DRAFT REPORT
COLORADO RIVER FLOW REGIMES, PRELIMINARY ANALYSIS

HABITAT-RELATED FLOWS FOR FISHERIES AND FLOWS FOR RECREATIONAL USES

EAGLE COUNTY, COLORADO

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EXECUTIVE SUMMARY

This report presents the preliminary analysis for the recommendation of flow regimes in the Colorado River in Eagle County, Colorado, to support non-consumptive water use. Specifically, this analysis includes recommendations for **habitat**-related flows for **fisheries** and flows for **recreational** uses. The study reach begins upstream of the Eagle River confluence and extends for approximately 40 miles to the Eagle-Grand County line. **This initial effort provides a quick estimate for a range of flows for several key resource parameters**. The results of this preliminary analysis are presented below.

Table ES-1. Summary of Preliminary Recommended Flows

Environmental Flows (habitat-related)	**Critical Flows**	**Optimum Flows**	**Maximum Flows**
October through March	400 cfs	600 cfs	Na
April through September	600 cfs	1000 cfs	Na
Recreation	**Critical Flows**	**Optimum Flows**	**Maximum Flows**
Kayaking	400 cfs	1000-2500 cfs	5000 cfs
Rafting	600 cfs	2500-3000 cfs	5000 cfs
Angling	none indicated	1000 cfs	none indicated

Note: flows in cubic feet per second (cfs)

Review of flow records reveals that flows in the range of the preliminary optimums, presented above, have been commonly present for many years. Investigation of parameters such as temperature and water quality did not result in flow requirements that would exceed the values estimated for critical or optimal conditions for either recreational or habitat-related flows. However, minimal data and information were found for water quality and temperature, and it is possible that needs exist that have yet to be identified. Currently, the Colorado Water Conservation Board does not hold an instream-flow right for this specific reach of the Colorado River.

The flow recommendations provided are aptly described throughout this report as “preliminary” because of the short time frame available for this study and because only a limited number of resource parameters are considered. Flow regimes should also incorporate flushing flow recommendations, as well as input from local, state, and federal agencies. Note also that this analysis focuses only on flow regimes as they relate to fisheries habitat and recreation. Other factors such as biological assessments, geomorphic analyses, and groundwater impacts should be considered for a complete flow regime and development of a streamflow management plan.

1.0 GENERAL

1.1 Introduction

This report presents the preliminary analysis for the recommendation of flow regimes in the Colorado River in Eagle County, Colorado, to support non-consumptive water use. The study reach is approximately 40 miles long, beginning at the confluence with the Eagle River and ending at the Eagle-Grand County line. See **Figure 1, Vicinity Map** for a general overview of the study reach. A detailed map book titled **Colorado River Flow Regime, Eagle County, Colorado, Map Book and Index,** is appended separately. Two general flow conditions are considered: **environmental** flows to address aquatic issues and the physical habitat requirements of fisheries; and flow conditions for **water users,** including recreational uses as well as diversions for irrigation and municipal needs**.** Considered together, these flows will make up the **recommended** flow regime**.** This report and the associated recommendations are preliminary only, based on available information, a cursory site reconnaissance, and several river surveys.

Preliminary draft information from the Grand County Stream Management Plan is incorporated into this report in light of the remote nature of the study reach, the short time frame for analysis, and the minimal amount of available data. In particular, data and information for the Colorado River in the Kremmling area, below the confluence with the Blue River, are used. Here, the Colorado River enters the Gore Canyon, flowing in a relatively confined canyon with few tributaries of significance until it reaches Dotsero on the downstream end of the study reach. Details are presented in the body of this report.

1.2 Physical Setting and Background

The Colorado River in Eagle County lies within west-central Colorado. The headwaters originate at the Continental Divide in the Rocky Mountain National Park, 50 miles northeast of Eagle County. The watershed covers all or a large majority of Eagle, Grand, Summit, and Route Counties and includes the major tributaries of Fraser River, Blue River, and Muddy Creek.

The impetus for this study is the potential for increase in water diversions from the Upper Colorado watershed in response to increased water demands in both the Denver Water and Northern Colorado Water Conservancy District service areas. This study aims to evaluate the adequacy of non-consumptive flows under the flow conditions that exist today and provide recommendations for future flow requirements.

COLORADO RIVER FLOW REGIME
EAGLE COUNTY, COLORADO

Pumphouse - 1 Site
Northern - 1 Site
Radium - 1 Site
GRAND COUNTY
EAGLE COUNTY
McCOY
Colorado River
BURNS
BOND
STATE BRIDGE
CO STATE HWY 131
Piney River
OK Corral - 4 Sites
Eagle River
DOTSERO
GYPSUM
EAGLE
Colorado River
AVON
VAIL
N
0 1 2 4 6 8 Miles

Legend

- Tt CROSS-SECTION SITES
- HIGHWAYS
- STREAMS
- CITIES
- COUNTIES

FIGURE 1
VICINITY MAP

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2.0 REACH DESCRIPTION

The Colorado River corridor within the study reach is narrow, generally confined by tall and often steep canyon walls with cliff faces and rock outcrops throughout. Forested vegetation includes spruce, Douglas fir, aspen, and ponderosa pine. Typically, open slopes are sparsely covered with sage brush and pinyon-juniper. Immediately adjacent to the river is a narrow corridor of willows, sedges, and cottonwood trees. There are several tributaries within the study reach, including Piney River, which reaches its confluence with the Colorado River at State Bridge. Elevations along the Colorado River within the study reach range from 7,250 feet above mean sea level (msl) on the upstream end, to elevation 6,200 feet above msl at Dotsero. The average river slope over the study reach is approximately 16 feet per mile (0.3 percent).

Much of the land along the study reach falls within public lands, including Bureau of Land Management (BLM), Forest Service, and state lands. Private property is interspersed along the river corridor and is primarily used for agriculture. Several small towns and settlements exist along this reach, including State Bridge, Bond, McCoy, Burns, and Dotsero, but the area is largely rural and relatively remote. The Denver and Rio Grande Western Railroad parallels the river, as do county and state roads. Most of the study reach is visible from either State Highway 131 or one of several county roads. Reach descriptions within the study reach, including photographs and a channel profile, are presented in **Appendix A**.

3.0 ENVIRONMENTAL FLOWS

The primary objectives of this analysis are to (1) acquire, analyze, and evaluate hydrologic data to describe the present stream flow regime of the Colorado River through the project reach; (2) acquire, analyze, and evaluate channel morphology, hydraulic geometry, and aquatic habitat information for the project reach to describe habitat-flow relations for target fish species and life stages; and (3) based on the findings under Objectives 1 and 2, recommend a preliminary flow regime for the project reach that will likely protect important environmental values. A detailed description of the methodology, results, and recommendations is presented in **Appendix B** and is summarized below**.**

3.1 Stream Flow Alterations

This analysis evaluates recent trends in flow alterations and develops flow recommendations for planning potential future flow modifications. The data and analysis look at two time periods: 1962 to 1984, and 1985 to 2007. The early 1960s represent the time period where all the major water projects are in-place, including Williams Fork, Green Mountain, and Dillon Reservoirs. The mid-1980s time frame reflects changes in water administration that affects trans-mountain diversions and flow releases out of Green Mountain Reservoir (CDSS).

Stream flow alterations are analyzed using the Indicators of Hydrologic Alteration (IHA) procedure developed by The Nature Conservancy. IHA is used to analyze flow regimes that have been altered from previous conditions. The IHA software can analyze up to 67 statistical parameters. These parameters are subdivided into two groups: the IHA parameters, and the Environmental Flow Component (EFC) parameters. Thirty-three IHA parameters are analyzed to quantify recent flow alteration and to generate target flow ranges using the Range of Variability Approach (RVA) within IHA. The EFC parameters were reviewed but not used, because the field-based, more substantive approach described under Objective 2 (Section 3.2) was available to quantify the preliminary optimum and critical instream flow requirements. The IHA approach methodology, including a full definition of RVA, is described in detail in Appendix B.

The results of this analysis indicate that the shape of the stream flow hydrograph for the Colorado River through the project reach appears typical for snowpack-dominated systems in the Central Rocky

Mountain region. Peak runoff flows typically occur in the late May to mid-June period and gradually diminish to late-season base flow conditions by the late fall and winter. Based on the 1962 to 2007 period of record for the Kremmling gage, median (50 percentile) monthly flows, as shown on **Figure 2**, are highest in June, about 1,500 cubic feet per second (cfs), and lowest in January and February (about 500 cfs), with monthly medians for the late summer in the range of 800 to 1,000 cfs. Median daily flows, presented on **Figure 3**, peak at 1,780 cfs on May 30 and reach the annual low of 500 cfs by January 31. Median daily flows during the important summer growth period for trout range from 1,240 cfs on July 1 to 791 cfs on September 29.

Note that exceedance curves are used to display the hydrograph because they not only present the median flow (the flow equaled or exceeded 50 percent of the time for the calendar day or month over the period of record considered), but also the range of flows that have occurred for the time increment chosen. For example, the 90 percent flows are equaled or exceeded 90 percent of the time, and hence are the very low flow that have occurred for the given date or period. The 10 percent flows are then the higher flows that have occurred on the given date. These values provide a reasonable picture of whether the recommended flow is "realistic" given the hydrology of the study stream.

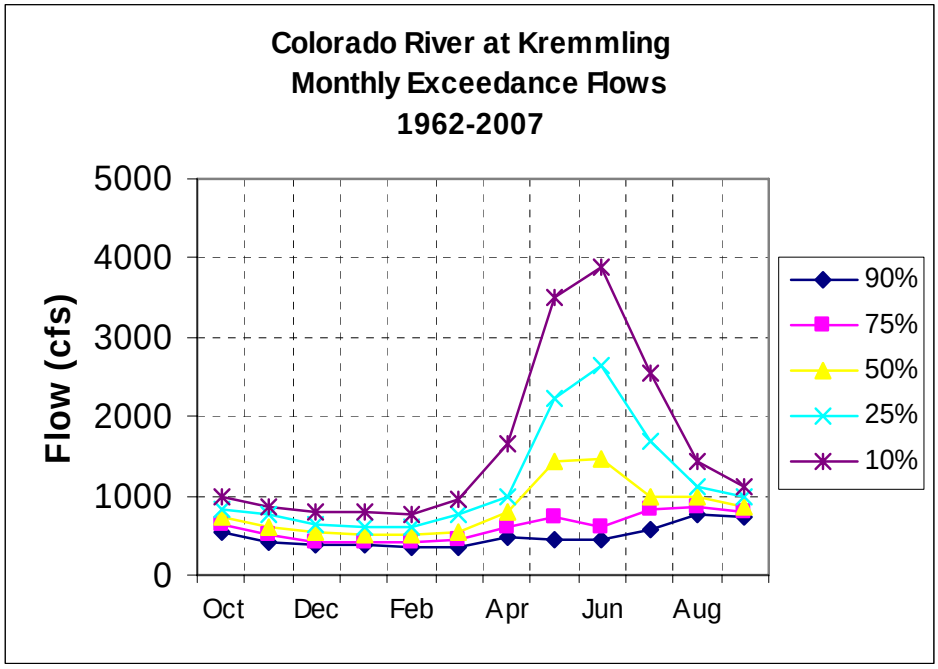

Figure 2. Monthly Exceedance Flows for Colorado River at Kremmling, Colorado, USGS gage #09058000, for Water Years 1962-2007.

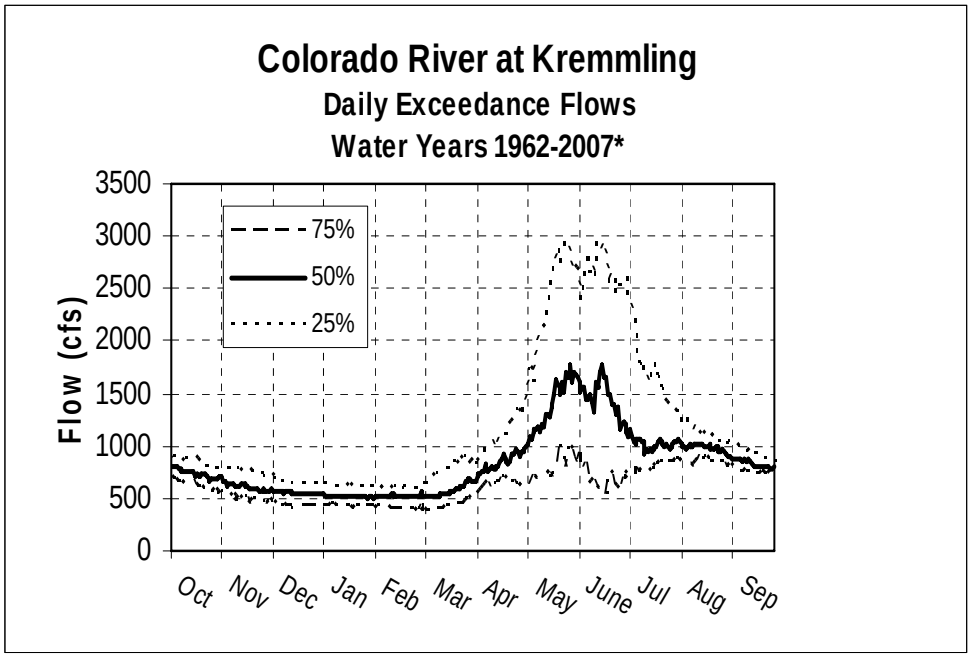

Figure 3. Daily Exceedance Flows for Colorado River at Kremmling, USGS gage #09058000, for Water Years 1962-2007.

Hydrologic alteration through the project reach was generally found to be low to moderate when the 1985 to 2007 period was compared with the 1962 to 1984 period (see tables in Appendix B). Of the 33 parameters evaluated with the IHA procedure, 18 were characterized by low alteration, 12 by moderate alteration, and only 3 were highly altered. Flow alterations are reviewed in detail in Appendix B. Several of the more notable findings are summarized as follows:

- Monthly flow magnitude: only the September median flow was found to be highly altered, with generally higher flows having occurred in the more recent time period. Also of possible environmental significance in this group is the reduction in June flows from almost 1,800 cfs to less than 1,200 cfs in the more recent period.

- Magnitudes and duration of annual extremes: this group exhibited the least alteration of any group, with most parameters falling into the low alteration category.

- Date of annual minimum flow: the median date of the annual low flow for the earlier time period occurred in mid-December (Julian date 346), while for the recent period the median date shifted to early May (Julian date 132). Inspection of the annual values indicated the explanation for this unexpected finding was the exceptionally low flows that occurred during the early spring of the drought years 2001 through 2004. At present, no information on the environmental consequences of such a time shift has been obtained, although it could be hypothesized that ecological functions such as trout reproduction and early-season growth could be affected.

3.2 Channel Morphology, Hydraulic Geometry, and Aquatic Habitat Information

Seven independent river cross-sections were surveyed during 2007 to address Objective 2. Cross section locations are shown on **Figure 1**. Three cross-sections are located near or within the upper portion of the project reach at the Pumphouse Boat Launch, the Northern Properties, and the Radium Boat Launch.

These cross-sections were selected based on habitat characteristics, accessibility, and likelihood that they could be waded at lower flow levels. Surveys were conducted in October 2007 at flows ranging from 509 to 958 cfs. See **Appendix C** for detailed survey information and photographs of these three cross sections. Water depth and velocity were measured and substrate was observed at more than 20 locations along each cross-section. Elevations were measured with a robotic total station.

The remaining four cross-sections are located at the Colorado River Road Bridge, 8 miles upstream of Dotsero, and were surveyed at a flow of 1,054 cfs on March 28, 2007. These surveys were conducted for another study unrelated to this project and included a total of 11 cross-sections, four that were eventually selected for this analysis (cross-sections 4, 5, 9, and 10) based on their channel geometry and alignment. Water velocities for these cross-sections were generated using the U.S. Army Corps of Engineer's HEC-RAS hydraulic model, while general substrate observations were made on the day of the survey. Elevations were measured with a robotic total station. See Appendix **C** for photographs, HEC-RAS, and cross section information for these four cross sections.

Flow-habitat relations are developed independently for each of the seven cross-sections based on one field-measured flow using the PHABSIM (Physical Habitat Simulation) for Windows modeling approach (USGS 2001). Verified habitat suitability curves for the target species brown trout (*Salmo trutta*) and rainbow trout (*Oncorhynchus mykiss*) and target life stages adult and juvenile were provided by the Colorado Division of Wildlife (CDOW) (Uppendahl 2007). Availability of spawning habitat was also evaluated using CDOW water depth and velocity suitability curves for brown and rainbow trout, assuming a substrate preference for gravel (less than 3.0-inch diameter). These habitat data are grouped into a generic set of suitability curves for "trout spawning" based on the similarity of these spawning curves, the lack of site-specific information to differentiate between species use patterns, and the general nature of much of the information available on the cross-section substrate. The habitat suitability curves and tables used in the analysis are presented in Appendix B.

PHABSIM modeling was conducted independently for each of the seven cross-sections over a range of flows extending from 200 to 1,600 cfs. Weighted useable habitat area (WUA) (expressed as square feet per 1,000 feet of channel length) was generated for each target species and life stage for each cross-section at each modeled flow. The mean WUA for the seven cross-sections for each species, life stage, and flow was then calculated to estimate flow-habitat relations for the project reach.

The analysis of flow-habitat relations found that available habitat for the target species and life stages varied substantially with flow and cross-section location. Appendix B lists WUA for the target species and life stages. **Figure 4** is a combined plot of the seven Colorado River Cross Sections showing the mean WUA and preliminary flow recommendations,

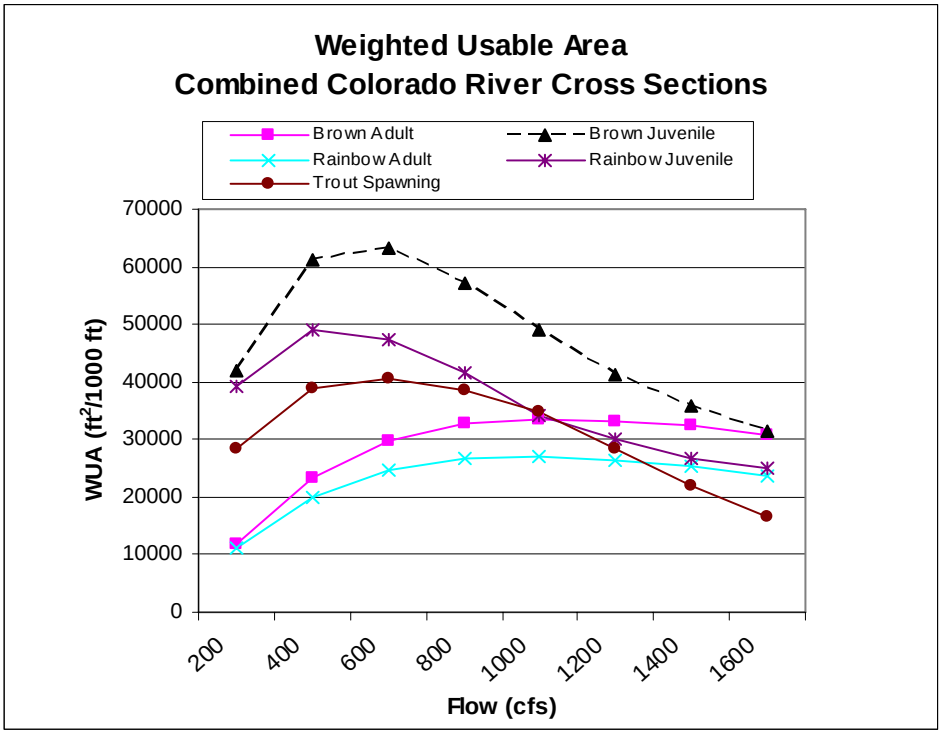

Figure 4. Mean Weighted Usable Area, Preliminary Flow Recommendations for Target Species and Life Stages at Seven Colorado River Cross Sections

The analysis indicates the following:

- Juvenile trout habitat is typically more abundant than either adult or spawning habitat, especially at flows less than 1,000 cfs, and is well-distributed among the cross-sections sampled.

- Brown trout juvenile habitat is more available at all flow levels than rainbow juvenile habitat, reaching its peak abundance at 600 cfs.

- Rainbow juvenile habitat is most available at 400 cfs.

- Habitat for juveniles of both brown and rainbows trout declined rapidly as flow dropped below 400 cfs.

- Likewise, adult trout habitat is present at all seven cross-sections sampled and, with the exception of several of the OK Corral cross-sections, is fairly well distributed.

- Habitat for adult brown trout is more abundant than for adult rainbow trout at all flow levels analyzed, with habitat availability for both species peaking at 1,000 cfs and declining rapidly as flows dropped below 600 cfs.

- Availability of trout spawning habitat appears to be most limited by the absence of suitable gravels at several cross-sections (Pumphouse, Northern, and OK Corral #4) where the substrate was dominated by cobble. Availability of spawning habitat peaked at 600 cfs and declined rapidly as flow dropped below 400 cfs.

3.3 Preliminary Flow Regime Recommendations

The preliminary environmental flow recommendations are based primarily on the fish habitat-flow relations described under Section 3.2 and are supported by the stream flow hydrograph analysis presented under Section 3.1. Based on these findings, the following flows are recommended as preliminary optimum environmental flow estimates:

- October through March, 600 cfs
- April through September, 1000 cfs

Recommendations for the spring and summer period provide the maximum amount of adult habitat for the target species during the portion of the year when water availability is greatest and trout rearing and growth are of primary concern. Although this flow does not maximize juvenile habitat during this portion of the year, it provides an almost equal amount of habitat as is allowed for the adult life stage.

Recommendations for the fall and winter period provide the maximum amount of spawning habitat for the fall-spawning brown trout and the early spring-spawning rainbow trout. Maintenance of this flow over the winter assures a stable incubation environment for trout eggs as they develop within the substrate and should protect important over-wintering habitat for adults, juveniles, and other forms of aquatic life.

The historical record shows that flows in the range of the preliminary optimums have been commonly present for many years. Review of the RVA approach (see Appendix B) boundaries for monthly median flows indicates these recommended flows fall within or near the target ranges identified by the IHA analysis for all months of the water year.

Preliminary critical environmental flow recommendations are also presented, based on the flow-habitat relations presented herein (Figure 4). These recommendations include:

- October to March, 400 cfs
- April to September, 600 cfs

These flows maintain more than 80 percent of the optimum available habitat for the target species and life stages and slightly exceed the flow ranges over which available habitat declines at an accelerating rate. As shown in Appendix B, these critical flows fall below the RVA target flow boundaries for all months of the year and should be considered survival flow levels for the fishery.

At this time, it is not possible to present preliminary flushing flow recommendations without further analysis. In the interim, the RVA boundaries for the 1-, 3-, and 7-day maximums, as presented for Parameter Group #2 in Appendix B, could be used should preliminary broad-level planning guidance be needed. Flushing flow recommendations will be included within the Grand County stream flow management plan scheduled for completion later in 2008.

3.4 Water Temperatures

Long-term data are available for only a few temperature gages in Eagle County on the Colorado River. Recent gage information is available from the U.S. Geological Survey (USGS) and Trout Unlimited (TU) and is used to examine recent flow and temperature patterns in the Colorado and Piney Rivers. USGS gages provide a small amount of historical temperature data, while TU gages provide data for 2007. The USGS gage on the Colorado River at Dotsero reports 18 years of temperature data but falls downstream of the Eagle River and therefore does not adequately represent temperatures in the study reach. A summary of available data is shown in **Table 1**.

Table 1. Summary of Gage Data

Gage Name	Number	Entity	Parameters	Date of Record
Colorado River near Dotsero	9070500	USGS	Discharge	12/01/40-11/20/07
Piney River near State Bridge, CO	9059500	USGS	Discharge	6/1/1944-11/20/07
Colorado River near Radium, CO	9058030	USGS	Discharge	8/20/1981-9/30/90
Eagle River below Gypsum, CO	9070000	USGS	Discharge	10/1/1946-11/20/07
Colorado River near Kremmling, CO	9058000	USGS	Discharge	8/1/1904-11/26/2007
Colorado River at Kremmling	1154716	GCWIN/BLM	Temp	7/31/06-7/30/07
Piney River	1170854	TU	Temp	7/27/07-11/3/07
Colorado River at State Bridge	1170848	TU	Temp	7/14/2007-11/3/07
Colorado River at Dotsero	1170849	TU	Temp	7/14/2007-11/3/07
Colorado River near Dotsero	9070500	USGS	Temp	2/15/80-9/15/98
Eagle River below Gypsum, CO	9070000	USGS	Temp	7/23/02-12/31/04

Standards

At the time of this report, only interim standards from the Water Quality Control Commission (WQCC) are available. Colorado Department of Public Health and Environment WQCCs Regulation 33, Classifications and Numeric Standards for Upper Colorado River Basin and North Platte River (Planning Region 12), effective September 1, 2007, section 33.5(1),states that:

> "Segments or portions of segments that are first, second or third order streams above 7000 feet elevation and classified as Aquatic Life cold 1 or 2 shall have a chronic temperature of 17 deg C, maximum weekly average temperature (MWAT) with no acute standard. The following waters designated as Gold Medal fisheries by the Colorado Wildlife Commission shall have a chronic temperature standard of 18.2 deg C (MWAT): Blue River from Dillon Reservoir downstream to the confluence with the Colorado River, Colorado River from Fraser to the confluence with Troublesome Creek…Other cold class 1 or 2 segments or portions of segments shall have a chronic temperature standard of 20 deg C (MWAT) with no acute standard."

In June 2008, a hearing will be held that will aid in establishing the new water quality standards. It is anticipated that the new standards will be further defined by stream order and elevation and will consider aquatic population distributions.

The study reach is, however, below the 7,000-foot elevation mark and is well beyond the third-order stream. Thus, the 17 °C MWAT standard does not apply to the study reach. It is likely that the standard for other cold class 1 or 2 segments will change in June 2008 to a lower value. Therefore, the temperatures in these reaches were compared with both the interim 20 °C standard, as well as the anticipated 18.2 °C standard. In addition to the state standards, the U.S. Fish and Wildlife Service (USFWS) recommendations for the optimal temperature range for brown trout adults and juveniles of 12 to 19 °C with a temperature tolerance range of 0 to 27 °C should be considered (Raleigh and others 1984a). Similarly, the USFWS reports the optimal temperature range for rainbow trout is 12 to 18 °C, with a temperature tolerance of 0 to 25 °C (Raleigh and others 1984b). This analysis plotted three reference temperatures (17, 18.2, and 20 °C) with available data.

Data Review

The 7-day average (MWAT) for temperature data from TU's gages at State Bridge, Dotsero, and on the Piney River are represented in **Figure 5**, along with a small amount of data from the Grand County Water

Information Network (GCWIN) for the Colorado River at Kremmling. Based on this plot of 2007 data, the following observations are made:

- Temperatures at the Dotsero gage tended to be warmer than at the State Bridge gage in the early summer.
- By late summer, temperatures at State Bridge and Dotsero were relatively similar.
- Temperatures at the Piney River gage were consistently 2 to 3 degrees cooler than in the Colorado River at Dotsero.

The summer 2007 temperature regime appears to support the target species and life stages. The 2007 data Trout Unlimited collected at State Bridge indicate the daily maximum temperature for the summer, of about 22 °C, occurred in late July, while the majority of daily maximums for the July-August period fell within the 15 to 18 °C range. The gage at the Colorado River at Dotsero exceeded 20 °C for more than 2 weeks in late July and early August 2007, remained above 18.2 °C for another 2 weeks, and then fell within the interim standards. The gage at the Colorado River at State Bridge never exceeded 20 °C, and rarely measured above 18.2 °C. The Piney River remained cool for most of the summer, reaching a peak of just over 17 °C in August. Thus, although summer water temperatures are not always optimum for trout growth, the overall regime appears to fall within the recommendations of the USFWS and support the target species and life stages. USGS records for 2006 and 2007 at the Kremmling gage station, shown in **Figure 6,** indicate a similar water temperature regime.

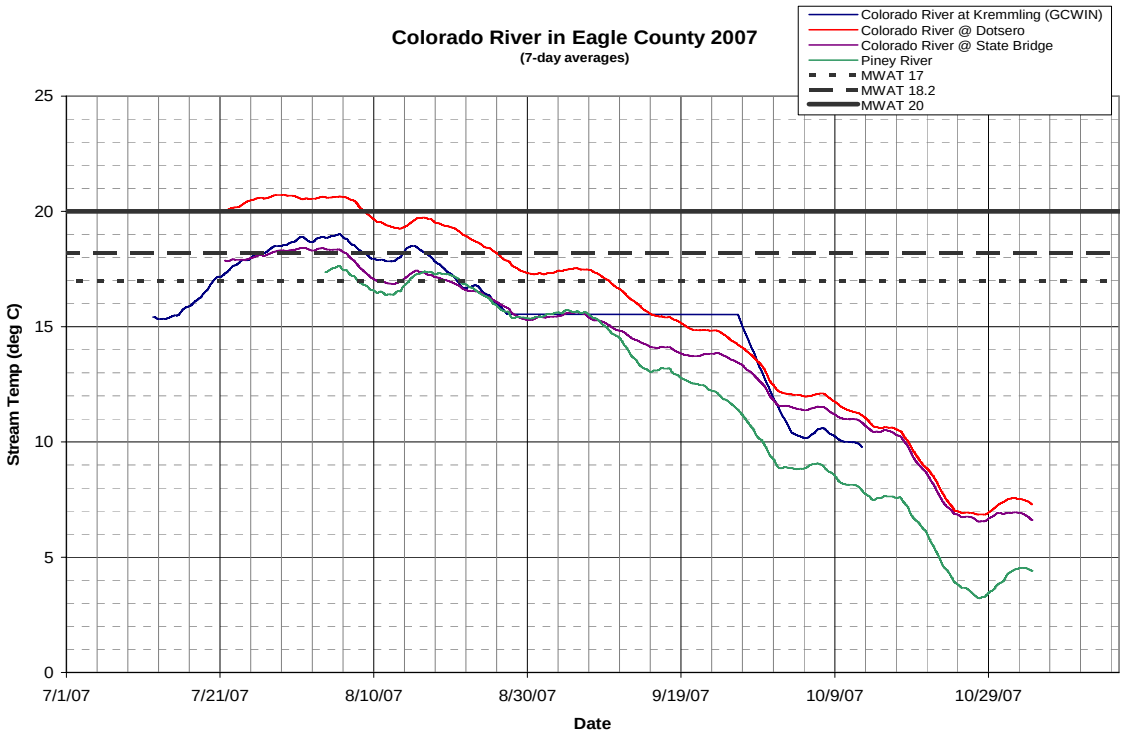

Figure 5. Seven-day Temperature Averages for Gages along the Colorado River and Piney River in Eagle County in 2007.

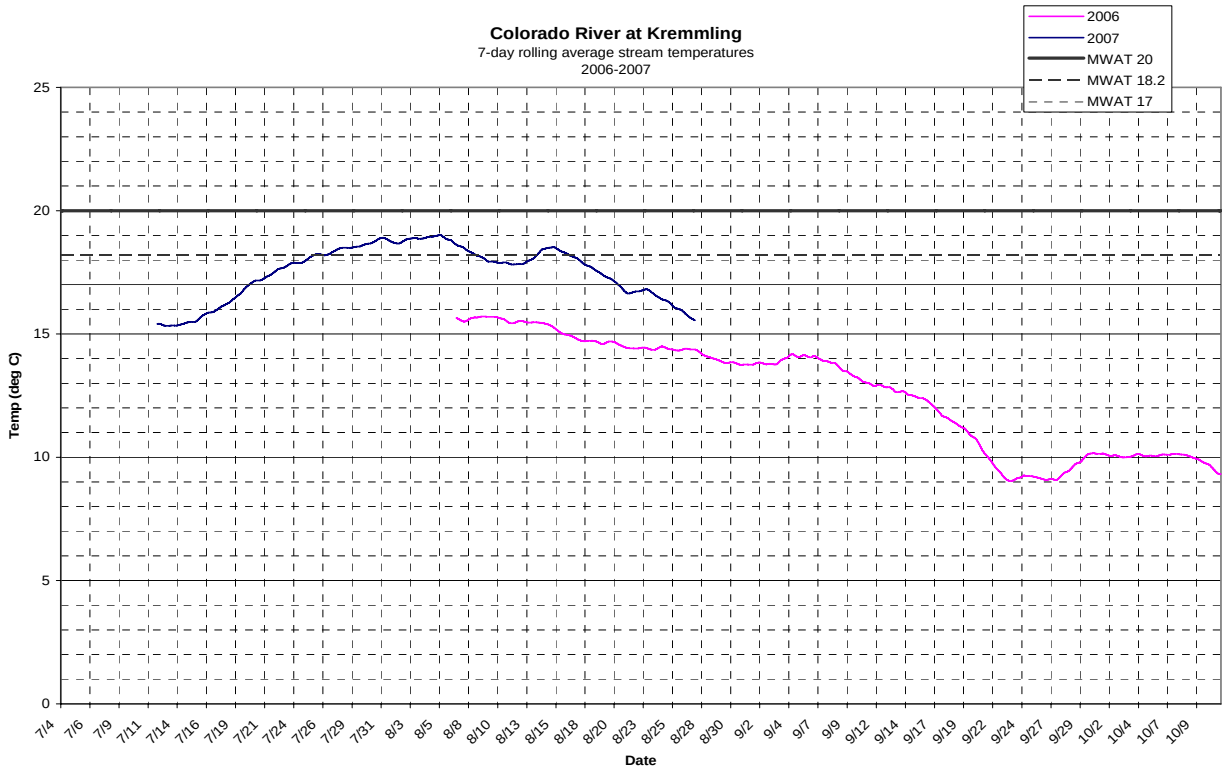

Figure 6. Seven-day Temperature Averages for USGS Kremmling Gage, 2006 and 2007

3.5 Water Quality

No water quality data were found in association with the USGS gage data, nor were any other readily available sources of water quality data identified. Data are available for various sites within Grand County; however, because of the site-specific nature of water quality and related issues, information developed in Grand County is not extrapolated to Eagle. Other sources of information and data may be available and should be pursued in conjunction with the next level of effort. Based on anecdotal information, no concerns have been identified about water quality.

4.0 WATER USERS PREFERRED FLOW CONSIDERATIONS

Research was conducted to identify, obtain, and review documents, reports, and data for information related to the flow conditions water users prefer within the study reach. This task provides an overview of key issues or important considerations, in addition to the environmental flows presented in Sections 1 through 3, which may warrant further investigation or studies. The focus of the research is on municipal water requirements (supply and diversions), irrigation diversions, and recreational considerations.

4.1 Diversion and Irrigators

Records indicate that there are a combined total of 10 diversions (gravity and pumped) along the Colorado mainstem within the study reach with water rights greater than 1 cfs. The largest of these is 6 cfs and the total of all 10 is 22 cfs. No municipal diverters or water users are known within the study reach. A summary of diverters with water rights greater than 1 cfs is included in **Appendix D** and is shown in the map book. The local water commissioner was interviewed on the telephone. Indications are that he has had no real concerns on the Colorado River in Eagle County. The ranchers and farmers along

the river in this area have not brought forth issues regarding water quality, algae, temperatures, or flows, nor have there been any reported problems concerning boating or angling. (Schaffner 2007)

4.2 Wild and Scenic Eligibility Report

In March 2007, the U.S. Department of Interior, BLM, completed the Final Wild and Scenic River Eligibility Report for the Kremmling and Glenwood Springs Field Offices, as part of the Resource Management Plan (RMP) revision process (BLM 2007b). The Colorado River within the study reach is one of the stream segments that was identified and reviewed to evaluate eligibility. The study reach overlaps with two stream segments: Colorado River Segment 5, Pumphouse to State Bridge; and Colorado River Segment 6, State Bridge to Dotsero. Key findings of the eligibility report for the study reach are summarized below.

Segment 5, Pumphouse to State Bridge: This segment splits Grand and Eagle Counties. The Red Gorge segment is primarily in Grand County, with the downstream reaches of the Red Gorge crossing into Eagle County. The scenic quality rating for the Red Gorge is A. The Red Gorge and the remaining segment offer unique and outstanding fishing and float boating opportunities. The preliminary classification of this segment is Recreational because a road and railroad are adjacent to the river.

Segment 6, State Bridge to Dotsero: Portions of this segment were determined to be Scenic Quality A, tied to unique and diverse topography and contrasting colors. This entire segment is also designated a Special Recreation Management Area for its float boating and scenic driving. Of note are the unique geologic qualities, including the world-renowned McCoy fan deltas. The preliminary classification of this segment is Recreational because a road and railroad are adjacent to the river.

Both segments 5 and 6 were determined to be eligible for the suitability study, which is currently under way by BLM. To date, none of the investigations or studies includes estimates of flows or a flow regime that would be associated with the Wild and Scenic Designation.

4.3 Recreational Flows (including Kayaking, Rafting, and Angling)

The Upper Colorado in Eagle County is a scenic and popular recreational stretch with a variety of conditions, from flat water to Class III. Because of its relatively gentle nature, a wide variety of boats often uses this stretch of river, including fishing dories, rafts, kayaks, and canoes. Camping and picnicking are available at many undeveloped sites. Facilities are also offered at several locations along this project reach. Access is excellent, with most of the property in public ownership, including BLM and Forest Service (BLM 2007a).

Various rafting and angling commercial outfits were contacted for their opinions as to the most beneficial recreational flows in these reaches. Since commercial kayaking is uncommon, local (non-commercial) boaters were also contacted for their opinions on flows. In addition, kayaking guidebooks were researched, as these books represent the most commonly held opinions in private kayaking. American Whitewater is currently completing a survey for recreational flows and will provide the results when they are available. Note that input from anglers reflect preferred flow for recreational fishing and should not be confused with habitat-related flows. Information and input gathered on recreational flow is summarized in **Table 2**.

In addition to opinions on flow regimes, concerns were received from anglers and commercial fishing outfits over warm waters that could affect fisheries and fishing. Anglers also indicated algae as a nuisance, as the algae tends to hook and tangle their fishing lines. . A list of contacts that were consulted in preparing this estimate in provided in **Appendix E**.

Table 2. Summary of Recreational Flows

Recreation	Critical Flows	Optimum Flows	Maximum Flows
Kayaking	400 cfs	1000-2500 cfs	5,000 cfs
Rafting	600 cfs	2500-3000 cfs	5,000 cfs
Angling	none indicated	1000 cfs	none indicated

Note: flows in cubic feet per second (cfs)

Input was also sought for flow limits downstream of the project reach in Glenwood Canyon in Garfield County. This stretch of the Colorado River is one of the most popular reaches for commercial and private rafters and kayakers in the state. As such, there is good anecdotal information on flow limitations relative to recreation. In general, indications are that recreational use tends to be limited when flows drop below 1,250 to 1,400 cfs (Kuhn 2007). For the Colorado River within Eagle County and the study reach, it is reasonable to assume that recreational flows will tolerate a lower limit than are preferred in the canyon. This assumption is reasonable because the Eagle County study reach is upstream of the Glenwood Canyon, as well as the confluence with the Eagle River. In addition, Glenwood Canyon is steep (19 to 39 feet per mile) and consists of many boulders, resulting in higher flow requirements for boating conditions than would be required in the flatter sections within Eagle County. Thus, the lower range of flows for rafting and kayaking on the Colorado River in Eagle County would be expected to be slightly less than 1,250 cfs, which appears reasonable and consistent with the ranges reported in Table 2.

5.0 SUMMARY OF PRELIMINARY RECOMMENDED FLOW REGIMES

The results of this preliminary analysis, for a range of flows for several key resource parameters in the study reach, are presented in **Table 3**. Investigation of other parameters, such as temperature, did not result in flow requirements, or needs, that would exceed the values estimated for critical or optimal conditions for either recreation or habitat. Given the preliminary nature of this investigation, it is possible that not all flow-related issues have been investigated or identified.

Table 3. Summary of Preliminary Recommended Flows

Environmental Flows (habitat-related)	Critical Flows	Optimum Flows	Maximum Flows
October through March	400 cfs	600 cfs	Na
April through September	600 cfs	1,000 cfs	Na
Recreation	**Critical flows**	**Optimum flows**	**Maximum flows**
Kayaking	400 cfs	1,000-2,500 cfs	5,000 cfs
Rafting	600 cfs	2,500-3,000 cfs	5,000 cfs
Angling	none indicated	1,000 cfs	none indicated

Note: flows in cubic feet per second (cfs)

Review of the historical flow records reveals that flows in the range of the preliminary optimums have been commonly present in recent years. These flows would indicate that outstanding or important flow-related issues (specifically habitat-related and recreation) for this reach of the Colorado River are generally encapsulated by this analysis and that the preferred flow regime has been and should continue to be represented by flows typical of the past 40 to 50 years. Currently, the Colorado Water Conservation Board does not hold instream-flow rights for this reach of the Colorado River.

The flow recommendations provided are aptly described throughout this report as “preliminary” because of the short time frame available for this study and because only a limited number of resource parameters are considered. Habitat-related flows are based on several key assumptions that should be further investigated if a more refined analysis is implemented. These assumptions include (1) the cross-sections

used for our habitat-flow analysis are representative of the 40-mile project reach; (2) flow conditions are homogenous through the reach, and (3) the target species and life stages selected are appropriate.

In terms of fisheries habitat, flow recommendations should also incorporate flushing flows, as well as input from local, state, and federal agencies, to make this effort complete. Note also that this analysis focuses only on flow regimes as they relate to fisheries habitat and recreation. Other factors such as biological assessments, geomorphic analyses, and groundwater impacts should be considered for a complete flow regime and development of a management plan.

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