Title

Addressing Institutional Vulnerabilities in California's Drought Water Allocation, Part 2: Improving Water Rights Administration and Oversight for Future Droughts

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ADDRESSING INSTITUTIONAL VULNERABILITIES IN CALIFORNIA'S DROUGHT WATER ALLOCATION
Part 2: Improving Water Rights Administration and Oversight for Future Droughts

A Report for:

California's Fourth Climate Change Assessment

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Edmund G. Brown, Jr., *Governor*

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Responsibility for the report's final content rests entirely with the authors. Any errors are our own.

PREFACE

California's Climate Change Assessments provide a scientific foundation for understanding climate-related vulnerability at the local scale and informing resilience actions. These Assessments contribute to the advancement of science-based policies, plans, and programs to promote effective climate leadership in California. In 2006, California released its First Climate Change Assessment, which shed light on the impacts of climate change on specific sectors in California and was instrumental in supporting the passage of the landmark legislation Assembly Bill 32 (Núñez, Chapter 488, Statutes of 2006), California's Global Warming Solutions Act. The Second Assessment concluded that adaptation is a crucial complement to reducing greenhouse gas emissions (2009), given that some changes to the climate are ongoing and inevitable, motivating and informing California's first Climate Adaptation Strategy released the same year. In 2012, California's Third Climate Change Assessment made substantial progress in projecting local impacts of climate change, investigating consequences to human and natural systems, and exploring barriers to adaptation.

Under the leadership of Governor Edmund G. Brown, Jr., a trio of state agencies jointly managed and supported California's Fourth Climate Change Assessment: California's Natural Resources Agency (CNRA), the Governor's Office of Planning and Research (OPR), and the California Energy Commission (Energy Commission). The Climate Action Team Research Working Group, through which more than 20 state agencies coordinate climate-related research, served as the steering committee, providing input for a multisector call for proposals, participating in selection of research teams, and offering technical guidance throughout the process.

California's Fourth Climate Change Assessment (Fourth Assessment) advances actionable science that serves the growing needs of state and local-level decision-makers from a variety of sectors. It includes research to develop rigorous, comprehensive climate change scenarios at a scale suitable for illuminating regional vulnerabilities and localized adaptation strategies in California; datasets and tools that improve integration of observed and projected knowledge about climate change into decision-making; and recommendations and information to directly inform vulnerability assessments and adaptation strategies for California's energy sector, water resources and management, oceans and coasts, forests, wildfires, agriculture, biodiversity and habitat, and public health.

The Fourth Assessment includes 44 technical reports to advance the scientific foundation for understanding climate-related risks and resilience options, nine regional reports plus an oceans and coast report to outline climate risks and adaptation options, reports on tribal and indigenous issues as well as climate justice, and a comprehensive statewide summary report. All research contributing to the Fourth Assessment was peer-reviewed to ensure scientific rigor and relevance to practitioners and stakeholders.

For the full suite of Fourth Assessment research products, please visit www.climateassessment.ca.gov. This report advances the understanding of how the State Water Resources Control Board could approach proactively improving water rights administration and oversight for future droughts by exploring the possibility of adopting a contingency-based framework to support drought decision making and implementing a suite of

complementary actions to reduce uncertainty and lay the groundwork for more timely and effective drought response.

ABSTRACT

In California, droughts are likely to become more frequent, longer, and more intense in the future, posing increasing challenges for water management, and raising the stakes for effective drought response. This project aims to help state water governance and decision-making structures adapt to the changing climatic reality. In a companion report in this volume, we analyzed the strategies the State Water Resources Control Board (Board) used for water rights administration and oversight during the last four major statewide droughts. Our findings suggest that more proactive planning and preparation, enabling reduced reliance on in-drought improvisation, would improve the Board's future drought responses. This report builds on that retrospective analysis with specific recommendations.

Our vision is simple: During droughts, California's limited water supplies should be allocated among different human and environmental water uses transparently, efficiently, and predictably, in accordance with the priorities that flow from state and federal law.

We suggest a structured means of implementing this vision that emphasizes proactive drought preparations. At the core is a contingency-based framework designed to support more timely and effective drought decision making. A suite of complementary actions aims to reduce uncertainty and lay the groundwork for improved water rights administration and oversight in future droughts. These actions include making key policy decisions that affect drought response in advance, strategically improving decision-related information, maximizing learning from droughts, prioritizing water rights enforcement between droughts, and capitalizing on the many synergies that exist between the Board's drought and non-drought work to achieve better water management outcomes, greater clarity for water users, and more efficient use of state resources. We view these actions as crucial components of effective climate adaption for California and encourage the Board to begin implementing them now, so that it is better prepared to face the challenges the next drought brings.

Keywords: State Water Resources Control Board, Water Board, drought, drought preparation, drought response, water rights, water rights administration, water rights oversight, adaptation, contingency-based framework, instream flow requirements, health and safety needs, curtailment, curtailment procedures

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HIGHLIGHTS

The State Water Resources Control Board (Board) can improve water rights administration and oversight for future droughts by taking proactive steps that reduce the need for in-drought improvisation. It can:

1. **Adopt a contingency-based framework to support drought decision making.** The goal setting, scenario planning and forethought required to develop a useful decision-support framework, as well as the structure it would bring to the decision-making process, would make the Board more nimble, empowering more timely and effective responses during future droughts.

2. **Make key policy decisions in advance of droughts**. The Board would maximize the transparency, timeliness, and effectiveness of its drought decision making by including the following among its top priorities for drought preparation:

    - Setting and implementing instream flow requirements that adequately protect fish and wildlife in priority water bodies over the full range of hydrologic conditions;
    - Defining and implementing minimum human health and safety protections; and
    - Establishing clear procedures for implementing curtailments of diversions during times of water shortage.

3. **Strategically improve decision-related information, data integration, and interoperability**. This includes information about water supply, water diversion and use, pre-1914 and riparian water rights, and ecological considerations.

4. **Maximize learning from droughts.** Following a drought, the Board should evaluate how effective its drought response actions were and, if it adopts a contingency-based decision support framework, how well that framework performed. This will allow the Board to identify needed improvements and follow up by adjusting its drought decision support structures and reprioritizing its future drought preparatory work.

5. **Prioritize water rights enforcement between droughts.** Although droughts highlight and provide added incentive to address compliance problems, enforcement between droughts is also critical.

For each of these actions, the Board can capitalize on synergies between drought and non-drought work to achieve better water management outcomes, greater clarity for water users, and more efficient use of the Board's, and the state's, resources.

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LIST OF ABBREVIATIONS

AB	Assembly Bill
Bay-Delta Plan	Bay-Delta Water Quality Control Plan
Board	State Water Resources Control Board
CDFW	California Department of Fish and Wildlife
CDEC	California Data Exchange Center
CEQA	California Environmental Quality Act
CVP	Central Valley Project
Delta	Sacramento-San Joaquin River Delta
DWR	California Department of Water Resources
DWRAT	Drought Water Rights Allocation Tool
FERC	Federal Energy Regulatory Commission
FNF	full natural flow
HUC12	12-digit hydrologic unit code (subwatershed)
IRWM	Integrated Regional Water Management
NOAA Fisheries	National Oceanic and Atmospheric Administration Fisheries Program
PDSI	Palmer Drought Severity Index
SEMS	Standardized Emergency Management System
SWP	State Water Project
SWRCB	State Water Resources Control Board
TUCP	temporary urgency change petition
USBR	United States Bureau of Reclamation
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey

1: Introduction and Overview

1.1 Motivation for Project

Climate change is already affecting California's water resources,[1] and its impacts will continue to grow. Of particular concern is the increased likelihood of hydrologic extremes, including more frequent, longer, and more intense droughts.[2] These droughts will have important consequences for the state's water supply, and for water managers at all levels.

Past droughts have stress tested California's water management institutions, revealing vulnerabilities that could impair effective adaptation to climate change. There is a substantial mismatch between the location and timing of water supply and water demand in California, and the amount of precipitation varies significantly from year to year. While extensive networks of storage and conveyance infrastructure have enabled the redistribution of water from wetter to drier places and times, other strategies are needed to respond effectively to multi-year droughts in which water supplies may be extremely limited across some or all of the state. During droughts, local, state, and federal actors make decisions that affect water allocation and use, often under significant time pressure. Appropriately allocating limited water supplies among different water users has been challenging during past droughts, and climate change will amplify conflicts over water, raising the stakes for effective drought response.

This report is the second part of a two-part project designed to help state water governance and decision-making structures adapt to the changing climatic reality. The project explores how one of California's primary water management institutions, the State Water Resources Control Board (Board), has responded to past droughts, and could better respond in the future.

In a companion report (**Part 1**), we analyzed the strategies the Board used for administration and oversight of California's water rights system during the last four major statewide droughts (in 1976–1977, 1987–1992, 2007–2009, and 2012–2016). We found that the Board employed an array of different drought response strategies that varied in depth and breadth from drought to drought, with the Board most actively engaged during the 2012–2016 drought. Despite some significant and creative in-drought efforts by the Board and others, leading to positive developments during and immediately following each drought, the Board appears to have done little proactive preparation between one drought and the next. Instead, our analysis suggests the Board developed its responses on a largely ad hoc basis in the midst of each drought emergency, with varying degrees of success. Over-reliance on in-drought improvisation likely hindered the Board's drought responses.

This report builds on that retrospective analysis with recommendations for improving the Board's future drought response. We concentrate on the opportunities and responsibilities that flow from the Board's central role in California water rights administration and oversight. However, we emphasize that effective state and local drought response involves much more, and that other state and federal agencies, as well as municipalities, special districts, and private actors, have important roles to play. Actions and programs that lie completely outside the Board's jurisdiction are beyond the scope of this project, but we highlight the need for effective coordination and cooperation among the many actors engaged in drought water management, and underscore how the Board's ability to effectively play its own role may depend on others.

1.2 Vision for Improving Drought Response

Our vision is simple: During droughts, California's limited water supplies should be allocated among different human and environmental water uses transparently, efficiently, and predictably in accordance with the requirements and priorities that flow from state and federal law.

We suggest a structured means of implementing this vision that emphasizes proactive drought preparations and reduces the need for in-drought improvisation. At the core is a contingency-based framework designed to support more timely and effective drought decision making. A suite of complementary actions aims to reduce uncertainty and lay the groundwork for improved water rights administration and oversight in future droughts. They include (1) making key policy decisions that affect drought response in advance, (2) strategically improving, and more effectively using, decision-related information, (3) maximizing learning from droughts, (4) prioritizing water rights enforcement between droughts, and (5) capitalizing on the many synergies that exist between the Board's drought and non-drought work to achieve better water management outcomes, greater clarity for water users, and more efficient use of state resources. We see these actions—which the Board can take before, during, and after droughts to improve the transparency, predictability, and effectiveness of its future drought responses (Figure 1)—as crucial components of effective climate adaption for California.

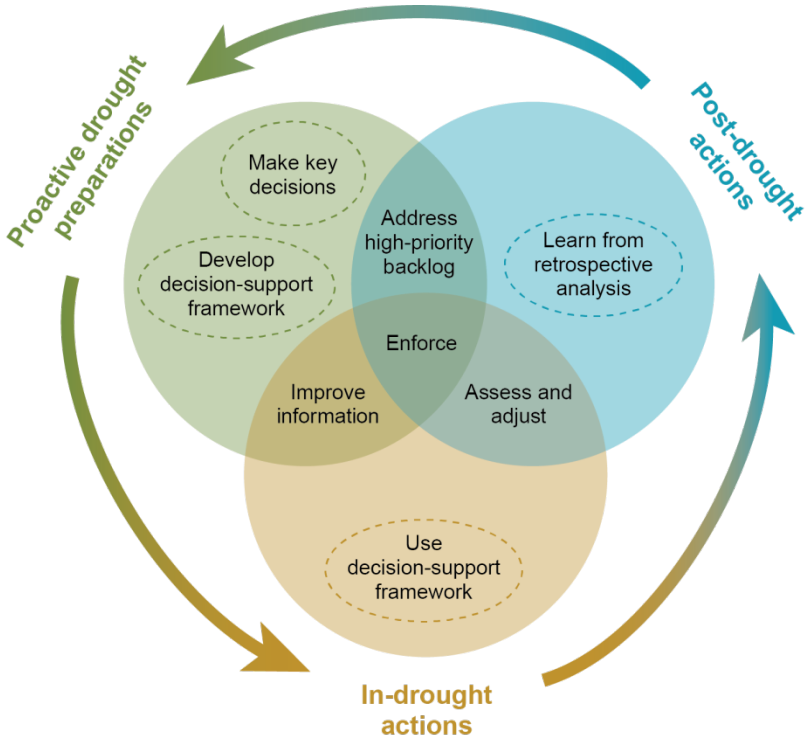

Figure 1: Actions the Board Can Take Before, During, and After Droughts to Improve Its Future Drought Response

1.3 Methods

This report builds on the retrospective analysis in **Part 1**. For both reports, we reviewed publicly available sources of information including reports, peer reviewed articles, law review articles, news articles, and websites, as well as documents produced by the Board including resolutions, decisions, orders, water quality control plans, hearing transcripts, reports, notices, fact sheets, and web-based materials. We also reviewed the legal and regulatory context for California water rights and the Board's water rights related authorities and responsibilities. A technical advisory group reflecting a range of perspectives and technical expertise provided invaluable input and feedback during the project. Finally, we engaged with Board staff, Department of Water Resources staff, and other public and private stakeholders through a number of workshops organized for related projects[3] and reviewed past recommendations for improving the Board's drought responses from a variety of sources.

1.4 Who Should Read this Report?

This report provides analysis and recommendations for improving the Board's future drought responses. It may be useful to a range of people interested in improving California water resource management during droughts, including the following:

- ***Board Members and Staff*** — We hope that Board members and staff find the report useful as a supplement to their own retrospective analyses to inform priority setting and planning efforts.
- ***Water Users and Advocates for Environmental Uses of Water*** — The Board's decisions directly or indirectly affect the interests of water users (including, but not limited to, those who directly hold or claim surface water or groundwater rights) and advocates for environmental uses of water. This report can help inform their comments and suggestions for improving the tools, processes, and information available to the Board during future droughts and their efforts to work collaboratively with the Board, other agencies, and one another to improve drought outcomes.
- ***Other Government Agencies*** — State, federal, and local agencies with responsibilities that intersect with California water management can use this report as a starting point for reflecting on how their interactions and coordination with Board could be improved in preparation for, during, and after future droughts.
- ***Legislators and Legislative Staff*** — Legislators and legislative staff can use the report to inform their thinking about what legislative changes would enable more timely and effective water rights administration and oversight during droughts

1.5 Report Organization

Section 1 briefly introduces the motivation and vision for the project, explains who may find this report useful, and summarizes the report's organization.

The remainder of the report describes a set of complimentary actions the Board could take to improve water rights administration and oversight for future droughts.

- **Section 2** provides the general outlines of a contingency-based framework to support drought decision making. Using actions related to curtailments as an example,

Appendix A illustrates how the framework could be fleshed out and made more detailed and discusses possible approaches to dealing with several difficult issues.

- **Section 3** identifies three key policy areas that we argue should be among the Board's top priorities for targeted decision making in advance of droughts: (1) setting and implementing instream flow requirements for priority water bodies, (2) defining and implementing minimum human health and safety protections, and (3) establishing clear curtailment procedures. This section also discusses a suite of important considerations related to making key policy decisions.
- **Section 4** addresses strategically improving decision-related information.
- **Section 5** focuses on maximizing learning from droughts and acting on lessons learned.
- **Section 6** argues for prioritizing enforcement between droughts.
- **Section 7** recognizes institutional challenges and identifies institutional opportunities for building the Board's capacity to make more timely and effective decisions during droughts. The Board can capitalize on synergies between its drought and non-drought work to achieve better water management outcomes, bring greater clarity for water users, and make more efficient use of the Board's, and the state's, resources.
- **Section 8** summarizes these recommendations.

2: Adopting a Contingency-Based Framework for Drought Decision Making

California experienced four major statewide droughts in the forty years leading up to 2016 (see **Part 1**). We know more droughts are coming, though not precisely when. An important question arises: How well will we be prepared to respond when the next drought arrives?

We argue that the Board can and should prepare for the more frequent and intense droughts we expect in the future by adopting a contingency-based framework to support more timely and effective drought decision making. It can proactively identify potential drought response strategies and the information, tools, and protocols needed to make in-drought improvisation less necessary.

2.1 Contingency Planning as a Critical Climate Adaptation

A common definition for drought is an extended "period of drier-than-normal conditions that results in water-related problems."[4] Droughts can be classified based on meteorological (precipitation), agricultural (soil moisture, evapotranspiration), hydrologic (streamflow, snowpack, groundwater conditions), or other indicators, used singly or in combination.[5]

How water is managed during droughts can have profound and lasting consequences for state and local water supply and, ultimately, for people and ecosystems. Dry conditions cause or exacerbate mismatches between the amount, quality, location, and timing of natural water

supply and the amount, quality, location, and timing of human water demand and environmental needs.[6]

The state's water management institutions will need to adapt to the increased frequency and severity of droughts expected as a consequence of continued climate change. Adaptation is the adjustment of natural or human systems to lessen harm in response to change.[7] Reactive adaptation occurs as a response to felt change, while anticipatory adaptation involves taking proactive steps in advance of change. Given the high confidence in projections of increased hydrologic extremes for California, effective adaptation will not depend on reducing uncertainty about the specific timing of upcoming critically wet or dry periods, a potentially impossible goal. Instead, it will require developing and implementing practices that make water management more robust and resilient to hydrologic extremes, regardless of when those extremes occur.

Contingency planning is an anticipatory adaptation strategy aimed at identifying and preparing for a range of possible future scenarios that may require rapid responses.[8] Abundant experience in various institutional contexts, including California water, demonstrates that this type of planning enables better decision making when emergency situations develop.[9]

Until now, the Board has generally found itself responding reactively to droughts, trying to pull together responses on short time scales in the midst of drought emergencies (see **Part 1**). In the wake of the 1976–1977 drought, the Board's Water Rights Division noted that it had entered the drought without a plan and concluded that it would be useful to "plan and standardize methodology and procedures to better administer water rights during [both] the normal year and future droughts."[10] Some advancements have occurred during, or shortly after, each of the last four major statewide droughts, including some especially significant strides during the recent drought, when the Board shifted into a more active and experimental mode, in which it was willing to confront controversy and litigation in the pursuit of better drought response strategies. Even then, the Board struggled to find an appropriate balance between acting, overreacting, and doing too little too late. Inadequate information, legal ambiguities, few clear precedents, and the lack a well-defined plan of approach led to inconsistencies and confusion that ultimately hindered water users' ability to plan and the Board's own efforts to oversee and enforce California's water rights system and to protect high priority environmental and public health and safety beneficial uses. These experiences support the need for an increased focus on preparation.

If the Board had come to the 2012–2016 drought prepared with a toolbox of potential response strategies for different contingencies and a framework to guide consideration of whether, when, and how to implement them, the Board's in-drought responses might not have needed to be so improvisational, its ability to invoke some strategies might have been less contested, and environmental and health and safety priorities might have been better reflected. These changes might have enabled more predictable, timely, and effective state drought response, better prepared water users, and better outcomes for at-risk communities and ecosystems.

Water users, too, can engage in proactive drought preparations if they have advance notice of how the Board will approach drought-related water shortages, as well as warning of potential shortages. The more lead time and information they have, the more thoroughly and thoughtfully they can prepare by making arrangements to cope with potential water supply disruptions, and the lower the transaction costs associated with planning and implementing

contingencies will be. This ability to plan enables short-term hedging behavior, whether based on financial market transactions (like short-term water transfers) or other actions (like developing voluntary agreements to protect environmental flows, identifying critical health and safety needs, or planning potential fallowing scenarios). It also enables long-term investments in alternative water supplies, like recycled water, stormwater capture, off-stream storage, and groundwater recharge.

2.2 Developing the Framework

In order to increase the resilience of California's water allocation system in the face of future droughts, the Board should consider developing and implementing a contingency-based framework to support drought decision making. The goal setting, scenario planning, and forethought required to develop a useful decision-support framework, as well as the structure it would bring to the decision-making process, would make the Board more nimble, empowering more timely and effective responses during future droughts. By clarifying how the Board will approach drought-related decisions, the framework will also make it easier for water users around the state to plan in the face of hydrologic uncertainty.

In this document, we provide a conceptual description and general structure for such a framework. It is important to emphasize that the information presented here is not intended as either a literal historical representation of the strategies the Board has used in the past or as a specific policy prescription. We do not intend to identify precise thresholds for decision making or to specify exactly which actions the Board should take in any particular circumstance. Our goal, instead, is to offer a general architecture for a drought decision support framework and some guidance for fleshing it out. We hope that the Board can build on this general structure as a starting point for developing a specific, actionable framework to support decision making during future droughts.

In Appendix A, we elaborate on the general framework described below to show how it can be made more specific, using curtailment-related decisions as a jumping off point.

To develop a functional drought decision-support framework, the Board will need to draw on its own experience and expertise while also seeking broad and meaningful stakeholder engagement on the goals, form, substance, and relationship of potential drought response actions. It needs to start now so that it is as prepared as it can be to respond effectively when the next significant drought hits.

Fleshing out the framework will involve a number of interrelated tasks and considerations (Table 1). These include (1) identifying decisions the board might need to make during a drought, (2) describing the context for each decision, (3) defining objectives and performance measures for evaluating potential actions, (4) identifying acceptable actions, (5) selecting appropriate triggers for considering or taking each action, (6) detailing the overall process and specific procedures related to each action, (7) identifying decision-relevant information, (8) mapping relationships and interdependencies between framework components, and (9) establishing mechanisms for learning and making adjustments.[11]

2.2.1 Identify Decisions the Board Might Need to Make During a Drought

As an important first step in developing a drought decision-support framework, the Board would need to identify the various decisions it might need to make to effectively administer

and oversee California's water rights system under different drought and dry-year scenarios. For example, one important decision is: How will the Board ensure that water users in a particular watershed appropriately exercise their surface water rights during a drought?

2.2.2 Describe the Context for Each Decision

For each decision, the Board will want to consider important context, including the appropriate spatial scale (e.g., the watershed or sub-watershed level) and timeframes (e.g., seasonally, monthly, weekly, or daily) for useful decision making.

2.2.3 Define Objectives and Performance Measures for Evaluating Potential Actions

To help it assess the likely impacts of alternative actions, and to retrospectively analyze whether a chosen action actually accomplished what was intended, the Board will need to define substantive and process objectives and associated performance measures. Objectives are likely to align with existing legal requirements—like water right priorities, the California Constitution's mandate that water be reasonably and beneficially used in the public interest, fish and wildlife protections like instream flow requirements—and declared policy preferences such as the Human Right to Water (see Section 3). Each objective should be paired with one or more, preferably quantitative, performance measures.

Figure 2 illustrates some potential relationships between example actions, objectives, and measures that may be relevant for deciding how to ensure that water users in a particular watershed appropriately exercise their surface water rights during a drought.

2.2.4 Identify Acceptable Actions

To identify acceptable drought response actions, the Board would evaluate the likely effects of potential actions on its ability to achieve the defined objectives. Alternative actions may be associated with different combinations of tradeoffs for different objectives or with different levels of uncertainty. Choosing wisely among them in a particular drought context will require an understanding of these, as well as determining the acceptable level of risk.

Table 1: Outline of Tasks and Relevant Considerations Associated with Developing a Contingency-Based Framework to Support Drought Decision Making[12]

Identify decisions the Board might need to make during a drought. For each decision:	
DECISION CONTEXT	**Describe the context for the decision.** • What is the appropriate spatial scale (e.g., statewide, watershed, sub-watershed)? • What is the appropriate temporal scope of the decision? • How is the decision related to other decisions in time and space?
OBJECTIVES & MEASURES	**Define objectives and performance measures for evaluating potential actions.** • What legal requirements and policy preferences help define objectives? • What critical underlying decisions would help define objectives? • What short-term and long-term substantive outcomes are intended? • What process objectives are associated with the decision? • How will substantive and procedural success be tracked and confirmed?
ACTIONS	**Identify acceptable actions.** • What are the possible / likely consequences of an action for each objective? • What are the possible / likely tradeoffs of an action for different objectives? • What is the acceptable level of risk?
For each acceptable action:	
TRIGGERS	**Select appropriate triggers for considering (or presumptively taking) the action.** • What circumstances should cause the Board to consider taking the action? • Under what circumstances, if any, would it be useful and appropriate for the action to be implemented as a default or presumptive action?
PROCESS & PROCEDURES	**Detail the overall process and specific procedures related to each action.** • What is the presumptive implementation process? • What variance procedures would be useful and appropriate? • What communication and engagement protocols are needed for the public at large, marginalized communities, and other stakeholder subgroups? • What coordination with other state, local, and federal actors is needed?
Overarching tasks and considerations:	
INFORMATION NEEDS	**Identify decision-relevant information.** • What information is already available and how will it be accessed and used? • What information improvements would aid the decision-making process? • What information improvements would enable better outcomes?
RELATIONSHIPS	**Map relationships and interdependencies between framework components.** • How are decisions, objectives, measures, actions, triggers, processes and procedures, and information needs related?
LEARNING & ADJUSTMENT	**Establish mechanisms for learning and making adjustments.** • How will the Board gauge the effectiveness of its actions during in-drought implementation? • How will the Board make in-drought adjustments? • What kind of post-drought retrospective analysis would be most useful? • How will the Board make between drought adjustments? • What proactive, non-emergency work would make particular decisions more straightforward or particular actions more effective?

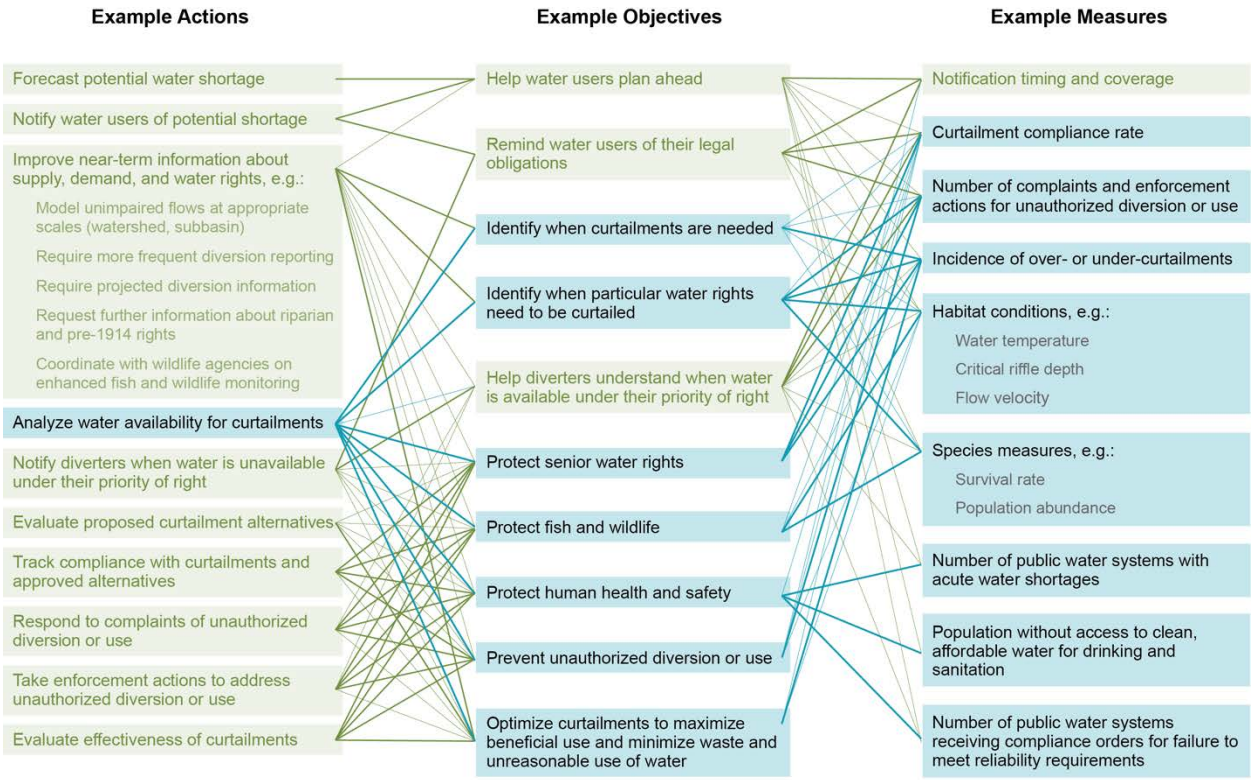

Figure 2: Potential Relationships Between Example Actions, Objectives, and Measures that May Be Relevant for Deciding How to Ensure that Water Users in a Particular Watershed Appropriately Exercise Their Surface Water Rights During a Drought

This figure provides a snapshot of many of the topics discussed in this report. Although incomplete, it illustrates the connectedness and complexity of the Board's water rights oversight decisions. The lines connecting example actions, objectives, and measures illustrate not only a diversity of interconnection, but also the varying strength of these interconnections. We highlight the example objectives that are most strongly related to one example action, as well as the measures that are most strongly related to those objectives, in blue.

2.2.5 Select Appropriate Triggers for Considering or Taking Each Action

To ensure that it considers potential drought response actions at useful junctures, the Board could establish a system of alerts for itself. This would involve identifying conditions that should trigger the consideration of each action. In many cases, it may be beneficial to design triggers to initiate one or more default or presumptive actions directly, instead of simply initiating their consideration (see Section 2.3). This could increase predictability for water users and ensure that time-sensitive actions are implemented quickly. Some important considerations for triggers include the following.

- Effective triggers are likely to be specific and unambiguous.
- The most basic trigger, underlying the use of the drought decision-support framework itself, is whether or not drought conditions exist in a particular watershed.
- More than one trigger might be appropriate for some actions, and the same mechanism might trigger the consideration of (or directly trigger) multiple actions.

- Triggers could include buffers tied to automated initial assessments that alert the Board when conditions are approaching critical thresholds.
- Compound triggers could be designed to account for both current conditions and for the probability and risks associated with past and potential future conditions.
- Triggers could include hydrologic thresholds, criteria, dates, other actions taken by the Board, or actions by other parties.
- The Board would likely derive some triggers directly from legal requirements in statutes, regulations, and water quality control plans.
- External triggers might include updated weather forecasts or updated reports of diversions (which could trigger fresh analysis of water availability).
- Complaints might trigger consideration of particular information gathering and assessment activities.

If triggers are set appropriately, the framework will bring relevant potential drought response actions to the Board's attention at appropriate times. Some triggers might automatically initiate one or more default actions (e.g., suites of actions tied to particular drought severity levels (Section 2.3) or actions that follow from the triggering actions of other parties). To decide whether and how to take others, the Board might use its discretion or seek guidance from a drought coordination team (Section 3.4.3), or from the public at large.

2.2.6 Detail the Overall Process and Specific Procedures Related to Each Action

To ensure its drought responses are timely, effective, and legally justifiable, the Board could identify the overall process and specific procedures it will follow to decide on and implement each action. Potentially important considerations include the level of staff versus Board involvement in decision making; the form, content, and timing of public notice and public engagement; and whether / to what extent specific government entities or stakeholder interests should be involved.

Developing specific procedures through a public process between droughts could help address water users' due process concerns, reduce uncertainty, and enhance the perceived legitimacy and fairness of the Board's drought decision making (see Section 3.4.1). This includes both default procedures and procedures for requesting variances. For example, in the curtailment context, the Board would establish clear curtailment procedures (see Section 3.3 and Appendix A), including procedures for effectively evaluating the adequacy of proposed alternatives to curtailments, through a transparent and accessible public process.

The Board should consider how it will balance the need to engage meaningfully with the stakeholders that are affected by its drought-time decisions with the need to be decisive and move forward under sometimes significant time pressure. Therefore, the Board will want to think about incorporating clear mechanisms, including specific triggers, for maintaining open and constructive engagement and communications with diverters and other stakeholders—including marginalized communities—during droughts. For example, the framework could incorporate clear guidance regarding when and how to inform stakeholders of current and forecast conditions, impending decision points, and opportunities to provide input or feedback, as well as for providing well-organized and easily accessible information about the basis for the

Board's drought-related decisions and the effectiveness of its past decisions. This guidance could build on the lines of communication and web-based resources the Board developed during the recent drought.

2.2.7 Identify Decision-Relevant Information

To identify critical data needs and gaps, the Board could identify what information would help it decide whether to take, and how to effectively implement, each action. For example: what information provides critical context for a decision about whether to approve, conditionally approve, or deny a request in a temporary urgency change petition? Similarly, what information would help the Board decide what conditions to place on a temporary change to ensure that it has the desired outcome and does not cause unintended consequences? And what information will allow the Board to track progress toward achieving important objectives? The Board could evaluate what information is already available and identify how, when, and why it will be accessed and used. Furthermore, the Board could identify high-priority information improvements likely to be especially helpful to the decision process or to effectively implementing chosen actions.

2.2.8 Map Relationships and Interdependencies Between Framework Components

To streamline and clarify the decision-support framework, the Board should consider how potential decisions, objectives, measures, actions, triggers, processes and procedures, and information needs are, or should be, linked with one another (see Figures 2 and 3). Some components might be more effective when nested, designed with clearly articulated interdependencies, or presented as alternatives optimized for different sets of circumstances.

Example: Relationships Between Different Types of Water Availability Analysis — During a drought, the Board may need to analyze water availability in different contexts. Analyses done for different purposes may require different, or more or less detailed, information. At the extremes, an early forecast of the potential for water shortage in a priority watershed might use very coarse-scale watershed-wide estimates of supply and demand, while much more specific information might be needed to support an enforcement action against a particular water user alleged to have diverted water at a time when no water was available under their priority of right (see Appendix A at A.1, A.2, A.6). The Board should consider how different forms and purposes of water availability analysis might relate to one another. Some analyses might be able to serve multiple purposes, allowing the Board to reduce the number of single-purpose analyses in a way that eliminates unnecessary redundancy while ensuring that each purpose is adequately served. Alternatively, it might make sense for certain water availability analyses to automatically trigger or otherwise interact with others (see Appendix A.1, Tables A-1, A-2).

2.2.9 Establish Mechanisms for Learning and Making Adjustments

The framework will not be perfect, but even a flawed decision-support framework will enable more timely and effective drought response. To ensure that the framework improves over time, the Board can include clear mechanisms, including specific triggers, for evaluation and adjustment that allow the framework to respond to new information, legal developments, strategies, and tools, as well as experience gained during in-drought implementation. In addition to post-drought retrospective analysis and adjustment (Section 5), these mechanisms should include in-drought components designed to gauge the effectiveness of drought actions and whether in-drought course-corrections (for example, to address unexpected developments that the framework does not account for) are needed.

The current information, procedures, and tools that are available to support some actions may be lacking in important ways. So that it can prioritize addressing these in its proactive drought preparations, the Board should periodically consider what proactive, non-emergency work would make particular decisions more straightforward or particular actions more effective.

It is important to keep in mind that some in-drought innovation and improvisation will always be necessary. Every drought will be different, and no amount of proactive planning can eliminate the need for on-the-job learning and the need to respond when something truly unexpected happens. Temporary urgency change petitions (TUCPs) have been used as a flexibility mechanism in the past, but, as we discuss in Section 3.1.1, an important goal of proactive drought preparation is minimizing the need for them, and for other individualized ad hoc measures. Needed flexibility can be achieved in other ways, and applied more fairly and systemically across whole watersheds or regions, instead of on a one-off quasi-adjudicatory basis. The decision support framework can build in recognition of the need for flexibility as well as tools, ideally developed through public processes, for providing it.

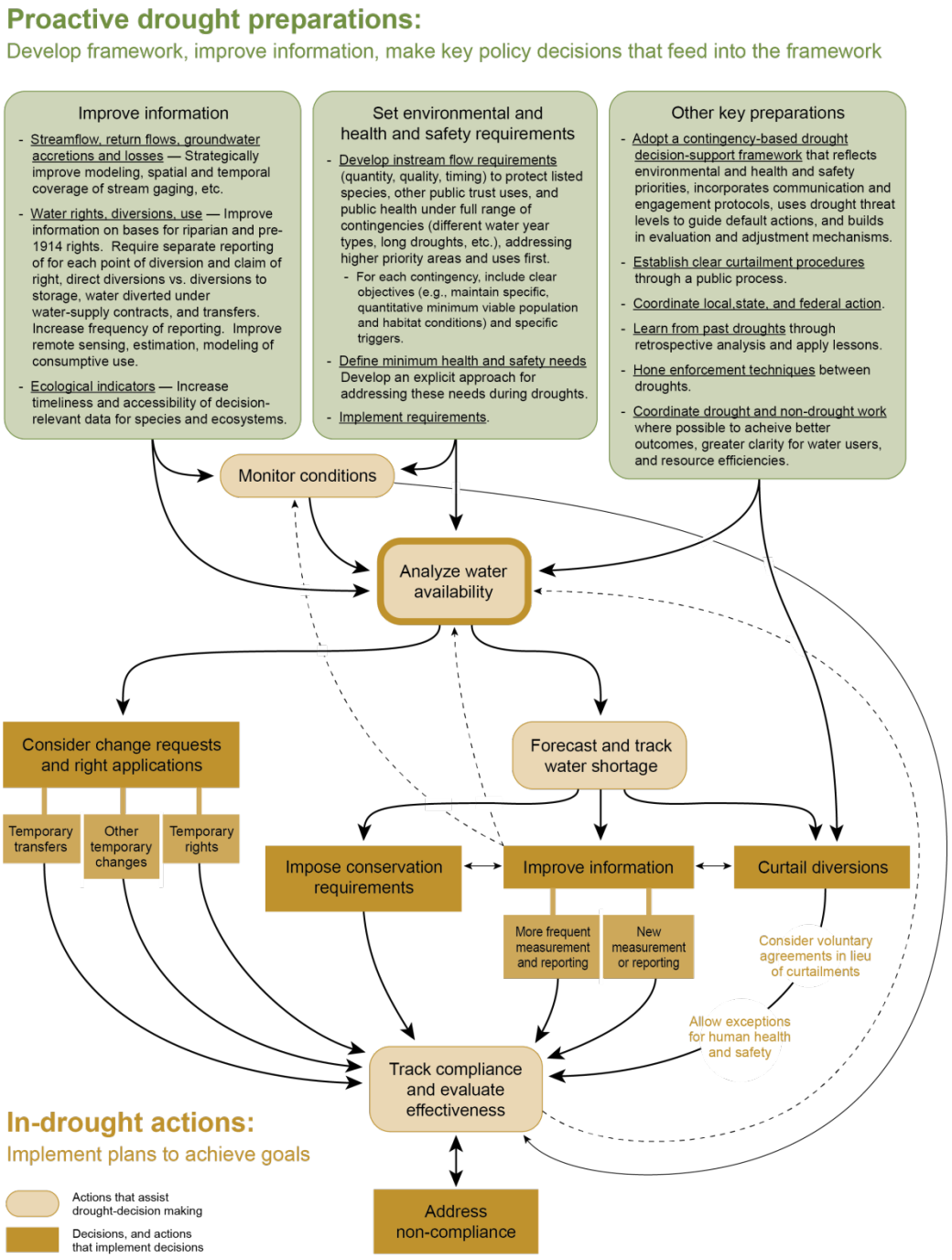

Figure 3: Potential Relationships Between General Categories of Drought Response Actions and Proactive Drought Preparations

2.3 Using Tiered Drought Severity Levels to Guide Default Actions

Some watershed-based actions might be organized around successively higher drought severity levels, each defined by triggers that would automatically initiate a specific tier or suite of default actions for a particular watershed.

Keying suites of actions to particular drought severity levels might be a good way to operationalize tiered drought response measures developed in advance of drought, like conservation requirements and information gathering and assessment activities. As an example (for illustrative purposes only), drought severity Level 3 (extreme drought) might trigger the following default actions: (1) requiring monthly or more frequent meetings of a drought management coordination team that includes representatives of wildlife agencies, water utilities, agricultural users, disadvantaged communities, and other stakeholder interests in the affected watershed; (2) requiring water suppliers and individuals to take mandatory conservation measures aimed at achieving a 30% reduction in per-capita water use, including limiting residential and commercial outdoor irrigation to 2 assigned days per week from June–October or 1 assigned day per week from November–May; (3) requiring enhanced diversion reporting (monthly to daily measurements, depending on diversion size and type) and projected diversions for the following month; (4) requiring enhanced monitoring of stream depth, temperature, and the presence, location, numbers, and physical condition of at-risk fish populations; (5) making weekly assessments of health and safety needs and shortfalls; and (6) undertaking daily drought water availability analyses at the 12-digit hydrologic unit code (HUC12) subbasin scale,[13] incorporating enhanced diversion reporting and projections (Table 2).

Table 2. Illustration of How Drought Severity Levels Could Potentially Be Used to Trigger Different Sets of Default actions in a Particular Watershed that Is Important for Listed Fish Species

Action category	**Level 1:** Moderate Drought	**Level 2:** Severe Drought	**Level 3:** Extreme Drought	**Level 4:** Exceptional Drought
Coordination team	Activated + initial meeting	Monthly meeting	Monthly meeting +	Weekly meeting +
Conservation	Voluntary; ~10%	Mandatory; ~20%; Outdoor reduction 1	Mandatory; ~30%; Outdoor reduction 2	Mandatory; ~40%; No landscape irrigation
Diversion reporting	Monthly	Monthly to Weekly + projected	Monthly to Daily + projected	Monthly to Hourly + projected
Fish-related monitoring	Basic	Enhanced	Enhanced	Enhanced
Health & safety assessment	Initial	Monthly +	Weekly	Weekly +
Drought water availability analysis	Watershed scale (monthly, for shortage forecasting)	HUC12 subbasin scale (weekly, for curtailments)	HUC12 subbasin scale (daily, for curtailments)	HUC12 subbasin scale (daily, for curtailments)

Table based in part on San Diego County Water Authority's Model Drought Response Ordinance[14] and the U.S. Drought Monitor's drought severity classification.[15]

Triggers for each drought severity level, associated default actions, and flexibility provisions would need to be designed carefully to avoid locking the Board into an ineffective course of action that puts water users at risk. To ensure that triggers are not short-sighted, they could account for not just current conditions but also for the probability and risks of continued shortage in the context of past and projected future conditions. So, drought severity Level 2 in Table 2 might be triggered by different combinations of past, present, and (forecasted) future conditions, for example: when current water year conditions in the watershed meet the "severe"

drought threshold on May 1st of a very dry water year following several wet water years, but also when current water year conditions in the watershed meet the "moderate drought" threshold on January 1st following several abnormally dry water years. There is more certainty surrounding summer and fall surface water drought severity in the former case, since the wet season is over, but an important risk of even greater potential drought impacts in the latter. Default actions would need to be tiered appropriately based on the best available information about their ability to efficiently mitigate short-term and long-term impacts on people and ecosystems under different drought scenarios.

The Board could consider integrating voluntary conservation agreements into this tiered structure. By creating a framework designed to encourage local creativity and innovation, the board could enable more cost effective methods of achieving conservation to emerge. It would be essential for these options to be defined and negotiated in advance, so that they are in place and ready to be called upon in a drought. For example:

- **Alternative drought conservation actions —** In lieu of the Board's default conservation requirements for a particular drought severity level, a water user might take specific alternative actions expected to provide an equal or better conservation benefit. Compliance with an approved alternative could function as a substitute for the default requirements and prevent the imposition of more stringent conservation requirements until changed conditions triggered a higher drought severity level. For example, if the Board were to develop a default mandate that required municipalities to stop watering vegetated median strips at drought Level 2 (moderate drought), a city that uses recycled water to maintain publicly valued shade trees in medians might propose a temporary increase in turf replacement programs or other behavioral incentives.

- **Water-use reduction option agreements —** A water user with less flexible demand, such as a private aquarium operator, might enter into an option agreement with a more flexible water user, such as a small batch brewery, in which the brewery agreed to cease (or greatly reduce) its water use at a time when both water users are supposed to be meeting a particular conservation standard. If used on a regional level, this alternative could be designed as a system of tradable water conservation credits that would allow communities for whom water use reductions are easier to take on more of the conservation burden.[16]

- **Permanent water use reductions —** To encourage water users to frontload significant conservation measures, the Board might consider agreements that specify permanent water use reductions by a city or other large water user, over and above any permanent reductions required by law, that could be credited against the default conservation requirements for a particular drought severity level. For example, a city with low per-capita use and a successful, well-documented, long-term program to subsidize water audits and low-flow fixture retrofits for low-income households might propose to avoid additional conservation requirements unless drought Level 3 is reached.

A proposed alternative would need to conserve at least as much water as the default requirements would have. To ensure that it would help, not hinder, effective drought response—and watershed management more generally—the Board would need to evaluate each proposal carefully in the broader context of watershed hydrology and connectivity. Naturally, the details of such agreements would be critical, as would tracking and verification,

but the point is that building in flexibility could enable innovation to help meet drought response burdens in novel and unexpected ways that provide additional benefits. (Such an agreement would not purport to protect the water user from curtailment, or provide the water user with a benefit in return for complying with curtailments, and the benefit would accrue only for the reduction in diversion beyond what would have occurred under the default conservation requirement for the applicable drought severity level.)

Other actions would not align neatly with drought severity level boundaries and would need to be considered and taken on parallel tracks. For example, in the illustration above, subbasin-scale drought water availability analyses may indicate that curtailments to protect senior water rights are needed. The Board would send curtailment notices out based on that analysis, irrespective of the current drought severity level. Similarly, the results of fish-related monitoring might trigger the implementation of particular contingencies in voluntary agreements between watershed diverters and wildlife agencies to maintain specific fish flows (see Section 3.1.1.1).

3: Making Key Policy Decisions in Advance of Droughts

Developing a drought decision-support framework is one form of proactive preparation the Board can undertake to improve its drought response capabilities. But other efforts to reduce uncertainty and lay the groundwork for improving water rights administration and oversight in future droughts are also needed. At the most basic level, drought preparations should flow from desired outcomes. Where key policy decisions have not been made, drought (and non-drought) water management priorities and procedures are not clear, and the Board's in-drought decisions may seem opaque, arbitrary, and unfair to the most deeply affected stakeholders. The process of building a decision-support framework will highlight key policy choices and other issues that, left unaddressed, will pose ongoing problems for effective drought planning and response. Addressing these issues head on—and beginning as soon as possible—will benefit not just the Board's future drought responses, but also water rights administration and oversight more broadly.

3.1 Setting and Implementing Appropriate Instream Flow Requirements

Despite the fact that there are numerous protections for fish and wildlife,[17] water quality,[18] and human health and safety[19] built into state and federal law, these priorities have not been adequately protected during past droughts (see **Part 1**). Reconciling existing protections for fish and wildlife with other aspects of environmental and water law and with one another is often not straightforward. It involves deciding how to appropriately address sometimes competing legal requirements and management objectives Often, the Board has not developed clear, quantitative water quality and flow standards for implementing environmental requirements in particular watersheds. Where such standards do exist, they frequently do not account for the full range of relevant hydrologic conditions, including severe or prolonged droughts, leading

water users to pursue TUCPs, and the Board to make ad hoc decisions about what to prioritize, in the midst of droughts (see Section 3.1.1).

Although the Board can set and implement instream flow requirements to protect fish and wildlife and other beneficial uses of water, it has not yet done so for many biologically important surface waters.[20] Recognizing that flow quantity, quality, and timing affect and are important aspects of fish and wildlife habitat,[21] the Board should prioritize setting and implementing instream flow requirements that account for the full range of hydrologic conditions for priority water bodies. To minimize the need for temporary urgency changes, requirements should account for drought by including critical thresholds with appropriate margins of safety under different contingencies (different water year types, long droughts, etc.). Contingency requirements should include clear objectives (e.g., maintaining specific, quantitative minimum viable population and habitat conditions) and should be clearly applicable when triggered by specific drought criteria.

The concept of an ecosystem water budget—which addresses whole ecosystems instead of individual species[22]—may be useful here. Whether designed as a regulatory set aside or a as a high-priority water right, an ecosystem water budget could increase regulatory certainty for all water users in a watershed.[23]

Developing and implementing instream requirements with regulatory effect (often called instream objectives) is a multi-step process that involves partnering with other agencies and organizations, including the CDFW, the Regional Water Quality Control Boards, federal wildlife agencies, and others.[24] Steps include completion of an instream flow study, setting instream flow objectives after considering all public trust and (other) public interest concerns, and implementing those objectives through regulatory or adjudicative proceedings.

The Board has many sources of authority and responsibility for establishing instream flow requirements. These include Article X, Section 2, of the California constitution,[25] the Public Trust Doctrine,[26] California Fish & Game Code Section 5937,[27] California Public Resources Code Sections 10001 to 10004 and California Water Code Section 1257.5,[28] the federal Clean Water Act and the state Porter-Cologne Water Quality Control Act,[29] the state and federal Endangered Species Acts, and Water Code Section 1253.[30]

The 2009 Delta Reform Act[31] and the California Water Action Plan introduced some specific instream-flow-related deadlines. The Delta Reform Act directed the Board to "develop new flow criteria for the Delta ecosystem necessary to protect public trust resources" (including "the volume, quality, and timing of water necessary . . . under different conditions") within nine months of enactment.[32] In its August 2010 report to the legislature, the Board identified flow criteria, but did not determine their feasibility or consistency with the broader public interest.[33] The Act also required the Board to come up with "a prioritized schedule and estimate of costs to complete instream flow studies for the Delta and for high priority rivers and streams in the Delta watershed" by 2012, and for other major rivers and streams by 2018.[34] In response, the Board identified 138 rivers and streams in need of instream flow studies but noted that the Act's timelines were unrealistically short, both because instream flow studies require monitoring for three or more years and because performing studies for all stream systems would take considerably more time, effort, and funding than would be available by either deadline.[35] It identified waters that are habitat for threatened or endangered anadromous fish as high priorities. However, this still left on the order of 100 water bodies with "priority group 1"

status. The state's 2014 California Water Action Plan provided additional direction, instructing the Board and CDFW to work together to establish instream flows and take other actions to enhance flows in five or more stream systems around the state that provide critical habitat for anadromous fish.[36]

Currently, the Board is working on updating or developing flow objectives to protect fish and wildlife uses in the Sacramento and San Joaquin River watersheds and five other priority streams. For example, as part of its updates to the Bay-Delta Plan, the Board is proposing to increase instream flow objectives for the San Joaquin River and to add flow requirements for three of its tributaries.[37] In September 2016, the Board released draft proposed amendments to the Bay-Delta Plan that would establish an "adaptive flow range" of 30 to 50 percent of the unimpaired flow to allow optimization of "the balance between fishery and human uses, while rewarding actual improvements in biological conditions that support native fish" and enabling "a nimble response to changing information and changing conditions while minimizing unintended impacts."[38] This is essentially one version of an environmental water budget.

In response to the California Water Plan directive, CDFW and the Board have identified and are analyzing possible actions for five priority stream systems: the Shasta River (a tributary to the Klamath River), the South Fork Eel River, Mark West Creek (a Russian River tributary), Mill Creek (a Sacramento River tributary), and the Ventura River.[39] The Board is cognizant of existing and planned flow enhancement efforts by some watershed stakeholders and has said it intends to work collaboratively with them.[40]

The Board should continue to work with wildlife agencies and other stakeholders to develop and effectively implement interim and final instream flow requirements for prioritized water bodies. Depending on the circumstances, implementation activities[41] might include adopting regulations that codify environmental baselines and contingency triggers; accounting for instream flows in water availability analyses for curtailments (see Appendix A.4), permits, and water right changes; permit and license changes and amendments; voluntary agreements (see Section 3.1.1.1, below)[42]; and Clean Water Act Section 401 water quality certifications[43] for Federal Energy Regulatory Commission (FERC) relicensing.

3.1.1 Reducing Reliance on Temporary Urgency Change Petitions (TUCPs) Before Appropriate Instream Flow Requirements Are in Place

During a drought, the Board is likely to receive petitions from diverters requesting temporary changes to conditions attached to their permits or licenses that are meant to protect fish and wildlife or water quality—for example, requirements to bypass certain flows at the point of diversion, requirements to maintain minimum instream flows or water quality requirements at downstream compliance points, or biological constraints on diversions (e.g., fish presence or number in the vicinity of a pump). Diverters sometimes make these requests even when their permits purport to include drought contingencies, as DWR and the U.S. Bureau of Reclamation (USBR) did repeatedly during the recent drought for the permits and licenses that govern State Water Project (SWP) and Central Valley Project (CVP) operations (**Part 1**). As researchers from the Public Policy Institute of California have noted, the lack of effective contingency planning for managing fish and wildlife under severe drought conditions led the Board "to make trade-offs on the fly . . . based on limited knowledge and almost no scientific or public review" during the recent drought.[44]

To preserve water in storage for later use—including flows for Sacramento River temperature management, for salinity control in the Delta, and for agricultural and municipal use—DWR and the USBR sought, and the Board approved, multiple modifications of water quality and flow requirements that were intended to provide near-term protection for Delta smelt and other fishes in the Delta. These modifications coincided with historically low populations levels of several Delta resident species, including Delta smelt and longfin smelt.[45] While the TUCPs did allow the projects to store substantial amounts of water for later use—including cold water critical for salmon smolt survival—there was, nonetheless, a significant failure to protect salmon. Inaccurate assumptions and inadequate monitoring and reporting related to temperature management had severe consequences for the fish they were meant to safeguard.[46]

Setting instream flow requirements that include appropriate drought contingencies, as described above, would eliminate the need for TUCPs to relax environmental permit or license conditions. However, in watersheds for which the Board has not yet adopted appropriate flow requirements, encouraging proactive planning and voluntary agreements by water users may reduce the need for TUCPs in the interim and produce better outcomes for watersheds and water users.

3.1.1.1 Encouraging Contingency Planning and Voluntary Agreements

Temporary urgency changes and alternatives to curtailment (see Appendix A.5) that diverters might seek during a drought would benefit from contingency planning that begins in advance of that drought. Thinking possibilities through and establishing procedures ahead of time will increase their likelihood of success. This is true even when diverters believe their proposed actions will reduce the impacts of drought on fish and wildlife. For example, a petitioner might want to change their place of diversion to a point below a critical fish passage zone, shift the timing of diversion to a wetter time of year, request a transfer that keeps water instream en route to a downstream wildlife refuge, or coordinate with other water users to schedule their diversions in order to avoid excessive drawdown from simultaneous diversions.

Diverters in sensitive watersheds may be able to work with wildlife agencies to come up with collaborative, creative, and effective means of meeting environmental goals in lieu of a default action like curtailment based on emergency regulations for the protection of fishery flows (see **Part 1**). At the request of wildlife agencies, the Board adopted emergency curtailment regulations during the recent drought to protect at risk fish species in Mill, Deer, and Antelope Creeks, all tributaries to the Sacramento River. While diverters in Deer and Antelope Creek were subject to curtailment orders under the regulations, diverters in Mill Creek were able to avoid fishery-related curtailments entirely because the major water users in those watersheds entered into voluntary agreements with the wildlife agencies to take actions that would provide comparable protection to curtailments.[47] Post-drought analysis suggests that voluntary agreements and curtailment orders were similarly effective in maintaining flows and enabling fish passage in the three Creeks.[48] However, poor conditions in the mainstem of the Sacramento River due to the temperature management problems described above left local diverters feeling as if their sacrifice had been for naught.[49]

An important lesson is that taking a more "comprehensive approach to fish protection that better addresses the full suite of threats to species' survival" would lead to better outcomes for at-risk species and greater cooperation from stakeholders, who would find such an approach more fair.[50] The voluntary agreements and Sacramento River temperature management

decisions in this example were worked out on the fly in the midst of drought, and not coordinated. With better contingency planning that considered actions and impacts throughout the watershed, a better overall outcome might have been achieved.

To encourage proactive, cooperative behaviors that are more likely to achieve the desired results, the Board could identify when contingency planning and related preparatory efforts should be required as a prerequisite for, or considered as a benefit in, approving water users' drought response proposals, as well as whether some form of preliminary or programmatic approval could be beneficial.

3.2 Defining and Implementing Minimum Health and Safety Protections

Like environmental requirements, minimum health and safety needs have not been adequately protected during past droughts. This result flows in part from the (as yet largely unmet) need to reconcile these needs with other aspects of water and environmental law, and from concerns that doing so might reduce incentives for surface water diverters, including public drinking water systems, to pursue critical water supply reliability improvements.

As Article X, § 2, of the California Constitution and subsequent case law make clear, California does not recognize a property right in an unreasonable use of water.[51] Instead, every water right is limited to the amount of water that is "reasonably required for the beneficial use to be served."[52] What is considered reasonable necessarily changes with time and "with the facts and circumstances" of each case[53] but "cannot be resolved in vacuo isolated from state-wide considerations of transcendent importance," such as the need for conservation.[54] While the requirement for reasonable use injects some uncertainty into the water rights system, it also provides critical flexibility in the face of changing hydrologic conditions, societal values, and needs.

Arguably, almost any use becomes unreasonable if it deprives others of the ability to meet their basic health and safety needs. The logical implication of this argument is that it may not be reasonable to curtail certain uses of water when, for example, curtailment would eliminate the diverter's sole source of water for their own, or their customers', urgent drinking and sanitation needs. The Board's analysis of this issue is informed by a number of state statutory provisions. Specifically, the California Water Code describes domestic use as the "highest use" of water[55] and recognizes a Human Right to Water, defined as the right to "safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes."[56] State agencies, including the Board, must consider this right when developing policies, regulations, and grant criteria that might affect it.[57] Additionally, the California Health and Safety Code requires drinking water systems to provide "a reliable and adequate supply of pure, wholesome, healthful, and potable water" to those they serve.[58] Water systems that fail to meet this requirement may face enforcement action. These statutory provisions are directly relevant to the Board's interpretation of reasonable use.

During the recent drought, the Board experimented with how to handle the issue of water being used to meet the minimum health and safety needs of individual diverters and communities that would otherwise be curtailed based on water right priority (see **Part 1**). It included an explicit exception for minimum health and safety needs in its emergency regulations for curtailments to protect fish flows in Mill, Deer, and Antelope Creeks.[59] However, the Board

chose not to include an explicit exception in its emergency regulations for curtailments to protect senior water rights. It had received mixed feedback from stakeholders in public workshops and comments—with some arguing that any exception would violate priority and others arguing that some form of exception was necessary under Article X, Section 2, of California's constitution—and decided to rely instead on enforcement discretion. Therefore, those needing a health and safety exception remained in a sort of legal limbo, and continued use to meet a nebulous conception of minimum health and safety needs increased the uncertainty associated with curtailment-related water availability analyses. The Board's Division of Drinking Water addressed the issue for 22 curtailed water systems by issuing them compliance orders for violating the requirement for water supply reliability.[60] These orders prohibited new service connections, required metering, and directed the systems to develop and implement plans to establish alternative water sources to meet projected system demand, including during future severe droughts.

Reconciling the tensions between urgent needs for water to support human health and safety, water right priority, environmental water needs, and the requirement for water system supply reliability might be challenging, but it is important. An overly broad curtailment exception for human health and safety needs would reduce incentives for water systems and other diverters to pursue alternative water supplies to help them through future droughts. It would be unreasonable to reward those who have not worked diligently to improve supply reliability by allowing them to jump to the front of the priority line during times of shortage. On the other hand, some may work hard to try to improve supply reliability, yet find improvements elusive due to financial and other constraints.

Because California cannot fallow its residents, and diverters of all water right priorities will continue to have need of water adequate to meet minimum health and safety needs during future droughts, the Board should consider developing an explicit approach to defining and addressing these needs.[61] As for other difficult issues, using a public non-emergency process to define and decide how to implement priorities for urgent health and safety needs would be beneficial. It would provide a constructive forum for stakeholders to air the legal and fairness concerns they have regarding health and safety exceptions in a more formal way, to provide feedback on staff proposals, and to offer their own ideas and solutions. Through this process, the Board could establish narrowly tailored priorities for water urgently needed to satisfy minimum drinking and sanitation needs (often considered to be on the order of 50 gallons per person, per day), fire preparedness and response, and for other clearly defined urgent health and safety needs. Considerations should include both physical water needs and affordability, consistent with the Human Right to Water. The Board should also consider how it might address water for subsistence fishing and farming and other fundamental needs of low-income individuals, households, neighborhoods, and communities.

3.3 Establishing Clear Procedures for Implementing Curtailments

Perhaps the most controversial of the actions the Board took during the recent drought were actions related to curtailments (see **Part 1** and Appendix A). As others have recognized, more water users will need to curtail their diversions more often in the future as droughts become more frequent, longer, and more severe with climate change.[62] (Note that we use a fairly broad definition of "curtailment" that encompasses reducing or stopping diversions during times when there is not enough water available to support all desired uses, whether voluntarily or

under order.) To increase the accuracy and defensibility of its actions to implement curtailments, UC Davis researchers have suggested that the Board develop a formal drought curtailment system that uses "modern data, computation, and communications technology to make more complete and appropriate allocations of available water, with greater transparency and forewarning to water right holders and other interests," while explicitly addressing "other legal and social water management objectives, particularly environmental and urgent public health and safety demands."[63]

Procedures may be needed to support the following curtailment-related functions:

- Analyzing when curtailments are legally and hydrologically appropriate (i.e., analyzing water availability);
- Addressing environmental requirements and minimum health and safety needs;
- Providing curtailment-related information to water users;
- Issuing enforceable curtailment notices or orders;
- Evaluating proposed alternatives to curtailment, and;
- Enabling effective enforcement.

The most important function of a curtailment system may be helping water users understand water shortages so they can prepare and respond appropriately. Developing procedures for analyzing water availability and communicating the results to water users in affected watersheds for informational purposes will probably be less controversial than developing procedures to support other goals. Curtailment notices or orders that have legal effect independent of subsequent enforcement actions are likely to be controversial unless they follow transparent procedures developed through non-emergency public processes that include notice and the opportunity for a hearing. The Board will also need to consider how to incorporate non-water-right priorities—instream flow requirements and minimum health and safety protections—into curtailment analyses and other procedures.

Appendix A explores these and other curtailment issues in more detail.

3.4 Considerations for Key Policy Decisions

3.4.1 Using Non-Emergency Public Processes When Feasible

It would be preferable for the Board to make most of the decisions that guide its drought response using non-emergency processes in advance of droughts. As others have highlighted, droughts are not "unanticipated events which need to be addressed [primarily] via truncated processes with limited public input."[64]

Although the political will to support drought-related activities is stronger during droughts, developing feasible and effective drought responses under time pressure in the midst of drought is challenging[65] and increases the risk of unintended consequences. Using non-emergency processes serves many worthy goals, including the following:

- When the Board makes important drought-relevant decisions ahead of time, it will spend less time trying to find its footing in the midst of drought, reducing the time needed to decide on and implement critical drought response actions.

- Resolving issues (either on a temporary or permanent basis) between droughts increases certainty for water users by giving them notice of how the Board will approach drought decisions, so their own contingency planning is more effective.
- When the Board is considering adopting regulations, establishing policies, or making other broadly applicable decisions that are relevant for future drought response, public outreach, education, workshops, and notice and comment periods can ensure useful feedback from a wide range of stakeholders, revealing decision-critical information, concerns, and creative solutions the Board might not otherwise identify.[66]
- More time-intensive means of gathering information, like hearings, are better suited to a non-emergency context. Hearings are an important means of affording affected parties adequate due process protections in quasi-adjudicatory contexts.[67] Evidentiary hearings can accompany water right applications, petitions for long-term changes, permit or license amendments, public trust determinations, decisions about whether to declare streams "fully appropriated," and water right adjudications.[68]
- Ensuring the meaningful participation of marginalized communities in non-emergency processes is likely to be less resources intensive than ensuring their meaningful participation in emergency processes, which are often abbreviated and expedited. Meaningfully engaging these communities will require affirmative efforts at capacity-building—including stakeholder outreach, education, and, potentially, intervenor funding—to provide them with meaningful access to the decision-making process.[69]

This is not to say that using non-emergency processes to make important decisions between droughts is politically or logistically easy. For example, during the 1976–1977 and 2012–2016 droughts, the Board substantially shifted its attention and resources away from its other work and toward drought response activities. This shift was aided by political sentiment, and backed up by the actions and directives of the governor and legislature.

3.4.2 Making Interim Decisions When Timely Long-Term Resolution Is Not Possible

It will not be possible to achieve durable solutions for every critical stumbling block to effective drought response before the next drought. When an important issue is unlikely to be resolved quickly, the Board could prioritize adopting an interim, provisional solution that provides temporary certainty about how the Board will address the issue in its upcoming drought responses. For example, it could potentially adopt interim decisions on public trust determinations for instream flows to ensure that temporary protections for environmental uses of water are in place even if "years-long and delay-prone proceedings are pending."[70]

3.4.3 Increasing Coordination Among Local, State, and Federal Actors

Although we focus the majority of our attention on the Board, it is important to keep in mind that is not the only entity with a critical role to play in drought planning and response.

Local governments and private individuals, not state actors, make most drought decisions. Together with other state and federal actors, the Board's work should inform, and be informed by, these local decision makers. Drought responses at all levels will be most successful when these moving parts are cognizant of one another's goals, challenges, and concerns and are actively working to coordinate, and to collaborate where possible.[71]

Some potentially valuable ways to approach increasing coordination include:

- Appointing a dedicated point person in each major watershed (perhaps patterned after the Delta Watermaster[72]) who can serve as a liaison between locals and the Board, facilitate the local drought management coordination team, and spearhead local water rights administration and oversight.

- Establishing watershed-based drought management coordination teams that include representatives of wildlife agencies, water utilities, water districts, agricultural users, municipalities, Tribes, disadvantaged communities, non-governmental organizations, and other watershed interests. Where possible, these should take advantage of or build off of existing cooperative structures, like those developed to support Integrated Regional Water Management (IRWM), the governor's Drought Task Force, and California's Standardized Emergency Management System (SEMS).[73] If appropriately scaled, watershed-based teams will have the type of on-the-ground, shared experience that can enable a deeper and more practical understanding of one another's concerns and constraints, without losing sight of important coarser-scale issues that require an integrative approach (see 3.1.1.1).

- Using watershed-based working groups that incorporate relevant stakeholder perspectives, as well as public workshops, to help the Board identify important considerations for proposed temporary urgency changes and for voluntary agreements proposed in lieu of default drought response actions (like conservation requirements or curtailments).

- Establishing or enhancing coordination procedures with other agencies on specific issues (e.g., with state and federal wildlife agencies on environmental flows, potentially via a network of ecosystem trustees empowered to protect public trust resources[74]).

- Increasing transparency around state and federal water project operations, including the assumptions that underlie reservoir operations, annual water allocation forecasting, and temperature management modeling in these complex systems.

- Integrating the drought responses and triggers the Board selects for its contingency-based decision-support framework into the state's planning and operational models, such as CalSim,[75] to improve the accuracy of modeling how the system would respond under extremely dry conditions. Without this integration, modeling results may suggest inaccurate outcomes (such as reservoirs running dry) because the model continues to operate as if regulations, water demands, diversions under water rights, and other inputs remain unchanged from what would be expected under non-drought conditions.

3.4.4 Planning for Changes in the Timing of Runoff

As we noted in **Part 1**, although most of California's precipitation occurs in the winter and spring, water demand peaks during the summer.[76] Historically, snowpack has served as a critical natural reservoir that accounts for roughly one-third of surface water supply,[77] and the siting, size, and operation of California's water storage and distribution systems has been heavily dependent on the timing and location of snowmelt.[78] However, in the future, the warming climate will reduce the amount of precipitation that falls as snow and melt the snow

that does fall earlier in the water year, significantly reducing the storage potential of snowpack and shifting the timing of runoff.[79]

The Board should consider how changes in the timing of snowmelt will affect water supplies[80] and interact with water rights, and whether it can or should (and how it might) help water users adapt to this new reality, including during times of drought.

Toward the end of the recent drought, the Board initiated two programs designed to expand or encourage water storage opportunities. One facilitated temporary water right permits to divert water for groundwater recharge and/or storage for a specified later beneficial use.[81] The other expedited the process for riparian water users in CDFW's Northern and Bay Delta Regions to get approval to install an emergency storage tank for small domestic use in order to capture water during high flows during and after the rain events that punctuated the drought.[82] Without a new appropriative water right, a riparian water user would not be entitled to store water for use later in the year. The goal was to avoid diverting water during the drier parts of the year, when competition for reduced flows would have greater impacts on fish and wildlife.[83] This is an example of how the Board attempted to reconcile health and safety and environmental priorities in the midst of drought. The emergency storage tank program was suspended in April 2017, when Governor Brown terminated the Drought State of Emergency for the counties involved with the program.[84]

This issue of changes in the timing of runoff is much broader than drought. For example, there are ongoing programs to shift the timing of diversions, using off-stream storage like stockponds and storage tanks, in coastal streams to better protect rivers during low flow summer periods.[85]

The Board should continue to proactively explore such storage options, their potential impacts on other beneficial uses and users of water, and what conditions and eligibility rules would minimize potential negative impacts.

4: Improving Decision-Related Information

An uncomfortable truth is that decisions about water will always be made in the context of imperfect information. As past droughts have shown, the perceived need to minimize uncertainty before deciding what action to take is in tension with the need to act, regardless of continued uncertainty, to avoid or mitigate the impacts of drought. This is a version of the "uncertainty fallacy" that has developed around the idea that reducing uncertainty in climate projections is a prerequisite for decision making to support effective climate adaptation.[86] This mindset fails to recognize that there are consequences for putting off important decisions until better information is available because inaction is a passive form of decision making. Water decision makers, ranging from the Board to individual water users, will never have perfect data, and a host of uncertainties will always exist. Yet they will continue to make decisions, whether actively or passively, that affect the current and future availability of water and health of communities and ecosystems across the state.

Information provides critical context for water decision making. Among the most foundational context for water rights administration and oversight is how much water is (or is projected to be) available for diversion from a particular stream under a particular priority of right. The mere fact that water is present in a stream at a water user's point of diversion does not mean that water is legally available for their use. Instead, determining water availability involves a

comparison of water supply and water demand[87] in the context of a particular set of allocation priorities—most commonly, water right priorities.

The Board has faced ongoing challenges getting adequate information about watershed supply and demand to support effective water rights administration and oversight. During the recent drought, the Board's Division of Water Rights identified the goal of "[r]eal-time management of flows and diversions that accurately tracks water availability and the need for curtailment based on the accounting of water rights [and] hydrology, and . . . ensuring that minimum in-stream flow levels are met."[88] Recent efforts by the Board, the legislature, and others to increase the timeliness and accuracy of information to support decision making are moving this goal towards reality. We discuss opportunities for further improvements, including better use of existing information, below.

We focus on the information that informs, or should inform, water availability analyses in individual watersheds to illustrate how the Board could strategically improve key decision-related information and more effectively use the information it already has.

4.1 Information about Water Supply

The Board uses water supply data collected and analyzed by others, including the California Department of Water Resources (DWR) the U.S. Geological Survey (USGS), and academic researchers. The Board should continue to use available data. It should also continue to engage with information providers to ensure that they understand the Board's information needs, that the Board is fully aware of any limitations of the available data, and that different information gathering efforts are complementary, to the extent feasible.

During the recent drought, the Board used estimates of runoff at a limited number of locations as supply information for drought water availability analyses. For example, for the Delta watershed and its major constituent watersheds, the Board relied on forecasts of monthly runoff DWR produces for specific locations as part of its February through May Bulletin 120 updates,[89] supplemented by daily and monthly "full natural flow" data from the California Data Exchange Center (CDEC) website.[90] These runoff estimates are based on measurements made at a few locations, with adjustments for ungaged "minor streams" based on estimated runoff for water year 1977 (which, like water year 2015, experienced low snowpack) as well as assumed return flows.[91]

While the Board has so far relied on supply estimates at the level of entire watersheds or major tributaries, finer scale water supply information would enable more useful and accurate curtailment analyses (see Appendix A.1). Researchers from the Public Policy Institute of California and others have urged the adoption of new water accounting technologies for monitoring and predicting flow and water quality, including "automated gaging, remote sensing, and improved hydrologic models,"[92] as well as strategic improvements in the spatial coverage of stream gaging to ensure that biologically important small streams are monitored.[93] Because monitoring protocols and locations can be controversial, the Board and other agencies should pursue improvements in water supply information collaboratively with watershed stakeholders.

Modeling can also be used to improve flow estimates. For example, UC Davis researchers have modeled full natural flow for watershed subbasins, most of which are ungaged, to support more detailed water availability analyses (see Appendix A.1.3).[94]

As the Board prepares to adopt new water quality standards for the Bay-Delta that are based on a percentage of unimpaired flow (**Part 1**), it is essential for the state to improve the accuracy of full natural flow estimates by accounting for accretions and depletions downstream of rim dams on a daily basis.

4.2 Information About Water Diversion and Use

In the last ten years, the Board has acquired or developed new tools for getting more timely, accurate, and complete information about surface water diversion and use. These tools come from Legislation passed in 2009 (Senate Bill x7-8) and 2015 (Senate Bill 88), regulations the Board adopted to implement the latter,[95] and informational orders the Board issued under emergency regulations[96] during the recent drought. While SBx7-8 effectively required most pre-1914 and riparian users to report their diversions every three years, going forward, SB 88 now requires all surface water users to report at least annually on how much water they divert and use.[97] The Board adopted regulations under SB 88 that require those diverting more than 10 acre-feet of water per year to measure their diversions on a weekly, daily, or hourly basis, depending on the size and type (direct vs. storage) of diversion.[98] During times of shortage, the regulations allow the Board to require monthly or more frequent reporting (up to the measurement frequency) of these measurements.[99] To take full advantage of more frequently reported data, the Board will need to ensure it has the technological and institutional infrastructure in place to organize and analyze it. The Board can continue to improve the quality and utility of reported data by performing automated and manual checks for potential reporting problems and by working with water users to ensure that they separately report diversion and use data for each point of diversion and claim of right, for direct diversions vs. diversions to storage, for water diverted under water-supply contracts, and for transfers.

In addition to improving its understanding of the timing, location, and amount of surface water diversions, the Board needs to develop a better understanding of consumptive (net) agricultural water use and the timing and location of return flows.[100]

To improve drought water availability analyses, the Board could potentially use emergency informational orders or other means to get information from diverters about large, projected upcoming diversions and about large agricultural return flows.[101]

4.3 Information About Pre-1914 and Riparian Water Rights

Information about surface water diversion and use is necessary for understanding the demand side of a water availability analysis, but it is not sufficient. The Board also needs to understand how much water each diverter is legally entitled to take based on the relative priorities of their diversions. The Board has a relatively good understanding of the legal basis for and characteristics of the appropriative rights permitted, licensed, or registered since 1914. However, because pre-1914 appropriative rights and riparian rights were exempted from that permitting system, the Board generally knows much less about them, except where the rights were involved in an adjudication or were the target of a specific water rights investigation.

During the recent drought, the Board sought information about the basis for many riparian and pre-1914 rights in the Delta watershed through emergency informational orders (described in **Part 1**). But this self-reported information alone does not validate or quantify claims of right,[102] and it is unclear whether the information the Board received is now stored in a format that is

readily accessible and useful for purposes like drought water availability analyses. The Board could expand and modify its Electronic Water Rights Information Management System (eWRIMS) database to include materials that support the basis for riparian and pre-1914 claims of right coupled with metadata that facilitate access and use (see Section 4.5). In some circumstances, it might consider encouraging comprehensive adjudications to validate and quantify these senior water rights.[103]

4.4 Ecological Information

Information that could help the Board understand the impacts of curtailments, temporary transfers, and other temporary water right changes on fish, wildlife, and ecosystems—such as data regarding the distribution and health of threatened or endangered species or migratory birds—could be made more readily accessible on time scales and in formats that can feed into drought decisions.[104] This will involve strengthening coordination with those who produce ecological information, including the U.S. Fish and Wildlife Service (USFWS), the National Oceanic and Atmospheric Administration's Fisheries program (NOAA Fisheries), the California Department of Fish and Wildlife (CDFW), the USGS, and the academic community.

4.5 Improving Accessibility, Integration, and Interoperability of Existing and Future Data

The Board's efforts to improve decision-related information and its use will benefit from coordination with, and will ideally be carried out in coordination with, other data efforts.[105]

Assembly Bill 1755 — In 2016, the legislature passed Assembly Bill (AB) 1755, The Open and Transparent Water Data Act,[106] which aims to improve the accessibility, integration, and interoperability of existing water and ecological data.[107] The bill requires DWR, in consultation with the Board, the CDFW, and the California Water Quality Monitoring Council to create and maintain a statewide integrated water data platform and to develop protocols for data sharing, transparency, documentation, and quality control.[108] AB 1755 requires that these state agencies coordinate and integrate existing water and ecological data from local, state, and federal agencies for several purposes, including implementing the Sustainable Groundwater Management Act, increasing the transparency of water transfers and markets, and to support water management more generally.

AB 1755 holds great promise as an opening for improving data quality and availability in ways that are directly relevant to the Board's decision making during droughts. A range of improvements to data provision and data systems may emerge in coming years in order to meet the goals of AB 1755.

Modernizing the Board's Water Rights and Use Information System — One example of particular relevance to the Board is a proposal to modernize its water rights and use information system.[109] The Board's current system, eWRIMS, arguably does not provide the basic information necessary to support effective water rights administration and oversight, and, furthermore, the information that is available is lacking in fundamental ways. Given advances in information technology since eWRIMS was developed, the potential to create a system that more fully organizes the complement of legal and physical information—including materials that support the basis for riparian and pre-1914 claims of right, environmental documents, etc.—and enables the rapid querying of this information in a spatially and temporally explicit

way, could be a crucial step in moving the Board's decision-making towards its stated goal of effective, real-time management.

The nature of the guidelines for transparency and interoperability adopted by the state under AB 1755 could also result in changes to the way the Board provides information, so that other agencies and stakeholders can more easily access it and conduct their own, parallel analyses. Because the details of AB 1755 implementation are not yet clear, the Board will want to continue tracking and contributing to developments.

5: Learning from Droughts

Following a drought, the Board should evaluate how effective its drought response actions were and, if it adopts a contingency-based decision support framework, how well that framework performed. This will allow the Board to identify needed improvements and to follow up by adjusting its drought decision support structures and reprioritizing its future drought preparatory work.

5.1 Assessing In-Drought Performance

Regardless of how prepared the Board thinks it is when a drought begins, that drought will stress test the Board's preparations, inevitably revealing areas that need improvement. The Board will want to ensure that it learns from the experience by identifying what worked well, and what did not, gleaning lessons to support improvements. If the Board adopts a contingency-based decision support framework, this would include assessing both the functionality of the framework and the effectiveness of particular drought-response actions taken under it.

For its drought-response actions, the Board would compare its stated objectives with actual outcomes and examine whether triggers, decision-related information, and the associated processes and procedures were adequate. For example:

- For curtailments intended to protect senior water rights in a particular watershed:
    - To what extent did those subject to curtailment comply?
    - Was water actually available to senior water users?
    - To what extent were there under- or over-curtailments?
    - Were curtailment start and end dates and priority cutoffs appropriate?
    - Was the scale and granularity of the water availability analysis appropriate?
- For curtailments intended to protect fish and wildlife in a particular watershed:
    - To what extent did those subject to curtailment comply?
    - How well did voluntary agreements in lieu of curtailments function?
    - To what extent were minimum flows and water quality requirements maintained?

- What were the impacts to fish and wildlife as measured against stated objectives? Were specific, quantitative minimum viable population and habitat conditions maintained?
- How did curtailment exceptions for those with urgent minimum health and safety needs affect watershed outcomes?
- What would have made the curtailments more effective?

The Board will also need to periodically revisit the scientific and legal assumptions that underpin aspects of the framework. These should change over time as data improves and legal ambiguities surface or are resolved. One potential trigger for this type of review could be the post-drought assessment process.

The Board should consider how to maximize learning from retrospectively assessing its in-drought actions. Possibilities include the following:

- Inviting public feedback at different points in the assessment process to learn how others experienced the Board's drought response actions and what ideas they might have for improving future drought response.
- Writing up and publishing the assessment to help maintain institutional memory, promote transparency, and provide the basis for more informed and useful feedback. The Board published an extensive retrospective analysis following the 1976–1977 drought and a shorter mid-drought analysis in 2015. It is currently working on a retrospective analysis for the 2012–2016 drought.
- Requesting feedback from an independent review panel.

5.2 Making Adjustments

Based on the results of its assessment of in-drought performance, the Board can operationalize lessons learned by adjusting the contingency-based framework and by reprioritizing further drought preparations. Because effective adaptive governance should, among other things, provide information, address conflict, and enable change,[110] the framework we propose explicitly builds in a cycle of evaluation, revision, and improvement (see Section 2.2.9).

6: Prioritizing Enforcement Between Droughts

Droughts highlight and provide added incentive to address compliance problems like unauthorized diversions. When a drought ends, so does the feeling of urgency associated with ongoing enforcement. Conflicts between water users may seem less pressing, and the Board has ample work related to water rights administration to catch up on.

Nevertheless, for a host of reasons, it is also important to identify and address unauthorized diversions and other water rights violations that occur outside of droughts:

- It is a matter of basic fairness. The Board should enforce the law to protect those who abide by the terms of their water rights.

- Unauthorized diversions during wetter years could jeopardize ecosystem recovery during critical rebuilding periods following droughts.[111]
- Carrying out enforcement actions outside the context of droughts builds the Board's experience and expertise, helping prepare it to undertake more timely and effective enforcement actions during droughts.
- Fair, credible enforcement can help water users understand their rights and responsibilities and develop trust in the Board's motives, contributing to a culture of compliance.

Additionally, following through with drought-related enforcement actions after drought conditions abate provides the opportunity for courts to weigh in on key unresolved legal issues, including the extent of the Board's authority to take various drought response actions.

7: Institutional Challenges and Opportunities

As this report and the companion retrospective analysis make clear, key opportunities exist to build the Board's capacity to make more timely and effective decisions under pressure during droughts. Acting on these opportunities is important because the Board's decisions—both within and outside the context of droughts—can have broad repercussions for California water management, people, and ecosystems.

That is not to say it will be easy. Strategically raising the priority of certain work that is already in the Board's queue will go a long way, but this effort will also require concerted and long-term engagement with the state legislature. Additional funding to support additional staff on an ongoing basis will be needed. Because the Board cannot currently collect user fees for most riparian and pre-1914 appropriative rights, funding will need to come from the General Fund or another, dedicated source.[112]

Beyond resources, the Board may need direction, and potentially additional authority, from the legislature. In February, the Santa Clara County Superior Court held that Water Code Section 1052 "does not authorize the Board to 'curtail' or take enforcement action against pre-1914 appropriators based on their use of water in excess of that available under their priority of right," reasoning that the section includes language which explicitly limits its application to post-1914 rights.[113] The court also concluded that the Board's 2015 water unavailability notices violated the plaintiffs' due process rights and that its partial rescission and clarification did not cure the violation.[114] However, the court noted that it had expressed "no opinion" regarding alternative sources of the Board's authority, such as alternative provisions of the Water Code or the possible "future delegation of power by the Legislature."[115] Clarifying the Board's water rights oversight authorities will be a crucial step in ensuring more timely and effective drought response. This framework and the pre-drought decision making suggested here should enable the Board to reduce the confusion and ambiguity that have, in the past, led to lawsuits about its actions—or, at least, to provide some opportunity to resolve those disputes in advance of droughts. It will not do that job perfectly, for each drought will raise some unanticipated issues, and crises tend to bring out latent legal conflicts. But developing a framework in advance can at least reduce the inefficiency and delay associated with litigation during the drought itself.

7.1 Synergies Between Drought and Non-Drought Work

Although the focus of this report is improving the Board's future drought response, many of our recommendations would be useful for water rights administration and oversight more broadly. By taking advantage of potential synergies between drought preparations and its other work, the Board could improve water management over the full spectrum of water-year types, from "wet" and "above normal" to "below normal," "dry," and critically dry water years.[116] The benefits of such an approach could be substantial and are likely to include better water management outcomes than could have been achieved through separate efforts, greater clarity for water users, and more efficient use of the Board's resources.

Better Water Management Outcomes — California's lack of "average" water years and strong seasonal and regional precipitation patterns (which run counter to seasonal and regional patterns of demand) make it important for the Board to consider how decisions and actions focused around one part of the hydrologic spectrum will affect human and environmental water uses in other hydrologic contexts. Doing so will help avoid short-sighted decisions with unintended consequences. For example, to increase ecosystem drought resilience and promote the long-term viability of native species, water quality and flow standards for non-drought years must be adequately protective to enable population recovery during critical rebuilding periods following droughts.[117] Mount et al. have suggested developing annual ecosystem "watering plans" with objectives that vary depending on recent water-year history and forecast conditions (e.g., short-term objectives for a wet water year might center around improving ecosystem conditions and rebuilding native species populations, whereas short-term objectives for a critically dry year might be geared toward avoiding "irreversible change in priority waterways and retain[ing] capacity to recover").[118]

Greater Clarity for Water Users — Proactive planning that addresses the full range of hydrologic conditions expected in a watershed will give water users a more complete picture of, and more realistic expectations for, the future availability of surface water. This will help water users more accurately weigh their personal risks and identify critical steps to improve their own drought resiliency, including planning investments in conservation and alternative water supplies.

More Efficient Use of Resources — The Board is a busy agency with multiple important responsibilities that translate into potentially competing demands on its human and financial resources. To lessen the burden, the Board could actively seek to combine work that would benefit from coordinated information gathering, analysis, resolution, or execution. Organizing one effort to achieve multiple goals will make more efficient use of the Board's resources than addressing related problems through separate efforts. For example, the Board could consider:

- Strategically addressing backlogged water-rights work by prioritizing resolution of outstanding administrative issues that hinder drought planning and response (see Appendix B).
- Using a single regulatory effort to both set and implement instream flow requirements that address the range of expected conditions in a priority watershed.
- Standardizing the inclusion of drought contingency terms when processing new water right permits and water right change petitions.

Effective coordination might require more concentrated front-end work than separately initiating several smaller efforts over a longer period of time. But it will reduce the overall effort required by minimizing duplication of effort and the risk of inconsistency.

8: Conclusions

In **Part 1**, we analyzed the strategies the State Water Resources Control Board (Board) used for administration and oversight of California's water rights system during the last four major statewide droughts. We found that the Board had done little proactive preparation in advance of droughts and instead relied heavily on in-drought improvisation, with mixed results. We concluded that increased emphasis on drought preparation would enable the Board to mount a more effective response during future droughts. This report builds on that retrospective analysis with specific recommendations.

We argue that the Board can improve water rights administration and oversight for future droughts by taking the following proactive steps:

1. **Adopting a contingency-based framework to support drought decision making.** We provide a general structure for that framework, as well as guidance for fleshing it out. The goal setting, scenario planning and forethought required to develop a useful decision-support framework, as well as the structure it would bring to the decision-making process, would make the Board more nimble, empowering more timely and effective responses during future droughts. Using actions related to curtailments as an example, Appendix A illustrates how the framework could be fleshed out and made more detailed and discusses possible approaches to dealing with several difficult issues.

2. **Making key policy decisions in advance of droughts**. Decisions that establish drought priorities and procedures or that resolve other knotty legal issues are best made deliberately using a non-emergency public process (an option that is effectively off the table in the midst of drought). Meaningfully engaging stakeholders, thinking through potential trade-offs, making key policy choices, and establishing clear protocols for making and implementing drought decisions in advance of drought can reduce conflict and enable more timely, transparent, and effective drought response that intentionally reconciles competing legal requirements and policy values.

   We argue that the following should be among the Board's top priorities:

   - **Setting and implementing appropriate instream flow requirements for priority water bodies.** Ecosystems have not been adequately protected during past droughts. Recognizing that flow quantity, quality, and timing affect and are important aspects of fish and wildlife habitat, the Board can prioritize setting and implementing requirements that account for the full range of hydrologic conditions for priority water bodies, including prolonged and severe droughts.
   - **Defining and implementing minimum health and safety protections.** Like environmental requirements, minimum human health and safety needs have not been adequately protected during past droughts. This flows in part from the need to reconcile these needs with other aspects of water and environmental law,

and from concerns about providing unintentional incentives for surface water diverters, including drinking water systems, to avoid pursuing critical water supply reliability improvements. The Board can develop an explicit approach to defining and addressing these needs that appropriately addresses these tensions.

- **Establishing clear procedures for implementing curtailments.** Some of the most controversial, but important, actions the Board took during the recent drought were those related to curtailments. The Board can increase the accuracy and defensibility of its water rights oversight efforts by developing specific curtailment procedures through non-emergency public processes. Among other things, procedures should address how the Board will (1) analyze when curtailments are legally and hydrologically appropriate, (2) address environmental requirements and minimum human health and safety needs, (3) provide curtailment-related information to water users, (4) issue enforceable curtailment notices or orders, (5) evaluate proposed alternatives to curtailment, and (6) support effective enforcement actions.

In addressing these priorities, we recommend that the Board use non-emergency public processes, make interim decisions when timely long-term resolution is not possible, increase coordination among local, state, and federal actors, and plan for changes in the timing of runoff that are occurring with climate change.

3. **Strategically improving decision-related information.** Water decision makers, ranging from the Board to individual water users, will never have perfect data, and a host of uncertainties will always exist. Yet they will continue to make decisions, whether actively or passively, that affect the current and future availability of water and health of communities and ecosystems across the state. To enable better decision making, the Board can strategically improve key decision-related information—including information about water supply, water diversion and use, riparian and pre-1914 appropriative water rights, and critical ecosystems—and more effectively use the information it already has.

4. **Maximizing learning from droughts.** To identify what drought response strategies, and what aspects of the decision-support framework, worked well and where improvements are needed, the Board can build mechanisms for assessment (and subsequent adjustment) into the framework.

5. **Prioritizing water rights enforcement between droughts.** Although droughts highlight and provide added incentive to address compliance problems, enforcement between droughts is also critical.

6. **Capitalizing on synergies between drought and non-drought work.** By coordinating its drought preparations with its other work, the Board can improve not just its future drought response, but also water rights administration and oversight more broadly. Potential benefits include better water management outcomes than could have been achieved through separate efforts, greater clarity for water users, and more efficient use of the Board's resources.

We see these actions as crucial components of effective climate adaption for California and encourage the Board to begin pursuing them now so that it is better prepared to face the challenges the next drought will bring.

9: Endnotes

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[8] Michael J. Bloom & Mary K. Menefee, *Scenario Planning and Contingency Planning*, 17 PUB. PRODUCTIVITY & MGMT. REV. 223, 224 (1994).

[9] *See, e.g.,* Jeffrey Odefey, *Why Planning for Drought is Good for Arizona*, AM. RIVERS, Feb. 1, 2018, https://www.americanrivers.org/2018/02/planning-drought-good-arizona/; Leon F. Szeptycki & Brian E. Gray, *California's Drought and the Environment: An Introduction*, 23 HASTINGS W.- NW. J. ENVTL. L. & POL'Y 51, 54–55 (2017); JACQUELINE PEEL & JANNY CHOY, WATER IN THE WEST, WATER GOVERNANCE AND CLIMATE CHANGE: DROUGHT IN CALIFORNIA AS A LENS ON OUR CLIMATE FUTURE 10–12 (2014), *available at* http://waterinthewest.stanford.edu/sites/default/files/Water%20Governance%20and%20Climate%20Change_final2.pdf; PLANNING ADVISORY SERVICE, AMERICAN PLANNING ASSOCIATION, PLANNING AND DROUGHT, REPORT NO. 574, at 29–42 (James C. Schwab ed., 2013), *available at* https://www.drought.gov/drought/sites/drought.gov.drought/files/media/reports/Planning_and_Drought_Schwab_APA.pdf.

[10] STATE WATER RES. CONTROL BD., DROUGHT 77: DRY YEAR PROGRAM 25 (1978), *available at* https://www.waterboards.ca.gov/publications_forms/publications/general/docs/dryyearprogram.pdf.

[11] This tasks and considerations described in this section and summarized in Table 1 are based in part on the concept of structured decision making described in the following sources: ROBIN GREGORY, LEE FAILING, MICHAEL HARSTONE, GRAHAM LONG, TIM MCDANIELS, AND DAN OHLSON, STRUCTURED DECISION MAKING: A PRACTICAL GUIDE TO ENVIRONMENTAL MANAGEMENT CHOICES (2012); U.S. Fish & Wildlife Service, National Conservation Training Center, Structured Decision Making Fact Sheet, Oct. 2008, https://www.fws.gov/science/doc/structured_decision_making_factsheet.pdf.

[12] *See* prior note.

[13] *See* U.S. Dep't of Agric., Natural Res. Conservation Serv., Watersheds, Hydrologic Units, Hydrologic Unit Codes, Watershed Approach, and Rapid Watershed Assessments (2007), *available at* https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1042207.pdf.

[14] *Model Drought Response Ordinance*, SAN DIEGO CNTY. WATER AUTH., https://www.sdcwa.org/model-drought-response-ordinance (last visited Dec. 23, 2017).

[15] *Drought Classification: Drought Severity and Coverage Index*, U.S. DROUGHT MONITOR, http://droughtmonitor.unl.edu/AboutUSDM/DroughtClassification.aspx#dsci (last visited Dec. 23, 2017); *Drought Stressor Monitoring Case Study: Mill Creek Central Valley Spring-Run Chinook Salmon Monitoring*, CAL. DEP'T OF FISH & WILDLIFE, https://www.wildlife.ca.gov/Drought/Projects/Mill-Creek (last visited Dec. 23, 2017).

[16] *See* Patricia Gonzales, Newsha Ajami & Yujie Sun, *Coordinating Water Conservation Efforts Through Tradable Credits: A Proof of Concept for Drought Response in the San Francisco Bay Area*, 53 WATER RESOURCES RESEARCH 7662 (2017), https://doi.org/10.1002/2017WR020636.

[17] Fish and wildlife protections stem from the state and federal Endangered Species Acts, the public trust doctrine, state and federal water quality laws, and other sources.

[18] Water quality protections arise under the federal Clean Water Act, the state Porter-Cologne Water Quality Control Act, the state and federal Safe Drinking Water Acts, and the state Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65), among other sources.

[19] Human health and safety protections flow from California's constitution, legislative protections, and administrative protections. *See, e.g.,* CAL. CONST. art. X, § 2, requiring "reasonable and beneficial use . . . in the interest of the people and for the public welfare"); CAL. WATER CODE § 106 (the Human Right to Water statute); State Water Res. Control Bd., Resolution No. 2016-0010, Adopting the Human Right to Water as a Core Value and Directing Its Implementation in Water Board Programs and Activities, Feb. 16, 2016, *available at* https://www.waterboards.ca.gov/board_decisions/adopted_orders/resolutions/2016/rs2016_0010.pdf.

[20] For example, as of September 2016, "the Bay-Delta Plan specifie[d] a combined requirement for flow at a single point upstream of the southern Delta on the San Joaquin River below the confluence of the tributaries," and "[t]here [wa]s no existing requirement for the flows in the major tributaries to sustain fish in the tributaries or to contribute to the flow at this compliance point." STATE WATER RES. CONTROL BD., SUMMARY OF PROPOSED UPDATES TO THE BAY-DELTA WATER QUALITY CONTROL PLAN 3 (Sept. 15, 2016), *available at* https://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/bay_delta_plan/water_quality_control_planning/2016_sed/docs/prp_update_sum.pdf. However, "[t]he draft update to the Bay-Delta Plan proposes to provide the necessary flow on all three tributaries, in dry years as well as wetter ones, to ensure suitable habitat and migratory pathways upstream of the Bay Delta to support native fish." *Id.* Another example is the Trinity River. *See* JEFFREY MOUNT, BRIAN GRAY, CAITRIN CHAPPELLE, GREG GARTRELL, TED GRANTHAM, PETER MOYLE, NATHANIEL SEAVY, LEON SZEPTYCKI & BARTON "BUZZ" THOMPSON, MANAGING CALIFORNIA'S FRESHWATER ECOSYSTEMS LESSONS FROM THE 2012–16 DROUGHT: LESSONS FROM THE 2012–16 DROUGHT, TECHNICAL APPENDIX: EIGHT CASE STUDIES OF ENVIRONMENTAL WATER MANAGEMENT DURING THE 2012–2016 DROUGHT, at 5–11 (2017), *available at* http://www.ppic.org/wp-content/uploads/1117ccr_appendix.pdf (explaining that "the flow schedule did not include an adequate margin of safety to account for hydrologic uncertainty, anticipated changes in the timing and numbers of returning salmon spawning, variable weather and water temperatures, and the biological responses of Chinook salmon to water conditions in the lower Klamath River").

[21] STATE WATER RES. CONTROL BD., DEVELOPMENT OF FLOW CRITERIA FOR THE SACRAMENTO-SAN JOAQUIN DELTA ECOSYSTEM 4–7 (2010), *available at* https://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/deltaflow/docs/final_rpt080310.pdf.

[22] *See* JEFFREY MOUNT BRIAN GRAY, CAITRIN CHAPPELLE, GREG GARTRELL, TED GRANTHAM, PETER MOYLE, NATHANIEL SEAVY, LEON SZEPTYCKI & BARTON "BUZZ" THOMPSON., MANAGING CALIFORNIA'S FRESHWATER ECOSYSTEMS: LESSONS FROM THE 2012–16 DROUGHT, at 5 (2017), *available at* http://www.ppic.org/wp-content/uploads/r_1117jmr.pdf; BRIAN GRAY, ELLEN HANAK, RICHARD FRANK, RICHARD HOWITT, JAY LUND, LEON SZEPTYCKI, BARTON "BUZZ" THOMPSON, ALLOCATING CALIFORNIA'S WATER: DIRECTIONS FOR REFORM 11 (2015), *available at* http://www.ppic.org/content/pubs/report/R_1115BGR.pdf.

[23] *See* GRAY ET AL., *supra* note 22, at 3, 10–11.

[24] *Instream Flow Program*, CAL. DEP'T OF FISH & WILDLIFE, https://www.wildlife.ca.gov/Conservation/Watersheds/Instream-Flow (last visited Dec. 23, 2017).

[25] This section states that "[t]he right to water or to the use or flow of water in or from any natural stream or water course in this State . . . does not and shall not extend to the waste or unreasonable use or unreasonable method of use or unreasonable method of diversion of water." CAL. CONST. art. X, § 2.

[26] The public trust doctrine imposes an affirmative duty on state agencies, including the Board, "to take the public trust into account in the planning and allocation of water resources, and to protect public trust uses whenever

feasible" and requires them to exercise "continuing supervision over the taking and use" of water. *Nat'l Audubon Soc'y v. Superior Court*, 33 Cal. 3d 419, at 443, 446–447 (1983) (explaining that "[a]ll uses of water, including public trust uses, must . . . conform to the standard of reasonable use"); *see also El Dorado Irrigation Dist. v. State Water Res. Control Bd.*, 142 Cal. App. 4th 937, 966 (2006). If past allocation decisions turn out to be "incorrect in light of current knowledge or inconsistent with current needs," the Board can reconsider them. *Nat'l Audubon*, 33 Cal. 3d at 447 (holding that "[n]o vested rights bar such reconsideration").

[27] Section 5937 requires dam owners to "allow sufficient water at all times to pass over, around, or through the dam, to keep in good condition any fish that may be planted or exist below the dam." It represents "a legislative expression of the public trust protecting fish as trust resources when found below dams." *Cal. Trout, Inc. v. State Water Res. Control Bd.*, 207 Cal. App. 3d 585, 626, 631 (1989).

[28] The Public Resources Code requires the CDFW to prepare proposed streamflow requirements needed "to assure the continued viability of stream-related fish and wildlife resources." CAL. PUB. RES. CODE §§ 10001–10004. Since 1985, Water Code Section 1257.5 has allowed the Board to "establish such streamflow requirements as it deems necessary to protect fish and wildlife as conditions in permits and licenses" and required it to consider the CDFW's proposed streamflow requirements "in acting on applications to appropriate water."

[29] For example, Water Code Section 1243.5 requires that, "[i]n determining the amount of water available for appropriation, the board shall take into account, whenever it is in the public interest, the amounts of water needed to remain in the source for protection of beneficial uses, including any uses specified to be protected in any relevant water quality control plan," such as fish and wildlife uses.

[30] Water Code Section 1253 states that "[t]he board shall allow the appropriation for beneficial purposes of unappropriated water under such terms and conditions as in its judgment will best develop, conserve, and utilize in the public interest the water sought to be appropriated."

[31] CAL. WATER CODE §§ 85000–85350.

[32] CAL. WATER CODE § 85086.

[33] DEVELOPMENT OF FLOW CRITERIA, *supra* note 21, at 2–3.

[34] CAL. WATER CODE § 85087.

[35] STATE WATER RES. CONTROL BD., INSTREAM FLOW STUDIES FOR THE PROTECTION OF PUBLIC TRUST RESOURCES: A PRIORITIZED SCHEDULE AND ESTIMATE OF COSTS 2–3 (2010), *available at* https://www.waterboards.ca.gov/publications_forms/publications/legislative/docs/2011/instream_flow2010.pdf.

[36] CAL. NATURAL RES. AGENCY, CAL. DEP'T OF FOOD & AGRIC., & CAL. ENVTL. PROT. AGENCY, CALIFORNIA WATER ACTION PLAN 11 (2014), *available at* http://resources.ca.gov/docs/california_water_action_plan/2014_California_Water_Action_Plan.pdf.

[37] STATE WATER RES. CONTROL BD., RECIRCULATED DRAFT SUBSTITUTE ENVIRONMENTAL DOCUMENT IN SUPPORT OF POTENTIAL CHANGES TO THE WATER QUALITY CONTROL PLAN FOR THE SAN FRANCISCO BAY–SACRAMENTO SAN JOAQUIN DELTA ESTUARY: SAN JOAQUIN RIVER FLOWS AND SOUTHERN DELTA WATER QUALITY, at ES-1 (2016), *available at* http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/bay_delta_plan/water_quality_control_planning/2016_sed/docs/00_es.pdf; SUMMARY OF PROPOSED UPDATES, *supra* note 20, at 3; Phase I: Bay-Delta Plan Update - San Joaquin River Flows and Southern Delta Water Quality Objectives and Program of Implementation, STATE WATER RES. CONTROL BD., https://www.waterboards.ca.gov/waterrights/water_issues/programs/delta/bay_delta_plan/water_quality_control_planning/ (last updated Aug. 16, 2017); Phase II Update of the Bay-Delta Plan: Delta Outflows, Sacramento River and Delta Tributary Inflows, Cold Water Habitat and Interior Delta Flows, STATE WATER RES. CONTROL BD., https://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/comp_review.shtml (last updated Nov. 17, 2017).

[38] SUMMARY OF PROPOSED UPDATES TO THE BAY-DELTA WATER QUALITY CONTROL PLAN, *supra* note 20, at 3–4.

[39] *California Water Action Plan – Enhance Water Flows in Stream Systems Statewide*, STATE WATER RES. CONTROL BD., https://www.waterboards.ca.gov/waterrights/water_issues/programs/instream_flows/cwap_enhancing (last updated Nov. 16, 2017).

[40] *Id.*

[41] CAL. WATER CODE § 13242.

[42] STATE WATER RES. CONTROL BD., PHASE II UPDATE OF THE BAY-DELTA PLAN: INFLOWS TO THE SACRAMENTO RIVER AND DELTA AND TRIBUTARIES, DELTA OUTFLOWS, COLD WATER HABITAT AND INTERIOR DELTA FLOWS 2, 7, 11–12 (Oct. 4, 2017), *available at* https://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/docs/201710_phaseII_factsheet.pdf.

[43] *See PUD No. 1 of Jefferson Cnty. v. Wash. Dep't of Ecology*, 511 U.S. 700, 712–13 (1994).

[44] PUB. POLICY INST. OF CAL., MANAGING DROUGHTS 3 (Oct. 2016), *available at* http://www.ppic.org/content/pubs/report/R_1016JM2R.pdf.

[45] *See* MOUNT ET AL., *supra* note 22, at 14 tbl.2; *see also* MOUNT ET AL., TECHNICAL APPENDIX, *supra* note 20, at 28.

[46] State Water Res. Control Bd., Notice of Public Workshop: 2016 Sacramento River Temperature Management Planning and Implementation, at 3, Mar. 18, 2016, *available at* http://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/tucp/docs/notice_temp_plan031816.pdf; *see also* JEFFREY MOUNT, BRIAN GRAY, CAITRIN CHAPPELLE, GREG GARTRELL, TED GRANTHAM, PETER MOYLE, NATHANIEL SEAVY, LEON SZEPTYCKI & BARTON "BUZZ" THOMPSON, MANAGING CALIFORNIA'S FRESHWATER ECOSYSTEMS LESSONS FROM THE 2012–16 DROUGHT: LESSONS FROM THE 2012–16 DROUGHT, at 14 (2017), *available at* http://www.ppic.org/wp-content/uploads/r_1117jmr.pdf.

[47] Thomas Howard, National Marine Fisheries Service and California Department of Fish and Game Voluntary Drought Agreements on Mill Creek, June 4, 2014, *available at* https://www.waterboards.ca.gov/waterrights//water_issues/programs/drought/docs/mill_deer_antelope_creeks/mill_agreement.pdf; Thomas Howard, California Department of Fish and Wildlife and National Marine Fisheries Service Voluntary Drought Agreements on Mill Creek, Apr. 22, 2015, *available at* https://www.waterboards.ca.gov/waterrights//water_issues/programs/drought/docs/emergency_regulations/howard_mill_vol_agrmt_april2015.pdf.

[48] Elizabeth Vissers, *Low Flows, High Stakes: Lessons from Fisheries Management on Mill, Deer, and Antelope Creeks During California's Historic Drought*, 23 W.- NW. J. ENVTL. L. & POL'Y, 169, 190–91 (2017); JEFFREY MOUNT ET AL., MANAGING CALIFORNIA'S FRESHWATER ECOSYSTEMS LESSONS FROM THE 2012–16 DROUGHT, TECHNICAL APPENDIX: EIGHT CASE STUDIES OF ENVIRONMENTAL WATER MANAGEMENT DURING THE 2012–16 DROUGHT, at 32 (2017), *available at* http://www.ppic.org/wp-content/uploads/1117ccr_appendix.pdf.

[49] Vissers, *supra* note 48, at 190–91.

[50] *Id*. at 193–94.

[51] *Joslin v. Marin Mun. Water Dist.*, 67 Cal. 2d 132, 144, 145 (1967) (denying a takings claim on the basis that "since there was and is no property right in an unreasonable use, there has been no taking or damaging of property by the deprivation of such use and, accordingly, the deprivation is not compensable"); *Peabody v. City of Vallejo*, 2 Cal. 2d 351, 383 (1935) (concluding that "the rule of reasonable use . . . applies to all water rights enjoyed or asserted in this state, whether the same be grounded on the riparian right or the right, analogous to the riparian right, of the overlying land owner, or the percolating water right, or the appropriative right").

[52] CAL. CONST. art X, § 2; CAL. WATER CODE § 100.

[53] *In re Waters of Long Valley Creek Stream System*, 25 Cal. 3d 339, 354, 599 P.2d 656, 665 (1979); *see also Joslin v. Marin Mun. Water Dist.*, 67 Cal. 2d 132, 139–140 (1967); *Light v. State Water Res. Control Bd.*, 226 Cal. App. 4th 1463, 1488 (2014), *as modified on denial of reh'g* (July 11, 2014), *review denied* (Oct. 1, 2014).

[54] *Joslin v. Marin Mun. Water Dist.*, 67 Cal. 2d 132, 139–140 (1967).

[55] *See* CAL. WATER CODE § 106 (declaring as "the established policy of this State that the use of water for domestic purposes is the highest use of water and that the next highest use is for irrigation"); CAL. WATER CODE § 1254 (stating that, "[i]n acting upon applications to appropriate water the board shall be guided by the policy that domestic use is the highest use and irrigation is the next highest use of water"); CAL. WATER CODE § 1460 (stating that "[t]he application for a permit by a municipality for the use of water for the municipality or the inhabitants thereof for domestic purposes shall be considered first in right, irrespective of whether it is first in time").

[56] CAL. WATER CODE § 106.3(a).

[57] CAL. WATER CODE § 106.3(b).

[58] CAL. HEALTH & SAFETY CODE § 116555(a)(3).

[59] CAL. CODE REGS. Tit 23, § 878.1(a)(1).

[60] *Public Water Systems Curtailment Compliance Orders – October 2014*, STATE WATER RES. CONTROL BD., https://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/curtailment_compliance_orders.shtml (last updated Oct. 24, 2014).

[61] *See, e.g.*, GRAY ET AL., *supra* note 22, at 10; Ellen Hanak, Jeffrey Mount, Jay Lund, Greg Gartrell, Brian Gray, Richard Frank & Peter Moyle, Comments to the State Water Resources Control Board on Drought Response, at 3–4, Oct. 14, 2014, *available at* https://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/dryyear_report/comments2014oct/docs/ellen_hanak.pdf; Jay Lund, Ben Lord, William Fleenor & Ann Willis, Comment: Drought Curtailment of Water Rights — Problems and Technical Solutions, at 5, 9, Oct. 15, 2014, *available at* https://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/dryyear_report/comments2014oct/docs/jay_lund.pdf.

[62] *See* Lund et al., *supra* note 61, at 6; Hanak et al., *supra* note 61, at 1.

[63] Lund et al., *supra* note 61, at 6.

[64] John Herrick, Implementation and Enforcement of Water Rights During Drought Conditions (Comments on behalf of the South Delta Water Agency), at 1, Oct. 15, 2014, *available at* https://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/dryyear_report/comments2014oct/docs/john_herrick.pdf; *see also* Valerie Kincaid, San Joaquin Tributaries Authority Dry Year Report Comments, at 1–2, 8–10, Oct. 15, 2014, *available at* https://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/dryyear_report/comments2014oct/docs/valerie_kincaid.pdf.

[65] For example, at a September 24, 2014, workshop following the adoption of an emergency regulation for information orders, it became clear that the requirement to respond within 5 days was unworkable for many diverters. One potential problem commenters identified was that those who estimated their monthly diversions based on the energy required for pumping would not be able provide data for the current month until they received their energy bills. The Board had adopted the 5-day time limit with little discussion in July.

[66] *See* Kirsten Rudestam, *Loving Water, Resenting Regulation: Sense of Place and Water Management in the Willamette Watershed*, 27 SOC'Y & NAT. RESOURCES 20, 33 (2013), doi:10.1080/08941920.2013.840020.

[67] CAL. CODE REGS. tit. 23, § 649; *Hearings Program: What is a Water Right Hearing?*, STATE WATER RES. CONTROL BD., https://www.waterboards.ca.gov/waterrights/water_issues/programs/hearings/faqs.shtml (last updated July 10, 2017).

[68] State Water Res. Control Bd., Hearings Matrix (created May 17, 2016), *available at* https://www.waterboards.ca.gov/waterrights/water_issues/programs/hearings/docs/hearingsmatrix2.pdf (and statutes and regulations cited therein).

[69] MICHAEL KIPARSKY, DAVE OWEN, NELL GREEN NYLEN, HOLLY DOREMUS, JULIET CHRISTIAN-SMITH, BARBARA COSENS, ANDREW FISHER, AND ANITA MILMAN, DESIGNING EFFECTIVE GROUNDWATER SUSTAINABILITY AGENCIES: CRITERIA FOR EVALUATION OF LOCAL GOVERNANCE OPTIONS 35–36 (2016), *available at* https://www.law.berkeley.edu/wp-content/uploads/2016/02/CLEE_GroundwaterGovernance_2016-03-08.pdf.

[70] DAVID NAWI & JEANNETTE MACMILLAN, AUTHORITY AND EFFECTIVENESS OF THE STATE WATER RESOURCES CONTROL BOARD 36 (2008), *available at* http://deltavision.ca.gov/ConsultantReports/David_Nawi.pdf. Nawi and MacMillan argue that "[t]he Board should give priority to providing early and clear direction on the issues before it, even on difficult and intransigent issues" to help "the parties in developing their positions, and facilitate expeditious decision-making by the Board," and that issuing interim orders, "while years-long and delay-prone proceedings are pending . . . would tend to eliminate incentives for parties to delay Board action and result in effective action in a more timely manner." *Id.*

[71] This is especially important because there are no decision rules for dealing with conflicting mandates that involve trade-offs. *See generally* Dave Owen, *Law, Environmental Dynamism, Reliability: The Rise and Fall of CALFED*, 37 ENVTL. L. 1145 (2008).

[72] The Delta Watermaster exercises delegated authority to monitor and enforce Board orders and the terms and conditions of water right permits and licenses, providing "day-to-day" water rights administration and enforcement in the Delta. CAL. WATER CODE § 85230; *see also Role of the Delta Watermaster*, STATE WATER RES. CONTROL BD., https://www.waterboards.ca.gov/water_issues/programs/delta_watermaster/watermaster_role.shtml (last updated June 17, 2016).

[73] The SEMS provides an organizational structure for coordinating management of emergencies that involve more than one jurisdiction or response agency. It incorporates (1) the field-level emergency response Incident Command System, (2) a multiagency coordination system for affected agencies, (3) mutual aid systems that allow affected jurisdictions to obtain emergency resources from jurisdictions that are not affected, and (4) the "operational area concept" for coordinating information, requests for resources, and emergency response within a county. CAL. GOV'T CODE § 8607(a); *see also Standardized Emergency Management System*, CAL. GOVERNOR'S OFFICE OF EMERGENCY SERVS., http://www.caloes.ca.gov/cal-oes-divisions/planning-preparedness/standardized-emergency-management-system (last visited Dec. 23, 2017); CAL. EMERGENCY MGMT. AGENCY, FOUNDATION FOR THE STANDARDIZED EMERGENCY MANAGEMENT SYSTEM (Jan. 2010), *available at* http://www.caloes.ca.gov/PlanningPreparednessSite/Documents/SEMS_%20Foundation_ver_01-2010.pdf. State agencies must use SEMS, and local agencies are only eligible for reimbursement through state disaster assistance programs if they use SEMS. CAL. GOV'T CODE § 8607(d), (e).

[74] Mount et al., *supra* note 21, at 41–42.

[75] *See, CalSim 2 Model*, CAL. DEP'T OF WATER RES., http://baydeltaoffice.water.ca.gov/modeling/hydrology/CalSim/index.cfm (last visited May 12, 2018) (noting that "CalSim is the model used to simulate California State Water Project (SWP)/Central Valley Project (CVP) operations").

[76] DAVID CARLE, INTRODUCTION TO WATER IN CALIFORNIA 11 (2d ed. 2016).

[77] *Climate Change*, CAL. DEP'T OF WATER RES., http://www.water.ca.gov/climatechange/ (last modified Feb. 16, 2017); CAL. DEP'T OF WATER RES., CALIFORNIA WATER PLAN UPDATE 2013, at 3-28, 3-61 (2014), *available at* http://www.water.ca.gov/waterplan/docs/cwpu2013/Final/04_Vol1_Ch03_Ca_Water_Today.pdf.

[78] Diffenbaugh et al., *supra* note 2, at 3931; CALIFORNIA WATER PLAN UPDATE 2013, *supra* note 77, at 3-61.

[79] *Climate Change*, *supra* note 77; CALIFORNIA WATER PLAN UPDATE 2013, *supra* note 77, at 3-60 to 3-64.

[80] *See* Cal. Dep't of Water Res., CALIFORNIA CLIMATE SCIENCE AND DATA FOR WATER RESOURCES MANAGEMENT 10 (2015), *available at* https://www.water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/All-Programs/Climate-Change-Program/Climate-Change-And-Water/Files/California-Climate-Science-and-Data-for-Water-Resources-Management.pdf (illustrating how earlier runoff "place[s] additional stress on water supply systems" and identifying the need to adapt existing infrastructure to accommodate changes in runoff timing "as well as . . . higher flows from more powerful individual storm events in a warmer atmosphere," noting the need for greater flexibility).

[81] *See Water Rights for Groundwater Recharge*, STATE WATER RES. CONTROL BD., https://www.waterboards.ca.gov/waterrights/water_issues/programs/applications/groundwater_recharge/ (last updated Dec. 8, 2017).

[82] *See* Cal. Dep't Fish & Wildlife, State Streamlines Domestic Water Tank Storage Process in Response to Drought, Mar. 13, 2014, *available at* https://cdfgnews.wordpress.com/2014/03/13/state-streamlines-domestic-water-tank-storage-process-in-response-to-drought/; *Water Rights Registrations*, STATE WATER RES. CONTROL BD., https://www.waterboards.ca.gov/waterrights/water_issues/programs/registrations/index.html (last updated Oct. 19, 2017).

[83] Cal. Dep't Fish & Wildlife, *supra* note 82.

[84] *See Water Rights Registrations, supra* note 82; Edmund G. Brown, Jr., Executive Order B-40-17, Apr. 7, 2017.

[85] *See California Coastal Streamflow Stewardship Project*, TROUT UNLIMITED, https://www.tu.org/tu-projects/california-coastal-streamflow-stewardship-project (last visited Jan. 30, 2018); *see also* AB 964 of 2011.

[86] *See* Maria Carmen Lemos & Richard B. Rood, *Climate Projections and their Impact on Policy and Practice*, 1 WIREs CLIMATE CHANGE 670, 676 (2010), doi:10.1002/wcc.71.

[87] *See* CAL. CODE REGS. tit. 23, § 917(c), (d) (describing water availability analysis for determining "[w]hen flows or projected available supplies in a watershed or subwatershed are sufficient to support some but not all projected diversion demand," such that the Board may require "monthly or more frequent reports of water diversion").

[88] STATE WATER RES. CONTROL BD., RECOMMENDATIONS FOR IMPROVING THE ADMINISTRATION OF THE WATER RIGHTS PRIORITY SYSTEM IN DRY YEARS 3 (2015), *available at* https://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/dryyear_report/docs/feb2015_dyr.pdf; *see also* ALVAR ESCRIVA-BOU, HENRY MCCANN, ELLEN HANAK, JAY LUND & BRIAN GRAY, ACCOUNTING FOR CALIFORNIA'S WATER 19, 24 (2016), *available at* http://www.ppic.org/content/pubs/report/R_716EHR.pdf.

[89] *See* CAL. DEP'T OF WATER RES. & U.S. BUREAU OF RECLAMATION, CENTRAL VALLEY PROJECT AND STATE WATER PROJECT 2016 DROUGHT CONTINGENCY PLAN FOR WATER PROJECT OPERATIONS, FEBRUARY - NOVEMBER 2016, at 16 (Jan. 15, 2016), *available at* http://www.water.ca.gov/waterconditions/docs/2016-DroughtContingencyPlan-CVP-SWPOperations-

Feb-Nov_1.19.16-FINAL.pdf. The 2016 Drought Contingency Plan for Water Project Operations describes the forecasts as "combin[ing] runoff associated with antecedent conditions with anticipated runoff resulting from precipitation predicted to occur for the remainder of the year under the 50%, 90%, and 99% hydrologic exceedence scenarios" and explain that "the 90% exceedence hydrology assumes inflows from rainfall and snowmelt at levels that are likely to be exceeded with a 90% probability, or in other words, there is a 10% or less chance of actual conditions turning out to be this dry or drier from this point forward," while "[t]he 50% probability is the 50/50 assumption—it is just as likely to be drier or wetter." *Id.*

[90] *See* State Water Res. Control Bd., 2015 Combined Sacramento River Basin Senior Supply/Demand Analysis with North Delta Demand (dated Sept. 10, 2015), *available at* https://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/analysis/docs/sacndelta.pdf; *Daily Full Natural Flows for December 2017*, CAL. DEP'T OF WATER RES., CAL. DATA EXCHANGE CTR., https://cdec.water.ca.gov/cgi-progs/stages/FNF (report generated Dec. 22, 2017); *Unimpaired Runoff Calculations,* CAL. DEP'T OF WATER RES., CAL. DATA EXCHANGE CENTER, http://cdec.water.ca.gov/snow/current/flow/fnfinfo.html (last visited Dec. 23, 2017). DWR defines "Unimpaired Runoff" or "Full Natural Flow" as "the natural water production of a river basin, unaltered by upstream diversions, storage, or by export or import of water to or from other watersheds," noting that "[g]auged flows at the given measurement points are increased or decreased to account for these upstream operations." *Unimpaired Runoff Calculations*, *supra* this note.

[91] *See* CAL. DEP'T OF WATER RES., CALIFORNIA CENTRAL VALLEY UNIMPAIRED FLOW DATA, FOURTH EDITION, DRAFT (May 2007), https://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/bay_delta_plan/water_quality_control_planning/docs/sjrf_spprtinfo/dwr_2007a.pdf; 2015 Combined Sacramento River Basin Senior Supply/Demand Analysis, *supra* note 90.

[92] JEFFREY MOUNT, ELLEN HANAK, CAITRIN CHAPPELLE, BRIAN GRAY, JAY LUND, PETER MOYLE & BUZZ THOMPSON, POLICY PRIORITIES FOR MANAGING DROUGHT 5 (Mar. 2015), *available at* http://www.ppic.org/content/pubs/report/R_315EHR.pdf.

[93] ESCRIVA-BOU ET AL., *supra* note 88, at 12.

[94] *See* Lund et al., *supra* note 61, at 17.

[95] CAL. CODE REGS. tit. 23, §§ 907, 908, 910–912, 915–917, 920, 922, 924, 925, 929, 931–938.

[96] CAL. CODE REGS. tit. 23, § 879.

[97] CAL. WATER CODE § 1840(c); CAL. CODE REGS. tit. 23, §§ 920, 924, 925, 929.

[98] *See Water Use Reports and Measurement*, STATE WATER RES. CONTROL BD., https://www.waterboards.ca.gov/waterrights/water_issues/programs/diversion_use/water_use.html (last updated Dec. 18, 2017).

[99] CAL. CODE REGS. tit. 23, § 917

[100] ESCRIVA-BOU ET AL., *supra* note 88, at 6.

[101] GRAY ET AL., *supra* note 22, at 9.

[102] *See* CAL. WATER CODE §§ 2501, 2550–2552, 2575–2577, 2601, 2603, 2700 (describing the process of determining rights in a stream system through statutory adjudication).

[103] *See* GRAY ET AL., *supra* note 22, at 8–9.

[104] ESCRIVA-BOU ET AL., *supra* note 88, at 22.

[105] *See, e.g.*, ALIDA CANTOR, MICHAEL KIPARSKY, RÓNÁN KENNEDY, SUSAN HUBBARD, ROGER BALES, LIDIA CANO PECHARROMAN, KAMYAR GUIVETCHI, CHRISTINA MCCREADY & GARY DARLING, DATA FOR WATER DECISION MAKING: INFORMING THE IMPLEMENTATION OF CALIFORNIA'S OPEN AND TRANSPARENT WATER DATA ACT THROUGH RESEARCH AND ENGAGEMENT (Jan. 2018), *available at* https://www.law.berkeley.edu/research/clee/research/wheeler/data/.

[106] Assem. B. 1755, Cal. Stats. 2016, ch. 506, CAL. WATER CODE §§ 12400–12420. In addition to the lead agencies named in the bill, the Act identifies five federal agencies that hold data which are to be aggregated—the U.S. Bureau of Reclamation, the U.S. Fish and Wildlife Service, the National Oceanic and Atmospheric Administration (NOAA), the U.S. Geological Survey, and the U.S. Forest Service—but it does not specify precisely what those data are.

[107] CAL. WATER CODE § 12401.

[108] CAL. WATER CODE § 12410(a).

[109] This proposal, by a team that includes some of this report's authors, won the 2017 Imagine H20 California Water Policy Challenge. *See* Imagine H2O Announces Winners of CA Water Policy Challenge, Apr. 3, 2017, *available at* https://www.prnewswire.com/news-releases/imagine-h2o-announces-winners-of-ca-water-policy-challenge-300433280.html. *See* Michael Kiparsky, *A Water Rights Database For California's Future*, LEGAL PLANET, July 7, 2015, http://legal-planet.org/2015/07/07/a-water-rights-database-for-californias-future/, for more background on the concept.

[110] *See* Brian C. Chaffin, Hannah Gosnell & Barbara A. Cosens, *A Decade of Adaptive Governance Scholarship: Synthesis and Future Directions*, 19(3) ECOLOGY & SOC'Y art. 56 (2014), doi:10.5751/ES-06824-190356; Thomas Dietz, Elinor Ostrom, and Paul C. Stern, *The Struggle to Govern the Commons*, 302 SCI. 1907 (2003), doi: 10.1126/science.1091015.

[111] *See* MOUNT ET AL, *supra* note 46, at 5–6.

[112] *See* CAL. WATER CODE § 1525; *N. Cal. Water Ass'n v. State Water Res. Control Bd.*, 20 Cal. App. 5th 1204, 1220, 230 (Ct. App. 2018), review filed (Apr. 11, 2018).

[113] *California Water Curtailment Cases*, No. 1-15-CV-285182, Cal. Super., Santa Clara Co., Statement of Decision, Phase I Trial, at 24–31, Feb. 20, 2018.

[114] *Id.* at 38–39.

[115] *Id*. at 30–31.

[116] *See WSIHIST: Chronological Reconstructed Sacramento and San Joaquin Valley Water Year Hydrologic Classification Indices*, CAL. DEP'T OF WATER RES., CAL. DATA EXCHANGE CTR., http://cdec.water.ca.gov/cgi-progs/iodir/WSIHIST (last updated Mar. 21, 2017).

[117] MOUNT ET AL., *supra* note 46, at 5–7, 29.

[118] *Id.* at 27–29.

APPENDIX A: Decision-Support Framework for Curtailment

In this appendix, we look at the issue of curtailments in more detail to illustrate how the Board might approach fleshing out a drought decision-support framework. We use a fairly broad definition of "curtailment" that encompasses reducing or stopping diversions during times when there is not enough water available to support all desired uses, whether voluntarily or under order.

We believe that one of the Board's most important roles during droughts is oversight aimed at ensuring that water users are exercising their rights appropriately in the context of other water rights, environmental requirements, and urgent health and safety needs. Different oversight strategies may be useful at different times or in different watersheds. Curtailment is just one of these strategies (see **Part 1**).

The Board has relied on some form of curtailment during each of the last four major statewide droughts (see **Part 1**). It analyzed water availability in certain watersheds, warned waters users of potential upcoming shortages, and notified some groups of diverters that water appeared to be unavailable under their priority of right. Those who continued to divert when water was not available for them risked potential enforcement action. The Board issued independently enforceable curtailment notices or orders during the last three droughts under Term 91 and, during the recent drought, under emergency regulations to protect fish flows in specific tributaries to the Sacramento River. During the recent drought, the Board also used informational orders to improve its understanding of diversions and their relative priorities, and approved alternatives to curtailment in particular watersheds, including voluntary agreements to use alternative methods to achieve the goals of curtailment and enhanced mandatory conservation measures.

At the outset, it is important to note that there is ongoing litigation over the way the Board handled curtailments during the recent drought (see **Part 1** and Section 7). The litigation addresses an array of issues, including appropriate considerations for water availability analyses, the language in curtailment notices, the use of curtailment notices, whether the notices were consistent with water right priority, whether the Board's Executive Director had the authority to send the notices, the interaction between curtailments and temporary urgency change orders, the scope of the Board's jurisdiction over pre-1914 and riparian water users, whether and what types of oversight and enforcement are appropriate for them, and related due process and takings allegations.[1] Because this litigation touches on many issues that have not been directly addressed by courts before, the outcome is uncertain, yet certain to affect the way the Board approaches curtailments in the future.

For future drought curtailments, the Board may want to consider taking some or all the following actions. For some potential actions, we include brief comments on potential objectives, triggers, decision-related information, processes and procedures, useful advance work, and relationships between these.

A.1 Analyzing when Curtailments Are Legally and Hydrologically Appropriate

During the 1976–1977 drought and the recent drought, the Board performed curtailment analyses (water availability analyses aimed at determining whether water supply was available to meet demand) for different priority classes of water rights in major watersheds. Although the Board's curtailment analyses during the recent drought were in some ways improvements over their 1970s counterparts, they relied on the same general methodology: (1) comparing estimates of total watershed-wide supply to total watershed-wide demand and (2) assigning any shortfall to the most junior users in the watershed to arrive at a priority date for which demand no longer exceeds supply.[2] This coarse-level analysis may be appropriate as an initial screening mechanism for potential water shortage in a watershed (Table A-1). But it is unlikely to be as useful for identifying which water users should actually be curtailing their diversions due a lack of water availability under their priorities of right. There are at least two main reasons for this: failure to adequately account for hydrologic connectivity and uncertainty surrounding pre-1914 and riparian water rights.

More detailed water availability analyses that adequately address hydrologic connectivity and these more senior rights are needed to guide curtailments that are legally and hydrologically appropriate.[3]

Table A-1: Fleshing Out the Framework for Water Availability Analyses to Support Shortage Forecasting

ACTION: Analyzing water availability to forecast the potential for water shortage	
Objective(s)	To identify the potential for upcoming water shortage in the watershed.
Trigger(s)	Forecast suggests snowpack or other water supplies will be below particular threshold(s); other indicators suggest the potential for impending water shortage.
Information	Forecasts for watershed-wide monthly full natural flow (FNF); past or projected monthly diversion amounts; estimated return flow volumes; water right priorities; environmental priorities; health and safety priorities
Procedures	Compare 50- and 90-% exceedance levels for forecasted FNF (supply) with past or projected diversion amounts (demand)—adjusting for estimated return flows and taking into account water right, environmental, and health and safety priorities—to analyze whether adjusted demand is likely to exceed adjusted supply (= potential water shortage).
Preparations	Improving supply, demand, and water rights information; adopting curtailment procedures
Relationships	Result is a potential trigger for considering other actions (e.g., whether to provide notice of potential water shortage, require enhanced diversion reporting, begin more detailed water availability analysis for potential curtailment, or impose conservation requirements).

A.1.1 Hydrologic Connectivity

Streamflow is directional; therefore, the relative locations of inflows (runoff, wastewater discharges, agricultural return flows, groundwater accretion) and outflows (diversions, groundwater depletions) within a stream network matter. To accurately characterize water availability and minimize over- or under-curtailments, curtailment-related water availability

analyses must account for the hydrologic connectivity, or lack thereof, between different components of supply and demand (Figure A-1).[4]

The relative locations of points of diversion within a flow network will determine whether a more junior user curtailing their diversions at one location would actually benefit more senior users in other locations. Curtailments of diversions upstream of a particular point will increase flow at that point, while downstream curtailments will not. Where diversions occur on different tributaries within a larger watershed, a watershed-wide availability analysis that lumps together all supply and all demand could reach incorrect conclusions about when certain water users need to curtail their diversions (and the effects those curtailments should have). For example, under the scenario shown in Figure A-1, curtailments by more junior diverters within subbasins A_1, A_2, A_3, or C would not free up water for the use of more senior diverters within subbasin B. Similarly, curtailments by more junior diverters at points 7 and 8 in subbasin B would not free up water for a more senior diverter upstream at point 6. UC Davis's Drought Water Rights Allocation Tool (DWRAT) explicitly takes this connectivity logic into account.[5]

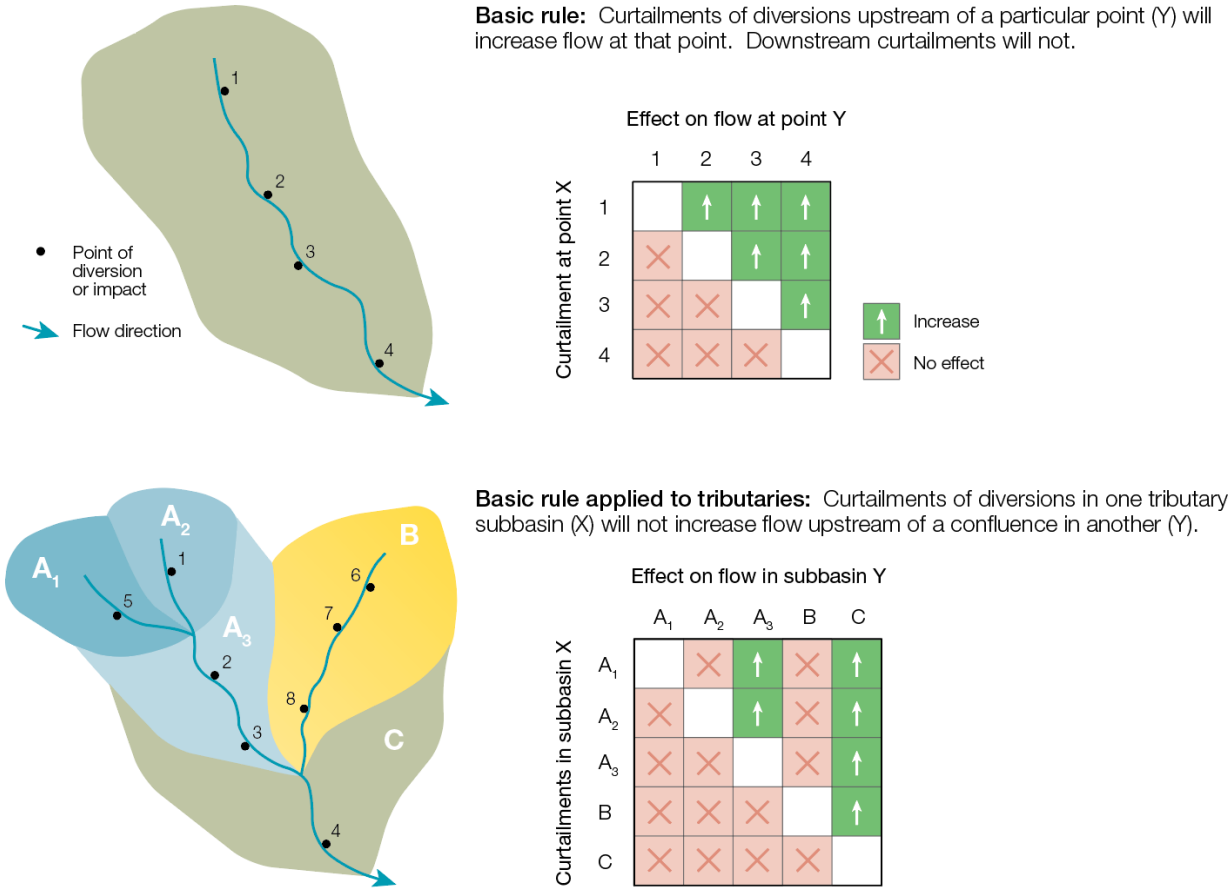

Figure A-1: **Effect of Curtailments of Diversions Upstream and Downstream of a Particular Point on a Stream**

A.1.2 Uncertainty Surrounding Pre-1914 and Riparian Water Rights

As we mentioned in Section 4.3, information about surface water diversion and use is important for drought water availability analyses, but it is not sufficient. The Board needs to understand the characteristics of water rights, including their relative priorities, in order to apply curtailment rules appropriately. However, the Board generally has less information about pre-1914 and riparian rights. In addition to questions about the extent of valid use under particular rights, one potential issue is that all riparian rights in a watershed may not be superior to all appropriative rights. Although this is generally the case, some riparian rights are junior to some appropriative rights based on the relative timing of the transfer of the riparian land into private ownership (see **Part 1**). This could make a big difference in the outcome of curtailment analyses for the watershed.

A.1.3 A More Formal Approach to Curtailment Analyses

The Board could adopt a transparent, effective, and less controversial system for drought curtailment analyses, notifications, and enforcement through a public process that addresses due process and other concerns (see Sections 3.3 and 3.4.1).

Researchers at UC Davis have been working to develop "a more formal and analytical approach to curtailing individual water rights" that includes subbasin-level modeling of full natural flows, estimated water right quantities and priorities, other water allocation quantities and priorities, and logic rules that reflect these priorities.[6] They have used versions of the resulting DWRAT to estimate the need for curtailments in the Eel, Russian, San Joaquin, and Sacramento River watersheds.[7] The Board should consider how it might implement a similarly detailed and formal approach to curtailment analyses. Table A-2 illustrates how the Board might start to flesh out the contingency framework basics for curtailment analyses.

Table A-2. Fleshing Out the Framework for Water Availability Analyses to Support Curtailments

ACTION: Analyzing water availability to guide curtailments	
Objective(s)	To identify the need for curtailments and classes of diverters or individual diverters for whom water does not appear to be available.
Trigger(s)	Forecast of potential water shortage (Table A-1); dates or other thresholds for periodic re-analysis after initial analysis; clusters of complaints; other indications of localized shortage.
Information	Forecasts for watershed-wide monthly full natural flow (FNF); daily FNF calculations; modeled full natural flow for hydrologic subbasins; past or projected diversion amounts, timing, and locations under different water rights; estimated return flow volumes, timing, and locations; water right priorities; environmental priorities; health and safety priorities
Procedures	Compare supply and demand—adjusting for estimated return flows and taking into account water right, environmental, and health and safety priorities—with sufficient spatial and temporal detail to enable diverters understand whether water is likely available for their use.
Preparations	Improving supply, demand, and water rights information; adopting curtailment procedures, including logic rules and integrated models for curtailment water availability analyses
Relationships	Result is a potential trigger for considering other actions (e.g., providing notice of water unavailability; notifying diverters of a change in availability, including lifting or suspending curtailments; requiring enhanced diversion reporting; imposing conservation requirements).

A.2 Providing Curtailment-Related Information to Water Users

The Board will want to consider the timing, content, and import of informational notices it provides to water users.

When water availability analysis indicates a current or potential future water shortage in a particular watershed, the Board will want to notify water users to make them aware of the situation and remind them of their legal obligations regarding curtailment. Notice does not eliminate uncertainty for water users, but instead serves an important role in informing decision making. Providing early warning of a potential water shortage gives water users time to plan and explore contingencies. If a water shortage does occur, sending notices of water unavailability (curtailment notices) to diverters will help them understand that the Board estimates that water is not available for their use.

We reiterate that, while watershed-wide estimates of availability may be adequate for early warnings of potential water shortage, the analyses behind notices of water unavailability need to be detailed enough that diverters can trust them to reasonably reflect reality. Analyses that are too coarse may leave diverters wondering whether an analysis that better accounts for watershed connectivity would yield a different result, leading some to decide to continue diverting and others to second guess the fairness and accuracy of the Board's water rights oversight methods.

Once it has issued curtailment notices, the Board will need to keep diverters apprised of changes in water availability, suspending or ending curtailments when water availability analysis indicates they are no longer needed.

Figure A-2 illustrates some potential relationships between different types of informational notices, and Table A-3 illustrates how the Board might start to flesh out the contingency framework basics for them.

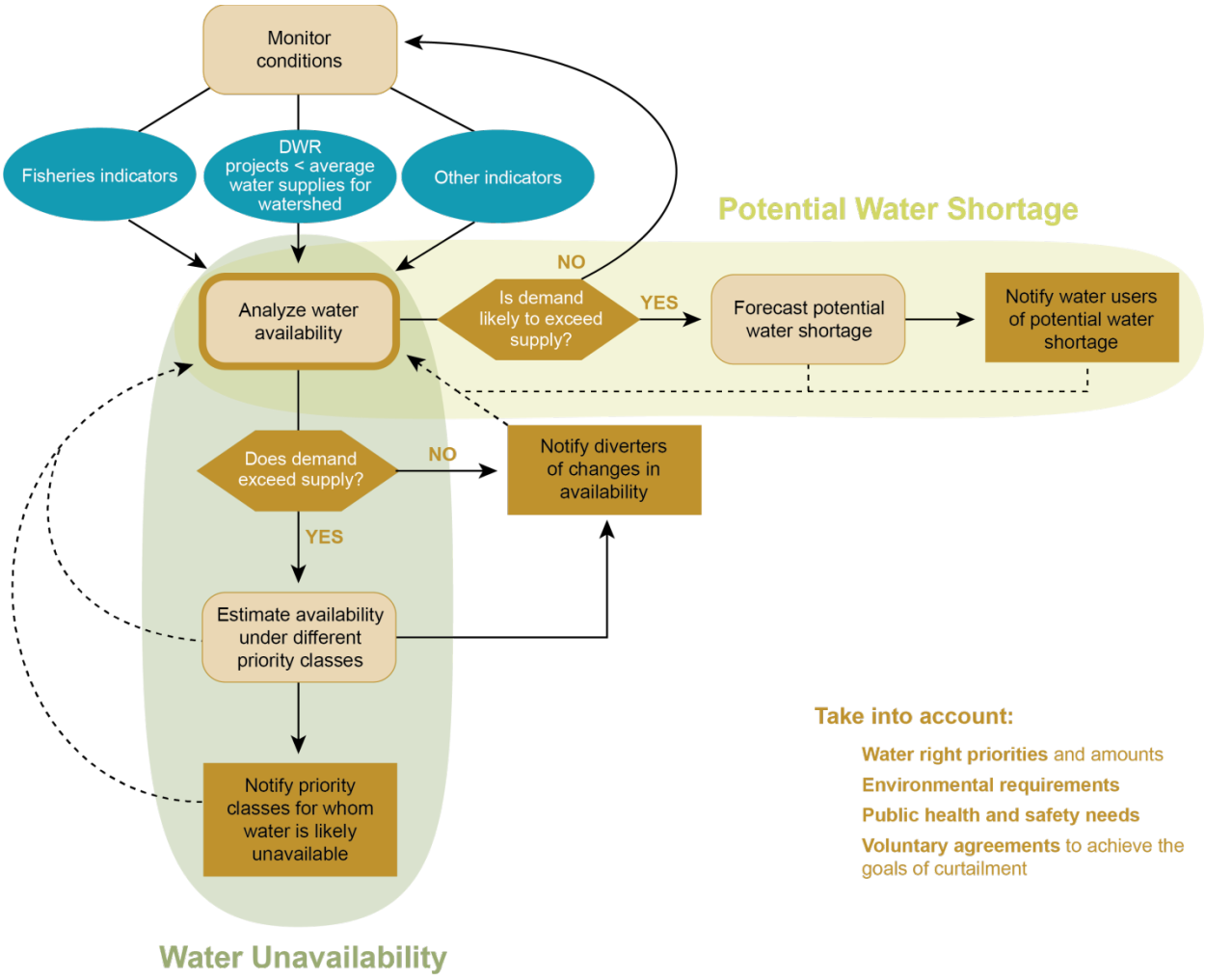

Figure A-2: Potential Relationships Between Informational Notifications Meant to Provide Notice of Potential Water Shortage and to Provide Notice of Water Unavailability (Curtailments)

Table A-3: Fleshing out the Framework for Informational Curtailment-Related Notices

ACTION: Providing notice of potential water shortage	
Objective(s)	To ensure that water users are aware of the potential for upcoming water shortage in the watershed; to remind water users of their legal obligations regarding curtailment.
Trigger(s)	The Board forecasts the potential for water shortage in the watershed.
Information	Contact information for all diverters, etc.
Procedures	Send letters to all water users in watershed; provide email notice; post forecast and supporting information, including water availability analysis, to website.
Preparations	Adopting curtailment procedures.
Relationships	Flows from triggering action. After providing notice, re-analyze water availability periodically (monthly or weekly) and after rain events to see if forecast conditions have changed.

ACTION: Providing notice of water unavailability (curtailment notice)	
Objective(s)	To inform classes of diverters or individual diverters when the Board thinks water is not available for their use; to remind water users of their legal obligations regarding curtailment.
Trigger(s)	Water availability analysis suggests that water is unavailable for classes of diverters or individual diverters.
Information	Contact information for affected diverters, etc.
Procedures	Send letters to affected water users in watershed; provide email notice; post conclusions about water unavailability and supporting information, including water availability analysis, to website.
Preparations	Adopting curtailment procedures.
Relationships	Flows from triggering action. After providing notice, periodically re-analyze water availability to see if conditions have changed.

ACTION: Providing notice of water availability (curtailment suspension notice)	
Objective(s)	To inform classes of diverters or individual diverters when the Board thinks water is again available for their use; to remind water users of their legal obligations regarding curtailment.
Trigger(s)	Water availability analysis suggests that water is available for classes of diverters or individual diverters who previously received curtailment notices.
Information	Contact information for affected diverters, etc.
Procedures	Send letters to affected water users in watershed; provide email notice; post conclusions about water availability and supporting information, including water availability analysis, to website.
Preparations	Adopting curtailment procedures.
Relationships	Flows from triggering action. After providing notice, periodically re-analyze water availability to see if conditions have changed.

A.3 Issuing Enforceable Curtailment Notices or Orders

Curtailment notices or orders that have legal effect independent of subsequent potential enforcement actions (Table A-4) are likely to be controversial unless they follow transparent

procedures developed through non-emergency public processes that include notice and the opportunity for a hearing.

Least contentious might be procedures that are based on clear rules and straightforward triggers that automatically initiate curtailments when specified conditions are met. For example, curtailments under Term 91 rarely elicit pushback. This standard term[8] prohibits diversions by most post-1965 diverters in the Delta watershed when, based on a formula that was established through hearings, releases of "Supplemental Project Water" are required to meet Delta water quality standards, including for flow and salinity. The Board adopted Term 91 in 1980 "[a]s an interim solution to the problem" of more junior diverters "forc[ing] the Projects to release more stored water to meet the Delta Water quality standards established by Decision 1485" than would otherwise be necessary.[9] The Board held a hearing in 1981, adopted the method for calculating water availability, and added the term to most post-August 16, 1978, Delta permits and licenses in 1983.[10] In 1983, after an additional hearing, the Board added the term to many water right permits issued since 1965 (pursuant to its reserved jurisdiction under Standard Permit Term 80) and deleted the term from some permits, including for small quantities of water and for non-consumptive power generation uses.[11] When the triggering conditions are met, the Board simply needs to notify the affected diverters that they are required to cease diverting.[12]

By contrast, a more general standard permit term, Term 90, puts diverters in the Delta and Russian River watersheds on notice that the Board may, by order, "reduce[] or completely eliminate[]" the authorized season of diversion "in any year of water scarcity . . . after notice to interested parties and opportunity for hearing."[13] Although the Board might disagree, water users with rights subject to Term 90 might interpret this language to impose a threshold hearing opportunity before any independently enforceable curtailment order can be issued. (However, it should not affect the Board's ability to pursue a targeted enforcement action for out-of-priority or otherwise unauthorized diversions.) One way to potentially resolve the issue would be to undertake a Term 91-like public notice and hearing process to establish procedures that will guide Term 90 curtailments during conditions of water scarcity.

Table A-4: Conceptual Differences Between Types of Curtailment-Related Notices[14]

Notice of potential shortage	**Notice of water unavailability** (curtailment notice)	**Enforceable curtailment notice or curtailment order**
Warns of potential for future water shortage	Warns of imminent need to curtail and the potential for eventual enforcement	Warns of requirement to curtail or face direct legal / financial consequences

A.4 Addressing Environmental Requirements and Minimum Health and Safety Needs

The Board will need to consider how to incorporate non-water-right priorities (e.g., instream flow requirements and minimum health and safety protections) into curtailment analyses and other procedures.

UC Davis's DWRAT illustrates a potential solution for addressing environmental and health and safety protections in curtailments.[15] First, DWRAT calculations exclude flows allocated for instream environmental uses from the total supply that is available for diversion by water users in and downstream of each subbasin. Second, the DWRAT's allocation rules include the constraint that all "[a]llocations must meet minimum public health and safety requirements."

The Board should explore the possibility of taking a similar approach through a non-emergency public process. It may be controversial, because some may view this type of broad-based accounting for environmental and health and safety priorities as the categorical determination of unreasonable use. They are likely to argue that each water user is entitled to a specific determination that their particular use is unreasonable in comparison to the identified environmental or health and safety needs.[16] However, this view would render the cumulative impacts of diversions on public trust resources in a watershed—which cannot easily be attributed to particular water users—effectively un-addressable. In fact, the California Court of Appeal has acknowledged that the Board can make limited categorical determines of reasonable use through regulations.[17] Through public processes, the Board can set specific, quantitative requirements for environmental and minimum health and safety needs (Sections 3.1, 3.2) and develop a reasonable methodology for ensuring that these priorities are protected.

A.5 Evaluating Alternatives to Curtailment

If the Board establishes clear procedures for drought curtailments, water users will gain certainty about the default processes for dealing with drought-related water shortages and what they are intended to accomplish. This certainty provides both incentive and essential context for water users to negotiate alternatives that achieve the outcomes sought by curtailments but better serve local needs and goals.

Alternatives might be based around:

- Mandatory enhanced conservation requirements;
- Voluntary agreements with state and federal wildlife agencies to maintain minimum flows needed to protect specific fisheries;
- Voluntary agreements to achieve diversion reductions intended to protect senior water rights, human health and safety, and the environment through alternative, negotiated means such as proportional reductions (regardless of water right priority) or more junior diverters agreeing to compensate more senior diverters in return for curtailing in their stead (forbearance agreements);
- Short-term transfers from those with more senior to those with more junior appropriative rights; and
- Water transfers that bring water into the basin.

The Board will need to determine whether proposed alternatives are appropriate and monitor their implementation to ensure they are effective.

Although they may need in-drought adjustments, alternatives that are developed in advance of drought based in solid contingency planning are likely to be more effective than alternatives cobbled together during drought emergencies. Therefore, the Board should consider ways to

encourage early development of alternative plans, for example a clear path for (appropriately conditioned) pre-drought approval that would expedite in-drought implementation.

A.6 Other Curtailment-Related Considerations

The Board will want to consider how drought curtailment procedures should address other issues as well. Some potentially important questions include the following:

- When would curtailment-related regulations be useful and appropriate?
- For diversion reporting to be useful to the Board, it has to be timely and match the decisions the Board needs to make in terms of resolution and accuracy. When should different degrees of enhanced diversion reporting requirements be triggered?
    - When would monthly reporting be useful and appropriate?
    - When would weekly or more frequent reporting for diverters required to measure at these frequencies be useful and appropriate?
    - When would projections of future diversions be useful and appropriate? On what time scale?
- To what extent and how should curtailment procedures distinguish between post-1914, pre-1914, and riparian rights?
- How will the Board track compliance with curtailments and curtailment alternatives? To what extent will it rely on self-reported information, monitoring data, investigating complaints, analyzing remote sensing data for signs of unauthorized use, engaging in random or targeted field inspections, and other techniques?
- For enforcement purposes,
    - What evidence would be needed to support a finding of water unavailability at a water user's point of diversion?
    - How does this vary in different hydrological contexts (e.g., in the Delta)?
    - What role should the timing of diversions play (e.g., does the Board need to demonstrate that diversions occurred at the same time the more senior users were diverting, or trying to divert)?

As an example, enforcement questions came to the fore during the recent drought. In July 2015, the Board issued a draft Cease and Desist Order to West Side Irrigation District (WSID) under Water Code § 1831, and an Administrative Civil Liability complaint to Byron-Bethany Irrigation District (BBID) under Water Code § 1052, alleging unauthorized diversions. Both Districts had continued to divert water after receiving notices of water unavailability.[18] BBID is a pre-1914 appropriator, while WSID holds a senior post-1914 license. The Board eventually dismissed the actions because it concluded that the prosecution team was unable to carry its burden of proving that water was truly unavailable under the Districts' rights with the information and analyses presented.[19] This result drove home the Board's need for more precise, accurate, and timely information about water supply and demand and a better process for analyzing water availability.

A.7 Endnotes

[1] *See California Water Curtailment Cases*, No. 1-15-CV-285182 (Cal. Super. Ct., Santa Clara Cnty.). This proceeding coordinates the following cases: *Banta-Carbona Irrigation Dist. v. Cal. Water Resources Control Bd.*, No. 39-2015-00326421 (Cal. Super. Ct., San Joaquin Cnty., filed date); *Byron-Bethany Irrigation Dist. v. Cal. Water Resources Control Bd.*, No. NI50967 (Cal. Super. Ct., Contra Costa Cnty.); *Byron-Bethany Irrigation Dist. v. Cal. Water Resources Control Bd.*, No. 34-2016-80002388 (Cal. Super. Ct., Contra Costa Cnty.); *Patterson Irrigation Dist. v. Cal. Water Resources Control Bd.*, No. 2015307 (Cal. Super. Ct., Stanislaus Cnty.); *San Joaquin Tributaries Auth. v. Cal. Water Resources Control Bd.*, No. 2015366 (Cal. Super., Stanislaus Cnty. Ct.); *San Joaquin Tributaries Auth. v. California Water Resources Control Board*, No. 34-2016-80002389 (Calif. Super. Ct., Stanislaus Cnty.); *The West Side Irrigation Dist. v. Cal. Water Resources Control Bd.*, No. 34-2015-80002121 (Cal. Super. Ct., Sacramento Cnty.); *The West Side Irrigation Dist. v. Cal. Water Resources Control Bd.*, No. 34-2016-80002387 (Cal. Super. Ct., Sacramento Cnty.).

[2] *See* ANDREW TWEET, WATER RIGHT CURTAILMENT ANALYSIS FOR CALIFORNIA'S SACRAMENTO RIVER: EFFECTS OF RETURN FLOWS 2 (2016) (M.S. thesis, University of California, Davis), *available at* https://watershed.ucdavis.edu/shed/lund/students/Andy_Tweet_MS.pdf.

[3] *See* TWEET, *supra* note 2, at 3.

[4] *See id.* at 5.

[5] E.g., DWRAT limits total flow available in each subbasin to the amount at the outlet; i.e., water from one subbasin is not counted towards availability in another upstream of their confluence. *See* Lund et al., *supra* note 61, at 11–16.

[6] Lund et al., *supra* note 61, at 3.

[7] *See* Jeff Laird, Benjamin Lord, Chad Wittington, Andy Tweet, Wesley Walker & Jay Lund, Drought Water Rights Allocation Tool, Eel River Application, at 11–12, Mar. 21, 2017, *available at* http://www.cwemf.org/AMPresentations/2017/s17/2.LAIRD_DWRAT_CWEMF2017.pdf; BENJAMIN LORD, WATER RIGHTS CURTAILMENTS FOR DROUGHT IN CALIFORNIA: METHOD AND EEL RIVER APPLICATION (2015) (M.S. thesis, UC Davis), *available at* https://watershed.ucdavis.edu/shed/lund/students/BenjaminLord_MS_thesis2015.pdf; TWEET, *supra* note 2; CHAD WHITTINGTON, RUSSIAN RIVER DROUGHT WATER RIGHT ALLOCATION TOOL (DWRAT) (2016) (M.S. thesis, University of California, Davis), *available at* https://watershed.ucdavis.edu/shed/lund/students/Chad_Whittington_MS.pdf.

[8] State Water Res. Control Bd., Permit Term 91 (2009), *available at* https://www.waterboards.ca.gov/waterrights/water_issues/programs/permits/terms/permitterm091.pdf.

[9] State Water Res. Control Bd., Water Right Decision 1594, at 8, Nov. 17, 1983, *available at* https://www.waterboards.ca.gov/waterrights/board_decisions/adopted_orders/decisions/d1550_d1599/wrd1594.pdf.

[10] State Water Res. Control Bd., Water Right Order WR 81-15, at 4–7, Nov. 19, 1981, *available at* https://www.waterboards.ca.gov/waterrights/board_decisions/adopted_orders/orders/1981/wro81-15.pdf.; Water Right Decision 1594, *supra* note 9, at 8, 12, 27.

[11] Water Right Decision 1594, *supra* note 9, at 27–28, 35; State Water Res. Control Bd., Water Right Order WR 84-2, at 26–28, Feb. 1, 1984, *available at* https://www.waterboards.ca.gov/waterrights/board_decisions/adopted_orders/decisions/d1550_d1599/wrd1594.pdf (scroll down about three-quarters of the way through the PDF).

[12] *See* Permit Term 91, *supra* note 8.

[13] State Water Res. Control Bd., Permit Term 90 (2009), *available at* https://www.waterboards.ca.gov/waterrights/water_issues/programs/permits/terms/permitterm090.pdf.

[14] Images: *Signs at the Crossing*, OPERATION LIFESAVER, https://oli.org/education-resources/safety-tips/signs-and-signals/signs-at-the-crossing (last visited Dec. 23, 2017); *Devices at the Crossing*, OPERATION LIFESAVER, https://oli.org/education-resources/safety-tips/signs-and-signals/devices-at-the-crossing (last visited Dec. 23, 2017).

[15] *See* Lund et al., *supra* note 61, at 11–16.

[16] *See, e.g.*, Kevin M. O'Brien, Comments on Agenda Items 12 (Proposed Resolution Regarding Drought-Related Emergency Regulations for Curtailment of Diversions) and 13 (Workshop Regarding Options for Drought-Related Curtailments of Post-1914 Water Rights in the Sacramento-San Joaquin River Delta Watershed), at 3–5, May 19, 2014, *available at* https://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/comments052014/docs/kevin_obrien.pdf.

[17] *See Light*, 226 Cal. App. 4th at *Light v. State Water Res. Control Bd.*, 226 Cal. App. 4th 1463, 1482–88 (2014), *as modified on denial of reh'g* (July 11, 2014), *review denied* (Oct. 1, 2014) (citing California Supreme Court cases that have recognized or assumed the Board's ability to adopt such regulations).

[18] *See* State Water Res. Control Bd., Order WR 2016-0015, In the Matter of Administrative Civil Liability Complaint Against Byron-Bethany Irrigation District And In the Matter of Draft Cease and Desist Order Against The West Side Irrigation District, June 7, 2016, *available at* http://www.waterboards.ca.gov/waterrights/board_decisions/adopted_orders/orders/2016/wro2016_0015.pdf.

[19] *Id.*

APPENDIX B: Strategically Addressing Other Backlogged Water-Rights Work

Some outstanding water rights issues may inject unhelpful levels of uncertainty into drought planning and response. In addition to making key policy decisions in advance of droughts and improving decision-related information, the Board could consider strategically prioritizing its backlog of day-to-day water rights work in a way that would enable significant progress towards eliminating especially significant sources of uncertainty before the next major drought.

Resolve Significant Long-Term Water Right Change Petitions — The Board could work with permittees and licensees to resolve requests for long-term water right changes that could significantly affect the outcome of drought water availability analyses. Until their requests are resolved, these diverters are likely to rely on temporary urgency change petitions (TUCPs) to get through droughts. For example, Sonoma County Water Agency has requested changes to minimum instream flow requirements and a related hydrologic index in four permits to bring them in line with a 2008 Biological Opinion that protects steelhead and Coho salmon in the Russian River watershed.[1] Before the Board can act on the petition, it must consider the environmental effects of the proposed changes under the California Environmental Quality Act (CEQA), but the Sonoma County Water Agency has not yet completed its final Environmental Impact Report.[2] Therefore, the agency has been operating under a series of temporary urgency changes, instead of a permanent change that builds in appropriate flexibility.[3]

Complete Water Rights Licensing for Significant Diversions — Acquiring a new appropriative water right involves three phases: (1) applying for a permit, (2) developing a diversion project and diverting water under a permit, and (3) receiving a license. When the project is complete, the permittee provides the Board with a report of completion, and Board staff verify actual diversion and use through a field inspection, then issue a license for the quantity of water the permittee put to beneficial use in compliance with the permit's terms and conditions.[4] If less water was used than the permit allowed, the license reflects the smaller amount. If more water was used, the diverter will need to apply for a new water right with a new, and much more junior, priority date to divert the excess water. Therefore, it is in water right applicants' interest to overestimate the amount of water they expect to be able to develop under a permit, and licenses will generally be for less than the face value of the corresponding permit. The Board has a large backlog of licensing work, in part because it involves field inspection and analyzing often substantial quantities of information, and in part because many permittees petition for extensions of time to complete their projects. Many of the diversions involved are small, but some are very large. Completing water rights licensing for these significant diversions would clarify how much water these permittees are legally entitled to use under their rights, reducing uncertainty and improving the accuracy and legal defensibility of curtailment analyses and other water availability analyses (see Appendix A).

Other possibilities that may be worth exploring for prioritization include completing water quality certifications related to Federal Energy Regulatory Commission (FERC) relicensing projects and evaluating the utility of declaring additional streams "fully appropriated."

B.1 Endnotes

[1] *See Changes to Flows in the Russian River*, SONOMA CNTY. WATER AGENCY, http://www.scwa.ca.gov/decision1610/ (last visited Oct. 20, 2017).

[2] *See* State Water Res. Control Bd., Notice of Petitions for Change and Petitions for Extension of Time, Second Revision, Feb. 3, 2017, *available at* https://www.waterboards.ca.gov/waterrights/water_issues/programs/applications/petitions/2016/12947a_renotice2.pdf.

[3] *See Temporary Urgency Change Petition*, SONOMA CNTY. WATER AGENCY, http://www.scwa.ca.gov/tucp/ (last visited Oct. 20, 2017).

[4] *See* CAL. WATER CODE § 1600–1650*; see also* STATE WATER RES. CONTROL BD., PROCESS FOR WATER RIGHT LICENSING 1 (2013), *available at* https://www.waterboards.ca.gov/waterrights/water_issues/programs/applications/docs/licensing.pdf.