Colorado Water Quality Control Division

WATER QUALITY PERMITS
Policies & Procedures

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Procedures for Conducting Assessments for Implementation of Temperature Standards in Discharge Permits

I. INTRODUCTION

The Basic Standards and Methodologies for Surface Waters (Regulation No. 31, 5 CCR 1002-31), as updated in 2007, provides a framework for implementing water quality standards throughout the State of Colorado. This guidance is designed as a framework to provide a documented methodology for implementation and to ensure that the temperature standards are interpreted in a consistent manner in water quality assessments prepared to support issuance of discharge permits.

This document is intended to provide guidance to Water Quality Control Division ("Division") staff and to the public regarding the implementation of the interim numeric temperature standards found in Regulations Nos. 32 – 38 (see Table A), and the other temperature standards found in Regulation No. 31 (see Table B). All of these numeric temperature standards and criteria were adopted by the Water Quality Control Commission (WQCC) during the January 2007 rulemaking hearing, and became effective July 1, 2007. The Water Quality Control Commission (WQCC) stated their intent that the numeric table values in Table A below be used as the starting point for establishing segment-specific numeric standards for individual segments, while providing an opportunity for a demonstration that alternative site-specific standards are appropriate. In Regulation No. 31, at Section 31.16, the WQCC has also established the more species-specific temperature standards seen in Table B, and stated their intent that these be adopted as further refinement of the temperature standards for segments around the State. As the normal triennial reviews of basin regulations around the state come up, the WQCC is expected to adopt the Table B criteria below as streams standards for individual segments, unless it decides that a more site-specific standard is appropriate. These numeric standards shall not be interpreted or applied in a manner inconsistent with section 25-8-104, C.R.S.

II. COLORADO WQCC TEMPERATURE TABLE VALUE STANDARDS

Table A
Interim Chronic* MWAT Temperature Criteria (°C) (Effective until December 31, 2012)

Cold Water Class 1 or Class 2				Warm Water Class 1 or Class 2
1st, 2nd, and 3rd Order Streams > 7000 ft in Elev.	CDOW Gold Medal Fisheries	Other Streams	Other Lakes	Streams & Lakes
17	18.2	20	20	30

* - Until segment specific temperature standards are adopted no acute standard will apply.

Table B Aquatic Life Temperature Criteria (°C)					
TEMPERATURE TIER	TIER CODE	SPECIES EXPECTED TO BE PRESENT	APPLICABLE MONTHS	TEMPERATURE STANDARD (°C)	
				(MWAT)	(DM)
Cold Stream Tier I	CS-I	brook trout, cutthroat trout	June – Sept.	17.0	21.2
			Oct. – May	9.0	13.0
Cold Stream Tier II	CS-II	brown trout, rainbow trout, mottled sculpin, mountain whitefish, longnose sucker, Arctic grayling	April – Oct.	18.2	23.8
			Nov. – March	9.0	13.0
Cold Lake	CL	brook trout, brown trout, cutthroat trout, lake trout, rainbow trout, Arctic grayling, sockeye salmon	April – Dec.	17.0	21.2
			Jan. – March	9.0	13.0
Cold Large Lake (>100 acres)	CLL	rainbow trout	April – Dec.	18.2	23.8
			Jan. – March	9.0	13.0
Warm Stream Tier I	WS-I	common shiner, Johnny darter, orangethroat darter	March – Nov.	24.2	29.0
			Dec. – Feb.	12.1	14.5
Warm Stream Tier II	WS-II	brook stickleback, central stoneroller, creek chub, longnose dace, Northern redbelly dace, finescale dace, white sucker	March – Nov.	27.5	28.6
			Dec. – Feb.	13.7	14.3
Warm Stream Tier III	WS-III	razorback sucker	March – Nov.	27.7	31.3
			Dec. – Feb.	13.9	15.2
Warm Stream Tier IV	WS-IV	all other warmwater species	March – Nov.	28.7	31.3
			Dec. – Feb.	14.3	15.2
Warm Lakes	WL	yellow perch, walleye, pumpkinseed, smallmouth bass, striped bass, white bass, largemouth bass, bluegill, spottail shiner, Northern pike, tiger muskellunge, black crappie, common carp, gizzard shad, sauger, white crappie, wiper	April – Dec.	26.5	29.3
			Jan. – March	13.3	14.6

Regulation No. 31.16 Table I Footnote 5 and Statement of Basis and Purpose language provides four situations that are not to be considered exceedances of the numeric table value standards.

1. Air Temperature Excursion: The ambient water temperature may exceed the applicable temperature standard when the daily maximum air temperature exceeds the 90th percentile value of the annual maximum air temperatures calculated using at least 10 years of air temperature data.
2. Low Flow Excursion: The ambient water temperature may exceed the applicable temperature standard when the daily stream flow falls below the acute critical low flow or

monthly average stream flow falls below the chronic critical low flow, calculated pursuant to Regulation 31.9(1)

3. Lakes and Reservoirs: When a lake or reservoir is stratified, the mixed layer may exceed the criteria in Table's A & B provided that an adequate refuge exists in water below the mixed layer. Adequate refuge depends on concurrent attainment of applicable dissolved oxygen standards. If the refuge is not adequate because of dissolved oxygen levels, the lake or reservoir may be included on the 303(d) List as "impaired" for dissolved oxygen, rather than for temperature.
4. Natural hot springs: Ambient water temperature in a water body may exceed the criteria in Table's A & B or the applicable site-specific standard, when the temperature in that water body is influenced by a natural hot springs

These four situations are only related to attainment of the standard for 303(d) listing purposes.

In Section 31.11(1) of the regulations, narrative standards are also applied to any pollutant of concern, even where there is no numeric standard for that pollutant. These standards can be paraphrased as waters of the state shall be "free from harmful substances in harmful amounts." Narrative criteria for temperature adopted by the WQCC are addressed in Footnote 5 of Table 1 located at 31.16. Specifically;

> "Temperature shall maintain a normal pattern of diel and seasonal fluctuations and spatial diversity with no abrupt changes and shall have no increase in temperature of a magnitude, rate, and duration deleterious to the resident aquatic life. These criteria shall not be interpreted or applied in a manner inconsistent with section 25-8-104, C.R.S."

The Regulation No. 31 Statement of Basis and Purpose goes on to clarify (with emphasis added) the WQCC's intention with respect to the narrative standard as follows:

> **Normal Pattern of Summertime Diel Fluctuation:** The narrative provision contains the requirement that temperature shall maintain a normal pattern of summertime diel fluctuation. The addition of "summertime" represents a modification of the longstanding language in the Basic Standards. While it is clear that aquatic life need nighttime cooling during the summers, to allow recovery from daily afternoon high temperatures, it is not clear that this recovery period is necessary during the rest of the year. A single value to protect summertime diel fluctuation would not address the myriad site-specific conditions, and so the Commission is relying upon the narrative statement. <u>The Division is directed to impose permit conditions where best professional judgment indicates such protection is necessary to protect the use.</u>
>
> **Normal Pattern of Spatial Diversity**: The narrative standard also contains the requirement that temperature shall maintain a normal pattern of spatial diversity. Spatial diversity is a concept that incorporates the importance of a distribution of conditions along the stream reach. Natural aquatic ecosystems have a range of temperatures available to organisms in microhabitats. This array of microhabitats makes it possible for a broader range of organisms and life-cycles to flourish in the aquatic system. Although spatial diversity is critical to a fully functioning aquatic community, the Commission does not see a way to quantify or define the lower threshold in regulation at this time. <u>The Commission's intent is that the Division use its discretion to implement the narrative requirement for spatial diversity in situations where there is evidence that an activity does or will create spatial uniformity that will threaten or impair the aquatic life use.</u>

Abrupt Changes / Thermal Shock: The thermal shock provisions were reviewed and revised. Even though there is a need to provide clear direction for implementation of the narrative prohibition of abrupt changes, the complexity of the phenomenon and the confusion over implementation indicate that Colorado is not yet ready for a numeric thermal shock criterion at this time. The Commission directs the Division to continue to explore means to protect aquatic life from anthropogenic thermal shock, with particular emphasis on an implementation strategy that is straightforward. The Commission expects to see a revised thermal shock proposal in the 2010 Basic Standards rulemaking proceedings. In the meantime, the Division is directed to impose permit conditions where best professional judgment indicates protection is necessary to protect the use from abrupt thermal changes.

As directed by the WQCC, the Division will use its best professional judgment to determine if permit conditions are necessary to protect the above aspects of the narrative standard.

III. WATER QUALITY ASSESSMENTS FOR DISCHARGE PERMITS

1. Framework for Determining When Temperature is a Pollutant of Concern and When an Effluent Limit Must be Included in the Permit

Consistent with the Basic Standards and Methodologies for Surface Waters ("Basic Standards") and the CDPS Regulations, this document describes the process for conducting a water quality assessment for the implementation of temperature standards into a discharge permit. Prior to conducting the assessment, a permit writer determines if temperature is a pollutant of concern for the discharge. This determination is made based on a review of the permit application and evaluation of the known or expected temperature of the discharge. Examples of information that may be used include effluent data, the type of industrial process generating the wastewater to be treated and discharged, the type of treatment process(s) used, and published information on the industrial sector.

If it is found that temperature is a pollutant of concern a quantitative assessment for temperature will be conducted. The first goal of the assessment is to determine if a discharge is excluded from a quantitative assessment of the assimilative capacity based on site specific characteristics or the low flow to discharge flow dilution ratio. When it is found the discharge is not excluded from further analysis, the maximum allowable temperature of the effluent that will not cause exceedances of the appropriate water quality standards (assimilative capacity) is calculated. Once the assessment is complete, the permit writer makes a determination of whether the discharge has reasonable potential to cause or contribute to an excursion of the applicable temperature standard consistent with the Division's *Determination of the Requirement to Include Water Quality Standards-Based Limits in CDPS Permits Based on Reasonable Potential: Procedural Guidance* (WQCD, February 2003). If there is reasonable potential, the permit must contain an effluent limit(s) for temperature. Consistent with the CDPS regulations and Division practices, compliance schedules are included for existing discharges as appropriate when a new effluent limit(s), or a limit lower than that in the current permit, cannot be met.

2. Exclusions from a Quantitative Assessment

Regulation 31.14(14) provides that, for two situations, no effluent temperature limitations will be required because natural conditions may prevent attainment of the standard. Because effluent limits are not required, a quantitative assessment is not needed.

a. **Effluent Dependent Waters**: No temperature effluent limit will be applied if a discharge is to an effluent dependent (ephemeral) stream and there is no evidence that the aquatic life use may be negatively affected by the thermal component of the discharge. In implementing this provision, the Division will consider all readily available and pertinent evidence regarding the potential for the thermal properties of a discharge to affect aquatic life (31.14(14)(a)).

b. **Natural Hot Springs:** No temperature effluent limit will be applied to a discharge of water from a natural hot springs, so long as that water enters the receiving water in the vicinity of its natural outflow (31.14(14)(b)).

IV. QUANTITATIVE ASSESSMENT

1. Standards Identification

The first step in conducting a water quality assessment for temperature is to identify the appropriate segment specific temperature standard that has been adopted by the WQCC and must be considered for implementation into the permit. These standards will normally appear in the segment specific numeric standards in WQCC basin regulations No. 32 through 38. In the absence of a site-specific standard, the interim Table A standards adopted by the WQCC as applied to all basin regulations will be used. Table B standards, or other site-specific values, will be applied once they become effective. In accordance with WQCC intentions, the Division may use appropriate biological data provided by the permittee to conduct a site-specific recalculation procedure as per *Temperature Criteria Methodology. Policy Statement 06-1 (*WQCC 2007). This site-specific recalculation procedure will be performed as part of the permitting process at the permittee's request if the information required to conduct the analysis is provided by the permittee at the time the permit application is received or a later date at the Division's discretion.

Data Review

Upstream data, or other data representative of upstream temperature, are needed to complete the quantitative assessment for temperature. As with other parameters, the Division will use (where available) the last five years of data to establish upstream conditions. A determination will be made as to whether available site-specific data is adequate for a quantitative assessment of temperature. When site-specific upstream temperature data is not readily available, the Division will use the best available data. This data could come from representative upstream sites, sites in similar watersheds, or sites with a demonstrable correlation to the receiving water of the discharge. The site chosen for comparison to a specific discharge point should be reflective of the monthly temperature variation upstream of the discharge point. Further collection of site-specific data to refine temperature assessments is encouraged by the Division. The representative instream data will be evaluated against the appropriate numeric standard(s), either the default values adopted from Table A, the values in Table B, or site-specific numeric value(s) adopted by the WQCC.

2. Temperature Data Requirements

Location: Temperature measurements should be taken from a location in the effluent and from a location (or locations) in the stream that are representative of the waterbody. Locations such as deep pools or exposed sidewater riffles may not be typical of the entire stream. The monitoring

location's characteristics will be used in the assessment to determine the available assimilative capacity.

Ambient Upstream Chronic Sample Timing: Ambient upstream temperatures will vary from day to day. The highest 7-day mean of daily average stream temperature, over a seven consecutive day period will be used in calculations of the chronic temperature assimilative capacity The daily average temperature should be calculated from a minimum of three measurements spaced equally through the day. Where monthly analysis of assimilative capacity is desired, the data should be collected so that at least 4 days occur in the month of interest. The use of recording thermographs is encouraged, but is not required.

Ambient Upstream Acute Sample Timing: Ambient upstream temperatures will vary from hour to hour. The highest 2-hour mean of stream temperature will be used in calculations of the acute temperature assimilative capacity. The highest 2-hour mean should be calculated from a minimum of 12 measurements spaced equally through the day. Data should be collected at least once during every 2-hour period. Again, the use of recording thermographs is encouraged, but is not required.

Chronic Sample Timing for Effluent:
The Weekly Average Effluent Temperature (WAET) will be the highest 7-day mean of daily average effluent temperature over a seven-day consecutive period, with the daily average calculated from a minimum of three measurements spaced equally through the day. The data should be collected on at least a daily basis with at least 4 days occurring in the month of interest. The use of recording thermographs is encouraged, but is not required.

Acute Sample Timing for Effluent:
The Daily Maximum Effluent Temperature (DMET) will be the highest 2-hour mean of effluent temperature. The daily maximum should be calculated from a minimum of 12 measurements spaced equally through the day. Data should be collected at least once during every 2-hour period. The use of recording thermographs is encouraged, but is not required.

3. Mixing Zone Considerations

Determination of the assimilative capacity for temperature standards will account for dilution of the effluent in the receiving water, where appropriate, consistent with the requirements of Regulation 31. These determinations will be made consistent with the Division's *Colorado Mixing Zone Implementation Guidance* (WQCD, 2002).

The implementation of a mixing zone in a permit for discharges to waters designated as critical habitat for threatened or endangered aquatic species is subject to review by the U.S. Fish and Wildlife Service in accordance with Appendix 4 of the Mixing Zone Guidance and a Memorandum of Agreement (MOA) between the Division, USFWS, and EPA (2007). Assessments for these waters will not necessarily follow the protocol described herein where that would conflict with the requirements of the MOA.

4. Antidegradation Considerations

The Division is still assessing the approach for implementation of antidegradation provisions with

respect to temperature. Any change from the protocol in the Division's *Antidegradation Significance Determination for New or Increased Water Quality Impacts Procedural Guidance* (WQCD, 2001) will be noticed in the Water Quality Bulletin for comment.

5. Assimilative Capacity Calculations

The Division will use a mass balance approach for determination of assimilative capacity (as shown in Equation 1 below). While this approach over simplifies heat transfer, it is a straight forward method that utilizes readily available information. Other more rigorous approaches, such as thermodynamic modeling, will be considered on a case-by-case basis. Because of the possible impacts to dischargers, the Division is open to specialized site-specific assessments. To calculate the upstream dilution flow, the current DFLOW low flow software will be used to predict the chronic (7E3), and acute (1E3) low flows. These are the lowest 7-day harmonic mean, and 1-day average flows, respectively, that recur once-in-three years.

Equation 1:

$$(T_{u/s} Q_{u/s}) + (T_{eff} Q_{eff}) = (T_{d/s} Q_{d/s})$$

$T_{u/s}$ = Upstream Temperature
$Q_{u/s}$ = Upstream Flow
T_{eff} = Effluent Temperature
Q_{eff} = Effluent Flow
$T_{d/s}$ = Downstream Temperature
$Q_{d/s}$ = Downstream Flow ($Q_{u/s} + Q_{eff}$)

a. Extreme Dilution Streamlined Assessment

Using the above mass balance equation the Division identified the following situations where, because of the physical properties of water in industrial WWTF effluent and common temperature characteristics of domestic WWTF effluent, that there is no reasonable potential for the effluent to cause or contribute to exceedances of water quality standards. These two situations are:

i. **Domestic Wastewater Treatment Facilities (WWTF):** Due to the temperature of domestic facilities generally not exceeding 30° C and the relatively steady-state nature of these dischargers, no temperature effluent limit will be applied to the discharge from a domestic WWTF if the ratio of the 7E3 annual low flow to the permitted flow is greater than 10:1.

ii. **Industrial Sources:** No temperature effluent limit will be applied if the discharge is from an industrial point source and the ratio of the annual 7E3 low flow to design flow is greater than 40:1. This is because at this high dilution the effluent temperature needed to cause exceedances of typical receiving water temperature are higher than that possible in liquid water. Where the permittee can demonstrate that the temperature of the discharge is less than 30° C and the variability of the discharge flow and temperature is similar to that of a

domestic WWTF, the Division has the discretion to exclude industrial discharges from further analysis where the annual low flow to permitted flow ratio is 10:1 or greater.

b. Calculating Chronic Assimilative Capacity for Temperature

For the interim temperature standards in Table A, an assessment will be done based on a chronic (7-day Avg.) annual basis. This assessment will calculate the allowable WAET. This will be done utilizing the annual 7E3 and the annual ambient MWAT in the mass balance calculation. In the future, when segment-specific standards are adopted by the WQCC, the specified Table B levels (or other adopted standards) will be used in Equation 2 for an assessment for each of the appropriate seasonal standards of the year. For seasonal calculations, the lowest monthly 7E3 low flow that occurs in the season of interest will be used in the calculation of that seasonal assimilative capacity. Monthly calculations may be allowed in some situations. However to streamline calculations this will only be applied where the Division feels further resolution on the assimilative capacity is necessary or the permittee demonstrates such need based on economic impact. Rearranging Equation 1 yields Equation 2 below.

Equation 2:

$$WAET = [(T_{d/s} * Q_{d/s}) - (T_{u/s} * Q_{u/s})] / Q_{eff}$$

$T_{d/s}$ = Applicable chronic MWAT temperature criteria, or other site-specific criteria
$Q_{d/s}$ = Downstream Flow ($Q_{u/s} + Q_{eff}$)
$T_{u/s}$ = Highest 7-day average temperature that occurs in the season of interest
$Q_{u/s}$ = Appropriate Upstream Chronic 7E3 Low Flow
Q_{eff} = Permitted Effluent Flow

c. Calculating Acute Assimilative Capacity for Temperature

Because there are no acute interim temperature standards, no assessment will be done for the acute assimilative capacity until segment specific acute standards are adopted.

In the future when segment-specific Daily Maximum (DM) standards are adopted by the WQCC, these specific Table B levels (or other adopted standards) will be used in Equation 3 for an assessment for each of the appropriate seasonal standards of the year. For seasonal calculations the applicable DM standard and the lowest monthly 1E3 low flow that occurs in the season of interest will be used in the calculation of the allowable Daily Maximum Effluent Temperature (DMET). Monthly calculations may be allowed in some situations. However to streamline calculations this will only be applied where the Division feels further resolution on the assimilative capacity is necessary. Rearranging Equation 1 yields Equation 3 below.

Equation 3:

$$DMET = [(T_{d/s} * Q_{d/s}) - (T_{u/s} * Q_{u/s})] / Q_{eff}$$

$T_{d/s}$ = Applicable DM acute temperature criteria from Table B, or other site-specific standard
$Q_{d/s}$ = Downstream Flow ($Q_{u/s} + Q_{eff}$)
$T_{u/s}$ = Highest 2-hour average temperature that occurs in the season of interest
$Q_{u/s}$ = Appropriate Upstream Acute 1E3 Low flow
Q_{eff} = Permitted Effluent Flow

V. ALTERNATIVE APPROACHES

If an entity is not excluded from temperature limitations, and will be unable to immediately meet effluent limitations derived from the assessment techniques presented in Equation 2, Equation 3, or other acceptable thermodynamic balance method, there are alternative approaches that may be pursued.

1. Recalculation of the Temperature Standard

As part of a permit action, where a site-specific recalculation procedure demonstrates that alternative numerical criteria are more appropriate for protection of aquatic life, these alternative criteria will be used for development of the quantitative assessment. This site-specific temperature recalculation procedure is outlined in *Temperature Criteria Methodology, Policy Statement 06-1* (WQCC, 2007).

2. CWA Section 316(a) Waiver

Consistent with section 316(a) of the federal Clean Water Act, and federal implementing regulations, the Division may impose alternate effluent limitations with respect to the thermal component of such discharge. The CWA states:

> *THERMAL DISCHARGES*
>
> *SEC. 316. (a) With respect to any point source otherwise subject to the provisions of section 301 or section 306 of this Act, whenever the owner or operator of any such source, after opportunity for public hearing, can demonstrate to the satisfaction of the Administrator (or, if appropriate, the State) that any effluent limitation proposed for the control of the thermal component of any discharge from such source will require effluent limitations more stringent than necessary to assure the projection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in and on the body of water into which the discharge is to be made, the Administrator (or, if appropriate, the State) may impose an effluent limitation under such sections for such plant, with respect to the thermal component of such discharge (taking into account the interaction of such thermal component with other pollutants), that will assure the projection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in and on that body of water.*

In 1977 the USEPA prepared an Interagency 316(a) Technical Guidance Manual to provide direction on how to prepare 316(a) assessments for temperature limitation waivers (EPA, 1977). This guidance is currently being updated by USEPA, with no date yet set to being completed. To facilitate WQCD evaluation of 316(a) assessments it is very important that any entity considering such an assessment contact the Division before beginning that assessment.

VI. REFERENCES

"Basic Standards and Methodologies for Surface Water", Regulation No. 31, Colorado Department of Public Health and Environment, Water Quality Control Commission, effective May 31, 2008.

"Colorado Mixing Zone Implementation Guidance," Colorado Department of Public Health and Environment, Water Quality Control Division, April 2002

"*Determination of the Requirement to Include Water Quality Standards-Based Limits in CDPS Permits Based on Reasonable Potential*", Colorado Department of Public Health and Environment, Water Quality Control Division, February 2003.

Interagency 316(a) Technical Guidance Manual and Guide for Thermal Effects of Nuclear Facilities Environmental Impact Statements [Draft], U.S. Environmental Protection Agency, May 1977.

"Memorandum of Agreement (MOA) among the Colorado Department of Public Health and Environment's Water Quality Control Division, the U.S. Fish and Wildlife Service's Colorado Field Office and the U.S. Environmental Protection Agency Region 8's Ecosystem Protection and Water Programs Regarding Enhanced Coordination in Implementing Colorado's Mixing Zone Rule/Implementation Guidance and the Service's August 11, 2003 Biological Opinion on this Matter" October 2005.

"Temperature Criteria Methodology. Policy Statement 06-1". Colorado Department of Public Health and Environment, Water Quality Control Commission, Approved December 2007.