Temperature Criteria Methodology

Policy Statement 06-1

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Water Quality Control Commission
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Approved: May 8, 2006
Expires: December 31, 2007

I. INTRODUCTION

This policy addresses the Water Quality Control Commission's methodology and rationale for developing water temperature criteria and standards for the protection of aquatic life in Colorado's surface waters. Colorado's temperature criteria are in the process of being revised and this policy records the incremental progress towards final criteria. The Commission believes that it is appropriate to adopt this policy statement due to the importance of temperature criteria and the need for guidance on their development. This policy is intended as a general informational guide of the Commission's approach to the adoption of these criteria and standards.

The contents of this document have no regulatory effect, but rather summarize the Commission's thinking. Moreover, this policy is not intended and should not be interpreted to limit any options that may be considered, or adopted by the Commission in future rulemaking proceedings. Therefore, this policy statement can, and will, be modified over time as warranted by future rulemaking proceedings.

II. BACKGROUND

Water temperature directly governs the metabolic rate of fish and influences their behavior. Water temperature also can have a dramatic influence on the diversity and health of the aquatic community. Fish and macroinvertebrates are cold blooded organisms that have evolved with specific thermal requirements, and changes from the natural patterns or ranges can have deleterious effects on the individuals and the communities. Water temperatures are affected by various factors including solar radiation, ambient air temperature, stream shade, channel morphology, stream flows and various anthropogenic activities. The intent of Colorado's temperature standard is to protect aquatic life from adverse warming and cooling caused by anthropogenic activities, both point source and nonpoint sources.

The Basic Standards and Methodologies for Surface Waters (Regulation No. 31, 5 CCR 1002-31) provides a framework for implementing water quality standards throughout the State of Colorado. Temperature Criteria have been adopted in the Basic Standards. Temperature criteria provide protection for the aquatic community from both lethal and sublethal effects. The temperature criteria also provide protection against abrupt changes in water temperatures, which may lead to thermal shock, a condition that can have lethal effects.

The Colorado temperature standard was first adopted by the Commission in 1978. The same temperature criteria remained intact for over 25 years. The Division reviewed historic files from both the Division and Commission to determine the basis of these criteria. The Commission hearing files from those two years are scarce and incomplete and no records were found regarding adoption of the temperature criteria. Likewise, the Division's files lacked any background information for the temperature criteria adoption. There was no clear guidance regarding the intent.

To address these issues, several references, including US EPA criteria documents, were reviewed to understand the historical background for Colorado's temperature criteria and to shed light on the scientific basis for their development.

A. Colorado Temperature Criteria Adopted in the Late 1970s

Table 1
Colorado Temperature Standard Adopted in the Late 1970s

PARAMETER	CLASS 1 COLD WATER BIOTA	CLASS 1 WARM WATER BIOTA
Temperature (ºC)	Max 20ºC, with 3 ºC Increase (5)(G)	Max 30ºC, with 3 ºC increase (5)(G)

(5) Temperature shall maintain a normal pattern of diurnal and seasonal fluctuations with no abrupt changes and shall have no increase in temperature of a magnitude, rate and duration deemed deleterious to the resident aquatic life. Generally, a maximum 3 degrees Celsius increase over a minimum of a four-hour period, lasting 12 hours maximum is deemed acceptable for discharges fluctuating in volume or temperature. Where temperature increases cannot be maintained within this range using BMP, BATEA and BPWTT control measures, the Division will determine whether the resulting temperature increase preclude an aquatic life classification.
(G) Recommendations based on review of all available information by the Committee on Water Quality Standards and Stream Classification.

The temperature criteria consisted of two parts: 1) the 20 °C and 30 °C "numerics"; and 2) the narrative contained in the footnote, which includes language on the "normal pattern of diurnal and seasonal fluctuations" and reference to the maximum 3 °C increase. Further explanations of the averaging period for criteria evaluation were not provided. For instance, most criteria are for the protection of acute (1-day) or chronic (30-day) exposures. The temperature criteria were not described in a similar manner.

Historically, the Division generally did not assess whether waterbodies were in attainment with the temperature standard; therefore, the issue of the appropriate averaging period (1-day, 30-day, etc.) has not been critically considered. The Division has issued CDPS permits for many years including to dischargers of heated effluent to receiving waterbodies. When developing permit limits, the Division included the appropriate 20 °C and 30 °C values as explicit, not-to-exceed effluent limits in the permits for coldwater and warmwater classified waterbodies, respectively. This past practice was questioned in the year 2000 as to whether it was protective of the 3 °C increase portion of the temperature standard.

B. What was the problem with the former criteria?

The three problems with the 1970's version of the criteria were that they inconsistently applied in permits, Footnote 5 was unclear, and there were disagreements about how the attainment of this standard should be assessed in the context of the 303(d) List.

A workgroup was convened in the fall of 2001 to discuss the interpretation of the temperature criteria for the purpose of assessing ambient water quality and its implementation in CDPS permits. Efforts towards understanding the criteria increased in

preparation for the 2005 Regulation No. 31 Basic Standards rulemaking hearing. The Division proposed new temperature standards in the June 2005 Basic Standards Rulemaking.

C. Commission's Action in June 2005

The temperature workgroup was far from consensus for the June 2005 Basic Standards Rulemaking. In response, the Commission adopted revised temperature standards with an effective date of December 31, 2007. This delay was provided to enable the Division and stakeholders to continue to work on refining the methodology and the data quality protocols.

D. Process Post Basic Standards Rulemaking Hearing 2005

In 2005 and 2006, the Division and stakeholders continued to work on the methodology and data quality protocols through various venues. A Temperature Technical Advisory Committee (TAC) was formed to discuss temperature issues through a series of four technical memos and conference calls. The TAC consisted of six members from a wide range of disciplines: academia, government, discharger and environmental consultants. The Division reported back to the stakeholders through monthly temperature stakeholder meetings where stakeholders had the opportunity to comment on the work the TAC was doing. In addition, a consultant was hired to develop the Colorado Temperature Database using this Policy Document once it is endorsed by the Commission.

III. CENTRAL CONCEPTS

It is the policy of the Commission to establish temperature standards to protect against negative effects to aquatic life. These include a range of effects from lethality to decreased rates of growth and reproduction.

A combination of criteria that can protect from adverse effects of temperature include:

- an acute or maximum temperature criterion (lethality),
- a chronic criterion for a longer duration average (growth, etc.),
- a season/location/species specific spawning criteria (sensitive life stages),
- a criterion to maintain a normal temperature pattern (upstream/downstream),
- a criterion to avoid effects due to sudden temporary changes (thermal shock).

Establishing limits on both maximum (acute) and average (chronic) temperatures offers the best opportunity to protect aquatic life, and is appropriate to address the variety of temperature regimes found in Colorado. This approach also allows for use of both lethal and non-lethal effects data in deriving acute and chronic criteria.

A. Elements of Criterion

The three elements of criterion are magnitude, duration and frequency. Criterion magnitude is the element of a numeric water quality criterion specifying acceptable

ambient levels of a pollutant or other indicator. Criterion duration is the period of time (averaging period) over which ambient data is averaged for comparison with a criterion-magnitude. Criterion frequency is the element of a numeric water quality criterion describing how often waterbody conditions can surpass the combined magnitude and duration components (i.e., specifying the allowed number of excursions that can occur within a certain period time (i.e., the acceptable rate of excursions). All three elements of criterion will be addressed in this policy document.

B. Acute Temperature Criterion

Acute temperature criterion provides protection against lethal effects that elevated temperature can cause. Short duration, acute numeric criteria are useful for addressing short duration changes in ambient temperature (e.g., associated with an intermittent discharge) and also daily high temperatures due to seasonal warming. Acute numeric criterion is also useful where monitoring is intermittent, and the available ambient data are not sufficient to compare to a chronic criteria.

C. Chronic Temperature Criterion

Chronic temperature criterion provides protection against sublethal effects on metabolism, growth and reproduction.

D. Protection for Sensitive Life Stages Criterion

Sensitive life-stages (e.g. eggs and fry) and critical activities (migrations, spawning) related to reproduction need to be considered when developing temperature criteria. The temperatures during spawning seasons must be protective of the offspring (eggs, fry, early life stages).

E. Protection of Normal Temperature Pattern

Variations from the normal temperature pattern can have biological consequences, such as shifts in migration timing, incubation rates, and spawning timing and also interfere with essential rearing periods. To assure that ambient conditions remain under the acute and chronic numeric table values at all times may not be sufficiently protective if the seasonal and diurnal temperature patterns are not maintained.

F. Protection Against Thermal Shock Provision

Thermal shock provisions provide another way to address short duration changes attributable to discharges. "Thermal Shock" can result from sudden releases of very hot water, and can result in serious sublethal or lethal conditions for fish (Parker and Krenkel, 1969). Sudden discharges of hot water can overwhelm a fish's heat tolerance range, its ability to acclimate to changes in ambient water temperatures, and its avoidance reactions. Likewise, sudden discharges of cold water can have similar effects. Thermal shock can lead to increased susceptibility to predation, increased avoidance energy costs,

increased metabolism and resultant oxygen and food requirements that may be difficult to meet, and other negative effects (McCullough, 1999; McCullough et. al., 2001).

G. Community Composition

This concept refers to how species are grouped to protect the community that is in question. Aquatic life cold and warm use classifications are too general to capture the natural temporal and spatial variability associated with temperature in the state of Colorado.

H. Adoption of Criteria into Standards

Criteria are based on specific levels of pollutants that would make water harmful to the various uses assigned to that waterbody. Standards prescribe the uses of the waterbody and criteria are adopted to protect these uses.

IV. CRITERIA - MAGNITUDE

The Commission chose two criteria to protect fish against negative effects of temperature. The acute criterion protects against lethality, and the chronic criterion protects against adverse effects that could include reduction of growth or reproduction. The Commission also chose to create special provisions for protection against thermal shock and to protect sensitive life stages.

The acute and chronic criteria chosen by the Commission are defined in Sections A and B below:

A. Acute Criteria

This criterion uses the upper incipient lethal temperature (UILT) data derived using acclimation temperatures typical of summertime in Colorado above the lower optimum temperature for all species that are expected to be present. This includes all ultimate upper incipient lethal temperature (UUILT) data. The calculation uses only species for which there are data.

If a scientifically defensible relationship can be found between the UILT data and the critical thermal maximum (CTM) data, this data can be used as well.

A margin of safety (MOS) is subtracted from the species values to take the acute criterion from an effect level to a no effect level. These data are ranked and the value for the 95th percentile species in the community is chosen. (e.g. if there are 100 species, this would generally equate to the value that protects 95 of the 100 species). The 95th percentile is not appropriate where a more protective approach is deemed necessary to protect a commercially, recreationally or environmentally important species.

This criterion is intended to protect 95 percent of the species present (provided that commercially, recreationally or environmentally important species are protected) at a no effect level.

B. Chronic Criteria

This criterion uses the upper range of the optimum temperature for growth and reproduction for a given species. Only species for which there are data are used in the calculation. In cases where the upper range of the optimum data are not available, the "1/3 Rule" can be used to estimate the upper bound or a level slightly above the upper bound of the optimum temperatures.

The chronic species criteria data are ranked and the value for the 95th percentile species is chosen (e.g. if there are 100 species, this would generally equate to the value that protects 95 of the 100 species). The 95th percentile is not appropriate where a more protective approach is deemed necessary to protect a commercially, recreationally or environmentally important species.

This criterion is intended to protect 95 percent of the species present (provided that commercially, recreationally or environmentally important species are protected) at the upper bound of their optimal levels.

C. Special Provisions

1. Spawning

It is the policy of the Commission that protection of spawning from anthropogenic thermal effects is appropriate. However, the broad range of species requirements and seasonal considerations makes it impossible to develop a single table value for each current use classification at this time. The diversity of thermal regimes and species assemblages in Colorado waters means that no single spawning criterion will work.

The Commission intends the following actions to occur before October 1, 2006[1] in regards to spawning standards development in Colorado:

a. Compile spawning data in the database. Identify current and historic spawning dates relative to temperature, to the maximum extent possible.

b. From the database, calculate species-specific spawning table values where sufficient data are available. These spawning criteria could then be established on a segment-specific basis using available information about the expected fish assemblage (e.g., using data for the most sensitive species that is expected to occur). The compilation of data will be useful in the future if the Commission decides to adopt calculated spawning table values for each category or use classification (to serve as default values).

c. The Division will propose the following options for consideration:

[1] The approximate date by which the Division Proposal must be finalized for the January 2007 Rulemaking Hearing.

i. Adopt a statewide narrative criteria to protect spawning. Implement the criteria using a guidance document containing species-specific values calculated from the available data that will be implemented in individual permits where the Division determines the discharge may have adverse effects on spawning.

ii. Adopt site-specific numeric spawning criteria on a segment specific basis where a defensible rationale is presented to the Commission.

iii. Adopt numeric spawning criteria on cold-water segments, or for a limited number of key fish species.

2. Thermal Shock Provision

It is the policy of the Commission that a provision against thermal shock is warranted but may be difficult to implement. The Commission intends the following actions to occur before October 1, 2006 to study thermal shock in Colorado:

a. A review of appropriate literature regarding thermal shock (and perhaps also summary of the thermal shock criteria adopted by other states/agencies) to establish Colorado-specific criteria.

b. Investigation of the practicality of adoption of a numeric spatial change of temperature (ΔT^{o}/distance) to be measured at the edge of the mixing zone. Examine what differences may exist in warm water and cold water systems in regards to thermal shock.

c. Investigation of the practicality of adoption of a numeric temporal change of temperature (ΔT^{o}/time) to be measured at the edge of the mixing zone. Examine what differences may exist in warm water and cold water systems in regards to thermal shock.

d. The Division will propose the following for consideration:

i. Adoption of a narrative or numeric criterion for Thermal Shock.

V. CRITERIA – FREQUENCY

Reserved for January 2007. *The methodology to derive the frequency element of the temperature criteria will be determined by the WQCC in January 2007.*

VI. CRITERIA – DURATION

Reserved for January 2007. *The methodology to derive the duration element of the temperature criteria will be determined by the WQCC in January 2007.*

VII. COMMUNITY COMPOSITION

Reserved for January 2007. *Reserved for January 2007. The methodology to derive the community composition is included below in Section VIII-A-4*
These analyses will be completed by September 2006 and community compositions will be determined by the WQCC in January 2007.

VIII. METHODOLOGY TO DEVELOP CRITERIA

The Commission endorsed the following methodology to develop temperature table values in Colorado. This section includes recommended methods on the overall process to determine temperature standards, how to screen the data, the use of lab and field data, how to calculate acute and chronic species criteria, how to calculate community criteria.

A. General Data Collection Process

These are the general guidelines for all data that are collected. The Commission recommends the following methodology to determine water quality criteria for temperature:

1. Data Screening

The studies are screened for applicability to Colorado temperature criteria. Data screening guidelines are included Section VI, Data Quality Screening Guidelines below.

2. Database Compilation

All data that passes the initial data screening should be added to the database. All appropriate information should be included. It is important to cast a wide net to capture all types of information. Any additional information that may influence the results must be noted in the "Notes" field.

3. Species Specific Data Calculations

Species-specific temperature criteria are calculated (both acute and chronic). See below for acute and chronic methodology.

4. Community Composition Analysis

An analysis of fish distribution from various categories (as listed below for example) will determine whether a separate qualifier is warranted. If the data shows no difference from the subcategory community criteria and the overall table

value, then there would be no need to make that distinction. If a significant difference was noted then it may be appropriate to have separate tables values for a subcategory of the use. This could alleviate an overly conservative temperature value for some circumstances or offer more protection for more sensitive species. Table values will be calculated for the existing use classifications and for the following subcategories:

- East Slope versus West Slope
- West Slope T&E Species
- Aquatic Life Cold Streams
- Aquatic Life Cold Lakes and Reservoir
- Aquatic Life Warm Streams
- Aquatic Life Warm Lakes and Reservoir
- Transition Zone
- Cutthroat Trout
- Varying Elevation Zones

The Commission intends the following actions to occur in regards to the subcategories listed above:

a. The Division will compile data for the subcategory in question.

b. From the database, calculate a subcategory-specific table value for both acute and chronic. These table values will be calculated using the same procedures as temperature table values, but only using data for the specific species present.

c. Determine whether this subcategory-specific table value is significantly lower or higher than the table value for the appropriate use. If it is, the Division will recommend a subcategory-specific table value.

d. The Commission will consider adoption of this subcategory-specific table value to be applied to streams where this specific community is present or expected to be present on a case-by-case basis.

B. Data Screening

Data screening guidelines are included Section VI, Data Quality Screening Guidelines below.

C. The role/use of lab data

The Commission intends laboratory-derived temperature tolerance data to be used to develop the criteria. Data from literature should be collected, reviewed and compiled into a database. Data screening guidelines are included in Section VI, Data Quality Screening Guidelines, in this Policy document.

The following excerpt of Sullivan et al, 2000[2] discusses the use of field and lab data by the Environmental Protection Agency (EPA):

> The Environmental Protection Agency (EPA) and other agencies have conducted water quality research over the years to accomplish two major objectives: 1) develop cause–and effect relationships between water quality conditions and biological response, and 2) develop repeatable methodologies that use research findings to craft regulatory water quality criteria grounded in sound science. A primary technique used by researchers is to subject fish and other aquatic organisms to pollutants in a controlled laboratory setting to determine the relationship between dosage, length of exposure and biological responses such as growth loss, stress, altered behavior, disease, or death. Such laboratory-based research has been a cornerstone of fisheries science during this century and its validity has been confirmed in field-based studies (Brett 1971, Shuter et al. 1980, Baker et al. 1995, Filbert and Hawkins 1995). Conversely field observations alone are often not reliable for deriving water quality criteria because of variability in the natural environment and the complexity of factors controlling natural systems and habitat response. Brett (1971) observed that "it is inherently difficult to examine existing conditions and deduce the important biological factors which have occurred in the past to explain the present". Laboratory studies were the basis for EPA recommended temperature criteria (U.S. EPA 1977) and field studies have been used mainly for validating the appropriateness of water quality criteria (Hansen 1989, Mount et al. 1984).

D. Data that should be used

All thermal tolerance data should be recorded in the database in case there becomes a need to use it in the future should the methodologies in this policy document change. The following data are preferred:

1. Acute Thermal Endpoints:

a. Ultimate Upper Incipient Lethal Temperature (UUILT): UUILT is the highest Upper Incipient Lethal Temperature (UILT) that can be produced by selection of an acclimation temperature. At the point where a certain high acclimation temperature is provided prior to estimating UILT, any further increases in acclimation temperatures do not result in higher UILT values.

b. Upper Incipient Lethal Temperature (UILT): UILT is an estimate of acute exposure maximum temperature relative to a previous acclimation temperature. It is the temperature at which 50% of the test organisms die within a 1- or 7-day exposure period, given a previous acclimation to a

[2] Sullivan K., D. Martin, R. Cardwell, J. Toll, and S. Duke. 2000. *An analysis of the Effects of Temperature on Salmonids of the Pacific Northwest With Implications for Selecting Temperature Criteria*. Sustainable Ecosystems Institute, Portland OR

constant lower temperature that is within the zone of tolerance of the organism. Generally, the higher the acclimation temperature, the higher will be the UILT, until the ultimate UILT is reached. At this point, further increases in acclimation temperature do not result in any further increase in UILT.

The most acceptable surrogate for UUILT is the UILT reported for the highest acclimation temperature. One caution would be because of the acclimation temperature effect; UILTs vary with acclimation temperature, so the highest UILT available may represent the UUILT, provided that acclimation was provided at temperatures near the upper limit of distribution in the field. In the case of UILT, acclimation temperatures must be recorded.

c. Critical Thermal Maximum (CTM) Data: CTM is an estimate of the median temperature reached in a gradually increasing temperature environment that produces either loss of equilibrium or death of test organisms. Important factors in CTM studies include the rate of temperature change and the initial acclimation temperature.

CTM data may be used if a valid relationship could be found between UUILT and CTM. CTM and UUILT may be correlated to see if a conversion factor can be developed.

2. Chronic Thermal Endpoints:

a. Optimum Temperature (OT): The optimum temperature is derived from the species-specific performance over a range of temperatures and includes parameters such as growth rate, digestion rate, gross conversion efficiency, swimming performance, metabolic scope, cardiac scope, etc.

Optimum temperature data from various studies are combined by taking the median of all reported optima data including lower and upper optima. This results in one central tendency OT value for a given species.

b. Growth Optimum (GO): The use of growth optimum (GO) data can be a surrogate for Optimal Temperature (OT). It is appropriate to include GO data from a well-designed, comprehensive study or set of studies looking at a wide range of temperatures *and* ration levels. However, studies that report optimal growth and reproductive success from laboratory studies are preferred.

c. Final Preferred Temperature: Final preferred temperature for fish given a wide range of thermal choices and enough time to select the temperature (multiple days) is also an appropriate surrogate for OT data. Acclimation temperature should not play a role in this, because studies of preference should be long enough that any prior acclimation effect is superseded by the

exposure to the experimental temperature; in thermal preference studies where the fish are given enough time to select their ultimate thermal preferendum, the same thing should happen.

3. Other data that should be recorded:

a. Acclimation temperature: the temperature within a species' tolerance zone that test fish are experimentally exposed to for several days (usually at least 14 days) before a tolerance test (Armour, 1991). Acclimation temperature affects the temperature range that a fish can tolerate.

b. Life stage: The life stage of the test organism at the time of the study is important to record.

E. The role/use of field data

The Commission intends field data to be used as validation of the calculated standards. In other words, field observations should be used to ground truth the values derived from laboratory test results.

Where field observations indicate that a species thought to be sensitive (based on laboratory data) thrives in conditions that are warmer than predicted by the laboratory data, such information should be considered in determining whether the criteria or standards need to be adjusted. Likewise, where field observations indicate that unacceptable effects occur at temperatures thought to be protective (based on lab data) such information should be considered in determining whether the criteria or standards need to be adjusted.

F. Species Criteria were developed based on the following steps:

1. Acute Species Criterion:

a. Acute Species Criterion: It is the policy of the commission to protect aquatic species from lethal effects due to temperature. A margin of safety (MOS) is subtracted from the temperature that causes an effect level in order to obtain a criterion that equates to a no-effect level.

b. Data Collection: Collect all thermal tolerance data with lethal (or near lethal endpoints). This includes ultimate upper incipient lethal temperature (UUILT), upper incipient lethal temperature (UILT), and critical thermal maximum (CTM) data for each species.

c. Data Consolidation: Compile all UUILT, and UILT data derived using acclimation temperatures typical of summertime temperatures in Colorado above the lower optimum temperature for each species.

If a scientifically defensible relationship can be found between the UILT data and the critical thermal maximum (CTM) data, this data can be used as well.

d. Data Selection: Select the median of the data.

e. Determination of MOS: Investigate what an appropriate MOS should be for the acute species criterion. Note: This may vary based on the species and/or the community criterion that is being calculated (e.g. cold and warm water species may require different MOSs).

f. Include Safety Factor: Subtract a MOS.

g. Record Species Acute Criteria: This value is then used as the species acute criteria.

2. Chronic Species Criterion

It is the policy of the commission to protect aquatic species from sub-lethal effects due to temperature.

a. Data Collection: Collect all thermal tolerance data with optimal endpoints. This includes OT, GO, final preferrenda. Record upper and lower optima where published.

b. "Upper Range of Optimum" Calculation: Select the median of the data reported to represent the upper end of the optimum temperature range reported for growth and reproduction.

If data are not available to calculate the upper range of the optimum, proceed to step three. If there was sufficient data for the upper bound for the optimum for a species – proceed to step 4.

c. "1/3 Rule" Calculation (where data are not available for the upper bound of the optimum):

i. Select the median of all the optimum temperature (OT) data reported for growth and reproduction.

ii. Select the median of the UUILT temperatures from the data collected. (Compile all UUILT, and UILT data derived using acclimation temperatures typical of summertime temperatures in Colorado above the lower optimum temperature, for each species.)

iii. Calculate the Chronic Species Criterion: Using the two temperatures calculated above**,** calculate the species chronic standard with the following equation:

Criterion = OT + 1/3 (UUILT-OT)

d. Record Species Chronic Criterion: This value can be then used to determine a community chronic criterion, or can be used for any site-specific criteria that focuses on this particular species as the most sensitive species.

G. Community Criteria were developed based on the following steps:

1. Acute/Chronic Community Criterion

The Commission determined that community criteria for acute temperature standards should be determined following the same methodology as the chronic temperature criteria. Therefore, there is a need to identify only one methodology for the community criteria. These steps are as follows:

a. Determine the species that are expected in the specific community.

b. Compile and rank the species data (acute or chronic) for the community.

c. Identify the value for the 95^{th} percentile species. (e.g. if there are 100 species, this would generally equate to the value that protects 95 of the 100 species).

d. Determine if there are commercially, recreationally or environmentally important species that would not be protected with the criteria developed using the 95^{th} percentile approach. If there are species that will not be protected, determine the value that would be protective of that species.

e. The more protective value (from Step #3 or Step #4) becomes the community criterion (acute or chronic).

IX. DATA QUALITY SCREENING GUIDELINES

A. Initial Data Screening Objectives

The following table outlines elements of a good study, or the data quality objectives, that must be considered when choosing data to be used in the database:

Initial Data Screening Objectives	
Element	**A good study includes…**
Replications	An adequate number of replications.
Endpoint of the Study	The intent to study thermal tolerances and Clearly stated biological endpoint that was used.
Acclimation History	Sufficient time for acclimation.
Acclimation Rate	The acclimation rate (this applies to Critical Thermal Maximum (CTM) and UILT studies).
Life Stage	The life stage of the test organism.
Appropriate Methods Employ appropriate controls Size of Fish	Same size fish are used throughout the study.
Appropriate Methods Employ appropriate controls Feeding State	Well documented Nutritional Status. (Noted that fasted fish prefer colder waters, fed fish prefer warm water and animals should not be fed within 24 hours of the study to decrease the stress due to digestion.)
Appropriate Methods Employ appropriate controls Standard environment	A standard environment should be used.
Peer Reviewed Study	Evidence that it has been Peer reviewed (Any grey literature should be noted.) Study present in a published scientific journal. Be from the original study. (although secondary citation may be necessary if the original study is not available)
Quality of Animals	Good quality Animals. Limit the stress on the animals – limited handling, not abnormally stressed, not subject to prior disease.
Field Conditions (where appropriate)	Collection under known conditions. Collection from known regions Lab Studies should have light similar to that season.
For field studies…	A natural environment during testing including competitors and predators. Normal physical environmental conditions/natural substrate, current speed and habitat complexity.
From hatchery	Information of known origin and history.
Number of Tanks for	Information on how many fish per tank. Will not be run with

Initial Data Screening Objectives	
Element	**A good study includes…**
Critical Thermal Maximum (CTM) Studies	more than one fish per tank.

B. Data Screening Process

The following steps should be considered in the initial data quality screening.

1. Determine if the intent of the study to investigate how fish respond to changes/differences in temperature (for lab and field studies).

If it was not, save the data and make a comment of the intent of the study. This data should not be used, unless necessary.

2. Determine if the data makes sense.

Was an appropriate range of temperatures used such that maximum lethal temperatures were evident at the higher end of the range, and/or an optimal temperature was distinguished from higher and lower temperatures? A list of fish species of Colorado that shows a rough estimate of the optimum range and the upper lethal temperature range can be developed from the 2005 Colorado Temperature database. This list will give a general idea of what temperature ranges are pertinent in a study.

3. Was the replication adequate?

4. If it is a laboratory study, are the design criteria met?

Check to see that the study did not deviate substantially from typical test procedures for upper incipient lethal and/or critical thermal maximum described in question 2.

5. If it is a field study, check to see whether the study was conducted in streams where another confounding stressor may have altered the results (e.g. in metals impacted streams, or in a lake where heavy parasitism was observed).

Studies should be flagged where less than 20 sites were used to establish a thermal gradient, since these studies may be used in the ground-truthing phase rather than in the calculations of the criteria.

6. Does the study return a set of useable, numeric values?

Qualifiers should be examined at this stage in the process.

The results of the data screening process will result in three sets of studies:

1. **USE** – this study is of good quality and should be used in the calculations

2. **SAVE** – this study may not be of good quality but it should be saved for ground truthing purposes

3. **DISCARD** – this study is not recommended for any use.

The data from the USE and SAVE categories will be entered into the database. The DISCARD data is not recommended for use and should not be entered into the database.

C. Data Rich Scenario

The policy of the Commission is that all studies are equal after the study/data quality screening is completed – no study should have more weight than another. Likewise, no studies should be discounted if it passes the initial data screening. In a rulemaking hearing the Commission may choose to exclude some data if a good rationale is presented why not to use this data.

D. Data Poor Scenario

The policy of the Commission is only use good quality data. Data that does not pass the initial data screening should not be used. In a rulemaking hearing, if there are no data for a species, the Commission may choose to include data from a surrogate species if a good rationale is presented.

E. Data Qualifiers

Qualifiers (such as less than, or more than) should be recorded and then some level of professional judgment will have to be applied as to how to handle that data. There may be many types of qualifiers that need to be recorded along with any numeric value. It is important for the compiler/analyst to recognize all the kinds of experimental conditions that could have a bearing on the results so that the results can be compared and contrasted. Some qualifiers might cause some numeric values to be discounted somewhat in importance if the conditions producing the result were somehow anomalous, unusual, or not typical of natural conditions or likely to elicit abnormal responses.

Regardless, significant qualifiers or caveats that are associated with experimental results should be collected and included in the dataset.

In many cases the temperature tolerance data are presented with the “less than” and/or “greater than." The Commission recommends that these are handled in the following manner:

1. **For optimum temperatures and UILT, the value X in a " > X" situation should be entered as the lower optimum or as an unadjusted UILT (that is, do not adjust with the 2°C safety factor). This is a conservative/protective approach, and allows the data to be used.**

2. **Do not use "X" temperature in an "< X" scenario for optimum and UILT temperature.**

   It could overestimate the value. For example using UILT data, the study reported a UILT of <17°C but the study was conducted between 17-21°C. If the species OT is actually 15°C then using 17°C does not reflect the optimum. Where possible, the data qualifiers should be interpreted in the most conservative fashion.

3. **These data should be evaluated on a case-by-case basis.**

X. DATABASE

A. Location

The temperature database will be housed at the Water Quality Control Division.

B. Updates

The database will be updated when recalculation procedure has occurred. Recalculations must involve a literature search for any new data. The database can also be updated with new studies as they are found.

XI. IMPLEMENTATION INTO REGULATIONS

The following reflects the Commission's current thinking about implementation of temperature criteria and standards, based on input at the April 2006 hearing on this policy. The Commission requests that the Division explore this implementation approach further in stakeholder group discussions. This approach to implementation will be considered in connection with the January 2007 rulemaking hearing, along with any alternative approaches that may be advanced.

A. Numerical Temperature Criteria

The revised numeric temperature criteria will be incorporated into Table I of the Basic Standards. Separate criteria will be developed for separate aquatic life subcategories, as determined appropriate. Table I contains criteria known as "table values" that are generally considered to protect the beneficial use classifications. For many parameters, table values are routinely used as the basis for site-specific standards for segments throughout each of the river basins, unless evidence is developed that establishes that an alternative site-specific numerical standard is appropriate.

The Commission does not intend to automatically apply the numerical temperature table values as standards for individual water segments throughout each of the river basins. Rather, the Commission intends that the numerical table values would be used in two ways:

As the starting point for implementation of a narrative temperature criteria, as described below; and

As the starting point for developing site-specific numerical criteria for individual segments where it is determined that there is a need for such standards.

B. Narrative Standard

A narrative standard will be added to section 31.11 of the Basic Standards to address human-caused alterations that may be detrimental to aquatic life. The table value criteria noted above will be used as the starting point for implementation of the narrative standard where an implementation issue arises (e.g., for discharge permits or section 303(d) listing issues). The Commission intends that implementation guidance would be developed to facilitate implementation of the narrative standard, although the Commission does not intend that implementation of the narrative standard would be delayed pending finalization of such guidance.

The table value criteria would be used as the default numerical values for implementation. However, the Division or other interested persons could bring forth information regarding site-specific circumstances that may warrant variation from the table value criteria in implementing the narrative standard in a specific instance, including implementation of the narrative standard for the purpose of section 303(d) listing.

C. Development of Site-Specific Standards for individual segments

As noted above, the numerical temperature table values would be used as the starting point for developing site-specific numerical standards for individual segments where it is determined that there is a need for such standards. Circumstances where there is a need for site-specific numerical standards may include, e.g., where a discharge may alter in-stream temperature, where there is a concern about potential existing impairment of in-stream temperature conditions, where the presence of a sensitive resource warrants specific protection against future adverse temperature changes, or where the numerical temperature table values are overly protective of aquatic life.

Although the numerical table value criteria would serve as a default for site-specific numerical standards where needed, where appropriate based on site-specific analysis the Commission may determine that alternative site-specific standards are appropriate.

As outlined in the Basic Standards at 31.7(1)(b) Ambient Quality-Based or Site-Specific Criteria Based Standards may be adopted by the Commission. These situations include:

1. Ambient Based Standards may be established where evidence has been presented.

31.7(1)(b)(ii) Ambient Quality-Based Standards

For state surface waters where the natural or irreversible man-induced ambient water quality levels are higher than specific numeric levels contained in tables I, II, and III, but are determined adequate to protect classified uses, the Commission may adopt site-specific chronic standards equal to the 85th percentile of the available representative data. Acute standards shall be based on table values or site-specific-criteria-based standards, and in no case may an ambient chronic standard be more lenient than the acute standard.

2. The Recalculation Procedure

One way to propose site-specific standards is included in this document above in Section X.B. Policy for Updating the Database. The Policy of the Division is to use a recalculation procedure modeled after EPA's recalculation procedures. The adapted Recalculation Procedure is included below.

XII. THE RECALCULATION PROCEDURE

The Recalculation Procedure is intended to result in a site-specific temperature criterion that differs from the aquatic life table value criterion if justified by differences between the aquatic species that occur at the site and those that were used in the derivation of the table value. There are at least three reasons why such differences might exist between the two sets of species. First, the statewide dataset contains aquatic species that are known to exist somewhere in the state, but these species might not occur at the site. Second, a species that is critical at the site might be sensitive to temperature and require a lower criterion. (A critical species is a species that is commercially or recreationally important at the site, a species that exists at the site and is listed as threatened or endangered under section 4 of the Endangered Species Act, or a species for which there is evidence that the loss of the species from the site is likely to cause an unacceptable impact on a commercially or recreationally important species, a threatened or endangered species, the abundances of a variety of other species, or the structure or function of the community.) Third, the species that occur at the site might represent a narrower mix of species than those in the statewide dataset due to a limited range of natural environmental conditions.

The phrase “occur at the site” includes the species, genera, families, orders, classes, and phyla that:

1) are usually present at the site.
2) are present at the site only seasonally due to migration.
3) are present intermittently because they periodically return to or extend their ranges into the site.
4) were present at the site in the past, are not currently present at the site due to degraded conditions, and are expected to return to the site when conditions improve.

5) are present in nearby bodies of water, are not currently present at the site due to degraded conditions, and are expected to be present at the site when conditions improve.

The taxa that "occur at the site" cannot be determined merely by sampling downstream and/or upstream of the site at one point in time. "Occur at the site" does not include taxa that were once present at the site but cannot exist at the site now due to permanent physical alteration of the habitat at the site resulting from dams, etc.

The definition of the "site" can be extremely important when using the Recalculation Procedure. For example, the number of taxa that occur at the site will generally decrease as the size of the site decreases. Also, if the site is defined to be very small, the permit limit might be controlled by a criterion that applies outside (e.g., downstream of) the site.

The concept of the Recalculation Procedure is to create a dataset that is appropriate for deriving a site-specific criterion by modifying the statewide dataset in some or all of three ways:

- Correction of data that are in the statewide dataset.
- Addition of data to the statewide dataset.
- Deletion of data that are in the dataset.

Each step is discussed in more detail below.

A. Corrections

1. Only corrections approved by the Water Quality Control Division may be made.

2. The concept of "correction" includes removal of data that should not have been in the dataset in the first place. The concept of "correction" does not include removal of a datum from the dataset just because the quality of the datum is claimed to be suspect.

3. Two kinds of corrections are possible.

a. The first includes those corrections that are known to and have been approved by the Water Quality Control Division; a list of these will be available from the Water Quality Control Division.

b. The second includes those corrections that are submitted to the Water Quality Control Division for approval. If approved, these will be added to Water Quality Control Divisions list of approved corrections.

4. Selective corrections are not allowed. All corrections on Water Quality Control Divisions newest list must be made.

B. Additions

1. **Only additions approved by the Water Quality Control Division may be made.**

2. **Two kinds of additions are possible:**

   a. The first includes those additions that are known to and have been approved by the Water Quality Control Division; a list of these will be available from the Water Quality Control Division.

   b. The second includes those additions that are submitted to the Water Quality Control Division for approval. If approved, these will be added to Water Quality Control Divisions list of approved additions.

3. **Selective additions are not allowed. All additions on Water Quality Control Divisions newest list must be made.**

C. The Deletion Process

The basic principles are:

1. **Additions or corrections must be made as per steps A and B above, before the deletion process is performed.**

2. **Selective deletions are not allowed.**

   If any species is to be deleted, the deletion process described below **must** be applied to all species in the statewide dataset, after any necessary corrections and additions have been made to the statewide dataset. The deletion process specifies which species **must** be deleted and which species **must not** be deleted. Use of the deletion process is optional, but no deletions are optional when the deletion process is used.

Comprehensive information **must** be available concerning what species occur at the site; a species cannot be deleted based on incomplete information concerning the species that do and do not satisfy the definition of "occur at the site".