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MEMORANDUM

TO: Upper Colorado River Wild and Scenic Stakeholder Group (SG)

FROM: Torie Jarvis, QQ Director, and Bill Hoblitzell, Lotic Hydrological
Reviewed by an informal temperature standards workgroup

DATE: April 13, 2018

SUBJECT: Background on temperature exceedances, temperature standards, and standard setting at the Water Quality Control Commission

1 Introduction

The Upper Colorado River Wild and Scenic Stakeholder Group Management Plan ("SG Plan") establishes provisional Resource Guides to assist with protection of the outstandingly remarkable values (ORVs) in the Upper Colorado Wild & Scenic Segments ("W&S Segments," which includes Segments 4-7). The provisional Resource Guides in the SG Plan are "one source of information among others for informing SG discussions under the Plan. The Resource Guides are not intended to be used as a test for Plan success, nor for use by permitting agencies or entities as the criterion for evaluating a project's effects on the ORVs."[1]

The SG Plan states that, during the provisional period:

> The Resource Guides for temperature are the CDPHE stream temperature water quality standards for Daily Maximum (DM) and Maximum Weekly Average Temperature (MWAT) for the portion of the stream segment that CDPHE has designated COUCUC03 . . . that is within Wild and Scenic Segments 4 through 7.[2]

[1] SG Plan, III.A.2 at 17.
[2] SG Management Plan, III.C.4. at 23.

The 2016 Monitoring Report for the Stakeholder Group (SG) identifies ongoing exceedances of the WQCC temperature standard for the W&S Segments. Most exceedances are Maximum Weekly Average Temperature (MWAT) exceedances occurring mid-summer at Dotsero, also known as the Upper Colorado above the Eagle River, (at border between W&S Segment 6 and 7) and No Name Creek (W&S Segment 7). However, all temperature sites have logged at least one MWAT exceedance. This trend appears to have continued in 2017. There has been only one daily max (DM) exceedance in the W&S Segments, logged at Dotsero in 2013.

These ongoing exceedances may provide an opportunity for SG discussion of temperature as a Provisional Resource Guide for the fishing ORV.[3] The purpose of this memorandum is to provide background on both the existing W&S dataset regarding temperature and some of the regulatory tools used by the WQCC to address temperature issues to aid in those discussions.

This memorandum does four things: 1) summarizes existing temperature data from the SG for sites within W&S Segments; 2) provides background on WQCC's temperature standard and the process for setting and adjusting standards; 3) highlights some available regulatory pathways, should temperature exceedances be determined to be natural or irreversible; and 4) begins to gather outstanding questions and to identify additional data needed to more fully understand temperature issues.

2 Existing Temperature Conditions in Wild & Scenic Segments

The available data compiled from the SG Monitoring Committee from 2012-2017 shows multiple exceedances of the WQCC temperature standards on the three WQCD sub-segments comprising the W&S Segments (Figure 1 to show MWAT; Figure 2 to show DM). The WQCC establishes numeric and narrative temperature standards for designated segments of the state's waterbodies to protect identified uses (recreation, aquatic life, agriculture, etc.). The W&S segments are within Segment COUCUC03, which includes the mainstem of the Colorado River from the outlet of Lake Granby to the Roaring Fork River. It is classified as Cold Stream Tier II for temperature standard purposes. The temperature standard for April-October is 18.3˚C (MWAT) and 23.9˚C (DM)[4], and, Nov-March, is 9˚C (MWAT) and 13˚C (DM). COUCUC03 is a long segment, extending approximately 130 miles from the outlet of Lake Granby to the confluence with Roaring Fork River in Glenwood Springs. Segment COUCUC3 is further divided into subsegments A through E; the W&S Segments are captured in subsections C, D, and E (shown as 3 different colors in Figure 3, p.7).

[3] The Resource Guide for temperature is for the entirety of the Wild & Scenic stretch, Segments 4-7, while the Plan only identifies the fishing ORV in Segments 4-6.

[4] The DM has changed in statewide water quality regulations (Reg. 31, 5 CCR 1002-31) to 24.3, and will be incorporated into the Upper Colorado Basin standards (Reg. 33, 5 CCR 1002-33) in 2019.

No Name and Dotsero[5] sites, at the downstream end of the segment, remain the most-consistent problem areas (Figure 3). The included figures demonstrate lower flow years produced more days and more sites with MWAT standard exceedances, although exceedances still occurred in more typical flow years at a smaller group of sites (Figure 4).[6]

The WQCC, through its staff, the Water Quality Control Division (WQCD), has found ongoing exceedances of the temperature standard in subsegments C through E (Kremmling to Roaring Fork River, which comprise the W&S Segments) utilizing its own data. Because of a documented failure to attain temperature standards, the WQCD recently added these segments to the 303(d) list of water quality-limited segments ("the 303(d) list").[7] The specific dataset of sites and years used by WQCD to support the segment listing has not yet been obtained and evaluated by the SG, but should be available from the WQCD upon request. For more information about 303(d) listings, see Section 4.1, below.

The sub-segment above the W&S Segments and the segment below the Wild & Scenic segments (COUCUC03_A and COLCLC01 respectively) also have ongoing exceedances of summer temperature standards, and they, also, are 303(d)-listed for temperature. The downstream segment (from the confluence of the Roaring Fork to below Rifle Creek), is categorized as Cold Stream Tier II fishery with the same temperature standards as the W&S Segments.

Not all temperature monitoring sites recorded exceedances in all years; data gaps and outstanding questions remain. Figures, tables, and charts provided here are meant to illustrate the overall temperature regime on the W&S Segments, and utilize only temperature data collected by the SG Monitoring Committee. Preliminary datasets may still contain errors or provisional data and conclusions that still need QAQC checks and additional analyses.

2.1 Summary of available data

The following figures illustrate the spatial and temporal nature of temperature issues in the W&S Segments, based on temperature data from the SG.

Figures 1 and 2 display the complete W&S temperature dataset. They show the available period of record and monthly gaps by site, as well as the basic timing and occurrences of exceedances. Weekly average temperature (WAT) is calculated as a rolling seven-day average of daily mean temperatures from each site's 15-minute recording interval.

[5] Note that this memorandum refers to the "Dotsero" gage, which is called "Colorado River above Eagle" within the SG. Dotsero is an abbreviated name for the same gage.
[6] There is potential for additional research and graphics that could examine other influences on water temperature (e.g., air temperature and water temperature, or elevation and water temperature).
[7] Note: a 303(d) listing is not a Resource Guide for temperature.

The most complete datasets exist at the Kremmling site (at the Hwy 9 bridge, upstream of the Blue River confluence) and the No Name site, at the lower end of Glenwood Canyon just upstream of the confluence of No Name Creek and the Colorado River. At these sites, 6 years of data are reported, and monitoring successfully captured the peak of summer warming at each location—usually late July or early August. The remaining sites have 2 to 5 years of data, and occasionally failed to capture peak summer temperatures, possibly due to sedimentation of the data logger or other issues.

The number of days with MWAT exceedances across the study area demonstrate that the most downstream two sites (Dotsero, at the end of Segment 6, and No Name, in Segment 7) more frequently fail to meet the temperature standard. However, this observation requires qualification, as the intermediate sites between Pumphouse and Red Dirt have fewer years in the data record and sometimes failed to log the peak seasonal temperatures.

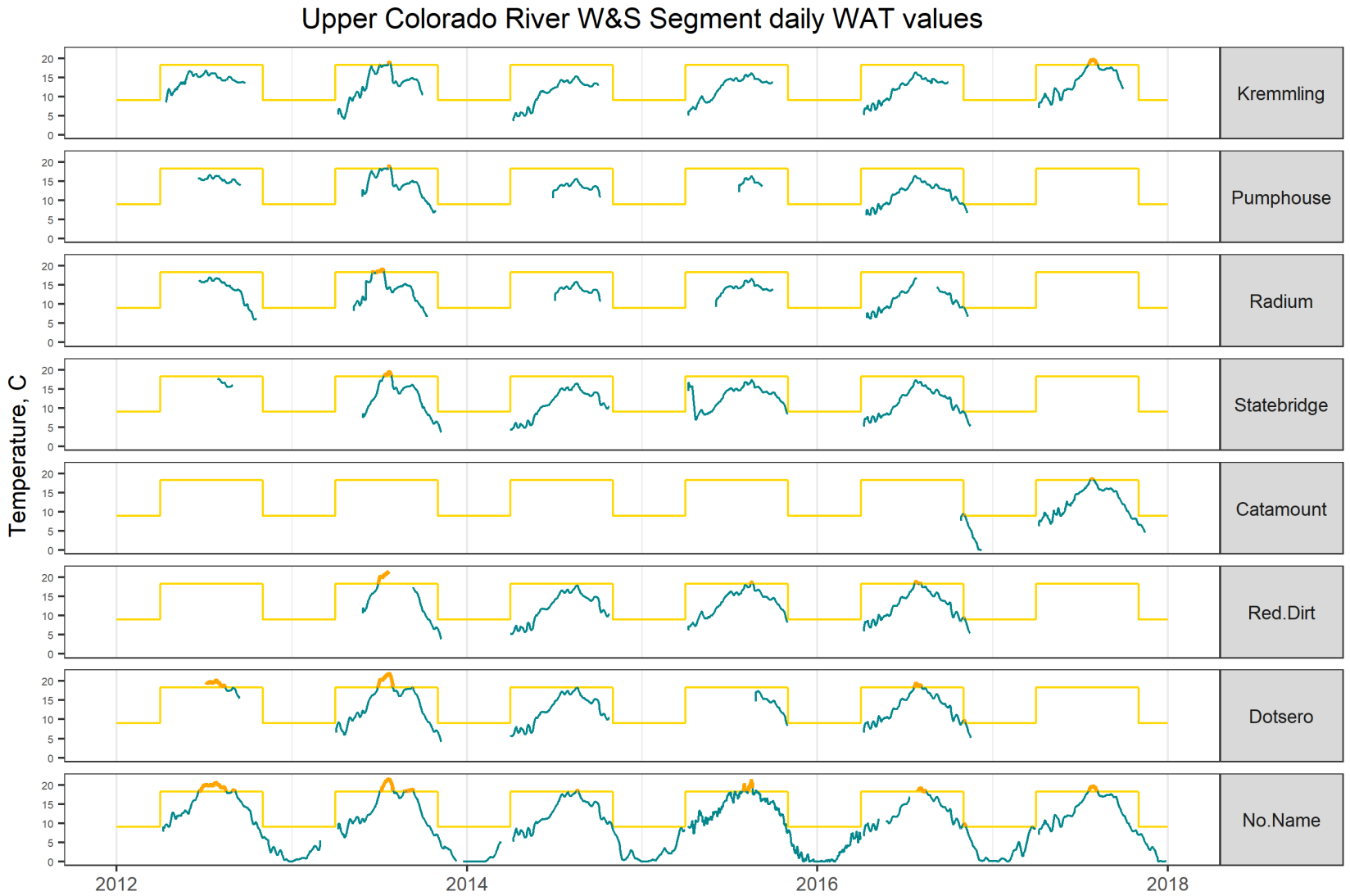

Figure 1. Available Wild & Scenic temperature time series by site. Days with MWAT exceedances are displayed in orange. These datasets are provisional and may require further cleaning and QAQC prior to submittal or inclusion in regulatory processes.

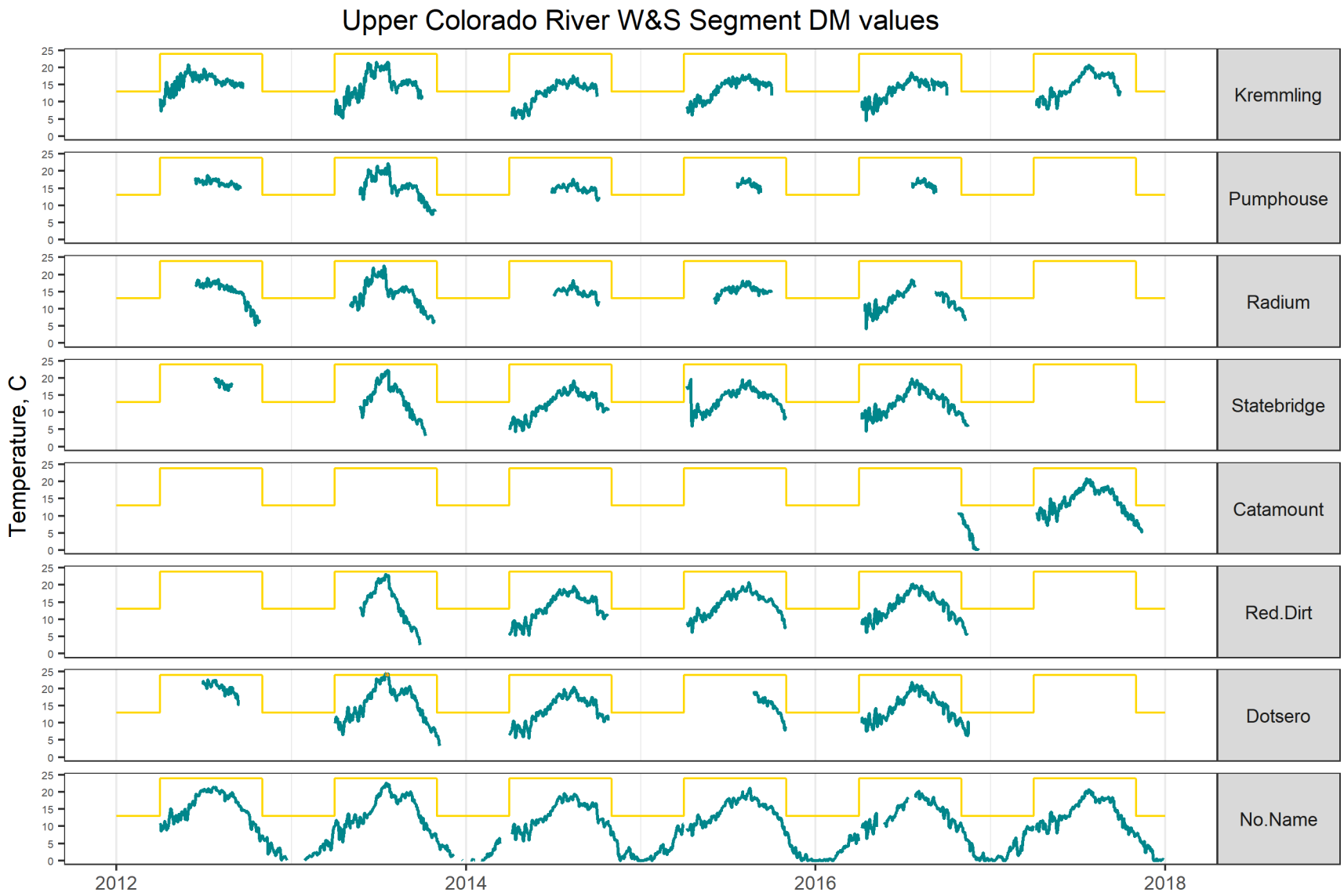

Figure 2. Available Wild & Scenic temperature time series by site. Days with DM exceedances are displayed in orange. These datasets are provisional and may require further cleaning and QAQC prior to submittal or inclusion in regulatory processes.

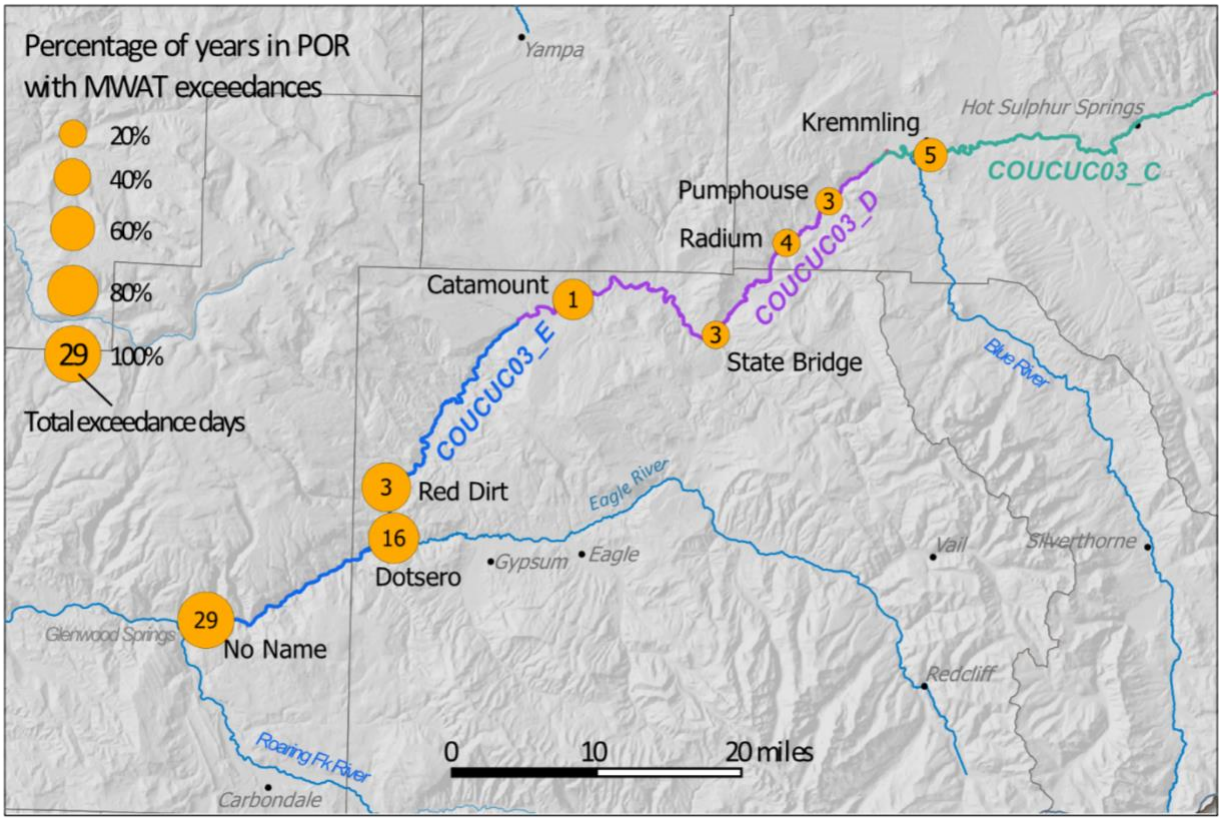

Figure 3. Temperature monitoring site locations. Green circles at monitoring sites are proportionally sized to symbolize the number of days with WAT exceedances at that site in its available Wild & Scenic data record.

Figure 3 shows the number of "official" MWAT exceedances on a seven-consecutive-day rolling average at each W&S monitoring site, calculated by the Monitoring Committee. In contrast, the rest of the figures illustrate total number of days with exceedances (which results in a higher number). The only reason the other figures use raw number of exceedances is simply resource allocation (it would have taken significant additional consultant time to do otherwise).

Figure 4 compares the total number of MWAT exceedances, by site and by year, to the water year flow percentiles for the 40-year record of annual mean daily flow at the Dotsero gage. This figure requires careful qualification, since not all sites had full data records. Notably, while MWAT exceedances are more prevalent in dry years (2012, 2013), they still occur even in average flow years (2016, 2017), and even in wet flow years (2014) at the two downstream sites. In summary, Figure 4 demonstrates that lower-flow years experience higher exceedance frequencies, and vice versa. However, mean annual flow should be understood only as a very coarse characterization of flow conditions in a given year. Exceedances may result from a host of factors such as river flow management, local diversions, spring runoff timing and magnitude, summer heat spells, and elevation-related climate gradients.

Figure 4

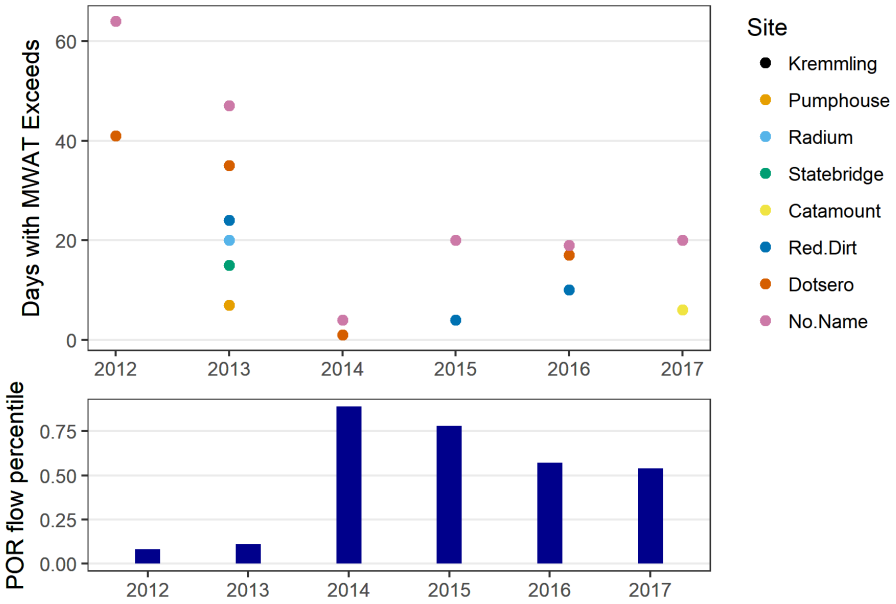

Figure 4. Upper panel: MWAT exceedance count by site by year. Lower panel: Flow year percentile. The period of record (POR) flow percentile compares mean annual daily cfs for the USGS Dotsero gage 09070500, from 1946-2017. Note: Many monitoring sites have missing data years or did not capture the seasonal temperature peak due to sedimentation or other issues, therefore the number of days with MWAT exceedances is a conservative estimate.

2.2 Existing research on temperature regime drivers

Of the currently compiled literature available to the SG, few studies have dealt with temperature issues through the W&S segments of the Upper Colorado River. The Colorado River Inventory and Assessment (CRIA), completed by Colorado State University in 2013 for Eagle River Watershed Council, conducted a limited analysis of water quality issues in the reach, including sediment, macroinvertebrates, and temperature.[8] In the Executive Summary, the CRIA suggested that "elevated temperatures within the study area are primarily a consequence of tributary influences and reservoir operations in the upper watershed. Further investigation during the summer months by collecting continuous data from each tributary and in the main stem above and below each tributary, especially in August, is recommended to fully understand the influence of tributaries on main stem temperatures."[9] The study contains additional analyses that may be of interest to the SG in its future discussions.

As additional existing or new temperature literature pertaining to W&S segments becomes available, stakeholders are encouraged to bring them forward to the group to provide additional shared understanding of the temperature situation. Other potential factors to consider, such as increased local diversions, spring runoff timing and magnitude, summer heat

[8] Beeby, Bledsoe, and Hardie, Colorado River Inventory and Assessment, Colorado State University for Eagle River Watershed Council, at viii (2013). *See also*, Section 3.7.3, "Water Temperature In the Upper Watershed," 96-108. Available at http://www.erwc.org/projects/current-projects/colorado-river-restoration-conservation-project/.
[9] *Id.* at viii.

spells, and elevation-related climate gradients, are highlighted in Section 5, outstanding questions identified.

3 Background on Water Quality Control Commission (WQCC) temperature standards and processes

The WQCC revises water quality standards for specific stream segments on a basin-by-basin level or on a statewide level, conducting a triennial updating and review cycle culminating with a rulemaking hearing to review existing classifications and standards and consider proposals for changes to standards, called the Classifications and Numeric Standards Hearing ("Standards Hearing"). In preparation for the Standards Hearing, the WQCC first holds an Issues Scoping Hearing to broadly identify issues expected in the Standards Hearing. The WQCC holds a second hearing, the Issues Formulation Hearing, to identify more specific issues for changes proposed by the WQCD or other parties.

WQCC Upper Colo. (Reg. 33)
Rulemaking dates:
- *Oct. 2017: Issues Scoping Hearing*
- *Nov. 13, 2018: Issues Formulation Hearing*
- *June 10, 2019: Standards Hearing for Upper Colo. (Reg. 33)*

WQCC Regulation 33 establishes water quality standards for the Upper Colorado Basin, including temperature.[10] The WQCC has already held the Issues Scoping Hearing for Reg. 33 for this rulemaking cycle, with the Issues Formulation Hearing scheduled for late 2018 and the Standards Hearing set for June, 2019. WQCD proposals for changes to classifications and standards for the Upper Colorado River Basin rulemaking will likely be publicly available in December, 2018. At that time, stakeholders may decide if they would like to bring forward their own proposals and/or be parties to the rulemaking and respond formally to any proposals. Because of the attention drawn to temperature issues and disagreements surrounding various proposals in the statewide rulemaking held in 2016, significant continued interest and engagement by Colorado Basin parties should be anticipated.

In addition to these basin-wide standard and classifications hearings, a party may propose site-specific standards and classifications to the WQCC for segments within a basin anytime outside of the WQCC's basin-wide review cycle.

4 Available strategies to address temperature issues

4.1 303(d) listing

In addition to setting water quality standards that are protective of the identified uses, the WQCC through the its staff, the WQCD, identifies stream segments that are not attaining established standards and lists them either in a "303(d) list" or in a "Monitoring and Evaluation

[10] 5 CCR 1002-33, at https://www.colorado.gov/pacific/sites/default/files/33_2017%2809%29.pdf.

List" depending on the circumstances. The WQCD listed all three subsections that encompass the W&S Segments on the 303(d) list for failure to meet temperature standards.[11]

This recent listing is relevant to the SG Process because it demonstrates that the WQCD has documented exceedances of the temperature standard through the W&S Segments, and because, once listed, the WQCD may undertake additional studies of 303(d)-listed segments.

Traditionally, a 303(d) listing initiates a Total Maximum Daily Load (TMDL) process for pollution budgeting. Sources of pollutants are identified, and a total pollutant load for the stream that would still result in attainment of numeric standards is allocated among various sources, natural or anthropogenic. While this approach works well in traditional point-source water pollution scenarios such as industrial discharges, it may not function well in the W&S Segments, where thermal influences are predominantly unrelated to traditional point sources. The Upper Colorado between Kremmling and Glenwood contains few or no point-source thermal discharges, has minimal or no NPDES permitted dischargers, and the segments are in an undeveloped watershed with relatively high-functioning riparian zones and uplands.

The CRIA hypothesized the major predictor of water temperatures in the Upper Colorado to be differences in source-water entering the system upstream of the W&S segments. Authors identified the most-effective mechanism to potentially manage temperature to be the manipulation of reservoir release mixes from the Blue, Williams, Muddy, and mainstem Colorado Rivers.[12] From the SG perspective, this might be a topic to discuss with the Cooperative Measure committee.

Advantages and disadvantages: While there may be funding available to evaluate temperature issues in 303(d)-listed river segments, the process can be long. The WQCD typically seeks to assign causes and initiate TMDL processes or other measures within 10 years. This approach may not function well in the W&S Segments since, as noted above, there are no significant discharges and the wide river already contains well-functioning riparian zones and watershed uplands. As mentioned above, the SG may consider having the Cooperative Measures committee explore temperature solutions.

4.2 WQCC approaches to temperature standards

4.2.1 Resegmentation

Resegmentation involves reassignment of stream segment boundaries, potentially based on a demonstration that aquatic life communities differ or there are substantial physiographic or political subdivision reasons for adjusting segment boundaries and changing use classifications. A proposal for resegmentation would provide alternate ways to assign river temperature

[11] The WQCD also put segments within the W&S Segments on the Monitoring and Evaluation list for arsenic and macroinvertebrates. Arsenic is a drinking water standard and thus not of concern to the SG.
[12] CRIA Section 3.7.3, p 100-108.

standards. To address temperature, a new proposed segment would be categorized as a different category of fishery, for example a warm water fishery instead of a cold water fishery. This would require documentation that a difference in expected and observed species assemblages occurs in the reach, such that a different temperature standard would still protect the existing aquatic life.

Advantages and disadvantages: Resegmentation may appear as an advantageous approach because this is a long-distance reach. Sometimes, in longer segments, the lower end may more appropriately be a warm water fishery or blend aspects of warm and cold water fisheries. The W&S segments are categorized as Cold Water Tier II (CS2) for temperature, based on the fish species expected to occur in these segments, with the next temperature standard being for a warm water fishery (WS1). CS2 is generally indicative of a salmonid (trout) fishery, containing slightly less sensitive species such as brown and rainbow trout. Notably, the segment of the Colorado River below the W&S Segments (Glenwood Springs to Rifle) is also a CS2 fishery. A resegmentation approach would likely require more in-depth data analysis of fish populations to determine appropriateness. CPW personnel have indicated that existing data, even though potentially sparse in spatial and temporal coverage, indicates a cold-water salmonid fishery.

4.2.2 Site-specific standards

WQCC regulations allow for site-specific standards either based on the feasibility of achieving a numeric standard ("ambient quality-based standards") or based on a site-specific analysis approved by WQCC such as through a use attainability analysis ("site-specific-criteria-based standards").[13]

Advantages and disadvantages: Proponents must establish that a site-specific approach justifiably recognizes ambient conditions that don't fit well into the existing regulatory framework. Statewide, some parties opposed to this approach have noted that it may be a convenient method to accept and brush aside drivers of temperature stress on the reach by enshrining the current status quo. Given the downstream segment is also listed as a CS2 fishery, it's difficult to envision changing upstream segments without a more coordinated effort to look at temperature downstream as well.

Also, there is an underlying question of whether the observed conditions on the W&S Segments could have ever been truly "ambient" or "naturally occurring," given that the mainstem Upper Colorado temperature regime may be influenced from water diversions and operations and land use prior to entering the lower reach.

As Section 5 notes, a better understanding of the WQCD's plans for addressing temperature, if any, in the upcoming Reg. 33 hearing would be a good next step.

[13] 5 CCR 1002-31.7(1)(b)(ii-iii).

4.2.3 Temperature standard adjustments in transition zones

In 2015 and 2016, during the statewide rulemaking for Regulation 31 (Basic Standards and Methodologies for Surface Water), WQCC considered proposals from WQCD for statewide changes to temperature standards to address statewide problems with so-called "transition zones," where temperatures may naturally warm due to changes in gradient, elevation, and climate.[14] WQCC elected to address temperature issues through the basin-specific rulemakings instead of instituting statewide standard changes.[15]

While the W&S Segments may be in an area the WQCD would target for changes in temperature standards through a transition zone, this particular option is complicated by the fact that the segment immediately below the W&S Segments, from the Roaring Fork to below Rifle Creek, is also categorized as a Cold Water II fishery. This indicates the W&S Segments are not transitioning to a warm water fishery, although significant water volumes of cold tributary inputs from the Roaring Fork River may partially support a case for a discontinuity in upstream/downstream temperature regimes. Advantages and disadvantages of the approach listed in this subsection are absent pending further consultation with WQCD on its merits.

5 Outstanding questions identified

An informal group of interested SG members ("temperature standards workgroup") met via conference call on February 12, 2018, to discuss this memorandum. The group identified several preliminary questions that could be helpful in more fully understanding temperature as a Resource Guide in the SG Plan. This section outlines those preliminary questions in Section 5.1 and lists a number of additional data-related questions in Part 5.2.

There are separate questions on how ongoing exceedances are addressed by the SG moving forward. This white paper does not address those questions.

5.1 Preliminary outstanding questions

a. Should temperature standards be a Resource Guide for the whole of the SG Segments 4-7 (as currently written in the SG Plan), or only for those with a fishing ORV (4-6)?
b. What is the cause or causes of temperature exceedances through the W&S Segment? While this white paper reviews some general conclusions from the Colorado River

[14] The same rulemaking also looked at WQCD proposals to address exceedances during shoulder seasons (spring and fall season), which are not as relevant to temperature exceedances in the W&S Segments, where exceedances mostly occur mid-summer.
[15] During the 2017 Gunnison Basin rulemaking, WQCD staff recommended changes to temperature standards on many stream segments based on existing exceedances that they believed were natural conditions, as well as modeled projections of stream segments that may experience exceedances due to certain factors. These site-specific changes were supported by Use Attainability Analyses (UAAs).

Inventory and Assessment, the SG may wish to do additional research on the causes of temperature problems.

c. What is the WQCD currently thinking about potential temperature standard changes in the Upper Colorado region? Do they anticipate any proposals for W&S Segments or major tributaries? (Initial feedback from the WQCD was that they would start looking at proposals for the Upper Colorado, including temperature, in late summer or early fall 2018)[16]

5.2 Data-related outstanding questions

a. What other temperature data exists that should be considered? In particular, what data did the WQCD use in their determination to add COUCUC03_C through COUCUC03_E to the 303(d) list? What temperature data does GCWIN currently have, if different from the W&S dataset?
b. What are the main influences on temperature, either naturally-occurring or human-created, and to what degree is temperature affected? (also captured in 5.1.b., above)
    i. While Section 2.2 discussed causes identified in existing literature, there are other factors about which additional research could occur, including information regarding river flow management, local diversions, spring runoff timing and magnitude, summer heat spells, and elevation-related climate gradients
    ii. While Section 3.2 identified the presence of upstream reservoirs as a potential influence on temperature, to what extent is this true? How far downstream do impacts persist? Are impacts more significant in some locations?
    iii. Additional graphics could be developed that track ambient air temperature compared to water temperatures.
    iv. The Windy Gap Firming or Moffat Environmental Impact Statements may be another source for information on temperature in the Upper Colorado.
c. What are the influences of the tributaries to the Upper Colorado throughout the W&S Segments (warming or cooling in particular)?
    i. Could obtain the original CRIA analyses and outputs from CSU for further review
    ii. Additional loggers could be deployed to the existing GCWIN sites for modelling and simulation of reservoir influences on downstream temperature regime (Blue R, Muddy Ck, Williams Fk, CO @ Windy Gap, Fraser R, CO abv Fraser R)
d. What is the effect of sending water downstream when there is a Cameo call versus not? How do those releases track with exceedances?
e. Depending on the desire to look at site-specific or other temperature standard change options, how much additional fisheries data would be needed? E.g., for resegmentation, documentation of a shift to warm water fishery would be required.
    i. Additionally, does the SG already have access to this type of fish data that could contribute to an investigation of temperature exceedances.

[16] Email communication, Torie Jarvis and Blake Beyea, Standards Unit Manager, WQCD, April 3, 2018.

f. Outstanding questions related to particular monitoring sites:
    i. Re: No Name, are there unique warming influences such as the Shoshone Reservoir or naturally-occurring hot springs?
    ii. Re: Dotsero, there is an 7-year temperature dataset by USGS available at the Dotsero gage from 1980-1998 and 10 years of data from 2008-2018 available at the Gore Canyon gage below the Blue River confluence. It could be analyzed to create a statistically stronger dataset for frequency of exceedances, seasonal regime characteristics, and temperature modelling inputs on this reach. Would the SG want to pursue this additional analysis?
        - It may add context or depth the W&S dataset by:
            - Describing temperature regimes, including the frequency and seasonal timing of MWAT or DM exceedances, for a longer time period that both overlaps (Gore Canyon gage) and precedes (Dotsero gage) the record included in this paper.
            - Supply a long-term dataset for modelling relationships between temperature, flows (paired stream gage), and air temperatures (long term record at very nearby Gypsum airport).