited and often considered when making assessment decisions. Both internal WPP and external data deemed reliable and usable constitute the basis for making water quality assessments in accordance with the requirements set forth in §305(b) and §303(d) of the CWA.

Section B.9 of WPP’s programmatic monitoring QAPP addresses the use of secondary or external data. WPP categorizes external data into three general levels, which are related to the monitoring objectives (i.e., why the data were collected):

- Educational/Stewardship-level
- Screening-level
- Regulatory/Assessment-level

While extremely important, data determined to be Level 1 generally do not meet the rigor (i.e., accuracy, precision, frequency, comparability, overall confidence, etc.) required for use in waterbody assessments or TMDL development. MassDEP would not use Level 1 data for CWA §305(b) or §303(d) decision-making. These data are commonly collected and/or can be used for educational and/or stewardship purposes. Data classified as Level 1 generally (1) lack an agency-approved QAPP, (2) may not use a state certified or otherwise qualified laboratory for analyses, and/or (3) lack representative, documented, and accurate data and/or metadata. Regardless of usability, WPP encourages groups to submit for review data that are anticipated to be classified as Level 1.

Screening-level data (Level 2) may meet the data quality objectives in the submitter’s QAPP but generally fail to meet one or more WPP criteria required for direct use in assessments (i.e., fail to meet criteria used in WPP’s monitoring program QAPP approved by the EPA). These data, however, are important for their potential to direct future sampling efforts or as supporting evidence.

Regulatory/Assessment-level data (Level 3) are determined by MassDEP, based on WPP's external data review procedures, to be directly usable for CWA §305(b) and §303(d) decision-making. These data are considered scientifically sound and legally defensible, and are typically the result of extensive planning, attention to detail, relatively stringent data quality objectives, training, standard field and lab procedures, metadata collection, project organization, and data verification. Contingent upon WPP staff review and approval, quality-controlled data can help determine if a waterbody is healthy (i.e., meeting water quality standards) or impaired (i.e., not supporting the designated use).

All external data submitted electronically are reviewed by WPP using a defined and consistent procedure. Use of WPP's data submittal template is required for external data submittals when not submitting data to EPA’s Water Quality eXchange (WQX). NOTE: QAPP approval, submittal of the data integrity statement, and/or submittal of monitoring data do

not guarantee that the data will be used by WPP for CWA §305(b), §314, and §303(d) decision-making.

External data can be submitted to WPP using guidelines found on MassDEP's External Data Submittals to the Watershed Planning Program webpage. All submitted external data are reviewed using a consistent procedure. Each potential secondary data source is evaluated using the following preliminary criteria: 1) adherence to an acceptable QAPP, including a laboratory quality assurance plan and associated SOPs for field sampling and laboratory analyses; 2) use of a state-certified (or as otherwise acceptable to MassDEP) analytical laboratory; and 3) availability of QC data supporting the validity of the data. Meeting these criteria provides a basic level of confidence that the data were generated using appropriate field sampling and analytical methods and that the data were assessed by the external group for accuracy, precision, and representativeness. External data meeting these criteria are then further reviewed by WPP staff to verify that the group's DQOs were met based on the QC data provided, compared to WPP's DQOs to identify any large discrepancies, reviewed for missing information, and analyzed for usability in assessments. External data can be considered unusable due to poor or undocumented QAPP implementation, lack of project documentation, incomplete reporting of data or information, poor quality control results, and/or project monitoring objectives unsuitable for WPP assessment purposes.

Sources of Information

The existing monitoring networks and program elements described under Monitoring Objective 1 in Section V constitute a major source of data and information for making assessment and listing decisions but are not the only sources utilized. Additional sources typically include monitoring data and information from MA sister agencies, federal agencies, non-governmental organizations, and other state and/or local partners (e.g., grants federally funded through the CWA [e.g., §314, §319, §104(b)3, or §604(b)]).

For the assessment of some designated uses, WPP is entirely reliant on data and information provided by other agencies. For example, the GIS data layer on shellfish classification areas, maintained and updated annually by the MA Division of Marine Fisheries (DMF), is used to assess the support status of the shellfish harvesting use. Similarly, while MassDEP collects data on mercury and other contaminants in fish tissue to support fish edibility risk assessments, assessment of the fish consumption use relies on whether the MA Department of Public Health (DPH) has issued fish consumption advisories.

While not exhaustive, the following list highlights multiple agencies and programs providing data and information to WPP to inform the integrated assessment and listing process:

- DFG fish population assessments are available statewide, primarily for freshwater riverine sites, and these are utilized in the assessment of the aquatic life use.

- DMF anadromous fishery technical reports and database are available for coastal systems. These resources provide data for evaluating barriers to fish passage as part of the aquatic life use assessment decision. Special studies conducted by DMF biologists (i.e., river herring habitat assessments and smelt spawning area studies) may also be utilized.
- The frequency and duration of public beach closures at marine and DCR-managed freshwater facilities.
- Whole Effluent Toxicity (WET) data, submitted as a requirement of NPDES wastewater discharge permits, provide information on the survival of test organisms exposed to ambient river water samples, and may be used to determine the support status of the aquatic life use.
- Releases from Combined Sewer Overflows (CSOs) discharging to waters that are not covered by variances in the MA SWQS.
- Stream discharge and water quality data from USGS continuous gaging sites (as well as estimated streamflows from ungauged sites). Data on such water quality variables as bacteria, chloride, ammonia, metals, nutrients, polycyclic aromatic hydrocarbons, and pesticides are available from USGS through their network.
- DER is managing Habitat Restoration Projects statewide involving such stream improvement measures as dam removal, tidal flow restoration, culvert size remediation, and urban river revitalization. Information generated by these projects may be used as part of the aquatic life use assessment.
- Precipitation and other climatic data are available from the Global Historical Climatology Network maintained by the National Oceanic and Atmospheric Administration's National Climatic Data Center, and from DCR's Rainfall Program.

Assessment Process Overview

Detailed assessment methodologies for individual designated uses (e.g., aquatic life, contact recreation, fish consumption, etc.) are presented in the Massachusetts CALM Guidance Manual. The latest CALM Guidance Manual is available on MassDEP's Water Quality Assessments webpage. A brief overview of the assessment process is described below.

The CWA §305(b) water quality reporting process used to generate the Massachusetts Integrated List of Waters is an essential ingredient of the Nation's water pollution control effort. It is the principal means by which the EPA, Congress, and the public gain awareness of existing surface water quality conditions, progress made in maintaining and restoring water quality, and the extent of remaining problems. States report on waterbodies within the context of supporting their designated uses. These uses include *Aquatic Life, Fish Consumption, Drinking Water, Primary Contact Recreation, Secondary Contact Recreation, Shellfish Harvesting* and *Aesthetics*.

The MA SWQS prescribe minimum water quality criteria to sustain the designated uses. The determination of whether a waterbody supports each of its designated uses is a function of the type(s), quality, and quantity of available data and information on that waterbody, and how that information is evaluated under the MA SWQS and MA CALM Guidance Manual. Although data/information older than five years are usually considered "historical" and used for descriptive purposes, they can be utilized in the use attainment determination provided they are known to reflect the current conditions. While the MA SWQS prescribe minimum water quality criteria to sustain the designated uses, numerical criteria are not available for every indicator of pollution. Best available guidance in the literature may be applied in lieu of actual numerical criteria. Excursions from criteria due solely to "naturally occurring" conditions do not constitute violations of the MA SWQS and are not causes of use impairment.

For each AU, designated uses are assessed as **supporting** or **not supporting**. When too little current data/information exists, the use is identified as having **insufficient information**. When no reliable data are available, the use is **not assessed**. It is important to note that not all waters are assessed. Many small and/or unnamed rivers, lakes, and estuarine areas have never been assessed; the status of their designated uses has never been reported to EPA in the Integrated List of Waters report nor is information on these waters maintained in ATTAINS.

The assessment process described here and in greater detail in the MA CALM Guidance Manual is applied to those waterbodies for which adequate targeted data and information are available and, as such, reporting on the condition of Massachusetts' waters has been limited in the past to a small percentage of water resources in the state. To provide complete coverage of selected waterbody types, both spatially and temporally, Massachusetts has also adopted three networks (wadeable rivers and stream; lakes and ponds; and coastal and estuarine waters) of randomly selected sampling sites that allow for statistically unbiased assessments that can be applied statewide. At the same time, WPP has designed its statistically valid probabilistic surveys with sufficient sampling replication at each randomly chosen site to provide the necessary data and information to complete targeted assessments for those sites. The probabilistic survey design achieves the goal of reporting, in accordance with CWA §305(b), the status of all waters without having to monitor each, in addition to reporting on individual waterbodies. These statistical survey results are reported to EPA and the public using ATTAINS.

Resources needed to implement this program element:

- *Cross-training in computer programming*

X. Reporting on Massachusetts Waters

Monitoring Reports and Technical Memoranda

WPP reports the results of its watershed-based water quality and biological monitoring surveys in individual technical reports or memoranda. A technical report or memorandum typically includes a brief explanation of why the monitoring was performed, the field and laboratory methods employed, and the sampling results with interpretive discussion, if applicable.

Watershed Assessments Documentation

Assessment decisions for each Integrated Reporting cycle are documented in the Integrated Report, public-facing, watershed-based decision documents, a published MassGIS geospatial layer, and in the publicly accessible ATTAINS database. For each AU, a use-support determination is made and, whenever possible, causes and sources of impairment are specified.

The data sources and decisions may also be maintained in internal WPP watershed "repository" documents that are not intended for publication, but that also contain the data and information reviewed when making the assessment and listing decisions. Documentation related to the latest Integrated Report is provided on the MassDEP's Integrated Lists of Waters & Related Reports webpage.

The Integrated List of Massachusetts Waters

EPA guidance provides the states with the option of presenting the status of all their assessed waters in a single integrated report and accompanying multi-part list, thus combining the reporting requirements of §305(b), §303(d) and §314 of the CWA (EPA 2001). States choosing this option list each assessment unit (i.e., waterbody or segment thereof) in one of the following five categories:

1) Unimpaired and not threatened for all designated uses;
2) Unimpaired for some uses and not assessed for others;
3) Insufficient information to make assessments for any uses;
4) Impaired or threatened for one or more uses, but not requiring the calculation of a TMDL; or
5) Impaired or threatened for one or more uses and requiring a TMDL.

Category 4 is further divided into three sub-categories – 4a, 4b and 4c – depending upon the reason that TMDLs are not needed. Category 4a includes waters for which the required TMDL(s) have already been completed and approved by EPA. However, since MassDEP chooses to list each segment in only one category, waters that have an approved TMDL for some pollutants, but not others, remain in Category 5 until TMDLs are approved for all

pollutants impairing those waters. Category 4b was proposed by EPA to list waters for which pollution control measures other than TMDLs are expected to attain all designated uses. Finally, the CWA distinguishes between "pollutants," such as nutrients, metals, pesticides, solids and pathogens, that all require TMDLs and "pollution," such as low flow, habitat alterations or non-native species infestations, that do not require TMDLs. Waterbodies impaired solely by "pollution" are included in Category 4c unless these waterbodies also have approved TMDLs, in which case they appear in Category 4a.

Waters listed in Category 5 constitute the CWA §303(d) list of waters impaired by one or more pollutants and requiring the derivation of TMDLs. As such, this list is subject to public review and comment and must be formally approved by EPA. Categories 1 – 4 are submitted in fulfillment of the requirements under CWA §305(b). The most recent EPA-approved Integrated Report and related information is available on MassDEP's Integrated Lists of Waters & Related Reports webpage and historical and current Integrated Report decisions are available using the MassDEP Water Quality Data Viewer.

XI. Programmatic Evaluation

A high priority of MassDEP is assuring that programmatic evaluation occurs for all aspects of the monitoring design and at varying levels of detail. for example, WPP prepares QAPPs for all the monitoring efforts, which are submitted to EPA for review. Detailed SAPs are prepared by WPP Monitoring Coordinators and reviewed by supervising staff. Mid-course corrections are implemented, as needed, and routine changes and additions are recommended and incorporated into future monitoring cycles. Progress on individual projects is communicated at weekly staff meetings. Finally, the EPA conducts state quality system assessments, approximately every five years, to evaluate MassDEP's adherence to the QMP.

Outreach to stakeholders is an ongoing process consisting of meetings with volunteers and sister agencies, and attendance at workshops and conferences. WPP's External Data & Monitoring Coordinator, QA Analyst, and other staff coordinate with external groups on data submittals to WPP, review of draft external group QAPPs, technical assistance, and public comments.

Strategic planning for the monitoring program is performed as needed considering the addition (or loss) of personnel or other resources, the release of new monitoring and assessment guidance from EPA, or changes to the MA SWQS or other pertinent policies.

XII. General Support and Infrastructure Planning

MassDEP will continue to conduct water monitoring and related activities to provide the timely scientific data and information that are essential for resource management decision-making. Monitoring resource needs of MassDEP are summarized following the description of each individual program element throughout this report. Several program enhancements are required, not only to implement the new program elements in this strategic plan, but also to maintain existing elements. In addition, the implementation of each new monitoring program element will increase the demand for support services, such as QA/QC and data management. Long-term staffing and funding support are critical to the development and implementation of the comprehensive water monitoring program.

The resources needed to continue to implement the monitoring plan effectively generally fall into four categories: 1) staffing; 2) funding for equipment and supplies; 3) funding for contractual services and 4) training. A summary of these needs is presented below.

Staffing

MassDEP has made a concerted effort to ensure an appropriate level of monitoring and support personnel and continues to utilize partnerships with other government agencies and NGOs. While MassDEP continues to utilize a highly trained workforce to achieve watershed management program goals, full-time Monitoring Coordinators and seasonal staff support program elements designed to fulfill all five monitoring objectives outlined in Section V. Additional full-time personnel would assist in the development and implementation of targeted monitoring to support assessment and listing decisions, TMDL development, criteria development, and water management program effectiveness. WPP relies each year on CWA §106 supplemental funding to support five seasonal employees to achieve monitoring objectives.

MassDEP also seeks to continue its successful eelgrass mapping program. The status (i.e., extent and health) of eelgrass populations constitutes the primary source of information used to assess the aquatic life use in estuarine waters and is an important biological indicator for the MEP. As such, successional planning will ensure the effective continuation of the program.

As the William X. Wall Experiment Station continues to expand their analytical capabilities, an increase to the current staff complement will ensure the continued effective and timely analysis of samples generated by both existing and new monitoring program elements.

Funding for Monitoring Equipment and Supplies

To continue MassDEP's effective and wide-ranging monitoring of watersheds throughout the Commonwealth, funding will be needed for the purchase of monitoring equipment and supplies for all monitoring elements covered by this plan. All the equipment and supplies

purchased each year to support existing monitoring programs are funded by CWA §106 and §319 grants. Likewise, MassDEP's Wetlands Program and ORS will need funding for equipment and supplies to continue wetland assessments and research on mercury levels in fish, respectively.

Additionally, a continuous commitment to replace and update analytical instrumentation at WES is needed to realize the effective implementation of ongoing and new monitoring programs. Furthermore, purchasing new instrumentation for emerging contaminants of concern will expand capabilities at WES. This support should be planned well in advance for the anticipated needs of MassDEP and other agencies serviced by WES.

Contractual Support

MassDEP will continue to rely, to a limited extent, on in-kind laboratory services from EPA and, even more extensively, on the use of contractual services to fill resource gaps in the existing water quality monitoring and management program. Additional funding will be needed to secure commercial laboratories or contractors to perform non-routine analyses, or to keep within prescribed sample holding times when monitoring activities are performed in remote watersheds. Contracted laboratory support will also be needed for bacteriological analyses of samples obtained from waterbodies far from WES and or WPP, as well as for taxonomic identifications of macroinvertebrates and phytoplankton.

Funding will be needed in the future to support important monitoring activities that are beyond the existing monitoring capabilities of MassDEP. A need exists for the establishment of long-term monitoring stations in selected interstate rivers (e.g., Blackstone and Connecticut rivers, etc.) to quantify pollutant loads at state boundaries and to measure the effectiveness of measures taken to reduce those loads.

MassDEP currently relies on EPA N-STEPS for development activities to support potential numeric nutrient criteria in coastal and marine waters. Further technical support of this kind will be needed to advance nutrient criteria development and potentially to further the establishment and implementation of biocriteria over the next several years.

WPP continues to implement and maintain the EQuIS database system to support data management needs. It is critical to WPP's data operations that a functioning water quality database is maintained for staff use and CWA reporting. WPP utilizes available state and/or federal funds to support the development of EQuIS.

Training

While WPP conducts in-house training each year in the safe and proper conduct of its field and laboratory techniques, more opportunities for skill enhancement and career development through attendance at conferences and workshops are also desirable. While future training costs are not actually estimated for the purpose of this monitoring strategy,

career development will be an important consideration for existing and future monitoring and assessment staff.

XIII. References

Barbour, M.T., J. Gerritsen, B.D. Snyder and J.B. Stribling. 1999. *Rapid Bioassessment Protocols for Use in Streams and Wadable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition*. EPA 841-B-99-002. U.S. Environmental Protection Agency, Office of Water, Washington D.C.

DeSimone, L.A., P.A. Steeves, and M.J. Zimmerman. 2001. *Statewide Water-Quality Network for Massachusetts*. Water-Resources Investigations Report 01-4081. U.S. Geological Survey, Northborough, MA.

EPA. 1995. *A Conceptual Framework to Support Development and Use of Environmental Information in Decision-Making*. EPA 239-R-95 012. U.S. Environmental Protection Agency, Office of Policy, Planning and Evaluation. Washington, D.C.

ITFM. 1995. *The Strategy for Improving Water-Quality Monitoring in the United States – Final Report of the Intergovernmental Task Force on Monitoring Water Quality*. U.S. Geological Survey, Reston, VA.

MassDEP. 2005. *A Water Quality Monitoring Strategy for the Commonwealth of Massachusetts*. CN 203.0 Massachusetts Department of Environmental Protection, Division of Watershed Management. Worcester, MA.

MassDEP. 2016. *Massachusetts Consolidated Assessment and Listing Methodology (CALM) Guidance Manual for the 2016 Reporting Cycle*. CN 445.0 Massachusetts Department of Environmental Protection, Division of Watershed Management. Worcester, MA.

MassDEP. 2018. *A Strategy for Monitoring and Assessing the Quality of Massachusetts' Waters to Support Multiple Water Resource Management Objectives*. CN 203.5 Massachusetts Department of Environmental Protection, Division of Watershed Management, Watershed Planning Program. Worcester, MA.

MassDEP. 2020. Massachusetts Probabilistic Monitoring and Assessment Program Assessment of Wadeable Rivers and Streams 2011-2015. CN 529.0, Massachusetts Department of Environmental Protection, Bureau of Water Resources, Division of Watershed Management, Watershed Planning Program. Worcester, MA.

MassDEP. 2021. Final Massachusetts Integrated List of Waters for the Clean Water Act 2018/2020 Reporting Cycle. CN 505.1, Massachusetts Department of Environmental Protection, Bureau of Water Resources, Division of Watershed Management, Watershed Planning Program. Worcester, MA.

MassDEP. 2024a. Massachusetts Nonpoint Source Management Plan 2025 – 2029. CN 605.0, Massachusetts Department of Environmental Protection, Bureau of Water Resources, Division of Watershed Management, Watershed Planning Program. Worcester, MA.

MassDEP. 2024b. Massachusetts Vision 2.0: Clean Water Act Section 303(d) and Total Maximum Daily Load Development. CN 591.1, Massachusetts Department of Environmental Protection, Bureau of Water Resources, Division of Watershed Management, Watershed Planning Program. Worcester, MA.

Plafkin, J. L., M. T. Barbour, K. D. Porter, S. K. Gross and R. M. Hughes. 1989. Rapid Bioassessment Protocols for Use in Streams and Rivers: Benthic Macroinvertebrates and Fish. EPA/444/4-89-001. Assessment and Watershed Protection Division, U.S. Environmental Protection Agency, Washington, D.C.

U.S. EPA. 2001. *2002 Integrated Water Quality Monitoring and Assessment Report Guidance* Memorandum. Robert H. Wayland III, Director, Office of Wetlands, Oceans and Watersheds. November 19, 2001.

U.S. EPA. 2002. *Consolidated Assessment and Listing Methodology*. *Toward a Compendium of Best Practices*. Office of Wetlands, Oceans and Watersheds, U.S. Environmental Protection Agency, Washington, D.C.

U.S. EPA. 2003. *Elements of a State Water Monitoring and Assessment Program*. EPA 841-B-03-003. Assessment and Watershed Protection Division, Office of Wetlands, Oceans and Watersheds, U.S. Environmental Protection Agency, Washington, D.C.

Wong, Wai Hing. J.J. Dudula, T. Beaudoin, K. Groff, W. Kimball, J. Swigor. 2018. Declining ambient water phosphorus concentrations in Massachusetts' rivers from 1999 to 2013: Environmental protection works. In Water Research. Volume 139. pp 108-117. 26 March 2018. Available at https://doi.org/10.1016/j.watres.2018.03.053

Appendix 1

MassDEP's Targeted and Probabilistic Monitoring Schedule through 2040

Table A 1. MassDEP monitoring timelines through 2040 for Targeted Assessment Monitoring (TAM) and the Massachusetts Probabilistic Monitoring and Assessment Program (MAP2).

<table>
<tr><th>YEAR</th><th>TARGETED</th><th>PROBABILISTIC</th></tr>
<tr><td>2020</td><td>CWF Monitoring</td><td rowspan="2">MAP2 Coastal & Marine (2020-2023)</td></tr>
<tr><td>2021
2022
2023
2024
2025
2026
2027</td><td rowspan="2">Seven-Year TAM Cycle (2021-2027)</td><td></td></tr>
<tr><td>2028</td><td>TAM Transition Year</td><td rowspan="2">MAP2 Rivers & Streams (2025-2028)</td></tr>
<tr><td>2029
2030
2031
2032</td><td>Four-Year TAM Cycle (2029-2032)</td><td>MAP2 Lakes & Ponds (2029-2032)</td></tr>
<tr><td>2033
2034
2035
2036</td><td>Four-Year TAM Cycle (2033-2036)</td><td>MAP2 Coastal & Marine (2033-2036)</td></tr>
<tr><td>2037
2038
2039
2040</td><td>Four-Year TAM Cycle (2037-2040)</td><td>MAP2 Rivers & Streams (2037-2040)</td></tr>
</table>

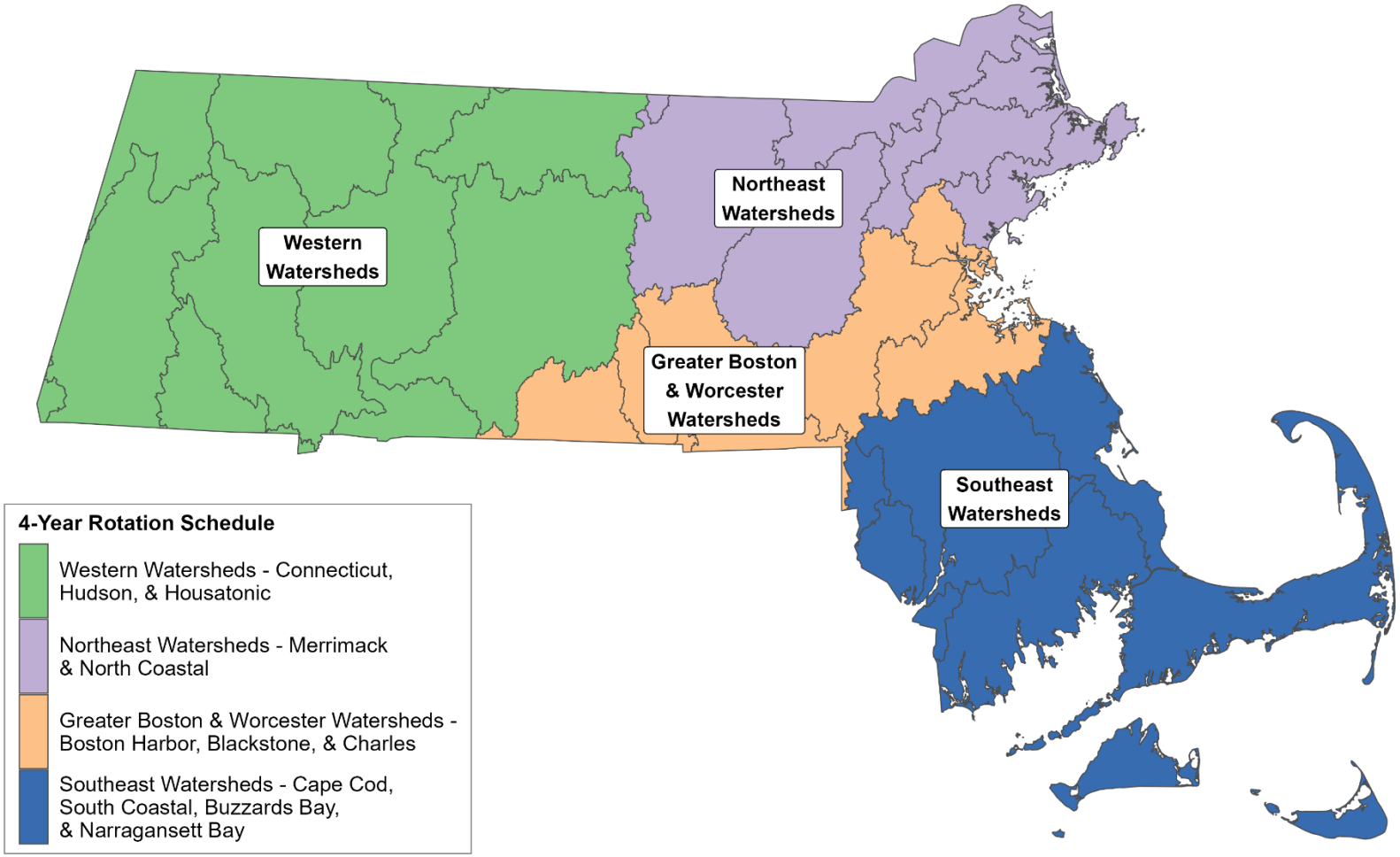

Figure A 1. MassDEP's basin groupings for the four-year (2029 – 2032) Targeted Assessment Monitoring (TAM) cycle.

Appendix 2

MassDEP's Basin Groupings for the current Seven-Year Targeted Assessment Monitoring Cycle

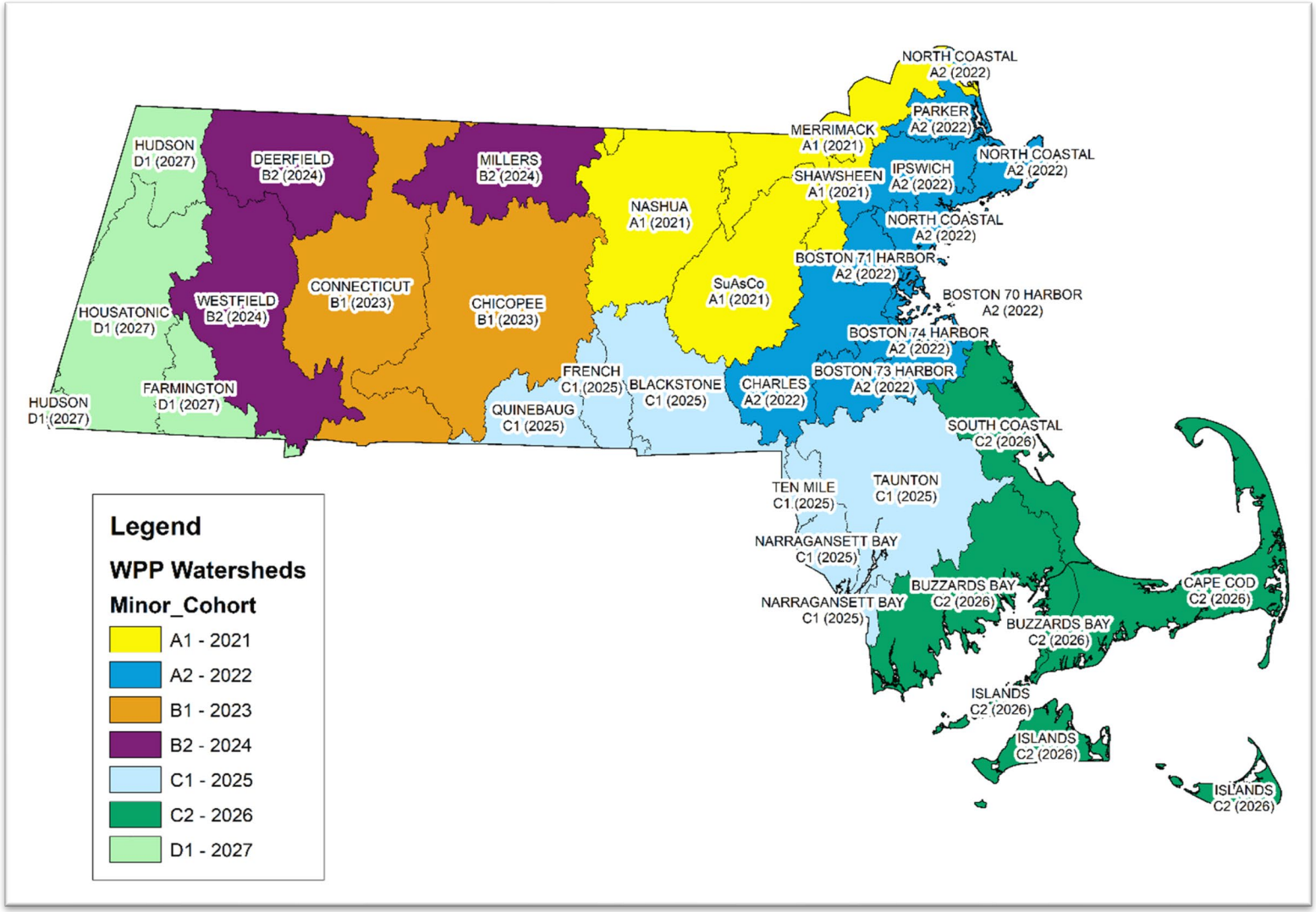

Figure A 2. MassDEP's basin groupings for the seven-year (2021 – 2027) Targeted Assessment Monitoring (TAM) cycle.