EXHIBIT I
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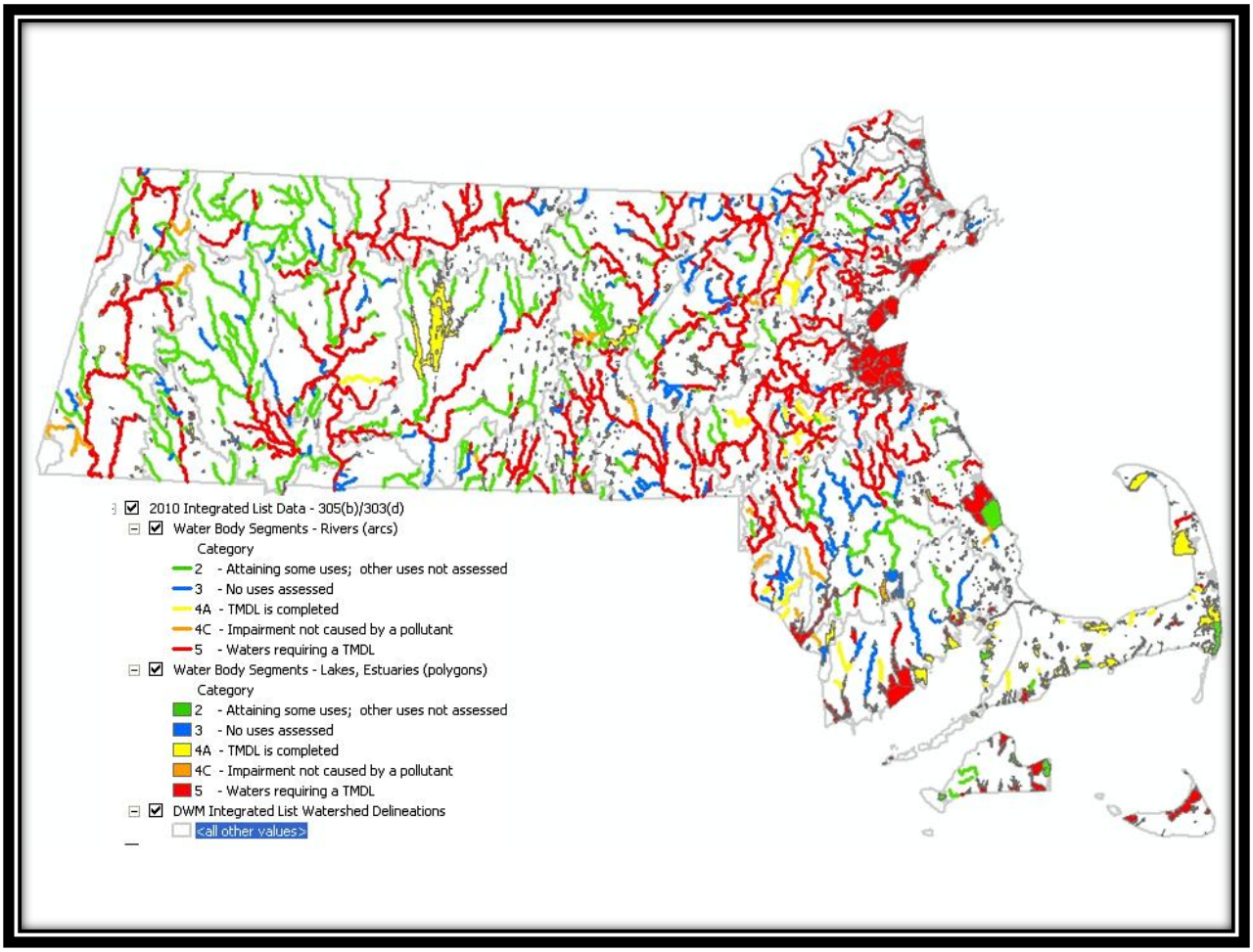
Massachusetts Consolidated Assessment and Listing Methodology (CALM) Guidance Manual
July 2012



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I. INTRODUCTION

The *Massachusetts Consolidated Assessment and Listing Methodology (CALM) Guidance Manual* was prepared to satisfy reporting requirements pursuant to Sections 305(b), 314, and 303(d) of the Federal Clean Water Act (CWA) and to fulfill the Performance Partnership Agreement (PPA) between the Environmental Protection Agency (EPA) and the Massachusetts Department of Environmental Protection (MassDEP). This manual contains a brief summary of the Massachusetts Surface Water Quality Standards (SWQS) that define the goals for water quality in the state (MassDEP 2006), 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 the MassDEP Division of Watershed Management (DWM) analysts to make use assessment decisions, and the use of the EPA's Assessment Database (ADB) for consolidated reporting and the generation of the *2012 Massachusetts Integrated List of Waters* report (Figure 1).

The CWA directs states to monitor and report on the condition of their water resources. This water quality reporting process is an essential aspect of the Nation's water pollution control effort. It is the principal means by which the EPA, Congress, and the public evaluate existing water quality, assess progress made in maintaining and restoring water quality, and determine the extent of remaining problems. The directives of the CWA and the process by which the MassDEP DWM staff implemented the consolidated reporting for the 2012 cycle are illustrated in Figure 2 and are described in more detail in this document.

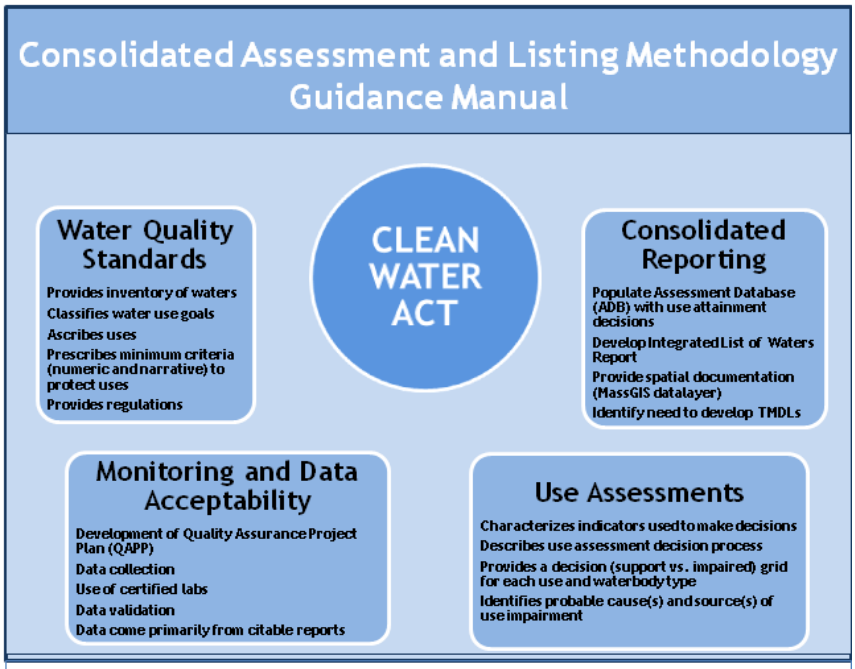

Figure 1. Components of Consolidated Assessment and Listing Methodology Guidance Manual.

Section 305(b) codifies the process whereby waters are evaluated with respect to their capacity to support designated uses as defined in the SWQS. These uses include *Aquatic Life*, *Fish Consumption*, *Drinking Water*, *Shellfish Harvesting*, *Primary* (e.g., swimming) and *Secondary* (e.g., boating) *Contact Recreation*, *Aesthetics, Agricultural, and Industrial* (MassDEP 2006). The 305(b) process entails assessing the water quality conditions suitable to attain each of these uses, where applicable, for rivers, lakes and coastal waters in the state and identifies, wherever possible, causes and sources of use impairment.

Through the 2012 reporting cycle the MassDEP has documented assessment decisions and the data used to make them in individual watershed assessment reports (http://www.mass.gov/dep/water/resources/wqassess.htm) (Figure 2.). For the 2010 and 2012 reporting cycles the assessment decisions themselves have been stored in the EPA-developed Access database, the ADB V2.3.1. This tool is now used by the MassDEP for producing the *Integrated List of Waters* report and for providing the electronic data to the EPA. The *Integrated List of Waters* report allows states to provide the status of all their assessed waters in a single, multi-part list -- each waterbody or segment thereof is listed in one of five categories. Development of Category 5, which is the "List of Impaired Waters" mandated in Section 303(d) of the CWA (the 303(d) List), includes a more rigorous public review and comment process than does reporting under the remaining four categories and the final version of this List must be formally approved by the EPA.

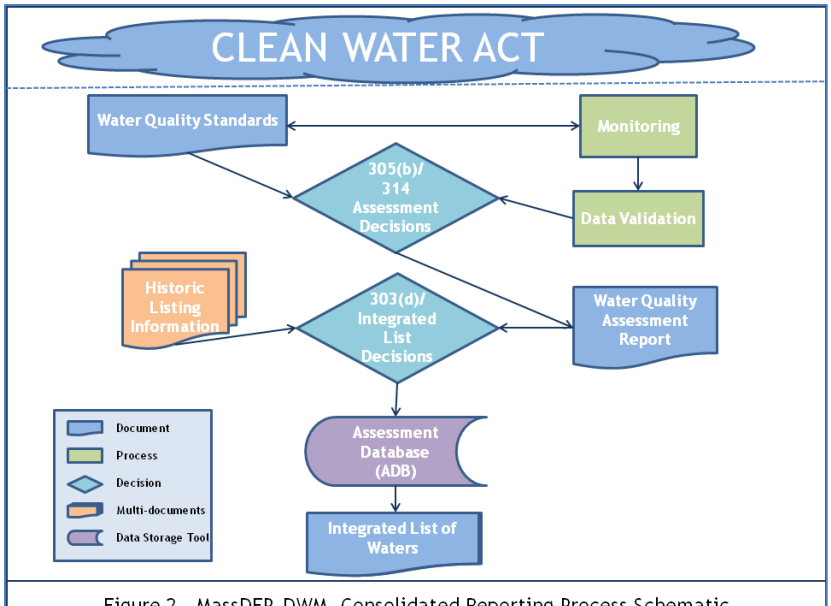

Figure 2. MassDEP, DWM, Consolidated Reporting Process Schematic.

II. WATER QUALITY STANDARDS

The Massachusetts Surface Water Quality Standards (SWQS) serve as the foundation for the state's water quality management program -- 305(b) water quality assessments, 303(d) lists of impaired waters, TMDLs, National Pollutant Discharge Elimination System (NPDES) permits, and nonpoint-source management measures. The SWQS 1) define the *goals* for a waterbody by designating the most sensitive uses for which the surface waters of the Commonwealth shall be enhanced, maintained and protected; 2) prescribe minimum water quality criteria required to sustain the designated uses (both numeric and narrative criteria); and 3) include provisions for the maintenance and protection of existing uses and high quality waters (antidegradation policy), which may include the prohibition of discharges (MassDEP 2006). These regulations should undergo public review every three years. The surface waters are segmented and each segment is assigned to one of the six classes described below (314 CMR 4.05 and 4.06 in MassDEP 2006). Each class is identified by the most sensitive and, therefore, governing water uses to be achieved and protected. Other waters not specifically designated in 314 CMR 4.06 or listed in the tables to 314 CMR 4.00 (commonly referred to as "unlisted waters" by DWM analysts) are Class B for inland waters and Class SA for coastal and marine waters. Inland fisheries designations and coastal and marine shellfishing designations for unlisted waters shall be on a case-by-case basis as necessary. Surface waters may be suitable for other beneficial uses, but shall be regulated by MassDEP to protect and enhance both existing (attained in waterbody on or after November 28, 1975) and designated uses.

CLASSIFICATION OF MASSACHUSETTS SURFACE WATERS – RIVERS, LAKES, ESTUARIES

INLAND WATER CLASSES

CLASS A *- These waters include waters designated as a source of public water supply and their tributaries. They are designated as excellent habitat for fish, other aquatic life and wildlife, including for their reproduction, migration, growth and other critical functions, and for primary and secondary contact recreation, even if not allowed. These waters shall have excellent aesthetic value. These waters are protected as Outstanding Resource Waters.*

CLASS B *- These waters are designated as a habitat for fish, other aquatic life, and wildlife, including for their reproduction, migration, growth and other critical functions, and for primary and secondary contact recreation. Where designated in 314 CMR 4.06, they shall be suitable as a source of public water supply with appropriate treatment ("Treated Water Supply"). Class B waters shall be suitable for irrigation and other agricultural uses and for compatible industrial cooling and process uses. These waters shall have consistently good aesthetic value.*

CLASS C *- These waters are designated as a habitat for fish, other aquatic life and wildlife, including for their reproduction, migration, growth and other critical functions, and for secondary contact recreation. These waters shall be suitable for the irrigation of crops used for consumption after cooking and for compatible industrial cooling and process uses. These waters shall have good aesthetic value.*

COASTAL AND MARINE CLASSES

CLASS SA *- These waters are designated as an excellent habitat for fish, other aquatic life and wildlife, including for their reproduction, migration, growth and other critical functions, and for primary and secondary contact recreation. In certain waters, excellent habitat for fish, other aquatic life and wildlife may include, but is not limited to, sea grass. Where designated in the tables to 314 CMR 4.00 for shellfishing, these waters shall be suitable for shellfish harvesting without depuration (Approved and Conditionally Approved Shellfish Areas). These waters shall have excellent aesthetic value.*

CLASS SB *- These waters are designated as a habitat for fish, other aquatic life and wildlife, including for their reproduction, migration, growth and other critical functions, and for primary and secondary contact recreation. In certain waters, habitat for fish, other aquatic life and wildlife may include, but is not limited to, seagrass. Where designated in the tables to 314 CMR 4.00 for shellfishing, these waters shall be suitable for shellfish harvesting with depuration (Restricted and Conditionally Restricted Shellfish Areas). These waters shall have consistently good aesthetic value.*

CLASS SC *- These waters are designated as a habitat for fish, other aquatic life and wildlife, including for their reproduction, migration, growth and other critical functions, and for secondary contact recreation. They shall also be suitable for certain industrial cooling and process uses. These waters shall have good aesthetic value.*

The Massachusetts SWQS prescribe minimum water quality criteria to sustain the existing and designated uses. These criteria are summarized in Table 1. Furthermore, the standards describe the hydrological conditions at which water quality criteria must be applied (MassDEP 2006). In rivers the lowest flow conditions at and above which aquatic life criteria must be applied are the lowest mean flow for seven consecutive days to be expected once in ten years (7Q10). In waters where flows are regulated by dams or similar structures the lowest flow conditions at which aquatic life criteria must be applied are the flows equal to or exceeded 99% of the time on a yearly basis or another equivalent flow that has been agreed upon (see Mass DEP 2006 for more detail). In coastal and marine waters and for lakes the MassDEP will determine on a case-by-case basis the most severe hydrological condition for which the aquatic life criteria must be applied.

Table 1. Summary of Massachusetts Surface Water Quality Standards (MassDEP 2006, MA DPH 2002, FDA 2003).

Dissolved Oxygen	Class A Cold Water Fishery (CWF) and Class B Cold Water Fishery (BCWF) and Class SA: ≥6.0 mg/L Class A and Class B Warm Water Fishery (BWWF) and Class SB: ≥5.0 mg/L Class C: Not <5.0 mg/L at least 16 hours of any 24-hour period and not <3.0 mg/L at any time. Class SC: Not <5.0 mg/L at least 16 hours of any 24-hour period and not <4.0 mg/L anytime. For all classes, where natural background conditions are lower than the criteria stated for each class, DO shall not be less than natural background conditions. Natural seasonal and daily variations that are necessary to protect existing and designated uses shall also be maintained.
Temperature	Class A CWF: ≤68°F (20°C) based on the mean of the daily maximum temperature over a seven day period in cold water fisheries, unless naturally occurring and ΔT due to a discharge ≤1.5°F (0.8°C). Class A WWF: ≤83°F (28.3°C) and ΔT due to a discharge ≤1.5°F (0.8°C). Class BCWF: ≤68°F (20°C) based on the mean of the daily maximum temperature over a seven day period in all cold water fisheries, unless naturally occurring, and ΔT due to a discharge ≤Δ3°F (1.7°C) Class BWWF: ≤83°F (28.3°C) and ΔT due to a discharge ≤5°F (2.8°C) in rivers (based on the minimum expected flow for the month) and ΔT due to a discharge ≤3°F (1.7°C) in the epilimnion (based on the monthly average of maximum daily temperatures) in lakes, Class C and Class SC: ≤85°F (29.4°C) and ΔT due to a discharge ≤5°F (2.8°C) Class SA: ≤85°F (29.4°C) nor a maximum daily mean of 80°F (26.7°C) and ΔT due to a discharge ≤1.5°F (0.8°C) Class SB: ≤85°F (29.4°C) nor a maximum daily mean of 80°F (26.7°C) and Δ T due to a discharge ≤1.5°F (0.8°C) between July and September and ≤4.0°F (2.2°C) between October and June. *For all classes, natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained. There shall be no changes from natural background conditions that would impair any uses assigned to each class, including those conditions necessary to protect normal species diversity, successful migration, reproductive functions or growth of aquatic organisms.* For CWF waters, where a reproducing cold water aquatic community exists at a naturally higher temperature, the temperature necessary to protect the community shall not be exceeded and natural daily and seasonal temperature fluctuations necessary to protect the community shall be maintained. Class B, C, SA, SB, and SC: See MassDEP 2006 for language specific to alternative effluent limitations relating to thermal discharges and cooling water intake structures.
pH	Class A, Class BCWF and Class BWWF: 6.5 - 8.3 SU and Δ0.5 outside the natural background range. Class C: 6.5 - 9.0 SU and Δ1.0 outside the natural background range. Class SA and Class SB: 6.5 - 8.5 SU and Δ0.2 SU outside the natural background range. Class SC: 6.5 - 9.0 SU and Δ0.5 SU outside the natural background range. There shall be no change from natural background conditions that would impair any use assigned to each class.
Solids	All Classes: *These waters shall be free from floating, suspended, and settleable solids in concentrations or combinations that would impair any use assigned to each class, that would cause aesthetically objectionable conditions, or that would impair the benthic biota or degrade the chemical composition of the bottom.*
Color and Turbidity	All Classes: *These waters shall be free from color and turbidity in concentrations or combinations that are aesthetically objectionable or would impair any use.*
Oil and Grease	Class A and Class SA: *Waters shall be free from oil and grease, petrochemicals and other volatile or synthetic organic pollutants.* Class SA: *Waters shall be free from oil and grease and petrochemicals.* Class B, Class C, Class SB and Class SC: *Waters shall be free from oil, grease, and petrochemicals that produce a visible film on the surface of the water, impart an oily taste to the water or an oily or other undesirable taste to the edible portions of aquatic life, coat the banks or bottom of the water course, or are deleterious or become toxic to aquatic life.*
Taste and Odor	Class A and Class SA: *None other than of natural origin.* Class B, Class C, Class SB and Class SC: *None in such concentrations or combinations that are aesthetically objectionable, that would impair any use assigned to each class, or that would cause tainting or undesirable flavors in the edible portions of aquatic life.*
Aesthetics	All Classes: *All surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance species of aquatic life.*

Table 1. Summary of Massachusetts Surface Water Quality Standards (MassDEP 2006, MA DPH 2002, FDA 2003).

Toxic Pollutants	All Classes: *All surface waters shall be free from pollutants in concentrations or combinations that are toxic to humans, aquatic life or wildlife. For pollutants not otherwise listed in 314 CMR 4.00, the National Recommended Water Quality Criteria: 2002, EPA 822-R-02-047, November 2002 published by EPA pursuant to Section 304(a) of the Federal Water Pollution Control Act, are the allowable receiving water concentrations for the affected waters, unless the Department either establishes a site specific criterion or determines that naturally occurring background concentrations are higher. The Department shall use the water quality criteria for the protection of aquatic life expressed in terms of the dissolved fraction of metals when EPA's 304(a) recommended criteria provide for use of the dissolved fraction* (see Mass DEP 2006 for more detail regarding permit limits, conversion factors, site specific criteria).
Nutrients	*Unless naturally occurring, all surface waters shall be free from nutrients in concentrations that would cause or contribute to impairment of existing or designated uses and shall not exceed the site specific criteria developed in a TMDL or as otherwise established by the Department pursuant to these Standards.*
Bacteria (MassDEP 2006 and MA DPH 2002) Class A criteria apply to the *Drinking Water Use*. Class B and SB criteria apply to *Primary Contact Recreation Use* while Class C and SC criteria apply to *Secondary Contact Recreation Use*.	Class A: *At water supply intakes in unfiltered public water supplies:* either fecal coliform shall not exceed 20 organisms/100 ml in all samples taken in any six month period, or total coliform shall not exceed 100 organisms/ 100 ml in 90% of the samples taken in any six month period. If both total and fecal coliform are measured, then only the fecal coliform criterion must be met. Class A other waters, Class B: Where *E.* coli is the chosen indicator at public bathing beaches as defined by MA DPH: The geometric mean of the five most recent *E. coli* samples taken within during the same bathing season shall not exceed 126 colonies/ 100 ml and no single sample taken during the bathing season shall exceed 235 colonies/ 100 ml (these criteria may be applied on a seasonal basis at the Department's discretion). Where Enterococci are the chosen indicators at public bathing beaches*:* The geometric mean of the five most recent samples taken during the same bathing season shall not exceed 33 colonies /100 ml and no single *Enterococci* sample taken during the bathing season shall exceed 61 colonies /100 ml. For other waters and, during the non bathing season, for waters at public bathing beaches: The geometric mean of all *E. coli* samples taken within the most recent six months shall not exceed 126 colonies/ 100 ml typically based on a minimum of five samples and no single sample shall exceed 235 colonies/ 100 ml. These criteria may be applied on a seasonal basis at the Department's discretion. The geometric mean of all *Enterococci* samples taken within the most recent six months shall not exceed 33 colonies/ 100 ml typically based on a minimum of five samples and no single sample shall exceed 61 colonies/ 100 ml. These criteria may be applied on a seasonal basis at the Department's discretion. Class C: *The geometric mean of all E. coli samples taken within the most recent six months shall not exceed 630 E. coli/ 100 ml, typically based on a minimum of five samples and 10% of such samples shall not exceed 1260 E. coli/ 100 ml.* This criterion may be applied on a seasonal basis at the discretion of the Department. Class SA: Waters designated for shellfishing: *Fecal coliform bacteria shall not exceed a geometric mean (Most Probable Number (MPN) method) of 14 organisms/100 ml, nor shall more than 10% of the samples exceed an MPN of 28 organisms/100 ml, or other values of equivalent protection based on sampling and analytical methods used by the Massachusetts Division of Marine Fisheries and approved by the National Shellfish Sanitation Program in the latest revision of the Guide for the Control of Molluscan Shellfish Areas (more stringent regulations may apply, see 314 CMR 4.06(1)(d)(5)).* Class SB: Waters designated for shellfishing: *Fecal coliform median or geometric mean MPN shall not exceed 88 organisms/100 ml, nor shall more than 10% of the samples exceed an MPN of 260 organisms/100 ml or other values of equivalent protection based on sampling and analytical methods used by the Massachusetts Division of Marine Fisheries and approved by the National Shellfish Sanitation Program in the latest revision of the Guide for the Control of Molluscan Shellfish Areas (more stringent regulations may apply, see 314 CMR 4.06(1)(d)(5)).* Class SA and Class SB: At public bathing beaches, as defined by MA DPH: No single *Enterococci* sample taken during the bathing season shall exceed 104 colonies /100 ml and

Table 1. Summary of Massachusetts Surface Water Quality Standards (MassDEP 2006, MA DPH 2002, FDA 2003).

	the geometric mean of the five most recent *Enterococci* samples taken within the same bathing season shall not exceed 35 colonies /100 ml. At public bathing beaches during the non-bathing season and in non bathing beach waters: No single *Enterococci* sample shall exceed 104 colonies/ 100 ml and the geometric mean of all samples taken within the most recent six months, typically a minimum of five samples, shall not exceed 35 colonies/ 100 ml. These criteria may be applied on a seasonal basis at the discretion of the Department). Class SC: *The geometric mean of all Enterococci samples taken within the most recent six months shall not exceed 175 colonies/ 100 ml, typically based on the five most recent samples, and 10% of such samples shall not exceed 350 colonies/ 100 ml. This criterion may be applied on a seasonal basis at the discretion of the Department.*

Note: *Italics are direct quotations.* Δ criterion (referring to a change from natural background conditions) is applied to the effects of a permitted discharge.

It should be noted here that waterbodies affected by combined sewer overflow (CSO) discharges are qualified in the standards, however, unless a variance has been granted that states otherwise, excursions from criteria are not allowed during storm events (designated uses still need to be sustained).

Antidegradation Policy

The third component of the SWQS is the antidegradation rule that contains provisions designed to preserve and protect the existing beneficial uses and to minimize degradation of the state's water quality. These provisions restrict or prohibit the authorization of wastewater discharges to critical resource waters. Most notable is the Outstanding Resource Water (ORW) designation that applies to all Class A waters and certain Class B, Class SA and Class SB waters. These waters exhibit exceptional socio-economic, recreational, ecological and/or aesthetic qualities. ORWs include, but are not limited to, Class A public water supplies and their bordering vegetated wetlands and vernal pools certified as such by the Massachusetts Division of Fish and Game. Other waters designated as ORWs may include those protected by special legislation, as well as selected waters found in National Parks, State Forest and Parks, or Areas of Critical Environmental Concern (ACECs).

III. DATA ACCEPTABILITY

The availability of appropriate and reliable scientific data and technical information is fundamental to the 305(b) reporting and 303(d) listing process. It is EPA policy (EPA Classification No. CIO 2106.0) that any individual or group performing work for or on behalf of the EPA needs to establish a quality system to support the development, review, approval, implementation, and assessment of data collection operations. The MassDEP's Quality Management Plan ensures that environmental data are of known and documented quality and are suitable for their intended use. Although the MassDEP relies most heavily on data collected as part of the DWM'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 considered when making assessment decisions. Results of the MassDEP's monitoring efforts, combined with all other reliable information, constitute the basis for making water quality assessments in accordance with the requirements set forth in Section 305(b) and 303(d) of the CWA.

Each year, the MassDEP-DWM monitors selected surface waters throughout the Commonwealth for chemical, physical and biological parameters of interest (e.g., nutrients, *E. coli* bacteria, dissolved oxygen, temperature, benthic macroinvertebrates, chlorophyll a, algae, fish tissue contaminants and fish communities). These data are collected by trained DWM staff following DWM's programmatic monitoring Quality Assurance Project Plan (QAPP), including field and laboratory Standard Operating Procedures (SOPs). In addition to MassDEP's Wall Experiment Station laboratory, the DWM often uses contract labs for sample analysis. All labs are evaluated for analytical accuracy and precision using double-blind QC samples, Proficiency Testing (PT) materials and/or inter-laboratory comparison testing. Resulting water quality data are evaluated against QAPP data quality objectives (DQOs) following DWM SOPs. These procedures involve 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. Following QC-level and project-level reviews, water quality data are accepted, accepted with qualification, or censored. Through a separate review process, the DWM's biological data (benthic macroinvertebrate, algae, periphyton, fish communities) are evaluated in light of QAPP data quality objectives, as well best professional judgment regarding the quality of the data. For fish toxics data, the DWM relies predominantly on QC review at the laboratory to assess usability. The DWM's most recent validated data are utilized for making the use assessment decisions. Ideally these data are 5 years old or less; the DWM data used for the 2012 reporting cycle are 9 years old or less.

Section B.9 of the DWM's programmatic monitoring QAPP addresses the use of secondary or external data. The MassDEP evaluates each potential secondary data source using the following preliminary criteria: 1) adherence to an acceptable QAPP, including a laboratory Quality Assurance Plan (QAP); 2) use of a state-certified (or as otherwise acceptable to the MassDEP) analytical laboratory ; and 3) reporting of sample data, QC data, metadata and other pertinent information in a citable report. 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 group for accuracy, precision, representativeness and completeness. External group data meeting the criteria are then further reviewed by one or more DWM staff to verify that the group's DQOs were met based on the QC data provided. These DQOs are then compared to the DWM's DQOs to look for any large discrepancies that could affect acceptability. Notes regarding each review are documented on a standard external data review form. In cases where additional information is needed, the external group is contacted for the information. If available information is deemed insufficient to complete the review, the data source is rejected. Data can also be rejected 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 MassDEP assessment purposes. Data are rejected as a whole or in part, depending on the results of the external data review. Best professional judgment is used to make the final determination regarding data validity and usability to assess water use support. External data are not qualified in any way; the data are either considered acceptable for use (without qualification) or rejected. External data greater than 5 years old, with few exceptions, are generally considered unusable for assessment decisions.

IV. USE ASSESSMENT DECISION PROCESS

The Massachusetts Surface Water Quality Standards (SWQS) designate the most sensitive uses for which the surface waters of the Commonwealth shall be enhanced, maintained and protected. The determination of whether or not a waterbody supports each of the uses designated in the SWQS is a function of the type(s), quality and quantity of available current information. The EPA provides guidelines to states for making their use support determinations and recommends that states prepare their 2012 Integrated Reports (IRs) (available at http://www.epa.gov/owow/tmdl/guidance.html) consistent with previous guidance including the EPA's 2006 IR Guidance (Keehner 2011), which supplements earlier EPA IR memoranda and guidance (EPA 2002, Grubbs and Wayland III 2000, Regas 2003, 2005, 2006, Schwartz 2009, and Wayland III 2001). While the SWQS (Table 1) prescribe minimum water quality criteria to sustain the designated uses, numerical criteria are not available for every indicator of pollution. Best available guidance from available literature may be applied in lieu of actual numerical criteria (e.g., freshwater sediment data may be compared to *Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario* 1993 by D. Persaud, R. Jaagumagi and A. Hayton). Excursions from criteria due solely to "naturally occurring" conditions (e.g., slightly low pH in some areas) do not constitute violations of the SWQS.

The designated uses of Massachusetts surface waters are described below (MassDEP 2006).

DESGNATED USES OF MASSACHUSETTS SURFACE WATERS

AQUATIC LIFE - suitable habitat for sustaining a native, naturally diverse, community of aquatic flora and fauna, including, but not limited to, wildlife and threatened and endangered species and for their reproduction, migration, growth and other critical functions. Two subclasses of aquatic life are also designated in the SWQS for freshwater bodies: *Cold Water Fishery* - capable of sustaining a year-round population of cold water aquatic life, such as trout; *Warm Water Fishery* - waters that are not capable of sustaining a year-round population of cold water aquatic life. In certain [estuarine] waters, excellent habitat for fish, other aquatic life and wildlife may include, but is not limited to, seagrass.

FISH CONSUMPTION - pollutants shall not result in unacceptable concentrations in edible portions of marketable fish or for the recreational use of fish, other aquatic life or wildlife for human consumption.

DRINKING WATER - used to denote those waters used as a source of public drinking water. They may be subject to more stringent regulation in accordance with the Massachusetts Drinking Water Regulations (310 CMR 22.00). These waters are designated for protection as Outstanding Resource Waters under 314 CMR 4.04(3).

SHELLFISH HARVESTING (in SA and SB segments) – Class SA waters where designated shall be suitable for shellfish harvesting without depuration (Approved and Conditionally Approved Shellfish Areas); Class SB waters where designated shall be suitable for shellfish harvesting with depuration (Restricted and Conditionally Restricted Shellfish Areas).

PRIMARY CONTACT RECREATION - suitable for any recreation or other water use in which there is prolonged and intimate contact with the water with a significant risk of ingestion of water. These include, but are not limited to, wading, swimming, diving, surfing and water skiing.

SECONDARY CONTACT RECREATION - suitable for any recreation or other water use in which contact with the water is either incidental or accidental. These include, but are not limited to, fishing, including human consumption of fish, boating and limited contact incident to shoreline activities. Where designated, secondary contact recreation also includes shellfishing, including human consumption of shellfish. Human consumption of fish and shellfish are assessed as the *Fish Consumption* and *Shellfish Harvesting* uses, respectively.

AESTHETICS - all surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance species of aquatic life.

AGRICULTURAL - suitable for irrigation or other agricultural uses

INDUSTRIAL – suitable for compatible industrial cooling and process uses.

As part of the 305(b) reporting process, each designated use (*see exception note below*) of the surface waters in the state for each waterbody segment (called an assessment unit or AU in the assessment database) is individually assessed as ***support*** or ***impaired***. When too little current data/information exist or 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 ponds, rivers, and estuaries have never been assessed. The status of their designated uses has never been reported to the EPA in the Commonwealth's 305(b) Report or the Integrated List of Waters nor is information on these waters maintained in the assessment database (ADB). These waterbodies are also considered not assessed.

***Exception Note**: There are three uses - *Drinking Water, Agricultural,* and *Industrial* - not assessed for 305(b) reporting purposes by DWM analysts. The *Drinking Water Use* denotes those waters used as a source of public drinking water. These waters may be subject to more stringent regulation in accordance with the Massachusetts Drinking Water Regulations (310 CMR 22.00). They are designated for protection as Outstanding Resource Waters in 314 CMR 4.04(3). The MassDEP's Drinking Water Program (DWP) has primacy for implementing the provisions of the Federal Safe Drinking Water Act (SDWA). Except for suppliers with surface water sources for which a waiver from filtration has been granted (these systems also monitor surface water quality), all public drinking water supplies are monitored as finished water (tap water). Monitoring includes the major categories of contaminants established in the SDWA: bacteria, volatile and synthetic organic compounds, inorganic compounds and radionuclides. The DWP maintains current drinking supply monitoring data. The suppliers currently report to the MassDEP and the EPA on the status of the supplies on an annual basis in the form of a consumer confidence report (http://yosemite.epa.gov/ogwdw/ccr.nsf/Massachusetts). While the EPA does provide guidance to assess the status of the *Drinking Water Use* (impairment decision if there is one or more advisories, more than conventional treatment is required, or there is a contamination-based closure of the water supply), this use is currently not assessed by DWM analysts. Rather, information on the drinking water source protection and finished water quality can/should be obtained at http://www.mass.gov/dep/water/drinking.htm and from local public water suppliers. The *Agricultural* and *Industrial* uses have never been assessed or reported on to date.

The guidance used to assess the *Aquatic Life, Fish Consumption, Shellfish Harvesting, Primary* and *Secondary Contact Recreation* and *Aesthetics* uses are provided in the following pages of this manual. For each of these designated uses the background and context information on the data /indicators used for making the use assessment decision are provided. Depending on the water body type, assessment decision trees for the use assessment indicator(s) are also given. When too little data or information are available the use is not assessed.

Aquatic Life Use

Waters supporting the *Aquatic Life Use* should be suitable for sustaining a native, naturally diverse, community of aquatic flora and fauna. This use includes reproduction, migration, growth and other critical functions. Two subclasses of aquatic life are designated in the SWQS for freshwater bodies -- *Cold Water Fishery* - capable of sustaining a year-round population of cold water stenothermic aquatic life, such as trout, and *Warm Water Fishery* - waters that are not capable of sustaining a year-round population of cold water stenothermic aquatic life. In estuarine waters, excellent habitat for fish, other aquatic life and wildlife may include, but is not limited to, seagrass (MassDEP 2006).

Use Assessment Decision-Making Process:

Results from biological (and habitat), toxicological, physico-chemical, sediment, and body burden investigations are all considered in assessing the *Aquatic Life Use*. The type, quality, and amount of data generated for each of these indicators are first evaluated to determine if they are appropriate for use in the assessment decision-making process. Very often only one of the indicators is represented in the available data set or data from one indicator is obviously superior to the others. In these cases use support decisions are made based solely or mostly on one indicator. However, in cases where data are available from multiple indicators and the data are of equal quality the biological community data, in most cases, outweigh all other types in the decision-making process because they are considered an integration of the effects of pollutants and other conditions over time. Under these circumstances the biological community data, particularly those generated by a RBP III multi-metric analysis (Plafkin *et al.* 1989) or, in the case of Cold Water Fisheries, the fish population data are usually considered by the MassDEP to be the best and most direct measure of the *Aquatic Life Use*. Since toxicological testing data also measure biological response to environmental stressors in the absence of biological community data they are given more weight than direct measurements of physico-chemical stressors. Thus, assuming all data are of equal quality, the weight-of-evidence gradient for data used by the MassDEP analysts follows this continuum -- biological (including habitat) data first, followed by toxicological data, followed by chemical (physico-chemical, sediment chemistry data, whole-fish tissue residue) data.

The background and context information for the indicators used in the *Aquatic Life Use* assessment decision process are provided below in the order of the weight-of-evidence gradient used by MassDEP. Within each indicator a summary decision tree (i.e., support decision and impairment decision) is provided. When too little data or information are available, the *Aquatic Life Use* is not assessed. An overall summary of the indicators and the decision process used by the MassDEP analysts for making the *Aquatic Life Use* assessment decisions can be found in Table 2 (see end of this use assessment guidance).

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Benthic macroinvertebrate data (rivers) The benthic macroinvertebrate sampling data generated by DWM biologists are usually from 100-organism subsamples, which are analyzed by a multimetric approach based on a modification of Rapid Bioassessment Protocol III (RBP III) metrics and scoring (Plafkin *et al.* 1989). [Note: occasionally other sampling regimes are employed (e.g., in deep rivers or where kick sampling is inappropriate or impractical, multi-plate samplers may be used).] Sampling takes place during the months of July through September when baseflows are at their lowest of the year and water quality is presumed to be at its worst. The sampling index for a specific watershed also approximates historical sampling periods for that watershed, when possible. Metric values for each station are scored based on comparability to a reference station, and scores are totaled. The percent comparability of total metric scores for each study site to those for a pre-selected least impaired reference station (i.e. "best attainable" condition) yields an impairment score for each site. The RBP III analysis separates sites into four categories (% of reference condition): non-impaired (>83%), slightly impaired (54 – 79%), moderately impaired (21 – 50%), and severely impaired (<17%). Reference station sites and sites determined to be non-impaired or slightly impaired based on the RBP III analysis are assessed as supporting the *Aquatic Life Use*. Moderately and severely impaired RBP III sites are assessed as non-support. Occasionally, sample attributes may be noted by DWM biologists that influence an assessment decision (e.g., biologists note hyperdominance by a pollution tolerant species even though the RPB III analysis indicated only slight impairment. In this case a determination of "impaired" may be made).

The DWM's benthic macroinvertebrate monitoring results are typically summarized in a technical memorandum by watershed. These memoranda combine habitat assessment information and the analysis of multi-metric benthic community characteristics for comparison to previously established reference station data (RBPIII analyses). Quality-assured external sources of benthic macroinvertebrate survey reports are occasionally available from outside parties (e.g., other state/federal agencies, consultants, watershed associations, NPDES permittees).

Use is Supported	Use is Impaired
Non-impaired/most slightly impaired RBP III analysis, reference sites	Moderately impaired/severely impaired RBP III analysis, slightly impaired RBP III with special condition (e.g., hyperdominance by pollution tolerant sp.) as noted by DWM biologists

Benthic macroinvertebrate data (lakes) – Not currently utilized to evaluate *Aquatic Life Use* of lentic waters.

Benthic macroinvertebrate data (estuaries) DWM analysts occasionally utilize external sources of benthic macroinvertebrate data combined with other water quality monitoring data when making *Aquatic Life Use* assessments of estuarine waterbodies. While no standardized multi-metric analysis is currently employed, some quantitative benthic sampling has been conducted in Massachusetts estuaries (e.g., Massachusetts Water Resources Authority (MWRA) and Massachusetts Estuaries Project (MEP) projects). Sample attributes typically reported include number of species, number of individuals, diversity (H'), evenness (E), and organism-sediment relationship (e.g., opportunistic, deep burrowers, etc.). The overall analyses reported by these external data sources are utilized to make *Aquatic Life Use* attainment decisions.

Use is Supported	Use is Impaired
High number species, high number individuals, good diversity and evenness, moderate to deep burrowing, tube dwelling organisms present, as reported from external data sources.	Low number species, low number individuals, poor diversity and evenness, shallow dwelling opportunistic species or near absence of benthos, thin feeding zone, as reported from external data sources.

Background/context: MassDEP DWM Benthic Macroinvertebrate Biomonitoring Quality Assurance Project Plan (MassDEP 2005)

The biological sampling methodology is described in an SOP (MassDEP 2007) and is based on the USEPA Rapid Bioassessment Protocols (RBPs) (Plafkin et al. 1989). The main objectives of biomonitoring are: (a) to determine the biological health of streams within the watershed by conducting assessments based on aquatic macroinvertebrate communities; and (b) to identify problem stream segments so that efforts can be focused on developing or modifying NPDES and Water Management Act permits, storm water management, and control of other nonpoint source (NPS) pollution.

A regional reference station approach is currently used for comparisons to site data…this is useful in assessing nonpoint source (NPS) pollution impacts (e.g., physical habitat degradation), including NPS pollution at upstream sites as well as suspected impacted sites downstream from known point source stressors…benthic data from some stations are not compared to a regional reference station due to considerable differences in stream morphology, flow regimes, and drainage area, or simply lack of a suitable reference site.

A site-specific sampling approach (downstream study site compared to an upstream reference site) is occasionally employed for an assessment of a known impact site (e.g., point source discharge), provided that the stations being compared share basically similar instream and riparian habitat characteristics…

Background/context: MassDEP DWM Fish Collection Procedures for Evaluation of Resident Fish Populations Standard Operating Procedures (MassDEP 2011a)

Monitoring of the fish assemblage is an integral component of the Massachusetts DEP water quality management program, and its importance is reflected in state stream class and use-support designations. Assessments of the fish assemblage must measure the overall structure and function of the ichthyofaunal community to adequately evaluate biological integrity and protect surface water resource quality.

Species composition classifications:
Tolerance Classification **- Tolerant, Moderately Tolerant, Intolerant**
Classification of tolerance to environmental stressors similar to that provided in Plafkin *et al.* (1989), Barbour *et al.* (1999), and Halliwell *et al.* (1999). Final tolerance classes are those provided by Halliwell *et al.* (1999).
Macrohabitat Classification **- Macrohabitat Generalists, Fluvial Specialists, Fluvial Dependents**
Classification by common macrohabitat use as presented by Bain (1996) modified regionally following discussions between MassDEP and MA DFG fishery biologists.

Cold Water Species: brook, brown and rainbow trout; Atlantic salmon; slimy sculpin; longnose sucker; American brook lamprey; and burbot
Warm Water Fluvial Specialist/Dependent Species: blacknose dace, fallfish, common shiner, white sucker, longnose dace, creek chubsucker, tessellated darter, bridle shiner, creek chub, shortnose sturgeon, Atlantic sturgeon, blueback herring, American shad, margined madtom, spottail shiner, eastern silvery minnow, mimic shiner

Fish population data (rivers) MassDEP biologists use electrofishing gear (i.e., backpack or barge shockers) to sample fish from 100 m reaches of wadeable streams. Specimens that can be identified in the field are counted, examined for external anomalies, (i.e., deformities, eroded fins, lesions, and tumors) and this information is recorded on field data sheets. The procedures generally follow the protocols outlined in the RBP V (Plafkin *et al.* 1989 and Barbour *et al.* 1999), however, these call for the analysis of the data generated from fish collections using an established Index of Biotic Integrity (IBI) similar to that described by Karr *et al.* (1986). Since no formal fish IBI for Massachusetts currently exists, the data provided by the DWM's sampling effort are used to qualitatively assess the general condition of the resident fish population as a function of the overall abundance (number of species and individuals) and species composition classifications (see inset for more detail) (MassDEP 2011a). MassDEP analysts also utilize fish population sampling data available from the Massachusetts Department of Fish and Game's (MA DFG), Division of Fisheries & Wildlife (MassWildlife) (MassWildlife 2008).

When evaluating the status of the *Aquatic Life Use* in lotic waters based on fish population information, the data are evaluated using the following approach as developed by the DWM's fisheries biologists: For waters designated Class B Cold Water Fishery or for those waters on MA DFG's "Coldwater Fishery Resource List", the fish population should contain multiple age classes (indicative of reproducing populations) of any cold water fish (see inset). In a Class B Warm Water Fishery, the fish population should be well represented by fluvial specialist/dependents species (see inset). The *Aquatic Life Use* is assessed as impaired in Class B, Cold Water Fisheries, if no fish were found or cold water species were absent. In Class B, Warm Water Fisheries, the *Aquatic Life Use* is assessed as impaired if no fish were found or fluvial fish were absent or relatively scarce (few numbers). Prior to any impairment decision based on the fish population data the sources are reviewed for any notes regarding sampling efficiency or other problems encountered by the field sampling crews that may have resulted in less than optimal sampling effectiveness. In waterbodies where poor sampling efficiencies were noted the *Aquatic Life Use* would not be assessed based on the fish population data. The presence of external anomalies (i.e., deformities, eroded fins, lesions, tumors -- DELTS) are noted and, if found in >10% of the sample, follow-up histology may be conducted to evaluate pollution-related conditions.

Use is Supported Cold Water Fishery	**Use is Impaired Cold Water Fishery**
Multiple age classes (indicative of reproducing populations) of any cold water fish	No fish found or cold water species absent, DELTS with abnormal fish histology
Use is Supported Warm Water Fishery	**Use is Impaired Warm Water Fishery**
In lotic environments the fish population should be well represented by multiple age classes of fluvial specialist/dependents species	No fish found or fluvial fish were absent or relatively scarce (few numbers), DELTS with abnormal fish histology

Fish population data (lakes, estuaries) –Not currently utilized to make *Aquatic Life Use* support determination for either lentic or estuarine waters. However, impact evaluations based on studies of site-specific fish population data (e.g., those associated with large power plant type operations relating to impingement and entrainment) and/or the presence of DELTS with abnormal fish histology have been used to determine that the *Aquatic Life Use* is impaired.

Use is Supported	**Use is Impaired**
None made	> 5% population losses estimated , DELTS with abnormal fish histology

EXHIBIT I
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Habitat and flow data (rivers, lakes, estuaries)
Most often evaluations of in-stream habitat support the biological survey results and enhance the interpretation of the biological data. When biological communities are determined to be impaired from RBP analyses obvious habitat stresses (e.g., sedimentation) are evaluated as possible causes of the impairment. Occasionally, however, the habitat perturbations themselves are severe enough to warrant an impairment decision. These situations include absence of visible streamflow and/or dewatered streambed in a perennial stream or dewatered lake due to artificial regulation, extreme deviation from expected flows (e.g., channel status for all but one stream during a survey noted as full but the one stream had little flow), and lack of natural habitat structure (e.g., concrete channel, underground conduit). Any anadromous fish passage structures that are impassable are considered to be an impairment of the *Aquatic Life Use*. [Note: if impediments to fish passage (such as dams) exist but no structure has ever been built to allow fish passage, no impairment decision is currently made.] Impacts associated with water intakes in rivers, lakes, and estuaries (i.e., power plants, cooling water intake structures) are evaluated on a case-by-case basis by DWM biologists by looking at the thermal plumes --blockage of fish passage, potential toxicity, and its attractable nature, as well as impingement, entrainment, and fish returns. Evidence of impact(s) (i.e., determination of unhealthful habitat or population impact) may result in a determination that the *Aquatic Life Use* is impaired.

The sources of information that DWM analysts utilize to evaluate habitat quality and streamflow conditions include the following: the DWM's habitat assessment field sheets and scores (see inset, usually reported in technical memoranda), observations recorded on the DWM water quality monitoring field sheets (water quality technical memoranda or the DWM's open files) , the United States Geological Survey (USGS) real-time and historical streamflow data (http://waterdata.usgs.gov/ma/nwis/current/?type=flow), and the MA DFG, Division of Marine Fisheries (DMF) technical reports on surveys of anadromous fish passage in coastal Massachusetts (http://www.mass.gov/dfwele/dmf/publications/technical.htm#tr).

The MassDEP SWQS stipulate the most severe hydrologic conditions at which water quality criteria must be applied to prevent adverse impacts of discharges. For rivers, the lowest flow condition at and above which aquatic life criteria must be applied is the lowest flow to be expected for seven consecutive days during a 10-year period; the 7-day, 10-year low flow (7Q10). The analysts must understand the hydrologic conditions encountered during the surveys and evaluate them against the estimated 7Q10 flow. One of the following methods, in preferential order, may be utilized to estimate the 7Q10: the USGS supported program called StreamStats (provides estimated streamflow statistics for ungaged sites), a drainage area ratio transform method, a flow factor estimate based on drainage area, or DFLOW, a software program used by the EPA permit writers. For lakes and estuaries the extreme hydrologic condition at which the aquatic life criteria must be applied will be established by the MassDEP on a case-by-case basis.

The presence of dams, flood control projects, water supply withdrawals, hydropower projects, and intake structures are considered potential habitat alterations.

Use is Supported	Use is Impaired
No direct evidence of severe physical habitat or stream flow regime alterations, functioning anadromous fishways present	Physical habitat structure impacted by anthropogenic stressors (e.g., lack of flow, lack of natural habitat structure -- concrete channel, underground conduit), non-functioning anadromous fishway present

Background/context: MassDEP DWM Benthic Macroinvertebrate Biomonitoring Quality Assurance Project Plan (MassDEP 2005)

Habitat qualities *are scored using a modification of the evaluation procedure in Plafkin et al. (1989). Most parameters evaluated are instream physical attributes often related to overall land use and are potential sources of limitation to the aquatic biota. Key physical characteristics of the water body and surrounding land use include the following:*
instream cover, epifaunal substrate, embeddedness, sediment deposition, velocity/depth combinations, channel flow status, right and left bank vegetative protection, right and left bank stability, right and left bank riparian vegetative zone width. Habitat parameters are scored, totaled, and compared to a regional reference station and/or a site-specific control (upstream reference) station to provide a final habitat ranking.

Streamflow Conditions (MassDEP 2005b): *"Historically, river surveys conducted by DWM staff were typically performed during low-flow, dry-weather conditions which generally represented the worst-case scenario with respect to the assessment of impacts on receiving water quality from point discharges. Today, increased attention is given to the identification and control of nonpoint pollution, and survey methods are changing to reflect this shift in emphasis. For example, wet-weather sampling may provide the most reliable information pertaining to nonpoint pollutant loadings from stormwater runoff and, when compared with dry-weather survey data, may further distinguish the effects of point and nonpoint pollution sources."*

Background/context: MassDEP Eelgrass Mapping Project (MassGIS 2008 and Costello and Kenworthy 2011)

Seagrass beds are critical components of shallow coastal ecosystems. They provide food and cover for important fauna and their prey, their leaf canopy calms the water, filters suspended matter and together with extensive roots and rhizomes, stabilizes sediment. Eelgrass, Zostera marina, is the most common seagrass present on the Massachusetts coastline. The other species found in embayments is Ruppia maritima, widgeon grass, which is present in areas of less salinity along the Cape Cod and Buzzards Bay coast.

Often considered a sentinel species for evaluating ecosystem health, the distribution and abundance of eelgrass beds can be documented with aerial photographs, digital imagery and field verification. Much of the MA coast has a sandy substrate which provides a useful color contrast to map the darker seagrass photo signatures. Accuracy estimates of this quantitative mapping project were reported to be >85% for the 1994-1996 effort and had improved to 94% in the 2006-2007 effort. These eelgrass data layers are currently the best available information on general eelgrass extent in Massachusetts.

With appropriate temporal and spatial scaling, monitoring environmental quality and mapping the changes in seagrass distribution and abundance can provide scientists and managers with a sensitive tool for detecting and diagnosing environmental conditions responsible for the loss or gain of seagrasses. For example, unlike situations where degraded optical water quality reduces light penetration and threatens plants mostly in the deeper water, the effects of multiple stressors associated with eutrophication cause more widespread losses of eelgrass which are not just confined to the deepest edges of the seagrass beds.

Eelgrass bed mapping data (estuaries)

The primary biological information used to make assessment decisions for the *Aquatic Life Use* in marine or estuarine waters is obtained from estimated eelgrass bed maps based on surveys conducted by the MassDEP, Wetlands Conservancy Program (WCP), as part of the Eelgrass Mapping Project. Currently the best available information on the general eelgrass extent in Massachusetts come from these various eelgrass (seagrass) mapping efforts, which are available as data layers through the MassGIS (http://www.mass.gov/mgis/eelgrass.htm, http://www.mass.gov/mgis/eelgrass0607.htm) or MassDEP (51grass.shp). The earliest available data are from 1951, although these data were only anecdotally validated. The subsequent statewide seagrass mapping project was conducted in three phases beginning in 1994 and ending in 2007. Data acquisition and image interpretation are detailed in Costello and Kenworthy (2011). The initial mapping phase was conducted between 1994 and 1996 encompassing 46 embayments and portions of seven open-water near-shore areas. Remapping was conducted in 29 of the 46 embayments between 2000 and 2002. The third mapping effort in 33 of the 46 embayments was carried out in 2006 and 2007.

The percent of eelgrass within a waterbody segment area is calculated by DWM analysts for each mapping period available using ArcMap analysis tools. The delineated waterbody segment shape is intersected with each available eelgrass mapping data layer and the size of the eelgrass bed(s) within the waterbody segment area is calculated. The percentage of the waterbody segment area comprised of eelgrass bed is then calculated and, from these analyses, changes over the different mapping periods can be estimated. Analysts must still consider the relative presence of beds and whether change (i.e., loss) may be due to "natural" movement of beds either within, or adjacent to, a waterbody segment area. Since the 1951 data layer has confidence values provided for each bed, only those areas indicated with a high level of confidence should be used when making comparisons with data from subsequent years. Depending on the data years available for a waterbody an evaluation can be made as to whether or not beds are fairly stable or if there is loss.

Assessment decisions are based on whether or not the eelgrass beds within the waterbody segment area are stable or are being lost. If the beds are increasing or fairly stable (i.e., either no or minimal loss) the segment is considered to be supporting the *Aquatic Life Use*. When the analyses show that there has been a total loss of beds (no matter what size) within a segment area the *Aquatic Life Use* is assessed as impaired. Our definition of "substantial decline" up to this point in time has been based on comparisons of the percent eelgrass in the segment area from the earliest through the most recent mapping period(s). For example, if the percentage of the segment area determined to be eelgrass was 50% in 1951, but only 45% in the most recent evaluation (e.g., 2007) we consider this a 5% loss. Losses equal to or exceeding a value of 10% based on this method is considered a "substantial decline". When the confidence associated with the1951 data was not high and/or when more recent data were not available no assessment decision was made.

Use is Supported	Use is Impaired
Eelgrass bed habitat in segment area is increasing or fairly stable (i.e., no or minimal loss)	Substantial decline (more than 10% of the in bed size or total loss of beds no matter their size)

EXHIBIT I
AR J1

Non-native aquatic species data (rivers, lakes)
(not used to date for estuaries)

Waters supporting the *Aquatic Life Use* are suitable for sustaining a native, naturally diverse, community of aquatic flora and fauna. Non-native (or exotic) species, unlike the natural biota, have few or no controls, are often extremely invasive (dominating and/or eliminating native biota), and can displace a healthy and desirable aquatic community and produce economically and recreationally severe impacts even though no other change has occurred in the watershed (Mattson *et al.* 2004). Therefore, the presence of an introduced, non-native aquatic species in a waterbody is considered an impairment of the *Aquatic Life Use*.

DWM analysts use three main data sources to acquire information on the presence of non-native aquatic macrophytes or other aquatic organisms. They are: the herbicide application/permit file database maintained by the DWM, a non-native plant spreadsheet maintained by the Massachusetts Department of Conservation and Recreation (DCR), Lake and Pond Program staff periodically provided on request, and DWM survey field sheets. Occasionally information from watershed volunteer groups or private companies is also utilized.

The herbicide database files maintained by DWM staff occasionally note the presence of non-native aquatic macrophyte infestation(s) in a waterbody. When using this data source, however, there is a need to verify the identification of the non-native(s) listed in herbicide license applications since contractor identifications may not always be credible. The DCR, Lake and Pond Program, staff maintains a spreadsheet on the presence of non-native aquatic macrophytes and provides this spreadsheet to the DWM on request. Finally, DWM survey field sheets are reviewed since survey crews note the presence of any non-native plants observed during the surveys.

The presence of a non-native wetland or semi-terrestrial macrophyte(s) (e.g., *Phragmites* sp., *Lythrum salicaria*) is not usually considered an impairment of the *Aquatic Life Use* unless they have eliminated the open water area of the waterbody. In waterbodies where active aquatic plant management has occurred it is particularly important to have up-to-date information to accurately reflect the conditions during the time period in which the assessment is conducted. In these cases the mere historical presence of a non-native species may not be appropriate for an automatic impairment decision.

Use is Supported	Use is Impaired
Non-native aquatic species absent	Non-native aquatic species present

Background/context: MassDEP Surface Water Quality Standards (MassDEP 2006) and Guide to Selected Invasive Non-native Aquatic Species in Massachusetts (MA DCR 2007)

The Massachusetts Surface Water Quality Standards (2006) definition of Aquatic Life is "A native, naturally diverse, community of aquatic flora and fauna including, but not limited to, wildlife and threatened and endangered species." Since all waters are designated as habitat for aquatic life, DWM analysts use the presence of non-native aquatic organisms as an impairment of the Aquatic Life Use.

According to the MA DCR (2007), non-native (exotic) species have been introduced to our region in a variety of ways including: hitching rides in ship ballast water, accidental release from aquariums, escape from water gardens and intentional introduction. Exotic species are further spread unintentionally by boaters when plant fragments are tangled on boats, motors, trailers, fishing gear, and dive gear. Some species, including the zebra mussel, have a microscopic larval form that can travel undetected in ballast water, cooling water, live-well water and bait bucket water to new locations. Once an exotic species is established, it is almost impossible to eradicate and very expensive to control. The best way to protect a waterbody is through prevention, education, early detection and rapid response.

Background/context:
Draft Sampling Plan for Year 2010 Periphyton Percent Cover and Biomass Monitoring in the Northeast Region Watersheds (MassDEP undated)

Periphyton (or attached algae) are a useful biological indicator of water quality. The fast growing algae are sessile and take-up their entire nutrient and mineral needs from the water column. They are important primary producers in streams and are critical in oxygen production as well as carbon dioxide use and have been used by many to examine changes in nutrient (nitrogen and phosphorus) levels since they integrate nutrient concentrations over time… algal cover can be estimated with a viewing bucket and biomass can be measured using chlorophyll a analysis. Exposure to low nutrient levels over time will result in algal populations represented by genera that can utilize nutrients at that concentration. These sites are also likely to have reduced algal biomass. Higher algal biomass is often found in streams exposed to elevated nutrient levels.

Harmful Blue-Green Blooms (MassDEP 2010):

Blooms of cyanobacteria can be toxic to humans and animals. Anabaena, Nostoc, Microcystis, and Nodularia may contain the hepatotoxin microcystin, which can damage the liver. Others like Aphanizomenon flos-aquae, Anabaena circinalis and Cylindrospermopsis raciborskii may carry the neurotoxin saxitoxin. Counts of the cyanobacteria are performed in order to determine if the amount present would be enough to indicate a moderate level of risk to the public using the waterbody. The World Health Organization (WHO 1999) has found that when cyanobacteria cell counts exceed 100,000 cells/ml the risk is then considered moderate. Massachusetts Dept. of Public Health (MA DPH) (2007)…determined that a cell count of 70,000 cells/mL would correspond to a toxin level of approximately 14 ppb which is the current guideline for contact recreational waters." The MA DPH provides guidance on harmful algal blooms in fresh waterbodies (http://www.neiwpcc.org/neiwpcc_docs/protocol_MA_DPH.pdf).

Periphyton/algal blooms (rivers, lakes, estuaries)

Microalgae (also described as periphyton) typically appear as a thin film, often green or blue-green, or as a brown floc (loose material without any structure that breaks up when touched or removed). Macroalgae, the visible filamentous forms of green algae, are the "nuisance" type algae. Natural diversity and the presence of native species may not be sustained when there are dense growths of a monoculture of a particular alga. Loss of parts of the food web - vital for *Aquatic Life Use* support - may result from this alteration. In addition, die-off and decomposition of large amounts of biomass from macroalgae can fill in the interstitial sites in the substrate and destroy this habitat for the benthic invertebrates, further compromising aquatic life.

Currently no standardized reporting mechanism has been in place for cyanobacteria data and/or posting information either in-house (MassDEP) or on the MDPH website, nor is there any single source of data that DWM analysts can utilize to acquire frequency and/or duration of blue-green algal blooms. However, waterbodies with recurring frequent and/or prolonged cyanobacteria blooms are considered to be impaired for the *Aquatic Life Use*.

Visual estimates of the presence of phytoplankton blooms (particularly blue-greens), extensive cover of non-rooted aquatic macrophytes (particularly duckweed or water meal covering >25% of the surface) are made by DWM survey personnel during river and lake surveys and these data are recorded on survey field sheets. These data are used, in part, to evaluate response to nutrient enrichment (see water quality nutrient section). When the visual determination of the percent substrate cover by filamentous algae within the reach is below 40% the *Aquatic Life Use* is considered supported. However, when the growth of filamentous algae exceeds 40% cover in the stream reach it is considered as one of the indicators of enriched conditions.

The Massachusetts Estuaries Project (MEP), a major collaborative project between the MassDEP and the School of Marine Science and Technology (SMAST) at the University of Massachusetts Dartmouth, along with their project partners including Coastal Zone Management, the Cape Cod Commission, municipalities, Applied Coastal Research and Engineering, Inc., and the USGS, have also generated a significant amount of chlorophyll and enrichment indicator data for many estuarine systems in coastal Massachusetts. Since this project is intended to develop site-specific thresholds for these systems, their analyses are utilized to make *Aquatic Life Use* attainment decisions for coastal segments.

Use is Supported	Use is Impaired
No/infrequent algal blooms or growths; ≤25% cover noxious aquatic plants (e.g. Lemna); filamentous algal cover within riffle/reach ≤40%	Frequent and/or prolonged algal blooms or growths; cyanobacteria blooms that result in advisories (recurring and/or prolonged); >25% cover noxious aquatic plants (e.g. Lemna); filamentous algal cover within riffle/reach >40%

EXHIBIT I
AR J1

Toxicity testing data (rivers, lakes, estuaries)
The MassDEP DWM staff developed and maintain a toxicity testing database (ToxTD) to manage external toxicity testing data (both whole-effluent and ambient upstream sample data) submitted by facilities as part of their National Pollutant Discharge Elimination System (NPDES) permits. Validation procedures are implemented prior to uploading final data to the database. MassDEP analysts utilize this information for making *Aquatic Life Use* assessment and permitting decisions. Testing frequency varies by facility and is associated with the in-stream waste concentration of the discharge; many Massachusetts facilities conduct quarterly testing, some conduct tests twice per year, and some conduct tests on an annual basis or a different schedule.

Survival information for test organisms exposed to ambient (rivers, lakes, estuary) water samples utilized as either the dilution water or site control during the whole effluent toxicity test is maintained in the ToxTD database (MassDEP 2011b). Survival data for these test organisms are recorded for exposures at 24 and 48 hours and at the end of chronic test (~ 7-days) and are utilized by DWM analysts in the *Aquatic Life Use* assessment decision. Survival information is summarized for each test species since the last assessment was completed for a given waterbody segment. The survival data summary should include the number of tests conducted over the time period specified and indicate the time of exposure (e.g., 48 hours, 7-days, etc. depending on the test). It is the judgment of the DWM staff that a survival rate of the test organisms exposed to the ambient river water samples should be greater than or equal to 75% to warrant a use assessment decision of support. When survival of test organisms exposed to the river water samples is less than 75% these data are further evaluated by looking at the frequency and magnitude (with respect to temporal patterns) of the "low" survival events. The analyst notes any pattern of problems (e.g., seasonal) and reviews associated chemistry data to identify potential cause(s)/source(s). An impairment decision for the *Aquatic Life Use* is typically made when the frequency of low organism survival (i.e., <75%) occurs in more than 10% of the test events since the last assessment was completed.

Whole effluent toxicity testing results are also typically evaluated for compliance with permit requirements, species sensitivity, and any other patterns that may be of note. For assessment purposes, NPDES facility compliance with whole effluent toxicity test and other limits may be used to identify possible causes/sources of impairment but is not utilized, solely, for assessment decisions.

Other toxicity testing data sources may include EPA investigations or testing done as part of waste site investigations and may also included sediment toxicity testing results. Survival of test controls is always reviewed for data quality assurance. Typically the average survival of organisms exposed to the river water/sediment is calculated and any other test results (e.g., statistically significant from controls) are also noted but are not utilized for assessment decisions of impairment by themselves.

Use is Supported	Use is Impaired
≥75% survival of test organisms to water column or sediment samples in either 48 hr (acute) or 7-day exposure (chronic) tests.	<75% survival of test organisms to water column or sediment samples in either 48 hr (acute) or 7-day exposure (chronic) tests occurs in >10% of test events.

Background/context: Whole Effluent Toxicity (EPA 2011)

Whole Effluent Toxicity (WET) is a term used to describe the aggregate toxic effect of an aqueous sample (e.g., whole effluent wastewater discharge) as measured by an organism's response upon exposure to the sample (e.g., lethality, impaired growth or reproduction). WET tests replicate the total effect and actual environmental exposure of aquatic life to toxic pollutants in an effluent without requiring the identification of the specific pollutants. WET testing is a vital component of water quality standards implementation through the NPDES permitting process and supports meeting the goals of the Clean Water Act (Section 402), "maintain the chemical, physical and biological integrity of the nation's waters".

Freshwater organisms used in WET tests include Ceriodaphnia dubia (freshwater flea) and Pimephales promelas (fathead minnow). Estuarine organisms used in WET tests include Americamysis bahia (mysid shrimp), and Menidia beryllina (inland silverside). These species serve as indicators or surrogates for the aquatic community to be protected, and a measure of the real biological impact from exposure to the toxic pollutants. WET tests are designed to predict the impact and toxicity of effluents discharged from point sources into receiving waters. WET limits developed by permitting authorities are included in NPDES permits to ensure that water quality criteria for aquatic life protection (WET) are met.

Background/context:
MassDEP Monitoring Strategy (MassDEP 2005b)

One of the DWM's main programmatic objectives is to conduct surface water quality monitoring (collection of chemical, physical and biological data) to assess the degree to which designated uses, such as aquatic life, are being met in waters of the Commonwealth (CWA 305(b) purposes) (MassDEP 2005a, MassDEP 2010a). Massachusetts has selected a set of monitoring program elements that utilize a combination of deterministically and probabilistically derived sampling networks. Targeted designs may be used to identify causes and sources of impairments for reporting pursuant to sections 305(b) and 303(d) of the CWA, and to develop and implement control strategies such as TMDLs, NPDES permits, or Best Management Practices (BMP). Furthermore, targeted monitoring may provide data and information to define new and emerging issues or to support the formulation of water quality standards and policies.

River & stream water quality surveys generally consist of five or six monthly sampling events from April 1 to October 15 (primary contact recreation period). Typical analytes include pH, dissolved oxygen (DO), temperature, conductivity, turbidity, total suspended solids, true color, chloride, nutrients (TP, TN, NH3-N), dissolved metals and indicator bacteria (E. coli for freshwater and Enterococci for coastal areas). Lake surveys typically include such limnological measurements as chlorophyll a and Secchi depth, in-situ measurements using metered probes, and limited water quality sampling to provide data for the calculation of TMDLs or the derivation of nutrient criteria. Lake surveys are generally conducted during the summer months when productivity is high.

The use of single or multi-probe sondes for physical and chemical monitoring is now also an integral component of the DWM's ambient monitoring program. It allows for the acquisition of short-term, attended data, using hand-held multi-probe units in the field, and long-term, unattended data sets, using stand-alone multi-probe loggers deployed for 2-6 days, to collect continuous monitoring data for such analytes as DO and temperature, pH, and specific conductance. Continuous water temperature monitoring units are also available for deployments of three to four months from June through September. Deep-hole profiling for DO and temperature in lakes are usually taken between mid-July and early September to reflect the worse-case conditions.

Water quality data (rivers, lakes, estuaries)

The MassDEP SWQS include specific numeric physical and chemical water quality criteria adopted to protect aquatic life and human health from the effects of pollution. The standards also contain narrative criteria for other constituents (e.g., nutrients, toxics) that must also be evaluated as part of the *Aquatic Life Use* attainment decision.

The analysis of water quality monitoring data for evaluating the *Aquatic Life Use* depends, in part, on the data set(s) available. DWM analysts rely most heavily on internal monitoring program data to assess use attainment. Over the past 10 years the program has transitioned from a targeted, synoptic survey program, consisting typically of a minimum of three rounds of water quality sampling during the summer months, to a more intensive (minimum of five rounds of water quality data during the sampling season augmented with probe deployments) sampling program. The quality-assured and validated sampling results of the MassDEP DWM's surveys are published in the form of technical memoranda/reports, typically by watershed and/or sampling year. Water quality data published online by the USGS (http://waterdata.usgs.gov/ma/nwis/qw/, http://ma.water.usgs.gov/) are also available for stations across Massachusetts and are utilized for making *Aquatic Life Use* assessment decisions. There are also many other external sources of physico-chemical water quality monitoring data (e.g., environmental consultants, watershed and lake associations, and citizen monitoring programs, etc.). All external data from these and other sources are reviewed for quality/reliability according to the DWM's external data validation procedures and, so that when approved, they can also be utilized for assessment decisions.

When analyzing data sets for determining use attainment the analyst documents the total number of samples in the data set, the ranges of the data, and, if appropriate, the number of measurements that did not meet the criterion for each analyte. All validated, physico-chemical water quality monitoring data are compared to appropriate criteria, as noted below under individual analytes, from the MassDEP SWQS (MassDEP 2006). Every attempt is made to consider the frequency, duration and magnitude of exceedances from criteria or guidance in making impairment decisions. However, since the data sets available are usually limited, it is often difficult to have a clear picture of the frequency and/or duration of exceedances. Under these circumstances a single high or low result can skew the data, so an impairment decision is never based on a single sample result.

Assessment guidance is presented below for the following indicators of water quality conditions: dissolved oxygen, pH, temperature, nutrients, and toxic/priority pollutants.

Dissolved oxygen (DO)

DO is a very important indicator of a waterbody's ability to support aquatic life. DO enters water by diffusion directly from the atmosphere, by mechanical aeration (e.g., a spillway or dam), or as a result of photosynthesis by aquatic plants and algae and is generally removed from the water by respiration of aquatic organisms and decomposition of organic matter. Its solubility in water is mainly a function of temperature and pressure and content is reported in terms of concentration (mg/L or ppm) or as a percentage of saturation (% saturation). DO exhibits natural daily and seasonal fluctuations.

The MassDEP SWQS (2006) criteria for Dissolved Oxygen (DO) in mg/L are as follows:
Class A Cold Water Fishery (CWF) and Class B Cold Water Fishery (BCWF) and Class SA: ≥6.0 mg/L
Class A and Class B Warm Water Fishery (BWWF) and Class SB: ≥5.0 mg/L.
Class C: Not <5.0 mg/L at least 16 hours of any 24-hour period and not <3.0 mg/L at any time.
Class SC: Not <5.0 mg/L at least 16 hours of any 24-hour period and not <4.0 mg/L anytime.
For all classes…where natural background conditions are lower…DO shall not be less than natural background conditions. Natural seasonal and daily variations that are necessary to protect existing and designated uses shall also be maintained. There shall be no changes from natural background conditions that would impair any uses assigned to each class, including those conditions necessary to protect normal species diversity, successful migration, reproductive functions or growth of aquatic organisms. In cases where a segment has the qualifier "Aquatic Life" added to the class, the Class C DO criteria are applied.

National criteria for DO (EPA 1986 and 1988) were derived using biological production impairment estimates to protect survival and growth of aquatic life below which detrimental effects are expected. The national criteria accommodate an exposure concept (frequency, magnitude and duration of condition). The national criteria daily minima (1.0 mg/L less than the 7-day mean) were set to protect against acute (mortality) of sensitive species and they were also designed to prevent significant episodes of continuous or regularly recurring exposures to dissolved oxygen at or near the lethal threshold. DWM analysts use this daily minimum deviation (1.0 mg/L) from the criterion for impairment decisions.

Rivers: DWM analysts compare worse-case DO data (i.e., early morning/pre-dawn attended probe measurements) to the appropriate criterion (depending on a waterbody's classification). A minimum of three, but preferably five, sampling events during the summer sampling season is required. If all DO data meet (i.e., are above) the criterion, DO is considered sufficient to support the *Aquatic Life Use*. When two or more measurements (any time of the day) are below the DO criterion the analyst must consider whether or not the conditions are natural (e.g., wetland influence) or not. The magnitude, (i.e., >1.0 mg/L below the criterion), frequency, and duration of the excursions (e.g., non-consecutive vs. consecutive low DO measurements) must also be considered. DO is identified as a cause of impairment if data indicate frequent (typically >10%), prolonged and/or severe excursion(s) from the criteria.

Lakes: Low DO is considered an impairment if the area exhibiting oxygen depletion is >10% of the lake surface area. In deeper stratified lakes impairment decisions are sometimes made using one deep-hole DO profile during the later part of the summer growing season. Data requirements for shallow, unstratified lakes follow those of river described above.

Estuaries: DWM analysts compare DO data to the appropriate criterion (depending on a waterbody's classification) for surface water and depth measurements. If all DO data meet (i.e., are above) the criterion, DO is considered sufficient to support the *Aquatic Life Use*. The analyst must evaluate the frequency and duration of excursions (whether or not they exceed 10% of the measurements) as well as the magnitude of any excursions (i.e., >1.0 mg/L below the criterion). DO is identified as a cause of impairment if data indicate frequent, prolonged and/or severe excursion(s) from the appropriate criterion.

Note: DO as an indicator related to nutrient enrichment can be found in nutrients.

Use is Supported			**Use is Impaired**		
Rivers	***Lakes***	***Estuaries***	***Rivers***	***Lakes***	***Estuaries***
No more than one excursion from criteria (minimum three preferably five measurements representing critical --i.e., pre-dawn, conditions)	No/little depletion (the criterion is met in all depths over ≥90% of the lake surface area during summer season)	No/infrequent (≤10%) prolonged or severe excursions from criteria in surface or bottom waters	Frequent (>10%) and/or prolonged or severe excursions (>1.0 mg/L below standards) from criteria	The criterion is not met at all depths for >10% of the lake surface area during periods of maximum oxygen depletion	Frequent (>10%) and/or prolonged or severe excursions (>1.0 mg/L below standards) from criteria

pH.

The pH of water is a measure of its hydrogen ion (H^+) concentration on a negative logarithmic scale, which ranges from 0 to 14 standard units (SU). A pH value less than 7 indicates higher H^+ content (acidic solutions), whereas pH values above 7 denote alkaline solutions. Natural waters exhibit a wide range of pH values depending upon their chemical and biological characteristics. Unpolluted river water usually has a pH between 6.5 and 8.5 SU (Hem 1970). In productive segments diurnal fluctuations in pH may occur as photosynthetic organisms take up dissolved carbon dioxide during the daylight hours reducing the acidity of the water so pH increases. Respiration and decomposition during the night produces CO_2 that dissolves in water as carbonic acid, thereby lowering the pH. The pH of water affects the solubility (amount that can be dissolved in the water) and biological availability (amount that can be utilized by aquatic life) of chemical constituents such as nutrients (phosphorus, nitrogen, and carbon) and heavy metals (lead, copper, cadmium, etc.).

The MassDEP SWQS criteria for pH are as follows:
Class A, Class BCWF and Class BWWF: 6.5 - 8.3 SU and Δ0.5 outside the natural background range.
Class C: 6.5 - 9.0 SU and Δ1.0 outside the natural background range.
Class SA and Class SB: 6.5 - 8.5 SU and Δ0.2 SU outside the natural background range.
Class SC: 6.5 - 9.0 SU and Δ0.5 SU outside the natural background range.
There shall be no change from natural background conditions that would impair any use assigned to each class.

Studies done to evaluate the acidity of surface waters in Massachusetts found geographical differences within the state (Walk *et al.* 1991). The regions with the lowest average pH and acid neutralizing capacity (ANC) were the southeastern and north-central areas of the state while the highest average pH and ANC were in the western-most area (the only area with significant limestone deposits). Mattson *et al.* (1992) used the state map of bedrock formations produced by Zen (1983) to delineate the boundaries between six regions of similar bedrock geology and water quality. According to Portnoy *et al.* (2001) the seashore kettle ponds are naturally acid (varying between pH 4 and 6 SU) and have been for millennia.

Rivers and Estuaries: MassDEP analysts compare pH data to the appropriate criteria range. If all pH data are within the range the *Aquatic Life Use* is considered to be supported. When two or more measurements are outside the range analysts must consider whether or not the conditions are natural given the tendency towards acidic conditions described above (e.g., low pH in an wetland dominated sampling area based on field sampling notes and MassGIS topographic maps, orthophotos, and/or land use coverage). The magnitude of the excursion (i.e., >0.5 SU below the criterion), and the frequency of the excursions (e.g., non-consecutive vs. consecutive low or high pH measurements) should be considered. pH is identified as a cause of impairment if data indicate frequent, prolonged and/or severe excursion(s) from the criteria. The use may be impaired if criteria are exceeded in >10% of measurements that are not considered to be due to natural conditions.

Lakes: An impairment decision can be made using one deep-hole probe profile during the summer growing season that indicates an extreme excursion from the criteria range.

Use is Supported			**Use is Impaired**		
Rivers	***Lakes***	***Estuaries***	***Rivers***	***Lakes***	***Estuaries***
No or slight excursions (<0.5 SU) from criteria (minimum five measurements)	No or slight excursions (<0.5 SU) from criteria (minimum one deep-hole profile during summer growing season)	No or slight excursions (<0.5 SU) from criteria (minimum five measurements)	Frequent (>10%) and/or prolonged or severe excursions (>0.5 SU) from criteria	Excursion from criteria (>0.5 SU) summer growing season	Frequent (>10%) and/or prolonged or severe excursions (>0.5 SU) from criteria

Temperature.

Most aquatic organisms are unable to internally regulate their core body temperature. Therefore, temperature exerts a major influence on the biological activity and growth of aquatic organisms and the ability of organisms to tolerate certain pollutants. Temperature is also important because of its influence on water chemistry. Temperature affects the solubility of oxygen in water. Warm water holds less oxygen that cool water, so it may be saturated with oxygen but still not contain enough for survival of aquatic life. The rate of chemical reactions generally increases at higher temperature, which in turn affects biological activity. Some compounds are also more toxic to aquatic life at higher temperatures.

The MassDEP SWQS criteria for temperature are as follows (MassDEP 2006):
Class A CWF: ≤68 F (20°C) based on the mean of the daily maximum temperature over a seven day period in cold water fisheries, unless naturally occurring and ΔT due to a discharge ≤1.5°F (0.8°C).
Class A WWF: ≤83°F (28.3°C) and ΔT due to a discharge ≤1.5°F (0.8°C).
Class B CWF: ≤68°F (20°C) based on the mean of the daily maximum temperature over a seven day period in all cold water fisheries, unless naturally occurring, and ΔT due to a discharge ≤Δ3°F (1.7°C).
Class B WWF: ≤83°F (28.3°C) and ΔT due to a discharge ≤5°F (2.8°C) in rivers (based on the minimum expected flow for the month) and ΔT due to a discharge ≤3°F (1.7°C) in the epilimnion (based on the monthly average of maximum daily temperatures) in lakes.
Class C and Class SC: ≤85°F (29.4°C) and ΔT due to a discharge ≤5°F (2.8°C).
Class SA: ≤85°F (29.4°C) nor a maximum daily mean of 80°F (26.7°C) and ΔT due to a discharge ≤1.5°F (0.8°C).
Class SB: ≤85°F (29.4°C) nor a maximum daily mean of 80°F (26.7°C) and Δ T due to a discharge ≤1.5°F (0.8°C) between July and September and ≤4.0°F (2.2°C) between October and June.
For all classes, natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained. There shall be no changes from natural background conditions that would impair any uses assigned to each class, including those conditions necessary to protect normal species diversity, successful migration, reproductive functions or growth of aquatic organisms. Alternative effluent limitations established in connection with a variance for a thermal discharge issued under 33 U.S.C § 1251 (FWPCA, § 316(a)) and 314 CMR 3.00 are in compliance with 314 CMR 4.00. As required by 33 U.S.C. § 1251 (FWPCA, § 316(a)) and 314 CMR 3.00, for permit and variance renewal, the applicant must demonstrate that alternative effluent limitations continue to comply with the variance standard for thermal discharges.

Rivers: For waters designated as Cold Water Fisheries (CWF) the analyst evaluates if temperature measurements meet the criterion (≤20°C) particularly during the summer index period. When only small data sets are available the *Aquatic Life Use* is assessed as support if there are no/infrequent/small excursions (1 to 2°C) from the criterion. With the availability of deployed probe (long term) data sets the mean of the daily maximum temperatures over 7-day periods should be ≤ 20°C. The analyst should note the deployment period, the number of measurements, the temperature range, and provide the number of 7-day periods the cold water criterion (20ºC) is exceeded (based on rolling average calculations of 7-day mean of the daily maximum temperatures) out of the number of 7-day periods during the deployment. Excursion from criteria should not be frequent or prolonged. With small data sets the analyst must consider the frequency/magnitude of exceedances to evaluate if elevated temperature measurements are enough to impair the *Aquatic Life Use*. However, more data are typically considered necessary to make an impairment decision. For long-term data sets, the analyst should impair the *Aquatic Life Use* when the criterion is frequently exceeded or by >2°C.

Rivers and Lakes: For Warm Water Fisheries (WWF) the analyst evaluates if temperature measurements meet the criterion (≤28.3°C) particularly during the summer index period. With small data sets the *Aquatic Life Use* is assessed as support if there are no or infrequent excursions from the criterion. When deployed probe (long term) data sets are available the maximum temperature and the total number of measurements should be determined as well as the number of days, the number of hours exceeding 28.3°C, and the average number of hours when the exceedances occurred. Excursions from criteria should not be frequent or prolonged. With small data sets the analyst considers the frequency/magnitude of exceedances to evaluate if elevated temperature measurements are enough to impair the *Aquatic Life Use*. For long-term data sets the analyst impairs the *Aquatic Life Use* if temperatures frequently (>10% measurements) exceed 28.3°C in a waterbody or by >2°C.

Estuaries: The analyst evaluates if temperature measurements meet the criteria (≤29.4°C and maximum daily mean of 26.7°C). Impact of large thermal discharges: Site specific evaluations are made with regard to the rise in *in-situ* temperatures due to the discharge. Changes over the ΔT criteria result in impairment decisions.

Use is Supported		**Use is Impaired**	
Cold Water Fishery	*Warm Water Fishery*	*Cold Water Fishery*	*Warm Water Fishery*
no/infrequent/small excursions (1 to 2°C) above 20°C	no/infrequent excursions above criteria (28.3°C)	criterion frequently exceeded (>10%) or by >2°C	criterion frequently exceeded (>10% measurements) or by >2°C.

Nutrients. The MassDEP SWQS include both narrative nutrient and aesthetic criteria (see excerpts below) that are applicable to all surface waters (MassDEP 2006).

> *"Unless naturally occurring, all surface waters shall be free from nutrients in concentrations that would cause or contribute to impairment of existing or designated uses and* [concentrations] *shall not exceed the site specific criteria developed in a TMDL ….Any existing point source discharge containing nutrients in concentrations that would cause or contribute to cultural eutrophication* [defined elsewhere in the MassDEP SWQS as '*The human induced increase in nutrients resulting in acceleration of primary productivity, which causes nuisance conditions, such as algal blooms or dense and extensive macrophyte growth, in a waterbody.*'], *including the excessive growth of aquatic plants or algae, in any surface water shall be provided with the most appropriate treatment … to remove such nutrients* [point and nonpoint source controls] *to ensure protection of existing and designated uses…"*
>
> *And "All surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance* [growth or amount] *species of aquatic life."*

To evaluate a waterbody for nutrient related impairment MassDEP analysts rely on multiple, supporting indicators as evidence of nutrient enrichment. Biological indicators of nutrient enrichment include the presence of nuisance growths of primary producers or population changes in certain critical species. Indications of high primary productivity are often observed as changes to certain physico-chemical analytes, as well. The more combinations of these indicators can be documented the stronger the case for the *Aquatic Life Use* to be assessed as impaired. And, while total phosphorus or nitrogen concentration data, which are screened against 1986 EPA recommended "Gold Book" criteria, are not currently utilized alone to determine impairment due to nutrient enrichment they help to corroborate indicator data and can help to identify potential sources (e.g., release of phosphorus from anoxic sediments). Nutrient enrichment is not considered to be problematic when indicators, as described above, are absent even if nutrient concentrations exceed their recommended criteria. However, when the multiple, supporting indicators show nutrient enrichment to be problematic and concentration data exceed their criterion, the nutrient is also identified as a cause of impairment.

Rivers: DWM analysts currently support the *Aquatic Life Use* if there are no/limited observable nuisance growths of algae in forms such as filamentous coverage, planktonic blooms, or mats, or macrophytes (particularly non-rooted forms) during the summer index period (see periphyton/algal bloom indicator summary). When excessive growths are observed the analyst also considers changes in physico-chemical data, such as: dissolved oxygen (concentration and supersaturation), pH, and chlorophyll *a*. If a combination of these indicator data strongly suggests high productivity/nutrient enrichment the *Aquatic Life Use* is assessed as impaired.

Lakes: Nutrient enrichment indicators in lake surface waters typically include the occurrence of planktonic blooms (particularly bluegreens), extensive cover of non-rooted aquatic macrophytes (particularly duckweed or water meal covering >25% of the surface), decreased Secchi disk transparency (<1.2 m), oxygen supersaturation (>125%), elevated pH values >8.3 SU, and elevated chlorophyll *a* concentrations (frequently and substantially >16 µg/L). In the absence of these indicators the *Aquatic Life Use* is assessed as support.

Estuaries: DWM analysts currently utilize areal coverage of seagrasses or other submerged aquatic vegetation and, when available, the MEP habitat health indicator analysis. Assessment decisions are based on whether or not the eelgrass beds within the waterbody segment area are stable or are being lost. For embayments in Southeastern Massachusetts the MEP has also generated a significant amount of enrichment indicator data based on a weight-of-evidence approach that includes several response variables (e.g., eelgrass, infauna, macroalgae, chlorophyll *a*, DO, Secchi disk, TN concentrations). Since this project is intended to develop site-specific nutrient (nitrogen) thresholds for these systems, their overall analysis of habitat health are utilized to make *Aquatic Life Use* attainment decisions.

Use is Supported			**Use is Impaired**		
Rivers	***Lakes***	***Estuaries***	***Rivers***	***Lakes***	***Estuaries***
No/ minimimal amount visible filamentous algae, blooms, mats	No/limited observable growths of nuisance algae or macrophytes	Eelgrass bed habitat in segment area is increasing or fairly stable (i.e., no or minimal loss), MEP analysis indicates support (excellent to good/fair health)	Combination of indicators present: excessive visible nuisance algae (filamentous, blooms, mats), large diel changes in oxygen/saturation/pH, elevated chlorophyll *a,* elevated Phosphorus (Total)	Combination of indicators present: excessive visible nuisance algae or non-rooted macrophytes, low Secchi disk transparency, high oxygen super-saturation, elevated pH elevated chlorophyll *a,* elevated Phosphorus (Total)	Substantial decline (> 10% of bed size or total loss of beds no matter their size, MEP analysis indicates moderately to severely degraded health due to nitrogen enrichment

Toxic and other pollutants (Rivers, Lakes, Estuaries)
The MassDEP SWQS include a narrative statement pertaining to toxic pollutants (see excerpt below) that is applicable to all surface waters (MassDEP 2006). To evaluate the potential for observing adverse biological effects the water quality data for toxic and other pollutants (e.g., metals, ammonia, chlorine, polycyclic aromatic hydrocarbons, chlorinated organics) are compared to their respective Water Quality Criteria (EPA 2009 available at http://water.epa.gov/scitech/swguidance/standards/current/upload/nrwqc-2009.pdf). In general the EPA recommends both acute (typically expressed as one-hour averages) and chronic (typically expressed as four-day averages) to protect against short and long-term effects. For most toxicants the EPA also recommends that the criteria should not be exceeded more than once every three years. For those analytes measured in the water column a matrix of analytes and their respective acute and chronic criteria values is developed. When the ratio of the pollutant to the criterion exceeds a value of 1.0 it is considered a concentration of concern. This ratio (a "Toxic Unit" calculation) also provides the relative magnitude of the exceedance. Since concentrations above criteria often do not result in toxicity the weight-of-evidence approach/gradient is followed by DWM analysts. Therefore, when they are available and of at least equal data quality, the analysts rely more heavily on survival data from ambient toxicity tests than on chemical concentration data.

> *"All surface waters shall be free from pollutants in concentrations or combinations that are toxic to humans, aquatic life or wildlife. For pollutants not otherwise listed in 314 CMR 4.00, the National Recommended Water Quality Criteria: 2002, EPA 822-R-02-047, November 2002 published by the EPA pursuant to Section 304(a) of the Federal Water Pollution Control Act, are the allowable receiving water concentrations for the affected waters, unless the Department either establishes a site specific criterion or determines that naturally occurring background concentrations are higher. The Department shall use the water quality criteria for the protection of aquatic life expressed in terms of the dissolved fraction of metals when the EPA's 304(a) recommended criteria provide for use of the dissolved fraction* (see Mass DEP 2006 for more detail regarding permit limits, conversion factors, site specific criteria)*."*

Metals. In-stream metals data were historically collected by the DWM during water quality monitoring surveys and NPDES facilities still report these data as part of their Whole Effluent Toxicity Testing requirements. Much of these data were utilized to make *Aquatic Life Use* assessment decisions. However, none of these historical data were collected using "clean sampling techniques" and their validity for making use-impairment decisions came into question in the late 1990s. Since that time DWM analysts have not been utilizing metals data as part of the water quality assessment reporting. In 2007 an effort was initiated by the DWM to develop clean sampling techniques for gathering in-stream dissolved metal data. It is expected that data generated using these procedures will be used in making future *Aquatic Life Use* assessment decisions when they are validated and become available. In particular these data will be used to evaluate whether or not historical impairment decisions, based on "non-clean technique" metals data, were appropriate. When the criteria are hardness dependent the actual in-stream hardness data are utilized to calculate the criteria.

***Ammonia*.** According to the EPA (1999) the freshwater acute criterion for ammonia is dependent on pH and fish species and the chronic criterion is dependent on pH and temperature. At lower temperatures the chronic criterion is also dependent on the presence or absence of early life stages (ELS) of fish. The EPA also recommends 30 days as the averaging period for the ammonia chronic criterion and that within the 30-day averaging period no 4-day average concentration should exceed 2.5 times the chronic criterion. Because the ammonia criterion is a function of pH and temperature the analyst should first screen results by using the highest pH and temperature measurements taken in the watershed during the course of the surveys to determine the conservative acute and chronic ammonia criteria. The concentration data can then be compared to these basin-specific conservative ammonia criteria values. If data exceed the criteria then the actual pH and temperature of the sample are used to calculate the sample-specific ammonia criteria to which data are then compared. The analyst should note the number of exceedances as well as

> EPA (1999) *"regarding the dependence of the toxicity of ammonia to aquatic organisms on various physicochemical properties of the test water, especially temperature, pH, and ionic composition… in aqueous solution, ammonia primarily exists in two forms, un-ionized ammonia (NH3) and ammonium ion (NH4 +)…the individual fractions vary markedly with temperature and pH…ammonia speciation also depends on ionic strength, but in fresh water this effect is much smaller… These speciation relationships are important to ammonia toxicity because un-ionized ammonia is much more toxic than ammonium ion…it was observed that increased pH caused total ammonia to appear to be much more toxic… because it is a neutral molecule and thus is able to diffuse across the epithelial membranes of aquatic organisms much more readily than the charged ammonium ion…ammonia is unique among regulated pollutants because it is an endogenously produced toxicant that organisms have developed various strategies to excrete, which is in large part by passive diffusion of un-ionized ammonia from the gills…high external un-ionized ammonia concentrations reduce or reverse diffusive gradients and cause the buildup of ammonia in gill tissue and blood".*

the magnitude, frequency, and duration of exceedances. Frequent and/or prolonged (more than one acute or more than 10% of the chronic criteria) or severe excursions from criteria are usually considered an impairment.

***Chlorine*.** Chlorine is primarily used as a biocide to disinfect municipal wastewater effluents, to control fouling organisms in cooling water systems, as a bleaching agent in textile mills and paper-pulping facilities, and in cyanide destruction in electroplating and other industrial operations. The freshwater ambient water quality criteria for this toxicant are expressed as total residual chlorine (TRC) --the sum of the concentrations of free and combined residuals as measured by amperometric titration or an equivalent method. The EPA recommended acute criterion for TRC is 0.019 mg/L (one-hour average), and the chronic criterion for TRC is 0.011 mg/L (four-day average). Neither is to be exceeded more than once every three years. The minimum quantification level for reporting TRC concentrations in the NPDES permit and whole effluent toxicity (WET) test reports historically was 0.05 mg/L. Concentrations reported at or below this minimum quantification level were considered by the EPA and the MassDEP to be meeting the criteria for permitting and assessment purposes. However, if in-stream TRC concentrations exceed 0.05 mg/L the analyst should note the number of times the TRC criteria (acute and chronic) are exceeded as well as the magnitude and frequency of exceedances. Frequent and/or prolonged (more than one acute or more than 10% of the chronic criteria) or severe excursions from criteria are usually considered an impairment. [Note: the most recent minimum quantification level for TRC in NPDES permits and whole effluent toxicity testing guidelines is now 0.02 mg/L, so the assessment methodology will be changed to this level in the future.]

DWM analysts evaluate whether or not there are exceedances of toxic and other pollutants by comparing the data to their respective acute and chronic water quality criteria. Infrequent excursions (no more than a single exceedance of an acute criterion or 10% samples exceeding a chronic criterion) are not considered an impairment. Frequent and/or prolonged (more than one acute or more than 10% of the chronic criteria) or severe excursions from criteria is considered an impairment unless a weight-of-evidence based decision suggests otherwise.

Use is Supported	Use is Impaired
Infrequent excursion from criteria (no more than a single exceedance of acute criteria or ≤10% samples exceed chronic criteria)	Frequent and/or prolonged excursions from criteria (more than a single exceedance of acute criteria or >10% samples exceed chronic criteria).

Sediment quality data (rivers, lakes, estuaries)

The MassDEP SWQS do not currently contain numeric sediment quality criteria. To evaluate the potential for adverse biological effects, surficial sediment quality data for heavy metals, polyaromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs),and pesticides are compared to the Canadian Interim Sediment Quality Guidelines (ISQL), which represent the concentration below which adverse biological effects are expected to rarely occur and the probable effect levels (PEL), which represent the levels for which adverse biological effects are expected to frequently occur (CCME 2002).

For those analytes measured in surficial sediment samples where ISQL and PEL guidance are available a matrix of analytes and their respective guidance values is developed. Ratios of the sediment concentration for each analyte to its respective ISQL and PEL are then calculated. When the ratio of the contaminant to the guideline exceeds a value of 1.0 the concentration is considered to be of concern. To assess the overall quality of the sediment at a site all of the ratios that exceed a value of 1.0 are added together. This sum is noted as the total factor over the ISQL and/or PEL.

Sediment quality data alone are not typically used to assess the *Aquatic Life Use* as impaired. However, when there are exceedances of sediment screening values (ISQLs and/or PELs) along with other indicators of impairment (e.g., fish tissue contamination or impaired biological community) the analyst will use best professional judgment (BPJ) and likely add the sediment screening value exceedances as a cause of impairment for the *Aquatic Life Use*. It should be noted here that for areas in Massachusetts where the sediments are known to be severely contaminated and are undergoing remedial actions (e.g., Housatonic River or Inner New Bedford Harbor.) sediment contamination is identified as one source of the impairment.

Use is Supported	Use is Impaired
No/infrequent excursion of ISQL guidelines and no other indicators of impairment.	Frequent excursions over PEL guidelines along with other evidence of impairment, waterbodies known to have sediment contamination undergoing remedial actions.

Background/context:
Sediment and tissue chemistry (CCME 1999b)

Highly persistent, bioaccumulative compounds, such as PCBs, dichlorodiphenyltrichloroethane (DDT), toxaphene, dioxin and furans, and mercury, are not often detectable in water because they readily partition into other environmental media, including sediment and biota (CCME 1999b).

Organochlorine compounds, which include insecticides and PCBs, had been in widespread use since World War II but have since been restricted or banned because of their toxic effects on wildlife and human health. According to Coles (1998) "They are resistant to biochemical degradation…which contributes to excessive buildup in aquatic environments…they are prone to atmospheric transport…have a high affinity for sediment organic matter…tend to partition strongly into the lipid component of aquatic organisms…they can be passed up the food chain to higher trophic feeders through bioaccumulation…the National Academy of Science/National Academy of Engineering's (NAS/NAE) recommended guidelines for the protection of fish-eating wildlife apply to whole fish tissue. These guidelines were based on experimental studies showing induction of eggshell thinning in birds by DDT and metabolites. More conservative guidelines for other organochlorines were set by analogy to DDT, based on their greater toxicity to wildlife."

EXHIBIT I
AR J1

Tissue residue data (rivers, lakes, estuaries)

Body burdens of chemicals in aquatic organisms (i.e., fish, shellfish, invertebrates, and plants) also provide a mechanism to evaluate risk to wildlife consumers of aquatic biota. According to Coles (1998) the National Academy of Science/National Academy of Engineering (NAS/NAE) guidelines based on whole fish for the protection of fish-eating wildlife are as follows:

Total PCBs: ≤ 500 μg/kg (ppb) wet weight
Total DDT, DDE, DDD: ≤ 1,000 μg/kg (ppb) wet weight
Chlordane and Heptachlor epoxide: ≤ 200μg/kg (ppb) wet weight (also applies to total residues of aldrin, BHC, chlordane, dieldrin, endosulfan, endrin, heptachlor, heptachlor epoxide, lindane, and toxaphene either singly or in combination).

Rivers, Lakes: Residues of contaminants in whole body samples of fish are compared to the NAS/NAE recommended guidelines based on whole fish for the protection of fish-eating wildlife. If the concentration of contaminants is below the guideline(s) (e.g., [total PCB] ≤ 500 μg/kg (ppb) wet weight) then no impairment decision for the *Aquatic Life Use* is made. However, if whole body burden residue(s) exceed the recommended guideline(s), best professional judgment is used by the analyst to evaluate whether or not an impairment decision is warranted. While an impairment decision will not be made on one or a few samples, an impairment decision will be made based on several samples exceeding NAS/NAE guidelines combined with any other data types that corroborate an impairment decision (see DELTS/abnormal fish histology in Fish Population Section).

Use is Supported	Use is Impaired
Residue of contaminants in whole body samples do not exceed NAS/NAE guidelines	Residue of contaminants in whole body samples frequently exceed NAS/NAE guidelines, DELTS with abnormal fish histology.

Background/context:
Body Burdens
(CCME 1999c, 1999d, 2001c and 2000)

***DDT**, a chlorinated hydrocarbon insecticide, was used world-wide since the 1940s to control insects (CCME1999c). "DDT, as well as its breakdown products, is highly lipophilic and presents serious problems for wildlife that feed at high trophic levels in the food chain…for aquatic-based wildlife species, food resources provide the main route of exposure…exposure to DDT and its metabolites [DDD and DDE] is known to reduce longevity and alter cellular metabolism, neural activity and liver function…mutagenic and carcinogenic effects, as well as adverse effects on reproduction, growth, and immunocompetence."*

***Toxaphene** "(chlorinated camphenes known as campheclor, chlorocamphene, or polychlorocamphene (PCC)) was developed in 1946 and used as a contact insecticide for crops, as an herbicide and to control ectoparasites on livestock… also applied to lakes and streams in Canada and the northern US to eliminate undesirable fish, lamprey, and invertebrate communities…exposure to toxaphene is known to induce adverse effects on cardiovascular, hepatic, renal, endocrine, immunological, and neurological systems, and to decrease longevity in birds and mammals…while contamination of surface waters may continue to occur as a result of erosion of toxaphene-contaminated soils, atmospheric deposition is a main source"* (CCME 1999d).

***Dioxin and Furans** "(polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurnas (PCDFs) are planar tricyclic aromatic compounds…while they have never been intentionally produced they are byproducts formed as a result of anthropogenic activities including waste incineration, chemical manufacturing, petroleum refining, wood burning, metallurgical processes, fuel combustion (autos), residential oil combustion, and electric power generation…natural sources include forest fires and volcanic activity…the 2,3,7,8-substituted PCDD/Fs are thought to elicit most of their toxicity via the aryl hydrocarbon (Ah) receptor, a protein present in mammals, birds, and fish…by binding however linkages between enzyme induction and specific organ toxicity are unclear"* (CCME 2001). Mortality and a multitude of sublethal effects on organisms were described.

***Methyl mercury**, "the most toxicologically relevant form, is a potent neurotoxicant for animals and humans…It is produced through the biological and chemical methylation of inorganic mercury…Methyl mercury is not very lipid soluble but it binds strongly with sulfhydryl groups in proteins and is therefore readily accumulated and retained in biological tissues".(CCME 2000).*

Aquatic Life Use Assessment

Table 2. *Aquatic Life Use* assessment decision indicator summary by weight-of-evidence gradient.

Indicator for *Aquatic Life Use* Assessment	Use is Supported	Use is Impaired
BIOLOGICAL MONITORING INFORMATION		
Benthic macroinvertebrate data (rivers)	Non-impaired/most slightly impaired RBP III analysis, reference sites	Moderately impaired/severely impaired RBP III analysis, slightly impaired with special condition (e.g., hyperdominance by pollution tolerant sp.) as noted by DWM biologists
Benthic macroinvertebrate data (estuaries)	High # species, high # individuals, good diversity and evenness, moderate to deep burrowing, tube dwelling organisms present, as reported from external data sources	Low # species, low # individuals, poor diversity and evenness, shallow dwelling opportunistic species or near absence of benthos, thin feeding zone, as reported from external data sources
Fish population data (rivers)	**Cold Water Fishery** Multiple age classes (or reproducing populations) of any cold water fish **Warm Water Fishery** In lotic environments the fish population should be well represented by fluvial specialist/dependents species	**Cold Water Fishery** No fish found or cold water species absent, DELTS with abnormal fish histology **Warm Water Fishery** No fish found or fluvial fish were absent or relatively scarce (few numbers), DELTS with abnormal fish histology
Fish population data (lakes, estuaries)	None made	> 5% population losses estimated , DELTS with abnormal fish histology
Habitat and flow data (rivers, lakes, estuaries)	No direct evidence of severe physical habitat or stream flow regime alterations, functioning anadromous fishways present	Physical habitat structure impacted by anthropogenic stressors (e.g., lack of flow, lack of natural habitat structure such as concrete channel, underground conduit), non-functioning anadromous fishway present
Eelgrass bed mapping data (estuaries)	Eelgrass bed habitat in segment area is increasing or fairly stable (i.e., no or minimal loss)	Substantial decline (more than 10% of the in bed size or total loss of beds no matter their size)
Non-native aquatic species data (rivers, lakes)	Non-native aquatic species absent	Non-native aquatic species present
Periphyton/algal bloom (rivers, lakes, estuaries)	No/infrequent algal blooms or growths of periphyton, ≤25% cover noxious aquatic plants (e.g. *Lemna*), periphyton cover within riffle/reach ≤40%,	Frequent and/or prolonged algal blooms or growths of periphyton, cyanobacteria blooms result in advisories (recurring and/or prolonged), >25% cover noxious aquatic plants (e.g. *Lemna*), periphyton cover within riffle/reach >40%
TOXICOLOGICAL MONITORING INFORMATION		
Toxicity testing data (rivers, lakes, estuaries)	≥75% survival of test organisms to water column or sediment samples in either 48 hr (acute) or 7-day exposure (chronic) tests.	<75% survival of test organisms to water column or sediment samples in either 48 hr (acute) or 7-day exposure (chronic) tests occurs in >10% of test events.
PHYSICO-CHEMICAL WATER QUALITY INFORMATION		
Water quality data - DO (rivers)	No excursions, a single excursion from criteria (minimum three preferably five measurements representing critical --i.e., pre-dawn conditions)	Frequent (>10%) and/or prolonged or severe excursions (>1.0 mg/L below standards) from criteria
Water quality data - DO (lakes)	No/little depletion (the criterion is not met in hypolimnetic area <10% of the lake surface area during summer season)	In deep lakes (with a hypolimnion) the criterion is not met in a hypolimnetic area >10% of the lake surface area during maximum oxygen depletion (summer growing season)
Water quality data - DO (estuaries)	No/infrequent prolonged or severe (≤10%) excursions from criteria in surface or bottom waters	Frequent (>10%) and/or prolonged or severe excursions (>1.0 mg/L below standards) from criteria
Water quality data - pH (rivers)	No or slight excursions (<0.5 SU) from criteria (minimum five measurements)	Frequent (>10%) and/or prolonged or severe excursions (>0.5 SU) from criteria
Water quality data - pH (lakes)	No or slight excursions (<0.5 SU) from criteria (minimum one deep-hole profile during summer growing season)	Excursion from criteria (>0.5 SU) summer growing season
Water quality data - pH (estuaries)	No or slight excursions (<0.5 SU) from criteria (minimum five measurements)	Frequent (>10%) and/or prolonged or severe excursions (>0.5 SU) from criteria
Water quality data - temperature (rivers and lakes)	**Cold Water Fishery** no/infrequent/small excursions (1 to	**Cold Water Fishery** criterion frequently exceeded (10%) or by

Indicator for *Aquatic Life Use* Assessment	Use is Supported	Use is Impaired
	2°C) above 20°C **Warm Water Fishery** no/infrequent excursions above criteria (28.3°C)	>2°C **Warm Water Fishery** criterion frequently exceeded (10% measurements) or by >2°C.
Water quality data - temperature (estuaries)	No/infrequent/small excursions (≤29.4°C and maximum daily mean of 26.7°C)	Criterion frequently exceeded, rise due to discharge exceeds ΔT standards
Water quality data nutrient indicators (rivers)	No/ minimimal amount visible filamentous algae, blooms, mats	Combination of indicators present: excessive visible nuisance algae (filamentous, blooms, mats), large diel changes in oxygen/saturation/pH, elevated chlorophyll *a*, elevated total phosphorus (>0.05 to 0.1 mg/L "Gold Book")
Water quality data nutrient indicators (lakes)	No/limited observable growths of nuisance algae or macrophytes	Combination of indicators present: excessive visible nuisance algae or macrophytes, low Secchi disk transparency, high oxygen super-saturation, elevated pH elevated chlorophyll *a*, elevated total phosphorus (>0.025 mg/L "Gold Book")
Water quality data nutrient indicators (estuaries)	Eelgrass bed habitat in segment area is increasing or fairly stable (i.e., no or minimal loss), MEP analysis indicates support (excellent to good/fair health)	Substantial decline (> 10% of bed size or total loss of beds no matter their size, MEP analysis indicates moderately to severely degraded health due to nitrogen enrichment
Water quality data Toxic and other pollutants (rivers, lakes, estuaries)	Infrequent excursion from criteria (no more than a single exceedance of acute criteria or ≤10% samples exceed chronic criteria)	Frequent and/or prolonged excursions from criteria (more than a single exceedance of acute criteria or >10% samples exceed chronic criteria).
SEDIMENT AND TISSUE RESIDUE INFORMATION		
Sediment quality data (rivers, lakes, estuaries)	No/infrequent excursion of ISQL guidelines and no other indicators of impairment.	Frequent excursions over PEL guidelines along with other evidence of impairment, waterbodies known to have sediment contamination undergoing remedial actions.
Tissue residue data (rivers, lakes, estuaries)	Residue of contaminants in whole body samples do not exceed NAS/NAE guidelines	Residue of contaminants in whole body samples frequently exceed NAS/NAE guidelines, DELTS with abnormal fish histology.

Fish Consumption Use

The definition of "Secondary Contact Recreation" in the Massachusetts Surface Water Quality Standards (SWQS) includes the statement that waters supporting the *Secondary Contact Recreational Use* are suitable for "…Any recreation or other water use in which contact with the water is either incidental or accidental. These include but are not limited to fishing, including human consumption of fish, boating and limited contact incident to shoreline activities." (MassDEP 2006). For the purpose of assessment and 305(b)/303(d) Integrated List reporting, however, the status of the *Fish Consumption Use* (human consumption of fish) is reported as its own use rather than part of the *Secondary Contact Recreational Use*. Another part of the SWQS states that "pollutants shall not result in unacceptable concentrations in edible portions of marketable fish or for the recreational use of fish, shellfish, other aquatic life or wildlife for human consumption" (see 314 CMR4.05(5)(e)3b in MassDEP 2006).

Use Assessment Decision-Making Process:
MassDEP DWM biologists have been conducting fish toxics monitoring since 1983. As the years passed it became increasingly clear that the major problems in Massachusetts (as in the other New England States) were related to either the widespread atmospheric deposition of mercury or to the historic use and disposal of PCBs (MassDEP 2010c). Currently, freshwater fish tissue contaminant testing in Massachusetts is conducted by the MassDEP in cooperation with the MA Department of Public Health (MA DPH) and the Department of Fish and Game (MA DFG). The three agencies work together as the Interagency Committee on Freshwater Fish Toxics Monitoring and Assessment, through a Memorandum of Understanding (MOU) established in 1994, to facilitate the communication, coordination, and dissemination of information pertaining to contaminants in freshwater fish (MassDEP 2010c). The collaborative efforts of the MassDEP, the MA DPH, and the MA DFG ensure the state's ability to conduct limited testing and evaluation of contaminants in fish tissue for purposes of protecting public health and the environment. Each of the three agencies named in this MOU has responsibilities unique to their mission. While the MassDEP provides much of the field and analytical support (refer to background/context inset on next page for the MassDEP DWM Fish Toxics Monitoring Program), all data are sent to the MA DPH and the MassDEP Office of Research and Standards (ORS) for risk assessment and issuance of advisories, if appropriate. Ultimately, the MA DPH is responsible for decisions regarding the need for and/or implementation of public health advisories.

In a June 03, 2009 press release MA DPH reminded consumers of statewide fish advisories in place:

Fish Consumption Advisory for Marine and Fresh Water Bodies (MA DPH 2009b)

Fish is good for you and your family. It may also protect you against heart disease. It is a good source of protein and it is low in fat. A varied diet, including safe fish, will lead to good nutrition and better health. If you may become pregnant or are pregnant or nursing, you and your children under 12 years old may safely eat 12 ounces (about 2 meals) per week of fish or shellfish not covered in this advisory. This recommendation includes canned tuna, the consumption of which should be limited to 2 cans per week. Very small children, including toddlers, should eat less. Consumers may wish to choose to eat light tuna rather than white or chunk white tuna, the latter of which may have higher levels of mercury. Otherwise, it is important to follow the Safe Eating Guidelines included in this advisory.'

Safe eating guidelines for pregnant women, women who may become pregnant, nursing mothers and children under 12 years old: **(contaminants of concern in parenthetical as noted by MA DPH and MassDEP analysts)**

Do Not Eat: *Freshwater fish caught in streams, rivers, lakes, and ponds in Massachusetts** **(Hg)**

Safe To Eat: *Fish that are stocked in streams, rivers, lakes, and ponds in Massachusetts*

Safe To Eat: *Cod, haddock, flounder and pollock in larger amounts*

Do Not Eat: *Lobster from New Bedford Harbor* **(PCB)**

Do Not Eat: *Swordfish, shark, king mackerel, tilefish, and tuna steak* **(Hg)**

Do Not Eat: *Bluefish caught off the Massachusetts coast* **(PCB)**

Do Not Eat: *Lobsters, flounder, soft-shell clams and bivalves from Boston Harbor* **(PCB and other contaminants)**. ***This Boston Harbor advisory is also recommended for people with weakened immune systems.*** **NOTE: For assessment purposes Boston Harbor is broadly defined to include all coastal waters that drain into it.**

Safe eating guidelines for everyone

Do Not Eat: *Fish and shellfish from the closed areas of New Bedford Harbor* **(PCB)**

Do Not Eat: *Lobster tomalley* **(PCB)**

*More specific consumption advice is available for certain freshwater bodies that have been tested at: http://www.mass.gov/dph/fishadvisories or by calling the Massachusetts Department of Public Health, Bureau of Environmental Health at 617-624-5757.

In addition to these statewide fish advisories, the MA DPH periodically (every one to three years) updates their **Freshwater Fish Consumption Advisory List**. The most recent list was made available in October 2011 (MA DPH 2011). This list provides specific consumption advice for individual water bodies that is to be considered in addition to the statewide advisories (MA DPH 2009b). This list identifies the waterbody, the town(s), the fish consumption advisory language, and the hazard (see http://www.mass.gov/dph/fishadvisories). MassDEP analysts assess waterbodies that have site-specific fish consumption advisories as impaired due to the hazard identified on the MA DPH list.

Background/context
MassDEP DWM Fish Toxics Monitoring Program (MassDEP 2010c)

"Originally, monitoring was conducted either in the vicinity of known or suspected waste sites or in conjunction with much larger watershed surveys to attempt to assess the potential for bioaccumulative effects of past or present wastewater treatment plant or other discharges…the objective of DWM's sampling is primarily to screen edible fillets of fishes for a variety of contaminants (i.e. mercury, polychlorinated biphenyls (Aroclors), and organochlorine pesticides). Due to the highly variable concentrations of bioaccumulative contaminants in fish tissue and the wide range of environmental conditions which affect bioaccumulation (bioconcentration, bioaccumulation, and biomagnification), screening is conducted in an effort to sample as many of the Commonwealth's waters as possible during a given sampling season. Although screening may not accurately predict bioaccumulation patterns among a full range of year classes of any given fish species, sampling a three fish composite of average sized individuals answers the questions with regard to the presence/absence of any given analyte and its relative concentration. All screening analyses are performed at the Senator William X. Wall Experiment Station (WES). All data are sent to the MDPH and the MassDEP Office of Research and Standards (ORS) for assessment and advisory issuance if appropriate…"

"In order to assess the level of contamination present in fish of different trophic guilds and habitat types, screening involves the collection of three to five fish composites representing fishes of three trophic groups (i.e. predators, water column feeders, bottom feeders). Fish species targeted include at a minimum; largemouth bass, Micropterus salmoides, and/or chain pickerel, Esox niger, (predators); yellow perch, Perca flavescens, and/or white perch, Morone americana, (water column invertivores/omnivores); and bullhead, Ameiurus sp. and/or common carp, Cyprinus carpio, (bottom feeding omnivores). Average-sized fish (above legal length limit when applicable) are analyzed as composite samples. Additional species or substitute species are chosen on a site-by-site basis."

According to Grubbs and Wayland (2000) "For purposes of determining whether a waterbody is impaired and should be included on a section 303(d) list, EPA considers a fish or shellfish consumption advisory…to be existing and readily available data and information that demonstrates non-attainment of a section 101(a) "fishable" use when: 1. the advisory is based on fish and shellfish tissue data."

The assessment of the *Fish Consumption Use* is made using the most recent fish consumption advisory lists issued by the MA DPH Bureau of Environmental Health Assessment (MA DPH 2009a, MA DPH 2009b, MA DPH 2011). Because of the statewide advisories that affect both fresh and estuarine waters in Massachusetts no surface waters can be assessed as support for the *Fish Consumption Use*. Where a site-specific advisory is in place (i.e., the waterbody is on the MA DPH Freshwater Fish Consumption Advisory List) the *Fish Consumption Use* is assessed as impaired. If no site-specific advisory is in place the *Fish Consumption Use* is not assessed. The guidance used to assess the *Fish Consumption Use* is summarized below.

Fish Consumption Use Assessment

Use is Supported	Use is Impaired
Not applicable in Massachusetts, precluded by statewide advisories (Hg and/or PCBs)	Waterbody has site specific MA DPH Fish Consumption Advisory with hazard (e.g., mercury, PCBs, pesticides, DDT, etc.)

When waters are assessed as impaired for the *Fish Consumption Use* due to elevated mercury and no source of mercury other than atmospheric deposition is identified, atmospheric deposition is listed as the source since it is anticipated that the waterbody will be restored in accordance with the Northeast Regional Mercury Total Maximum Daily Load (TMDL) (Northeast States 2007). This TMDL is a Federal Clean Water Act mandated document that identifies pollutant load reductions necessary for regional waterbodies to meet and maintain compliance with state and federal water quality standards. It was prepared by the New England Interstate Water Pollution Control Commission (NEIWPCC) for the six New England States and New York and was approved by the EPA in December 2007. The TMDL target for Massachusetts is 0.3 ppm or less of methyl mercury in fish tissue. The TMDL also called for a 75% reduction of in-region and out of region atmospheric sources by 2010 and a 90% or greater reduction in the future (NEIWPCC 2007). The TMDL will be reassessed in the future based on an evaluation of new, on-going monitoring and air deposition data. Final targets will be determined at a later time. Waters for which MA DPH mercury advisories have been issued since the approval date of the TMDL are considered on a case-by-case basis for coverage under that document.

Shellfish Harvesting Use

The definition of "Secondary Contact Recreation" in the Massachusetts Surface Water Quality Standards includes the statement that "Waters supporting the *Secondary Contact Recreational Use* are suitable for any recreation or other water use in which contact with the water is either incidental or accidental….Where designated, secondary contact recreation also includes shellfishing, including human consumption of shellfish" (MassDEP 2006). For the purpose of assessment and 305(b)/303(d) Integrated List reporting, however, the status of the *Shellfish Harvesting Use* (human consumption of shellfish) is reported as its own use rather than part of the *Secondary Contact Recreational Use*. In 314 CMR 4.05(5)(e)3b the SWQS state that "pollutants shall not result in unacceptable concentrations in edible portions of marketable fish or for the recreational use of fish, shellfish, other aquatic life or wildlife for human consumption" (MassDEP 2006).

Use Assessment Decision-Making Process:
Grubbs and Wayland (2000) provided states the following guidance for 305(b)/303(d) reporting: "*For purposes of determining whether a waterbody is impaired and should be included on a section 303(d) list, EPA considers a shellfish consumption advisory, a NSSP classification, and the supporting data, to be existing and readily available data and information that demonstrates non-attainment of a section 101(a) "fishable" use when: 1. the advisory is based on fish and shellfish tissue data. 2. a lower than "Approved" NSSP classification is based on water column and shellfish tissue data (and this is not a precautionary "Prohibited" classification or the state water quality standard does not identify lower than "Approved" as attainment of the standard) 3. the data are collected from the specific waterbody in question*".

The Massachusetts Department of Fish and Game (DFG), Division of Marine Fisheries (*MarineFisheries*), is responsible for implementing the Shellfish Sanitation and Management Program (see inset). Based on the results of their sanitary surveys, triennial evaluations and annual reviews the *MarineFisheries* biologists assign a sanitary classification to each shellfish growing area. DFG's designated shellfish growing area is an area of potential shellfish habitat. Growing areas are managed with respect to shellfish harvest for direct human consumption, including commercial shellfishing. The DFG classifications range from Approved (shellfishing taking permitted) to Prohibited (no shellfishing taking permitted) (see descriptions in inset on next page). Administrative or Management Closure's may be assigned by DFG if sufficient work has not been done to properly classify a growing area or if the associated risks to the fishery cannot be managed in a manner that ensures public health.

According to the SWQS (MassDEP 2006), the shellfish harvesting goals for SA and SB waters are as follows:

- Class SA waters, where designated, shall be suitable for shellfish harvesting without depuration (Approved and Conditionally Approved Shellfish Areas);
- Class SB waters, where designated, shall be suitable for shellfish harvesting with depuration (Restricted and Conditionally Restricted Shellfish Areas).

MarineFisheries Shellfish Sanitation and Management Overview (MA DFG undated)

The Shellfish Program has two primary missions, public health protection and both direct and indirect management of the Commonwealth's molluscan shellfish resources. Public health protection is afforded through the sanitary classification of all 1,745,723 acres of overlying waters within the states territorial sea in accordance with the provisions of the National Shellfish Sanitation Program (NSSP). The NSSP is the federal/state cooperative program recognized by the U.S. Food and Drug Administration (FDA) and the Interstate Shellfish Sanitation Conference (ISSC) for the sanitary control of shellfish produced and sold for human consumption.

Public health protection is achieved as a result of sanitary surveys of shellfish growing areas to determine their suitability as shellfish sources for human consumption. The principal components of a sanitary survey include: 1) an evaluation of pollution sources that may affect an area, 2) evaluation of hydrographic and meteorological characteristics that may affect distribution of pollutants, and 3) an assessment of water quality.

Each growing area must have a complete sanitary survey every twelve years, a triennial evaluation every three years and an annual review in order to maintain a classification, which allows shellfish harvesting. Minimum requirements for sanitary surveys, triennial evaluations, annual reviews and annual water quality monitoring are established by the ISSC and set forth in the NSSP. Each year water samples are collected at 2,320 stations in 294 growing areas in Massachusetts's coastal waters at a minimum frequency of five times while open to harvesting. Water and shellfish samples are tested for fecal coliform bacteria at two *MarineFisheries* laboratories located in Gloucester and New Bedford using a Most Probable Number (MPN) method (American Public Health Association) for classification purposes and a membrane filtration technique (usually M-tec) for pollution source identification.

MarineFisheries Shellfish Growing Area Classifications (USFDA)

Approved - *"...open for harvest of shellfish for direct human consumption subject to local rules and regulations..." An approved area is open all the time and closes only due to hurricanes or other major coastwide events."*

Conditionally Approved - *"...subject to intermittent microbiological pollution..." During the time the area is open, it is "...for harvest of shellfish for direct human consumption subject to local rules and regulations…" A conditionally approved area is closed some of the time due to runoff from rainfall or seasonally poor water quality. When open, shellfish harvested are treated as from an approved area."*

Restricted – *"…area contains a "limited degree of pollution." It is open for "harvest of shellfish with depuration subject to local rules and state regulations" or for the relay of shellfish. A restricted area is used by DMF for the relay of shellfish to a less contaminated area."*

Conditionally Restricted - *"...subject to intermittent microbiological pollution..." During the time area is restricted, it is only open for "the harvest of shellfish with depuration subject to local rules and state regulations." A conditionally restricted area is closed some of the time due to runoff from rainfall or seasonally poor water quality. When open, only soft-shell clams may be harvested by specially licensed diggers (Master/Subordinate Diggers) and transported to the DMF Shellfish Purification Plant for depuration (purification)."*

Prohibited – "*Closed for harvest of shellfish*."

DWM analysts assess the *Shellfish Harvesting Use* with the most recent and available *MarineFisheries* classification of the Shellfish Growing Areas. The most recent GIS datalayer, available online at http://www.mass.gov/mgis/dsga.htm, is dated September 30, 2009. Shellfish Growing Areas that are under administrative or management closures are not assessed. The guidance used by DWM analysts to assess the *Shellfish Harvesting Use* is summarized below.

Shellfish Harvesting Use Assessment

Use is Supported	Use is Impaired
SA Waters: Approved SB Waters: Approved, Conditionally Approved, or Restricted	SA Waters: Conditionally Approved, Restricted, Conditionally Restricted, or Prohibited SB Waters: Conditionally Restricted or Prohibited

An impairment decision for this use presumes that the cause is the result of elevated fecal coliform bacteria in the water column and, therefore, in shellfish. The source(s) of impairment may be identified based on *MarineFisheries* reports and information, TMDL reports, and/or BPJ of DWM analysts using orthophotos, land-use, and urbanized area MassGIS datalayers.

It should be noted that whether or not a shellfish growing area was classified as prohibited based on a precautionary measure (e.g., proximity of wastewater treatment discharge, marina) is not readily available to the DWM analysts. To date impairment decisions have been made based on the prohibited classification alone when, in fact, no impairment decision should have been made for precautionary prohibitions.

Primary Contact Recreational Use

Waters supporting the *Primary Contact Recreational Use* are suitable for any recreation or other water use in which there is prolonged and intimate contact with the water with a significant risk of ingestion of water during the primary contact recreation season. These include, but are not limited to: wading, swimming, diving, surfing and water skiing (MassDEP 2006). For purposes of 305(b) reporting the "bathing season" each year is defined as 1 April to 15 October.

Use Assessment Decision Making Process:
The assessment of the *Primary Contact Recreational* Use is based on sanitary (i.e., bacteria), safety (e.g., Secchi depth) considerations, and/or aesthetics of the waters. DWM analysts assess this use as support when sanitary, safety, and aesthetic (i.e., desirability) conditions are suitable (e.g., low bacteria densities, low turbidity, infrequent beach closures/postings) and when aesthetics are good (e.g., narrative aesthetics criteria are met – see *Aesthetics Use* assessment guidance for details). While the current bacteria criteria for Massachusetts surface waters include both a geometric mean and a single sample maximum, the assessment decisions are based on whether or not the geometric mean of bacteria samples collected within the "bathing season" meet the criterion for *Primary Contact Recreation* (i.e., *E. coli* and/or *Enterococci* bacterial indicators for Class A, B, SA, SB waters) (MassDEP 2006).

Bacteria Standards for Recreation (EPA 2003)

"Fecal bacteria have been used as an indicator of the possible presence of pathogens in surface waters and the risk of disease, based on epidemiological evidence of gastrointestinal disorders from ingestion of contaminated surface water or raw shellfish. Contact with contaminated water can lead to ear or skin infections, and inhalation of contaminated water can cause respiratory diseases. The pathogens responsible for these diseases can be bacteria, viruses, protozoans, fungi, or parasites that live in the gastrointestinal tract and are shed in the feces of warm-blooded animals… concentrations of fecal bacteria, including fecal coliforms enterococci, and Escherichia coli, are used as the primary indicators of fecal contamination. The latter two indicators are considered to have a higher degree of association with outbreaks of certain diseases than fecal coliforms and were recommended as the basis for bacterial water quality standards in the 1986 Ambient Water Quality Criteria for Bacteria document (both for fresh waters, enterococci for marine waters). The standards are defined as a concentration of the indicator above which the health risk from waterborne disease is unacceptably high".

E. coli bacteria	*Enterococci* bacteria
Geo mean ≤126 colonies/100 ml	Geo mean ≤33 colonies/100 ml Class A, B Geo mean ≤35 colonies/100 ml Class SA, SB

[Note: Single sample maximum bacteria criteria are also in the SWQS however, the geometric mean criterion is considered by DWM analysts to be a more robust and appropriate measure for making the *Primary Contact Recreational Use* assessment decision while the single sample is more appropriate for determining the need to close beaches because of an immediate risk.]

An overview of the data types and the decision process used by DWM analysts to make assessment decisions for the *Primary Contact Recreational Use* is as follows.

Bacteria data (Rivers, Lakes, Estuaries)
For freshwater segments (rivers and lakes) the primary source of bacteria data is the results of the DWM's water quality surveys. The validated (quality-assured) bacteria data from these surveys are usually published by the MassDEP DWM in technical memoranda/reports. There are also many other external sources of bacterial quality monitoring data (e.g., environmental consultants, watershed and lake associations, and citizen monitoring programs, etc.). All external data from these and other sources are reviewed for quality/reliability according to the DWM's external data validation procedures and, when approved, they can also be utilized for assessment decisions. The MA DPH's uncertainty associated with accurate reporting of freshwater beach closure information (Beaches Bill reporting) has precluded its use for making assessment decisions up to this time.

The geometric mean of either *E. coli* and/or *Enterococci* data (minimum of five sampling events) during each "bathing season" (1 April through 15 October) is calculated for each sampling station by year. It is then compared directly to standards (provided above). [Note: Geometric mean calculation used the Method Detection Limit (MDL) when necessary.]

Aesthetics (Rivers, Lakes, Estuaries)
It should be emphasized here that because of the narrative aesthetics criteria, which are applicable to all surface waters (see *Aesthetics Use* assessment guidance for details) DWM analysts assess the *Primary Contact Recreational Use* as impaired when the *Aesthetics Use* of a waterbody is assessed as impaired.

Risk Assessment (Rivers, Lakes, Estuaries)
Occasionally site-specific health risk assessments performed by consultants, the MA DPH, and/or MassDEP, Office of Research and Standards staff are utilized to evaluate dangers posed to organisms and humans by contaminants in the aquatic environment. Routes of exposure can include ingestions, dermal

contact, or respiration. When risk is calculated to be greater than acceptable (e.g., total hazard index value exceeds a threshold of 1) some or all of the designated use(s) may be assessed as impaired for the contaminant of concern.

Beach Closures (Estuaries): The Beaches Bill monitoring program is a major data source of bacteria and beach posting/closing information. Administered by the MA DPH, communities are required to report their beaches monitoring data (most beaches sampled weekly) and decisions to post/close their beaches over the course of each year's beach season (see inset for details). MA DPH publishes annual reports of these data and periodically (~ every two years) provides DWM analysts with a copy of their database (MA DPH 2011b). To date the beach closing/posting information has been used by DWM analysts as a surrogate indicator of water quality conditions rather than using the actual bacteria data for assessments. This surrogate was chosen by DWM analysts until such a time as all data quality assurance considerations (e.g., QAPP, QAQC, sample collection, analysis, data quality and validation procedures) for the bacteria data are in place. The current assessment decision guidance for using these data is that at "public bathing beach" areas postings/advisories should be neither frequent nor prolonged during the swimming season (the number of days posted or closed should not exceed 10% during the locally operated swimming season). DWM analysts calculate the number of days and the percentage of time during each beach season (typically over a five year window or as an update to the last reporting cycle) that each marine beach was posted/closed. The *Primary Contact Recreational Use* is assessed as support if the marine beach(es) along the shoreline of an estuarine segment are posted for ≤10% of the swimming season. If postings exceed 10% of the swimming season(s) the *Primary Contact Recreational Use* will be assessed as impaired. Data for multiple beaches located along the shoreline of a segment that may lead to conflicting assessment decisions are handled on a case-by-case basis by the DWM analysts.

Beaches Bill (MA DPH 2010): *"There are over 1,100 public and semi-public bathing beaches in Massachusetts, both freshwater and marine…bathing beach water quality is regulated by the Massachusetts Department of Public Health (MDPH) under Massachusetts General Law and the Code of Massachusetts Regulations. These 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. The exact dates of a given bathing season vary from beach to beach, and are determined by the operators of each individual beach. Some beaches open as early as Memorial Day, but the majority begin operation when the school year ends in mid-June, and most close for the season during the week of Labor Day. Most freshwater samples are analyzed at private laboratories hired by beach operators or boards of health, while a small number are analyzed at municipal laboratories. The vast majority of beach water sampling in Massachusetts is conducted by local boards of health, the Barnstable County Department of Health and the Environment, and the Massachusetts Department of Conservation and Recreation (MDCR). Most marine beach samples are analyzed at laboratories under contract with MDPH's Bureau of Environmental Health (BEH). BEH utilizes federal Environmental Protection Agency (USEPA) funds to support these costs. Bathing water samples that are found to contain levels of bacterial contamination in excess of regulatory standards are termed exceedances. If water samples from a beach are found to be in exceedance of regulatory standards, the beach waters must be closed. When this happens signs must be posted at access points to the beach notifying the public that swimming is unsafe due to bacterial contamination. For marine beaches, the public is also notified via the Beach Water Quality Locator, on the MDPH/BEH website, which is operated in collaboration with local health officials and MDPH contract laboratories.4 Local health officials and MDPH/BEH contract laboratories collect and analyze the samples and perform a majority of the data entry onto the website. MDPH/BEH is notified of exceedances within 24 hours (105 CMR 445.040). Beaches are to remain closed until their bacteria counts decrease to levels below the applicable standard, at which point the postings can be removed and MDPH/BEH is notified of the beach reopening."*

Approved Shellfish Growing Area Classification (Estuaries) Although the bacteria indicator species are different (i.e., fecal coliform bacteria for shellfish and *Enteroccoci* for bathing beach areas) an "*approved*" shellfish growing area classification is indicative of excellent water quality ("Approved" areas are "*open for harvest of shellfish for direct human consumption subject to local rules and regulations. An approved area is open all the time and closes only due to hurricanes or other major coastwide events*" (see additional detail in *Shellfish Harvesting Use*). DWM analysts consider water quality to be excellent in terms of bacterial quality and, therefore, supportive of the *Primary Contact Recreational Use* when the Massachusetts Department of Fish and Game's Division of Marine Fisheries (DMF) Shellfish Growing Area Classification is "Approved" (MA DFG 2009). However, when the Shellfish classification is anything less than "approved" no use assessment determination for the *Primary Contact Recreational Use* can be made.

Primary Contact Recreational Use Assessment

Use is Supported		Use is Impaired	
Rivers, Lakes	***Estuaries***	***Rivers, Lakes***	***Estuaries***
Geo mean bacteria below criterion, no aesthetic use impairment	Geo mean bacteria below criterion , no aesthetic use impairment, Beach Closures ≤10% season, DMF "Approved" Shellfish Growing Area Classification	Geo mean bacteria above criterion , aesthetic use impairment risk calculation exceeds hazard threshold for contaminant of concern	Geo mean bacteria above criterion , aesthetic use impairment Beach Closures >10% season risk calculation exceeds hazard threshold for contaminant of concern

Secondary Contact Recreational Use

Waters supporting the *Secondary Contact Recreational Use* are suitable for any recreation or other water use in which contact with the water is either incidental or accidental. These include, but are not limited to:fishing, including human consumption of fish, boating and limited contact incident to shoreline activities. Where designated, secondary contact recreation also includes shellfishing, including human consumption of shellfish. [Note: For the purpose of assessment and 305(b) reporting the status of the consumption of fish and shellfish are reported as the *Fish Consumption* and *Shellfish Harvesting* uses, respectively, and not reported on as part of the *Secondary Contact Recreational Use*.] For purposes of 305(b) reporting the *Secondary Contact Recreational Use* is assumed to occur year-round. Since water quality conditions during the *Primary Contact Recreational* season are often considered representative of worse-case (e.g., higher temperatures, increases in population density at bathing beaches) data collected during that season are considered appropriate for making *Secondary Contact Recreational Use* assessment decisions.

Use Assessment Decision Making Process:
Similar to the *Primary Contact Recreational Use* assessment guidance, the assessment of the *Secondary Contact Recreational* Use is based on sanitary (i.e., bacteria), safety (e.g., Secchi depth) considerations, and/or aesthetic/practical usability of the waters. While the current bacteria criteria for Massachusetts surface waters include both a geometric mean and a single sample maximum, the assessment decisions are based on whether or not the geometric mean of bacteria samples collected meet the criterion for *Secondary Contact Recreation* (i.e., *E. coli* and/or *Enterococci* bacterial indicators for Class C, SC waters) (MassDEP 2006).

E. coli bacteria	*Enterococci* bacteria
Geo mean $\leq$630 colonies/100 ml Class C	Geo mean $\leq$175 colonies/100 ml Class SC

[Note: While single sample maximum bacteria criteria are also ascribed in the SWQS, they are utilized for making short term closure/posting decisions. The geometric mean criterion is considered by DWM analysts to be a more robust and appropriate measure for making the *Secondary Contact Recreational Use* assessment decision.]

An overview of the data types and the decision process used by DWM analysts to make assessment decisions for the *Secondary Contact Recreational Use* is as follows:

Bacteria data (Rivers, Lakes, Estuaries) For freshwater segments (rivers and lakes) the primary source of bacteria data is the results of the DWM's water quality surveys. The validated (quality-assured) bacteria data from these surveys are usually published by the MassDEP DWM in technical memoranda/reports. There are also many other external sources of bacterial quality monitoring data (e.g., environmental consultants, watershed and lake associations, and citizen monitoring programs, etc.). All external data from these and other sources are reviewed for quality/reliability according to the DWM's external data validation procedures and, when approved, can also be utilized for assessment decisions. The MA DPH's uncertainty associated with accurate reporting of freshwater beach closure information (Beaches Bill reporting) has precluded use assessment decisions with those data up to this time.

The geometric mean of either *E. coli* and/or *Enterococci* data (minimum of five sampling events) each year is calculated for each sampling station by year. The results are then compared directly to standards (provided above). [Note: Geometric mean calculations included the Method Detection Limit (MDL) when necessary.]

Aesthetics (Rivers, Lakes, Estuaries) It should be emphasized here that because of the narrative aesthetics criterion, which is applicable to all surface waters (see *Aesthetics Use* assessment guidance for details), DWM analysts assess the *Secondary Contact Recreational Use* as impaired when the *Aesthetics Use* of a waterbody is assessed as impaired.

Beach Closures (Estuaries) The *Secondary Contact Recreational Use* is assessed as support if the marine beach(es) along the shoreline of an estuarine segment are posted for $\leq$10% of the swimming season. If postings exceed 10% of the swimming season(s) the *Secondary Contact Recreational Use* is not assessed using this indicator data.

Approved Shellfish Growing Area Classification (Estuaries) DWM analysts consider water quality to be excellent in terms of bacterial quality and, therefore, supportive of the *Secondary Contact Recreational Use* when the Massachusetts Department of Fish and Game's Division of Marine Fisheries (DMF) Shellfish Growing Area Classification is "Approved" (MA DFG 2009). However, when the Shellfish Growing Area Classification is anything less than "approved" no use assessment determination for the *Secondary Contact Recreational Use* can be made.

Secondary Contact Recreational Use Assessment		
Use is Supported		**Use is Impaired**
Rivers, Lakes	***Estuaries***	***Rivers, Lakes, Estuaries***
Geo mean bacteria below criterion, no aesthetic use impairment	Geo mean bacteria below criterion, no aesthetic use impairment, Beach Closures ≤10% season, DMF "Approved" Shellfish Growing Area Classification	Geo mean bacteria above criterion, aesthetic use impairment

Aesthetics Use

The narrative aesthetics criterion in the Massachusetts Surface Water Quality Standards states that surface waters should be "*free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance species of aquatic life*" (MassDEP 2006). Waters supporting the *Aesthetics Use* are pleasing to the senses for both active and passive activities: to look upon, to walk or rest beside, to contemplate, to recreate on, and should enhance the visual scene wherever it appears (Federal Water Pollution Control Administration 1968).

Use Assessment Decision Making Process:

Aesthetic observations (Rivers, Lakes, Estuaries) An evaluation is often made regarding the aesthetic quality of a waterbody based on information described in the field sheet metadata maintained by the DWM for their surveys. The field sheet records provide good documentation of conditions that exist at a site whether indicative of nutrient enrichment (e.g., algal growth/blooms) or other aesthetically objectionable conditions (e.g., deposits, sheens, odors, color, turbidity (clarity), trash/debris, etc.). Field sheet survey information is recorded at each site during each survey so analysts can determine the general magnitude and frequency of any objectionable conditions over the course of the sampling period. It should be noted here that a waterbody will not be assessed as impaired for the occasional presence of litter or debris in it, but rather for other more serious indicators of water quality degradation. External sources of these types of data may include volunteer stream team/shoreline survey and lake reports. Additional guidelines for interpreting aesthetic observations are provided below.

Planktonic algae blooms (Rivers, Lakes) The visual presence of planktonic blooms/mats/scums (particularly bluegreens) are associated with aesthetically objectionable conditions. Depending on the severity of a bloom, water could range from appearing slightly colored to resembling pea soup or paint. Additionally, the MA DPH (undated) also recommends an advisory or closure of a waterbody to avoid contact with the water when a visible scum or mat layer is present, cyanobacteria cell counts exceed 70,000 cells/ml, or when the microcystin level of lysed cells exceeds 14 parts per billion (ppb) in order to protect public health. Their guidelines for evaluating potential health concerns regarding cyanobacteria in fresh waterbodies in Massachusetts can be found online at (http://www.mass.gov/eohhs/docs/dph/environmental/exposure/protocol-cyanobacteria.pdf).

Macroalgae (Rivers) Waterbodies with greater than 40% percent cover of macroalgae (filamentous green algae > 2 cm) may exhibit aesthetic impairment (Barbour *et al.* 1999). DWM analysts currently utilize this general guideline of 40% cover of the substrata in a riffle/run with visible filamentous forms of green algae to evaluate whether or not the aesthetics of a stream reach is supported. When more than 40% of the substrates are covered by macroalgal filaments the *Aesthetic Use* (and also the recreational use of the waterbody) is generally considered to be impaired (i.e., excess algae growth).

Secchi disk depth (Lakes) The DWM applies the 4-foot (1.2 m) Secchi disk transparency guideline as best professional judgment to indicate when conditions are unsafe for recreational use and undesirable aesthetically. When waters fail to meet this guideline it is felt that hazardous objects are not visible to someone diving (or falling) into the water and rescuers are unable to easily locate a possible drowning victim. Currently the DWM accepts three Secchi disk transparency readings as a minimum acceptable number of sampling events taken during the summer months when productivity is high. With few data points ($n \leq 10$), however, DWM analysts will not impair a waterbody unless there is more than one exceedance of the guideline. With >10 readings more than 10% would need to exceed the guideline to be assessed as impaired. This approach applies to cases where low Secchi disk transparency results from algal or non-algal turbidity but does not include highly tannic, tea-stained waters with high color that may result in low Secchi readings. This is considered to be a naturally-occurring condition resulting from associated wetland influence.

According to the "Green Book" (Federal Water Pollution Control Administration 1968) *"(II. Criteria for desirable factors. (a) For primary contact waters, clarity should be such that a Secchi disc is visible at a minimum depth of 4 feet. In "learn to swim" areas, the clarity should be such that a Secchi disc on the bottom is visible. In diving areas, the clarity shall equal the minimum required by safety standards, depending on the height of the diving platform or board"*.

Macrophyte cover (Lakes) Determining whether recreational uses are impaired due to overabundant (i.e., undesirable or nuisance) growths of aquatic macrophytes or algae requires some judgment decisions. In the case of macrophytes, a combination of factors is considered, including: the area of the lake that is covered, the percentage of biovolume that is filled, the growth habit and type of species, and the dominance of the species within the plant community. Areal coverage is considered excessive if more than 25% of the lake is affected, particularly if the area encompasses bathing areas. Within the areas covered by plant populations the biovolume would need to be dense (>50 – 75%) or very dense (>75 – 100%). There are certain species with growth habits that tend to grow from the bottom to the surface in close proximity and, thus, fill the biovolume and cause a safety hazard for extended or

incidental contact with the water, as well as undesirable aesthetic conditions. Among the species with this growth habit are non-natives, like *Myriophyllum heterophyllum*, *M. spicatum*, and *Cabomba caroliniana* but also native species, like *Ceratophyllum demersum* or *Elodea* sp. Note that there are often cases where dense/very dense macrophyte populations are found, but they are part of a diverse, naturally-occurring community. These cases do not represent impairment. There are also cases where algae or certain floating macrophyte species, like *Lemna* sp. or *Wollfia* sp., can "bloom" to cause unsafe and aesthetically undesirable conditions, almost always as a result of increased enrichment. In these instances Secchi disk transparency readings can also be used to determine impairment.

Macroalgae (Estuaries) No current guidelines developed.

Aesthetics Use Assessment

Use is Supported	Use is Impaired
No aesthetically objectionable conditions; waterbodies are generally "*free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance species of aquatic life*"	Aesthetically objectionable conditions frequently observed (e.g., blooms, scums, water odors, discoloration, taste, visual turbidity highly cloudy/murky, excess algal growth (>40% filamentous cover in rivers, nuisance growths >25% dense/very dense macrophytes or blooms in lakes), Secchi disk transparency < 4 feet at least twice during survey season.)

Causes and Sources of Use Impairments

When a waterbody is assessed as impaired for a particular designated use the 305(b) reporting process requires that the pollutant(s)/pollution causing the impairment and the source(s) of the pollutants/pollution be identified, if possible. The EPA maintains lists of available cause codes (http://www.epa.gov/waters/adb/documents/ADB_CAUSE_LUT.xls) and source codes (http://www.epa.gov/waters/adb/documents/SOURCES_LUT.xls) that are available to states choosing to store assessments in EPA's Assessment Database (ADB).

The typical cause(s) of impairment used by DWM analysts for each designated use are based on the indicator(s) used to make an impairment decision as described in the preceding use assessment guidance. As an example, Figure 3 illustrates the decision process for identifying whether nutrient enrichment is present and, if so, the causes of impairment.

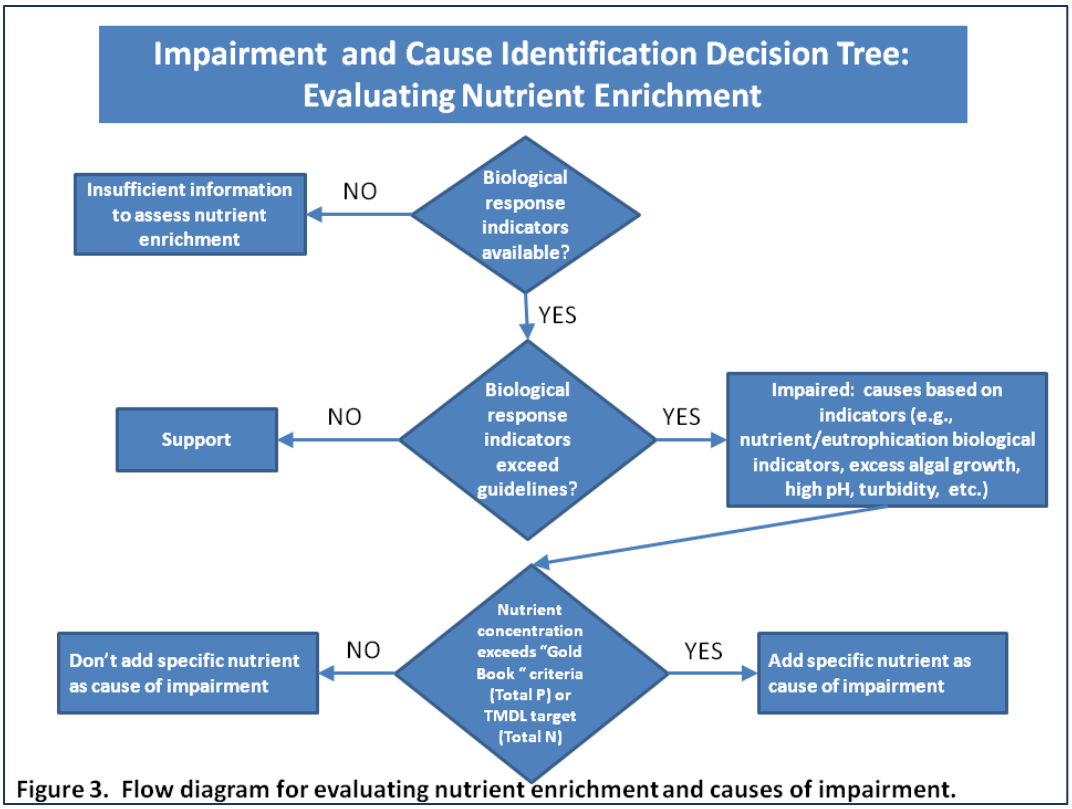

Figure 3. Flow diagram for evaluating nutrient enrichment and causes of impairment.

Sources are the discharges or activities that contribute pollutants or stressors resulting in impairment of designated uses in a waterbody. Sources of impairments may include both point sources and nonpoint sources of pollution. Point sources discharge pollutants directly into surface waters from a conveyance and include, but are not limited to: industrial facilities, municipal sewage treatment facilities, combined sewer overflows, and storm sewers. Nonpoint sources deliver pollutants to surface waters from diffuse origins. Nonpoint sources include: urban runoff that is not captured in a storm sewer, agricultural runoff, leaking septic tanks, and landfills. The source(s) of impairment may be identified based on *MarineFisheries* reports (e.g., sanitary surveys) and information and/or BPJ

of DWM analysts using MassGIS datalayers (e.g., orthophotos, land-use, urbanized areas) for example, but in general the actual sources of impairment are not confirmed until a TMDL or similar analysis is conducted on the waterbody.

A summary of the typical cause(s) associated with the impairment decisions (based on the indicator(s) as appropriate) and the typical source(s) of the impairment for each designated use used by DWM analysts can be found in Appendix A.

V. CONSOLIDATED REPORTING

Since 2001 the EPA has recommended that states combine their 305(b) and 314 water quality assessment reporting elements with their 303(d) List of Impaired Waters into a consolidated *Integrated List of Waters* report. The *Integrated List of Waters* report is submitted to the EPA every two years for review and, in the case of waters identified pursuant to Section 303(d), EPA approval.

The Section 305(b) reporting process entails determining the attainment status of each of the designated uses, where applicable, for rivers, lakes and coastal waters in the state, and identifying, wherever possible, causes and sources of any use impairment. Use assessment determinations are made for each waterbody segment for which adequate data and information are available. However, many waters are not assessed for one or more uses in any given assessment cycle, and many small and/or unnamed streams and ponds have never been monitored and/or assessed. Similarly, Section 314 of the CWA provides for cooperative agreements between federal, state and local entities to restore publicly-owned freshwater lakes and ponds and protect them against degradation. During the late 1970s through the early 1990s diagnostic and feasibility (D&F) studies were completed for many lakes and ponds throughout Massachusetts and were used in earlier 305(b) assessments and 303(d) listing decisions. Information from these studies continues to carry over into new assessment and listing cycles unless new monitoring information results in a change in their assessment and listing status. It should also be mentioned that information contained in the nonpoint source assessment report, prepared in 1989 in accordance with the requirements of Section 319, is also reflected in 305(b) and 303(d) reporting elements unless more recent information has resulted in a modification of the original assessment.

Under Section 303(d) of the Clean Water Act, states, territories, and authorized tribes are required to develop lists of impaired waters. These are waters that are too polluted or otherwise degraded to meet the state's water quality standards. The law requires that these jurisdictions establish priority rankings for waters on the lists and develop TMDLs for these waters. A Total Maximum Daily Load, or TMDL, is a calculation of the maximum amount of a pollutant that a waterbody can receive and still safely meet water quality standards. The formulation of the 303(d) List includes a more rigorous public review and comment process than does reporting under Section 305(b), and the final version of the list must be formally approved by the EPA.

The Assessment Database (ADB)

The EPA-developed Access database, the ADB (Version2.3.1), is a relational database designed for tracking water quality assessment decision data, including use attainment status and causes and sources of impairment. The ADB was designed to make the assessment and listing process accurate, straightforward and user-friendly for states, tribes and other water quality reporting agencies. Finally, the ADB automates the production of reports required by the CWA, which states submit to the EPA, thus reducing the burden of reporting under sections 305(b), 314 and 303(d). Massachusetts implemented the ADB for the 2010 listing cycle.

Currently in Massachusetts the ADB has been populated with basic segment information, use attainment decisions, causes and sources of impairment, and the TMDL status for the final 2010 *Integrated List of Waters*. Much of the information supporting the decision-making process, however, has not yet been entered (e.g., the level of data quality (assessment documentation), dates of monitoring, comments on listing decisions, etc.). For future reporting cycles, however, the plan is to add more of this information as time and resources allow.

The Integrated List of Waters

The ADB is used to generate output files, which are then assembled into an *Integrated List of Waters* in a single, multi-part list. Each waterbody, or segment thereof, is listed in one of five categories (see Table 3) for brief description of each List Category). It should be reiterated here that the ADB and its precursor databases never contained an entry for every surface water or segment thereof in Massachusetts. Rather, waters represented are only those for which assessments of one or more designated uses were actually completed at some time in the past. As assessments are carried out in new waters they are added to the ADB, resulting in greater representation of Massachusetts' surface waters in future versions of the *Integrated List of Waters*. The MassDEP acknowledges that with the new multi-part listing format, all surface waters could be categorized whether or not they have ever been assessed. However, the time and resources are currently not available to add all of the surface waters in Massachusetts to the ADB. Therefore, it is acknowledged that many of the Massachusetts surface waters that have never been assessed are missing from the *Massachusetts Integrated List of Waters* report. By definition, they would all be listed as Category 3.

Table 3. Brief description of the five list categories of assessed waters used by MassDEP for the *Integrated List of Waters*.

The Integrated List of Waters -- categories of assessed waters	
Category 1	Support and not threatened for all designated uses
Category 2	Support for some uses and not assessed for others
Category 3	Insufficient information to make assessments for any uses
Category 4	Impaired for one or more uses, but not requiring the calculation of a Total Maximum Daily Load (TMDL); (impairment due to "pollution" such as low flow, habitat alterations or non-native species infestations).
Category 5	Impaired for one or more uses and requiring a TMDL (impairment due to pollutant(s) such as nutrients, metals, pesticides, solids and pathogens). This constitutes **the 303(d) List.**

List Categories 1 - 3

Integrated List categories 1-3 include those waters that are either unimpaired or not assessed with respect to their attainment of designated uses. Often insufficient data and information exist to assess all designated uses of any particular waterbody or segment. Furthermore, no Massachusetts waters are listed in Category 1 because a statewide Department of Public Health advisory pertaining to the consumption of fish precludes any waters from being in full support of the *Fish Consumption Use* as described previously in the use assessment decision process. Waters listed in Category 2 were found to support the uses for which they were assessed, but other uses were not assessed. Finally, Category 3 contains those waters for which insufficient or no information was available to assess any uses. Waters for which assessments were determined to be insufficient for 303(d) listing were also included in Category 3.

List Category 4

Waters exhibiting impairment for one or more uses are placed in either Category 4 (impaired but not requiring TMDLs) or Category 5 (impaired and requiring one or more TMDLs) according to the EPA guidance. 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) has already been completed and approved by the EPA. However, since the 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 of the pollutants. 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. Non-pollutant stressors are marked with an asterisk in the *Integrated List of Water* report to distinguish them from pollutants requiring TMDLs. Waterbodies impaired solely by “pollution” are included in Category 4c. The restoration of these waters requires measures other than TMDL development and implementation. Waters that have one or more approved TMDLs, but also continue to be impaired by non-pollutants, are listed in Category 4a.

List Category 5 – The 303(d) List of Impaired Waters Requiring Development of TMDL

While the EPA guidance provides the overall framework for a five-part list of waters, the development, submittal, and review of Category 5 remains subject to the prevailing regulation governing the implementation of Section 303(d) of the CWA. This regulation requires states to identify and list those waterbodies that are not expected to meet surface water quality standards after the implementation of technology-based controls and, as such, require the development of TMDLs. Specific cause(s) of the impairment (if known) are included in the 303(d) List. On some occasions biological impairment is found but the cause of the impairment is unclear or unknown. In these cases the waterbody segment is placed, by default, into Category 5 until further evidence can better define the cause.

Reporting on impaired waters as required by Section 303(d) includes a more rigorous public review and comment process than does reporting under Section 305(b), and the final version of the list must be formally approved by the EPA. Once a water body is identified as impaired by a pollutant, the MassDEP is required, based on Section 303(d) of the CWA and the implementing regulations at 40 CFR 130.7, to develop a pollutant budget designed to restore the health of the impaired water body. The process of developing this pollutant budget, generally referred to as a Total Maximum Daily Load (TMDL), includes: identifying the cause (type of pollutant) and source (where the pollutant comes from), determining how much of the pollutant is from direct discharges (point sources) or indirect discharges (non-point sources), determining the maximum amount of the pollutant that can be discharged to a specific water body to meet water quality standards, and developing a plan to meet that goal. In short, a TMDL is a clean-up plan that is required under the CWA to restore water quality and enable waters to attain designated uses. The EPA tracks the states’ progress with completing TMDLs in its Assessment and Total Maximum Daily Load (TMDL) Tracking and Implementation System (ATTAINS), which can be accessed at http://www.epa.gov/waters/ir. This system assigns a unique identification number to each approved TMDL. This number is included for reference in categories 4a and 5 of the *Massachusetts Integrated List of Waters* reports.

Waterbodies, or segments thereof, can be removed from Category 5, or delisted, when a TMDL is approved by the EPA for that waterbody or segment. Waters with approved TMDLs move into Category 4a until it is determined that they are no longer impaired. In addition, there are some instances when a previously listed waterbody can be removed from the 303(d) List without calculating a TMDL, for example, when a new assessment reveals that the waterbody is now meeting all applicable water quality standards.

Spatial Documentation

Another component of consolidated reporting is the spatial georeferencing of the river, lake, and estuary segments (as illustrated in Figure 4). DWM analysts maintain geospatial information for each waterbody segment (or assessment unit) stored in the ADB. Two georeferenced ArcMap shapefiles contain the geospatial documentation delineating these waterbody segments. These two feature classes include an arc (primarily river) shapefile and a polygon (primarily lake and estuary areas) shapefile. The geo-referencing of individual segments relied on linework derived from the MassGIS 1:25,000 hydrography based on USGS topographic maps. Additional on-screen editing was performed as needed using USGS topographic quadrangles and/or MassGIS color orthophotos as a base map for all river segments. Occasionally National Oceanic and Atmospheric Administration nautical charts at several scales and the "Planimetry of Harbors for the 1984 305(b) Report" were utilized. Where definitions were still ambiguous after using these references, DWM staff members were consulted to define and geo-reference individual water body segments. No two river segments overlap nor do any two lake features nor do any two estuary features. In addition to the georeferenced segment locations, data from the ADB can be related to each shape and spatially displayed. This allows mapping to display the *Massachusetts Integrated List of Waters* by their category (Figure 4) as well as the ability to obtain more detailed information for each segment (Figure 5). A table generated from the ADB containing the support status for each individual use with associated cause(s) and source(s) of impairment, as well as approved TMDL information, can be linked and displayed through the waterbody segment (AU) shapefiles.

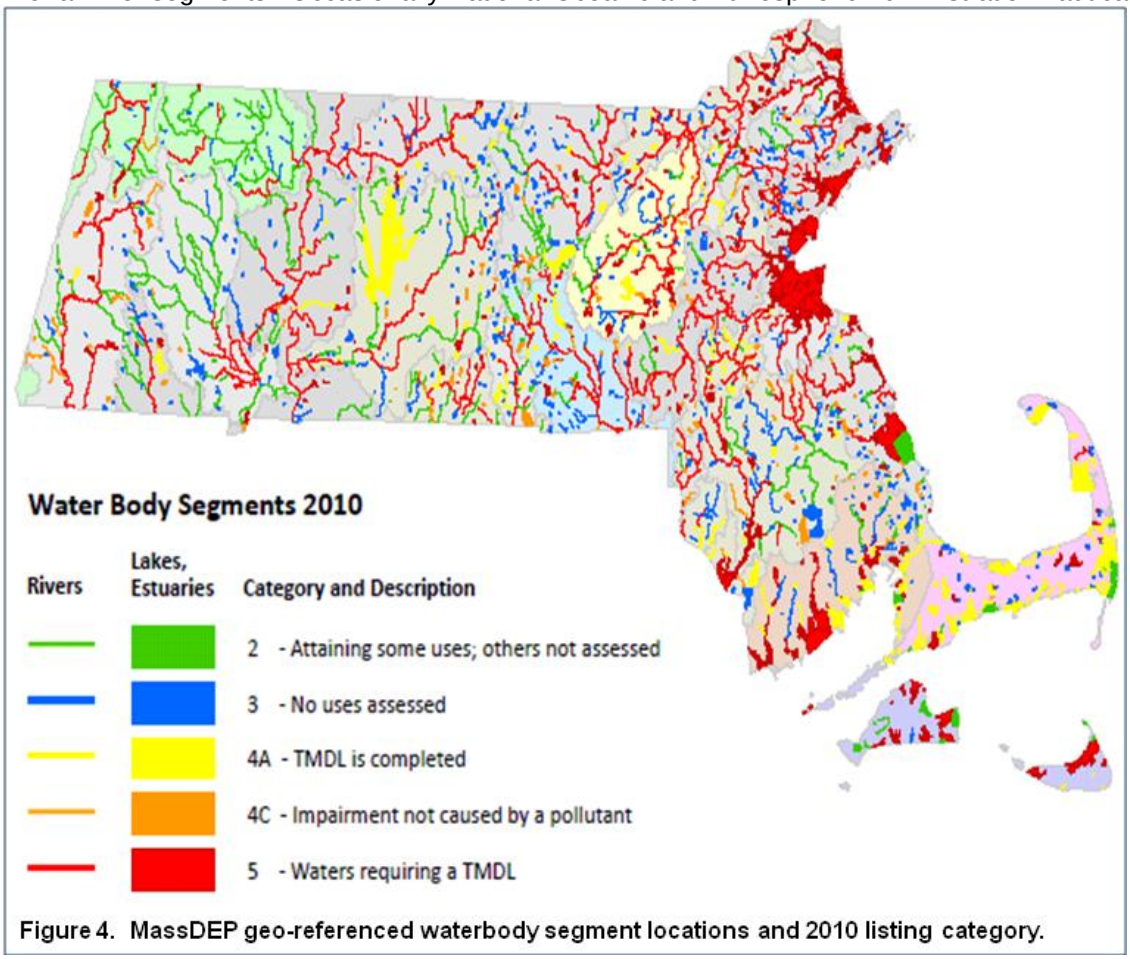

Figure 4. MassDEP geo-referenced waterbody segment locations and 2010 listing category.

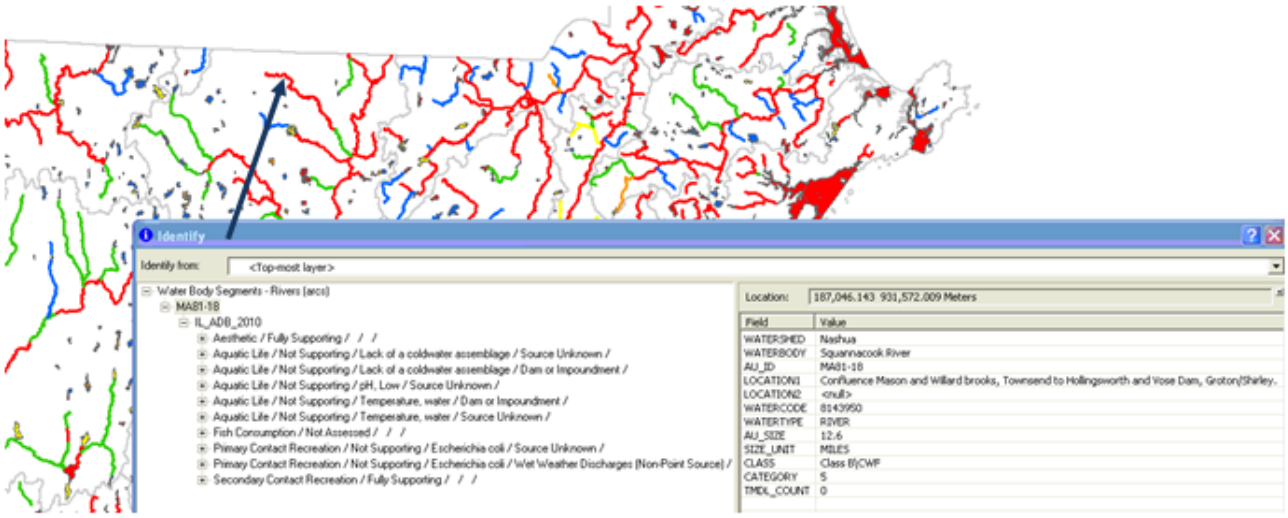

Figure 5. MassDEP Assessment Database (ADB) data associated with geo-referenced waterbody segment locations.

The Massachusetts 2010 Integrated List of Waters (305(b)/303(d)) data layers and all of the data elements (including metadata) are available at the Commonwealth of Massachusetts' Office of Geographic Information (MassGIS) website (http://www.mass.gov/mgis/wbs2010.htm). The datalayers for the 2012 Integrated List of Waters will be developed by DWM analysts once the 2012 303(d) list (Category 5 waters) is approved by EPA.

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APPENDIX A

Typical cause(s) and source(s) of use impairments (*Aquatic Life, Fish Consumption, Shellfish Harvesting, Primary Contact Recreation, Secondary Contact Recreation,* and *Aesthetics*) based on the indicator(s) used to make the use impairment decisions.

AQUATIC LIFE USE IMPAIRMENT CAUSES AND SOURCES			
Aquatic Life Use **Assessment Indicators**	**Use is Impaired**	**Typical Cause(s) of Impairment**	**Typical Source(s) of Impairment**
BIOLOGICAL MONITORING INFORMATION			
Benthic macroinvertebrate data	**Rivers** Moderately impaired/severely impaired RBP III analysis, slightly impaired with special conditions (e.g., hyperdominance by pollution tolerant sp.) as noted by DWM biologists **Estuaries** Low #species, low # individuals, poor diversity and evenness, shallow dwelling opportunistic species or near absence of benthos, thin feeding zone, as reported from external data sources	Aquatic Macroinvertebrate Bioassessments Organic Enrichment (Sewage) Biological Indicators Nutrient/Eutrophication Biological Indicators Combined Biota/Habitat Bioassessments	Municipal Point Source Discharges Dam or Impoundment Unspecified Urban Stormwater Impacts from Hydrostructure Flow Regulation/Modification Discharges from Municipal Separate Storm Sewer Systems (MS4) Source Unknown
Fish population data	**Rivers - *Cold Water Fishery*** No fish found or cold water species absent, DELTS with abnormal fish histology **Rivers - *Warm Water Fishery*** No fish found or fluvial fish were absent or relatively scarce (few numbers), DELTS with abnormal fish histology **Lakes, Estuaries** > 5% population losses estimated , DELTS with abnormal fish histology	Lack of a coldwater assemblage Fishes Bioassessments Fish Kills Abnormal Fish deformities, erosions, lesions, tumors (DELTS)	Municipal Point Source Discharges Dam or Impoundment Source Unknown
Habitat and flow data	**Rivers, Lakes, Estuaries** Physical habitat structure impacted by anthropogenic stressors (e.g., lack of flow, lack of natural habitat structure such as concrete channel, underground conduit), non-functioning anadromous fishway present	Fish-Passage Barrier Low flow alterations Habitat Assessment (Streams) Other flow regime alterations Other anthropogenic substrate alterations Physical substrate habitat alterations Sedimentation/Siltation Bottom Deposits Alteration in stream-side or littoral vegetative covers Petroleum Hydrocarbons (Oil Spills) Total Suspended Solids Turbidity	Hydrostructure Impacts on Fish Passage Dam or Impoundment Channelization Streambank Modifications/destabilization Flow Alterations from Water Diversions Impacts from Hydrostructure Flow Regulation/Modification Habitat Modification - other than Hydromodification Loss of Riparian Habitat Unspecified Urban Stormwater Source Unknown
Eelgrass bed mapping data	**Estuaries** Substantial decline (more than 10% of the in bed size or total loss of beds no matter their size)	Estuarine Bioassessments	Source Unknown
Non-native aquatic species data	**Rivers, Lakes** Non-native aquatic species present	Non-Native Aquatic Plants Non-native Fish, Shellfish, or Zooplankton Eurasian Water Milfoil, *Myriophyllum spicatum* Zebra mussel, *Dreissena polymorph*	Introduction of Non-native Organisms (Accidental or Intentional) Source Unknown
Periphyton/algal blooms	**Rivers, Lakes, Estuaries** Frequent and/or prolonged algal blooms or growths of periphyton, cyanobacteria blooms result in advisories (recurring and/or prolonged), >25% cover noxious aquatic plants (e.g. *Lemna* sp.), periphyton cover within riffle/reach >40%	Excess Algal Growth Nutrient/Eutrophication Biological Indicators	Municipal Point Source Discharges Unspecified Urban Stormwater Internal Nutrient Recycling Discharges from Municipal Separate Storm Sewer Systems (MS4) Source Unknown

AQUATIC LIFE USE IMPAIRMENT CAUSES AND SOURCES			
Aquatic Life Use **Assessment Indicators**	**Use is Impaired**	**Typical Cause(s) of Impairment**	**Typical Source(s) of Impairment**
TOXICOLOGICAL MONITORING INFORMATION			
Toxicity testing data	**Rivers, Lakes, Estuaries** <75% survival of test organisms to water column or sediment samples in either 48 hr (acute) or 7-day exposure (chronic) tests occurs in >10% of test events.	Ambient Bioassays -- Acute Aquatic Toxicity Ambient Bioassays -- Chronic Aquatic Toxicity Sediment Bioassays -- Acute Toxicity Freshwater Whole Effluent Toxicity (occasionally used)	Contaminated Sediments Municipal Point Source Discharges Source Unknown
PHYSICO-CHEMICAL WATER QUALITY INFORMATION			
Water quality data - DO	**Rivers** Frequent (>10%) and/or prolonged or severe excursions (>1.0 mg/L below standards) from criteria **Lakes** In deep lakes (with a hypolimnion), the criterion is not met in a hypolimnetic area >10% of the lake surface area during maximum oxygen depletion (summer growing season) **Estuaries** Frequent (>10%) and/or prolonged or severe excursions (>1.0 mg/L below standards) from criteria	Oxygen, Dissolved Dissolved oxygen saturation	Municipal Point Source Discharges Discharges from Municipal Separate Storm Sewer Systems (MS4) Unspecified Urban Stormwater Industrial Point Source Discharge Dam or Impoundment Combined Sewer Overflows Impacts from Hydrostructure Flow Regulation/Modification Source Unknown
Water quality data - pH	**Rivers** Frequent (>10%) and/or prolonged or severe excursions (>0.5 SU) from criteria, **Lakes** Excursion from criteria (>0.5 SU) summer growing season, **Estuaries** Frequent (>10%) and/or prolonged or severe excursions (>0.5 SU) from criteria	pH, Low pH, High	Municipal Point Source Discharges Source Unknown
Water quality data - temperature	**Rivers - *Cold Water Fishery*** Criterion frequently exceeded (>10%) or by >2°C **Rivers and Lakes - *Warm Water Fishery*** Criterion frequently exceeded (>10% measurements) or by >2°C. **Estuaries** Criterion frequently exceeded, rise due to discharge exceeds ΔT standards	Temperature, water	Dam or Impoundment Baseflow Depletion from Groundwater Withdrawals Source Unknown
Water quality data nutrient indicators	**Rivers** Combination of indicators present: excessive visible nuisance algae (filamentous, blooms, mats), large diel changes in oxygen/saturation/pH, elevated chlorophyll *a*	Chlorophyll-a Excess Algal Growth Phosphorus (Total) pH, High Secchi disk transparency Turbidity Dissolved oxygen saturation Nutrient/Eutrophication Biological Indicators	Municipal Point Source Discharges Unspecified Urban Stormwater Internal Nutrient Recycling Discharges from Municipal Separate Storm Sewer Systems (MS4) Non-Point Source Urban Runoff/Storm Sewers Source Unknown
	Lakes Combination of indicators present: excessive visible nuisance algae or macrophytes, low Secchi disk transparency, high oxygen super-saturation, elevated pH elevated chlorophyll *a*	Secchi disk transparency Chlorophyll-a Excess Algal Growth Phosphorus (Total) Turbidity Aquatic Plants (Macrophytes)	Municipal Point Source Discharges Unspecified Urban Stormwater Internal Nutrient Recycling Discharges from Municipal Separate Storm Sewer Systems (MS4)

AQUATIC LIFE USE IMPAIRMENT CAUSES AND SOURCES			
Aquatic Life Use **Assessment Indicators**	**Use is Impaired**	**Typical Cause(s) of Impairment**	**Typical Source(s) of Impairment**
		Secchi disk transparency Dissolved oxygen saturation Nutrient/Eutrophication Biological Indicators	Non-Point Source Urban Runoff/Storm Sewers Source Unknown
	Estuaries Substantial decline (> 10% of bed size or total loss of beds no matter their size, MEP analysis indicates moderately to severely degraded health due to nitrogen enrichment	Nitrogen (Total) Nutrient/Eutrophication Biological Indicators Chlorophyll-a Excess Algal Growth	Municipal Point Source Discharges Unspecified Urban Stormwater Internal Nutrient Recycling Discharges from Municipal Separate Storm Sewer Systems (MS4) Industrial Point Source Discharge On-site Treatment Systems (Septic Systems and Similar Decentralized Systems) Septage Disposal Source Unknown
Water quality data toxic and other pollutants	**Rivers, Lakes, Estuaries** Frequent and/or prolonged excursions from criteria (more than a single exceedance of acute criteria or >10% samples exceed chronic criteria).	Ammonia (Un-ionized) Chlorine, Residual (Chlorine Demand) Heavy metals* (e.g., arsenic, mercury) PAHs* (e.g., acenaphthene, naphthalene) chlorinated organic* (e.g., aldrin, heptachlor) Non priority pollutants" (e.g., choride, aluminum, Sulfide-Hydrogen Sulfide)	Municipal Point Source Discharges Highway/Road/Bridge Runoff (Non-construction Related) Combined Sewer Overflows Contaminated Sediments Source Unknown
SEDIMENT AND TISSUE RESIDUE INFORMATION			
Sediment quality data	**Rivers, Lakes, Estuaries** Frequent excursions over PEL guidelines along with other evidence of impairment, waterbodies known to have sediment contamination undergoing remedial actions.	Sediment Screening Value (Exceedence) Arsenic, Cadmium, Chromium (total), Copper, Lead, Mercury, Nickel, Zinc Petroleum Hydrocarbons' Polycyclic Aromatic Hydrocarbons (PAHs) (Aquatic Ecosystems)	Contaminated Sediments CERCLA NPL (Superfund) Sites Inappropriate Waste Disposal
Tissue residue data	**Rivers, Lakes, Estuaries** Residue of contaminants in whole body samples frequently exceed NAS/NAE guidelines, DELTS with abnormal fish histology.	Abnormal Fish deformities, erosions, lesions, tumors (DELTS), Abnormal Fish Histology (Lesions) PCB in Fish Tissue Polychlorinated biphenyls	Contaminated Sediments Inappropriate Waste Disposal Releases from Waste Sites or Dumps Source Unknown

* Asterisk indicates there are many possible contaminants that belong to these classes of pollutants, the cause of impairment however is the individual pollutant (see EPA list of cause codes **http://www.epa.gov/waters/adb/documents/ADB_CAUSE_LUT.xls)** for complete listing.

FISH CONSUMPTION USE IMPAIRMENT CAUSES AND SOURCES			
Indicator for *Fish Consumption Use* Assessment	**Impaired Decision**	**Cause(s)**	**Typical Source(s) of Impairment**
	Waterbody has site specific MA DPH Fish Consumption Advisory with hazard (e.g., mercury, PCBs, pesticides, DDT, etc.)	Mercury in Fish Tissue PCB in Fish Tissue Dioxin (including 2,3,7,8-TCDD) (Pentachlorophenol (PCP)* Chlordane DDT Polycyclic Aromatic Hydrocarbons (PAHs) (Aquatic Ecosystems)	Atmospheric Deposition - Toxics Contaminated Sediments CERCLA NPL (Superfund) Sites Inappropriate Waste Disposal Releases from Waste Sites or Dumps Source Unknown

SHELLFISH HARVESTING USE IMPAIRMENT CAUSES AND SOURCES			
Indicator for *Shellfish Harvesting Use* Assessment	**Impaired Decision**	**Cause(s)**	**Typical Source(s) of Impairment**
	SA Waters: Conditionally Approved, Restricted, Conditionally Restricted, or Prohibited SB Waters: Conditionally Restricted or Prohibited	Fecal Coliform Polychlorinated biphenyls	Discharges from Municipal Separate Storm Sewer Systems (MS4) Combined Sewer Overflows Marina/boating Pumpout Releases Marina/Boating Sanitary On-vessel Discharges Unspecified Urban Stormwater Municipal Point Source Discharges Illicit Connections/Hook-ups to Storm Sewers Sanitary Sewer Overflows (Collection System Failures) On-site Treatment Systems (Septic Systems and Similar Decentralized Systems) Source Unknown

PRIMARY CONTACT RECREATIONAL USE IMPAIRMENT CAUSES AND SOURCES			
Indicator for *Primary Contact Recreational Use* Assessment	**Impaired Decision**	**Cause(s)**	**Typical Source(s) of Impairment**
	Geometric mean bacteria above criterion, aesthetic use impairment Beach Closures >10% season	*Enterococcus* *Escherichia coli* Polychlorinated biphenyls** Any applicable aesthetic causes (see list below)	Municipal Point Source Discharges Combined Sewer Overflows Municipal (Urbanized High Density Area) Discharges from Municipal Separate Storm Sewer Systems (MS4) Unspecified Urban Stormwater Wet Weather Discharges (Non-Point Source) Illicit Connections/Hook-ups to Storm Sewers Urban Runoff/Storm Sewers Waterfowl Introduction of Non-native Organisms (Accidental or Intentional) Source Unknown

** Example of risk calculation exceeds hazard threshold for (contaminant of concern)

PRIMARY CONTACT RECREATIONAL USE IMPAIRMENT CAUSES AND SOURCES			
Indicator for *Secondary Contact Recreational Use* Assessment	**Impaired Decision**	**Cause(s)**	**Typical Source(s) of Impairment**
	Geometric mean bacteria above criterion, aesthetic use impairment	*Enterococcus* *Escherichia coli* Any applicable aesthetic causes (see list below)	Municipal Point Source Discharges Combined Sewer Overflows Municipal (Urbanized High Density Area) Discharges from Municipal Separate Storm Sewer Systems (MS4) Unspecified Urban Stormwater Wet Weather Discharges (Non-Point Source) Illicit Connections/Hook-ups to Storm Sewers Urban Runoff/Storm Sewers Waterfowl Introduction of Non-native Organisms (Accidental or Intentional) Source Unknown

AESTHETICS USE IMPAIRMENT CAUSES AND SOURCES			
Indicator for *Aesthetics Use* Assessment	**Impaired Decision**	**Cause(s)**	**Typical Source(s) of Impairment**
	Aesthetically objectionable conditions frequently observed (e.g., blooms, scums, water odors, discoloration, taste, visual turbidity highly cloudy/murky, excess algal growth (>40% filamentous cover in rivers, nuisance growths >25% dense/very dense macrophytes or blooms in lakes), Secchi disk transparency < 4 feet at least twice during survey season.)	Excess Algal Growth Debris/Floatables/Trash Foam/Flocs/Scum/Oil Slicks Turbidity Total Suspended Solids Nutrient/Eutrophication Biological Indicators Organic Enrichment (Sewage) Biological Indicators Secchi disk transparency Taste and Odor Color Oil and Grease Sedimentation/Siltation	Municipal Point Source Discharges Unspecified Urban Stormwater Municipal (Urbanized High Density Area) Combined Sewer Overflows Internal Nutrient Recycling Discharges from Municipal Separate Storm Sewer Systems (MS4) Introduction of Non-native Organisms (Accidental or Intentional) Source Unknown