WATER QUALITY ASSESSMENT GUIDANCE

Utah Division of Water Quality
Utah Department of Environmental Quality

WATER QUALITY ASSESSMENT GUIDANCE

Tom Toole

October 7, 2010

Utah Division of Water Quality
Department of Environmental Quality

This page intentionally left blank.

DISCLAIMER

This document is for review and provides the public with information and methods used by the Division of Water Quality to assess waters of the State. Every attempt will be made to update this document in a timely manner, but the Division of Water Quality (DWQ) does not guarantee that it is free of errors. If anyone uses the methods in this guidance to assess water quality of the State, they cannot directly state or imply that a river, stream, lake or reservoir is supporting or not supporting its designated beneficial uses. Only the DWQ has the authority to make such determinations.

ACKNOWLEDGMENTS

Special thanks to Ying-Ying Macauley for her assistance in editing and making suggestions to improve the format and presentation of the information contained in the guidance document. Thanks are also extended to Harry Judd for his recommendations and to Theron Miller for assisting in writing the lake and reservoir chapter. Scott Daly, John Whitehead, Mark Stanger, and Carl Adams provided information and graphics for the document.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDICES

Chapter 1. Overview of Water Quality Assessment Guidance

1.1 Introduction

This guidance manual contains the methodologies that the DWQ uses to assess whether the designated beneficial uses assigned to the waters of the state are being supported. Field and water chemistry data are compared against water quality standards and the determination of whether a water is supporting or not supported is made following the methods contained in this document.

1.2 Designated Beneficial Uses

The DWQ has assigned designated beneficial uses to the rivers, streams, lakes and reservoirs of the state. These designated uses, listed below, are set forth in *Section R317-2-6* of Utah Administrative Code "Standards of Quality for Waters of the State. Pursuant to the requirements of the CWA, the DWQ has developed water quality standards, including narrative standards, which are used to determine if the beneficial uses are supported.

The beneficial uses that the State can assign to its waters are domestic use sources, primary and secondary recreation, aquatic life uses, and agricultural uses. The definition of each of the classes is listed in Table 1.

Table 1 Designated Beneficial Uses for Rivers, Streams, Lakes and Reservoirs

Class	Definition
1C	Protected for domestic purposes with prior treatment by treatment processes as required by the Utah Division of Drinking Water.
2A	Protected for primary contact recreation such as swimming.
2B	Protected for secondary contact recreation such as boating, wading, or similar uses.
3A	Protected for cold water species of game fish and other cold water aquatic life, including the necessary aquatic organisms in their food chain.
3B	Protected for warm water species of game fish and other warm water aquatic life, including the necessary aquatic organisms in their food chain.
3C	Protected for nongame fish and other aquatic life, including he necessary aquatic organisms in their food chain.
3D	Protected for waterfowl, shore birds and other water-oriented wildlife not included in Classes 3A, 3B, or 3C, including the necessary aquatic organisms in their food chain.
3E	Severely habitat-limited waters. Narrative standards will be applied to protect these waters for aquatic wildlife.
4	Protected for agricultural uses including irrigation of crops and stock watering.
5	The Great Salt Lake. Protected for primary and secondary contact recreation, aquatic wildlife, and mineral extraction.

1.3 Assessment Units

To accomplish the assessment, the rivers and streams of the state have been separated into waterbodies called Assessment Units (see Chapter 3). Lakes and reservoirs are delineated as individual Assessment Units (AU). Data collected from these Assessment Units (AUs) are compared against the standards. An Assessment Unit can be assigned multiple designated beneficial use classes such as 2B, 3A, and 4.

Data are compared against the standards for each of these classes to determine if there have been any violations of the standards and to what extent the violations have occurred to determine whether each beneficial use is supported.

1.4 Assessment Methodologies

The assessment methodologies using field and water chemistry data are contained in Chapters 5, 6, 7, 8 and 9. Methods include those used to assess rivers, streams, lakes and reservoirs to determine if their designated beneficial uses are being met.

Figure 1 is a flow chart illustrating the overall assessment process used by the DWQ to determine if the waters of the state are being supported.

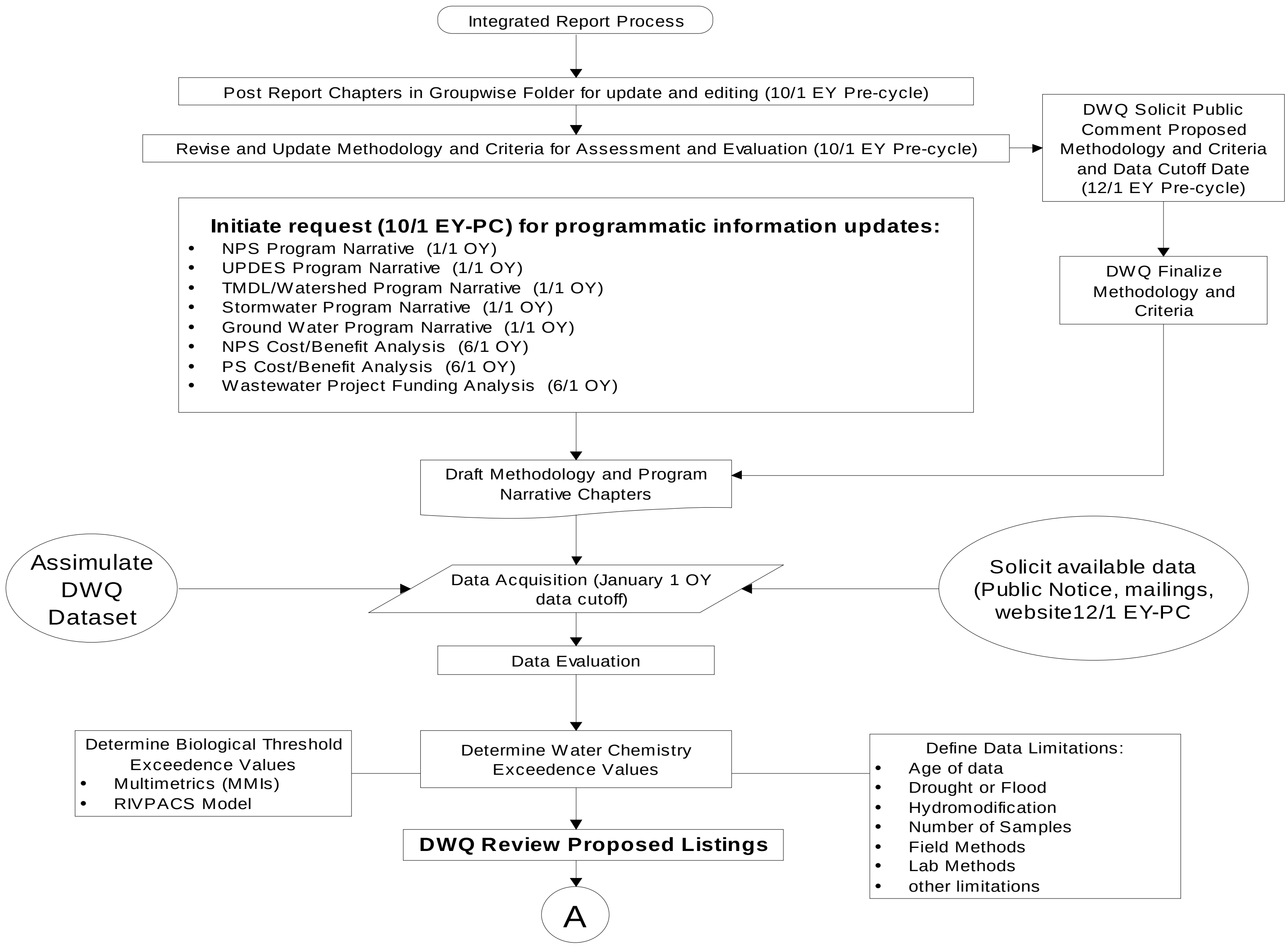
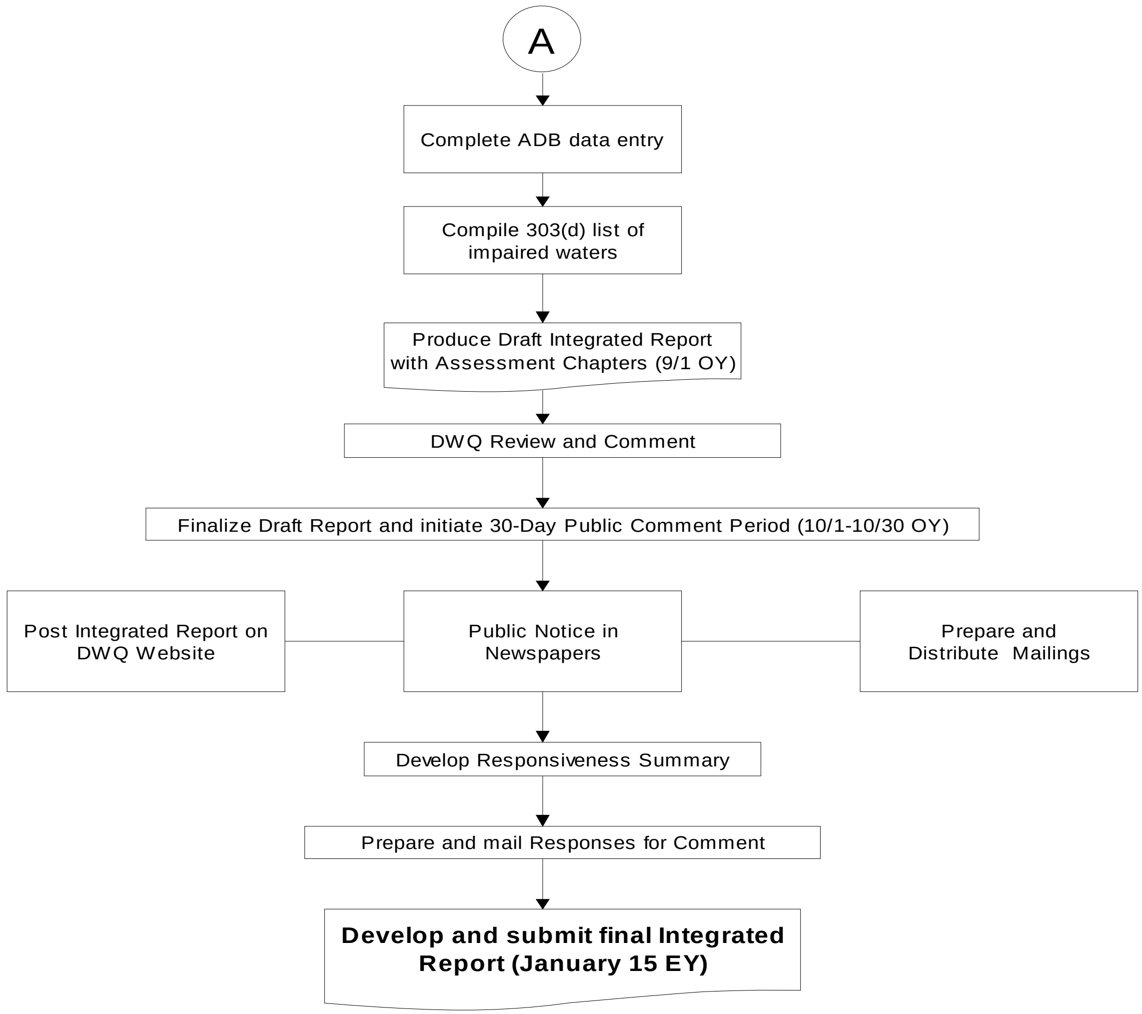


Figure 1 Flow chart illustrating the overall assessment process used by the DWQ to determine if the waters of the state are being supported



(Figure 1 continued - Flow chart illustrating the overall assessment process used by the DWQ to determine if the waters of the state are being supported)

Chapter 2. Data Used in Making Assessments

2.1 Introduction

States are mandated in the Clean Water Act (CWA) to use all "existing and readily available" data. The DWQ defines data as field data and laboratory analysis data. The DWQ to reviews raw data and uses it to determine beneficial use support.

The DWQ uses data collected by the DWQ, cooperators, and the United States Geological Survey (USGS) that meet the requirements for use in assessments. The DWQ also solicits data from other agencies, private organizations, and the public that may be involved in water quality monitoring. To accomplish this, the DWQ publishes public notices requesting data to be used in Integrated Report assessment. The request is also placed on the Division's website www.waterquality.utah.gov and mails requests to groups or individuals interested in water quality, and contacts others by phone.

The DWQ has cooperative monitoring programs with the United States Forest Service, United States Bureau of Land Management, Salt Lake City, United States National Park Service, Central Utah Water Conservancy District, Salt Lake County and the Provo River Watershed Council. Water quality data from the U.S.G.S are requested and used in making beneficial use assessments for the Integrated Report. This includes data collected for the Great Salt Lake Basins National Water-Quality Assessment Program (NAWQA) study and any monitoring projects that the USGS is doing for other federal agencies or other entities.

2.2 Data Requirements

Data should be applicable to state water quality standards and beneficial use designations. To ensure that data meet the requirements to be used in making assessments the following minimum data requirements should be met.

2.2.1 Field Collection Methods

The data should be collected following DWQ's field procedures listed in the DWQ Monitoring Manual (DWQ, 2006). Data collected using procedures accepted by EPA and U.S.G.S approved methods will be considered for assessment purposes. If the procedures used are not State, EPA, or USGS approved, a Quality Assurance Plan (QAPP) including standard operating procedures (SOPs) and data sheets must be submitted with the data. The DWQ assesses the quality of the data collected to determine if it can be used in making beneficial use assessments.

2.2.2 Water Quality Field Data

All field data must be accompanied with a Quality Assessment and Quality Control (QA/QC) data for the DWQ to determine the reliability of the data. Such data should include copies of calibration data for any instrument or method used in measuring the field parameters.

2.2.3 Water Quality Laboratory Analysis

All water quality samples should be analyzed in a State or EPA certified laboratory or in a USGS approved laboratory. If the samples are analyzed in a non-certified laboratory, a QAPP must be submitted with the data which includes the QA/QC data used in quality control checks within the laboratory. These data should include quality assurance data such as results from field blanks, duplicate samples, spiked samples and samples with a known concentration for each of the parameters submitted to the DWQ. A citation of the method used to analyze the samples should be included to assist the DWQ in evaluating the data. If the method was developed by the laboratory, the method should be submitted along with the data for evaluation.

2.2.4 Number of Samples

The DWQ recommends a minimum of ten data points at individual sites except for metals analysis and in cases where access is limited or protocol of analysis is supported by fewer samples (e.g. phytoplankton). If less than 10 samples are collected, the data will be reviewed to determine if a sound decision can be made using it.

The DWQ prefers that the data be collected within one year and that seasonality is incorporated into collection of the data. For rivers and streams, data from four samples, one collected each quarter, are considered sufficient to determine beneficial use support for the acute standard for dissolved metals and ammonia. If accessibility to the monitoring site is limited due to access, or costs and resources, the DWQ will assess the data and determine if sufficient data are available to determine beneficial use support. If the water is not already listed, the data may indicate that further study is needed to consider it for listing.

2.2.5 Age of Data

Analysis of data by DWQ will focus on data not older than 5-years. Data as old as ten years may be used if information is available to validate that there has not been a significant disturbance in the watershed during the ten years that would significantly change the results of the assessment.

2.2.6 Electronic Format

All data must be submitted in electronic format. Data can be submitted in EXCEL or in a comma delimited format. The data should contain the following information.

- The latitude and longitude of the monitoring site that the sample was collected.
- The date the sample was collected.
- The time the sample was collected.
- The type of Assessment Unit sampled: river (r), stream (s), lake or reservoir (l).
- The type of sample collected, i.e. grab (g), composite (c), or profile (p).
- The parameter ID.
- The code for identifying measurements that are less than the minimum detectable limit.
- The measurement for the parameter, e.g. Mg/L, ppm, degrees, etc.
- The unit of measurement used, mg/L, ppm, degrees, etc
- The analytical method used to obtain the data.

2.3 Reports, Professional Publications and Other Types of Information

Reports, articles from refereed journals, and other types of information are reviewed to determine if they can be used in making water quality assessments. They should include the methods of field collection, observation, and laboratory methods used to analyze the samples.

The publications are evaluated for applicability to water quality standards, both numeric and narrative. Although a conclusion about impairment of water quality may be drawn in the publications, the DWQ will make the final judgment as to whether there is impairment or not.

2.4 Decision Flow Chart for Data Evaluation

Figures 2 and 3 are flow charts that illustrate the data quality evaluation decisions used to determine whether or not the field and laboratory data being used meet the requirements for making beneficial use assessments. The assessments are done following the methods in Chapters 5, 6, 7, 8, and 9.

If the submitted dataset is determined to be usable, the preliminary assessment is conducted to determine if the data meet other data limits. Other items taken into consideration before a final decision is made to accept the assessment are listed below.

- Age of Data – If the data are older than 5 years, a review of activities in the watershed will be made to determine if there has been a significant change in environment that could possibly result in a different beneficial use assessment.

- Naturally occurring or severe environmental conditions not reflective of a normal hydrological regime occurred during the monitoring period, e.g., severe to extreme drought or flooding.

- Robustness of the data set including spatial and temporal characteristics.

- Sufficient data - If there are less than ten samples for conventional data, are they considered acceptable for assessment?

- Adherence to QAPP and QA/QC guidelines

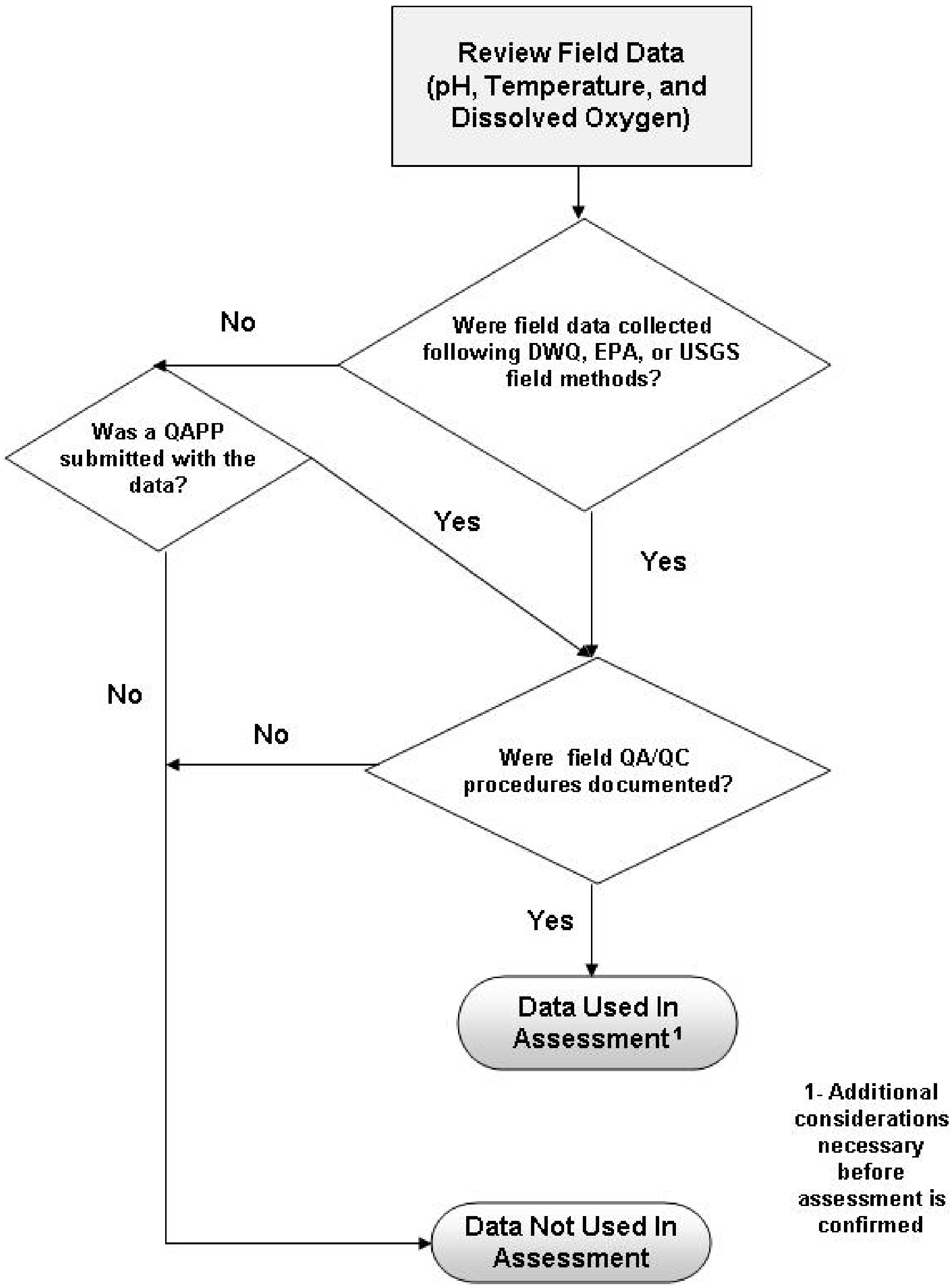


Figure 2 Decision flow chart used to evaluate field data

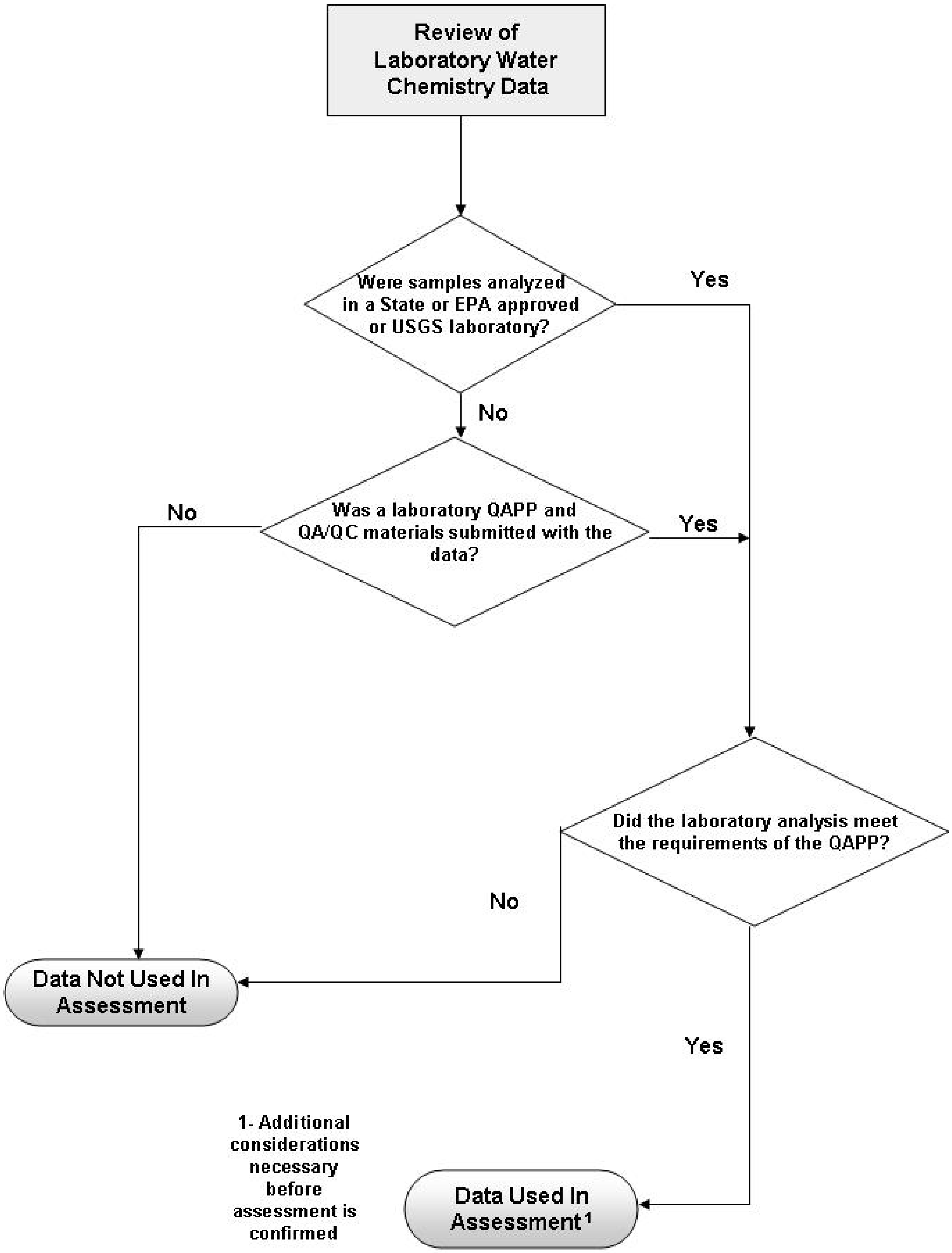


Figure 3 Decision flow chart used to evaluate laboratory water chemistry data measurements

Chapter 3. Assessment Unit Delineation and Identification

3.1 Introduction

Streams, Rivers, lakes and reservoirs have been delineated into discrete units called Assessment Units (AUs). Assessment Units are used in identifying waters of the State that have been assessed to determine if they are supporting their designated beneficial uses. Lakes and reservoirs have been delineated as individual AUs and the size is reported in acres. Rivers and streams have been delineated by specific river, river or stream reach, or several stream reaches in sub-watersheds. When using sub-watersheds to delineate stream AUs, the new USGS 5th (10-digit) and 6th (12-digit) level watershed units for Utah are used to delineate the AUs. These watershed units allow for the aggregation of stream reaches into individual AUs that are hydrologically based. The 5th and 6th hydrological units were developed by individuals representing state and federal agencies, and have been certified by the Natural Resource Conservation Service.

3.2 Guidelines for Delineating Stream and River Assessment Units (AUs)

When delineating river and stream AUs, DWQ followed the guidelines listed below with the first two guideline statements being fixed rules.

- The AU is within an eight-digit USGS hydrologic unit (HUC).

- Each river and stream AU is comprised of stream reaches having the same designated beneficial use classifications, i.e. a stream that has beneficial uses of Class 1C, 2B and 3A and at another part of the stream has Class 2B and 3B. This stream would have at least two AUs because of the difference in beneficial use designations.

- Large rivers, such as the Green River, Colorado River and portions of other large rivers (Bear River, Weber River, etc), were delineated into "linear" or "ribbon" AUs. Where a major tributary enters these rivers or hydrological features such as dams exist, the river is further delineated into two or more AUs.

- Tributary rivers and streams were delineated primarily using the 5th and 6th level hydrologic units to define the AUs.

- Additional AUs were defined by combining or splitting 5th or 6th level watersheds using tributary streams, stream size, and ecological changes such as geology, vegetation, or land use.

- Small tributary streams to larger streams that could not be incorporated into a watershed unit were combined into separate unique AUs.

New assessment units can be created based upon additional ecological, geological, and beneficial use assessment information that provides greater resolution in identifying and delineating rivers and streams into more assessment units that provide for a more precise assessment of the State's rivers and streams.

These AUs units have been geo-referenced (indexed) to the National Hydrologic Database using a reach-indexing tool that provides the capability of using GIS techniques to display information and data for each AU. Beneficial use classifications and assessments for individual AUs can be mapped or displayed to provide visual representation of assessment results. Individual stream AUs were assigned a unique identification code for indexing which includes the 8-digit hydrological unit (HUC) number with the prefix UT and followed by a 3-digit code to identify each unique AU in a HUC. Lake and reservoir AUs were identified by adding the prefix UT-L- to the 8-digit HUC follow by a 3-igit code.

Figure 4 illustrates one example of the results of using the above guidelines to delineate and identify AUs. The Weber River was delineated as a linear AU from its confluence with Chalk Creek upstream to the Wanship Dam (UT16020101-017). One AU, UT16020101-011, in the Chalk Creek watershed was delineated by combining two 5th level watershed units located in the South Fork Chalk Creek sub-basin. The first AU (UT16020101-010) in the Chalk Creek watershed was delineated using the confluence of the South Fork as the upstream point. This necessitated splitting the 5^{th} level watershed unit into two segments. An example of small tributary streams that could not be combined into a hydrological based AU is illustrated by the AU, (UT16020101-019). These are very small tributaries and the Weber River is not reflective of their stream order or the habitat that they flow through. Rockport Reservoir (UT-L-16020101-002) and Echo Reservoir (UT16020101-001) are examples of lake and reservoir AUs

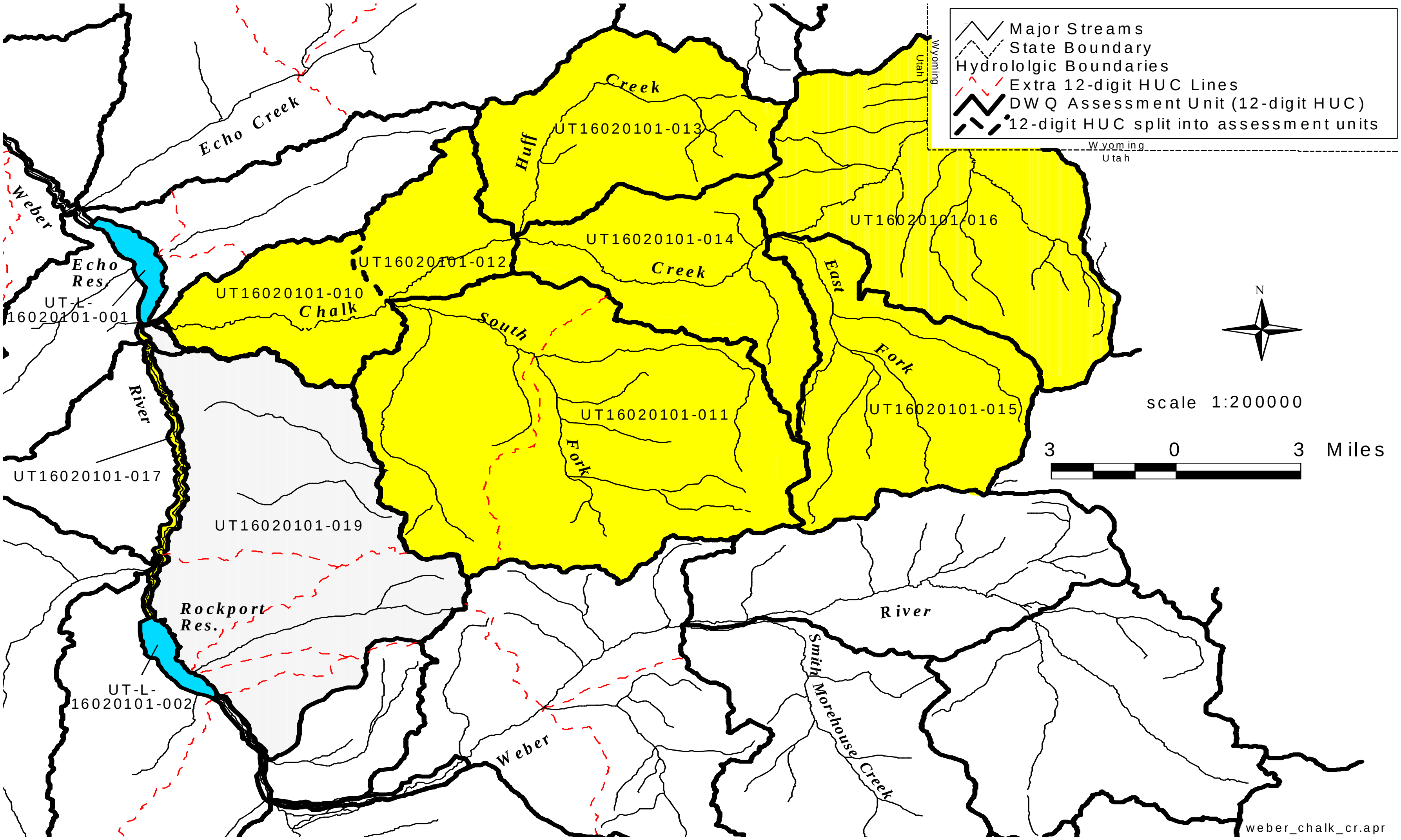


Figure 4 Example of delineation of assessment units following established guidelines

Chapter 4. Beneficial Use Assessment Categories

4.1 Introduction

Beginning in 2002, the U.S. EPA, recommended that states adopt their assessment procedure that consists of five categories denoting the type of assessment made for each assessment unit within a state. The five categories of reporting were developed by EPA to provide a clearer summary of a state's water quality status and to assist in developing management actions to protect and restore waters of a state to meet the state's water quality standards and support its designated beneficial uses. Utah uses the five categories developed by EPA.

The assessment category or categories that an AU will be placed in is determined using the methods used to determine beneficial use support. These methods are found in Chapters 5, 6, 7, 8, and 9. The unique assessment categories are described as follows:

4.2 Beneficial Use Assessment Categories

Category 1: All designated uses are attained.

Assessment Units are listed in this category if there are data and information that meet all requirements of the assessment and listing methodology and support a determination of fully support for all of an AU's designated beneficial uses.

Category 2: Some of the designated uses are attained, but there is insufficient data to determine beneficial use support for the remaining designated uses.

AUs are listed in this category if there are data and information that meet requirements of the assessment and listing methodology to support a determination that some, but not all, uses are attained. Attainment status of the remaining uses is unknown because there is insufficient or no data to assess beneficial use support.

Category 3: Insufficient data to make a determination, or lakes and reservoirs that show indication of impairment for one monitoring cycle only.

Three sub-categories for Category 3 are defined below.

- Category 3A: Assessment Units are listed in Category 3A if there are no data to do an assessment,
- Category 3B: This category includes waters identified where data and information are insufficient to determine an assessment status. The DWQ will devise an assessment plan for waters identified in this category. The plan will address data and information needed to make an assessment decision, a time-

line goal for obtaining essential data and information and a projected date when the assessment will be completed.

- Category 3C: Lakes and reservoirs that have been assessed as not supporting a beneficial use for one monitoring cycle are included in Category 3C. If a lake or reservoir is assessed as impaired for two consecutive monitoring cycles it is listed on the 303(d) list.

Category 4: Impaired for one or more designated uses, but does not require development of a TMDL.

- **Category 4A: TMDL has been completed for any pollutant.**

  Assessment Units are listed in this sub-category when any TMDL(s) has been developed and approved by EPA, that when implemented, are expected to result in full support of the water quality standards or support the designated beneficial uses. Where more than one pollutant is associated with the impairment of an AU, the AU and the parameters which have an approved TMDL are listed in this category. If it has other pollutants that need a TMDL, it is also listed in Category 5. Therefore, an AU can be listed in Category 4A and 5.

- **Category 4B: Other pollution control requirements are reasonably expected to result in attainment of the water quality standard in the near future.**

  Consistent with the regulation under 40 CFR, 130.7(b)(I) (ii), and (iii), AUs are listed in this subcategory where other pollution control requirements (e.g., best management practices required by local, state, or federal authority are stringent enough to meet any water quality standard or support any beneficial use applicable to such waters.

- **Category 4C: The impairment is not caused by a pollutant.**

  Assessment units are listed in this subcategory if the impairment is not caused by a pollutant (e.g., habitat alteration).

Category 5: The water quality standard is not attained and is caused by a pollutant.

The AU is found not supporting one or more of its designated beneficial uses as determined by current water quality standards and assessment methodologies. This category constitutes EPA’s definition of Section 303(d) list of waters.

- **Category 5: A TMDL is underway or scheduled and the AU is on the 303d(d) list of impaired waters.**

  Assessment Units are listed in this category if the AU is impaired for one or more designated uses by a pollutant. This constitutes the 303(d) list because a

Total Maximum Daily Load (TMDL) analysis is required to evaluate the sources of the pollutant(s).

The decision flowcharts used for determining which category or categories an AU will be placed are illustrated in Figures 5 and 6. An AU can be listed in more than one category depending on how many pollutants it is impaired by or if it is impaired by pollution.

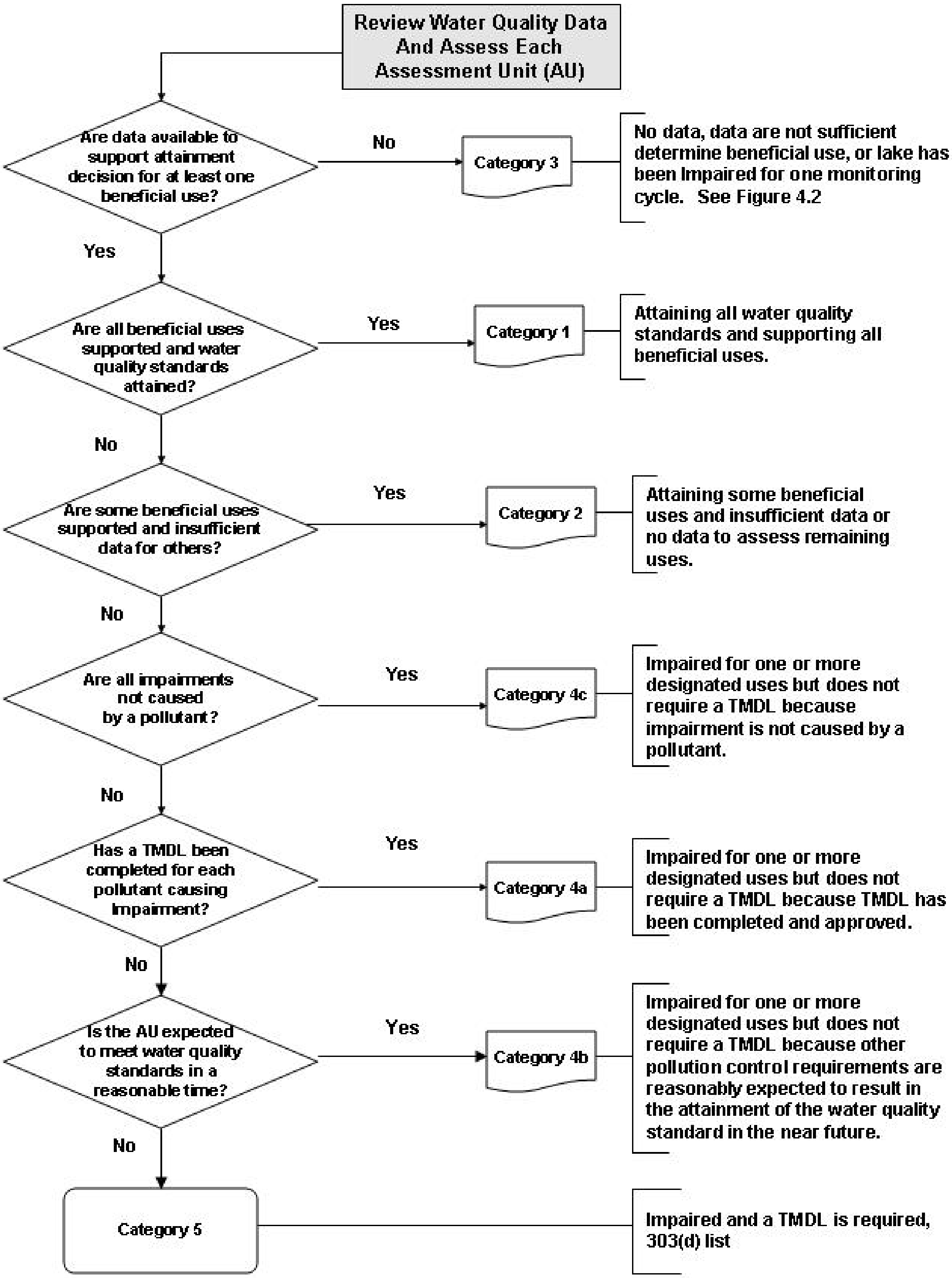


Figure 5 Decision flow chart for assessing Assessment Units by categories

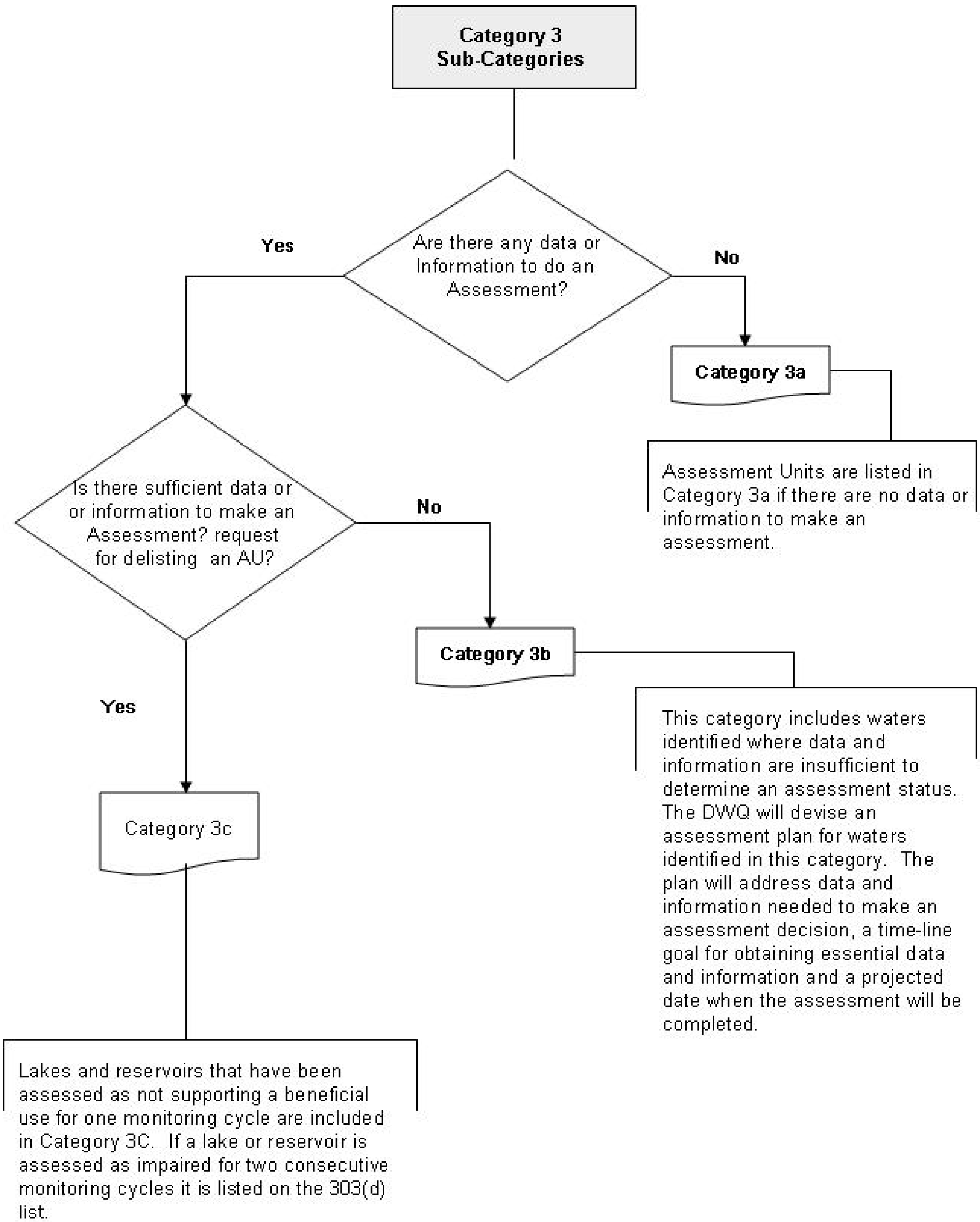


Figure 6 Decision flow chart for assessment diagram for Categories 3A, 3B and 3C

Chapter 5. Domestic Source Use Support Determination (Class 1C)

5.1 Introduction

Utah water quality standards allow water bodies to be designated as Class 1C, protected for domestic purposes with prior treatment by treatment processes as required by the Utah Division of Drinking Water (*UAC R317-2-6).* The assessment is made using field, water chemistry, and bacteriological data. The use of restriction data for assessment is being evaluated.

5.2 Domestic Source Water Assessment Procedure and Criteria

Beneficial use assessment is based upon the analysis of field, water chemistry, bacteriological, and restriction data. The AU can be listed on the 303(d) list if any of the listing criteria for each of the data types is met.

5.2.1 Field and Water Chemistry Data

- **Conventional Data (pH)**

Beneficial Use Supported – For any one conventional pollutant, the beneficial use is supported if any of the following conditions are met:

1. The criterion was violated no more than (≤) one time.
2. The criterion was violated in no more than ten percent (≤ 10%) of the measurements if the criterion was exceeded more than (>) one time.

Beneficial Use Not Supported – For any one conventional pollutant, the beneficial use is not supported if both of the following conditions are met:

1. The criterion was exceeded more than (>) one time.
2. The criterion was exceeded in more than 10 percent (> 10%) of the measurements.

Table 2 A list of various examples of assessment results for using conventional data.

Table 2 Examples of Beneficial Use Support Using Above Procedure for Conventional Pollutants

Number of Times Exceeded	Number of Samples Collected	Percent of Measurements That Exceeded Criterion	Beneficial Use Support
1	11	9.1	Supported
1	9	11.1	Supported
2	9	22.2	Not Supported
2	20	10.0	Supported
4	15	27.7	Not Supported

- **Toxicant Data (Dissolved Metals, Organics, and Radiological)**

Beneficial Use Supported – For any one toxic pollutant, the beneficial use is supported if the standard is not violated more than one time.

Beneficial Use Not Supported – For any one toxic pollutant, the beneficial use is not supported if the standard is exceeded two or more (≥ 2) times both of the following conditions are met:

5.2.2 Restriction Data

The DWQ is in the process of investigating whether the Division of Drinking Water has a method for issuing advisories and closures for drinking water sources.

5.2.3 Bacteriological Data

The bacteriological standard for 1C waters is based on *E. coli* counts, which is the same indicator used to evaluate support of recreation uses. E. coli data are evaluated to assess support of 1C uses following the same procedures used to evaluate recreation uses (see Chapter 6 for details). If, following the recreation assessment methods, the *E. coli* numeric criteria specified for domestic sources are also exceeded, then the AU will be listed as failing to support both it domestic water uses.

Table 3 *E. coli* Assessment Criteria Used to Determine Beneficial Use Support for Source Water

Criterion 1 - For Class 1C, the geometric mean should not exceed 206 per 100 mL for any 30-day period.
Criterion 2 - For Class 1C, if the maximum value is exceeded one time and is confirmed in the follow-up sample the AU will be listed.

Chapter 6. Contact Recreation Use Support Determination (Class 2A and 2B)

6.1 Introduction

Section R317-2-6 of the Utah water quality standards allow water bodies to be designated as Class 2A or 2B waters for primary contact and secondary contact recreation. Class 2A is primary contact recreation and includes activities that entail swimming. Class 2B is secondary contact recreation and includes activities such as boating, wading or similar activities.

6.2 Contact Recreation Classifications

All rivers and streams within the state are designated as Class 2B waters, protected for secondary contact recreation such as boating, wading, or similar uses. Some lakes and reservoirs have been designated as Class 2A, waters protected for primary contact recreation such as swimming. The beneficial use for lakes and reservoirs greater than 20 acres are listed *in* R317-2-13.12. All lakes and reservoirs not designated in the standards as 2A are designated as Class 2B waters by default. Lakes or reservoirs not listed in the standards are assigned uses by default to the classification(s) of their tributary streams.

6.3 Recreation Use Assessment Procedure

DWQ considers assessing the recreational beneficial use of an Assessment Unit (AU) if *E. coli* data or pH data are collected. An AU can be assessed as not supporting the primary or secondary recreation beneficial use if the pH standard is violated and *E. coli* data are not available.

The following factors are considered to determine whether the primary contact (Class 2A) or the secondary contact beneficial use (Class 2B) is being supported.

- Bacteriological Data
- Bathing Closure Data (being investigated)
- Other parameters (DWQ will investigate the possibility of using of algal communities as a criterion for evaluation of recreational uses.)

6.3.1 Bacteriological Data

The bacteriological standard is based on *E. coli* counts and the data used to make assessments must be less than 5 years old. The factors for assessing beneficial use support using *E. coli* are listed below.

- Samples should be collected during the recreational season. In general, the recreational season is defined as June 1 to September 30. Exceptions to this time period will be taken into consideration during the assessment if they are justified. The recreational season varies by latitude and elevation. For example, waters in southern Utah may have a longer recreational season than in northern Utah. Waters at higher elevations such as Mirror Lake are open for recreation from the time the snow is removed from the roads until it is closed for winter. State or federal agencies such as the USFS and BLM may set recreational seasons by limiting access to campgrounds or other areas as they deem necessary.

- The geometric mean should not exceed the criterion for streams that are classified 2A or 2B.

- At least five samples should be collected as equally spaced as possible over a 30 day period during the recreational season.

- The moving 30-day geometric mean will be calculated if data are collected over a period greater than 30-days. The data should be equally spaced over any period where samples are collected for more than 30 days.

The 30-day geometric mean and the single sample maximum for *E. coli data* will be compared to the standards listed in Table 4 to determine beneficial use support. The standards are found in Section R317-2-14 of the state water quality standards.

Table 4 *E. coli* Assessment Criteria for Determining Beneficial Use Support for Contact Recreation

Criterion 1 - For Class 2A, the geometric mean should not exceed 126 per 100 mL for any 30-day period. For Class 2B, the geometric mean should not exceed 206 per 100 mL for any 30-day period.
Criterion 2 - For Class 2A, single sample maximum should not exceed 576 per 100 m/L. For Class 2B, the single sample maximum should not exceed 940 per 100/mL

Beneficial Use Supported - The beneficial use is supported if both Criteria 1 and 2 are met.

Beneficial Use Not Supported – The beneficial use is not supported if one or both criteria (Criteria 1 or 2) are not met are not met.

6.3.2 Bathing Area Closure Data

The development of decision criteria for listing using bathing closures is being investigated.

6.3.3 Conventional Parameters (pH)

Beneficial Use Supported – For any one conventional pollutant, the beneficial use is supported if any of the following conditions are met:

1. The criterion was exceeded no more than (≤) one time.

2. The criterion was exceeded in no more than ten percent (≤ 10%) of the measurements if the criterion was exceeded more than (>) one time.

Beneficial Use Not Supported – For any one conventional pollutant, the beneficial use is not supported if both of the following conditions are met:

1. The criterion was exceeded more than (>) one time.

2. The criterion was exceeded in more than 10 percent (> 10%) of the measurements.

The decision criteria for making beneficial use assessments for primary and secondary contact recreation are diagramed in Figures 7 and 8.

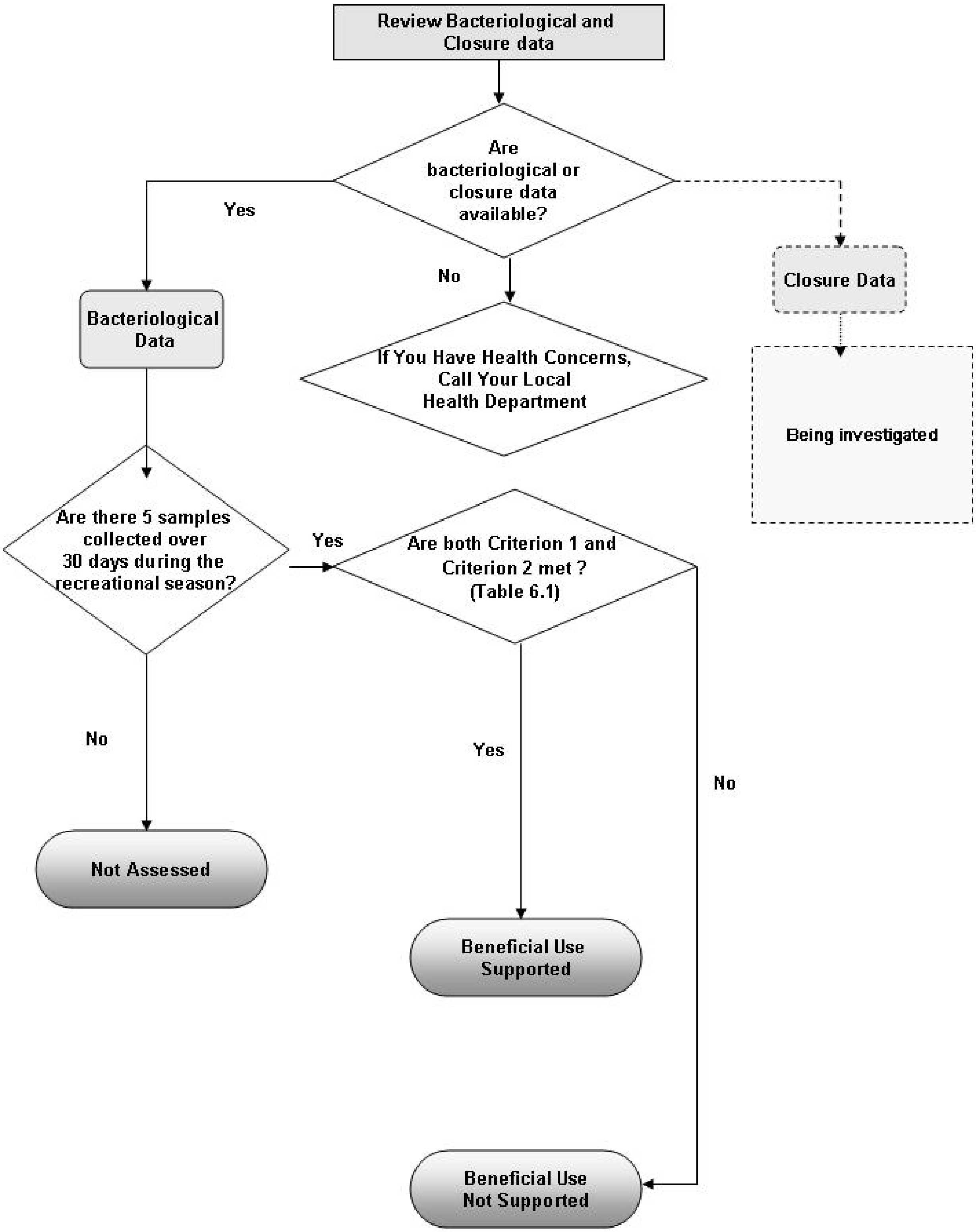


Figure 7 Decision flow diagram to determine recreation beneficial use support using bacteriological and closure data

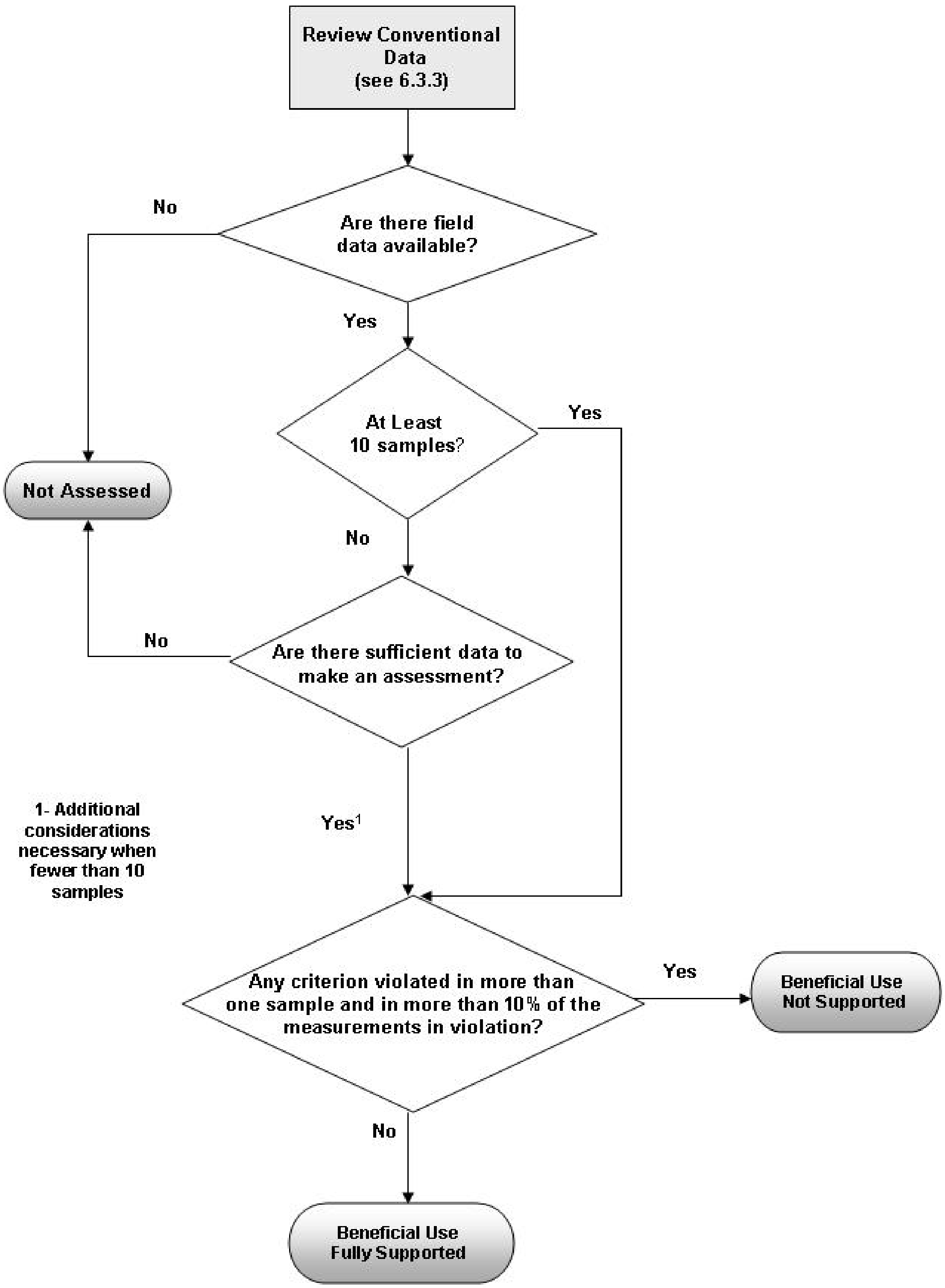


Figure 8 Decision flow chart to determine recreation beneficial use support using conventional data (pH data)

Chapter 7. Aquatic Life Use Support Determination (Class 3)

7.1 Aquatic Life Use Classifications

Utah water quality standards R317-2-6 allow waters to be protected for use by aquatic life. There are five beneficial use classifications for aquatic life that can be assigned to stream and rivers in Utah. They include the following:

- Class 3A, protected cold water species of game fish and other cold water aquatic life including the necessary aquatic organisms in their food chain;

- Class 3B, protected for warm water species of game fish and other warm water aquatic life, including the necessary aquatic organisms in their food chain;

- Class 3C, protected for nongame fish and other aquatic life, including the necessary aquatic organisms in their food chain;

- Class 3D, protected for waterfowl, shore birds and other water-oriented wildlife not included in Classes 3A, 3B or 3C, including the necessary aquatic organisms in their food chain, and

- Class 3E, severely habitat-limited waters. Narrative standards will be applied to protect these waters for aquatic wildlife chain.

7.2 Aquatic Life Beneficial Use Support Assessment Procedure

The data used to assess the beneficial use support of the aquatic life uses includes field and water chemistry data. The assessment is made by comparing sample results against the standards for Classes 3A, 3B, 3C, 3D and Class 3E

7.2.1 Field and Water Chemistry Data

Field data include pH, dissolved oxygen, and temperature. These are also referred to as conventional parameters. Among the water chemistry data, toxicant data include dissolved metals and ammonia. The sample results for toxicants are compared to the acute and the chronic criteria to determine beneficial use support.

Conventional Pollutants (pH, Dissolved Oxygen, and Temperature)

Because grab samples are generally not collected during worst case conditions for dissolved oxygen (early morning hours before sunrise, the conservative 30-day standard for dissolved oxygen (DO) is used for assessment of data that are collected during day light hours. Dissolved oxygen follows a diurnal cycle with the highest values occurring during the day. The AU is listed on the 303(d) list if two or more samples are less than the 30-day standard and if the standard is violated in more than 10% of the samples. As a follow-up, DWQ may conduct a diurnal dissolved oxygen assessment to determine if the AU is supporting the aquatic life beneficial use or delist it based upon diurnal data.

Beneficial Use Supported – For any one conventional pollutant, the beneficial use is supported if any of the following conditions are met:

1. The criterion was exceeded no more than (≤) one time.

2. The criterion was exceeded in no more than 10 percent (≤ 10%) of the measurements if the criterion was exceeded more than (>) one time.

Beneficial Use Not Supported – For any one conventional pollutant, the beneficial use is not supported if both of the following conditions are met:

1. The criterion was exceeded more than (>) one time.

2. The criterion was exceeded in more than 10 percent (> 10%) of the measurements.

<u>**Toxic Parameters (Dissolved Metals and Ammonia)**</u>

- **Acute Standard For Toxic Parameters**

  Beneficial Use Supported – The beneficial use is supported if for any one toxic pollutant, there is no more than (>) one violation of the acute standard in a 3-year period.

  Beneficial Use Not Supported – The beneficial use is not supported if there are 2 or more violations (≥2) of the acute standard in a 3-year period.

- **Chronic Standard For Toxic Parameters**

  If ten or more samples are collected, the following procedure is used to determine beneficial use support.

  Beneficial Use Supported – The beneficial use is supported if there is no more than one (≤ 1) violation of the chronic standard in a 3-year period.

  Beneficial Use Not Supported – The beneficial use is not supported if for anyone toxic pollutant, there are 2 or more (≥ 2) violations of the chronic standard in a 3-year period.

Beneficial Use Supported – The beneficial use is supported if there is no more than (>) 1 violation of the chronic listing value within a 3-year period.

Beneficial Use Not Supported – The beneficial use is not supported if there are 2 or more (≥ 2) violations of the chronic listing value in a 3-year period.

The decision flow chart for assessing aquatic life uses for Classes 3A, 3B, 3C, and 3D, are diagramed in Figures 9 and 10.

7.2.2 Beneficial Use Assessment Based on Mercury Health Advisories

Health Advisories for mercury are issued by the Utah State Department of Health (USDH), in conjunction with the DWQ, the Division of Wildlife Resources (DWR) and local health departments. These advisories include the amounts of fish tissue that can be safely eaten. Just because a fish advisory has been issued does not automatically require the water to be listed on the 303(d) list. The listing methodology is listed below. The DWQ and the USDH developed a sampling protocol based upon statistical analyses to determine how many fish are required to be collected to use in an advisory (need citation).

- **Fish**

Currently health advisories are issued if the mercury concentration in fish tissue 0.3 ppm (3 mg/kg, or 0.3 ug/g) or greater. This concentration is recommended by EPA but is less than the United States Food and Drug Administration (FDA) value of 1.0 mg/kg. The FDA set the consumption concentration at 1.0 mg/kg, which correlates to the water column mercury concentration of 0.012 ug/l in previous studies by EPA. (EPA, 1985). Utah's water quality standard for mercury is 0.012 ug/l as a 4-day average. Therefore, the corresponding fish tissue concentration of 1.0 mg/ is used for assessment.

Beneficial Use Supported – No fish consumption advisories for mercury or fish tissue mercury concentration is less than or equal to (≤) 1.0 mg/kg.

Beneficial Not Supported - Fish consumption advisory for mercury is in place and fish tissue mercury concentration is greater than (>) 1.0 mg/kg.

- **Waterfowl**

The DWQ will work on a listing methodology for the 2010 Integrated Report based on waterfowl consumption advisories..

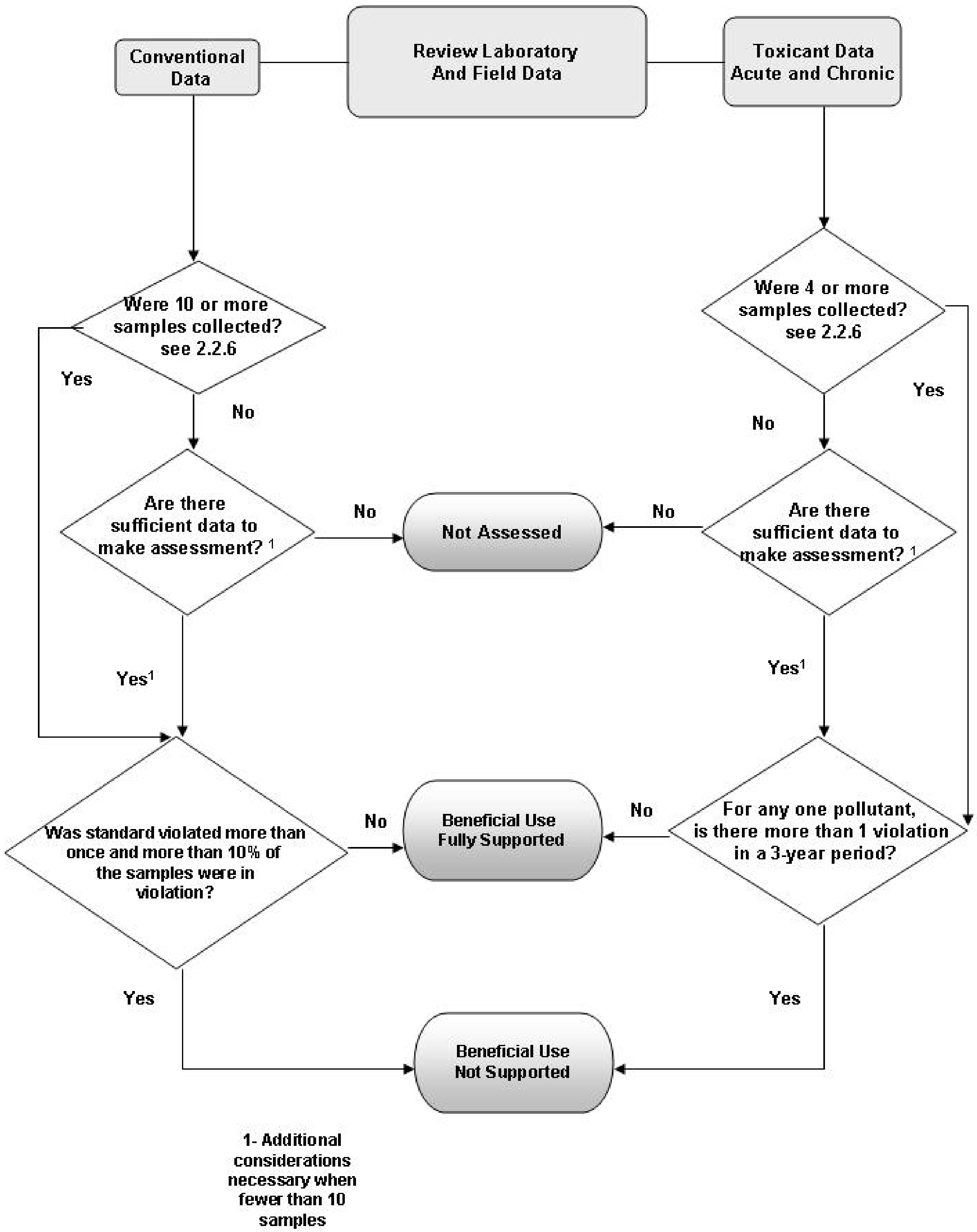


Figure 9 Decision flowchart for determining aquatic life use support using conventional, acute and chronic toxicant data

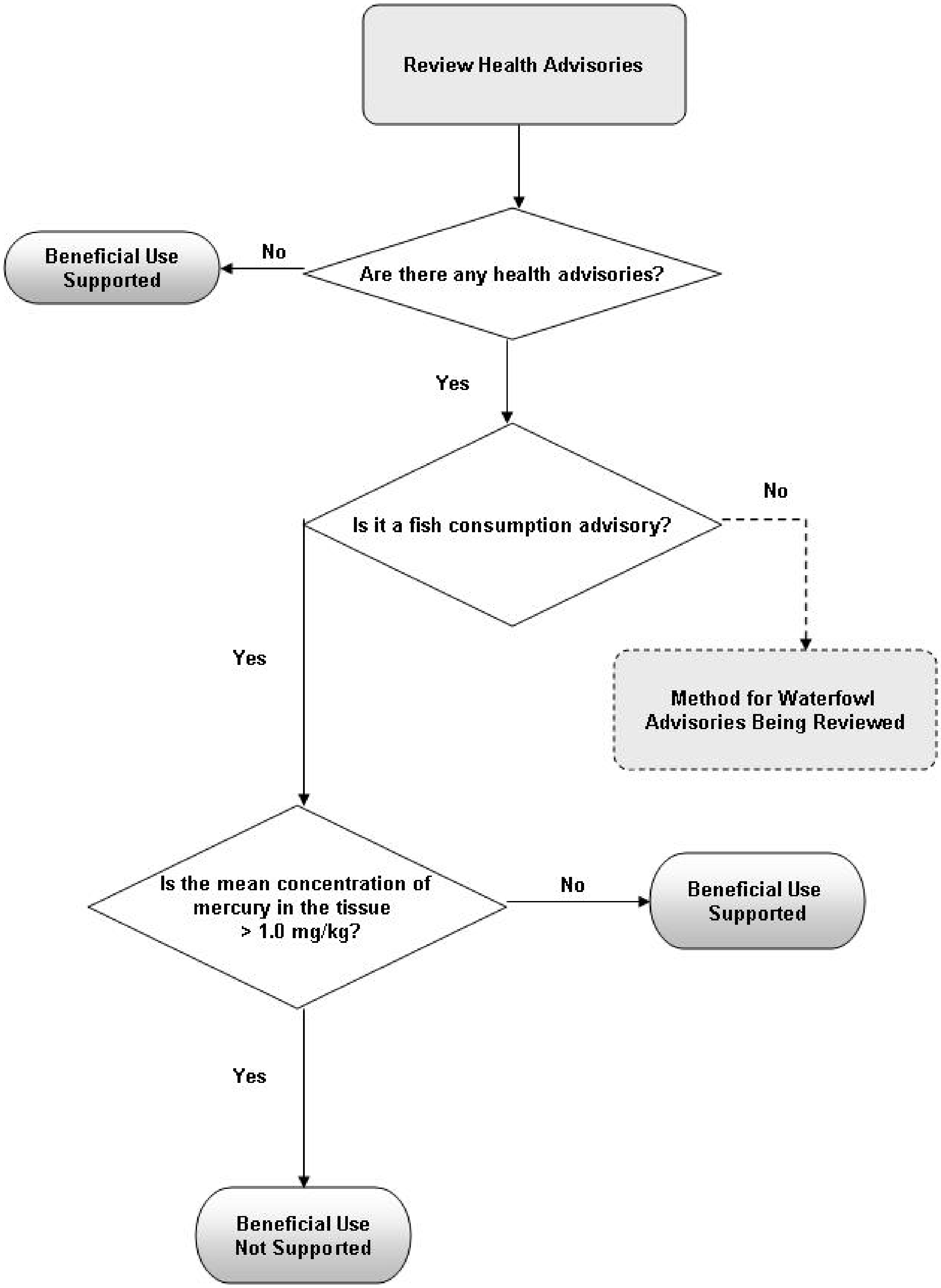


Figure 10 Assessment methodology using health advisories for mercury

7.3 Biological Beneficial Use Support Assessment Procedure

7.3.1 Introduction

Utah's biological beneficial uses require the protection of fish (e.g., cold- or warm-water species) and the organisms upon which they depend. In the past, DWQ has assessed these beneficial uses via water chemistry sampling and associated standards that assume to protect aquatic organisms. However, DWQ has recently developed an empirical model that directly assesses attainment of biological beneficial uses by quantifying the 'health' of macroinvertebrate assemblages. Measuring biological communities directly has the advantage that it integrates the combined effects of all pollutants which allows a direct examination of how pollutants are interacting to affect the condition of a stream ecosystem. (Karr, 1981). Moreover, because aquatic macroinvertebrates spend the majority of their life in aqueous environments, they are capable of integrating the effects of stressors over time providing a measure of past, transient conditions (Karr and Dudley, 1981).

Biological assessments are often conducted by comparing the biological assemblage *observed* at a site with the *expected* biological assemblage in the absence of human-caused disturbance. Ideally, these comparisons are made using historical data to measure changes to the current biological community. However, in most cases historical data are not available. As a result, biological conditions representing an absence of human-caused stress are typically set using reference sites as controls, or benchmarks, to establish the biological condition expected in the absence of human-caused disturbance. The biological integrity of sites can be evaluated by comparing the biological composition observed at a site against a subset of physically similar reference sites. Collectively, such comparisons are referred to as biological assessments.

In aquatic biological assessments, reference sites are selected to represent the best available condition for streams with similar physical and geographical characteristics (see Hughes et al 1986, Suplee et al. 1995, and the Western Center for Monitoring and Assessment of Freshwater Ecosystems website http://www.cnr.usu.edu/wmc for more details). When reference sites are selected for water quality programs, conditions vary regionally depending upon adjacent historical landuse. For example, reference sites in Utah mountains are generally more pristine than in valleys. As a result, biological benchmarks are higher in areas of the State that receive less man-made disturbance than those with more disturbances.

A numeric index is a useful tool that quantifies the biological integrity, or biological beneficial use of stream and river segments. Data obtained from biological collections are complex with hundreds of species found throughout Utah that vary both spatially and temporally. Similarly, the physical template upon which biota depends also varies considerably across streams. A robust index of biological integrity should simultaneously account for naturally occurring physical and biological variability and summarize these conditions with a single, easily interpretable number.

7.3.2 River Invertebrate Prediction and Classification System (RIVPACS) Models

DWQ employs the RIVPACS (River Invertebrate Prediction and Classification System) model approach (Wright 1995) to quantify biological integrity. RIVPACS is a classification of freshwater sites based on macroinvertebrate fauna that was first derived in 1977. In the early 1970's scientists and water managers recognized a need to understand the links between the ecology of running waters and macroinvertebrate communities. This began some of the very early biological assessment work in Europe. A four-year project was initiated to create a biological classification of unpolluted running waters in Great Britain based on the macroinvertebrate fauna (Furse et al., 1984, Wright 1995, Clarke et al., 1996, Moss et al., 1999). Over the past 30 years, equivalent RIVPACS models have been developed for aquatic ecosystems throughout the world including Australia (Metzeling et al., 2002, Marchant and Hehir, 2002, Davies et al., 2000) and Indonesia (Sudaryanti et al., 2001). In the United States scientists have developed RIVPACS models to assess the biological integrity of the country's aquatic habitats (Hawkins et al., 2000, Hawkins and Carlisle, 2001). Recently, many western states have adapted the RIVPACS model to determine beneficial uses of aquatic life in the rivers of State's such as Colorado (Paul et al., 2005), Montana (Feldman, 2006, Jessup et al., 2006) and Wyoming (Hargett et al., 2005).

RIVPACS-based methods for conducting biological assessments were initially developed in Great Britain (Wright, 1995) and have subsequently been used in numerous biological assessment programs worldwide. To quantify biological condition, RIVPACS models compare the list of taxa (the lowest practical taxonomic resolution to which taxonomic groups are identified) that are observed (O) at a site to the list of taxa expected (E) in the absence of human-caused stress. Predictions of E are obtained empirically from reference sites that together are assumed to encompass the range of ecological variability observed among streams in the region where the model was developed. In practice, these data are expressed as the ratio O/E, the index of biological integrity.

Interpretation of RIVPACS models requires an understanding of the O/E ratio. In essence, O/E quantifies loss of biodiversity. It is not a measure of raw taxa richness since O is constrained to include only those taxa that the model predicted to occur at a site. The fact that O/E only measures losses of native taxa is an important distinction because the stream ecological template changes in response to human-caused disturbance and taxa richness can actually increase as conditions become more advantageous to taxa that are more tolerant of the degraded condition. Despite the mathematical complexities of model development, O/E is easily interpreted as it simply represents the extent to which taxa have become locally extinct as a result of human activities. For example, an O/E ratio of 0.40 implies that, on average, 60% of the taxa have become locally extinct as a result of human-caused alterations to the stream.

O/E has some very useful properties as an index of biological condition. First, it has an intuitive biological meaning. Species diversity is considered the ecological capital on which ecosystem processes depend; thus, O/E can be easily interpreted by researchers, managers, policy-makers, and the public. Second, O/E is universally spatial which allows direct and meaningful comparison throughout the state (Figure 11). This is particularly important for Utah where streams vary considerably from high-altitude mountain environments to the arid desert regions of the state. Third, its derivation and interpretation does not require knowledge of stressors in the region; it is simply a biological measuring tool. Finally, the value of O/E provides a quantitative measure of biological condition.

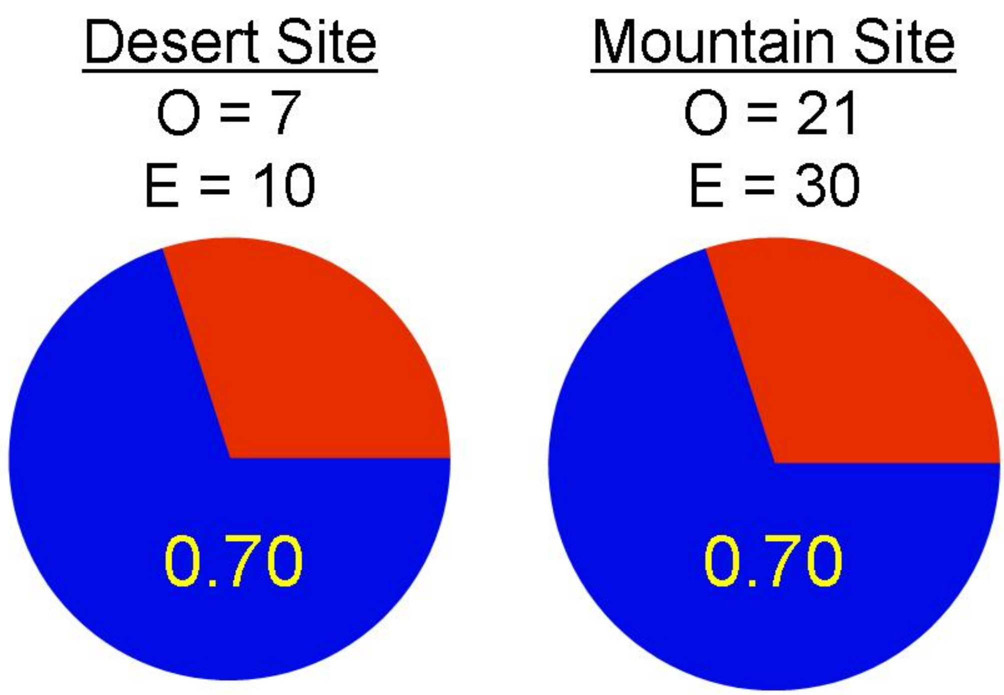


Figure 11 A hypothetical example of observed/expected (O/E) as a standardization of biological assessments in different natural environments using numbers benthic macroinvertebrate taxa

In the desert site, 7 taxa were observed (O) from an expected number (based on reference) of 10 taxa (E). Thus, the O/E score was .70 or a loss of 30% of the taxa expected at the site.

7.3.3 Model Construction and Performance

Construction of a RIVPACS model for Utah began in 2002 which involved developing and evaluating dozens of models. Details of model development procedures can be found elsewhere (Wright et al. 1993, Wright 1995, Clarke et al., 1996, Moss et al. 1999). Here a brief summary is provided so Utah's model results and subsequent assessments are better understood.

As mentioned in the introduction, predictions of E are obtained empirically from reference site collections made throughout Utah. Reference sites were selected using experienced DWQ scientists who identified sites that represented the reference conditions in different biogeographical settings throughout Utah. The initial list of candidate reference sites was independently ranked by different scientists familiar with the streams. Only reference sites with a consensus representing best available conditions were used in model development.

Some of the calculations involved in obtaining E are complex. A heuristic description of the steps involved in predicting E provides some context of the assessment methodology. The first step in model development is to classify reference sites into groups of sites with similar taxonomic composition using a cluster analysis. Next, models are developed based on watershed descriptors (i.e., climatic setting, soil characteristics, stream size) to generate equations that predict the probability of a new site falling within each group of reference sites. These equations account for environmental heterogeneity and ensure that when a new site is assessed, it is compared against ecologically similar reference sites. When a new site is assessed, predictions of group membership are then coupled to the distributions of taxa across groups of reference sites to estimate the probability of capturing ($P_{c)}$ each taxon from the regional pool of all taxa found across all reference sites. E is then calculated as the sum of all taxa P_cs that had a greater than 50% chance of occurring at a site given the site's specific environmental characteristics.

The accuracy and precision of RIVPACS models depend in part on the ability of the models to discriminate among groups of biologically similar reference sites. An extensive list of 82 Geographic Information System (GIS)-based watershed descriptors were evaluated as potential predictor variables in models that predict the probability of membership within biological groups for sites not used in model construction. GIS-based predictor variables, such as soils, meteorology, and geography, instead of field-derived descriptors, were evaluated for a couple of reasons. First, GIS-based descriptors are unlikely to be influenced by human disturbance and are therefore unlikely to bias estimates of expected conditions (Hawkins, 2004). Second, these predictors are easily obtained for any site which allows inclusion of additional macroinvertebrate samples collected by others. Various subsets of potential predictors were evaluated in an iterative, analytical process that explored different combinations of predictors able to explain the biological variability among reference sites. The final analysis selected 15 variables that resulted in the most precisely predictive model (Table 5).

The RIVPACS model used for the 2007 assessments was both accurate and precise when evaluated by examining the range of O/E scores obtained from reference sites. If the model was perfectly accurate and precise, the O/E score for all reference sites would equal 1. Instead, reference O/E values are typically spread in a roughly normal distribution centered on 1 (Wright, 1995). Model precision is often expressed as the standard deviation (SD) of reference O/E values with lower SDs indicating higher model precision. The RIVPACS model used for the *2008 Integrated Report* assessments had a

SD of 0.13 which is more precise than most traditionally ‘accepted’ water quality models. The average reference O/E score for Utah’s model is 1.04 which means that the model is slightly biased to generate higher O/E values than expected (Figure 12). The accuracy of the model was evaluated by examining the distribution of reference O/E scores in different environmental settings and revealed reference O/E values were not biased by stream size, elevation, or ecoregion.

Table 5 Final Predictor Variables used in Model Construction

General Category	Description
Geographical	Maximum watershed elevation (meters) from National Elevation Dataset
Geographical	Mean watershed elevation (meters) from National Elevation Dataset.
Geographical	Average slope calculated from Geographic Information System (GIS) data
Geographical	Watershed area in square kilometers.
Geology	Predicted potential for soil erosion based on lithology from state geology maps and estimated physical weathering rates based on known rock hardness.
Geology	Variable indicates dominant geology (1=yes; 2=no)
Soils	Watershed mean high values of available water capacity of soils (fraction) from State Soil Geographic (STATSGO) Database.
Soils	Watershed mean high values of soil bulk density of soils types within the basin (grams per cubic centimeter) from State Soil Geographic (STATSGO) Database.
Weather	Average of the annual minimum of the predicted mean monthly number of days with measurable precipitation (days) derived from PRISM (Parameter-elevation Regressions on Independent Slopes Model) data for all pixels in a watershed.
Weather	Watershed average of the mean day of year (1-365) of the first freeze derived from the PRISM data.
Weather	Watershed average of the mean day of year (1-365) of the last freeze derived from the PRISM data.
Weather	Annual minimum of predicted mean monthly precipitation (mm) derived from the PRISM data for the sampling site
Weather	Annual mean of the predicted mean monthly precipitation (mm) derived from the PRISM data for the sampling site.
Weather	Stream network average of the annual mean of the predicted mean monthly air temperature (tenths of degree Celsius) derived from PRISM data.
Weather	Watershed average of the annual mean of the predicted mean monthly air temperature (tenths of degree Celsius) derived from PRISM data.

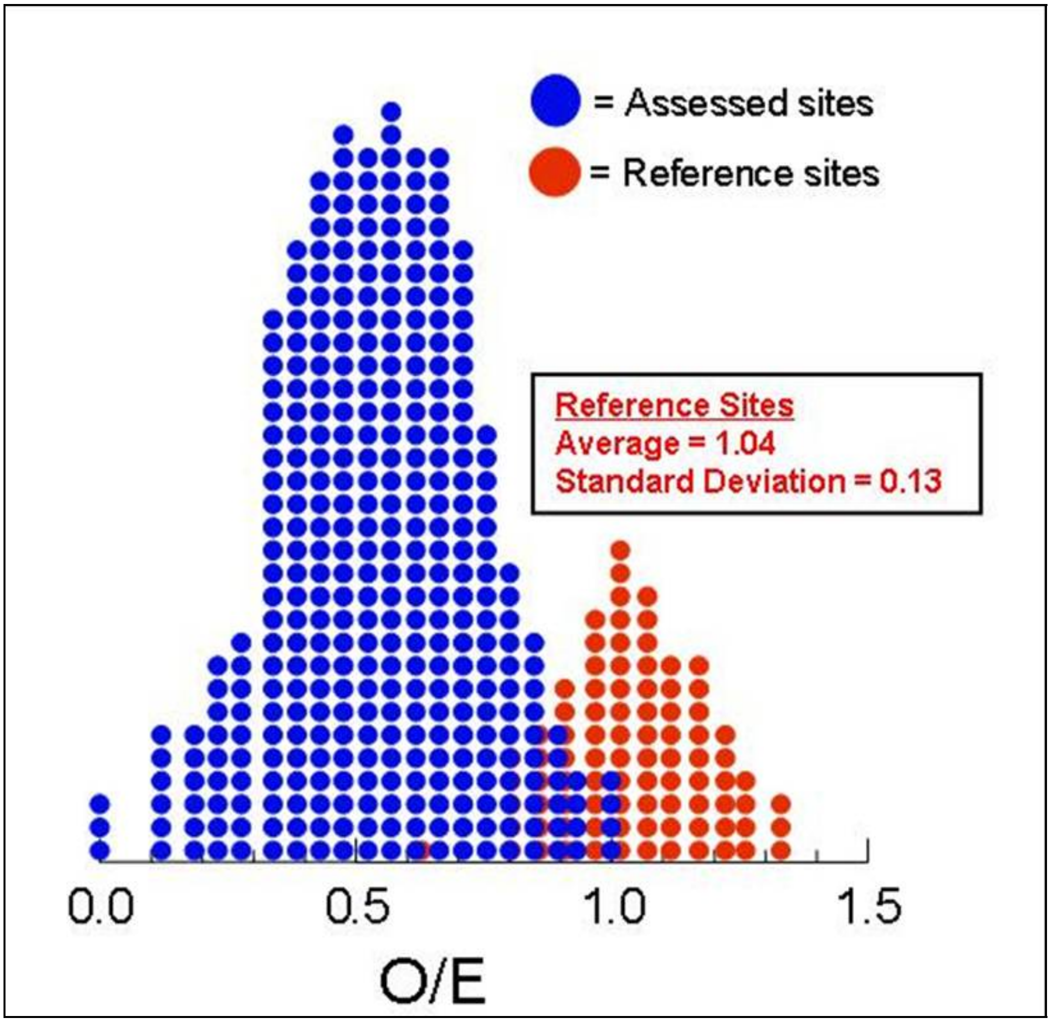


Figure 12 Distribution of reference and test O/E scores

7.3.4 Assessing Biological Beneficial Use Support

Utah does not currently have numeric biological criteria. However, model outputs are used to guide assessments under the narrative standards of the Utah Clean Water Act (R317-2). To make the narrative assessments as rigorous as possible, a systematic procedure was devised to use the RIVPACS model O/E values to determine aquatic life beneficial use support (Figure 13). The goal of this assessment process is to characterize each Assessment Unit (AU) as *Fully Supporting* or *Not Supporting* aquatic life beneficial uses. The assessment methods are described below.

Utah currently assesses watersheds based on established Assessment Units (AUs). While many AUs contain a single biological collection site, some AUs contain multiple sites. In such instances, DWQ staff examined available data to determine if multiple sites within an AU occur in similar ecological settings. Data evaluated to make these comparisons include: stream hydrology, stream order, predominant riparian and upland vegetation, and/or major changes in habitat characteristics measured at each site. When comparisons suggest that sites within an AU are ecologically similar, O/E scores from all sites within an AU are averaged for assessment purposes provided that conclusions of biological condition are similar. If O/E scores differ appreciably among multiple sites within an AU, then DWQ will investigate possible explanations for such discrepancies. If DWQ finds multiple sites within an AU from different environmental settings AUs are subdivided into smaller watershed units whenever clear boundaries can be identified (e.g., political/landuse boundaries, tributary confluence).

To translate the O/E values into assessment categories it is necessary to devise impairment thresholds, or O/E scores that indicate whether or not a site is meeting biological beneficial uses (Table 6). For these assessments, DWQ determined that a mean O/E value less than 0.74 (26% loss of expected species) indicates non-support of beneficial uses if >3 samples are used to assess the site. The threshold of 0.74 represents a departure from 1 (no taxa loss) of two (2) standard deviations of reference O/E scores. For all sites with multiple years of data, the average difference between maximum and minimum O/E values is 0.2. At least 3 yearly samples are preferred for assessments because O/E scores can vary from year-to-year and assessments based on average conditions. Assessments based on the average condition of ≥3 samples reduces the possibility of making an error of biological beneficial use support as a result of an unusual sampling event (i.e., following a flash flood, improperly preserved sample).

One ramification of requiring at least three samples is that remediation efforts may be postponed for years because biological samples are only collected once per year. To minimize delayed response times, DWQ identified a second threshold value of 0.54 (0.74 – 0.20 average year-to-year variability) for sites with <3 samples (Table 6). This second threshold expedites environmental response at severely degraded sites where additional sampling would be unlikely to alter an assessment of impairment. Sites with < 3 samples that have a mean O/E score ≥0.54 and <0.74 will be placed in impairment category 3A, which indicates that there is insufficient data to make an assessment. All sites listed as 3A will be given a high priority for future biological monitoring.

Table 6 Beneficial Use Support Determination for O/E Values Obtained from Different Sample Sizes

Sample Size	O/E Threshold	Use Determination	Comments
≥ 3 samples collected over 3 years	Mean O/E score ≥ 0.74	Fully Supporting	
≥ 3 samples collected over 3 years	Mean O/E score < 0.74	Not supporting	Threshold based on 2 SD of reference O/E scores
< 3 samples	Mean O/E score >0.54 – 0.74	Category 3A (insufficient data)	
< 3 samples	Mean O/E score <0.54	Not supporting	Original threshold with consideration for year-to-year variability of 0.20

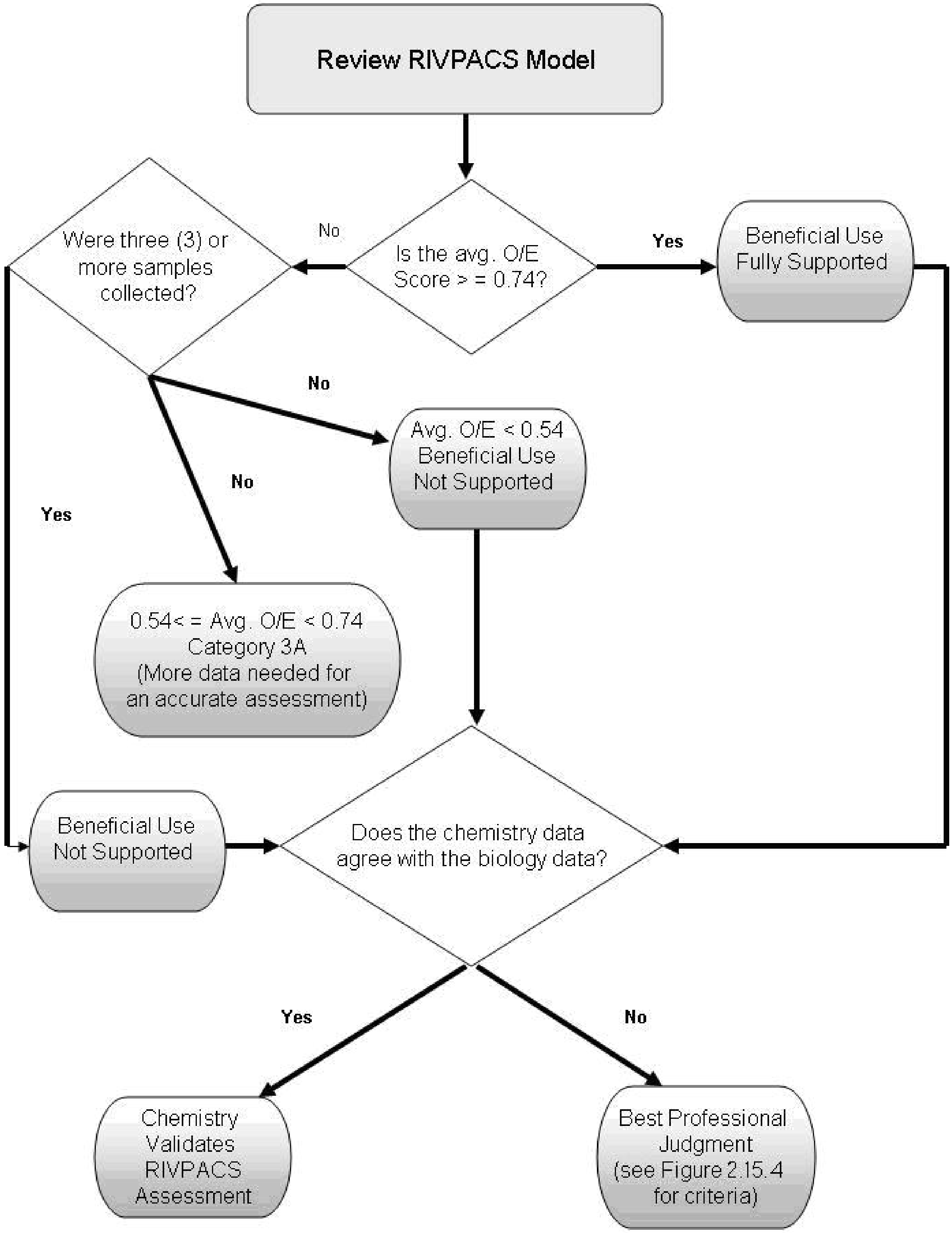


Figure 13 Flow diagram depicting decision tree for biological assessment

7.3.5 Merging Biological and Chemical Assessments

For years, DWQ has assessed biological beneficial use attainment with water chemistry standards that are assumed to be protective of stream biota. Before making final decisions about biological beneficial use support, a comparison is made between impairment assessments obtained from stream biota with those obtained from stream chemistry. The primary goal behind these evaluations is to eliminate both false positive and false negative assessments. There are four potentially confounding factors that warrant a more careful scrutiny of incongruous biological and chemical assessments. These factors are summarized in a Best Professional Judgment (BPJ) framework (Figure 14) wherein disagreements between chemistry and biology assessments are objectively and systematically evaluated on a case-by-case basis.

These judgment decisions are based in part on EPA's "Consolidated Assessment and Listing Methodology" (CALM) guidance published in 2002. The guidance provides a framework to weigh multiple types of data used for waterbody assessment. Specifically, the guidance refers to the policy of independent applicability which stresses that if any one type of applicable data indicates water quality standards are not attained the water body shall be identified impaired.

7.3.5.1 Were the chemical and biological samples collected in similar locations?

Biological and chemical sample sites are not always co-located which may lead to different assessments if land-use or habitat is different among chemical and biological sampling sites. For instance, in one assessment unit a biological sample may have been collected in the upper watershed and represent the water quality in the headwaters versus a downstream water quality station that is potentially located in a different ecological setting. If the chemical and biological sample locations are clearly distinct, the assessment unit is divided at a clear boundary (e.g., Forest Service boundary, tributary convergence, water withdrawal) where they existed. However, in some cases, sites may be assessed as 3A (more data required) because clear boundaries are not immediately apparent from available data.

7.3.5.2 Is the model applicable to the site?

One of the fundamental assumptions of RIVPACS models is that the suite of reference sites used in model construction encompasses the range of conditions observed in the sites that are to be assessed. All sites are evaluated to determine whether this assumption is met before a final assessment is made. For example, DWQ found a site located in a relatively undisturbed environmental setting with low O/E values. Investigations into this unexpected result revealed that the site was located in a large, sandy bottomed river, and that the current model cannot be appropriately applied to such sites because it based generated with few reference sites with similar characteristics. In instances where model results are suspect, the AU is placed into category 3A until additional reference sites can be sampled and incorporated into the model.

7.3.5.3 Were the chemical or biological samples collected during unusual environmental conditions?

Conclusions of impairment can potentially be biased when samples are collected during unusual environmental conditions. For instance, both biological composition and chemical criteria are known to be altered by drought and data collected under these conditions may be suspect. Similarly, the composition of stream assemblages is known to be altered by flash floods and samples collected following these events are suspect. In these situations, the AU is placed into category 3A until additional data can be collected to corroborate assessment results.

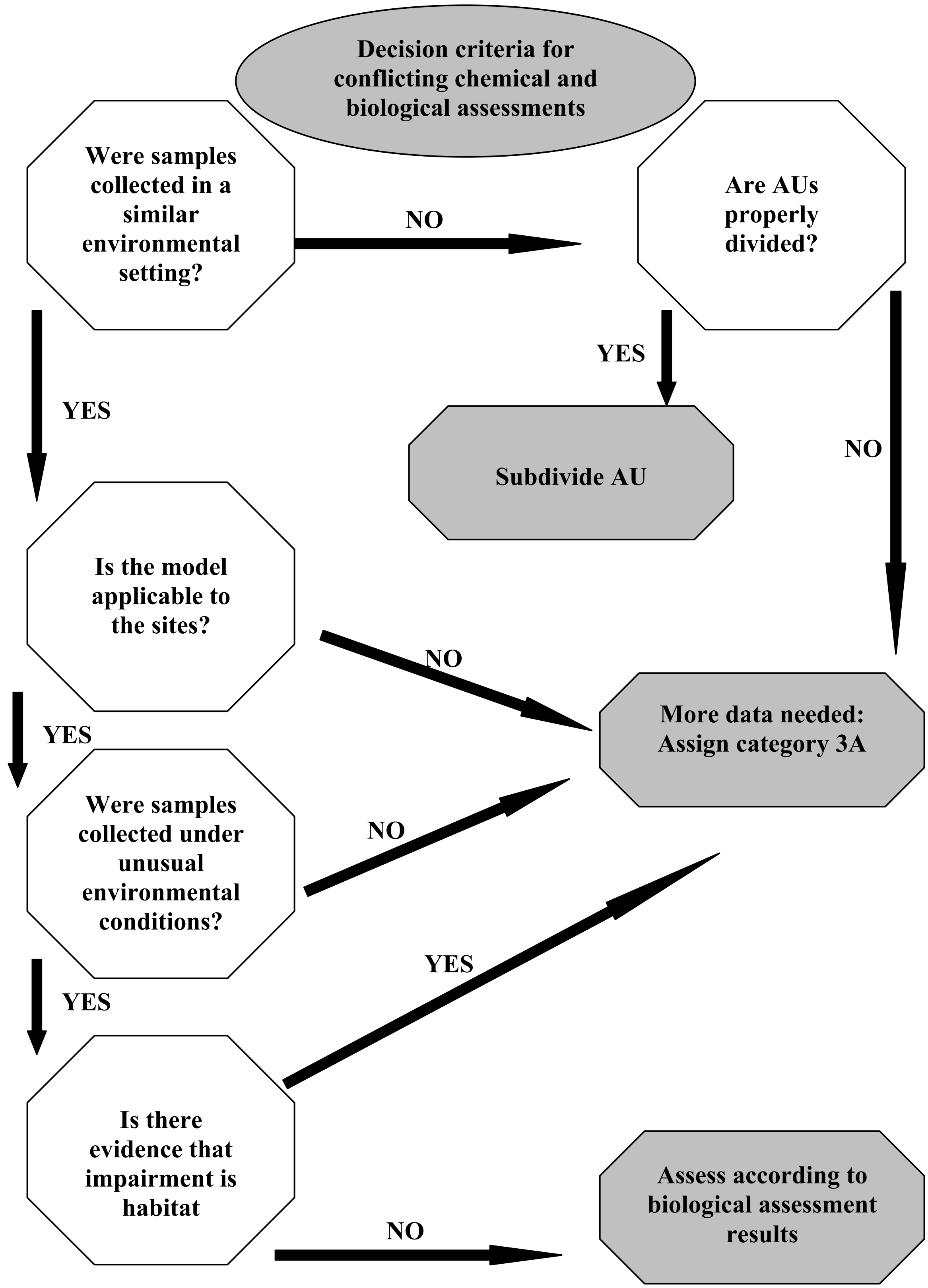


Figure 14 Best professional judgment criteria

7.3.5.4 Is there strong evidence that impairment is habitat related?

If biological assessments indicate impairment and chemistry data indicates full support, habitat degradation may be the source of impairment. Currently, DWQ does not have approved methodology to categorize nonsupport status because of impaired habitat. Therefore, additional data is required to better understand assessment discrepancies in the AU and was listed as 3A.

Finally, if an AU results in a 3A listing for either biological or chemical assessment, the assessment type with sufficient data to determine the listing will be used. For example, if the biological data of an AU indicates Full Support while chemical data indicates 3A, the AU will be listed as Full Support.

Chapter 8. Agricultural Beneficial Use Support Determination (Class 4)

8.1 Introduction

Waters of the State that are protected for agricultural use are classified as Class 4 and include irrigation of crops and stock watering. Numerical standard for this beneficial use are found in the *Standards of Quality for Waters of the State* (*UAC R317-2).* Criteria have been established for toxicants, radiological and conventional data including total dissolved solids (TDS).

8.2 Agricultural Beneficial Use Assessment Procedure

Agricultural beneficial use support assessment is made using conventional, toxicant, and radiological data. The standards for these three types of data are found in found in *Section R317-2-14* of the standards.

8.2.1 Conventional Data

Total dissolved solids (TDS) and pH are the two conventional parameters that are evaluated to determine beneficial use support. With the exception of those streams segments that have a site specific TDS standard, there are two standards for TDS. One is for irrigation and the other is for stock watering. The TDS standard for irrigation waters is 1,200 mg/l and 2,000 mg/l for waters designated for stock watering only. However, the DWQ has not identified any waters that are used for stock watering only. Therefore, all assessments are done using the more stringent standard of 1,200 mg/L standard. The standard for pH is 6.5-9.0. These standards and listed in
R317-2-14.

To do an assessment, 10 or more (≥ 10) measurements are needed for conventional data unless there are mitigating reasons why ten measurements could not be obtained.

Beneficial Use Supported – For any one conventional pollutant, the beneficial use is supported if any of the following conditions are met:

1. The criterion was exceeded no more than (≤) one time.

2. The criterion was exceeded in no more than ten percent (≤10%) of the measurements if the criterion was exceeded more than (>) one time.

Beneficial Use Not Supported – For any one conventional pollutant, the beneficial use is not supported if both of the following conditions are met:

1. The criterion was exceeded more than one time.

2. The criterion was exceeded in more than ten percent (>10%) of the measurements.

8.2.2 Toxicant Data

Toxicant data include dissolved metals and nitrates. To do an assessment, 4 or more measurements are needed for toxicant data.

Beneficial Use Supported – For any one pollutant, no more than one (≤ 1) violation of the standard during a 3-year period. (see Section R317-1-14)

Beneficial Use Not Supported - For any one pollutant, two or more (≥ 2) violations of the standard during a 3-year period. (see Section R317-1-14)

8.2.3 Radiological Data

Gross alpha measurements are compared to the standard to determine beneficial use support. Gross alpha is treated as a toxicant and the beneficial use support assessment is the same as for toxicant data.

Beneficial Use Supported – For any one pollutant, no more than one (≤ 1) violation of the standard during a 3-year period. (see Section R317-1-14)

Beneficial Use Not Supported - For any one pollutant, two or more (≥ 2) violations of the standard during a 3-year period. (see Section R317-1-14)

The decision flow diagram to determine beneficial use support for agricultural waters using water chemistry and field data are illustrated in Figure 15.

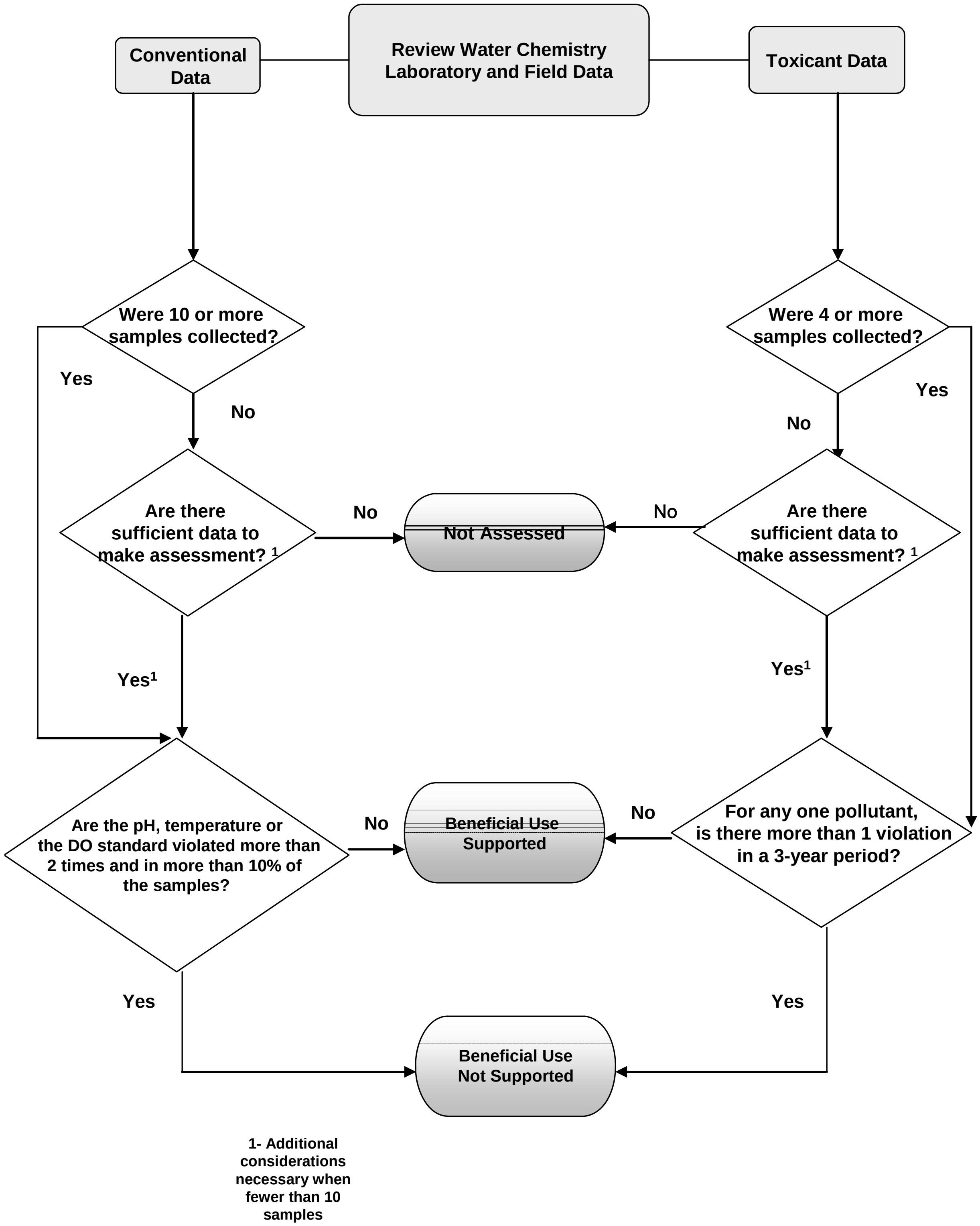


Figure 15 Decision flow diagram to determine beneficial use support for agricultural waters using chemistry and field data

Chapter 9. Lake and Reservoir Assessment Methodology for Determining Beneficial Use Support

9.1 Introduction

Lakes and reservoirs are defined as waters of the State which are protected by beneficial use designations. Each lake and reservoir has been designated as an Assessment Unit (AU) for purposes of assessment. The terms lake, reservoir and assessment unit are used interchangeably in this chapter.

Section R317-2-14 contains the standards established for both toxicants and conventional parameters including total dissolved solids. Lakes and reservoirs greater than 20 acres are listed along with their beneficial use classifications. Lakes or reservoirs not specifically listed in Section R317-2-13.12 are assigned beneficial uses by default to the classification(s) of their tributary stream(s).

9.2 Great Salt Lake

The issues related to the Great Salt Lake are many and complex. The hydrologic restrictions caused by the Union Pacific causeway that was constructed in 1959 resulted in large differences in salinity between the different bays and interrupted natural circulation patterns. Gunnison Bay has the highest salinity (25-30%), and regularly precipitates NaCl. Gilbert Bay has intermediate salinity (12-18%). The Farmington Bay (Syracuse) causeway (built in 1967), restricts circulation between Farmington Bay and Gilbert Bay. Consequently, tributary flow into Farmington Bay dilutes the salinity to a range of 2 to 10%. Similarly, the fresh water from Bear River keeps Bear River Bay between 0.5 and 2%. These discrete ranges of salinity clearly result in biological communities dominated by different species and hence, different occupants of food chain levels and ecological guilds. This information supports the Division's position to divide the lake into four sub-classes (assessment units). The four assessment units would be Gilbert Bay (South Arm), Gunnison Bay (North Arm), Farmington Bay and Bear River Bay. These areas of the lake would be sub-classes of beneficial use Class 5, i.e. 5A, 5B, 5C and 5D (see Table 1). This will likely result in appropriate modification of our current defined beneficial uses for the open-water regions and include different standards or criteria for each region.

Until such time numeric standards are developed, the Great Salt Lake and Farmington Bay will be assessed using the narrative standard in the water quality standards. The draft Assessment Methodology is presented in an Appendix to this document.

9.3 Reservoir and Lake Assessments

When the DWQ started to monitor lakes and reservoirs, 132 lakes based on size and public interest were selected to make lake and reservoir assessments for the Integrated Report, i.e., 305(b) Report and 303(d) List of Impaired Waters. These lakes and reservoirs account for 93% of the water surface acres in the State. The lakes were divided into two groups, one group being sampled during even years e.g., 2002; and the other group during the odd years, e.g., 2003. Monitoring for each lake and reservoir is done twice each year. The first set of samples is typically collected starting about June 1st and the second set is collected starting about August 1st.

Currently, one hundred thirty-two (132) lakes are monitored. The odd/even year monitoring has been maintained, but some lakes and reservoirs are monitored every year because a Total Maximum Daily Load (TMDL) analysis is required or because a special project is being conducted. The TMDL and special studies lakes and reservoirs are monitored four times during the monitoring season.

The profile data are collected at the surface and at every meter of the water column depth, and is completed when the probe is 1 meter above the bottom. All water chemistry samples, except dissolved metals and algal samples, are collected at the surface, one meter above the thermocline, one meter below the thermocline, and near the bottom. The dissolved metals sample is collected 1 meter above the bottom at the deepest site on the lake or reservoir. The algal sample is collected as a composite sample from 3 times the depth of the secchi disc reading to the surface. The algal sample is collected once at the deepest monitoring site on the lake or reservoir.

The assessment of reservoirs and lakes consists of three tiers:

- **Tier I assessment** is the preliminary determination of support status based on conventional parameters, such as DO, temperature, pH, toxicants, etc.

- **Tier II assessment** looks further into the weighted evidence criteria (trophic state index TSI, fish kills, and blue-green algal dominance) using best professional judgment. The Tier I preliminary support status may be modified through an evaluation of the TSI, winter DO conditions with reported fish kills, and the presence of significant blue-green algal populations in the phytoplankton community. The Tier II evaluation could adjust the preliminary support status ranking if at least two of the three criteria indicate a different support status.

  For lakes or reservoirs that are stratified, the dissolved oxygen concentrations and temperature above the thermocline are reviewed to determine if the lens of habitat is sufficient enough to protect the fishery. If it is not sufficient, the lake or reservoir is listed in Category 3C or 5, the 303(d) list. The determination is based on best professional judgment.

  If the data collected during the first cycle of monitoring indicate overwhelming evidence of impairment to the fishery, the lake or reservoir can be listed.

- **Tier III assessment** is the final evaluation based on cyclic nature of the data. Any change of support status requires two consecutive assessment cycles of equivalent support status.

9.4 Tier I Assessment Based On Total Dissolved Solids

Data collected on individual Assessment Units (AU) from all monitoring sites are used to determine the beneficial use support based on total dissolved solids (TDS).

> **Beneficial Use Supported –** The beneficial use is supported if the standard is exceeded not more than one time (≤ 1) in two consecutive monitoring cycles, e.g., 2002 and 2004 for even-numbered years, or 2001 and 2003 for odd-numbered years.
>
> **Beneficial Use Not Supported –** The beneficial use is not supported if the TDS standard is exceeded two or more times (≥ 2) in two consecutive monitoring cycles.

9.5 Tier I Assessment Based On pH, Temperature and Dissolved Oxygen

The water column measurements are compared against the State water quality standards to assess beneficial use support. Dissolved oxygen (DO) profile measurements collected at the deepest site are used to do the assessment, unless there is sufficient reason to use the profile data from other locations on the lake or reservoir. In addition, only DO readings collected in the fall monitoring period (August 1st or later) are used to do the assessment because they are more indicative of the worst scenarios.

Temperature and pH measurements from all sites and all monitoring dates are used to make the beneficial use assessment for aquatic life and other beneficial uses.

9.5.1 Using pH Data

The criteria for assessing the beneficial use support for all beneficial uses assigned to lakes and reservoirs using pH data are based on the pH profile data collected at the surface and then at one meter intervals. Data collected from the deepest location during the spring (June 1st - July 31$^{st)}$ sampling period and the fall sampling period (August 1st or later.) are used to calculate the percentage of violations (see Section R317-2-14 for the range of the pH standard).

> **Beneficial Use Supported –** The beneficial use is supported if the number of violations are less than or equal to 10 percent (≤10%) of the measurements.
>
> **Beneficial Use Not Supported –** The beneficial use is not supported if more than 10 percent (>10%) of the measurements violate the pH standard.

Figures 16 and 17 are of examples illustrating the procedure used to determine beneficial use support using pH data. Figure 16 is a diagram of the pH profile that would be assessed as fully supporting all beneficial uses that have the pH standard of 6.5 to 9.0. Figure 17 illustrates a profile that would result in a beneficial use not being supported because more than 10 percent (>10%) of the measurements are violations.

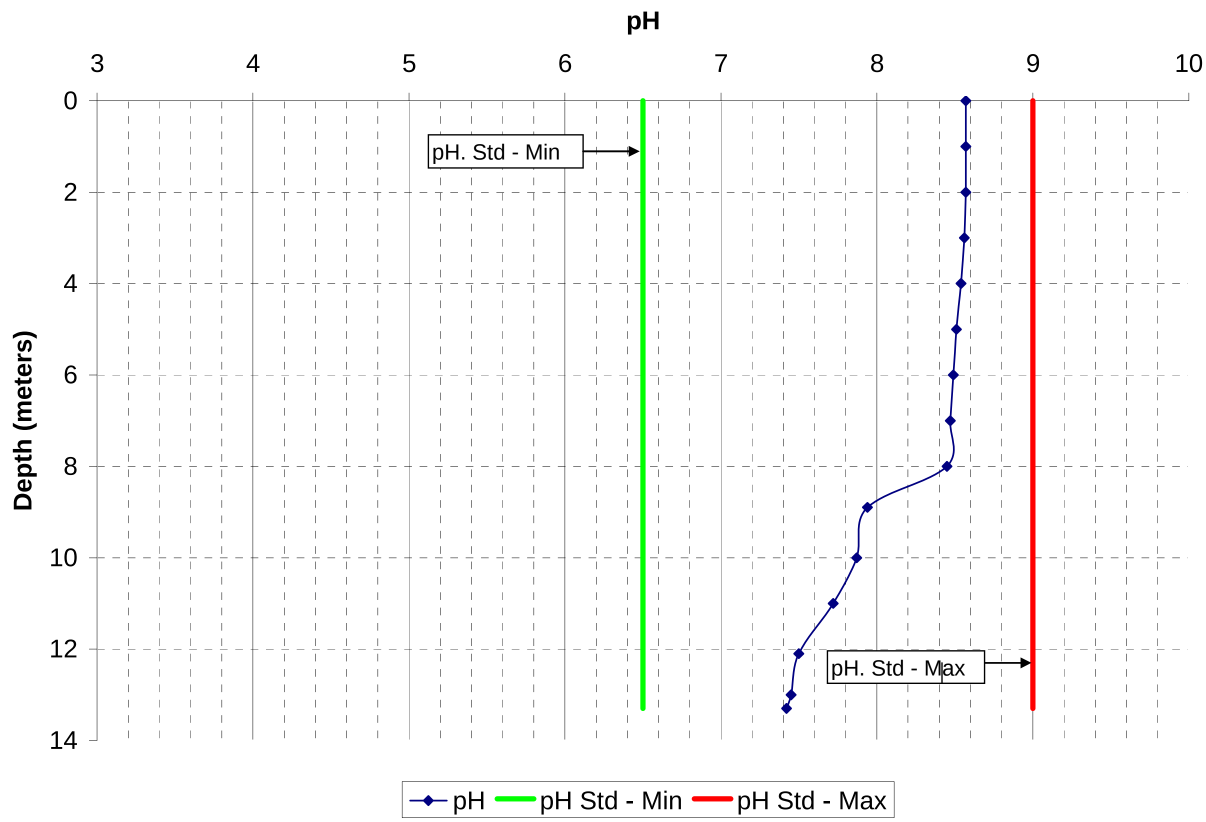


Figure 16 Tier I example of beneficial use supported based on pH data (100% of the pH measurements are within the pH standard range)

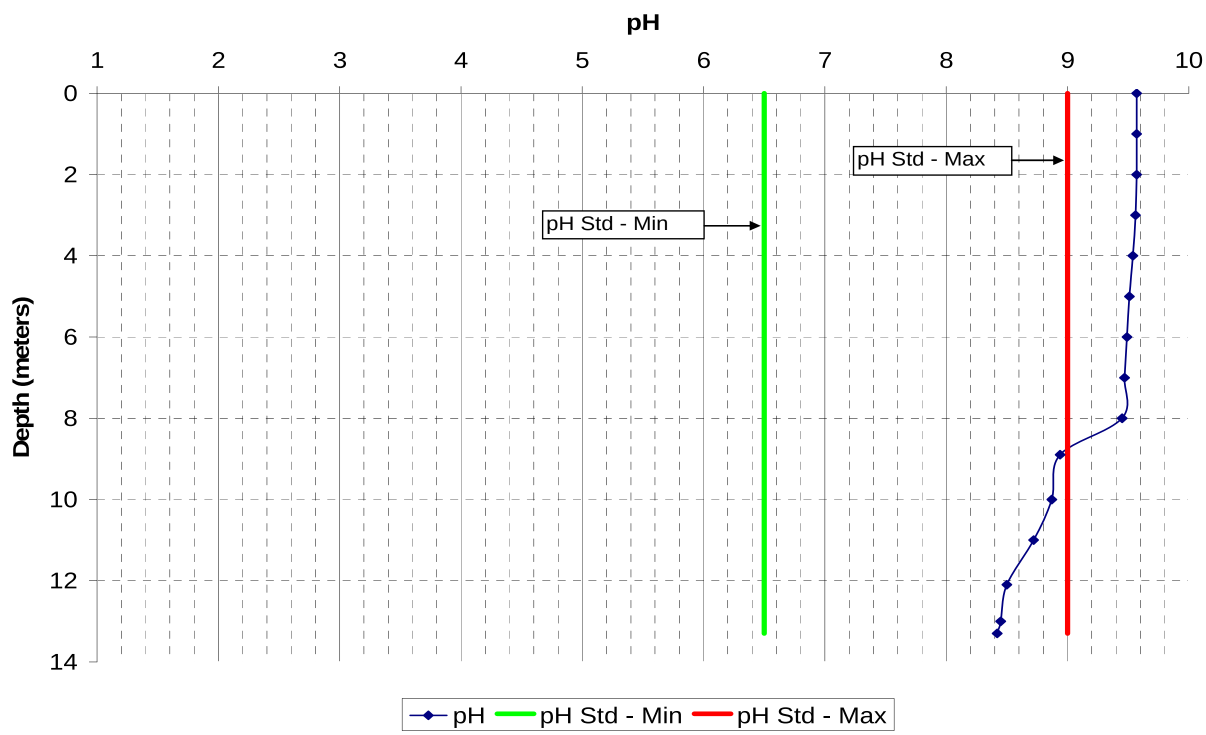


Figure 17 Tier I example of beneficial use not supported based on pH data (>10% of the measurements are outisde of the pH standard range)

9.5.2 Using Temperature Data

The criteria for assessing the beneficial use support for lakes and reservoirs using temperature data is based upon profile data collected at the surface and then at one meter intervals. Data collected from the deepest site during the spring (June 1st through July 31st) and fall monitoring periods are used to calculate the percentage of violations. For a lake or reservoir to be placed on the 303(d) list, the temperature standard must be exceeded in two consecutive monitoring cycles, e.g., in the 2002 and 2004 monitoring cycles the temperature was exceeded in more than 10 percent (> 10 %) of the measurements.

Beneficial Use Fully Supported – The beneficial use is supported if the number of violations are less than or equal to 10 percent (≤10%) of the measurements (see Figure 18).

Beneficial Use Not supported – The beneficial use is not supported if more than 10 percent (>10%) of the measurements violate the temperature standard (see Figure 19).

9.5.3 Using Dissolved Oxygen Data

The dissolved oxygen (DO) assessment uses the DO standard of 4.0 mg/L for Class 3A waters and 3.0 mg/L for Class 3B waters (see R317-2-14). State standards account for the fact that anoxic or low dissolved oxygen (DO) conditions may exist in the bottom of deep reservoirs. Therefore, a fully supporting status is assigned for DO when all the measurements are above the applicable DO standard for the upper 50% of the entire water column depth at the deepest site for each lake.

The DWQ recognizes that the standard does not address depth per se. Some lakes are shallow and an anoxic zone may not be formed. The DWQ will not use the 50% depth criteria for lakes that do not thermally stratify. In these cases, DWQ uses the entire water column to assess DO. See Figures 20 and 21 for examples of beneficial use supported and not supported.

Beneficial Use Supported – For stratified lakes, the beneficial use is supported if the oxygen concentrations are greater than the dissolved oxygen standard for the upper 50% of the water column depth (see Figure 20). For non-stratified lakes, the beneficial use is supported if at least 90% (≥ 90%) of the oxygen measurements are greater than the dissolved oxygen standard for the entire water column depth.

Beneficial Use Not Supported – For stratified lakes, the beneficial use is not supported if the dissolved oxygen concentrations are not greater than the dissolved oxygen standard for the upper 50% of the water column (see Figure 21). For non-stratified lakes, the beneficial use is not supported if more than 10% (> 10%) of the oxygen measurements are below the dissolved oxygen standard for the entire water column depth.

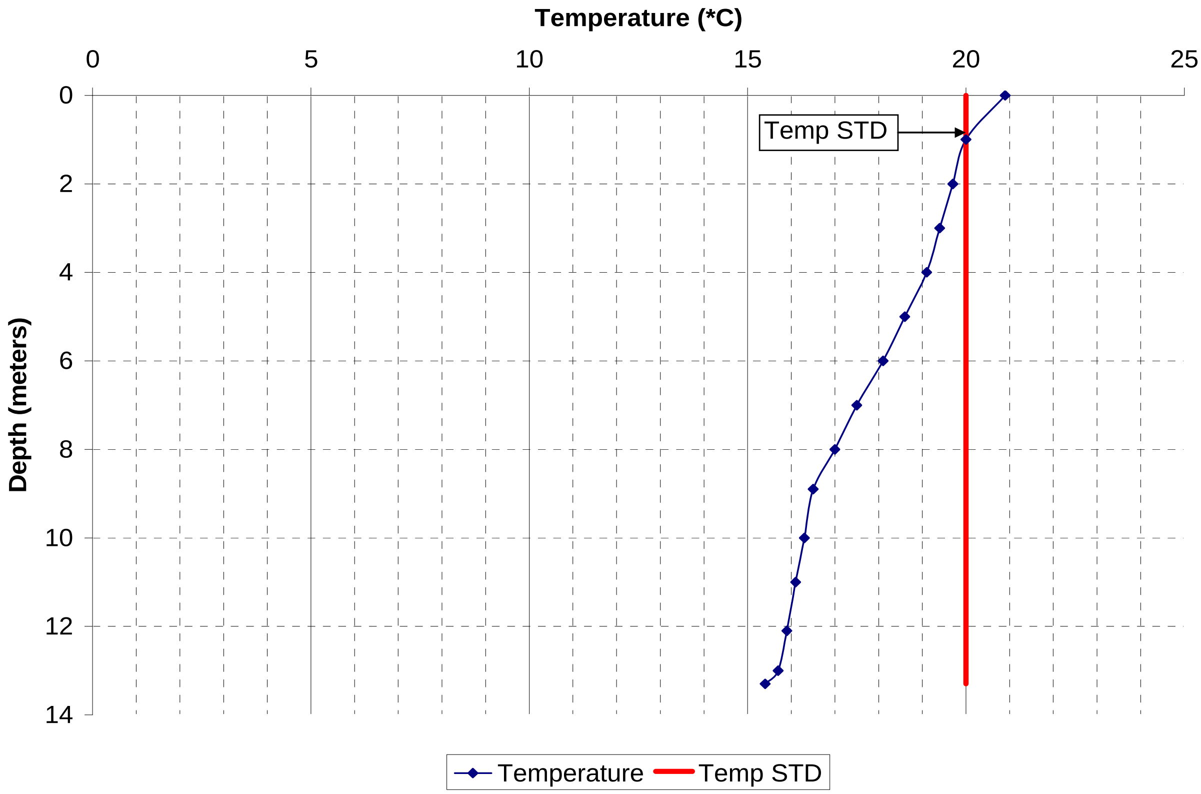


Figure 18 Tier I example of the beneficial use being supported based on temperature data (≤10% of the measurements exceed the Class 3A standard for temperature)

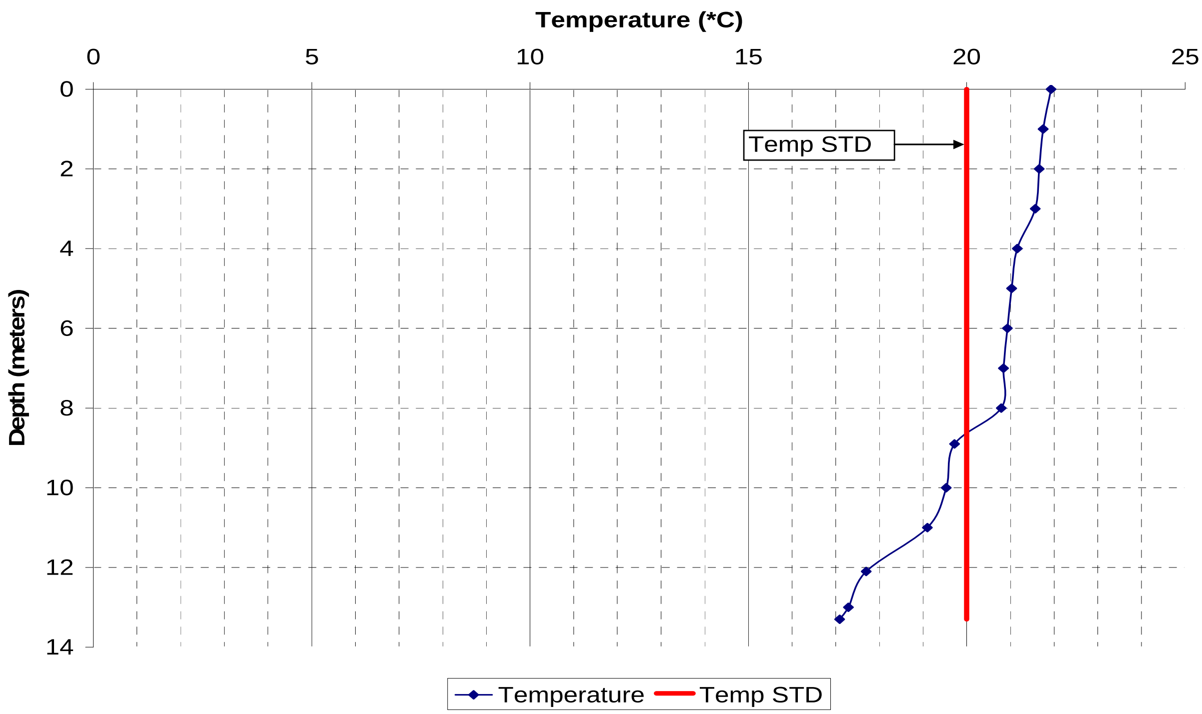


Figure 19 Tier I example of beneficial use not supported based on temperature data (>10% of measurements exceed the Class 3A standard for temperature)

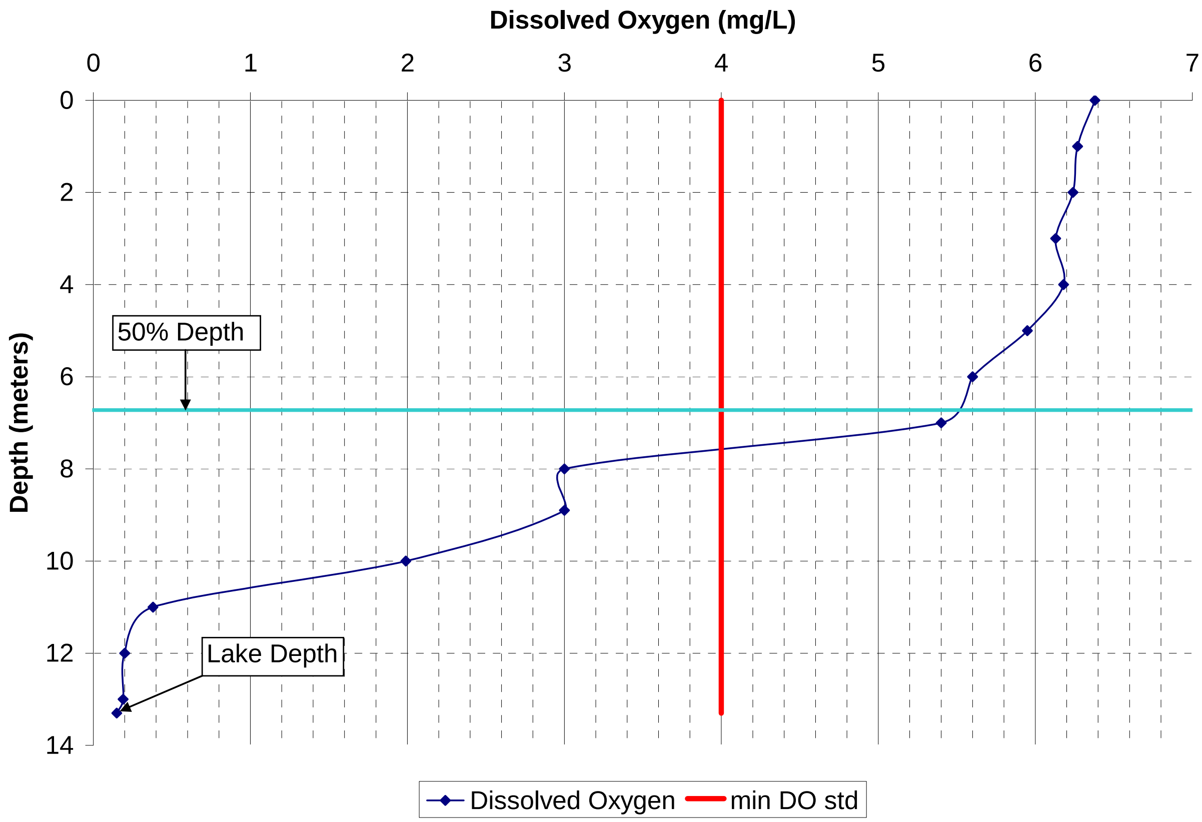


Figure 20 Tier I example of beneficial use supported based on dissolved oxygen data (All of the DO concentrations are greater than 4.0mg/L in the upper 50% of the water column - Class 3A)

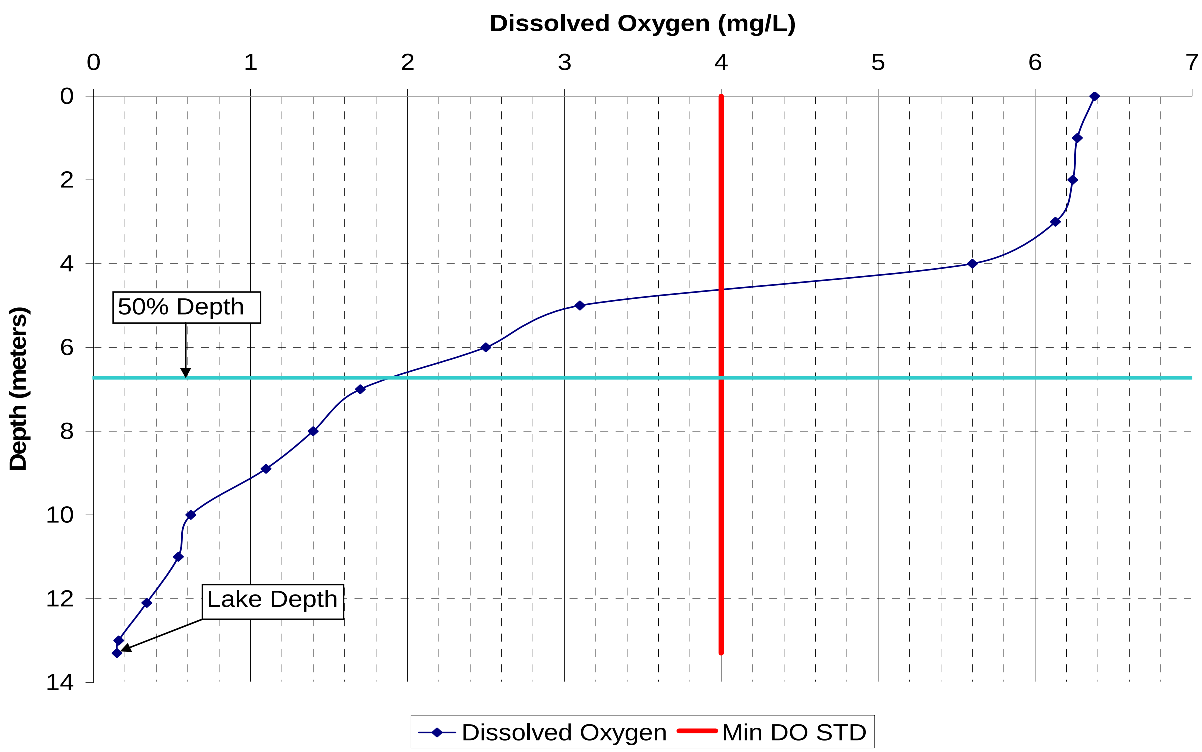


Figure 21 Tier I example of beneficial use not supported based on dissolved oxygen data (Some of the DO concentrations are less than 4.0mg/L in the upper 50% of the water column - Class 3A)

9.5.4 Tier I Assessment Based on Dissolved Oxygen Concentration and Temperature Above The Thermocline

If the temperature profile indicates that the habitat is reduced by high temperatures at or near the surface, an assessment of the thickness of the lens is made to determine if there is sufficient habitat for the fishery. If the data indicates insufficient habitat for fishery, the lake or reservoir shall be listed. This assessment is largely based upon best professional judgment because of the variability in the size and depth of the lake or reservoir. In the case of reservoirs that are subject to human controlled operations, drawdown is taken into consideration. Drawdown can change from year to year based upon the spring runoff and how full they were at the end of the previous irrigation season or how much water was needed for culinary purposes. Figures 22 and 23 are examples of supporting and not supporting the beneficial use based on the DO and temperature data above the thermocline.

Beneficial Use Supported – Sufficient habitat for fish based on DO and temperature above the thermocline.

Beneficial Use Not Supported – Insufficient habitat for fish based on DO and temperature above the thermocline.

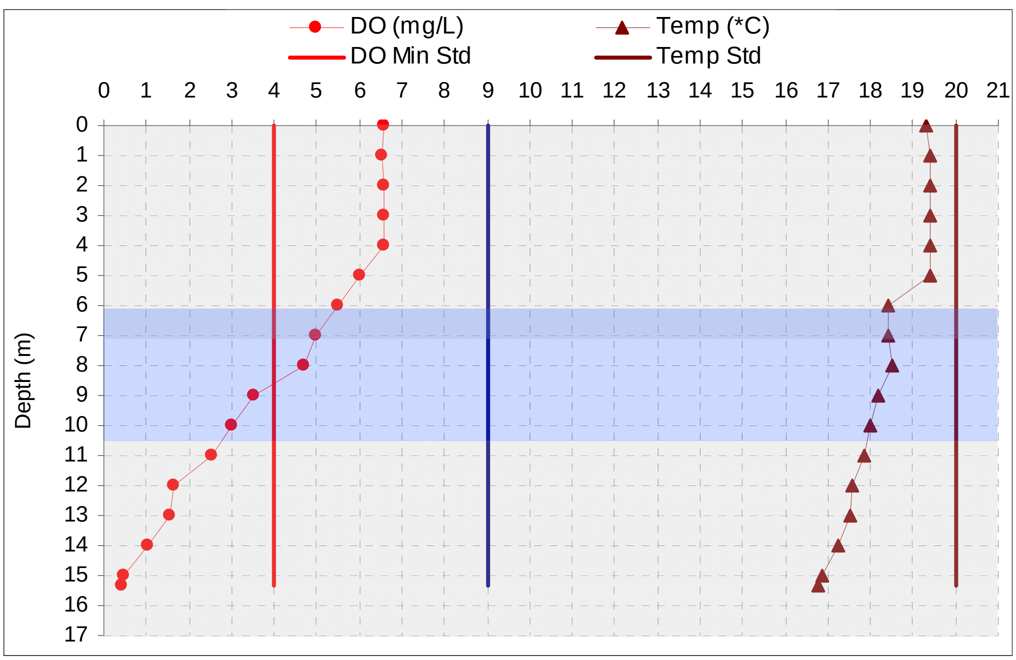


Figure 22 Lens formed between dissolved oxygen and temperature above thermocline - supported

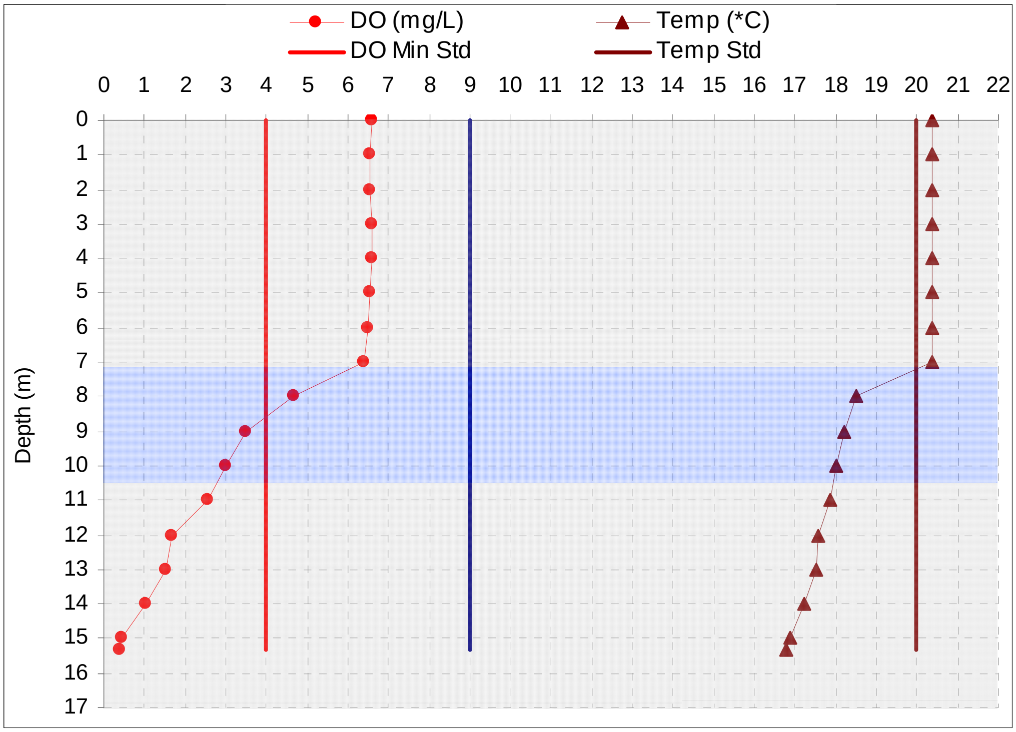


Figure 23 Lens formed between dissolved oxygen and temperature above thermocline - not supported

9.6 Tier I Assessment Based on Dissolved Metals, Ammonia and Gross Alpha Data

One sample is collected near the bottom at the deepest site in the lake or reservoir for dissolved metals, ammonia and gross alpha. If the concentration exceeds the standard, DWQ will return to the site to conduct follow-up sampling. In some cases this may occur the following year.

> **Beneficial Use Supported** – The beneficial use is supported if there are less than two (< 2) exceedances of the chronic or acute standard.
>
> **Beneficial Use Not Supported** – The beneficial use is not supported if concentration exceeds the chronic or acute standard two or more (≥ 2) times.

9.7 Tier I Assessment Based on Mercury Health advisories

Beneficial use support for health advisories on lakes or reservoirs are the same as for rivers and stream. (See Section 7.2.2 and Figure 10)

9.8 Tier II Assessment Based on Weighted Evidence Criteria

The weighted evidence criteria consist of the following three data types. These evaluations are based to a large extent on best professional judgment.

1. There is an increasing TSI trend over a long-term period or a TSI greater than 50.

2. There are winter fish kills or low winter dissolved oxygen when it is measured.

3. There is a dominance of blue blue-green algae.

Beneficial Use Supported - To be assessed as supporting, these lakes must be assessed as supporting for two consecutive assessment cycles.

Beneficial Use Not Supported - To be assessed as not supporting, these lakes must be assessed as not supporting for two consecutive assessment cycles.

9.8.1 Tier II Assessment Using Carlsons Trophic State Index

The Carlson's Trophic State Index (TSI) is calculated using secchi disk transparency total phosphorus and chlorophyll-a. Typically, the average of the three is calculated to obtain the TSI. The TSI calculation method may be re-evaluated using best professional judgment, if specific data indicate overwhelming evidence that differ from the results of averaging TSI. The TSI value ranges from 0 to 100 with increasing values indicating a more eutrophic condition. Carlson's TSI estimates are calculated using the following equations:

Trophic status based on secchi disk (TSIS):

TSIS = 60 - 14.41 ln (SD),
where SD = Secchi disk transparency in meters.

Trophic status based on total phosphorus (TSIP):

TSIP = 14.20 ln (TP) + 4.15,
where TP = Total phosphorus concentration in µg/L.

Trophic status based on chlorophyll-a (TSIC):

TSIC = 9.81 ln (TC) + 30.60,
where TC = Chlorophyll-a concentrations in µg/L.

The abbreviation “ln” indicates the natural logarithm

Trophic State Index (TSI) = (TSIS + TSIP + TSIC) / 3

9.8.2 Tier II Assessment Using Fish Kill Data Or Dissolved Oxygen Data

Regional biologists within the Division of Wildlife are contacted and fish kill information is obtained. If dissolved oxygen (DO) data are available, it is evaluated also. In general, winter is defined as from November through March depending on the latitude and elevation of a lake or reservoir. To assess DO data in the winter months, a DO profile is taken and 3.0 mg/L DO is used as the listing value.

9.8.3 Tier II Assessment Using Blue-Green Algae Abundance

Phytoplankton (algal) data are used in the Tier II assessment process, because they reflect nutrient abundance and nutrient ratios. Although there is seasonal variability, diatoms dominate lakes that have relatively low nutrient concentrations and the nitrogen:phosphorus ratios are normal (16:1 respectively). These lakes are classified as oligotrophic (meaning low food or nutrients).

On the other end of the scale, nutrient loading often leads to an imbalance of nutrients. In freshwater lakes, excess phosphorus is the most common problem. Such lakes are classified as eutrophic or even hypereutrophic (meaning true or high food or nutrients, respectively). This high and imbalanced nutrient ratio favors another group of algae known as cyanobacteria or blue-green algae. This group is unusual in that it can "fix" or convert atmospheric nitrogen to biologically available organic forms. This can allow explosive growth of the algal biomass, which may coat the surface of lakes or wetlands with algal films unless the nutrient ratio in the algal cells once again approaches 16:1.

Although daytime dissolved oxygen may be very high, evening oxygen depletion often results from respiration and biodegradation of cyanobacteria may cause dissolved oxygen to fall below values needed to support aquatic life.

9.9 Tier III Assessment Based on Cyclic Nature of the Data

Lakes or reservoirs are identified as being cyclic if they are assessed as not supporting in the during the odd (2003) or even year (2004) they are monitored and then assessed as fully supporting during the next odd (2005) or even (2006) year monitoring. If the assessment is the reverse of the above, the lake or reservoir is cyclic also. In general, if an AU is assessed as not supporting the aquatic beneficial use designation on a consistent basis, it is listed on the 303(d) list. Lakes that fluctuate between fully supporting and not supporting the beneficial use over several cycles are not automatically listed on the 303(d) list. They are first placed in Utah's Category 3C. In order to be listed on the 303(d) list, lakes or reservoirs that exhibit this cyclic characteristic must be assessed as impaired for two consecutive assessment cycles.

The decision flow diagram for Tier I beneficial use support determination for lakes and reservoirs for total dissolved solids data is illustrated in 24. The flow chart for Tier I evaluation of pH, temperature and dissolved oxygen is illustrated in Figure 25. The decision flow chart for Tier 1 determination of toxicants is illustrated in Figure 26. The flow chart for Tier II and Tier

III lake assessment and lake beneficial use support determination are illustrated in Figures 27 and 28.

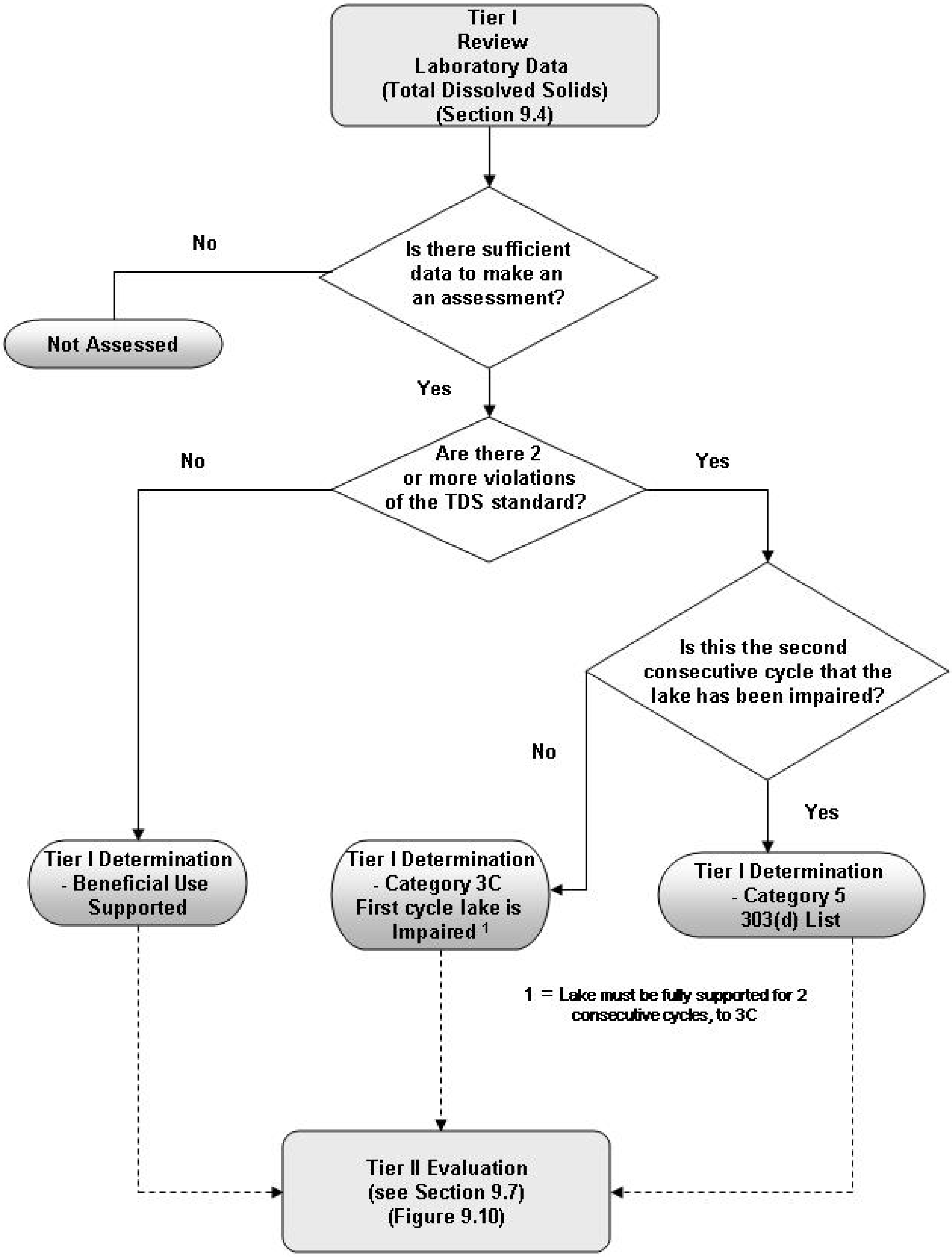


Figure 24 Tier I decision flow diagram to determine beneficial use support for lakes and reservoirs using total dissolved solids data

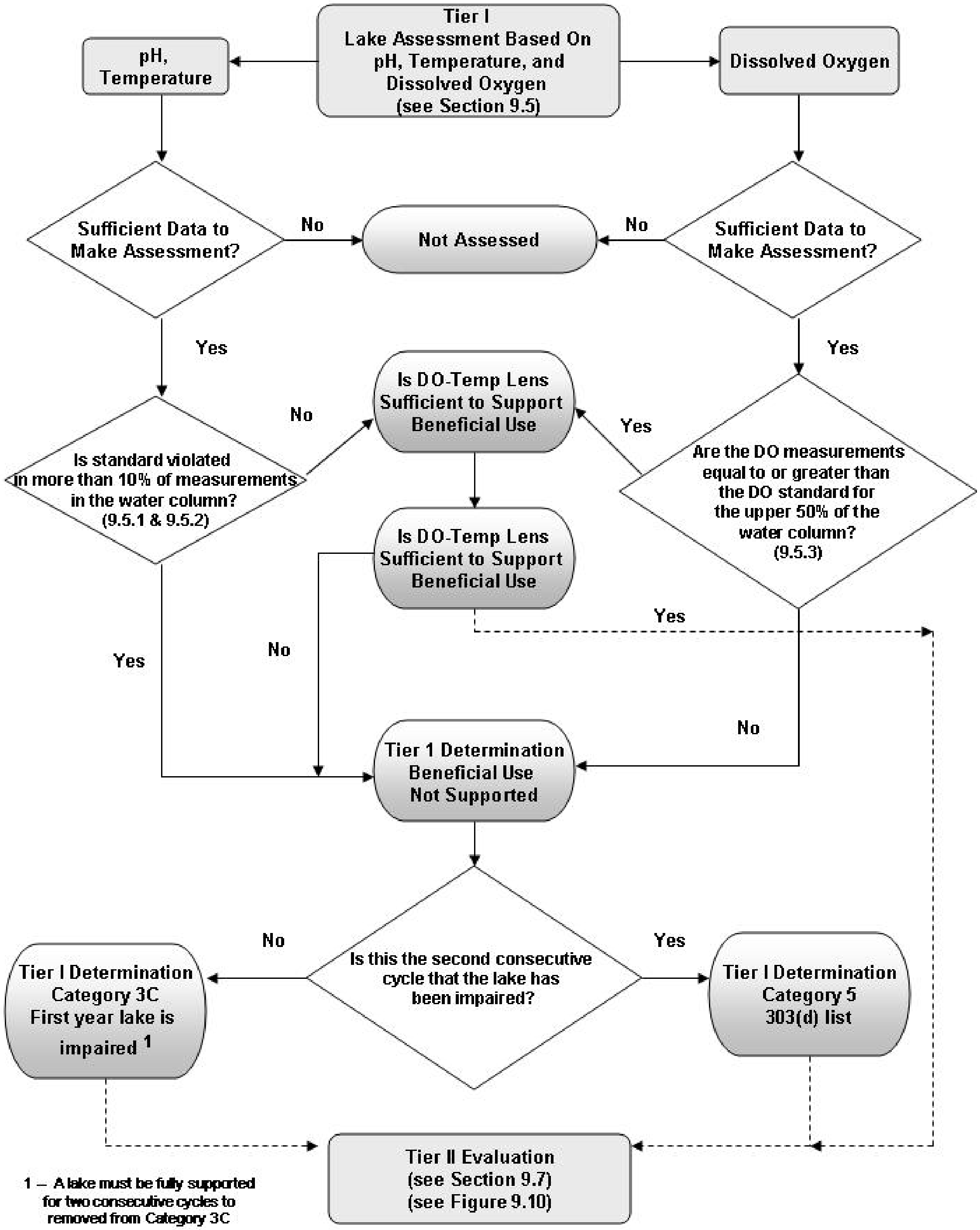


Figure 25 Tier I decision flow diagram to determine beneficial use support for lakes and reservoirs using pH, temperature and dissolved oxygen data

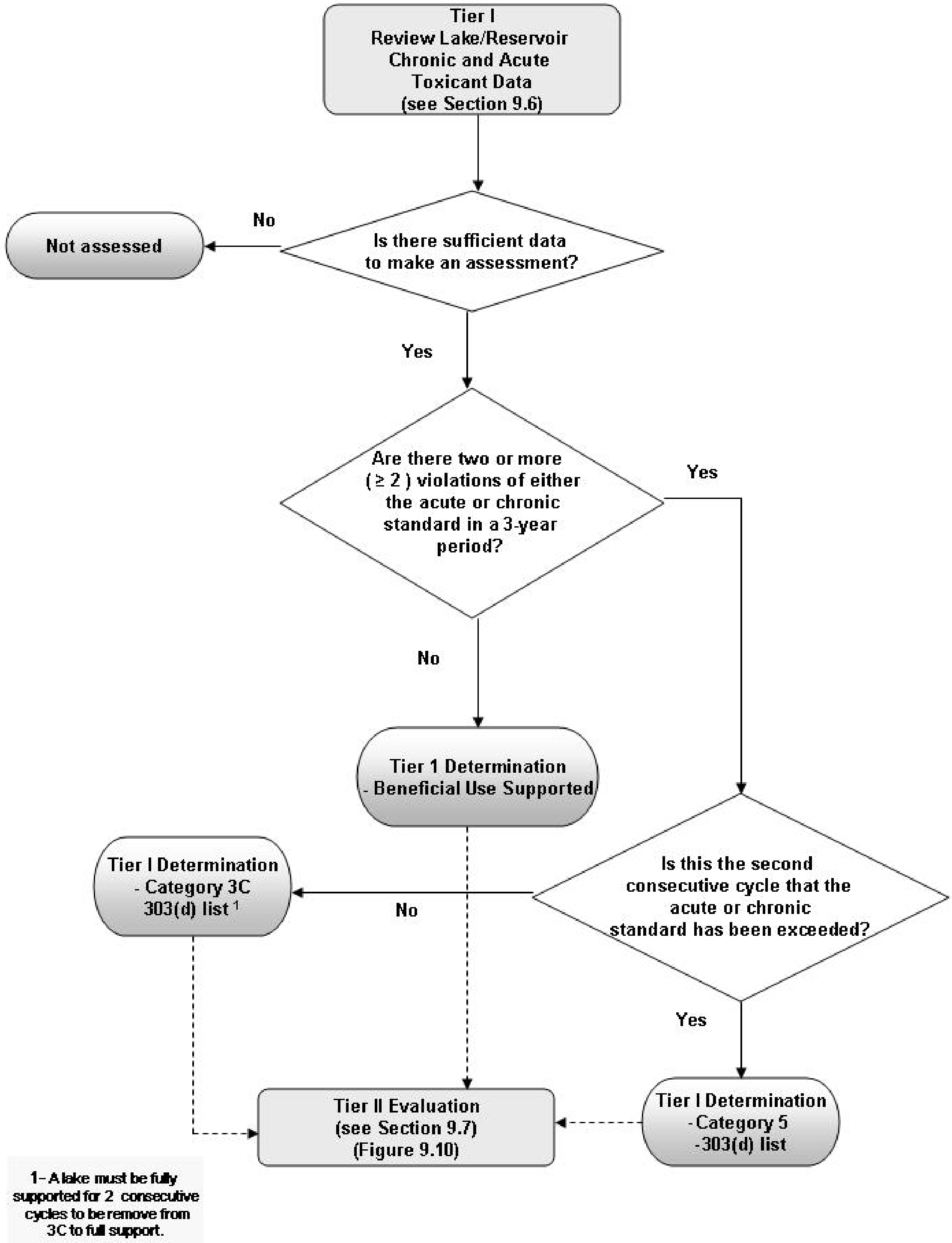


Figure 26 Tier I decision flow diagram to determine beneficial use support for lakes and reservoirs using acute and chronic toxicant data

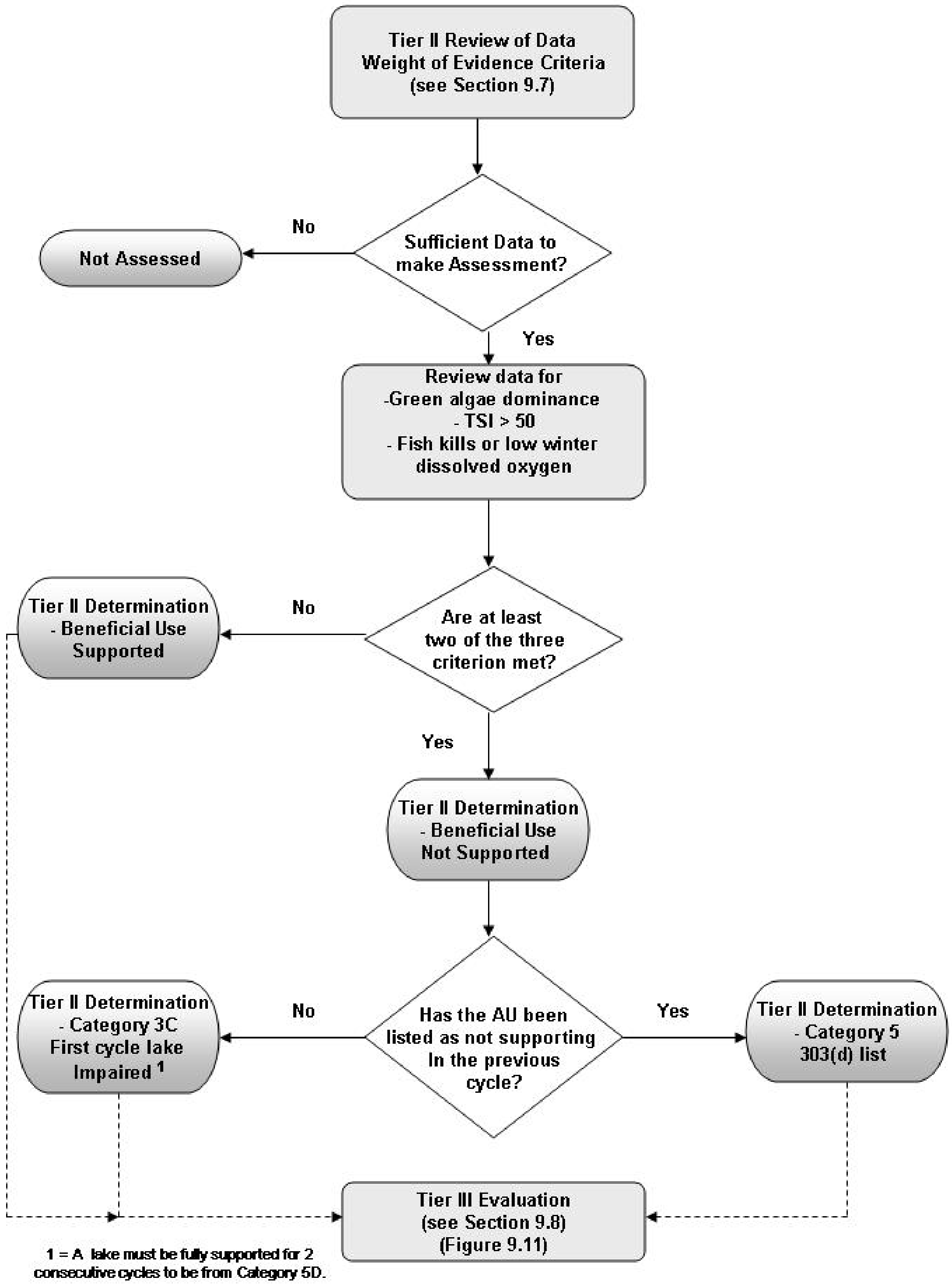


Figure 27 Tier II decision flow diagram to determine beneficial use support for lakes and reservoirs

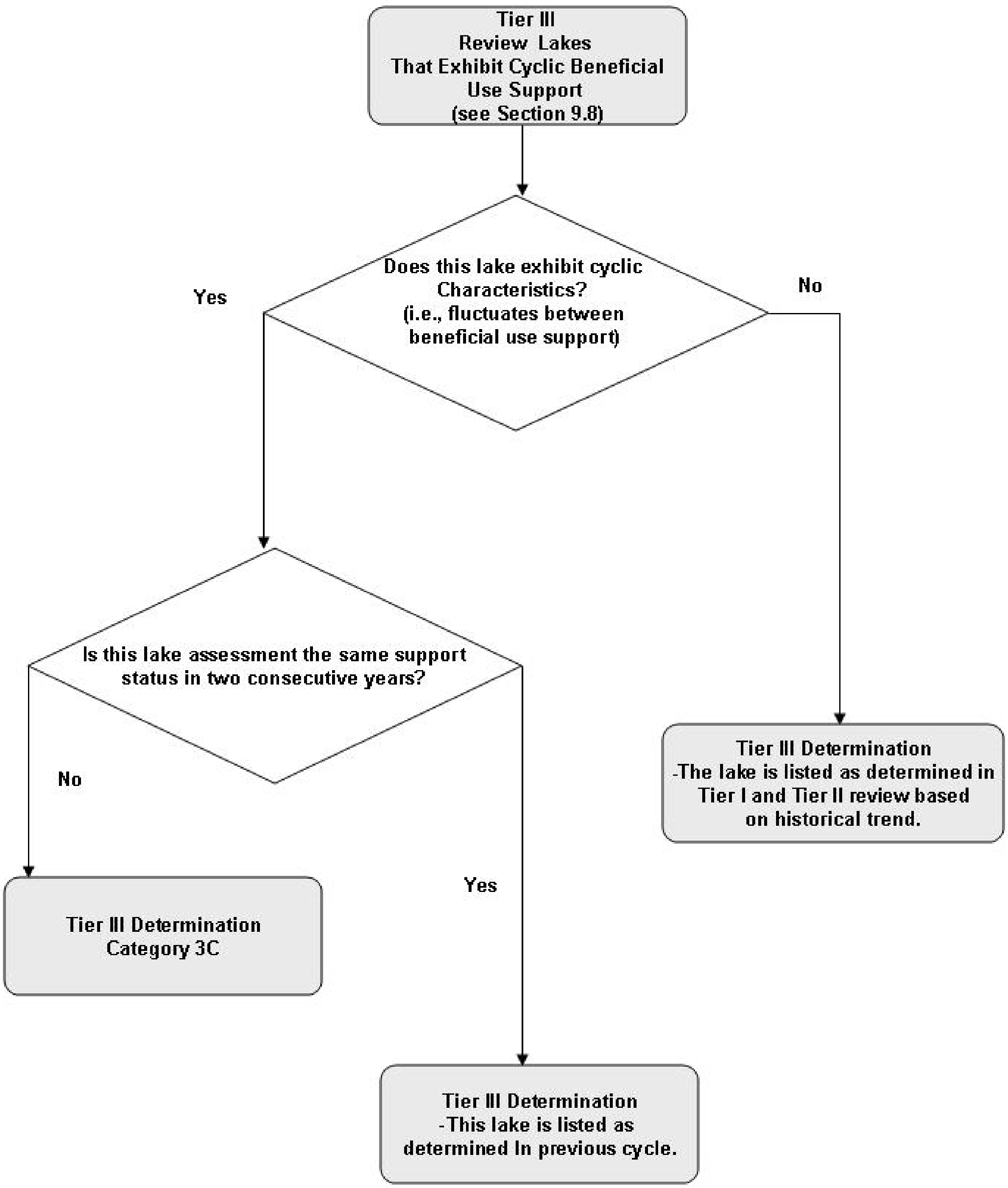


Figure 28 Tier III evaluation of lakes exhibiting cyclic beneficial use support

Chapter 10 Special Considerations of Beneficial Use Assessments

10.1 Overview

There are times when the beneficial use support decisions need to be evaluated further because of mitigating circumstances that may result in the assessment being changed. One of the most common occurrences that results in a review of an assessment is when it is based upon less than the number of samples recommended by the DWQ. For conventional parameters, the recommended number of samples is ten, and for toxicants, the number of samples is four. For conventional parameters, the samples should be as evenly distributed as possible across the collection period. For toxicants, the recommendation is that the samples be collected quarterly. Quarterly being defined as the first, second, third and fourth quarters of the calendar year. This chapter addresses how and when assessments will be made using less than the recommended number of samples or data are not collected following the DWQ prescribe procedures for assessment.

10.2 When Fewer than the Recommended Number of Samples Are Collected

After the preliminary determination of beneficial use support, those assessments based on less than the recommended number are reviewed to determine if the assessment is valid or if it should be changed. The list below includes some of the situations for which there may be valid reasons for using less than the suggested number of samples to make a final determination.

- Inaccessibility to sites due to weather conditions. For example, the monitoring site is located in the mountains where snow prevents access to it during the winter months.

- The monitoring site is remote and its access is limited. Floating the Green River to assess some tributary streams is an example of when less than the recommended number of samples can be collected. Available resources and the cost are limiting factors in the collection of samples.

- Manpower limitations at peak periods of sampling. This may result in some sites not being collected as scheduled.

- Other reasons where the number of samples is less than the number recommended, e.g., laboratory analysis not done, sample lost, etc.

- Samples collected during a synoptic survey of limited duration. Most synoptic surveys are based upon collecting only one sample and have limited value in making beneficial use assessments.

Decisions to accept the beneficial use support decision under the conditions outlined above are to an extent based upon best professional judgment. Historical data, if available, are reviewed to determine if a similar pattern of collection has occurred at the monitoring site in the past.

10.3 Lake Data Collection

Chapter 9 of this guidance outlines the specific methodology for evaluating lakes and reservoirs. Data should be collected following the methodology stated in Chapter 9 of this document as closely as possible in order to be considered adequate enough to be used in an assessment. However, if data are submitted that would provide significant evidence that a beneficial use is impaired, the lake or reservoir could be listed.

10.4 Natural Hydrological Conditions

Severe or extreme natural conditions, such as a drought, can be considered during the beneficial use assessment. During severe to extreme drought conditions, streams can have temperatures greater than the standard but are rare in occurrence if the normal hydrological regime occurs. In this case, the DWQ reserves the right to identify these waters, but not list the AU on the 303(d) list. A rationale for not listing will be provided whenever this occurs. The AU will be assessed again when normal flow conditions return. For example, during the extreme drought in southern Utah, the Paria River was listed as not being assessed because the stream dried up during several months of the year and samples could not be collected.

10.5 Field and Water Chemistry Data Versus Biological Data

There are instances when a biological assessment for an AU has been done using a Multimetric Index approach (MMIs) or River Invertebrate Prediction and Classification Scheme (RIVPACS) models. The DWQ is in the process of developing the assessment methods for benthic macroinvertebrate data. Where the assessments are different and the compelling evidence indicate that the bioassessment is more reliable, the biological assessment results will take priority in determining beneficial use support.

Data from the current biological assessment program will be used on a limited basis to assess some waters that have been categorized as "in need of further study."

Chapter 11 Criteria For Removing Assessment Units From 303(d) List.

11.1 Introduction

There are various reasons for removing an Assessment Unit (AU) from the 303(d) list. Any AU can be removed from the 303(d) list based upon the criteria listed below. Once a decision is made the pollutant is removed from the 303(d) list. The AU is listed in the assessment category that results because of the delisting, e.g., an assessment unit is moved to Category 4A if a TMDL has been completed and approved by EPA. As a result of a delisting, an AU could be placed in multiple assessment categories.

11.2 List Criteria for Which an Assessment Unit Can Be Removed from the 303(d) List

1. The AU was placed on list due to error in assessment or because an AU was listed incorrectly in place of another AU or any other error not based on water quality assessment.

2. The most recent data assessment indicates that the AU is now meeting the State water quality standard or is supporting the designated beneficial use support for all of its designated beneficial uses that were assessed.

3. A total maximum daily load analysis (TMDL) for any pollutant(s) has been completed and approved by EPA. The approved TMDL and the pollutant(s), is automatically moved to Category 4A. Any pollutant(s) remaining on the 303(d) list for which a TMDL has not been completed and approved for that AU will remain on the 303(d) list (Category 5A). Therefore, an AU may be listed in both Categories 4A and 5A.

4. An existing AU delineation has changed**.**

(1) An AU has been changed by dividing it into several assessment units.

(2) The AU boundaries have been changed and it is now a part of a different AU or portions of the AU are included in newly defined assessment units.

5. A change in the method(s) of determining beneficial use support. The methodology change may cause the assessment to result in all of the beneficial uses being assessed as fully supported.

6. A change in State water quality standards or pollution indicator values may change assessment to fully supporting all beneficial uses that have sufficient data to be assessed.

7. A determination that insufficient amounts of data were collected to place the AU on the list originally, e.g., too few samples collected to make a reliable determination of beneficial use support.

8. Utah exercises discretion in using data or information that goes beyond the criteria listed above in determining whether to de-list an AU and can include other types of information and best professional judgment.

Chapter 12. Total Phosphorus Evaluations

The concentrations of total phosphorus are evaluated to determine what stream and river AUs may need further studies to determine if total phosphorus is causing an impairment of the aquatic life use in Class 3A and 3B.

12.1 Overview

Total phosphorus does not directly affect aquatic life, but as a nutrient it can stimulate growth of aquatic algae and emergent plants. Nuisance blooms of algae and other aquatic plants can have an effect on the amount of dissolved oxygen (DO) and habitat that fish and macroinvertebrates occupy. During the day, algae produce dissolved oxygen and the concentrations of DO may reach supersaturated concentrations. At night, the cycle is reversed and DO is used in respiration. This can cause a reduction in the DO concentrations and it can cause stress on fish or even death if the concentration is too low.

The DWQ has developed a screening technique to determine if an AU needs to have further study to determine whether there is an impact caused by total phosphorus. Those AUs that exceed the screening criteria are identified and placed on a list of waters that need further evaluation. If an AU is currently part of an ongoing or completed Total Maximum Daily Load analysis (TMDL) for total phosphorus, it will not be listed in the further study list. The AU may be evaluated by doing a DO diurnal study to determine if the DO concentrations are low enough to cause impairment to the fishery. Another method that can be used is to evaluate the benthic macroinvertebrate community and compare the results with a reference site to determine if there has been an impact to the community.

DWQ is currently developing indices and thresholds for waters of the State that will enhance assessment methodology in determining impairment. Limited use of this data will be used to support assessments during the 2008 cycle. This process is well underway and the preliminary thresholds will be established during the 2008 cycle.

The longterm project is to develop defensible biological criteria in support of water qater quality assessments and support a Tier Aquatic Life Use (TALU) support for inclusion in Utah's water quality standards.

12.2 Total Phosphorus Assessment

The assessment methodology to determine the need for further studies based on the potential impact of total phosphorus is listed below.

- **Assessment Unit Needs Further Evaluation** –The mean concentration of the total phosphorus exceeds 0.06 mg/L AND more than ten percent (>10%) of the samples exceed the total phosphorus indicator value of 0.05 mg/L.

- **Assessment Unit Does Not Need Further Evaluation** – The mean concentration of total phosphorus does not exceed 0.06 mg/L OR less than 10% of the samples exceed the total phosphorus indicator value of 0.05 mg/L.

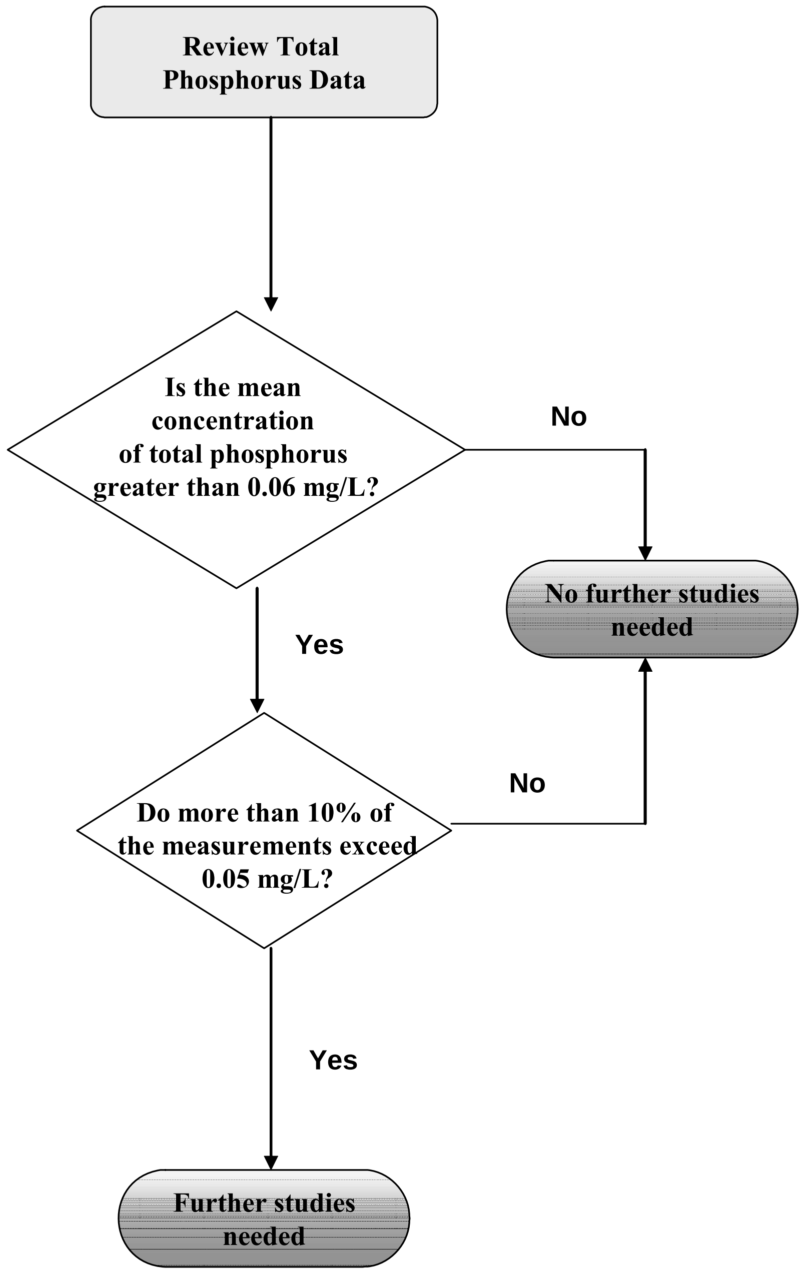


Figure 29 Decision flow chart to determine if further studies are needed to assess the beneficial use support for Class 3A and 3B waters based on total phosphorus data

REFERENCES

Clarke, R.T.; M.T. Furse, J.F. Wright and D. Moss. 1996. Derivation of a biological quality index for river sites: comparison of the observed with the expected fauna. Journal of Applied Statistics 23: 311-332.

Davies, N.M, R.H. Norris and M.C. Thoms. 2000. Prediction and assessment of local stream habitat features using large-scale catchment characteristics. Freshwater Biology, 45:343-369.

DWQ. 2005. Standards of quality for waters of the State, R317-2, Utah Administrative Code, Utah Department of Environmental Quality, Utah Division of Water Quality. 62 pp.

DWQ. 2006. Monitoring Manual, Utah Division of Water Quality, Utah Department of Environmental Quality.

Feldman, David. 2006. A Report to the DEQ Water Quality Planning Bureau on the Proper Interpretation of Two Recently Developed Bioassessment Models. Montana Department of Environmental Quality. 17 pgs.

Furse, M.T., D. Moss, J.F. Wright and P.D. Armitage. 1984. The influence of seasonal and taxonomic factors on the ordination and classification of running-water sites in Great Britain and on the prediction of their macro-invertebrate communities. Freshwater Biology, 14:257-280.

Hawkins, C.P. and D.M. Carlisle. 2001. Use of Predictive Models for Assessing the Biological Integrity of Wetlands and Other Aquatic Habitats. In *Bioassessment and Management of North American Freshwater Wetlands*, edited by Russell B. Rader, Darold P. Batzer, and Scott A. Wissinger. John Wiley & Sons, Inc.

Hawkins, C.P, R.H. Norris, J.N. Hogue, and J.W. Feminella. 2000. Development and evaluation of predictive models for measuring the biological integrity of streams. Ecological Applications 10: 1456-1477.

Hawkins, C.P. 2004. Predictive Model Assessments: A Primer. The Western Center for Monitoring and Assessment of Freshwater Ecosystems, Utah State University, 29 September 2004. Website (http://129.123.10.240/wmcportal/DesktopDefault.aspx).

Hargett, E.G., J.R. ZumBerge, and C.P. Hawkins. 2005. Development of a RIVPACS Model for Wadable Streams of Wyoming. Wyoming Department of Environmental Quality, Water Quality Division, 64 pgs

Horne, Alexander, and Charles Goldman. 1994. Limnology. 2nd ed. McGraw-Hill. New York

Hughes, R.M.; D.P. Larsen; and J.M. Omernik. 1986. Regional reference sites: a method for assessing stream potential. Environmental Management 5: 629-635.

Jessup, B., C.P. Hawkins, and J. Stribling. 2006. Biological Indicators of Stream Condition in Montana Using Benthic Macroinvertebrates. Tetra Tech. Technical Report prepared for the Montana Department of Environmental Quality, Helena, Montana. 76 pgs.

Karr, J.R. 1981. Assessment of biotic integrity using fish communities. Fisheries 6:21-27.

Karr, J.R. and D.R. Dudley. 1981. Ecological perspectives on water quality goals. Environmental Management 5(1): 55-68.

Marchant, R. and G. Hehir. 2002. The use of AUSRIVAS predictive models to assess the response of lotic macroinvertebrates to dams in south-east Australia. Freshwater Biology, 43:1022-1050.

Metzeling, L., D. Robinson, S. Perris and R. Marchant. 2002. Temporal persistence of benthic invertebrate communities in south-eastern Australian streams: taxonomic resolution and implications for the use of predictive models. Marine and Freshwater Research, 53:1223-1234.

Moss, D. J.F. Wright, M.T. Furse, and R.T. Clarke. 1999. A comparison of alternative techniques for prediction of the fauna of running-water sites in Great Britain Freshwater Biology. 41:167-181.

Paul, M. J., J. Gerritsen, CP. Hawkins, and E. Leppo. 2005. Development of Biological Assessment Tools for Colorado. Tetra Tech. Technical Report prepared for the Colorado Department of Public Health and Environment, Water Quality Control Division – Monitoring Unit, Denver, CO. 41 pgs.

Sudaryanti, S., Y. Trihadiningrum, B.T. Hart, P.E. Davies, C. Humphrey, R.H. Norris, J. Simpson and L. Thurtell. 2001. Assessment of the biological health of the Brantas River, East Java, Indonesia using the Australian River Assessment System (AUSRIVAS) methodology. Aquatic Ecology, 35(2):135-146.

Suplee, M; R. Sada de Suplee; D. Feldman; and T. Laidlaw. 2005. Identification and Assessment of Montana Reference Streams: A Follow-Up and Expansion of the 1992 Benchmark Biology Study. Montana Department of Environmental Quality, Planning Prevention and Assistance Division, Water Quality Planning Bureau, Water Quality Standards Section. 1520 E. 6th Avenue, Helena, MT 59620.

USEPA. 2006. Guidance for 2006 assessment, listing and reporting requirements pursuant to Sections 303(d) and 305(b) of the Clean Water Act. United States Environmental Protection Agency.

USEPA. 2004. Guidance for 2004 assessment, listing and reporting requirements pursuant to Sections 303(d) and 305(b) of the Clean Water Act. United States Environmental Protection Agency.

USEPA. 1997. Guidelines for preparation of the comprehensive state water quality assessments 305(b) reports and electronic updates: supplement. EPA-841-B-97-002B.

USEPA. 2006. Guidance for 2006 assessment, listing and reporting requirements pursuant to Sections 303(d) and 305(b) of the Clean Water Act. Watershed Branch, Assessment and Watershed Protection Division, Office of Wetland, Oceans and Watershed, United States Environmental Protection Agency.

Wright, J.F. 1995. Development and use of a system for predicting the macroinvertebrate fauna in flowing waters. Australian Journal of Ecology 20: 181-197.

Wright, J.F., M.T. Furse, and P.D. Armitage. 1993. RIVPACS: a technique for evaluating the biological water quality of rivers in the UK. European Water Pollution Control 3: 15-25.