Vermont Surface Water Assessment and Listing Methodology

In accordance with
USEPA 2006 Guidance

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Executive Summary

The federal Water Pollution Control Act, also known as the Clean Water Act, requires the State of Vermont and each of the other forty-nine states to develop and submit to the US Environmental Protection Agency two surface water quality-related documents. The documents, to be prepared every two years, arise out of two sections of the Act. Section 305b of the Act requires submittal of a report that describes the quality of the State's surface waters and that contains an analysis of the extent to which its waters provide for the protection and propagation of a balanced population of fish, shellfish and wildlife. This analysis is also referred to as the extent to which Vermont's waters achieve the Act's fishable and swimmable goals. The biennial Vermont Water Quality Assessment Report is commonly known as the "305b Report."

The second document, developed in response to Section 303d of the Act, is a listing of surface waters that:

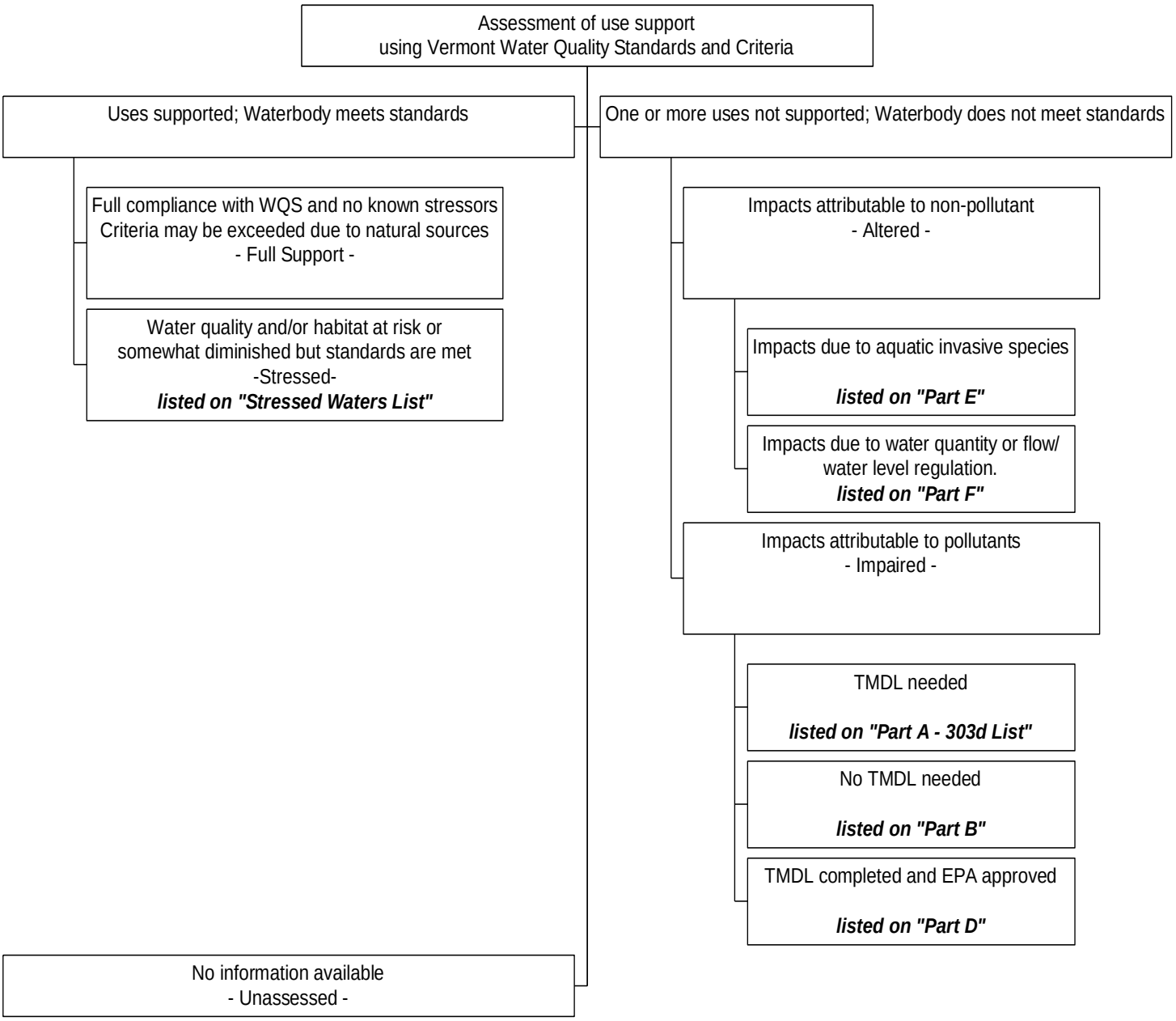
1) are impaired or threatened by one or more pollutants; and,
2) are not expected to meet Water Quality Standards within a reasonable time even after the application of best available technology standards for point sources of pollution or best management practices for nonpoint sources of pollution; and,
3) require development and implementation of a pollutant loading and reduction plan, called a Total Maximum Daily Load, which is designed to achieve Water Quality Standards.

The collection, analysis and evaluation of water quality monitoring data and other information represent the assessment of a water's condition. The assessment of a water is most accurate when judgements about the water's condition are made using chemical, physical and/or biological data of known reliability collected through monitoring. While not as reliable as data collected though monitoring, an assessment of a water's condition can also take into account professional opinion, direct observations or other qualitative information.

The Vermont Water Quality Standards, revised and promulgated by the Vermont Water Resources Board, provide the basis used by the Vermont Department of Environmental Conservation in determining the condition of surface waters including whether the water meets (attains) or does not meet (exceeds or violates) certain criteria. The assessment of a water's condition within the context of the Water Quality Standards requires consideration of the water's classification and management type, a variety of designated or existing uses, and a series of criteria which can be numerical or narrative. The outcome of an assessment conducted by the Department is to categorize Vermont's surface waters as either "full support," "stressed," "altered," or "impaired." Over time, the Department is gradually reducing the number of waters characterized as "unassessed."

This document describes the process used by the Department of Environmental Conservation when making water quality attainment decisions to fulfill 305b reporting and 303d listing requirements. The document contains an overview of the Water Quality Standards (Chapter 1); a description of water quality monitoring approaches that are utilized and their linkage to assessment efforts (Chapter 2); the four assessment categories and the factors and decision principles applied when evaluating data and other information to determine if a water meets the Standards (Chapter 3); and, the rationale when deciding where and how to list a particular water (Chapter 4). Figure 1 illustrates the major components of DEC's assessment and listing process.

Figure 1. Organization of Vermont's Water Quality Assessment and Listing Methodology



Chapter One. Introduction

The Vermont Department of Environmental Conservation (DEC) is charged with implementing the Vermont Water Quality Standards (VTWQS). As part of this responsibility, the Department must characterize the quality of Vermont's surface waters and determine what factors or stressors may be bringing about observed changes. In Vermont and nationwide, significant emphasis is placed on how the condition of surface waters is determined and whether waters are in compliance with the applicable water quality standards. The methods used for making these determinations are important because whether the waters meet or do not meet the water quality standards informs and directs water quality management strategies for each waterbody and may lead to significant regulatory consequences. It is essential that determinations are accurate and defensible.

The Water Quality Standards provide the specific criteria and policies for the management and protection of Vermont's surface waters. The classification of waters (rivers, streams, lakes and ponds) as Class A, Class B or Class B with Waste Management Zone are the management goals to be attained and maintained. The classification also specifies the designated water uses for each class and establish narrative and numeric criteria to support designated and existing uses. The following table serves to indicate applicable designated uses. Chapter Four of this Assessment Methodology describes DEC's approach towards assessing the level of support of these designated uses in light of the criteria established in the Water Quality Standards.

Table 1. Designated Uses for Water Classifications.

Designated Uses	**Class A(1) – Ecological Waters**	**Class A(2) – Public Water Supplies**	**Class B Waters**
Aquatic Biota, Wildlife & Aquatic Habitat	✓	✓	✓
Aesthetics	✓	✓	✓
Swimming & Other Primary Contact Recreation	✓		✓
Boating, Fishing & Other Recreation Uses	✓		✓
Public Water Supplies		✓	✓
Irrigation of Crops & Other Agricultural Uses			✓

Surface water assessment is part science and part careful observation of the causes of the measured conditions. Assessment begins with an examination of the water's chemical, physical and biological condition, and the causality of the conditions observed. Data is used to estimate the water quality standards "attainment status" of waters. Selecting representative data with known and quantifiable precision is the first step in assessing standards attainment. If a waterbody is determined not to attain one or more criteria of the Vermont Water Quality Standards, then it is first necessary to determine whether or not the impact to the surface water is of natural or anthropogenic origin. Identifying the actual cause of impairment will also have considerable bearing on decisions about what approach to initiate to restore the waterbody. The Department also seeks to provide avenues for Vermont's citizenry to contribute in a meaningful way to the protection and improvement of waters.

This document explains how DEC carries out surface water quality monitoring and assessment activities and how it makes decisions on a regular basis regarding a water's condition based on the Vermont Water Quality Standards. It also describes how DEC considers certain factors and how DEC makes decisions when interpreting the meaning of samples and observations obtained through monitoring efforts, whether monitoring information is generated by DEC or by others. This document does not describe DEC's broad array of monitoring programs, which can be found in Appendix A of the Vermont DEC Water Quality Monitoring Strategy 2011 -2020.

Throughout the Assessment and Listing Methodology document, the terms "waters" and "water resources," are used generically and mean lakes and ponds, streams and rivers, and wetlands. The Department does not conduct or carry out any systematic monitoring on many types of waterbodies including wetlands, vernal pools, lakes and ponds less than five acres, closed trout waters, rivers and streams not considered "wadeable," ephemeral or intermittent streams. This Assessment and Listing Methodology document is evolving and reflects the ever-improving methods available for water quality monitoring and interpretation. Vermont's citizenry, federal and academic collaborators, and others are encouraged to view the Assessment and Listing Methodology with an eye towards where and how they can improve or add to the quality of data and other information used to understand, protect, and improve Vermont's water resources.

Chapter Two. Surface Waters Assessment Methodology

Overview and Data Sources

The assessment process involves identifying, compiling and evaluating all existing and readily available water quality data and information as well as evident point and nonpoint source pollution impacts on designated and existing uses specific to the basins and waters being assessed in any given year. The data and other information are maintained in EPA's Assessment Database (ADB) or in databases specifically designed to allow the population of the ADB. Vermont relies on the following sources of reliable data and information when assessing use support:

1) DEC Watershed Management Division (monitoring data)
2) DEC Wastewater Management Program (National Point Source Discharge Elimination System permit compliance, indirect discharge permit compliance, residuals management)
3) DEC Waste Management and Prevention Division (solid and hazardous waste sites monitoring data)
4) DEC Laboratory Services at the R.A. LaRosa Laboratory (quality assurance, analytical services, pollutant data)
5) Vermont Agency of Natural Resources Enforcement Division (violations of water quality standards)
6) Vermont Department of Fish & Wildlife (data on game fish and temperature, habitat studies)
7) Vermont Department of Health (beach closure information, fish consumption risk assessments)
8) Vermont Department of Forests, Parks, and Recreation (bacteriological testing, beach closure information)
9) Vermont Agency of Agriculture, Food and Markets (agricultural water quality violations)
10) US Department of Agriculture, Natural Resource Conservation Service (agricultural nonpoint sources, locations of pollution abatement projects)
11) Citizens and citizen associations (citizen monitoring data, location of sources, complaints)
12) US Geological Survey Water Resources Division (monitoring and research)
13) US Forest Service (fish habitat and water quality data and information)
14) US Environmental Protection Agency (monitoring and research)
15) US Army Corps of Engineers (environmental assessments of project waters)
16) University of Vermont, Vermont State Colleges System and other colleges (monitoring and research)

The DEC Biomonitoring and Aquatic Studies and River Management Sections provide much of the data used in the assessment of monitored river miles. The DEC Lakes and Ponds Section provides much of the data used in the assessment of monitored lake acres. The other sources noted above provide fewer and less widespread, but nevertheless important, data points.

Rotational Watershed Assessment Approach

For the purposes of water quality management planning and implementation, which includes assessing and reporting water quality information, Vermont has been divided into fifteen planning basins. Each major basin has from four to twenty-two river watersheds, subwatersheds and river mainstem segments. These sub-watersheds and mainstem segments and the various lakes and ponds are known as "waterbodies." There are a total of 208 river and stream waterbodies (37 as mainstem segments) and 574 lake and pond waterbodies designated throughout Vermont. The fifteen major river basins are located in one of the four large regional drainages: Lake Champlain, Connecticut River, Lake Memphremagog, or Hudson River. The fifteen basins are presented in Figure 2 below.

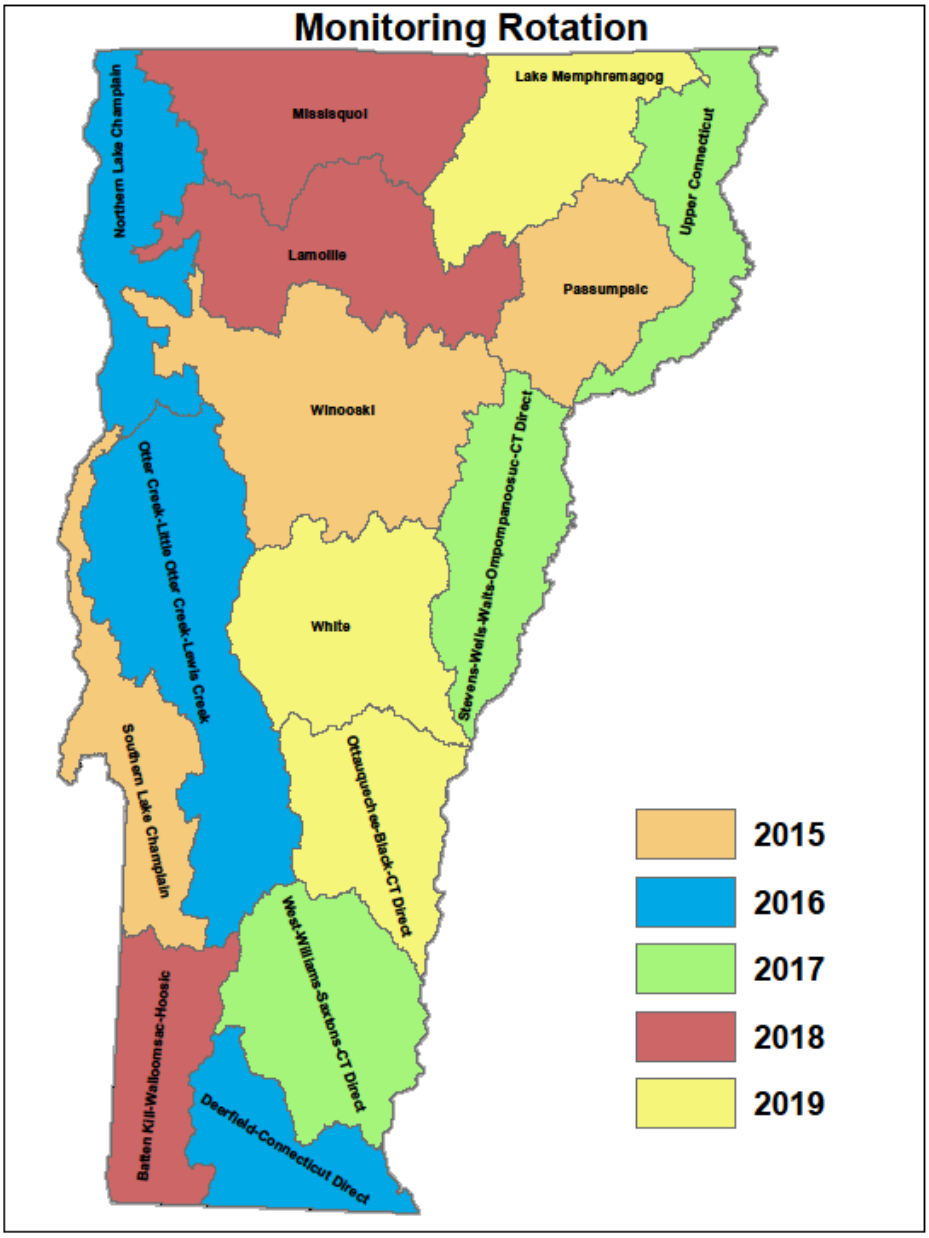


Figure 2. Vermont's 15 major planning basins with rotation monitoring schedule

In order to more thoroughly assess the State's surface waters and to take advantage of all existing and readily available sources of water quality information, the DEC Watershed Management Division (WSMD) has designed and is carrying out a rotational watershed assessment process over every five years. By focusing evaluations on selected basins each year, more systematic and intensive efforts can be made to collect and evaluate information related to the sources and causes of pollution. The monitoring year for each basin is shown in Figure 2 above.

Under the rotational monitoring and assessment process, DEC staff compile and evaluate all water quality and biological data and information; determine impacts to designated and existing uses; and document very high quality waters and aquatic habitat. Once the data and other information for each waterbody in a particular basin is assessed, a basin assessment report is prepared. The information contained in each basin assessment report is an early and vital piece of the basin planning process. Following completion of the basin assessment report, the basin planning process can stimulate more detailed assessments, propose re-classifications and/or typing, or outline protection or restoration activities that could be incorporated in a river basin water quality management plan. One or more assessment reports have been prepared for all of the basins.

River Watershed Assessment Reports and Updates

Basin	Original report written	Updated Assessment Report (s)
1 – Battenkill, Hoosic, Walloomsac	August 2002	Hoosic River Watershed December 2014
2 – Poultney, Mettawee Rivers	December 1999	January 2013
3/4 – Otter, Little Otter, and Lewis Creeks, Southern Lake Champlain	June 1998	
5 – Upper Lake Champlain	December 2003	Shelburne Bay Watershed June 2013 St. Albans Bay Watershed June 2013 Malletts Bay Watershed July 2013
6 – Missisquoi River	November 2004	Missisquoi Watershed August 2015
7 – Lamoille River	February 2001	Lamoille River Watershed February 2016
8 – Winooski River	April 2008	
9 – White River	November 1997	November 2002 July 2012
10 – Ottauquechee, Black Rivers	June 2000	
11 – West, Williams,Saxtons Rivers	November 2001	West River Watershed October 2014 Williams River Watershed October 2014 Saxtons River Watershed October 2014 Lower Connecticut R Tribs October 2014
12 – Deerfield River	March 2003	December 2012
13 – Lower Connecticut River	April 2002	The former basin 13 waterbodies are now part of Basins 10, 11, and 12
14 – Stevens, Wells, Waits, Ompompanoosuc	April 1999	Stevens River Watershed June 2014 Wells River Watershed August 2014 Waits River Watershed August 2014 Ompompanoosuc River Watershed Dec 2014
15 – Passumpsic River	June 2009	February 2013
16 – Upper Connecticut River	March 2011	
17 – Lake Memphremagog	March 2006	

Monitoring Designs to Collect Assessment Data

A full description of the Department's monitoring work is given in the Vermont Department of Environmental Conservation Water Quality Monitoring Strategy 2011 - 2020, May 2011. The strategy contains goals, objectives, and recommendations as well as complete descriptions of the various monitoring and assessment programs in the DEC Watershed Management Division.

Fixed Station Monitoring Approach

DEC coordinates a large number of fixed-station monitoring projects, incorporating river and lake water quality projects. Projects considered as fixed station in Vermont are long-term, recurring efforts that DEC has operated (or intends to operate) for several years. Some of these projects, such as the Ambient Biomonitoring Network and Lake Assessment Program (both of which incorporate several individual monitoring projects and studies) achieve dense statewide spatial coverage. The total number of river/stream and lake monitoring stations established under these two well-established programs exceed 1,650 and 650 respectively.

Fixed-station monitoring also includes monitoring done by other groups, schools or agencies. To be considered a part of the fixed-station approach, DEC must have knowledge of the particular monitoring plan (e.g. sampling site location, sampling frequency, parameters being collected and tested). Data generated by these other fixed-station monitoring efforts must have a quality assurance plan in order for DEC to characterize the data as reliable.

DEC's and the other fixed-station monitoring networks are designed to assess the status of current water quality conditions and to detect trends or changes in water quality condition. One of Vermont's major lake monitoring programs is a fixed-station, volunteer-based initiative.

Probability-based Monitoring Approach

Results from probability surveys are used to determine statewide water quality conditions in regard to use and provide statistically sound estimates of use attainment on a statewide or basin-wide basis. DEC recognizes the value of probability-based monitoring initiatives especially where predictability of use attainability is inherent in the project design. Such designs permit the use of statistically-derived models for inferring use attainment in appropriately selected waters where sampling was not performed.

DEC has incorporated probability sampling as part of its Water Quality Monitoring Program strategy, and such projects are linked to a larger national probability survey initiative. Probability surveys undertaken by DEC to date include:

- A REMAP assessment of mercury concentration in sediments, waters, and biota of 46 Vermont lakes and 47 New Hampshire lakes using a spatially randomized design (1998-2003).
- Characterization of use attainment for aquatic life using a spatially randomized draw of existing Ambient Biomonitoring Network data at varying site intensities (2001). The reader is referred to the Vermont 2002 Section 305b Report for a further description of this effort.
- A REMAP assessment of aquatic life use attainment in New England Wadeable Streams (2002-2006).
- Participation in the National Study of Chemical Residues in Fishes (2002-2005).

- Probability assessment of aquatic life use attainment in Vermont Streams based on a rotational basin design. The reader is referred to the Vermont 2008 Section 305b Report for a further description of this effort.
- Probability assessment of Vermont Lakes – 2007. The reader is referred to Vermont 2010 Section 305b Report for a further description of this effort.
- Probability surveys in conjunction with the USEPA through the National Aquatic Resources Surveys (NARS). These include the National Wetland Condition Assessment (2011), National Lakes Assessment (2012) and the National Rivers Assessment (2013).

Special Studies and TMDL-related Studies

DEC undertakes monitoring associated with special and Total Maximum Daily Load (TMDL) studies as needed, in response to compelling data and information supplied under the rotational assessment and fixed-station and probability-based projects. The number and nature of special studies is commonly dictated by the nature of issues and problems that are reported as needing further monitoring or that may arise as interest or funding permit. These types of studies include detailed sampling to assess use support or standards violations, diagnostic-feasibility studies, effectiveness evaluations of pollution control practices/measures and watershed-based surveys and evaluations. TMDL studies are scheduled as needed consistent with the timeline established in Vermont's 303d List of Waters and dependent on available resources.

Biological Monitoring and Assessments

Assessment of biological integrity is conducted on the state's rivers and streams for the purpose of trend detection, classification, evaluation of permitted activities and site-specific impact evaluation. Macroinvertebrate and/or fish populations of rivers and streams considered to be "wadeable" are assessed by comparing a series of biometrics measuring community structure and function to numeric criteria that represent the biological expectation for the stream type being evaluated. These numeric criteria directly interpret the narrative criteria for biota found in the Vermont Water Quality Standards.

Individual site surveys and subsequent processing steps are detailed in *"Methods for Determining Aquatic Life Use Status in Selected Wadeable Streams Pursuant to Applicable Water Quality Management Objectives and Criteria for Aquatic Biota Found in Vermont Water Quality Standards (WQS) Chapter 3, Section 3-01, as well as those specified in Section 3-02(A1 and B3), Section 3-03(A1 and B3), and Section 3-04(A1 and B4, parts a-d)"* (a.k.a. biocriteria procedure). Using the biocriteria procedures, the integrity of the aquatic biota is attributed a rank of excellent, very good, good, fair or poor. Rankings are indicative of aquatic life use support status for each water quality classification and water management type.

Sampled streams include both fish and macroinvertebrate assemblage collections where possible. Both community assessments must meet class criteria in order for a site/reach to comply with applicable standards. While information from both assemblages is desirable, an overall biological assessment declaring support or non-support of aquatic life uses can be made based on just one community alone. A determination of support - nonsupport is made only when data has been determined to be fully representative of the stream reach under consideration.

The biological potential for various sites has been established through statewide reference site monitoring. Information from this program element also serves to refine existing biocriteria and detect trends in baseline biological integrity. The long-term goal of reference site monitoring is to gather information on a set of known reference sites every year or every other year, so as to generate continuous data for each site. There are twenty-one of these long-term biological stream reference sites. Sites are stratified across stream ecotypes differing in drainage area size, elevation, and alkalinity. Human activity in reference site drainages is considered to be minimal relative to other streams in the ecoregion.

Where site-specific impact assessments are conducted (including an evaluation of the appropriate chemical and physical data), potential pollution sources that are not of natural origin are spatially bracketed (i.e. above and below) with sample sites to determine effects on the aquatic biota attributable to the pollution source. Either macroinvertebrate or fish populations or both may be sampled. Approximately 130 river sites are assessed each year in the late summer-early fall (September to October 15) on a five-year rotational watershed basis. DEC has evaluated over 1,650 sites since 1990.

The Department implements biocriteria only when appropriate reference conditions have been described. The Department recognizes differences between biological expectations for different types of waterbodies including lakes and ponds, wetlands, large and small rivers and perennial and intermittent streams. Management decisions are made accordingly.

VTDEC uses monitoring of fish and macroinvertebrates for direct assessment of aquatic life use attainment in streams. The lake assessment program began evaluating the status of selected biological species and communities in 1996 with the aim of developing numeric measurements to assess aquatic life use attainment in lakes. This initial effort led to the development of protocols for phytoplankton (VTDEC, 2003c) and macroinvertebrates (VTDEC, 2007). In 2009, further development of approaches for using macroinvertebrates ensued as part of the Littoral Habitat Assessment study. A Vermont and NEIWPCC led regional lake biomonitoring workgroup continues to pursue the development of biocriteria for lakes.

Stream Geomorphic/Physical Habitat Assessment

Data collected during stream geomorphic assessments according to recognized procedures provide a better understanding of the physical processes and features shaping a watershed; help identify high quality habitat or habitat and aquatic communities that have been compromised; and contribute to understanding the effects of watershed land use activities on stream condition.

The Vermont Stream Geomorphic Assessment Protocols (DEC, 2003b) provide a method for assigning a geomorphic and physical habitat condition to stream reaches. The term “departure from reference” is used synonymously with stream geomorphic condition throughout the protocols. The degree of departure is captured by the following three terms:

A stream reach in *reference and good* condition that:

- Is in dynamic equilibrium which involves minor to moderate localized change to its shape or location while maintaining the fluvial processes and functions of its watershed over time and within the range of natural variability; and
- Provides very high to high quality aquatic and riparian habitat with persistent bed features and channel forms that experience periodic disturbance as a result of erosion, deposition, and woody debris.
- Aquatic communities are likely assessed as excellent to very good when sampled in a subset of the geomorphically assessed reach

A stream reach in *fair* condition that:

- Has experienced major changes in channel form and fluvial processes outside the expected range of natural variability; may be poised for additional adjustment with future flooding or changes in watershed inputs that would change the stream type; and
- Provides aquatic and riparian habitat that may lack certain bed features and channel forms due to increases or decreases in the rate of erosion and deposition-related processes.
- Aquatic communities are expected to be assessed in the "good to fair" range depending on whether the sample site reflects the erosional or deposition changes underway.

A stream reach in *poor* condition that:

- Is experiencing severe adjustment outside the expected range of natural variability; is exhibiting a new stream type; is expected to continue to adjust, either evolving back to the historic reference stream type or to a new stream type consistent with watershed inputs; and
- Provides aquatic and riparian habitat that lacks certain bed features and channel forms due to substantial increases or decreases in the rate of erosion and deposition-related processes. Habitat features may be frequently disturbed beyond the range of many species' adaptability.
- Aquatic communities are likely fair- to- poor or poor. Aquatic biota sampling sites from previous years may not exist in the same location due to the stream type departure.

Phase 1 of the DEC protocols is the remote sensing phase and involves the collection of data from topographic maps and aerial photographs, from existing studies, and from very limited field studies. Geomorphic reaches and provisional reference stream types are established based on valley land forms and their geology. Predictions of channel condition (departure from reference), adjustment process, and reach sensitivity are based on evaluations of watershed and river corridor land use and channel and floodplain modifications.

Phase 2 of the protocols is known as the rapid field assessment phase and involves the collection of field data from measurements and observations at the reach or sub-reach (segment) scale. Existing stream types are established based on channel and floodplain cross-section and stream substrate measurements. Stream geomorphic condition, physical habitat condition, adjustment processes, reach sensitivity, and stage of channel evolution are based on a qualitative field evaluation of erosion and depositional processes, changes in channel and floodplain geometry, and riparian land use/land cover. At least Phase 1 and Phase 2 stream geomorphic data will be used in determining stressed or altered waters due to physical problems.

Phase 3 is the survey-level field assessment phase and involves the collection of detailed field measurements at the sub-reach or site scale. Existing stream types and adjustment processes are further detailed and confirmed based on quantitative measurements of channel dimension, pattern, profile, and sediments. Phase 3 assessments are completed with field survey and other accurate measuring devices.

Data Solicitation and Quality

In conjunction with each biennial assessment and reporting cycle, DEC solicits data to further enhance the quantity and spatial coverage of water quality data and other information that is used in assessing surface waters. The solicitation for water quality data is distributed to various watershed groups and is posted on the WSMD website (refer to http://www.watershedmanagement.vt.gov). The solicitation seeks data and information to be submitted by mid-November in odd-numbered years in order to be considered for the even- year reporting cycle. Data and other information submitted after that date will be considered for the next reporting cycle.

Data used must be of known quality and should be representative of the water's condition. All data generated by DEC in conjunction with WSMD monitoring programs are subject to quality assurance planning using USEPA quality assurance guidance. Moreover, any and all data generated in part or whole using funding from USEPA must be subject to a USEPA-approved quality assurance project plan (QAPP). All data generated in conjunction with any active and/or approved QAPP are considered readily available and reliable data (subject to data limitations identified in the quality assurance/quality control validation and verification process for each project), and are considered in determining use support. Data can be rejected from consideration in the event that it does not meet data quality objectives established by individual QAPPs. DEC's Quality Management Plan and Water Quality Monitoring Strategy provide listings of project-specific QAPPs. Guidance and assistance regarding quality assurance is also provided from the R.A. LaRosa Laboratory.

For data provided by organizations other than DEC and WSMD such as colleges, universities and citizen-based activities, data quality must be assured prior to considering it as the sole basis for use support. The number of samples, the length of the sampling period, the antecedent weather conditions, degree of compliance or violation and other factors are all considered when evaluating data from other organizations. Where data of unknown or unquantifiable quality are at odds with companion data of quantified quality, the higher quality data will be accorded higher weight in determining use support. Where data of unknown or suspect quality are the only information available, the waterbody is scheduled for additional monitoring prior to determining use support.

Vermont Surface Water Assessment Categories

Vermont's rivers, streams, lakes, and ponds have been categorized into "waterbodies" which serve as the cataloging units for the overall statewide assessment. Waterbodies are typically entire lakes, subwatersheds of river drainages or segments of major rivers. Using data that is quality assured along with other contextual information that is reliable, the Watershed Management Division determines whether each waterbody meets or does not meet Vermont Water Quality Standards, and

then places waters into one of four assessment categories, taking into account the waterbody classification and water management type. The four categories used in Vermont's surface water assessment are **full support, stressed, altered** and **impaired**. Waters that support designated and existing uses and meet Water Quality Standards are placed into the full support or stressed categories. Waters that do not support uses and do not meet standards are placed into the altered or impaired category. Waters can also be put into an **unassessed** category. These assessment categories are described below.

Full Support Waters

This assessment category includes waters of high quality that meet all use support standards for the water's classification and water management type.

In Vermont, there are many waters, such as intermittent streams, that are a lower priority for sampling visits given resource constraints, lack of public access or interest, and competing needs within DEC's water quality monitoring program. DEC therefore makes preliminary assessments, where practical, by considering five factors that address the likelihood that significant stressors exist within the subject watershed. Waters that meet all these factors are then considered to support their uses. The factors DEC uses to develop preliminary, screening-level assessments for these waters are:

- no discharges or contaminated sites in proximity to the waterbody;
- low probability of habitat degradation as evaluated by "Phase One" geomorphic assessments or other remote sensing evaluations;
- nearby sites have biological assessment findings compliant with Vermont Water Quality Standards, for like class and water management type;
- no problems are uncovered during outreach efforts associated with the rotational assessment process and basin planning; and
- no known water level manipulations.

Stressed Waters

These are waters that support the uses for the classification but the water quality and/or aquatic biota/ habitat have been disturbed to some degree by point or by nonpoint sources of human origin and the water may require some attention to maintain or restore its high quality; the water quality and/or aquatic habitat may be at risk of not supporting uses in the future; or the integrity of the aquatic community has been changed but not to the degree that the standards are not met or uses not supported. Data or other information that is available confirms water quality or habitat disturbance but not to the degree that any designated or existing uses have become altered or impaired (i.e. not supported).

Some stressed waters have documented disturbances or impacts and the water needs further assessment.

Altered Waters

These are waters where a lack of flow, water level or flow fluctuations, modified hydrology, physical channel alterations, documented channel degradation or stream type change is occurring and arises from some human activity, OR where the occurrence of exotic species has had negative impacts on designated uses. The aquatic communities are altered from the expected ecological state.

This assessment category includes those waters where there is a documentation of water quality standards violations for flow and aquatic habitat but EPA does not consider the problem(s) caused by a pollutant OR where a pollutant results in water quality standards not being met due to historic or previous human-caused channel alterations that are presently no longer occurring.

Impaired Waters

These are surface waters where there are chemical, physical and/or biological data collected from quality assured and reliable monitoring efforts (refer to section 5 of this chapter) that reveal 1) an ongoing violation of one or more of the criteria in the Water Quality Standards and 2) a pollutant of human origin is the most probable cause of the violation.

Unassessed Waters

Waters for which DEC has no monitoring data and only limited information and knowledge is available are considered unassessed.

Chapter Three. Assessment Use Support Determinations

The following pages provide specific criteria, principles for making decisions, and other information that DEC applies when making an assessment of water quality conditions and determining whether individual designated are fully supported, stressed, altered, impaired or unassessed. Information below is presented by each of the seven designated uses to show how relevant, representative and reliable water quality monitoring data and other information relates directly to the degree of use support for assessment reporting purposes. If not otherwise specified, the decision-making criteria apply to both streams and lakes.

Aquatic Biota/Habitat (Aquatic Life) Use

In assessing Aquatic Life Use, the DEC Watershed Management Division uses several types of water quality and water quantity data and information to determine use support. The specific data types are biological monitoring, habitat assessment, conventional pollutants, toxicants, and invasive aquatic species. For lakes, additional assessment guidelines are used to directly or indirectly assess uses using conventional pollutants, nutrients, and information regarding water-level impacts. Where there is biological (aquatic community) data then use support is determined by the assessment of that data even if conventional pollutant measures or habitat indicators are indicating otherwise. Specific decision-making criteria are as follows:

Biological Monitoring

Full Support: Biological assessments for fish and/or macroinvertebrate communities demonstrate compliance with appropriate threshold criteria as described in DEC biocriteria implementation methodologies. In the absence of applicable biocriteria, all available information and data are used to make scientifically defensible weight-of-evidence findings that designated aquatic life uses are fully supported. In most cases, biological condition ratings of *excellent, very good,* and *good* will indicate full support status for Class A(1), Class B(1), and Classes A(2) B, B(2) and B(3) respectively.

Stressed: Biological assessments for fish and/or macroinvertebrate communities and/or habitat assessments indicate that impacts have occurred but are inconclusive with regard to support status determination or demonstrate that the biological condition is at risk of making a transition between support and non-support. In the absence of applicable biocriteria, all available information and data are used to make scientifically defensible weight-of-evidence findings that designated aquatic life uses are stressed. Additional biological assessment may be needed. In most cases, biological condition ratings of *"excellent-to-very good"* will indicate stressed status for Class A(1) waters, *"very good-to-good"* will indicate stressed status for Class B(1) waters; "good" or "good to fair" will indicate stressed status for Class B waters and *"good-to-fair"* will indicate stressed status for Class A(2), B(2) and B(3) waters.

Altered: Biological assessments for fish and/or macroinvertebrate communities demonstrate non-compliance with appropriate threshold criteria as described in DEC biocriteria implementation methodologies and the cause is not a pollutant (e.g. flow regulation or non-native species). In the absence of applicable biocriteria, all available information and data are used to make scientifically

defensible weight-of-evidence findings that designated aquatic life uses are not fully supported. In most cases, biological condition ratings of *very good or lower, good or lower,* and *fair or lower* will indicate altered status for Class A(1), Class B(1), and Classes A(2), B, B(2) and B(3) respectively. Generally, biological data indicating non-attainment from the previous two or more successive samples are necessary in order to determine this condition.

Impaired: Biological assessments for fish and/or macroinvertebrate communities demonstrate non-compliance with appropriate threshold criteria as described in DEC biocriteria implementation methodologies and the cause is due to a pollutant of human origin. In the absence of applicable biocriteria, all available information and data are used to make scientifically defensible weight-of-evidence findings that designated aquatic life uses are not fully supported. In most cases, biological condition ratings of *very good or lower, good or lower,* and *fair or lower* will indicate impaired status for Class A(1), Class B(1), and Classes A(2), B, B(2) and B(3) respectively. Generally, biological data indicating non-attainment from the previous two or more successive samples are necessary in order to determine this condition.

Habitat Assessment

Full Support: Depending on the water's classification and typing {A(1), A(2), B, B(1), B(2), B(3)}, very high or high quality habitat with up to a moderate change from natural or reference condition exists "consistent with the full support of all aquatic biota and wildlife uses."

Stressed: Stream or river physically under stress – in adjustment with stresses greater than as naturally occurs to a "fair" condition derived from a geomorphic assessment completed using recognized protocols.

Altered: Changes to the habitat are greater than minimal to a moderate change from reference, depending on the water's classification and typing. There is an undue adverse effect on the physical nature of the substrate. Aquatic habitat surveys show significant deviation from the reference condition due to human-caused changes and/or geomorphic assessment indicated "fair" to "poor" conditions. All life cycle functions, including over-wintering and reproductive requirements, are not adequately maintained and protected due to the physical habitat changes.

Impaired: A pollutant of human origin is shown to cause more than the allowable change to aquatic habitat as defined by Vermont Water Quality Standards.

Conventional Pollutants (temperature, pH, D.O., turbidity, phosphorus, nitrate-nitrogen.)

Streams and Lakes

Full Support: Waters that are not stressed or impaired due to conventional pollutants, assessed using the Vermont Water Quality Standards. For example, the total increase from the ambient temperature due to all discharges and activities is not known to exceed 1.0 degree F for a coldwater fishery and the total increase from ambient temperature due to all discharges and activities shall not exceed the temperature criteria derived from tables 1 or 2 in Section 3-01.B.1.c. except as provided for in Section 3-01 B.1.d. of the Vermont Water Quality Standards (pertaining to both a coldwater and warmwater fishery).

Stressed: Waters where the level of a conventional pollutant or a combination of conventional pollutants of human origin may be resulting in some disturbance. For example, temperatures are such that in coldwater fishery waters, one or more trout species are reduced in number or biomass as compared to reference condition. Waters with alkalinities between 2.5 and 5.0 mg/l (as CaCO3), and pH values may occasionally drop below 6.5. Coldwater fishery waters where dissolved oxygen may be between 6 and 7 mg/l and 75 to 85% saturation.

Altered: This assessment category is not used in this context.

Impaired:
Temperature: Temperatures are too high as a result of human activities to fully support coldwater fish species in waters designated as a coldwater fishery OR the total increase from the ambient temperature due to all discharges and activities exceeds 1.0 F for a coldwater fishery and the total increase from ambient temperature due to all discharges and activities exceeds the temperature criteria derived from tables 1 or 2 in Section 3-01.B.1.c. except as provided for in Section 3-01 B.1.d. of the Vermont Water Quality Standards (pertaining to both a coldwater and warmwater fishery).

Acidity: Reliable, representative monitoring indicates that pH values repeatedly fall below 6.5 standard units or exceed 8.5 standard units across a range of weather conditions, and values are not due to natural sources.

Dissolved oxygen: Reliable, representative monitoring indicates D.O. values or percent saturation repeatedly fall below the standard for the water's classification and type except as noted below.

Turbidity: Reliable, representative monitoring shows that the mean turbidity values are above the standard for a water's classification and type as measured at or below low median monthly flows and values are not due to natural sources.

Nitrates: Reliable, representative monitoring shows that nitrate-nitrogen repeatedly and/or consistently exceeds the standard for the water's classification, type, and elevation as noted in VWQS Section 3-01.B.3.

Combined Nutrient Criteria: For all lakes save Lakes Champlain and Memphremagog, and all streams and rivers save non-wadeable rivers, reliable, representative monitoring shows that mean phosphorus concentrations repeatedly and/or consistently exceed the criteria contained in Tables 3, 4, or 5 of Section 3 of the Vermont Water Quality Standards. Consistent with the Technical Support Document for nutrient criteria, and for lakes and reservoirs only, the Department may not require consistency with Aquatic Biota, Wildlife, and Aquatic Habitat provisions of Tables 3, 4, or 5.

Phosphorus: For Lakes Champlain and Memphremagog, reliable, representative monitoring shows that mean phosphorus concentrations repeatedly and/or consistently exceed the criteria contained in Table 6 of Section 3 of the Vermont Water Quality Standards.

<u>Lakes Only – Alkalinity and D.O.</u>

Full Support: Waters that are not stressed or impaired.

Stressed: Reliable long-term monitoring data indicates that a lake's alkalinity routinely drops below 12.5 mg/l (as CaCO3) during the spring runoff period.
Reliable long-term monitoring data indicates that a lake's hypolimnetic dissolved oxygen concentration periodically falls to (or near) 0 mg/l or 0% saturation during peak summer stratification, but macroinvertebrates are present. The area designated as stressed, as a result of human disturbance, is limited to the lake acreage underlain by the hypolimnetic oxygen-deficient area.

Altered: This assessment category is not used in this context.

Impaired: Reliable monitoring data indicates that alkalinity routinely drops below 2.5 mg/l (as acid neutralizing capacity) during the spring runoff period.
Reliable monitoring data indicates that a lake's hypolimnetic dissolved oxygen concentration falls to (or near) 0 mg/l or 0% saturation for a period of greater than 50% of the summer stratification period, **and** the hypolimnetic sediments are devoid of a macroinvertebrate community. The area designated as impaired, as a result of human disturbance, is limited to the lake acreage underlain by the hypolimnetic oxygen-deficient area. However, if in the best professional judgement of DEC scientists, the dissolved oxygen deficit is due to natural causes, aquatic life uses will be considered instead as fully supported.
The epi- and metalimnetic lake waters will be considered impaired if dissolved oxygen concentrations fall below Water Quality Standards in greater than or equal to 10% of samples, and the anoxia is not a natural phenomenon.
Reliable monitoring data indicates nitrates in excess of 5.0 mg/l in 10% or more of samples collected.
A minimum of four evenly-spaced sampling events across the summer stratification period are commonly used to make a determination regarding conventional pollutants in lakes, except for alkalinity, which is most commonly measured in spring, which corresponds to peak acidity loading for lakes.

Toxicants (priority pollutants, metals, chlorine & ammonia)

All Toxics but Chloride (addressed below)

Full Support: Waters that are not stressed or impaired due to toxicants, as described below.

Stressed: Water quality monitoring or sediment samples reveal the presence of toxics below criteria or there are no relevant criteria and the source of the pollutants has not been remediated. Groundwater data in wells adjacent to the stream shows levels of pollutants above the Vermont Groundwater Enforcement Standards but no in-stream data exists or no sediment samples have been taken.

Altered: Toxicants are considered pollutants, therefore, the category "altered" is not applicable.

Impaired: In most cases, the following exposure presumptions are applicable to compliance determinations: for any one pollutant, an acute aquatic biota criterion is exceeded more than once

within a 3-year period, for longer than one hour, above ten-year, seven-day flow minimum (7Q10) flows; or a chronic aquatic biota criterion is exceeded for more than four consecutive days in a three year period, above 7Q10 flows.

(DEC recognizes that the literal interpretation of the exposure scenario cited would be difficult to replicate in a field situation. The language cited reflects the exposure conditions used to develop the numerical criterion that is the water quality standard. It is likely that available monitoring data would be collected under a variety of temporal and spatial formats. In evaluating data, DEC uses the exposure assumptions of the criterion development as guidelines in the interpretation of data and uses empirical and judgmental means to assess whether or not there is reasonable potential for those exposure assumptions to be violated. Given the variable nature of available information, evaluations will vary on a case-by-case basis. DEC takes into consideration guidance provided by EPA when evaluating toxicants in surface waters (see "Technical Support Document for Water Quality-based Toxics Control." EPA/505/2-90-001).

Chloride

Full support: No exceedances in excess of chronic criterion of 230 mg/l.

***Stressed*:** One or more exceedances of the chronic criterion for any given 3 year period or evidence of consistently elevated chloride levels. The determination of "elevated chloride levels" will be assessed on a case by case basis. Where available, biomonitoring information will be evaluated to assist in the aquatic life use assessment. The water will be assessed as stressed and flagged for follow-up monitoring, likely the development a continuous dataset.

***Impaired*:**

Chronic criterion:
Grab Samples: Given the duration and frequency terms of the chronic criteria, limited numbers of chloride grab samples will rarely be sufficient to document the four-day average over a three year period. Surface waters with multiple samples above the criterion will direct the need for follow-up monitoring, using a continuous dataset. However, if a sufficiently large chloride dataset exists to confidently calculate any unique 96 hour average exceeding the criterion, then the water will be assessed in non-support.

Continuous Monitoring Using Conductivity: Where continuous monitoring datasets indicate an average chloride concentration in excess of 230 mg/L for more than one 96 hour period in a three-year period, the waterbody will be assessed in non-support (See Appendix A).

Acute Criterion:
Grab Samples: A minimum of 2 samples, separated by one hour, that exceed 860 mg/L for any given 3-year period.

Continuous Monitoring Using Conductivity: Where continuous monitoring datasets indicate an average chloride concentration in excess of 860 mg/L for more than one hour in a three-year period, the waterbody will be assessed in non-support.

Invasive Non-native Species

Invasive non-native species such as Eurasian watermilfoil (*Myriophyllum spicatum*), water chestnut (*Trapa natans*), alewives (*Alosa pseudoharengus*) or zebra and quagga mussels (*Dreissena spp*.) have significant impacts on existing aquatic plant and animal communities. Information on the extent and distribution of these species is used to assess aquatic life use support.

Full Support: No established population of an invasive non-native species.

Stressed: Invasive non-native species are present but in low densities (e.g. scattered areas of plant growth in limited areas of the littoral zone). In the case of Eurasian milfoil, lakes within a 10-mile radius of an infested lake are considered stressed, unless access to the lake is remote or inaccessible by conventional means.

Altered: Invasive non-native species present in densities sufficient to alter native biological communities. For example, overall plant density is classified as "moderate," indicating locally abundant (50% or greater coverage) growth, or "heavy," (75% or greater littoral cover overall) indicating growth in most shoreline areas.

Impaired: Invasive non-native species are not considered pollutants. Therefore, this category is not applicable.

Fluctuated Reservoirs and Lakes

Reservoirs present special cases in regards to assessment of aquatic life use support (ALUS). In the absence of direct biological measurements beyond routine aquatic plant survey data, ALUS can be assessed using the following decision-making 'tree.' In order to use this decision tree, several pieces of information regarding the reservoir are useful. These include bathymetry, maximum and mean waterbody depth, the limnological shoreline development index, and the magnitude and timing of the drawdown. These data can be used collectively to estimate the proportion of the littoral zone likely to be affected by the drawdown regimen. Where available, biological data (in particular the presence and distribution of aquatic macrophytes within the littoral zone) are also useful.

1) Can the level of the waterbody be regulated by an artificial structure (e.g. dam, sluice, weir)?
   Answer is NO: no alteration or stress to ALUS due to water level fluctuation. ***Full Support.***
   Answer is YES: go to 2.
2) Is the waterbody connected to a licensed or unlicensed hydroelectric generating system, a flood control system, or subject to promulgated Vermont Water Resources Board rules regulating the fluctuation?
   Answer is NO: a stress or alteration to ALUS could potentially exist, but must be verified by direct assessment before the waterbody can be correctly assessed; go to 4.
   Answer is YES: go to 3.
3) Is the waterbody regulated by a federal Clean Water Act Section 401 water quality certification issued by VTDEC after January 1, 1990?
   Answer is NO: go to 4.

Answer is YES: ***no alteration or stress to ALUS due to water level fluctuation if operated in accordance with the license.***

4) Is the waterbody in fact subject to periodic fluctuations that are attributable to operation or manipulation of the outflow structure?

   Answer is NO: ***a stress to ALUS is presumed to exist***, due to the ability of the outflow operators to fluctuate water levels if the need arises, which can negatively impact littoral zone communities. Such littoral zone impacts have the potential to cause cascading changes within the trophic web of the waterbody but cause no more than a minor change in habitat or moderate change in aquatic biota from the reference condition. The entire waterbody acreage will be assessed as stressed for ALUS.

   Answer is YES: Go to 5.

5) Does there exist a sufficient area of littoral habitat below the drawdown zone to enable establishment of a viable and stable aquatic community, with all expected functional groups, while accommodating the drawdown regimen, **or**, does available biological data suggest that such a community exists within the drawdown zone?

   Answer is NO: ***ALUS is altered.*** These alterations create more than a moderate change to aquatic habitat. Littoral zone impacts of this magnitude will have cascading impacts throughout the trophic web, resulting in more than a moderate change in aquatic biota from the reference expectation. Aquatic macroinvertebrate and fish assemblages exhibit more than moderate changes in the relative proportions of tolerant, intolerant, taxonomic and functional components. Accordingly, the entire acreage is assessed as altered.

   Answer is YES: ***ALUS is stressed.*** These stresses cause no more than a moderate change to aquatic habitat. Littoral zone impacts of this magnitude could have cascading effects within the trophic web of the waterbody, but these are presumed to create no more than a moderate change to aquatic biota from the reference expectation based on the relative proportions of tolerant, intolerant, taxonomic and functional groups. The waterbody's entire acerage is presumed to be stressed for ALUS.

Fish Consumption Use

Vermont interprets the U.S. EPA guidance on fish consumption use attainment to indicate that no waters fully support fish consumption. This is due to well-documented contamination of varying levels of lakes by mercury in waters, sediments, and aquatic biota arising from atmospheric deposition. In the tissues of fish inhabiting Lake Champlain (and elsewhere), other contaminants including polychlorinated biphenyls, polyaromated hydrocarbons, and "DDT" derivatives, have been identified.

DEC does not, however, subscribe to the notion that fish tissue consumption is impaired on a statewide basis. This is because most fish species can, indeed, be consumed from most Vermont waters, albeit at a reduced rate. Fish consumption use is considered impaired only in the event that the fish species subject to the consumption advisory is documented to exist in the waterbody and contaminant data exist for that species from the particular waterbody. This approach is consistent with current EPA guidance.

Full Support: No fish consumption advisory in effect.

Stressed: "Restricted consumption" of fish is in effect (restricted consumption is defined as limits on the number of meals or size of meals consumed per unit time for one or more fish species).

Altered: Tissue contaminants are derived from the deposition or release of pollutants into the aquatic environment. Accordingly, this assessment category is not relevant.

Impaired: Fish consumption use is considered impaired only in the event that the fish species subject to the consumption advisory is documented to exist in the waterbody and contaminant data exist for the species from the particular waterbody. For a given fish species present in a waterbody, a 'no-consumption' advisory is in place for a designated sub-population (e.g., children or women of childbearing age) or for the general population.

Swimming/Contact Recreation Use

For assessment of Swimming/Contact Recreation Use, the DEC Watershed Management Division uses one or more types of data to determine whether this use is supported. The specific data types are bacterial monitoring, invasive aquatic species growth, and on rare occasion, the presence of chemical contaminants. Decision-making criteria are as follows:

Indicator Bacteria

To assess waters for support of swimming and contact recreation using *E. coli* monitoring data, a minimum number of data points are necessary, and supporting contextual data such as antecedent weather and flow conditions must be considered. DEC considers at least five (5) reliable and quality assured sample results over a swimming season and gathered across a range of weather/flow conditions to be the minimum practical number of samples necessary to document representative conditions and to assess attainment of contact recreational uses. In a practical sense, weekly or more frequent *E. coli* data across the swimming season is most useful to determine impairment and observe weather-related patterns in bacterial concentrations. If there are questions regarding the representativeness of the data, the water is identified as needing monitoring and is recommended for follow-up *E. coli* sampling in the next season.

Vermont's standards for bacteria now are similar to those recommended by EPA. In Class A waters, *E. coli* not to exceed the geometric mean of 126 organisms /100 ml obtained over a representative period of 60 days and no more than 10% of samples above the statistical threshold value of 235 organisms/100ml with none attributable to the discharge of wastes are the criteria. It is the same for Class B waters, except for the preclusion of treated waste, and with criteria in a shorter averaging period for waters receiving CSOs.

The following guidelines are applied during the assessment process:

Full Support: Waters are suitable for swimming with generally low *E. coli* values.

Stressed: Individual samples occasionally exceed the class-specific single-sample criteria values following a rain event. The geometric mean does not exceed the criterion value.

Altered: *E. coli* indicator bacteria are considered a pollutant. This assessment category is not applicable.

Impaired: For class B waters, the geometric mean of 126 *E. coli* /100 ml is exceeded in a given segment or area and/or more than 10% of the samples are above 235 organisms/100 ml. The contamination must be attributable to sources other than natural sources. DEC accepts a weight-of-evidence approach to confirm that *E. coli* values are or are not of natural origin. The WQS state that samples should be obtained "over a representative period of 60 days" and "in water receiving combined sewer overflows, the representative period shall be 30 days". However, at least five samples collected regularly over the representative period is recommended, and flow and antecedent precipitation are important in this determination.
For class A(1) and A(2) waters, the geometric mean exceeds 126 *E. coli* /100ml over a representative period of 60 days and/or more than 10% of the samples are above 235 organisms/100ml. No elevated *E. coli* can be "attributable to the discharge of wastes". Generally, data from at least two swimming seasons are needed to assess waters as impaired for swimming.

Alternatively, waters with CSOs present that do not meet DEC's 1990 CSO Control Policy are considered impaired for swimming without the direct water *E. coli* sampling numbers (per the sampling parameters described above).

Nuisance and Invasive Aquatic Species

Full Support: Waters have native plant species and communities as would be expected and in good ecological balance. Waters are not stressed or altered by invasive non-native aquatic species.

Stressed: Invasive non-native species are present but not at levels where a nuisance has been documented or in "light" densities (scattered areas of growth in limited areas of the littoral zone). In the case of Eurasian milfoil, lakes within a 10-mile radius of an infested lake are considered stressed, unless access to the lake is remote or inaccessible by conventional means.

Altered: Invasive non-native species present in densities such that swimming uses are not met. For aquatic macrophytes, typically these conditions are characterized by greater than 75% cover of the non-native macrophyte and designated as "moderate" or "heavy" infestations. For species other than aquatic macrophytes such as zebra mussels, colonies would be present in such densities and at such depths as to impact swimming uses due to potential for injury to bare feet. Nutrients are not applicable in this category.

Impaired: An on-going record of public complaint concerning the algal conditions in the water has been established. For cyanobacteria (blue-green algae), regular, reliable monitoring indicates that cyanobacteria routinely exceed guidelines established by the Vermont Department of Health for recreation . Invasive non-native aquatic species are not applicable in this category.

Chemical Contamination

Water quality criteria do not address incidental/accidental ingestion of water or dermal exposure to recreational users where there is chemical contamination present. Chemical contamination can enter surface waters or be deposited on beaches from both natural and anthropogenic sources. These may be point sources, such as municipal and industrial outfalls, or nonpoint sources such as runoff from land or leaching from old hazardous waste sites. In most cases there will be significant dilution or attenuation of contaminants.

Drinking water guidelines can provide a starting point for deriving values that could be used to make a screening level risk assessment. It has been suggested (WHO Guidelines for Safe Recreational Waters 2009) that water quality standards for chemicals in recreational waters should be based on the assumption that recreational water makes only a minor contribution to intake.

It is assumed that contribution of swimming is equivalent of 10% of drinking-water consumption. Based on drinking water consumption value of 2 liters a day, this would result in an intake of 200ml per day from recreational contact with water. A simple screening approach therefore would be that a substance occurring in recreational water at a concentration of ten times the drinking water guidelines (VDOH Drinking Water Guidance) is considered stressed and needs further assessment.

Organic contaminants can be present in surface waters from industrial and agricultural activity. EPA studies have shown that dermal contact and inhalation can contribute as much as water ingestion. Many of these are associated with sediments and particulate matter. Consideration should be given to the possibility of sediment being disturbed and ingested by infants and young children. EPA Regional Screening Levels (RSL) for Residential Soil can be used to screen sediment chemistry data from a site. If the screening value is exceeded, it suggests the need for specific evaluation of the contaminant taking local circumstances into consideration.

Full Support: No chemical contamination present in sediments or surface waters at any level of concern.

Stressed: A chemical is present in surface water samples at a concentration that is ten times the Vermont Department of Health Drinking Water Guidance. Or, for dermal exposure to the contaminants in sediments, the EPA Regional Screening Levels for Residential Soils are exceeded. Further assessment is needed following exceedance of screening levels.

Altered: This category is not used under these situations.

Impaired: A water is part of a Superfund site or other Hazardous waste site where special health and safety training and precautions are required to access the site or the public is restricted access from all activities including swimming, fishing and trespassing for health and safety reasons by an entity such as the Vermont Department of Health.

Secondary Contact/Non-Contact Recreation Use

For assessment of Secondary Contact/Non-Contact Recreation Use, the DEC Watershed Management Division uses information regarding water quantity and water quality, data and other information regarding the game fishery and records of public feedback and complaint to determine levels of support.

Full Support: Water quantity and quality sufficient for boating and fishing.

Stressed: Odor, color, plant growth, low water conditions occasionally discourage boating or fishing.

Altered: Fishing and/or boating are limited due to insufficient or diminished or lack of water, aquatic nuisance species or channel alterations. Boating is not feasible to the degree deemed achievable for the water's Water Management Type.

Impaired: Fishing and/or boating are limited due to water quality or aquatic habitat impairment(s) caused by pollutants from human sources.

Drinking Water Supply Use

Drinking water supply use is assessed using data on toxicants and bacteria; information on water treatment plant operation and operating costs; and, data describing cyanobacterial (blue-green algae) toxin concentrations.

Full Support: Water quality suitable as a source of public water supply with disinfection and filtration.

Stressed: This category is not applicable.

Altered: A well-established zebra mussel infestation or frequent cyanobacteria blooms are known to increase cost or effort to produce water that is suitable for drinking.

Impaired*:* In rivers, streams, brooks and riverine impoundments the exceedance, due to human sources, of any one human health-based toxic pollutant criteria listed in Appendix C of the Water Quality Standards (or as otherwise determined by the Natural Resources Agency Secretary in accordance with the Toxic Discharge Control Strategy) at flows equal to or exceeding the median annual flow for toxic substances that are classified as "non-threshold toxicants" or at flows meeting or exceeding the 7Q10 flow for toxic substances that are classified as "threshold toxicants." In all other waters, the exceedance, due to human sources, of any one human health-based toxic pollutant criteria listed in Appendix C (or as otherwise determined by the Secretary in accordance with the Toxic Discharge Control Strategy) at any time. (Note: "non-threshold toxicants" are probable or possible human carcinogens and "threshold toxicants" are not known or probable human carcinogens).

Criteria established by the Federal Safe Drinking Water Act can be met only by employing treatment practices that operationally or financially supercede customary practices that include filtration and disinfection.

Aesthetics Use

For assessment of Aesthetic Use, the DEC Watershed Management Division uses water quality and water quantity information from field surveys for rivers and streams and public feedback and complaints as well as field surveys for lakes and ponds to determine levels of support.

Full Support: Water character, flows, water level, riparian and channel characteristics, all exhibit good to excellent aesthetic value consistent with the waters classification. Water clarity and substrate condition is good. No floating solids, oil, grease, scum, or algae blooms. Limited or no record of public concern.

Stressed: Aesthetic quality is compromised somewhat. Water unnaturally turbid at times. Moderate levels of invasive, non-native plant growth. Small or disturbed riparian zone. Some record of public concern or complaint.

Altered: Aesthetic quality is poor due to a diminished amount of water to no water in the channel or lake resulting from human activities or due to moderate or heavy densities of invasive, non-native species. Streambanks are severely slumping, stream is braided, channel is highly straightened and rip-rapped, and channel bed material is severely jumbled and unsorted.

Impaired: Aesthetic quality of water is poor. Water is frequently and unnaturally turbid. Substrate is unnaturally silt-covered, mucky, or otherwise changed so as to adversely affect the aesthetics in an undue manner. Presence of solid waste, floating solids, scum, oil or grease occurs frequently and persistently. Rocks are unnaturally colored by metal contamination.

Agricultural Water Supply Use

There are no EPA definitions for agricultural water supply nor any state definitions and criteria. Consequently, this use is unassessed and the four assessment categories are not used.

Chapter Four. Listing and De-Listing Methodology

For the purposes of identifying and tracking important water quality problems where the VTWQS are not met, VTDEC has developed the Vermont Priority Waters List. This list is composed of several parts each identifying a group of waters with unique water quality concerns. Development of each part is guided by various regulations and/or management considerations including federal Clean Water Act requirements, EPA guidance or Vermont-specific management objectives. This list is produced biannually on even numbered years. Table 2 outlines the composition of the Priority Waters List while specific details of each list's composition are given below.

Table 2. Summary of Vermont Priority Waters List

List Section	Assessment status	Description
Part A (303d List)	Impaired	Also known as the §303(d) Impaired Waters List. This federally mandated list identifies impaired waters scheduled for TMDL development
Part B	Impaired	Waters assessed as impaired for which TMDLs are not required
Part D	Impaired	Impaired waters that have completed and EPA approved TMDLs
Part E	Altered	Waters assessed as altered due to the presence of invasive species
Part F	Altered	Waters assessed as altered due to flow regulation

Impaired Waters

All waters determined to be impaired are placed on Part A (303d List), Part B or Part D.

Part A - 303d List

Part A of the Priority Waters List identifies impaired surface waters that are scheduled for total maximum daily load (TMDL) development. Part A of the List is prepared in accordance with current EPA guidance and federal regulations 40CFR 130.7 ("Total maximum daily loads (TMDL) and individual water quality-based effluent limitations"). A TMDL is required for these waters in order to establish the maximum amount of a pollutant that may be introduced into the water after the application of required pollution controls and to ensure the Water Quality Standards are attained and maintained.

In addition to identifying the waterbody, Part A identifies the pollutant(s) causing the impairment, the priority ranking for TMDL development, which water use(s) are impaired and a brief description of the specific water quality problem.

Identification of Pollutant

The federal regulation governing 303(d) List development, 40CFR §130.7(b)(4), requires states to include the "pollutants causing or expected to cause violations of the applicable water quality standards". This pollutant then becomes the basis for TMDL loading allocations or for the control measures necessary to bring about compliance.

Where there is monitoring data that identifies a violation of numeric criteria, identification of the pollutant is evident. For example, long-term monitoring data may identify a segment of Lake Champlain as exceeding the numeric criterion for total phosphorus. Other numeric criteria are less indicative of the specific pollutant as in the instance of a dissolved oxygen criteria. The numeric criterion in this instance can be measured (low dissolved oxygen) but the pollutant causing that condition is not directly identified. Where there is monitoring data that identifies a violation of a narrative standard, the identification of the causal pollutant becomes more complex. An example is where biomonitoring data indicates a violation of the biocriteria for aquatic life use support.

In the instance of a biocriteria violation, VTDEC attempts to be as accurate as possible in identifying the causal pollutant. Where appropriate, VTDEC subscribes to EPA's Stressor Identification Methodology (USEPA, 2000b) or similar process. These assess site specific stressors and indicators such as biological and habitat indicators, land use information, proximity of known pollutant sources or other relevant information to identify by inference the most probable causal pollutants or stressors. This process can provide a defensible list of pollutant stressors or suite of stressors of common origin as in the case of runoff from impervious surfaces (i.e. stormwater).

At times, however, it may be necessary to identify a water as impaired without providing a specific causal pollutant. In these instances the pollutant is identified as "undefined".

TMDL Scheduling

Priority ranking for TMDL development is done with consideration of many factors. These include but are not limited to: (1) health issues, (2) the nature, extent, and severity of the pollutant(s), (3) the use or uses that are impaired, (4) the availability of resources and methods to develop a TMDL, (5) the degree of public interest, and (6) the utility of TMDL development to the elimination of the impairment.

Public Comment Opportunity, Submittal to EPA and EPA Approval

Upon compilation of the draft Part A-303d List, it is made available to the public for review and comment. Notification of availability is at a level sufficient to allow broad coverage of the general public and may include notices in newspapers, web sites and direct notification through email or mailing lists. In addition to notification, public meetings may be conducted to further the public's understanding. Following receipt of public comments, a response summary is developed that describes how the comments were addressed. Appropriate changes are made to the list and a final version of the Part A-303d List is then sent to the New England regional office of EPA for review and approval.

De-listing - Interim List

During development of new Part A-303d Lists, there may arise the need to propose for de-listing water(s) identified on previous lists. In this instance, waters proposed for de-listing are presented on the Interim List. This list is termed "interim" because it only exists during the period of Part A-303d List development in order to notify the public and EPA of de-listing proposals and to provide the rationale and justification for such proposals.

On the Interim List, each entry contains specific information for that particular waterbody as to why it is being proposed for de-listing. The waterbody-specific rationale is intended to provide "good cause" for de-listing and may be based on the following determinations:

- Assessment and interpretation of more recent or more accurate data demonstrate that the applicable WQS(s) is being met.

  The absence of impairment can be substantiated by data of a comparable quantity and quality as the data that was required to assess the water as impaired (for example, 2 years of biological or chemical data needed to establish impairment generally means 2 years of data needed to establish attainment).

- Flaws in the original analysis of data and information led to the segment being incorrectly listed.

- Documentation that a water included on a previous Part A-303(d) List was not required to be listed by EPA regulations, e.g. segments where there is no pollutant associated with the non-compliance

- A determination pursuant to 40 CFR 130.7(b)(1)(iii) that there are other pollution control requirements required by state, local or federal authority that will result in attainment of WQSs for a specific pollutant(s) within a reasonable time.

  In order to de-list these impaired waters from Part A, VTDEC must be convinced that other pollution control requirements, such as best management practices, will result in the attainment of Vermont Water Quality Standards. Specifically, DEC needs to show that (1) there are legal requirements in place (e.g. regulations, permits implementing regulations) that apply to the source(s) causing the water quality impairment and (2) that such legally required pollution control practices are specifically applicable to the impairment in question **and** are sufficient to cause the water to meet water quality standards within a reasonable time. These waters are then listed on Part B of the Vermont Priority Waters List.

- Approval or establishment by EPA of a TMDL since the last Part A-303(d) List
  These waters are then listed in Part D of the Vermont Priority Waters List.

- Other relevant information that supports the decision not to include the segment on the Part A-303(d) List

Part B List

All waters listed in Part B are assessed as impaired and do not require development of a TMDL as described in 40 CFR 130.7. Impaired waters that do not need a TMDL are those where other pollution control requirements (such as best management practices) required by local, state or federal authority are expected to address all water-pollutant combinations and the Water Quality Standards are expected to be attained in a reasonable period of time. DEC will provide information to show that (1) there are legal requirements in place (e.g. regulations or permits implementing regulations) that apply to the source(s) causing the water quality impairment and (2) that such legally required pollution control practices are specifically applicable to the impairment in question **and** are sufficient to cause the water to meet water quality standards within a reasonable time. Additional discussion of the Part B requirements are given in the EPA Integrated Report guidance document (USEPA 2005).

Part D List
All waters identified on Part D are assessed as impaired and have completed and approved TMDLs. If future assessments show the impairment has been eliminated, the waters will be removed from the Part D List. A comprehensive list of completed TMDLs is maintained on the Watershed Management Division's website.

Altered Waters

All waters determined to be altered are placed on one of several lists that track altered waters. These lists include: Part E List (water altered by invasive non-native species), and Part F (waters altered by flow regulation). The listing methodology for each list is given below.

Part E List
Waters appearing in Part E are assessed as "altered." They represent situations to be given priority for management where aquatic habitat and/or other designated uses have been altered to the extent that one or more designated uses are not supported due to the presence of aquatic invasive species. Waters will be removed from the Part E List when the population of the aquatic invasive species declines or is eliminated and the water is assessed as either "stressed" or in "full support" of the designated uses.

Part F List
Waters appearing in this part of the Vermont Priority Waters List are assessed as "altered." They represent priority management situations where aquatic habitat and/or other designated uses have been altered by flow regulation to the extent that one or more designated uses are not supported. Alterations arise from flow fluctuation, obstructions, or other manipulations of water levels that originate from hydroelectric facilities or other dam operations or from water withdrawals for industrial or municipal water supply or snowmaking purposes.

Waters will be removed from the Part F List as corrective actions are implemented.

Stressed Waters

Stressed Waters List
The Stressed Waters List identifies waters that have been assessed as "stressed". In the event a future assessment indicates non-compliance with the VTWQS, DEC will assess the water as "impaired" or "altered," depending on whether or not the cause of the violation is a pollutant, and place it on the appropriate part of the Priority Waters List.

Full Support Waters

Waters that fully support designated uses are not tracked on the Vermont Priority Waters List.

Comparison to EPA's Listing Categories

In 2005, the USEPA issued guidance ("*Guidance for 2006 Assessment , Listing and Reporting Requirements Pursuant to Sections 303(d), 305(b) and 314 of the Clean Water Act*") to provide states a recommended reporting format and suggested content to develop a single document that integrates the reporting requirements of Clean Water Act section 303(d) and 305(b). Known as the "Integrated Report", it is EPA's strategy to report on water quality standards attainment of assessed waters, document availability of data and information for each segment, identify trends in water quality conditions and provide information to managers for priority setting. This comprehensive report is broken down into five parts into which all water segments within a state can be categorized. These categories are described in Table 3.

Table 3. USEPA Integrated Report listing categories

Category 1	All designated uses are supported, no use is threatened	
Category 2	Available data and /or information indicate that some but not all of the designated uses are supported	
Category 3	Insufficient available data and/or information to make a use support determination	
Category 4	Available data and/or information indicate that at least one designated use is not being supported or is threatened, but a TMDL is not needed. This category is further divided into sub categories a-c;	
	4a	Segments with completed TMDLs
	4b	Segments for which control measures other than a TMDL are expected to bring about WQS compliance
	4c	Segments demonstrating failure to meet WQS but not by a pollutant
Category 5	Available data and/or information indicate that at least one designated use is not being supported and a TMDL is needed – 303(d) List	

As guidance, Vermont is not required to follow the USEPA suggested listing format as outlined in the guidance document and has instead opted to present the state's Priority Waters List as described above. It should be noted however that VTDEC does submit Vermont's water quality status to EPA electronically which is compatible with the five category format. Table 4 compares the parts of the Priority Waters List to EPA's five categories.

Table 4. EPA Categories compared to Vermont's Priority Waters Lists

EPA Category	Vermont listing component	Notes
Category 1	NA	Waters in full support are not tracked on the Priority Waters List[1]
Category 2	NA	Waters where some but not all of the uses are supported are not tracked on the Priority Waters List
Category 3	NA	Unassessed waters are not tracked on the Priority Waters List[2]
Category 4a	Part D	The waters in Part D are assessed as impaired. Waters coming back into compliance after a TMDL is complete will be removed from Part D.
Category 4b	Part B	
Category 4c	Parts E & F	
Category 5	Part A	EPA approved 303(d) list as well as proposed delistings

1 Waterbodies or river miles in full support can be identified from Vermont's database through queries

2 Waterbodies or river miles that are not assessed can be identified from Vermont's database through queries

Chapter Five. References

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Appendix A: Using Conductivity as a Surrogate for Chloride

Continuous Conductivity Datasets

Chloride is a unique parameter when it comes to measuring it in the aquatic environment. Not only can you measure it directly in the laboratory from grab samples, but specific conductivity has been shown to be a reliable surrogate for measuring it in the field. By using modern water quality probes and dataloggers, continuous estimates of chloride can be obtained for weeks or months at a time. Simple regression equations relate specific conductivity measurements to chloride concentrations and recent studies in the Chittenden County region of Vermont have successfully employed these techniques The continuous datasets make it easier to make assessments relating the 3 aspects of the WQS: magnitude, duration and frequency, and are particularly useful in assessing the 4-day duration aspects of the chronic criterion.

Where adequate continuous conductivity datasets exist, they will be assessed based on the duration of exposure and the frequency of exceedance criteria as described below:

Acute Criterion Dataset

A continuous dataset applicable for the acute criterion means specific conductivity samples taken at least every 15 minutes for a duration that equals or exceeds the duration that the acute criteria (i.e. 1 hour). The arithmetic average chloride concentrations estimated from specific conductivity measurements, taken over the 1 hour, shall be compared to the acute criterion to determine compliance or noncompliance.

Chronic Criteria Dataset

A continuous dataset applicable for the chronic criterion means specific conductivity samples taken at least every hour for a duration that equals or exceeds the duration that the chronic criteria (i.e., 96 hours). The arithmetic, moving average of chloride concentrations, estimated from specific conductivity measurements, taken over the 96 hour period shall be compared to the chronic criterion to determine compliance or noncompliance.

For a continuous dataset to be considered complete and comparable to the criteria, samples must have been collected over a time period that encompass the exposure period that the criteria is based on (i.e., 1 hour for acute and 96 hours for chronic criteria).

Rolling averages are calculated for all possible blocks of 1 hour (acute criteria) or 96 hours (chronic criteria). The time blocks overlap. For example, the 1 hour average value is calculated when four specific conductivity measurements were made within any given hour at 15 minute increments and the 96 hour average value is calculated if 384 specific conductivity measurements are made over any given four day period.

For comparison of continuous datasets to the frequency component of the standard, the average of either the acute or chronic exceedences shall not exceed the frequency of exceedance (i.e. an average of no more than 1 exceedence every 3 years).

Specific Conductivity as a Chloride Surrogate

Specific conductivity can be used as a surrogate for chloride samples. When specific conductivity is used as a surrogate for chloride, it is necessary to collect at least 2 chloride samples within each time period that the specific conductivity to chloride relationship is to be used. These samples will be used to confirm that the

site fits the statewide specific conductivity to chloride relationship. If confirmation samples do not adequately fit the statewide relationship, a site-specific relationship can be developed (see discussion below).

Conductivity/Chloride Relationship

An ordinary least squared regression was fit to all chloride-specific conductivity data pairs collected in Vermont from 2003 to 2010, and again in 2013. A minimum chloride threshold of 30 mg/L was applied to these data. Chloride concentration observations below 30 mg/L are numerous, far below water quality criteria, and tend to bias the results of regression analyses; removing low chloride concentrations improves regression fit and model diagnostics. A total of 441 observations were used in the model.

The final regression equation has an adjusted r-squared value of 0.94 (Eqn. 1):

$$Chloride\ (mg/L) = -69.72 + 0.292 * Specific\ Conductivty\ (\mu S) \qquad \text{Eqn. 1}$$

This r-squared value indicates that specific conductivity explains about 94% of the observed variation in chloride concentration.

The Division anticipates that this regression equation will be sufficient in most cases to accurately estimate chloride concentrations when site specific regressions are not available. However, where site specific data is sufficient, a site-specific regression may be preferred.

Criteria for Using the State-Wide Chloride Regression

Study Areas without a Site-Specific Chloride Regression

If the organization/researcher has not developed a site-specific chloride regression that is equal to or better than the WSMD state-wide chloride regression, the organization/researcher should use the WSMD state-wide chloride regression. The organization/researcher should follow the steps listed below to verify that the state-wide regression is acceptable for their study site.

1. The organization/researcher will collect at least 2 data pairs of chloride concentration and specific conductivity on water samples collected from the study area. If possible, the data pairs should be collected during different flow conditions and seasons.

2. If the data pairs consistently fall outside the 95th percentile prediction interval for the WSMD state-wide regression, then the organization/researcher should question whether the WSMD state-wide regression is appropriate for their study site. A figure depicting the WSMD state-wide regression line with 95% prediction intervals is provided below for reference.

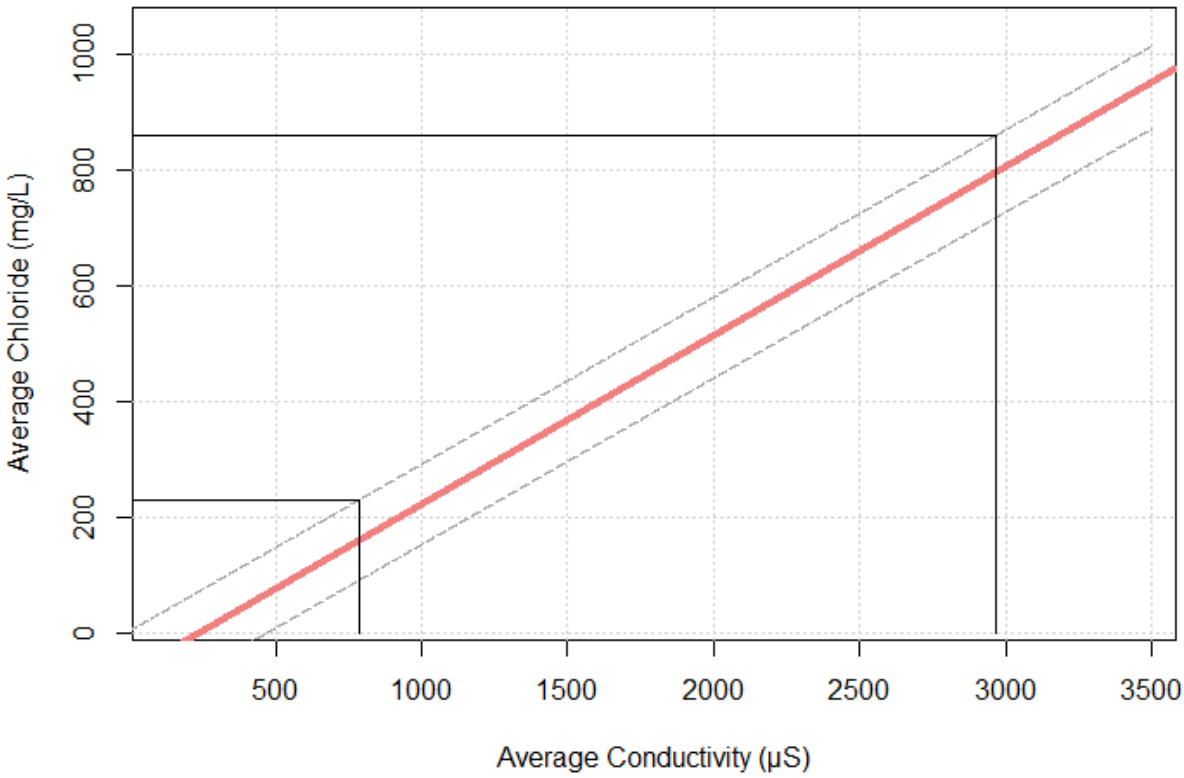

Figure A1. WSMD state-wide chloride-specific conductivity regression line with 95% confidence intervals. The points at which the 95% prediction interval exceeds the chronic (230 mg/L) and acute (860 mg/L) chloride concentrations are shown.

3. Because confidence and prediction intervals vary across the range of observed values, no single equation for these intervals can be provided. However, using the WSMD state-wide regression, the conductivity values associated with a 95% prediction interval above the relevant chloride criteria can be calculated; these values show the threshold at which an observed conductivity concentration is no longer 95% sure to be below the chloride criteria, based on the fitted model. These values are:

Table A1. Specific conductivity values whose 95% prediction interval exceed the chronic and acute chloride criteria, respectively.

Chloride (mg/L) Standard	**Conductivity (µS)**
Chronic, 230	784
Acute, 860	2966

For instance, we cannot be 95% confident that a conductivity value of 784 (µS) is below the chronic standard.

Study areas with Site-Specific Chloride Regressions

If the organization/researcher has developed a site-specific chloride regression that is equal to or better than the WSMD state-wide chloride regression, the organization/researcher should use the site-specific regression.

The following guidance should be used to determine if the site-specific regression is superior to the state-wide regression.

1. The chloride-specific conductivity data pairs should be representative of the study area in terms of seasons and flow conditions. In particular, the data pairs should have the following characteristics:

- If the organization/researcher collects specific conductivity data during the winter season (Nov-Mar), the data pairs should be collected during the winter season. If the organization collects specific conductivity data during the summer season (Jun-Sept), the data pairs should be collected during the summer season. If the organization collects specific conductivity data in both seasons, the data pairs should be collected from each season.

- Some of the data pairs should be collected during low flow conditions and some from high flow conditions in each season.

- Some of the data pairs should be for water samples with "high" conductivity readings relative to the maximum specific conductivity measured in the study area. The maximum conductivity in a calibration data pair should not be less than 75% of the maximum conductivity measured in the study area.

2. The site-specific regression should have a reasonable r-squared that will be evaluated by the WSMD on a case by case basis. As currently formulated, the state regression has an adjusted r-squared value of 0.94.

3. The site-specific regression should meet the four principal assumptions of linear and generalized linear regressions:

- The relationship between chloride and specific conductivity should be linear and additive.
- Model errors should be normally distributed.
- Model errors should exhibit statistical independence; for instance, error values should not be correlated by date, time, month, season, etc.
- Model errors should demonstrate constant variance (*homoscedasticity*) with regards to sample time and date, predicted chloride values, and specific conductivity values.