

**DRAFT**

# **TELEMETERED WATER MONITORING PROJECT**

## **Telemetry Report Part Two**

**Prepared for  
California State Water Resources Control Board**

**April 2025**



Lake Mendocino, Russian River Watershed, California

**DRAFT**

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## ABOUT THIS REPORT

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The Telemetry Research Unit (TRU), a subdivision of the State Water Resources Control Board (SWRCB), contracted with the California Water Data Consortium to establish the Telemetered Water Monitoring Project.

The California Water Data Consortium and its contractors and subcontractors working on this project are referred to as the Consortium Team. This work was scoped in partnership with the SWRCB's TRU and is funded under SWRCB Contract #22-073-300. The total agreement amount of \$2,300,000 represents compensation for multiple written reports. This report is being provided to the TRU to fulfill deliverable 2.4.

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# ACRONYMS AND ABBREVIATIONS

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<b>Acronym or Abbreviation</b>	<b>Definition</b>
AF	acre feet
AF/Yr	acre-feet per year
API	Application Programming Interface
APN	Access Point Name
C3WE	Center for Western Weather and Water Extremes
CalWATRS	California Water Accounting, Tracking, and Reporting System
CCR	California Code of Regulations
CDEC	California Data Exchange Center
CDFW	California Department of Fish and Wildlife
cfs	cubic feet per second
CLSI	California Land Stewardship Institute
CNRA	California Natural Resources Agency
DO	dissolved oxygen
DWR	Department of Water Resources
DWRAT	Drought Water Rights Allocation Tool
EC	electrical conductivity
ERPA	Eel-Russian Project Authority
ET	evapotranspiration
eWRIMS	Electronic Water Rights Information Management System
FERC	Federal Energy Regulatory Commission
FIRO	Forecast Informed Reservoir Operations
GSA	groundwater sustainability agency
GSP	groundwater sustainability plan
IV	image velocimetry
Mendocino RRFC	Mendocino County Russian River Flood Control & Water Conservation Improvement District
NGO	Non-governmental organization

<b>Acronym or Abbreviation</b>	<b>Definition</b>
NMFS	National Marine Fisheries Service
NWS	National Weather Service
O&M	operation and maintenance
PG&E	Pacific Gas and Electric company
POD	point of diversion
PVID	Potter Valley Irrigation District
PVP	Potter Valley Hydroelectric Project
QA/QC	quality assurance/quality control
R3MP	Russian River Regional Monitoring Program
RCD	Resource Conservation District
Reclamation	United States Bureau of Reclamation
RRCP	Russian River Coho Partnership
RWQCB	Regional Water Quality Control Board
SB	Senate Bill
SC	specific conductance
SCADA	Supervisory Control and Data Acquisition
SCWA	Sonoma County Water Agency
SGMA	Sustainable Groundwater Management Act
SWRCB	State Water Resources Control Board
TAC	Technical Advisory Committee
TRU	Telemetry Research Unit
TU	Trout Unlimited
UPWARD	Updating Water Rights Data
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey

# EXECUTIVE SUMMARY

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The Telemetered Water Monitoring Project, led by the California Water Data Consortium and supported by the State Water Resources Control Board's (SWRCB) Telemetry Research Unit (TRU), aims to advance real-time water monitoring in California. This report provides recommendations for the TRU's field telemetry study (Study) to evaluate telemetered water monitoring in the Russian River watershed.

## Project Context and Objectives

As California faces the escalating impacts of climate change, from severe droughts to extreme floods, timely water data is essential for effective management. The SWRCB's TRU initiated a Telemetry Pilot Project to evaluate the operational logistics and network design of real-time water monitoring, including a field study in the Russian River watershed. This report presents a set of recommendations for the Study design and implementation, based on two key inputs: 1) an analysis of current telemetry networks both within California and beyond, and 2) feedback from community members on how telemetry might address technical, environmental, and regulatory challenges within the Russian River watershed.

## Challenges and Opportunities in the Russian River Watershed

The Russian River watershed grapples with water management challenges common across California, including limited data for informed decision-making, unpredictable water availability, regulatory compliance complexities, and difficulty fostering collaboration in rural areas. While community members expressed concerns about data privacy or increased regulatory oversight, many agree that a telemetered water monitoring network could help alleviate some challenges and enable more effective water management. Potential benefits of telemetry include enhanced water rights administration, ecosystem protections, and drought and flood response.

## Summary of Recommendations for Russian River Telemetry Study

### 1. Leverage Telemetry for State Compliance

The Study network should prioritize monitoring sites that could help address state reporting requirements and/or that align with other state-supported monitoring efforts, such as the California Code of Regulations (CCR) 23:931-938 (i.e., Senate Bill 88, Water Measurement Regulations), the Senate Bill 19 Stream Gaging Prioritization Plan 2022, and Sustainable Groundwater Management Act (SGMA). Wherever possible, sites should also be selected to address critical data gaps that can inform state models for drought and flood preparedness.

**2. Test Non-Contact Monitoring Methods**

The Study should assess the potential for emerging non-contact methods for flow and diversion measurement to complement in-stream instrumentation, enhance quality assurance/quality control (QA/QC) approaches, reduce installation costs, minimize environmental impact, and provide more resilient data solutions during extreme weather events.

**3. Test a Variety of Equipment and Methods**

The Study should evaluate a range of monitoring technologies, sometimes side by side, to identify their strengths and limitations. This comparative assessment is critical for giving guidance on the most effective equipment for statewide implementation.

**4. Leverage Local Expertise for Environmental Permitting and Compliance**

The Study should collaborate with established monitoring organizations to expedite permitting processes and minimize environmental disruption. To avoid delays, installations should leverage existing permits wherever possible.

**5. Establish a Comprehensive Data Management System**

The Study should establish a robust data management system to streamline data integration, enhance data quality, and safeguard privacy. Such a system will provide consistent, reliable, and secure data that supports informed decision-making by state and local agencies.

**6. Explore Options for Long-Term Network Sustainability.**

The Study should explore potential governance models and opportunities for integrating with existing regional monitoring programs to ensure long-term success. Sustaining the network will require a governance structure that balances state oversight with local autonomy, as well as financing strategies for ongoing maintenance.

These recommendations are designed to guide the TRU in designing the Study to advance best practices for developing and maintaining effective telemetered water monitoring networks. The Study represents a significant step towards modernizing California’s water monitoring infrastructure, providing a foundation for adaptive, resilient water management across the state. Insights gained from the Russian River Study will inform recommendations for expanding and enhancing telemetered networks statewide, supporting California’s water security and ecological objectives in the face of a changing climate.

# TABLE OF CONTENTS

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<b>About this Report</b> .....	<b>i</b>
<b>Acronyms and Abbreviations</b> .....	<b>iii</b>
<b>Executive Summary</b> .....	<b>v</b>
Project Context and Objectives.....	v
Challenges and Opportunities in the Russian River Watershed.....	v
Summary of Recommendations for Russian River Telemetry Study.....	v
<b>1. Introduction</b> .....	<b>1</b>
1.1 Background.....	1
1.2 Project Goals and Research Objectives.....	1
1.3 Approach.....	3
1.4 Overview of the Russian River Watershed.....	5
Water Management Challenges.....	6
Telemetry Benefits and Concerns.....	6
<b>2. Recommendations for a Telemetered Water Monitoring Network</b> .....	<b>9</b>
2.1 Recommendation 1.....	9
2.1.1 Site and Parameter Selection for Surface Water Diversion Monitoring.....	9
2.1.2 Site and Parameter Selection for Stream and Well Gaging.....	11
2.1.3 Site Selection to Support Tools and Models for Drought and Flood Preparedness.....	21
2.1.4 Sampling Frequency and Data Density.....	22
2.2 Recommendation 2.....	22
2.2.1 Experiment 1: Remotely Sensed Water Consumptive Use Diversion Monitoring.....	22
2.2.2 Experiment 2: Non-Contact Image Velocimetry for Flow Gaging.....	23
2.3 Recommendation 3.....	23
2.3.1 Testing a Diversity of Data Transmission Pathways.....	25
2.4 Recommendation 4.....	25
2.5 Recommendation 5.....	26
2.5.1 Meeting Data Integration Challenges.....	27
2.5.2 Documenting Systems for Statewide Integration.....	27
2.6 Recommendation 6.....	28
2.6.1 Key Governance Elements.....	28
2.6.2 Potential Financing Sources for Sustainability.....	29
2.7 Potential Project Partners.....	30
2.8 Next Steps.....	31
<b>A. Russian River Watershed</b> .....	<b>A-1</b>
A.1 Watershed Context.....	A-1
A.1.1 Climate and Precipitation.....	A-1
A.1.2 Surface Water.....	A-1
Surface Water Diversion and Beneficial Uses.....	A-4
A.1.3 Flooding.....	A-4
A.1.4 Groundwater.....	A-5

	Ukiah Valley Groundwater Basin and Management .....	A-6
	Santa Rosa Plain Groundwater Basin and Management.....	A-6
A.1.5	Geomorphology .....	A-7
A.2	Water Rights .....	A-8
A.2.1	Large Water Rights Holders in the Russian River Watershed.....	A-9
	City of Ukiah .....	A-9
	Eugene J.M. McFadden.....	A-9
	Mendocino County Russian River Flood Control and Water Conservation Improvement District .....	A-9
	Michael Luke Miller .....	A-10
	Potter Valley Irrigation District (PVID) .....	A-10
	Sonoma County Water Agency (Sonoma Water) .....	A-10
	State Water Resources Control Board .....	A-11
A.3	Water Regulations.....	A-11
A.3.1	Surface Water Regulation .....	A-11
	Lake Mendocino/Coyote Valley Dam .....	A-11
	Lake Sonoma/Warm Springs Dam.....	A-14
	Minimum Instream Flow Requirements .....	A-15
A.4	Water Management Activities .....	A-17
A.5	Water Monitoring.....	A-17
<b>B.</b>	<b>Engagement Activity Feedback Summary.....</b>	<b>B-1</b>
B.1	Introduction .....	B-1
B.2	Virtual Informational Meeting: May 2024.....	B-1
B.2.1	Objectives.....	B-1
B.2.2	Agenda .....	B-1
B.2.3	Participants.....	B-2
B.2.4	Methods.....	B-2
B.2.5	Feedback Summary.....	B-3
	Potential Benefits.....	B-3
	Potential Concerns .....	B-3
	Water Management Challenges.....	B-3
	Water Monitoring Data to Support or Improve Challenges.....	B-4
	Questions .....	B-4
B.3	In-person Workshop 1: June 2024.....	B-5
B.3.1	Objectives.....	B-5
B.3.2	Agenda .....	B-6
B.3.3	Participants.....	B-6
B.3.4	Methods.....	B-7
B.3.5	Feedback Summary.....	B-7
	Station 1   Water Management Challenges and Potential Benefits of Telemetered Water Monitoring .....	B-7
	Station 2   Existing Monitoring Networks .....	B-9
	Station 3   Water Monitoring Questions, Problems, and Data Needs .....	B-9
	Station 4   Considerations for Study Participation.....	B-10
B.4	In-person Workshop 2: August 2024.....	B-11
B.4.1	Objectives.....	B-11
B.4.2	Agenda .....	B-11
B.4.3	Participants .....	B-12
B.4.4	Methods.....	B-12
B.4.5	Feedback Summary.....	B-12
B.5	Follow-up Meetings .....	B-19
B.5.1	Objectives.....	B-19
B.5.2	Participants.....	B-19

B.5.3	Feedback Summary.....	B-20
<b>C.</b>	<b>Experiments to Test Non-Contact Methods.....</b>	<b>C-1</b>
C.1	Experiment 1: Diversion Estimates from Satellite-Derived Evapotranspiration Measurements .....	C-1
C.1.1	Introduction.....	C-1
C.1.2	Methods.....	C-2
C.1.3	Considerations for Implementation.....	C-4
C.1.4	Costs .....	C-5
C.2	Experiment 2: Non-Contact Image Velocimetry .....	C-5
C.2.1	Introduction.....	C-5
C.2.2	Methods.....	C-7
Data Acquisition.....	C-7	
Data Processing and Analysis (Image Velocimetry Software) .....	C-7	
Water Discharge Calculation Steps.....	C-7	
Transmission .....	C-7	
C.2.3	Considerations for implementation .....	C-8
C.2.4	Equipment and Costs.....	C-8
Equipment Costs .....	C-8	
Installation Costs .....	C-9	
Maintenance Costs .....	C-9	
<b>D.</b>	<b>Environmental Permitting.....</b>	<b>D-1</b>
<b>E.</b>	<b>Data Management.....</b>	<b>E-1</b>
E.1	Data Pipeline.....	E-1
E.2	Data Quality .....	E-3
E.2.1	Level I Errors .....	E-3
E.2.2	Level II Errors .....	E-4
E.2.3	Level III Errors .....	E-5
E.3	Data Preservation and Restatement.....	E-5
E.4	Data System Context .....	E-6
E.5	Data Exchange Standards and Formats .....	E-7
E.6	Data Privacy and Data Security .....	E-8

## Figures

Figure 1-1	An Overview of the Russian River Telemetry Study Timeline and Key Milestones.....	2
Figure 1-2	Approach Used by the Consortium Team to Develop Telemetry Study Recommendations .....	4
Figure 2-1	Points of Diversion Within the Mendocino RRFC Boundary .....	12
Figure 2-2	Potential Governance Structure to Sustain Telemetry Study Network .....	28
Figure A-1	Russian River Watershed.....	A-2
Figure A-2	Russian River Minimum Instream Flow Requirements Defined in Sonoma Water's Water Rights Permits.....	A-16
Figure C-1	Water balance conceptual model used to estimate diverted water from consumptive use data. Green arrows derive from precipitation and blue arrows derive from applied water.....	C-1
Figure C-2	Proposed workflow to test the accuracy of using OpenET to estimate diverted water for land lacking in-field instrumentation.....	C-4
Figure E-1	Manufacturer-Customer Data Pipeline Scenarios .....	E-2
Figure E-2	Potential Data Architecture for the Telemetry Study.....	E-6

**Tables**

Table 1-1	Summary of Engagement Activities that Supported Telemetry Study Recommendation Development.....	4
Table 2-1	Major Active Water Rights Holders in the Russian River (Face value >10,000 AF/yr).....	10
Table 2-2	Recommended Additional Parameters for Active and Telemetered Stream Gage Stations in the Russian River Watershed .....	13
Table 2-3	Recommended Existing Stream Gage Stations for Upgrade and/or Telemetry in the Russian River Watershed .....	16
Table 2-4	Recommended New Stream Gage Stations in the Russian River Watershed .....	19
Table 2-5	Recommended Equipment to Test in the Study .....	24
Table 2-6	Entities Operating in the Russian River Watershed with Expertise and/or Interest in Telemetered Water Monitoring .....	31
Table A-1	Groundwater Basins in the Russian River Watershed* .....	A-5
Table A-2	Additional Water Regulations, Policies, and Requirements for the Russian River Watershed .....	A-12
Table A-3	Water Management Activities in the Russian River Watershed .....	A-18
Table A-4	Existing Water Monitoring Efforts in the Russian River Watershed .....	A-21
Table B-1	Participant Affiliations for Virtual Informational Meeting (listed alphabetically) .....	B-2
Table B-2	Participant Affiliations for In-Person Workshop 1 (listed alphabetically).....	B-6
Table B-3	Water Management Challenges .....	B-7
Table B-4	Benefits of Telemetry .....	B-8
Table B-5	Participant Affiliations for In-Person Workshop 2 (listed alphabetically).....	B-12
Table B-6	Summary of Feedback on Technical Recommendations .....	B-13
Table B-7	Participant Affiliations for Follow-up Meetings (listed chronologically) .....	B-19

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# 1. INTRODUCTION

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## 1.1 Background

California’s water systems face intense pressure from rising populations, increasing demand, prolonged droughts, and extreme floods. As climate impacts grow, sustainable water management is more crucial than ever. These pressures make timely water monitoring essential for effectively administrating existing water rights, maintaining sufficient water supply, and meeting ecological requirements.

In July 2021, the California State Water Resources Control Board (SWRCB) received funding to modernize the Division of Water Rights data systems. This funding partially established the Updating Water Rights Data (UPWARD) Project, which is developing a modern geospatial data management system (named CalWATRS). This system will house data on streamflow, water usage, diversions, storage, rights, and fees. It will also support integration of data from telemetry-enabled water monitoring devices that automatically collect and transmit data.

The Telemetered Water Monitoring Project is part of the Telemetry Research Unit’s Telemetry Pilot Project. Coordinated by the California Water Data Consortium and supported by its contractors (“Consortium Team”),<sup>1</sup> the Telemetered Water Monitoring Project is developing recommendations for telemetry field studies and for scaling telemetered water monitoring in California. The SWRCB’s TRU will implement a field study in the Russian River watershed based on the recommendations.

As outlined in **Figure 1-1**, the Russian River Telemetry Study will run from 2024 to 2029 and investigate all necessary components of a telemetered data network, including network design, sensor procurement, equipment deployment, maintenance, testing, and any necessary equipment removal and site remediation.

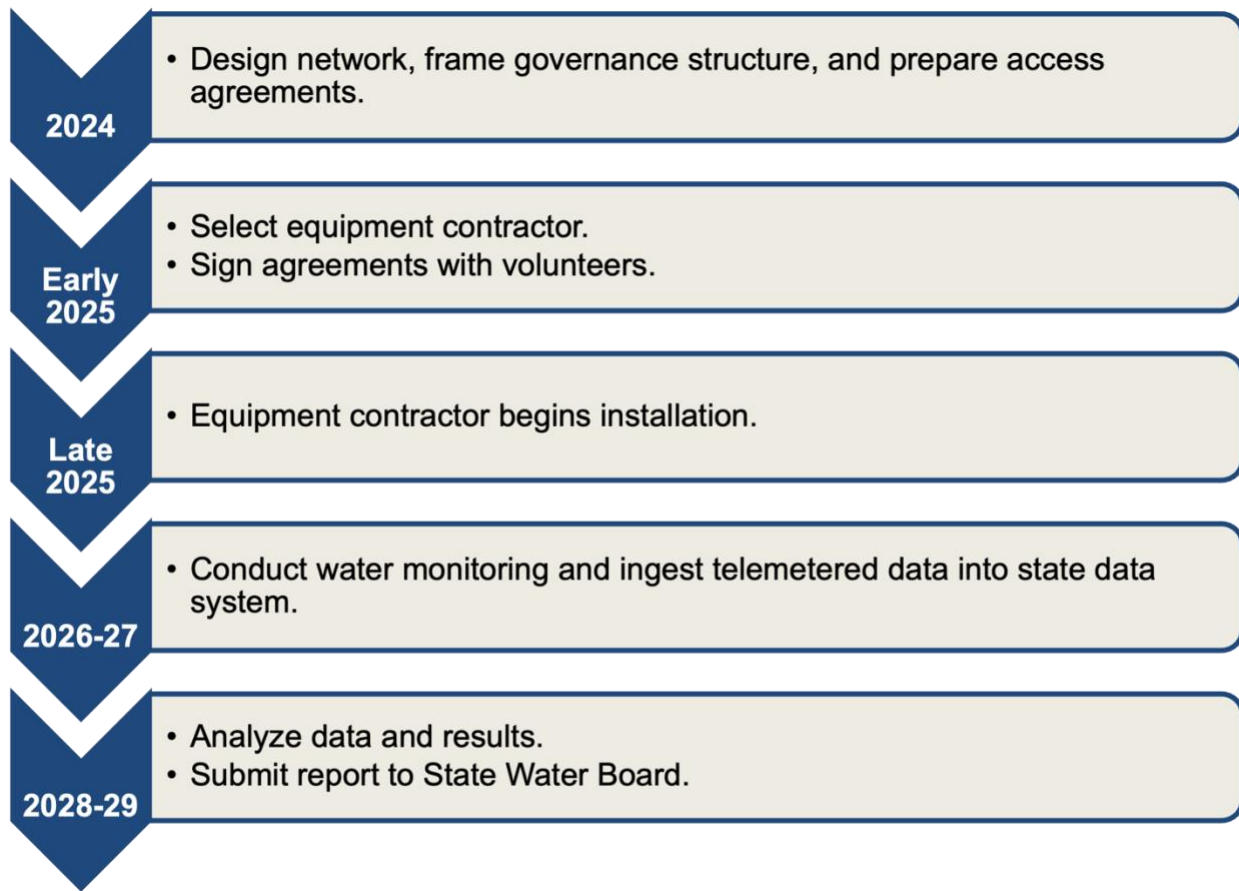
## 1.2 Project Goals and Research Objectives

The Study should be designed to advance best practices for developing and maintaining telemetered water monitoring networks that enable improvements in water management. The effort should improve the SWRCB’s and other decision makers’ understanding of how best to generate consistent, reliable, usable, and interoperable telemetered data at the watershed scale, and the costs and tradeoffs associated with different approaches in building and maintaining watershed-scale networks.

While the Study only spans a few years, a robust exploration of best practices for monitoring networks must consider the long-term costs, benefits, and impact of different design and governance choices on operation over time. Therefore, the Study should evaluate best practices in telemetry not only from a technological standpoint, but also in terms of the design and governance approaches most likely to enhance and sustain network value in the long run.

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<sup>1</sup> The “Consortium Team” is comprised of the California Water Data Consortium, Environmental Science Associates, Davids Engineering, and Kearns & West.



**Figure 1-1**  
An Overview of the Russian River Telemetry Study Timeline and Key Milestones

More specifically, the Study's objectives should be:

1. **Identify and test, in partnership with local entities, the critical monitoring components required to support longer-term decision-making** and sustainable water management in the Russian River watershed.
2. **Test the flow and compatibility** of telemetered data from the water monitoring network into a system like CalWATRS and address challenges with integrating data from existing networks.
3. **Evaluate costs** associated with design, permitting, installation, and ongoing operations and maintenance (O&M) of various sensor and telemetry configurations.
4. **Assess the operational benefits and limitations of different water monitoring sensors, data transmission pathways, and data systems** on data quality, reliability, and data ingestion into a system like CalWATRS.

Outreach and engagement with water agencies/districts, community groups, nongovernmental organizations (NGOs), state and federal agency employees, Tribes, diverters, and other interested parties is critical in meeting these objectives. Encouraging a diverse participant base helps to foster critical relationships between the SWCRB and local entities and creates channels for learning, feedback, and collaboration. Lessons learned in collaboration with diverse Study participants will inform

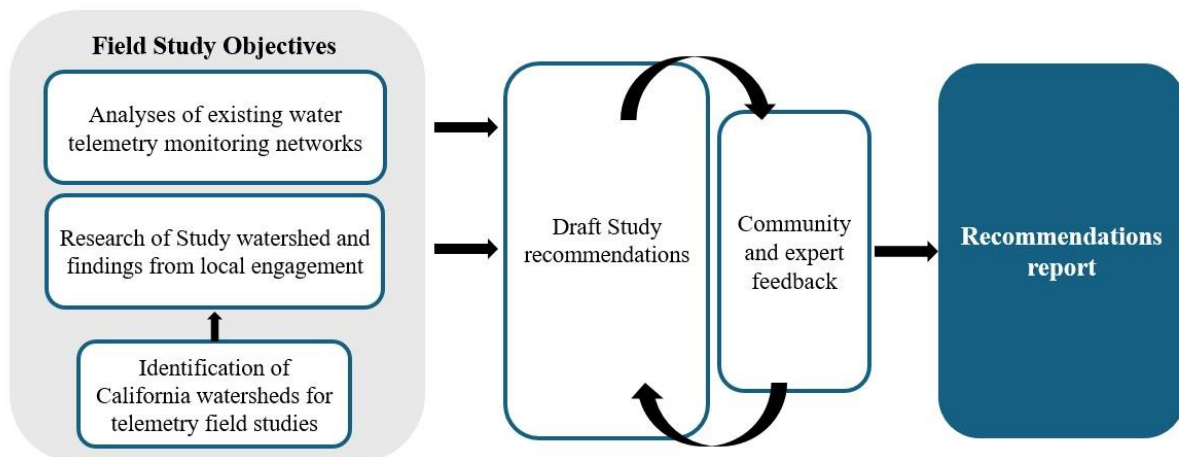
recommendations on expansion of telemetry-based monitoring networks across California, providing a roadmap for future implementation and statewide testing.

## 1.3 Approach

To develop recommendations that meet the project goals, the Consortium Team conducted three analyses:

1. The analysis of current telemetry networks and practices, detailed in Telemetry Report Part One, identified critical insights and considerations for field study design through case study reviews and interviews with state, national, and international water leaders and telemetry experts.
2. The Consortium Team evaluated potential watersheds for the field studies using criteria developed in collaboration with the TRU. In March 2024, the SWRCB approved the Consortium Team’s recommendation of the Russian River watershed for the first field study based on the developed criteria<sup>2</sup>.
3. The Consortium Team conducted a detailed review of the Russian River watershed, focusing on its hydrology, existing water management practices, monitoring networks, and data challenges (**Appendix A**). The Consortium Team built on this background to gather community feedback from local water NGOs, water agencies/districts, state and federal agency employees, Tribes, diverters, and other interested parties about the region’s water management challenges and the potential role of telemetry in addressing them (**Appendix B**).

These analyses, as well as the Study objectives outlined above, served as the foundation of the Consortium Team’s recommendations for the Study (Section 2). **Figure 1-2** provides an overview of the approach undertaken by the Consortium Team in developing these recommendations.



<sup>2</sup> Read more about the selection criteria and analysis of watersheds for the Study: [https://cawaterdata.org/wp-content/uploads/2024/07/TMD\\_Deliverable\\_2.1\\_Watershed-Recs-Memo\\_ADA-508.pdf](https://cawaterdata.org/wp-content/uploads/2024/07/TMD_Deliverable_2.1_Watershed-Recs-Memo_ADA-508.pdf)

**Figure 1-2****Approach Used by the Consortium Team to Develop Telemetry Study Recommendations**

The recommendations developed for the Study build on the above analyses and seek to address critical water management challenges in the region as well as Study goals. Because community participation is crucial to the Study's success, these recommendations were refined with significant input from local community members. Community feedback on draft recommendations was incorporated into the final recommendations presented in this report.

**Table 1-1** summarizes each engagement activity of the Consortium Team, including the purpose and the number of community participants. Participants included NGOs, water agencies/districts, state and federal agency employees, Tribes, diverters, and other interested parties. Further details on outreach and engagement can be found in Appendix B.

**TABLE 1-1  
SUMMARY OF ENGAGEMENT ACTIVITIES THAT SUPPORTED TELEMETRY STUDY RECOMMENDATION DEVELOPMENT**

<b>Timing</b>	<b>Activity</b>	<b>Purpose</b>	<b>Number of Community Participants</b>
May 2024	Virtual Informational Meeting	<ul style="list-style-type: none"> <li>• Inform interested parties about the Study.</li> <li>• Answer questions and capture concerns or other feedback regarding the Study.</li> <li>• Discuss water management challenges within the Russian River watershed that may benefit from a telemetered water monitoring network.</li> <li>• Determine the ongoing engagement interests of participants.</li> </ul>	36
May-August 2024	Follow-up Meetings (concurrent to other activities)	<ul style="list-style-type: none"> <li>• Gather information to inform Study recommendations.</li> <li>• Learn about existing water monitoring networks.</li> </ul>	30
June 2024	Field Trip	<ul style="list-style-type: none"> <li>• Visit Lake Mendocino, diversion sites, and stream gages across the upper Russian River.</li> <li>• See a range of existing monitoring sites.</li> <li>• Meet landowners and hear about their water monitoring challenges and suggestions for improvement.</li> </ul>	-
June 2024	In-person Workshop 1	<ul style="list-style-type: none"> <li>• Respond to questions raised during the May informational meeting.</li> <li>• Introduce the SWRCB Telemetry Research Unit.</li> <li>• Generate discussion regarding key Russian River water management challenges and potential benefits of telemetry at the watershed and individual diverter levels.</li> <li>• Gather input to support development of Study recommendations, including existing networks and data gaps.</li> </ul>	18
August 2024	Field Trip	<ul style="list-style-type: none"> <li>• Visit Lake Sonoma, diversion sites, and stream gages across the lower Russian River.</li> <li>• See existing monitoring sites.</li> <li>• Learn about the monitoring network at Pepperwood Preserve.</li> <li>• Better understand water management and monitoring efforts in the watershed.</li> </ul>	-
August 2024	In-person Workshop 2	<ul style="list-style-type: none"> <li>• Present and solicit feedback on the Study recommendations.</li> <li>• Discuss access agreements (facilitated by SWRCB Telemetry Research Unit).</li> </ul>	15

The Consortium Team also received feedback via email and web-based surveys administered after each workshop and meeting. Appendix B summarizes feedback collected during these activities.

In addition to feedback from community participants, the Consortium Team solicited information from the TRU about the Study timeline, funding, structuring, and other key guidelines that should be considered when developing recommendations for the Study design. Key takeaways include:

- SWRCB is the lead agency responsible for Study implementation. The TRU will procure contractor support through a competitive contracting process, with the scope of work informed by the recommendations provided in this report.
- Individual monitoring site and sensor selection, installation, calibration, and maintenance will be conducted in partnership with the selected contractor. The contractor may also assist with regulatory compliance documentation and environmental permitting.
- Participation in the Study is voluntary and will impact the available monitoring site locations.
- The TRU will provide equipment and technical support. Equipment may transfer ownership or be removed at the project's conclusion, depending on the individual partner agreements.
- Real-time or near real-time data will be collected, subject to QA/QC, and stored in a research database similar to CalWATRS.
- The project budget is approximately \$10 million USD, covering equipment installation, calibration, maintenance, project management, training, technical support, and more. Project costs may vary over time.

## 1.4 Overview of the Russian River Watershed

The Russian River flows 110 miles, and the watershed spans 950,400 acres across Mendocino and Sonoma counties. Key surface water sources include two reservoirs – Coyote Dam and Lake Mendocino, and Warm Springs Dam and Lake Sonoma – owned and operated by the U.S. Army Corps of Engineers (USACE). Additional water supply comes from the Potter Valley Hydroelectric Project (PVP), which imports Eel River water to the Russian River's East Fork through an interbasin diversion. However, imports from the Eel River have declined over time and the project is set for decommissioning, making these imports less reliable in the future.

The Russian River also overlies several groundwater basins and subbasins, including the Ukiah Valley and Santa Rosa Plain basins. Both basins were designated medium priority under the Sustainable Groundwater Management Act (SGMA) and required to form a groundwater sustainability agency (GSA) and groundwater sustainability plan (GSP).

Water uses in the Russian River Watershed include domestic and municipal supply, agriculture, and recreation. The Russian River provides drinking water to over 600,000 people<sup>3</sup> and serves as a primary irrigation source for local agriculture. There are approximately 2,200 diversions supporting riparian and appropriative water rights. The river also supports diverse ecosystems, including approximately 63 species of fish, three of which – Chinook salmon, Coho salmon, and Steelhead trout – are threatened or

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<sup>3</sup> Sonoma Water (n.d.). Water Supply. Retrieved from <https://www.sonomawater.org/water-supply>

endangered.<sup>4</sup> Four designated reaches in the Russian River watershed have minimum instream flow requirements. These include:

- East Fork Russian River (between Coyote Valley Dam and confluence with the main river).
- Main Russian River (between confluence and Dry Creek).
- Main Russian River (between Dry Creek and Pacific Ocean).
- Dry Creek (between Warm Springs Dam and confluence with Russian River).

## Water Management Challenges

The Russian River watershed includes complex water management challenges<sup>5</sup>, many of which are reflective of water management challenges across California. Water management challenges faced include, but are not limited to:

- **Unreliable Water Data for Decision-Making.** Inconsistent data collection methods, including manual systems and limited automated measurement, hamper timely management in a watershed with multiple water uses and diversions.
- **Low Water Supply Availability and Climate Change.** Drought and reduced imports from the Eel River exacerbate water scarcity. Increasing evaporative demands and more variable precipitation under climate change also strain surface and groundwater resources.
- **Regulatory Challenges and Compliance.** Adjusting to a changing hydrology while also facing inconsistent and evolving reporting requirements creates a burden for local managers. Further, regulatory changes don't always keep pace with new technologies or shifting hydrology.
- **Community Coordination and Communication.** Rural engagement for new projects, such as the Study, can be difficult, making partnering with local entities essential for success.

## Telemetry Benefits and Concerns

Potential benefits of telemetry to address water management challenges in the Russian River watershed include, but are not limited to:

- **Enhanced Water Management and Drought Response.** Telemetry can provide timely water supply and use data, supporting more responsive water management strategies.
- **Improved Modeling and Emergency Response.** Telemetry can aid emergency managers by quantifying streamflow during floods to improve emergency response. The data would also benefit watershed-scale flood modeling efforts by providing higher-quality information for model calibration, simulation, and predictive/comparative results.
- **Support for Groundwater Sustainability.** More frequent well level, diversion, and stream gage data would help GSAs improve water budget development and evaluate depletions of interconnected surface water caused by groundwater pumping.

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<sup>4</sup> Russian River Watershed Association. (2024). About Us. Retrieved from <https://www.rrwatershed.org/about/>

<sup>5</sup> For purposes of this report, *water management challenges* are complex issues related to the management of water facing local water users in the Russian River watershed under existing and anticipated regulations and climate conditions.

- **Streamlined Water Rights Management.** Telemetry can streamline reporting for the SWRCB with baseline data and early warnings for water rights administration. Transparent data from a telemetered water monitoring network would also allow the SWRCB and water rights holders to more quickly flag and address data concerns, leading to more proactive resolution of any disputes about water diversion and use estimates.
- **Holistic Ecosystem Management and Protections.** Telemetry supports environmental balance through strategic and responsive reservoir releases to protect fisheries and Tribal interests.

Despite the potential benefits of telemetered water monitoring, concerns about additional telemetered water monitoring in the watershed include:

- **Data Quality.** Some water users question the ability to sufficiently monitor the quality and reliability of telemetered data, and to flag issues with data quality before the data is used for consequential decisions.
- **Higher Costs.** Telemetry requires investment in equipment and subscriptions, which may burden smaller water users.
- **Data Privacy and Security.** Local users have privacy concerns about the handling of sensitive water data.
- **Challenges in Data Transmission.** Remote locations with limited connectivity present technical challenges for data transmission.

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## 2. RECOMMENDATIONS FOR A TELEMETERED WATER MONITORING NETWORK

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Based on the Study goals, analyses, and community engagement described in Section 1, the Consortium Team developed six recommendations for establishing a telemetered water monitoring network in the Russian River watershed. These recommendations create a “win-win” that address the knowledge goals of the Study in a way that also benefits water management in the watershed.

### 2.1 Recommendation 1

**Leverage the Study network design to support State reporting and compliance requirements for local entities.**

The recommended monitoring network includes measurement of surface water points of diversion (PODs), streamflow, water quality, and wells at a variety of strategic locations throughout the watershed. If maintained beyond the Study, this network design would support a variety of local entities in more efficiently meeting State reporting requirements, particularly Senate Bill 88, and support other monitoring efforts as part of Senate Bill 19 and SGMA. This recommendation also supports Study objective 3 of evaluating costs and logistics of telemetered monitoring of a diverse network.

This section outlines the locations and monitoring parameters recommended for the monitoring network within three primary categories:

1. Surface Water Diversions
2. Stream Gages and Wells
3. Other Sites to Support Models and Decision-Support Tools

#### 2.1.1 Site and Parameter Selection for Surface Water Diversion Monitoring

Incorporating a variety of telemetered gaging for surface water diversions in the Study will help assess how telemetered devices can be efficiently and effectively deployed to provide real-time, accurate data for water rights management and compliance with reporting requirements. Diversions are typically gaged for flow rate and volume to comply with regulatory requirements.

While the Russian River is home to thousands of water rights holders, seven entities hold water rights greater than 10,000 acre-feet per year (AF/yr) and are thus subject to stricter reporting requirements under Senate Bill 88. **Table 2-1** provides an overview of these water rights, their beneficial use, and the number of points of diversions associated with each water right. Additional information about each entity in Table 2-1 is provided in Appendix A.

**TABLE 2-1  
MAJOR ACTIVE WATER RIGHTS HOLDERS IN THE RUSSIAN RIVER (FACE VALUE >10,000 AF/YR)**

<b>Water Rights Holder (listed alphabetically)</b>	<b>Face Value Amount of Water Right in Acre-feet per Year (Beneficial Use)</b>	<b>Number of Points of Diversion</b>
City of Ukiah	289,591 (P)	1
	14,479 (M)	3
Eugene McFadden	50,000 (P)	1
Mendocino Russian River Flood Control and Water Conservation Improvement District	130,500 (I, M)	86
Michael Luke Miller	89,321 (P)	1
Potter Valley Irrigation District	22,711 (I)	1
Sonoma County Water Agency	209,953.5 (P)	1
	375,316 (M)	26
	160,044 (I, M)	27
	14,480 (M)	26
	21,779 (I, M)	26
State Water Resources Control Board	800,000 (D, I, M, In, R, FW)	5
	598,188 (D, I, FC)	1
	388,810 (M, including In, D, R)	1
	300,000 (D, I, M, In, R, FW)	1

NOTES: Beneficial use abbreviations: D (Domestic), FC (Flood Control), FW (Fish and Wildlife), I (Irrigation), In (Industrial), M (Municipal), P (Power).

To reduce the number of access agreements that the TRU needs to negotiate and manage over the duration of the Study, the Consortium Team recommends prioritizing partnership with the largest water rights holders who also have multiple points of diversion and diverse beneficial uses. The City of Ukiah, the Mendocino County Russian River Flood Control and Water Conservation Improvement District (Mendocino RRFC), and Sonoma County Water Agency (Sonoma Water) meet these criteria.<sup>6</sup> However, this does not mean that only large diverters should participate in the Study – it is important to publicize the Study broadly and allow an open application process to include a diversity of diverters.

The Mendocino RRFC is especially notable in the diversity of customer types, variety of water diversion points, and monitoring challenges it faces. The complex features provide a useful testing ground for telemetry:

1. Diverse Customer Types - Includes water retailers, business owners, and individuals.
2. Various Diversion Types - Includes direct river diversions, underflow wells, and seasonal and permanent setups.
3. Monitoring Equipment - Covers a range of existing equipment, including both tested and untested technologies.
4. Customer Contract Amounts - Ranges from four to 1,171 AF/Yr.

<sup>6</sup> Filings that list SWRCB as the owner are State Filed Applications, which represent water reserved by the state for large projects. The water is not used and therefore, the SWRCB is not considered a water user that could participate in the Study.

5. Additional Water Rights - Includes riparian, appropriative, and stored water rights, as well as recycled water from the City of Ukiah.
6. Challenging Locations - Includes PODs that are outside of cellular range and/or difficult to access.

Given these characteristics, the Consortium Team recommends including priority PODs within Mendocino RRFC in the Study, with a focus on high-use, retail, or technically challenging PODs.

**Figure 2-1** presents the PODs within the Mendocino RRFC boundary by logger type, equating to a total of over 300 loggers. This figure demonstrates the potential PODs that could be included in the Study, if Mendocino RRFC and other diverters are willing to participate, to create a dense monitoring network in this region. It also shows cellular coverage in the area.

Sonoma Water operates an extensive telemetered monitoring network of seven active and telemetered PODs feeding data into a SCADA system to track operations. An additional 27 PODs are inactive or recorded by Sonoma Water customers. Sonoma Water's water rights and number of diversions are listed in Table 2-1. Sonoma Water may provide an opportunity to test the ingestion of telemetered data into the Study network as a data-only partner (Subsection 2.7).

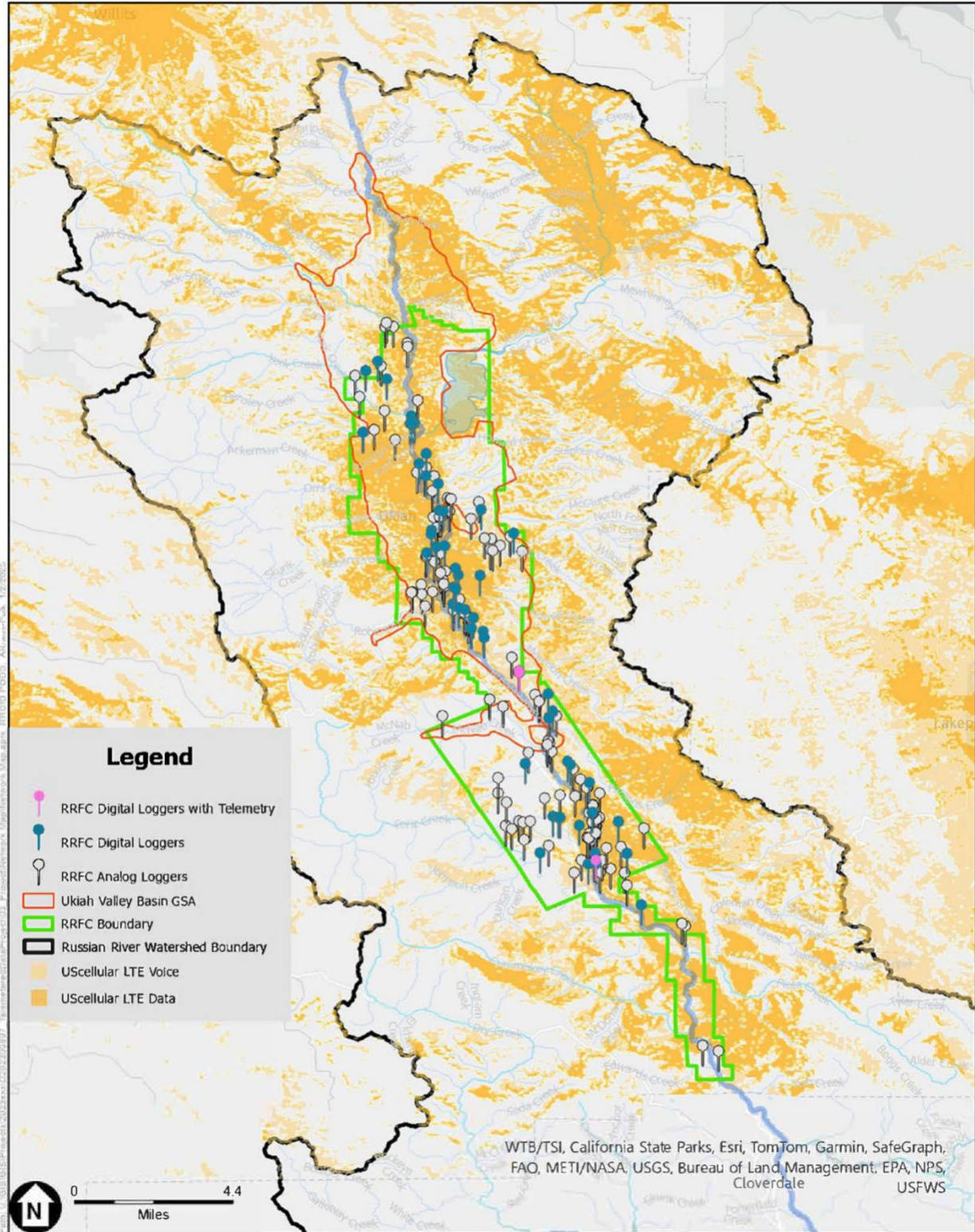
Finally, the City of Ukiah has three telemetered PODs for their water supply operations. These PODs provide an opportunity to install different equipment as part of the Study alongside existing equipment to assess how the new equipment performs under the same circumstances, without disrupting normal operations.

### 2.1.2 Site and Parameter Selection for Stream and Well Gaging

The Study should incorporate the installation of new telemetered stream gages and retrofit existing stream gages with telemetry and additional water quality parameters. **Tables 2-2, 2-3, and 2-4** present recommended stream gage sites in the Russian River watershed, including current and proposed parameters, telemetry status (i.e., active or none), operator, and the source of the recommendation. These sites align with priorities outlined by the *California Stream Gaging Prioritization Plan 2022*, the California Department of Fish and Wildlife (CDFW), the North Coast Regional Water Quality Control Board (NCRWQCB), and the Russian River Regional Monitoring Program (R3MP). These groups have experience in the watershed and have conducted reviews of existing and new stations needed to sustain watershed health. Feedback from local water users, technical advisors, and modelers further supports and expands these recommendations.

Although specific sites are not ranked by priority, the tables are presented in ascending order of intervention required. Table 2-2 shows a list of important existing sites with active telemetry, where the Study could either integrate existing data as-is or incorporate additional recommended water quality parameters. Table 2-3 shows existing sites without telemetry and/or those that would require more extensive maintenance and higher costs to add the recommended parameters (e.g. developing rating curves). Lastly, Table 2-4 shows a list of proposed new sites, where the effort would be greatest in terms of securing permits and installing all new equipment.

These tables are not an exhaustive list of potential sites, and the level of available detail varies; additional follow-up is needed to verify these sites with potential Study partners. Contact information for the operators of each station will be provided to the TRU in a separate document.



SOURCE: ESA, 2024

Telemetered Water Monitoring Project

**Figure 2-1**  
Points of Diversion Within the Mendocino RRFC Boundary

**TABLE 2-2  
RECOMMENDED ADDITIONAL PARAMETERS FOR ACTIVE AND TELEMETERED STREAM GAGE STATIONS IN THE RUSSIAN RIVER WATERSHED**

Station Name	Site Code	Parameters Currently Measured	Parameters to be Added	Telemetry	Operator*	Source of Recommendation
DRY CK BLW LAMBERT BR NR GEYSERVILLE CA	11465240	Stage, flow, temp., DO, SC., pH, turbidity	None	Active	USGS/SCWA	SB 19 <sup>a</sup>
RUSSIAN R NR GUERNEVILLE CA	11467000	Stage, flow, temp., DO, SC, pH, turbidity	None	Active	USGS/SCWA/DWR	SB 19 <sup>a</sup> , R3MP <sup>b</sup>
RUSSIAN R A JIMTOWN CA	11463682	Stage, flow**, temp., DO, SC, pH, turbidity	None	Active	USGS/SCWA	SB 19 <sup>a</sup> , R3MP <sup>b</sup>
RUSSIAN R A DIGGER BEND NR HEALDSBURG CA	11463980	Stage, flow, temp., DO, SC, pH, turbidity	None	Active	USGS/SCWA	SB 19 <sup>a</sup> , R3MP <sup>b</sup>
Upper Eel River above Lake Pillsbury Gage		Stage, flow, temp., turbidity	None	Active	McBain Associates	McBain Associates <sup>c</sup>
Tomki Creek below Lake Pillsbury Gage		Stage, flow, temp.	None	Active	McBain Associates	McBain Associates <sup>c</sup>
Rice Fork above Lake Pillsbury Gage		Stage, flow, temp., turbidity	None	Active	McBain Associates	McBain Associates <sup>c</sup>
Eel River below Scott Dam - E2		Temp., turbidity	None	Active	McBain Associates	McBain Associates <sup>c</sup>
Porter Ck at fish weir	Po03	Stage, flow, temp.	None	Active	TU	TU & RRCP <sup>d</sup> , RRTFMDI&P <sup>e</sup>
Mill Ck above the falls	Mi03	Stage, flow, temp.	None	Active	TU	TU & RRCP <sup>d</sup> , RRTFMDI&P <sup>e</sup>
Mark West Ck below Porter Ck	MW12	Stage, flow, temp.	None	Active	TU	TU & RRCP <sup>d</sup>
EF RUSSIAN R NR CALPELLA CA	11461500	Stage, flow, temp., DO, SC, pH	None	Active	USGS/SCWA	SB 19 <sup>a</sup> , R3MP <sup>b</sup>
RUSSIAN R NR HOPLAND CA	11462500, HOP	Stage, flow, temp., DO, pH, SC, turbidity	None	Active	USGS/USACE	SB 19 <sup>a</sup> , R3MP <sup>b</sup>
RUSSIAN R NR CLOVERDALE CA	11463000	Stage, flow**, temp., DO	None (SB-19), pH (R3MP)	Active	USGS	SB 19 <sup>a</sup> , R3MP <sup>b</sup>
EF RUSSIAN R BLW COYOTE DAM	11462000, CDM	Stage, flow, temp.	None (SB-19), DO, pH(R3MP)	Active	USACE	SB 19 <sup>a</sup> , R3MP <sup>b</sup>
Green Valley Bones Rd	Gv01	Stage, flow, temp.	DO, pH	Active	TU	R3MP <sup>b</sup> , TU & RRCP <sup>d</sup> , RRTFMDI&P <sup>e</sup>
Mill Ck above Wallace Ck	Mi06	Stage, flow, temp.	DO	Active	TU	TU & RRCP <sup>d</sup> , RRTFMDI&P <sup>e</sup>

**TABLE 2-2**  
**RECOMMENDED ADDITIONAL PARAMETERS FOR ACTIVE AND TELEMETERED STREAM GAGE STATIONS IN THE RUSSIAN RIVER WATERSHED**

Station Name	Site Code	Parameters Currently Measured	Parameters to be Added	Telemetry	Operator*	Source of Recommendation
Mark West Ck Below Tarwater Rd	Mw01	Stage, flow, temp.	DO	Active	TU	TU & RRCP <sup>d</sup> , RRTFMDI&P <sup>e</sup>
DUTCH BILL CK AT WESTMINSTER WOODS	DBT	Stage	Temp.	Active	NWS	SB 19 <sup>a</sup>
DOOLEY CK AT OLD TOLL RD NR HOPLAND	DOT	Stage	Temp.	Active	NWS	SB 19 <sup>a</sup>
RUSSIAN R AT GUERNEVILLE BR	GVB, GUL	Stage	Temp.	Active	NWS	SB 19 <sup>a</sup>
MARIPOSA CK ABV TOMKI RD	MRK	Stage	Temp. (SB-19) DO, pH (R3MP)	Active	NWS	SB 19 <sup>a</sup> , R3MP <sup>b</sup>
DRY CK BLW WARM SPRINGS DAM	WRM	Stage	Temp.	Active	USACE	SB 19 <sup>a</sup>
DRY CK NR GEYSERVILLE CA	11465200, DGY	Stage, flow	Temp.	Active	USGS	SB 19 <sup>a</sup>
DRY C NR MOUTH NR HEALDSBURG CA	11465350	Stage, flow	Temp. (SB-19), DO, pH(R3MP)	Active	USGS/SCWA	SB 19 <sup>a</sup> , R3MP <sup>b</sup>
RUSSIAN R NR WINDSOR CA	11465390	Stage, flow	Temp. (SB-19), DO, pH (R3MP)	Active	USGS/SCWA	SB 19 <sup>a</sup> , R3MP <sup>b</sup>
COPELAND C A ROHNERT PARK CA	11465660	Stage, flow	Temp.	Active	USGS/SCWA	SB 19 <sup>a</sup>
RUSSIAN R NR TALMAGE CA	11462080	Stage, flow	Temp.	Active	USGS/SCWA	SB 19 <sup>a</sup>
BIG SULPHUR C A G RESORT NR CLOVERDALE	11463170	Stage, flow	Temp. (SB-19), DO, pH (R3MP)	Active	USGS/Sonoma Co Permit & Res. Mgmt.	SB 19 <sup>a</sup> , R3MP <sup>b</sup>
BIG SULPHUR C NR CLOVERDALE CA	11463200	Stage, flow	Temp. (SB-19), DO, pH (R3MP)	Active	USGS/SCWA	SB 19 <sup>a</sup> , R3MP <sup>b</sup>
RUSSIAN R A GEYSERVILLE	11463500	Stage, flow	Temp. (SB-19), DO, pH (R3MP)	Active	USGS/SCWA	SB 19 <sup>a</sup> , R3MP <sup>b</sup>
MAACAMA C NR KELLOGG CA	11463900	Stage, flow	Temp. (SB-19), DO, pH (R3MP)	Active	USGS/SCWA	SB 19 <sup>a</sup> , R3MP <sup>b</sup>
RUSSIAN R NR HEALDSBURG CA	11464000, HEA	Stage, flow	Temp. (SB-19), DO, pH (R3MP)	Active	USGS/DWR	SB 19 <sup>a</sup> , R3MP <sup>b</sup>
LAGUNA DE SANTA ROSA A STONY PT RD NR COTATI CA	11465680	Stage, flow	Temp. (SB-19), DO, pH(R3MP)	Active	USGS/SCWA	SB 19 <sup>a</sup> , R3MP <sup>b</sup>

**TABLE 2-2**  
**RECOMMENDED ADDITIONAL PARAMETERS FOR ACTIVE AND TELEMETERED STREAM GAGE STATIONS IN THE RUSSIAN RIVER WATERSHED**

Station Name	Site Code	Parameters Currently Measured	Parameters to be Added	Telemetry	Operator*	Source of Recommendation
COLGAN C NR SANTA ROSA	11465690	Stage, flow	Temp.	Active	USGS/SCWA	SB 19 <sup>a</sup>
COLGAN C NR SEBASTOPOL CA	11465700	Stage, flow	Temp. (SB-19), DO, pH(R3MP)	Active	USGS/SCWA	SB 19 <sup>a</sup> , R3MP <sup>b</sup>
LAGUNA DE SANTA ROSA C NR SEBASTOPOL CA	11465750	Stage, flow	Temp.	Active	USGS/DWR	SB 19 <sup>a</sup>
MATANZAS C A SANTA ROSA	11466170	Stage, flow	Temp.	Active	USGS/SCWA	SB 19 <sup>a</sup>
SANTA ROSA C A SANTA ROSA	11466200	Stage, flow	Temp.	Active	USGS	SB 19 <sup>a</sup>
SANTA ROSA C A WILLOW-SIDE RD NR SANTA ROSA	11466320	Stage, flow	Temp. (SB-19), DO, pH (R3MP)	Active	USGS/City of Santa Rosa	SB 19 <sup>a</sup> , R3MP <sup>b</sup>
MARK WEST C NR MIRABEL HEIGHTS CA	11466800	Stage, flow	Temp. (SB-19), DO, pH (R3MP)	Active	USGS/SCWA	SB 19 <sup>a</sup> , R3MP <sup>b</sup>
RUSSIAN R A JOHNSONS BEACH A GUERNEVILLE CA	11467002	Stage	Temp.	Active	USGS	SB 19 <sup>a</sup>
AUSTIN C NR CAZADERO CA	11467200	Stage, flow	Temp.	Active	USGS/SCWA	SB 19 <sup>a</sup>
RUSSIAN R A HIGHWAY 1 BRIDGE NR JENNER CA	11467270	Stage	Temp.	Active	USGS	SB 19 <sup>a</sup>
Green Valley Ck	GMR, 114GV2455	Stage, flow, temp.	DO, pH	Active	NMFS, RWQCB1	R3MP <sup>b</sup>
Mark West Ck	MWS3	None - Inactive	Stage, flow, temp., DO, pH	Possibly Active	CDFW	R3MP <sup>b</sup>
Mill Ck	MLL	Stage, flow, temp.	DO, pH	Active	CW3E	R3MP <sup>b</sup>
White Ck	WHT	Stage, flow, temp.	DO, pH	Active	CW3E	R3MP <sup>b</sup>
Willow Ck	RR-WIL-003.68	Stage, flow, temp.	DO, pH	Possibly Active	CA Sea Grant	R3MP <sup>b</sup>

## NOTES:

- a. California Gage Analysis Priority Watersheds Tool. Retrieved from <https://gispublic.waterboards.ca.gov/portal/apps/webappviewer/index.html?id=8a1049434db74a13b83fbfdbadb88e45>
- b. Russian River Regional Monitoring Program (R3MP). Draft "Initial 5-Year Monitoring Plan." E. Salomone, personal communication, May 21, 2024.
- c. S. Pittman, personal communication, July 29, 2024.
- d. M. van Docto, personal communication, August 8, 2024.
- e. Russian River Tributary Monitoring Data Inventory and Prioritization Report (RRTFMDI&P), 2021. Includes prioritization of sites. B. McFadin, personal communication, May 21, 2024.
- \* Operator refers to the current operator of the parameters currently measured, usually stage and flow. If other parameters are added, other agencies may be responsible for monitoring of those parameters. It is recommended to work with the current operators, R3MP, and NCRWQCB to determine ownership of the monitoring of new parameters.
- \*\* Denotes potential opportunities for Non-Contact Image Velocimetry flow gage co-location. See Recommendation 2 and Appendix C.

Temp.: water temperature

**TABLE 2-3**  
**RECOMMENDED EXISTING STREAM GAGE STATIONS FOR UPGRADE AND/OR TELEMETRY IN THE RUSSIAN RIVER WATERSHED**

Station Name	Site Code	Parameters Currently Measured	Parameters to be Added	Telemetry	Operator	Source of Recommendation
FELIZ C NR HOPLAND CA	11462700 (former)	None - Inactive	Reactivate (SB-19) Flow, temp., DO, pH (R3MP)	None	NMFS	SB 19 <sup>a</sup> , R3MP <sup>b</sup>
DRY C NR YORKVILLE CA	11464400	Stage, flow (pending)	Reactivate (SB-19) DO, pH (R3MP)	None	CW3E	SB 19 <sup>a</sup> , R3MP <sup>b</sup>
RUSSIAN R NR UKIAH CA	11461000, RRU	None - Inactive	Stage, flow**, DO, pH (R3MP), temp. (SB-19)	Active	USACE/USGS	SB 19 <sup>a</sup> , R3MP <sup>b</sup>
GREEN VALLEY CK AT MARTINELLI RD	GMR	Stage	Upgrade*	Active	NWS	SB 19 <sup>a</sup>
WILLOW CK NR 3 <sup>RD</sup> BR	W3B	Stage	Upgrade*	Active	NWS	SB 19 <sup>a</sup>
Powerhouse Canal	114EFRRPH, 11471106	None - inactive	Stage, flow, temp., DO, pH	None	Formerly USGS, RWQCB1	R3MP <sup>b</sup>
Austin Ck	AST1	Temp., DO, pH	Stage, flow	None	SCWA	R3MP <sup>b</sup>
Forsythe Ck		Stage, flow, temp.	DO, pH	Possibly active	Ukiah Valley GSA	R3MP <sup>b</sup>
Lower Porter Ck	Po02	None - Inactive	Reactivate: stage, flow, temp.	None	TU	TU & RRCP <sup>c</sup> , RRTFMDI&P <sup>d</sup>
Porter Ck below releases	Po04	None - Inactive	Reactivate: stage, flow, temp.	None	TU	TU & RRCP <sup>c</sup> , RRTFMDI&P <sup>d</sup>
Upper Porter Ck	Po06	None - Inactive	Reactivate: stage, flow, temp.	None	TU	TU & RRCP <sup>c</sup> , RRTFMDI&P <sup>d</sup>
Dutch Bill at Alliance	Db07	Stage, flow, temp.	None	None	TU	TU & RRCP <sup>c</sup>
Dutch Bill below Tyrone Rd	Db05	Stage, flow, temp.	None	None	TU	TU & RRCP <sup>c</sup> , RRTFMDI&P <sup>d</sup>
Dutch Bill near Grub Ck	Db02	Stage, flow, temp.	DO, pH	None	TU	R3MP <sup>b</sup> , TU & RRCP <sup>c</sup> , RRTFMDI&P <sup>d</sup>
Dutch Bill above Tyrone Rd	Db04	Stage, flow, temp.	None	None	TU	TU & RRCP <sup>c</sup> , RRTFMDI&P <sup>d</sup>
Green Valley Purrington	GV02	Stage, flow, temp.	None	None	TU	TU & RRCP <sup>c</sup>

**TABLE 2-3  
RECOMMENDED EXISTING STREAM GAGE STATIONS FOR UPGRADE AND/OR TELEMETRY IN THE RUSSIAN RIVER WATERSHED**

Station Name	Site Code	Parameters Currently Measured	Parameters to be Added	Telemetry	Operator	Source of Recommendation
Green Valley above Purrington	GV08	Stage, flow, temp.	None	None	TU	TU & RRCP <sup>c</sup>
Green Valley below Harrison		None - Inactive	Reactivate: stage, flow, temp.	None	TU	TU & RRCP <sup>c</sup> , RRTFMDI&P <sup>d</sup>
Mill Ck Felta		None - Inactive	Reactivate: stage, flow, temp.	None	TU	TU & RRCP <sup>c</sup> , RRTFMDI&P <sup>d</sup>
Mill Ck at Mill Ck Lane	Mi08	Stage, flow, temp.	None	None	TU	TU & RRCP <sup>c</sup> , RRTFMDI&P <sup>d</sup>
Mill Ck at Bear Flat	Mi01	Stage, flow, temp.	DO, pH	None	TU	R3MP <sup>b</sup> , TU & RRCP <sup>c</sup> , RRTFMDI&P <sup>d</sup>
Mill Ck below Puccioni Rd	Mi05	Stage, flow, temp.	None	None	TU	TU & RRCP <sup>c</sup> , RRTFMDI&P <sup>d</sup>
Mark West Ck above Porter Ck	Mw02	Stage, flow, temp.	None	None	TU	TU & RRCP <sup>c</sup> , RRTFMDI&P <sup>d</sup>
Mark West Ck below Humbug Ck	Mw10	Stage, flow, temp.	None	None	TU	TU & RRCP <sup>c</sup>
Mark West Ck above van Buren Ck	Mw11	None - Inactive	Reactivate: stage, flow, temp.	None	TU	TU & RRCP <sup>c</sup>
Mark West Ck at Regional Park	MW13	Stage, flow, temp.	None	None	TU	TU & RRCP <sup>c</sup>
Pena 1	Pn01	Stage, flow, temp.	None	None	TU	TU & RRCP <sup>c</sup>
Pena 3	Pn03	Stage, flow, temp.	None	None	TU	TU & RRCP <sup>c</sup>
Willow Ck Upper (above 3 <sup>rd</sup> bridge)	Wi03	Stage, flow, temp.	None	None	TU	TU & RRCP <sup>c</sup> , RRTFMDI&P <sup>d</sup>
Willow Ck Lower	Wi01	Stage, flow, temp.	None	None	TU	TU & RRCP <sup>c</sup>
Willow Ck Middle	Wi02	Stage, flow, temp.	None	None	TU	TU & RRCP <sup>c</sup>
McNab 1a		Stage	Flow	None	CLSI	CLSI <sup>e</sup>
McNab 4		Stage	Flow	None	CLSI	CLSI <sup>e</sup>
McClure		Stage	Flow (CLSI), temp., DO, pH (R3MP)	None	CLSI	R3MP <sup>b</sup> , CLSI <sup>e</sup>
Feliz 2		Stage	Flow	None	CLSI	CLSI <sup>e</sup>
Feliz 3		Stage	Flow	None	CLSI	CLSI <sup>e</sup>

**TABLE 2-3**  
**RECOMMENDED EXISTING STREAM GAGE STATIONS FOR UPGRADE AND/OR TELEMETRY IN THE RUSSIAN RIVER WATERSHED**

Station Name	Site Code	Parameters Currently Measured	Parameters to be Added	Telemetry	Operator	Source of Recommendation
Feliz 4		Stage	Flow	None	CLSI	CLSI <sup>e</sup>
McNab 8		Stage	Flow	None	CLSI	CLSI <sup>e</sup>
Dooley 2		Stage	Flow	None	CLSI	CLSI <sup>e</sup>
Dooley 3		Stage	Flow	None	CLSI	CLSI <sup>e</sup>
Dooley 4		Stage	Flow	None	CLSI	CLSI <sup>e</sup>
Dooley 5		Stage	Flow	None	CLSI	CLSI <sup>e</sup>
West Fork Russian River		Stage	Flow	None	CLSI	CLSI <sup>e</sup>
York		Stage	Flow	None	CLSI	CLSI <sup>e</sup>
Salt Hollow 1		Stage	Flow	None	CLSI	CLSI <sup>e</sup>
Salt Hollow 2		Stage	Flow	None	CLSI	CLSI <sup>e</sup>

## NOTES:

If a number is included (e.g. "Dooley 2"), the number is part of the station name.

- a. California Gage Analysis Priority Watersheds Tool. Retrieved from <https://gispublic.waterboards.ca.gov/portal/apps/webappviewer/index.html?id=8a1049434db74a13b83fbfdbadb88e45>
- b. Russian River Regional Monitoring Program. Draft "Initial 5-Year Monitoring Plan." E. Salomone, personal communication, May 21, 2024.
- c. M. van Docto, personal communication, August 8, 2024.
- d. Russian River Tributary Monitoring Data Inventory and Prioritization Report (RRTFMDI&P), 2021. Includes prioritization of sites. B. McFadin, personal communication, May 21, 2024.
- e. L. Marcus, personal communication, November 22, 2024.

\* In the California Stream Gaging Prioritization Plan 2022, the recommendation for an "upgrade" refers to "adding telemetry or incorporating flow measurement equipment and operation and maintenance tasks necessary to establish high quality flow data, plus additional site-specific needs including adding sensors".

Temp.: water temperature

**TABLE 2-4  
RECOMMENDED NEW STREAM GAGE STATIONS IN THE RUSSIAN RIVER WATERSHED**

Approximate Station Location	Parameters to be Added	Telemetry	Operator	Source of Recommendation
Russian River RSS10	Stage, flow, temp., DO, pH	Needed	SCWA, RWQCB1	R3MP <sup>a</sup>
Copeland Ck CPL1	Stage, flow, temp., DO, pH	Needed	TBD	R3MP <sup>a</sup>
Kellogg Ck KLL1	Stage, flow, temp., DO, pH	Needed	CDFW	R3MP <sup>a</sup>
Mark West Ck MWS2	Stage, flow, temp., DO, pH	Needed	NMFS, RWQCB1	R3MP <sup>a</sup>
Pieta Ck PTA1	Stage, flow, temp., DO, pH	Needed	NMFS	R3MP <sup>a</sup>
Santa Rosa Ck SRS2 (previously USGS 11465800)	Stage, flow, temp., DO, pH	Needed	SCWA, RWQCB1	R3MP <sup>a</sup>
Windsor Ck WND1	Stage, flow, temp., DO, pH	Needed	RWQCB1	R3MP <sup>a</sup>
Austin Ck	Stage, flow, temp., DO, pH	Needed	RWQCB1	R3MP <sup>a</sup>
Dutch Bill Ck	Stage, flow, temp., DO, pH	Needed	RWQCB1	R3MP <sup>a</sup>
Austin Ck - East Austin	Stage, flow, temp.	Needed	TU	TU and RRCP <sup>b</sup>
Austin Ck - Gilliam	Stage, flow, temp.	Needed	TU	TU and RRCP <sup>b</sup>
Austin Ck - Gray	Stage, flow, temp.	Needed	TU	TU and RRCP <sup>b</sup>
Green Valley below Purrington	Stage, flow, temp.	Needed	TU	TU and RRCP <sup>b</sup>
Mill Ck Palmer	Stage, flow, temp.	Needed	TU	TU and RRCP <sup>b</sup>
Pena 5	Stage, flow, temp.	Needed	TU	TU and RRCP <sup>b</sup>
Pena Woods	Stage, flow, temp.	Needed	TU	TU and RRCP <sup>b</sup>
Maacama (5) TBD	Stage, flow, temp.	Needed	TU	TU and RRCP <sup>b</sup>
Bellacana	Stage, flow, temp.	Needed	TU	TU and RRCP <sup>b</sup>
Constellation	Stage, flow, temp.	Needed	TU	TU and RRCP <sup>b</sup>

## NOTES:

If a number is included (e.g. "Pena 5"), the number is part of the station name. If a bracketed number is included (e.g., "Maacama (5)"), the number indicates the number of stations recommended at that approximate location.

a. Russian River Regional Monitoring Program. Draft "Initial 5-Year Monitoring Plan." E. Salomone, personal communication, May 21, 2024.

b. M. van Docto, personal communication, August 8, 2024.

Temp.: water temperature

TBD: to be determined

As the TRU moves ahead with site selection under this recommendation, the following considerations should be kept in mind:

- **Enhance Water Quality Data**

Water quality parameters, particularly water temperature, dissolved oxygen (DO), and pH, are recommended for stream gages in Russian River tributaries that provide critical habitats for Coho salmon and steelhead. Monitoring these parameters will support efforts to maintain healthy aquatic ecosystems and manage habitat conditions for sensitive fish species.

- **Focus on Surface and Groundwater Interactions**

The Study should prioritize monitoring along stream reaches where surface and groundwater interactions are suspected, particularly where such data would address critical data gaps identified by GSAs in the watershed. Recently, the California Legislature approved funding for portions of the California Stream Gaging Prioritization Plan, including installing stream gages to support SGMA implementation, creating opportunities for resource-sharing between programs. The TRU is collaborating with the team responsible for SB19 implementation to identify potential synergies across these efforts.

Two groundwater basins in the Russian River watershed, the Ukiah Valley (DWR Basin 1-052) and the Santa Rosa Plain (1-055.01), are designated as medium priority under SGMA. This designation requires GSAs in these areas to develop and submit a Groundwater Sustainability Plan (GSP). The GSPs of both GSAs contain maps showing high probability of surface and groundwater connectivity along many reaches of the Russian River mainstem and tributaries.<sup>7,8</sup> Both GSPs identified the need for additional data to better understand surface and groundwater interactions. While direct measurements of the flux between surface and groundwater are difficult to make, measured groundwater-level and streambed elevation differences can help identify where interconnected surface waters likely occur.

Both the Ukiah Valley and Santa Rosa Plain GSAs have access to an extensive and expanding groundwater monitoring network, which includes irrigation, residential, and monitoring wells. These sites should be included as part of the Study to enhance understanding of surface and groundwater interactions, along with, where possible, additional monitoring wells near streams paired with stream gages and meteorological stations.<sup>9</sup> Close partnership with GSAs is needed to identify updated data gaps and potential collaboration opportunities with well owners.

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<sup>7</sup> Ukiah Valley Basin Groundwater Sustainability Agency (GSA). (2021, December). *Ukiah Valley Groundwater Sustainability Plan*. December 2021. Retrieved from <https://ukiahvalleygroundwater.org/wp-content/uploads/2023/01/GSP.pdf>. Figure 2.56.

<sup>8</sup> Santa Rosa Plain Groundwater Sustainability Agency. (2021, December). *Santa Rosa Plain Groundwater Sustainability Plan*. Retrieved from <https://santarosaplaingroundwater.org/gsp/>. Figure 3-18e.

<sup>9</sup> In case there are not enough monitoring wells or landowner willingness to participate is insufficient, workshop attendees suggested the use of production wells and abandoned wells to increase groundwater monitoring. However, more work is needed to identify locations that would be useful for understanding surface and groundwater interactions based on proximity to stream gages and/or PODs.

### 2.1.3 Site Selection to Support Tools and Models for Drought and Flood Preparedness

The Study should also deploy stream gages and diversion monitoring in support of ongoing modeling and collaborative efforts to improve water management during drought conditions and periods of excess flows.

One example is the Drought Water Rights Allocation Tool (DWRAT) used in the Upper Russian River Water Sharing Program, which identified the need for more accurate, real-time water-use data to enable effective, timely water management decisions during droughts (**Box 1**). The DWRAT and other models (**Table A-3** in Appendix A) require frequent empirical streamflow and diversion data from wells and surface water to drive computations. Telemetered data can support these models by providing:

1. **Accurate and Timely Data for Major Water Diversions:** Collect measurements on the largest water diversions and demands (see Table 2-1) in the Russian River watershed.
2. **Monitoring for Instream Flow Compliance:** Collect additional measurements on key tributaries like Forsythe Creek and Salt Hollow Creek to monitor minimal instream flows as required by Decision 1610, in support of fish populations, water supply, and agricultural operations.
3. **Data for Potter Valley Project (PVP) Monitoring:** Place gages on Burright Creek to track changes in PVP diversions.
4. **Support for FIRO at Lake Mendocino:** Install gages on Cold Creek (tributary to Lake Mendocino) and in Lake Mendocino to support Forecast Informed Reservoir Operations (FIRO) during high flows and help increase water supply storage in the reservoir. These gages can also inform flood planning and response by providing real-time data on high flows.

#### **Box 1. Water Data to Support Decision-Making**

During drought conditions, water shortages in the upper Russian River can lead to water rights curtailments and significant economic impacts on the community.<sup>1</sup> Initiated in April 2021, the Russian River Water Sharing Program (WSP) is a locally driven approach to manage demands and address shortages. The fundamental basis of the WSP is that more senior water right holders voluntarily forbear their diversions so that junior water right holders may divert water to which they would otherwise not be legally entitled (see also Table A-3).

A main challenge of the WSP was the monthly determination of forbearance thresholds (the required reductions for each participant class to ensure sufficient water was made available for junior water holders). This process proved difficult due to changing hydrology, lack of sufficient and real-time data, and a lack of sufficient staff time to conduct the analysis.

A main recommendation from the 2022 Implementation Report<sup>2</sup> was to improve access to real-time use data to:

1. enable timely and efficient determination of forbearance thresholds;
2. confirm that thresholds are being met, as well as free up water supply when demand is below the threshold;
3. increase transparency to verify water use within the WSP, improve enforcement, and build trust in the program; and
4. improve overall understanding of available water and validate and calibrate existing models.

1 State Water Resources Control Board. (2022). Water Sharing Program 2022. Upper Russian River Watershed. Factsheet. Retrieved from [https://www.waterboards.ca.gov/drought/russian\\_river/docs/2022/2022-rr-water-sharing-program-factsheet.pdf](https://www.waterboards.ca.gov/drought/russian_river/docs/2022/2022-rr-water-sharing-program-factsheet.pdf)

2 Water Sharing Program Steering Committee. (2023, January 31). 2022 Upper Russian River Voluntary Water Sharing Program Implementation Report. Retrieved from [https://www.waterboards.ca.gov/drought/russian\\_river/docs/2022/2022-wsp-implement-report.pdf](https://www.waterboards.ca.gov/drought/russian_river/docs/2022/2022-wsp-implement-report.pdf)

## 2.1.4 Sampling Frequency and Data Density

The Study offers an opportunity to test both the spatial and temporal features of the water monitoring network (i.e., station density and data sampling frequency). The Consortium Team recommends starting with a 15-minute sampling interval for all sensors to balance the value of frequent data collection with the challenges of managing large data volumes. These results will inform long-term sampling recommendations that align with data storage capacity, environmental needs, and decision-making requirements.

## 2.2 Recommendation 2

### **Explore non-contact methods for flow and diversion measurement.**

The Consortium Team recommends that the Study include two experiments to test emerging non-contact methods for measuring flow and diversions. These experiments support Study objectives 1 and 4 to identify and test critical monitoring components and methods that support longer-term sustainable water management in the study watershed and to assess the benefits and limitations of different water monitoring sensors and technologies.

The experiments aim to test the use of non-contact data for:

1. **Enhancing QA/QC Capabilities:** Identify discrepancies between direct and remote measurements, which can indicate sites requiring further investigation or maintenance.
2. **Addressing Data Gaps:** Improve understanding of stream flow and diversions in areas where fewer direct measurement devices are present due to logistical, financial, or other constraints.

The experiments are intended to test ways to complement traditional flow measurement methodologies, which often require direct contact with water, such as pressure transducers for depth or electromagnetic meters for flow through pipes. Traditional flow measurement methods can disrupt ecosystems, are susceptible to damage from high flows or vandalism, and require site access for installation and ongoing O&M, which require expertise and can be costly across large areas. The Study offers an opportunity to assess the ways in which non-contact methods might complement traditional approaches consistent with project goals.

Workshop participants were particularly supportive of this recommendation, with one participant saying, “This field of data collection is ripe for innovation. Such innovations are likely to decrease O&M costs.” There was consensus on co-locating non-contact methods with traditional flow meters, stream gages, and groundwater monitors to assess accuracy, add resolution, and validate their performance. Below are summaries of the two recommended experiments; additional details are available in **Appendix C**.

### 2.2.1 Experiment 1: Remotely Sensed Water Consumptive Use Diversion Monitoring

Experiment 1 would evaluate the relationship between remotely sensed evapotranspiration (ET) measurements (e.g. OpenET) and direct diversion measurements in areas where the volume of applied groundwater and surface water are known. By comparing ET measurements to conventional flow gages, the experiment would assess whether correlations between ET and diversions are strong and consistent

enough to supplement direct measurements for smaller or hard-to-maintain diversions. It could also provide a secondary quality control for in-ground or in-stream sensor data by flagging significantly divergent values for further investigation. Participants recommended testing multiple area sizes and crop types to build trust in the viability of remotely sensed data across the region's diverse landscape. ET is currently used as part of an SB 88 alternative compliance plan in the Sacramento-San Joaquin Delta<sup>10</sup> and as part of the Madera Verification Project to administer groundwater allocation in Madera County GSAs.<sup>11</sup> An extensive and promising intercomparison study was also conducted for OpenET against full path eddy covariance tower datasets located across the U.S.<sup>12</sup>

## 2.2.2 Experiment 2: Non-Contact Image Velocimetry for Flow Gaging

The image velocimetry (IV) approach uses a camera to capture and calculate the speed and direction of water movement across a wide section of the river.<sup>13</sup> This non-contact setup offers broad coverage, uses existing infrastructure (e.g., bridges), and leverages simple camera technology, making it a relatively cost-effective approach to flow gaging that also minimizes environmental impacts of installation and monitoring.

Translation of this velocity data into flow volume measurements also requires concurrent depth measurements at various points across the river using sonar or traditional instruments. The non-contact IV experiment should be deployed in areas with existing stream gages, enabling a direct comparison between IV and conventional measurement methods. Ideally, the comparison could be made at a number of sites with varying characteristics to allow for more robust statistical analysis of the accuracy of the remote option relative to direct measurement with stream gages.

## 2.3 Recommendation 3

### Experiment with a wide range of monitoring network componentry, methodologies, and technologies.

The Study should conduct a robust comparison of monitoring equipment to assess the benefits and limitations of various measurement types and manufacturers. This recommendation directly supports Study objectives 2 and 4 to assess different equipment and to test the flow and compatibility of data into a system like CalWATRS.

<sup>10</sup> State Water Resources Control Board. (2024, September 23) Delta Measurement Experimentation Consortium (DMEC). Retrieved from [https://www.waterboards.ca.gov/water\\_issues/programs/delta\\_watermaster/consortium.html](https://www.waterboards.ca.gov/water_issues/programs/delta_watermaster/consortium.html)

<sup>11</sup> Davids Engineering, Inc. (2024, April). 2023 Madera Verification Project Final Report. Retrieved from [https://www.maderacountywater.com/wp-content/uploads/2024/06/2023\\_Madera\\_Verification\\_Project\\_Report\\_Final\\_20240430.pdf](https://www.maderacountywater.com/wp-content/uploads/2024/06/2023_Madera_Verification_Project_Report_Final_20240430.pdf)

<sup>12</sup> Volk, J.M., Huntington, J.L., Melton, F.S. *et al.* (2024, February). Assessing the accuracy of OpenET satellite-based evapotranspiration data to support water resource and land management applications. *Nat Water* 2, 193–205. doi: <https://doi.org/10.1038/s44221-023-00181-7>

<sup>13</sup> Some IV methods calculate the speed and direction by tracking tiny natural particles like leaves or foam floating downstream. The software uses the IV-derived velocity data to generate a detailed profile of the water flow velocity across the river's cross-section. The water discharge (volumetric flow rate) is then determined by multiplying the water velocity at each point by the corresponding river depth and integrating these values across the entire river width.

**Table 2-5** outlines broad recommendations and notes for data loggers, flow meters, and water quality sensors, selected by the Consortium Team based on field experience, data quality, durability, and compatibility with data delivery/management systems. While not an exhaustive list, these options are compatible with the Study’s goals and data needs at the time of writing. Additional compatible equipment may become available during Study implementation.

Workshop participants expressed mixed opinions about which equipment is “best,” supporting findings from Telemetry Report Part One that no single solution fits all locations. The Consortium Team recommends working closely with experienced and well-respected equipment installers and maintenance teams to:

1. Select the most appropriate sensor(s) or sensor configuration for each monitoring site.
2. Ensure proper sensor installation, calibration, and testing.
3. Develop site documentation and recommended site maintenance plans.

**TABLE 2-5**  
**RECOMMENDED EQUIPMENT TO TEST IN THE STUDY**

Category	Equipment	Notes
<b>Data Loggers</b>		
	Campbell Scientific CRXX	Broad compatibility with many types of sensors/manufacturers and data hosting option.
	Sutron SatLink 3	
	Sutron XLink	
	YSI Storm 3	
<b>Flow Meters</b>		
<b>Pressurized</b>	Electromagnetic Flow Meter	Pulsed output preferred for data logging (for battery power); SDI-12 communication protocol preferred, then MODBUS-ASCII (for solar or AC power).
	Propeller Meter	Only to be used if magnetic interference is a realistic consideration; Pulsed output preferred for data logging (for battery power); SDI-12 communication protocol preferred, then MODBUS-ASCII (for solar or AC power).
	SmartMeter	Power monitoring and power to discharge curve.
<b>Open Channel</b>	Weir/Flume with Radar	Only if a small, temporary weir/flume is possible and radar is applicable; Sufficient head is available to avoid submergence; No variable backwater conditions that will impact the stage-discharge relationship.
	Weir/Flume with Pressure	Only if a small, temporary weir/flume is possible and radar is NOT applicable; Sufficient head is available to avoid submergence; No variable backwater conditions that will impact the stage-discharge relationship.
	Doppler Flow Meter	Only if weir/flume is NOT possible (e.g., not enough headloss available or variable backwater conditions impacting stage-discharge relationship).
<b>Water Quality</b>		
<b>Temperature</b>	Integrated Temperature/Depth Sensor	If site is also used for stream gaging, many in-water sensors (e.g. pressure sensors) offer both temperature and depth measurements from the same instrument. Must be compatible with third-party data logging and/or data hosting options.
	Temperature Sensor	Must be compatible with third-party data logging and/or data hosting options.

**TABLE 2-5**  
**RECOMMENDED EQUIPMENT TO TEST IN THE STUDY**

Category	Equipment	Notes
<b>Dissolved Oxygen (DO)</b>	Integrated DO/Temperature Sensor	Must be compatible with third-party data logging and/or data hosting options.
	Multi-Parameter Sonde	If measuring DO along with EC and/or pH and/or turbidity, a multi-parameter sonde may be the most cost-efficient option. Must be compatible with third-party data logging and/or data hosting options.
<b>Electrical Conductivity (EC)</b>	Integrated EC/Temperature/Depth Sensor	If site is also used for stream gaging, many in-water sensors (e.g. pressure sensors) offer EC, temperature, and depth measurements from the same instrument. Must be compatible with third-party data logging and/or data hosting options.
	Integrated EC/Temperature Sensor	Must be compatible with third-party data logging and/or data hosting options.
	Multi-Parameter Sonde	If measuring EC along with DO and/or pH and/or turbidity, a multi-parameter sonde may be the most cost-efficient option. Must be compatible with third-party data logging and/or data hosting options.
<b>pH</b>	pH Sensor	Must be compatible with third-party data logging and/or data hosting options.
	Multi-Parameter Sonde	If measuring pH along with DO and/or EC and/or turbidity, a multi-parameter sonde may be the most cost-efficient option. Must be compatible with third-party data logging and/or data hosting options.
<b>Turbidity</b>	Turbidity Sensor	Must be compatible with third-party data logging and/or data hosting options.
	Multi-Parameter Sonde	If measuring Turbidity along with DO and/or EC and/or pH, a multi-parameter sonde may be the most cost-efficient option. Must be compatible with third-party data logging and/or data hosting options.

### 2.3.1 Testing a Diversity of Data Transmission Pathways

The Study should test and compare three different data transmission pathways: 1) cellular, 2) radio transmission, and 3) satellite. Section 3.3 of Telemetry Report One provides an overview of these pathways. Cellular transmission should be prioritized, but the Study should also test the longevity and reliability of LoraWAN equipment, radio systems, and existing and emerging satellite technologies to measure flow and volume in areas lacking cell coverage. Up-to-date cellular coverage maps, shown in Figure 2-1, could be used to identify locations without cell reception.

## 2.4 Recommendation 4

**Leverage existing environmental permitting and expertise when exploring the role of telemetry in environmentally sensitive areas.**

Developing networks in ecologically sensitive areas can deliver significant benefits by providing near-real-time information on critical conditions such as water temperature and flow rates, which are vital for species protection. However, installing sensors, flow measurement structures, antennae, or other equipment in environmentally sensitive locations will likely trigger compliance with the California Environmental Quality Act (CEQA); Assembly Bill 52 Native American consultation; and other federal, state, and/or local environmental permits, depending on location and potential environmental impact. Additional details on permitting requirements are available in **Appendix D**. The Consortium Team

recommends collaborating closely with existing monitoring organizations, permitting agencies, and permit streamlining initiatives when exploring monitoring options in these critical stream reaches.

This recommendation supports Study objectives 1 and 3 to identify and test key monitoring components for longer-term sustainable water management in the study watershed and to evaluate potential costs and challenges of different monitoring sites. The information collected will inform the logistical effort needed to develop new monitoring stations where the data are most valuable for decision-making. It will also provide critical insights on regulatory compliance and regulatory streamlining programs that could support the scalability of the Telemetry Pilot Project beyond the Russian River watershed.

This recommendation is particularly relevant for juvenile salmonid rearing areas in the Russian River, with one reviewer noting, “The four priority coho streams (Mill, Green Valley, Mark West, and Dutch Bill) are important sites for telemetered flow data for future curtailment scenarios.” Given the short-term nature of the Study, where some installed equipment will be removed after project completion, it is advised to avoid new or intensive equipment installation in highly sensitive areas that could lead to significant environmental impacts. For example, weirs are not recommended due to their potential environmental disruption. To minimize permitting challenges and environmental impact while still enhancing critical data for environmental management, the Consortium Team suggests the following actions:

1. **Collaborate with Existing Monitoring Organizations:** Partner with organizations already monitoring the watershed to leverage their existing permits and expertise, and to streamline any new permitting processes in high-priority locations. Pursue new permits only if there are volunteer organizations likely to maintain equipment after the Study ends. **Table A-4** in Appendix A lists groups currently conducting monitoring in the Russian River watershed.
2. **Work with Permitting Agencies to Streamline Requirements:** Engage with current permitting agencies to clarify requirements and explore opportunities to streamline the permitting process. Consider conducting pre-project consultations to assess concerns and explore options such as blanket permits or other innovative solutions.
3. **Learn from Permit Streamlining Initiatives:** Connect with individuals and agencies involved in recent permit streamlining efforts, like the Cutting Green Tape Initiative<sup>14</sup> to understand how these processes were developed and assess whether similar approaches could be applied to streamline environmental monitoring permits across California.

## 2.5 Recommendation 5

**Build a data management system to ingest data from various sources, automate error detection, and prioritize data privacy and security.**

Study objective 2 seeks to test the flow and compatibility of telemetered data from the water monitoring network into a data system like CalWATRS and address challenges with integrating data from existing networks. This recommendation lays out a framework to effectively manage the variety of data types likely to be encountered during the Study through the development of an intermediate data system,

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<sup>14</sup> California Natural Resources Agency. (2018). Cutting green tape. Retrieved from <https://resources.ca.gov/Initiatives/Cutting-Green-Tape>

referred to as the Water Data Service. This system would act as a bridge between various sensor data sources and the higher-level data systems developed by the Division of Water Rights. As introduced in Telemetry Report Part One, the Water Data Service is designed to standardize diverse incoming data streams, ensuring that the final flow and volume data transmitted to Division of Water Rights is consistent and comparable in format, semantics, and quality.

### 2.5.1 Meeting Data Integration Challenges

Measurement data will be generated by a wide range of sensors and communications channels, arriving in different formats from raw electrical measurements to refined flow and volume data. These differences must be resolved and standardized to ensure reliable data for decision-making. The Water Data Service would serve as an abstraction layer, simplifying the complexities of raw data for higher-level SWRCB data systems, which can then focus on applying data to various water management needs. The Water Data Service could also address community concerns regarding data privacy, accuracy, archiving, and quality assurance.

**Appendix E** provides additional details on the form and function of the Water Data Service. Some of the key functional responsibilities of the Water Data Service include:

1. **Data Quality Management.** Telemetry programs of this scale will inevitably encounter errors, omissions, and inconsistencies in data. The Water Data Service must include a robust data quality plan that automates error correction whenever possible and flags complex issues for manual review.
2. **Operational Support for Monitoring Networks.** A critical aspect of maintaining data quality is ensuring that all sensors in the network are functioning correctly. The Water Data Service should provide near real-time visibility into the status of each sensor, checking network connectivity and identifying potential equipment failures that need attention.
3. **Logistics and Data Delivery.** Beyond sensor measurements, the Water Data Service must manage metadata, including sensor specifications, site characteristics, location, installation, maintenance history, and landowner contact information. Keeping this metadata up to date facilitates data interoperability. Assuming there will be numerous maintenance technicians from several different organizations that will need to coordinate and update Water Data System metadata based on installation and maintenance activities, the Water Data Service should provide the Application Programming Interfaces (API) necessary for mobile applications supporting in-field repair and diagnostic activities. The Study should also plan for recurring check-ins among project participants (and maintenance technicians) to facilitate coordination on data standards and protocols.
4. **Data Governance.** The Water Data Service must enforce uniform privacy and security protocols, especially for data containing personally identifying information and water usage details considered confidential by diverters. This ensures compliance with California's data privacy laws and protects sensitive information across all data sources and communications channels.

### 2.5.2 Documenting Systems for Statewide Integration

To accommodate the variety of vendors, devices, networks, and sophistication of data-related services involved in the Study, the considerations detailed in Appendix E should be codified in the system's

design and operations. Proper documentation of these systems and procedures will be essential for supporting statewide integration in the future.

## 2.6 Recommendation 6

### **Investigate options for long-term sustainability of the telemetry network established by the Study.**

A telemetered water monitoring network will only be sustainable if it is sustainably funded, governed effectively, and operated in alignment with the diverse management needs and interests of the local community. This recommendation addresses Study objectives 1 and 3 to identify critical management components required to support decision-making and long-term sustainable water management and to assess the costs associated with the ongoing operation and maintenance of a telemetered monitoring network capable of supporting local- and state-level decision making. During the Study, the TRU should work with local and state agencies to explore potential governance structures and funding models for long-term network sustainability that would balance both local and state objectives. Workshop participants emphasized the importance of working within existing structures to avoid “fatigue from interacting with all the different agencies” and redundant information-sharing requirements. Community feedback highlighted the need to: 1) leverage existing organizations across different operational levels and 2) ensure coordination with state agencies while respecting local needs.

### 2.6.1 Key Governance Elements

The Consortium Team recommends exploring the feasibility and structure of a governance plan that would include local, regional, and state-level participation (**Figure 2-2**). This exploration should occur in part via regular meetings between local, regional, and state entities directly involved in the Study or those who might benefit from longer-term sustainability of a telemetered water monitoring network in the watershed. Additional information on the potential role of each proposed governance entity is provided below, along with a brief description of how each one might function within the Russian River watershed.



**Figure 2-2**  
Potential Governance Structure to Sustain Telemetry Study Network

#### **State or State-Affiliated Telemetered Monitoring Council:**

The governance structure could include a state or state-affiliated monitoring council to coordinate telemetry efforts across regions. This council could:

- Develop and promote best management practices.

- Administer state-funded grants and coordinate with federal entities and other telemetered monitoring networks inside and outside of California.
- Host working groups and provide guidance to support successful implementation and maintenance of telemetered water monitoring networks in California.

### **Local Coordinating Entity (or Entities):**

A local coordinating entity within the watershed could support long-term efforts to streamline data reporting processes and improve data consistency. This entity could:

- Collaborate with local monitoring groups to develop a common monitoring vision and identify critical regional data gaps.
- Seek funding, coordinate applications for block grants, and advocate for regional priorities, aligning with local monitoring needs and objectives.
- Tailor best management practices from the state or state-affiliated monitoring council or others to local needs.
- Host working groups to tackle shared challenges, set annual goals, and support ongoing updates.
- Conduct monitoring to fill identified data gaps, if needed.

### **Local Monitoring Entities:**

Section A.5 of Appendix A provides examples of existing monitoring entities within the Russian River watershed. These entities could work with the existing or established coordinating entities to:

- Set a common monitoring vision that meets local needs.
- Identify data gaps.
- Adopt and support telemetered water monitoring data reporting formats.

## **2.6.2 Potential Financing Sources for Sustainability**

Many community members voiced concern about the added responsibility and costs of maintaining telemetered water monitoring site(s). While various funding models exist, additional research is needed to identify viable sources to support the goals of the monitoring network. For example:

- Network components that primarily meet regulatory requirements would likely rely on reporting entities for primary funding, with potential for state or federal assistance.
- Network components exceeding regulatory requirements could leverage diverse funding sources, such as membership fees, local taxes, and grants at the local, state, or federal levels.

Investigating existing funding models, example organizations (e.g., the Delta Consortium), and resources aligned with specific network goals would help support the long-term viability of telemetered water monitoring networks in the Russian River watershed and elsewhere. Report Part One includes discussion on how other U.S. states and other countries have funded water monitoring networks.

## 2.7 Potential Project Partners

The success of the Study will rely heavily on engaged and willing partners to provide land, equipment, and/or data access. Benefits for partners might include (among others):

1. Free new or updated telemetered water monitoring equipment
2. Technical support to configure and connect to state data systems
3. Learning from the Study implementors about how best to manage and report data

For those who already operate telemetered monitoring stations and have interest in participating in the Study for the data management benefits, there is an opportunity to participate as a data-only partner. Benefits for these data-only partners might include (among others):

1. Support with merging different sets of data or data platforms
2. Support with streamlining reporting to the State
3. Learning from the Study implementors about how best to manage and report data

The primary benefit for the Study from data-only partners is access to existing datasets that may be compared with newly acquired data from emerging technologies installed by the TRU in the same location. In addition, data-only partners may provide local advisory capacity on the installation and maintenance of telemetry equipment. These potential partners are willing to share their data with the Study team in exchange for data system support. Some have even volunteered to share their data without receiving anything in exchange.

**Table 2-6** lists entities and agencies operating within the Russian River watershed that have interest or relevant expertise in telemetered water monitoring networks. This list, organized alphabetically by recommendation, serves as a starting point for the TRU's outreach efforts and is not exhaustive. Inclusion on this list does not imply a formal commitment to engage in the Study, rather the table highlights possible partners for the Study. Sensitive information, such as contact information and other details, has been omitted.

**TABLE 2-6**  
**ENTITIES OPERATING IN THE RUSSIAN RIVER WATERSHED WITH EXPERTISE AND/OR INTEREST IN**  
**TELEMETERED WATER MONITORING**

<b>Recommendation</b>	<b>Entity operating in the Russian River watershed</b>
Recommendation 1 - Leverage the Study network design to support State reporting and compliance requirements for local entities.	
Surface Water Diversion Monitoring	City of Ukiah; Mendocino RRFC; Palomino Lakes Mutual Water Company**; Potter Valley Irrigation District; Sonoma Water**, individual landowners.
Stream gaging, water quality monitoring, and groundwater monitoring	California Land Stewardship Institute (CSLI); California Sea Grant; Department of Fish & Wildlife (CDFW); Department of Water Resources (DWR); Gold Ridge Resource Conservation District; Larry Walker and Associates (Ukiah Valley GSA); McBain Associates**, Mendocino County Resource Conservation District (MCRCD); North Coast Regional Water Quality Control Board (NCRWQCB); State Water Resources Control Board; Sonoma County Resource Conservation District; Sonoma County Permit & Resource Management Department; Sonoma Water**, Tribal governments (additional information to be provided separately); Trout Unlimited (TU); USACE (South Pacific Division); USGS (California-Great Basin region)**.
Tools and Models	Center for Western Weather and Water Extremes (C3WE); CLSI; Mendocino RRFC; USACE (South Pacific Division); USGS (California- Great Basin region)**.
Recommendation 2 - Explore non-contact methods for flow and diversion measurement.	C3WE; Delta Experimentation Consortium; OpenET; USACE (South Pacific Division); USGS (California- Great Basin region)**.
Recommendation 3 - Experiment with a wide range of monitoring network componentry, methodologies, and technologies.	TRU to work with selected contractor.
Recommendation 4 - Leverage existing environmental permitting and expertise when exploring the role of telemetry in environmentally sensitive areas.	Cutting Green Tape Initiative Organizations conducting water monitoring (Table A-4 in Appendix A).
Recommendation 5 - Build a data management system to ingest data from various sources, automate error detection, and prioritize data privacy and security.	TRU to work with selected contractor.
Recommendation 6 - Investigate options for long-term sustainability of the telemetry network established by the Study.	Russian River Regional Monitoring Program (R3MP); Russian River Confluence
NOTES:	
** Indicates a potential data-only partner.	

## 2.8 Next Steps

Beyond creating recommendations specific to the Study, the Consortium Team is tasked with adapting these recommendations for broader application in other California watersheds. Future activities, still in the planning stages, may involve a Technical Advisory Committee (TAC) to explore specific aspects of these recommendations that may benefit from further investigation, such as studying potential governance structures and financing options. The TAC will also provide essential technical expertise to support the scaling of these recommendations. Another report is expected for release in 2027 that will contain recommendations on how best to scale the implementation of telemetered water monitoring networks across the state in support of improved water management for all of California.

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# Appendix A. Russian River Watershed

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## A. RUSSIAN RIVER WATERSHED

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The Consortium Team conducted a detailed review of the Russian River watershed to inform the Study recommendations. This section characterizes the Russian River watershed by presenting the watershed context, water rights, water uses, diversions and storage, water regulations, and an overview of water management in the region.

### A.1 Watershed Context

The Russian River watershed encompasses 950,365 acres in Mendocino and Sonoma counties, bounded by the Coast Ranges on the east and west (USGS HUC8 18010110).<sup>15</sup> The mainstem of the Russian River is divided into “upper” and “lower” sections. The upper Russian River begins at the confluence of the east and west forks (below Lake Mendocino) and ends at the river’s confluence with Dry Creek near Healdsburg<sup>16</sup>(**Figure A-1**). The lower Russian River starts below that confluence and ends at the ocean. The following subsections describe the watershed’s climate, precipitation, surface water, groundwater, and geomorphology.

#### A.1.1 Climate and Precipitation

Precipitation patterns in the Russian River watershed reflect a Mediterranean climate, characterized by hot, dry summers and cool, wet winters. The Russian River watershed transitions in its upper reaches from a dry interior to a more temperate coastal climate in its lower reaches. Mean daily summer temperatures range from 72-75 °F inland (with average high temperatures reaching up to 90 °F) to 61-64 °F near the coast, while mean winter temperatures range from 40 to 50 °F. Most precipitation falls as rain during winter months, with the average rainfall ranging from 30-80 inches, depending on location.<sup>17</sup>

#### A.1.2 Surface Water

The Russian River originates approximately 15 miles north of Ukiah in Mendocino County and flows 110 miles to the Pacific Ocean near Jenner in Sonoma County. The principal tributaries from the headwaters downstream are the East Fork Russian River, and Feliz, Pieta, Big Sulfur, Dry, Mark West (including the Laguna de Santa Rosa), Green Valley, and Austin creeks.<sup>18</sup> (see Figure A-1). Two reservoirs owned and operated by the U.S. Army Corps of Engineers (USACE) provide flood protection and water supply storage: 1) Coyote Dam and Lake Mendocino on the East Fork Russian River near Ukiah and 2) Warm Springs Dam and Lake Sonoma on Dry Creek west of Healdsburg. The USACE operates (i.e., makes release decisions) these two federal projects when storage is in the flood control pool. As the local sponsor for the two federal projects, Sonoma County Water Agency (Sonoma Water) operates the two reservoirs when storage is in the conservation pool.

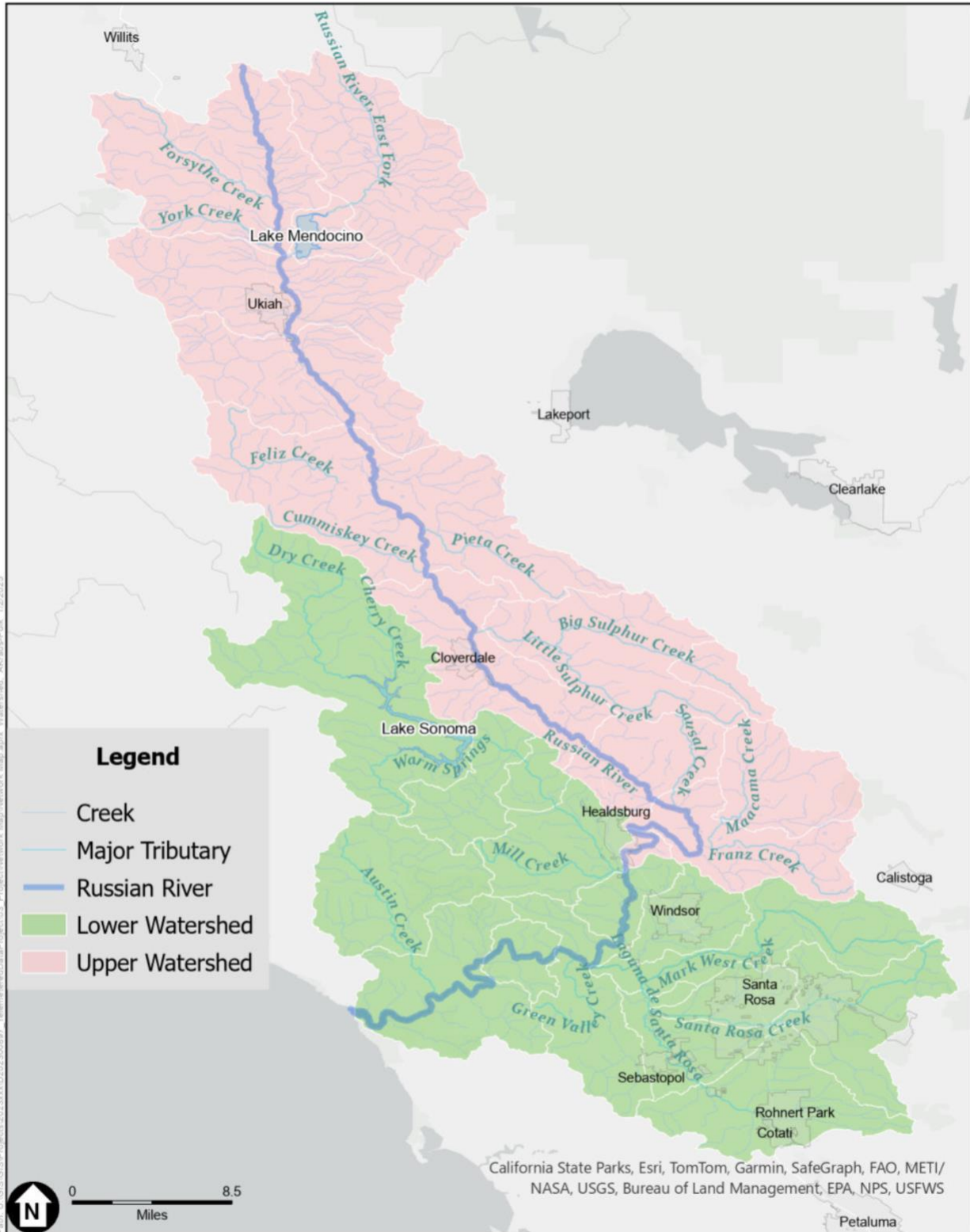
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<sup>15</sup> U.S. Geological Survey. (2024, January 10). Science in your watershed. Retrieved from [https://water.usgs.gov/wsc/a\\_api/wbd/basin18/180101.html](https://water.usgs.gov/wsc/a_api/wbd/basin18/180101.html)

<sup>16</sup> Russian River Water Forum. (2023, June 22). Water rights and water management technical briefing. Retrieved from <https://russianriverwaterforum.org/wp/wp-content/uploads/4-Water-rights-brief-Russian-River.pdf>

<sup>17</sup> North Coast Regional Water Quality Control Board. (2017, October 16). Russian River. Retrieved from [https://www.waterboards.ca.gov/northcoast/water\\_issues/programs/watershed\\_info/russian\\_river/](https://www.waterboards.ca.gov/northcoast/water_issues/programs/watershed_info/russian_river/)

<sup>18</sup> Russian River Watershed Association. (n.d.) About Us. Retrieved from <https://www.rwatershed.org/about/>



SOURCE: ESA, 2024

Telemetered Water Monitoring Project

**Figure A-1**  
Russian River Watershed

The Russian River experiences high flow in the winter and low flow in the summer. During the rainy season, natural drainage and streamflow contribute to most of the Russian River's flow. During the dry season, water releases from Lake Mendocino account for most of the flow.<sup>19</sup> The reach above the confluence of the East Fork Russian River is typically dry or nearly dry from late summer to early fall.

Downstream of Ukiah, flow is nearly constant from June through October at the Hopland, Cloverdale, and Healdsburg gages owing to release flows from Coyote Valley Dam at Lake Mendocino. Sonoma Water makes releases to meet demands from authorized downstream diverters, and to meet minimum instream flow requirements as part of the terms in Sonoma Water's water right permits. The Russian River near Hopland (USGS Gage 11462500) ranges between 1,000 and 2,000 cubic feet per second (cfs) in the winter and approximately 250 cfs in summer.

Before the construction of Coyote Valley Dam in 1958, the Russian River experienced higher median monthly winter flows (which peaked in January) and lower, more variable summer flows. Dam operations have reduced natural variability, muted winter peak flows, and increased summer flows relative to unregulated conditions.

There are four sources of surface water in the Russian River watershed:<sup>20</sup>

- Natural flow, derived from precipitation in the Russian River watershed.
- “Abandoned” Eel River water imported through the Potter Valley Hydroelectric Project (PVP). Construction of the PVP started in 1905. Since it became operational in 1908, the PVP imports water from the Eel River to the Russian River's East Fork through an interbasin diversion for hydroelectric power generation. Pacific Gas and Electric Company (PG&E) owns and operates the PVP under a Federal Energy Regulatory Commission (FERC) license. Some water is delivered to the Potter Valley Irrigation District under a water supply agreement with PG&E. As a condition of its FERC operating license, PG&E is also required to make minimum releases into the East Fork Russian River. Any additional water resulting from hydrogeneration is considered “abandoned water” (because PG&E does not use it). The amount of Eel River water imported through the project has significantly decreased over time because of an amendment to its FERC license and, more recently, failure and/or risk of failure of critical PVP facilities. PG&E is currently preparing a license surrender application and has stated that they intend to remove both dams associated with the project.<sup>21</sup> At that time, all imported water from the Eel River will stop, unless a new diversion facility is built.<sup>22</sup>
- Stored water from Lake Mendocino. Both Sonoma Water and the Mendocino County Russian River Flood Control and Water Conservation Improvement District (Mendocino RRFC) hold 1949 water rights to store water in Lake Mendocino. This water includes the natural flow from the East Fork and the “abandoned” PVP releases. Lake Mendocino has a storage capacity of approximately 122,500 acre-feet, with the top of the water conservation pool at 111,000 acre-feet. Sonoma Water is authorized to use up to 37,544 AF/Yr and Mendocino RRFC is authorized to

<sup>19</sup> Center for Western Weather and Water Extremes. (n.d.). Russian River. Retrieved from [https://cw3e.ucsd.edu/firo\\_russian\\_river/](https://cw3e.ucsd.edu/firo_russian_river/)

<sup>20</sup> Russian River Water Forum. (2023, June 22). Water rights and water management technical briefing. Retrieved from <https://russianriverwaterforum.org/wp/wp-content/uploads/4-Water-rights-brief-Russian-River.pdf>

<sup>21</sup> Russian River Keeper. (2024, January 17). Where the Potter Valley Project stands today: Part I. Retrieved from <https://russianriverkeeper.org/where-the-potter-valley-project-stands-today-part-i/>

<sup>22</sup> See Table A-3. Water Management Activities.

use up to 7,940 AF/Yr. Note that these amounts are for both direct diversion and re-diversion of stored water released from Lake Mendocino.

- Stored water from Lake Sonoma. Lake Sonoma has a total storage capacity of 381,000 acre-feet (AF) and a water supply pool of 245,000 AF. Sonoma Water is the local sponsor and controls the reservoir water supply pool releases, in a manner consistent with Decision 1610 requirements. Lake Sonoma is approximately four times the size of Lake Mendocino and is a crucial source of drinking water for the majority of Sonoma Water’s service area.<sup>23</sup>

## Surface Water Diversion and Beneficial Uses

Surface water is diverted from the Russian River and tributaries through in-river diversion infrastructure and underflow wells. While the term “underflow well” is commonly used to refer to a standard groundwater well that is located such that it pumps water predominantly from the river, the term lacks official definition. Surface water demands may be supplemented by extracting groundwater through pumping supply wells.<sup>24</sup> Groundwater is further discussed in subsection A.1.4.

Beneficial uses of surface water in the Russian River watershed include domestic and municipal supply, agricultural supply, and recreation. The Russian River supplies drinking water to over 600,000 people<sup>25</sup>. The river is a main source of irrigation water for agriculture in the region. The Russian River supports diverse ecosystems, including approximately 63 species of fish, three of which are listed as threatened or endangered: Chinook salmon, Coho salmon, and Steelhead trout.<sup>26</sup> Declines in freshwater species have had significant impacts on Tribes, which rely on many of these species for sustenance, cultural practices, and recreational and commercial fisheries.<sup>27</sup> Recreational uses in the watershed include fishing and boating.

### A.1.3 Flooding

Floods occur during the rainy season from November through April, when large storms have the potential to inundate portions of the alluvial valleys in Ukiah, Hopland, and Alexander adjacent to the river.<sup>28</sup> Floods in the upper Russian River watershed normally develop within 24 to 48 hours after the beginning of the storm and rapidly recede within two to three days.<sup>29</sup> Regulation by the Coyote Valley Dam can reduce peak flows, increasing the lag time between flood peaks entering and exiting Lake Mendocino and increasing the duration of high flow downstream. Historical floods of record include 1955, 1964, 1986, and 1997.

<sup>23</sup> Sonoma Water. (n.d.) Water supply. Retrieved from <https://www.sonomawater.org/water-supply>

<sup>24</sup> Ukiah Valley Basin Groundwater Sustainability Agency. (2021, December). *Ukiah Valley Groundwater Sustainability Plan*. Retrieved from <https://ukiahvalleygroundwater.org/managing-our-groundwater/groundwater-sustainability-plan/>

<sup>25</sup> Sonoma Water. (n.d.) Water supply. Retrieved from <https://www.sonomawater.org/water-supply>

<sup>26</sup> Russian River Watershed Association. (2024). About us. Retrieved from <https://www.rrwatershed.org/about/>

<sup>27</sup> Russian River Water Forum. (2023, April 17). Summary of findings with tribal representatives. Retrieved from <https://russianriverwaterforum.org/wp/wp-content/uploads/RRWF-Tribal-Briefing-Assessment-April-2023.pdf>

<sup>28</sup> USACE. (1986). Coyote Valley Dam and Lake Mendocino, Russian River, California, water control manual: Appendix 1 to master water control manual Russian River basin, California. Sacramento (CA): United States Army Corps of Engineers.

<sup>29</sup> USACE. (1984). Warm Springs Dam and Lake Sonoma, Dry Creek, California, water control manual: Appendix 2 to master water control manual Russian River basin, California. Sacramento (CA): United States Army Corps of Engineers.

## A.1.4 Groundwater

The Russian River overlies several groundwater basins and subbasins as defined by Bulletin 118<sup>30</sup> of the California Department of Water Resources (DWR). As presented in **Table A-1**, the groundwater basins and subbasins range from 1,500 to 86,400 acres. Groundwater from these basins is used for water supply and to supplement surface water right deliveries in drier years. The Ukiah Valley (DWR Basin 1-052) and the Santa Rosa Plain (1-055.01) groundwater basins were designated medium priority under the Sustainable Groundwater Management Act (SGMA), requiring the areas to form a groundwater sustainability agency (GSA) and a groundwater sustainability plan (GSP) (further described below). The other groundwater basins in Table A-1 are designated as low priority and are not required to develop a GSP or form a GSA.

**TABLE A-1**  
**GROUNDWATER BASINS IN THE RUSSIAN RIVER WATERSHED\***

Groundwater Basin/Subbasin (#)	Acres	Basin Priority
Wilson Grove Formation Highlands (1-059)	86,400	Very low
Santa Rosa Valley – Santa Rosa Plain (1-055.01)	81,284	Medium
Ukiah Valley (1-052)	37,500	Medium
Alexander Valley - Alexander Area (1-054.01)	24,500	Very low
Santa Rosa Valley - Healdsburg Area (1-055.02)	15,400	Very low
Sanel Valley (1-053)	5,570	Very low
Potter Valley (1-051)	8,243	Very low
Lower Russian River Valley (1-060)	6,600	Very low
Alexander Valley - Cloverdale Area (1-054.02)	6,500	Very low
Santa Rosa Valley – Rincon Valley (1-055.03)	5,600	Very low
Kenwood Valley (2-019)	5,135	Very low
Knights Valley (1-050)	4,100	Very low
McDowell Valley (1-056)	1,500	Very low

NOTES:

Displayed by size. Source: DWR. (2003). California Groundwater: Bulletin 118. State of California, Sacramento, CA.

The DWR approved the Ukiah Valley Basin GSP on July 27, 2023, and the Santa Rosa Plain GSP on January 26, 2023. As part of the approval process for the Ukiah Valley Basin, the DWR reviewed the GSP and released a Statement of Findings Regarding the Approval of the Plan with several recommended corrective actions, including providing additional details and discussion related to the water budget and continuing to fill data gaps, collect additional monitoring data, and coordinate with resources agencies and interested parties to understand beneficial uses and users that may be impacted by depletions of interconnected surface water caused by groundwater pumping.<sup>31</sup>

<sup>30</sup> California's Groundwater (Bulletin 118) is the State's official publication on the occurrence and nature of groundwater in California. Retrieved from [https://data.cnra.ca.gov/dataset/calgw\\_update2020](https://data.cnra.ca.gov/dataset/calgw_update2020)

<sup>31</sup> California Department of Water Resources Sustainable Groundwater Management Office. (2023, July 27). Statement of findings regarding the approval of the Ukiah basin groundwater sustainability plan. Retrieved from <https://ukiahvalleygroundwater.org/wp-content/uploads/2023/11/2023-07-27-Ukiah-Valley-Basin-GSP-Determination-v2.pdf>

## Ukiah Valley Groundwater Basin and Management

The Ukiah Valley groundwater basin encompasses a surface area of 37,500 acres (59 square miles) and is 22 miles long and 4.6 miles wide at its widest section (just north of the City of Ukiah). The Russian River flows through the entire length of the Basin and is joined by several smaller tributaries. The Basin is bounded by the Mendocino Range of the Coastal Ranges and the Sanel Valley Groundwater Basin (DWR Basin 1-53) to the south. The Ukiah Valley groundwater basin has a direct hydraulic connection with the Sanel Valley Groundwater Basin.

The City of Ukiah is the only incorporated city within the Basin. Most of the land within the basin is privately owned except for small California Tribal Reservations and Rancheria areas, some State-owned land, and Federally-owned lands in proximity of Lake Mendocino. There are 16 water agencies in the Ukiah Valley groundwater basin. The Ukiah Valley GSP lists the major ones to be the Mendocino RRFC, City of Ukiah, Millview County Water District, Redwood Valley County Water District, Rogina Water Company Inc., Willow County Water District, Calpella County Water District, City of 10,000 Buddhas, Flight Ridge, Lake View Mutual Company, and Yokayo Tribe Water System.<sup>32</sup>

Because the water table in parts of Ukiah Valley can be relatively shallow, surface waters and groundwater are often interconnected.<sup>33</sup> According to the Ukiah Valley GSP, “28 percent of the 50-meter streambed segments are connected to groundwater in [the] fall and 37 percent of the streambed segments are connected to groundwater during one or more representations in the spring”, especially along the Russian River mainstem and in the northern portion of the groundwater basin.<sup>34</sup>

## Santa Rosa Plain Groundwater Basin and Management

The Santa Rosa Plain Groundwater Subbasin, one of three subbasins of the Santa Rosa Valley Groundwater Basin, encompasses a surface area of 80,000 acres (125 square miles). It is bounded on the west by the Mendocino Range and on the east by Sonoma Mountains and Mayacamas Mountains. Beyond the city limits, the landscape is marked by native vegetation, rural properties, and agricultural activities (predominantly vineyards, but including nurseries, dairies, and row crops). The main streams in the Subbasin are Mark West Creek, Santa Rosa Creek, and Laguna de Santa Rosa, which drain an area of 262 square miles.<sup>35</sup>

Local agencies with jurisdiction in the Subbasin include the Santa Rosa Plain GSA; Town of Windsor; Cities of Cotati, Rohnert Park, Santa Rosa, and Sebastopol; Gold Ridge RCD, Sonoma RCD, Sonoma

<sup>32</sup> Ukiah Valley Basin Groundwater Sustainability Agency. (2021, December). *Ukiah Valley Groundwater Sustainability Plan*. Retrieved from <https://ukiahvalleygroundwater.org/managing-our-groundwater/groundwater-sustainability-plan/>

<sup>33</sup> In hydraulically connected systems, the groundwater table is in contact with the surface water of a river or stream. The relative elevations between the groundwater table and surface water level and the hydraulic conductivity of the streambed materials control the exchange of water between groundwater and surface water. Pumping of groundwater from wells can result in the depletion of streamflow. Factors that control the time response of streamflow depletion to groundwater pumping include the geologic structure, dimensions, and hydraulic properties of the groundwater system; the locations and hydrologic conditions along the boundaries of the groundwater system, including streams; the horizontal and vertical distances of wells from the streams.

<sup>34</sup> Ukiah Valley Basin Groundwater Sustainability Agency. (2021, December). *Ukiah Valley Groundwater Sustainability Plan*. Retrieved from <https://ukiahvalleygroundwater.org/managing-our-groundwater/groundwater-sustainability-plan/>. Refer to Figures 2.53-2.56.

<sup>35</sup> Santa Rosa Plain Groundwater Sustainability Agency. (2021, December). *Santa Rosa Plain Groundwater Sustainability Plan*. Retrieved from <https://santarosaplaingroundwater.org/gsp/>

Water; and County of Sonoma. Tribal lands include lands owned by the Federated Indians of Graton Rancheria and by the Lytton Band of Pomo Indians. State lands include Sonoma State University and several state parks and preserves. There are no federally owned lands within the Subbasin.

## A.1.5 Geomorphology

The current geomorphic conditions of the Russian River and Dry Creek reflect the evolution and intensity of current and past Euro-American land uses. Prior to European settlement in 1850, forests covered much of the Russian River and Dry Creek valleys, which were subject to dynamic fluvial interaction and characterized by large gravel bars, forested islands, side-channels, and sloughs. These landforms became less prevalent and the watercourses less dynamic as timber harvest, grazing, agriculture, gravel mining, and water storage and water regulation increased. In response, the Russian River and Dry Creek incised into their alluvial valleys, and their channels changed from relatively wide and shallow to narrow and deep, which simplified or eliminated fluvial landforms that provided habitat for aquatic and riparian biota.<sup>36</sup> Historical topographic maps and aerial photography show channel planform evolving from a sinuous channel surrounded by a wide riparian area to a straight channel surrounded by stabilization measures, agriculture, and gravel mining.

Levees constructed in the 1930s confined a portion of the Russian River from the Cloverdale Airport to Big Sulphur Creek. The USACE and local interests began channel maintenance activities in 1959 after the construction of Coyote Valley Dam.<sup>37</sup> In conjunction with the Coyote Valley Dam project, USACE constructed channel stabilization works from 1956 to 1963 that included channel clearing, pilot channels (conversion of a meander to a straight portion of river), bank protection works (including anchored steel jacks and wire mesh gravel revetments), and check dams.<sup>38</sup> The largest geomorphic change in the Russian River channel that affects water flows is channel incision. The bed of the mainstem Russian River has eroded nearly 30 ft in elevation from its historic condition largely due to the construction of the Coyote Valley Dam and implementation of USACE's dredging and channel straightening projects. Channel incision has significantly lowered the groundwater level in Ukiah Valley. Additionally, the incision of the mainstem river has migrated up tributaries, eroding out numerous stream channels.<sup>39</sup> The effects of incision on surface and groundwater interactions and potential implications on aquatic habitats are further detailed by the Russian River Independent Science Review Panel.<sup>40</sup>

<sup>36</sup> Sonoma County Water Agency. (2016, July). *Fish Habitat Flows and Water Rights Project Draft Environmental Impact Report*. Retrieved from <https://evogov.s3.amazonaws.com/185/media/165189.pdf>

<sup>37</sup> Florsheim JL, & Goodwin P. (1995). *Geomorphic and hydrologic conditions in the Russian River, California: Historic trends and existing conditions*. [place unknown]: California State Coastal Conservancy, Mendocino County Water Agency, Circuit Rider Productions, Inc.

<sup>38</sup> U.S. Army Corps of Engineers (USACE) San Francisco District. (1997). *Russian River Ecosystem Restoration Reconnaissance Report, Mendocino and Sonoma Counties, California*. San Francisco, CA.

<sup>39</sup> Russian River Independent Science Review Panel. (2016). *Conceptual Model of Watershed Hydrology, Surface Water and Groundwater Interactions and Stream Ecology for the Russian River Watershed, Executive Summary*. Retrieved from [http://www.russianriverisrp.org/Downloads/ISRP\\_Executive%20Summary\\_Final.pdf](http://www.russianriverisrp.org/Downloads/ISRP_Executive%20Summary_Final.pdf)

<sup>40</sup> Russian River Independent Science Review Panel. (2016). *Conceptual Model of Watershed Hydrology, Surface Water and Groundwater Interactions and Stream Ecology for the Russian River Watershed*. Retrieved from [http://www.russianriverisrp.org/Downloads/ISRP\\_FINAL\\_REPORT.pdf](http://www.russianriverisrp.org/Downloads/ISRP_FINAL_REPORT.pdf)

## A.2 Water Rights

California law distinguishes between surface water and groundwater even though they are typically hydrologically connected.<sup>41</sup> In California, there are two basic types of surface water rights: 1) riparian water rights that come with the ownership of land adjacent to a water source wherein owners of land adjacent to a stream have the right to make reasonable use of a correlative share of the natural flow stream; and 2) appropriative water rights defined as “first in time, first in right” principle water rights secured through a permit issued by the SWRCB whereby a user may take water from a particular source without regard to the contiguity of the land to the source.<sup>42</sup> The permit contains terms and conditions for use of the water. Actual water use is reported to the State Board and is publicly available on the California State Water Resources Control Board’s electronic Water Rights Information Management System (eWRIMS).

The following types of water rights broadly apply to the Russian River watershed, as outlined in the Russian River Water Forum 2023 report.<sup>43</sup> Information on the largest water rights holders in the Russian River watershed is provided in section A.2.1.

- **Riparian water rights.** Properties adjacent to a river possess riparian rights. These rights are linked exclusively to a river’s natural flow. In the case of the Russian River, riparian rights do not extend to “abandoned Eel River water” from the PVP or water released from storage. In scenarios where the only water present is PVP abandoned water or releases from Lake Mendocino, those with riparian rights are not legally permitted to divert this water.
- **Pre-1914 appropriative water rights.** Appropriative water rights acquired before 1914 do not require a water right permit unless the rights holder has increased their use of water under the right since 1914. There are about 58 water rights holders in the Russian River watershed with pre-1914 water rights, some of whom hold more than one pre-1914 right.<sup>44</sup>
- **Pre-1949 appropriative water rights.** The year 1949 is the priority date for Sonoma Water’s and Mendocino RRFC’s rights to store water in Lake Mendocino and deliver it for later use. Pre-1949 appropriate rights generally have priority over Sonoma Water and Mendocino RRFC to natural flows and PVP abandoned water. They do not include rights to water stored from either natural flows or PVP releases from Lake Mendocino unless a specific contract or arrangement exists with Sonoma Water or Mendocino RRFC.
- **Post-1949 appropriative water rights and “10,000 AF/Yr reservation.”** Generally, post-1949 water rights are subordinate to the rights held by Sonoma Water and the Mendocino RRFC for storing water in Lake Mendocino and subsequent use. However, there are notable exceptions. A provision in Sonoma Water’s water-right permit reserves 10,000 AF/Yr of Lake Mendocino water specifically for post-1949 appropriators in Sonoma County within the Russian River valley. The SWRCB has issued numerous post-1949 permits to these appropriators. A significant portion of the “10,000-AF/Yr reservation” has been utilized or is in pending water right applications. The

<sup>41</sup> State Water Resources Control Board. (2024). Water rights. Retrieved from [https://www.waterboards.ca.gov/waterrights/board\\_info/faqs.html#groundwater](https://www.waterboards.ca.gov/waterrights/board_info/faqs.html#groundwater)

<sup>42</sup> State Water Resources Control Board. (2018). Water words – glossary and definitions. Retrieved from [https://www.waterboards.ca.gov/publications\\_forms/available\\_documents/water\\_words.html](https://www.waterboards.ca.gov/publications_forms/available_documents/water_words.html)

<sup>43</sup> Russian River Water Forum. (2023, June 22). Water rights and water management technical briefing. Background on Russian River Water Sources and Water Rights. Prepared by Ryan Bezerra, Bartkiewicz, Kronick and Shanahan. Retrieved from <https://russianriverwaterforum.org/wp/wp-content/uploads/4-Water-rights-brief-Russian-River.pdf>

<sup>44</sup> According to demand data from 2017-2020 compiled for DWRAT.

10,000-AF/Yr reservation is subordinate to stored water needed to meet Sonoma Water’s minimum instream flow requirements.

## A.2.1 Large Water Rights Holders in the Russian River Watershed

The Russian River system includes approximately 2,200 diversions with associated riparian and/or appropriative water rights. There are seven water rights holders with water rights greater than 10,000 AF/Yr in the Russian River watershed (see Table 2-1), which makes the water rights holders subject to telemetry requirements under SB-88. This section provides some background information on these individuals and entities, in alphabetical order.

### City of Ukiah

The City of Ukiah (Ukiah) Water Treatment Department provides water to serve over 7,000 residential and commercial connections with over 90 miles of water main. Ukiah holds a pre-1914 water right and an appropriative right issued in 1954 to divert 14,479 AF/Yr; operates four groundwater facilities with a capacity of 4,000 AF/Yr from four wells; and has a contract with Mendocino RRFC for 800 AF/Yr.<sup>45</sup> Ukiah diverts water at its Ranney Collector, which has a capacity of 3,400 gallons per minute, and from two wells with a combined capacity of 900 gallons per minute<sup>46</sup>. Since 2019, Ukiah has been advancing a recycled water initiative. Currently the city is authorized to change the place of use and purpose of use of a monthly average of 1.5 million gallons per day of treated wastewater that would otherwise be discharged into the Russian River. This authorization covers the period from October 1 of each year to May 14 of the succeeding year.<sup>47</sup>

### Eugene J.M. McFadden

Eugene McFadden is the Registered Agent for McFadden Family Vineyard and Farm. The McFadden Family Vineyard and Farm is a 442-acre property in Mendocino County’s Potter Valley. The property features a hydroelectric plant and water rights that have been used for organic farming. McFadden holds License No. 12360 to divert 50,000 AF/Yr for power use, reduced from the original 133,200 AF/Yr in 2019. He also holds two smaller licenses for irrigation; the irrigation water comes from the PVP.

### Mendocino County Russian River Flood Control and Water Conservation Improvement District

The Mendocino RRFC holds and manages License No. 13898<sup>48</sup> authorizing the district to appropriate up to 7,940 AF/Yr from the East Fork Russian River, including storing water in and rediverting water from Lake Mendocino. The district has 86 licensed points of diversion (PODs) and re-diversion under License No. 13898, most of which are identified in contracts with account holders. Individual contract amounts range from four to 1,171 AF/Yr and may be diverting under one or more PODs per contract. Eighteen of the 86

<sup>45</sup> City of Ukiah. (2024). Water resources. Retrieved from <https://cityofukiah.com/water-resources/>

<sup>46</sup> City of Ukiah (2012). *Recycled Water Feasibility Study*. Retrieved from [https://cityofukiah.com/wp-content/uploads/2022/03/Ukiah\\_Recycled-Water-Feasibility-Study.pdf](https://cityofukiah.com/wp-content/uploads/2022/03/Ukiah_Recycled-Water-Feasibility-Study.pdf). Refer to Table 2-1.

<sup>47</sup> State Water Resources Control Board Division of Water Rights. (2015, August 31). *Order Approving Change in Place of Use, Purpose of Use, and Quantity of Discharge*. Retrieved from [https://www.waterboards.ca.gov/waterrights/water\\_issues/programs/applications/wastewater\\_petition\\_orders/docs/ww0082.pdf](https://www.waterboards.ca.gov/waterrights/water_issues/programs/applications/wastewater_petition_orders/docs/ww0082.pdf)

<sup>48</sup> State Water Resources Control Board Division of Water Rights. (2017, September 21). Right to divert and use water, license 13898. Retrieved from [https://www.rrfc.net/files/84bf8ceb9/License+13898\\_APP+12919B.pdf](https://www.rrfc.net/files/84bf8ceb9/License+13898_APP+12919B.pdf)

authorized PODs do not have active contracts with the district, and three are ‘long-term inactive’.<sup>49</sup> In addition to a contract with the district, some customers have additional water rights (e.g., riparian rights) in their own name that identify the same POD and are managed independently of License No. 13898.<sup>50</sup> Mendocino RRFC's License No. 13898 does not contain minimum streamflow requirements for the East Fork Russian River or Russian River. However, Sonoma Water’s release of stored water from Lake Mendocino to meet their instream flow requirements in the East Fork Russian River and downstream in the Russian River physically affects the volume of water available to Mendocino RRFC for diversion.<sup>51</sup>

## **Michael Luke Miller**

Michael “Luke” Miller holds a flow-through permit for hydroelectric power production in Potter Valley, with the source of water coming from the PVP diversion. Due to drought and changes in PVP diversions, the hydroelectric plant has not been able to function, and there has been no water diversion reported under this water right since 2017. Mr. Miller is contemplating revoking this permit and is in contact with SWRCB about his options for the future of this water right.

## **Potter Valley Irrigation District (PVID)**

Potter Valley Irrigation District (PVID) provides agricultural water for customers within its 6,900-acre boundary using a portion of the water diverted through the PVP. PVID provides irrigation water for 390 farmers using 16 miles of main canals and 18 miles of secondary laterals, all gravity-fed. PVID also delivers water to 33 storage ponds built by farmers. Due to its reliance on PVP water, PVID has a moratorium in place precluding new land annexations into PVID’s boundaries.<sup>52</sup>

PVID purchases water from PG&E. Its contract required PG&E to divert 50 cfs for use by PVID, up to a total of 19,000 AF/Yr. According to the PVID website, three of PG&E’s licenses (License #1424, #1199 and #5545) list PVID as the place of use and form the legal basis of the water delivered to PVID by PG&E. PVID also holds License #5246 for water released below the Potter Valley Powerhouse into the East Branch of the Russian River.

## **Sonoma County Water Agency (Sonoma Water)**

Sonoma Water is a wholesaler of potable water for 14 public water systems, including ten cities and special districts serving more than 623,000 residents of Sonoma and Marin counties.

As the local project sponsor for the construction of the Coyote Valley and Warm Springs dams, Sonoma Water retains rights to some of the water stored in these reservoirs and controls the releases from the reservoirs' water supply pools. Sonoma Water is required to maintain minimum stream flows, according

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<sup>49</sup> This refers to points of diversions still under contract but in which water has not been diverted by customers for multiple consecutive years.

<sup>50</sup> Balance Hydrologics. (2024, January 18). Senate Bill 88 alternative compliance plan for the Russian River Flood Control & Water Conservation Improvement District. E. Salomone, personal communication, October 27, 2023

<sup>51</sup> Russian River Flood Control and Water Conservation Improvement District. (2024). Mendocino County Russian River Flood Control & Water Conservation Improvement District's water rights. Retrieved from <https://www.rffc.net/mendocino-county-russian-river-flood-control-water-conservation-improvement-district-s-water-rights>

<sup>52</sup> Potter Valley Irrigation District. (2024). Potter Valley Irrigation District history. Retrieved from [https://www.pottervalleywater.org/pvid\\_history.html](https://www.pottervalleywater.org/pvid_history.html)

to requirements set forth in Decision 1610, at various points on the Russian River and Dry Creek in accordance with its water rights permits.

Sonoma Water’s diversion facilities extract Russian River underflow, which is reported under Sonoma Water’s surface water rights. Sonoma Water holds five water rights for municipal and irrigation uses with a face value of more than 10,000 AF/Yr (permit 16596 with a face value of 375,316 AF/Yr, permit 12947A with a face value of 160,044 AF/yr, permit 12949 with a face value of 14,480 AF/Yr, and permit 12950 with a face value of 21,779 AF/Yr). These five water rights list 34 unique PODs. Sonoma Water operates six radial collector wells at the Wohler and Mirabel production facilities adjacent to the Russian River. Sonoma Water also operates three groundwater wells in the Santa Rosa Plain.<sup>53</sup>

Sonoma Water has agreements to allow certain entities to divert water from the Russian River under Sonoma Water’s water rights using their own diversion facilities. The “Russian River Customers” that divert under Sonoma Water’s water rights include: City of Healdsburg, Town of Windsor, Camp Meeker Recreation and Park District, and Occidental Community Services District (pending petition approval from the SWRCB). Sonoma Water’s agreements require the customers to use any water right they may have before using Sonoma Water’s water rights.<sup>54</sup> The customers conduct measurements at these PODs.

## State Water Resources Control Board

The SWRCB holds four State Filed Applications in the Russian River. A State Filed Application is a special type of post-1914 appropriative water right application filed by a state agency to appropriate water for the development of water projects. Two are fully unassigned (available for use); one has a pending petition for assignment, and one is partially assigned and has a pending petition.

## A.3 Water Regulations

The Russian River watershed is governed by several State, regional, and local water regulations, policies, and requirements (**Table A-2**). Several of these regulations govern surface water releases (Subsection A.3.1).

### A.3.1 Surface Water Regulation

There are two major reservoirs that affect surface water flows in the Russian River watershed: Lake Mendocino (Coyote Valley Dam) and Lake Sonoma (Warm Springs Dam). These reservoirs and their operations are well described in the Russian River Hydrologic Modeling for the Fish Habitat Flows and Water Rights Project report<sup>55</sup>. However, brief descriptions of both dams are provided below.

#### Lake Mendocino/Coyote Valley Dam

Located approximately five miles northeast of Ukiah in Mendocino County, Lake Mendocino was created by the construction of the Coyote Valley Dam Project. The dam was authorized by the Flood Control Act

<sup>53</sup> Sonoma Water. (n.d.) Water supply. Retrieved from <https://www.sonomawater.org/water-supply>

<sup>54</sup> Brown and Caldwell. (2021, June). *2020 Urban Water Management Plan*. Prepared for Sonoma Water. Retrieved from [https://www.sonomawater.org/media/PDF/Water%20Resources/Water%20Supply/UWMP/Sonoma%20Water%202020%20UWMP\\_June%202021-ADA.pdf](https://www.sonomawater.org/media/PDF/Water%20Resources/Water%20Supply/UWMP/Sonoma%20Water%202020%20UWMP_June%202021-ADA.pdf)

<sup>55</sup> Sonoma Valley Water Agency (2016). *Russian River Hydrologic Modeling for the Fish Habitat Flows and Water Rights Project*. Retrieved from [https://pottervalleyproject.org/wp-content/uploads/2018/05/Hydrologic-Modeling-Report\\_Fish-Flow-Project-DEIR.pdf](https://pottervalleyproject.org/wp-content/uploads/2018/05/Hydrologic-Modeling-Report_Fish-Flow-Project-DEIR.pdf)

of 1944 for the purposes of flood control, water supply, recreation, and stream flow regulation. Construction of the Coyote Valley Dam was completed by the USACE in January 1959, with Sonoma Water serving as the non-federal sponsor. Lake Mendocino has an estimated storage capacity of 116,500 acre feet (AF). The water supply pool of the dam varies between 68,400 AF and 111,000 AF, depending on the time of year.

**TABLE A-2**  
**ADDITIONAL WATER REGULATIONS, POLICIES, AND REQUIREMENTS FOR THE RUSSIAN RIVER WATERSHED**

Jurisdiction	Date(s)	Name	Description
Local	1961	State Water Resources Control Board Decision D 1030	The State Water Resources Control Board's Decision D 1030 approved permits to the City of Ukiah, Mendocino RRFC, and the agency now called Sonoma Water authorizing diversion to storage at Coyote Dam and direct diversion and rediversion of water from various points on the Russian River. <sup>56</sup>
Local	1986	State Water Resources Control Board Decision 1610	The State Water Resources Control Board's Decision 1610 established minimum instream flow requirements in the East Fork Russian River, Russian River, and Dry Creek to preserve the fishery and recreation in the river and in Lake Mendocino to the greatest extent possible while serving the needs of the agricultural, municipal, domestic, and industrial uses which are dependent upon the water. <sup>57</sup>
State	2004	North Coast Instream Flow Policy (AB 2121)	The SWRCB's Instreams Flow Policy (also called the North Coast Instream Flow Policy) implements Water Code section 1259.4, which was added by Assembly Bill 2121 (Stats. 2004, ch. 943, § 3). <sup>58</sup> It applies to five counties, including Sonoma and Mendocino Counties. The policy does not set specific instream flow requirements but establishes guidelines for maintaining instream flows for the protection of fishery resources. Diverting within the policy area is a condition for 23 CCR §931-938 (i.e., Senate Bill 88, Water Measurement Regulations) telemetry requirements, if other conditions apply (see below).
Regional	2008	Russian River Biological Opinion	The 2008 Russian River Biological Opinion is a federally mandated 15-year blueprint to help save endangered fish and ensure a reliable water supply in the Russian River watershed. <sup>59</sup> The 2008 Biological Opinion sets limits on releases from Lake Mendocino and Lake Sonoma during the summer months to maintain suitable habitat for Central California Coast steelhead, coho salmon, and Chinook salmon, and to avoid take under the Endangered Species Act. The 2008 Biological Opinion required changes to the minimum instream flows previously controlled by the conditions of Decision 1610. This Biological Opinion expired in September 2023 and a new Biological Opinion is expected to be issued by National Marine Fisheries Services (NMFS).
State	2014	Sustainable Groundwater Management Act	The Sustainable Groundwater Management Act (SGMA) set forth a statewide framework to help protect groundwater resources over the long term. <sup>60</sup> SGMA requires local agencies to form groundwater sustainability agencies (GSAs) for the high and medium-priority basins. GSAs develop and implement groundwater sustainability plans (GSPs) to avoid undesirable results and mitigate overdraft within 20 years.
State	2015	Water Measurement and Reporting	The 23 CCR §931-938 (i.e., Senate Bill 88, Water Measurement Regulations) requires those who divert more than 10 AF/Yr to measure and report their

<sup>56</sup> State Water Resources Control Board. (1961). Decision D 1030. Retrieved from [https://www.waterboards.ca.gov/waterrights/board\\_decisions/adopted\\_orders/decisions/d1000\\_d1049/wrd1030.pdf](https://www.waterboards.ca.gov/waterrights/board_decisions/adopted_orders/decisions/d1000_d1049/wrd1030.pdf)

<sup>57</sup> State Water Resources Control Board. (1986, April). Russian River project decision 1610. Retrieved from [https://www.waterboards.ca.gov/waterrights/board\\_decisions/adopted\\_orders/decisions/d1600\\_d1649/wrd1610.pdf](https://www.waterboards.ca.gov/waterrights/board_decisions/adopted_orders/decisions/d1600_d1649/wrd1610.pdf)

<sup>58</sup> State Water Resources Control Board. (2014, February 4). *Policy for Maintaining Instream Flows in Northern California Coastal Streams*. Retrieved from [https://www.waterboards.ca.gov/waterrights/water\\_issues/programs/instream\\_flows/docs/adopted\\_policy.pdf](https://www.waterboards.ca.gov/waterrights/water_issues/programs/instream_flows/docs/adopted_policy.pdf)

<sup>59</sup> Sonoma Water. (n.d.) Russian River Biological Opinion. Retrieved from <https://www.sonomawater.org/biological-opinion>

<sup>60</sup> California Department of Water Resources. (2024). Sustainable groundwater management act (SGMA). Retrieved from <https://water.ca.gov/sgma>

**TABLE A-2**  
**ADDITIONAL WATER REGULATIONS, POLICIES, AND REQUIREMENTS FOR THE RUSSIAN RIVER WATERSHED**

Jurisdiction	Date(s)	Name	Description
		Regulation (Senate Bill 88)	diversions. <sup>61</sup> Telemetered measurements are required for diverters who divert 10,000 AF/Yr or more, own or operate a reservoir or pond with a storage capacity of 10,000 acre-feet or more, divert 30 cubic feet per second or more any time between June 1 and September 30, or divert more than 20 percent of the historical mean monthly stream flow between June 1 and September 30 if other conditions apply. <sup>62</sup>
Regional	2018	Water Quality Control Plan (Basin Plan) for the North Coast Region	The North Coast Regional Water Quality Control Board's (NCRWQCB) regulations control the discharge of waste and other factors affecting the quality of water within the North Coast Region. <sup>63</sup> The regulations include point source discharge prohibitions for the Russian River watershed, with seasonal limitations of a maximum discharge rate of 1% of the river's flow between October 1 and May 14. Discharges are prohibited for the rest of the year.
State	2019	Cannabis Cultivation Policy	Cannabis cultivation legislation enacted California Water Code section 13149, which directs SWRCB, with California Department of Fish and Wildlife (CDFW), to adopt requirements for the diversion and use of water for cannabis cultivation in areas where it may affect instream flows and water quality. These requirements are established in the Cannabis Cultivation Policy. In the Russian River watershed, the upper watershed above Lake Mendocino, Dry Creek, and Mark West creek have been identified as "Cannabis Priority Watersheds" that are of special environmental concern and at increased risk of impacts due to high densities of cannabis cultivation activities <sup>64</sup> .
State	2022	Stream Gaging and Prioritization Plan	The Senate Bill 19 Stream Gaging Prioritization Plan 2022 completed an assessment of existing and deactivated gages and established priorities for modernizing, reactivating, or placing new gages in locations that best meet the needs for water supply, flood, water quality, and ecosystem management. <sup>65</sup>

*Flood Control.* The USACE determines the timing and volume of flood control releases per their Water Control Manual, Appendix I to the Coyote Valley Dam Master Water Control Manual published by the USACE in April 1959 and most recently updated in August 1986. Storage in the reservoir is controlled by the reservoir guide curve defined in the USACE's Coyote Valley Dam Water Control Diagram, most recently revised by the USACE in 2004. This guide curve sets the maximum threshold for storage of conservation water in the reservoir, which varies seasonally.

Flood releases from Lake Mendocino are further guided by downstream maximum flow criteria defined in the Water Control Manual and the 2004 Water Control Diagram. Lake Mendocino also has an emergency

<sup>61</sup> State Water Resources Control Board. (2024, November 19). Water measurement and reporting regulation. Retrieved from [https://www.waterboards.ca.gov/waterrights/water\\_issues/programs/diversion\\_use/water\\_measurement.html#:~:text=The%20water%20measurement%20and%20reporting,resolution%20than%20previous%20standards%20required.](https://www.waterboards.ca.gov/waterrights/water_issues/programs/diversion_use/water_measurement.html#:~:text=The%20water%20measurement%20and%20reporting,resolution%20than%20previous%20standards%20required.)

<sup>62</sup> Any of the following four conditions: 1) threatened, endangered, or fully protected fish species are present or have historically been present; 2) the diversion is made from a stream that is part of the North Coast Instream Flow Policy area; 3) the diversion is made from the Deer Creek, Mill Creek, or Antelope Creek watersheds of the Sacramento River watershed; or 4) the diversion is made from the Mark West Creek, Green Valley Creek, Mill Creek, or Dutch Bill Creek watersheds of the Russian River watershed.

<sup>63</sup> North Coast Regional Water Quality Control Board. (2024, July 12). An introduction to the basin plan. Retrieved from [https://www.waterboards.ca.gov/northcoast/water\\_issues/programs/basin\\_plan/](https://www.waterboards.ca.gov/northcoast/water_issues/programs/basin_plan/)

<sup>64</sup> State Water Resources Control Board. (2021, January 20). California priority watersheds. Retrieved from [https://www.waterboards.ca.gov/water\\_issues/programs/cannabis/california\\_priority\\_watersheds.html](https://www.waterboards.ca.gov/water_issues/programs/cannabis/california_priority_watersheds.html)

<sup>65</sup> Department of Water Resources, State Water Resources Control Board, Department of Fish and Wildlife, Department of Conservation – California Geological Survey. (n.d.) *California Stream Gaging Prioritization Plan 2022*. Retrieved from [https://www.waterboards.ca.gov/waterrights/water\\_issues/programs/stream\\_gaging\\_plan/docs/sb19-report.pdf](https://www.waterboards.ca.gov/waterrights/water_issues/programs/stream_gaging_plan/docs/sb19-report.pdf)

release schedule that provides guidance for releases when reservoir water levels are within the emergency pool. An emergency release has never been made since the dam became operational.

*Water Supply.* Sonoma Water is non-federal sponsor for Lake Mendocino and has an agreement with the USACE to store and release water from Lake Mendocino to maintain minimum instream flows downstream of Coyote Valley Dam (more on minimum instream flow requirements below) and to divert water from the Russian River for reasonable and beneficial uses and purposes. Sonoma Water makes water supply releases as necessary to comply with its water rights permits and diversions made by downstream users when Lake Mendocino storage levels are within the water supply pool.

The Mendocino District RRFC and Russian River mainstem post-1949 water right holders also have water rights that authorize the re-diversion and use of water released from Lake Mendocino storage. Under a 10,000-AF/Yr reservation established and administered by the SWRCB in Order WR 74- 30, water is available to qualifying appropriative water rights in Sonoma County. Redwood Valley County Water District can divert water from Lake Mendocino's flood control pool. However, it is not authorized to redivert water stored in Lake Mendocino.

*Coyote Valley Egg Collection Facility.* The CDFW, under a contract with the USACE, operates a fish hatchery facility called the Coyote Valley Dam Egg Collection Facility. This facility is managed in conjunction with the Don Clausen Fish Hatchery located at Warm Springs Dam to support salmon populations. The fish hatchery diverts water released from Lake Mendocino to support operations. These diversions are released back into the Russian River after use.

*Hydroelectric Power.* Under a 1986 agreement with the USACE, the City of Ukiah operates and maintains a hydroelectric facility at the Coyote Valley Dam utilizing incidental releases. All water diverted by the power plant is returned to the river immediately downstream of the power plant.

## **Lake Sonoma/Warm Springs Dam**

Lake Sonoma is located on Dry Creek, a tributary to the Russian River, approximately 10 miles northwest of the City of Healdsburg in Sonoma County. The reservoir was created by the construction of the Warm Springs Dam Project, authorized by the Flood Control Act of 1962 for the purposes of flood control, water supply, environmental stewardship, and recreation. The USACE completed construction of the dam in January 1983. Similar to the Coyote Valley Dam, Sonoma Water serves as the non-federal sponsor for the Warm Springs Dam. Lake Sonoma has a total storage capacity of 381,000 AF, which includes a 225,000 AF water supply pool, a 136,000 AF flood control pool, and a 20,000 AF inactive pool.

*Flood Control.* The USACE determines releases of water from Lake Sonoma during flood control operations. The regulation of flood control and water supply operations is described in the Water Control Manual, Appendix II to the WSD Master Water Control Manual published by the USACE in September 1984. Storage in the reservoir is controlled by the reservoir Guide Curve defined in the Water Control Manual. Under flood operations, water is temporarily held in the flood control pool until the threat of flooding downstream is reduced. Once the flooding threat is diminished, water is released from the reservoir to bring storage levels back to the top of the water supply pool.

*Water Supply.* As the local sponsor for the dam, Sonoma Water makes water supply releases from Lake Sonoma to comply with the terms of their water rights permits and SWRCB Decision 1610.<sup>66</sup> When storage levels in Lake Sonoma are within the water supply pool, Sonoma Water makes releases to meet minimum instream flow requirements and satisfy downstream water supply needs.

*Water Springs Dam Fish Hatchery.* The CDFW, under a contract with the USACE, operates the Don Clausen Fish Hatchery. The hatchery is located at the base of the Warm Springs Dam and diverts flow from the outlet of Warm Springs Dam to support hatchery operations. Diverted water used by the hatchery is returned to Dry Creek downstream of the hatchery.

*Hydroelectric Power.* Sonoma Water operates the Warm Springs Dam Hydroelectric Project under a license from FERC. No releases from either Coyote Valley Dam or Warm Springs Dam are made solely for hydroelectric power generation.

## Minimum Instream Flow Requirements

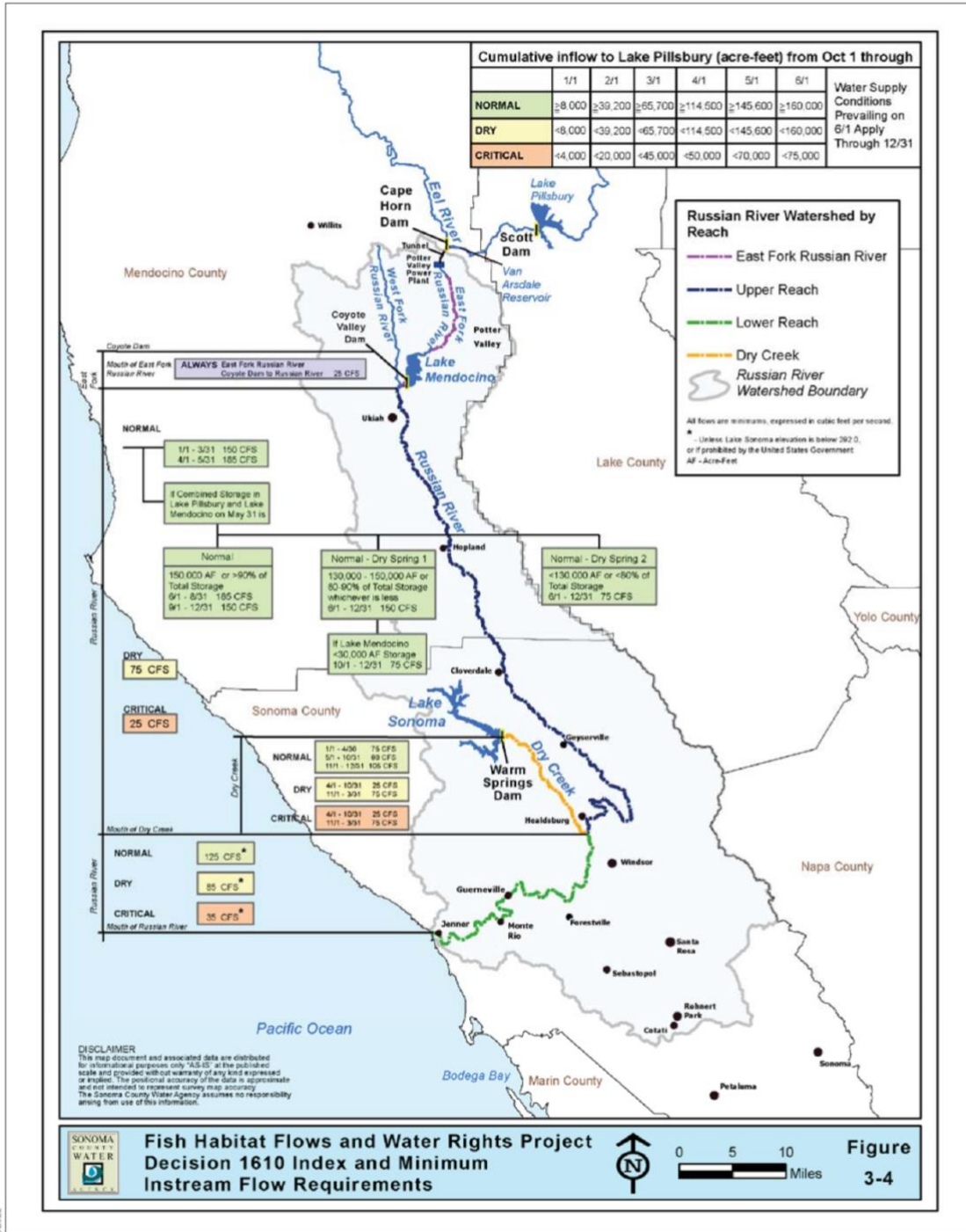
Sonoma Water makes releases from Lake Mendocino and Lake Sonoma: (1) to meet the downstream water demands of the hundreds of agricultural, commercial, and residential water users, Sonoma Water, and several public water systems along Russian River and Dry Creek; and (2) to maintain minimum instream flow requirements in the Russian River and Dry Creek as required under the terms of Sonoma Water’s water rights permits. **Figure A-2** summarizes Russian River instream minimum flow requirements, which are comprised of two main components.

The first component addresses different schedules of minimum instream flows for four reaches of the Russian River System. These reaches are the 1) East Fork Russian River between Coyote Valley Dam and the confluence with the Russian River (the dashed purple line in Figure A-2; 2) the Upper Reach (i.e., the Russian River between the East Fork Russian River confluence and Dry Creek – the dashed blue line in Figure A-2); 3) the Lower Reach (i.e., the Russian River between Dry Creek and the Pacific Ocean – the dashed green line in Figure A-2), and 4) Dry Creek between Warm Springs Dam and the confluence with the Russian River (the dashed yellow line in Figure A-2).

The second component of Russian River instream minimum flow requirement includes the definition of a hydrologic index based on cumulative inflow into Lake Pillsbury beginning on October 1 (beginning of the water year). Thresholds of cumulative Lake Pillsbury inflow are defined for the first of the month from January 1 to June 1 to determine the water supply condition. Sonoma Water’s water right permits have three water supply conditions: Normal, Dry, and Critical. Each of these conditions is used to determine a schedule of flows for each reach of the Russian River System.

Importantly, adherence with the minimum instream flow requirements is determined from observed flows at USGS gaging stations that provide real-time information for several locations along the Russian River and Dry Creek. These gaging stations are summarized in Table A-4.

<sup>66</sup> State Water Resources Control Board. (1986, April). Russian River project decision 1610. Retrieved from [https://www.waterboards.ca.gov/waterrights/board\\_decisions/adopted\\_orders/decisions/d1600\\_d1649/wrd1610.pdf](https://www.waterboards.ca.gov/waterrights/board_decisions/adopted_orders/decisions/d1600_d1649/wrd1610.pdf)



SOURCE: Sonoma County Water Agency, 2016. Russian River Hydrologic Modeling for the Fish Habitat Flows and Water Rights Project.

Telemetered Water Monitoring Project

**Figure A-2**  
 Russian River Minimum Instream Flow Requirements Defined in Sonoma Water's Water Rights Permits<sup>67</sup>

<sup>67</sup> Sonoma Valley Water Agency (2016). *Russian River Hydrologic Modeling for the Fish Habitat Flows and Water Rights Project*. Retrieved from [https://pottervalleyproject.org/wp-content/uploads/2018/05/Hydrologic-Modeling-Report\\_Fish-Flow-Project-DEIR.pdf](https://pottervalleyproject.org/wp-content/uploads/2018/05/Hydrologic-Modeling-Report_Fish-Flow-Project-DEIR.pdf)

## A.4 Water Management Activities

In addition to water regulations outlined above, there are numerous water management programs, partnerships, and agreements that have been developed to support sustainable water management in the Russian River watershed. **Table A-3** summarizes some of the key activities the Consortium Team learned about from research and outreach.

## A.5 Water Monitoring

The Russian River watershed has been described as “densely instrumented” and has benefited from significant research investment over many years.<sup>68</sup> Numerous water monitoring networks exist as part of a broader strategy to manage water resources sustainably – ensuring water availability for agricultural, municipal, and environmental needs while also preparing for and mitigating the impacts of droughts and floods in the watershed. Some of the key active efforts are summarized in **Table A-4**. Table A-4 is not an exhaustive list of monitoring in the region and likely missing data that is not publicly available.

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<sup>68</sup> Sumargo, E., Wilson, A.M., Ralph F.M., Weihs, R., White, A., Jasperse, J., Asgari-Lamjiri, M., Turnbull, S., Downer, C., & Monache, L.D. (2020, October 1). The Hydrometeorological Observation Network in California’s Russian River Watershed: Development, Characteristics, and Key Findings from 1997 to 2019. *Bulletin of the American Meteorological Society*, 101(10), E1781-E1800. doi: 10.1175/BAMS-D-19-0253.1

**TABLE A-3**  
**WATER MANAGEMENT ACTIVITIES IN THE RUSSIAN RIVER WATERSHED**

Water Management Activity	Description
<b>Water Supply and Demand</b>	
Groundwater Sustainability under SGMA	The Ukiah Valley (DWR Basin 1-052) and the Santa Rosa Plain (1-055.01) groundwater basins were designated medium priority under SGMA, requiring the areas to form a groundwater sustainability agency (GSA) and a groundwater sustainability plan (GSP). The GSPs lay out a management plan for ensuring sustainable groundwater supply in the future. The plans include metrics that need to be monitored, projects to be implemented, policies and actions to adopt in the face of declining groundwater conditions, and plans for long-term funding. <sup>69,70</sup>
Upper Russian River Voluntary Water Sharing Program (WSP)	Initiated in April 2021, the WSP is a collaborative effort to manage water resources in the Russian River watershed during drought conditions. The WSP provides water users in the Russian River watershed an alternative to curtailment of their water diversion and use. The fundamental basis of the WSP is that more senior water right holders forbear diverting water they are otherwise legally entitled to divert so that junior water right holders may divert water they would otherwise not be legally entitled to divert. <sup>71</sup> The 2022 implementation of the WSP was voluntary and limited but had significant impacts that will be relevant under future drought conditions. <sup>72</sup> The emergency regulations precipitating the WSP were rescinded on March 29, 2023.
Potter Valley Project (PVP) Decommissioning	Pacific Gas & Electric (PG&E) has decided not to relicense the PVP and is preparing to decommission Scott and Cape Horn Dams. The removal of Scott Dam will end the diversion of Eel River water to the Russian River unless another diversion facility, such as the New Eel-Russian Facility, is constructed. This is one of the goals of the Eel-Russian Project Authority (ERPA), a joint powers authority governed by Mendocino County Inland Water and Power Commission, Sonoma Water, County of Sonoma, and the Round Valley Indian Tribes. ERPA's proposal would see a dam-free diversion from the Eel River to the Russian River constructed and managed by ERPA. The new diversion facility will be constructed simultaneously with or immediately after the removal of Cape Horn Dam to minimize the disruption of flows into the Russian River basin. <sup>73</sup>
Forecast-Informed Reservoir Operations (FIRO)	FIRO originated at Lake Mendocino as a pilot project between Sonoma Water, USACE, and CW3E. The goal of FIRO is to leverage improvements in weather and water forecasts and monitoring to enable more effective management of reservoirs. <sup>74</sup> Based on the success at Lake Mendocino and because it may validate the benefits of FIRO on a watershed scale, FIRO is now being implemented at Lake Sonoma.
Lake Mendocino Water Supply Reliability Evaluation Report	A water supply reliability analysis was conducted and submitted to the SWRCB in 2015 as the Lake Mendocino Water Supply Reliability Evaluation Report. This analysis evaluated the long-term reliability of Lake Mendocino to meet water supply and environmental water demands, including informed perspectives on how Lake Mendocino is affected by climate change and PVP operations. <sup>75</sup>

<sup>69</sup> Ukiah Valley Basin Groundwater Sustainability Agency. (2021, December). *Ukiah Valley Groundwater Sustainability Plan*. Retrieved from <https://ukiahvalleygroundwater.org/managing-our-groundwater/groundwater-sustainability-plan/>

<sup>70</sup> Santa Rosa Plain Groundwater Sustainability Agency. (2021, December). *Santa Rosa Plain Groundwater Sustainability Plan*. Retrieved from <https://santarosaplaingroundwater.org/gsp/>

<sup>71</sup> State Water Resources Control Board. (2022). Water sharing program 2022. Upper Russian River Watershed. Factsheet. Retrieved from [https://www.waterboards.ca.gov/drought/russian\\_river/docs/2022/2022-rr-water-sharing-program-factsheet.pdf](https://www.waterboards.ca.gov/drought/russian_river/docs/2022/2022-rr-water-sharing-program-factsheet.pdf)

<sup>72</sup> Water Sharing Program Steering Committee. (2023, January 31). *2022 Upper Russian River Voluntary Water Sharing Program Implementation Report*. Retrieved from [https://www.waterboards.ca.gov/drought/russian\\_river/docs/2022/2022-wsp-implement-report.pdf](https://www.waterboards.ca.gov/drought/russian_river/docs/2022/2022-wsp-implement-report.pdf)

<sup>73</sup> Sonoma Water. (n.d.) Eel-Russian project authority. Retrieved from <https://www.sonomawater.org/pvp>

<sup>74</sup> Center for Western Weather and Water Extremes. (n.d.). Forecast informed reservoir operations. Retrieved from <https://cw3e.ucsd.edu/firo/>

<sup>75</sup> Sonoma County Water Agency. (2015, April 30). *Lake Mendocino Water Supply Reliability Evaluation Report*. Retrieved from [https://www.sonomawater.org/media/PDF/Environment/BiologicalOpinion/TUCP/2013/SCWA\\_ReliabilityReport\\_30apr15\\_Packet.pdf](https://www.sonomawater.org/media/PDF/Environment/BiologicalOpinion/TUCP/2013/SCWA_ReliabilityReport_30apr15_Packet.pdf)

**TABLE A-3**  
**WATER MANAGEMENT ACTIVITIES IN THE RUSSIAN RIVER WATERSHED**

<b>Water Management Activity</b>	<b>Description</b>
<b>Watershed Modeling</b>	
Russian River Integrated Hydrologic Modeling (RRIHM)	The USGS RRIHM is a comprehensive model of the Russian River watershed's interconnected surface and groundwater systems. The RRIHM includes data on climate, geology, surface water, groundwater, and land use, and it employs the Coupled Groundwater and Surface-Water Flow Model (GSFLOW) to simulate the watershed's hydrologic processes. <sup>76</sup>
Drought Water Rights Allocation Tool (DWRAT)	The DWRAT is a model developed to help manage water allocation during droughts in California. It considers factors like water rights priorities, streamflow forecasts, and water demands to determine how much water can be allocated to different water right holders. The DWRAT was implemented in the Russian River watershed to inform stream management decisions and water right curtailments in support of the drought emergency regulation in 2021. <sup>77</sup>
Water Evaluation and Planning System (WEAP)	WEAP is a software tool developed by the Stockholm Environment Institute's U.S. Center. It takes an integrated approach to water resources planning and addresses the challenges of freshwater management. <sup>78</sup> There is a WEAP model for the Russian River, but it is not currently being used in any water management activities.
Ukiah Valley Groundwater Basin Study of groundwater pumping on river flows	The California Land Stewardship Institute (CLSI) is carrying out modeling work to evaluate the location and rate of pumping that will affect flows in the Russian River under various climatic conditions in the Ukiah Valley groundwater basin. The project uses the model developed for the Ukiah Valley by the GSA and expands it with topographic survey data for the Russian River channel and groundwater monitoring and pumping data. The project will also create a water management decision support tool for farmers and municipal diverters. The project is funded by a grant from the U.S. Bureau of Reclamation (Reclamation) and will occur 2023-2026.
<b>Water Planning</b>	
Sonoma Water 2018 Water Supply Strategies Action Plan	The 2018 Water Supply Strategies Action Plan (Action Plan) is a key planning document for Sonoma Water on topics of water supply projects and programs. The Action Plan is an update of a 2013 plan developed in cooperation with Sonoma Water contractors that addresses immediate and long-term challenges in providing a reliable regional water supply, including aging infrastructure vulnerable to natural hazards and water supply uncertainties due to regulatory issues, drought, and climate change. <sup>79</sup> A key relevant activity outlined in the action plan is facilitating upper river water managers' quarterly meetings to collaborate, share information, and build relationships that may result in water use agreements and regional partnerships. This ongoing activity involves Mendocino County, the City of Ukiah, the City of Cloverdale, the City of Healdsburg, several Mendocino and Sonoma County water districts, agricultural representatives, Farm Bureaus, and Russian River water users. This activity includes increased coordination with Lake Mendocino water users, as well as Potter Valley Project relicensing activities.
Mendocino County Water Agency Action Plan	The Mendocino County Water Agency Action Plan is a plan to navigate regulatory, financial, water availability, and legislative challenges and issues to enable the agency to achieve its mission of protecting and enhancing the reliability, availability, affordability and quality of water resources. <sup>80</sup>

<sup>76</sup> California Water Science Center. (2018, December 19). Determining water availability in the Russian River watershed. Retrieved from <https://www.usgs.gov/centers/california-water-science-center/science/determining-water-availability-russian-river>

<sup>77</sup> State Water Resources Control Board. (2023, February 7) Drought tools and methods. Retrieved from [https://www.waterboards.ca.gov/drought/drought\\_tools\\_methods/](https://www.waterboards.ca.gov/drought/drought_tools_methods/)

<sup>78</sup> Stockholm Environment Institute. (2024). Why WEAP? Retrieved from <https://www.weap21.org/index.asp?action=201>

<sup>79</sup> Sonoma Water. (2018). *2018 Water Supply Strategies Action Plan*. Retrieved from <https://www.sonomawater.org/media/PDF/Water%20Resources/Water%20Supply/Water%20Supply%20Strategies/WSSAP%202018%20FINAL%20v2.pdf>

<sup>80</sup> Angelo, C.J. & Dukett, S. (2015). *Mendocino County Water Agency Action Plan*. Retrieved from <https://www.mendocinocounty.gov/home/showdocument?id=5434>

**TABLE A-3**  
**WATER MANAGEMENT ACTIVITIES IN THE RUSSIAN RIVER WATERSHED**

Water Management Activity	Description
<b>Local Projects</b>	
Fish Habitat Flows and Water Rights Project (Fish Flows Project)	The Fish Flows Project aims to meet the requirements of the National Marine Fisheries Service's (NMFS) Russian River Biological Opinion; improve conditions for threatened Chinook salmon in the Russian River and Dry Creek; replace the hydrologic index in Sonoma Water's water right permits to better reflect the watershed's conditions; extend Sonoma Water's right to divert and re-divert 75,000 AF/Yr until 2040; and add existing points of diversion for specific districts as authorized points in Sonoma Water's permits. <sup>81</sup> Sonoma Water released a Draft Environmental Impact Report on August 19, 2016. The Fish Flows Project is pending the certification of a CEQA document. Short term changes have been implemented through temporary urgency change petitions in the interim until permanent changes are in effect.
Russian River Estuary Management Project	Operated by Sonoma Water, the project aims to enhance fish habitat and provide flood protection. Estuary management focused on minimizing flood risk through artificial breaching of the closed river mouth, until a management plan was developed in response to a 2008 Biological Opinion from the NMFS. The Biological Opinion requires the addition of adaptive beach management from May 15th to October 15th to support the improvement of estuary rearing habitat for young salmonids. The plan is updated annually. <sup>82</sup>
Russian River Frost Program	The Russian River Frost Program is a collaborative program with winegrape growers and local farm bureaus. The program aims to manage the diversion and use of water for frost protection, which is critical for preventing crop damage during cold spells but can lead to stream de-watering if poorly managed. <sup>83</sup>
Fish Friendly Farming (FFF)	The FFF program was written specifically for the Russian River watershed and later amended for use in other watersheds. Now operated by CLSI, the program works closely with farmers to assure that soil moisture or canopy ET monitoring are used to make irrigation decisions, all water diversions have NMFS and CDFW compliant fish screens, and that water use amounts are within typical irrigation amounts for the crop. The program also ensures compliance with Total Maximum Daily Load regulations. <sup>84</sup>
City of Ukiah Recycled Water Project	The City of Ukiah is expanding its recycled water project in the Ukiah Valley. This project increases recycled water from 1,000 AF/Yr to 1,500 AF/Yr and is expected to be fully operational by fall 2024. The recycled water will irrigate various areas throughout the city through approximately 11 miles of "purple pipes". <sup>85</sup>

<sup>81</sup> Sonoma County Water Agency. (n.d.) *Fish Habitat Flows and Water Rights Project – Draft EIR*. Retrieved from <https://www.sonomawater.org/fish-flow#:~:text=The%20Fish%20Flow%20Project%20has,conditions%20for%20coho%20and%20steelhead>.

<sup>82</sup> Sonoma Water. (n.d.) Russian River estuary management project. Retrieved from <https://www.sonomawater.org/russian-river-estuary>

<sup>83</sup> State Water Resources Control Board. (2009). Russian River frost program. Retrieved from [https://www.waterboards.ca.gov/waterrights//water\\_issues/programs/hearings/russian\\_river\\_frost/presentations2009nov/winegrape\\_growers.pdf](https://www.waterboards.ca.gov/waterrights//water_issues/programs/hearings/russian_river_frost/presentations2009nov/winegrape_growers.pdf)

<sup>84</sup> Fish Friendly Farming. (2019). About. Retrieved from <https://www.fishfriendlyfarming.org/about>

<sup>85</sup> City of Ukiah. (n.d.) Ukiah recycled water project. Retrieved from [https://www.waterboards.ca.gov/waterrights//water\\_issues/programs/hearings/russian\\_river\\_frost/presentations2009nov/winegrape\\_growers.pdf](https://www.waterboards.ca.gov/waterrights//water_issues/programs/hearings/russian_river_frost/presentations2009nov/winegrape_growers.pdf)

**TABLE A-4**  
**EXISTING WATER MONITORING EFFORTS IN THE RUSSIAN RIVER WATERSHED**

<b>Program Name or Monitoring Entity</b>	<b>Summary of Monitoring Activities</b>
California Department of Forestry and Fire Protection (CAL FIRE)	CAL FIRE operates two weather stations in the Russian River watershed that collect hourly meteorological variables, including air temperature, relative humidity, precipitation, and fuel moisture. These stations also collect daily precipitation data. These data are publicly available on CDEC.
California Land Stewardship Institute (CLSI)	CLSI operates 14 stations in the Russian River watershed that collect river stage data primarily for the Russian River Frost Program. These stations do not compute flow. These data are not publicly available. However, there may be opportunities to partner with the implementing agency to access these data.
Center for Western Weather and Water Extremes (CW3E)	<p>CW3E operates 16 water-related monitoring stations in the Russian River watershed, including:</p> <ul style="list-style-type: none"> <li>• 10 stations collect 15-min meteorological variables, including air temperature, relative humidity, precipitation, and soil moisture, as well as hourly cumulative precipitation;</li> <li>• four stations collect 15-min river stage and flow data;</li> <li>• one station collects 15-min river stage data;</li> <li>• one station that collects hourly snow elevation data.</li> </ul> <p>These data are publicly available on CDEC.</p>
DWR Department of Flood Management (DFM)	<p>DWR DFM operates four water-related monitoring stations, including:</p> <ul style="list-style-type: none"> <li>• one station collects 15-min, hourly, and daily river stage and flow data;</li> <li>• three stations collect hourly meteorological variables, including air temperature, relative humidity, precipitation, and fuel moisture.</li> </ul> <p>These data are publicly available on CDEC.</p>
National Weather Service (NWS)	<p>NWS operates six water-related monitoring stations in the Russian River watershed, including:</p> <ul style="list-style-type: none"> <li>• three stations collect 15-min river stage and flow data;</li> <li>• two stations collect monthly precipitation data;</li> <li>• one station collects daily precipitation data.</li> </ul> <p>These data are publicly available on CDEC.</p>
Pacific Gas & Electric (PG&E)	<p>PG&amp;E operates two water-related monitoring stations in the Russian River watershed, including:</p> <ul style="list-style-type: none"> <li>• one station collects hourly meteorological variables, including air temperature, relative humidity, and precipitation, as well as daily cumulative precipitation and monthly canal diversions;</li> <li>• one station reports monthly discharge from power generation.</li> </ul> <p>These data are publicly available on CDEC.</p>
Pepperwood Preserve	<p>Pepperwood Preserve serves as a watershed sentinel site and collaborates with research institutions and other partners, including Sonoma Water, USGS, and University of California, Berkeley. The site has over 20 stations to collect data, including:</p> <ul style="list-style-type: none"> <li>• five stations collect 15-min meteorological data including precipitation, temperature, relative humidity, barometric pressure, wind speed and direction, and soil moisture;</li> <li>• five stations monitor fog frequency and precipitation;</li> <li>• two sites collect stream stage data.</li> </ul>

**TABLE A-4**  
**EXISTING WATER MONITORING EFFORTS IN THE RUSSIAN RIVER WATERSHED**

Program Name or Monitoring Entity	Summary of Monitoring Activities
	These data are publicly available on a separate website maintained by Pepperwood Preserve. <sup>86</sup>
Round Valley Indian Tribe	<p>The Round Valley Indian Tribe operates four water monitoring stations, including:</p> <ul style="list-style-type: none"> <li>• two stations collect river stage, flow, water temperature, and turbidity;</li> <li>• one station collects stage, discharge, and temperature;</li> <li>• one station collects temperature and turbidity.</li> </ul> <p>These data are not publicly available. However, there may be opportunities to partner with the implementing agency to access these data.</p>
Santa Rosa Plain GSA	The Santa Rosa Plain GSA monitoring network consists of 113 wells within and along the boundaries of the contributing watershed areas, including 96 wells within the Subbasin itself. <sup>87</sup> As allowed under SGMA, monitoring in the basin includes a representative monitoring network (RMN) to understand lowering of groundwater levels. The RMN includes 14 wells screened within the shallow aquifer system and 12 wells screened within the deep aquifer system. The Santa Rosa Plain GSA offers a Voluntary Groundwater Well Monitoring Program for property owners to add their wells to the data hub. <sup>88</sup> These data are publicly available on the CNRA Open Data Portal.
Sonoma County	Sonoma County operates one water-related monitoring station in the Russian River watershed that collects monthly precipitation data. These data are publicly available on CDEC.
Sonoma County Water Agency (Sonoma Water)	Sonoma Water operates a radio telemetry network of 29 stations, which all collect precipitation data. 20 stations collect hourly stage data, and four stations collect 4-hr. soil moisture data. These data are publicly available on a separate website maintained by Sonoma Water <sup>89</sup> and the USGS website.
Trout Unlimited (TU)	TU operates 30 streamgages in the Russian River, which collect 15-min stage, flow, and temperature data. These data are publicly available on a separate website maintained by TU. <sup>90</sup>
Ukiah Valley groundwater basin monitoring	Groundwater monitoring in the Ukiah Valley groundwater basin is conducted by a variety of entities, including the DWR through the California Statewide Groundwater Elevation Monitoring (CASGEM) program, the MCRCD, and CLSI. Collectively these entities monitor 32 groundwater wells for seasonal (twice annually) groundwater elevations. Currently, eight well sites provide continuous, telemetered groundwater elevation data. An additional four sites are slated to be equipped with telemetry equipment using funds from a Reclamation WaterSMART grant. These data are publicly available on the CNRA Open Data Portal.
United States Army Corps of Engineers (USACE)	<p>USACE operates nine water-related monitoring stations in the Russian River watershed, including:</p> <ul style="list-style-type: none"> <li>• four stations collect 15-min river stage and flow data. The station below Coyote Valley Dam also collects 15-min water temperature data;</li> <li>• two stations collect 15-min meteorological variables, including air temperature, relative humidity, and precipitation. The Lake Mendocino weather station also collects hourly evaporation rate data;</li> <li>• two stations collect daily reservoir elevation, storage, storage change, outflow, and inflow. These stations also collect daily precipitation, temperature, and evaporation rate data; and</li> </ul>

<sup>86</sup> Pepperwood Preserve. (n.d.) Pepperwood Preserve Conrail Page. Retrieved from <https://pepperwood.onerain.com>

<sup>87</sup> Santa Rosa Plain Groundwater Sustainability Agency. (2024, February). *Santa Rosa Plain Subbasin Annual Report Water Year 2023*. Retrieved from [http://santarosaplaingroundwater.org/wp-content/uploads/X-Additional-Attachment-SRP-Annual-Report-WY2023-Final\\_sm-ada.pdf](http://santarosaplaingroundwater.org/wp-content/uploads/X-Additional-Attachment-SRP-Annual-Report-WY2023-Final_sm-ada.pdf)

<sup>88</sup> Santa Rosa Plain Groundwater Sustainability Agency. (n.d.). Voluntary groundwater well monitoring program. Retrieved from <https://santarosaplaingroundwater.org/voluntary-monitoring/>

<sup>89</sup> Sonoma Water. (n.d.) Sonoma County real-time rainfall, river-stream, and reservoir data. Retrieved from <https://sonoma.onerain.com>

<sup>90</sup> Trout Unlimited. (n.d.) Trout Unlimited Gage Network View. Retrieved from <https://www.arcgis.com/home/item.html?id=0010a1b7c26542058c198affd1407435>

**TABLE A-4**  
**EXISTING WATER MONITORING EFFORTS IN THE RUSSIAN RIVER WATERSHED**

Program Name or Monitoring Entity	Summary of Monitoring Activities
	<ul style="list-style-type: none"> <li>one station collects 15-min precipitation and air temperature.</li> </ul> USACE also collects hourly reservoir elevations of Lake Mendocino and Lake Sonoma. These data are publicly available on CDEC.
United States Bureau of Land Management (BLM)	BLM operates one water-related monitoring station in the Russian River watershed that collects hourly meteorological variables, including air temperature, relative humidity, precipitation and fuel moisture. These data are publicly available on CDEC.
United States Geological Survey (USGS)	USGS operates 29 water-related monitoring station in the Russian River watershed, including: <ul style="list-style-type: none"> <li>27 stations collect 15-min river stage and flow data. Of these stations, six collect water temperature data, five collect dissolved oxygen data, four collect pH, two collect specific conductance, and one station collects turbidity.</li> <li>two stations collect daily river flow and stage data.</li> </ul> Many of these stations are operated in cooperation with local entities. These data are publicly available on CDEC and/or the USGS website.
Water Quality Monitoring Plan for the Russian River Estuary Management Project	Sonoma Water conducts water quality monitoring at seven stations in the Russian River Estuary with multi-parameter datasondes to measure conductivity, temperature, turbidity, pH, and dissolved oxygen. <sup>91</sup> Water grab samples are collected weekly from May 15 to October 15 from three surface-water sites and analyzed for nutrients, chlorophyll a, standard bacterial indicators, and dissolved organic carbon. Weekly summaries of some of these data are published to Sonoma Water's website during temporary urgency change petition periods. There may be opportunities to partner with the implementing agency to access all of these data.

## NOTES:

CDEC: California Data Exchange Center  
 CNRA: California Natural Resources Agency

<sup>91</sup> Sonoma County Water Agency. (2019, July). *Water Quality Monitoring Plan for the Russian River Estuary Management Project*. Retrieved from [https://www.sonomawater.org/media/PDF/Environment/BiologicalOpinion/TUCP/2019/WQ%20Mon%20Plan\\_2019\\_FINAL.pdf](https://www.sonomawater.org/media/PDF/Environment/BiologicalOpinion/TUCP/2019/WQ%20Mon%20Plan_2019_FINAL.pdf)

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## **Appendix B. Engagement Activity Feedback Summary**

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## B. ENGAGEMENT ACTIVITY FEEDBACK SUMMARY

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### B.1 Introduction

As described in Section 1.3, the Consortium Team conducted outreach and engagement throughout the Telemetered Water Monitoring Project to gather local knowledge and input from the Russian River watershed community to develop recommendations for a telemetered water monitoring network in the Russian River watershed. Table 1-1 summarizes group engagement activities, including the timing of engagement activities, purpose, and number of participants. This appendix summarizes feedback gathered during three public meetings (one virtual and two in-person). The meetings were designed to solicit increasingly specific feedback from the community on watershed challenges, potential benefits of telemetry, existing networks, data gaps, and the draft recommendations.

As noted in Table 1-1, feedback from these meetings were supplemented by 30 interviews and two field visits, where the Consortium Team was able to view some of the existing monitoring networks, diversions, and other equipment being used to support water management in the Russian River watershed and talk with agencies, municipalities, individual diverters, and others about challenges and potential benefits of telemetry in the region. An overview of the follow-up meetings is also provided in this appendix.

### B.2 Virtual Informational Meeting: May 2024

A virtual informational meeting was held May 13, 2024, from 10:00 a.m. to 12:00 p.m. via the Zoom platform. The virtual informational meeting served as a “kickoff” meeting for the Telemetered Water Monitoring Project. Members from the Consortium Team attended, in addition to 36 participants representing potential partners, interested parties, and technical advisors.

#### B.2.1 Objectives

The objectives of the meeting were to:

1. Inform participants about the Telemetered Water Monitoring Project.
2. Document participant questions about the Russian River Study and capture feedback regarding the project’s potential benefits and barriers.
3. Discuss how water monitoring could support existing water management challenges in the Russian River watershed.

#### B.2.2 Agenda

The meeting agenda was as follows:

1. Welcome, Orientation, & Introductions
2. Telemetered Water Monitoring Project Overview
3. Breakout Room Discussions
4. Engagement Opportunities & Next Steps

## B.2.3 Participants

**Table B-1** presents the affiliations of those who participated in the virtual informational meeting.

**TABLE B-1**  
**PARTICIPANT AFFILIATIONS FOR VIRTUAL INFORMATIONAL MEETING (LISTED ALPHABETICALLY)**

Affiliation	Number of Attendees
California Department of Fish and Wildlife	1
California Land Stewardship Institute	1
CalTrout	1
City of Ukiah	2
Flight Ridge	1
Gold Ridge Resource Conservation District	1
Larry Walker Associates	1
MBK Engineers	1
Mendocino County Russian River Flood Control & Water Conservation Improvement District (Mendocino RRFCD)	2
No listed affiliation	2
North Coast Water Board	1
North Coast Regional Water Quality Control Board	1
Palomino Water Co	1
Potter Valley Irrigation District	1
Russian River Confluence	1
Russian River Regional Monitoring Program, North Coast Regional Water Board	1
Redwood Valley County Water District, UVBGSA, UVWA	1
Russian Riverkeeper	2
Sonoma County Resource Conservation District	1
Sonoma Water	4
Town of Windsor	1
Trout Unlimited	3
UCCE Sonoma County	1
Ukiah Valley Groundwater Sustainability Agency	1
University of California, Santa Barbara	1
Wagner & Bonsignore	1
West Yost	1

## B.2.4 Methods

During the meeting, the Consortium Team used “breakout rooms” to engage participants in an interactive discussion using Miro Boards, an innovation workspace.

Following the project overview presentation, participants were randomly assigned to one of three breakout rooms. Each room had a representative from the Consortium Team. Participants were asked to anonymously respond to the following prompts using “sticky notes” on the Miro board, by speaking responses, or by typing responses into the chat:

1. What are some of the benefits you foresee with the telemetry Study?

2. Based on what you learned today, what questions or concerns do you have regarding the Study?
3. What are your water management challenges?
4. How could water monitoring data support or improve those challenges?
5. List any specific locations/areas where water monitoring data can help improve water management challenges.

Each breakout room had the opportunity to review other groups' work during the last 10 minutes of the breakout discussion before wrapping up as a larger group.

## B.2.5 Feedback Summary

The following presents a summary of the collective responses to the breakout discussion prompts.

### Potential Benefits

Participants most frequently mentioned water supply management as a potential benefit of the Study. In the context of water supply management, participants identified opportunities related to improved water supply operations (e.g., real-time), improved efficiency, increased coordination, and possible integration with existing monitoring efforts. Other potential benefits included water rights administration and enforcements, watershed-scale modeling, ecosystem management, and water quality management. There were multiple mentions of wanting to identify water shortages, characterize natural vs. imported water, identify flow changes, and quantify diversions. Participants explained that with increased transparency around water supply and demand, planning efforts for ecosystem and supply management could become more proactive. Participants expressed a desire for increased regional and watershed scale coordination of existing monitoring and management efforts.

### Potential Concerns

The greatest concern shared by participants was that telemetry would increase water rights regulation and enforcement. Participants also expressed about telemetered data accuracy. Because telemeters require maintenance and quality assurance (QA) and quality control (QC), there was concern among participants representing smaller water district that telemetry could strain resource managers in terms of both maintenance cost and labor. In turn, if the telemeters are not worked into existing metering systems, nor maintained, the quality of data could not be assured and could lead to either regulation that is based on inaccurate data or result in unnecessary litigation. Participants encouraged the Consortium Team to consider both current and future needs of the water community. Other concerns included ensuring the Study is the right size to impact water management practices.

### Water Management Challenges

Key water management challenges raised by participants are presented below.

- The lack of reliable and trusted data to support management and decision-making was the most frequently mentioned challenge, cited 39 times. Participants noted that there is an inability to determine available water as well as its source.

- Water supply management was mentioned 37 times, with flow variation identified as the main factor contributing to water management challenges. Flow variation is due to multiple causes, including releases, diversions, drought, flooding, and curtailment.
- Ecosystem management was mentioned 24 times, particularly the effects of floods, droughts, and water supply issues on habitat for several keystone species.
- Compliance with water rights, monitoring, and reporting were mentioned nine times.

## Water Monitoring Data to Support or Improve Challenges

Participants were asked to describe how water monitoring data supports or improves those challenges. Select responses are presented below.

- Increased public trust in programs to improve water management, efficiency, and needs.
- Identify when flow conditions are approaching thresholds.
- Provide timely and accurate data for models in response to water supply uncertainties.
- Early season warnings for summer drought conditions.
- Data could help identify depletion of natural flows and imported water.
- Accountability to decrease take and water usage outside of water rights.
- Support in identifying the "colors of water" when exercising & reporting water rights.
- Accurate water supply and demand data to prepare for a post-Potter Valley Project world.

Participants offered **specific physical locations or topic areas** where water monitoring data can improve challenges. Some of the responses included:

- Mark West, Dutch Bill, Green Valley, Mill, Willow, Mayacama, Pena, and Austin Creeks have been areas where flows were of particular concern in recent drought years. Additional stream flow gages in these locations, as well as on the West Fork Russian River and the East Fork Russian River above Lake Mendocino would help fill data gaps.
- More monitoring points in the Alexander Valley to analyze streamflow losses.
- Real time operations model.
- Integrated hydrologic model inputs to run future scenarios and inform management decisions.
- Better data can assist in the management of Russian River stored water.

## Questions

Outstanding questions generally related to the Study (e.g., location, timeline, etc.) and understanding how the data would be used and/or integrated. Some questions were answered, but many were documented and passed on to TRU staff to address in subsequent meetings. The following presents a summary of the types of questions asked by participants:

- What is expected of the Study in terms of the outcomes of the project and/or roles and responsibilities?
- Are you trying to test the telemetered system or trying to learn about this watershed?
- What is the duration of the Study?

- Is there a minimum threshold for the number of participants or number of diversions for this to go forward?
- Will the Study be for the mainstem of the Russian River, tributaries, or both?
- Have you put together a more technical document available that describes what you are doing? For example, how does the QA/QC process work and how does it compare to the standard protocol for collecting streamflow and discharge measurements (i.e., does telemetry leave out those steps?).
- Will this Study be based on the existing Senate Bill 88 requirements? Who is subject to the telemetry requirements and the requirements for monitoring and posting?
- What is the expected role of non-water rights holders without meters in this Study?
- Will water users who get the equipment be able to keep it or will they need to return it? How many sensors could we reasonably expect to receive/convert?
- With the option to keep the data private, when do you expect the Study to be far enough along such that the data could be actionable for water managers?
- Are there any data or measurement systems that you know you will or won't be compatible with?
- Are there opportunities to collaborate/incorporate the Study with our organization's existing streamflow gage network in the Russian River watershed?
- Will these data be integrated with the California Data Exchange Center (CDEC)?
- Will this be strictly for surface water monitoring (e.g., stream gages)? There is also telemetered groundwater level data being collected.
- Would you consider integrating mapped wells (shallow) to see where connections are between streamflow and groundwater well use?
- Are there credits or advantages for recharging the groundwater system?

Participants also brought forward specific program requests, including to provide a technical document that describes how the Study would function, integrate with a real-time integration model, and be implemented alongside the water rights priority system. Other requests included coordinating with the U.S. Geological Survey who “maintains numerous gages in the Russian River and does an amazing job with producing reliable data”; integrating mapped wells to see where connections are between streamflow and groundwater use; identifying when flow conditions are approaching water quality (i.e., dissolved oxygen) thresholds, and using protocols consistent with other agencies for aquatic species monitoring.

## B.3 In-person Workshop 1: June 2024

The first in-person workshop was held June 12, 2024, from 8:30 a.m. to 1:00 p.m. at The Alex Rorabaugh Recreation Center (the ARRC), 1640 South State Street, Ukiah, CA 95482. Members of the Consortium Team and TRU staff attended, in addition to 18 participants representing potential partners, interested parties, and technical advisors.

### B.3.1 Objectives

The objectives of the workshop were to:

1. Present an overview of the Telemetered Water Monitoring Project and a summary of participant feedback from the Kickoff Meeting.

2. Hear from the State Water Board’s Telemetry Research Unit (TRU) about the telemetry study in the Russian River watershed.
3. Gather information to support development of the initial set of recommendations for the telemetry Study.

### B.3.2 Agenda

The workshop agenda was as follows:

1. Welcome & Agenda
2. Presentations:
  1. Telemetered Water Monitoring Project Overview and Summary of Initial Feedback
  2. Telemetry Research Unit & Telemetry Study
3. Question & Answer
4. Breakout Activity - Input for Initial Set of Recommendations
5. Breakout Debrief
6. Wrap up and Next Steps

### B.3.3 Participants

**Table B-2** presents the affiliations of those who participated in the workshop.

**TABLE B-2  
PARTICIPANT AFFILIATIONS FOR IN-PERSON WORKSHOP 1 (LISTED ALPHABETICALLY)**

Affiliation	Number of Attendees
Atlas Vineyard Management	1
City of Ukiah	2
Coyote Valley Band of Pomo Indians	1
Flight Ridge / Mendocino County Russian River Flood Control & Water Conservation Improvement District (Mendocino RRFC)	1
MBK Engineers	1
Mendocino County Farm Bureau	1
Mendocino RRFC	2
Nelson & Sons, Inc.	1
Palomino Water Co	1
Pinoleville Pomo Nation	2
Redwood Valley County Water District, UVBGS, UVWA	1
Sonoma Water	1
Upper Russian River Water Agency	1
Wagner & Bonsignore	1
Yokayo Tribe of Indians	1

### B.3.4 Methods

During the workshop, the Consortium Team used “breakout sessions” to systematically gather feedback from participants to be incorporated into the report. Specifically, the goal of the breakout sessions was to receive input and recommendations regarding a telemetered water monitoring network design for the Study in the Russian River watershed. The input and recommendations were used to inform the initial set of recommendations described in the draft report to be presented at the next workshop (i.e., In-person Workshop 2).

Following the presentations and short Q&A session, the group came together to introduce the breakout sessions. There were four stations around the room with different discussion topics and instructions. The breakout station topics were:

- Station 1: Water Management Challenges and Potential Benefits of Telemetered Water Monitoring
- Station 2: Existing Monitoring Networks
- Station 3: Water Monitoring Questions, Problems, and Data Needs
- Station 4: Considerations for Study Participation

### B.3.5 Feedback Summary

The following presents a summary of the information gathered at each breakout session station.

#### Station 1 | Water Management Challenges and Potential Benefits of Telemetered Water Monitoring

The goal of this station was to facilitate open table conversations regarding water management challenges and potential benefits of telemetered water monitoring at both the watershed and local/individual scale. Participants were invited to express their comments on the listed challenges and benefits and welcomed to add or mention anything that was missed. **Tables B-3 and B-4** summarize participants’ perspectives on water management challenges and potential benefits of telemetry, respectively.

**TABLE B-3**  
**WATER MANAGEMENT CHALLENGES**

Water Management Challenges	Participant Perspectives
Equipment Reliability and Maintenance	Concerns were raised regarding the reliability and maintenance of monitoring equipment. Participants noted potential challenges associated with equipment failures impacting data accuracy. They highlighted the need for regular maintenance and calibration of monitoring devices to ensure reliable data collection. These concerns underscore the importance of robust infrastructure and maintenance protocols in sustaining the project's effectiveness.
Regulatory and Compliance Issues	Participants discussed challenges related to meeting regulatory requirements, particularly in rural areas. They expressed concerns about compliance burdens and potential legal implications for water users. These insights highlight the complexities associated with regulatory compliance and the need for tailored approaches to address diverse water users' needs.
Data Quality and Integration	Issues surrounding data consistency and integration from diverse sources were a point of discussion. Participants emphasized the importance of ensuring data accuracy and reliability for effective decision-making. They underscored the challenges of integrating telemetry data into existing management systems, reflecting broader concerns about data quality management.

**TABLE B-3  
WATER MANAGEMENT CHALLENGES**

<b>Water Management Challenges</b>	<b>Participant Perspectives</b>
Community Engagement in Rural Regions	Engaging rural communities and small water agencies emerged as a significant challenge. Participants noted resistance and skepticism from these water users regarding the Study. They emphasized the importance of effective communication and outreach strategies to garner support and address community concerns. These insights underscore the complexities of outreach and engagement in implementing new water management initiatives.
Operational Complexity and Scale	Managing diverse geographic areas and integrating telemetry data into existing management systems posed operational challenges. Participants discussed the complexity of monitoring various water sources and the scale of implementation required for effective telemetry deployment. They highlighted the need for comprehensive strategies to address operational complexities and scale challenges.
Technical and Infrastructure Limitations	Technical limitations and infrastructure challenges were noted as potential barriers to project implementation. Participants discussed the difficulty of deploying telemetry across varied terrain and locations. They emphasized the importance of addressing infrastructure gaps and improving data transmission and storage capabilities. These insights underscore the critical role of technical solutions in overcoming infrastructure limitations.
Data Privacy and Security Concerns	Participants expressed concerns about data privacy and security in transmitting sensitive information. They highlighted the need to ensure compliance with data protection regulations and secure telemetry networks. These insights underscore the importance of robust cybersecurity measures and privacy protocols in safeguarding telemetry data.
Financial and Resource Constraints	Financial implications and resource constraints were discussed in relation to project sustainability. Participants noted the cost implications of deploying and maintaining telemetry infrastructure. They highlighted budgetary constraints and the need for sustainable funding mechanisms to support ongoing operation and maintenance. These insights underscore the importance of financial planning and resource allocation in sustaining long-term project viability.
Adaptation and Flexibility in Regulations	Participants emphasized the need for adaptive regulatory frameworks that can accommodate technological advancements and diverse water use scenarios. They discussed the importance of regulatory flexibility in addressing local conditions and water users' needs. These insights underscore the challenges of aligning regulatory frameworks with local needs and evolving technological capabilities.

**TABLE B-4  
BENEFITS OF TELEMETRY**

<b>Benefit</b>	<b>Participant Perspectives</b>
Improved Water Supply Management	Participants highlighted the potential benefits of real-time data for enhancing water supply management. According to one participant, "Real-time data for better management and allocation of water resources" is crucial for ensuring efficient water use and adherence to supply agreements. Another mentioned the project's potential to "enhance administration and enforcement of water rights through accurate data," emphasizing improved compliance and equitable allocation. These insights underscore the project's aim to optimize water supply management practices through enhanced monitoring capabilities.
Enhanced Groundwater Sustainability	The Study was seen as instrumental in supporting sustainable groundwater management efforts. Participants discussed the capability of the project to provide better insights into groundwater levels and usage patterns. By improving monitoring capabilities, the project aims to contribute to long-term groundwater sustainability goals, as noted by participants.
Effective Water Rights Administration and Enforcement	Discussions emphasized the project's potential to streamline water rights administration and enforcement processes. Participants pointed out that accurate, real-time data could significantly improve regulatory compliance and ensure fair water allocation. This perspective highlights the project's role in enhancing the efficiency and transparency of water rights management practices.
Holistic Ecosystem Management and Protections for Tribal Beneficial Uses	The integration of ecological considerations into water management strategies was a focal point of discussions among participants. They underscored the importance of monitoring water quality and quantity impacts on ecosystems, suggesting that the project could facilitate more informed ecosystem management decisions. This holistic approach aims to balance water use with environmental conservation objectives, reflecting broader sustainability goals.

## Station 2 | Existing Monitoring Networks

The purpose of the station was to present the known existing networks using a map print-out and for workshop participants to add any that were missed. Participants were reassured that the Study aimed to integrate diverse data streams effectively, accommodating their unique systems to achieve project objectives. The following summarizes discussions at this station.

- **Monitoring of Water Quality:** Water quality monitoring emerged as a recurring theme, alongside concerns about the compatibility of various monitoring systems.
- **Monitoring of Ponds:** Participants discussed the feasibility of incorporating continuous or telemetered reporting for monitoring ponds, currently measured discretely once a week. They sought clarity on how such data would be utilized and whether the water right(s) contributing to pond inputs needed tracking.
- **Monitoring of Sub watershed and Microclimate Rainfall Data:** There was interest in using sub watershed and microclimate rainfall data to inform watershed monitoring and response strategies. Participants highlighted the potential for these data to enhance understanding and management of localized environmental conditions.
- **Tribal Engagement and Collaboration:** The topic of Tribal engagement and collaboration surfaced, acknowledging Tribal Groups as active water quality monitoring participants in the region. Questions were raised about potential Tribal involvement and buy-in for the project, reflecting interest in fostering inclusive collaboration with Indigenous communities.
- **Existing Infrastructure:** Various existing technologies were mentioned, including Cellular/Wildeye, SCADA with radio, Xio, Sensus, and LoRa. Participants noted shifts away from radio technologies in the upper watershed due to topographic differences, highlighting the importance of adaptable technological solutions.

## Station 3 | Water Monitoring Questions, Problems, and Data Needs

The goal of this station was to address water monitoring questions and understand problems and data needs. The following summarizes discussions at this station.

- **Data Gaps:** Other discussion topics included frustrations over data gaps in Eel River diversions via the Potter Valley Project, advocacy for consistent water quality data collection, reliance on existing gages for water modeling, and challenges in integrating diverse data sources for water management decisions. There were continued discussions on improving water supply models and integrating diverse data sources for effective water management.
- **Data Accessibility and Quality:** Participants expressed a keen interest in data accessibility and quality, emphasizing the need for reliable and accessible data sources. There was a strong interest among participants in accessing reliable and accurate data. Questions were raised about the availability and public accessibility of various gages and datasets, such as those shown in USEPA's How's my Waterway. Participants observed the importance of monitoring and data sharing across different regions.
- **Surface and Groundwater Interactions:** There was a strong desire for greater understanding of surface and groundwater interactions within the watershed, particularly concerning water movement and its implications during different water year types. Participants expressed a significant need for better understanding of surface and groundwater interactions within the

watershed. They discussed the movement of water during different water year types and emphasized the importance of accurately tracking water flow and usage. Discussions centered on water diversion monitoring near Cloverdale and concerns over water losses. The group emphasized the importance of static water levels from wells and user-friendly data access for effective decision-making.

- **Post-Potter Valley Project Concerns:** The group explored the need for real-time telemetry and anticipated changes following modifications to the Potter Valley Project. Participants highlighted uncertainties and potential impacts on water resources after the project's modifications.

## Station 4 | Considerations for Study Participation

The goal of this station was to gather considerations for Study participation. Participants were asked to use three colors of stickers to prioritize concerns regarding participation in the Study, with red indicating the highest concern, yellow indicating some concern, and green indicating no concern. Key concerns included:

- the potential for inaccurate data being automatically sent to the state,
- issues with equipment maintenance and calibration,
- covering operation and maintenance costs after the Study ends,
- increased labor costs,
- fears of increased regulation, and
- uncertainties about data privacy and public availability.

There were also concerns about the Study's scale and compatibility with existing monitoring efforts in the watershed. Additionally, participants expressed worries about the potential impact on compliance with reporting requirements, the perceived complexity of the Project's data systems, and technical challenges related to equipment longevity and maintenance.

Participants proposed several mitigation measures to address these concerns. Suggestions included:

- enhancing quality assurance and quality control processes for data accuracy,
- ensuring public agency partnerships for equipment maintenance, and
- clarifying terms in agreements to safeguard data privacy.

There were calls for coordination with the Ukiah Valley GSA, CLSI, City of Ukiah, and suppliers to support pre-existing monitoring efforts, clear agreements on data usage and enforcement protocols, and the implementation of an open data standard. Participants emphasized the need for ongoing local support and technical expertise during the Study, advocating for simplified compliance processes and proactive notification systems for data issues. Concerns about equipment costs, telemetry, and permitting were also highlighted, along with the importance of respecting agreements with Federal Trust Lands and addressing technical challenges related to equipment standardization and integration.

## B.4 In-person Workshop 2: August 2024

The second in-person workshop was held August 21, 2024, from 1:00 to 4:00 p.m. at the Finley Community Center (Cypress Room), 2060 W College Ave, Santa Rosa, CA 95401. Members of the Project Team attended, in addition to 14 participants representing potential partners, interested parties and technical advisors.

### B.4.1 Objectives

The objectives of the workshop were to:

1. Learn about and provide feedback on the draft Study network design and technical recommendations developed by the Consortium Team.
2. Understand how feedback from interested parties will be incorporated into the final Study recommendations.
3. Provide feedback on Access Agreements to be developed between Study volunteers and the Telemetry Research Unit.

### B.4.2 Agenda

The workshop agenda was as follows:

1. Welcome & Agenda
2. Overview of Study and Feedback Process
  1. Study Structure and Objectives
  2. Summary of Previous Feedback
  3. Process for Providing and Integrating Feedback on Recommendations
3. Study Recommendations
  1. Draft Study Network Design
  2. Feedback on Study Network Design
  3. Study Assumptions and Uncertainties
  4. Question & Answer
  5. Breakout Activity - Input for Initial Set of Recommendations
4. Access Agreements
  1. Considerations for Land, Equipment, & Data Access Agreements
  2. Questions & Answers
  3. Participant Feedback
5. Wrap up and Next Steps

### B.4.3 Participants

**Table B-5** presents the affiliations of those who participated in the workshop.

**TABLE B-5  
PARTICIPANT AFFILIATIONS FOR IN-PERSON WORKSHOP 2 (LISTED ALPHABETICALLY)**

<b>Affiliation</b>	<b>Number of Attendees</b>
Atlas Vineyard Management, Mendocino County RRFC	1
California Department of Fish and Wildlife	1
Mendocino County Farm Bureau	1
Mendocino County Russian River Flood Control & Water Conservation Improvement District (Mendocino RRFC)	1
North Coast Regional Water Quality Control Board (NCRWQCB)	1
Onset Data Loggers	1
Palomino Water Co	1
Russian River Property Owners/County of Sonoma	1
Russian Riverkeeper	1
Sonoma Resource Conservation District, and Alexander Valley landowner	1
Sonoma Water	2
Technical Advisor	1
Trout Unlimited	1
Wagner & Bonsignore Consulting Civil Engineers	1

### B.4.4 Methods

In advance of the workshop, the draft report was sent to workshop registrants via email. The Consortium Team invited participants to share feedback at the workshop directly, while also inviting participants and/or those who could not attend the workshop to provide feedback via email and/or a web-based survey. The web-based survey mirrored the questions asked in the in-person workshop. As of September 2024, 22 people provided feedback on the draft report through either in-person workshop participation, response to the web-based survey, and/or via email. Feedback will continue to be collected and incorporated into the final recommendations report.

During the workshop, the Project Team used “breakout sessions” to gather feedback from participants to be incorporated into the report. Specifically, the goal of the breakout sessions was to receive feedback on each recommendation presented in the report for the Study in the Russian River watershed. This input on the draft recommendations was used to inform the final set of recommendations for the Study presented in the report.

Following the presentation of the Study recommendations, participants were asked to provide both qualitative and quantitative input for each recommendation in breakout groups. The questions asked aligned with the web-based survey sent out with the draft report.

### B.4.5 Feedback Summary

**Table B-6** presents a summary of the information gathered for each recommendation.

**TABLE B-6**  
**SUMMARY OF FEEDBACK ON TECHNICAL RECOMMENDATIONS**

Is the recommendation clear and do you agree with it?	What suggestions could enhance this recommendation?	What concerns do you have regarding this recommendation, and what could alleviate these concerns?	Are there potential barriers to implementation you think should be considered?	Which elements of this recommendation offer the most significant benefits?	Any other feedback?
<b>Recommendation 1: Leverage the Study network design to support State reporting and compliance requirements for local entities.</b>					
<ul style="list-style-type: none"> <li>- 73% agreed the recommendation was clear, while 27% somewhat agreed it was clear (n=15).</li> <li>- 100% agreed with the recommendation (n=15).</li> </ul>	<ul style="list-style-type: none"> <li>- Set a geographic boundary for additional potential partners</li> <li>- For studying surface and groundwater interactions, consider using production wells where possible or abandoned wells (if accurate).</li> <li>- Align site identifiers in stream gage table to allow comparison with R3MP and USGS.</li> </ul>	<ul style="list-style-type: none"> <li>- How the Study would deal with surface and groundwater interactions, particularly in losing reaches. There could be loss to the aquifer between the upstream gage and downstream gage. Additionally, for wells reasonably close to the river, it is assumed this is 100% Russian River water (when in fact it may be groundwater).</li> <li>- To alleviate concerns, groundwater wells could be used to capture gradients and may also have some indication of volume flux from the surface water to groundwater system.</li> </ul>	<ul style="list-style-type: none"> <li>- Identifying willing partners, landowners, and volunteers for the Study.</li> </ul>	<ul style="list-style-type: none"> <li>- Leveraging the existing work of the Mendocino RRFC.</li> <li>- Stream gaging for salmon recovery reasons.</li> <li>- Improvements to tools and models to facilitate data-driven approaches to manage water during prolonged drought periods and State curtailments.</li> <li>- More widespread telemetry would provide early season (April/May) measurements to help forecast projected conditions.</li> <li>- Ensure individual diverters are compliant with their water right limit.</li> <li>- A robust dataset for modeling development and calibration.</li> </ul>	<ul style="list-style-type: none"> <li>- Improve reporting outputs as current reporting requirements are disparate.</li> <li>- Create a dashboard where people can see what type of water and where.</li> </ul>

**TABLE B-6**  
**SUMMARY OF FEEDBACK ON TECHNICAL RECOMMENDATIONS**

Is the recommendation clear and do you agree with it?	What suggestions could enhance this recommendation?	What concerns do you have regarding this recommendation, and what could alleviate these concerns?	Are there potential barriers to implementation you think should be considered?	Which elements of this recommendation offer the most significant benefits?	Any other feedback?
<b>Recommendation 2: Explore non-contact methods for flow and diversion measurement.</b>					
<p><b>Remotely Sensed Water Consumptive Use Diversion Monitoring</b></p> <ul style="list-style-type: none"> <li>- 93% agreed the recommendation was clear, while 7% somewhat agreed it was clear. (n=14)</li> <li>- 93% agreed with the recommendation, while 7% percent somewhat agreed (n=14).</li> </ul> <p><b>Non-Contact Image Velocimetry for Flow Gaging</b></p> <ul style="list-style-type: none"> <li>- 100% agreed the recommendation was clear (n=14)</li> <li>- 100% agreed with the recommendation (n=14).</li> </ul>	<p><b>Remotely Sensed Water Consumptive Use Diversion Monitoring</b></p> <ul style="list-style-type: none"> <li>- Link the point of diversion to the point of use or application, and the conveyance infrastructure (e.g., ditch, natural channel).</li> <li>- Explain the accuracy in microclimates with different soil types and lag time in hydrologic response (as is typical for growing grapes).</li> </ul> <p><b>Non-Contact Image Velocimetry for Flow Gaging</b></p> <ul style="list-style-type: none"> <li>- Link the point of diversion to the point of use or application, and the conveyance infrastructure (e.g., ditch, natural channel)</li> <li>- Explain the accuracy of cameras at low velocity streamflow where the water is often too clear.</li> <li>- Estimate the cost of the required equipment and the methods of taking the photographs (computer versus human).</li> </ul>	<p><b>Remotely Sensed Water Consumptive Use Diversion Monitoring</b></p> <ul style="list-style-type: none"> <li>- Ground truthing the data. Large growers used OpenET and most were way off. It could work for others, but it was rough with the large growers. It seems to be the calculations that are off.</li> <li>- Potential future costs associated with using OpenET.</li> <li>- Using this technology on grapes, whereas it was designed more for crops like alfalfa. There have been a lot of issues with pistachios.</li> <li>- Overall novel state of the technology.</li> <li>- To alleviate concerns, deploy a study to test technology across a couple fields and develop the models before applying to uncensored fields. Pair with application where people can use an app to spot count.</li> <li>- Aerial imagery should be done by multiple companies.</li> </ul> <p><b>Non-Contact Image Velocimetry for Flow Gaging</b></p> <ul style="list-style-type: none"> <li>- Keep expectations low for the Study.</li> <li>- Coagulate and pepper the data.</li> </ul>	<p><b>Remotely Sensed Water Consumptive Use Diversion Monitoring</b></p> <ul style="list-style-type: none"> <li>- Using the technology for regulatory purposes (and whether it is ready for that).</li> <li>- Need for multiple networks to get accurate information.</li> </ul> <p><b>Non-Contact Image Velocimetry for Flow Gaging</b></p> <ul style="list-style-type: none"> <li>- Certain reaches of the Russian River would need to be resurveyed frequently (every 6 weeks or so in the summer months).</li> </ul>	<p><b>Remotely Sensed Water Consumptive Use Diversion Monitoring</b></p> <ul style="list-style-type: none"> <li>- The ability to monitor large areas of water.</li> </ul> <p><b>Non-Contact Image Velocimetry for Flow Gaging</b></p> <ul style="list-style-type: none"> <li>- Since we are headed to reworking Senate Bill 88, this would be a good tool for small diverters.</li> </ul>	<p>- No response</p>

**TABLE B-6  
SUMMARY OF FEEDBACK ON TECHNICAL RECOMMENDATIONS**

Is the recommendation clear and do you agree with it?	What suggestions could enhance this recommendation?	What concerns do you have regarding this recommendation, and what could alleviate these concerns?	Are there potential barriers to implementation you think should be considered?	Which elements of this recommendation offer the most significant benefits?	Any other feedback?
<b>Recommendation 3: Experiment with a wide range of monitoring network componentry, methods, and technologies</b>					
<ul style="list-style-type: none"> <li>- 100% agreed that the recommendation was clear (n=15).</li> <li>- 93% agreed with the recommendation, while 7% somewhat agreed (n=15).</li> </ul>	<ul style="list-style-type: none"> <li>- Develop a way to evaluate site accuracy, permits will likely not be a barrier, but cost could be.</li> <li>- Reach out to (pump) repair companies, and service communities, the ones growers reach out to</li> <li>- Consider partnering with Wild Eye.</li> <li>- Indicate challenges with cellular reception (AT&amp;T) versus Starlink (better reception).</li> <li>- Measuring water quality and dissolved oxygen would be helpful. DO and temp are usually paired on a meter. Recommend HOBO DO U26 sensors, USGS uses YSI for water quality.</li> <li>- Add some low cost data loggers to the list of equipment.</li> <li>- Consider magnetic meters because they work well for low flows. Others countered that propeller meters seem to be much more reliable in low flows.</li> <li>- Consider ultrasonic flow meters.</li> <li>- Use solar panels versus power lines to power equipment.</li> </ul>	<ul style="list-style-type: none"> <li>- Ability to experiment with a wide range when another recommendation is to avoid highly sensitive areas.</li> <li>- Offer additional options in monitoring technologies and companies.</li> <li>- Recommend setting minimum criteria for equipment based on locations.</li> <li>- Impacts of variable weather and water quality measurements.</li> <li>- For measurements of reservoir water levels, concerns with data frequency (pressure transducers can have noise due to wind, etc.)</li> <li>- Concerns with data quality and calibration.</li> <li>- Concerns with reliable connectivity (cellular, radio).</li> <li>- Use of a deployable small-scale fish ladder or similar technology at low flows to allow juvenile fish passage at weir sites. Avoiding use of weirs would alleviate the concerns.</li> <li>- Include EC, especially in or downstream of significant return flows.</li> </ul>	<ul style="list-style-type: none"> <li>- Permitting for various equipment types.</li> <li>- Operation and maintenance post-Study.</li> <li>- Existing gaging sites may not be properly installed in the first place. Often a farmer will just throw in a meter to be in compliance, so it might not always be reliable data. Old meters may not read properly but may not be replaced if they are reading low.</li> <li>- Willingness to partner.</li> <li>- There are weather stations in vineyards, but not all are well calibrated nor ideally placed. Weather stations can even vary based on if they are in the sun, so be careful with grabbing other data. Every site is going to have its separate calibration requirements, as well as different vendors.</li> </ul>	<ul style="list-style-type: none"> <li>- Wide range of monitoring to see what works.</li> <li>- Flexibility in approach and equipment.</li> </ul>	<ul style="list-style-type: none"> <li>- No response</li> </ul>

**TABLE B-6  
SUMMARY OF FEEDBACK ON TECHNICAL RECOMMENDATIONS**

Is the recommendation clear and do you agree with it?	What suggestions could enhance this recommendation?	What concerns do you have regarding this recommendation, and what could alleviate these concerns?	Are there potential barriers to implementation you think should be considered?	Which elements of this recommendation offer the most significant benefits?	Any other feedback?
<b>Recommendation 4: Avoid highly sensitive areas that may trigger environmental permitting.</b>					
<ul style="list-style-type: none"> <li>- 67% agreed the recommendation was clear, 27% somewhat agreed, and 7% somewhat disagreed (n=15).</li> <li>- 80% agreed with the recommendation, while 20% somewhat agreed (n=15).</li> </ul>	<ul style="list-style-type: none"> <li>- Construction of some infrastructure (e.g., weir flume) may trigger a permit. To avoid this, probably need to work within existing channels flow measurements.</li> <li>- If installing gages in sensitive areas, work with a partnering organization like Trout Unlimited.</li> <li>- Existing gages already have a permit, so advise working within those existing gage locations.</li> <li>- Depending on the permit, the process may be doable in a reasonable timeframe.</li> <li>- Specificity about the resources that are of concern (e.g., juvenile fish migration).</li> </ul>	<ul style="list-style-type: none"> <li>- Smaller gages may not need permits. The telemetry gages don't need to be intrusive.</li> <li>- Is reactivation of an existing gage easier than installing a new gage?</li> <li>- A decision to avoid areas where measurement is needed.</li> <li>- The possibility of avoiding important stream reaches or those locations that provide the best conditions for accurate measurements. Pre-project consultation to determine the scope of concerns before writing off a good location.</li> </ul>	<ul style="list-style-type: none"> <li>- Regarding permitting, Mendocino County will be a little easier to deal with than Sonoma County.</li> </ul>	<ul style="list-style-type: none"> <li>- Stay away from those sensitive areas unless absolutely necessary</li> </ul>	<ul style="list-style-type: none"> <li>- Juvenile salmonid rearing areas should be given more careful consideration, but not avoided. Stream reaches that have unsuitable water quality conditions during summer months won't have the same concerns as core rearing areas.</li> <li>- The 4 priority coho streams (Mill, Green Valley, Mark West, and Dutch Bill) are important sites for telemetered flow data for future curtailment scenarios.</li> </ul>

**TABLE B-6  
SUMMARY OF FEEDBACK ON TECHNICAL RECOMMENDATIONS**

Is the recommendation clear and do you agree with it?	What suggestions could enhance this recommendation?	What concerns do you have regarding this recommendation, and what could alleviate these concerns?	Are there potential barriers to implementation you think should be considered?	Which elements of this recommendation offer the most significant benefits?	Any other feedback?
<b>Recommendation 5: Build a data management system to ingest data from various sources, automate error detection, and prioritize data privacy and security</b>					
<ul style="list-style-type: none"> <li>- 100% agreed the recommendation was clear (n=13).</li> <li>- 100% agreed with the recommendation (n=13).</li> </ul>	<ul style="list-style-type: none"> <li>- Move the data from raw to curated to allow for adjustment before it is considered "final".</li> <li>- Explain whether data sets need to be in a certain format.</li> <li>- Have an error bar for each piece of equipment/data type to show what the "best" option is.</li> <li>- Explain if there will be an archive of those data and whether the data would go to California Data Exchange Center.</li> <li>- Partner with academic institution around data science and engineering for a peer review.</li> <li>- Be clear about what the end goal is of the new system.</li> <li>- Discuss frequency of data collection (hourly is good, 15 minutes is great).</li> <li>- Provide tutorials on the user interface/business interface tools.</li> <li>- Enable push-button csv data export.</li> <li>- Consider using XIO (Scada) to ingest data.</li> </ul>	<ul style="list-style-type: none"> <li>- Problems will occur if the person (diverter) is identified, indemnification needed for verifying when legal actions can occur before (i.e. no legal action should occur before data are finalized).</li> <li>- Data aggregation: what is the unit to protect a water right holder (e.g., 5 or 10 diverters)? What about spatial aggregation?</li> <li>- Describe data privacy, PII protected so don't allow download, data and location is all that is needed (General Data Protection Regulation precedence).</li> <li>- Deploy Multifactor Authentication for security (keep it simple and do not require the installation of new applications).</li> <li>- Explain if CalWATRS is going to allow data access and what the tools are to access the data.</li> </ul>	<ul style="list-style-type: none"> <li>- With regard to small/ low flow gaging, can we upload that after the fact in a batch?</li> <li>- Different users have different data needs (real time versus yearly).</li> <li>- The need for everyone to be in the database to view the data.</li> <li>- Quality assurance and quality control of the data.</li> <li>- How is shielding water rights data consistent with the Public Records Act? Water rights, permits, and licenses are public documents.</li> </ul>	<ul style="list-style-type: none"> <li>- Housing all these data in one central location.</li> <li>- A data clearinghouse.</li> </ul>	<ul style="list-style-type: none"> <li>- Supply demand calculations aren't working since supply demand data are poor quality.</li> </ul>

**TABLE B-6  
SUMMARY OF FEEDBACK ON TECHNICAL RECOMMENDATIONS**

Is the recommendation clear and do you agree with it?	What suggestions could enhance this recommendation?	What concerns do you have regarding this recommendation, and what could alleviate these concerns?	Are there potential barriers to implementation you think should be considered?	Which elements of this recommendation offer the most significant benefits?	Any other feedback?
<b>Recommendation 6: Work within an existing organizational structure that can sustain the telemetry network after the Study</b>					
<ul style="list-style-type: none"> <li>- 85% agreed that the recommendation was clear, while 15% somewhat agreed (n=13)</li> <li>- 75% agreed with the recommendation, while 8% somewhat agreed and 17% somewhat disagreed (n=12).</li> </ul>	<ul style="list-style-type: none"> <li>- Explain if the structure would allow all users to contribute, or if it would start with existing organizations.</li> <li>- Test different committees to help decide how to sustain the telemetry network.</li> <li>- Propose other potential organizations (not just R3MP).</li> <li>- Some type of technical assistance for local entities when problems arise.</li> </ul>	<ul style="list-style-type: none"> <li>- Creating a new organization should not be the goal, but maybe existing ones can complement each other and combine.</li> </ul>	<ul style="list-style-type: none"> <li>- The capacity of local entities.</li> <li>- The Russian River Regional Monitoring Program (R3MP) is not operating equipment and doesn't have boots on ground (compared to other groups described in the report). The other groups already have agreements with landowners.</li> </ul>	<ul style="list-style-type: none"> <li>- R3MP may have bandwidth and be available to take on the telemetry network after the Study. Municipalities are very involved in R3MP, many watershed groups are less involved.</li> <li>- Some diverters may have fatigue from interacting with all the different agencies. People will be thankful if we coordinate with other organizations. It might be better to go through the Farm Bureau or local flood control districts.</li> <li>- Local entities have existing relationships and site-specific understandings.</li> </ul>	<ul style="list-style-type: none"> <li>- Request the State (DWR or Regional Board) take on the organizational structure.</li> <li>- Consider others like Sonoma Water.</li> </ul>

## B.5 Follow-up Meetings

Follow-up meetings were held between May and August 2024 with potential partners, interested parties, and technical advisors. Meeting participation range from individual conversations to a maximum of three participants. The affiliations of individuals or groups that the Consortium Team met with are provided in Table B-7 below. While the Consortium Team had a total of 28 meetings, follow-up meetings with others from the same organization are not included in Table B-7.

### B.5.1 Objectives

The objectives of the follow-up meetings were to:

1. Answer additional questions regarding the Study
2. Gather technical information to inform the technical recommendations
3. Acquire datasets, equipment specifications, etc. to support the technical recommendations
4. Identify additional contacts and/or entities that the Consortium Team should engage with

### B.5.2 Participants

**Table B-7** presents the affiliations of those who participated in the follow-up meetings.

**TABLE B-7**  
**PARTICIPANT AFFILIATIONS FOR FOLLOW-UP MEETINGS (LISTED CHRONOLOGICALLY)**

No.	Affiliation
1	Larry Walker Associates/Ukiah Valley Groundwater Sustainability Agency
2	State Water Resources Control Board (SWRCB) Division of Water Rights
3	Mendocino RRFC
4	Wagner & Bonsignore
5	City of Ukiah, SWRCB
6	Palomino Water Company
8	California Department of Fish and Wildlife, North Coast Regional Water Quality Control Board
9	Center for Western Weather and Water Extremes (CW3E), Scripps Institution of Oceanography at UC San Diego
10	USGS
11	California Land Stewardship Institute (CLSI)
12	Mendocino RRFC (Board Member)
13	HOB0 Data Loggers
14	Trout Unlimited
15	CSU Monterey Bay
16	Yokayo Tribe of Indians
17	SWRCB Division of Water Rights' Supply Demand & Instream Flows Section
18	Sonoma Water
19	McBain Associates
20	San Francisco Estuary Institute (SFEI) / Russian River Regional Monitoring Program (R3MP)

### B.5.3 Feedback Summary

To meet the objectives described above, the Consortium Team conducted follow-up meetings with potential partners, interested parties, and technical advisors. In some cases, members of the TRU participated in the meetings. Meetings were on average one hour in duration. Discussion topics varied based on the meeting. Topics included, but were not limited to:

- Address questions and concerns regarding the Study
- Explore willingness to partner in the Study
- Discuss participation in the Study, including benefits
- Gather feedback on the list of potential partners, interested parties and technical advisors
- Strategize Tribal outreach and engagement
- Identify areas of the watershed to be visited during a field site visit
- Discuss existing networks and locations of existing gages
- Discuss priority locations for the Study (e.g., Senate Bill 19)
- Discuss specific data needs of the organization
- Discuss specific telemetry equipment types
- Discuss how telemetry may benefit existing modeling efforts in the Russian River watershed
- Exchange information regarding other relevant projects in the Russian River watershed (e.g., FIRO, plans for future telemetry)
- Acquire specific datasets related to water diversions, water demand, etc.
- Gather feedback on governance structure

Feedback gathered during these meetings, as well as email follow-ups, is incorporated into this report.

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# Appendix C. Experiments to Test Non-Contact Methods

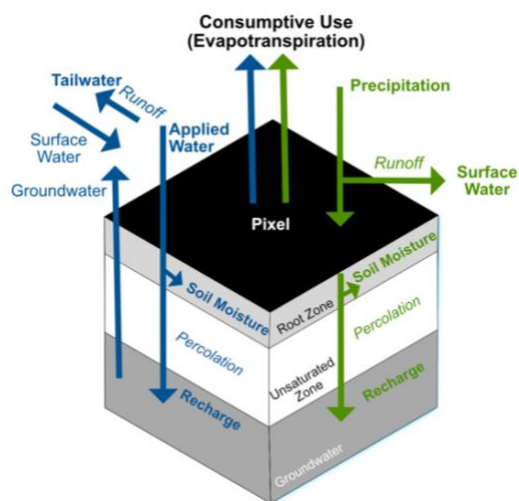
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## C. EXPERIMENTS TO TEST NON-CONTACT METHODS

### C.1 Experiment 1: Diversion Estimates from Satellite-Derived Evapotranspiration Measurements

#### C.1.1 Introduction

Allocating water in the Russian River remains a critical water management challenge due to limited data on how much water is being diverted, where and when it is being applied, and how much is consumptively used. Consumptive water use refers to the amount of water transpired by plants and evaporated from soil and plant surfaces, which is collectively referred to as evapotranspiration (ET). ET represents water truly "consumed" by the environment and no longer available for downstream uses, unlike diverted and applied water that runs off or infiltrates back into the ground. In watersheds where return flows from applied water are recoverable, ET is a good proxy for total consumptive water use (**Figure C-1**).



**Figure C-1**

Water balance conceptual model used to estimate diverted water from consumptive use data. Green arrows derive from precipitation and blue arrows derive from applied water.

Until recently, quantifying consumptive use has been logistically challenging at regional scales relevant to water managers. To solve this challenge, OpenET (<https://etdata.org/>) was developed to provide satellite-derived estimates of ET to support water management decisions.<sup>92</sup> OpenET is a freely available platform (funded by the California Department of Water Resources) that water agencies can utilize to access and perform large-scale analysis of ET data via an API. Integrating satellite-based ET data with in situ measurements of diverted water enhances monitoring networks since it enables water managers to

<sup>92</sup> Melton, F.S., Huntington, J., Grimm, R., Herring, J., Hall, M., Rollison, D...Anderson, R.G. (2021, November 2). OpenET: Filling a critical data gap in water management for the western United States. *Journal of the American Water Resources Association, JAWR-20-0084-P*. doi: 10.1111/1752-1688.12956

differentiate between total water diverted, non-recoverable consumed water used to create crop biomass, and recoverable<sup>93</sup> return flows. Specifically, remotely sensed water consumption estimates can be used to:

- augment QA/QC processes by allowing data stewards to track where diversion measurements differ in unexpected ways from estimates of associated consumptive water use
- provide a more holistic understanding of water movement within the watershed to support hydrologic modelling
- reduce the required density of on-ground or in-stream measurement, thereby reducing the long-term costs and maintenance requirements of the monitoring network.

Moving forward, it is recommended that the Russian River Study explore whether OpenET can complement traditional measurement approaches to provide a more cost effective, accurate, and real-time assessment of water diversions in the basin. By leveraging satellite-based ET data, water managers in the Russian River basin can potentially improve the accuracy of water use monitoring throughout the watershed by estimating the portion of diverted water that is consumptively used versus the portion that may be flowing back into streams or recharging local groundwater basins. Basin-wide water use assessments using OpenET can overcome limitations of traditional point-based measurements by filling in data where it is financially or logistically infeasible to deploy instrumentation. Rapid deployment of readily available OpenET data is also possible since it leverages existing Earth observation and in situ climate data, thereby reducing O&M costs relative to new deployment of diversion monitoring sensors and telemetry. Furthermore, the insights derived from ET data can be used by water managers in the Russian River Basin to inform sustainable water management and watershed health strategies.

## C.1.2 Methods

OpenET consumptive use data can potentially be used to monitor diverted water for agricultural parcels lacking field instrumentation but first must be locally calibrated and tested with diversion data. In the case of the Russian River Study, it is highly recommended that this process be done in consultation with industry experts at OpenET. Telemetered study data sample sizes should be sufficiently large to represent the range of land cover and irrigation approaches in the watershed. Diversion field data should be split into training and testing sets, so that relationships between ET and applied water, or consumptive use fraction (CUF),<sup>94,95</sup> can be established for different classifications of land use and irrigation approaches and then tested to assess the validity of these relationships for estimating diversions with ET data wherever metering is infeasible. To assess the validity of the approach, telemetered data collected during the Study should be randomly divided into training and test sets data with a 80% and 20% split, which is standard practice. The training data can be used to establish a relationship between the OpenET and diversion data, and the remaining 20% of the data in the test set is withheld to assess the accuracy of that relationship. A relationship between ET and diversion volumes can be processed for the training sites using the proposed workflow in **Figure C-2**. Computing ETPR is not a trivial process nor is there agreement in the literature, however, there are several approaches that can be explored: (1) National Engineering Handbook Approach (NEH-623; section

<sup>93</sup> Outflows are not considered recoverable in systems overlying saline/contaminated aquifers and/or upstream of the ocean. However, in this case, neither of these conditions applies.

<sup>94</sup> Johnson, L., Sharma, F.C., Harding, J., Herring, J., Melton, F. (2021, August 5-9). *Derivation and testing of consumptive water use fraction for specialty crops* [Conference presentation abstract]. American Society for Horticultural Science conference, virtual, United States. <https://ntrs.nasa.gov/citations/20210015729>

<sup>95</sup> California Department of Water Resources. (2016). *A Resource Management Strategy of the California Water Plan*. Retrieved from [https://cawaterlibrary.net/wp-content/uploads/2016/07/CWP-RMS-Ch-1-Ag\\_Water\\_Efficiency\\_July2016.pdf](https://cawaterlibrary.net/wp-content/uploads/2016/07/CWP-RMS-Ch-1-Ag_Water_Efficiency_July2016.pdf)

623.0207(e));<sup>96</sup> (2) US Bureau of Reclamation 1967 approach (see Table 40-1);<sup>97</sup> and (3) Pixel-scale rootzone water budget model following the approach for the Integrated Water Flow Model Demand Calculator.<sup>98</sup> Soil parameters are a critical variable for deriving conveyance fractions and diverted water estimates. Empirical infiltration rate can be determined using ponding tests<sup>99</sup> or inflow-outflow (conveyance reach water budgets), which can then be correlated to soil parameters from SSURGO and then extended to other locations. Once a CUF has been established for the training set data, the CUFs for each separate land cover and irrigation approach category can then be applied to parcels lacking metered data (test set and everywhere else). Diverted water can then be estimated at each test site with the CUF and OpenET-derived ETAW following the steps in Figure C-2. The test set can then be used to perform an uncertainty analysis between the field diversion measurements and the modeled estimates derived using the CUF and OpenET outputs, so that the uncertainties can be known for monitoring diverted water with satellite data on various spatial and temporal scales relevant to management.<sup>100</sup>

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<sup>96</sup> United States Department of Agriculture. (1993). *Part 623 National Engineering Handbook*. Retrieved from <https://www.wcc.nrcs.usda.gov/ftpref/wntsc/waterMgt/irrigation/NEH15/ch2.pdf>

<sup>97</sup> Stamm, G.G. (1967). *Problems and Procedures in Determining Water Supply Requirements for Irrigation Projects*. In Hagan, R.M., Haise, H.R. & Edminster, T.W. (Eds.), *Irrigation of Agricultural Lands* (pp. 769-785). Madison, WI: American Society of Agronomy.

<sup>98</sup> California Department of Water Resources. (2024, October 8). IDC: Integrated water flow model demand calculator. Retrieved from <https://water.ca.gov/Library/Modeling-and-Analysis/Modeling-Platforms/Integrated-Water-Flow-Model-Demand-Calculator>

<sup>99</sup> Leigh, E. & Fipps, G. (n.d.) Measuring seepage losses from canals using the ponding test method. Retrieved from <https://texaslocalproduce.tamu.edu/files/2023/08/B-6218-Measuring-Seepage-Losses-from-Canals-Using-the-Ponding-Test-Method.pdf>

<sup>100</sup> Ott, T., Majumdar, S., Huntington, J.L., Pearson, C., Bromley, M., Minor, B.A... Jasoni, R.L. (2024, September 1). Toward field-scale groundwater pumping and improved groundwater management using remote sensing and climate data. *Agricultural Water Management, Elsevier*, vol. 302(C). doi: 10.1016/j.agwat.2024.109000

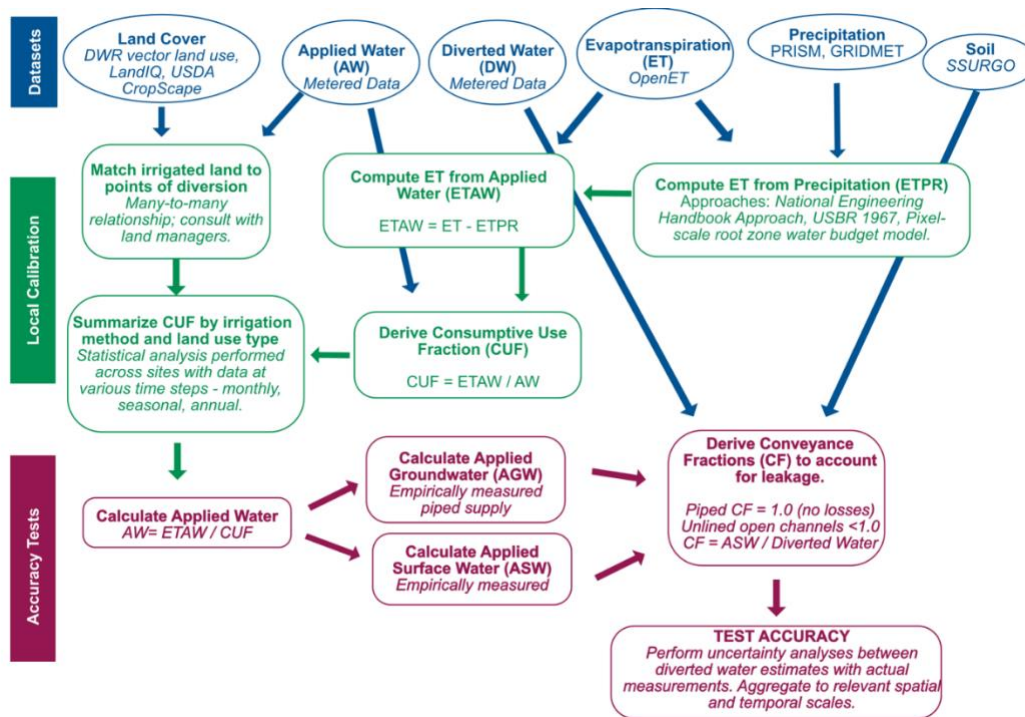


Figure C-2

Proposed workflow to test the accuracy of using OpenET to estimate diverted water for land lacking in-field instrumentation.

### C.1.3 Considerations for Implementation

Implementation challenges include but are not limited to the following:

- Accounting for factors influencing ET not captured by satellite imagery, such as soil moisture and local weather variations.<sup>101</sup>
- Data gaps during long periods of cloud cover, smoke, or other atmospheric interference with remote sensing of the land surface.
- Measuring or estimating the ratio of consumed water to applied water (i.e., consumptive use fraction).
- Measuring or estimating conveyance system losses for non-piped conveyances (e.g., open channels).
- Partitioning estimates of applied water between applied surface water and applied groundwater; one of these needs to be either estimated or measured to solve for the other.
- Incorporating changes in storage (e.g., soil moisture in the rootzone) to improve short-duration (e.g., daily/weekly/monthly) estimates of diversion.
- Developing robust linkages between points of diversion and places of application.

<sup>101</sup> Work is being done on ET and plant stress as an integrated proxy for soil moisture, so this limitation is slowly being addressed.

## C.1.4 Costs

Because the approach is still being developed, there are significant costs to implement this study. For example, for 200,000 acres in Madera County,<sup>102</sup> annual costs are approximately \$800,000-1,200,000.<sup>103</sup> This includes:

1. \$400K / year (or \$2 / acre): Ongoing water accounting and allocation support, including processing, quality controlling, and reporting of P, ET, ETPR, ETAW, ASW, AGW, ETASW, and ETAGW datasets, database management, quality control, grower reporting, grower interactions, and training with County staff.
2. \$400K / year (or \$2 / acre): In field verification measurements of AGW, place of application, cropping (including fallow field verification), grower interactions/questions, annual verification reporting (including individualized grower reports and summary GSA-wide results).
3. \$400K / year (or \$2 / acre): Measurement costs for Land IQ and Hydrosat (IrriWatch) combined. Some costs included here are for development and maintenance of the platform developed for quality controlling AGW/ASW flowmeter measurements. If OpenET data was used instead, this cost would not apply because OpenET is currently a free platform.

Costs are decreasing as streamlined or automated processes are being developed.

## C.2 Experiment 2: Non-Contact Image Velocimetry

### C.2.1 Introduction

Non-contact image velocimetry for stream gaging is a non-contact method for measuring discharge in rivers, streams, and artificial channels. This technique involves capturing videos (i.e., collections of images over time) of the water surface and analyzing the movement of visible features or particles to estimate flow velocities and water level.<sup>104,105</sup> While measuring surface velocity is not the same as measuring average cross-sectional velocity of the entire channel, having a continuous record of water level and velocity is more informative than just measuring water level alone, which is the common practice for stage-discharge gaging sites.

Non-contact image velocimetry can convert surface velocities to average cross-sectional velocity using theoretic equations or a process known as velocity indexing. Theoretical equations have the benefit of not needing any site-specific observations but generally have higher uncertainty in reported flows due to the lack of calibration. To reduce measurement uncertainty, a velocity-index relationship relates the measured average cross-sectional velocity with the index velocity measured with the non-contact image velocimetry

<sup>102</sup> Davids Engineering, Inc. (2024, April). 2023 Madera verification project final report. Retrieved from [https://www.maderacountywater.com/wp-content/uploads/2024/06/2023\\_Madera\\_Verification\\_Project\\_Report\\_Final\\_20240430.pdf](https://www.maderacountywater.com/wp-content/uploads/2024/06/2023_Madera_Verification_Project_Report_Final_20240430.pdf)

<sup>103</sup> J. Davids, personal communication, January 21, 2025.

<sup>104</sup> Pena-Haro, S., M. Carrel, B. Luthi, I. Hansen, and R. Lukas. 2021. Robust Image-Based Streamflow Measurements for Real-Time Continuous Monitoring. *Frontiers in Water* 3:766918. doi: 10.3389/frwa.2021.766918

<sup>105</sup> Bradley, A.A., A.Kruger, E.A. Meselhe, and M.V. I. Muste, 2002. Flow measurement in streams using video imagery, *Water Resources Research*, 38(12), 1315. doi:10.1029/2002WR001317.

device.<sup>106</sup> Once the velocity-index relationship is empirically derived over the range of expected flows, it can be used to translate index velocity measured in real-time to average cross-sectional velocity. The level of effort involved in creating a velocity-index rating is generally equivalent to developing a rating curve, with periodic measurements of discharge needed to calibrate and validate the index rating.<sup>107</sup>

One common non-contact image velocimetry approach is Large-Scale Particle Image Velocimetry (LSPIV), which uses video imagery to track the movement of particles or patterns on the water surface. The captured images are processed to calculate the surface velocity field, which can then be used to estimate the stream's discharge or volumetric flow rate.<sup>108,109</sup> Additional image velocimetry approaches include Surface Structure Image Velocimetry (SSIV), Space-Time Image Velocimetry (STIV), Kanade-Lucas Tomasi Image Velocimetry (KLTIV), and Optical Tracking Velocimetry (OTV). In addition to image-based approaches, devices that rely on the Doppler shift of radar signal backscattering from water surface roughness are also becoming available.<sup>110</sup>

These approaches are applicable in open channels (natural and artificial), from small creeks and canals to large rivers and canals and are especially suitable for sites with large and sudden variations in flow conditions, including intermittent and ephemeral channels.

In the context of this project, Image Velocimetry can be used to monitor both (1) streamflows in natural channels and (2) diversions.

The potential advantages of non-contact flow measurement techniques, including image velocimetry, for water use measurement include:

- **Non-contact measurements:** The sensors are out of the water, which can lead to less sensor failure.
- **Non-Intrusive Methodology:** Image Velocimetry offers a safe approach that avoids physical disturbance to the river ecosystem.
- **Continuous Monitoring:** The system facilitates real-time data acquisition on water flow, enabling continuous monitoring of water usage patterns.

<sup>106</sup> Dynamic cross-sections affecting the stage-area relationship must be addressed in all streamflow measurement techniques. Updated bathymetry data should be used to revise the stage-area relationship after events that alter channel geometry. Stream gages should be placed in stable cross-section locations when possible. The velocity-index relationship, which links surface velocity to mean channel velocity, may still be valid after cross-section changes, but each streamflow measurement should reassess this relationship. The USGS historically visits key streamflow gaging sites monthly, which is ideal if resources permit. Stage-discharge and velocity-index relationships should be evaluated promptly after each ADCP or ADV streamflow measurement.

<sup>107</sup> Levesque, V.A., & Oberg, K.A., (2012, April 12). Computing discharge using the index velocity method: U.S. Geological Survey Techniques and Methods. Retrieved from <https://pubs.usgs.gov/tm/3a23/>

<sup>108</sup> Mohajeri, S.H., Noori, A., Mehraein, M. & Nabipour, M. (2024, January 26). On the performance of streamflow gauging using CCTV-integrated LSPIV in diverse hydro-environmental conditions. *Environmental Monitoring Assessment* 196, 202. doi: 10.1007/s10661-024-12369-9

<sup>109</sup> Ventia. (n.d.) Image velocimetry drone gauging. Retrieved from <https://www.ventia.com/what-we-do/projects/image-velocimetry-drone-gaugings>

<sup>110</sup> OTT. (n.d.) OTT SVR 100 Surface velocity radar. Retrieved from [https://cdn.hach.com/1XMCM0ZF/at/2n9gkqtmvx79hnhj3b4j899n/WP\\_SVR100\\_EN.pdf](https://cdn.hach.com/1XMCM0ZF/at/2n9gkqtmvx79hnhj3b4j899n/WP_SVR100_EN.pdf)

- **Scalable Implementation:** The technique can be adapted to rivers of varying widths by adjusting camera positioning and data processing algorithms.
- **Direct velocity measurement:** Measuring both water level and velocity is substantially more informative. This enables significantly faster development of robust rating curves that might have otherwise taken years to develop.

## C.2.2 Methods

The Image Velocimetry process involves data acquisition, software-assisted data processing and analysis, and water discharge calculation and transmission.

### Data Acquisition

Video cameras will capture high-frame-rate videos of the river flow, ensuring the motion is adequately resolved. Consistent lighting conditions are paramount. Ideally, data acquisition should occur during daylight hours with minimal glare or shadows impacting the water surface. Infrared cameras or artificial illumination are alternatives for nighttime measurements.

### Data Processing and Analysis (Image Velocimetry Software)

Various image velocimetry methods and associated algorithms use data to determine flow velocity, water level, and discharge. There are two options for processing non-contact image velocimetry data:

- The image processing can be performed locally at the site (i.e. edge) and then only processed stage and discharge data can be transmitted to a centralized data repository.
- Alternatively, raw image data can be transferred to a centralized server (i.e. server-side) and the image processing can take place there.

### Water Discharge Calculation Steps

- Measure the bathymetry once at a stable cross-section to develop the depth-area relationship.
- Measure surface velocity and depth continuously.
- Use the depth-area relationship to determine the cross-sectional area.
- Use a theoretical (higher uncertainty) or empirical (e.g. velocity-index) method to convert surface velocity to depth-averaged velocity (ideally, have an Acoustic Doppler Current Profiler (ADCP) measurement to help develop the understanding between surface velocity and depth-averaged velocity over the expected range of flows).
- Compute volumetric flow rate as the product of cross-sectional area from step 3 and depth-averaged velocity from step 4.

### Transmission

While both edge and server-side processing require telemetry for near real-time access to data, cloud processing is significantly more data intensive from a transmission perspective. If server-side processing is preferred, it is important for these sites to have high or unlimited bandwidth internet connectivity, which is most readily available at sites with robust cellular data connections or with broadband radio telemetry on a private radio network.

### C.2.3 Considerations for implementation

Implementation challenges include but are not limited to the following:

- **Data Accuracy:** The accuracy of Image Velocimetry measurements depends on several factors, including particle size, camera resolution, quality of the velocity-index rating (if used), and thorough software calibration and development.
- **Environmental Influences:** External factors such as wind, waves, and variations in lighting can potentially affect the quality of the acquired data. For example, shadows cast by bridges can significantly affect accuracy. To reduce these effects, careful planning of camera placement and timing of image capture is essential to lessen shadow interference. Moreover, sophisticated image processing techniques can be utilized to adjust for distortions caused by shadows.
- **Data Processing Expertise:** The analysis of Image Velocimetry data necessitates specialized software and personnel with the requisite expertise for accurate interpretation.
- **Permitting:** Permissions might be needed from bridge authorities for mounting equipment.
- **Maintenance:** Regular cleaning of cameras and system checkups to ensure optimal performance. The frequency of required camera cleaning depends on a variety of factors, including but not limited to: (1) the amount of dust in the nearby environment, frequency of precipitation events, distance from the camera to the surface velocities being observed, and resolution of the camera(s) being used. If server-side image processing is being performed, monthly checks of these video files can reveal if cleaning is necessary. If videos are not being transmitted to a central repository, the frequency of cleaning may need to be adjusted based on observed conditions from one site visit to the next but is generally on the monthly to annual scale.

### C.2.4 Equipment and Costs

The costs for an image velocimetry-based stream gage can vary depending on several factors, including the type of equipment, installation, and maintenance.

#### Equipment Costs

The primary equipment required for non-contact image velocimetry includes cameras, mounting structures, power supplies, required lighting if night measurements are essential, and possibly additional and/or redundant sensors for observing water depth. The cost of a high-quality camera suitable for image velocimetry can range from a few hundred to several thousand dollars depending on site conditions and project needs (e.g., width of the stream, distance from the camera mounting location to the water surface being analyzed).<sup>111,112</sup> In general, the cost of equipment and materials for do-it-yourself packages can range from \$1,000 to \$5,000, while turnkey solutions with built in image processing, power supplies, and telemetry range from \$15,000 to \$30,000. It should be noted that these technologies are extremely new, and price points are subject to significant changes.

<sup>111</sup> Pena-Haro, S., Carrel, M., Luthi, B., Hansen, I., & Lukes, R. (2021, December 14). Robust image-based streamflow measurements for real-time continuous monitoring. *Frontiers in Water, Vol 3*. doi: 10.3389/frwa.2021.766918

<sup>112</sup> Tauro, F., Piscopia, R., & Grimaldi, S. (2017, December 10). Streamflow observations from cameras: large-scale particle image velocimetry or particle tracking velocimetry? *Water Resources Research, 53*, 10,374-10,394. doi: 10.1002/2017WR020848

***Equipment:***

- High-resolution cameras (possibly two for 3D measurement)
- Image Velocimetry software license
- Computer for data processing
- Light source for nighttime measurements (optional)

***Bridge Mounting System:***

- Frame to hold the cameras securely
- Power supply (if using lights)
- Data transmission system (optional for remote data collection with edge processing)

**Installation Costs**

Installation costs can vary depending on the site's complexity and the need for additional infrastructure. This may include mounting poles, a power supply, and internet connectivity for real-time data transmission.

***Travel and Labor:***

- Cost of mobilizing personnel and equipment to the bridge site
- Time investment for setup, calibration, data collection, and retrieval (if not remote)

***Data Processing:***

- Software expertise or staff training required to analyze Image Velocimetry data

**Maintenance Costs**

Regular maintenance is required to ensure the accuracy and reliability of the system. This includes cleaning the camera lens, checking the alignment, and updating the software. Maintenance costs vary but are generally lower than those for traditional contact-based methods.

The cost of software for processing the images and calculating flow velocities can also vary. Some systems may require a one-time purchase, others are open sourced,<sup>113</sup> while others may have ongoing subscription fees. For example, DischargeKeeper<sup>114</sup> is a specific, nonintrusive turnkey optical flow measurement system for rivers, irrigation, and wastewater channels. The full cost of the system with equipment and mounting is around \$17,000 per station and includes data processing. A cheaper option is being developed, which will be only for smaller rivers and will be more limited in data output options.

<sup>113</sup> Rainbow Sensing. (n.d.) Live Open River Cam GitHub repository. Retrieved from <https://github.com/localdevices/LiveORC/blob/main/README.md>

<sup>114</sup> DischargeKeeper. (n.d.) Retrieved from <https://www.photrack.ch/dischargekeeper.html>

Operational costs vary depending on the camera's installation site. If an existing structure like a mast, bridge, or wall on the shore is suitable for mounting the camera, the system can be installed and configured within one day, assuming the cross-section is already available.

Maintenance requirements are minimal. Some sites have gone years without a visit, while others may require a reboot once a year. Hardware exchanges are rare; they typically fall under the system's warranty when they occur. The end customer usually performs maintenance.

Compared to traditional intrusive methods that require placing instruments in the water, Image Velocimetry offers a potentially lower cost in terms of long-term maintenance and avoiding potential damage to aquatic ecosystems. Compared to hydroacoustic sensors typically used for continuous water monitoring of water velocities, non-contact image velocimetry equipment is similar in cost, if not cheaper. Additional cost savings for non-contact image velocimetry may be realized by using open-source Image Velocimetry software<sup>115</sup> to avoid commercial license fees, and, if possible, designing a system that doesn't require remote data transmission to save on additional equipment.

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<sup>115</sup> Options include 1) KLT-IV: This software is designed for estimating 2D river flow velocities and flow discharge using optical imagery from various remote sensing platforms. It includes image stabilization routines for mobile platforms and uses the Kanade-Lucas-Tomasi feature detection and tracking procedures. 2) pyOpenRiverCam (pyorc): This library performs image-based river flow analysis using Large-scale Particle Image Velocimetry (LSPIV). It supports surface velocity estimation, discharge estimation, and plotting of results. It leverages OpenPIV and OpenCV for its computations. 3) Fudaa-LSPIV: This tool provides non-intrusive measurement techniques for obtaining two-dimensional velocity fields and discharge estimates on a plane surface. It's particularly useful for large-scale PIV applications.

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# Appendix D. Environmental Permitting

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## D. ENVIRONMENTAL PERMITTING

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Implementation of the telemetry field studies may trigger federal, state, and local permits, including:

- **Lake and Streambed Alteration Agreement (LSAA)** under Section 1602 of the California Fish and Game Code from the California Department of Fish and Wildlife to ensure that any construction activity that occurs in a streambed does not harm fish or wildlife. An LSAA relates to activities that (a) divert or obstruct the natural flow of any river, stream, or lake; (b) change the bed, channel, or bank of any river, stream, or lake; (c) use material from any river, stream, or lake; or (d) deposit or dispose of material into any river, stream, or lake, require notification to CDFW. The LSAA includes mitigation measures for any impacts of the activity on fish and wildlife resources.
- An **Incidental Take Permit** from:
  - CDFW under the California Endangered Species Act (CESA) if the project has the potential to harm a state-protected species. Section 2081(b) of the Fish and Game Code allows CDFW to authorize take of species listed as endangered, threatened, or candidate pursuant to the CESA, and CCR Title 14, Section 786.9 similarly allows CDFW to authorize take of plants listed as rare pursuant to the Native Plant Protection Act, if that take is incidental to otherwise lawful activities and if certain conditions are met. Impacts on state-listed species would need to be fully mitigated; and
  - U.S. Fish and Wildlife Service (if the project has the potential to harm a federally protected terrestrial or aquatic species) or from the National Marine Fisheries Service (if the project has the potential to harm a federally protected anadromous species) under the federal Endangered Species Act (FESA; Section 7). The triggering of the need for consultation under FESA stems from a federal agency taking action. Frequently, the USACE needs to consult with the U.S. Fish and Wildlife Service and National Marine Fisheries Service under Section 7 of FESA to obtain biological opinions and ITPs. The formal consultation would be initiated by submitting biological assessments that represent USACE's determination of the project effects on federally listed species.
- **Clean Water Act Section 401 Water Quality Certification** obtained from the North Coast SWRCB that certifies that the project complies with all applicable water quality standards, limitations, and restrictions. The USACE may not issue a Section 404 permit (see below) until this certification has been granted.
- **Clean Water Act Section 404 Individual Permit/Rivers and Harbors Act Section 10 Permit** from the USACE under section 404 of the federal Clean Water Act to protect from the effects of construction activity in waterways. A permit needs to be obtained for discharging dredged or fill materials in waters of the United States. This section of the Water Act has several potentially applicable components that are a separate process from obtaining a water right permit or license and would be solely related to the sensor, gage, structure, etc.
- **National Pollutant Discharge Elimination System General Permit for Stormwater Permit for Discharges Associated with Construction and Land Disturbance Activities (Order 2022-0057-DWQ)** from the SWRQCB. Construction activity subject to this permit (also referred to as the Construction General Permit) includes clearing, grading, and disturbances to the ground such as stockpiling or excavation but does not include regular maintenance activities performed to restore the original line, grade, or capacity of a facility. If construction activities associated with the field studies involve the

types of activities subject to this permit, and these activities disturb one (1) or more acres of soil or disturb less than one acre but are part of a larger common plan of development that in total disturbs one or more acres, dischargers are required to obtain coverage. Other approvals from the RWQCB may also be required if the field studies could harm water quality because of discharges to navigable waters or their tributaries.

- Section 408 Permit under Section 14 of the **Rivers and Harbor Appropriates Act** of 1899 (33 United States Code [USC] 408) if the field studies would modify federal infrastructure facilities. National Environmental Policy Act (NEPA) compliance would be required prior to a final Section 408 decision from the USACE.
- **Encroachment permits** from the California Department of Transportation and/or Mendocino or Sonoma Counties may be required if field study equipment were to be installed on a state or county property and/or in their right-of-way.

Note that completion of CEQA documentation (including AB 52 Native American consultation) would be required for any state agency to issue any of the state permits listed above. Similarly, completion of NEPA documentation would be required for federal permit issuance.

# Appendix E. Data Management

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## E. DATA MANAGEMENT

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The data management recommendations presented in this Appendix for the telemetry field studies draw from the foundational knowledge and best practices presented in Telemetry Report Part One. This section presents a high-level architecture and specific data system recommendations for the Russian River Study network design and implementation.

### E.1 Data Pipeline

In the context of the Telemetry Pilot Project, the term “data pipeline” relates to the processing and transformation of data in discrete stages or steps, originating with the raw inputs at the sensor and ending with aggregated flow and volume measurements. Data originating from the electrical circuitry in the sensors and data loggers must undergo numerous sensor-specific transformations and refinements before ultimately rendering flow and volume measurements. These transformations are based on the characteristics of specific manufacturer models and external metadata concerning site, installation, and calibration attributes. For example, a piezometer used to gage a river may operate using a 4-20mA current loop. Depending on the model-specific pressure range, the sensor output would generate a current in the range of 4-20mA. That output would first need to be converted into pressure (potentially requiring information about the current barometric pressure), and eventually depth. Once depth is established, site-specific installation metadata (e.g., position in a vertical datum) and a site-specific rating curve would be utilized to estimate flow or discharge at that point in the river. While the operating principles of different types of sensors vary greatly, all sensors generally convert electrical signals into either volume or flow using varied parameter sets and calculations.

In addition to the measurement observations (e.g., pulse counts, current loop measurements, etc.), received data packets can also contain information concerning the status of the hardware, the software running on it, and the current state of the data communications network. Examples of status data elements include:

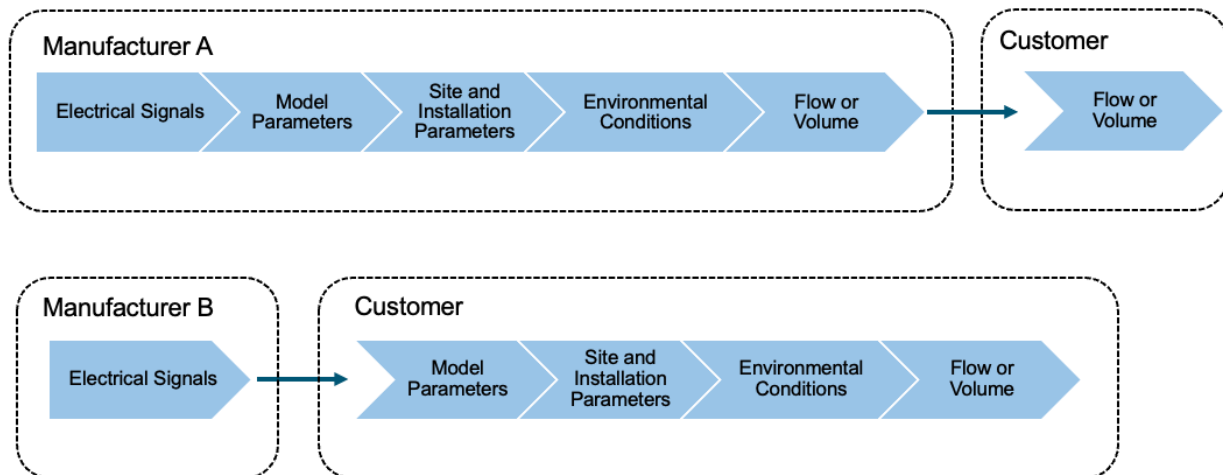
- Battery voltage
- Solar panel voltage
- Ambient temperature (which affects battery voltage)
- Internal temperature of the enclosure
- Data communications signal strength
- Signal-to-noise ratio
- Memory consumption
- Number of software exceptions
- Next scheduled transmission

Manufacturers vary in the IT tools and options they offer customers but can be simplified into two general styles (**Figure E-1**).

Manufacturer A (Figure E-1, top panel) operates the network that the sensors use to report data, performs flow and volume calculations, offers some basic forms of analysis and data export, and, in some cases, implements a proprietary API for integrations into customer data lakes or data warehouses. The customer is provided with the flow and/or volume calculations only.

Manufacturer B (Figure E-1, bottom panel) supplies only the hardware, including the radio and modem used to transmit the data, and leaves the customer responsible for operating the data plan and the backend processing. In this scenario, the customer would provision a cellular, satellite, or LoRA communications network device depending on available networks and cost. The customer would be responsible for: reliably handling the data packets as each arrives asynchronously from the network, landing them in a data storage account, refining that data, performing quality controls according to the established quality management plan, and ultimately making high-quality volume and flow calculations available for allowed uses. These processes often occur within modern data lakes or data warehouses via data pipelines that perform customized sequences of extract, transform, and load steps. The specific device models deployed in the Study will likely each require specialized validation and transformation logic to transform the raw data received from the sensor into a standardized output format that can be further refined and aggregated in subsequent pipeline stages.

The Study would likely operate in a heterogeneous environment with station deployments that mimic both Manufacturer A and B scenarios. Therefore, the backend data system for the Study must be designed to accommodate multiple formats, data communication methods, and primitive stages of the data from the deployed network.



**Figure E-1**  
Manufacturer-Customer Data Pipeline Scenarios

## E.2 Data Quality

A sensor network where all sensors report normally and within allowable thresholds is a foundational element of data quality. No combination of sensor, logger, and radio technologies is 100% accurate 100% of the time. However, manufacturers provide an accuracy rating for sensors (e.g.,  $\pm 3\%$  is the highest possible accuracy for a particular station). The ability to estimate the level of accuracy for each station over time is critical for customer uses of these data. For example, making water management decisions (e.g., determining a water right curtailment) using flow data that has a large confidence interval introduces greater uncertainty and risk compared to flow data with a narrow confidence interval.

Data packet information can be managed to enhance data quality assessments. Data packets normally include unique sequential packet identifiers to detect dropped packets and duplicate packets. By creating a time series for these elements with thresholding and alerting capabilities, the customer can establish real-time observability over the entire network, giving rise to powerful management capabilities, including detecting a sensor that failed to report, identifying a battery that is near the end of its life, detecting a damaged or dirty solar panel, or detecting deteriorating network conditions due to vegetation growth or other environmental factors.

The conditions can be symbolized and spatially mapped to give operators a real-time assessment of the entire network and/or individual stations' status. In cases where a sensor goes offline, dispatching repair technicians to the station quickly is imperative to minimize data loss. By modeling battery and solar panel performance, predicting future failures becomes possible to help provide intelligent routing and scheduling services, ultimately lowering the number of site visits and reducing overall maintenance costs.

From a data quality standpoint, the data collected during the Study should meet the accuracy specifications outlined by each manufacturer, provided that the station is operating within normal parameters, in the environments for which it was designed, and has been properly maintained. Any adverse ancillary conditions could create errors or gaps in the data that would lower the overall data accuracy and potentially impact management decisions based on that data. Missing or erroneous data can contribute to poor data quality and should be addressed in a quality management plan and addressed via quality controls, using automation wherever possible. A data quality management plan should take into account all possible categories of error from the deployed sensors and network and assess the impact each error category has on the intended use of the data, factoring in duration of the error condition. For example, a single erroneous value in a week's worth of 15-minute observations may not have a material impact on the intended use, whereas the continuous presence of that same error over a three-day period would be material. Depending on the intended use, erroneous data can be accepted but flagged as a caveat, excised from the dataset, or substituted with an estimated value based on a number of possible techniques. Level I, II, and III errors are described in more detail below and should be addressed in the data quality management plan.

### E.2.1 Level I Errors

Level I errors are those most directly related to site environmental factors and the hardware and software deployment at the site. The underlying causes for missing or erroneous data from a station could include:

- Battery depletion (which could include a faulty solar panel)

- Fouled sensors
- Hardware or software malfunctions
- Insufficient grounding
- Operating temperature threshold exceedance

Transmission problems (no signal, noisy signal, failures in data communication network)

- Physical damage to the sensor, logger, or radio (e.g., wildlife, floods, vandalism, lightning)

Such conditions would ultimately lead to missing packets, duplicate packets, or sensor data that exceeds allowed thresholds. For example, a 4-20mA current loop piezometer reading 0mA could indicate an electrical short in the sensor that needs to be resolved quickly. A QC process that does not check for these model-specific range violations may generate flow and volume calculations that deviate materially from the actual flow or volume conditions in the field.

During peak irrigation periods, prompt detection and correction of these errors should be essential to the quality management plan. Dead batteries or other failure conditions not detected for days or weeks can create unrecoverable data gaps that render that station partially or wholly unusable for certain types of water management and decision-making. In some cases, it may be possible to use metadata concerning sensor-specific and network-specific operating characteristics to establish "normal" multivariate data reporting ranges for a sensor to predict potential future failures when reported values indicate slowly degrading performance over time. In matters where litigation may arise, maintaining all metadata concerning QC processes, maintenance records, sensor operations, and data quality will be important, and these considerations should be factored into the data system's design. These metadata may include but are not limited to: sensor model, accuracy ratings, operating characteristics, installation and maintenance history (including calibration history), data transmission history, battery voltage history, site characteristics, and any data correction methods that may have been applied.

## E.2.2 Level II Errors

Level II errors are those where the sensor appears to be operating normally but produces a measurement error that only becomes detectable when observing that measurement in the context of similar/correlated measurements across time and space. Indicators of Level II errors may include:

- A measurement that exceeds a reasonable threshold (e.g., a stream temperature greater than 80F when the ambient air temperature is 45F).
- A rapid change in a measurement value that would be difficult to explain other than through anomalous measurements.
- Excessive "noise" in measurements (i.e., higher than normal "jitter" in measurements)
- Measurements that differ substantially or are trending in different directions from measurements of nearby sensors of the same type.

Level II errors are most often detected by examining the statistical properties of a time series, often through techniques based on auto-regressive integrated moving average (ARIMA) modeling. ARIMA models can analyze time series data, isolating the trend, seasonality, and error components of the series.

In this case, “error” means that portion of the measurement which is not explained by trend or seasonality and thus is not necessarily a true problem with the data. By subtracting out the trend and seasonality components and examining the distribution of the remaining error, noisy data can often be flagged for further review. A single sensor's trend, seasonality, and error components can also be compared to corresponding components of spatially related sensors to help identify potential problems.

Automating Level II error detection techniques such as ARIMA within the data system reduces the need for manual review of numerous observations. For example, a model detecting water temperature errors flags suspicious data for human review. Reviewers can then accept or mark data as erroneous, take corrective actions, and document the process in an audit log. This automation streamlines the review process and ensures thorough documentation.

### E.2.3 Level III Errors

Level III errors (e.g., ghost data conditions) are not detectable by Level I or Level II mechanisms alone. Feedback from water users can be an effective indicator of potential Level III errors. For example, in the Twin Platte Natural Resource District’s water management program, irrigators have real-time access to pumping data for their wells available through their mobile phones. Irrigators will often compare these real-time pumping data against the current status of the pump. A “ghost data” condition occurs when no pumping is happening, yet the sensor indicates a positive pumping volume for some reason. Incorporating a diverter-based monitoring program as part of the quality control should be considered as part of the Study to engage diverters and build trust in the data collection process.

Given the heterogeneity of sensors, accuracy levels, maintenance histories, and environmental conditions present in the upper Russian River watershed, data produced by the network would have varying levels of quality. Therefore, an estimate of the data quality becomes important to understanding the purposes for which the data can be used. The Study should incorporate an objective framework grounded in idealized sensor performance against Level I, II, and III errors to estimate data quality levels.

A data quality management plan should be developed in the Study that addresses specific QC mechanisms for Level I, II, and III errors. Automated algorithms will need to be tailored to the various sensor types, data communications methods, and site characteristics present within the Study, correcting errors using automated means when possible and flagging data anomalies for human review when automation is not possible. Newly ingested data should be considered "provisional" until all defined QC controls in the plan have been performed and resulting anomalies have been satisfactorily resolved and documented. The goal should be to use automation and efficient workflows to reduce the time that data remains in provisional status.

## E.3 Data Preservation and Restatement

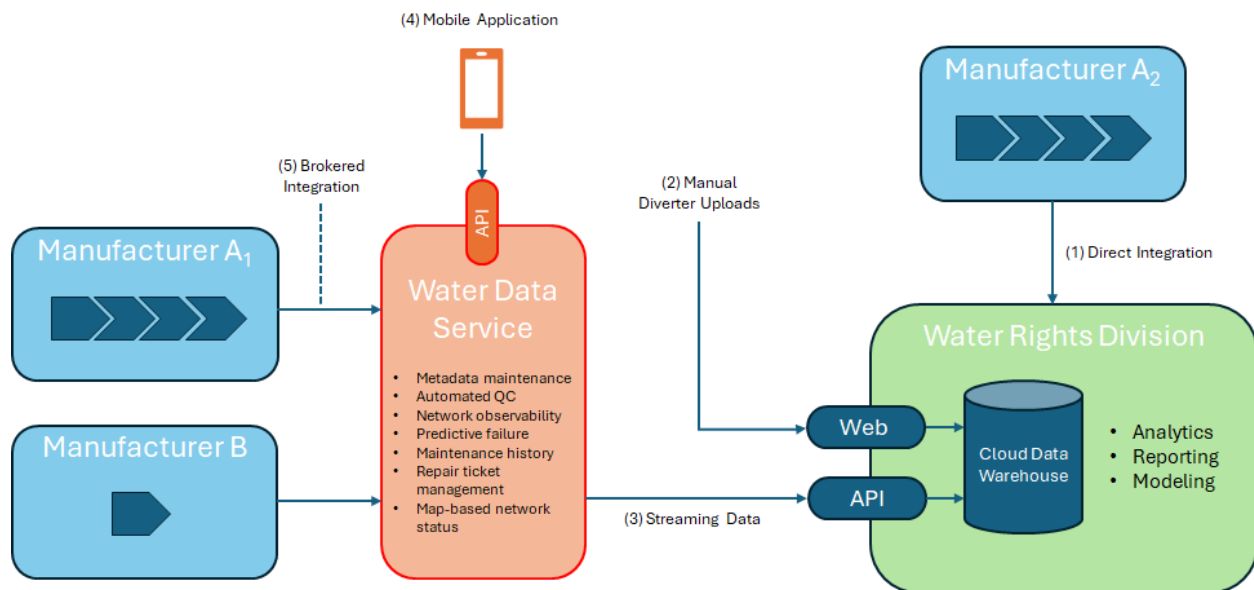
Data preservation and restatement is another important aspect of data management, ensuring continued stability and access to data for as long as necessary. The quality of the flow and volume measurements depend on site-specific metadata such as installation data, model-specific operating data, and site characterization data. These metadata may be found to be erroneous following publication and/or use. For example, a flood event that causes a material change in the bedform of a channel may invalidate the rating

curve used by the gaging station in the affected reach. Operators may require weeks to months to establish a new rating curve. In this case, the data system must retain all raw sensor measurement data necessary to recalculate and restate flow data using the corrected curve over the impacted time period.

## E.4 Data System Context

In the development of data systems for the Study, several possible architectures can be considered.

**Figure E-2** illustrates one potential architecture where the SWRCB, Division of Water Rights, establishes a cloud-based data warehouse to store monitoring data collected during the Study. These data will not be ingested into CalWATRS or shared with external third parties during the study phase. Figure E-2 demonstrates the high-level logical relationships between the cloud data warehouse (shown in green), the various sensor manufacturers (blue), and the Water Data Service (orange), an application detailed further in Telemetry Report Part One. Each numbered item in Figure E-2 represents a specific integration point between systems, highlighting the methods and protocols used for data transmission, exchange formats, and interaction endpoints.



**Figure E-2**  
Potential Data Architecture for the Telemetry Study

Under this architecture, Manufacturers A<sub>1</sub> and A<sub>2</sub> are those that handle the full sensor data pipeline and emit “finished product” flow and volume measurements. The Division of Water Rights has developed a direct integration<sup>116</sup> (Figure E-2, path “1”) of one manufacturer’s data into a cloud data warehouse to support staff monitoring and could elect to develop more in support of the Study in the future. The

<sup>116</sup> Direct integrations are manufacturer-specific and likely follow proprietary data exchange formats. Often, data is “pulled” from external manufacturers from the point of view of the cloud data warehouse or water data service. Authenticator management would also be a design consideration. If each diverter has a separate manufacturer account for their one station, then the system will need to maintain one authenticator per account/sensor. A simpler model for the Study may be to have all State-purchased sensors under one account for each manufacturer so that a single authenticator and a single session can be used to retrieve all measurement data. This would also minimize the amount of technical coordination between the implementation contractor and the water user who owns the account.

Division of Water Rights could make available a method for diverters to manually upload diversion data<sup>117</sup> and usage/water rights metadata via a website (Figure E-2, path “2”). In the case where a manufacturer does not have a direct integration to the cloud data warehouse or the manufacturer does not support full data pipelines and an integration API<sup>118</sup> (Figure E-2, path “3”), an intermediary such as the Water Data Service would be required. A well-designed Water Data Service, accessed via a mobile application<sup>119</sup> (Figure E-2, path “4”), has the potential to provide several benefits to the Study, including the ability to:

- Accept streaming and batch data from all manufacturer types, including brokered integration<sup>120</sup> (Figure E-2, path “5”)
- Maintain metadata structures necessary to facilitate QC processes
- Automate QC processes
- Provide corrections to data and maintain audit trails
- Enforce data governance policies
- Minimize station downtime and repair costs
- Provide real-time visibility to water users in the field
- Provide a user-friendly view into the data that is consistent across all users of the application and isolates unwanted complexity from the core of the downstream Division of Water Rights reporting and analytics systems
- Provide for the ability to be nimble in response to emerging manufacturer technologies

## E.5 Data Exchange Standards and Formats

The following section describes data exchange standards and formats published by the Open Geospatial Consortium. WaterML 2.0 is a comprehensive data exchange standard designed to be an XML-based and schema-validated data encoding format for the standardized transmission of water observation data between systems over a network.<sup>121</sup> To maximize the interoperability of water data between systems, choosing a standard like WaterML 2.0 is most beneficial when sharing data broadly with several systems under the control of different organizations. The underlying information model and encoding requirements for WaterML 2.0 are verbose and non-trivial from an implementation and testing perspective, which also should be considered. Since the nature of the data systems envisioned as part of the Study is closed (i.e., not openly sharing data with third-party systems), investments in WaterML 2.0

<sup>117</sup> Manual diverter uploads are based on data upload templates defined by the Division of Water Rights, which are simple forms or spreadsheet formats that capture diversion and storage values by use type, water right, etc.

<sup>118</sup> Streaming data from a water data service could be designed to follow the SensorThings information model and API specification, where streaming data is either “pushed” from the water data service to the cloud data warehouse or periodically (e.g., daily) “pulled” from the water data service by the cloud data warehouse.

<sup>119</sup> A mobile application used by a water right holder would minimally display current status and time series data related to sensors monitoring the water right. A SensorThings API implementation within the Water Data Service would supply real-time information to such an application.

<sup>120</sup> Brokered integration is similar to direct integration except that the responsibility for interfacing with the manufacturer API is delegated to the Water Data Service.

<sup>121</sup> Open Geospatial Consortium. 2024. OGC WaterML. Viewed online at: <https://www.ogc.org/standard/waterml/>.

compliance should be limited or deferred entirely as part of the Study and instead revisited if and when open data sharing agreements are in place as part of statewide implementation.

Similar to WaterML 2.0, SensorThings is another standard published by the Open Geospatial Consortium.<sup>122</sup> The goals are broader than WaterML 2.0 in that it is not specific to water measurement data but rather designed to accommodate any type of measurement series coming from one or more sensors on Internet-connected devices. For example, the time series of voltage measurements of a battery at a gaging station would not be appropriate to encode in WaterML 2.0, but would be easily accommodated in the SensorThings standard, as would water-related data from sensors. The WaterML 2.0 standard is based on XML and is a data encoding standard only. The SensorThings standard is rooted in JavaScript Object Notation (JSON). Additionally, it defines the semantic behavior of a standardized API that can be used to manipulate observational data in persistent storage, which WaterML 2.0 lacks. SensorThings is a more modern and flexible standard that would also be easier to implement and should be considered for use in the Study.

## E.6 Data Privacy and Data Security

Cybersecurity policies and control requirements apply to all information systems owned or operated by the State of California, including the system(s) that would store and process data collected as part of the Study. Cybersecurity policies and controls exist to help protect the privacy of individuals and organizations from unauthorized disclosure of personal and confidential data and to help protect the integrity and availability of information systems and the data they manage from an array of threats. These threats include but are not limited to accidental or intentional destruction of data, ransomware attacks, malware propagation, unauthorized manipulation or exfiltration of data, and denial of service attacks. As described below, by law or administrative rule, each information system must have a System Security Plan, a document that describes how the design and implementation of the system complies with applicable security policy and controls. Systems that have higher levels of sensitive data and/or lower tolerance for downtime and data loss require more stringent security controls. High-level cybersecurity recommendations are provided to identify common best practices that should be followed.

The first steps in crafting a System Security Plan involve understanding what data would be housed in the system and how sensitive that data is. The types of data that could potentially be present in the Water Data Service and cloud data warehouse include but are not limited to:

- Diverter contact information (name, email, phone numbers, etc.) to coordinate access for station installation, maintenance, and repairs as well as to aid in technical support. If diverters use a mobile application to access their data in the system, an authenticator (password) may also be required.
- Station location information along with metadata concerning station/sensor configuration, purpose, site configuration, maintenance history, and authenticators to manufacturer API endpoints.
- Data concerning water use by water right. Water use information is regarded by many water users as sensitive information that must be protected from unauthorized disclosure.
- Personally identifying information (PII) belonging to any user of the Water Data Service.

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<sup>122</sup> Open Geospatial Consortium. 2024. OGC SensorThings API. Viewed online at: <https://www.ogc.org/standard/sensorthings/>.

The California Department of Technology requires the use of a formal standard like the widely used Federal NIST 800-53 cybersecurity framework to protect State information systems. This prescriptive framework contains over 1,000 best-practice security controls grouped into 20 control families. These control categories include Access Control, Audit and Accountability, Awareness and Training, Incident Response, Risk Assessment, Configuration Management, Contingency Planning, and many more. Each of these categories and the controls contained within them are designed to mitigate the risk of specific threats to information systems, and are the primary topics addressed in the System Security Plan.

While the NIST 800-53 standard is too comprehensive to address fully in this report, based on best practices, the System Security Plan should minimally:

1. Require all data to be encrypted in transit and at rest, including all data backups.
2. Limit the need to store personally identifying information (PII) or other sensitive information in data systems to the minimum amount required to fulfill identified functional requirements.
3. Limit an individual user's access to data to the minimum necessary to fulfill that user's job.
4. Require authentication for access to any data in the system.
5. Create auditable logs or records when users access PII or sensitive data, or when user accounts are created and account permissions changed and review those logs regularly. No user should have the ability to alter or delete log entries.
6. Require multi-factor authentication prior to a user performing any administrative action, including adding users, changing roles, or making significant configuration changes to the system.

Lastly, the System Security Plan should incorporate controls that enforce the terms of any data sharing agreements that may exist between the Division of Water Rights and the water user where such terms are not pre-established by statute or administrative rule. Data sharing policies should minimally indicate what data can be shared (if any), for what purpose(s), and whether it can be shared at a detail level or only in aggregated / non-identifiable forms.

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