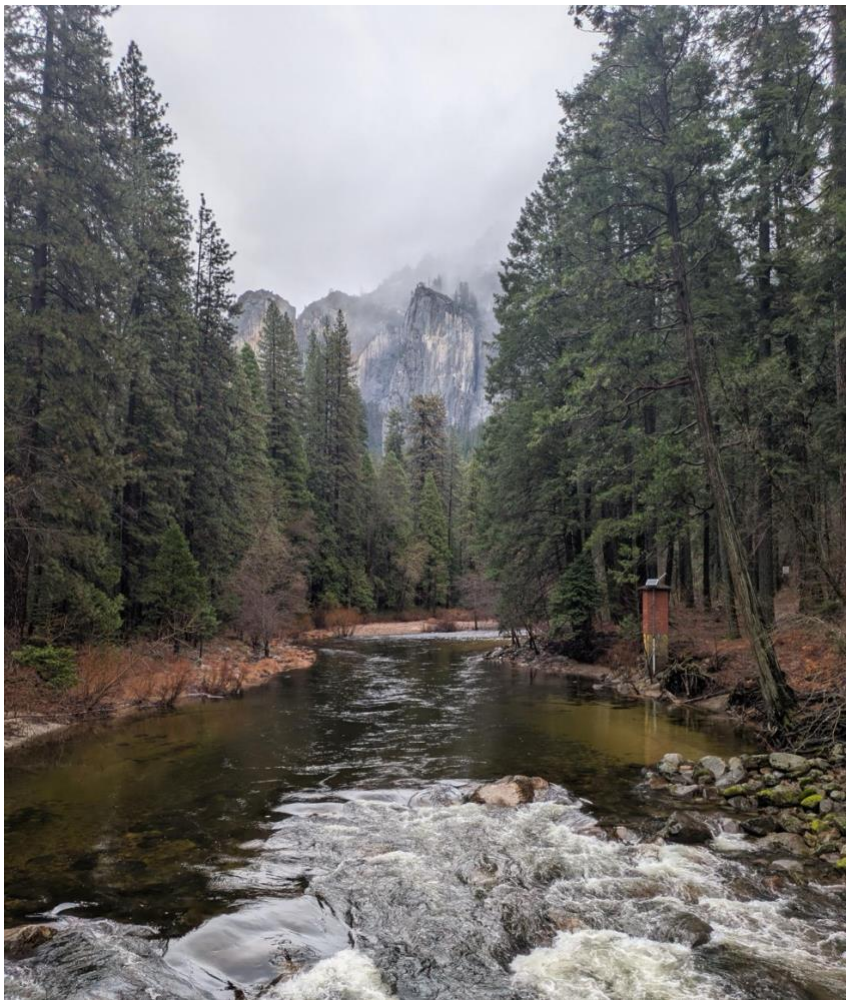
TELEMETERED WATER MONITORING PROJECT



Final Report

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Prepared for
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EXECUTIVE SUMMARY

ES.1 Introduction

California's increasingly unpredictable climate, characterized by intense floods and prolonged droughts, requires timely monitoring for effective water management. Delayed, inconsistent, and inaccessible water data limit the ability of local, state, and federal agencies to understand hydrologic systems and make urgent decisions. While California has taken important steps through legislation and policy to improve water data for management, significant gaps remain.

Telemetered water monitoring networks can provide timely data that support water management decisions and long-term sustainability. However, their design and maintenance require careful planning to ensure these networks meet state and local management needs.

The Telemetered Water Monitoring Project is part of the State Water Resources Control Board's (SWRCB) Telemetry Research Unit's (TRU) Telemetry Pilot Project. Coordinated by the California Water Data Consortium and supported by its contractors ("Consortium Team"), the Telemetered Water Monitoring Project developed independent recommendations about telemetered water monitoring through research and collaborative dialogue. This report presents those recommendations in three parts.

ES.2 Report Structure

This report is composed of three parts which discuss the current context, practical evaluation, and future recommendations for telemetered water monitoring in California.

PART I. GLOBAL INSIGHTS FROM TELEMETERED WATER MONITORING NETWORKS

The Consortium Team conducted interviews with a range of experts related to the design, installation, operation and maintenance (O&M), data systems, data governance, and overall governance of telemetered water monitoring networks. Part I synthesizes findings from these analyses into an overview of telemetered water monitoring, key network components, common technical and institutional challenges, and best practices for designing effective networks.

PART II. RECOMMENDATIONS FOR A WATERSHED TELEMETRY STUDY
In collaboration with local community members and agencies, the Consortium Team developed recommendations that respond to local water management conditions and existing data collection practices for the TRU's Russian River Telemetry Study (Study). Part II presents recommendations for the Study design and implementation, drawing on best practices from Part I and community feedback on how telemetry can address technical, environmental, and regulatory challenges in the Russian River watershed.

PART III. STATEWIDE APPLICATIONS OF TELEMETRY
The Consortium Team convened a Technical Advisory Committee (TAC) of experts from diverse sectors to develop recommendations for telemetered water monitoring in California. Part III presents TAC recommendations for how the SWRCB and other water managers can demonstrate telemetry's value for state and local decision making, encourage adoption around the state, and increase trust in telemetered data.

ES.3 Report Lessons and Recommendations

Each part of the report provides detailed key lessons and actionable recommendations, summarized here.

PART I. GLOBAL INSIGHTS FROM TELEMETERED WATER MONITORING NETWORKS
Designing a telemetered water monitoring network involves complex planning to address technical and social challenges. These challenges emphasize the need for customized and collaborative approaches in developing effective telemetered water monitoring networks.

Key challenges of telemetered water monitoring

1. **Unique monitoring network requirements.** Each watershed's distinct geologic and climatic conditions, as well as seasonal variations, require tailored station placement.
2. **Shortage of qualified personnel.** A lack of trained field and information technology (IT) personnel leads to data quality issues and increased costs.
3. **Location difficulties.** Locations that are remote or topologically complex present challenges for reliable power and data transmission.
4. **Technology limitations.** Failures in instruments, sensors, and transmission can result in data loss, data delays, and increased operational costs.

5. **Equipment and data security.** Equipment security concerns, including theft and damage, threaten data collection and increase operational costs. Network partners may disagree on data security approaches.
6. **Collaboration dynamics.** Building trust and consensus among diverse partners can be challenging.
7. **Cost and regulatory challenges.** High operational costs and complex regulations disproportionately impact smaller water systems.
8. **Data management issues.** Integrating data from various sources into a central system is complicated by issues of data standardization, quality, accessibility, interoperability, and error correction.

Best practices for telemetered water monitoring

Interviewees provided insights on developing and operating telemetered water monitoring networks. The wide-ranging practices listed below emphasize that a successful network must consider logistical, economical, and social issues.

1. **Build trust in equipment and technology.** Use appropriate equipment for each site, avoid in-water sensors as possible, and explore emerging measurement and transmission technologies.
2. **Engage qualified professionals early.** Involve qualified professionals during design, operation, and maintenance to ensure reliability and cost-effectiveness of the network.
3. **Equitably distribute monitoring costs.** Share costs among all water users to enhance equity. Offer uniformly applied incentives, such as technical and/or financial assistance, to encourage participation.
4. **Avoid overly prescriptive approaches.** Design adaptable networks and data systems that can incorporate changing instruments and technologies. Prioritize non-proprietary transmission protocols, data protocols, and data systems.
5. **Address privacy and security concerns.** Proactively address equipment security concerns. Establish clear data-sharing agreements and policies surrounding data disclosure.
6. **Adopt a transparent governance structure.** Involve diverse parties in overall governance to ensure sustainability of the network. Include processes for consensus-building. Implement a clear management and leadership structure for operations.
7. **Plan for long-term cost savings.** Invest in high-quality monitoring equipment and data systems to reduce maintenance problems and ensure data quality. Plan and budget for monitoring and regulatory compliance to reduce long-term costs.

8. **Tailor data operations.** Focus on audience-specific data management and interoperability, quality control, and data visualization to improve operational efficiency and user engagement.

PART II. RECOMMENDATIONS FOR A WATERSHED TELEMETRY STUDY

Part II presents recommendations for designing a watershed-scale telemetry study to evaluate real-world conditions and advance best practices for developing and maintaining effective telemetered water monitoring networks. The Consortium Team recommended that the TRU conduct their telemetry study in the Russian River watershed due to the presence of willing local partners, existing data networks, hydrologic complexity, and other factors.[1] Part II's recommendations are tailored to the Russian River watershed but may be useful for planning telemetry projects in other watersheds.

Russian River Telemetry Study Goals

1. Identify and test the critical monitoring components required to support longer-term decision making and sustainable water management.
2. Test the flow and compatibility of telemetered data into state systems.
3. Evaluate monitoring and telemetry costs.
4. Understand benefits and limitations of different water measurement sensors and telemetry equipment.

Recommendations for the Russian River Telemetry Study

1. **Leverage telemetry for state compliance.** 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 [SB] 88, Water Measurement Regulations), the SB 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.** 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.

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[1] California Water Data Consortium (2024, March 15). *Piloting a Telemetered Water Monitoring Network in California: Recommendations for Potential Watersheds* [Memo]. https://cawaterdata.org/wp-content/uploads/2024/07/TMD_Deliverable_2.1_Watershed-Recs-Memo_ADA-508.pdf

3. **Test a variety of equipment and methods.** Evaluate a range of monitoring technologies to identify their strengths and limitations. This comparative assessment is critical for giving guidance on the most effective equipment for implementation across diverse conditions around the state.
4. **Leverage local expertise for environmental permitting and compliance.** 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.** 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 and builds public trust.
6. **Explore options for long-term network sustainability.** Explore potential governance models and opportunities for integrating with existing regional monitoring programs to ensure long-term success. Sustaining the network will require an overall governance structure that balances state oversight with local autonomy and require financing strategies for ongoing maintenance.

Insights gained from the Russian River Telemetry Study should be used to inform recommendations for expanding and enhancing telemetered networks around the state, supporting California's water security and ecological objectives in the face of a changing climate.

PART III. STATEWIDE APPLICATIONS OF TELEMETRY

The Telemetry TAC addressed the vision of moving California toward a future where all water managers and users can make timely, well-informed decisions based on widely available and credible water data. The TAC consisted of major water-rights holders; organizations representing diverse water users; environmental and social justice organizations; water policy and water data experts; academics and researchers; and local, state, and federal government representatives. Over nine months, the TAC aligned on goals, formed topic-specific workgroups, and developed recommendations for successful water data telemetry in California. These recommendations are detailed in Part III and aim to address the technology, governance, and implementation challenges outlined in Part I.

Recommendations for applied telemetry

1. **Demonstrate the value of telemetry through exemplary use cases.** The TAC developed ten use cases to highlight how telemetered data supports real-world decision making: (1) water rights management, (2) water trading, (3) instream flow dedications, (4) flood-managed aquifer recharge (Flood-MAR), (5) crop water use studies, (6) groundwater monitoring, (7) information for vulnerable communities, (8) infrastructure operations, (9) flood forecasting, and (10) environmental management.
   Many of the datasets needed for the use cases are useful across sectors, highlighting the opportunity for different sectors to collaborate and coordinate monitoring and data collection efforts to fill mutual data gaps. Implementing these use cases requires funding, expertise, and collaboration between state agencies (e.g., the SWRCB, California Department of Water Resources [DWR]) and regional and local entities.
2. **Improve reported water data.** The TAC developed actionable recommendations for the SWRCB to enhance reporter compliance with water measurement and reporting regulations and improve the accuracy and availability of reported diversion data, including:
   a. Develop an approach for determining measurement and reporting frequency required by SB 88 based on localized, context-specific criteria.
   b. Build trust in and prepare to handle increased telemetered diversion data by (1) demonstrating why telemetered data are needed; (2) developing the staff capacity, technical infrastructure, and business processes necessary to efficiently evaluate telemetered diversion data and maintain robust QA/QC; (3) ensuring timely enforcement and management actions can be taken based on the data received; and (4) illustrating costs and benefits associated with telemetered data.
   c. Track and publicly report SB 88 compliance metrics (e.g., the number of water rights holders who submit data in compliance with SB 88 criteria) and data accessibility and use metrics (e.g., time from when data are measured to when they are publicly available).
3. **Reduce reporter burden.** The TAC identified potential solutions to the challenges water managers and water right holders face in incorporating telemetry into their water monitoring networks. Key recommendations include: (1) facilitate regional collaboration; (2) develop additional guidelines and procedures for equipment selection and installation, QA/QC, costs, etc.; (3) provide technical support to reporters through trainings and services; and (4) standardize reporting requirements across state agencies.

4. **Develop data governance approaches.** The TAC recommended a baseline level of standardization in data governance to enable data interoperability across datasets and effective integration with state data systems. This includes:
    a. Clearly defined roles and responsibilities for data collection, storage, and use, developed collaboratively.
    b. A future-state system architecture diagram to support consistent data collection across California; simplify data processing; and improve data availability between local, state, federal, and tribal levels. The diagram developed by the TAC includes an optional Regional Data Steward (RDS) to support with data management functions.
    c. A concise set of minimum data output requirements. The TAC recommended learning from existing models used by established organizations, such as the United States Geological Survey (USGS).
    d. A standardized, statewide QA/QC framework to improve data integrity, consistency, and early error detection, including a clear process schematic, tiered options for organizations of different capacities, and universal error/quality codes.
    e. A clear framework to guide the appropriate use of provisional data for curtailment and enforcement purposes.

ES.4 Conclusion

Building on meaningful progress already underway, California has both an opportunity and responsibility to develop unified, modern water datasets and systems that enable timely and effective water management for the benefit of all Californians. Achieving this vision will require unprecedented collaboration across local, state, federal, and tribal agencies that is grounded in trust and designed to invite broad participation. The Telemetered Water Monitoring Project integrated global best practices with local, regional, state, and tribal expertise in telemetered water monitoring and translated the findings into clear, actionable recommendations — first to guide a watershed-scale telemetry study and then to catalyze telemetry adoption across California. Findings from the Russian River Telemetry Study and implementation of TAC use cases will be essential to refining state-level understanding and planning, while demonstrating tangible value of telemetry at the local level.

The technology for telemetered water monitoring is proven and ready to implement. The barriers to expanded telemetry use are institutional, political, and social. Overcoming these barriers will require integrating technical expertise with local and state knowledge,

supported by transparent governance, collaborative communication, and sustained institutional commitment. California has a clear and actionable path forward. By staying focused on high-value telemetry applications, partnering with willing local leaders, and investing in regional coordination and capacity-building, the State can — and must — scale telemetry in ways that deliver immediate and lasting management benefits. Doing so requires sustained, strategic investment in:

1. State capacity to manage, analyze, and operationalize reported data, while providing technical assistance to regional and local partners.
2. Durable governance structures and interoperable data and systems.
3. Watershed-based assessments and pilot projects to define priorities and inform implementation of telemetry.
4. Consistent QA/QC protocols and shared data standards that ensure trust, usability, and long-term value.

As climate change intensifies hydrologic variability and operational risk, California's water resilience depends on modern, reliable, and timely data. Implementing the recommendations in this report will strengthen water management decisions at every level – local, state, and federal – and ensure that public investments in telemetry translate into measurable, lasting benefits for California's water future.