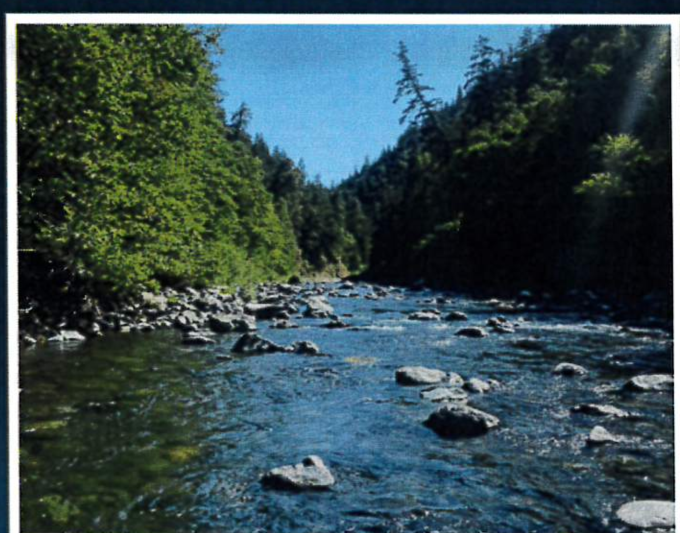
HUMBOLDT BAY MUNICIPAL WATER DISTRICT

Special Board of Directors Meeting

April 29, 2024

Ecological Enhancement Through Instream Flow Dedication



Mad River (Baduwa't)

Humboldt Bay Municipal Water,
828 7th street
Eureka, CA

Agenda for Special Meeting of the Board of Directors
April 29, 2024
Meeting Start Time: 4:30 PM

District Mission
Reliably deliver high-quality drinking water to the communities and customers we serve in the greater Humboldt Bay Area at a reasonable cost; reliably deliver untreated water to our wholesale industrial customer(s) at a reasonable cost; and protect the environment of the Mad River watershed to preserve water rights, water supply and water quality interests of the District.
****

Members of the public may join the meeting online at:
https://us02web.zoom.us/j/86710296323?pwd=MjZldGxRa08wZ0FWOHJrUlNhZnFLQT09
Or participate by phone: 1-669-900-9128 Enter meeting ID: 867 1029 6323 **Enter password:** 484138
If you are participating via phone and would like to comment, please press *9 to raise your hand.

How to Submit Public Comment: Members of the public may provide public comments via email until 5 p.m. the day before the Board Meeting by sending comments to office@hbmwd.com. Email comments must identify the agenda item in the email's subject line. Written comments may also be mailed to 828 7th Street, Eureka, CA 95501. Written comments should identify the agenda item number. Comments may also be made in person at the meeting.

Announcement recording of meeting: This meeting may be recorded to assist in the preparation of minutes. Recordings will only be kept 30 days following the meeting, as mandated by the California Brown Act.

1. **ROLL CALL**
2. **FLAG SALUTE**
3. **ACCEPT AGENDA**
4. **PUBLIC COMMENT**
   Members of the public are invited to address the Board on items not listed on the agenda that are within the scope and jurisdiction of the District. At the discretion of the President, comments may be limited to three minutes per person. The public will be allowed to address items on the agenda when the Board takes up that item. Under the Brown Act, the Board may not take action on any item that does not appear on the agenda.

5. **CONTINUING BUSINESS**
   5.1 Instream Flow
      a. 1707 petition for change*-discuss and possibly approve
      b. 1707 CEQA Notice of Exemption*-discuss and possibly approve

ADJOURNMENT
ADA compliance statement: In compliance with the Americans with Disability Act, if you need special assistance to participate in this meeting, please contact the District office at (707) 443-5018. Notification 48 hours prior to the meeting will enable the District to make reasonable arrangements to ensure accessibility to this meeting. (Posted and mailed April 26, 2024.)

CONTINUING BUSINESS

Please indicate County where your project is located here:

Humboldt, Trinity

MAIL FORM AND ATTACHMENTS TO:
State Water Resources Control Board
DIVISION OF WATER RIGHTS
P.O. Box 2000, Sacramento, CA 95812-2000
Tel: (916) 341-5300 Fax: (916) 341-5400
http://www.waterboards.ca.gov/waterrights

PETITION FOR CHANGE

Separate petitions are required for each water right. Mark all areas that apply to your proposed change(s). Incomplete forms may not be accepted. Location and area information must be provided on maps in accordance with established requirements. (Cal. Code Regs., tit. 23, § 715 et seq.) Provide attachments if necessary.

☐ **Point of Diversion** Wat. Code, § 1701
☐ **Point of Rediversion** Cal. Code Regs., tit. 23, § 791(e)
☐ **Place of Use** Wat. Code, § 1701
☐ **Purpose of Use** Wat. Code, § 1701
☐ **Distribution of Storage** Cal. Code Regs., tit. 23, § 791(e)
☐ **Temporary Urgency** Wat. Code, § 1435
☒ **Instream Flow Dedication** Wat. Code, § 1707
☐ **Waste Water** Wat. Code, § 1211
☐ **Split** Cal. Code Regs., tit. 23, § 836
☐ **Terms or Conditions** Cal. Code Regs., tit. 23, § 791(e)
☐ **Other**

Application Permit License Statement

I (we) hereby petition for change(s) noted above and described as follows:

Point of Diversion or Rediversion – Provide source name and identify points using both Public Land Survey System descriptions to ¼-¼ level and California Coordinate System (NAD 83).
Present:

Proposed:

Place of Use – Identify area using Public Land Survey System descriptions to ¼-¼ level; for irrigation, list number of acres irrigated.
Present:

Proposed:

Purpose of Use
Present: See Narrative Summary Attachment. Permit 11715

Proposed: Change of instream flow for environmental benefit. Averaged between Permits 11714 & 11715.

Split
Provide the names, addresses, and phone numbers for all proposed water right holders.

In addition, provide a separate sheet with a table describing how the water right will be split between the water right holders: for each party list amount by direct diversion and/or storage, season of diversion, maximum annual amount, maximum diversion to offstream storage, point(s) of diversion, place(s) of use, and purpose(s) of use. Maps showing the point(s) of diversion and place of use for each party should be provided.

Distribution of Storage
Present: See Narrative Summary Attachment

Proposed: See Narrative Summary Attachment

Temporary Urgency
This temporary urgency change will be effective from to .

Include an attachment that describes the urgent need that is the basis of the temporary urgency change and whether the change will result in injury to any lawful user of water or have unreasonable effects on fish, wildlife or instream uses.

Instream Flow Dedication – Provide source name and identify points using both Public Land Survey System descriptions to ¼-¼ level and California Coordinate System (NAD 83).

Upstream Location: Gosselin hydro plant -40.369878 123.431581. Also see Narrative Summary maps Appendix C.

Downstream Location: Essex Facility Station 6 forebay -40.907117 124.055328. Also see Narrative Summary maps Appendix C.

List the quantities dedicated to instream flow in either: ☐ cubic feet per second or ☐ gallons per day:

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00

Will the dedicated flow be diverted for consumptive use at a downstream location? ☒ Yes ☐ No
If yes, provide the source name, location coordinates, and the quantities of flow that will be diverted from the stream.

Essex Facility Station 6 forebay, See Narrative Summary Attachment: "Instream Flow Will Not Increase the Amount of Water the District is Entitled to Use Or Injure Other Legal Users of water" and Consumptive Use and Injury Analysis"

Waste Water
If applicable, provide the reduction in amount of treated waste water discharged in cubic feet per second.

Will this change involve water provided by a water service contract which prohibits your exclusive right to this treated waste water? ☐ Yes ☐ No

Will any legal user of the treated waste water discharged be affected? ☐ Yes ☐ No

General Information – For all Petitions, provide the following information, if applicable to your proposed change(s).

Will any current Point of Diversion, Point of Storage, or Place of Use be abandoned? ☐ Yes ☒ No

I (we) have access to the proposed point of diversion or control the proposed place of use by virtue of:
☒ ownership ☐ lease ☐ verbal agreement ☐ written agreement

If by lease or agreement, state name and address of person(s) from whom access has been obtained.

Give name and address of any person(s) taking water from the stream between the present point of diversion or rediversion and the proposed point of diversion or rediversion, as well as any other person(s) known to you who may be affected by the proposed change.

See Narrative Summary Appendix F.

All Right Holders Must Sign This Form: I (we) declare under penalty of perjury that this change does not involve an increase in the amount of the appropriation or the season of diversion, and that the above is true and correct to the best of my (our) knowledge and belief. Dated at .

Right Holder or Authorized Agent Signature

Right Holder or Authorized Agent Signature

NOTE: All petitions must be accompanied by:
(1) the form Environmental Information for Petitions, including required attachments, available at: http://www.waterboards.ca.gov/waterrights/publications_forms/forms/docs/pet_info.pdf
(2) Division of Water Rights fee, per the Water Rights Fee Schedule, available at: http://www.waterboards.ca.gov/waterrights/water_issues/programs/fees/
(3) Department of Fish and Wildlife fee of $850 (Pub. Resources Code, § 10005)

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Narrative Summary for Humboldt Bay Municipal Water District Petition for Change

Introduction

The Humboldt Bay Municipal Water District (HBMWD or "the District") provides water on a wholesale basis to municipal and industrial customers in the Humboldt Bay area, and on a retail basis to a few hundred retail customers. Located in Humboldt County, the District's wholesale municipal customers include the cities of: Arcata, Blue Lake and Eureka; and the Humboldt, McKinleyville, Manila and Fieldbrook-Glendale Community Services Districts. Via the wholesale relationship, the District serves a population of approximately 90,000 in the greater Humboldt Bay area, or about 2/3 of the region's population.

The District's water system is comprised of a reservoir (Matthews Dam impounding Ruth Lake), and the natural Mad River channel that runs approximately 75 miles downstream to various facilities at Essex. At the Essex Facility, the District operates diversion facilities, a turbidity reduction facility, a disinfection system. Historically the District provided untreated water to two pulp mills. One mill ceased operation and water demand in 1994, and the second mill ceased operation and its water demand in 2009. Since 2009, the District has been releasing water flows from Ruth Reservoir as if the second mill was still operating and consuming water. This has resulted in greater than natural flow in the summer within the 75 miles of river between Matthews Dam and Essex, which is permitted under the District's current water rights.

The additional water benefits aquatic organisms and habitat in and along the river corridor downstream of the dam. These releases are within the District's permitted rights and do not injure any senior water rights holders, as described below.

This Petition for Change is a request that the District be able to continue these releases by adding to its existing purposes of use for instream purposes of preserving or enhancing fish and wildlife resources. Without adding this purpose of use, the District could be required to cease releasing the additional water over and above its municipal and industrial demands (current permitted uses), which would be detrimental to aquatic organisms and habitat.

The District currently holds two post-1914 appropriative water rights on the Mad River (**Appendix A**). They are:

- Permit No. 11714 issued on March 16, 1959, which provides storage of 100,000 acre-feet from about October 1 to April 30, diversion methods and uses, and a fish protection release schedule.

Permit No. 11715 issued on March 16, 1959, which provides direct diversion of 200 cfs year round and 20,000 acre-feet to storage from about October 1 to April 30, diversion methods and uses, and a fish protection release schedule.

On February 28, 2007, the State Water Board (dated February 28, 2007) approved a permit time extension from 2009 to 2029 (**Appendix A**). The order also reduced the amount of water subject to appropriation as follows:

- Permit 11714: Storage of 48,030 acre-feet from October 1 to April 30.
- Permit 11715: Direct diversion of 116 cfs year-round and 20,000 acre-feet to storage from October 1 to April 30.
- Total annual diversion under Permits 11714 and 11715 not to exceed 132,020 acre-feet per year.

The bypass and minimum flow requirements in Permits 11714 and 11715 are incorporated into the District Habitat Conservation Plan (HCP). HCP describes the activities conducted by the District on the Mad River and the impacts of these activities on listed fish and designated critical habitat. The National Marine Fisheries Service analyzed the HCP and in 2005 issued an incidental take permit to the District addressing the effects of the District's Mad River Operations on Northern California (NC) steelhead (*Oncorhynchus mykiss*), Southern Oregon/Northern California Coast (SONCC) coho (*O. kisutch*) salmon, and California Coastal (CC) Chinook salmon (*O. tshawytscha*) and on designated critical habitat for SONCC coho salmon under the Federal Endangered Species Act. These activities include current, ongoing activities and those activities that occur only when needed. Ongoing activities include releasing flow at Matthews Dam (including the bypass and minimum flow requirements in Permits 11714 and 11715), diverting water in the Essex Reach of the Mad River, operating the direct diversion facility including fish screens, dredging the forebay, and maintaining adequate water surface elevations at and flow to the Station 6 diversion facility. As-needed activities include maintaining adequate capacity in the tailrace and spillway pools below Matthews Dam, access to and maintenance of Ranney collectors, and repair and maintenance of rock structures and revetments.

The District's HCP is available on its website at:
https://www.hbmwd.com/files/d0c19c09a/HBMWD-HCP+2004.pdf

In 2013, the District initiated a scoping process to determine the feasibility of an instream flow dedication. During that process, the National Marine Fisheries (NMFS) questioned the daily fluctuations observed in the USGS Arcata gage during the low-flow season. NMFS and District staff collaborated to conduct field monitoring. The investigation found very little change in river or habitat conditions, and no adverse effects to salmonids or their habitat. The results of the original daily flow fluctuations performed during the HCP investigation were presented in an August 2005 memo. (See attachment B included in **Appendix E** attached hereto) In 2005, the District was operating both the municipal and industrial systems, thus pumping rates were much higher than in 2013. The District agreed to again investigate the potential effect of flow fluctuations at four locations downstream of its Essex point of diversion/rediversion. The results of this study are attached in **Appendix E** (Technical Memorandum dated March 3, 2014 by Stillwater Sciences).

In addition to the HCP with NMFS, the District obtained a Long Term Streambed Alteration Agreement (LTSAA) with the California Department of Fish and Wildlife (CDFW) (No.R1-2010-0093). The term of the agreement is 15 years, with the opportunity for a single five-year extension. The agreement defines eight authorized activities, three of which are related to the District's diversion and by pass activities. The remaining five activities involve maintenance actions in the channel or along the banks. One condition of the LTSAA was to perform a hydrological and fish passage assessment. The assessment was to determine the effects of stream impoundment (at Matthews Dam) and stream diversions at Essex. A copy of the Mad River Fish Passage Study Technical Memorandum December 2014 by Stillwater Sciences is attached as **Appendix D.**

The District's LTSAA is available on its website at:
https://www.hbmwd.com/files/11269d7b1/LTSAA-fully+executed+document+with+sigs.pdf

The District's water supply infrastructure is described in greater detail here (Figure 1). Near the top of the Mad River watershed, the District operates a small reservoir (Ruth Lake, storage capacity 48,000 acre-ft), Matthews Dam, and a small 2-MW hydroelectric facility. The reservoir generally fills quickly each year, usually after the first two or three major storms in the fall. After it fills, the District generally releases water through the facility penstock and over the ungated spillway, and flow is described as "run of the river." Water continues to flow approximately 75 miles downstream to the Essex Facility, where the District operates its diversion facilities. Downstream of the Essex Facility, water flows approximately 9 miles to the Mad River estuary and Pacific Ocean. Essex is a point of re-diversion under Permits 11714 and 11715 and a point of direct diversion under Permit 11715.

During the late spring and throughout the summer, discharge over the spillway ceases and flows in the Mad River are from tributary contributions and releases from Ruth Lake through the penstock. The District releases water to meet its municipal and industrial demands, minimum flow environmental requirements, and to incidentally generate electricity.

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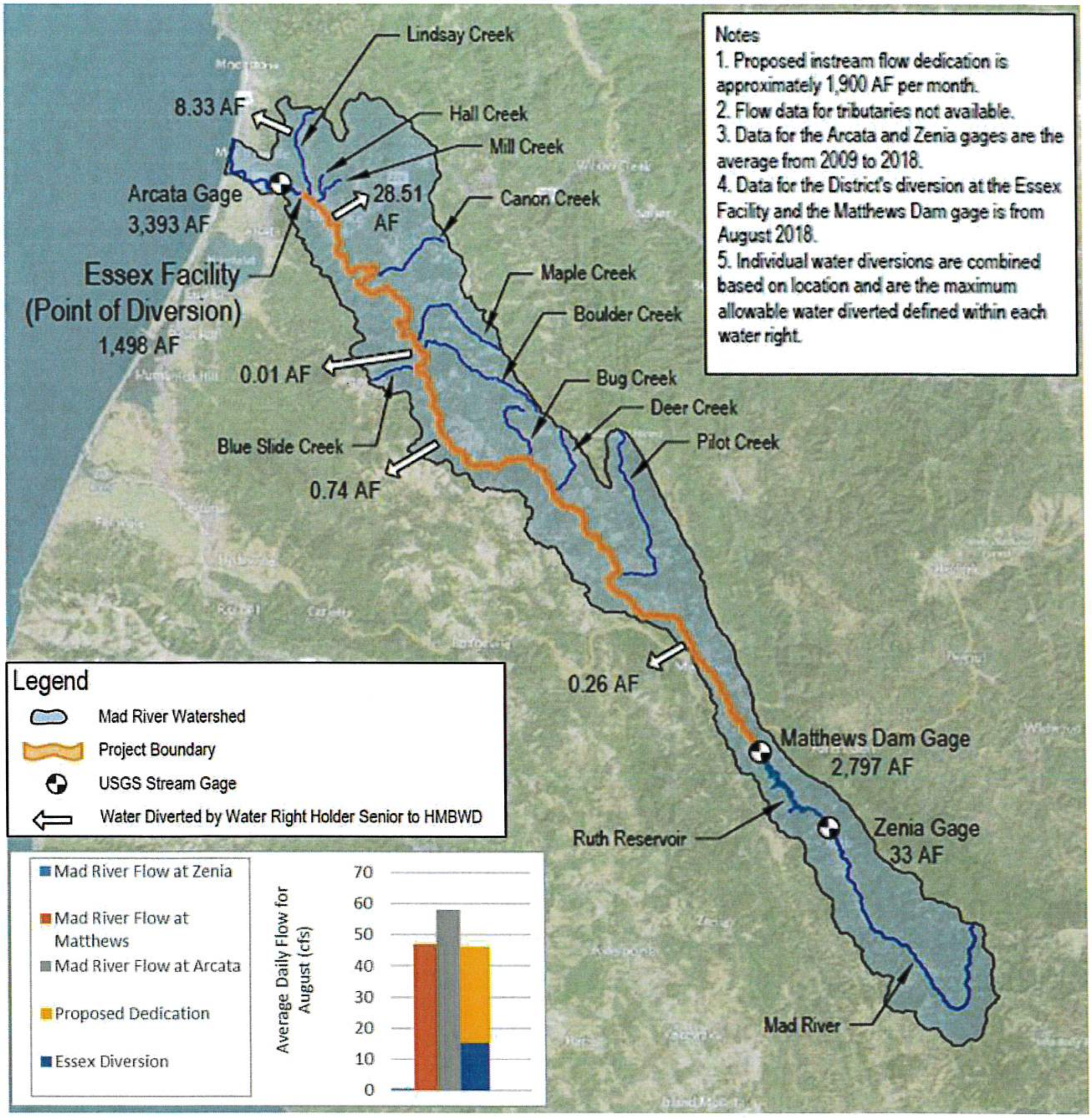

Figure 1. Water Diversions and Flow Measurements for the Proposed Dedication for the Month of August, Based on Data from January 1, 2010 to July 25, 2023. Representative Low River Flow Augmentation. See Appendix C § 715 Project Maps

History of District Operations

When the District government and infrastructure were formed in the late 1950s and early 1960s, two pulp mills on the Samoa peninsula were the District's primary industrial customers, who required up to 65 million gallons per day (MGD) (100 cfs). Since 2009, both pulp mills have closed and industrial demand is negligible. New industrial users are likely to re-develop the Samoa peninsula in the future, but their water use will be a fraction (likely no more than 20%) of the former pulp mills' demands.

Revenue from industrial water sales significantly decreased when the pulp mills closed. To address both the decrease in revenue and a potential loss of water rights due to lack of use, the District organized a public engagement process starting in 2008, to understand the public's views and desires related to water use. The engagement process continues to the present, and the public's views are consistent over time. The public supports three beneficial water use options: 1) local use by existing and new municipal customers; and new industrial customers; 2) transport outside of District boundaries to a public agency; and 3) instream flow releases for environmental benefit.

Given the public's desire for instream flow releases for environmental benefit, the impacts from climate change, and the District's desire to continue environmentally beneficial releases, the District is pursuing a permanent water rights change in purpose of use under Water Code Section 1707. Given that our current permits and extension expire in 2029, we request a Long-Term Change Petition under Water Code Section 1707 for permits 11714 and 11715.

Purpose of the Project

The purpose of the Project is to:

- Improve summer rearing habitat for juvenile salmonids
- Improve spring mainstem shallow water river edge habitat for foothill yellow-legged frogs and salmonid fry
- Provide resilience for river biota to ameliorate the effects of climate change

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The District's infrastructure and operations pose minimal environmental impacts compared to many large-scale dams in California. There are several reasons for this:

1. The total volume of water impounded at Ruth Lake represents a small fraction of the total runoff within the Mad River watershed because Matthews Dam is: a) located high in the watershed; and b) relatively small compared to the size of the watershed and the total discharge of the watershed.
2. Ruth Lake is a fill-and-spill reservoir with an ungated spillway that generally fills early in the rainy season. This allows the river to experience the high flow winter hydrograph and associated geomorphic processes.
3. Tributaries downstream of Matthews Dam contribute significantly to the Mad River discharge.
4. Matthews Dam is upstream of a full barrier to salmon migration and a partial barrier for steelhead migration.
5. No out-of-basin transfers occur in the upper watershed, as happens on other North Coast rivers, for example, the Eel River to the Russian River or Trinity River to Sacramento River.
6. The hydroelectric facility at Matthews Dam does not operate on a power-peaking mode as do many other California dams.

Throughout the year, but particularly in the summer and early fall low flow periods, the District's flow releases substantially augment flows in the Mad River, compared to what otherwise would occur without the District's operations.

Proposed and Current Operations

Comparisons of the District's current and proposed water rights parameters are tabulated below in Table 1.
The District's Essex bypass flow schedule as described in its Habitat Conservation Plan is provided below in Table 2.

Table 1. Comparison of District's Current and Proposed Water Rights Parameters

Water Rights Parameter	Current	Proposed
Amount	• Permit No. 11714. Limited to what can be beneficially used • Permit No. 11715. Limited to what can be beneficially used	No changes proposed
Rate	• Permit No. 11714. Not to exceed 48,030 acre-ft per year to storage • Permit No. 11715. Not to exceed 116 cfs by direct diversion and 20,000 acre-ft per year to storage	No changes proposed

Water Rights Parameter	Current	Proposed
Season of diversion	• Permit No. 11714. From October 1 to about April 30 of the succeeding year • Permit No. 11715. Year-round for direct diversion and about October 1 of each year to April 30 of the succeeding year for storage.	No changes proposed
Authorized purposes and place of use	• Permit No. 11714. Municipal use within HBMWD boundaries according to schedule downstream of the Essex Facility[1] • Permit No. 11715. Same as 11714	Add purpose of use to instream preservation or enhancement of fish and wildlife resources
Points of diversion	• Permit No. 11714. Diversion to storage at Matthews Dam; re-diversion at the Essex Facility • Permit No. 11715. Diversion to storage at Matthews Dam; direct diversion and re-diversion at the Essex Facility	No changes proposed
Priority	• Permit 11714. July 7, 1955 • Permit 11715. September 21, 1956	No changes proposed
[1] See Table 2. Bypass Flows Schedule downstream of Essex Diversion.		

Table 2. Bypass Flow Schedule Downstream of the Essex Facility, Measured at the Arcata Gage

Time Periods	Minimum Flow Downstream of Essex Diversion, cfs*
October 1 through October 15	30
October 16 through October 31	50
November 1 through June 30	75
July 1 through July 31	50
August 1 through August 31	40
September 1 through September 30	30

*Or natural flow, whichever is less. "Natural flow" is defined in the District's HCP as a calculated number based on the equation: Natural flow = (Essex diversion + flow below Essex + inflow into Ruth at Zenia) - flow release at Matthews Dam.

Instream Flow Will Not Increase the Amount of Water the District is Entitled to Use Or Injure Other Legal Users of Water

Water Code sections 1700 through 1707 govern changes to permitted water rights. Such changes must be approved by the State Water Board and "[b]efore permission to make such a change is granted the petitioner shall establish, to the satisfaction of the board, and it shall find, that the changes will not operate to the injury of any legal user of the water involved." (Wat. Code, § 1702.) Under Water Code section 1707, in order to approve a change in purpose of use for instream use the State Water Board must also find that the proposed change will not increase the amount of water the person is entitled to use.

The addition of a purpose of use for instream use to preserve or enhance fish and wildlife resources will not increase the amount of water the District is entitled to use because the water released for this purpose is within the water available for diversion under the District's existing rights. During winter months, the District will store water in Ruth Reservoir as permitted by its existing water rights. During the late spring, summer and early fall months, the District will release water from Matthews Dam within the quantities authorized under its existing permits. As reflected in Figures 2 and 2a, during the months of May through October, flows as measured above Matthews Dam at Zenia (blue bars) are lower than the District's releases as measured at Matthews Dam (gray bars). In the summer months of July through September, the District's releases from Matthews Dam are a significant portion of the flow at the Arcata gage (green bars), which demonstrates that the District's releases augment flows for the benefit of the environment.

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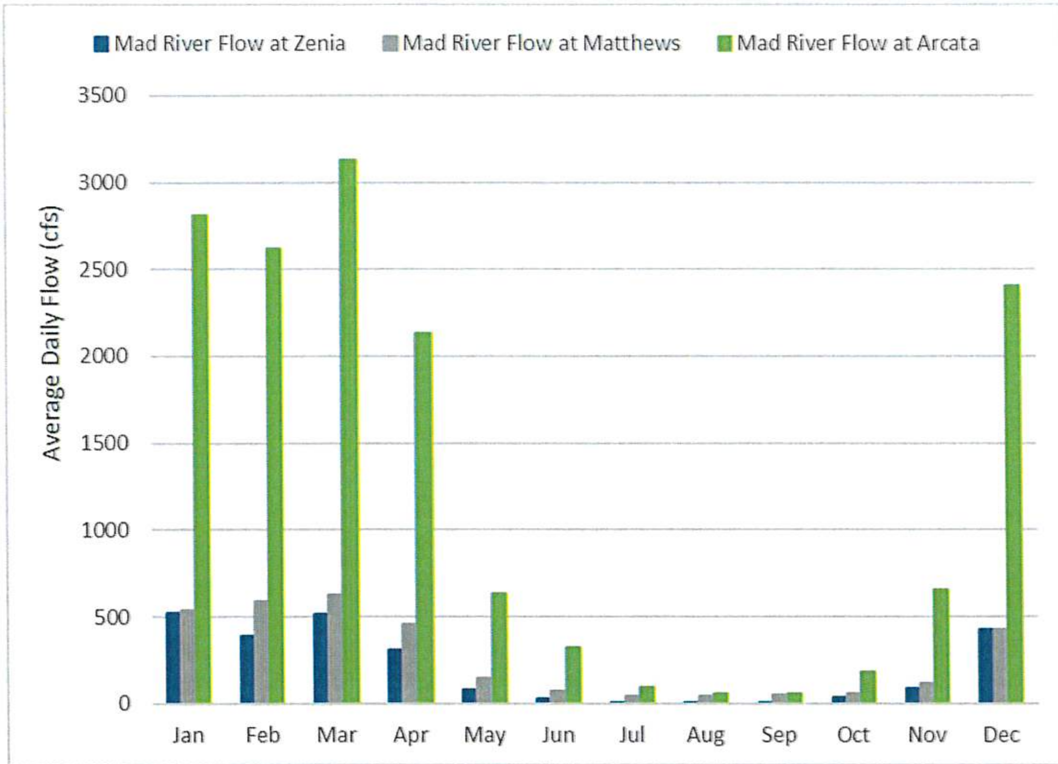

Figure 2. Mad River Average Daily Flows by Month at Indicated Locations, from January 1, 2010 to July 25, 2023.

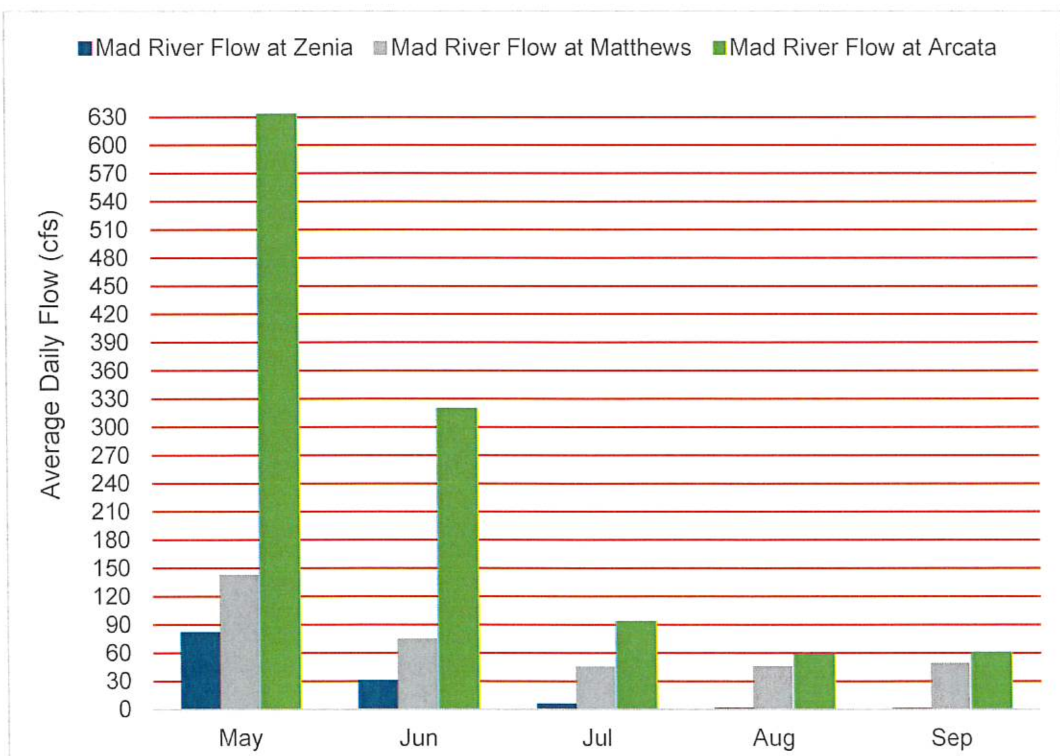

Figure 2a. Mad River Average Daily Flows May to September at Indicated Locations, from January 1, 2010 to July 25, 2023.

The flow volume requested to be permanently dedicated for May 1st through September 30th is 1,900 AF per month (31 cfs, 20 MGD), based on monthly average daily flows. The approximate flow that the District diverts at Essex (yellow line in Figure 3) is the volume of water that would be released from Matthews Dam without the instream flow dedication. The red line indicates the sum of the water requested to be put to instream use for fish and wildlife plus the needs of the municipal and industrial users.[1] During the dry season (July through September), the red line and gray bar are approximately equal, which suggests that all of the water released by the District from Ruth Reservoir has been previously stored by the District and is available for use for instream purposes for fish and wildlife resources from Matthews Dam to the ocean.

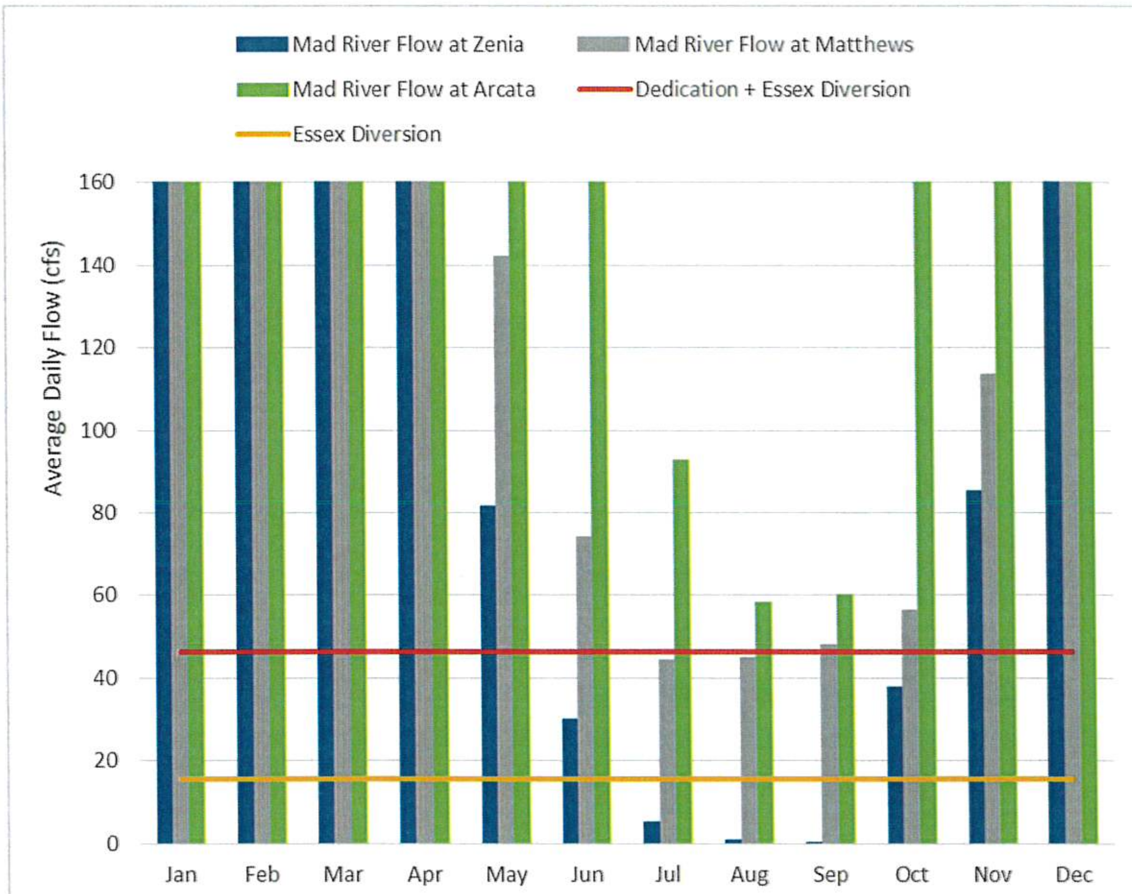

Figure 3. Mad River Average Daily Flow by Month (based on data from January 1, 2010 to July 25, 2023) at Indicated Locations with District's Diversion and Proposed Dedication

The additional use for instream purpose would not result in injury to other legal users of water because the District's past and current operations involve the release of its stored water that is and has historically been put to consumptive use. As explained above, there is little to no natural flow available

[1] The lines reflect uniform average monthly volumes based on water available for appropriation under the District's water rights, not measured values.

for diversion during the July through September and most of the water in the River from Matthews Dam to the ocean is comprised of the District's previously stored water. In other months, the District will release previously stored water within the limits of its water rights. In this way, the amount of water that will be dedicated to instream use will not decrease the amount of water available to other legal users of water. Dedicating the District's release of previously stored water to instream purpose will maintain water levels and water quality in the River for other water users to access diversion of natural flow water that may be available for diversion under other rights.

Under current operations, during the summer and early fall months (typically July 1 to October 1), the District releases water from Ruth Lake for three reasons: 1) to run one turbine of the hydroelectric facility; 2) to supply water for diversion at the Essex Facility for municipal and industrial uses; and 3) to provide required bypass flows (dam and Essex). Currently, industrial uses are minimal but recent interest in developments on the Samoa peninsula could increase industrial water demand again. In the District's history, its maximum consumptive water demand was 116 cfs (75 MGD) year-round from the two pulp mills (100 cfs [65 MGD]) and its municipal customers (16 cfs [10 MGD]).

Between 2010 (after the last pulp mill closed) and 2023, average daily flows during the summer at the Arcata gage have been highly variable but have been greater than 33 cfs. The District's daily average diversion at Essex during this time has been approximately 13.5 cfs with a maximum diversion of 16.1 cfs in August (Table 3). During this time, the District's Habitat Conservation Plan (HBMWD 2004) minimum Essex bypass flow requirements have been met. If future industrial demands increase, the District will release more water during the summer to meet the demands of the industrial and municipal customers and the minimum bypass flow requirements, if necessary.

To understand how the District has operated since 2009, when the last pulp mill closed, the District's consultant GHD has compiled water diversion and use data using the State Water Board's LIFO-FILO methodology to quantify the following parameters:

- Collection to storage at Ruth Lake reservoir/R.W. Matthews Dam,
- "Regulatory diversion" to storage at Ruth Lake reservoir/R.W. Matthews Dam
- "Regulatory Withdrawal" from Ruth Lake reservoir/R.W. Matthews Dam,
- Withdrawal from storage at Ruth Lake reservoir/R.W. Matthews Dam,
- Direct Diversion from the Mad River at Essex,
- Re-Diversion from the Mad River at Essex, and
- Bypass flows below the Essex Diversion/Re-Diversion

The process and results of this analysis are described and shown in the GHD Technical Memorandum dated April 2024 and attached hereto as **Appendix G**. The monthly average quantities of previously stored water available for instream use are summarized in the following Figure 4.

Year	Previously Stored Water Available for Instream Use AF / Month	CFS / Month
2016	2,004.9	33.28
2017	2,274.6	37.76
2018	2,215.9	36.78
2019	2,491.3	41.36
2020	1,201.8	19.95
2021	1,686.0	27.99
2022	1,399.8	23.24
2023	1,549.1	25.71
Overall average	1,852.92	30.76

Figure 4. Previously Stored Water Available for Instream Use in AF and CFS per Month

Under the proposed instream flow dedication, the District expects to release 31 cfs on a monthly average while the project is operating (e.g., releasing stored water) for instream use in addition to the 13.5 cfs monthly average diversion for consumptive use (Table 3), plus 5 cfs minimum fish flow release at Matthews dam for combined beneficial use of 49.5 cfs monthly average from May 1st through September 30th , which is well within the water available and historically used by the District under its water rights. The requested additional purpose of use will not change the volume or timing of releases under these current operations. It will also not change the place of consumptive use because the District will continue to put water under Permits 11714 and 11715 to municipal use at the downstream Essex point of diversion/rediversion. Similarly, the requested change will not increase the amount of water the District is entitled to use under its water rights.

Consumptive Use and Injury Analysis

Using extremely conservative assumptions, there is no injury to senior water rights users resulting from the District's proposed instream flow dedication. There is also no impact to water rights holders that are junior to the District. See attached **Appendix F** – eWRIMS summary.

To assess potential effects to other legal users, an injury/impact analysis was performed. Flow data were very limited for the 75-mile project reach (Figure 1), so a comparison of known values was used to assess injury/impact.

Values used in this analysis included measured flow rates entering and exiting Ruth Reservoir (at Zenia and Matthews Dam gages, respectively) and downstream of the Essex Facility (at the Arcata gage), maximum allowable diversion rates for legal water users, and the District's measured diversion rates. Locations of the three gages and the District's diversion are shown in Figure 1. All other points of diversion (i.e., legal water users) are combined based on proximity as indicated on Figure 1.

Water users in the Mad River watershed were listed, and data sources that characterize their water rights and usage were reviewed. Water users were categorized into these general groups:

- Legal water rights holders. Data were available through the State Water Resources Control Board Electronic Water Rights Information Management System (eWRIMS). Water right holders were identified as senior or junior to the District's water rights.
- Humboldt Bay Municipal Water District. Data were available through District records.

- Cannabis cultivation operationsLegal cultivators who have applied for water rights are included in the eWRIMS database. In this injury/impact analysis, no attempt has been made to estimate water use of illegal cannabis operations, and we assume that illegal operations will become fewer in the future due to increased law enforcement.

Since 2010, after the last pulp mill closed, to 2023, a comparison of flows indicates that minimum summer flows at the USGS Arcata gage were always greater than the maximum demand of senior water rights holders according to eWRIMS and actual diversions by the District (Table 3), even when applying very conservative assumptions.[2] The proposed instream water dedication from May 1st through September 30th will support water levels and water quality between Matthews Dam and Essex while still allowing for diversion by senior right holders to the extent that is available for them to divert pursuant to their priority of right. Junior right holders will not be injured because water levels will be maintained to support diversion of any remaining water that is available for diversion pursuant to their junior priority. Therefore, no water rights holders will experience injury from the District's diversions.

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[2] Actual amounts of water diverted by other water rights holders were not available so maximum diversion rates included in their water rights were used as a conservative assumption.

Table 3. Monthly average diversion rates for the District (HBMWD) and water rights holders senior to the District (based on data from January 1, 2010 to July 25, 2023) and indicated average flow rates (cfs)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Senior Water Rights Holders	0.02	0.02	0.02	0.02	0.50	0.64	0.64	0.64	0.64	0.02	0.02	0.02
HBMWD Diversions @ Essex	12.1	12.7	12.2	12.4	13.1	14.6	16.1	15.7	15.0	13.5	12.8	12.2
Total Consumptive Use	12.1	12.7	12.2	12.4	13.6	15.2	16.7	16.4	15.6	13.6	12.8	12.2
Flow at Arcata Gage	2,873	2,442	2,969	1,877	637	291	89	54	57	177	594	2,229
HCP Flow Requirements at Arcata Gage	75	75	75	75	75	75	50	40	30	50	75	75
HCP Flow Requirement Met?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Available for 31 cfs Dedication?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes:
Proposed dedication (20 MGD) = 31 cfs on a monthly average
HCP Flow = Flow requirements in the District's Habitat Conservation Plan (HCP). If a single month had two different minimum flows, the higher of the two is shown.
Senior Water Right Holders = The total flow rate assumed to be diverted by all water right holders that are senior to the District.
HBMWD @ Essex= Actual average flow diverted by the District at Essex
Total = The sum of Water Right Holders and HBMWD @ Essex.
Flow at Arcata Gage = Average monthly flow rate at the Arcata gage for 2010 – 2023.

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Water Quality Considerations of the Petition

The North Coast Regional Water Quality Control Board has listed the Mad River as impaired for sediment, turbidity, and temperature under Section 303(d) of the California Clean Water Act, and water quality is an important consideration in the conservation of salmonids and other special-status species.

The major sources of sediment and turbidity in the Mad River are from landslides and surface erosion associated with roads, timber harvest, and other disturbance within the watershed; most of this disturbance occurs in the watershed downstream of Matthews Dam, which is approximately 76% of the basin area (Stillwater Sciences and RCAA 2010). The District's operations and release pattern will not significantly change under this Petition for Change so the proposed instream use would have no effect on sediment and turbidity in the middle and lower reaches of the Mad River, but the dam does hold back sediment immediately below the dam.

Ruth Reservoir has a seasonal effect on water temperature in the river downstream of Matthews Dam (**Appendix B**). During warmer months, because the intake for the discharge outlet is deep (approximately 132 feet below crest elevation), water temperatures downstream of the outlet are cool, ranging from 48.4°F in May 2018 to 61.2°F degrees in October 2018. The cool water source at the outlet affects water temperatures in the 7.5 miles downstream of Matthews Dam (at the sensor at Highway 36). However, stream temperature equilibrates with air temperature by the next downstream temperature sensor, 38.6 miles downstream from the Dam (at RM 41.6) (Figure 5). Temperature sensors from RM 41.6 to the downstream-most sensor on the mainstem at the Mad River Boat Launch (RM 3.1) are affected by ambient air temperatures, which cool closer to the coast due to the influence of the Pacific Ocean, as well as localized cooler water inputs from specific tributaries in the lower Mad River.

The main benefits of releases from Matthews Dam primarily occur in the first 10 miles or so downstream of the dam. These benefits increase habitat quality and quantity for salmonids (e.g., juvenile steelhead and resident rainbow trout) and northern foothill yellow-legged frogs in spring and summer, and water quality (e.g., cooler water temperatures) in the upper reach during the summer. Releases from Matthews Dam increase habitat in the Mad River primarily by providing higher discharge in the summer months than inflow into Ruth Reservoir. This higher discharge results in increased holding habitat for adult summer steelhead downstream of Pilot Creek, improved shallow river edge water rearing habitat for juvenile salmonids in the mainstem, expanded habitat for egg and juvenile life stages of northern foothill yellow-legged frogs, and resilience to climate change.

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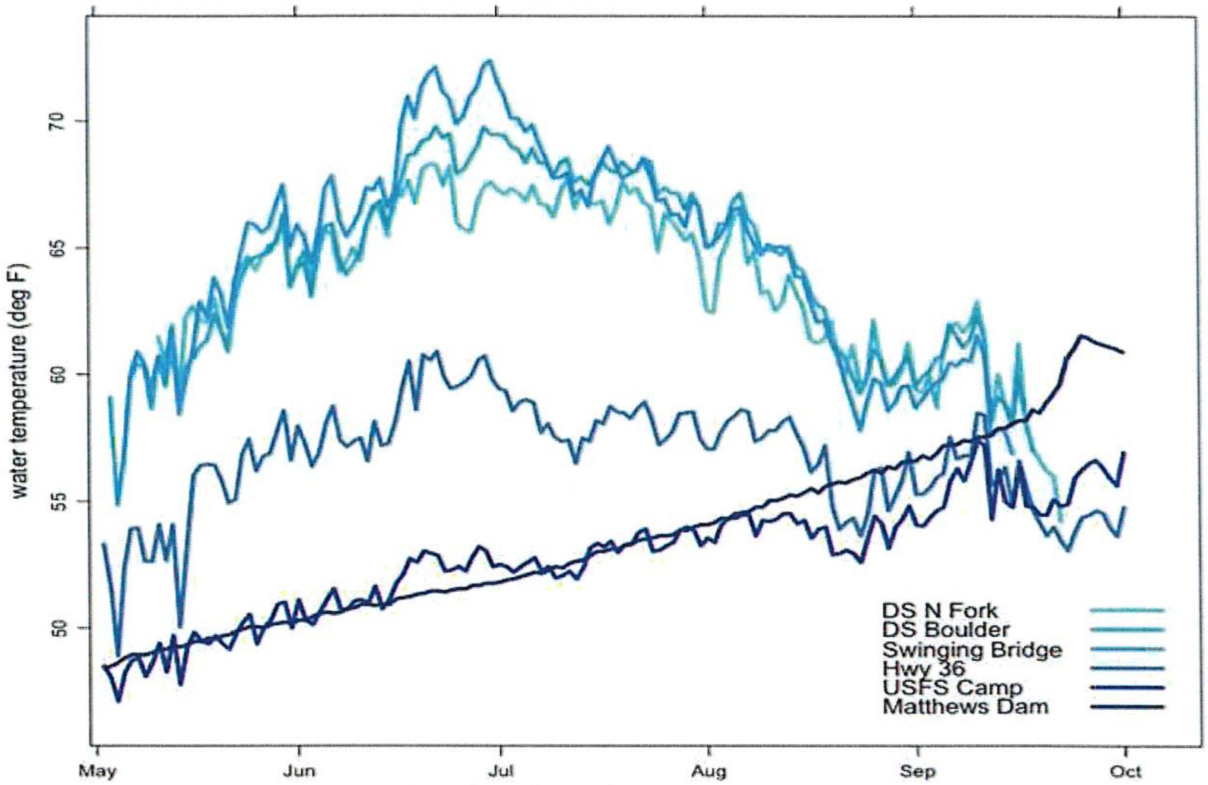

Figure 5. Water temperatures at stations along the Mad River in 2018
Lower Reach of the Mad River (DS N Fork [RM 13.7], DS Boulder [RM 32.6]) and the Middle Reach (Swinging Bridge [RM 41.6]) had similar temperatures. Note: Here, daily values only, distinctly warmer than those recorded from the Upper Reach (Hwy 36 [RM 72.7], USFS Camp [RM 77.0], Matthews Dam [RM 80.2]). Matthews Dam=MRDam, USFS Camp=MRUSFSCamp, Hwy 36=MRHWY36, Swinging Bridge=MRSwingB, DS Boulder=MRDSBoulder, DS N Fork=MRDSNF.

The District's releases from Matthews Dam have resulted in additional instream flow in the mainstem Mad River between the dam and estuary, particularly between June and October. Without these releases, the aquatic habitat that many fish and amphibians rely on would be significantly diminished. In the upper Mad River, between Matthews Dam and Pilot Creek, District releases are the source of inflow to the mainstem and provide important shallow river edge water habitat for early life stages of steelhead and foothill northern yellow-legged frogs. Less of this important habitat would be available if releases from Matthews Dam were to be decreased.

Releases of bottom water from Matthews Dam (RM 80) currently results in water temperatures that are below 60°F (the preferred temperature zone for juvenile steelhead rearing during the summer and early fall months) downstream to Hwy 36 (RM 72.7). If releases were decreased, a consequence could be less habitat available with preferred temperatures because decreased volume and depth of water in the river would equilibrate more quickly with air temperature.

Over the last 60 years, the releases from Matthews Dam have resulted in higher summer and fall flows in the lower river. These higher flows have possibly allowed for the mouth of the river to remain open to the ocean year-round, which has enabled Chinook salmon, coho salmon, and steelhead to enter the river in the fall unencumbered by the presence of a barrier beach. Reduced flows could result in seasonal development of a barrier beach bar that would block upstream migration of anadromous salmonids until fall and winter runoff conditions are high enough to breach the bar. Given that Chinook salmon begin their upstream spawning migration and enter the Mad River in late August or early

September, a barrier beach could delay or eventually eliminate the early part of the run.

The lower Mad River provides habitat for juvenile steelhead and coho salmon rearing during the summer months. Augmented flows increase the amount of suitable habitat for these species during the summer and fall months. Reduced flows would decrease the amount of available habitat and increase the potential for density-related effects.

HBMWD 1707 Flows and California Salmon Strategy for Hotter and Drier Future

The proposed instream flow dedication by the HBMWD(District) is in sync with the California Salmon Strategy for a Hotter and Drier Future (CSS) that was published by the State of California in 2024. The CSS states that "State agencies can promote, prioritize, and expedite projects that help augment or protect flows, water temperature, and related habitat." The District's proposed 1707 instream flow dedication is aligned with the goal of protecting flows, water temperature, and related habitat.

The CSS references the California Environmental Flows Framework fact sheet (CDFW 2020) (https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=162122&inline), which can be used to inform CDFW recommendations and related State Water Board regulatory actions. The CA Environmental Flows Framework fact sheet then references the functional flow metrics that reports reference flow conditions have been estimated for every reach in the state using models (CEFWG 2021 and Zimmerman et al. 2023) trained on the set of reference gages and are available on the California Natural Flows Database website (https://rivers.codefornature.org/#/home).

To access the modeled flows, one needs to click on the "map" button (https://rivers.codefornature.org/#/map) of the website and up pops a map with modeled flow nodes throughout the state of which there are several on the Mad. Clicking on a node gives you seasonal base flows in cubic feet per second (cfs) for the 10, 50, and 90 percentiles for a selection of water year types. The estimated dry season natural flows for all and dry water year types at the Forest Glen gage downstream of Matthews dam are reported in Tables 1 and 2.

Table 1. Modeled flows for all water year types at the USGS Forest Glen Gage #11480500 downstream of Matthews Dam (California Natural Flows Database).

Flow Metric	10th percentile cfs	50th percentile cfs	90th percentile cfs
Dry season baseflow	0.5	5.2	19.1
Dry season high baseflow	25.2	53.1	125

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Table 2. Modeled flows for dry water year types at the USGS Forest Glen Gage #11480500 downstream of Matthews Dam (California Natural Flows Database).

Flow metric	10th percentile cfs	50th percentile cfs	90th percentile cfs
Dry-season baseflow	0.5	3.8	15.8
Dry-season high baseflow	18.8	36.5	92.1

The modeled dry season baseflows in Tables 1 and 2 match well with the measured flows logged by the USGS gage at Forest Glen prior to the construction of Matthews Dam (Table 3).

Table 3. Daily mean stream flows (cfs) during low-flow months prior to operation of Matthews Dam from October 1953 to October 1961 at the USGS Forest Glen gage #11480500 (HBMWD and Trinity Associates 2004).

Year	August			September			October			November		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
1953	–	–	–	–	–	–	3	16	5	4	2,330	279
1954	2	7	3	2	4	3	2	11	5	5	987	120
1955	2	5	3	1	3	2	2	5	2	3	1,890	176
1956	2	5	4	2	2	2	2	1,050	52	10	214	42
1957	3	7	5	2	23	4	7	1,400	168	32	3,350	455
1958	2	18	8	6	19	14	1	5	2	2	72	13
1959	2	2	2	2	20	7	2	9	6	2	3	2
1960	2	7	5	1	3	2	2	5	3	2	1,250	117
1961	1	10	5	1	8	4	2	8	3	2	380	51
AVG	**2**	**8**	**4**	**2**	**10**	**5**	**2**	**279**	**27**	**7**	**1,164**	**139**

The mean monthly dam-augmented flows at USGS Forest Glen gage 11480410, downstream of Matthews Dam during August and September 2015–2022 are presented in Table 4.

Table 4. Mean monthly flows for the months of August and September at USGS Forest Glen gage 11480410.

Water year	August	September
	Mean cfs	Mean cfs
2015	43	45
2016	45	-
2017	45	46
2018	51	45
2019	44	45
2020	33	41
2021	38	43
2022	44	64
AVG	**43**	**47**

As one can see, the modeled dry season flows modeled by the California Natural Flows Database and the pre-Matthews Dam natural flows are significantly less than those measured by the USGS and in Table 4. The dam releases have resulted in significantly greater flow downstream of Matthews Dam than would be available naturally. For the last 60 years, the flow releases have resulted in a significant increase of instream habitat area, cool water, and deeper pools for rearing juvenile and holding adult summer-run steelhead. The proposed instream flow dedication would maintain the existing status quo releases and protect the instream habitat conditions critical for summer-run steelhead, which are listed under the California Endangered Species Act (ESA) and included in the federal ESA listing for steelhead.

USGS Hwy 299 Gage

The California Natural Flows database (https://rivers.codefornature.org/#/map) estimates the natural flows for all (Table 5) and dry (Table 6) water year types at the USGS Arcata (Hwy 299) gage as follows:

Table 5. Modeled natural flows for all water year types at the USGS Arcata gage #1148100 at Highway 299 (California Natural Flows Database).

Flow Metric	**10th percentile cfs**	**50th percentile cfs**	**90th percentile cfs**
Dry season baseflow	30.1	57.4	110
Dry season high baseflow	126	209	358

Table 6. Modeled natural flows for dry water year types at the USGS Arcata gage #1148100 at Highway 299 (California Natural Flows Database).

Flow metric	**10th percentile cfs**	**50th percentile cfs**	**90th percentile cfs**
Dry-season baseflow	20.7	44.7	89.2
Dry-season high baseflow	88.3	180	317

The pre-dam construction mean monthly flows derived from measured streamflow at the USGS Arcata (Hwy 299) gage #1148100 for the years 1953–1961 are reported in Table 7.

Table 7. Monthly mean stream flows (cfs) during low-flow months prior to operation of Matthews Dam from August 1953 to October 1961 at the USGS Mad River near Arcata gage #11481000 (http://waterdata.usgs.gov/nwis/monthly/).

Year	**August mean daily flow (cfs)**	**September mean daily flow (cfs)**	**October mean daily flow (cfs)**	**November mean daily flow (cfs)**
1953	67	41	107	2903
1954	47	45	47	448
1955	34	30	41	1075
1956	39	28	536	405
1957	37	45	591	2,472
1958	43	39	34	378
1959	19	30	39	32
1960	34	24	30	1,043
1961	38	30	80	-
Mean of monthly discharge	**40**	**35**	**167**	**1,090**

The post-dam construction August and September mean monthly flows derived from measured streamflow at the USGS Arcata (Hwy 299) gage #1148100 for the years 2015–2022 are reported in Table 8.

Table 8. Post-dam construction mean monthly flows for August and September at the USGS Arcata gage #1148100.

Water year	August	September
	Mean cfs	Mean cfs
2015	42.1	41.4
2016	49.8	43.5
2017	62.4	58.7
2018	54.3	46.6
2019	57.8	52
2020	37.1	37
2021	33.2	42
2022	56.4	63.2
AVG	**49.1**	**48.0**

As one can see, the dam-augmented flows at USGS Arcata gage for the late summer and early fall are within the 50th percentile range of the California Natural Flows database's modeled estimated dry season natural flows for all water years and most of the dry water years.

Prior to operation of Matthews Dam, a sand bar/barrier beach closed the mouth of the Mad River during periods of low flow in most years (DWR 1958). Mean pre-dam flows during this period at the USGS Arcata gage ranged from 34 to 36 cfs during August and September of 1954 to 1961 (Table 4-2). In the years when the mouth was open, Chinook salmon were able to enter the river as early as August, but were often blocked by dry stretches of stream only a few miles above the mouth (DWR 1958). The CDFG (1953) reported that the mouth of the Mad River remained open to the ocean during all of 1952. CDFG (1953) also reported, "The fall rains were late in arriving and until November 14 salmon could not ascend the river further (sic) than a point approximately one-half mile below the mouth of the North Fork of the Mad River. At that point the stream bed surface was completely dry for a stretch of nearly 200 yards. There were several other dry stretches immediately above. Portions of the river from about a half-mile downstream of the North Fork were dry. Fish were in the river up to that point." Average daily flows from 1 September to 13 November 1952 on the lower Mad River at the Arcata gage (# 11481000) ranged from 21 to 25 cfs (USGS 2024).

The proposed instream flow dedication would maintain and protect the instream flows and habitat conditions that the lower river, Chinooks salmon, coho salmon, and steelhead have experienced for six decades. These flows also have maintained a connection between the mouth of the river and the ocean. This connection has resulted in entry into and upstream migration in the Mad River during August and early September by Chinook salmon and steelhead, which is generally the start of the spawning migration in northwest California. Without enough water to maintain the open river mouth and/or allow upstream movement, the fish would need to wait until the rains begin, which can be November or December. This delay would subject the holding fish to continued predation by pinnipeds, which station themselves at the mouth of the river.

The instream flows currently augmented by the Matthews Dam water releases also enhance riffle and pool habitat in the lower river. The increased flows have enhanced riffle habitat for benthic macroinvertebrates, which are a primary food resource for the juvenile steelhead and coho salmon that rear in the mainstem Mad River. The flows have enhanced pool features (depth, volume, and area), which are critical for over summer holding habitat for adult summer-run steelhead.

Climate change resiliency

One of the stated goals of the HBMWD's instream flow dedication is to release stream flows within the Mad River that provide resiliency to the impacts of climate change. The Office of Environmental Health Hazard Assessment (OEHHA 2022) published a report titled "Indicators of Climate Change in California." The OEHHA report presents a collection of indicators that track climate change, its drivers, and its impacts. The OEHHA (2022) reported that statewide minimum air temperatures in California have risen 2.9 degrees Fahrenheit (°F) in the last century. In the North Coast (includes coastal Humboldt County) and North Central (includes Matthews Dam area) regions of California minimum air temperatures have risen 1.4°F and 2.3°F, respectively (OEHHA 2022).

The OEHHA (2022) states that "warmer air temperatures alter precipitation and runoff patterns, influencing the availability of freshwater supplies. Increased temperature leads to a wide range of impacts on ecosystems — including changes in species' geographic distribution, in the timing of life cycle events, and in their abundance." Air temperature is also one of the primary drivers of water temperatures. As air temperatures increase, it can be expected that water temperatures can follow suit. The rate of water temperature increase is in part related to the volume of water being heated. The smaller the volume of water exposed to a given high air temperature, the more rapidly it will warm up and vice versa.

Matthews Dam releases cold bottom water into the Mad River. Water temperature monitoring conducted at 14 mainstem Mad River sites between river miles (RM) 0.7 (Widow White Creek downstream of Hwy 101) and 80.2 (Matthews Dam) from May 1 to September 26, 2018 by the Mad River Alliance (MRA). The MRA used Onset HOBO temperature loggers for this effort, which recorded water temperature on 30-minute intervals for the entire study period. The water temperature data were analyzed by H.T. Harvey and Associates.

Maximum weekly average temperatures (MWAT) above 19 degrees Celsius (C) (66 degrees F) are considered stressful for rearing juvenile steelhead, as are maximum weekly maximum temperatures (MWMT) above 24°C (75°F) (Carter 2008). The analyses of the data showed that dam releases moderated water temperatures at least 7.5 miles (RM 80.2–72.7) downstream of Matthews Dam. MWAT and MWMT within the 7.5-mile reach downstream of Matthews Dam ranged from 14.7–17.1 and 16.5–19.9°C (25.5–62.8° and 61.7–67.8°F), respectively while the dam was releasing according to its normal schedule. The MWAT and MWMT at the next downstream station (RM 41.6) were 23.3°C (73.9°F) and 24.9°C (76.8°F), respectively. Therefore, the river reached equilibrium with the outside environment somewhere between RM 72.7 and 41.6. Equilibrium would have been reached much closer to the Matthews Dam site if the natural flows (see the modeled dry season and recorded pre-dam flows above) or less than status quo flows were running in the channel below the dam. Therefore, the existing dam releases are currently providing climate resiliency by maintaining flow volume, moderating water temperatures, and providing critical instream habitat for aquatic species, including summer-run steelhead.

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Actions and Approvals Requested of the State Water Board

The District requests that the SWRCB process a change petition under Water Code section 1707 that would dedicate a release of approximately 31 cfs on a monthly average (as described above in Figure 3) for the purpose of enhancing the fishery and aquatic/riparian ecosystem of the Mad River. This change would take effect upon approval by the SWRCB and would be a permanent change to the District's water rights.

Key Findings In Support of 1707 Change Petition

Will the change initiate a new water right or increase the amount of water the District is entitled to use? No, the District's water right Permits 11714 and 11715 currently allow for releases of previously stored water at Matthews Dam to meet the requested 31 cfs (on a monthly average) use of water for instream purposes.

Will the change injure any legal water user? No, the proposed instream water dedication will support water levels and water quality between Matthews Dam and Essex while still allowing for diversion by right holders to the extent that was is available for them to divert pursuant to their priority of right.

Does the change petition address CEQA requirements? Yes. The Project is Categorically Exempt under

sections: 15301; 15304; 15307 and 15308. This determination was made at the HBMWD Board meeting on April 29, 2024 and filed with the State Clearing House. #
Will the change have any adverse effects on public trust resources? No, the requested change will improve aquatic habitat between Matthews Dam to the Essex facility.

Is the change in the public interest? Yes, the instream use will benefit fish and wildlife resources and maintain existing conditions to support other lawful beneficial uses of water in the project area.

Project Map

A project map is included as **Appendix C**. This map includes:

- ✓ A delineation of the project (75 miles of the Mad River from Ruth Lake to Essex)
- ✓ Identification of HBMWD's existing point of diversion/rediversion

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APPENDIX A. HBMWD Water Rights Permits

STATE OF CALIFORNIA
STATE WATER RESOURCES CONTROL BOARD

ORDER WRO - 2004 - 0038

In the Matter of Permits 11714 and 11715
Regarding Diversions by
HUMBOLDT BAY MUNICIPAL WATER DISTRICT

SOURCE: Mad River

COUNTIES: Humboldt and Trinity

ORDER APPROVING AN EXTENSION OF TIME AND PARTIAL REVOCATION OF PERMITTED WATER RIGHTS

BY THE BOARD:

1.0 BACKGROUND

Permits 11714 and 11715 were issued to the Humboldt Bay Municipal Water District (District) on March 16, 1959, pursuant to water right applications 16454 and 17291, respectively. These permits allow diversion to storage of up to 120,000 acre-feet per annum (afa), plus direct diversion of up to 200 cubic feet per second (cfs). At present, the District has developed a reservoir storage capacity of 48,030 acre-feet (af) in Ruth Lake, and has diversion capacity of 116 cfs at the community of Essex on the Mad River. These facilities and capacities constitute Phase I of the District's project. The remaining diversion and storage capacities allowed by the permits, presently undeveloped, constitute Phase II of the project.

Permits 11714 and 11715 were subsequently amended three times to add additional time to allow full development of the water allowed to be beneficially used under the two permits. These time extensions, for ten years each, were granted on April 29, 1971; July 7, 1982; and March 2, 1992. The last time extension required the District to fully develop its water rights by December 31, 2002.

On March 18, 2002, the District filed a Petition for Extension of Time (Petition) for an additional ten years to complete development of its rights. By letter of June 20, 2002, the District requested the time extension be granted for 25 years, instead of ten years.

The State Water Resources Control Board (SWRCB) provided the public notice of the Petition on July 22, 2002. No protests to the proposed action were received.

The District has recognized that Phase II will not be developed for several decades, if ever, and will require preparation of an Environmental Impact Report prior to development, as part of the petition process. Therefore, as part of its Petition for Extension of Time, the District Board of Directors also approved submittal of a request that the SWRCB revoke authorization of Phase II of its project, thus limiting the scope of the Petition to the present facilities and capacities (combined direct diversion and storage of 132,030 afa). The District submitted this request on April 30, 2004. The District also submitted substantial evidence in support of its contention that Phase I could be developed to full beneficial use within the next 25 years.

In accordance with the California Environmental Quality Act, the District, as lead agency, has completed and certified a Mitigated Negative Declaration in connection with the proposed project. The SWRCB received no comments or protests to the proposed action.

2.0 DISCUSSION

Approval of Petitions for Extension of Time is normally delegated to the Chief of the Division of Water Rights (SWRCB Resolution No. 2002—0106, section 2.6.11), except when the requested period of extension, combined with all extensions previously granted under delegated authority, exceeds 25 years (section 2.6.11(c)(2)). The District has already been granted time extensions totaling 30 years, and is requesting an additional 25-year time extension. Therefore, the SWRCB must approve any additional extension of time for these permits.

2.1 Applicable Law

Water Code section 1396 requires a permittee to prosecute project construction and beneficial use of water with due diligence, in accordance with the Water Code, the SWRCB's regulations, and the terms specified in the permit. The SWRCB may approve a request for an extension of time if the SWRCB finds that there is good cause for the extension. (Wat. Code § 1398, subd. (a).) The SWRCB's regulations allow an extension of time to be granted only on such conditions as the SWRCB determines to be in the public interest, and on a showing to the SWRCB's satisfaction that (1) due diligence has been exercised, (2) failure to comply with previous time requirements has been occasioned by obstacles which could not reasonably be avoided, and (3) satisfactory progress will be made if an extension of time is granted. (Cal. Code Regs., tit. 23, § 844.) The SWRCB generally will not accept conditions incident to the person and not to the enterprise as good cause for delay. (Ibid.) After a hearing on a petition for an extension of time, the SWRCB may revoke the permit. (Wat. Code § 1398, subd. (b); § 1410, subd. (a) – (b)(1).)

2.1.1 Due Diligence

The District completed construction of the major Phase I components of its project within four years of the issuance of the permits.

2.1.2 Obstacles

Water usage in the District has developed at a slower rate than originally anticipated, particularly following the closure of a pulp mill near Eureka that had used a substantial amount of water for processing wood pulp. While in past years, prior to 1992, the District has diverted as much as 75,000 afa, it is currently using about 30,000 afa. The pulp mill closed, and the use of water was reduced for reasons beyond the District's control. The District has taken all actions within its power to put the water to reasonable and beneficial use.

2.1.3 Satisfactory Progress

The District has identified several municipal development projects within the authorized place of use of these permits. These projects are in various stages of authorization and development. The District anticipates that these developments will be served with water from Phase I of its project. (see Wat. Code § 106.5.)

3.0 FINDINGS

1. The permittee (District) has proceeded with due diligence, and good cause has been shown for an extension of time.

2. The SWRCB has determined that the petition for an extension of time neither constitutes the initiation of a new right nor operates to the injury of any other lawful user of water.

3. The permit conditions relating to the continuing authority and water quality objectives of the SWRCB should be updated to conform to Section 780 (a & b), Title 23 of the California Code of Regulations.

4. Fish, wildlife, and plant species have been or may be listed under the federal Endangered Species Act and/or the California Endangered Species Act. A condition should be added to the permits stating that the permits do not authorize any act that results in the taking of a threatened or endangered species.

5. The SWRCB is a responsible agency pursuant to the California Environmental Quality Act (CEQA). The SWRCB has considered the environmental effects of the Petition for Change as described by the petitioner in the Mitigated Negative Declaration prepared for this project. The proposed mitigation measures will reduce any potential impacts of the continued operation of Phase I of the project to less than significant levels.

6. The SWRCB has determined that the partial revocation of the District's water rights is consistent with a reasonable expectation of future demand in the District's place of use.

ORDER

IT IS HEREBY ORDERED THAT PERMITS 11714 AND 11715 ARE AMENDED AS FOLLOWS:

1. Condition 4 of the permits shall be deleted. Condition 5 shall be amended to read:

   Construction work and complete application of the water to the authorized use shall be prosecuted with reasonable diligence and completed by December 31, 2029.

(0000009)

2. The continuing authority condition shall be updated to read as follows:

   Pursuant to California Water Code sections 100 and 275 and the common law public trust doctrine, all rights and privileges under this permit and under any license issued pursuant thereto, including method of diversion, method of use, and quantity of water diverted, are subject to the continuing authority of the SWRCB in accordance with law and in the interest of the public welfare to protect public trust uses and to prevent waste, unreasonable use, unreasonable method of use, or unreasonable method of diversion of said water.

   The continuing authority of the SWRCB may be exercised by imposing specific requirements over and above those contained in this permit with a view to eliminating waste of water and to meeting the reasonable water requirements of permittee without unreasonable draft on the source. Permittee may be required to implement a water conservation plan, features of which may include but not necessarily be limited to: (1) reusing or reclaiming the water allocated; (2) using water reclaimed by another entity instead of all or part of the water allocated; (3) restricting diversions so as to eliminate agricultural tailwater or to reduce return flow; (4) suppressing evaporation losses from water surfaces; (5) controlling phreatophytic growth; and (6) installing, maintaining, and operating efficient water measuring devices to assure compliance with the quantity limitations of this permit and to accurately determine water use as against reasonable water requirements for the authorized project. No action will be taken pursuant to this paragraph unless the SWRCB determines, after notice to affected parties and opportunity for hearing, that such specific requirements are physically and financially feasible and are appropriate to the particular situation.

The continuing authority of the SWRCB also may be exercised by imposing further limitations on the diversion and use of water by the permittee in order to protect public trust uses. No action will be taken pursuant to this paragraph unless the SWRCB determines, after notice to affected parties and opportunity for hearing, that such action is consistent with California Constitution article X, section 2; is consistent with the public interest; and is necessary to preserve or restore the uses protected by the public trust.

(0000012)

3. The water quality objectives condition shall be updated to read as follows:

The quantity of water diverted under this permit and under any license issued pursuant thereto is subject to modification by the SWRCB if, after notice to the permittee and an opportunity for hearing, the SWRCB finds that such modification is necessary to meet water quality objectives in water quality control plans which have been or hereafter may be established or modified pursuant to Division 7 of the Water Code. No action will be taken pursuant to this paragraph unless the SWRCB finds that: (1) adequate waste discharge requirements have been prescribed and are in effect with respect to all waste discharges which have any substantial effect upon water quality in the area involved, and (2) the water quality objectives cannot be achieved solely through the control of waste discharges.

(0000013)

4. Permits 11714 and 011715 shall be amended to include the following Endangered Species condition:

This permit does not authorize any act which results in the taking of a threatened or endangered species or any act which is now prohibited, or becomes prohibited in the future, under either the California Endangered Species Act (Fish and Game Code sections 2050 to 2097) or the federal Endangered Species Act (16 U.S.C.A. sections 1531 to 1544). If a "take" will result from any act authorized under this water right, the permittee shall obtain authorization for an incidental take prior to construction or operation of the project.

Permittee shall be responsible for meeting all requirements of the applicable Endangered Species Act for the project authorized under this permit.

(0000014)

5. Paragraph 1 of Permit 11714 is deleted in its entirety, and the following term is substituted:

   The amount of water to be appropriated shall be limited to the amount that can be beneficially used and shall not exceed 48,030 afa by storage, to be collected from October 1 of each year to April 30 of the succeeding year. The maximum amount per annum to be stored under this permit and Permit 11715 shall not exceed 48,030 afa. The total annual diversion and use allowed under this permit and Permit 11715 shall not exceed 132,030 afa.

(0000005)

6. Term 1 of Permit 11715 is deleted in its entirety, and the following term is substituted:

   The amount of water to be appropriated shall be limited to the amount that can be beneficially used and shall not exceed 116 cfs by direct diversion, year-round, and 20,000 afa by storage, to be collected from October 1 of each year to April 30 of the succeeding year. The maximum amount to be appropriated by direct diversion under this permit shall not exceed 84,000 afa. The maximum amount per annum to be stored under this permit and Permit 11714 shall not exceed 48,030 afa. The total annual diversion and use allowed under this permit and Permit 11714 shall not exceed 132,030 afa.

(0000005)

7. All other conditions of Permits 11714 and 11715 are still applicable.

CERTIFICATION

The undersigned Clerk to the Board does hereby certify that the foregoing is a full, true, and correct copy of an order duly and regularly adopted at a meeting of the State Water Resources Control Board held on August 26, 2004.

AYE: Peter S. Silva
Richard Katz
Gary M. Carlton

NO: None.

ABSENT: Arthur G. Baggett, Jr.
Nancy H. Sutley

ABSTAIN: None.

Debbie Irvin
Clerk to the Board

PERMIT No. 11714

This is to certify that the application of which the foregoing is a true and correct copy has been considered and approved by the State Water Rights Board SUBJECT TO VESTED RIGHTS and the following limitations and conditions:

1. The amount of water to appropriated shall be limited to the amount which can be beneficially used and shall not exceed 100,000 acre-feet per annum by storage to be collected from about October 1 of each year to about April 30 of the succeeding year.

2. The maximum amounts herein stated may be reduced in the license if investigation so warrants.

3. Actual construction work shall begin on or before December 1, 1960, and shall thereafter be prosecuted with reasonable diligence, and if not so commenced and prosecuted, this permit may be revoked.

4. Said construction work shall be completed on or before July 1, 1967.

5. Complete application of the water to the proposed use shall be made on or before July 1, 1970.

6. Progress reports shall be filed promptly by permittee on forms which will be provided annually by the State Water Rights Board until license is issued.

7. All rights and privileges under this permit including method of diversion, method of use, and quantity of water diverted are subject to the continuing authority of the State Water Rights Board in accordance with law and in the interest of the public welfare to prevent waste, unreasonable use, unreasonable method of use or unreasonable method of diversion of said water.

8. For the protection, propagation and preservation of fish life permittee shall:

a. At all times by-pass or release minimum flow of five cubic feet per second into the natural stream bed of

Mad River immediately below Ruth Dam.

b. During the periods herein specified, by-pass or release into the natural stream bed of Mad River immediately below Essex Diversion Dam the following minimum flows or the natural flow of Mad River as regulated by diversions now in existence, whichever is less:

October 1 through October 15	30 cfs
October 16 through October 31	50 cfs
November 1 through June 30	75 cfs
July 1 through July 31	50 cfs
August 1 through August 31	40 cfs
September 1 through September 30	30 cfs

9. This permit is subject to the Memorandum of Understanding between Humboldt Bay Municipal Water District and County of Trinity, drafted on January 28, 1959, and duly approved by both agencies and on file with the State Water Rights Board.

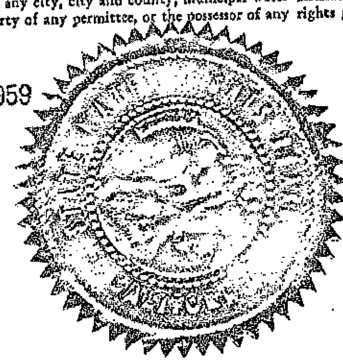
<u>*This permit is issued and permittee takes it*</u> subject to the following provisions of the Water Code:

Section 1390. A permit shall be effective for such time as the water actually appropriated under it is used for a useful and beneficial purpose in conformity with this division (of the Water Code), but no longer.

Section 1391. Every permit shall include the enumeration of conditions therein which in substance shall include all of the provisions of this article and the statement that any appropriator of water to whom a permit is issued takes it subject to the conditions therein expressed.

Section 1392. Every permittee, if he accepts a permit, does so under the conditions precedent that no value whatsoever in excess of the actual amount paid to the State therefor shall at any time be assigned to or claimed for any permit granted or issued under the provisions of this division (of the Water Code), or for any rights granted or acquired under the provisions of this division (of the Water Code), in respect to the regulation by any competent public authority of the services or the price of the services to be rendered by any permittee or by the holder of any rights granted or acquired under the provisions of this division (of the Water Code) or in respect to any valuation for purposes of sale to or purchase, whether through condemnation proceedings or otherwise, by the State or any city, city and county, municipal water district, irrigation district, lighting district, or any political subdivision of the State, of the rights and property of any permittee, or the possessor of any rights granted, issued, or acquired under the provisions of this division (of the Water Code).

Dated: MAR 16 1959



STATE WATER RIGHTS BOARD

L. K. Hill

L. K. Hill
Executive Officer

60669 7-58 16M SPO

APPLICANT MUST NOT FILL IN BLANKS BELOW

PERMIT No. 11715 SECTION 5.1a PAGE NO. 40

This is to certify that the application of which the foregoing is a true and correct copy has been considered and approved by the State Water Rights Board SUBJECT TO VESTED RIGHTS and the following limitations and conditions:

1. The amount of water appropriated shall be limited to the amount which can be beneficially used and shall not exceed 200 cubic feet per second by direct diversion, year-round, and 20,000 acre-feet per annum by storage to be collected from about October 1 of each year to about April 30 of the succeeding year.

2. The maximum amounts herein stated may be reduced in the licenses if investigation so warrants.

3. Actual construction work shall begin on or before December 1, 1960, and shall thereafter be prosecuted with reasonable diligence, and if not so commenced and prosecuted, this permit may be revoked.

4. Said construction work shall be completed on or before July 1, 1967.

5. Complete application of the water to the proposed use shall be made on or before July 1, 1970.

6. Progress reports shall be filed promptly by permittee on forms which will be provided annually by the State Water Rights Board until license is issued.

7. All rights and privileges under this permit including method of diversion, method of use, and quantity of water diverted are subject to the continuing authority of the State Water Rights Board in accordance with law and in the interest of the public welfare to prevent waste, unreasonable use, unreasonable method of use or unreasonable method of diversion of said water.

8. For the protection, propagation and preservation of fish life permittee shall:

a. At all times by-pass or release minimum flow of five cubic feet per second into the natural stream bed of Mad River immediately below Ruth Dam.

b. During the periods herein specified, by-pass or release into the natural stream bed of Mad River immediately below Essex Diversion Dam the following minimum flows or the natural flow of Mad River as regulated by diversions now in existence, whichever is less:

October 1 through October 15	30 cfs
October 16 through October 31	50 cfs
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September 1 through September 30	30 cfs

9. This permit is subject to the Memorandum of Understanding between Humboldt Bay Municipal Water District and County of Trinity, drafted on January 28, 1959, and duly approved by both agencies and on file with the State Water Rights Board.

water.

This permit is issued and permittee takes it subject to the following provisions of the Water Code:

Section 1390. A permit shall be effective for such time as the water actually appropriated under it is used for a useful and beneficial purpose in conformity with this division (of the Water Code), but no longer.

Section 1391. Every permit shall include the enumeration of conditions therein which in substance shall include all of the provisions of this article and the statement that any appropriator of water to whom a permit is issued takes it subject to the conditions therein expressed.

Section 1392. Every permittee, if he accepts a permit, does so under the conditions precedent that no value whatsoever in excess of the actual amount paid to the State therefor shall at any time be assigned to or claimed for any permit granted or issued under the provisions of this division (of the Water Code), or for any rights granted or acquired under the provisions of this division (of the Water Code), in respect to the regulation by any competent public authority of the services or the price of the services to be rendered by any permittee or by the holder of any rights granted or acquired under the provisions of this division (of the Water Code) or in respect to any valuation for purposes of sale to or purchase, whether through condemnation proceedings or otherwise, by the State or any city, city and county, municipal water district, irrigation district, lighting district, or any political subdivision of the State, of the rights and property of any permittee, or the possessor of any rights granted, issued, or acquired under the provisions of this division (of the Water Code).

Dated: MAR 16 1959

STATE WATER RIGHTS BOARD

L. K. Hill
L. K. Hill
Executive Officer

80590 7-60 15M SPO

APPENDIX B. Temperature and DO Modeling Report

APPENDIX B. Temperature and DO Modeling Report

1.1 Introduction

The North Coast Regional Water Quality Control Board has listed the Mad River as impaired for sediment, turbidity, and temperature under Section 303(d) of the California Clean Water Act, and water quality is a critically important factor with regard to the conservation of salmonids and other special-status species. This project would dedicate instream flows to the Mad River for environmental benefit purposes. However, stream flow enhancement has the potential to affect the quality of the water downstream from the point of discharge, but is anticipated to benefit fish and wildlife. The District and its partners monitored water temperature, air temperature, turbidity, and discharge between May 1 and October 31, 2018, to analyze the relationships among these factors. The goal of the 2018 monitoring was to determine whether the instream flow dedication could improve water quality over existing conditions, which may be a limiting factor for salmonids and other special-status species in the Mad River.

1.2 Methods and Results

1.2.1 Sources of Information

Water and air temperature data on the Mad River were collected by the Mad River Alliance (MRA) from May 1 to September 26, 2018, using Onset HOBO temperature loggers. The deployment locations for the temperature loggers were selected on the basis of: (1) accessibility; (2) capability to provide an accurate representation of ambient creek/river temperatures; (3) avoidance of known springs and seeps; and (4) ability to conceal the data loggers to reduce vandalism and ensure instrument and data recovery (Pounds pers. comm. 2019). Mainstem water temperature data were recorded every 30 minutes at 17 sites, but unfortunately three of the mainstem HOBO temperature loggers were lost or stolen. Tributary water temperature data were collected at 8 sites (Table 14, Figure 8). H. T. Harvey & Associates examined the data set and determined that some of the temperature data were collected prior to the HOBO logger being deployed; these data were subsequently cropped. We also removed temperature data from the Mad River upstream of Cañon Creek (MRUSCanon) between July 7 at 7:00 p.m. and July 19 at 6:30 a.m. because there was a 10°F decrease in recorded temperatures that was not observed at neighboring sites. Additional water temperature data from the Ruth Lake Marina (at surface) and the Matthews Dam tailrace, as well as turbidity, rainfall and discharge data at the dam (tailrace), were provided by the District for May 1 to October 31, 2018. Stream gage data from the U.S. Geological Survey were checked against the District data but were not included in the analyses.

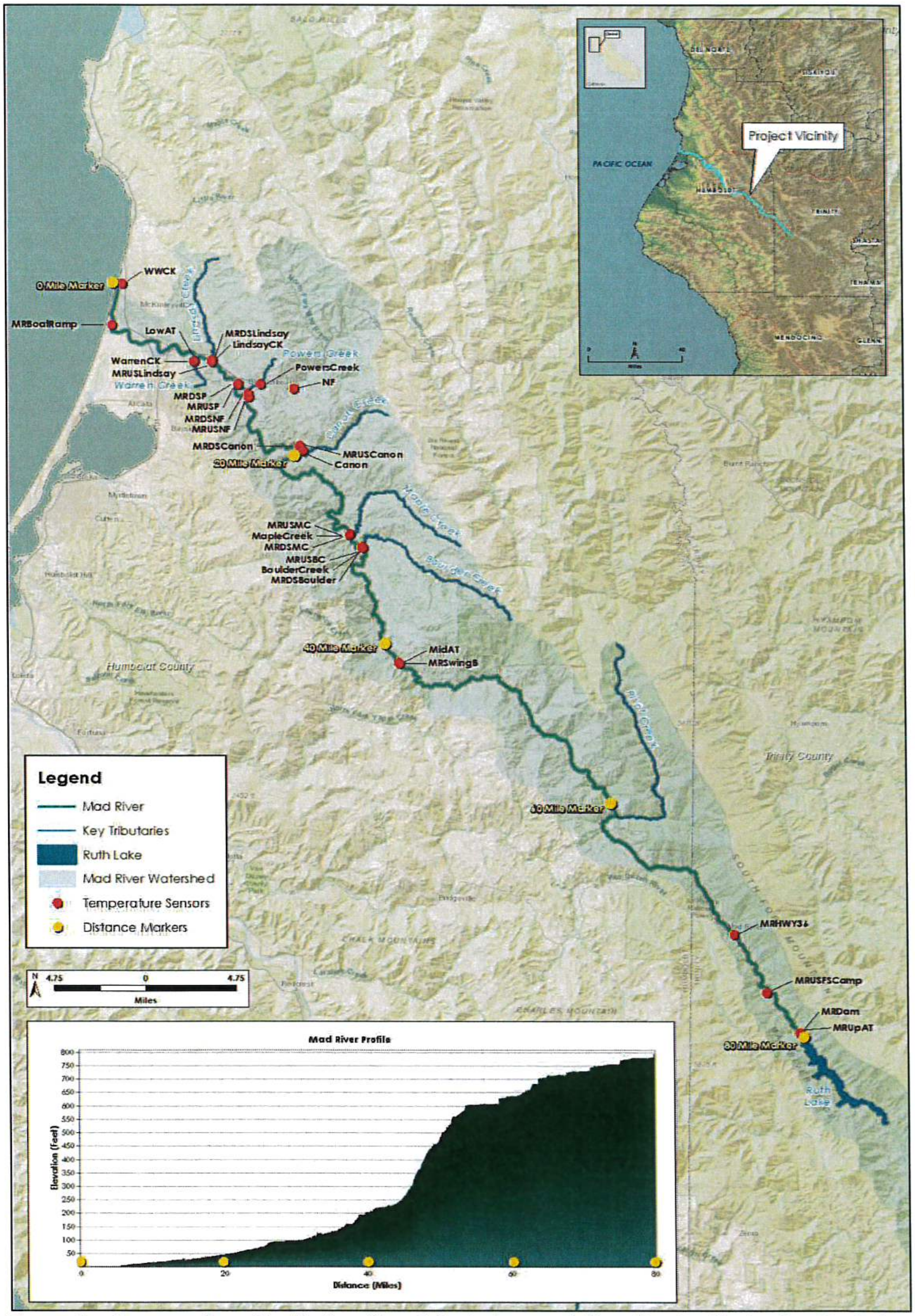

Figure 1. Temperature Monitoring Sites, Tributaries, and Elevation Profile for the Mad River, Humboldt County, California

Table 1. Water and Air Temperature Monitoring Sites on the Mad River

RM	ID	Reach	Category	Name	Lat	Lon
0.7	WWCK	E	TR	Widow White Creek	40.9623443	-124.1203722
3.1	MRBoatRamp	E	MS	Mad River Boat Ramp	40.92896818	-124.1297681
9.5	LowAT	LR	AT	Lower Mad River Air Temp	40.90131994	-124.0469784
9.5	WarrenCK	LR	TR	Warren Creek	40.90138535	-124.0471489
10.3	MRDSLindsay	LR	MS	Mad River downstream of Lindsay Creek	40.90174272	-124.0304291
10.3	LindsayCK	LR	TR	Lindsay Creek	40.90277703	-124.0296433
10.4	MRUSLindsay	LR	MS	Mad River upstream of Lindsay Creek	40.90116693	-124.0297067
12.4	MRDSP	LR	MS	Mad River downstream of Powers Creek	40.88395270	-124.0028767
12.4	PowersCreek	LR	TR	Powers Creek	40.88407803	-123.9802949
12.4	MRUSP	LR	MS	Mad River upstream of Powers Creek	40.88339983	-124.0028903
13.7	MRDSNF	LR	MS	Mad River downstream of North Fork	40.87623962	-123.9926627
13.7	NF	LR	TR	North Fork Mad River	40.88102512	-123.9473143
13.9	MRUSNF	LR	MS	Mad River upstream of North Fork	40.87343792	-123.9919857
19.6	MRDSCanon	LR	MS	Mad River downstream of Cañon Creek	40.83528060	-123.9403968
19.6	Canon	LR	TR	Cañon Creek	40.83136258	-123.9370303
19.6	MRUSCanon	LR	MS	Mad River upstream of Cañon Creek	40.83477073	-123.9401075
31.2	MRDSMC*	LR	MS	Mad River downstream of Maple Creek	40.76495528	-123.8887041
31.3	MapleCreek	LR	TR	Maple Creek	40.76459488	-123.8886667
31.3	MRUSMC*	LR	MS	Mad River upstream of Maple Creek	40.76446717	-123.8891854
32.6	MRDSBoulder	MR	MS	Mad River downstream of Boulder Creek	40.75471003	-123.8765421
32.6	BoulderCreek	MR	TR	Boulder Creek	40.75523691	-123.8763601
32.6	MRUSBC*	MR	MS	Mad River upstream of Boulder Creek	40.75435072	-123.8755169
41.6	MidAT	MR	AT	Middle Mad River Air Temperature	40.66226768	-123.8381917
41.6	MRSwingB	MR	MS	Mad River at Swinging Bridge	40.66176464	-123.8372687
72.7	MRHWY36	UR	MS	Mad River at Highway 36 Bridge	40.44925597	-123.5023560

RM	ID	Reach	Category	Name	Lat	Lon
77.0	MRUSFSCamp	UR	MS	Mad River at USFS Campground	40.40264200	-123.4688680
80.2	MRUpAT	UR	AT	Upper Mad River Air Temperature	40.37083274	-123.4347936
80.2	MRDam	UR	MS	Mad River at Matthews Dam	40.37068642	-123.4359363

RM is river mile, ID is the site code, and Reach identifies each site as estuarine (E), lower reach (LR), middle reach (MR), or upper reach (UR). Name provides the site name with some location information. Lat stands for latitude; Lon for longitude. Category is either mainstem (MS), tributary (TR), or air temperature (AT).

* HOBO lost or stolen from this site; no data recovered.

The time series from the MRA 2018 temperature monitoring data are depicted collectively in Figure 9.

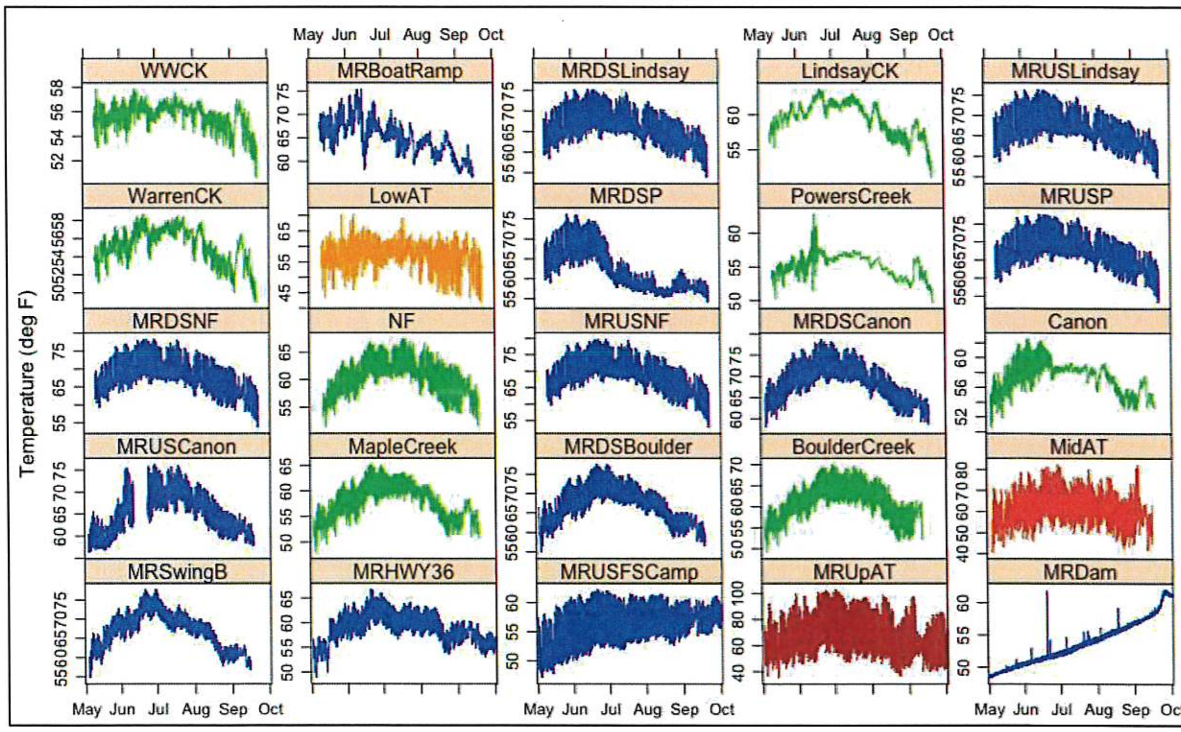

Figure 2. Mad River Water and Air Temperatures (May 1–September 26, 2018), Recorded Using HOBO Temperature Loggers at Multiple Mainstem (Blue), Tributary (Green), and Air Temperature (Orange-Red) Sites

1.2.2 Analytical Approach

We used graphical analyses, permutation distribution clustering (pdc), multiple regression with ARIMA[1] errors, and cross correlation functions (CCF) to explore the potential relationship between: (1) water temperatures at the point of discharge at Matthews Dam and downstream; (2) water temperatures from tributaries and the

[1] Auto Regressive Integrated Moving Average

mainstem downstream from the tributary confluence; (3) air temperatures and local or downstream mainstem water temperatures; and (4) dam discharge rates and downstream water temperatures. We had originally intended to use the Multiple Regression Stream Temperature Model[2] (MRSTM) developed by the U.S. Forest Service (USFS), but determined that this approach required data that we were unable to acquire, particularly discharge time series from tributaries. Instead, we retained the basis for the analysis used by the MRSTM (i.e., multiple regression) and employed additional statistical methods to refine this approach (Fellman et al. 2015). The MRSTM was not capable of implementing the ARIMA error terms associated with non-stationary time series data, such as what was collected during the 2018 monitoring on Mad River. Time series manipulation, analyses, and modelling were performed using R (R Core Team 2019), particularly the astsa (Stoffer 2019), lattice (Sarker 2008), lubridate (Grolemund and Wickham 2011), pdc (Brandmaier 2015), tseries (Trapletti and Hornik 2019), and zoo packages (Zeileis and Grothendieck 2005).

Mad River mainstem water temperatures and the associated water quality may be affected by or correlated with multiple factors. The factors that we evaluated were: (1) the temperature of upstream sites; (2) the temperature of tributaries to the Mad River; (3) local air temperature; and (4) the temperature and volume of water released at Matthews Dam. The volume of water contributed by tributaries also has the potential to affect water quality in the mainstem. Because we lacked flow data from these tributaries, we could not analyze the influence of tributary discharge on mainstem temperature. Similarly, while the range of discharge volumes observed in the mainstem during the monitoring period ranged from 41 to 227 cubic feet per second (cfs), the highest releases were limited to relatively short intervals in June and early July, which restricted our ability to model the effects of lower or higher discharge rates from Matthews Dam on downstream water temperature.

Maximum Weekly Average Temperature (MWAT) and Maximum Weekly Maximum Temperature (MWMT) were calculated from the HOBO temperature logger data. MWAT is the average daily temperature for the warmest 7-day period, and MWMT is the 7-day average of the daily maximum temperatures. These indices are useful to compare with temperature thresholds developed for different salmonid species and their life stages to assess the potential for chronic temperature effects (Stillwater Sciences 2010, Carter 2008).

1.2.2.1 Graphical Analyses and Permutation Distribution Clustering

The MRA 2018 temperature monitoring data time series (Figure 9) show a broad range of water and air temperatures between May 1 and September 26, 2018. Water temperatures ranged from the mid-40s to the mid-70s (°F) in both the mainstem Mad River and the tributaries. The corresponding air temperatures varied from 35 to 103°F (Figures 9 and 10). Both air and water time series displayed a strong diel component (i.e., 24-hour period), with a more limited range observed at lower elevation sites compared to their counterparts at higher elevations and closer to Matthews Dam. Most of these time series had the same general structure whereby average temperatures peaked around the end of June and gradually declined, with the lowest mean temperatures occurring near the end of the study period. The time series that did not exhibit this pattern were the two mainstem sites at the highest elevations: Mad River at USFS Campground (MRUSFSCamp) and Mad

[2] https://www.fs.fed.us/rm/boise/AWAE/projects/stream_temp/multregression_model.shtml

River at Matthews Dam (MRDam). Both of these sites showed a steady increase in average water temperature over the course of the 2018 monitoring period. MRUSFSCamp displayed the greatest diel temperature fluctuations, and MRDam exhibited the lowest diel temperature fluctuations. The two sites are 3.2 river miles (RMs) apart (2.8 miles straight-line distance) (Table 14). The mainstem site lowest in elevation, the Mad River Boat Ramp (MRBoatRamp), displayed the smallest diel fluctuations, probably due to its estuarine setting and the influences of ocean water temperatures and cooler coastal air temperatures.

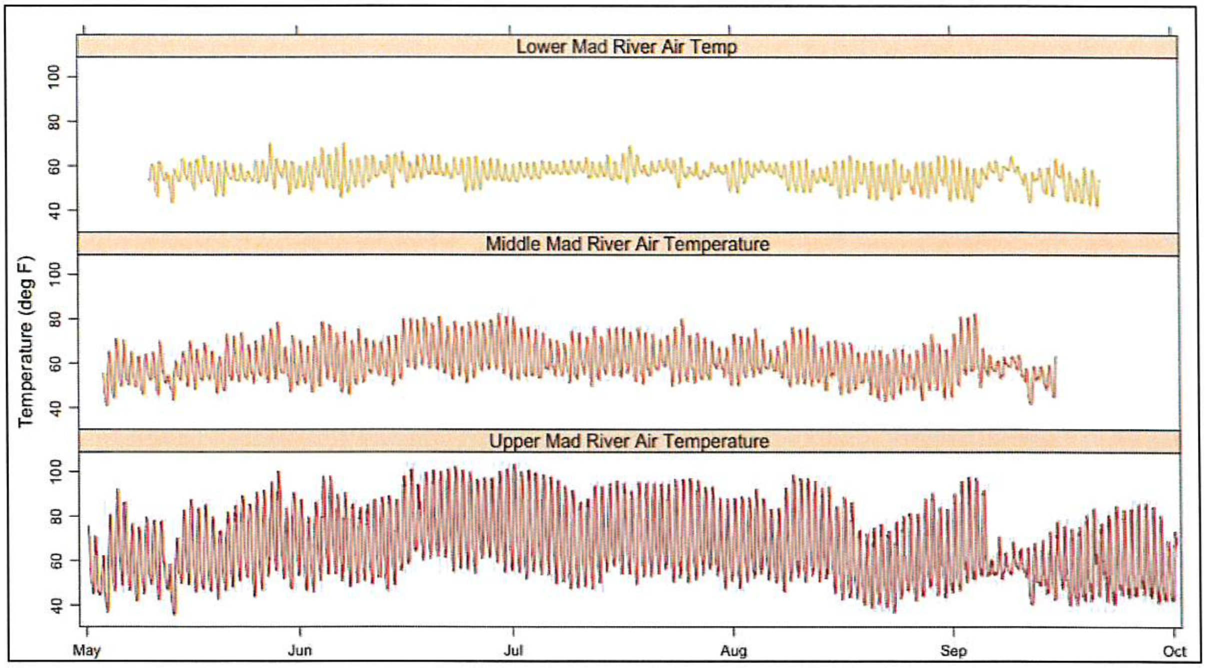

Figure 3. Air Temperatures along the Mad River (May 1–September 26, 2018), Recorded Using HOBO Temperature Loggers

Based on the general pattern of mainstem water temperatures over the 2018 monitoring period, it appeared that temperature in the upper reaches was predictive of temperature further downstream; however, both tributaries and local air temperature also affected mainstem water temperature. Tributary effects were most apparent when we compared the mainstem temperatures upstream and downstream of each confluence. Paired site data were collected for four tributaries in the lower reach of the Mad River: Lindsay Creek, Powers Creek, North Fork Mad River, and Cañon Creek. Temperature loggers were deployed in each of these tributaries upstream of their confluences with the mainstem, and in the mainstem immediately (less than 30 feet) upstream and downstream of each confluence. We also evaluated the tributary effect of Boulder Creek, except that the upstream mainstem temperature logger was lost or stolen. Therefore, we used time series data from the next site upstream at Swinging Bridge (MRSwingB), 9.0 RMs above the Boulder Creek confluence (Table 14, Figure 8). We generated time series of the temperature differentials for each of the five tributaries (Figure 11). Not all tributaries affected mainstem temperatures; the effects of Lindsay Creek, North Fork Mad River, and Boulder Creek were essentially undetectable in the mainstem. However, Powers Creek and, to a lesser extent, Cañon Creek affected (locally reduced) the mainstem temperature. During July and August, Powers Creek reduced the water temperature in the Mad River by more than 10°F; the maximum difference was 15.0°F on August 13, 2018; Powers Creek typically is subsurface at its confluence with the Mad River during this time of year, contributing cool water via a seep to the mainstem.

The diel water and air temperature fluctuations demonstrated that changing levels of solar heat energy directly affect both measurements, but the differences in heat capacity between water and air are also evident from the time series data. The fluctuations in diel air temperatures spanned wider ranges than the fluctuations for diel water temperatures. Seasonal changes in temperature suggested that multiple factors determine mainstem water conditions—the air temperature time series showed a similar initial climb and gradual decline observed in most water temperature time series, but the pattern was comparatively muted, which was indicative that local solar heat energy (evidenced by the air temperature time series) was only one of multiple contributing factors.

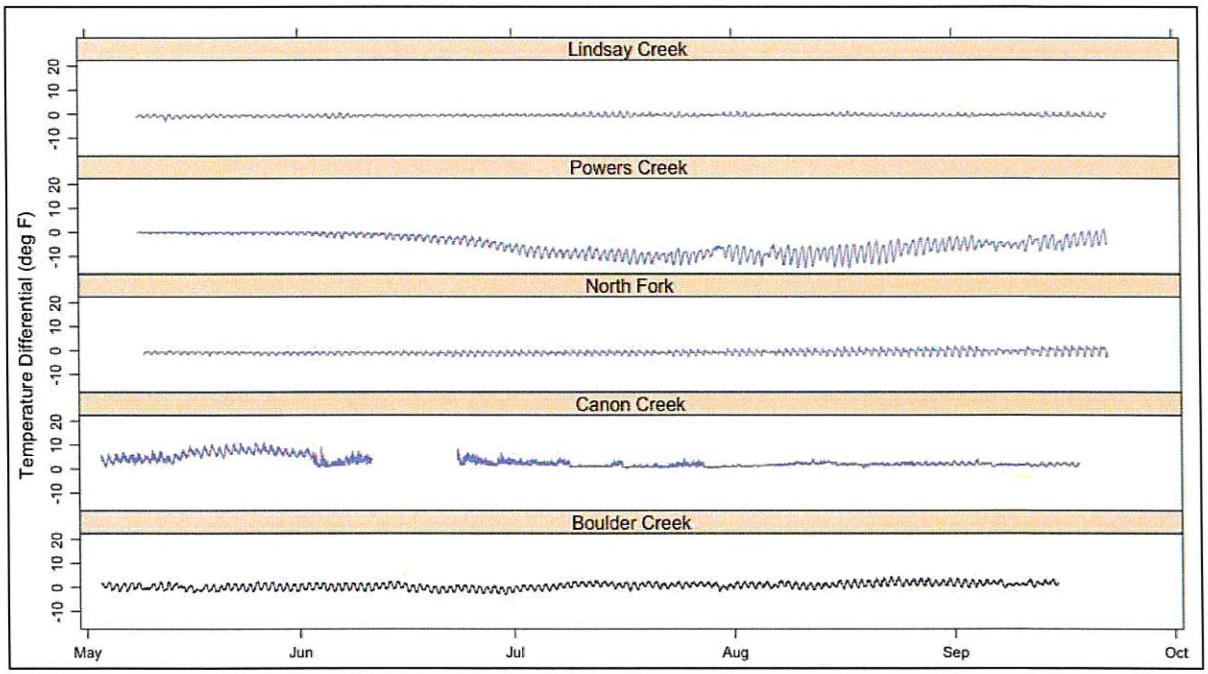

Figure 4. Mad River Mainstem Temperature Differences Measured Upstream and Downstream of Selected Tributaries (May 1–September 26, 2018)

Similar temperature time series are indicative of similar environmental conditions, connectivity between sites, or both (Brown 1969, Johnson 2004, Ferencz and Cardenas 2017). We used permutation distribution clustering (pdc) analysis to examine the similarities among time series. This analysis is a complexity-based clustering method developed specifically for time series, and uses the permutation distribution of those series to compare their differences.

Clustering generally provides a means to distinguish hierarchical, meaningful subgroups within a population of data sets (Altman and Krzywinski 2017, Caruso et al. 2018). If conditions at downstream sites closely resemble upstream sites, we would expect time series from adjoining sites to exhibit only minor differences and to have a relatively close association in the resulting tree structure (Figure 12). In fact, the pdc results of comparisons among Mad River water temperature time series identified incremental but informative differences among the monitoring sites and suggested that sites tended to become progressively less similar as the downstream distance from the highest elevation sites increased, with some exceptions (Figure 12).

The pdc analysis generated two well-defined groups (note the 'height' of the legs separating these groups in Figure 12). The smaller group (MRDam, MRBoatRamp, MRUSCanon, and Mad River downstream of Powers Creek [MRDSP]) was composed of somewhat dissimilar time series, and the larger group contained well-ordered series that ranged from the blue sites high in the river system to the green sites closer to the river mouth. The primary findings of the pdc analysis were that: (1) while not exact, the pattern was very close to that of the sequential order of the sites and strongly supported the hypothesis that, the closer a site may be to an upstream site, the more similar the diel and seasonal patterns of water temperature; and (2) the smaller group was striking because it included the time series for the highest (MRDam) and lowest (MRBoatRamp) elevation sites. The MRDam time series was substantially different from the others, with a steady, seasonal climb in temperatures that displayed two kinds of anomalies: periodic spikes in water temperature and an unusual increase near the end of the 2018 monitoring period (roughly September 14–26). Two of the higher mainstem sites (MRUSFSCamp and Mad River at Highway 36 Bridge [MRHWY36]) were the only additional sites monitored during the September 14–26 period, and exhibited subtler versions of the increase, but the pdc analysis strongly suggested that water temperatures immediately below Matthews Dam had essentially no predictive value for downstream sites. We suggest that the other three sites clustered with MRDam because they each had a distinctive pattern; the rest of the sites displayed similar patterns. MRBoatRamp was the mainstem site closest to the river mouth and was strongly estuarine. The temperatures at this site were affected by tidal action, the presence of ocean water, and coastal air temperatures. As noted in the methods discussion, MRUSCanon had a period of anomalous temperature data between July 7 and July 19 that was excluded from the analysis after consulting the MRA; that gap in the time series sets this site apart. MRDSP was unusual because the previously strong diel fluctuations in water temperature were abruptly and severely muted, beginning on July 30, 2018.

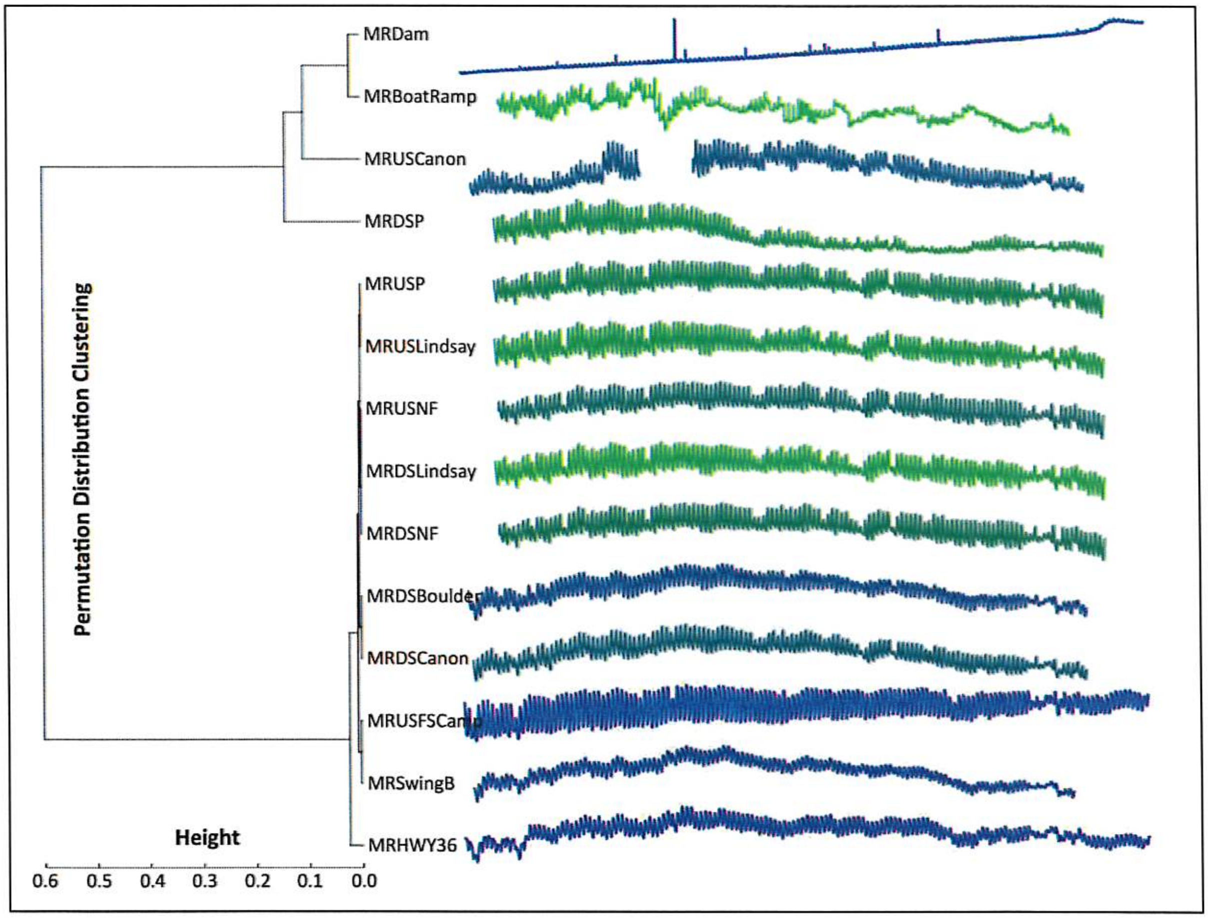

Figure 5. Permutation Distribution Clustering (PDC) of Mad River Mainstem Temperature Time Series (May 1–September 26, 2018) Showing their Relative Similarity
Note: Colors range from blue to light green, with the bluest colors from the highest elevation sites

1.2.2.2 Cross Correlation Functions

To further explore the potential effects of upstream sites on lower portions of the river and determine the predictive power of these observations, we used CCF to relate pairs of temperature time series. We tested the Matthews Dam (MRDam) time series against three downstream sites (Figure 13). Because of the apparently unusual series presented by the Matthews Dam data, we also used the MRUSFSCamp time series as the standard, but no pairs evolve concurrently, probably due to non-stationarity of the time series, and the sum of all autocorrelation functions (acf) for each analysis approaches 0 (Figure 13). We anticipated that the lag would correlate with the site separation in RMs, but no such relationship was detected.

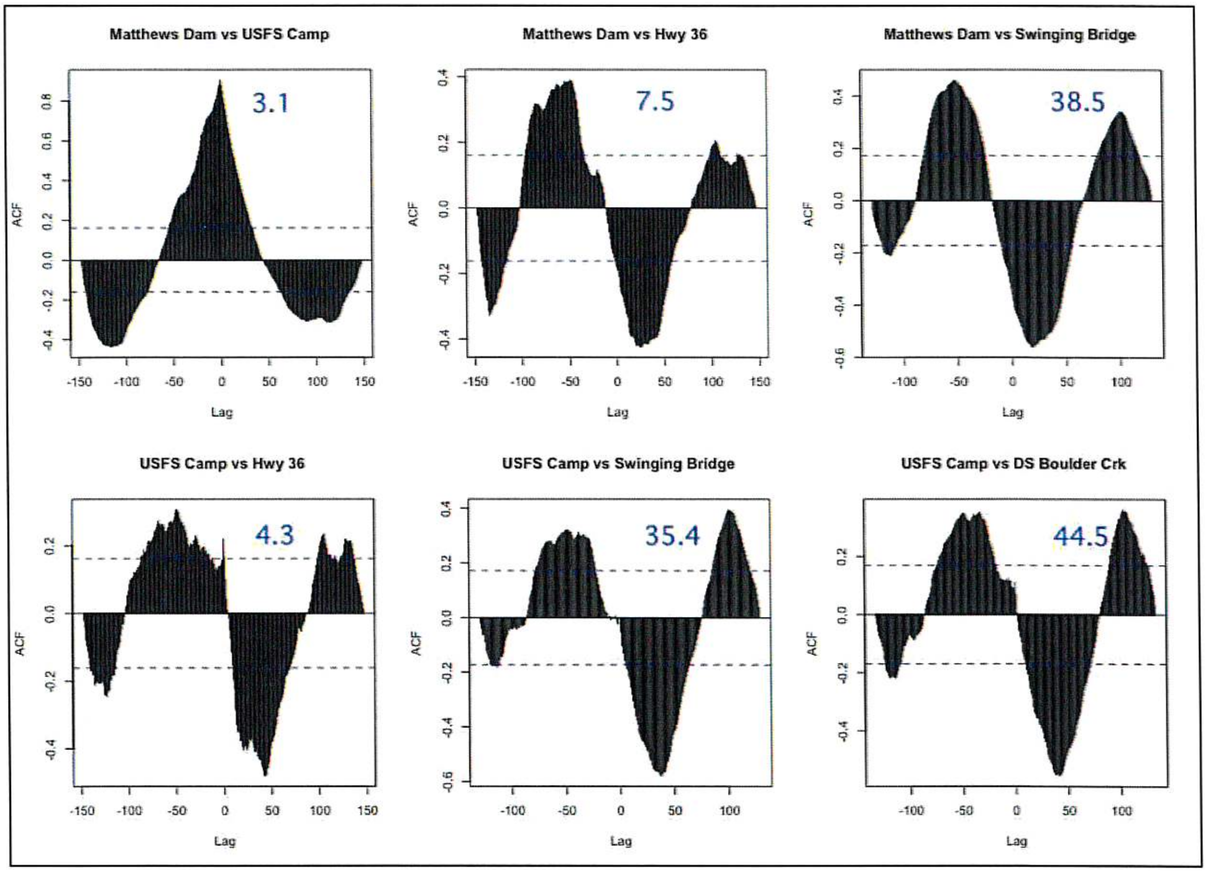

Figure 6. Autocorrelation and Lag in Upstream-Downstream Pairs of Time Series
Note: River miles separating pairs of sites are shown in blue. ACF= autocorrelation function, USFS Camp=MRUSFSCamp, Matthews Dam=MRDam, Hwy 36=MRHWY36, Swinging Bridge=MRSwingB, DS Boulder Crk=MRDSBoulder.

1.2.2.3 Modeling

We initially used lagged linear regression to model the relationship between mainstem water temperatures and multiple explanatory variables. This approach was selected based on published estimates of delayed events in comparable river systems; however, this approach was unsuccessful, leading to the use of CCF (discussed above). The CCF results suggested that hysteresis (e.g., lag) was probably not a strong factor, and led to the switch to a standard linear regression approach. Modeling efforts were focused on mainstem water temperatures in the middle and upper reaches of the Mad River, where water quality issues appeared to be most critical. We selected MRSwingB for the middle reach and MRHWY36 for the upper reach. The explanatory variables used in the initial models were middle and upper air temperatures (noon only); water temperatures from the MRDam site (3:00 p.m. only), the dam tailrace, and Ruth Lake; and the dam discharge rates supplied by the District. We chose a single temperature value from each day available to avoid the potential confounding effects of diel fluctuations and selected the time of day when these values were likely to be near their maximum.

The regression models with temperatures in the middle reach (MRSwingB) and upper reach (MRHWY36) as the dependent variables were not able to resolve the changing seasonal conditions (peaking summer air temperatures) and the steady increase in the dam discharge temperatures, despite the application of ARIMA errors. The progression of temperature profiles that were identified with the permutation distribution clustering (Figure 12) appeared to be a result of the reduction in the influence of dam discharge temperatures as the downstream distance increased, as well as the increased influence of ambient air temperature and other environmental factors. Mainstem water temperatures in the upper reach at MRUSFSCamp, which was 3.2 RMs below Matthews Dam, were strongly affected by the temperature of the discharged water and, to a lesser extent, by local air temperatures; these relationships were successfully modeled (Table 15). Even this close to Matthews Dam, however, retention of discharge volume in the models was never strongly supported, and therefore it is not possible to evaluate the effects of change in discharge on water temperature with the model given the available data.

Table 2. Multiple Linear Regression with ARIMA Errors, Relating Mad River Mainstem Water Temperatures at the MRUSFSCamp Site in the Upper Reach to Temperatures at Matthews Dam and Air Temperatures Recorded at the Upper Reach

Residuals				
Min	**1Q**	**Median**	**3Q**	**Max**
-1.00693	-0.20120	-0.03405	0.19353	1.28234
Coefficients				
	Estimate	**Std. Error**	**t value**	**Pr(>|t|)**
(Intercept)	6.172110	0.776089	7.953	4.88e-13 ***
MRDam	0.443359	0.024024	18.455	< 2e-16 ***
Tailrace	0.295129	0.030162	9.785	< 2e-16 ***
UpAir	0.130033	0.006452	20.153	< 2e-16 ***
Model Fit				
Residual standard error	0.399 on 144 degrees of freedom*			
Multiple R-squared	0.9693	Adjusted R-squared	0.9686	
F-statistic	1513 on 3 and 144 DF	p-value	< 2.2e-16	

Significance codes: 0 '***'; 0.001 '**'; 0.01 '*'; 0.05 '.' 0.1 ' ' 1
*36 observations deleted due to missingness
Model: USFS ~ MRDam + tailrace + UpAir

Because of the importance of discharge levels to the management of this river system, we ran multiple models again using data from June 1 to October 31 only, when dam release was entirely controlled by the District (e.g., no spill was occurring) and showed the greatest variance. Because of the comparatively extended period during late summer and early fall when dam releases were low and fairly constant, we anticipated that the greater variability in discharge volume and a quasi-monotonic increase in mean air temperature during this period would permit detection of a discharge volume effect, but the results were essentially the same: ambient air temperature and the temperature of the discharged water were far more important to the model outcome than discharge rates in determining mainstem water temperature (Figure 14).

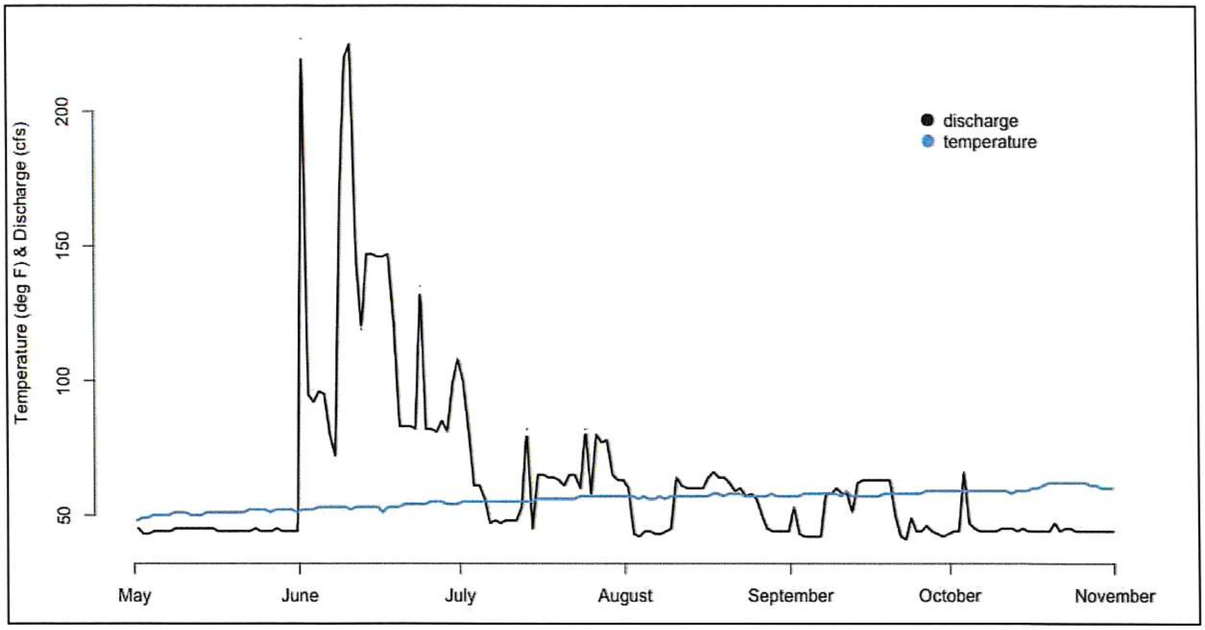

Figure 7. Time Series (June 1–October 31, 2018) of Matthews Dam Discharge Rates (Black) and Water Temperature at the Tailrace (Blue) (Daily Values)

The warmest water temperature recorded during the 2018 monitoring was 76.4°F at MRUSCanon in the lower reach on June 27. The coolest water temperature recorded during the 2018 monitoring was 47.1°F at MRUSFSCamp in the upper reach on May 4. Effects on mainstem water temperatures attributable to discharge temperatures diminished with distance downstream from Matthews Dam (Figure 15); these are discernable at MRHWY36 (7.5 RMs below the dam), but are no longer detectable under the conditions observed at MRSwingB (RM 41.6). Thus, the upper reach is influenced by discharge water temperatures, but not the middle or lower reaches. Figure 15, which includes representative sites from the lower (Mad River downstream of North Fork [MRDSNF], Mad River downstream of Boulder Creek [MRDSBoulder]), middle (MRSwingB), and upper (MRHWY36, MRUSFSCamp) reaches, clearly illustrates these results.

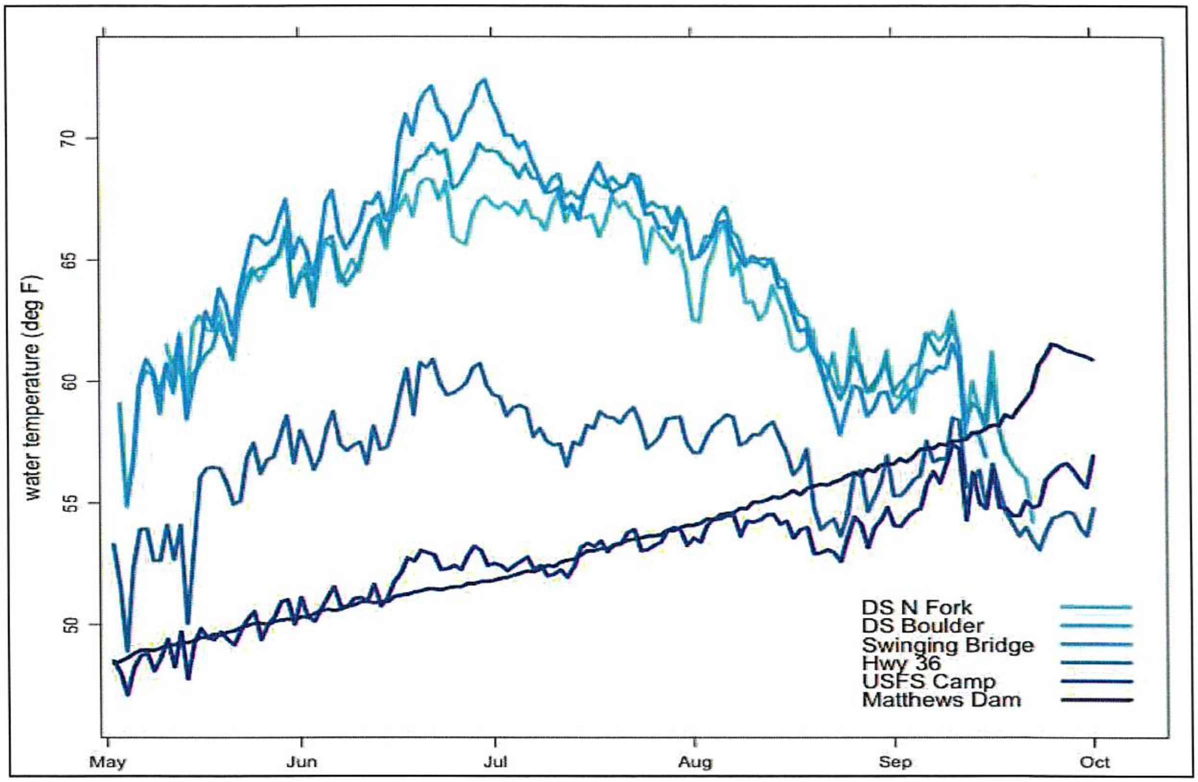

Figure 8. Lower Reach of the Mad River (DS N Fork, DS Boulder) and the Middle Reach (Swinging Bridge RM 41.6) in 2018 had Similar Temperatures
Note: Here, daily values only, distinctly warmer than those recorded from the Upper Reach (Hwy 36, USFS Camp, Matthews Dam). Matthews Dam=MRDam, USFS Camp=MRUSFSCamp, Hwy 36=MRHWY36, Swinging Bridge=MRSwingB, DS Boulder=MRDSBoulder, DS N Fork=MRDSNF.

1.2.2.4 Temperature Indices

Tributaries to the lower Mad River (e.g., Widow White, Warren, Lindsay, and Powers Creeks) had MWAT and MWMT values that were consistently lower than the mainstem Mad River and contributed cooler water to the mainstem, as evidenced by slightly lower MWAT and MWMT values upstream and downstream of Warren, Lindsay, and Powers Creeks (Table 15). MWAT and MWMT temperatures in the mainstem were coolest downstream of Matthews Dam, and warmest in the middle and upper reaches (Table 15). Additional years of water and air temperature recordings were obtained from MRA and the MWAT and MWMT indices were calculated, and are provided as an addendum to this report (Addendum A).

Table 3. Water Temperature Indices (Maximum Weekly Average Temperature [MWAT], Maximum Weekly Maximum Temperature [MWMT] in Degrees Celsius) at Monitoring Sites on the Mad River

RM	ID	Reach	Category	Name	MWAT	MWMT
0.7	WWCK	E	TR	Widow White Creek	13.6	14.1
3.1	MRBoatRamp	E	MS	Mad River Boat Ramp	21.2	23.1

RM	ID	Reach	Category	Name	MWAT	MWMT
9.5	WarrenCK	LR	TR	Warren Creek	14.2	14.6
10.3	MRDSLindsay	LR	MS	Mad River downstream of Lindsay Creek	20.8	23.9
10.3	LindsayCK	LR	TR	Lindsay Creek	17.1	17.4
10.4	MRUSLindsay	LR	MS	Mad River upstream of Lindsay Creek	21.2	24.5
12.4	MRDSP	LR	MS	Mad River downstream of Powers Creek	20.4	23.8
12.4	PowersCreek	LR	TR	Powers Creek	14.2	15.9
12.4	MRUSP	LR	MS	Mad River upstream of Powers Creek	21.7	25.3
13.7	MRDSNF	LR	MS	Mad River downstream of North Fork	22.1	25.5
13.7	NF	LR	TR	North Fork Mad River	17.4	19.3
13.9	MRUSNF	LR	MS	Mad River upstream of North Fork	22.8	26.3
19.6	MRDSCanon	LR	MS	Mad River downstream of Cañon Creek	22.9	25.6
19.6	Canon	LR	TR	Cañon Creek	15.2	16.5
19.6	MRUSCanon	LR	MS	Mad River upstream of Cañon Creek	21.6	24.0
31.2	MRDSMC*	LR	MS	Mad River downstream of Maple Creek	NA	NA
31.3	MapleCreek	LR	TR	Maple Creek	16.4	18.2
31.3	MRUSMC*	LR	MS	Mad River upstream of Maple Creek	NA	NA
32.6	MRDSBoulder	MR	MS	Mad River downstream of Boulder Creek	22.8	24.9
32.6	BoulderCreek	MR	TR	Boulder Creek	18.4	20.5
32.6	MRUSBC*	MR	MS	Mad River upstream of Boulder Creek	NA	NA
41.6	MRSwingB	MR	MS	Mad River at Swinging Bridge	23.3	24.9
72.7	MRHWY36	UR	MS	Mad River at Highway 36 Bridge	17.1	18.9
77.0	MRUSFSCamp	UR	MS	Mad River at USFS Campground	14.7	16.5
80.2	MRDam	UR	MS	Mad River at Matthews Dam	16.3	16.5

RM is river mile, ID is the site code, and Reach identifies each site as estuarine (E), lower reach (LR), middle reach (MR), or upper reach (UR). Name provides the site name with some location information. NA= not applicable. Note: Conversion from degrees Celsius to Fahrenheit is F = (Cx9/5) +32

* HOBO temperature logger lost or stolen from this site; no data recovered.

1.2.2.5 Turbidity and Other Factors

The Mad River was added to the California Clean Water Act Section 3030(d) impaired water list in 1992, partially due to elevated turbidity levels (Stillwater Sciences 2010). Turbidity, a measure of water opacity due to suspended solids, is an important factor in water quality assessments, and has demonstrable effects on salmonid ecology (Fellman et al. 2015, McElroy et al. 2018). The Mad River Watershed Assessment (MRWA) report (Stillwater Sciences 2010) noted that "mainstem sites showed a downstream increase in turbidity...with the highest values measured at Mad River near Arcata." The MRWA also reported that tributaries in the middle and lower reaches of the Mad River are the principal contributors to elevated mainstem turbidity levels and that the "Ruth Lake Reservoir reduces peak turbidity downstream of the dam but prolongs the event by slowly releasing turbid water" (Stillwater Sciences 2010). Data available for our report was limited to 2018 District measurements of Mad River turbidity at the dam tailrace. Turbidity at the tailrace ranged from a maximum of 13.84 nephelometric turbidity units (NTU) (May 1) to a minimum of 1.35 NTU (October 21) during the 2018 monitoring period (Figure 16). Turbidity increased in the fall in response to the first fall rain event (Figure 17).

The multiple linear regression analysis suggested that temperature at the dam tailrace is negatively correlated with turbidity at the same location (not a causative relationship); discharge fit the model reasonably well (adjusted R^2=0.54) but the relationship is weak (Table 16, Figure 17).

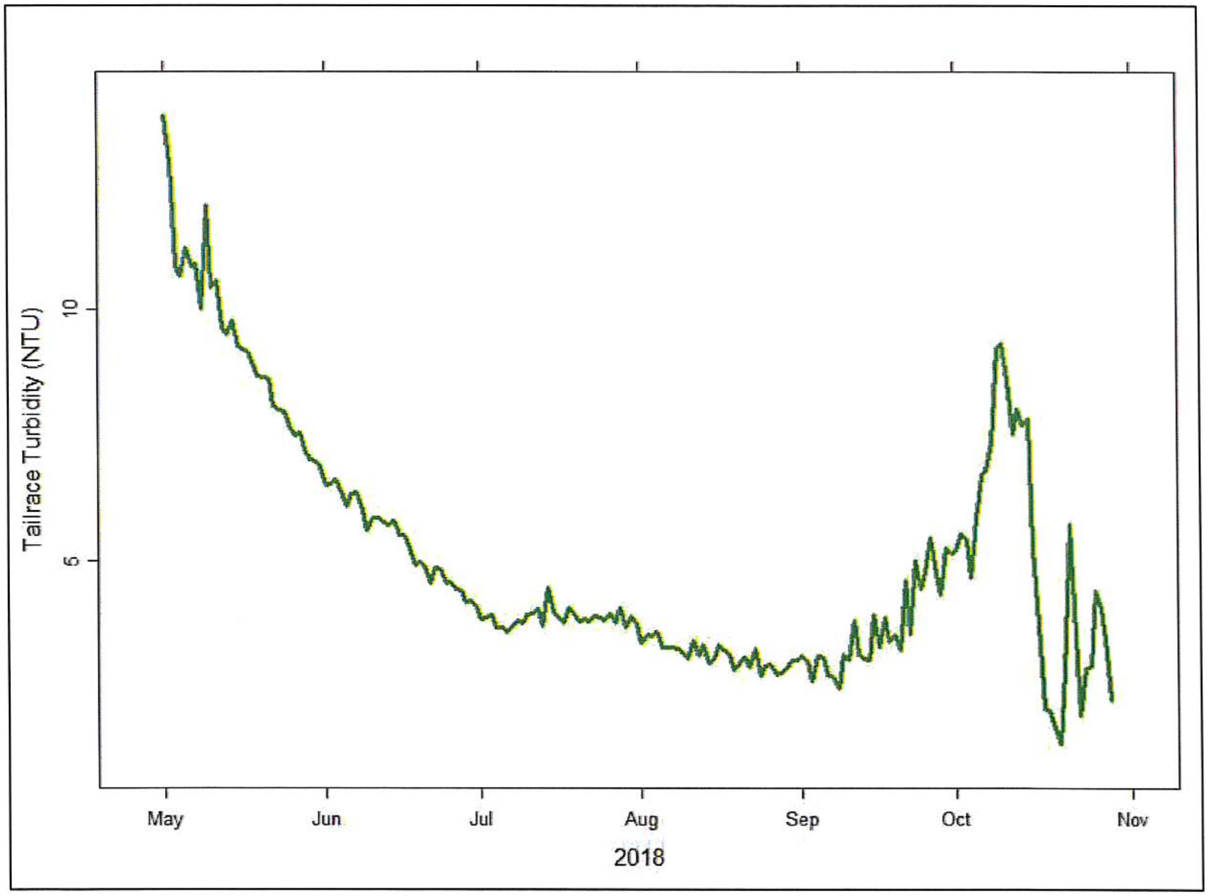

Figure 9. Turbidity Measurements at Matthews Dam (Daily Values)

Table 4. Linear Regression Model Output Relating Turbidity to Water Temperature and Discharge at the Matthews Dam Tailrace

Residuals				
Min	**1Q**	**Median**	**3Q**	**Max**
-2.4654	-1.0940	-0.6566	0.4176	5.8590
Coefficients:				
	Estimate	**Std. Error**	**t value**	**Pr(>|t|)**
(Intercept)	21.911302	3.103333	7.061	3.43e-11 ***
temperature	-0.333805	0.051566	-6.473	8.73e-10 ***
discharge	0.028703	0.005098	5.630	6.77e-08 ***
Model Fit				
Residual standard error	1.662 on 181 degrees of freedom			
Multiple R-squared	0.5495	Adjusted R-squared	0.5445	
F-statistic	110.4 on 2 and 181 DF	p-value	< 2.2e-16	

Significance codes: 0 '***'; 0.001 '**'; 0.01 '*'; 0.05 '.' 0.1 ' ' 1

Model: turbidity ~ temperature + discharge

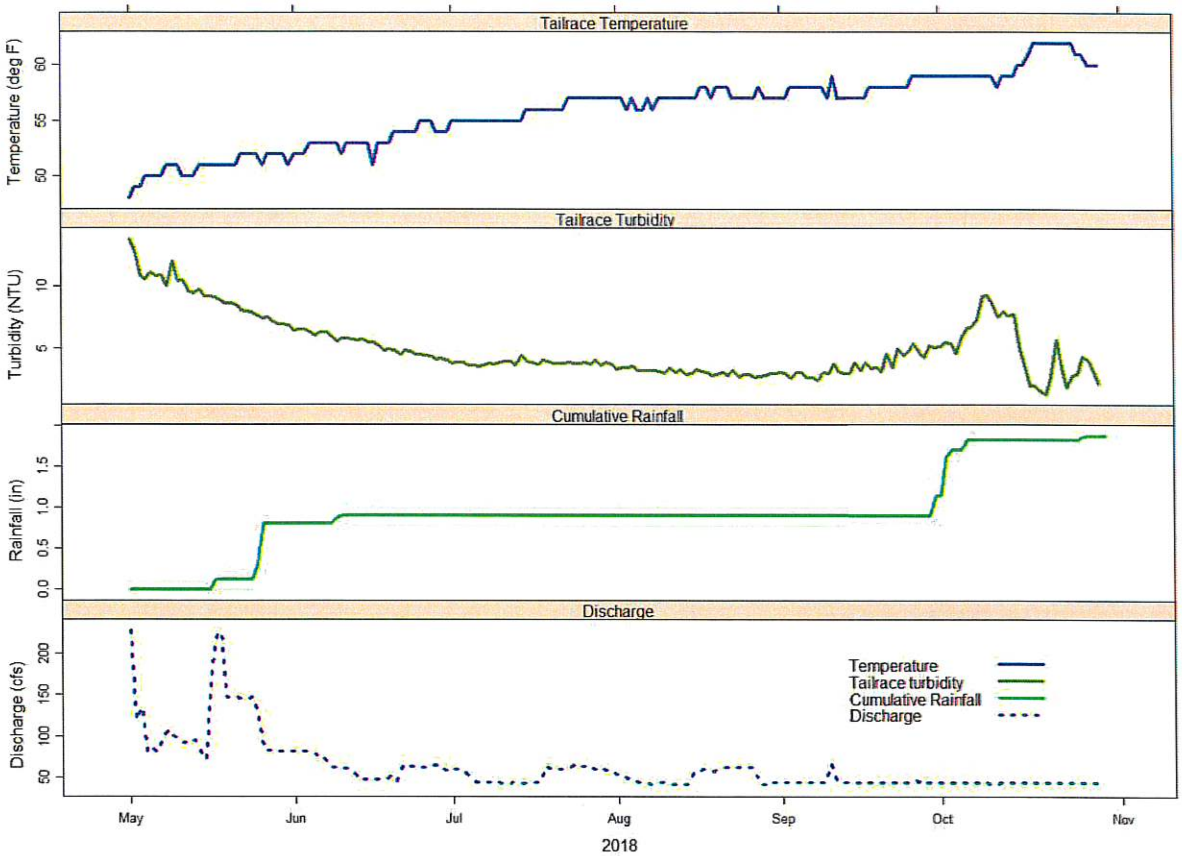

Figure 10. Temperature, Turbidity, Rainfall and Discharge Volume at Matthews Dam (Daily Values)

1.3 Discussion

Summer temperatures in the mainstem Mad River, especially downstream of the upper reach, continued to remain at levels considered "stressful" for salmonids, based on temperature thresholds developed for specific life stages (Stillwater Sciences 2010, Carter 2008). Summer high temperatures can limit distribution and growth of rearing juvenile coho salmon and steelhead (Carter 2008). MWMT values considered limiting for rearing juvenile coho salmon are generally 18.1 or greater, and MWAT values above 16.8 may preclude juvenile coho salmon from rearing in streams (Carter 2008). Many of the tributaries to the lower Mad River had MWAT and MWMT levels below those considered stressful or limiting, and their cooler water contributions to the mainstem Mad River may provide relief (e.g., locally decreased temperatures) for juveniles rearing in the mainstem. MWAT values for rearing juvenile steelhead are considered to be stressful above 19 (i.e., higher than for coho salmon), as are MWMT values above 24 (Carter 2008). The mainstem temperatures were warmer than these thresholds for steelhead in the middle and lower reaches but suitable in the upper reach, likely due to the cooling contribution of discharge from Matthews Dam even though summer air temperatures were highest in the upper watershed.

For the 2018 monitoring period, it appeared that temperature effects attributable to dam discharges did not extend far downstream, but did exert an influence at least 7.5 RMs downstream to MRHWY36 (Figure 8). The greatest change in the temperature profiles was observed in the river segment between temperature loggers at RMs 41.6 and 72.7: in this river segment, the channel gradient is the steepest (Figure 1) and a series of boulder falls occurs on the mainstem between Bug Creek and Deer Creek (RMs 50–53) that blocks upstream access for anadromous salmon and in many years, for most steelhead (Stillwater Sciences 2010). However, groundwater and hyporheic influences in the mainstem Mad River may affect local water temperatures (Pounds pers. comm. 2019), which may be important for summer steelhead that hold over the summer. Future efforts to monitor water temperatures should include sites in this difficult-to-access area[3] between RMs 41.6 and 72.7: this portion of the Mad River includes particularly important habitat where summer steelhead hold (RMs 41.6–48.8) (Pounds pers. comm. 2019, Naman et al. 2014).

Foothill yellow-legged frog oviposition typically begins in the beginning of May and continues to mid-June when stream temperatures are at least 50°F. In 2018, mainstem water temperatures were generally above 50°F after May 1: colder temperatures were only recorded once at the MRUSFSCamp in early May, and none were detected downstream of that site. Upstream of the MRUSFSCamp site, temperatures never fell below 50°F after mid-June. Therefore, discharge temperatures have the potential to shift suitable early-season reproductive conditions for the foothill yellow-legged frog to later in spring, based on the 2018 monitoring data and our modeling results, in the 3–4 RMs below Matthews Dam.

[3] Access is difficult due to the terrain and private land holdings.

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Addendum A. Summary Analysis of Mad River Alliance Temperature Data

A collaborative temperature monitoring project led by the Mad River Alliance (MRA) was initiated in 2014 to sample water temperatures throughout the Mad River Watershed and its tributaries, with most recent data available from 2021. Water temperature was collected with HOBO thermographs deployed annually between the Matthews Dam and Mad River Estuary. Annual sampling typically focused on the summer season low flow period when air and water temperatures reach their maximum. Deployments generally occurred in May, June, or July and retrievals in September or October before the first fall rains increase flow. The exact locations of deployment varied based on access and resource availability, and not all HOBOs deployed were successfully retrieved, but there were multiple sites that were routinely monitored. Collaborators include Green Diamond Resources, Blue Lake Rancheria, Six Rivers National Forest, Humboldt Bay Municipal Water District (HBMWD), North Coast Regional Water Quality Board (NCRWQCB), and in 2018, H. T. Harvey & Associates.

We analyzed time-series water temperature data collected annually between 2014 and 2021 from seven, consistently sampled stations at certain river locations. Temperature data from 2016 was excluded from analyses because the sensor data were deemed unreliable. The HOBO thermographs recorded ambient temperatures every 30-minutes during the period of deployment, and their time-series data were used to calculate the Maximum Weekly Average Temperature (MWAT) and Maximum Weekly Maximum Temperature (MWMT) from each year of deployment (Table 1, Figure 1). The MWAT represents the average daily rolling mean for the warmest 7-day period, and the MWMT represents the rolling maximum daily temperature over a 7-day period. These indices, outlined in Table 1 and graphically depicted in Figure 1, are often used to evaluate the potential for high summer temperatures to affect special status aquatic species (Stillwater Sciences 2010[4], Carter 2008[5]). HOBO thermographs also collected time-series air temperature data at three sites throughout the Mad River (upstream, middle stream, and downstream). The maximum air temperature detected and its associated date, and monthly averages were determined (Table 2 and 3).

While no statistical analyses were used to assess how temperatures change throughout the season of deployment or based on geographic location, there are clear trends in the data that may have implications for the survival and distribution of anadromous, special status species. Air temperature is consistently higher inland (at upstream sites) compared to the coastline (Figure 2), and generally cools off starting in September. These air temperatures influence the MWAT and MWMT metrics (Table 1; Figure 1). For example, peak water temperatures track periods with warmer air, which tend to occur in July and August, and the lowest water

[4] Stillwater Sciences. 2010. Mad River Watershed Assessment. In Association with Redwood Community Action Agency, and Natural Resources Management Corp, Eureka, California.
[5] Carter, K. 2008. Effects of Temperature, Dissolved Oxygen/Total Dissolved Gas, Ammonia and pH on Salmonids: Implications for California's North Coast TMDLs. California Regional Water Quality Control Board, North Coast Region. January.

temperatures occur at more coastal (downstream) sites, where air temperature is lower compared to more inland (upstream) sites. Temperatures at the Matthews Dam discharge are typically colder than downstream inland locations (Figure 1).

The indices derived from water and air temperature time-series data provide an overview of summer temperature conditions in the Mad River for different years, and can be reviewed in conjunction with the annual Mad River Temperature Monitoring Summary Reports, which provide the annual time series data at other locations in the basin as well, and the Water Quality Report, which contains an in depth depiction of the 2018 time series data and various analyses of water temperature from 22 sites within the mainstem of the Mad River and its tributaries.

Table 1. Water Temperature Indices (Maximum Weekly Average Temperature [MWAT], Maximum Weekly Maximum Temperature [MWMT] in °C at Sites Consistently Sampled.

Year	Matthews Dam (RM 80.2)		USFS Camp (RM 77.0)		Highway 36 Bridge (RM 72.7)		Swinging Bridge (RM 41.6)		Down Stream Powers Creek (RM 12.4)		Boat Ramp (RM 3.1)	
	MWAT	MWMT	MWAT	MWMT	MWAT	MWMT	MWAT	MWMT	MWAT	MWMT	MWAT	MWMT
2014	14.4	16.2	NA	NA	22.4	25.2	22.9	24.6	NA	NA	19	20.5
2015	NA	NA	19.3	28.3	19.2	28.1	23.6	25.4	NA	NA	21.0	21.9
2017	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2018	16.3	16.5	14.7	16.5	17.1	18.9	23.3	24.9	20.4	23.8	21.2	23.1
2019	15.7	15.9	16.3	18.2	18.2	19.7	22.1	23.3	23.3	25.6	22.5	23.7
2020	15.1	15.2	NA	NA	19.7	21.4	23.0	24.5	21.4	24.9	NA	NA
2021	20.7	22.6	NA	NA	19.7	22.4	23.5	25.4	NA	NA	20.8	22.6

The 6-selected were consistently sampled throughout the project duration, from upstream (Matthews Dam) to downstream (Boat Ramp). RM indicates the river mile mark. NA=not applicable. No data from 2016 or 2017 were analyzed.

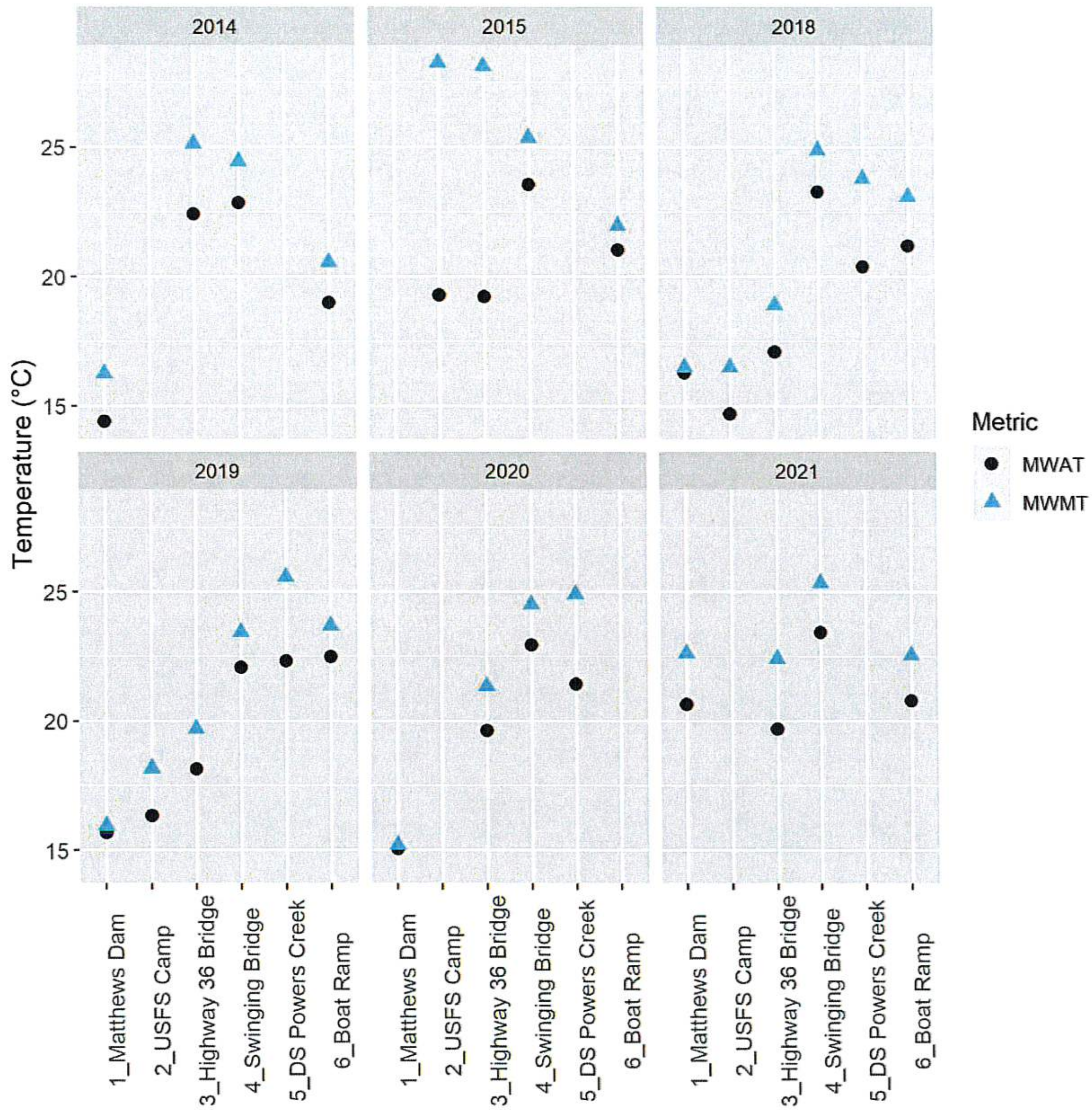


Figure 1. Maximum Weekly Average Temperature (MWAT) and Maximum Weekly Maximum Temperature (MWAT) in °C.
Stations (x-axis) are labeled from upstream to downstream. MWATs are the black dots and MWMTs are the blue triangles. No data from 2016 or 2017 were analyzed. The location of these stations can be referenced in Figure 8 of the Water Quality Report.

Table 2. Annual Maximum Air Temperature Indices in °C.

Year	Upper	Middle	Lower
2015	37.9 (10/14)	32.9 (7/29)	31.9 (6/9)
2018	39.6 (7/26)	32.5 (10/14)	25.2 (10/16)
2019	39.8 (8/27)	31.0 (8/27)	21.4 (8/21)
2020	42.8 (9/1 ; 9/7)	33.3 (9/7)	22.2 (8/15)
2021	40.5 (8/15)	NA	33.8 (7/7)

Air temperatures were measured in °C at the upper, middle, and lower reaches along the Mad River. Values in () next to temperatures are the date (M/DD) that the maximum temperature was detected. NA=no temperature sensors deployed. No data from 2016 or 2017 were analyzed.

Table 3. Monthly Average Air Temperatures in °C.

Month	2015			2018			2019			2020			2021		
	Up	Mid	Low	Up	Mid	Low	Up	Mid	Low	Up	Mid	Low	Up	Mid	Low
June	18.0	18.1	13.4	18.0	14.7	13.8	NA	NA	NA	14.9	14.3	14.4	NA	NA	NA
July	19.0	19.2	14.8	23.7	17.9	14.2	21.3	18.0	15.7	16.3	14.4	13.8	23.7	NA	18.7
Aug.	18.0	18.3	14.9	NA	16.7	14.5	21.6	18.4	15.9	17.9	16.0	15.2	21.9	NA	16.2
Sept.	15.5	15.8	13.0	NA	14.7	12.5	16.6	15.6	14.5	15.7	15.5	14.8	18.6	NA	14.7
Oct.	16.9	16.9	16.6	NA	15.6	14.9	9.9	10.0	8.2	11.6	14.7	13.4	15.2	NA	15.5

Air temperatures in °C were measured at the upper (Up), middle (Mid), and Lower (Low) reaches along the Mad River. NA=no temperature sensors deployed. No data from 2016 or 2017 were analyzed.

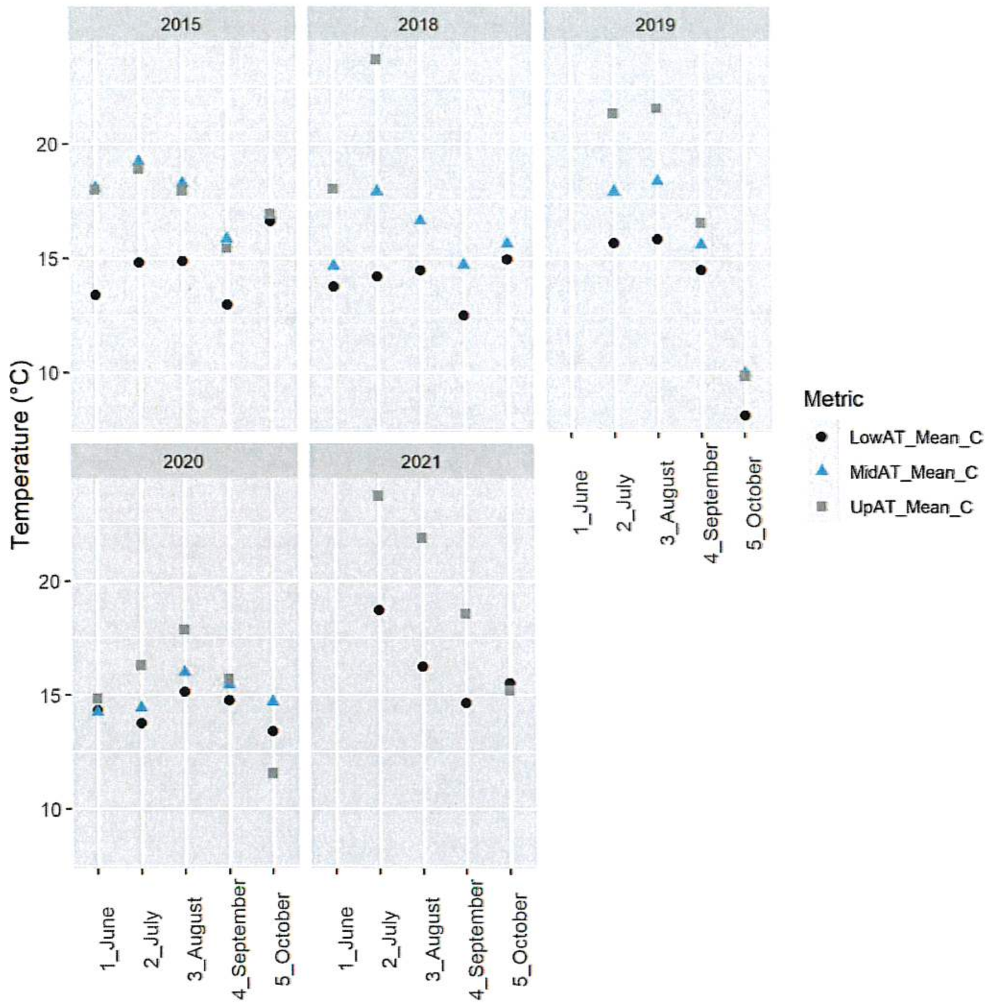
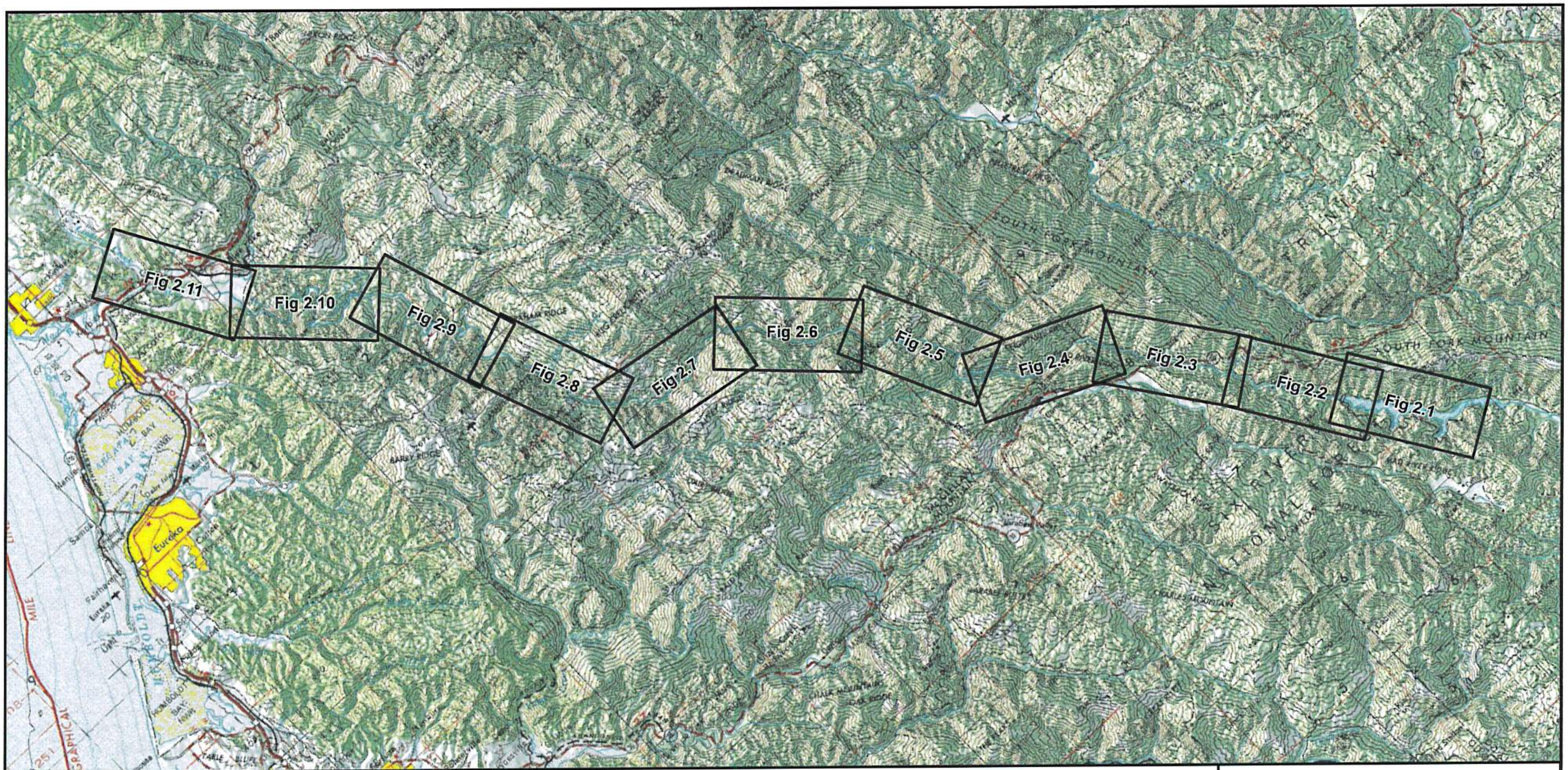


Figure 1. Monthly Average Air Temperatures in °C.
Monthly average air temperatures (AT) in °C measured at the upper (UpAT_Mean_°C; grey square), middle (MidAT_Mean_°C; blue triangle), and Lower (LowAT_Mean_°C; black dot) reaches along the Mad River. The location of these stations can be referenced in Figure 8 of the Water Quality Report.

APPENDIX C Project Maps



Legend

▭ Figure Extents

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Miles

Map Projection: Lambert Conformal Conic
Horizontal Datum: North American 1983
Vertical Datum: North American 1988
Grid: NAD 1983 StatePlane California I FIPS 0401 Feet

Paper Size ANSI B
1:250,000

REGISTERED PROFESSIONAL ENGINEER
NATHAN STEVENS
No. C85701
CIVIL
STATE OF CALIFORNIA

CERTIFICATE OF ENGINEER

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March 29, 2024

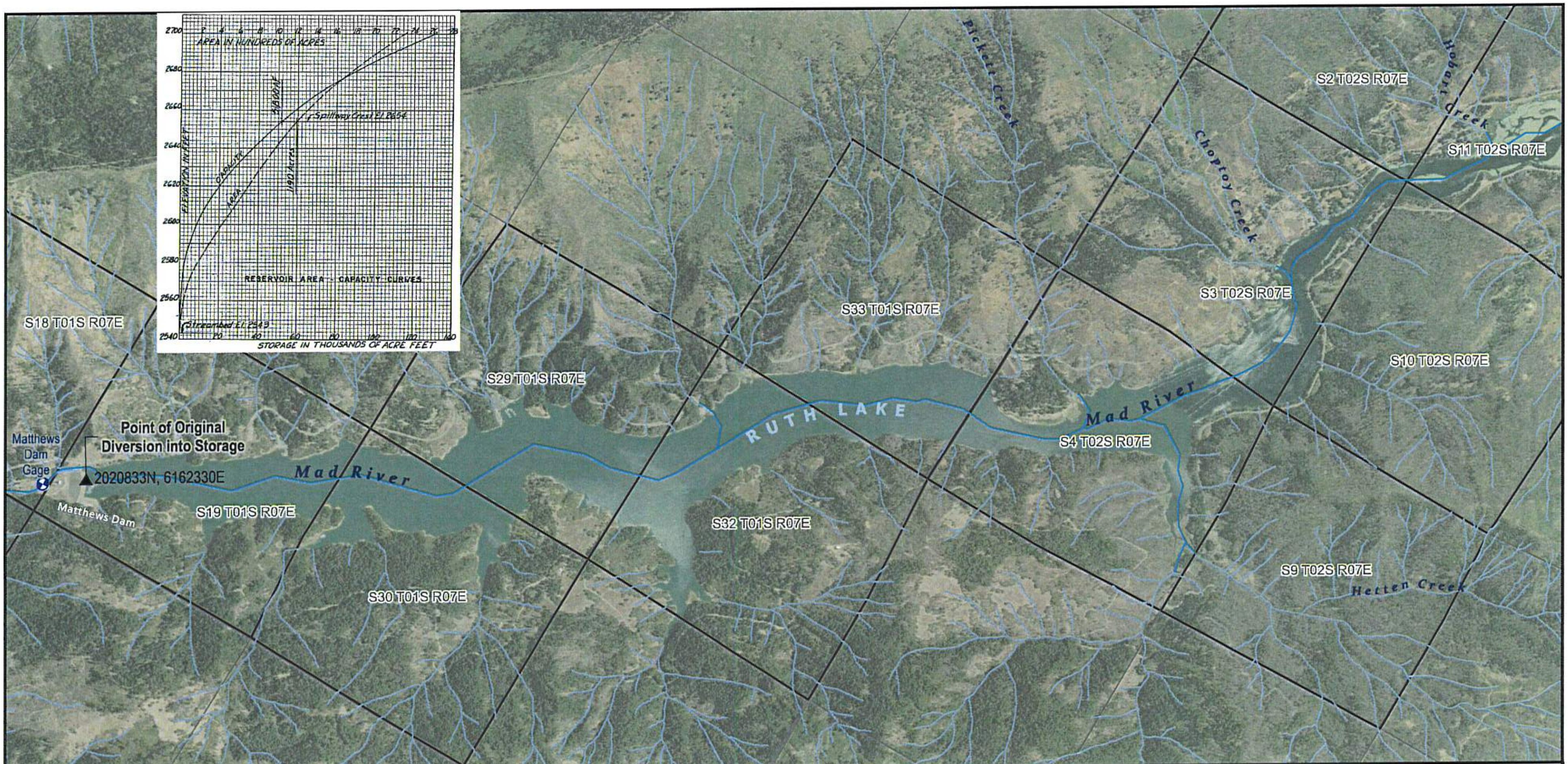
California Civil Engineer Certificate No. C85701

Instream Flow Project Map Overview
California Code of Regulations Section 715

GHD

Project No. 12606336
Revision No. -
Date 3/29/2024
Figure 1

Data source: USA_Topo_Maps: Copyright © 2013 National Geographic Society, i-cubed. Created by: jdark2



Legend

- ▲ Diversion Location
- Gage Station
- Stream/River
- Mad River (Place of Use)
- Section
- Township Range
- Section (intersecting project extent)

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[signature]

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Map Projection: Lambert Conformal Conic
Horizontal Datum: North American 1983
Vertical Datum: North American 1988
Grid: NAD 1983 StatePlane California I FIPS 0401 Feet

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Paper Size ANSI B
1:24,000

Instream Flow Project Map Series
California Code of Regulations Section 715

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Project No. 12606336
Revision No. -
Date 3/29/2024
Figure 2.1

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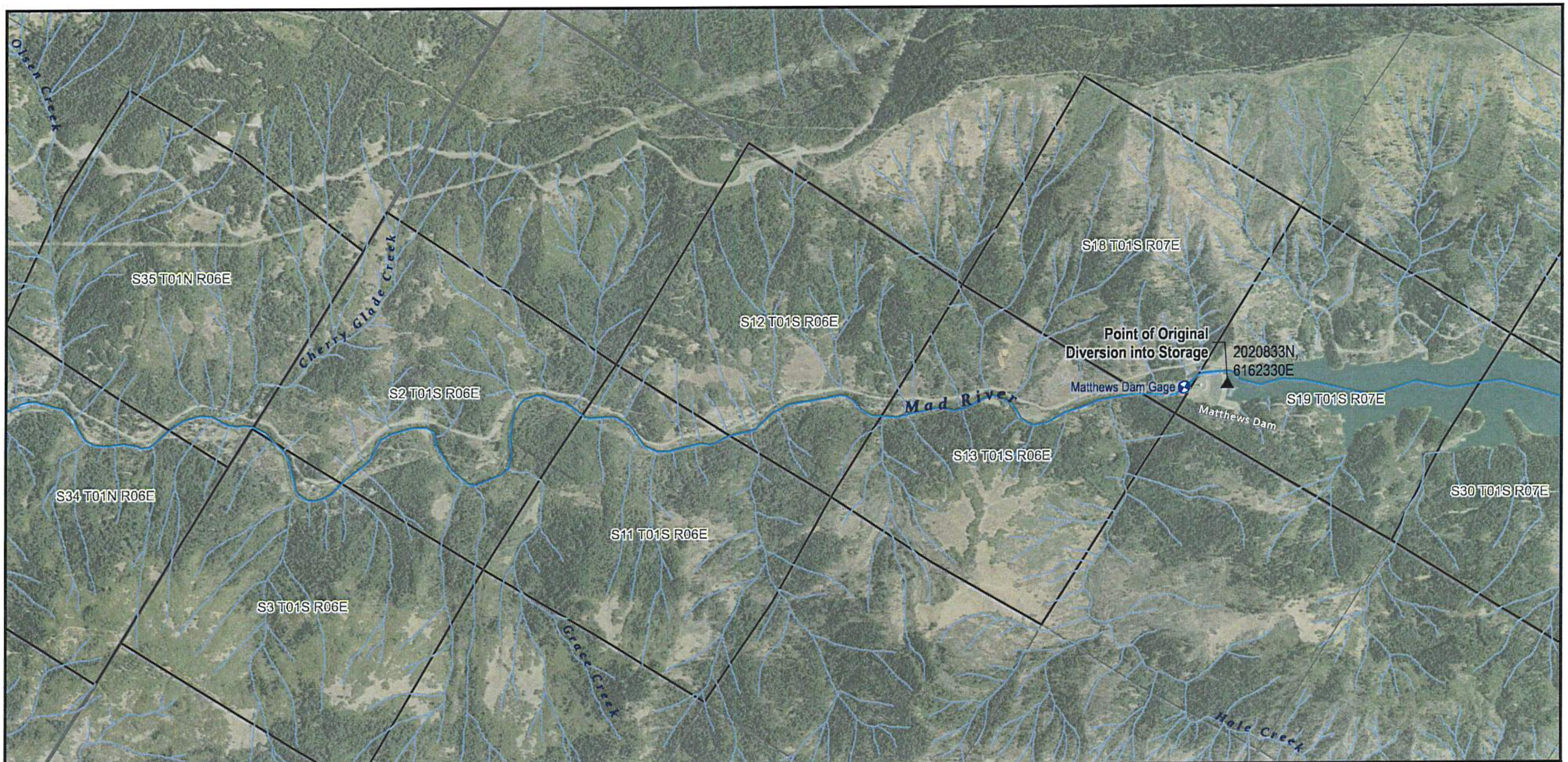

Legend

- ▲ Diversion Location
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Horizontal Datum: North American 1983
Vertical Datum: North American 1988
Grid: NAD 1983 StatePlane California I FIPS 0401 Feet

0 1,000 2,000 Feet

Paper Size ANSI B

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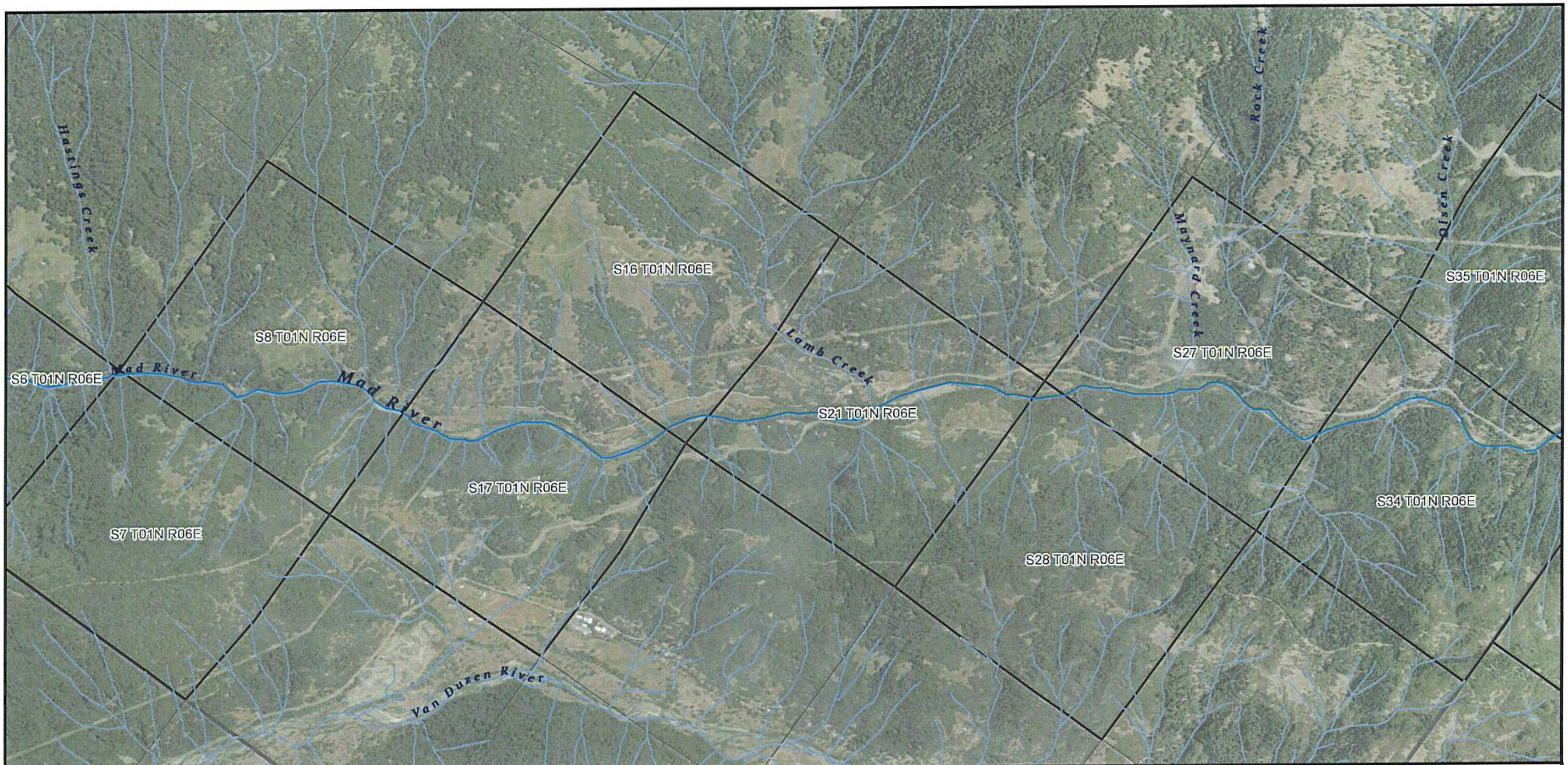
Instream Flow Project Map Series
California Code of
Regulations Section 715

GHD

Project No. 12606336
Revision No. -
Date 3/29/2024
Figure 2.2



Legend

- Stream/River
- Mad River (Place of Use)
- Section
- Township Range
- Section (intersecting project extent)

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Map Projection: Lambert Conformal Conic
Horizontal Datum: North American 1983
Vertical Datum: North American 1988
Grid: NAD 1983 StatePlane California I FIPS 0401 Feet

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Figure 2.3

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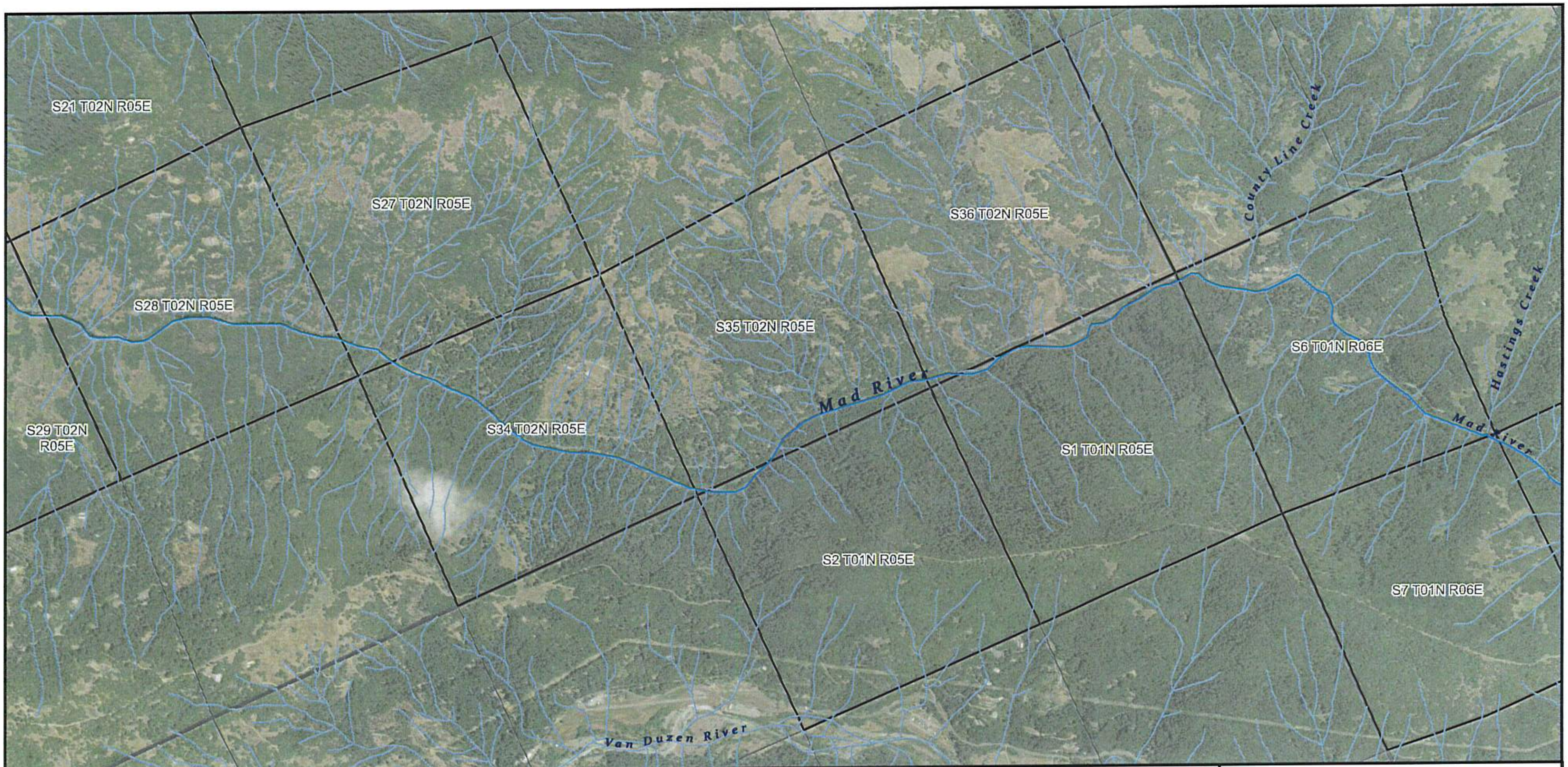

Legend

- Stream/River
- Mad River (Place of Use)
- Section
- Township Range
- Section (intersecting project extent)

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Map Projection: Lambert Conformal Conic
Horizontal Datum: North American 1983
Vertical Datum: North American 1988
Grid: NAD 1983 StatePlane California I FIPS 0401 Feet

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Paper Size ANSI B
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Figure 2.4

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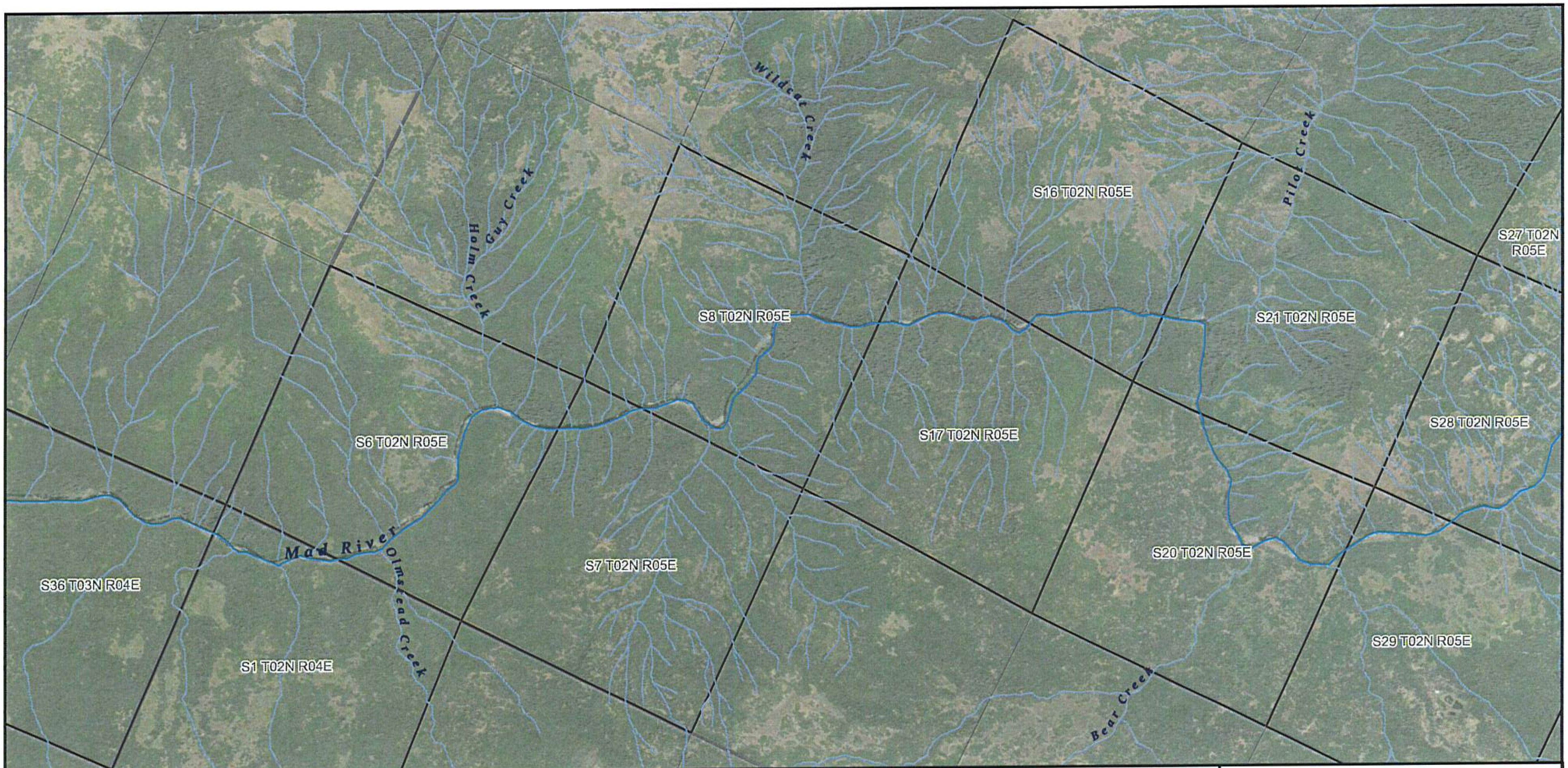

Legend

- Stream/River
- Mad River (Place of Use)
- Section
- Township Range
- Section (intersecting project extent)

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Map Projection: Lambert Conformal Conic
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Vertical Datum: North American 1988
Grid: NAD 1983 StatePlane California I FIPS 0401 Feet

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Instream Flow Project Map Series
California Code of Regulations Section 715

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Project No. 12606336
Revision No. -
Date 3/29/2024
Figure 2.5

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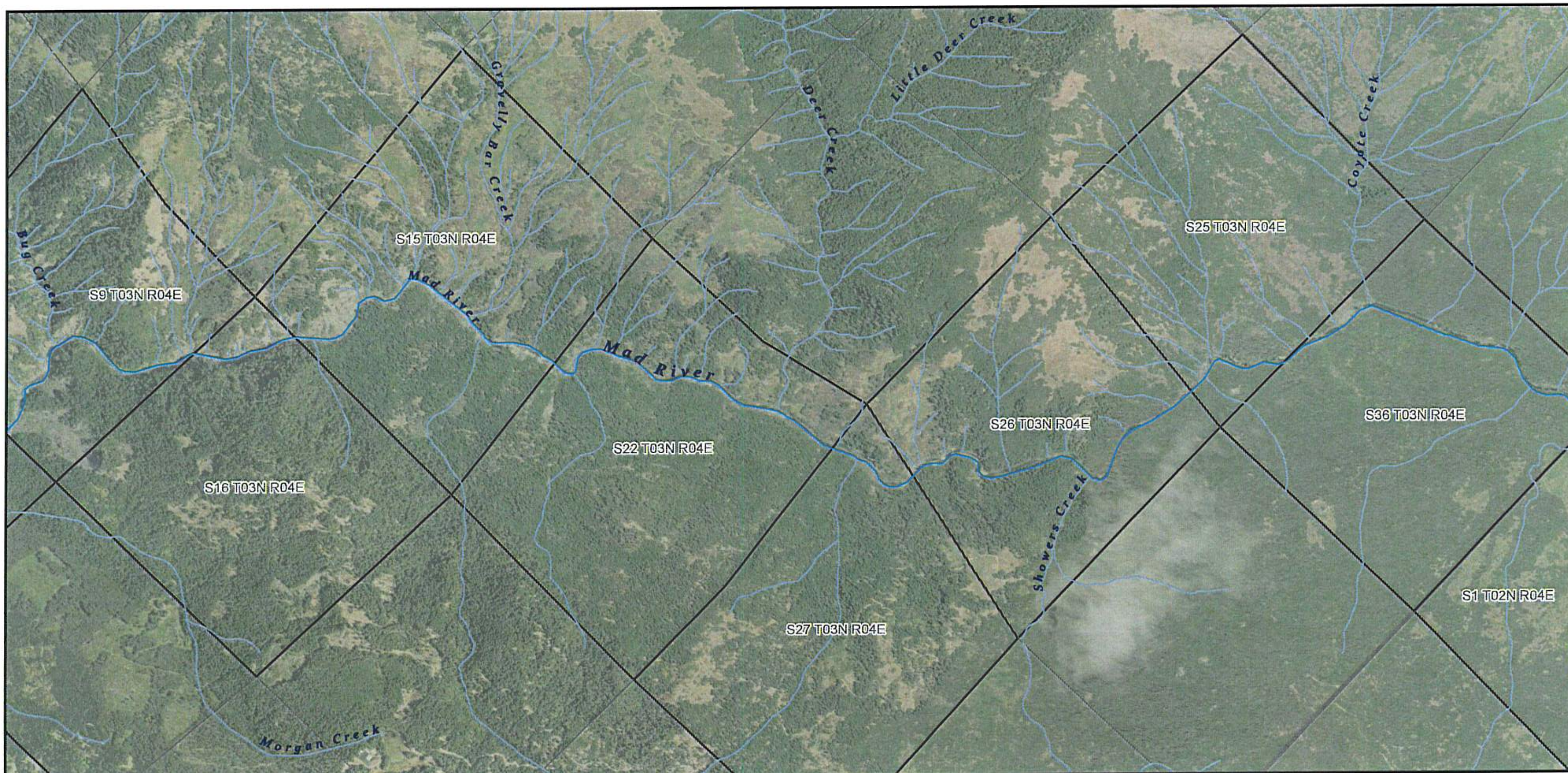

Legend

- Stream/River
- Mad River (Place of Use)
- Section
- Township Range
- Section (intersecting project extent)

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Map Projection: Lambert Conformal Conic
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Date 3/29/2024
Figure 2.6

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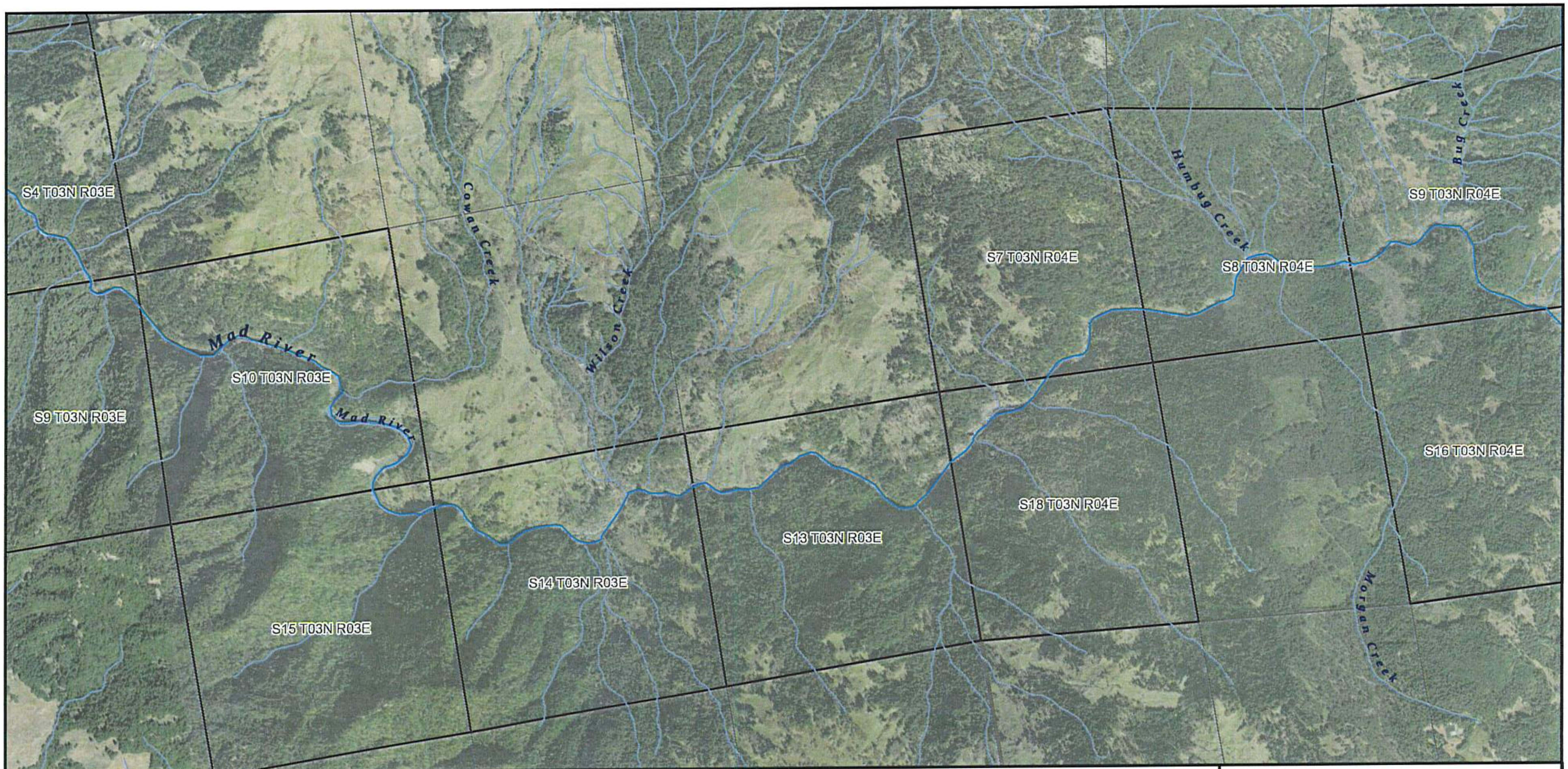

Legend

- Stream/River
- Mad River (Place of Use)
- Section
- Township Range
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Grid: NAD 1983 StatePlane California I FIPS 0401 Feet

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Date 3/29/2024
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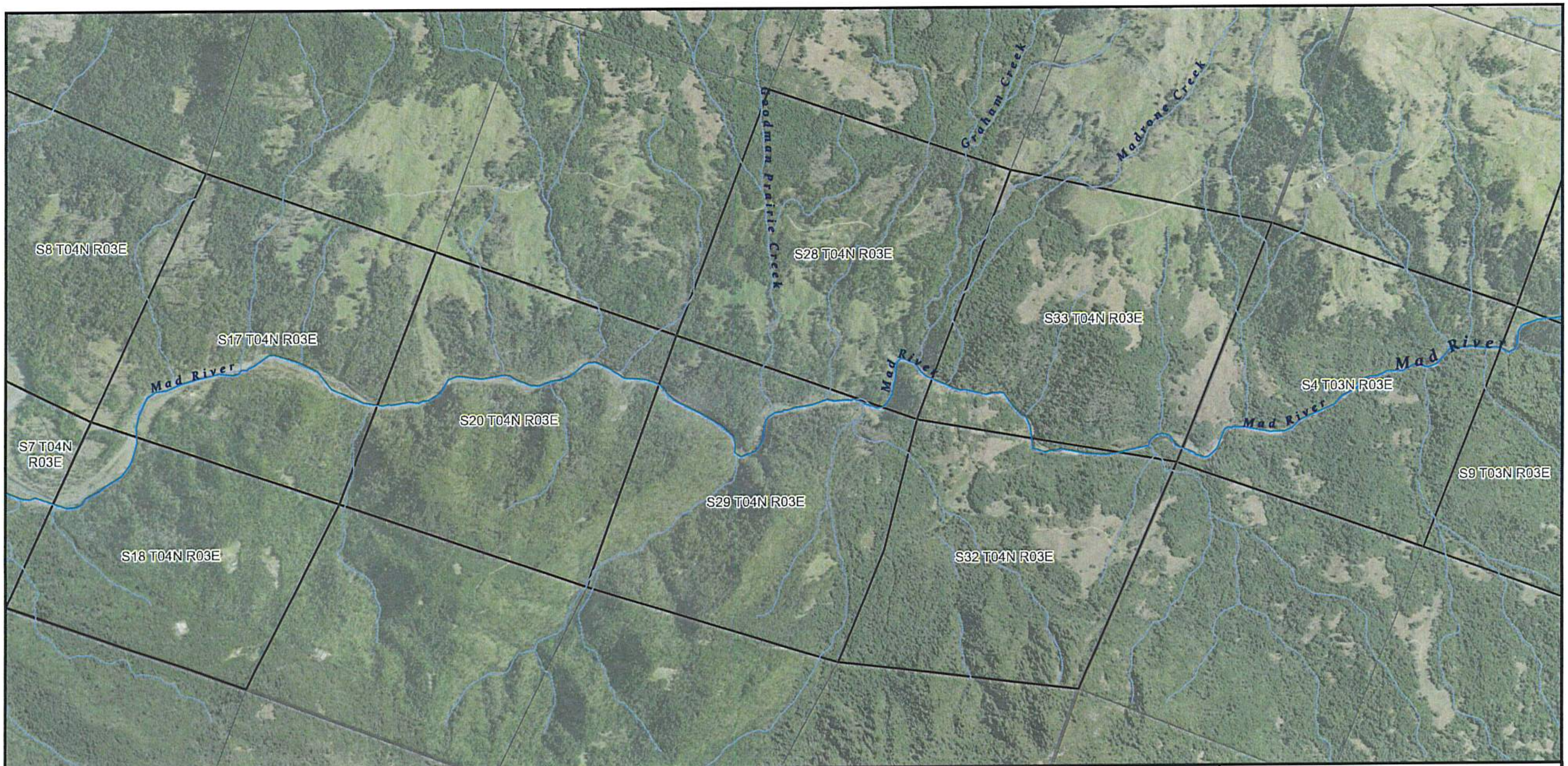
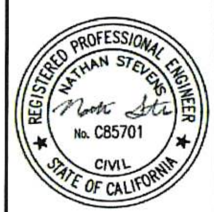


Legend

- Stream/River
- Mad River (Place of Use)
- Section
- Township Range
- Section (intersecting project extent)



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Map Projection: Lambert Conformal Conic
Horizontal Datum: North American 1983
Vertical Datum: North American 1988
Grid: NAD 1983 StatePlane California I FIPS 0401 Feet

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California Code of Regulations Section 715

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Project No. 12606336
Revision No. -
Date 3/29/2024
Figure 2.8

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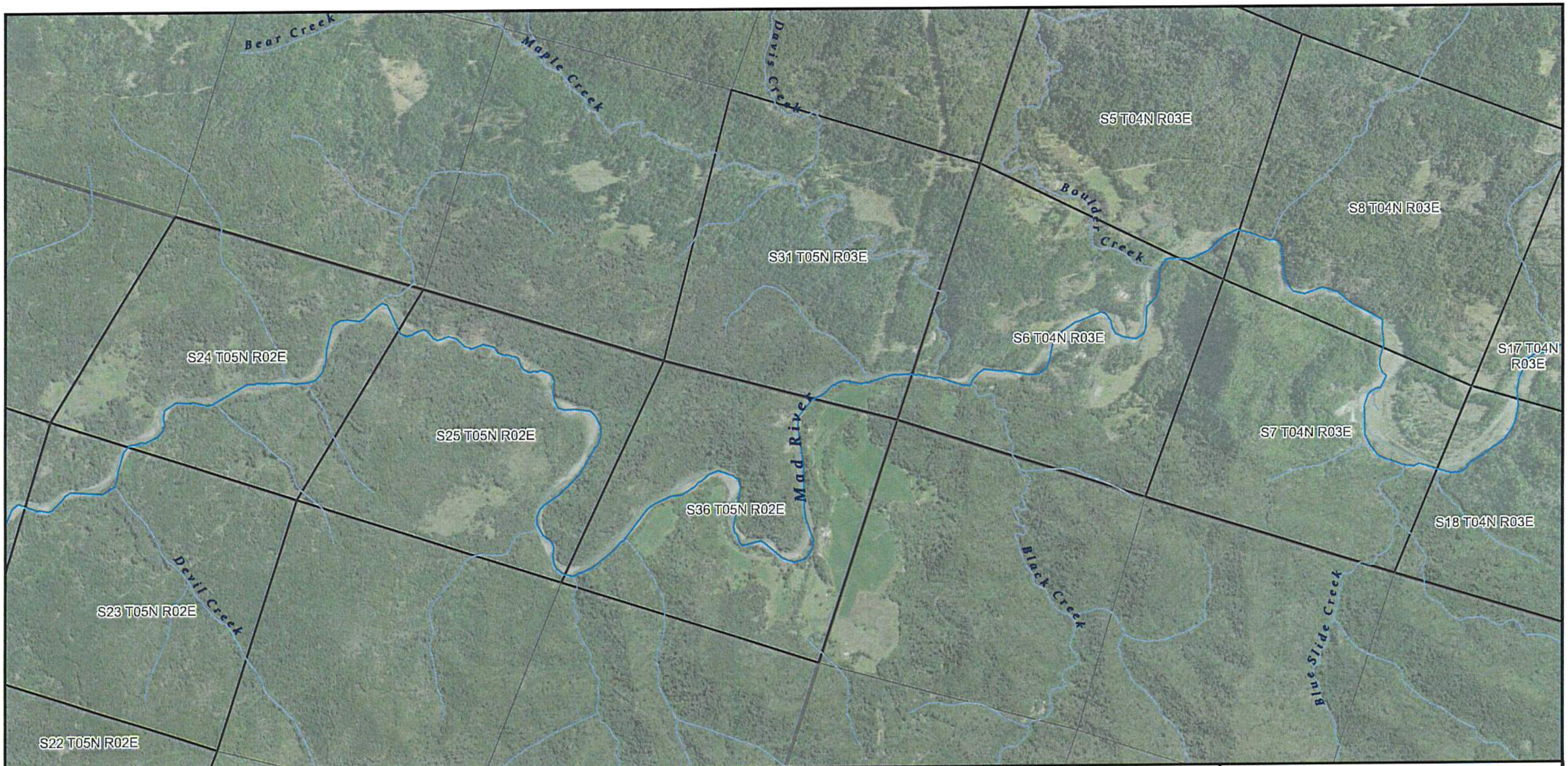

Legend

- Stream/River
- Mad River (Place of Use)
- Section
- Township Range
- Section (intersecting project extent)

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Horizontal Datum: North American 1983
Vertical Datum: North American 1988
Grid: NAD 1983 StatePlane California I FIPS 0401 Feet

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Instream Flow Project Map Series
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Project No. 12606336
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Date 3/29/2024
Figure 2.9

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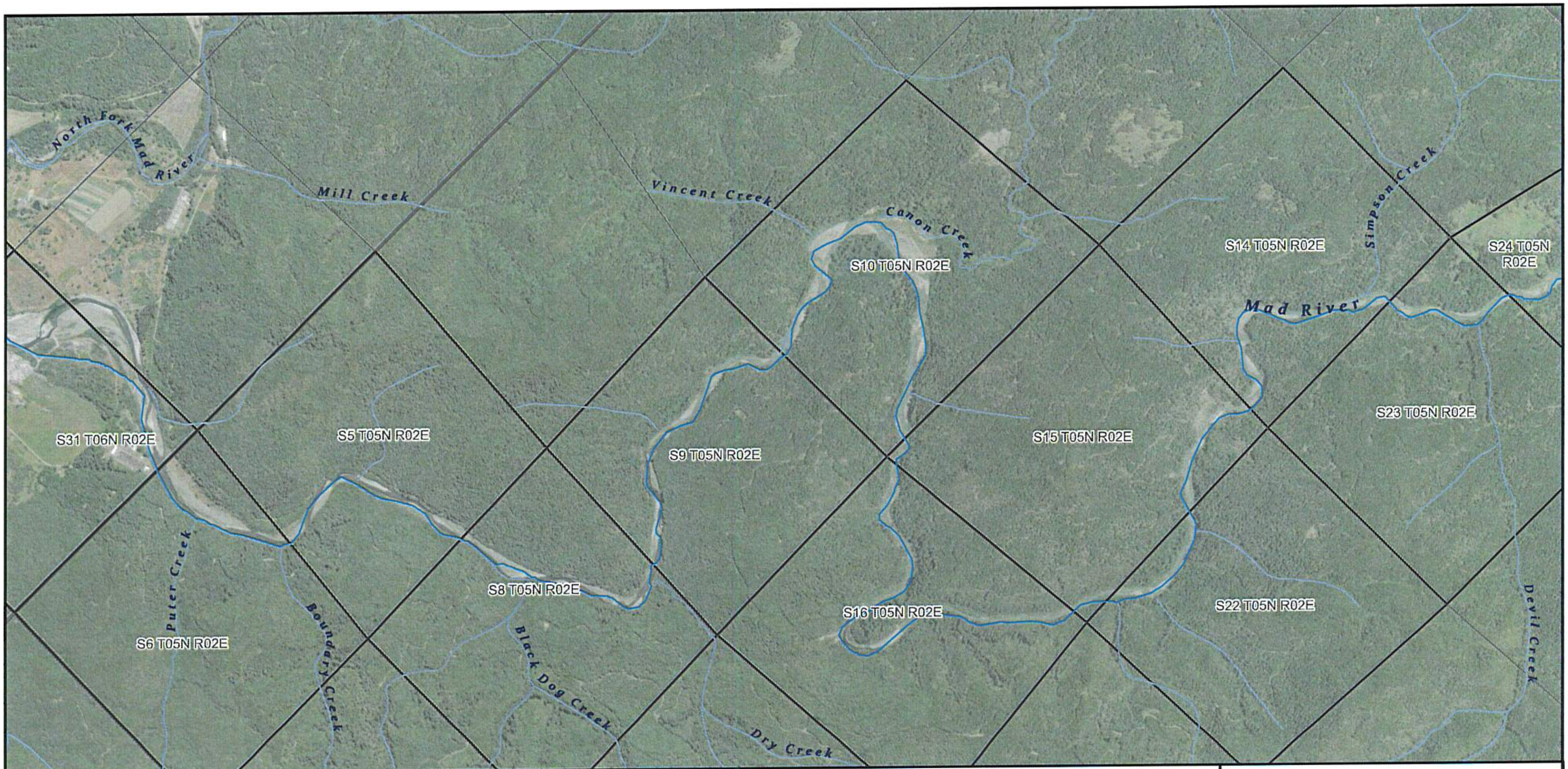

Legend

- Stream/River
- Mad River (Place of Use)
- Section
- Township Range
- Section (intersecting project extent)

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Map Projection: Lambert Conformal Conic
Horizontal Datum: North American 1983
Vertical Datum: North American 1988
Grid: NAD 1983 StatePlane California I FIPS 0401 Feet

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Paper Size ANSI B
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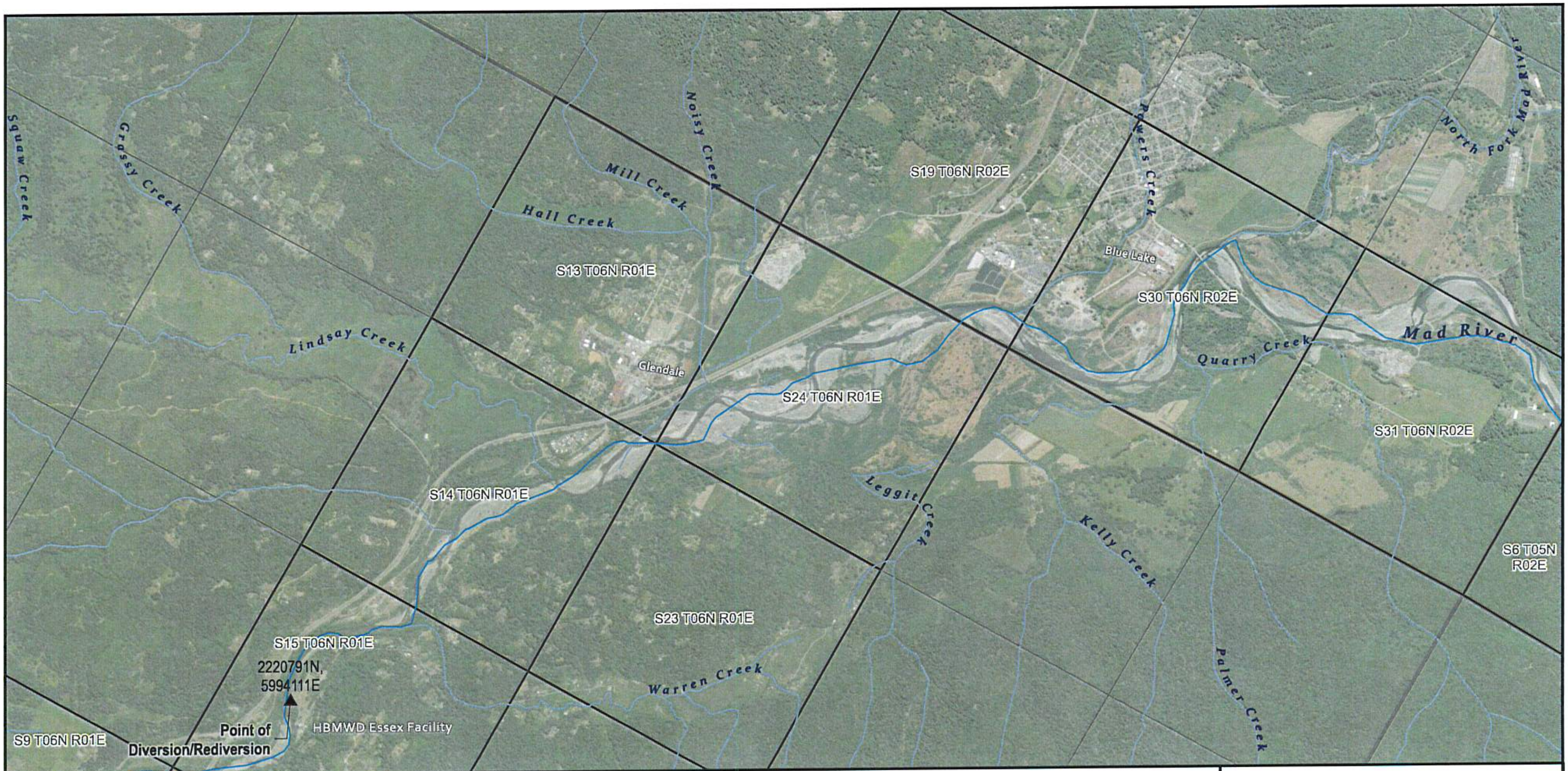
Instream Flow Project Map Series
California Code of Regulations Section 715

GHD

Project No. 12606336
Revision No. -
Date 3/29/2024
Figure 2.10



Legend

- ▲ Diversion Location
- Stream/River
- Mad River (Place of Use)
- Section
- Township Range
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Map Projection: Lambert Conformal Conic
Horizontal Datum: North American 1983
Vertical Datum: North American 1988
Grid: NAD 1983 StatePlane California I FIPS 0401 Feet

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Paper Size ANSI B
1:24,000

Instream Flow Project Map Series
California Code of Regulations Section 715

GHD

Project No. 12606336
Revision No. -
Date 3/29/2024
Figure 2.11

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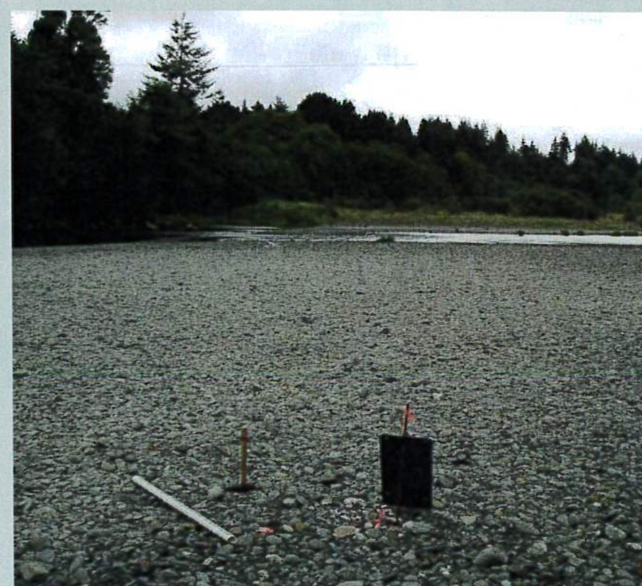
APPENDIX D – Stillwater Sciences Fish Passage Tech Memo December 2014

TECHNICAL MEMORANDUM ◦ DECEMBER 2014

Mad River Fish Passage Study



PREPARED FOR

Humboldt Bay Municipal Water District
828 Seventh Street
Eureka, CA 95502

PREPARED BY

Stillwater Sciences
850 G Street, Suite K
Arcata, CA 95521

Stillwater Sciences

Suggested citation:
Stillwater Sciences. 2014. Mad River fish passage study. Technical Memorandum. Prepared by Stillwater Sciences, Arcata, California for Humboldt Bay Municipal Water District. Eureka, California.

Cover photos: Study riffles at 50 cfs (photographs taken by Dennis Halligan, 11 July 2014).

Table of Contents

Tables

Figures

Appendix

1 INTRODUCTION

The Humboldt Bay Municipal Water District, herein after referred to as "District," was formed in 1956 to develop a regional water system that provides a reliable supply of drinking and industrial water to customers in the greater Humboldt Bay area of Humboldt County. The regional system comprises: (1) R.W. Matthews Dam, which forms Ruth Lake in southern Trinity County; (2) diversion, pumping, and control facilities on the Mad River at Essex (near Arcata); (3) storage and treatment facilities; and (4) pipeline systems that deliver treated drinking water or untreated surface water to customers throughout the Humboldt Bay region. The District operates almost exclusively at the wholesale level. The District supplies drinking water, drawn from its Ranney collectors at Essex, to seven public agencies which, in turn, serve the residents, businesses, and industries in the greater Humboldt Bay region.

Matthews Dam and Ruth Lake combine to form a "fill and spill" reservoir. The dam facility also includes a small powerhouse that generates electricity to offset the District's use. The power house generally runs from 40 to 100 cubic feet per second (cfs) through the turbine. The maximum release through the power house is about 250 cfs and that can occur only when the lake is full. Water from the power house is immediately released into the tailrace of the dam, which empties into the river. Summer time power house releases range from 40 to 50 cfs. The District manages its releases to meet its industrial and residential diversion requirements and comply with bypass flow requirements in its State Water Rights permits and Habitat Conservation Plan (HCP) to protect fisheries resources downstream of Essex.

During the late fall, the initial early season rainfall/runoff events upstream of Matthews Dam are captured in Ruth Lake and help replenish reservoir water levels. It generally takes several rainfall events to generate enough inflow into fill Ruth Lake to allow for flow over the spillway. Once the spillway is flowing, the entire river flow from the Ruth Lake headwaters to the estuary runs as a natural unimpaired river.

The District is well attuned to the need for protecting environmental resources while conducting its operations on the Mad River. In 2004, the District completed an HCP covering Chinook and coho salmon and steelhead for its Mad River operations. Development of the plan spanned eight years and involved significant input from the resource agencies including the National Marine Fisheries Service (NMFS), California Department of Fish and Wildlife (CDFW), and U.S. Fish and Wildlife Service (USFWS). The planning process included numerous studies to understand the effects of the District's operations and to define mitigation and monitoring activities. The HCP addressed the District's flow releases from Ruth Lake, its diversion and bypass flows at Essex, and all work in the streambed channel. This plan was accepted by NMFS, which issued a Biological Opinion and an Incidental Take Permit. Shortly thereafter, the CDFW issued a Consistency Determination for the state-listed coho salmon.

1.1 Long-term Streambed Alteration Agreement

On 2 February 2012, the District and CDFW entered into Long-term Lake and Streambed Alteration Agreement (LSAA) (No. R1-2010-0093). The term of the agreement is 15 years, with the opportunity for a single five-year extension. The agreement defines eight authorized activities, three of which are related to the District's diversion and bypass activities. The remaining five activities involve maintenance actions in the channel or along the banks.

The agreement contains a number of general and specific conditions. One condition (10.2C) requires that the District perform a hydrological and fish passage assessment. The assessment will determine the effects of stream impoundment (at Matthews Dam) and stream diversion at Essex. This condition also stated that the District will provide CDFW a draft of the assessment proposal within six months of execution of the LSAA. This deadline was met and the District and CDFW worked on the language in the proposal for the next year and a half. The final draft of the proposal was completed on 15 April 2013 and delivered to CDFW for its approval. Local CDFW staff concurred with the scope of the study proposal, but written response was not received from CDFW management in Redding. The District, in order to be in compliance with the study timeline in the LSAA, determined that it needed to move forward with the fish passage assessment after receiving local CDFW staff concurrence.

1.2 Purpose of Fish Passage Study

The Mad River is inhabited by Chinook and coho salmon, steelhead, and coastal cutthroat trout along with a number of other native and non-native fish species. Chinook salmon typically begin their upstream spawning migration when they enter the estuary in mid- to late August, followed by coho salmon in mid- to late October, and steelhead in the late fall and winter.

During the development of the LSAA, CDFW stated that impoundment of the early rainy season runoff that occurs during filling of Ruth Lake may reduce flow in the lower Mad River to the point where upstream Chinook salmon migration might be impeded. Therefore, CDFW conditioned the LSAA to require the District to perform a hydrologic and fish passage assessment to determine if impoundment of early rainy season runoff behind Matthews Dam may reduce downstream flows to the point affecting upstream salmon migration in the lower Mad River.

The purpose of the hydrologic and fish passage assessment was to "determine the effects of stream impoundment (Matthews Dam) and stream diversion at Essex" on upstream adult Chinook salmon migration passage. Chinook salmon were considered the "target" study species because their upstream migration in the Mad River begins in August and September (earlier than coho salmon and steelhead), they are the species most likely to be affected by early season filling of Ruth Lake, they have the largest body size of any salmonid, and they were the species CDFW was specifically concerned about during LSAA discussions.

To assist in the assessment of reservoir filling effects, the study includes a literature review of salmonid migration information (timing, holding locations, barriers, etc.) and addresses the following four critical questions:

1. What were the pre-dam flow patterns in the Mad River?
2. Does the early season filling of Ruth Lake affect downstream hydrology, and if so, how much?
3. Does the early season filling of Ruth Lake and interception of upper basin flow affect water depth over riffles in the lower river?
4. Is riffle depth altered during the early season filling of Ruth Lake such that upstream migration by Chinook salmon is hindered or delayed?

2 METHODS

2.1 Literature Review

The literature review accessed existing Mad River-specific monitoring reports and fisheries information including:

- adult salmonid migration timing, holding, and spawning information,
- U.S. Geological Survey (USGS) Arcata gage flow data recorded during the adult salmonid fall migration,
- riffle depth data collected in the lower river during the fall migration period, and
- migration barrier locations.

Sources for the literature review include instream gravel extraction monitoring reports, CDFW reports, spawning data from Green Diamond Resource Company, Mad River Watershed Assessment (Stillwater Sciences et al. 2010), and other independent sources.

2.2 Hydrologic Study

A Mad River hydrologic study (GHD 2013) was conducted to assess the effects of the operation of Matthews Dam on river flows. The hydrologic evaluation used the historical USGS gage data and compared effects on stream flow from before and after the construction of Matthews Dam and diversion at the District's Essex facilities. The GHD (2013) analysis was based on historical flow data collected from four gage stations along the Mad River. A summary of the gage stations used in this report along with their years of record and associated drainage area is presented in Table 2-1 and their locations shown in Figure 2-1.

Table 2-1. River flow gage locations and period of record.

Location	USGS Station ID	Period of record	Drainage area (mi^2)
Above Ruth (Zenia)	11480390 (MRF)	1980–2014	93.8
Matthews Dam	11480410 (MBD)	1980–2014	121
Forest Glen, Hwy 36	11480500	1953–1994	143
Near Arcata	11481000 (ARC)	1910–1913; 1952–2014	485

The downstream-most station in the drainage is the Arcata gage station (USGS #11481000), located in Arcata near the Highway 299 Bridge below the District's Essex facility. The next station upstream is the Forest Glen (USGS #11480500) gage, which operated from 1953 to 1994 and was located approximately 7 miles below Matthews Dam. The third gage station is located at Matthews Dam (USGS #11480410). The last and upstream-most gage station (USGS #11480390) is located above Ruth Lake and is referred to as the Zenia gage.

Flow ranges were determined for hydrologic year classifications of drier than normal years, normal years, and wetter than normal years. The river flows for these classifications are presented in Table 2-2 and are used in the analyses and comparisons presented in this report.

Table 2-2. Water year classifications for the Mad River watershed (GHD 2013).

Climatic condition	Average annual discharge (acre-feet) at USGS Arcata gage		
	Min	Average	Max
Drier-than-normal (low water year)	109,000	488,629	750,000
Normal (average water year)	750,000	1,034,350	1,200,000
Wetter-than-normal (high water year)	1,200,000	1,434,857	1,794,000

Figure 2-1. USGS gage locations in the Mad River (GHD 2013).

The potential effects on flow immediately downstream of Matthews Dam due to the operation of Ruth Lake and the dam were assessed by comparing the hydrographs from the Zenia gage above Ruth Lake and the Matthews Dam gage just below Ruth Lake (GHD 2013). The effects on flows in the middle reaches, below Ruth Lake and above the Essex facility were assessed by evaluating the hydrographs from the Matthews Dam gage just below Ruth Lake and comparing them with hydrographs from the Forest Glen gage approximately 7.25 miles downstream of Ruth Lake. The effects on flows in the lower reaches, near the Essex facility, were assessed by comparing the hydrographs at the Arcata gage with the hydrographs for the three upstream gages. The hydrographs were plotted together and the differences between the plots show three distinct regions of response:

- augmented flow,
- muted flow, and
- translated flow.

Augmented flow is defined as the condition when the downstream gaging station indicates higher flows than the upstream station. This is caused by the release of more water from the dam than is entering Ruth Lake and typically occurs in summer and fall. During this condition, the flows below the reservoir are significantly greater than they would be if the dam was not in operation and serve to augment the base flow of the river.

Muted flow is defined as the condition when the downstream gaging station indicates lower flows than the upstream station. This is caused by impounding water in Ruth Lake, typically during periods of higher rainfall in the upper reaches of the watershed. During this condition, peak storm flows are moderated downstream of the dam. These muted flows are later offset by augmented flows when impounded water is released.

Translated flow is defined as a condition when the upstream and downstream gaging stations exhibit similar hydrographs. The amount and timing of water entering Ruth Lake essentially equals the amount and timing of water discharged from the lake.

The GHD (2013) quantitative assessment focused on the following characteristics:

- comparison of total river flow to total District extractions,
- timing of when the muting period occurs within the water year,
- magnitude of the observed muting of peak hydrographs at Arcata, and
- impact on arrival times of peak events.

The assessment of the District's diversion effects on total river flow was conducted by comparing the total annual river flow, as measured at the USGS Arcata gage, with the total volume of water the District diverts to supply its customers.

The muted flow period was quantified by determining the amount of time between the first muted peak event hydrograph and when the first peak hydrograph was translated, for each water year of record. The analysis of the muting was performed using the hydrographs from above and below Ruth Lake for the 1981 through 2010 water years.

To quantify the muting impacts of Matthews Dam on the magnitude of peak flows, a comparison of peak flow events was conducted between the Forest Glen and Arcata gages. The comparison between the gage stations was made for those years that had historical records prior to the construction and filling of Matthews Dam and Ruth Lake. The comparative analysis included seven years of records between 1954 and 1960. This period included four average water years, two high water years, and one low water year.

The arrival time of the peak flow events were determined by the date of highest magnitude daily flow for a given storm. The impacts of individual storm events were typically observed over several days and exhibit a rapid rise, a peak, and slower recession of the flow hydrograph. The determination of peak flow was made by a visual inspection of individual hydrographs. The peak arrival times and peak magnitudes for each event were tabulated and comparisons between both stations' recorded peaks were made. The time between the peak arrival times for a specific event was calculated along with the percentage of the Arcata flow observed at Forest Glen.

2.3 Riffle Depths

2.3.1 Field data collection preparation

Preparation for field data collection included acquisition of the 2013 aerial photographs of the lower Mad River between the Mad River Hatchery and the Highway 101 Bridge. These aerial photographs were flown as part of the Humboldt County instream gravel mining monitoring program. GIS-based field maps were developed from the photographs.

The field maps were reviewed to preliminarily identify up to eight critical riffles that would be potential candidates for the study. Critical riffles were defined as those that present the greatest likelihood of inhibiting upstream adult salmonid migration (i.e. shallowest riffles in the reaches). A field review with CDFW was then conducted on 8 November 2013 to identify the types and locations of riffles that could be considered critical to fish passage in the lower river. CDFW agreed on the selection criteria for the study and expressed confidence that the District's riffle selection in 2014 would be appropriate.

Four critical riffles were identified for data collection on 18 April 2014 during a field review with Points West Surveying (Figures 2-2 and 2-3). Two of the riffles (#s 3 and 4) were located upstream of the District's diversion reach, and as such, were unaffected by water withdrawals (control riffles). The other two riffles (#s 1 and 2) were located within the diversion reach and were influenced by District operations (treatment riffles).

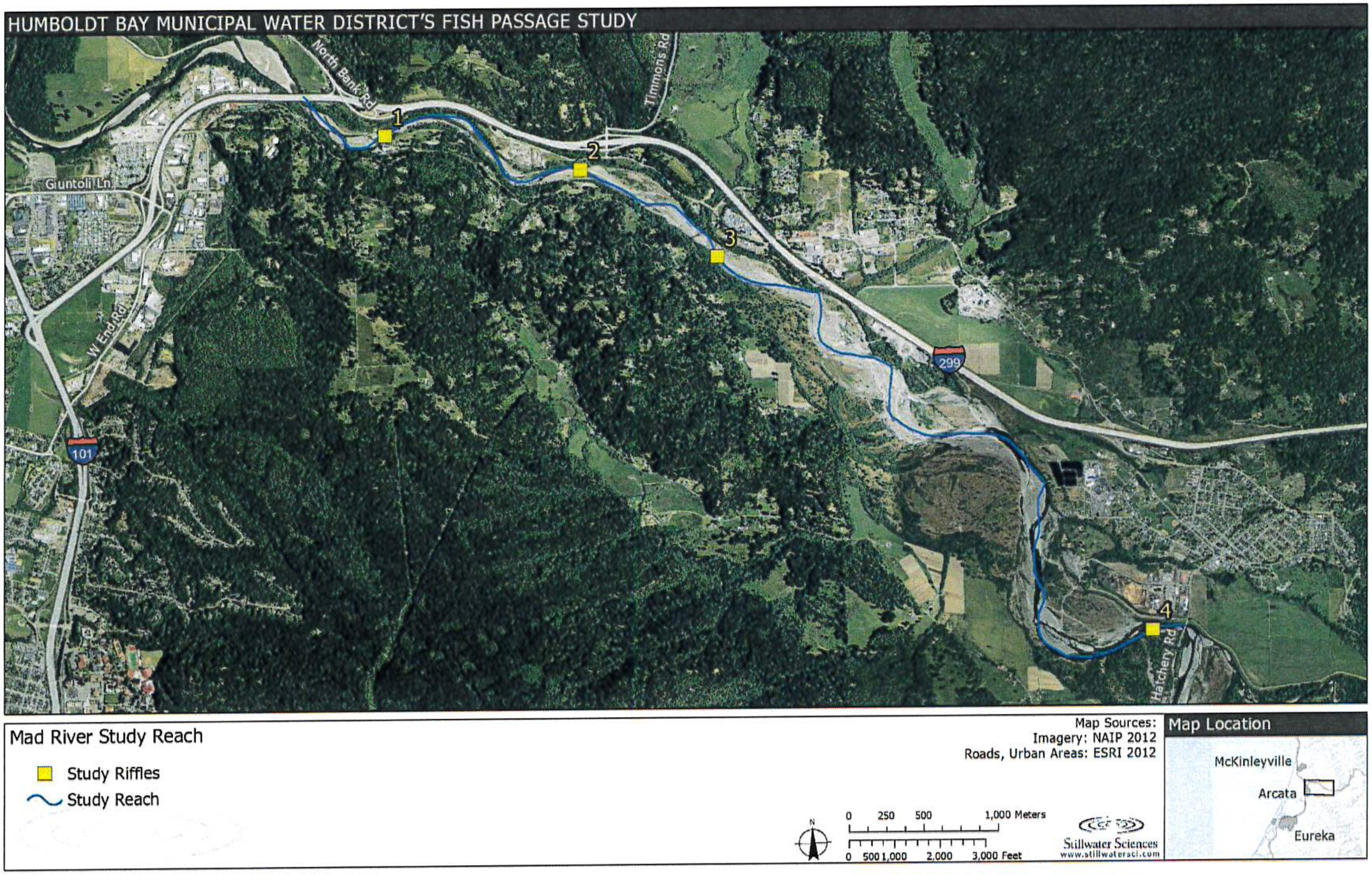


Figure 2-2. Fish passage study riffle locations.

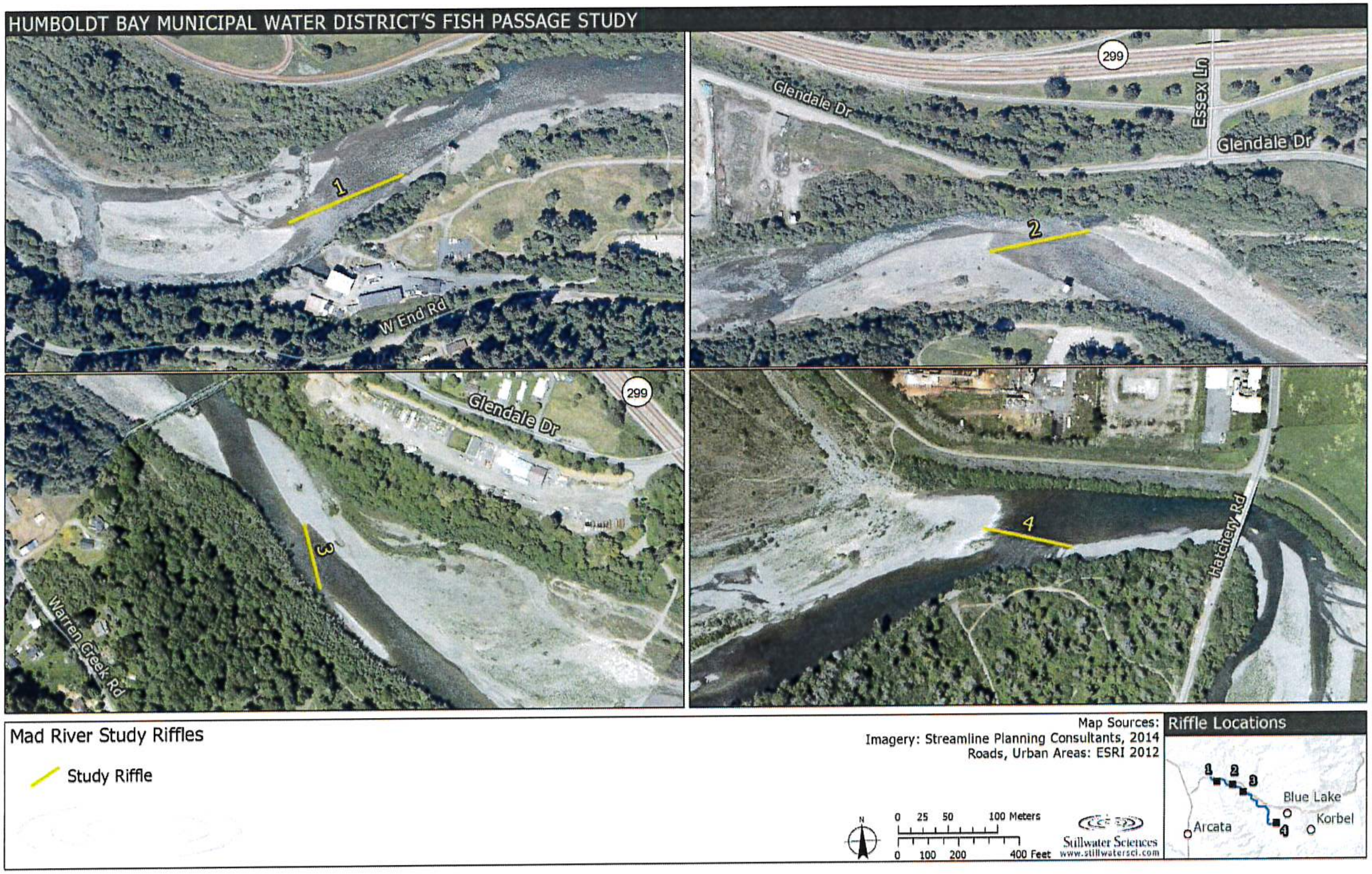


Figure 2-3. Individual study riffles.

2.3.2 Field data collection

Cross-sections were established at each of the four riffles (two in the control reach and two in the treatment reach) that appeared to be the most limiting for upstream adult migration. Rebar pins, set flush to the ground surface, were installed on both sides of the river at the critical riffle location to establish a repeatable cross-section for measurements. The initial cross-section at each riffle was established at 264 cfs (as measured at the USGS Arcata gage) along riffle crest or shallowest transect and extended up the left and right banks to rebar pins that were sunk into the dry substrate. The initial cross-section was shot with a total station. Bathymetry and water surface elevations were shot at approximately 4-foot (ft) increments along the cross-section.

Subsequent depth measurements were taken along each cross-section at 202, 160, 110, and 50 cfs, as measured at the USGS Arcata gage. A measuring tape was attached at one pin and run across the river to the other pin. Water depth measurements were taken along each cross-section at the edges of water, thalweg, and breaks in topography. All data points were recorded in a field notebook.

As stated above, the original cross-section was shot at 264 cfs along the shallowest transect extending from bank to bank. Each subsequent cross-section was shot along the exact same transect. However, as flow decreased through the study, the riffle hydraulics changed and the shallowest transects may or may not have been along the original cross-section location.

2.3.3 Data analysis

Analysis of the cross-section data was done by differencing the original 264 cfs cross-sections' water surfaces with the lower flow edge of water, thalweg, and topographic break locations' water depths.

A riffle depth/flow regression for the critical riffles was developed using the individual cross-sections' thalweg water depth data and USGS Arcata gage data. This was done by comparing the mean daily flow as measured at the USGS Arcata gage with the thalweg depth data. This enabled correlation of the critical riffle depth data with the USGS gage flow data. This allowed for each critical riffle to have its own depth/flow curve and facilitated the determination fish passage depths for various flows as recorded at the USGS Arcata gage.

The potential effect that early season reservoir filling has on riffle depths was assessed by subtracting the flow at the USGS Zenia gage from the individual riffle depth/flow curves and determining the muted depth.

The effect that these muted depths potentially have on salmon migration passage was evaluated by looking at historical USGS Arcata gage flow records on the dates that Chinook salmon were observed in the lower Mad River upstream of the Essex diversion reach.

3 LITERATURE REVIEW

3.1 Adult Salmonid Migration Timing and River Flow

In California, most adult fall-run Chinook enter streams from August through November, with peak arrival usually occurring in October and November (Leet et al. 1992), and spawning from early October into January. Adult Chinook salmon have been observed upstream of the Mad River estuary beginning the first week of September (Halligan 1998, 1999, 2000). These fish then move fairly quickly upstream as flows permit and have been observed adjacent to and upstream of Blue Lake soon thereafter (Halligan 1998, 1999, 2000, 2005; Stillwater Sciences 2012, 2013).

The late summer and early fall flows tend to be the lowest of the entire year and typically range from 30 to 80 cfs at the USGS Arcata gage. Underwater observations of adult Chinook salmon have been recorded within the lower Mad River (Mad River Hatchery to Guintoli Lane) for several years during the months of September or October (Table 3-1).

Table 3-1. Mad River flow at the USGS Arcata gage and observed Chinook salmon locations (Halligan 1998, 1999, 2000, 2003, 2005; Stillwater Sciences 2012, 2013).

Date	Flow range (cfs)	Chinook salmon location	Number of adult Chinook salmon
3 September 1997	50	Upstream of Hatchery Road Bridge	7
2 October 1998	37–40	Upstream of Hatchery Road Bridge	2
9 September 1999	50–55	Downstream of Mad River Hatchery	9
10 September 2002	30	Mad River Sand and Gravel	12
28 September 2004	31–33	Glendale to Mad River Hatchery	Many
22 September 2011	65–83	Hatchery Road Bridge	20+
2 October 2012	39–46	Glendale	54
3 October 2012	40–53	Hatchery Road Bridge	200+

As indicated in Table 3-1, it is apparent that adult Chinook salmon can migrate upstream under the current flow regime. For example, no adult Chinook salmon were observed in the Hatchery Road Bridge pool during an underwater observation on 27 September 2012 (D. Halligan, Stillwater Sciences, pers. comm., May 2013). A second dive occurred on 3 October 2012 and more than 200 adult Chinook salmon were present (D. Halligan, Stillwater Sciences, pers. comm., May 2013). Therefore, these fish migrated into the pool between those two dive dates. The flow at the USGS Arcata gage between 27 September and 3 October 2012 ranged from 40 to 53 cfs. Releases from Matthews Dam at the time were 50 cfs (USGS 2014a). Given that the District draws approximately 13 cfs to supply its customers, the natural flow[1] in the river without the Matthews Dam releases would have been about 16 cfs. It is likely that without the releases few, if any, of the Chinook in the estuary would have been capable of migrating upstream to the Hatchery Road Bridge pool.

3.2 Riffle Depths

Thalweg water depth data have been recorded at riffle crests between the Mad River Hatchery and Guintoli Lane since 1997 as part of the instream gravel mining fisheries monitoring program. The fisheries monitoring program data collection typically occurs during the late summer or early fall (Halligan 2005, 2007; Stillwater Sciences 2008–2014). Since 2004, riffle crest depths have ranged from 0.2 to 2.0 ft depending on location (Table 3-2). Average riffle crest depths have ranged from 0.7 to 1.0 ft (Table 3-2).

[1] Natural flow = Arcata gage + Essex diversions + Zenia gage – Matthews Dam gage

Table 3-2. Thalweg depths at riffle crests between the Mad River Hatchery and Guintoli Lane (Halligan 2005, 2007; Stillwater Sciences 2008–2014).

Year	Number of riffle crests	Riffle crest depth range (ft)	Average riffle crest depth (ft)
2004	13	0.3–2.0	0.7
2005	7	0.3–1.3	0.9
2006	30	0.4–1.5	0.9
2007	26	0.3–1.2	0.9
2008	29	0.3–1.5	0.8
2009	30	0.2–1.2	0.7
2010	30	0.3–1.5	0.9
2011	31	0.2–1.4	0.8
2012	28	0.4–1.4	0.9
2013	38	0.3–1.6	1.0

3.3 Mainstem Spawning Locations

Chinook salmon are known to spawn in the mainstem Mad River. Surveys and observations conducted as part of the instream gravel mining fisheries monitoring program have recorded redds and spawning activity in the lower Mad River between the Mad River Hatchery and Highway 299. On 17 September 2002, 15 redds were observed on the lower Mad River between the Mad River Hatchery and Guintoli Lane (Halligan 2003). Mean daily flows at the USGS Arcata gage prior to the redd survey ranged from 19 to 65 cfs. A total of 75 redds, 52 Chinook carcasses, and 10 live Chinook were identified between the Annie and Mary Railroad Bridge and the Mad River Hatchery on 15 November 2004 (Halligan 2005). Mean daily flows at the USGS Arcata gage for the two weeks prior to the 15 November 2004 observation ranged from 109 to 187 cfs.

Green Diamond Resource Company (GDRC) has conducted spawning surveys on a nearly annual basis upstream of the Mad River Hatchery between 2002 and 2012. The GDRC survey reach extends 9.7 miles from the Mad River Hatchery to Simpson Creek. GDRC has typically conducted a single survey in November of each year. The surveys for 2009 and 2012 were conducted in December and January, respectively. GDRC recorded between 8 and 411 Chinook salmon redds and from one to 190 redds constructed by unidentified salmonids during the survey years.

It is likely that Chinook salmon spawn between Simpson Creek and the Bug/Deer Creek barriers, but focused surveys have not been conducted in this reach.

3.4 Barriers to Migration

Natural boulder roughs, which form barriers to upstream migration of Chinook and coho salmon, have been documented in the mainstream river reach between Bug Creek (RM 50) and Deer Creek (RM 53) (DWR 1958, Stillwater Sciences et al. 2010). Some steelhead are able to make it past the barrier and migrate up to Matthews Dam (RM 84), but based on the results of the summer steelhead surveys, the number of fish capable of passing the blockage is a small part of the population.

4 HYDROLOGIC STUDY

A hydrologic report was developed by GHD (2013) to assess the potential effects that the District's operations at Matthews Dam and Essex may have on river flow under various scenarios. The evaluation used historical stream flow data and compared effects on stream flow from before and after the construction of Matthews Dam and diversion at the District's Essex facilities. The two primary questions addressed by the study were:

1. What were the pre-dam flow patterns in the Mad River?
2. Does the early season filling of Ruth Lake affect downstream hydrology, and if so, how much?

4.1 Pre-dam Flow Patterns

The pre-dam flow conditions in the Mad River above Ruth Lake were typically the same as the current condition. The flow in the Mad River above Ruth Lake is unimpaired. The flow levels in the river are directly related to precipitation and the river is typically dry during the late summer and fall, then wet once the rains start (GHD 2013).

A similar late-summer/fall flow condition existed immediately below and for several miles downstream of the Matthews Dam site. Mean pre-dam flows during this period at the USGS Forest Glen gage (~9 miles downstream of Matthews Dam) ranged from 2 to 10 cfs during August and September of 1954 to 1961 (HBMWD and Trinity Associates 2004) (Table 4-1).

Table 4-1. Daily mean stream flows (cfs) during low-flow months prior to operation of Matthews Dam from October 1953 to October 1961 at the USGS Forest Glen gage #11480500 (HBMWD and Trinity Associates 2004).

Year	August			September			October			November		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
1953	–	–	–	–	–	–	3	16	5	4	2,330	279
1954	2	7	3	2	4	3	2	11	5	5	987	120
1955	2	5	3	1	3	2	2	5	2	3	1,890	176
1956	2	5	4	2	2	2	2	1,050	52	10	214	42
1957	3	7	5	2	23	4	7	1,400	168	32	3,350	455
1958	2	18	8	6	19	14	1	5	2	2	72	13
1959	2	2	2	2	20	7	2	9	6	2	3	2
1960	2	7	5	1	3	2	2	5	3	2	1,250	117
1961	1	10	5	1	8	4	2	8	3	2	380	51
AVG	**2**	**8**	**4**	**2**	**10**	**5**	**2**	**279**	**27**	**7**	**1,164**	**139**

Prior to operation of Matthews Dam, a sand bar/barrier beach closed the mouth of the Mad River during periods of low flow in most years (DWR 1958). Mean pre-dam flows during this period at the USGS Arcata gage ranged from 34 to 36 cfs during August and September of 1954 to 1961 (Table 4-2). In the years when the mouth was open, Chinook salmon were able to enter the river as early as August, but were often blocked by dry stretches of stream only a few miles above the mouth (DWR 1958). The CDFG (1953) reported that the mouth of the Mad River remained open to the ocean during all of 1952. CDFG (1953) also reported, "The fall rains were late in arriving and until November 14 salmon could not ascend the river further (sic) than a point approximately one-half mile below the mouth of the North Fork of the Mad River. At that point the stream bed surface was completely dry for a stretch of nearly 200 yards. There were several other dry stretches immediately above. Portions of the river from about a half-mile downstream of the North Fork were dry. Fish were in the river up to that point." Average daily flows from 1 September to 13 November 1952 on the lower Mad River at the Arcata gage (# 11481000) ranged from 21 to 25 cfs (USGS 2014b). It must be noted that in 1952 and 1953, the confluence of the North Fork and mainstem Mad rivers was located near the current Blue Lake wastewater treatment ponds, approximately 1.3 miles downstream from the present day river mouth location. Therefore, the downstream-most dry location CDFG (1953) referred to was located about a half mile upstream of the Eureka Ready Mix plant in Glendale.

Table 4-2. Monthly mean stream flows (cfs) during low-flow months prior to operation of Matthews Dam from October 1953 to October 1961 at the USGS Mad River near Arcata gage #11481000 (http://waterdata.usgs.gov/nwis/monthly/).

Year	August mean daily flow (cfs)	September mean daily flow (cfs)	October mean daily flow (cfs)	November mean daily flow (cfs)
1953	-	-	107	2903
1954	47	45	47	448
1955	34	30	41	1075
1956	39	28	536	405
1957	37	45	591	2,472
1958	43	39	34	378
1959	19	30	39	32
1960	34	24	30	1,043
1961	38	30	80	-
Mean of monthly discharge	**36**	**34**	**167**	**1,090**

4.2 Post-dam Flow Patterns

The post-dam flow conditions in the Mad River above Ruth Lake are the same as those experienced prior to operation of Matthews Dam. The watershed upstream of the dam is unimpaired and subject to natural flow patterns.

Mean post-dam flows during the low-flow season at the USGS Forest Glen gage (~9 miles downstream of Matthews Dam) ranged from 73 to 107 cfs during August and September of 1962 to 1994 (the Forest Glen gage's period of record ended in 1994) (HBMWD and Trinity Associates 2004) (Table 4-3). This was an increase in flow of 71 to 107 cfs during the months of August and September over the pre-dam flow conditions. Dam releases during this time were used to supply two pulp mills and domestic uses.

There was a drop in the maximum flows for the months of October and November following initiation of operations at Matthews Dam. The maximum flows during October and November fell from 279 and 1,164 cfs, respectively, prior to dam operation to 250 and 688 cfs, respectively, during the post-dam period (Tables 4-1 and 4-3). The minimum and mean flows for October and

November following operation of Matthews Dam increased over the pre-dam flow condition (Tables 4-1 and 4-3). The reduction in maximum flows during October and November may be attributed to retention of flow behind the dam as it fills.

Table 4-3. Monthly mean stream flows (cfs) during low-flow months during operation of Matthews Dam from August 1962 to October 1994 at the USGS Forest Glen gage #11480500 (HBMWD and Trinity Associates 2004).

Year	August			September			October			November		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
1962	12	20	14	13	21	17	16	3,840	620	217	1,150	379
1963	48	135	92	118	271	220	9	213	65	29	807	362
1964	94	98	96	92	98	94	91	100	95	53	420	114
1965	45	73	53	65	73	70	69	79	76	73	425	213
1966	80	111	88	76	158	91	56	75	72	52	369	128
1967	81	121	101	99	119	111	123	269	171	70	178	122
1968	72	103	90	70	108	82	63	109	82	81	367	225
1969	73	105	95	73	119	97	95	113	109	95	206	134
1970	90	104	101	98	119	105	107	127	114	107	722	235
1971	83	100	94	95	111	100	92	141	107	102	228	122
1972	79	100	93	91	128	102	80	117	107	101	198	128
1973	83	123	95	95	118	104	102	199	111	105	3,060	1,262
1974	97	123	114	117	124	119	111	134	117	65	169	104
1975	70	108	88	87	108	91	87	330	117	123	620	316
1976	45	71	56	54	86	62	77	102	92	37	98	78
1977	57	81	68	14	69	56	10	51	37	9	238	44
1978	69	100	89	93	114	96	91	94	93	72	95	87
1979	93	104	98	100	102	101	45	361	94	46	1,500	302
1980	88	106	96	99	106	101	96	104	99	38	100	78
1981	81	93	84	81	91	85	34	139	70	27	3,000	814
1982	43	76	62	70	114	91	44	182	139	111	584	181
1983	41	137	63	70	116	87	98	143	124	147	2,600	584
1984	77	93	80	83	88	86	83	94	88	94	3,320	367
1985	85	96	91	90	98	95	51	121	92	40	84	63
1986	99	108	104	104	129	109	100	149	112	15	115	83
1987	90	95	93	89	97	92	87	93	90	29	87	57
1988	86	98	93	92	107	98	92	109	96	24	861	201
1989	94	104	99	83	103	98	55	231	98	55	115	90
1990	80	118	107	96	103	101	96	118	105	50	99	88
1991	94	105	99	94	102	97	34	103	88	13	86	48
1992	93	97	95	88	96	92	53	88	76	11	61	33
1993	41	43	42	42	58	52	57	64	60	59	64	61
1994	51	64	56	56	67	62	65	68	67	–	–	–
AVG	**73**	**97**	**85**	**81**	**107**	**93**	**72**	**250**	**112**	**67**	**688**	**238**

Mean post-dam flows during the low flow season at the USGS Matthews Dam gage (#11480410; immediately downstream of Matthews Dam) ranged from 70 to 79 cfs during August through October of 1981 to 2012 (Table 4-4). These flows are primarily dam releases through the power house. These releases represent an increase in flow of 66 to 80 cfs during the months of August through October over the pre-dam flow conditions as recorded at Forest Glen.

Table 4-4. Mean monthly flows at the USGS Matthews Dam gage (#11480410) for the water years 1981 through 2012.

Month	Minimum flow (cfs)	Maximum flow (cfs)	Mean flow (cfs)
August	41	103	70
September	42	101	76
October	56	118	79
November	25	607	122

Mean post-dam flows during the low-flow season at the USGS Arcata gage (# 11481000; ~76 miles downstream of Matthews Dam) ranged from 69 to 77 cfs during August and September of 2010 to 2013 (Table 4-5). This was an increase in monthly mean flow of 33 cfs during the months of August and September 2010 to 2013 over the pre-dam flow conditions. Mean monthly flows for October 2010 to 2013 were similar to those observed prior to operation of Matthews Dam. Mean monthly flows during November 2010 to 2013 were about 400 cfs lower than prior to operation of Matthews Dam.

Table 4-5. Monthly mean stream flows (cfs) during low-flow months during operation of Matthews Dam from August to October during water years 2010 to 2013 at the USGS Mad River near Arcata gage #11481000.

Water year	August			September			October			November		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
2010	33	114	82	68	157	86	52	264	87	55	718	232
2011	72	105	86	65	81	72	69	2,340	388	314	5,330	1,100
2012	52	81	63	47	53	49	76	1,070	202	97	2,670	512
2013	39	54	45	44	1,380	102	43	123	65	104	8,190	699
AVG	**49**	**89**	**69**	**56**	**418**	77	**60**	**949**	**186**	**143**	**4,227**	**636**

4.3 Effects of Early Season Filling of Ruth Lake

The effects of early season filling of Ruth Lake on lower river riffle depth and migration passage is significantly influenced by watershed characteristics and rainfall patterns. The watershed area upstream of Matthews Dam is about 120 square miles and contains approximately 452 miles of tributary streams (Stillwater Sciences et al. 2010). By contrast, the watershed area downstream of the dam is approximately 346 square miles and contains 1,525 miles of tributary length (Stillwater Sciences et al. 2010). Mean annual rainfall in the Mad River watershed averages from 40 inches along the coast to over 120 inches in the higher elevations. The areas that experience the heaviest rainfall are located downstream of Matthews Dam in the middle portion of the watershed (Figure 4-1).

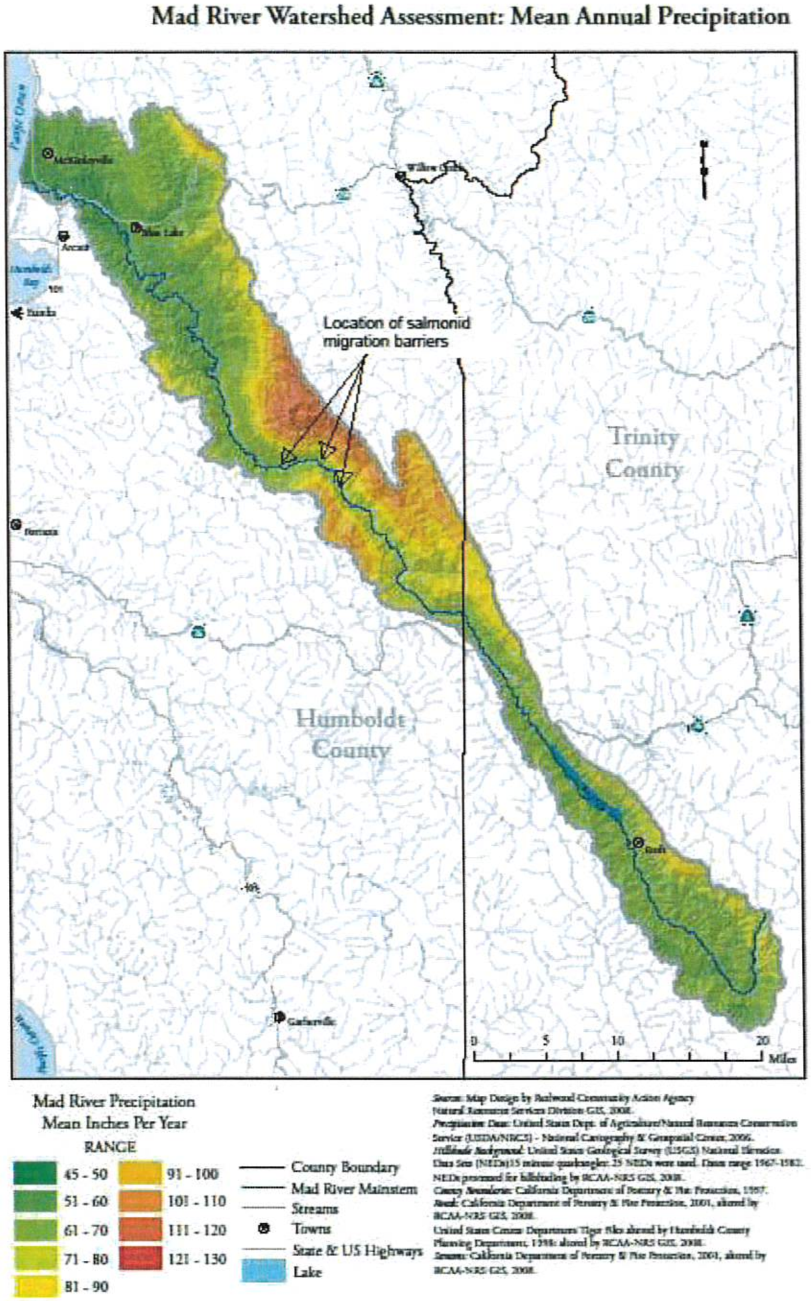


Figure 4-1. Mad River watershed mean annual precipitation (Stillwater Sciences et al. 2010).

Muting of the hydrograph immediately downstream of Matthews Dam occurs when the early rainy season flows above Ruth Lake are impounded and the reservoir outflow is less than its inflow. While the number and intensity of precipitation events vary from year to year, this muting condition was consistently observed from year to year, typically from the months of late October to December or January. An example of this can be seen in Figure 4-2. The flow above Ruth Lake

(USGS Zenia gage) for this runoff event reached approximately 1,500 cfs, while the release from Matthews Dam was approximately 200 cfs, which is close to the maximum amount of water that can be run through the power house.

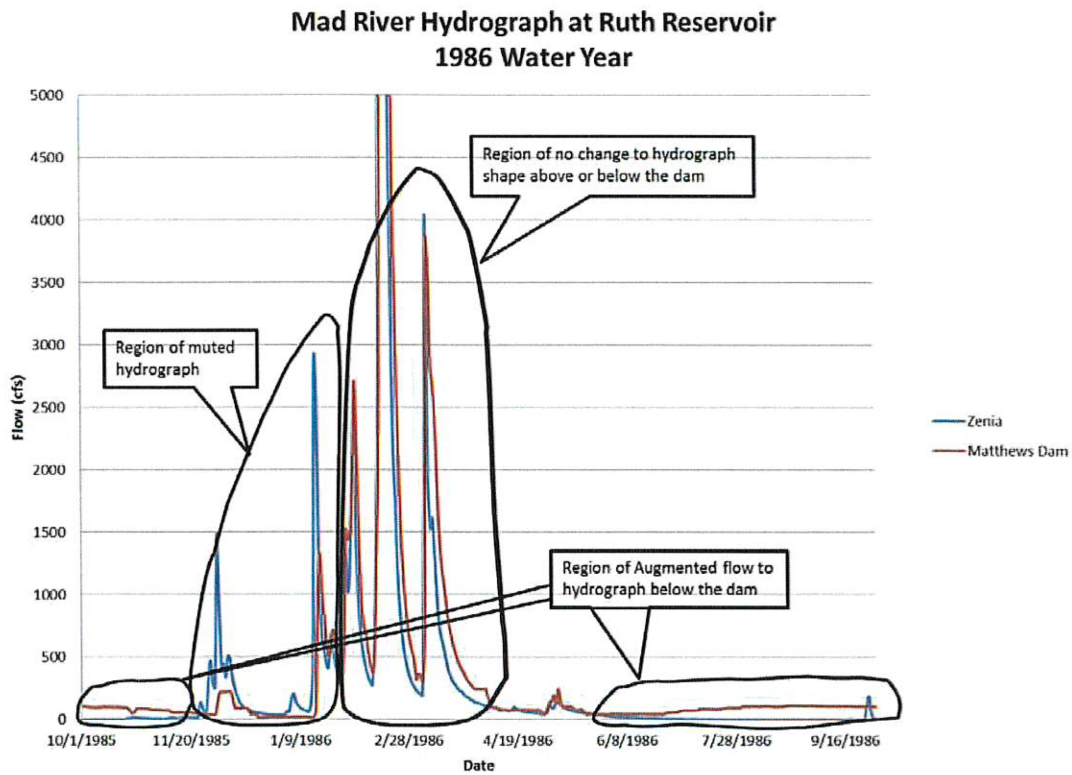


Figure 4-2. Mad River hydrograph below Matthews Dam and at Zenia for water year 1986 (GHD 2013).

The effect of this muting is attenuated relatively quickly in a downstream direction due to tributary accretion flow entering the mainstem river. This muting effect attenuation can be seen in Figure 4-3. For the same muting event depicted in Figure 4-2, the effect is moderated by the time the river reaches Forest Glen, where the flow is approximately 800 cfs (GHD 2013). The muting effect is further diminished as seen at the Arcata gage, where the flows exceed 5,000 cfs.

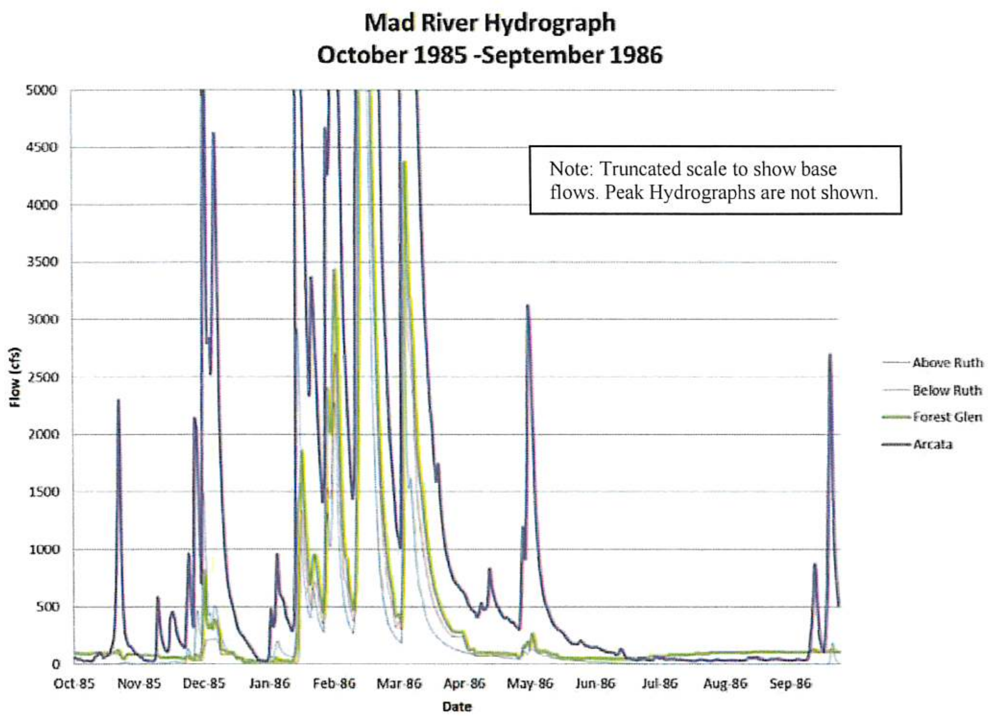


Figure 4-3. Mad River hydrograph for water year 1986 (GHD 2013).

In many years, there are a number of peak events recorded at the Arcata gage when there is little or no flow entering Ruth Lake (Figure 4-3). More recently, a significant storm event occurred in late September to early October 2013. This first-of-the-season storm resulted in flows at the USGS Arcata gage reaching approximately 1,900 cfs, while the USGS Zenia gage recorded a flow of about 9.5 cfs (Figures 4-4 and 4-5).

From a biological perspective, the muting effect of impounding early-season runoff events in Ruth Lake on adult Chinook salmon passage over riffles in the lower Mad River is minimal due to the natural accretion of flow from the watershed downstream of Matthews Dam. The muting effect ceases once the reservoir is full and spilling over the spillway. Once flow is going over the spillway, the river experiences a natural hydrograph until releases from the power house exceed the natural inflow into the lake.

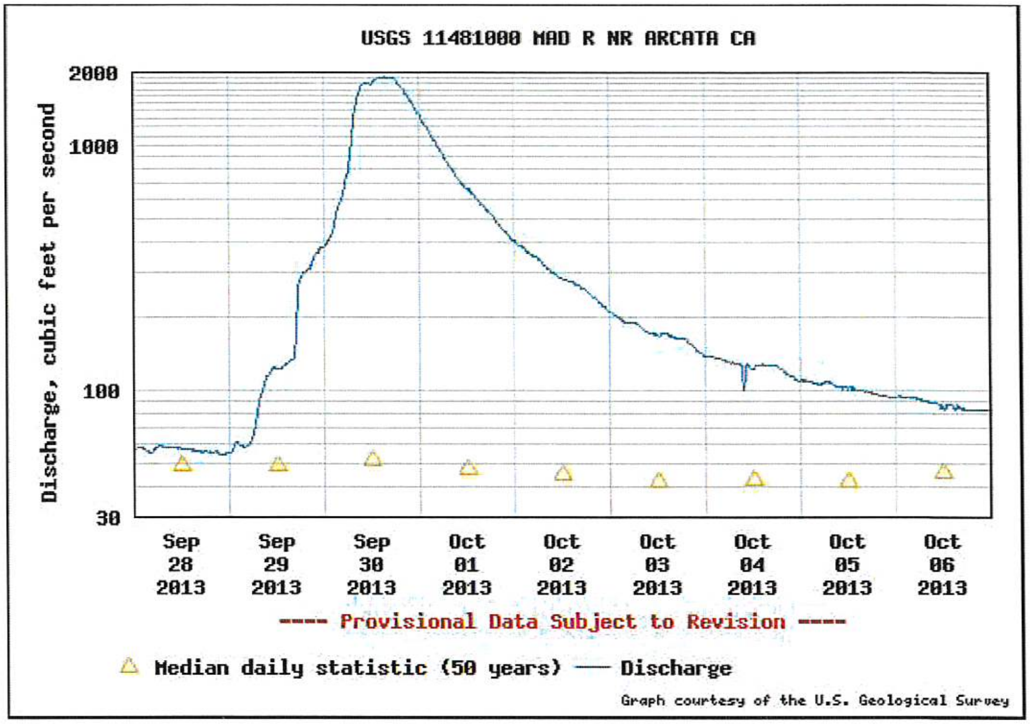


Figure 4-4. Early season rainfall event streamflows at USGS Arcata gage 28 September to 6 October 2013.

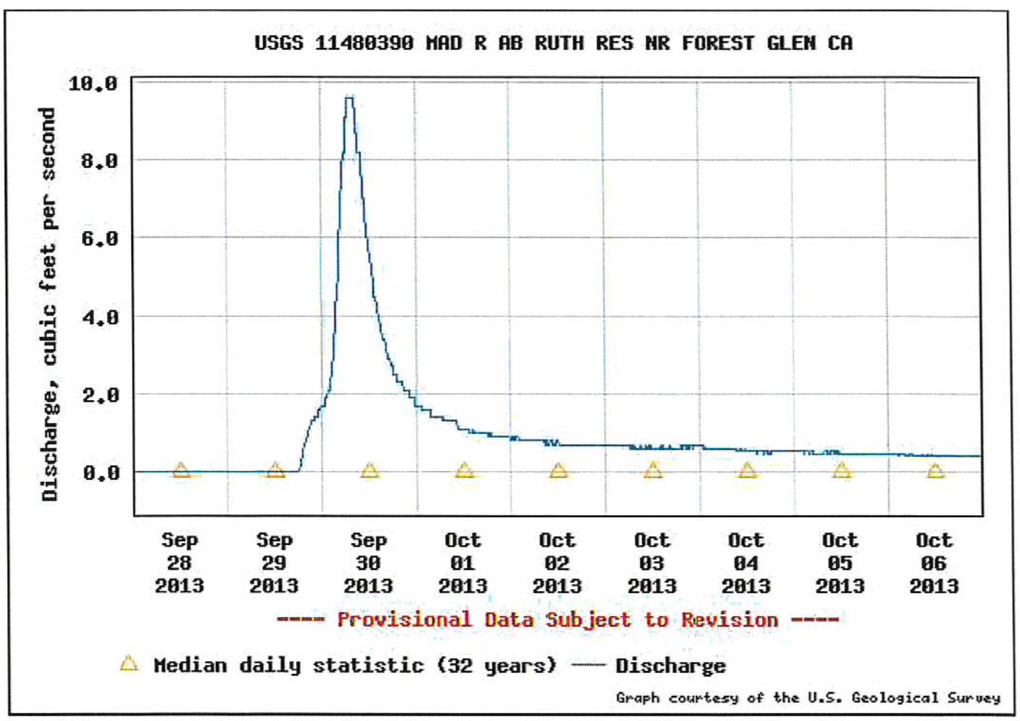


Figure 4-5. Early season rainfall event streamflows at USGS Zenia gage above Ruth Lake 28 September to 6 October 2013.

5 RIFFLE DEPTHS AND FISH PASSAGE

As stated in Section 1.2, the purpose of the hydrologic and fish passage assessment is to "determine the effects of stream impoundment (Matthews Dam) and stream diversion at Essex" on upstream adult Chinook salmon migration passage. To assist in the assessment of effects on upstream Chinook salmon passage, the following critical questions needed to be addressed:

1. Does the early season filling of Ruth Lake and interception of upper basin flow affect water depth over riffles in the lower river?
2. Is riffle depth altered during the early season filling of Ruth Lake such that upstream migration by Chinook salmon is hindered or delayed?

5.1 Ruth Lake Filling Effects on Upper River Riffle Depths

No riffle depth data have been collected in the Mad River in the upper river below Matthews Dam, so the potential effects of reservoir filling on riffle depths between the dam and Forest Glen can only be surmised from flow records.

Prior to operation of Matthews Dam, the reach between the headwaters and Forest Glen would experience intermittent or no flow during the summer and early fall (Table 4-1). Indeed, the entire reach upstream of the current dam site would have been dry during the low-flow season, similar to what has been experienced during the post-dam period. Therefore, there was generally little or no flow over riffles in the upper basin during the summer and early fall before the dam was constructed.

Matthews Dam typically releases 40–50 cfs or more through the power house during the late summer and early fall. Since there is usually no inflow into the lake during this time, the releases allow for the creation of mainstem river connectivity and augment depth over riffles between the dam and estuary. There is no muting-related effect on the riffle depths anywhere along the mainstem river during the early rainy season until the amount of lake inflow exceeds the volume of water released through the dam's power house. The effect may be fairly pronounced close to Matthews Dam only when natural reservoir inflow exceeds the power house releases and the accretion from nearby tributaries is relatively minor. However, the effect of lake filling on riffle depths diminishes with increasing watershed area and accretion of tributary flow.

5.2 Ruth Lake Filling Effects on Lower River Riffle Depths

To address the question of whether the early season filling of Ruth Lake and interception of upper basin flow affect water depth over riffles in the lower river, riffle depths were measured at the study cross-sections as river flows diminished during the spring and summer months (Table 5-1 and Figure 5-1). Depending on location, thalweg depths at the study cross-sections decreased by 0.3 to 0.6 ft as flows declined from 264 cfs to 50 cfs. However, Matthews Dam released between 41–56 cfs through the power house during the study period (between 22 April and 11 July 2014). Power house releases exceeded the Ruth Lake inflow during the entire study period and continued to do so throughout the fall of 2014. Therefore, during the study period, the interception of upper basin flow had no effect on water depths over riffles in the lower river.

Table 5-1. Thalweg depths at critical riffle cross-sections.

Survey Date	Discharge at USGS Arcata gage (cfs)	Inflow into Ruth Lake (cfs)	Matthews Dam power house releases (cfs)	Thalweg depth (ft) at critical riffle cross-sections			
				XS 1	XS 2	XS 3	XS 4
22 April 2014	264	53	56	1.1	1.3	1.0	0.9
2 May 2014	200	32	41*	0.8	1.0	0.8	0.8
7 May 2014	160	27	0**	0.7	1.0	0.8	0.7
30 May 2014	110	10	42	0.7	0.8	0.6	0.7
11 July 2014	50	<1	41	0.5	0.7	0.6	0.6

* Dam was also spilling 43 cfs over the spillway.
** Dam was spilling 20 cfs over the spillway. Power house was non-operational for one day due to maintenance.

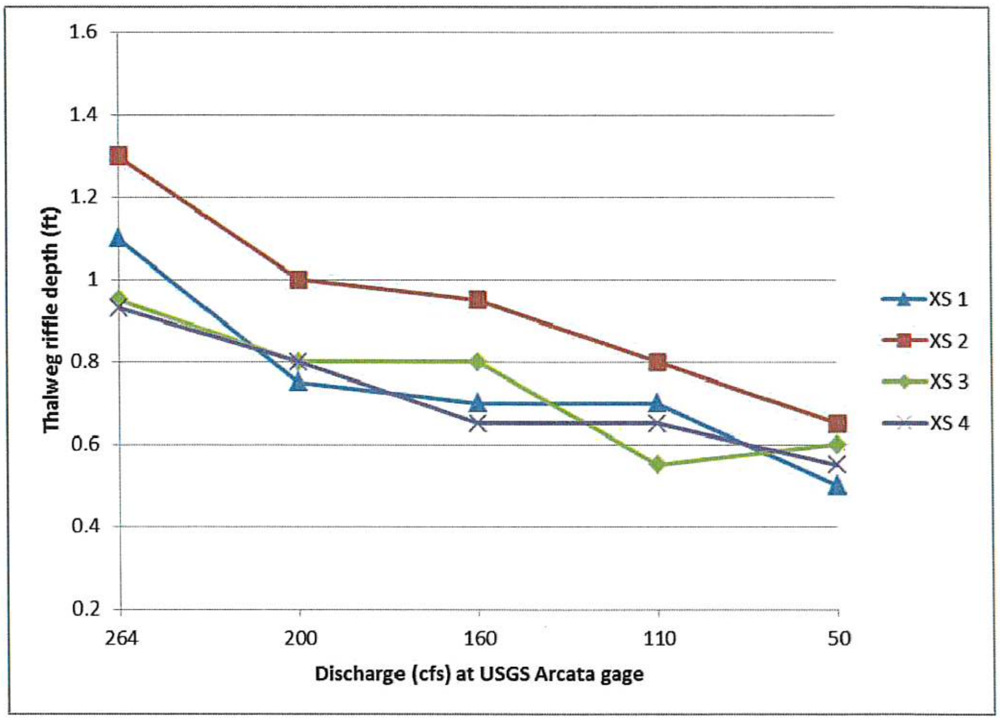


Figure 5-1. Critical riffle thalweg depths at study flows.

Between 25 September and 23 October 2014, early season storm events dropped 3.9 inches of rain at the Ruth (MADC1) weather station (http://raws.wrh.noaa.gov/cgi-bin/roman/meso_base_past.cgi?stn=MADC1&unit=0&time=LOCAL&day1=24&month1=10&year1=2014&hour1=0). During this period, about 8.3 inches of rain fell at the Kneeland Airport station (KNNC1), which drains into Black and Blue Slide creeks in the Middle Mad River basin (http://raws.wrh.noaa.gov/cgi-bin/roman/meso_base.cgi?stn=KNNC1). Therefore, over twice as much rain fell in the mountainous area downstream of Matthews Dam than upstream of the dam during this period.

River discharge downstream of Matthews Dam during the early season storm events typically exceeds that which enters Ruth Lake (Figures 4-3, 4-4, and 4-5). This condition also occurred during all 2014 (Table 5-2). It took approximately 3.9 inches of rain to fall in one month's time upstream of Matthews Dam to initiate a small amount (3 to 11 cfs) of surface runoff into Ruth Lake. During this time period, the flows at the USGS Arcata gage ranged from 305 to 1,100 cfs. The amount of interception in Ruth Lake was about 1% of the flow measured at the USGS Arcata gage. Therefore, the filling of Ruth Lake during early season storm events generally has little effect on water depths over riffles in the lower river.

Table 5-2. USGS gage data at Zenia (#11480390) and Arcata (#11481000).

Date	Zenia gage flow (cfs)	Arcata gage flow (cfs)
25 September 2014	0	165
14 October 2014	0	46
19 October 2014	0	63
20 October 2014	0	100
23 October 2014	11	305
24 October 2014	3	1100

On 30 November 2014, flow into Ruth Lake ranged from 274 to 479 cfs as measured at the USGS Zenia gage. Matthews Dam release that day was 44 cfs. Therefore, between 230 and 435 cfs was being used to fill the lake on that day. It takes about 2.5 days of travel time for water from Matthews Dam to reach Arcata. The USGS Arcata gage recorded 827 to 1,130 cfs on 1 December 2014. Therefore, filling of Ruth Lake on 30 November 2014 resulted in a 29 to 38 percent decrease (muting) of flow at the Arcata gage on 1 December 2014. It is likely that lower river riffles were shallower to some degree by the muting effect, but given that at 264 cfs (USGS Arcata gage) riffles are already a foot or more deep (Table 5-1), fish passage wasn't adversely affected by the muting that occurred on 1 December 2014.

The diversion at the Essex has the potential to compound the muting-related effects, discussed above, on riffle depths and fish passage. The Ranney wells, located in the Essex reach, draw about 12 cfs from below the river bed. Based on the data presented in Table 5-1 for Riffles #1 and 2, it takes a decrease in flow averaging 36 cfs to result in a loss of 0.1 ft of thalweg depth at riffle crests. Assuming a 1:1 relationship between the diversion and surface flow, the potential effect on riffle depth of diverting about 12 cfs would be approximately 0.03 ft at Riffles #1 and 2. Therefore, the effect of the diversion at Essex, combined with the muting effect on riffle depths and fish passage, is minimal.

It appears that early season interception of upper basin flow would have a small effect on water depth over lower river riffles only if significantly more rainfall and associated runoff is occurring upstream of Matthews Dam than downstream. The amount of riffle depth change in this unlikely scenario would depend on the amount of interception by Ruth Lake and how much water is being released through the power house. Flow into Ruth Lake would need to exceed the 40–50 cfs power house release before any downstream effect would be felt. For example, a 200 cfs interception in Ruth Lake would result in a muting of lower river flow of about 150 cfs. The effect on riffle crest depth would be between 0.2 and 0.3 ft when flows at Arcata are about 50 cfs (Figure 5-1). However, as mentioned before, this is a very unlikely scenario since the lower river flows tend to increase during the early part of the rainy season before there is any surface flow into Ruth Lake.

5.3 Effects on Migration Passage

As reported in Section 3.1, adult Chinook salmon are commonly observed migrating upstream in the Mad River during the late summer and fall when flows are in the 40 to 60 cfs range, as measured at the USGS Arcata gage. Augmented flow from Matthews Dam releases likely contributes to the presence of Chinook salmon in the lower Mad River during the late summer and early fall periods. This is because the dam releases help keep the mouth of the river open to the ocean during the low-flow season, which enables adult Chinook salmon to enter the estuary. In addition, as discussed in Section 3.1, the augmented flow creates enough water depth over riffles to allow for upstream migration.

Mike Sparkman, CDFW Fisheries Biologist (pers. comm., 20 October 2014) reported "*Yesterday was an amazing day at the DIDSON site on the Mad R (RM 7.01). From 10:00 a.m. to 2:00 p.m., we visually counted over 200 adult Chinook pass through the low gradient riffle below the DIDSON (now ARIS) sonar camera. We measure the riffle depths at this riffle, and the deepest part was 15 cm (or about 6"). They had no problem going through it.*" The flow, as measured at the USGS Arcata gage during the observation (19 October 2014), was between 61 and 66 cfs (http://waterdata.usgs.gov/ca/nwis/uv?cb_00060=on&cb_00065=on&format=html&site_no=11481000&period=&begin_date=2014-10-17&end_date=2014-10-24). The flow at the USGS Zenia gage was 0 cfs on that date. There was no flow into Ruth Lake at the time of the CDFW observation. Therefore, contrary to hindering or delaying upstream migration, operation of Matthews Dam has assisted earlier entry and upstream migration of Chinook salmon in the Mad River than would have occurred in the pre-dam period.

6 SUMMARY

The responses to the four critical questions addressed by this study are summarized as follows.

1. What were the pre-dam flow patterns in the Mad River?

The pre-dam flow conditions in the Mad River were unimpaired and flow levels in the river were directly related to precipitation and snow melt. Upstream of the Matthews Dam site, the river was typically dry during the late summer and fall, then wet once the rains began (GHD 2013). A slightly wetter late-summer/fall flow condition existed immediately below and for several miles downstream of the Matthews Dam site. Average pre-dam flows during this period at the USGS Forest Glen gage (~9 miles downstream of Matthews Dam) ranged from 2 to 10 cfs during August and September of 1954–1961 (HBMWD and Trinity Associates 2004).

Prior to operation of Matthews Dam, a sand bar/barrier beach closed the mouth of the Mad River during periods of low flow in most years (DWR 1958). Mean daily flows from 1 September to 13 November 1952 on the lower Mad River at the USGS Arcata gage (# 11481000) ranged from 21 to 25 cfs. Mean daily flows during August and September 1953–1961 were between 34 and 36 cfs. By comparison, mean post-dam flows during the low-flow season at the USGS Matthews Dam gage (#11480410; downstream of Matthews Dam) ranged from 70 to 76 cfs during August and September of 1981–2012. Mean post-dam flows during the low-flow season at the USGS Arcata gage (# 11481000; ~76 miles downstream of Matthews Dam) ranged from 69 to 77 cfs during August and September of 2010–2013.

2. Does the early season filling of Ruth Lake affect downstream hydrology, and if so, how much?

Muting of the hydrograph immediately downstream of Matthews Dam occurs when the early rainy season flows above Ruth Lake are impounded and the reservoir outflow through the power house is less than its inflow. The effect of this muting is most pronounced immediately downstream of the dam. The muting signature is attenuated relatively quickly downstream of Matthews Dam due to tributary accretion flow entering the mainstem river. The muting effect ceases once the reservoir is full and water spills over the spillway. Once flow is going over the spillway, the river experiences a natural hydrograph until releases from the power house exceed the natural inflow into the lake.

The analyses of the USGS gage hydrographs indicate a decrease of approximately 4% in the average percentage of Arcata peak flows between the pre-dam and post-dam conditions. This is likely due to the capture of peak flow events during the filling of the reservoir.

3. Does the early season filling of Ruth Lake and interception of upper basin flow affect water depth over riffles in the lower river?

There is no interception-related effect on the riffle depths anywhere along the mainstem river during the early rainy season until the amount of inflow into the lake exceeds the volume of water released through the dam's power house. By the time the lake receives inflow from the upper basin, the lower river is already running at a significantly higher level than summer low flow.

The typical early season hydrographs in the Mad River show increased storm runoff at the USGS Arcata gage prior to any measured surface flow at the USGS Zenia gage. For example, the amount of interception in Ruth Lake during October 2014 was about 1% of the flow measured at the USGS Arcata gage. Therefore, the filling of Ruth Lake during early season storm events typically has little effect on water depths over riffles in the lower river.

4. Is riffle depth altered during the early season filling of Ruth Lake such that upstream migration by Chinook salmon is hindered or delayed?

Adult Chinook salmon are commonly observed migrating upstream in the Mad River during the late summer and fall when flows are in the 40 to 60 cfs range, as measured at the USGS Arcata gage. This early-season upstream migration would likely be hindered or delayed if the 40–50 cfs releases from Matthews Dam did not occur.

The effect of impounding early season runoff in Ruth Lake on adult Chinook salmon passage over riffles in the lower Mad River is minimal due to the dam releases and natural accretion of rainfall runoff from the watershed downstream of Matthews Dam. This flow accretion results in adequate water depth over riffles to allow for upstream migration of Chinook salmon in the lower river.

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Appendix A

Study Riffle Photographs

Riffle #1

Riffle #1 at 200 cfs

Riffle #1 at 160 cfs

Riffle #1 at 110 cfs

Riffle #1 at 50 cfs

Riffle #2

Riffle #2 at 200 cfs

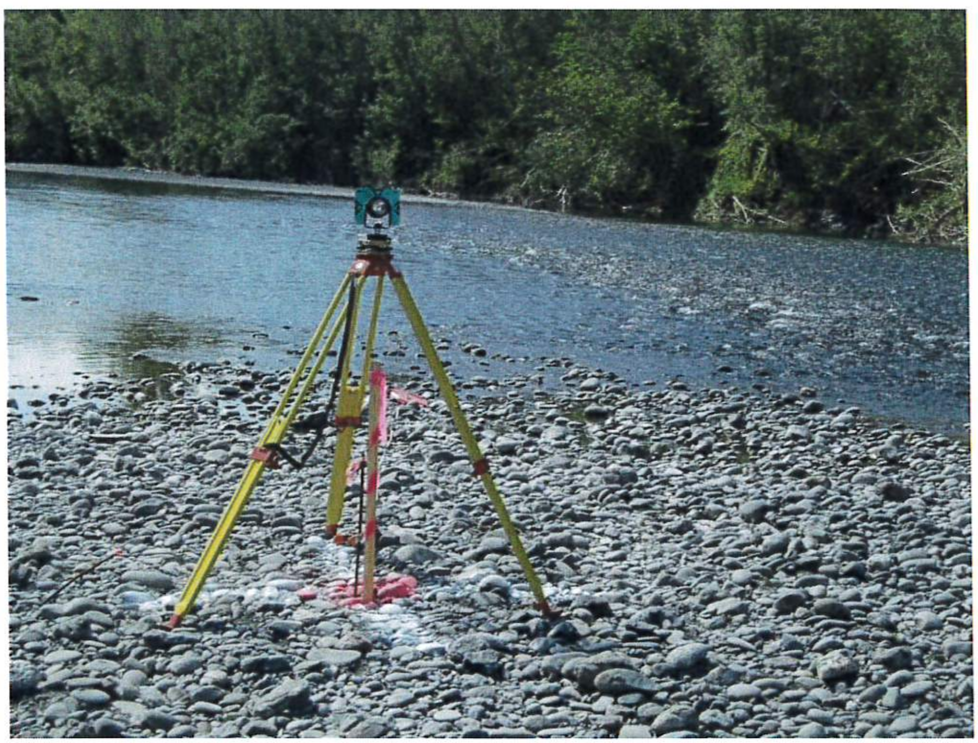
Riffle #2 at 160 cfs

Riffle #2 at 110 cfs

Riffle #2 at 50 cfs

Riffle #3

Riffle #3 at 200 cfs

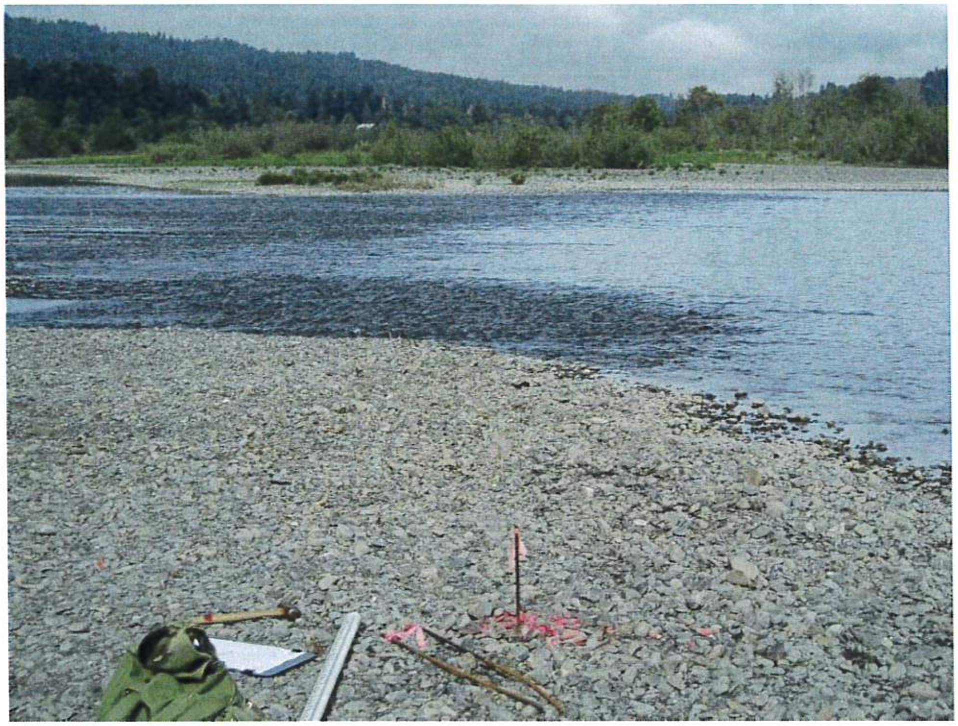


Riffle #3 at 160 cfs

Riffle #3 at 110 cfs

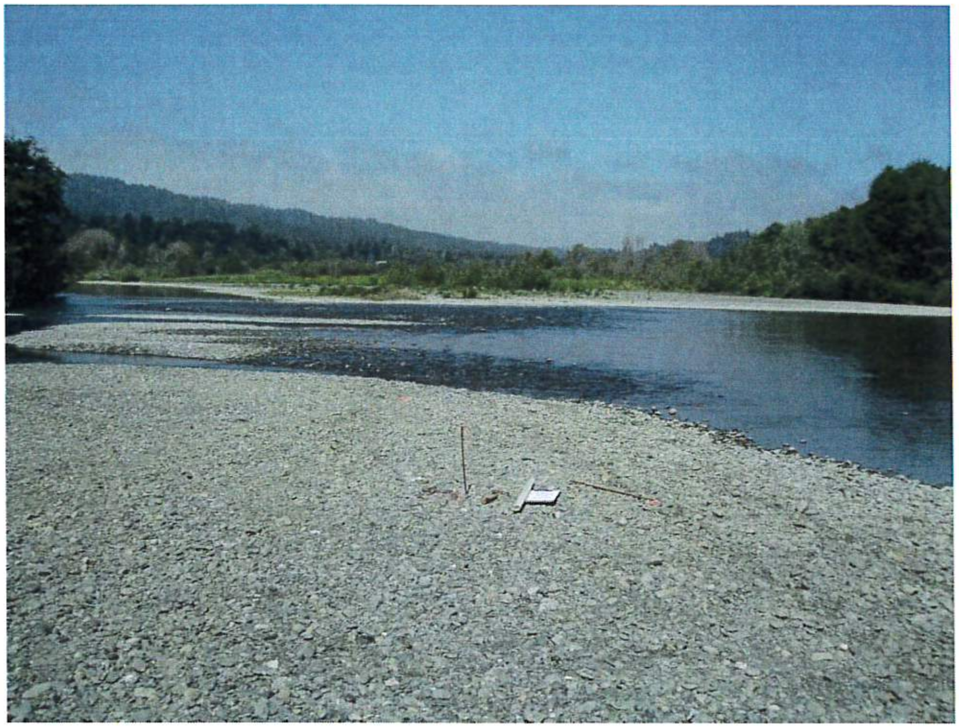
Riffle #3 at 50 cfs

Riffle #4

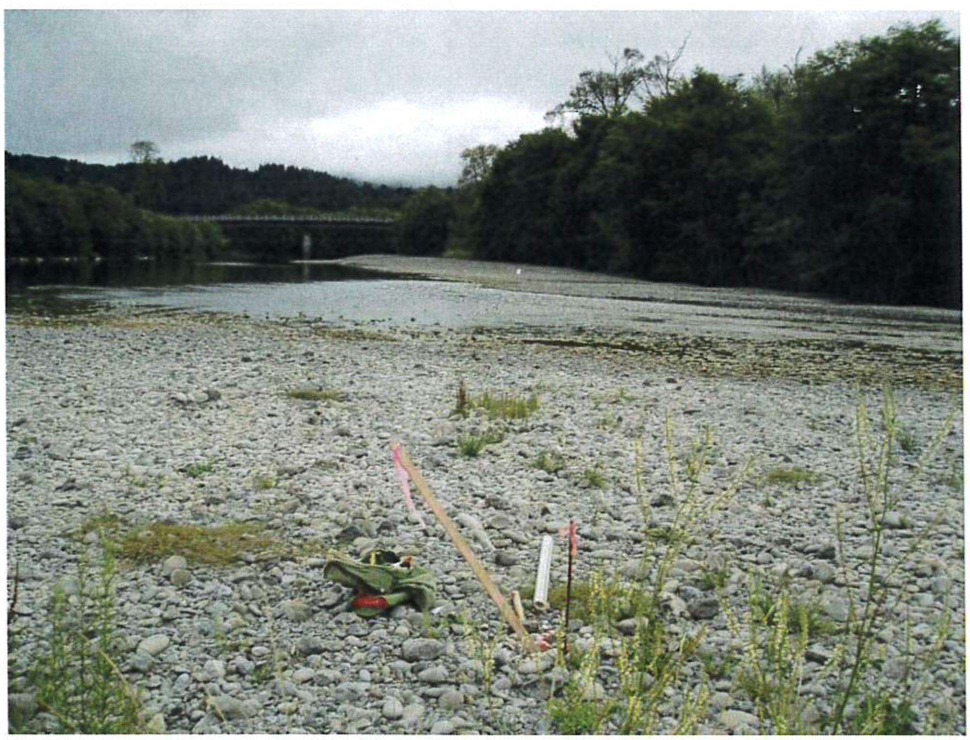


Riffle #4 at 200 cfs

Riffle #4 at 160 cfs



Riffle #4 at 110 cfs



Riffle #4 at 50 cfs

APPENDIX E – Stillwater Sciences Tech Memo

March 2014 Daily Flow Fluctuations

Stillwater Sciences

850 G Street, Suite K, Arcata, CA 95521
phone 707.822.9607 fax 707.822.9608

TECHNICAL MEMORANDUM

DATE: March 3, 2014

TO: Ann Garrett, National Marine Fisheries Service

FROM: Dennis Halligan, Senior Fisheries Biologist, Stillwater Science
Carol Rische, General Manager, Humboldt Bay Municipal Water District

SUBJECT: Mad River Flow Fluctuation Investigation

1 INTRODUCTION

The Humboldt Bay Municipal Water District (District) currently operates four Ranney Collector wells in the Mad River to supply drinking water to seven public agencies, who in turn, serve the residents, businesses and industries in the greater Humboldt Bay region. The District's wholesale municipal customers are the cities of Arcata, Eureka, Blue Lake, and four Community Service Districts - Fieldbrook-Glendale, Humboldt, Manila, and McKinleyville.

The District pumps between 10 and 20 million gallons per day from the Ranney Collectors to serve the municipal customers. The Collectors draw water from laterals that are buried 60 to 90 feet below the Mad River channel.

Between 1960 and 2009, the District also supplied untreated water to large industrial users on the Samoa Peninsula.

The District is currently engaged in a Water Resource Planning process to find and develop new water uses so as to maintain local control of the District's water rights for the benefit of the community and Mad River. The District is actively considering and pursuing three water-use options – new local sales, transport (e.g. transfer) to another municipality, and an instream flow dedication in the Mad River.

In 2013, the District initiated a scoping process to determine the feasibility of an instream flow dedication. During that process, the National Marine Fisheries Service (NMFS) questioned the daily fluctuations observed in the USGS Arcata gage during the low-flow season (Attachment A). NMFS assumed this variability was due to the District's municipal pumping operation and they questioned its effect.

During development of the District's Habitat Conservation Plan, NMFS posed a similar question. They observed daily fluctuations in the USGS staff gage during the low-flow season and questioned whether there were adverse effects. NMFS and District staff collaborated to conduct field monitoring. The investigation found very little change in river or habitat conditions, and no adverse effects to salmonids or their habitat. The results of the investigation were presented in an August 2005 memo (Attachment B). In 2005, the District was operating both the municipal and industrial systems, thus pumping rates were much higher than today.

Given the question posed by NMFS in 2013, the District agreed to investigate the potential effect of flow fluctuations at four locations downstream of its Essex diversion. The District invited NMFS personnel to participate in the field data collection effort, but due to the short lead time NMFS staff was unable to attend.

The purpose of this memorandum is to describe the methods and results of the flow fluctuation investigation.

2 METHODS

To determine the effect of the District's Ranney Collector diversion on surface flow, changes in water depth and wetted channel width were measured during pump-on and pump-off scenarios. The flow fluctuation data collection effort was conducted on September 3, 2013.

The first step in the data collection effort was to identify suitable cross-section locations to observe potential changes in surface flow characteristics. Four cross-section locations were identified between the Essex Station 6 and Highway 299 downstream (Figure 1). Two riffles and two runs were identified as appropriate locations for the investigation. See Attachment C for photographs of the four cross-sections.

Data collection was conducted by setting two rebar pins each at four locations along the left and right banks' edge of water after the upstream Ranney Collectors had been pumping for about 13 hours. This insured that the maximum amount of water surface response would be recorded. Marks were placed on each pin at 1.0 feet above the edge of water surface elevation. The distance between the left and right bank pins at each location was also recorded. Photographs of each location were taken (Attachment C) and the locations marked on an aerial photograph (Figure 1). USGS Arcata gage stages and flows were recorded during the pin placement period.

Once pumping ceased at 12:00 pm (noon), the river was given about four and a half to five hours to return to a natural state before the pump-off measurements were taken. Similar to the pump-on scenario, two rebar pins each were installed along the left and right banks' edge of water at the same four cross-section locations. A leveled line was stretched between the original 1.0-foot mark on the pump-on pin to the pump-off pin next to it. The vertical height between the point where the leveled line intersected the pump-off pin and the water surface was then recorded. The difference in water elevation between the two pins represented the change in depth between the pump-on and pump-off scenarios.

The distance between the pump-on and pump-off pins on both banks was also recorded. These combined distances between the two sets of pins at each location represented the change in wetted channel width between the pumping scenarios.

River elevation was also recorded in the Pump Station 6 forebay at Essex during the pump-on and pump-off scenarios. Station 6 was not in operation during the time of the investigation and the forebay acted like a stilling well that was not subject to the turbulence normally associated with riffles and runs.

USGS Arcata gage stages and flows were recorded during the investigation period to see how the gage responded to the pumping scenarios (Attachment A).

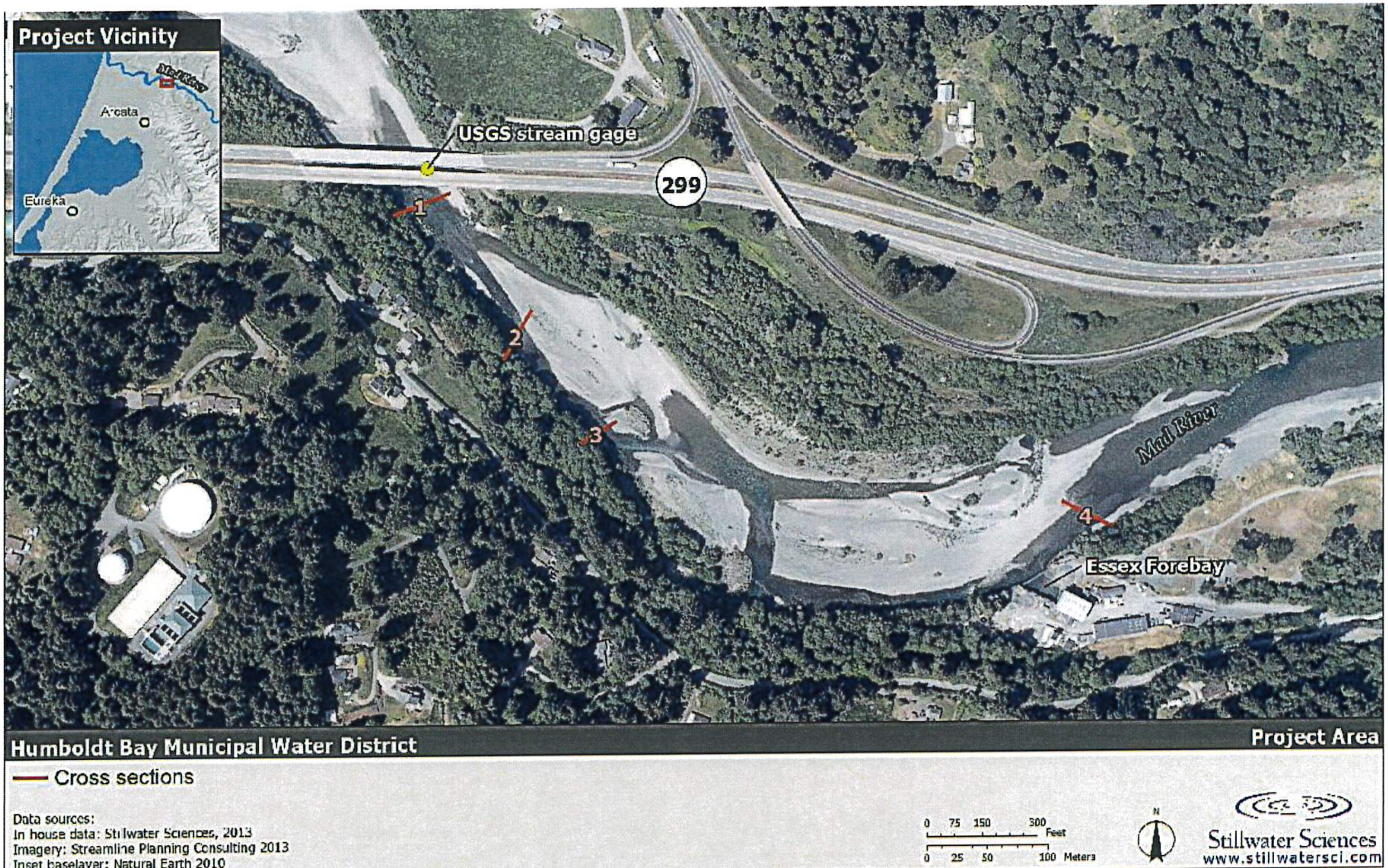


Figure 1. Project area and cross-section locations.

3 RESULTS AND DISCUSSION

3.1 Correlation between Domestic Water Pumping and River Stage

The District's municipal pumping schedule was compared with the USGS Arcata gage readings in July 2013. NMFS questioned the observed fluctuations in July. Figure 2 shows the comparison for a single day (July 22, 2013), and Figure 3 shows the comparison for an entire week. The original data from the USGS gage for this period are included in Attachment A. Figures 2 and 3 show a correlation between the District's Ranney pumping operation and the staff gage reading. During periods of domestic water production, the staff gage reading slowly decreased. When domestic pumping ceased, the staff gage reading increased.

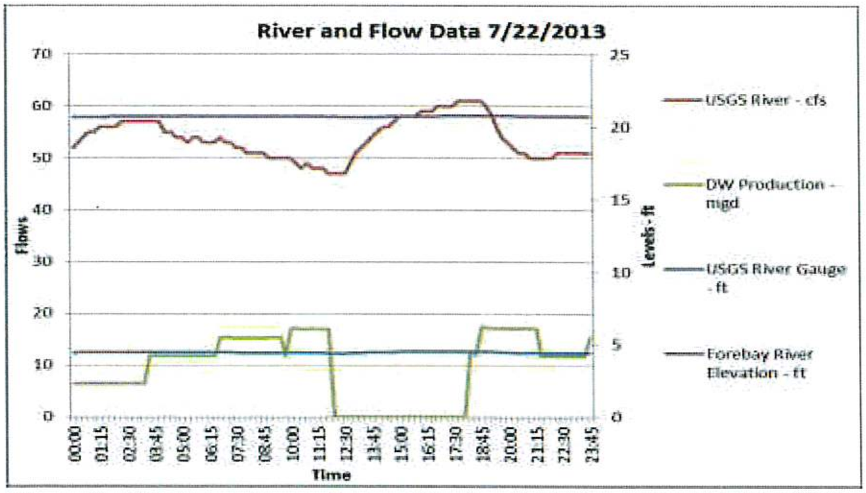


Figure 2. USGS Arcata gage flow and level vs. District pumping, July 22, 2013

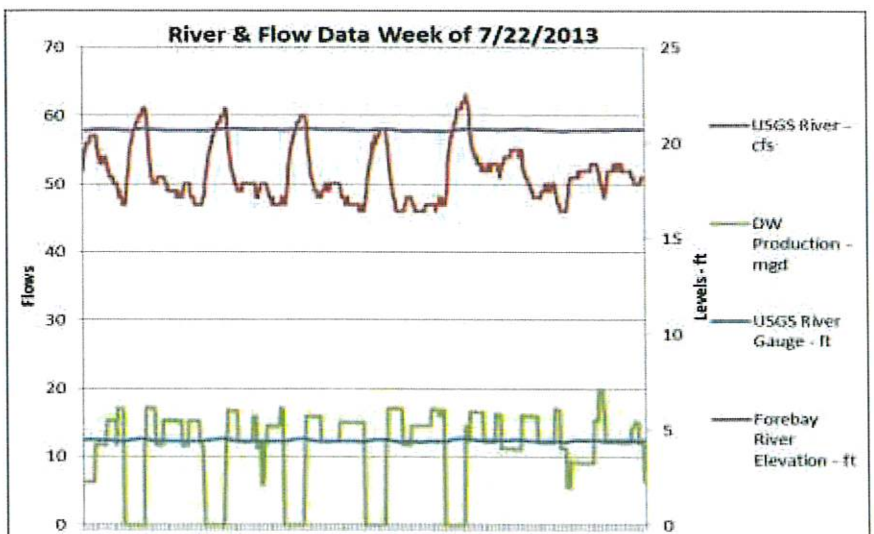


Figure 3. USGS Arcata gage flow and level vs. District pumping, week of July 22, 2013

3.2 Changes in Water Depth and Width and Four Cross Sections

Minor changes in water depth and wetted width were observed at each of the four cross-section locations between the pump-on and pump-off scenarios. Water depths at the four locations increased between 0.03 and 0.18 feet after the pumps were shut off (Tables 1 and 2). The wetted channel width increased modestly after the pump was turned off; between 1.1 and 2.2 feet depending on location (Tables 1 and 2). Therefore, it appears that operation of the Ranney wells result in modest decreases in water depth and wetted width averaging 0.1 feet and 1.46 feet, respectively.

The river elevation in the Pump Station 6 forebay was measured at 20.65 feet during the pump-on period. The river elevation rose by 0.03 feet to 20.68 feet during the pump-off period.

River stage at the USGS Arcata gage during the pump-on scenario was reported between 4.3 and 4.34 feet. The corresponding flow at the gage for the pump-on scenario was reported between 41 and 45 cubic feet per second (cfs) (Figure 4). After the pump was shut off, stage increased 0.15 feet to 4.45 feet, and the recorded flow increased to between 53 and 55 cfs.

The original gage data as presented by the USGS on their website are included in Attachment A (Figures A-5 & A-6). One thing of importance to note is that the Y-axis is truncated. The Y-axis for the gage height ranges from 4.20 or 4.25 feet to 4.60 feet. The truncated axis causes the fluctuation to appear quite amplified.

Table 1. Water levels and wetted widths at four cross-sections below Essex during pump-on and pump-off scenarios.

Cross-section location #	Habitat type	Pump on				Pump off			
		Time	Right bank pin water height (ft)	Left bank pin water height (ft)	Cross-section wetted width (ft)	Time	Right bank pin water height (ft)	Left bank pin water height (ft)	Cross-section wetted width (ft)
1	Run	0915	1.00	1.00	79.1	1750	1.15	1.18	81.3
2	Riffle	0925	1.00	1.00	98.7	1740	1.05	1.10	100.4
3	Run	0945	1.00	1.00	42.2	1725	1.10	1.11	43.1
4	Riffle	1005	1.00	1.00	68.5	1710	1.03	1.10	69.6
Average	-	-	1.0		72.1	-	1.10		73.6

Table 2. Change in water levels and wetted widths at four cross-section locations during pump-on and pump-off scenarios.

Cross-section location #	Habitat type	Change in height		Change in cross-section wetted width	
		(ft)	(inch)	(ft)	(%)
1	Run	0.15 – 0.18	1.8 - 2.2	2.2	2.7
2	Riffle	0.05 – 0.10	0.6 - 1.2	1.7	1.7
3	Run	0.10 – 0.11	1.2 - 1.3	0.9	2.1
4	Riffle	0.03 – 0.10	0.4 - 1.2	1.1	1.6

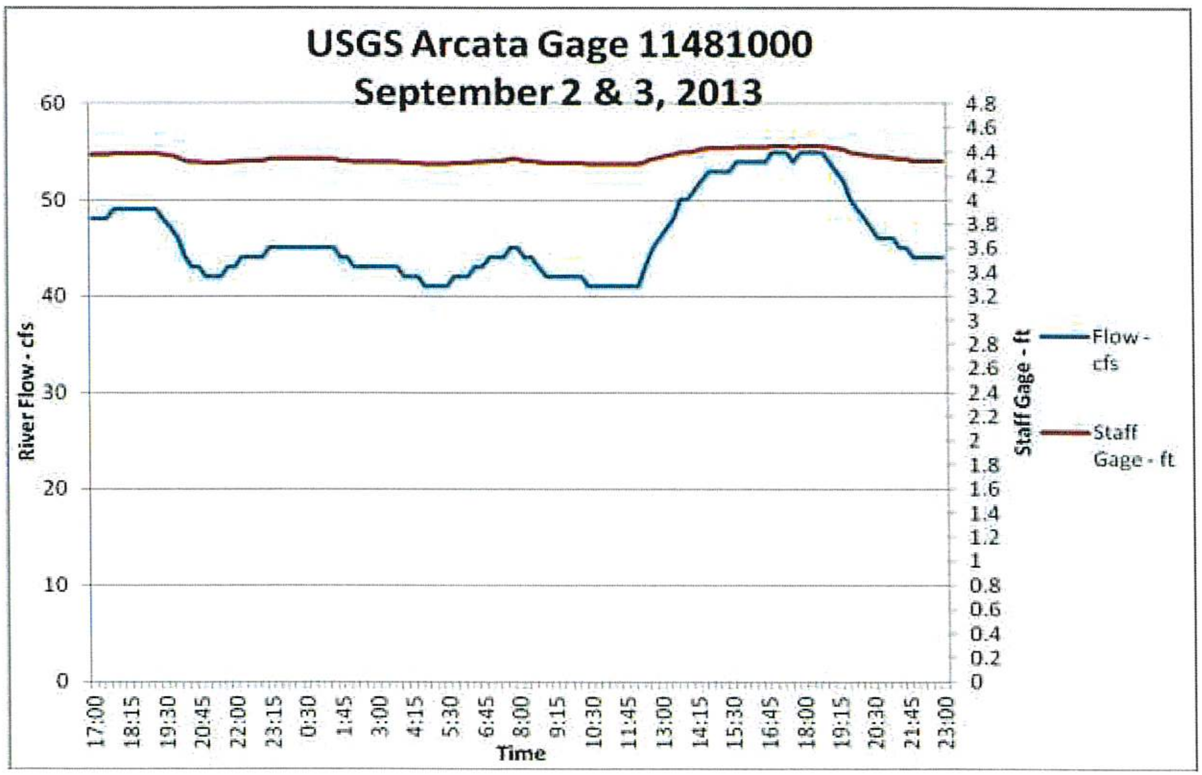


Figure 4. River flow (cfs) and stage (ft) at the USGS Mad River near Arcata gage during pump-on and pump-off scenarios.

4 CONCLUSION

Similar to the results of the 2005 monitoring, there is little risk of fish stranding or loss of instream habitat. The District's municipal pumping operation does not result in significant changes to river width or depth. The small change observed occurred slowly over several hours. Given the slow rate of change in depth and limited effect on wetted width, fish would have ample time to respond to any diversion-related effects on water surface characteristics in the lower Mad River.

Attachments

Attachment A

USGS Gage Data on Mad River near Arcata, CA

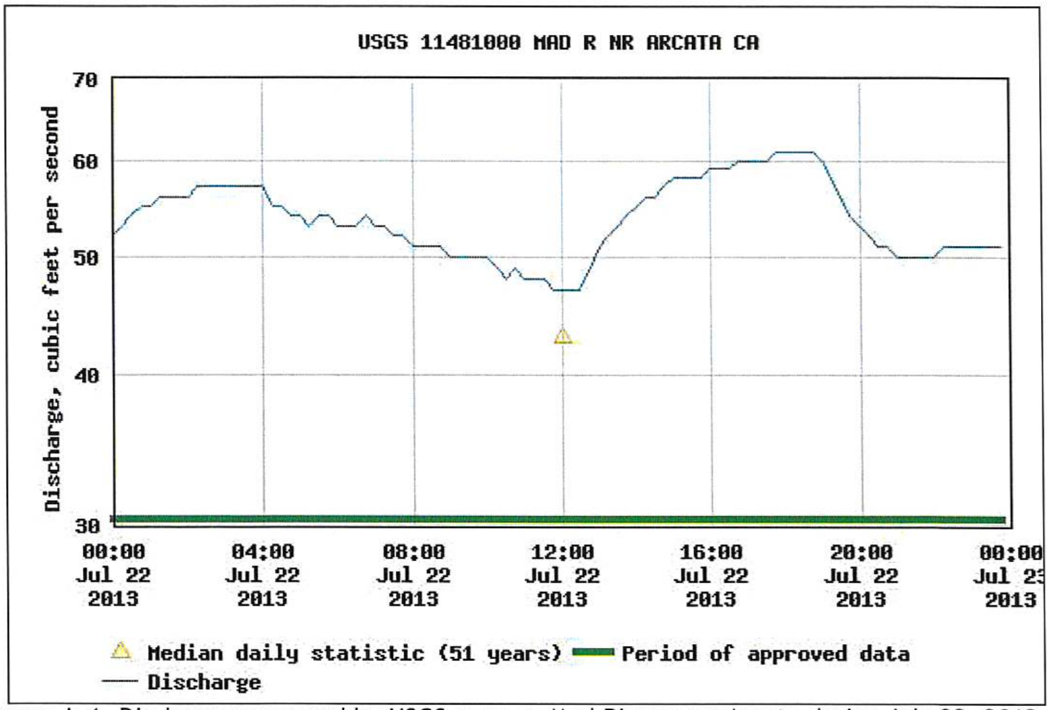


Figure A-1. Discharge measured by USGS gage on Mad River near Arcata during July 22, 2013.

Figure A-2. Gage height measured by USGS gage on Mad River near Arcata during July 22, 2013.

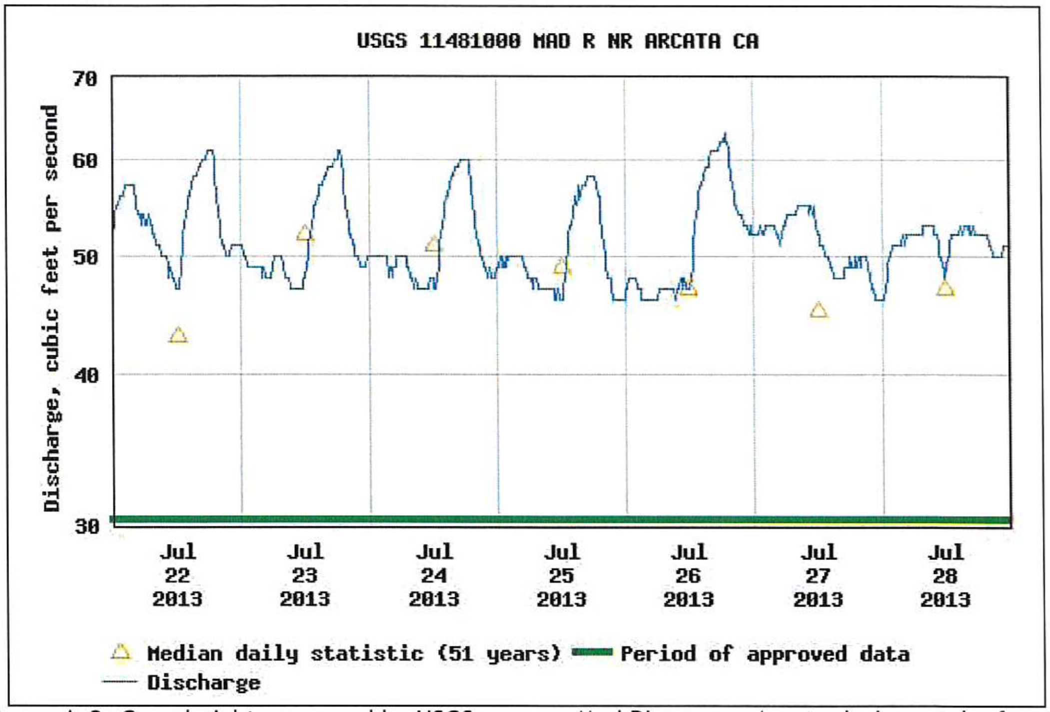


Figure A-3. Gage height measured by USGS gage on Mad River near Arcata during week of July 22, 2013.

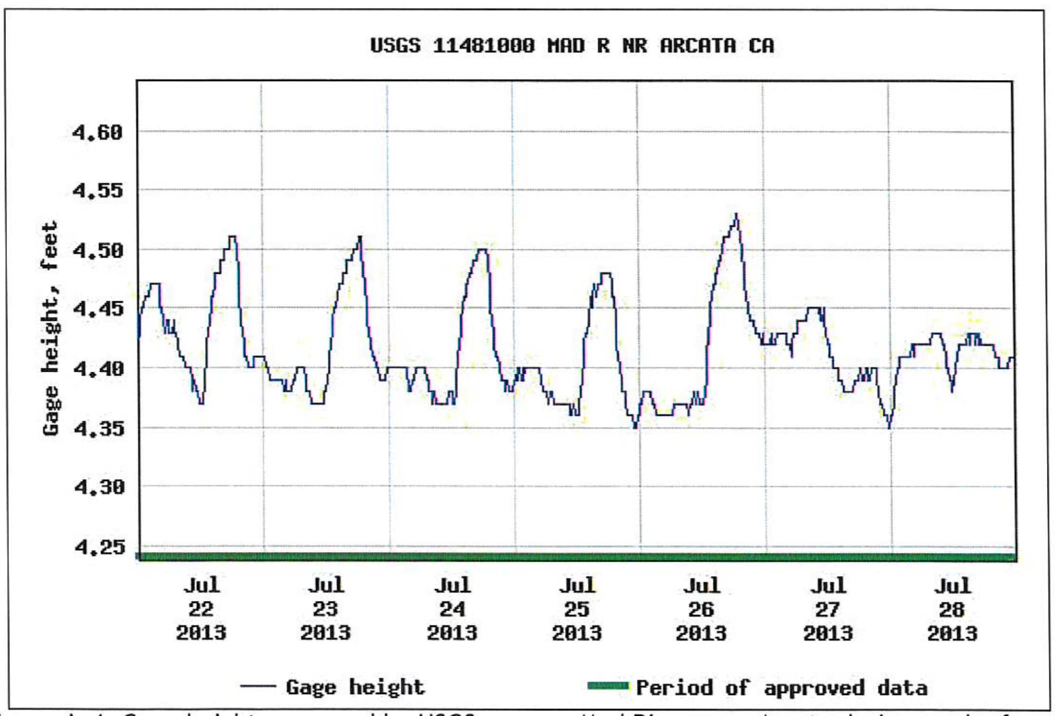


Figure A-4. Gage height measured by USGS gage on Mad River near Arcata during week of July 22, 2013.

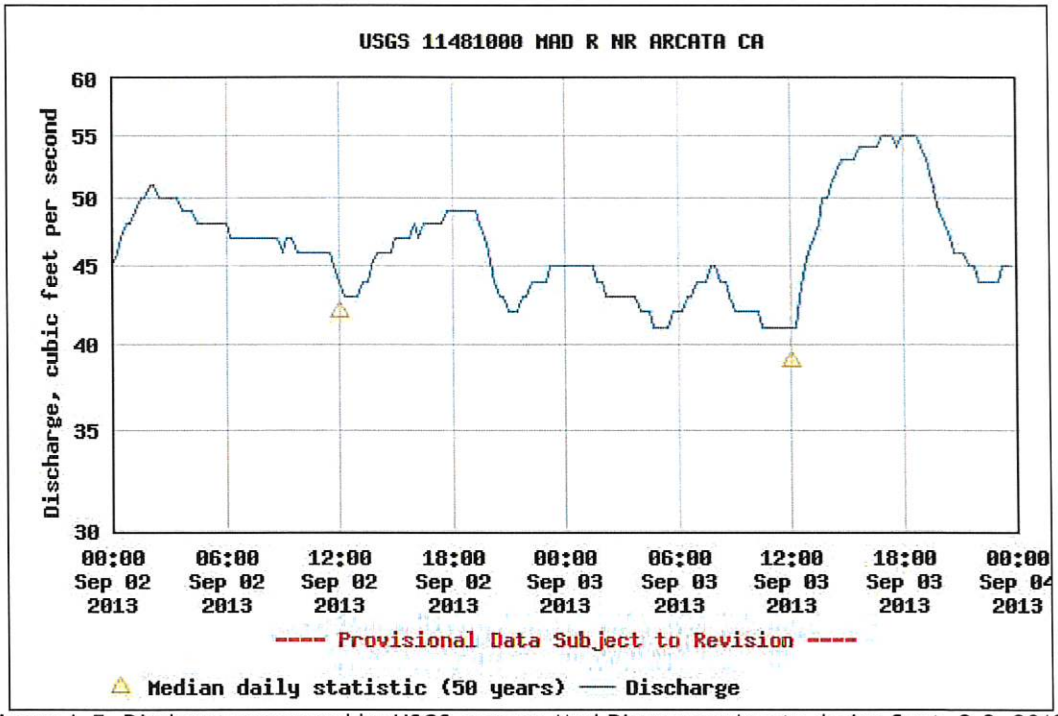


Figure A-5. Discharge measured by USGS gage on Mad River near Arcata during Sept. 2-3, 2013.

Figure A-6. Gage height measured by USGS gage on Mad River near Arcata during Sept. 2-3, 2013

Attachment B

NOAA memo re: Investigation of Mad River fluctuations below HBMWD facilities (August 2005)

Attachment 3

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region Arcata Office
1655 Heindon Road
Arcata California, 95521
Tel (707) 825-5163; Fax (707) 825-4840

In response refer to: 151422SWR99AR25
AUG 11 2005

MEMORANDUM FOR: File
Arcata Area Office

FROM: Sam A. Flanagan,
Fisheries Biologist

SUBJECT: Investigation of Mad River stage fluctuations below Humboldt Bay Municipal Water District Pumping Facilities.

On Tuesday, August 2, 2005, NMFS biologists Jim Simondet and Sam Flanagan visited the Humboldt Bay Municipal Water District's (District) Essex pumping facilities. The purpose was to follow-up on observations that river flows greater than expected under the current pumping regime were occurring on a daily basis. Data from the Arcata gage revealed river stage fluctuations on the order of 0.3 feet and flows changing by as much as 50 cfs. Of concern was the potential for stranding of salmonids due to the fluctuations in river stage. The 50 cfs range in flows is beyond the pumping capacity of the pump that is currently operating (approximately 27 cfs) and raises the additional question of how accurate the gage is at reading flows during such low flow periods.

The District arranged to have the pumps turned off when we arrived so that the river could achieve it's full flows below the Station 6 pumps. Once the pumps were turned on, flows below Station 6 would decrease. At 4:59pm, the 700 horsepower pump was turned on, thereby diverting flow into the industrial water distribution system. We visually recorded a 0.17 foot drop in stage at the Arcata gage located approximately ¼ mile below the Station 6 forebay. We did not note any appreciable exposure of formerly inundated shoreline, indicating that stranding potential was extremely low. The occurrence of these low flows, when pumping-induced stage changes are most readily observed from gage data, is also at a time when juvenile salmonids have reached sufficient size where they no longer utilize shallow margin waters for rearing habitat. Thus, our conclusion is that stranding risk under the current river flows and pumping regime is negligible.

Visual observations also suggest that the distribution of habitat types in the reach remained unchanged before and during pumping. No visual changes were apparent in the existing runs, deeper riffles and pools that salmonids would be most likely to utilize this time of year. Three photosets are attached that show the river conditions while the pumps are turned off and during pumping when the river stage was approximately 0.17 feet lower.

Photo taken prior to drawdown at 5:05pm. River stage 4.48. Note partially inundated gravels in upper left.

Photo taken with river stage 0.17 feet below previous photo at 5:32 pm. River stage 4.31. Note partially inundated gravels in upper left for comparison.

Photo set attempting to illustrate change in conditions prior to pumps turned on (top), and with 700hp pump operating (bottom).

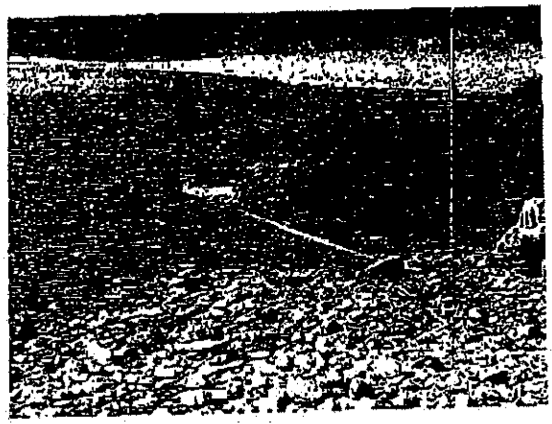


Photo set taken approximately 150m downstream of station 6 at tail of bedrock pool. Top photo is with pump off and bottom photo is with 0.18 foot drop in stage with pump on. Note slightly greater exposure in gravels between shore and log. Stick was placed at approximate waters edge prior to pumping.

Attachment C

Cross Section Photographs

Figure C-1. Cross-section #1. Water surface elevation changed ≈ 2 inches. Width changed 2.2 ft out of ≈ 80 ft (2.7 %).

Figure C-2. Cross-section #2. Water surface elevation changed ≈ 1 inch. Width changed 1.7 ft out of ≈ 100 ft (1.7%).

Figure C-3. Cross-section #3. Water surface elevation changed ≈ 1 inch. Width changed 0.9 ft out of ≈ 40 ft (2.1%).

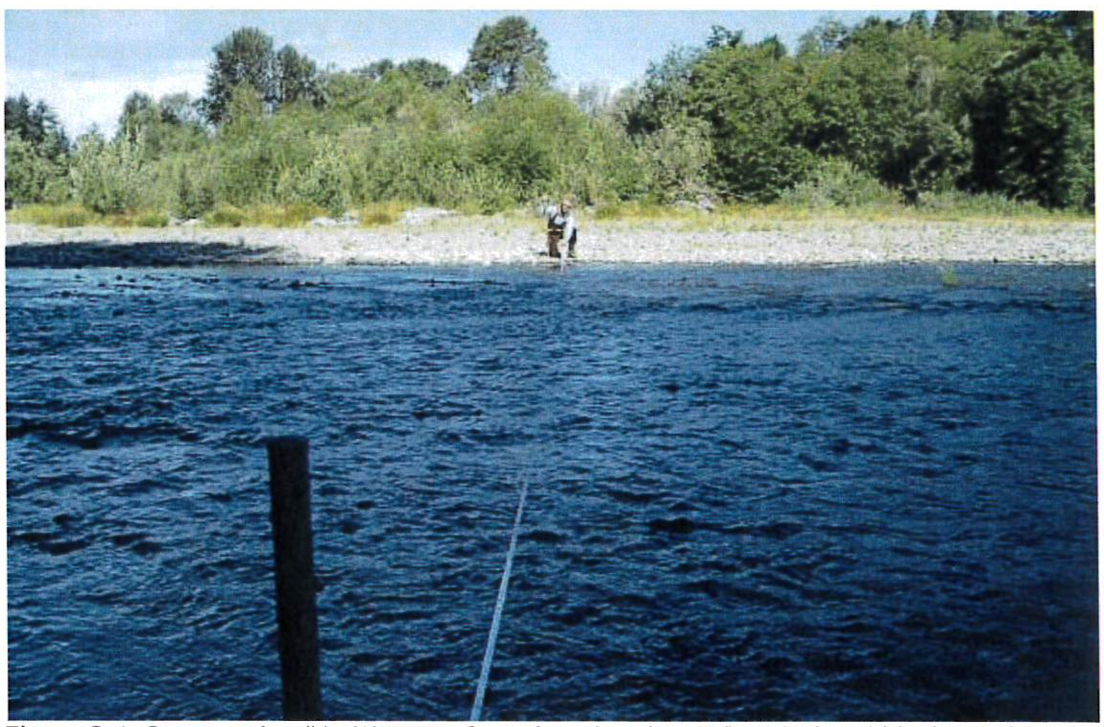


Figure C-4. Cross-section #4. Water surface elevation changed ≈ 1 inch. Width changed 1.1 ft out of ≈ 70 ft (1.6%).

APPENDIX F – Consumptive Use and Injury Analysis Tech Memo February 2020 and eWRIMS table

February 25, 2020

To:	John Friedenbach	Ref. No.:	11185389
From:	Pat Kaspari and Richela Maeda	Tel:	707-443-8326
cc:	Sheri Woo, Michelle Fuller, Sharon Kramer, Dennis Halligan, Patrick Sullivan		
Subject:	**Water Right Injury Analysis**		

1. Introduction

The Humboldt Bay Municipal Water District (District) is a regional water wholesaler capable of delivering both potable water (through its Domestic Water System) and untreated surface water (through its Industrial Water System). The District owns and operates R.W. Matthews Dam, which forms Ruth Reservoir in southern Trinity County, and a diversion, pumping, and control facility adjacent to the Mad River near Essex at the John R. Winzler Operations and Control Center (Essex Facility). Water is diverted via four Ranney Collectors and a surface water intake at the Essex Facility, approximately 75 miles downstream of the dam. Water collected in the Ranney Collectors is treated and distributed to the District's 88,000 customers. Water from the surface water intake is pumped via the Industrial Water System to the Samoa Peninsula where it previously served two pulp mills that have subsequently closed.

The District provides augmented flows to the Mad River under their 2004 Habitat Conservation Plan (HCP) (Trinity Associates and HBMWD 2004). The District is seeking to modify its appropriative water right to include an instream flow dedication to the Mad River that provides improved environmental benefits. The HCP would also be amended to reflect the instream flow dedication., Unlike typical Petitions for Change that seek to remove water from a source, the District's Petition for Change proposes to dedicate a portion of its water right to instream flow. The objective of this study is to assess the current factors that influence the Mad River hydrograph, and the potential impacts the District's flow dedication may have on other legal users. Potential environmental impacts of the District's flow dedication are assessed in other reports (H. T. Harvey & Associates and Stillwater Sciences 2019, HBMWD and Stillwater Sciences 2014). Again, unlike typical Petitions for Change that may prevent a current water user from utilizing their full water right, this report looks at how the proposed additional flows could enhance other Mad River water rights holders.

2. Hydrology of the Mad River Watershed

The Mad River drainage, shown in Figure 1, is located in the coastal range of California, approximately 270 miles north of San Francisco. The drainage area is approximately 485 square miles in area, approximately 100 miles long, and averages six miles in width. The headwaters of the watershed start at the western ridge of the coastal range with a divide at approximately 6,000 ft above mean sea level. The Mad River flows from southeasterly to northwesterly and discharges into the Pacific Ocean north of Humboldt Bay. Principal tributaries to the Mad River include South Fork Mad River, North Fork Mad River, Barry Creek, Pilot Creek, Deer Creek, Lindsey Creek, and Mill Creek. Vegetation in the watershed is composed of early to late seral coniferous forests, hardwoods, and grasslands (Stillwater Sciences 2010).

Mean annual rainfall in the Mad River watershed averages from 40 inches along the coast to over 120 inches in the higher elevations. Most rainfall occurs in the late fall, through winter, and into the middle of spring. Snowfall occurs but its storage and melting are not considerable hydrograph components. Due to the conditions of the watershed, it can be characterized as flashy, whereby rainfall events within the watershed quickly result in surface water flow. Likewise, the surface water flow can decline relatively quickly following the passing of a storm event.

Paper Size ANSI A

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Map Projection: Lambert Conformal Conic
Horizontal Datum: North American 1983
Grid: NAD 1983 StatePlane California I FIPS 0401 Feet

GHD

Humboldt Bay Municipal Water District
Injury Analysis

Mad River Watershed

Project No. 11185389
Revision No. -
Date 7/10/2019

FIGURE 1

\\ghdnet\ghd\US\Eureka\Projects\111\11185389 HBMWD-WCB Stream Flow Enhance Grant\08-GIS\Maps\Deliverables\11185389_001_StudyArea_RevB.mxd
Print date: 08 Jan 2020 - 14:46

Data source: Sources: Esri, USGS, NOAA
Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community. Created by: rmaeda

3. Historical Operations and Practices

The District was chartered in 1956 to provide water to several lower Mad River communities for both domestic and industrial use. In 1961, Matthews Dam and Ruth Lake were constructed in the upper reach of the Mad River. The District currently manages this source as a water supply reservoir and conducts releases from Matthews Dam in response to reservoir levels, municipal and industrial water supply needs, hydropower generation and to meet environmental goals. Prior to the District's operations, portions of the Mad River would regularly go dry in the later summer and fall (Trinity Associates and HBMWD 2004). Releases from Ruth Lake now augment flows in 84 miles of the river, and enhances habitat for aquatic species during the low-flow months (Trinity Associates and HBMWD 2004). Since the District began its operations, flows in the Mad River have been consistent and reliable year-round, and flow augmentation (i.e., discharge from Matthews Dam is greater than inflow to Ruth Reservoir) has occurred in every month except December when the reservoir is filling, as shown in Figure 1, which compares flows above and below Ruth Lake from 1989 to 2001 (Trinity Associates and HBMWD 2004).

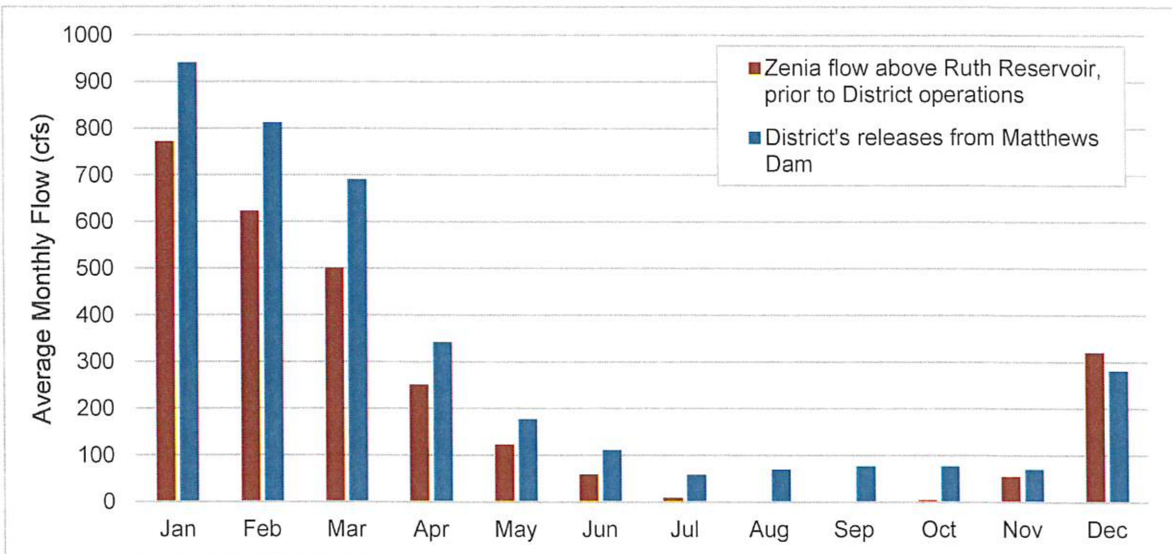

Figure 2. Mad River flow below Matthews Dam compared to natural flow (adapted from Trinity Associates and HBMWD 2004)

The Mad River drainage saw its largest logging boom in the mid-1900s (Stillwater Sciences 2010) with the harvesting of second-growth trees. During the late 1980s and early 1990s, the District's industrial water system supplied up to 60 MGD of untreated water to two pulp mills. Delivery continued at this rate until one of the pulp mills closed in the 1990s, and the remaining pulp mill ceased operation in 2009. With no existing industrial customers, the District has the capability of supporting future water supply needs, which they are currently exploring concurrently with dedicating a portion of the 60 MGD to instream flow to benefit the Mad River's aquatic and terrestrial environment.

4. Current Flow Rates

This section looks at the current flows in the Mad River since the closure of the pulp mills (from 2010 to 2018) in order to analyze the District's impact to the hydrology of the Mad River. The District has a Habitat Conservation Plan (HCP) for its operations on the Mad River; it is the first HCP from a water district in the state of California. The HCP categorizes water years as "Drier-than-Normal", "Normal", and "Wetter-than-Normal" based on the volume of water at the Arcata gage for a given water year (gage location shown in Figure 1). Classification definitions are shown in Table 1. Consistent with the HCP, flow data for current operational years was first assessed by identifying each water year as one of the indicated classifications. Figure 3 shows the hydrographs during dry months for the minimum, median, and maximum water year types (defined by the total annual flow at the Arcata gage). Minimum, median and maximum water years are shown instead of the HCP classifications because of the small dataset available. Hydrographs for the remaining portion of the year are provided in Exhibit A.

Table 1. Water Year Classification for the Mad River Watershed (adapted from Trinity Associates and HBMWD 2004).

Classification	Annual Flow (acre-ft)		
	Min	Average	Max
Drier-than-Normal	0	488,629	750,000
Normal	750,000	1,034,350	1,200,000
Wetter-than-Normal	1,200,000	1,434,857	1,794,000

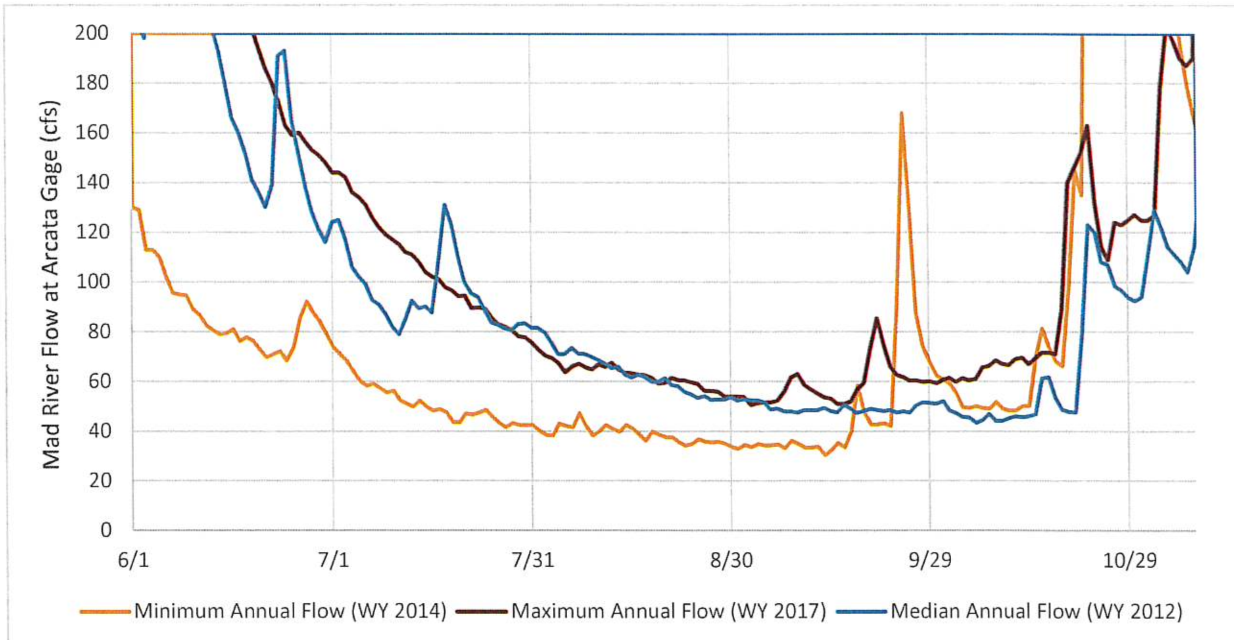

Figure 3. Summer Mad River flow at the Arcata gage for minimum, maximum and average water years from 2010 to 2018.

Annual hydrographs show temporal trends within a specific year but do not capture variability in monthly and daily flows across water years. The minimum water year defined by total annual flow shown in Figure 3 depicts flow rates for a low-flow year (2014), but may not capture the absolute minimum daily flows for the data record evaluated (2010-2018). Similarly, averaging the data does not provide useful insights when the goal of the analysis is to consider possible effects of District operations that are more nuanced. Only water years beginning with water year 2010 were used to reflect conditions following closure of the pulp mills.

To capture these nuances, and provide visualization of the dataset's variability, data was evaluated based on quartiles (Figure 4). Quartiles capture the deviation across a dataset by dividing the values into quarters. Quartiles can then be graphically represented. The gray-blue-red-gray segments of each line represent quartiles of the daily flow data. The ends of the gray quartile segments show the minimum and maximum values. Longer gray-blue-red-gray lines indicate a larger spread in the data. Where the blue and red segments meet represents the median value. Where the gray meets the red, and gray meets blue segments, indicates the first and third quartiles of the daily flow data. To more easily see the lower flow lines, the graph is reproduced with an expanded y axis in Figure 5.

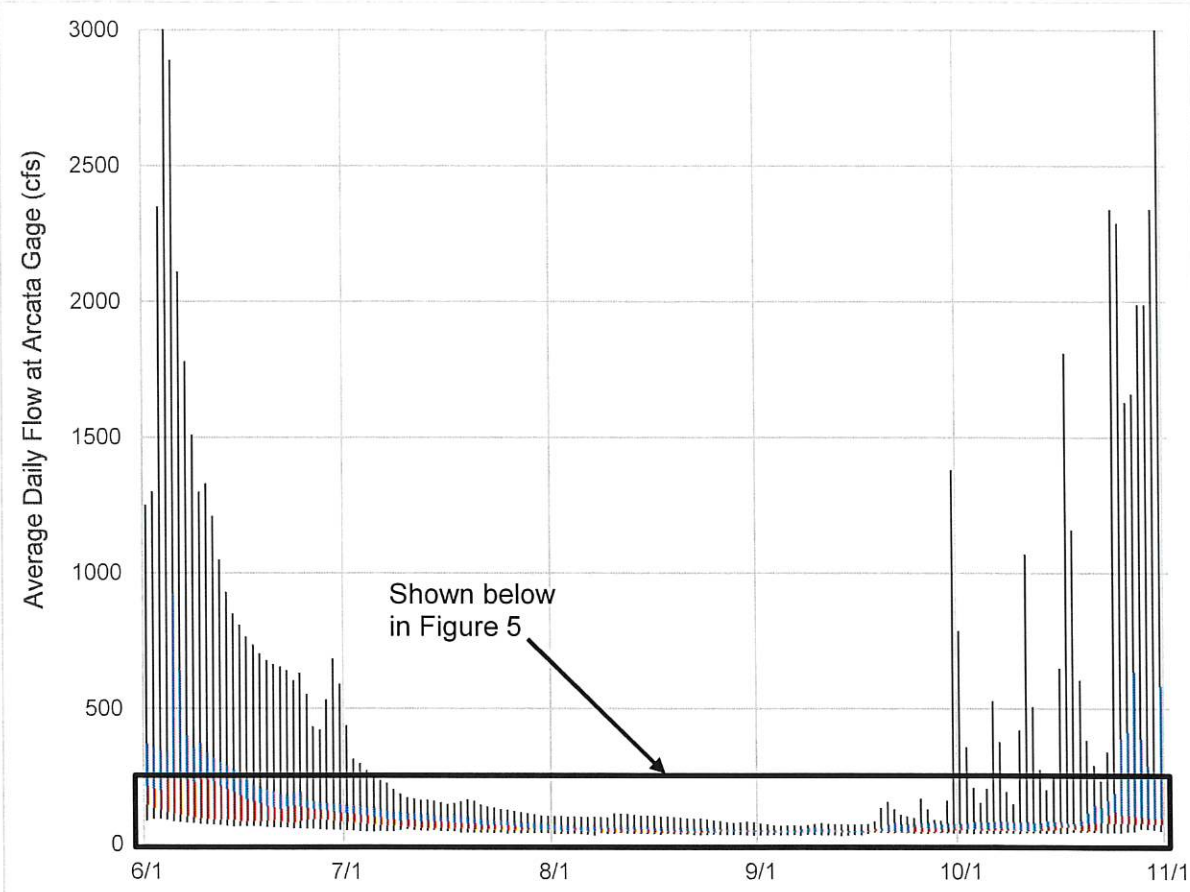

Figure 4. Representation of variation in average daily flow (cfs) during the summer at the Arcata Gage, for WY 2010 to 2018. Where red and blue segments meet is the median of the average daily flows. The ends of gray segments represent the minimum and maximum average daily flows.

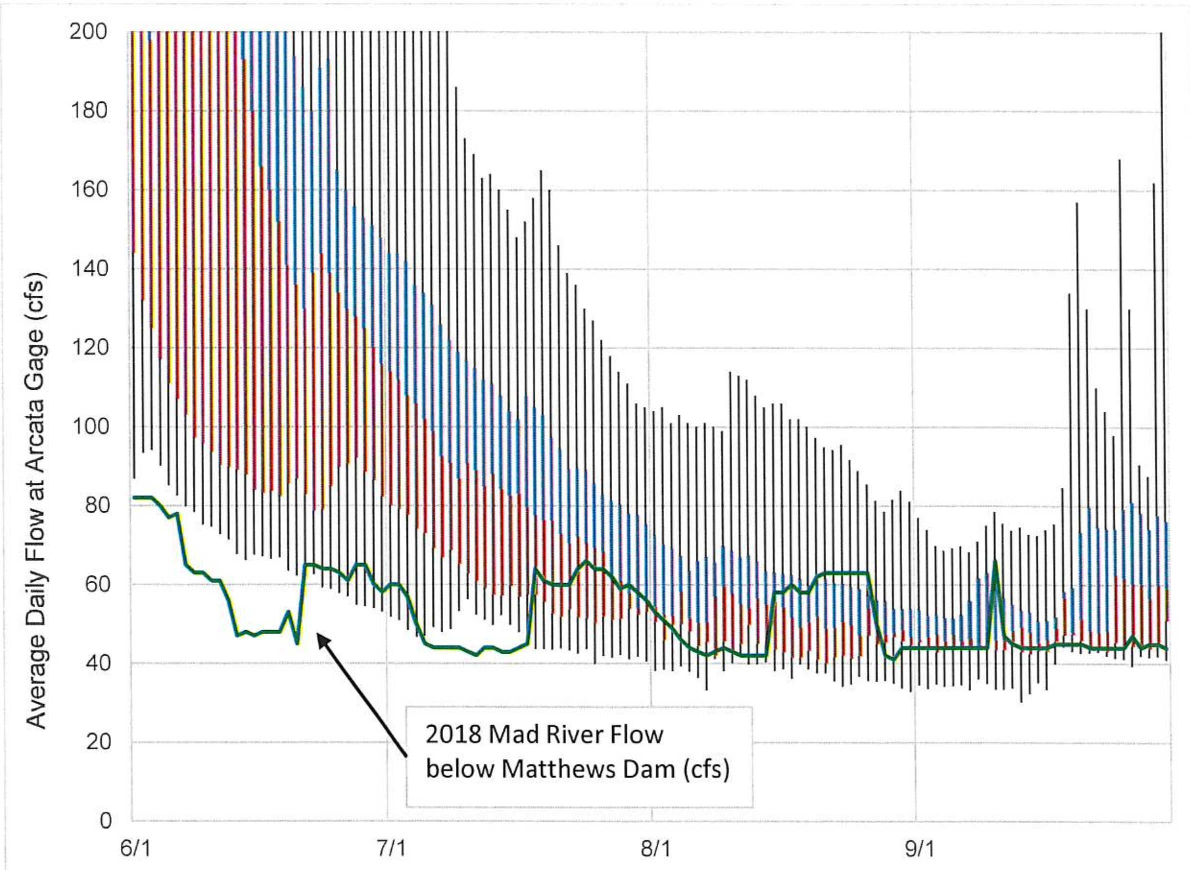

Figure 5. Representation of variation in average daily flow (cfs) with adjusted vertical access, for WY 2010 to 2018. Where red and blue segments meet is the median of the average daily flows. The ends of gray segments represent the minimum and maximum average daily flows.

Figure 5 demonstrates that, under current conditions, the Mad River does not "go dry" during the lowest flow months and is therefore not currently over-extracted. Anecdotal evidence suggests that Mad River would go dry prior to the District's operations. Flow below Matthews Dam (shown in green in Figure 5), even without instream flow dedications is an important flow component during summer months.

5. Extractions in the Mad River Watershed

Two primary data sources of extractions in the Mad River watershed were considered in this study: water rights available as detailed in the State Water Resources Control Board (SWRCB) Electronic Water Rights Information Management System (eWRIMS) database, and extraction data provided by the District.

Water rights within the Mad River watershed were obtained through the SWRCB's eWRIMS. eWRIMS provides a summary of submitted water rights applications in table or geospatial information systems

(GIS) format. The original water rights applications and Statements of Diversion and Use are also available through eWRIMS.

We also considered but ultimately did not include a dataset that characterizes both legal and illegal cannabis cultivation sites. Staff from CDFW conducted extensive research on the impacts of cannabis cultivation on streamflow in northwestern California (Bauer et al., 2015). In an assessment of the Mad River watershed, CDFW used high-resolution imagery from May 2014 to locate and digitize cannabis cultivation sites. Because imagery was used, the study did not discern which sites were legal or illegal. The results from the CDFW assessment provided the total number of cannabis plantings within the Mad River watershed and amounted to approximately 0.53 cfs of diversion (primarily from tributary streams) during the summer months. As shown in Figure 5, this is an additional stress on the river flows during the summer months, which the District's flow dedications will help mitigate. Because this analysis focuses on legal water users, the data developed by Bauer et al. (2015) were not included. Legal cannabis cultivators that have applied for water rights from the Mad River are included in the eWRIMS database and therefore captured in this study.

5.1 Data Gap Analysis

As of January 7, 2019, 473 points of diversion were listed in the eWRIMS database, which is the dataset used in this analysis. However, it should be noted that a search completed on February 26, 2019 returned eight new registered cannabis water rights. To evaluate the completeness of the eWRIMS database, the theoretical maximum number of parcels that could hold a riparian water right was estimated. Of the approximate 1,960 parcels that touch a National Hydrology Dataset flow line for the Mad River or a tributary to the Mad River and could therefore hold a riparian water right, approximately 200 parcels, or 10%, have a point of diversion in eWRIMS. Of the available data in eWRIMS, approximately 30% of the points of diversion were missing key data (e.g., diversion rates) required to complete a consumptive use analysis.

5.2 Data Reliability Analysis

The data listed in eWRIMS for approximately fifteen water rights were compared to the original water rights applications or statements. Based on these comparisons, and an overall evaluation of the eWRIMS data, the following observations and discrepancies, and resulting conservative assumptions were made:

- The window for which direct diversion is allowed was provided in the original application, but was not included in eWRIMS for one of the water rights. When diversion windows of time are not specified in eWRIMS, it was assumed that the diversion rate applies uniformly to the entire year.
- The diversion rate in eWRIMS did not match that of the original application for two water rights. For one water right, the value in eWRIMS was an order of magnitude less than shown in the application. For the second, the eWRIMS value was 10 GPD greater than shown in the application. It was assumed that the diversion rates listed in the eWRIMS database is correct; it is beyond the scope of this project to crosscheck all of the water rights.
- The diversion rate in eWRIMS was set to the maximum capacity of the diversion works (i.e., the diversion rate listed in eWRIMS assumes that the water right holder is constantly diverting the

maximum amount of water that their diversion system allows). If a diversion rate was listed in eWRIMS, it was used in the analysis.

- The majority of riparian water rights do not include dates for diversion. It was assumed that these users divert water during the entire year.
- Several riparian water rights did not have values specified for diversion. The original statements for two of these water rights included either a diversion rate and/or maximum storage capacity. For riparian water rights that do not have values specified for diversion, water use data were manually gathered from original statements of use.

5.3 Data Analyzed

The District provided their 2018 daily extraction rates; these values were used for the analysis. Of the 473 points of diversion included in the initial eWRIMS results, 304 water rights were included in this consumptive use analysis. The points of diversion excluded from the analysis were either duplicative, inactive, or not located within the reach of interest (between Ruth Lake and the Essex Facility). Key information associated with each of the water rights is included as Exhibit B.

6. Results and Discussion

Diversion and consumption rates gathered from the District were used as provided. Diversion rates from eWRIMS were applied for each month dependent upon the diversion window. Some of the water rights included a maximum diversion volume (i.e., face value). If the diversion rate over the course of the analysis period exceeded the maximum diversion volume, it was assumed that the maximum diversion volume was evenly distributed over the course of the analysis. It is important to note two caveats that could significantly overestimate the amount of water diverted:

1. Many of the diversion rates obtained from eWRIMS represent the maximum possible amount of water that could be diverted by a water rights holder. It is likely that many of these water rights holders divert less water.
2. Figure 6 shows flow data from the Arcata gage, which is located downstream of the extractions included in this analysis. Comparison of the Arcata gage flow with the extractions essentially "double counts" the extractions.

The purpose of this analysis was to evaluate the potential impacts the District's proposed flow dedication may have on other legal water users. It should be noted that a mass balance analysis was considered, but there is insufficient flow monitoring data available to perform a detailed mass balance. Inflow data is only available from above Matthews Dam at Zenia, and at the Arcata gage at the downstream end of the Mad River (downstream of all diversions). Flow contribution from all the major tributaries along the length is not available. A brief discussion of two components that would be included in a mass balance is provided here.

Seepage characterizes the interaction between river and groundwater flow. A stream can be a gaining or losing stream, or both depending on factors including groundwater levels, bedrock material, and flow rates. The Mad River is a bedrock-confined river and seepage is considered negligible along its mainstem.

Evaporation losses on the river surface are considered negligible; however, losses on Ruth Reservoir would likely be included in a mass balance. In its Water Shortage Contingency Plan (available upon request), the District estimated evaporation losses on Ruth Reservoir using nearby pan evaporation data (Table 2).

Table 2. Monthly and daily evaporation data

Month	Monthly (AF)	Average Daily (AF)
Jan	15,003	500
Feb	34,920	1,164
Mar	46,819	1,561
Apr	70,875	2,362
May	122,349	4,078
Jun	168,133	5,604
Jul	194,776	6,493
Aug	156,493	5,216
Sep	98,035	3,268
Oct	50,181	1,673
Nov	19,400	647
Dec	23,797	793

Estimated monthly water use for each of the water rights is included as Exhibit C. The cell shading in the table denotes how the values were determined. Cells with no shading indicate that the direct diversion provided in eWRIMS was used to determine the monthly water use.

Figure 6 shows maximum diversion rates within the Mad River watershed between the Zenia and Arcata gages during dry months. Included in the figure is the minimum daily flow rate at the Arcata gage for the water years 2010 to 2018. The minimum daily flow rates shown do not represent a specific water year type, but are provided to show the worst-case scenario. As mentioned above, the Arcata gage already accounts for the extractions shown in Figure 6. Thus, days on which the minimum daily flow at Arcata drops below the total extractions do not necessarily imply that the Mad River is over-extracted. The comparison between the minimum daily flows at Arcata with the maximum extraction rates is drawn to assess the relationship between the quantities. Taking into consideration that the District's extractions are already accounted for in the flow at the Arcata gage, Figure 6 suggests there is sufficient water available in the Mad River. Year-round extraction rates are provided in Exhibit D.

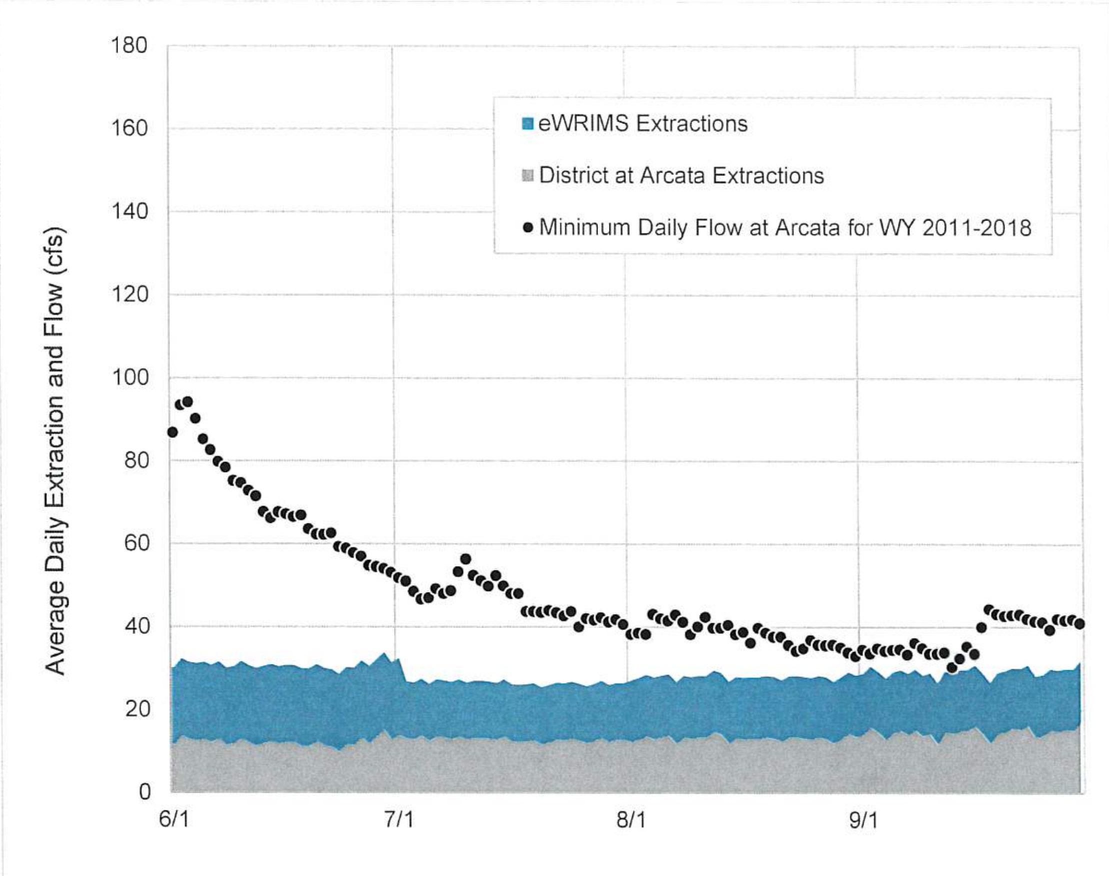

Figure 6. Daily extraction rates and instream flow comparison (cfs).

Although a true mass balance was not possible due to a lack of available data, water diverted and flow measurements were compared as a conservative analysis to demonstrate that the result of this project would not result in injury to water users senior to the District. Monthly values for water diverted, flow measurements at the Arcata Gauge (downstream of the District's diversions at the Essex Facility) and flow requirements outlined in the Habitat Conservation Plan (HCP) and the District's water rights permits are shown in Table 3a and Table 3b. In accordance with the District's permits, the District must bypass or release into the natural streambed of the Mad River immediately below the Essex diversion the minimum flows outlined below or the natural flow of the Mad River, whichever is less. The natural flow is defined by the following:

$$\text{Natural Flow at the Arcata Gauge} = \text{Inflow into Ruth Reservoir at Zenia} - \text{Flow Release at Matthews Dam} + \text{Essex Diversion} + \text{Flow at Arcata Gauge}$$

Figure 7 shows all known diverted water amounts and measured flow rates for the month of August, one of the driest months for the watershed.

Table 3a. Monthly diversion rates for the District and water rights holders senior to the District and indicated flow rates (cfs).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Senior Water Rights	0.02	0.02	0.02	0.02	0.50	0.64	0.64	0.64	0.64	0.02	0.02	0.02
HBMWD	12.1	12.7	12.2	12.4	13.1	14.6	16.1	15.7	15.0	13.5	12.8	12.2
Total	12.1	12.7	12.2	12.4	13.6	15.2	16.7	16.4	15.6	13.6	12.8	12.2
Flow at Arcata Gage	2,808	2,449	3,365	2,089	600	320	93	58	61	198	718	2,581
HCP Flow Requirements for Arcata Gauge	75	75	75	75	75	75	50	40	30	50	75	75
HCP Flow Requirement Met?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 3b. Monthly diversion rates for the District and all water rights holders and indicated flow rates (cfs).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
All Water Rights Holders	17	18	19	14	15	15	15	15	16	15	15	16
HBMWD	12.1	12.7	12.2	12.4	13.1	14.6	16.1	15.7	15.0	13.5	12.8	12.2
Total	29.1	30.5	30.8	26.1	27.9	29.2	30.9	30.8	30.8	28.7	28.3	28.4
Water at Arcata Gauge	2,808	2,449	3,365	2,089	600	320	93	58	61	198	718	2,581
HCP Flow Requirements for Arcata Gauge	75	75	75	75	75	75	50	40	30	50	75	75
HCP Flow Requirement Met?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes:
Proposed dedication (25 MGD) = 39 cfs
HCP Flow = Flow outlined in the HCP. If a single month had two different minimum flows, the higher of the two is shown.
Water Rights Holders = The total flow rate assumed to be diverted by water right holders listed in the water board's database.
Senior Water Right Holders = The total flow rate assumed to be diverted by all water right holders that are senior to the District.
HBMWD = The average flow diverted by the District.
Total = The sum of Water Right Holders and HBMWD.
Flow at Arcata Gage = Average monthly flow rate at the Arcata gage for 2010 – 2018.

Notes
1. Proposed instream flow dedication is approximately 2,300 AF per month.
2. Flow data for tributaries not available.
3. Data for the Arcata and Zenia gages are the average from 2009 to 2018.
4. Data for the District's diversion at the Essex Facility and the Matthews Dam gage is from August 2018.
5. Individual water diversions are combined based on location and are the maximum allowable water diverted defined within each water right.

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N

0 5 mi 10 mi 20 mi

1" = 10 mi

GHD

Humboldt Bay Municipal Water District

Water Diversions and Flow Measurements for the Month of August

Project No. **11185389**
Report No.
Date **1/6/2020**

FIGURE 1

Source:

Filename: N:\US\Eureka\Projects\111\11185389 HBMWD-WCB Stream Flow Enhance Grant\06-CAD\User\RKM\Injury Cartoon GeoRefd.dwg
Plot Date: 7 January 2020 - 11:35 AM

7. Concluding Remarks

Approving the District to dedicate a portion of its water right to instream flow would allow the District to provide beneficial biological conditions for salmonids and other special status species, particularly during the dry months of the year and into the fall when steelhead are present in the middle reaches. The District can release a maximum of 250 cfs from Matthews Dam, depending on the amount of water behind the dam. Once the water surface elevation in Ruth Lake drops and ceases flowing over the spillway, the District could release water to mimic or have a slower rate of hydrograph decline than would occur under existing dam operations (i.e., supplemental releases). This slower rate of decline may offset the anthropogenic reductions in tributary flows, minimize climate change-related effects, and add additional mitigation flows to help prevent the Mad River from going dry during summer months.

Because the proposed change does not remove water from the Mad River, other legal water users would not be adversely impacted by the instream flow dedication. The proposed Petition for Change may help ensure they have access to their water right. If the proposed petition for change is not accepted, the District would release less water in the dry months, which could force other legal water users downstream of the reservoir to curtail their water use, and have potential adverse effects on instream habitat and biota.

8. References

Bauer, S., Olson, J., Cockrill, A., van Hattem, M., Miller, L., Tauzer, M., and Leppig, G. (2015). Impacts of Surface Water Diversions for Marijuana Cultivation on Aquatic Habitat in Four Northwestern California Watersheds. PLoS ONE 10(3): e0120016. doi:10.1371/journal.pone.0120016.

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H. T. Harvey & Associates and Stillwater Sciences. 2019. Draft Environmental Effects Analysis of Instream Flow Dedication on Habitats and Species of the Mad River.

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Trinity Associates and HBMWD. 2004. Humboldt Bay Municipal Water District Habitat Conservation Plan for its Mad River Operations. Final Approved HCP - April 2004. Prepared for the Humboldt Bay Municipal Water District.

Exhibit A: Average Daily Flow at Arcata Gage

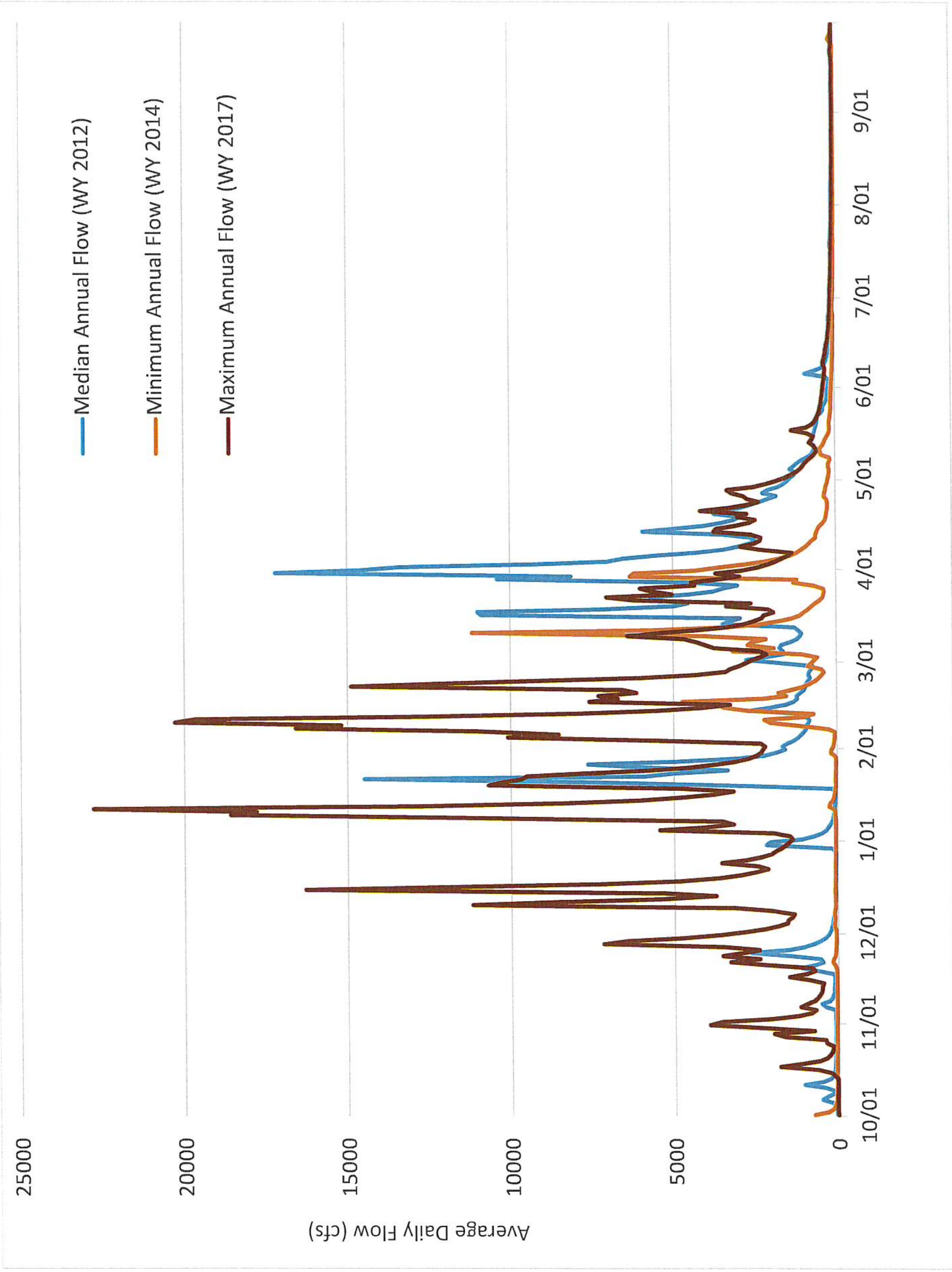
Median Annual Flow (WY 2012)
Minimum Annual Flow (WY 2014)
Maximum Annual Flow (WY 2017)
Average Daily Flow (cfs)
25000
20000
15000
10000
5000
0
10/01
11/01
12/01
1/01
2/01
3/01
4/01
5/01
6/01
7/01
8/01
9/01

Exhibit B: eWRIMS Water Rights Information

Application Number	Latitude	Longitude	Water Right Type	Pre-1914	Riparian	Acceptance Date[1]	Priority[2]	POD Direct Diversion Rate	POD Direct Diversion Rate Units	Face Value (AFY)	Direct Diversion Beg Month/ Day	Direct Diversion End Month/Day	Storage Beg Month/Day	Storage End Month/Day
A007545	40.88202722	-124.01127277	Appropriative			04/27/1933	Senior	0.12	Cubic Feet per Second	29.5	1-May	1-Sep		
A007898	40.67130193	-123.7862058	Appropriative			04/09/1934	Senior	1000.0	Gallons per Day	1.1	1-Jan	31-Dec		
A009292	40.65276019	-123.82175897	Appropriative			05/16/1938	Senior	7000.0	Gallons per Day	7.8	1-Jan	31-Dec		
A009486	40.27722089	-123.35128564	Appropriative			01/16/1939	Senior	150.0	Gallons per Day	0.1	1-May	30-Oct		
A011983	40.27722089	-123.35128564	Appropriative			07/14/1947	Senior	850.0	Gallons per Day	0.7	15-Mar	1-Dec		
A013523	40.44762334	-123.51249011	Appropriative			12/29/1949	Senior	110.0	Gallons per Day	0.1	1-Jan	31-Dec		
A014677	40.85877782	-123.99031772	Appropriative			02/14/1952	Senior	0.38	Cubic Feet per Second	116.1	1-May	1-Oct		
A015328A	40.96853905	-124.04124353	Appropriative			05/01/1953	Senior	0.05	Cubic Feet per Second	12.1	1-Jun	30-Sep		
A015328B	40.96350989	-124.04615981	Appropriative			05/01/1953	Senior	0.03	Cubic Feet per Second	7.3	1-Jun	30-Sep		
A015328C	40.96267382	-124.04685845	Appropriative			05/01/1953	Senior	0.01	Cubic Feet per Second	2.4	1-Jun	30-Sep		
A015328D	40.95717906	-124.04705118	Appropriative			05/01/1953	Senior	0.04	Cubic Feet per Second	9.7	1-Jun	30-Sep		
A015328E	40.95634939	-124.04738777	Appropriative			05/01/1953	Senior	0.01	Cubic Feet per Second	2.4	1-Jun	30-Sep		
A015336	40.45264894	-123.5061345	Appropriative			05/11/1953	Senior	2200.0	Gallons per Day	2.5	1-Jan	31-Dec		
A015997	40.76246832	-123.88867614	Appropriative			08/13/1954	Senior	100.0	Gallons per Day	0.1	1-Apr	1-Nov		
A016562	40.43531713	-123.48777905	Appropriative			08/31/1955	Senior	500.0	Gallons per Day	0.6	1-Jan	31-Dec		
A017510	40.4342239	-123.48739544	Appropriative			3/14/1957	Junior	150.0	Gallons per Day	0.2	1-Jan	31-Dec		
A017540	40.4342239	-123.48739544	Appropriative			04/04/1957	Junior	100.0	Gallons per Day	0.1	1-Jan	31-Dec		
A017552	40.74436383	-123.87083458	Appropriative			04/17/1957	Junior	1500.0	Gallons per Day	1.7	1-Jan	31-Dec		
A017824	40.40068589	-123.46941264	Appropriative			09/16/1957	Junior	400.0	Gallons per Day	0.5	1-Jan	31-Dec		
A017996	40.86259794	-123.99169789	Appropriative			02/11/1958	Junior	0.41	Cubic Feet per Second	78	1-May	1-Oct		
A018206	40.88808944	-124.0413047	Appropriative			07/02/1958	Junior	0.03	Cubic Feet per Second	11	1-May	1-Nov		
A019466	40.3277295	-123.35194507	Appropriative			06/01/1960	Junior	0.047	Cubic Feet per Second	14.4	1-Jan	31-Dec		
A019919	40.98033221	-124.02638964	Appropriative			01/13/1961	Junior	4425.0	Gallons per Day	2.8	1-Jan	31-Dec	1-Nov	30-Apr
A022694	40.66169315	-123.83840817	Appropriative			01/31/1967	Junior	100.0	Gallons per Day	0.1	1-Jan	31-Dec		
A023034	40.32675587	-123.38743846	Appropriative			04/25/1968	Junior	500.0	Gallons per Day	0.6	1-Jan	31-Dec		
A023209	40.916383	-124.044818	Appropriative			01/16/1969	Junior	600.0	Gallons per Day	0.7	1-Jan	31-Dec		
A023957	40.9549988	-123.88473771	Appropriative			01/04/1972	Junior	8300.0	Gallons per Day	5.2	1-Jan	31-Dec		
A027463	40.62125718	-123.73730213	Appropriative			07/30/1982	Junior	700.0	Gallons per Day	0.1	1-Jan	31-Dec		
C005478	40.91234182	-123.95681609	Stockpond			12/29/1997	Junior	0.0	Gallons per Day	4			1-Jan	31-Dec
C005479	40.90876859	-123.97317746	Stockpond			12/29/1997	Junior	0.0	Gallons per Day	7			1-Jan	31-Dec
C005480	40.92373557	-123.96493449	Stockpond			12/29/1997	Junior	0.0	Gallons per Day	6			1-Jan	31-Dec
C005481	40.90881106	-123.95454067	Stockpond			12/29/1997	N/A	0.0	Gallons per Day	3			1-Jan	31-Dec
C005482	40.9146499	-123.95833183	Stockpond			12/29/1997	N/A	0.0	Gallons per Day	3			1-Jan	31-Dec
D030029	40.39884559	-123.44136172	Registration Domestic			11/04/1991	N/A	1350.0	Gallons per Day	1.2	1-Jan	31-Dec		
D030274	40.33848913	-123.37063926	Registration Domestic			08/11/1993	N/A	294.0	Gallons per Day	0.3	1-Jan	31-Dec		
D030576	40.86220786	-123.99837678	Registration Domestic			09/19/1996	N/A	3000.0	Gallons per Day	1.5	1-Jan	31-Dec		
D030651	40.51660423	-123.55433135	Registration Domestic			10/10/1997	N/A	4500.0	Gallons per Day	10	1-Jan	31-Dec	1-Nov	30-Apr
D030716	40.32292186	-123.35220681	Registration Domestic			06/17/1998	N/A	4500.0	Gallons per Day	2.5	1-Jan	31-Dec		
D030783	40.34929582	-123.4298895	Registration Domestic			10/02/1998	N/A	4500.0	Gallons per Day	3	1-Jan	31-Dec		
D030816	40.40293109	-123.44396358	Registration Domestic			11/23/1998	N/A	4500.0	Gallons per Day	5	1-Jan	31-Dec		
D030916	40.5165	-123.5547	Registration Domestic			07/01/1999	N/A	400.0	Gallons per Day	0.5	1-Jan	31-Dec		
F003655C	40.52189539	-123.52244563	Federal Stockponds			05/05/1982	N/A	0.0	Gallons per Day	0.21			1-Oct	30-Jun
F003659C	40.49390256	-123.56244595	Federal Stockponds			05/05/1982	N/A	0.0	Gallons per Day	0.28			1-Oct	30-Jun
F003977S	40.36964119	-123.40537671	Federal Claims			10/23/1967	N/A	360.0	Gallons per Day	0.19	1-May	31-Oct		
F003978S	40.36664832	-123.40316033	Federal Claims			1/1/1967	N/A	720.0	Gallons per Day	0.39	1-May	31-Oct		
F003980S	40.41275439	-123.49158786	Federal Claims			01/01/1967	N/A	2880.0	Gallons per Day	0.215	1-May	31-Oct		
F003990S	40.40318604	-123.46713313	Federal Claims			01/01/1967	N/A	2000.0	Gallons per Day	1.22	1-May	15-Nov		
F003992S	40.34167525	-123.40227868	Federal Claims			01/01/1967	N/A	2000.0	Gallons per Day	0.94	1-May	30-Sep		
F003993S	40.39074621	-123.43041545	Federal Claims			01/01/1967	N/A	720.0	Gallons per Day	0.37	15-May	31-Oct		

[1]Acceptance date not available for Registration Cannabis water rights
[2]Priority date not applicable for riparian and pre-1914 water rights

Application Number	Latitude	Longitude	Water Right Type	Pre-1914	Riparian	Acceptance Date[1]	Priority[2]	POD Direct Diversion Rate	POD Direct Diversion Rate Units	Face Value (AFY)	Direct Diversion Beg Month/ Day	Direct Diversion End Month/Day	Storage Beg Month/Day	Storage End Month/Day
F007913S	40.52936471	-123.53880751	Federal Claims			01/01/1972	N/A	350.0	Gallons per Day	0.18	16-May	31-Oct		
F007921S	40.40179181	-123.4900867	Federal Claims			01/01/1972	N/A	500.0	Gallons per Day	0.269	10-May	31-Oct		
F007923S	40.34788767	-123.3767522	Federal Claims			01/01/1972	N/A	500.0	Gallons per Day	0.269	10-May	31-Oct		
F010768S	40.40649927	-123.44404053	Federal Claims			03/16/1982	N/A	450.0	Gallons per Day	0.157	1-May	31-Oct		
H500272	40.2237	-123.3058	Registration Cannabis				-	10.0	Gallons per Minute	1.89	1-Nov	31-Mar	1-Nov	31-Mar
H500321	40.4435	-123.4971	Registration Cannabis				-	10.0	Gallons per Minute	0.18	1-Nov	31-Mar	1-Nov	31-Mar
H500465	40.9695	-124.0843	Registration Cannabis				-	10.0	Gallons per Minute	0.2	1-Nov	31-Mar	1-Nov	31-Mar
H500552	40.375	-123.44	Registration Cannabis				-	10.0	Gallons per Minute	0.12	1-Nov	31-Mar	1-Nov	31-Mar
H500602	40.5126	-123.5612	Registration Cannabis				-	10.0	Gallons per Minute	0.2	1-Nov	31-Mar	1-Nov	31-Mar
H500642	40.5124	-123.6358	Registration Cannabis				-	10.0	Gallons per Minute	0.17	1-Nov	31-Mar	1-Nov	31-Mar
H500670	40.4531	-123.5027	Registration Cannabis				-	10.0	Gallons per Minute	0.57	1-Nov	31-Mar	1-Nov	31-Mar
H500711	40.4384	-123.4918	Registration Cannabis				-	10.0	Gallons per Minute	0.46	1-Nov	31-Mar	1-Nov	31-Mar
H500712	40.6039	-123.6807	Registration Cannabis				-	10.0	Gallons per Minute	0.17	1-Nov	31-Mar	1-Nov	31-Mar
H500771	40.53453663	-123.64212431	Registration Cannabis				-	0.0		0.75	1-Nov	31-Mar	1-Nov	31-Mar
H500793	40.75599067	-123.88611358	Registration Cannabis				-	0.0		0.05	1-Nov	31-Mar	1-Nov	31-Mar
H500815	40.5245	-123.6454	Registration Cannabis				-	10.0	Gallons per Minute	0.12	1-Nov	31-Mar	1-Nov	31-Mar
H500854	40.4397	-123.4927	Registration Cannabis				-	10.0	Gallons per Minute	0.28	1-Nov	31-Mar	1-Nov	31-Mar
H500868	40.6558	-123.8537	Registration Cannabis				-	0.0		0.59	1-Nov	31-Mar	1-Nov	31-Mar
H500877	40.8638	-123.9191	Registration Cannabis				-	10.0	Gallons per Minute	1.45	1-Nov	31-Mar	1-Nov	31-Mar
H502014	40.7205	-123.7666	Registration Cannabis				-	10.0	Gallons per Minute	0.4	1-Nov	31-Mar	1-Nov	31-Mar
H502019	40.1479	-123.2129	Registration Cannabis				-	10.0	Gallons per Minute	0.18	1-Nov	31-Mar	1-Nov	31-Mar
H502200	40.515822	-123.55419	Registration Cannabis				-	10.0	Gallons per Minute	0.48	1-Nov	31-Mar	1-Nov	31-Mar
H502323	40.5147	-123.6462	Registration Cannabis				-	10.0	Gallons per Minute	0.54			1-Jan	31-Dec
H502385	40.5475	-123.565	Registration Cannabis				-	10.0	Gallons per Minute	0.27	1-Nov	31-Mar	1-Nov	31-Mar
H502425	40.24423852	-123.31861288	Registration Cannabis				-	0.0		0.63	1-Nov	31-Mar	1-Nov	31-Mar
H502514	40.7196	-123.904	Registration Cannabis				-	10.0	Gallons per Minute	0.77	1-Nov	31-Mar	1-Nov	31-Mar
H503581	40.584	-123.6293	Registration Cannabis				-	10.0	Gallons per Minute	0.18	1-Nov	31-Mar	1-Nov	31-Mar
H504249	40.601169	-123.690375	Registration Cannabis				-	10.0	Gallons per Minute	0.18	1-Nov	31-Mar	1-Nov	31-Mar
H504313	40.448317	-123.501399	Registration Cannabis				-	10.0	Gallons per Minute	0.12	1-Nov	31-Mar	1-Nov	31-Mar
H504319	40.440207	-123.489497	Registration Cannabis				-	10.0	Gallons per Minute	0.06	1-Nov	31-Mar	1-Nov	31-Mar
H504422	40.511523	-123.628245	Registration Cannabis				-	10.0	Gallons per Minute	0.34			1-Jan	31-Dec
H504601	40.667644	-123.865233	Registration Cannabis				-	10.0	Gallons per Minute	0.21	1-Nov	31-Mar	1-Nov	31-Mar
H504663	40.510906	-123.636565	Registration Cannabis				-	10.0	Gallons per Minute	0.61	1-Nov	31-Mar	1-Nov	31-Mar
H505143	40.85407373	-123.91326389	Registration Cannabis				-	0.0		0.23	1-Nov	31-Mar	1-Nov	31-Mar
H505373	40.505901	-123.575507	Registration Cannabis				-	10.0	Gallons per Minute	0.41	1-Nov	31-Mar	1-Nov	31-Mar
S003981	40.40649927	-123.44404053	Statement of Div and Use		Y	01/01/1967	N/A	0.0	Gallons per Day	0	1-May	31-Oct		
S004938	40.85828126	-124.00314079	Statement of Div and Use		Y	01/01/1970	N/A	0.0	Gallons per Day	0	1-May	30-Sep		
S007914	40.52104335	-123.52458485	Statement of Div and Use		Y	01/01/1972	N/A	0.0	Gallons per Day	0	16-May	31-Oct		
S007925	40.49390256	-123.56244595	Statement of Div and Use		Y	01/01/1972	N/A	0.0	Gallons per Day	0	1-May	31-Oct		
S008799	40.66709548	-123.79186228	Statement of Div and Use	Y	Y	05/26/1976	N/A	0.044	Cubic Feet per Second	0	1-Jan	31-Dec		
S010329	40.27622422	-123.34266286	Statement of Div and Use		Y	05/13/1981	N/A	0.0	Gallons per Day	0	1-Jan	31-Dec		
S010387	40.27675214	-123.34446567	Statement of Div and Use		Y	05/29/1981	N/A	300.0	Gallons per Day	0	1-Jan	31-Dec		
S010424	40.27649029	-123.34338508	Statement of Div and Use		Y	06/23/1981	N/A	150.0	Gallons per Day	0				
S011457	40.29163232	-123.36304891	Statement of Div and Use		Y	01/22/1985	N/A	400.0	Gallons per Day	0	1-Jan	31-Dec		
S012962	40.85494521	-123.98966055	Statement of Div and Use		Y	03/30/1987	N/A	30.0	Cubic Feet per Second	0	1-Jan	31-Dec		
S015530	40.32931641	-123.41764909	Statement of Div and Use	Y		06/25/2004	N/A	0.07	Cubic Feet per Second	0	1-May	31-Oct		
S016794	40.4075	-123.4724	Statement of Div and Use		Y	04/19/2012	N/A	0.0	Acre-feet per Year	0				
S017691	40.8762	-123.9734	Statement of Div and Use		Y	04/19/2012	N/A	0.042	Cubic Feet per Second	0				
S017892	40.4549	-123.51	Statement of Div and Use		Y	05/18/2012	N/A	0.009	Cubic Feet per Second	0				

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Application Number	Latitude	Longitude	Water Right Type	Pre-1914	Riparian	Acceptance Date[1]	Priority[2]	POD Direct Diversion Rate	POD Direct Diversion Rate Units	Face Value (AFY)	Direct Diversion Beg Month/ Day	Direct Diversion End Month/Day	Storage Beg Month/Day	Storage End Month/Day
S018254	40.4091	-123.4764	Statement of Div and Use		Y	07/03/2012	N/A	0.011	Cubic Feet per Second	0				
S019715	40.4121	-123.4738	Statement of Div and Use		Y	01/27/2012	N/A	0.0	Cubic Feet per Second	0				
S019894	40.9186	-124.0445	Statement of Div and Use		Y	02/02/2012	N/A	0.1	Cubic Feet per Second	0				
S019897	40.9181	-124.044	Statement of Div and Use		Y	02/02/2012	N/A	0.0	Cubic Feet per Second	0				
S019940	40.4551	-123.5096	Statement of Div and Use		Y	07/11/2012	N/A	0.004	Cubic Feet per Second	0				
S020162	40.9408	-123.8763	Statement of Div and Use		Y	02/15/2012	N/A	0.11	Cubic Feet per Second	0				
S020233	40.6956	-123.8631	Statement of Div and Use		Y	02/10/2012	N/A	0.06	Cubic Feet per Second	0				
S021481	40.9817	-124.0353	Statement of Div and Use		Y	08/15/2012	N/A	0.0	Cubic Feet per Second	0				
S021535	40.4529	-123.5068	Statement of Div and Use		Y	08/20/2012	N/A	0.007	Cubic Feet per Second	0				
S021578	40.2767	-123.3416	Statement of Div and Use			08/22/2012	N/A	0.03	Cubic Feet per Second	0				
S022343	40.3603	-123.424	Statement of Div and Use		Y	11/27/2012	N/A	0.0	Cubic Feet per Second	0				
S022344	40.3599	-123.4238	Statement of Div and Use		Y	11/27/2012	N/A	0.0	Cubic Feet per Second	0				
S022345	40.3586	-123.4238	Statement of Div and Use		Y	11/27/2012	N/A	0.0	Cubic Feet per Second	0				
S022347	40.3584	-123.4232	Statement of Div and Use		Y	11/27/2012	N/A	0.0	Cubic Feet per Second	0				
S022349	40.358	-123.4229	Statement of Div and Use		Y	11/27/2012	N/A	0.0	Cubic Feet per Second	0				
S022351	40.3575	-123.4213	Statement of Div and Use		Y	11/27/2012	N/A	0.0	Cubic Feet per Second	0				
S022353	40.3573	-123.421	Statement of Div and Use		Y	11/27/2012	N/A	0.0	Cubic Feet per Second	0				
S022354	40.3557	-123.4204	Statement of Div and Use		Y	11/27/2012	N/A	0.0	Cubic Feet per Second	0				
S022355	40.3555	-123.4203	Statement of Div and Use		Y	11/27/2012	N/A	0.0	Cubic Feet per Second	0				
S022356	40.3537	-123.4195	Statement of Div and Use		Y	11/27/2012	N/A	0.0	Cubic Feet per Second	0				
S022357	40.3527	-123.419	Statement of Div and Use		Y	11/27/2012	N/A	0.0	Cubic Feet per Second	0				
S022358	40.3516	-123.415	Statement of Div and Use		Y	11/27/2012	N/A	0.0	Cubic Feet per Second	0				
S022359	40.3516	-123.415	Statement of Div and Use		Y	11/27/2012	N/A	0.0	Cubic Feet per Second	0				
S022360	40.3516	-123.415	Statement of Div and Use		Y	11/27/2012	N/A	0.0	Cubic Feet per Second	0				
S022361	40.3516	-123.415	Statement of Div and Use		Y	11/27/2012	N/A	0.0	Cubic Feet per Second	0				
S022362	40.349	-123.4111	Statement of Div and Use		Y	11/27/2012	N/A	0.0	Cubic Feet per Second	0				
S022363	40.332	-123.3943	Statement of Div and Use		Y	11/27/2012	N/A	0.0	Cubic Feet per Second	0				
S022364	40.3351	-123.3978	Statement of Div and Use		Y	11/27/2012	N/A	0.0	Cubic Feet per Second	0				
S022365	40.3358	-123.3982	Statement of Div and Use		Y	11/27/2012	N/A	0.0	Cubic Feet per Second	0				
S022366	40.335	-123.3972	Statement of Div and Use		Y	11/27/2012	N/A	0.0	Cubic Feet per Second	0				
S022367	40.335	-123.397	Statement of Div and Use		Y	11/27/2012	N/A	0.0	Cubic Feet per Second	0				
S022368	40.3349	-123.3969	Statement of Div and Use		Y	11/27/2012	Junior	0.0	Cubic Feet per Second	0				
S022369	40.334	-123.3965	Statement of Div and Use		Y	11/27/2012	N/A	0.0	Cubic Feet per Second	0				
S022370	40.3313	-123.3939	Statement of Div and Use		Y	11/27/2012	Junior	0.0	Cubic Feet per Second	0				
S022371	40.3297	-123.3932	Statement of Div and Use		Y	11/27/2012	N/A	0.0	Cubic Feet per Second	0				
S022372	40.3306	-123.3934	Statement of Div and Use		Y	11/28/2012	N/A	0.0	Cubic Feet per Second	0				
S022373	40.3293	-123.389	Statement of Div and Use		Y	11/28/2012	N/A	0.0	Cubic Feet per Second	0				
S022374	40.3223	-123.3889	Statement of Div and Use		Y	11/28/2012	N/A	0.0	Cubic Feet per Second	0				
S022375	40.3195	-123.3834	Statement of Div and Use		Y	11/28/2012	N/A	0.0	Cubic Feet per Second	0				
S022376	40.3189	-123.3834	Statement of Div and Use		Y	11/28/2012	N/A	0.0	Cubic Feet per Second	0				
S022377	40.3178	-123.3817	Statement of Div and Use		Y	11/28/2012	N/A	0.0	Cubic Feet per Second	0				
S022378	40.3563	-123.427	Statement of Div and Use		Y	11/28/2012	N/A	0.0	Cubic Feet per Second	0				
S022380	40.3364	-123.4195	Statement of Div and Use		Y	11/28/2012	N/A	0.0	Cubic Feet per Second	0				
S022381	40.3385	-123.4113	Statement of Div and Use		Y	11/28/2012	N/A	0.0	Cubic Feet per Second	0				
S022382	40.3152	-123.3683	Statement of Div and Use		Y	11/28/2012	Junior	0.0	Cubic Feet per Second	0				
S022383	40.3076	-123.3542	Statement of Div and Use		Y	11/28/2012	Junior	0.0	Cubic Feet per Second	0				
S022385	40.3075	-123.3542	Statement of Div and Use		Y	11/28/2012	N/A	0.0	Cubic Feet per Second	0				
S022387	40.3076	-123.354	Statement of Div and Use		Y	11/28/2012	N/A	0.0	Cubic Feet per Second	0				
S022388	40.3076	-123.354	Statement of Div and Use		Y	11/28/2012	N/A	0.0	Cubic Feet per Second	0				

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S022389	40.4582	-123.5106	Statement of Div and Use		Y	11/28/2012	N/A	1.12	Cubic Feet per Second	0				
S022696	40.9807	-124.0366	Statement of Div and Use		Y	05/31/2013	N/A	0.11	Cubic Feet per Second	0				
S023449	40.7189	-123.8455	Statement of Div and Use		Y	10/11/2013	N/A	0.0		0				
S023497	40.8759	-123.9917	Statement of Div and Use		Y	10/16/2013	Junior	1.11	Cubic Feet per Second	0				
S023751	40.6933	-123.7903	Statement of Div and Use	Y	Y	11/22/2013	N/A	0.23	Cubic Feet per Second	0				
S023752	40.6887	-123.8167	Statement of Div and Use	Y	Y	11/22/2013	N/A	0.23	Cubic Feet per Second	0				
S023756	40.7012	-123.8328	Statement of Div and Use	Y	Y	11/25/2013	N/A	0.78	Cubic Feet per Second	0				
S023778	40.7329	-123.8806	Statement of Div and Use	Y	Y	11/26/2013	N/A	0.0		0				
S023798	40.8019	-123.9552	Statement of Div and Use	Y	Y	11/27/2013	Junior	0.0		0				
S023800	40.8153	-123.9715	Statement of Div and Use	Y	Y	11/27/2013	N/A	0.0		0				
S023801	40.8148	-123.97	Statement of Div and Use	Y	Y	11/27/2013	N/A	0.0		0				
S023802	40.8114	-123.9189	Statement of Div and Use	Y	Y	11/27/2013	N/A	0.0		0				
S023815	40.7122	-123.7803	Statement of Div and Use	Y	Y	12/02/2013	N/A	0.23	Cubic Feet per Second	0				
S023820	40.7614	-123.8189	Statement of Div and Use	Y	Y	12/03/2013	N/A	0.0		0				
S023821	40.9521	-123.8663	Statement of Div and Use	Y	Y	12/03/2013	N/A	0.0		0				
S023826	40.7288	-123.8341	Statement of Div and Use	Y	Y	12/03/2013	N/A	0.5	Cubic Feet per Second	0				
S023836	40.8308	-123.9411	Statement of Div and Use	Y	Y	12/03/2013	N/A	0.0		0				
S023857	40.9486	-123.9879	Statement of Div and Use	Y	Y	12/05/2013	N/A	0.5	Cubic Feet per Second	0				
S023858	40.942	-123.992	Statement of Div and Use	Y	Y	12/05/2013	N/A	0.23	Cubic Feet per Second	0				
S023864	40.9191	-123.8716	Statement of Div and Use	Y	Y	12/05/2013	N/A	0.23	Cubic Feet per Second	0				
S023865	40.938	-123.9347	Statement of Div and Use	Y	Y	12/05/2013	Junior	0.78	Cubic Feet per Second	0				
S023873	40.7095	-123.8171	Statement of Div and Use	Y	Y	12/09/2013	N/A	0.23	Cubic Feet per Second	0				
S023875	40.86	-123.9871	Statement of Div and Use	Y	Y	12/09/2013	N/A	0.78	Cubic Feet per Second	0				
S023877	40.7486	-123.7814	Statement of Div and Use	Y	Y	12/09/2013	N/A	0.23	Cubic Feet per Second	0				
S023878	40.9623	-123.9489	Statement of Div and Use	Y	Y	12/09/2013	N/A	0.78	Cubic Feet per Second	0				
S023881	40.6262	-123.736	Statement of Div and Use	Y	Y	12/09/2013	Junior	0.5	Cubic Feet per Second	0				
S023898	40.5801	-123.623	Statement of Div and Use		Y	12/12/2013	N/A	0.0		0				
S024107	40.9025	-124.0591	Statement of Div and Use		Y	01/09/2014	N/A	0.0		0				
S024185	40.5021	-123.5682	Statement of Div and Use		Y	01/17/2014	N/A	0.007	Cubic Feet per Second	0				
S024429	40.528	-123.646	Statement of Div and Use		Y	06/02/2014	N/A	0.0	Cubic Feet per Second	0				
S024675	40.4416	-123.5012	Statement of Div and Use		Y	10/10/2014	N/A	10.0	Gallons per Minute	0				
S024695	40.5264	-123.6397	Statement of Div and Use		Y	11/20/2014	N/A	0.005	Cubic Feet per Second	0				
S024717	40.851	-123.8852	Statement of Div and Use		Y	01/21/2015	N/A	0.005	Cubic Feet per Second	0				
S024803	40.4446	-123.4976	Statement of Div and Use		Y	04/28/2015	N/A	500.0	Gallons per Day	0				
S024861	40.5193	-123.5806	Statement of Div and Use		Y	06/12/2015	N/A	0.0	Cubic Feet per Second	0				
S024906	40.7163	-123.7652	Statement of Div and Use			07/03/2015	N/A	8.0	Gallons per Minute	0				
S024980	40.4382	-123.4919	Statement of Div and Use		Y	07/14/2015	N/A	5.0	Gallons per Minute	0				
S025026	40.7191	-123.7675	Statement of Div and Use			07/21/2015	N/A	7.0	Gallons per Minute	0				
S025054	40.4748	-123.5293	Statement of Div and Use		Y	07/24/2015	N/A	60.0	Gallons per Day	0				
S025061	40.5988	-123.6947	Statement of Div and Use		Y	07/24/2015	N/A	6.6	Gallons per Minute	0				
S025118	40.5135	-123.5764	Statement of Div and Use		Y	08/04/2015	N/A	1800.0	Gallons per Day	0				
S025121	40.5266	-123.614	Statement of Div and Use		Y	08/05/2015	N/A	4.0	Gallons per Minute	0				
S025124	40.3761	-123.4456	Statement of Div and Use		Y	08/05/2015	N/A	2.0	Gallons per Minute	0				
S025125	40.3747	-123.4397	Statement of Div and Use		Y	08/05/2015	N/A	2.0	Gallons per Minute	0				
S025129	40.3748	-123.4408	Statement of Div and Use		Y	08/05/2015	N/A	2.0	Gallons per Minute	0				
S025130	40.6022	-123.69	Statement of Div and Use		Y	08/06/2015	N/A	2.0	Gallons per Minute	0				
S025131	40.6012	-123.6904	Statement of Div and Use		Y	08/06/2015	N/A	2.0	Gallons per Minute	0				
S025189	40.3693	-123.4282	Statement of Div and Use		Y	09/04/2015	N/A	0.0122	Cubic Feet per Second	0				
S025221	40.9747	-124.0088	Statement of Div and Use			10/02/2015	Junior	350.0	Gallons per Day	0				

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S025260	40.7227	-123.886	Statement of Div and Use			11/10/2015	Junior	4.0	Gallons per Minute	0				
S025299	40.7129	-123.7587	Statement of Div and Use		Y	12/29/2015	Junior	7.0	Gallons per Minute	0				
S025331	40.7264	-123.9036	Statement of Div and Use		Y	01/19/2016	N/A	6.0	Gallons per Minute	0				
S025341	40.7449	-123.9493	Statement of Div and Use		Y	01/22/2016	N/A	20.0	Gallons per Minute	0				
S025382	40.7654	-123.8773	Statement of Div and Use		Y	03/04/2016	N/A	0.0		0				
S025421	40.5126	-123.5612	Statement of Div and Use		Y	04/08/2016	N/A	2.0	Gallons per Minute	0				
S025422	40.5117	-123.5627	Statement of Div and Use		Y	04/11/2016	N/A	10.0	Gallons per Minute	0				
S025475	40.8472	-123.908	Statement of Div and Use			05/31/2016	N/A	4.0	Gallons per Minute	0				
S025480	40.5184	-123.6239	Statement of Div and Use		Y	06/06/2016	N/A	2.0	Gallons per Minute	0				
S025506	40.5301	-123.6456	Statement of Div and Use		Y	06/17/2016	N/A	100.0	Gallons per Day	0				
S025531	40.7568051	-123.8759046	Statement of Div and Use		Y	07/11/2016	N/A	20.0	Gallons per Minute	0				
S025705	40.7437	-123.8759	Statement of Div and Use		Y	08/22/2016	N/A	5.0	Gallons per Minute	0				
S025786	40.5267	-123.614	Statement of Div and Use			09/02/2016	N/A	4.0	Gallons per Minute	0				
S025835	40.524532	-123.645466	Statement of Div and Use		Y	10/10/2016	N/A	1.04	Gallons per Minute	0				
S025839	40.5099	-123.5925	Statement of Div and Use		Y	10/11/2016	N/A	4.0	Gallons per Minute	0				
S025840	40.7253	-123.8879	Statement of Div and Use		Y	10/11/2016	N/A	4.0	Gallons per Minute	0				
S025867	40.8615	-123.9127	Statement of Div and Use		Y	10/31/2016	N/A	3.0	Gallons per Minute	0				
S025877	40.7565	-123.8864	Statement of Div and Use		Y	11/02/2016	N/A	250.0	Gallons per Day	0				
S025878	40.7558	-123.8858	Statement of Div and Use		Y	11/02/2016	Junior	500.0	Gallons per Day	0				
S025879	40.6672	-123.8653	Statement of Div and Use		Y	11/02/2016	N/A	10.0	Gallons per Minute	0				
S025951	40.3233	-123.3725	Statement of Div and Use		Y	12/16/2016	N/A	800.0	Gallons per Day	0				
S025999	40.61867477	-123.743169	Statement of Div and Use		Y	02/06/2017	N/A	4.0	Gallons per Minute	0				
S026001	40.45311971	-123.5026899	Statement of Div and Use		Y	02/06/2017	N/A	10.0	Gallons per Minute	0				
S026005	40.61867477	-123.743169	Statement of Div and Use		Y	02/14/2017	N/A	4.0	Gallons per Minute	0				
S026007	40.8528999	-123.9223546	Statement of Div and Use			02/14/2017	N/A	4.0	Gallons per Minute	0				
S026068	40.4027	-123.4568	Statement of Div and Use		Y	03/07/2017	N/A	1.0	Gallons per Minute	0				
S026117	40.6347	-123.7739	Statement of Div and Use		Y	05/16/2017	N/A	6.0	Gallons per Minute	0				
S026147	40.8638	-123.9191	Statement of Div and Use		Y	05/24/2017	N/A	16.0	Gallons per Minute	0				
S026148	40.8601	-123.9205	Statement of Div and Use		Y	05/24/2017	N/A	14.0	Gallons per Minute	0				
S026149	40.8615	-123.9128	Statement of Div and Use			05/24/2017	N/A	15.0	Gallons per Minute	0				
S026150	40.862	-123.9141	Statement of Div and Use		Y	05/24/2017	N/A	10.0	Gallons per Minute	0				
S026167	40.51470327	-123.6461934	Statement of Div and Use		Y	05/30/2017	N/A	0.0		0				
S026198	40.59665751	-123.7052254	Statement of Div and Use		Y	06/13/2017	N/A	4.0	Gallons per Minute	0				
S026210	40.649348	-123.856826	Statement of Div and Use		Y	06/15/2017	N/A	2880.0	Gallons per Day	0				
S026241	40.51754006	-123.6431716	Statement of Div and Use		Y	06/26/2017	N/A	16.0	Gallons per Minute	0				
S026249	40.440042	-123.492906	Statement of Div and Use		Y	06/26/2017	N/A	150.0	Gallons per Day	0				
S026250	40.43861909	-123.49903182	Statement of Div and Use		Y	06/26/2017	N/A	150.0	Gallons per Day	0				
S026273	40.846	-123.917	Statement of Div and Use		Y	07/07/2017	N/A	2.0	Gallons per Minute	0				
S026297	40.7711	-123.951	Statement of Div and Use		Y	07/11/2017	N/A	0.0		0				
S026324	40.603301	-123.699619	Statement of Div and Use		Y	07/12/2017	N/A	0.0		0				
S026334	40.5144178	-123.5867626	Statement of Div and Use		Y	07/13/2017	N/A	1.0	Gallons per Minute	0				
S026361	40.7196	-123.904	Statement of Div and Use		Y	07/14/2017	N/A	0.0		0				
S026374	40.511975	-123.582302	Statement of Div and Use		Y	07/14/2017	N/A	55.0	Gallons per Day	0				
S026377	40.5113041	-123.5859615	Statement of Div and Use		Y	07/17/2017	N/A	10.0	Gallons per Minute	0				
S026392	40.5038	-123.558	Statement of Div and Use		Y	07/17/2017	N/A	5.0	Gallons per Minute	0				
S026408	40.7193	-123.894	Statement of Div and Use		Y	07/18/2017	N/A	0.0		0				
S026409	40.7193	-123.894	Statement of Div and Use		Y	07/18/2017	N/A	0.0		0				
S026463	40.506287	-123.57714	Statement of Div and Use		Y	07/24/2017	N/A	7.0	Gallons per Minute	0				
S026492	40.512122	-123.628538	Statement of Div and Use		Y	07/25/2017	Junior	2.0	Gallons per Minute	0				

[1]Acceptance date not available for Registration Cannabis water rights
[2]Priority date not applicable for riparian and pre-1914 water rights

Application Number	Latitude	Longitude	Water Right Type	Pre-1914	Riparian	Acceptance Date[1]	Priority[2]	POD Direct Diversion Rate	POD Direct Diversion Rate Units	Face Value (AFY)	Direct Diversion Beg Month/ Day	Direct Diversion End Month/Day	Storage Beg Month/Day	Storage End Month/Day
S026493	40.509208	-123.629348	Statement of Div and Use		Y	07/25/2017	N/A	2.0	Gallons per Minute	0				
S026494	40.511505	-123.628575	Statement of Div and Use		Y	07/25/2017	N/A	5.0	Gallons per Minute	0				
S026495	40.50590556	-123.57551944	Statement of Div and Use		Y	07/25/2017	Junior	0.0		0				
S026523	40.5874	-123.7012	Statement of Div and Use			07/27/2017	Junior	0.0		0				
S026526	40.88954	-123.991595	Statement of Div and Use			07/27/2017	Junior	0.0		0				
S026527	40.88545	-124.03536	Statement of Div and Use			07/27/2017	N/A	0.0		0				
S026541	40.5311341	-123.622244	Statement of Div and Use		Y	07/28/2017	Junior	1.0	Gallons per Minute	0				
S026542	40.531919	-123.62666	Statement of Div and Use		Y	07/28/2017	Junior	1.0	Gallons per Minute	0				
S026543	40.603873	-123.680689	Statement of Div and Use		Y	07/28/2017	Junior	6.0	Gallons per Minute	0				
S026549	40.511	-123.6176	Statement of Div and Use		Y	07/28/2017	Junior	3.0	Gallons per Minute	0				
S026559	40.65354444	-123.80150556	Statement of Div and Use		Y	07/31/2017	Junior	9.0	Gallons per Minute	0				
S026570	40.66114722	-123.81495	Statement of Div and Use		Y	07/31/2017	Junior	0.0		0				
S026578	40.75512	-123.87521	Statement of Div and Use		Y	08/01/2017	Junior	0.0		0				
S026617	40.980698	-124.02156	Statement of Div and Use		Y	08/01/2017	Junior	0.0		0				
S026618	40.980698	-124.02156	Statement of Div and Use		Y	08/01/2017	Junior	0.0		0				
S026671	40.6512	-123.8017	Statement of Div and Use		Y	08/04/2017	Junior	5.0	Gallons per Minute	0				
S026672	40.65139167	-123.80180556	Statement of Div and Use		Y	08/04/2017	Junior	5.0	Gallons per Minute	0				
S026763	40.511503	-123.628119	Statement of Div and Use		Y	08/10/2017	Junior	1.0	Cubic Feet per Second	0				
S026765	40.50938959	-123.6225148	Statement of Div and Use		Y	08/10/2017	Junior	2.0	Gallons per Minute	0				
S026779	40.50518421	-123.5858306	Statement of Div and Use		Y	08/11/2017	Junior	500.0	Gallons per Day	0				
S026836	40.773697	-123.840974	Statement of Div and Use		Y	08/16/2017	Junior	5.0	Gallons per Minute	0				
S026867	40.72211389	-123.77476944	Statement of Div and Use		Y	08/17/2017	Junior	20.0	Gallons per Minute	0				
S026902	40.5075	-123.5444	Statement of Div and Use			08/21/2017	Junior	0.0		0				
S026942	40.51242875	-123.6358109	Statement of Div and Use		Y	08/22/2017	Junior	0.0		0				
S026944	40.7274542	-123.8908287	Statement of Div and Use		Y	08/22/2017	Junior	0.0		0				
S026949	40.59895176	-123.6947915	Statement of Div and Use		Y	08/23/2017	Junior	0.0		0				
S027053	40.531375	-123.61409444	Statement of Div and Use		Y	08/29/2017	Junior	0.0		0				
S027065	40.521497	-123.638286	Statement of Div and Use		Y	08/30/2017	Junior	0.0		0				
S027068	40.528061	-123.608378	Statement of Div and Use		Y	08/30/2017	Junior	0.0		0				
S027104	40.528792	-123.608997	Statement of Div and Use		Y	09/01/2017	Junior	0.0		0				
S027116	40.371247	-123.441717	Statement of Div and Use		Y	09/05/2017	Junior	0.0		0				
S027118	40.507915	-123.567391	Statement of Div and Use		Y	09/05/2017	Junior	150.0	Gallons per Day	0				
S027123	40.509221	-123.571854	Statement of Div and Use		Y	09/05/2017	Junior	600.0	Gallons per Day	0				
S027125	40.507034	-123.569708	Statement of Div and Use		Y	09/05/2017	Junior	150.0	Gallons per Day	0				
S027128	40.508633	-123.568507	Statement of Div and Use		Y	09/05/2017	Junior	80.0	Gallons per Day	0				
S027142	40.524342	-123.617973	Statement of Div and Use		Y	09/05/2017	Junior	2000.0	Gallons per Day	0				
S027149	40.374941	-123.448861	Statement of Div and Use		Y	09/06/2017	Junior	300.0	Gallons per Day	0				
S027175	40.511881	-123.557447	Statement of Div and Use		Y	09/08/2017	Junior	0.0		0				
S027177	40.512384	-123.557996	Statement of Div and Use		Y	09/08/2017	Junior	0.0		0				
S027217	40.521667	-123.652844	Statement of Div and Use		Y	09/12/2017	Junior	20.0	Gallons per Minute	0				
S027347	40.521509	-123.639127	Statement of Div and Use		Y	09/26/2017	Junior	0.0		0				
S027356	40.85556667	-123.90985556	Statement of Div and Use		Y	09/26/2017	Junior	1.5	Gallons per Minute	0				
S027357	40.85556667	-123.90985556	Statement of Div and Use		Y	09/26/2017	Junior	2.0	Gallons per Minute	0				
S027412	40.978644	-124.018611	Statement of Div and Use		Y	10/10/2017	Junior	150.0	Gallons per Day	0				
S027424	40.317191	-123.35757	Statement of Div and Use		Y	10/18/2017	Junior	0.0		0				
S027490	40.737232	-123.95321	Statement of Div and Use		Y	11/01/2017	Junior	0.0		0				
S027492	40.72616261	-123.90355383	Statement of Div and Use		Y	11/01/2017	Junior	0.0		0				
S027562	40.6489	-123.8517	Statement of Div and Use		Y	11/16/2017	Junior	5.0	Gallons per Minute	0				
S027568	40.675896	-123.866928	Statement of Div and Use		Y	11/17/2017	Junior	600.0	Gallons per Day	0				

[1]Acceptance date not available for Registration Cannabis water rights
[2]Priority date not applicable for riparian and pre-1914 water rights

Application Number	Latitude	Longitude	Water Right Type	Pre-1914	Riparian	Acceptance Date[1]	Priority[2]	POD Direct Diversion Rate	POD Direct Diversion Rate Units	Face Value (AFY)	Direct Diversion Beg Month/ Day	Direct Diversion End Month/Day	Storage Beg Month/Day	Storage End Month/Day
S027623	40.471873	-123.516841	Statement of Div and Use		Y	01/04/2018	Junior	0.0		0				
S027733	40.58405345	-123.6293609	Statement of Div and Use		Y	05/24/2018	Junior	0.0		0				
S027753	40.75780675	-123.8842037	Statement of Div and Use		Y	06/15/2018	Junior	500.0	Gallons per Day	0				
S027764	40.677959	-123.818833	Statement of Div and Use			06/20/2018	Junior	0.0		0				
S027795	40.679436	-123.815815	Statement of Div and Use		Y	07/16/2018	Junior	0.0		0				
S027801	40.456549	-123.495343	Statement of Div and Use		Y	07/16/2018	Junior	4.0	Gallons per Minute	0				
S027881	40.677959	-123.818833	Statement of Div and Use			08/20/2018	Junior	0.0		0				
S027890	40.58405345	-123.6293609	Statement of Div and Use			08/24/2018	Junior	4.0	Gallons per Minute	0				
S027928	40.516526	-123.554519	Statement of Div and Use			09/18/2018	Junior	2.2	Gallons per Minute	0				
S028027	40.531381	-123.616567	Statement of Div and Use		Y	11/28/2018	Junior	0.0		0				

[1]Acceptance date not available for Registration Cannabis water rights
[2]Priority date not applicable for riparian and pre-1914 water rights

Exhibit C: Estimated Monthly Water Use for eWRIMS Water Rights

Application Number	Diversion Volume (gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
A007545	0	0	0	0	1,922,390	1,922,390	1,922,390	1,922,390	1,922,390	0	0	0	9,611,950
A007898	29,868	29,868	29,868	29,868	29,868	29,868	29,868	29,868	29,868	29,868	29,868	29,868	358,412
A009292	210,000	210,000	210,000	210,000	210,000	210,000	210,000	210,000	210,000	210,000	210,000	210,000	2,520,000
A009486	0	0	0	0	4,500	4,500	4,500	4,500	4,500	4,500	0	0	27,000
A011983	0	0	22,808	22,808	22,808	22,808	22,808	22,808	22,808	22,808	22,808	22,808	228,080
A013523	2,715	2,715	2,715	2,715	2,715	2,715	2,715	2,715	2,715	2,715	2,715	2,715	32,583
A014677	0	0	0	0	7,367,501	7,367,501	7,367,501	7,367,501	7,367,501	0	0	0	36,837,504
A015328A	0	0	0	0	0	969,408	969,408	969,408	969,408	0	0	0	3,877,632
A015328B	0	0	0	0	0	581,645	581,645	581,645	581,645	0	0	0	2,326,579
A015328C	0	0	0	0	0	193,882	193,882	193,882	193,882	0	0	0	775,526
A015328D	0	0	0	0	0	775,526	775,526	775,526	775,526	0	0	0	3,102,106
A015328E	0	0	0	0	0	193,882	193,882	193,882	193,882	0	0	0	775,526
A015336	66,000	66,000	66,000	66,000	66,000	66,000	66,000	66,000	66,000	66,000	66,000	66,000	792,000
A015997	0	0	0	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	0	24,000
A016562	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	180,000
A017510	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	54,000
A017540	2,715	2,715	2,715	2,715	2,715	2,715	2,715	2,715	2,715	2,715	2,715	2,715	32,583
A017552	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000	540,000
A017824	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	144,000
A017996	0	0	0	0	7,949,146	570,200	570,200	570,200	570,200	0	0	0	10,229,947
A018206	0	0	0	0	512,017	512,017	512,017	512,017	512,017	512,017	512,017	0	3,584,117
A019466	390,995	390,995	390,995	390,995	390,995	390,995	390,995	390,995	390,995	390,995	390,995	390,995	4,691,935
A019919	76,027	76,027	76,027	76,027	76,027	76,027	76,027	76,027	76,027	76,027	76,027	76,027	912,321
A022694	2,715	2,715	2,715	2,715	2,715	2,715	2,715	2,715	2,715	2,715	2,715	2,715	32,583
A023034	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	180,000
A023209	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	216,000
A023957	141,192	141,192	141,192	141,192	141,192	141,192	141,192	141,192	141,192	141,192	141,192	141,192	1,694,310
A027463	2,715	2,715	2,715	2,715	2,715	2,715	2,715	2,715	2,715	2,715	2,715	2,715	32,583
C005478	3,095	2,802	3,095	2,998	0	0	0	0	0	0	0	0	11,990
C005479	0	0	0	0	0	0	0	0	0	0	0	0	0
C005480	1,238	1,108	1,238	1,206	0	0	0	0	0	0	0	1,238	6,028
C005481	3,095	2,802	3,095	2,998	0	0	0	0	0	0	0	3,095	15,086
C005482	6,191	5,539	6,191	5,865	0	0	0	0	0	0	0	6,191	29,976
D030029	32,583	32,583	32,583	32,583	32,583	32,583	32,583	32,583	32,583	32,583	32,583	32,583	390,995
D030274	8,146	8,146	8,146	8,146	8,146	8,146	8,146	8,146	8,146	8,146	8,146	8,146	97,749
D030576	40,729	40,729	40,729	40,729	40,729	40,729	40,729	40,729	40,729	40,729	40,729	40,729	488,743
D030651	135,000	135,000	135,000	135,000	135,000	135,000	135,000	135,000	135,000	135,000	135,000	135,000	1,620,000
D030716	67,881	67,881	67,881	67,881	67,881	67,881	67,881	67,881	67,881	67,881	67,881	67,881	814,572
D030783	81,457	81,457	81,457	81,457	81,457	81,457	81,457	81,457	81,457	81,457	81,457	81,457	977,486
D030816	135,000	135,000	135,000	135,000	135,000	135,000	135,000	135,000	135,000	135,000	135,000	135,000	1,620,000
D030916	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	144,000
F003655C	0	0	0	8,999	9,299	8,999	9,299	9,299	8,999	9,299	0	0	64,196
F003659C	7,603	7,603	7,603	7,603	7,603	7,603	7,603	7,603	7,603	7,603	7,603	7,603	91,231
F003977S	0	0	0	0	10,318	10,318	10,318	10,318	10,318	10,318	0	0	61,907
F003978S	0	0	0	0	21,179	21,179	21,179	21,179	21,179	21,179	0	0	127,073
F003980S	0	0	0	0	11,676	11,676	11,676	11,676	11,676	11,676	0	0	70,053
F003990S	0	0	0	0	56,787	56,787	56,787	56,787	56,787	56,787	56,787	0	397,511
F003992S	0	0	0	0	60,000	60,000	60,000	60,000	60,000	0	0	0	300,000
F003993S	0	0	0	0	20,093	20,093	20,093	20,093	20,093	20,093	0	0	120,557

Adjusted because outside of diversion window

Values obtained from Statement of Diversion and Use

Adjusted because total diversion volume exceeded the face value

Application Number	Diversion Volume (gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
F007913S	0	0	0	0	9,775	9,775	9,775	9,775	9,775	9,775	0	0	58,649
F007921S	0	0	0	0	14,608	14,608	14,608	14,608	14,608	14,608	0	0	87,648
F007923S	0	0	0	0	14,608	14,608	14,608	14,608	14,608	14,608	0	0	87,648
F010768S	0	0	0	0	8,526	8,526	8,526	8,526	8,526	8,526	0	0	51,155
H500272	432,000	432,000	432,000	0	0	0	0	0	0	0	432,000	432,000	2,160,000
H500321	432,000	432,000	432,000	0	0	0	0	0	0	0	432,000	432,000	2,160,000
H500465	432,000	432,000	432,000	0	0	0	0	0	0	0	432,000	432,000	2,160,000
H500552	432,000	432,000	432,000	0	0	0	0	0	0	0	432,000	432,000	2,160,000
H500602	432,000	432,000	432,000	0	0	0	0	0	0	0	432,000	432,000	2,160,000
H500642	432,000	432,000	432,000	0	0	0	0	0	0	0	432,000	432,000	2,160,000
H500670	432,000	432,000	432,000	0	0	0	0	0	0	0	432,000	432,000	2,160,000
H500711	432,000	432,000	432,000	0	0	0	0	0	0	0	432,000	432,000	2,160,000
H500712	432,000	432,000	432,000	0	0	0	0	0	0	0	432,000	432,000	2,160,000
H500771	48,809	48,809	48,809	0	0	0	0	0	0	0	48,809	48,809	244,046
H500793	3,258	3,258	3,258	0	0	0	0	0	0	0	3,258	3,258	16,291
H500815	432,000	432,000	432,000	0	0	0	0	0	0	0	432,000	432,000	2,160,000
H500854	432,000	432,000	432,000	0	0	0	0	0	0	0	432,000	432,000	2,160,000
H500868	38,448	38,448	38,448	0	0	0	0	0	0	0	38,448	38,448	192,239
H500877	432,000	432,000	432,000	0	0	0	0	0	0	0	432,000	432,000	2,160,000
H502014	432,000	432,000	432,000	0	0	0	0	0	0	0	432,000	432,000	2,160,000
H502019	432,000	432,000	432,000	0	0	0	0	0	0	0	432,000	432,000	2,160,000
H502200	432,000	432,000	432,000	0	0	0	0	0	0	0	432,000	432,000	2,160,000
H502323	432,000	432,000	432,000	432,000	432,000	432,000	432,000	432,000	432,000	432,000	432,000	432,000	5,184,000
H502385	432,000	432,000	432,000	0	0	0	0	0	0	0	432,000	432,000	2,160,000
H502425	41,054	41,054	41,054	0	0	0	0	0	0	0	41,054	41,054	205,272
H502514	432,000	432,000	432,000	0	0	0	0	0	0	0	432,000	432,000	2,160,000
H503581	432,000	432,000	432,000	0	0	0	0	0	0	0	432,000	432,000	2,160,000
H504249	432,000	432,000	432,000	0	0	0	0	0	0	0	432,000	432,000	2,160,000
H504313	432,000	432,000	432,000	0	0	0	0	0	0	0	432,000	432,000	2,160,000
H504319	432,000	432,000	432,000	0	0	0	0	0	0	0	432,000	432,000	2,160,000
H504422	432,000	432,000	432,000	432,000	432,000	432,000	432,000	432,000	432,000	432,000	432,000	432,000	5,184,000
H504601	432,000	432,000	432,000	0	0	0	0	0	0	0	432,000	432,000	2,160,000
H504663	432,000	432,000	432,000	0	0	0	0	0	0	0	432,000	432,000	2,160,000
H505143	14,988	14,988	14,988	0	0	0	0	0	0	0	14,988	14,988	74,941
H505373	432,000	432,000	432,000	0	0	0	0	0	0	0	432,000	432,000	2,160,000
S003981	0	0	0	15,000	15,000	15,000	15,000	15,000	15,000	15,000	0	0	105,000
S004938	0	0	0	0	198,000	198,000	198,000	198,000	198,000	0	0	0	990,000
S007914	0	0	0	9,000	9,000	9,000	9,000	9,000	9,000	9,000	0	0	63,000
S007925	0	0	0	15,000	15,000	15,000	15,000	15,000	15,000	15,000	0	0	105,000
S008799	853,079	853,079	853,079	853,079	853,079	853,079	853,079	853,079	853,079	853,079	853,079	853,079	10,236,948
S010329	2,500	2,500	2,500	3,000	3,000	4,000	8,000	9,000	5,000	3,000	2,500	2,500	47,500
S010387	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	108,000
S010424	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	54,000
S011457	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	144,000
S012962	105000000	120000000	135000000	51000000	51000000	51000000	54000000	60000000	75000000	75000000	75000000	90000000	942,000,000
S015530	0	0	0	0	1,357,171	1,357,171	1,357,171	1,357,171	1,357,171	1,357,171	0	0	8,143,027
S016794	0	0	0	0	1,296,000	1,944,000	1,944,000	1,944,000	1,944,000	1,944,000	0	0	11,016,000
S017691	814,303	814,303	814,303	814,303	814,303	814,303	814,303	814,303	814,303	814,303	814,303	814,303	9,771,633
S017892	174,493	174,493	174,493	174,493	174,493	174,493	174,493	174,493	174,493	174,493	174,493	174,493	2,093,921

Adjusted because outside of diversion window

Values obtained from Statement of Diversion and Use

Adjusted because total diversion volume exceeded the face value

Application Number	Diversion Volume (gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
S018254	213,270	213,270	213,270	213,270	213,270	213,270	213,270	213,270	213,270	213,270	213,270	213,270	2,559,237
S019715	1,346	1,346	1,346	1,346	1,346	1,346	1,346	1,346	1,346	1,346	1,346	1,346	16,157
S019894	1,938,816	1,938,816	1,938,816	1,938,816	1,938,816	1,938,816	1,938,816	1,938,816	1,938,816	1,938,816	1,938,816	1,938,816	23,265,792
S019897	3,960	3,960	3,960	3,960	3,960	3,960	3,960	3,960	3,960	3,960	3,960	3,960	47,520
S019940	77,553	77,553	77,553	77,553	77,553	77,553	77,553	77,553	77,553	77,553	77,553	77,553	930,632
S020162	2,132,698	2,132,698	2,132,698	2,132,698	2,132,698	2,132,698	2,132,698	2,132,698	2,132,698	2,132,698	2,132,698	2,132,698	25,592,371
S020233	1,163,290	1,163,290	1,163,290	1,163,290	1,163,290	1,163,290	1,163,290	1,163,290	1,163,290	1,163,290	1,163,290	1,163,290	13,959,475
S021481	10,461	10,461	10,461	10,461	10,461	10,461	10,461	10,461	10,461	10,461	10,461	10,461	125,535
S021535	135,717	135,717	135,717	135,717	135,717	135,717	135,717	135,717	135,717	135,717	135,717	135,717	1,628,605
S021578	581,645	581,645	581,645	581,645	581,645	581,645	581,645	581,645	581,645	581,645	581,645	581,645	6,979,738
S022343	0	0	0	0	1,200	2,400	2,400	2,400	1,200	0	0	0	9,600
S022344	0	0	0	0	1,200	2,400	2,400	2,400	1,200	0	0	0	9,600
S022345	0	0	0	0	1,200	2,400	2,400	2,400	1,200	0	0	0	9,600
S022347	0	0	0	0	1,200	2,400	2,400	2,400	1,200	0	0	0	9,600
S022349	0	0	0	0	1,200	2,400	2,400	2,400	1,200	0	0	0	9,600
S022351	0	0	0	0	1,200	2,400	2,400	2,400	1,200	0	0	0	9,600
S022353	0	0	0	0	1,200	2,400	2,400	2,400	1,200	0	0	0	9,600
S022354	0	0	0	0	1,200	2,400	2,400	2,400	1,200	0	0	0	9,600
S022355	0	0	0	0	1,200	2,400	2,400	2,400	1,200	0	0	0	9,600
S022356	0	0	0	0	1,200	2,400	2,400	2,400	1,200	0	0	0	9,600
S022357	0	0	0	0	1,200	2,400	2,400	2,400	1,200	0	0	0	9,600
S022358	0	0	0	0	1,200	2,400	2,400	2,400	1,200	0	0	0	9,600
S022359	0	0	0	0	1,200	2,400	2,400	2,400	1,200	0	0	0	9,600
S022360	0	0	0	0	1,200	2,400	2,400	2,400	1,200	0	0	0	9,600
S022361	0	0	0	0	1,200	2,400	2,400	2,400	1,200	0	0	0	9,600
S022362	0	0	0	0	1,200	2,400	2,400	2,400	1,200	0	0	0	9,600
S022363	0	0	0	0	1,200	2,400	2,400	2,400	1,200	0	0	0	9,600
S022364	0	0	0	0	1,200	2,400	2,400	2,400	1,200	0	0	0	9,600
S022365	0	0	0	0	1,200	2,400	2,400	2,400	1,200	0	0	0	9,600
S022366	0	0	0	0	1,200	2,400	2,400	2,400	1,200	0	0	0	9,600
S022367	0	0	0	0	1,200	2,400	2,400	2,400	1,200	0	0	0	9,600
S022368	0	0	0	0	1,200	2,400	2,400	2,400	1,200	0	0	0	9,600
S022369	0	0	0	0	1,200	2,400	2,400	2,400	1,200	0	0	0	9,600
S022370	0	0	0	0	1,200	2,400	2,400	2,400	1,200	0	0	0	9,600
S022371	0	0	0	0	1,200	2,400	2,400	2,400	1,200	0	0	0	9,600
S022372	0	0	0	0	1,200	2,400	2,400	2,400	1,200	0	0	0	9,600
S022373	0	0	0	0	1,200	2,400	2,400	2,400	1,200	0	0	0	9,600
S022374	0	0	0	0	1,200	2,400	2,400	2,400	1,200	0	0	0	9,600
S022375	0	0	0	0	1,200	2,400	2,400	2,400	1,200	0	0	0	9,600
S022376	0	0	0	0	1,200	2,400	2,400	2,400	1,200	0	0	0	9,600
S022377	0	0	0	0	1,200	2,400	2,400	2,400	1,200	0	0	0	9,600
S022378	0	0	0	0	1,200	2,400	2,400	2,400	1,200	0	0	0	9,600
S022380	0	0	0	0	1,200	2,400	2,400	2,400	1,200	0	0	0	9,600
S022381	0	0	0	0	1,200	2,400	2,400	2,400	1,200	0	0	0	9,600
S022382	0	0	0	0	1,200	2,400	2,400	2,400	1,200	0	0	0	9,600
S022383	0	0	0	0	1,200	2,400	2,400	2,400	1,200	0	0	0	9,600
S022385	0	0	0	0	1,200	2,400	2,400	2,400	1,200	0	0	0	9,600
S022387	0	0	0	0	1,200	2,400	2,400	2,400	1,200	0	0	0	9,600
S022388	0	0	0	0	1,200	2,400	2,400	2,400	1,200	0	0	0	9,600

Adjusted because outside of diversion window

Values obtained from Statement of Diversion and Use

Adjusted because total diversion volume exceeded the face value

Application Number	Diversion Volume (gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
S022389	21,714,739	21,714,739	21,714,739	21,714,739	21,714,739	21,714,739	21,714,739	21,714,739	21,714,739	21,714,739	21,714,739	21,714,739	260,576,870
S022696	2,132,698	2,132,698	2,132,698	2,132,698	2,132,698	2,132,698	2,132,698	2,132,698	2,132,698	2,132,698	2,132,698	2,132,698	25,592,371
S023449	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	120,000
S023497	21,520,858	21,520,858	21,520,858	21,520,858	21,520,858	21,520,858	21,520,858	21,520,858	21,520,858	21,520,858	21,520,858	21,520,858	258,250,291
S023751	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	53,511,322
S023752	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	53,511,322
S023756	15,122,765	15,122,765	15,122,765	15,122,765	15,122,765	15,122,765	15,122,765	15,122,765	15,122,765	15,122,765	15,122,765	15,122,765	181,473,178
S023778	0	0	0	0	0	0	0	0	0	0	0	0	0
S023798	0	0	0	0	20,000	140,000	28,000	92,000	16,000	0	0	0	296,000
S023800	0	0	0	0	0	0	0	0	0	0	0	0	0
S023801	0	0	0	0	8,000	48,000	44,000	108,000	16,000	0	0	0	224,000
S023802	0	0	0	0	0	0	0	0	0	0	0	0	0
S023815	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	53,511,322
S023820	0	0	0	0	0	0	40,000	280,000	20,000	16,000	0	0	356,000
S023821	0	0	0	0	0	0	132,000	320,000	260,000	128,000	0	0	840,000
S023826	9,694,080	9,694,080	9,694,080	9,694,080	9,694,080	9,694,080	9,694,080	9,694,080	9,694,080	9,694,080	9,694,080	9,694,080	116,328,960
S023836	0	0	0	0	0	0	0	0	0	0	0	0	0
S023857	9,694,080	9,694,080	9,694,080	9,694,080	9,694,080	9,694,080	9,694,080	9,694,080	9,694,080	9,694,080	9,694,080	9,694,080	116,328,960
S023858	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	53,511,322
S023864	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	53,511,322
S023865	15,122,765	15,122,765	15,122,765	15,122,765	15,122,765	15,122,765	15,122,765	15,122,765	15,122,765	15,122,765	15,122,765	15,122,765	181,473,178
S023873	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	53,511,322
S023875	15,122,765	15,122,765	15,122,765	15,122,765	15,122,765	15,122,765	15,122,765	15,122,765	15,122,765	15,122,765	15,122,765	15,122,765	181,473,178
S023877	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	4,459,277	53,511,322
S023878	15,122,765	15,122,765	15,122,765	15,122,765	15,122,765	15,122,765	15,122,765	15,122,765	15,122,765	15,122,765	15,122,765	15,122,765	181,473,178
S023881	9,694,080	9,694,080	9,694,080	9,694,080	9,694,080	9,694,080	9,694,080	9,694,080	9,694,080	9,694,080	9,694,080	9,694,080	116,328,960
S023898	0	0	0	0	0	1,000	1,000	1,000	1,000	1,000	0	0	5,000
S024107	1,400	1,400	1,400	1,600	1,800	1,800	2,000	2,200	2,200	200	1,600	1,400	19,000
S024185	135,717	135,717	135,717	135,717	135,717	135,717	135,717	135,717	135,717	135,717	135,717	135,717	1,628,605
S024429	0	0	0	0	0	0	0	1,500	1,500	1,500	0	0	4,500
S024675	432,000	432,000	432,000	432,000	432,000	432,000	432,000	432,000	432,000	432,000	432,000	432,000	5,184,000
S024695	96,941	96,941	96,941	96,941	96,941	96,941	96,941	96,941	96,941	96,941	96,941	96,941	1,163,290
S024717	96,941	96,941	96,941	96,941	96,941	96,941	96,941	96,941	96,941	96,941	96,941	96,941	1,163,290
S024803	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	180,000
S024861	0	0	0	34,000	55,500	55,500	55,500	55,500	55,500	55,500	20,250	0	387,250
S024906	345,600	345,600	345,600	345,600	345,600	345,600	345,600	345,600	345,600	345,600	345,600	345,600	4,147,200
S024980	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	2,592,000
S025026	302,400	302,400	302,400	302,400	302,400	302,400	302,400	302,400	302,400	302,400	302,400	302,400	3,628,800
S025054	1,800	1,800	1,800	1,800	1,800	1,800	1,800	1,800	1,800	1,800	1,800	1,800	21,600
S025061	285,120	285,120	285,120	285,120	285,120	285,120	285,120	285,120	285,120	285,120	285,120	285,120	3,421,440
S025118	54,000	54,000	54,000	54,000	54,000	54,000	54,000	54,000	54,000	54,000	54,000	54,000	648,000
S025121	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	2,073,600
S025124	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	1,036,800
S025125	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	1,036,800
S025129	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	1,036,800
S025130	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	1,036,800
S025131	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	1,036,800
S025189	236,536	236,536	236,536	236,536	236,536	236,536	236,536	236,536	236,536	236,536	236,536	236,536	2,838,427
S025221	10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500	126,000

Adjusted because outside of diversion window

Values obtained from Statement of Diversion and Use

Adjusted because total diversion volume exceeded the face value

Application Number	Diversion Volume (gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
S025260	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	2,073,600
S025299	302,400	302,400	302,400	302,400	302,400	302,400	302,400	302,400	302,400	302,400	302,400	302,400	3,628,800
S025331	259,200	259,200	259,200	259,200	259,200	259,200	259,200	259,200	259,200	259,200	259,200	259,200	3,110,400
S025341	864,000	864,000	864,000	864,000	864,000	864,000	864,000	864,000	864,000	864,000	864,000	864,000	10,368,000
S025382	0	0	0	0	8,000	0	0	0	0	0	0	0	8,000
S025421	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	1,036,800
S025422	432,000	432,000	432,000	432,000	432,000	432,000	432,000	432,000	432,000	432,000	432,000	432,000	5,184,000
S025475	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	2,073,600
S025480	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	1,036,800
S025506	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	36,000
S025531	864,000	864,000	864,000	864,000	864,000	864,000	864,000	864,000	864,000	864,000	864,000	864,000	10,368,000
S025705	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	2,592,000
S025786	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	2,073,600
S025835	44,928	44,928	44,928	44,928	44,928	44,928	44,928	44,928	44,928	44,928	44,928	44,928	539,136
S025839	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	2,073,600
S025840	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	2,073,600
S025867	129,600	129,600	129,600	129,600	129,600	129,600	129,600	129,600	129,600	129,600	129,600	129,600	1,555,200
S025877	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	90,000
S025878	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	180,000
S025879	432,000	432,000	432,000	432,000	432,000	432,000	432,000	432,000	432,000	432,000	432,000	432,000	5,184,000
S025951	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	288,000
S025999	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	2,073,600
S026001	432,000	432,000	432,000	432,000	432,000	432,000	432,000	432,000	432,000	432,000	432,000	432,000	5,184,000
S026005	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	2,073,600
S026007	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	2,073,600
S026068	43,200	43,200	43,200	43,200	43,200	43,200	43,200	43,200	43,200	43,200	43,200	43,200	518,400
S026117	259,200	259,200	259,200	259,200	259,200	259,200	259,200	259,200	259,200	259,200	259,200	259,200	3,110,400
S026147	691,200	691,200	691,200	691,200	691,200	691,200	691,200	691,200	691,200	691,200	691,200	691,200	8,294,400
S026148	604,800	604,800	604,800	604,800	604,800	604,800	604,800	604,800	604,800	604,800	604,800	604,800	7,257,600
S026149	648,000	648,000	648,000	648,000	648,000	648,000	648,000	648,000	648,000	648,000	648,000	648,000	7,776,000
S026150	432,000	432,000	432,000	432,000	432,000	432,000	432,000	432,000	432,000	432,000	432,000	432,000	5,184,000
S026167	4,650	4,200	21,235	20,415	4,650	21,095	4,650	4,650	4,500	4,650	4,500	4,650	103,845
S026198	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	2,073,600
S026210	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	1,036,800
S026241	691,200	691,200	691,200	691,200	691,200	691,200	691,200	691,200	691,200	691,200	691,200	691,200	8,294,400
S026249	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	54,000
S026250	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	54,000
S026273	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	1,036,800
S026297	23,215	23,215	23,215	23,215	0	0	0	0	0	0	23,215	23,215	139,290
S026324	0	37,250	37,750	52,500	127,750	127,500	157,750	97,750	97,500	97,750	22,500	0	856,000
S026334	43,200	43,200	43,200	43,200	43,200	43,200	43,200	43,200	43,200	43,200	43,200	43,200	518,400
S026361	45,000	45,000	20,000	25,000	30,000	0	0	0	0	0	45,000	45,000	255,000
S026374	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	19,800
S026377	432,000	432,000	432,000	432,000	432,000	432,000	432,000	432,000	432,000	432,000	432,000	432,000	5,184,000
S026392	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	2,592,000
S026408	0	0	37,500	37,500	37,500	50,000	50,000	50,000	0	18,750	0	0	281,250
S026409	10,000	10,000	20,000	20,000	20,000	20,000	1,750	57,500	57,500	38,750	20,000	47,000	322,500
S026463	302,400	302,400	302,400	302,400	302,400	302,400	302,400	302,400	302,400	302,400	302,400	302,400	3,628,800
S026492	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	1,036,800

Adjusted because outside of diversion window

Values obtained from Statement of Diversion and Use

Adjusted because total diversion volume exceeded the face value

Application Number	Diversion Volume (gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
S026493	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	1,036,800
S026494	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	2,592,000
S026495	26,250	26,250	26,250	8,750	8,750	34,375	40,000	30,000	34,375	13,750	26,250	26,250	301,250
S026523	0	0	16,500	11,500	18,500	27,500	48,500	28,500	38,500	28,500	7,500	0	225,500
S026526	0	0	2,500	2,500	2,500	2,500	12,500	12,500	10,000	0	0	0	45,000
S026527	5,000	5,000	10,000	10,000	10,000	10,000	30,000	30,000	25,000	5,000	5,000	5,000	150,000
S026541	43,200	43,200	43,200	43,200	43,200	43,200	43,200	43,200	43,200	43,200	43,200	43,200	518,400
S026542	43,200	43,200	43,200	43,200	43,200	43,200	43,200	43,200	43,200	43,200	43,200	43,200	518,400
S026543	259,200	259,200	259,200	259,200	259,200	259,200	259,200	259,200	259,200	259,200	259,200	259,200	3,110,400
S026549	129,600	129,600	129,600	129,600	129,600	129,600	129,600	129,600	129,600	129,600	129,600	129,600	1,555,200
S026559	388,800	388,800	388,800	388,800	388,800	388,800	388,800	388,800	388,800	388,800	388,800	388,800	4,665,600
S026570	0	0	0	0	1,500	1,500	1,500	1,500	1,500	0	0	0	7,500
S026578	15,000	15,000	18,000	20,000	20,000	20,000	24,000	24,000	24,000	20,000	18,000	15,000	233,000
S026617	15,000	15,000	15,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000	15,000	15,000	390,000
S026618	15,000	15,000	15,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000	15,000	15,000	390,000
S026671	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	2,592,000
S026672	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	2,592,000
S026763	19,388,160	19,388,160	19,388,160	19,388,160	19,388,160	19,388,160	19,388,160	19,388,160	19,388,160	19,388,160	19,388,160	19,388,160	232,657,920
S026765	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	1,036,800
S026779	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	180,000
S026836	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	2,592,000
S026867	864,000	864,000	864,000	864,000	864,000	864,000	864,000	864,000	864,000	864,000	864,000	864,000	10,368,000
S026902	0	0	0	0	0	0	0	0	0	0	0	0	0
S026942	22,000	22,000	22,000	22,000	17,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	147,000
S026944	0	0	0	600	6,250	12,500	12,500	14,285	14,285	12,500	0	0	72,920
S026949	3,000	3,000	3,000	3,750	4,500	6,000	10,500	12,000	10,500	9,000	4,500	3,000	72,750
S027053	0	0	0	0	31,000	45,000	46,500	46,500	45,000	46,500	0	0	260,500
S027065	38,700	35,400	29,100	15,100	7,500	0	0	0	0	0	28,000	62,400	216,200
S027068	46,900	42,900	35,200	18,300	9,100	0	0	0	0	0	33,900	75,600	261,900
S027104	12,000	12,000	12,000	4,000	0	0	0	0	0	0	0	0	40,000
S027116	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	60,000
S027118	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	54,000
S027123	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	216,000
S027125	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	54,000
S027128	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	28,800
S027142	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	720,000
S027149	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	108,000
S027175	4,000	3,000	2,000	0	0	0	0	0	0	0	3,000	4,000	16,000
S027177	4,000	3,000	3,000	3,000	1,000	0	0	0	0	0	4,000	4,000	22,000
S027217	864,000	864,000	864,000	864,000	864,000	864,000	864,000	864,000	864,000	864,000	864,000	864,000	10,368,000
S027347	8,900	8,100	6,700	3,500	1,700	0	0	0	0	2,600	6,400	11,800	49,700
S027356	64,800	64,800	64,800	64,800	64,800	64,800	64,800	64,800	64,800	64,800	64,800	64,800	777,600
S027357	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	1,036,800
S027412	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	54,000
S027424	3,000	3,000	6,000	9,000	12,000	15,000	15,000	15,000	15,000	14,000	13,000	9,000	129,000
S027490	8,100	8,100	8,100	8,100	8,000	8,100	8,100	8,100	9,000	9,000	8,100	8,100	98,900
S027492	0	0	800	2,000	14,000	22,400	22,400	22,400	14,000	2,000	0	0	100,000
S027562	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	2,592,000
S027568	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	216,000

Adjusted because outside of diversion window

Values obtained from Statement of Diversion and Use

Adjusted because total diversion volume exceeded the face value

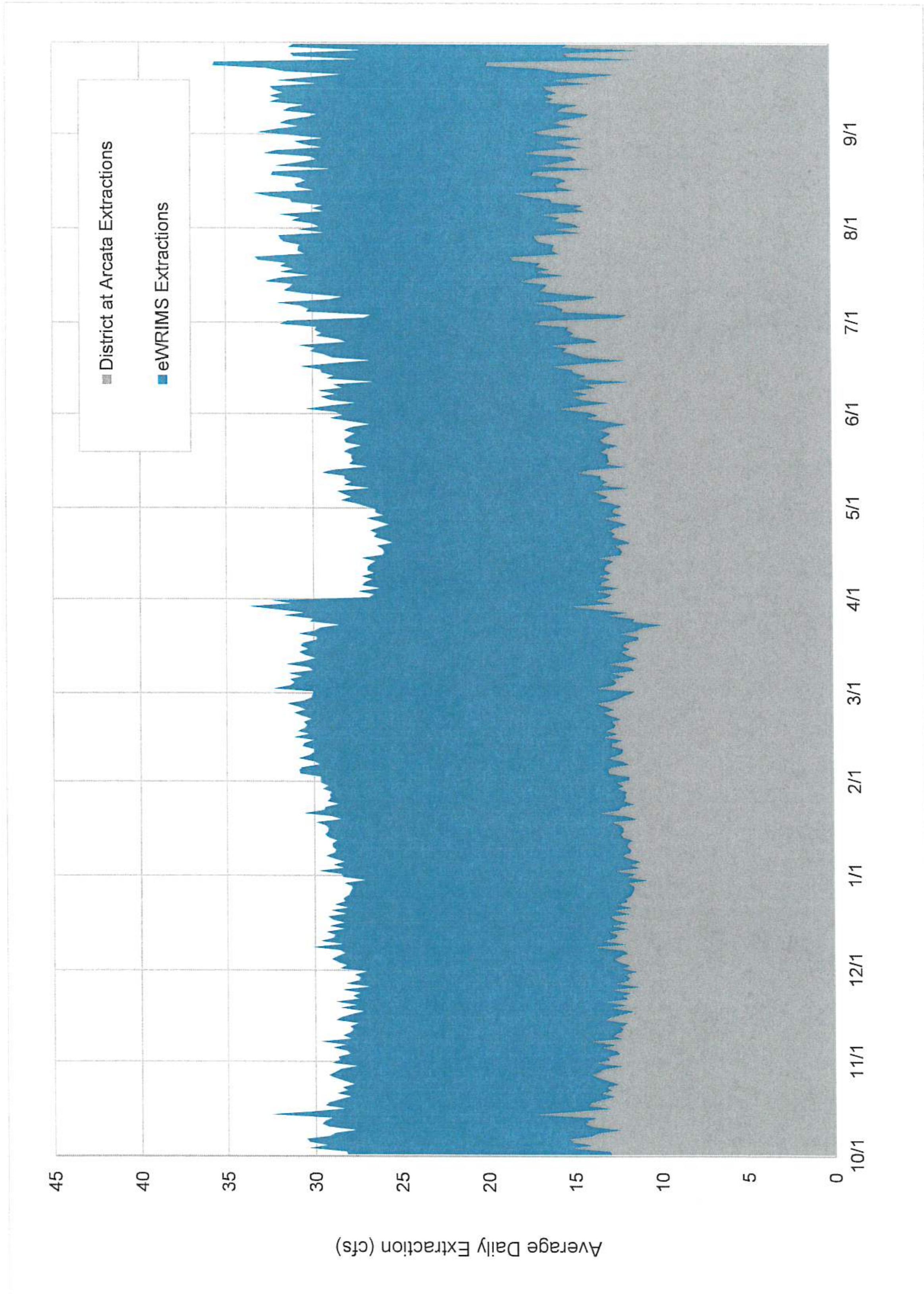
Application Number	Diversion Volume (gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
S027623	0	0	0	0	0	0	0	0	0	0	0	0	0
S027733	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	72,000
S027753	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	180,000
S027764	25,660	25,660	25,660	25,660	25,660	25,660	25,660	25,660	25,660	25,660	25,660	25,660	307,920
S027795	6,696	6,696	6,696	6,696	6,696	6,480	6,696	6,696	0	0	0	6,696	60,048
S027801	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	2,073,600
S027881	25,660	25,660	25,660	25,660	25,660	25,660	25,660	25,660	25,660	25,660	25,660	25,660	307,920
S027890	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	2,073,600
S027928	95,040	95,040	95,040	95,040	95,040	95,040	95,040	95,040	95,040	95,040	95,040	95,040	1,140,480
S028027	5,466	5,466	5,468	0	0	0	0	0	0	0	0	0	16,400

Adjusted because outside of diversion window

Values obtained from Statement of Diversion and Use

Adjusted because total diversion volume exceeded the face value

Exhibit D: Extractions for HBMWD at Essex and eWRIMS Water Rights


District at Arcata Extractions
eWRIMS Extractions
Average Daily Extraction (cfs)
0
5
10
15
20
25
30
35
40
45
10/1
11/1
12/1
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1

APPENDIX G – Water Rights Data Analysis

GHD Tech Memo April 2024

718 Third Street,
Eureka, California 95501
United States
ghd.com

Our ref: 12606336

April 18, 2024

John Friedenbach
Humboldt Bay Municipal Water District
828 Seventh Street
Eureka, CA 95501

Instream Flow Water Rights Data Analysis Project

Dear John,

Purpose

The Purpose of this memorandum (memo) is to address review comment #6 from Britney Newby of the State Water Resources Control Board (SWRCB) on Humboldt Bay Municipal Water District's (HBMWD or District) draft 1707 Petition. The comment reads:

"*The District should compile water diversion and use data into a single comprehensive spreadsheet to allow the State Water Board to understand how the District has operated since 2009, which appears to be the year when District operations changed significantly and represents the current status through 2023. This information should show amounts of rate/amount of water directly diverted, water diverted to storage, water bypassed, releases from storage for downstream diversion/environmental needs (or likely both), how the District accounts for storage releases and differentiates between direct diversion or re-diversion of release stored water, and whether/how releases to generate power are included in the releases for downstream diversion/environmental needs (or likely both)*".

To address this comment the District and GHD have compiled the available data and performed an analysis using the State Waterboards LIFO process to quantify the following parameters:

- Collection to storage at Ruth Lake reservoir/R.W. Matthews Dam,
- "Regulatory diversion" to storage at Ruth Lake reservoir/R.W. Matthews Dam
- "Regulatory Withdrawal" from Ruth Lake reservoir/R.W. Matthews Dam,
- Withdrawal from storage at Ruth Lake reservoir/R.W. Matthews Dam,
- Direct Diversion from the Mad River at Essex,
- Re-Diversion from the Mad River at Essex, and
- Bypass flows below the Essex Diversion/Re-Diversion.

A schematic of the District's diversion locations are shown in Figure 1.

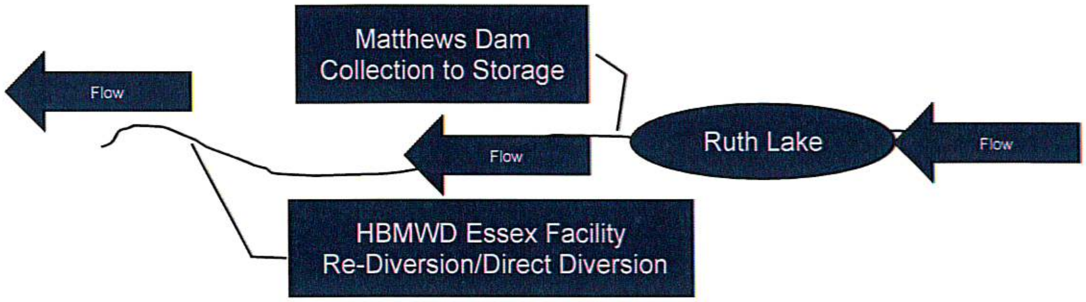


Figure 1. Schematic of HBMWD Diversions

Analysis Overview

Diversions at Ruth Lake/Matthews Dam

The District has several water rights along the Mad River and Ruth Lake that allow the District to divert water to storage in Ruth Lake, among other uses discussed further below. Matthews Dam is considered the point of diversion to storage. Diverted water entering the reservoir comes from the upper reaches of the Mad River, other minor tributaries, and overland stormwater runoff. The only inflow to Ruth that is monitored is at the USGS Zenia gage station (11480390) on the Mad River. Water may be released from storage at Matthews Dam by several methods, including through the power plant, through the Howell Bunger valve, through the fish flow bypass valve, and over the spillway. There are separate flow measurement methods for each release type. There are separate flow meters on the hydraulic machines, Howell Bunger valve and fish bypass flow. Flows over the spillway are estimated with a rating discharge curve (weir equation) using the stage elevation of the reservoir. The District does not have any flow controls for flows over the spillway. The various methods of measuring diversions and releases pose difficulties when attempting to compare and calculate total flows and volumes of water. Additionally, it is not possible to measure inflows into Ruth Lake between the Zenia Gage and R.W. Matthews Dam. Consequently, the available measurements for inflow and outflow were not used in the analysis. Instead, daily reservoir water impoundment volumes based on measurements of the stage of the reservoir were used for the diversion analysis. This approach accounts for all inflows into the reservoir and all forms of releases (power plant, Howell Bunger valve, fish bypass, and spillway).

The amount of water impounded in the reservoir corresponds to the stage elevation, which is recorded daily. The analysis of diversions into and out of Ruth Lake reservoir/R.W. Matthews Dam was performed by evaluating the change in the daily volume of water impounded in Ruth Lake. The amount of daily diversion to storage or release from storage was calculated by subtracting the storage volume for a day from the storage volume of the previous day. If the change in storage increased, it was considered a diversion to storage. Diversion to storage would include all inflows to Ruth Lake less all outflows for a given day. If the change in storage decreased, it was considered a release from storage.

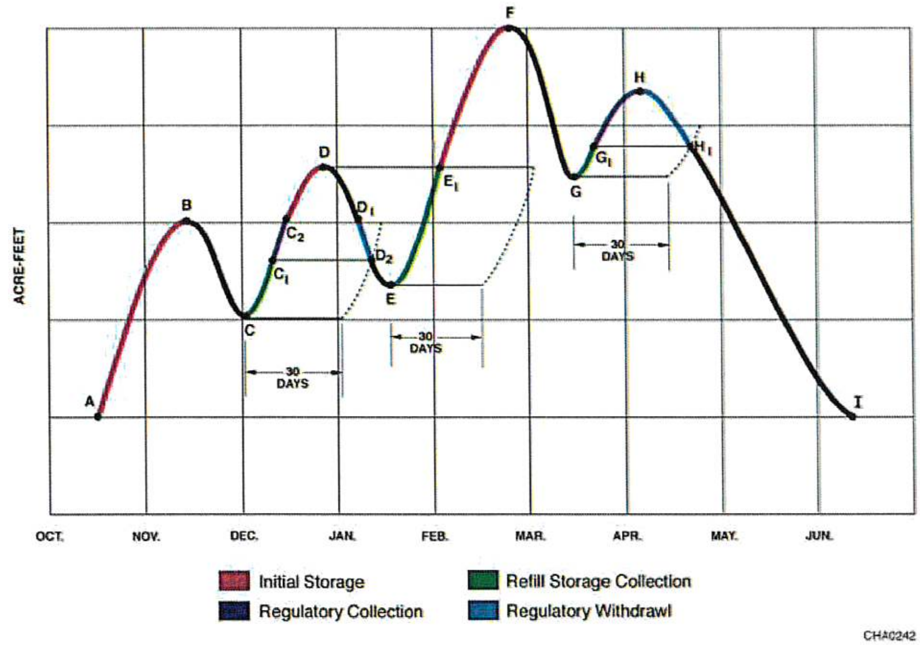
The California Code of Regulations, title 23, section 658 states the following:

> "*Storage of water means the collection of water in a tank or reservoir during a time of higher stream flow which is held for use during a time of deficient stream flow. For licensing purposes all initial collections within the collection season plus refill, in whole or in part, held in a tank or reservoir for more than 30 days shall be considered water diverted for storage except as provided in Section 735(c).*"

Water that is stored for 30 days or less is considered a "regulatory storage," "regulatory collection to storage," or "regulatory withdrawal." Water that is stored for over 30 days is considered a "diversion to storage." Because Ruth Lake/Matthews Dam is on a continuous cycle of diverting and releasing flows, the daily change in storage values were evaluated to determine if they are considered "collection to storage" or "regulatory collection to storage."

The discharges (discharges from storage and regulatory discharges I.E. the volume of water flowing past the dam) from Ruth/Matthews Dam were evaluated using the "Last-In, First-Out" and "First-In, Last-Out" (LIFO-FILO) methodology, which was developed by SWRCB in accordance with California Code of Regulations, title 23, sections 657 and 658 (Considerations for Reservoir Licensing Division of Water Rights, SWRCB, 11/21/2013 https://www.waterboards.ca.gov/waterrights/water_issues/programs/applications/docs/licensing.pdf). The methodology is applied on a water year basis and assumes that the last volume of water that flows into a reservoir is the first volume to flow out and that the first volume of water that flows into a reservoir is the last volume to flow out. The LIFO-FILO methodology is applicable if the reservoirs serve as both water storage points and direct diversion points; and, reservoirs from which water is released and then refilled to any extent by inflow from other sources. Release of water from the reservoir after it has been initially filled is considered withdrawal from storage. Water that is diverted to storage and subsequently released from the reservoir within 30 days after the reservoir has been refilled is considered "Regulatory" collection of water until the previous draw-down level is exceeded. Once the previous draw-down level is exceeded, the volume of water released beyond this level is withdrawal from initial storage. The methodology is illustrated in the sample hydrograph shown in Figure 2.

SAMPLE HYDROGRAPH



1. A-B, C2-D and E1-F constitute initial collection to storage.

2. Refill of initial storage C-C2, E-E1 and G-H must be analyzed to determine if all or part of refills were released within 30 days.
   a. Withdrawal D1-D2 occurred within 30 days, therefore **C1-C2** is considered regulatory. **C-C1** is determined to be collection to storage.
   b. Analyzing **E-E1** results in no withdrawal of this water within a 30-day period. Therefore **E-E1**is considered collection to storage.
   c. On analyzing G-H, it is determined that **G-G1** is held for 30 days or more and therefore is considered collection to storage. **H-H1** was withdrawn within a 30-day period. Therefore **G1-H** is considered regulatory storage.

3. The total storage is comprised of **A-B**, **C-C1**, **C2-D**, **E-E1**, **E1-F** and **G-G1**.

Since **C1-C2** (**D1-D2**) and **G1-H** (**H-H1**) are considered regulatory, the total withdrawal from storage is comprised of **B-C**, **D-D1**, **D2-E**, **F-G** and **H1-I**.

Figure taken from "Storage/Regulatory Determination for Reservoirs Filled in Whole or Part More Than Once During a Single Water Year" by Glen K. Mork, Division of Water Rights, SWRCB, 1/1990

Figure 2 Sample Hydrograph Illustrating LIFO-FILO Methodology

Diversions at HBMWD Essex Facility

The District diverts water for potable and industrial uses at their Essex Facility. All water diverted at the Essex Facility is metered. The District has two water diversion permits for the Essex Facility: permit 11715 authorizes direct diversion, and permit 11714 and 11715 authorizes Re-Diversion of previously stored water. Water that is diverted at the Essex Facility at a rate that is greater than discharge from Ruth Lake/Matthews Dam is considered Direct Diversion (permit 11715). Water that is diverted at the Essex Facility at a rate that is less than or equal to the discharge from Ruth Lake/Matthews Dam is considered Re-Diversion (permit 11714 or 11715).

Bypass Flow

Bypass flows are any flows in the Mad River which are not collected to storage. All flows entering Ruth Lake are considered either regulatory storage (stored greater than 30 days) or collections to storage (stored up to 30 days) because they are impounded by R.W. Matthews Dam for some period of time. Permits 11714 and 11715 require a minimum or "bypass" flow of 5cfs at Ruth Dam.

The bypass flows at the Essex Facility are any flows passing the Facility that are not diverted for beneficial use. There is a USGS stream measurement gage directly below the Facility (USGS 11481000 MAD R NR ARCATA CA). The daily average flow is used to estimate the volume of water that is bypassed at the Essex facility.

Data Used

The data used for this analysis was primarily obtained from the District's operational monitoring data. Flow data for the Mad River at Arcata was obtained from the USGS gage station 11481000. The District's operational data included daily water level (Stage) of Ruth Lake at Matthews Dam and total daily water volume produced at the Essex facility. The water produced at the Essex facility includes domestic potable water and industrial water; however, minimal industrial water was produced during the analysis period. The District had production data from the Essex Facility for water years 2016 through 2023 (the most recent complete water year) and Ruth Lake stage data for water years 2012 through 2023. The analysis was performed on eight water years' worth of data, 2016 through 2023. Data prior to 2012 was not readily available to conduct this analysis, however, the District's operations prior to 2009 included higher diversion to storage volumes to meet industrial water demands.

Summary of Analysis

The analysis described above was applied to the seven water years of data, 2016 through 2023. The analysis produced daily volumes for direct diversion at Essex, re-diversion at Essex, bypass flow at Essex, collection to storage at Ruth Lake, regulatory storage at Ruth Lake, withdrawal from storage at Ruth Lake, and regulatory withdrawal at Ruth Lake. The daily volumes for each diversion, release, and bypass were then summed up and reported for each month of the water year. The results are presented in the following eight tables.

Table 1. Summary of Results for Water Year 2016

Month	Collection to Ruth Storage (AF)	Regulatory Storage at Ruth Lake (AF)	Regulatory Withdrawal from Ruth Lake (AF) *	Withdrawal from Ruth Storage (AF) *	Essex (11715) Direct Diversion (AF)	Essex (11714) Re-Diversion (AF)	Essex Bypass Flow (Measured at Arcata Gage 11481000) (AF)
October	0.0	0.0	0.0	3023.0	0.0	851.5	2722.9
November	0.0	0.0	0.0	2783.0	0.0	736.4	7136.3
December	23960.0	0.0	0.0	4338.0	491.0	264.6	271106.8
January	4197.0	8618.0	6407.0	2843.0	485.0	238.6	425057.9
February	202.0	1642.0	3461.0	1969.0	407.1	281.8	122993.1
March	2736.0	8468.0	8860.0	1994.0	532.0	187.6	368905.8
April	0.0	1547.0	169.0	1855.0	404.4	312.4	48759.7
May	0.0	232.0	1578.0	710.0	558.0	247.2	25083.0
June	0.0	11.0	43.0	2002.0	116.8	815.3	7853.6
July	0.0	0.0	0.0	2840.0	8.3	936.3	4315.0
August	0.0	0.0	0.0	3451.0	0.0	961.9	3060.5
September	0.0	0.0	0.0	2968.0	22.5	884.2	2589.6
Grand Total	**31095.0**	**20518.0**	**20518.0**	**30776.0**	**3025.1**	**6717.8**	**1289584.1**

Table 2. Summary of Results for Water Year 2017

Month	Collection to Ruth Storage (AF)	Regulatory Storage at Ruth Lake (AF)	Regulatory Withdrawal from Ruth Lake (AF) *	Withdrawal from Ruth Storage (AF) *	Essex (11715) Direct Diversion (AF)	Essex (11714) Re-Diversion (AF)	Essex Bypass Flow (Measured at Arcata Gage 11481000) (AF)
October	9021.0	173.0	146.0	1220.0	477.9	373.6	35878.2
November	8728.0	0.0	27.0	1789.0	349.4	386.9	122854.2
December	7112.0	3010.0	3010.0	8323.0	271.6	484.0	245057.9
January	5970.0	7198.0	7174.0	5139.0	465.7	276.0	415735.5
February	0.0	14908.0	12872.0	1901.0	631.5	27.1	466869.4
March	0.0	4412.0	4473.0	0.0	745.3	0.0	233097.5
April	0.0	2536.0	3165.0	0.0	700.7	0.0	155147.1
May	0.0	572.0	1942.0	1855.0	492.0	270.1	46133.6
June	0.0	10.0	10.0	3157.0	59.0	760.0	15135.9
July	0.0	0.0	0.0	2935.0	30.1	895.0	6509.4
August	0.0	2651.0	2651.0	2992.0	311.8	635.8	3838.0
September	0.0	0.0	0.0	2950.0	0.0	857.6	3494.7
Grand Total	**30831.0**	**35470.0**	**35470.0**	**32261.0**	**4535.0**	**4966.1**	**1749751.4**

Table 3. Summary of Results for Water Year 2018

Month	Collection to Ruth Storage (AF)	Regulatory Storage at Ruth Lake (AF)	Regulatory Withdrawal from Ruth Lake (AF) *	Withdrawal from Ruth Storage (AF) *	Essex (11715) Direct Diversion (AF)	Essex (11714) Re-Diversion (AF)	Essex Bypass Flow (Measured at Arcata Gage 11481000) (AF)
October	0.0	0.0	0.0	3460.0	10.9	821.7	5665.2
November	9584.0	32.0	32.0	1735.0	425.7	331.6	62205.6
December	55.0	27.0	27.0	2386.0	89.8	670.3	26068.8
January	13955.0	902.0	901.0	200.0	642.2	80.1	122530.9
February	0.0	0.0	1.0	4669.0	0.0	634.6	55027.4
March	5324.0	1004.0	1004.0	728.0	564.8	134.5	223477.7
April	4187.0	427.0	215.0	5339.0	177.7	499.4	151785.1
May	0.0	1383.0	1595.0	2299.0	383.0	314.6	28369.6
June	0.0	0.0	0.0	2904.0	23.9	748.5	11375.2
July	0.0	0.0	0.0	3390.0	8.6	891.9	5191.1
August	0.0	0.0	0.0	3227.0	27.2	893.5	3336.8
September	0.0	0.0	0.0	3068.0	30.5	792.9	2773.5
Grand Total	**33105.0**	**3775.0**	**3775.0**	**33405.0**	**2384.3**	**6813.7**	**697807.0**

Table 4. Summary of Results for Water Year 2019

Month	Collection to Ruth Storage (AF)	Regulatory Storage at Ruth Lake (AF)	Regulatory Withdrawal from Ruth Lake (AF) *	Withdrawal from Ruth Storage (AF) *	Essex (11715) Direct Diversion (AF)	Essex (11714) Re-Diversion (AF)	Essex Bypass Flow (Measured at Arcata Gage 11481000) (AF)
October	0.0	0.0	0.0	2960.0	0.0	832.7	3349.5
November	2674.0	779.0	779.0	4204.0	197.9	559.4	8468.2
December	8753.0	340.0	269.0	0.0	760.1	0.0	46153.4
January	15328.0	0.0	71.0	4512.0	481.0	241.3	177649.6
February	10956.0	7118.0	5488.0	5483.0	359.8	274.8	339732.9
March	10.0	3302.0	3067.0	5134.0	337.8	361.5	231272.7
April	0.0	3374.0	5205.0	667.0	542.7	134.4	149454.5
May	0.0	2537.0	2070.0	1204.0	557.8	139.8	56993.1
June	0.0	0.0	501.0	3066.0	126.7	645.7	18620.8
July	0.0	0.0	0.0	2657.0	0.0	900.6	5796.1
August	0.0	0.0	0.0	2965.0	0.0	920.7	3552.2
September	0.0	0.0	0.0	2878.0	0.0	823.4	3092.0
Grand Total	**37721.0**	**17450.0**	**17450.0**	**35730.0**	**3363.8**	**5834.3**	**1044135.1**

Table 5. Summary of Results for Water Year 2020

Month	Collection to Ruth Storage (AF)	Regulatory Storage at Ruth Lake (AF)	Regulatory Withdrawal from Ruth Lake (AF) *	Withdrawal from Ruth Storage (AF) *	Essex (11715) Direct Diversion (AF)	Essex (11714) Re-Diversion (AF)	Essex Bypass Flow (Measured at Arcata Gage 11481000) (AF)
October	0.0	0.0	0.0	3169.0	0.0	764.2	3885.2
November	0.0	34.0	34.0	2749.0	22.9	727.6	4597.3
December	4077.0	35.0	17.0	347.0	585.7	114.9	55127.6
January	16738.0	0.0	18.0	625.0	643.6	68.9	199110.7
February	0.0	212.0	169.0	2300.0	414.4	251.2	51421.5
March	1009.0	22.0	54.0	433.0	417.0	286.0	23155.0
April	360.0	1475.0	960.0	0.0	668.7	0.0	47837.4
May	0.0	1504.0	1331.0	1182.0	546.1	205.3	42289.6
June	0.0	0.0	699.0	1518.0	161.3	575.3	17736.2
July	0.0	0.0	0.0	2372.0	47.8	832.7	4837.5
August	0.0	0.0	0.0	2489.0	0.0	915.2	2279.8
September	7.0	0.0	0.0	2783.0	27.1	804.4	2201.3
Grand Total	**22191.0**	**3282.0**	**3282.0**	**19967.0**	**3534.6**	**5545.6**	**454479.1**

Table 6. Summary of Results for Water Year 2021

Month	Collection to Ruth Storage (AF)	Regulatory Storage at Ruth Lake (AF)	Regulatory Withdrawal from Ruth Lake (AF) *	Withdrawal from Ruth Storage (AF) *	Essex (11715) Direct Diversion (AF)	Essex (11714) Re-Diversion (AF)	Essex Bypass Flow (Measured at Arcata Gage 11481000) (AF)
October	0.0	0.0	0.0	2495.0	30.2	754.0	1998.5
November	0.0	0.0	0.0	6609.0	0.0	708.7	9021.4
December	2761.0	232.0	108.0	1187.0	403.6	299.9	23825.5
January	13885.0	0.0	0.0	0.0	676.8	0.0	85499.5
February	7772.0	620.0	744.0	3173.0	297.1	345.9	203147.1
March	368.0	1579.0	1378.0	1200.0	465.4	198.8	97259.5
April	368.0	442.0	281.0	0.0	696.0	0.0	20273.1
May	0.0	91.0	453.0	1170.0	249.7	544.1	9099.4
June	0.0	0.0	0.0	1998.0	0.0	819.7	4516.4
July	0.0	0.0	0.0	2942.0	0.0	835.5	2689.0
August	0.0	0.0	0.0	2802.0	0.0	804.9	2045.4
September	0.0	0.0	0.0	2741.0	4.3	773.8	2431.5
Grand Total	**25154.0**	**2964.0**	**2964.0**	**26317.0**	**2823.1**	**6085.3**	**461806.2**

Table 7. Summary of Results for Water Year 2022

Month	Collection to Ruth Storage (AF)	Regulatory Storage at Ruth Lake (AF)	Regulatory Withdrawal from Ruth Lake (AF) *	Withdrawal from Ruth Storage (AF) *	Essex (11715) Direct Diversion (AF)	Essex (11714) Re-Diversion (AF)	Essex Bypass Flow (Measured at Arcata Gage 11481000) (AF)
October	15210.0	0.0	0.0	2732.0	166.7	580.7	24247.9
November	868.0	1048.0	1048.0	3358.0	206.0	470.3	53022.1
December	7284.0	1254.0	1254.0	4282.0	295.3	409.1	128425.8
January	237.0	3557.0	3251.0	1382.0	407.5	296.9	179049.9
February	0.0	90.0	283.0	0.0	644.4	0.0	15619.8
March	0.0	351.0	340.0	34.0	611.2	32.8	12503.8
April	0.0	3471.0	3007.0	124.0	535.1	73.3	94583.8
May	0.0	419.0	1007.0	558.0	510.3	156.1	66575.2
June	0.0	436.0	336.0	201.0	614.3	87.4	18382.8
July	0.0	11.0	111.0	1587.0	104.4	653.0	6748.8
August	0.0	0.0	0.0	2681.0	0.0	804.8	3413.8
September	0.0	2.0	2.0	4147.0	23.8	723.7	3670.0
Grand Total	**23599.0**	**10639.0**	**10639.0**	**21086.0**	**4118.9**	**4288.0**	**606243.8**

Table 8. Summary of Results for Water Year 2023

Month	Collection to Ruth Storage (AF)	Regulatory Storage at Ruth Lake (AF)	Regulatory Withdrawal from Ruth Lake (AF) *	Withdrawal from Ruth Storage (AF) *	Essex (11715) Direct Diversion (AF)	Essex (11714) Re-Diversion (AF)	Essex Bypass Flow (Measured at Arcata Gage 11481000) (AF)
October	0.0	0.0	0.0	2797.0	13.6	705.8	2992.3
November	0.0	150.0	150.0	1400.0	202.6	465.6	8602.3
December	21176.1	1328.0	579.0	329.1	673.7	24.1	166847.6
January	0.0	7749.0	8498.0	7251.0	376.6	378.3	296997.0
February	335.0	1072.0	1072.0	1341.0	427.5	226.7	77262.1
March	3254.0	7667.0	7392.0	859.0	639.8	68.2	330009.9
April	0.0	1423.0	1698.0	1071.0	452.1	241.6	131444.6
May	0.0	791.0	577.0	158.0	701.9	25.7	39048.6
June	0.0	11.0	225.0	497.0	434.3	330.1	10688.9
July	0.0	0.0	0.0	2472.0	30.3	814.7	4551.9
August	0.0	0.0	0.0	2874.0	0.0	883.9	3018.2
September	0.0	432.0	432.0	2441.0	55.0	736.3	3072.4
Grand Total	**24765.1**	**20623.0**	**20623.0**	**23490.1**	**4007.2**	**4900.9**	**1074535.9**

Regards

Patrick Sullivan, PE
Lead Water Engineer

(707) 267-2238
patrick.sullivan@ghd.com

Nathan Stevens, PE
District Engineer

(707) 267-2204
nathan.stevens@ghd.com

Humboldt Bay Municipal Water District

To: Board of Directors
From: John Friedenbach
Date: April 11, 2024

Re: **Approval of Instream Flow 1707 Petition for Change Project**
CEQA Notice of Exemption

History / Background

In accordance with the District's Water Resource Planning efforts to preserve local control and use of our water rights subsequent to the closure of the Samoa Peninsula Pulp Mills, the District has been preparing a State Water Resources Control Board, Division of Water Rights, form 1707 Petition for Change. The purpose of the petition for change is to modify a portion of our existing water rights beneficial use to an Instream Flow Dedication from the R. W. Matthews dam to our points of direct diversion and re-diversion at our pumping facilities at Essex.

The District was awarded a $ 693,408 grant from the Wildlife Conservation Board to fund the costs of the biological and water rights analyses reports to prepare the form 1707 application to the Water Board.

Discussion

CEQA is required for the project. The project is categorically exempt under several CEQA Code Sections. Specifically, they are: 15301 – Existing Facilities Exemption; 15304 – Minor Alterations to Land Exemption; 15307 and 15308 – Actions by Regulatory Agencies for Protection of Natural Resources and/or the Environment. District Special Counsel has analyzed the project and these CEQA exemption codes and their applicability to the project.

Recommendation and Action

Staff recommends that the board approve the project and find that the project is exempt from CEQA under the following code sections: 15301; 15304; 15307; and 15308. Furthermore, the board directs staff to complete and file the required CEQA Notice of Exemption forms.

Notice of Exemption

To: Office of Planning and Research
P.O. Box 3044, Room 113
Sacramento, CA 95812-3044

County Clerk
County of: Humboldt
825 5th Street
Eureka, CA 95501

From: (Public Agency): Humboldt Bay Muncipal Water District
PO Box 95
Eureka, CA 95502-0095
(Address)

Project Title: Form 1707 Petition For Change - Water Rights

Project Applicant: Humboldt Bay Municipal Water District

Project Location - Specific:

Mad River Basin: R.W. Matthews dam to Essex pumping facility (approx. 75 miles)

Project Location - City: Arcata Project Location - County: Humboldt

Description of Nature, Purpose and Beneficiaries of Project:

The Petition for Change requests to expand the purpose of use in its water rights under permits 11714 & 11715 to include use for instream flow purposes of preserving or enhancing fish and wildlife resources.

Name of Public Agency Approving Project: Humboldt Bay Municipal Water District

Name of Person or Agency Carrying Out Project: Humboldt Bay Municipal Water District

Exempt Status: **(check one):**

- ☐ Ministerial (Sec. 21080(b)(1); 15268);
- ☐ Declared Emergency (Sec. 21080(b)(3); 15269(a));
- ☐ Emergency Project (Sec. 21080(b)(4); 15269(b)(c));
- ☒ Categorical Exemption. State type and section number: 15301;15304;15307;15308 See attached.
- ☐ Statutory Exemptions. State code number: ________

Reasons why project is exempt:

See attached explanation.

Lead Agency
Contact Person: John Friedenbach, General Manager Area Code/Telephone/Extension: 707-443-5018

If filed by applicant:

1. Attach certified document of exemption finding.
2. Has a Notice of Exemption been filed by the public agency approving the project? Yes No

Signature: ________ Date: ________ Title: ________

Signed by Lead Agency Signed by Applicant

Authority cited: Sections 21083 and 21110, Public Resources Code.
Reference: Sections 21108, 21152, and 21152.1, Public Resources Code.

Date Received for filing at OPR: ________

Reason why project is exempt:

Existing Facilities Exemption (CEQA Guidelines § 15301)

The Project fits within the exemption for minor alterations to existing facilities. A water distribution system is an existing facility for purposes of this exemption. (See *North Coast Rivers Alliance v. Westlands Water District* (2014) 227 Cal.App.4th 832, 867; *Turlock Irrigation Dist. v. Zanker* (2006) 140 Cal.App.4th 1047, 1065–1066.) The proposed instream flow dedication is not an expansion of use. No changes are proposed with respect to the amount, rate, season, points of diversion, or priority with respect to the existing water rights. The only proposed change is to add a purpose of use to instream preservation or enhancement of fish and wildlife resources. This change does not expand the existing use, nor is there any increase in consumptive use. To the extent that changing the purpose of use to allow for environmental preservation activities would be considered to be an expansion, the change is negligible in nature, akin to activities such as maintenance of streams and stream channels to protect fish and wildlife resources (CEQA Guidelines, § 15301(i)) and other activities listed in the exemption.

Additionally, no exception is applicable to the proposed Project.

Minor Alterations to Land Exemption (CEQA Guidelines, § 15304)

This exemption applies to "minor public or private alterations in the condition of . . . water. . . ." (CEQA Guideline, § 15304.) The Project fits within the criteria applicable to this exemption. The proposed Project would involve altering existing water rights to add a purpose of use. The Project would alter flows along the Mad River in a relatively minor capacity, and in a way that would benefit habitat for fish and wildlife resources in the area. Furthermore, no exception applies that would prevent application of this exemption.

Actions by Regulatory Agencies for Protection of Natural Resources and/or the Environment (CEQA Guidelines, §§ 15307, 15308)

The exemption in CEQA Guidelines section 15307 applies to "actions taken by regulatory agencies as authorized by state law or local ordinance to assure the maintenance, restoration, or enhancement of a natural resource where the regulatory process involves procedures for protection of the environment." The exemption in CEQA Guidelines section 15308 applies to "actions taken by regulatory agencies, as authorized by state or local ordinance, to assure the maintenance, restoration, enhancement, or protection of the environment where the regulatory process involves procedures for protection of the environment."

Water Code section 1707 authorizes the State Water Board to approve an instream flow dedication only where the requested change is "for purposes of preserving or enhancing wetlands habitat, fish and wildlife resources, or recreation in, or on, the water." As such, issuance of an approval pursuant to Water Code section 1707 is therefore an action by the State Water Board acting as a regulatory agency, authorized by state law to assure protection and enhancement of natural resources and the environment.

Further, CEQA Guidelines section 15307 notes that "wildlife preservation activities of the State Department of Fish and Game" are an example of activities falling within the scope of that exemption. Such activities are very similar to the proposed instream flow dedication, which is also a wildlife preservation activity. Therefore, the Project fits within the criteria for these exemptions, and no exception applies.