Data for Water Decision Making:
Compilation of Stakeholder-Developed Use Cases

December 12, 2017

Note: This set of use cases was developed as part of a larger project on "Data for Water Decision Making" led by UC Water, the California Department of Water Resources (DWR), and the California Council on Science and Technology (CCST). The project seeks to inform the implementation of the Open and Transparent Water Data Act, AB 1755, which presents an opportunity to improve water decision making and data provision in California (see "About this document" on p. 4).

The results from these use cases are presented in a UC Berkeley report titled "Data for Water Decision Making: Informing the Implementation of California's Open and Transparent Water Data Act through Research and Engagement." This report draws from the use cases in this document to develop an argument in support of decision-driven data systems, along with observations and lessons learned from the use case development process and their content. The report is expected to be released in January 2018.

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About this document

This set of use cases was developed as part of a larger project on "Data for Water Decision Making" led by UC Water, the California Department of Water Resources (DWR), and the California Council on Science and Technology (CCST). The project seeks to inform the implementation of the Open and Transparent Water Data Act (AB 1755), and to look towards a larger vision for improving the connection between data provision and water decision making in California.

These use cases are intended to serve as a tool for a) assessing stakeholder data needs, and b) communicating those needs to technical developers. In this context, a use case is a short document that communicates the data needs for a particular decision by providing a set of answers to the question: *Who* needs *what type* of data, in *what form*, to make *what decisions*? Taken collectively, the set of use cases provide a way to identify core data sources or sets where interoperability is particularly important. The set of use cases also provide a way to better understand data gaps, including gaps in interoperability or accessibility. Above all, the use cases are intended to be responsive to stakeholder data needs, as well as useful for technical developers seeking to understand the data needs of system users.

Use cases were developed at two stakeholder workshops (February and May 2017) that focused on engaging stakeholders and decision makers in the development of a) a conceptual understanding of use cases to inform decision-driven data provision, b) a method to generate such use cases, and c) an initial sample of example use cases. A total of 20 use cases were developed. Eight use cases were produced at the workshops described above. UC Berkeley also facilitated separate meetings to generate additional use cases, and supported other organizations in contributing use cases using our template, based on their expertise. The use case format presented in this report evolved out of an iterative process based on the workshop series. Engagement with policy makers and decision makers, as well as with data scientists, was crucial to developing the use case format.

Please note that a UC Berkeley report is currently in preparation, entitled "Data for Water Decision Making: Informing the Implementation of California's Open and Transparent Water Data Act through Research and Engagement." This report draws from the use cases in this document to develop an argument in support of decision-driven data systems, along with observations and lessons learned from the use case development process and their content. The report is expected to be released in January 2018.

Use case template with definitions of terms

Objective Decision, goal or desired action	The objective describes what the user is trying to accomplish. The objective is the goal or desired action on the part of the system user. Decisions may involve investment and policy decisions (longer-term); programmatic implementation (medium-term); or operational decisions (short term).
Description Important context and background information	The description provides important context and background information that might help a reader understand the objective.
Participants The main decision-maker; also note other parties involved or affected	The participants include the main actor(s) or decision-maker(s). Participants may also include other parties who may be involved in accomplishing the objective (in this case, note the main decision-maker).
Regulatory context Legal, regulatory, and reporting requirements	Regulatory context could include, for example, specific statutes or regulations; legal operational constraints; specific governmental agency programs or programs under development; reporting requirements; etc. May also include other boundaries: for example, fiscal boundaries, quarterly reporting requirements, etc. This is intended to provide additional context, information about constraints, and points of cross-reference.
Workflow Progression of steps and specific actions taken by participants to accomplish objective	The workflow describes a progression of steps taken by the participants in order to accomplish the objective. The workflow should make clear the specific actions that are necessary to accomplish the objective.
Data sources Existing data sources; data gaps. **Be as specific as possible**	Data sources include existing data sources as well as gaps. This section should describe the data sources that are already in use, along with additional sources that data users would like to see developed. Be as specific as possible in listing existing data sources that participants are familiar with or are already using. **(See table at the end of this document for example of data sources including links)**
Data characteristics Notes about type and form of data	Data form includes notes about the type, form, and format of data that would be most useful for making decisions. Anything peculiar about the data.

Additional comments: Includes notes on uncertainties, barriers and opportunities, etc.

Use case 1: Planning a groundwater recharge project under the Sustainable Groundwater Management Act

Developed at Data for Water Decision Making Workshop 1, February 9, 2017

Objective Decision, goal or desired action	Objective: To avoid undesirable results including declining groundwater levels through the recharge of groundwater. Decision: When, where, and how to recharge groundwater? With what water?
Description Important context and background information	Under SGMA, GSAs must achieve sustainability of the groundwater basins they manage by avoiding undesirable results[1] that include the chronic lowering of groundwater levels. Managed Aquifer Recharge (MAR) is one tool GSAs can use.[2] MAR is the use of various methods such as infiltration basins, green infrastructure, aquifer storage, and recovery wells to actively increase the amount of water that enters an aquifer. MAR can offset reductions in groundwater levels by increasing storage of water.
Participants The main decision-maker; also note other parties involved	GSA water manager (primary decision-maker) Consultant (e.g., engineer assisting primary decision-maker) Local land use planner (may be consulted) SWRCB and DWR (interested in results of groundwater sustainability plan) GSA constituent
Regulatory context	• Sustainable Groundwater Management Act – avoidance of Undesirable Results[3]

[1] CA Water Code § 10721 (x)(1)

[2] For more information, see, for example: "Why we can't just suck it up: The challenges of groundwater recharge in California." Bea Gordon, March 31, 2017, Stanford Water in the West. http://waterinthewest.stanford.edu/news-events/news-insights/why-we-cant-just-suck-it-challenges-groundwater-recharge-california

[3] CA Water Code § 10721 (x)

Legal, regulatory, and reporting requirements	• Funding for development and implementation of groundwater plans and projects[4] • Other regulatory contexts: for example, CEQA, NEPA, water rights issues, water quality issues • These types of project will often require approval of the SWRCB in the form of a new permit or change to an existing permit or license. This is in addition to the Board's role under SGMA.
Workflow Progression of steps and specific actions taken by participants to accomplish objective	• The water manager must identify potential source(s) of water, and for each determine the quantity and timing of water available for recharge and its cost. • To determine where the project should be located, the water manager must examine different options based on geological characterization, basin capacity and suitability of recharge areas; parcel data indicating available land and land values; and water quality implications based on current or past land use and the design of the project. • To determine the best method for recharge, basin characteristics such as subsurface characteristics, soil types, topography, current and planned land use, and basin capacity must be taken into account.

Data sources
Existing data sources; data gaps. Be as specific as possible
	• Water availability data: Water rights information, precipitation data, projected flows, projections/forecasts of water availability. Specific sources include:
	  ○ DWR California Data Exchange Center datasets: "California Statewide Water Conditions" (includes information on precipitation, snowpack, runoff forecasts, river runoff, and reservoir storage)
	  ○ Executive Update on Hydrologic Conditions in CA (03/31/2017; updated monthly)
	  ○ 2017 WY Precipitation Summary
	  ○ Reservoir Water Storage, by hydrologic region
	  ○ USGS Current Water Data for California: Daily Streamflow Conditions
	  ○ NOAA Precipitation Frequency Data Server (PFDS)
	  ○ CA Water Board Electronic Water Rights Information Management System (eWRIMs)
	• Basin characteristics data: Soil types, basin capacity, subsurface characteristics, assimilative capacity, models of basin characteristics, evidence for natural recharge. Specific sources include:
	  ○ DWR Groundwater Basin Maps and Descriptions (Bulletin 118)

[4] See "Water Quality, Supply, and Infrastructure Improvement Act of 2014 (AB 1471), commonly referred to as "Proposition 1. See also CA Water Code § 79771; CA Water Code § 79775; and "Proposition 1 Groundwater Grant Program Guidelines," adopted by the State Water Board May 18, 2016.

	○ USGS Groundwater Modeling: California Groundwater Model Archive ○ UC Davis California Soil Research Lab Soil Agricultural Groundwater Banking Index (SAGBI) suitability index for groundwater recharge • Land use data: Available land, water quality concerns from past land use history, historical data on land use (requires both temporal and spatial dimensions). Specific sources include: ○ DWR Land Use Survey data (available at county scale; available years vary) ○ USDA National Agricultural Statistics Service "Cropscape" Cropland Data Layer ○ USGS Global Land Cover Characteristics Data Base, Version 2.0 ○ CA Department of Conservation Farmland Mapping and Monitoring Program, county-level data • Data gaps: ○ Water rights data may be incomplete or unavailable. ○ Data on water demands for managed habitat, including state, federal and private wildlife refuges, hunting clubs, and incidental habitat areas ○ Quantity, pattern, and function of groundwater pumped to irrigate managed habitat lands ○ Understanding future groundwater needs of managed and non-managed habitat SEE TABLE BELOW for list of data sources with access methods.
Data characteristics Notes about type and form of data	• In order to capture potential impacts of previous land uses, land use data must include both historical/temporal and spatial dimensions. This is important because groundwater basins may be contaminated by certain previous land uses. • Map layers are helpful in capturing spatial dimensions of data, and for spatial analysis such as finding areas of overlap between various characteristics. • Groundwater models (hydrologic models used to simulate and predict movement and use of water) may be required to make decisions in some cases, but not all. Existing groundwater models, such as those

	archived by the USGS[5], may be useful in some cases, but in other cases existing models may be insufficient. • Not all the required data is digitized, which presents problems for those seeking to access and use data.

Additional comments:

- **Water budget as organizing principle:** The water budget should be considered as a straightforward model that can be the organizing principle for the data interactions between groundwater basins, sub-basins, GSA entities, etc.
    - The water budget is influenced by land use, and thus managing water budgets requires land use data.
- **Notes on GSAs as decision makers:** The GSA is not a monolithic decision maker-- there is granularity to the GSA as a decision maker. SGMA provides an opportunity to rethink data needs and reporting requirements. Much of the water demand data is collected at the local level, which needs to be fed into the overall SGMA water budget to inform management decisions.
- **Uncertainties:** Uncertainties in this case include land use impacts on groundwater, as well as climate change and other uncertainties.

Use case 1: Data sources

Topic	Description	Data source description	Access Method
Water	Precipitation	DWR CDEC 2017 WY Precipitation Summary	http://cdec.water.ca.gov/cgi-progs/precip/PRECIPSUM
Water	Hydrologic conditions	DWR CDEC Executive Update on Hydrologic Conditions in CA (03/31/2017; updated monthly)	http://cdec.water.ca.gov/cgi-progs/reports/EXECSUM
Water	Reservoir water storage	DWR CDEC reservoir storage by hydrologic region	http://cdec.water.ca.gov/cgi-progs/reservoirs/STORAGEW
Water	California Statewide Water Conditions	DWR CDEC information on precipitation; snowpack; runoff forecasts; river runoff; and reservoir storage	http://cdec.water.ca.gov/water_cond.html

[5] See USGS Groundwater Modeling, California Groundwater Model Archive, available at https://ca.water.usgs.gov/sustainable-groundwater-management/california-groundwater-modeling.html

Water	Precipitation	NOAA Precipitation Frequency Data Server (PFDS)	http://hdsc.nws.noaa.gov/hdsc/pfds/
Agriculture	Farmland maps	California Department of Conservation Farmland Mapping and Monitoring Program (county-level data)	http://www.conservation.ca.gov/dlrp/fmmp/Pages/county_info.aspx
Water	Groundwater basin maps	DWR Bulletin 118 basin boundaries	http://www.water.ca.gov/groundwater/bulletin118/gwbasins.cfm
Land use	Land use surveys	DWR Land Use Survey data (available at county scale; available years vary)	http://www.water.ca.gov/landwateruse/lusrvymain.cfm
Water	Water rights	SWRCB Electronic Water Rights Information Management System (eWRIMs)	http://www.waterboards.ca.gov/waterrights/water_issues/programs/ewrims/index.shtml
Water	Groundwater models	USGS Groundwater Modeling: California Groundwater Model Archive	https://ca.water.usgs.gov/sustainable-groundwater-management/california-groundwater-modeling.html
Water	Groundwater recharge suitability	SAGBI (Soil Ag Groundwater Banking Index) suitability index	https://casoilresource.lawr.ucdavis.edu/sagbi/
Land use	Land cover maps	USGS Global Land Cover Characteristics Data Base Version 2.0	https://lta.cr.usgs.gov/glcc/globdoc2_0
Agriculture	Agricultural land use	USDA National Agricultural Statistics Service Cropscape Cropland Data Layer	https://nassgeodata.gmu.edu/CropScape/
Water	Streamflow	USGS California streamflow data	https://waterdata.usgs.gov/ca/nwis/rt
Water	Water rights		Data gap-- data may be incomplete or unavailable

Use case 2: Capital investment: Financing a groundwater recharge project under Proposition 1

Developed at Data for Water Decision Making Workshop 1, February 9, 2017

Objective Decision, goal or desired action	To maximize expected return on investment for a (hypothetical) groundwater recharge project in the San Joaquin Valley, financed under Proposition 1, based on an evaluation of costs, benefits, risks, and expected return on investment. **Decision**: Where should a water storage capital investment project be located in order to maximize the return on investment?
Description Important context and background information	California's Proposition 1, the Water Bond (2014)[6], provides funding for state water infrastructure projects. The objectives of Proposition 1 are to improve operation of the state water system, integrate projects for maximum regional benefit, provide return on public investment for benefits provided, and contribute to groundwater sustainability. The bond dedicates specific funding for investments in water storage projects. This use case topic addresses capital investment projects related to water infrastructure in California. The case focuses on a hypothetical case of a groundwater recharge project in the Central Valley. The local context includes: groundwater in overdraft, the need for increased water supply, and the need to address fallow land supply. The goals of the hypothetical project are to capture flood flows, store "saved" surface water, allow for withdrawals by "depositors," and leave water behind for regional benefit.
Participants The main decision-maker; also note other parties	Local project proponents and/or investors (main decision-maker(s) putting forth proposal) Government investors (must approve proposal) Other: Public stakeholders (project site neighbors, ratepayers, and community benefit/environmental interests)

[6] http://www.waterboards.ca.gov/water_issues/programs/grants_loans/proposition1.shtml

involved or affected	
Regulatory context Legal, regulatory, and reporting requirements	• Groundwater quality funding program process and guidelines[7] • Groundwater quality funding program timeline[8] • 50% of the funding must go toward ecosystem benefits, regardless of project type. • State funding for a project cannot exceed 50% of the total project cost.
Workflow Progression of steps and specific actions taken by participants to accomplish objective	A local government is planning to apply for funding under Proposition 1 to build a groundwater storage and recharge project. Project developers must determine the expected return on investment, weigh the risks and benefits, and define and determine the sustainability and resiliency of the project. The development of this project involves a number of decisions and considerations: • Identifying the optimal location based on aquifer characteristics and capacity. • Identifying potential sources of water to be stored, and associated costs, to determine whether the project is worth pursuing. • Financing options for the project. • Measuring ecosystem benefits of the project. • Measuring benefits that may be difficult to quantify, including longer-term benefits (for example, preventing loss of groundwater capacity by preventing subsidence) and the cost of no action. • Identifying what is the market value of the water to be stored, and the location of the stored water with respect to the most valued uses (e.g. Is the water to be used for high value production - like microchips - or is it going to be used to produce alfalfa?)
Data sources Existing data	• Groundwater basin information- physical characteristics; Recharge rates for potential sites; Aquifer capacity and characteristics. Specific sources include:

[7] http://www.waterboards.ca.gov/water_issues/programs/grants_loans/gw_funding/
[8] http://www.waterboards.ca.gov/water_issues/programs/grants_loans/gw_funding/docs/gwqf_timelines_updated.pdf

sources; data gaps. Be as specific as possible	○ Groundwater basin maps ○ Hydrological models: USGS model archive ○ SAGBI (Soil Ag Groundwater Banking Index) suitability index • Water information: Water availability, supply, and demand. Specific sources include: ○ California Data Exchange Center information, including water supply and statewide water conditions information ○ USGS California water flow data ○ NOAA Precipitation Frequency Data Server • Return on investment: quantifying costs and benefits (Economic ROI, technical performance, public benefits, environmental benefits, energy and GHG costs/benefits, preventing subsidence, etc). Specific tools include: ○ ISI Envision • Land use data. Specific sources include: ○ DWR Land Use Surveys ○ USDA National Agricultural Statistics Service Cropland Data Layer ○ USGS Global Land Cover Characteristics Data Base ○ CA Department of Conservation Farmland Mapping Program • Climate change data (understanding future water availability projections) Data gaps include: • Aquifer storage capacity data • Complex water pricing issues SEE TABLE BELOW for list of data sources with access methods.
Data characteristics	• Data must be accessible and open source • Data must be comparable across the state • Data will involve both direct and proxy measurements

Notes about type and form of data	

Additional comments:

- Open data: Principles of open data are important. It is also important to recognize difference between direct measurement, proxy measurement, and modeling, and the potential need for a "data dictionary" to help with interoperability. Any data portal developed should be responsible and responsive to multiple users (e.g. through multiple dashboards and datasets).
- Relationships with SGMA: Any groundwater project would need to be closely evaluated in relation to the goals and the undesirable results outlined in SGMA.
- Measuring sustainability:
    - Uncertainties exist around how to quantify ecosystem benefits and services. Economics is only one part of an ROI assessment.
    - Other existing sustainability/ ROI tools may be useful—for example, the ISI Envision rating and credentialing system, similar to the LEED system.
- Measuring ecosystem benefits: could be challenging. Existing tools such as the ISI Envision system may be useful for this but ideally data and analysis systems should be open source.

Use case 2: Data sources

Topic	Description	Data source description	Access Method
Economics	Ecosystem benefits	ISI Envision system (for quantifying ecosystem benefits)	https://sustainableinfrastructure.org/
Water	Statewide water conditions and supply	DWR CDEC water supply and statewide water conditions information	http://cdec.water.ca.gov/
Land use	Land cover characteristics	USGS Global Land Cover Characteristics Data Base	http://edc2.usgs.gov/glcc/globdoc2_0.php
Water	Precipitation	NOAA Precipitation Frequency Data Server	http://hdsc.nws.noaa.gov/hdsc/pfds/

Topic	Description	Data source description	Access Method
Agriculture	Farmland maps	California Department of Conservation Farmland Mapping Program	http://www.conservation.ca.gov/DLRP/fmmp/Pages/index.aspx
Weather and Climate	Climate change data (understanding future water availability projections)	Seager et al "Projections of declining surface-water availability for the southwestern United States"	http://www.nature.com/nclimate/journal/v3/n5/full/nclimate1787.html?foxtrotcallback=true#supplementary-information
Weather and Climate	Climate patterns	PRISM climate group precipitation data	http://www.prism.oregonstate.edu/mtd/
Water	Groundwater basin maps	DWR Bulletin 118 basin boundaries	http://www.water.ca.gov/groundwater/bulletin118/gwbasins.cfm
Land use	Land use surveys	DWR Land Use Surveys	http://www.water.ca.gov/landwateruse/lusrvymain.cfm
Water	Groundwater models	USGS Groundwater Modeling: California Groundwater Model Archive	https://ca.water.usgs.gov/sustainable-groundwater-management/california-groundwater-modeling.html
Water	Groundwater recharge suitability	SAGBI (Soil Ag Groundwater Banking Index) suitability index	https://casoilresource.lawr.ucdavis.edu/sagbi/
Agriculture	Farmland maps	USDA National Agricultural Statistics Service Cropland Data Layer	https://nassgeodata.gmu.edu/CropScape/
Ecology	Ecosystem benefits	ISI Envision system (for quantifying ecosystem benefits)	https://sustainableinfrastructure.org/
Water	Streamflow	USGS California streamflow data	https://waterdata.usgs.gov/ca/nwis/rt
Socioeconomic	Water pricing data		Data gap
Water	Aquifer storage capacity		Data gap

Use case 3: Management of environmental flows to protect salmon habitat

Developed at Data for Water Decision Making Workshop 1, February 9, 2017

Objective Decision, goal or desired action	To manage environmental flows for winter-run Chinook Salmon in the Upper Sacramento River through reservoir management. **Decision:** How much water should be released from the reservoir, at what time, in order to maintain optimal water level and temperature range for salmon?
Description Important context and background information	Winter run Chinook salmon[9] travel upriver to lay their eggs in redds (gravel "nests") created in the shallow gravel at the edges of the riverbed below the Keswick and Folsom dams. Endangered species regulations stipulate the need to protect salmon habitats and manage river flow for their reproductive success. Necessary habitat conditions include maintaining water levels to ensure eggs remain submerged, and ensuring the water temperature range is optimal for fry emergence. Management of cold-water pools is difficult given the physical constraints on water release.
Participants The main decision-maker; also note other parties involved or affected	• Reservoir operator implementing decisions about flows and releases • Broader level stakeholders concerned with outcomes: Regulatory agencies; Environmental NGOs
Regulatory context Legal, regulatory, and	Constraints on dam operations include: • Endangered Species Act rules • Fish and Game Code 5937[10] • FERC regulations and licensing processes[11]

[9] http://www.nmfs.noaa.gov/stories/2015/09/spotlight_chinook_salmon.html

[10] California FGC § 5937 states: "The owner of any dam shall allow sufficient water at all times to pass through a fishway, or in the absence of a fishway, allow sufficient water to pass over, around or through the dam, to keep in good condition any fish that may be planted or exist below the dam."

[11] See https://www.ferc.gov/industries/hydropower/gen-info/regulation/dam-safety.asp

reporting requirements	Dam operators must balance environmental flows with other dam requirements including hydropower, storage, flood protection, and downstream reservoir needs.
Workflow Progression of steps and specific actions taken by participants to accomplish objective	The operator must analyze the physical constraints on the system in terms of handling velocity and volume. This information must be combined with monitoring data on the status of endangered species populations impacted by the flow. Based on this information the operator must make decisions around how much water to release, and the timing of the release. Operational decisions made by the operator must include data that spans multiple timeframes. For example, data on the forecasted water year type helps determine the annual to monthly minimum flow. Inflows and reservoir storage decisions are made at the weekly level, and hydropower generation happens on a daily basis depending on base load or peaking.

Data sources
Existing data sources; data gaps. Be as specific as possible
	• Fish data: Seasonal population field surveys; number of spawning salmon; redd counts; seasonal mortality estimates; status of redds (hatch data)
	  ○ CA Department of Fish and Wildlife Data Portal
	• Real time monitoring of water depth and temperature at redd sites
	  ○ CA Data Exchange River Stage Maps
	• Reservoir-related data: Flood storage capacity; Spatial context (routing and travel time); time series (inflow/outflow at different time intervals- 15 min, hourly, daily, monthly yearly; Exceedance probability); Reservoir levels; inflow projections; hydrology above dam; Rule curves
	  ○ CA Data Exchange Center: Reservoirs
	  ○ NOAA River & Reservoir data
	• Weather and climate data: Snowpack content; precipitation forecast; temperature forecast
	  ○ California Data Exchange Center information, including precipitation, reservoirs, and snow
	  ○ USGS California water flow data
	  ○ NOAA Precipitation Frequency Data Server
	• Regulatory-related information: Downstream flow requirements; Water quality objectives

	• Alternatives for management: Flow management decisions, alternatives, & options at other dams in the area • Data gaps found: no consistent data found regarding rule curves for reservoir operations. Not consistently or readily available for all reservoirs. SEE TABLE BELOW for list of data sources with access methods.
Data characteristics Notes about type and form of data	• Time scales vary: Some data is seasonal, while other data must be real-time • Current data systems vary across infrastructure, geography, and by organization; multiple entities coordinate flows. • Barriers include time lags in data review, as well as issues of outdated technology, and potential trust issues around sharing of data.

Additional comments:

- **Complexity and intersection of multiple data types:** This management scenario involves multiple categories of decisions, including operational, tactical, and strategic decisions depending on the frequency of the decision and relationship to overall policy. The types of data and level of data analysis relates to the type of decision. Data needs include real time air temperature, solar radiation levels, threshold temperatures for different species, water release temperature, transit time, and ambient temperature.
- **Decision implementation:** Dam operators often are the ones implementing decisions based on data, but do not necessarily make the decisions. There are critical decisions like this for every Federal Energy Regulatory Commission (FERC) licensed dam.
- **Importance of information infrastructure:** Information infrastructure (what moves data throughout the management system, as well as data validation and risk/uncertainty assessments) is particularly critical to environmental flows decisions.
    - Dam operations affect water systems, and there are many dams in California. It is necessary to consider standards of exchange among unlike systems. Multiple systems exist and serve different priorities. A narrow focus on the modeling for a specific system may miss the bigger picture. There is a need for extensible, enabling standards that can also be added to in the future. Additionally, a solid understanding of the physical system is critical—there is a need for a spatial network that includes the groundwater system, which is a key part of the data needed to build the model of the overall water system.

- The communication of information has to match the need for the timeliness of the decision. In the case of 2016 winter run Chinook salmon management, key data monitoring technology failed and the error was not caught in time.
- This case raises opportunities, including the chance to conduct a data quality assessment, the potential for harnessing current technologies, and the potential for long term investment in data management.

Use case 3: Data sources

Topic	Description	Data source description	Access Method
Fish and Wildlife	Seasonal salmon population estimates	CDFW Anadromous Assessment	http://www.dfg.ca.gov/fish/Resources/Chinook/CValleyAssessment.asp
Water	Hydrologic conditions	DWR CDEC information, including precipitation, reservoirs and snow	http://cdec.water.ca.gov/
Weather and Climate	Weather and climate data	DWR CDEC Snowpack content; precipitation forecast; temperature forecast	http://cdec.water.ca.gov/
Water	Reservoir levels	DWR CDEC daily reservoir storage summary	http://cdec.water.ca.gov/cgi-progs/current/RES
Water	Flood storage capacity of reservoirs	DWR CDEC Real time reservoir storage data	http://cdec.water.ca.gov/cgi-progs/getAll?sens_num=15
Water	Reservoir management alternatives at nearby dams	DWR CDEC Reservoir information	http://cdec.water.ca.gov/misc/resinfo.html
Water	Reservoir scheduled releases	DWR CDEC reservoir scheduled releases data	http://cdec.water.ca.gov/queryRes.html
Water	Precipitation	NOAA Precipitation Frequency Data Server	http://hdsc.nws.noaa.gov/hdsc/pfds/
Water	River stage and flow	NOAA River and Reservoir data	http://www.cnrfc.noaa.gov/river_data.php
Ecology	Seasonal salmon population estimates	CDFW Anadromous Assessment	http://www.dfg.ca.gov/fish/Resources/Chinook/CValleyAssessment.asp
Water	Water quality objectives	SWRCB water quality goals database	http://www.waterboards.ca.gov/water_issues/programs/water_quality_goals/
Water	Reservoirs	DWR CDEC Reservoirs	https://cdec.water.ca.gov/reservoir.html
Water	River stage and flow	DWR CDEC River Stage Maps	https://cdec.water.ca.gov/stage_maps/
Ecology	Spawning salmon counts	CDFW data portal	https://nrm.dfg.ca.gov/
Ecology	Salmon redd counts	CDFW data portal	https://nrm.dfg.ca.gov/
Ecology	Status of redd hatches	CDFW data portal	https://nrm.dfg.ca.gov/

Topic	Description	Data source description	Access Method
Ecology	Seasonal salmon mortality estimates	CDFW data portal	https://nrm.dfg.ca.gov/
Water	Inflow/outflow at different time intervals	USGS California streamflow data	https://waterdata.usgs.gov/ca/nwis/rt
Water	Streamflow	USGS California streamflow data	https://waterdata.usgs.gov/ca/nwis/rt
Water	Downstream flow requirements	CDFW Instream Flow Recommendations map	https://www.wildlife.ca.gov/Conservation/Watersheds/Instream-Flow/Recommendations
Water	Rule curves for reservoir operations		Data gap- not consistently or readily available for all reservoirs

Use case 4: Groundwater basin water budgets

Developed at Data for Water Decision Making Workshop 2, May 8, 2017

Objective Decision, goal or desired action	Quantify inputs, outputs, and changes in storage (i.e., water budget) within the basin, at appropriate spatial and temporal scales, with accuracy sufficient to inform groundwater management.
Description Important context and background information	The Sustainable Groundwater Management Act (SGMA) [12] requires local public agencies and groundwater sustainability agencies (GSAs) residing within high and medium priority groundwater basins to develop and implement groundwater sustainability plans (GSPs) with the goal of managing groundwater sustainably. A tool that many GSAs may choose to employ in developing their GSPs is that of a *water budget.* Water budget is defined as an accounting of the total groundwater and surface water entering and leaving a basin including the changes in the amount of water stored.[13] Absent direct measurements of groundwater pumping data, groundwater is generally calculated as a closure term after approximating other water uses such as evapotranspiration. Absent direct measurements of groundwater pumping data, groundwater level is generally calculated as a closure term after approximating how much water is used by evapotranspiration (which is still an uncertain measurement). SGMA requires that aggregate annual groundwater extractions be calculated. The goal of a water budget is to track and compare inflows and withdrawals over a given time period to understand the system and identify changes in storage. Furthermore, a water budget is required by DWR's regulations for Groundwater Sustainability Plans.[14]

[12] All references to SGMA relate to California Water Code sections in Division 6, Part 2.74.

[13] Cal.Water Code § 10721 (y)

[14] See section 354.18. Note that DWR is developing a pilot water budget framework which includes two pilot study areas: Tulare Lake and the Central Coast. Both include six critically over-drafted basins and several high/medium priority basins. Tulare Lake is considered “data rich” while the Central Coast region is “data

Participants The main decision-maker; also note other parties involved or affected	Primary decision-makers: • GSA—multiple GSAs will need to coordinate with each other to develop a water budget • Water users Other participants: • DWR • SWRCB Groundwater Management Unit • IRWM groups • Groundwater management agencies; other water agencies • Groundwater-reliant groups/individuals (e.g., farmers, rural communities) • Neighboring areas • Local government (e.g., cities, counties) • Non-governmental organizations (e.g., groundwater-dependent ecosystem constituents and advocates) • Stakeholders required under SGMA and other regulations (SWRCB, Department of Fish & Wildlife, tribes, federal agencies, etc.)
Regulatory context Legal, regulatory, and reporting requirements	Primary regulatory context : • Sustainable Groundwater Management Act (SGMA)[15] Other aspects: • Best Management Practices (BMPs) developed by DWR include water budgets, along with modeling, and monitoring networks. • DWR requires an annual report that includes information about groundwater elevation, groundwater extraction, surface water supply used for or available for use for groundwater recharge, total water use, and change in groundwater storage.[16] • If GSP is inadequate or incomplete, there is a distinct process outlining state intervention. Intervention

poor." The lessons learned will be used to develop a watershed-based water budget framework, enhancing the data and assumptions in the pilot study areas, and implementing the water budget framework in other hydrologic regions.

[15] Cal. Water Code D. 6 Pt. 2.74

[16] Cal. Water Code section 10728.

	mandates monthly (or more frequent) data reporting in addition to meters. This is more frequent than what would otherwise be required.

Workflow
Progression of steps and specific actions taken by participants to accomplish objective
	• Develop a data collection and coordination agreement within the basin.[17] This agreement might include:
	  ○ Development of a conceptual model, methods, and data sources (can evolve).
	  ○ Identification of the appropriate temporal and spatial scale for data collection, analysis, etc., and the level of data accuracy needed to quantify changes in storage.
	  ○ Identification of financial resources to support the development of the water budget.[18]
	• Develop a water budget.
	  ○ Identify water budget's inputs and outputs, with enough accuracy to inform management.
	• Validate and clean up data.

Data sources Existing data sources; data gaps.	Groundwater recharge is typically calculated as a closure term after calculating evapotranspiration. Data gaps vary by region. Data sources include: Locally available: • Ag commissioners' reports • Groundwater pumping records • Local planting records • Other local records Statewide: • California Water Plan Water Portfolio • C2VSim/CVHM and other state and federal models • DWR Land Use Surveys • Remote Sensing ET/crop information (including Metric, Land IQ, SIMs, and other methods) • Cal-SIMETAW and California Irrigation Management Information System (CIMIS)

[17] Multiple GSPs in a single basin must use the same data and must be coordinated by a single point of contact established by GSAs within the basin.
[18] Compliance is mandatory regardless of resources available, but identifying what funds will be used is necessary to complete the water budget.

	• State and federal delivery records • Stream gauge data • CASGEM groundwater elevations • California Pesticide Database • Other statewide datasets • SWRCB probationary basin data as data source for those probationary basins who regain local control. Other: • Groundwater-dependent ecosystems (TNC) • Climate change scenarios (WSIP, BMPs) defined in California Water Plan • Water storage investment program (can be downscaled for GSPs; not required but available) • Bulletin 118—basin boundaries • Precipitation—PRISM Data gaps: • The availability to local planting records varies by location and region • Economic impacts of water allocation decisions • Groundwater-surface water connectivity • Groundwater pumping • Groundwater-dependent ecosystems • Terrain models and base models • Pumping data not yet available, although the data source is being created SEE TABLE BELOW for list of data sources with access methods.
Data characteristics Notes about type and form of data	Issues to address: • It is important to reduce and/or characterize uncertainty within the data, and the effect of the uncertainty on the decision making process. • Terms may have multiple meanings in different contexts. Clarifying meanings of terms is important. (e.g., deep

	percolation means several different things)
	• Allowable data gaps must be defined (e.g., sometimes data are discarded if there are more than 2 months of missing data)
	• SGMA raises concerns among land managers about their ability to decide how much they can pump sustainably. Water pumping decisions by individual land managers requires more fine-grained data than what is calculated in the aggregate annual basin-scale measurements required by SGMA.
	• Some other **data gaps** that may arise if new information is required:
	  o Groundwater quality
	  o Terrain models—base models; accuracy and precision; vertical control; pinning digital data to measured locations via geodetic networks & applying cooperatively
	  o Socioeconomics—somewhat out of the purview of water budgets, but this is likely how allocation decisions will get made
	  o Land use is an uncertainty, and is important because it is necessary to derive ET.
	  o The validation of ET calculations.

Additional comments:

- Goals of water budgets vary between different users: individual land managers vs GSA-scale decision making. This raises scalar tensions around data needs. “Appropriate spatial and temporal scales” for different objectives and different decisions will vary.
- Uncertainty may be very significant. Some data may be sufficiently certain, while other data may be unacceptable for informing decision making.
- Metadata is important.
- There are important differences between derivative/ calculated vs primary data. Derived data must be trackable.
- High and medium priority basins will each need a water budget as specified by SGMA—this is a big project.
- Land use is the biggest relevant data gap.

Use case 4: Data sources

Topic	Description	Data source description	Access Method
Agriculture	Evapotranspiration	California Irrigation Management Information System (CIMIS)	http://www.cimis.water.ca.gov/
Water	Groundwater quality	SWRCB Groundwater Ambient Monitoring and Assessment Program (GAMA)	http://geotracker.waterboards.ca.gov/gama/
Agriculture	Pesticide data	DPR California Pesticide Database	http://www.cdpr.ca.gov/dprdatabase.htm
Agriculture	Evapotranspiration	California Irrigation Management Information System (CIMIS)	http://www.cimis.water.ca.gov/
Land use	Remote sensing land analysis	Land IQ	http://www.landiq.com/
Weather and Climate	Climate patterns	PRISM climate group precipitation data	http://www.prism.oregonstate.edu/mtd/
Water	Groundwater basin maps	DWR Bulletin 118 basin boundaries	http://www.water.ca.gov/groundwater/bulletin118/gwbasins.cfm
Water	Groundwater elevation	DWR CASGEM Groundwater elevation monitoring	http://www.water.ca.gov/groundwater/casgem/
Water	Groundwater levels	DWR CASGEM Groundwater elevation monitoring	http://www.water.ca.gov/groundwater/casgem/
Land use	Land use surveys	DWR Land Use Surveys	http://www.water.ca.gov/landwateruse/lusrvymain.cfm
Agriculture	Crop ET	DWR SIMETAW-- Simulation of Evapotranspiration of Applied Water (SIMETAW)	http://www.water.ca.gov/landwateruse/models.cfm
Water	State water delivery records	DWR State water project monthly operations data	http://www.water.ca.gov/swp/operationscontrol/monthly.cfm
Weather and Climate	Climate change scenarios	DWR - California Water Plan scenarios	http://www.water.ca.gov/waterplan/scenarios/index.cfm
Water	Water balances	DWR California Water Plan Water Portfolio-DWR	http://www.water.ca.gov/waterplan/topics/water_portfolios/index.cfm
Geology and soils	Subsidence	USGS subsidence map	https://ca.water.usgs.gov/land_subsidence/california-subsidence-areas.html

Topic	Description	Data source description	Access Method
Water	Groundwater models	USGS Groundwater Modeling: California Groundwater Model Archive	https://ca.water.usgs.gov/sustainable-groundwater-management/california-groundwater-modeling.html
Water	Stream gauge data	USGS California streamflow data	https://waterdata.usgs.gov/ca/nwis/rt
Agriculture	Agricultural commissioner reports	USDA agricultural comissioner reports database	https://www.nass.usda.gov/Statistics_by_State/California/Publications/AgComm/Detail/
Water	Federal water delivery records	USBR Central Valley Project operations data	https://www.usbr.gov/mp/cvo/
Water	Water storage investment program (can be downscaled for GSPs; not required but available)	CDFW Water Storage Investment Program [info about, not data]	https://www.wildlife.ca.gov/Conservation/Watersheds/WSIP
Mapping and modeling	Terrain models base models; accuracy and precision; vertical control; pinning digital data to measured locations via geodetic networks and applying cooperatively		Data gap
Socioeconomic	Economic impacts of water allocation decisions		Data gap
Agriculture	Local planting records	Varies	Data gap-- Availability and accessibility of data varies by location and region
Water	Pumping data		Data gap
Water	Groundwater-surface water connectivity		Data gap
Water	Groundwater pumping		Data gap
Water	Groundwater-dependent ecosystems		Data gap (For now-- TNC working with DWR to create this data source?)

Use case 5: Delta hydrographs

Developed at Data for Water Decision Making Workshop 2, May 8, 2017

Objective Decision, goal or desired action	Establish Delta water quality thresholds and hydrology thresholds for different water quality standards as a proactive approach as an alternative to Temporary Urgency Change Petitions (TUCPs).[19] Types of potential thresholds could include mean sea level; levee condition; water quality (salinity); and/or reservoir levels; Hydrological state of the headwater catchments.
Description Important context and background information	The Sacramento-San Joaquin Bay-Delta is a highly complex and intensely managed system that has been impacted by recent droughts, TUCPs, and a warming climate.[20] Looking forward, managing the Delta in the context of climate change will require adaptation planning.[21] This use case considers projected climate change impacts on seasonal hydrographs affecting Delta water quality, and how projections impact Delta water management options and issues (such as habitat for native species, risk management for levees and Delta communities, and water conveyance to the export facilities). Specifically, this use case considers the proactive establishment of thresholds for water quality standards in the Delta as an alternative to Temporary Urgency Change Petitions (TUCPs).[22]
Participants The main decision-maker; also note other	Main decision maker: SWRCB **Other participants:** Local water agencies, DWR, USBR

[19] For more information see http://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/tucp/index.shtml
[20] For more information on the Delta and climate change, see http://deltaconservancy.ca.gov/climate-change-1/
[21] Aspects of adaptation planning that can be leveraged into operational implementation in the Delta include: dam management; resource management; land use; policy and funding; sediment; wildlife; exports and water use; and regulatory structure, implementation, and process.
[22] For more information see http://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/tucp/index.shtml

parties involved or affected	
Regulatory context Legal, regulatory, and reporting requirements	• The federal Endangered Species Act involves the issuance of Biological Opinions to protect endangered species; these biological opinions constrain water project operations .[23] • Other regulatory contexts include the federal Clean Water Act, the state Water Code, and the Public Trust Doctrine.

Workflow
Progression of steps and specific actions taken by participants to accomplish objective
	1. Identify and engage with stakeholders to determine priorities, tradeoffs, and costs
	2. Determine a priori thresholds (triggers and priorities)
	  a. Identify space/time locations for thresholds
	3. Collect data on different thresholds
	  a. Quantify volume and timing to necessary meet water management objectives
	4. Use decision-support tools to conduct analysis
	  a. Use analytical methods to move from hydrograph to water use priorities
	  b. Compare different types of thresholds
	  c. Evaluate data requirements: which data is essential; which data doesn't make a dent in the water budget?
	5. Make decisions around which thresholds can best meet priorities

Data sources Existing data sources; data gaps. Be as specific as possible	Data needs: • Sonar images for bathymetry (DWR) • Electrical conductivity sensors (DWR) • Vegetation maps (DFW) • Crab samples (SWRCB/DWR/local government) • Fish counts (DWR/DFW)

[23] For more information see https://www.fws.gov/sacramento/es/Consultation/Biological-Opinions/es_consultation_biological-opinions.htm

	• Stream gauges (USGS/DWR)
	• CEDEN—not real time
	• Water supply (water agencies, wholesalers, districts, retailers, contractors, etc.)
	• Water demand (disparate interests)
	  ○ Urban
	  ○ Recreation
	  ○ Agriculture
	  ○ Environment
	• Water rights
	• Water use (total withdrawals, consumptive use)
	• Water in the system for future use
	  ○ Snowpack storage
	  ○ Surface storage
	  ○ Accessible groundwater
	  ○ Existing water quality
	• Precipitation forecasts (10 day to 30+ year)
	• Species of concern
	• Acreage in permanent crops
	• Critical industrial needs
	• Water diversions
	• Groundwater pumping
	• Return flows
	• Delta inflow
	• Reservoir storage levels—inflow forecast
	• Historical precipitation patterns
	• Tidal projections/relationships
	• City/county land use (general plans for future demands)
	• Extreme event costs (unrealized investments)

	• Groundwater depletion • Land subsidence • Studies of past TUCP events and outcomes Data gaps: • Critical Industrial Needs • Cost of extreme events (unrealized investments) • Groundwater pumping • City/county land use (general plans for future demands) • Water demand for recreation • Small stream flow accretions • Water diversions and discharges in real time • Return flows • Water demand (disparate interests) • Studies of past TUCP events and outcomes SEE TABLE BELOW for list of data sources with access methods.
Data characteristics Notes about type and form of data	Desired characteristics—in one place, uniform assumptions • Some other **data gaps** that may arise if new information is required: o Real time diversions and discharges o Weather forecasts beyond 8 days o Tools to model scenarios

Use case 5: Data sources

Topic	Description	Data source description	Access Method
Agriculture	Agricultural land use	DWR land use survey	http://www.water.ca.gov/landwateruse/lusrvymain.cfm
Agriculture	Acreage in permanent crops	USDA National Agricultural Statistic Service-Fruits and Nuts	https://www.nass.usda.gov/Statistics_by_State/California/Publications/Fruits_and_Nuts/index.php
Agriculture	Agricultural land use	DWR land use survey	http://www.water.ca.gov/landwateruse/lusrvymain.cfm
Agriculture	Farmland maps	California Department of Conservation Farmland Mapping and Monitoring Program (county-level data)	http://www.conservation.ca.gov/dlrp/fmmp
Ecology	Vegetation maps	CDFW Vegetation Classification Program (VegCAMP)	https://www.wildlife.ca.gov/Data/VegCAMP
Ecology	Environment	CDFW BIOS (Biogeographic Information and Observation System)	https://www.wildlife.ca.gov/Data/BIOS
Ecology	Species of concern	CDFW BIOS (Biogeographic Information and Observation System)	https://www.wildlife.ca.gov/Data/BIOS
Ecology	Fish counts	CDFW data portal	https://nrm.dfg.ca.gov/
Ecology	Benthic data- grab samples	DWR Environmental Monitoring Program	http://www.water.ca.gov/bdma/meta/benthic/data.cfm
Geology and soils	Land subsidence	USGS subsidence map	https://ca.water.usgs.gov/land_subsidence/california-subsidence-areas.html
Mapping and modeling	Sonar images for bathymetry	DWR Delta bathymetric surveys	http://www.water.ca.gov/levees/evaluation/bathy.cfm
Water	Historical precipitation patterns	Western Regional Climate Center historical data	https://wrcc.dri.edu/
Water	Stream gauge data	USGS California streamflow data	https://waterdata.usgs.gov/ca/nwis/rt
Water	Tidal projections/relationships	USGS continuous monitoring in the Delta	https://ca.water.usgs.gov/projects/baydelta/
Water	Precipitation forecasts	NOAA Weather Prediction Center	http://www.wpc.ncep.noaa.gov/index.shtml#page=ovw
Water	Water rights	SWRCB Water Board Electronic Water Rights Information Management System (eWRIMs)	http://www.waterboards.ca.gov/waterrights/water_issues/programs/ewrims/index.shtml

Topic	Description	Data source description	Access Method
Water	Electrical conductivity sensors	DWR San Joaquin River Real-Time Water Quality Program	http://www.water.ca.gov/waterquality/sjr_realtime/
Water	Water use (total withdrawals/consumptive use)	DWR agricultural water use models	http://www.water.ca.gov/landwateruse/models.cfm
Water	Groundwater depletion	DWR CASGEM Groundwater elevation monitoring	http://www.water.ca.gov/groundwater/casgem/
Water	Existing water quality	DWR Bay-Delta Monitoring Program	http://www.water.ca.gov/bdma/meta/continuous.cfm
Water	Water supply (water agencies/wholesalers/districts/retailers/contractors/etc.)	DWR CDEC water supply	http://cdec.water.ca.gov/water_supply.html
Water	Snowpack storage	DWR CDEC information on precipitation; snowpack; runoff forecasts; river runoff; and reservoir storage	http://cdec.water.ca.gov/water_cond.html
Water	Reservoir and surface storage	DWR CDEC reservoir storage by hydrologic region	http://cdec.water.ca.gov/cgi-progs/reservoirs/STORAGEW
Water	Accessible groundwater	DWR Bay-Delta IWFM Model	http://baydeltaoffice.water.ca.gov/modeling/hydrology/IWFM/
Water	Delta inflow	DWR Bay-Delta IWFM Model	http://baydeltaoffice.water.ca.gov/modeling/hydrology/IWFM/
Weather and Climate	Climate predictions (short term)	National Weather Service Climate Predictions and forecasts (1-13 months)	http://www.cpc.ncep.noaa.gov/products/forecasts/
Water	Water demand (disparate interests)		Data gap- what interests are included?
Water	Return flows		Data gap- possible to calculate from other numbers?
Socioeconomic	Studies of past TUCP events and outcomes		Data gap- may exist but not readily available
Land use	City/county land use (general plans for future demands)		Data gap- available locally at city and county level in many cases
Socioeconomic	Critical industrial needs		Data gap

Topic	Description	Data source description	Access Method
Socioeconomic	Extreme event costs (unrealized investments)		Data gap
Water	Water demand for recreation		Data gap
Water	Water diversions and discharges- real time		Data gap
Water	Groundwater pumping		Data gap
Water	Small stream flow accretions		Data gap

Use case 6: Water transfers for environmental purposes

Developed at Data for Water Decision Making Workshop 2, May 8, 2017

Objective Decision, goal or desired action	**Goal:** Assess a plan for a hypothetical 1-year instream water transfer on a small stream in upper Sacramento River watershed (e.g., Mill Creek). The goal of the hypothetical water transfer is to maintain or enhance instream flows for environmental purposes. Decisions: 1. Is the transfer legal? 2. Does the transfer accomplish the purpose (i.e., does the completed transfer solve the environmental problem)? 3. What benefits were achieved and for what environmental resource (e.g., X amount of water at Y time abundance and for what species)?
Description Important context and background information	An environmental water transfer is a mechanism to allow water rights holders to transfer appropriative water rights to others. The transfer dedicates existing diversionary rights for instream use to protect or restore environmental values. For example, the Nature Conservancy buys water for September/October attractant flows for migratory fish species. Identification of environmental goals and benefits is traditionally left up to the buyer and seller, requiring a sophisticated, funded buyer to determine where to buy water, but having good data could potentially create the opportunity for a more automated system that identifies and enables environmentally beneficial transfers.
Participants The main decision-maker; also note other parties involved or affected	• Water rights holders (proponents for financial reasons, proponents, potential injured) • NGOs (proponents) • SWRCB (regulatory decision-maker) • Fisheries agencies (DFW, NMFS) • Federal Energy Regulatory Commission (FERC), as appropriate
Regulatory context	• Clean Water Act • Porter-Cologne Act

Legal, regulatory, and reporting requirements	• Federal and state Endangered Species Act; • Possibly FERC relicensing (with upstream reservoirs) • California Water Code § 1707, Petitions for Instream Flow Dedication (to ensure protection of flows, others' water rights) • CEQA (may be required for pre-1914 transferors, although post-1914's are CEQA exempt)
Workflow Progression of steps and specific actions taken by participants to accomplish objective	• Clearly identify the environmental goals and benefits • Identify participants • Identify transaction process (e.g., CWC § 1707) • Reach agreement on baseline (what would have happened absent the transfer) • Carry out transaction process • Track transfer and demonstrate benefit

Data sources
Existing data sources; data gaps. Be as specific as possible
	General categories:
	• Transaction information (buyer, seller, location, price)
	• Information needed about source water
	• Information needed to track the transfer
	• Information needed to demonstrate the benefit
	
	More detailed types of data needed:
	• Transfer based on stored water
	  ○ Storage baseline
	  ○ Release volume (cfs)
	• Transfer based on groundwater substitution
	  ○ Daily pumping, each well
	• Transfer based on crop changes
	  ○ Crop types
	  ○ Crop acreage (satellite, aerial, etc.)

	• Water rights holders
	• Flow paths → assessment of changes
	  o (Historical) diversions
	  o Consumptive use
	  o Percolation
	  o Returns
	• Regulated flows
	• Stream flows
	  o Volume
	  o Temperature
	  o Timing
	• Benefits data
	  o Streamflow volume, temperature, timing
	  o Environmental characteristics / functionality
	
	Sources:
	• California Data Exchange Center (CDEC)
	• California Environmental Data Exchange Network (CEDEN)
	• CIMIS
	• USGS (flow gauges, temperature)
	• EWRIMS
	• SWRCB file room
	• County agricultural commissioner reports
	• Landsat, etc.
	• Aerial imagery
	
	Data gaps:
	• Transaction information (buyer/seller/location/price)

	• Long term impacts of ground water pumping • Well logs • Water rights • Methodology for transfers from urban areas (better info. for urban groundwater substitution) • Some other **data gaps** that may arise if new information is required: Data on inelastic subsidence SEE TABLE BELOW for list of data sources with access methods.

Use case 6: Data sources

Topic	Description	Data source description	Access Method
Agriculture	Agricultural commissioner reports	USDA agricultural commissioner reports database	https://www.nass.usda.gov/Statistics_by_State/California/Publications/AgComm/Detail/
Agriculture	Crop types	USDA NASS- estimates of crop types (statewide)	https://www.nass.usda.gov/Quick_Stats/Ag_Overview/stateOverview.php?state=CALIFORNIA
Agriculture	Crop acreage (satellite/aerial/etc.)	DWR land use survey	http://www.water.ca.gov/landwateruse/lusrvymain.cfm
Agriculture	Farmland mapping	California Department of Conservation Farmland Mapping and Monitoring Program (county-level data)	http://www.conservation.ca.gov/dlrp/fmmp
Agriculture	Evapotranspiration	California Irrigation Management Information System (CIMIS)	http://www.cimis.water.ca.gov/
Ecology	Environmental characteristics / functionality	FWS HEP (Habitat Evaluation Procedure)	https://www.fws.gov/policy/ESMindex.html
Geology and soils	Data on inelastic subsidence	USGS subsidence map	https://ca.water.usgs.gov/land_subsidence/california-subsidence-areas.html
Land use	Landsat data	USGS Landsat Look Viewer	https://landsatlook.usgs.gov/
Land use	Aerial imagery	USGS aerial imagery collection	https://eros.usgs.gov/aerial-photography
Water	Regulated flows	CDFW Instream Flow Recommendations map	https://www.wildlife.ca.gov/Conservation/Watersheds/Instream-Flow/Recommendations

Topic	Description	Data source description	Access Method
Water	Percolation	USDA soil survey mapping tool	https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm
Water	Consumptive use	USGS water use data	https://waterdata.usgs.gov/ca/nwis/wu
Water	Streamflow	USGS California streamflow data	https://waterdata.usgs.gov/ca/nwis/rt
Water	Volume	USGS water data	https://ca.water.usgs.gov/data/waterdata/
Water	Water rights	SWRCB Water Board Electronic Water Rights Information Management System (eWRIMs)	http://www.waterboards.ca.gov/waterrights/water_issues/programs/ewrims/index.shtml
Water	Returns	California Irrigation Management Information System (CIMIS)- Can be calculated based on ET	http://www.cimis.water.ca.gov/
Water	Water quality	California Environmental Data Exchange Network (CEDEN) Water Quality data	http://www.ceden.org/
Water	Stream temperature	Rangeland WaterShed Laboratory	http://rangelandwatersheds.ucdavis.edu/main/projects/project_stream_temperature.html
Water	Storage release	DWR CDEC reservoir scheduled releases data	http://cdec.water.ca.gov/queryRes.html
Water	Storage baseline	DWR CDEC reservoir storage by hydrologic region	http://cdec.water.ca.gov/cgi-progs/reservoirs/STORAGEW
Water	Hydrologic conditions	DWR CDEC hydrologic conditions	http://cdec.water.ca.gov/
Water	Historical diversions of water	C2VSim: California Central Valley Groundwater-Surface Water Simulation Model	http://baydeltaoffice.water.ca.gov/modeling/hydrology/C2VSim/index_C2VSIM.cfm
Weather and Climate	Temperature data	NOAA weather service	http://www.weather.gov/
Water	Water rights	SWRCB file room	Data gap-- Data is not online, physical copies only
Water	Well logs	DWR Well Completion Reports	Data gap- not readily available. See http://www.water.ca.gov/groundwater/wells/well_completion_reports.cfm
Socioeconomic	Transaction information (buyer/seller/location/price)		Data gap
Water	Methodology for transfers from urban areas (better info. for		Data gap

Topic	Description	Data source description	Access Method
	urban groundwater substitution)		
Water	Long-term impacts of groundwater pumping		Data gap

Use case 7: Capital investment in headwaters restoration

Developed at Data for Water Decision Making Workshop 2, May 8, 2017

Objective Decision, goal or desired action	Key objectives: 1. Restore and maintain headwaters in a sustainable condition. 2. Build public support, link awareness and knowledge. 3. Quantify the suite of benefits from management and restoration. Key issues: • These are investments the public is not used to supporting. • There is a need to make the environmental benefits obvious. • Grey infrastructure is affected by green infrastructure. Types of decisions include: • Investment and policy decisions • Programmatic implementation decisions • Operational decisions
Description Important context and background information	Capital investments in headwaters are needed to ensure the long-term sustainability of state water sources. Future water needs are unclear, but climate change and population trends indicate increased pressure on the state system overall. Water users do not typically know where their water comes from beyond the tap, and do not necessarily think of themselves as stakeholders, although they may benefit from infrastructure in the headwater regions. Headwater restoration requires an awareness of downstream and upstream communities, and the threats and opportunities therein. Headwater management requires a willingness to invest or take action and an awareness of the benefits to users. The goal of headwater management is to restore, maintain, and monitor the green infrastructure of headwaters.

	There are multiple ecosystem benefits to headwater restoration; those derived from investments in the water system can often be monetized. Headwater restoration is part of natural resources portfolio accounting. There is a need to quantify across multiple management systems. Headwater restoration has the potential to positively affect: • Water availability later in spring/summer • Water quality and downstream water treatment cost (i.e. protection) • Recreational benefits and the recreational economy • Fire risk and the risk to infrastructure (e.g., power lines, pipes) • Other risk and insurance premiums Determining supply and demand (water markets), water yields, and return on investment (ROI) are important aspects of headwater investment. Decision-makers are concerned about headwaters from a variety of perspectives; some want to sustain, others want to augment and improve headwater infrastructure. In headwater regions and across the state there are diverse stakeholders with diverse funding opportunities.
Participants The main decision-maker; also note other parties involved or affected	• State and federal agencies with public funding (e.g. Bureau of Reclamation grant programs) • Land managers, forest supervisors (USFS, USFW) • State and federal legislatures • Local stakeholders: Tribes, NGOs, GSAs, Watershed Councils, private land owners • Consumers/voters/ratepayers • Public health evaluators • Air Resources Control Board • Sierra Business Council • Community Water Center • Water and electricity providers (e.g., PG&E, SMUD, TID) • Water quality control boards • Private companies (e.g., breweries, water bottling companies, beverages companies)

	• Potential funders and thought leaders (e.g. tech companies, foundations)
Regulatory context Legal, regulatory, and reporting requirements	• NEPA • CEQA • Fish and Wildlife Service, Forest Service rules and oversight • Clean Water Act • Endangered Species Act (ESA) • Historic preservation • State requirements • Antiquities Act of 1906 Key issue: The U.S. Forest Service's congressional mission does not fully address the value of water nor the nexus of forest and water management. The primary focus of the Forest Service is on timber production and the reduction of wildfire threats.
Workflow Progression of steps and specific actions taken by participants to accomplish objective	The workflow needs to address how partners with different perspectives can work together in a more simplified and cost-effective way. It should also outline long-term and short-term actions and assess the regulatory and project management framework. Overview of steps to accomplish headwater restoration projects: • Develop local awareness of restoration need (e.g. to reduce fire, address climate change) • Assess and identify goals (i.e. where to locate a projection, what to do, how to design for multiple benefits) • Gather data • Examine regulatory context • Secure project funding and implement the project • Conduct additional stakeholder engagement • Iterate design • Develop financing and business plan to implement project

	Example: the Sierra Nevada Adaptive Management Project (SNAMP)
Data sources Existing data sources; data gaps. Be as specific as possible	There are data needs at every step in the workflow. Sources: • State databases (CDEC and CDEN) • USGS • PRISM • WRCC • Watershed improvement network • Forest Service improvements (hosted data base) • NOAA weather service • Local academic sources for data Data needs: • NEPA requirements for USFS • Decision-making guidelines and management practices • Willingness-to-pay; recreation use • Fire risk as a function of climate • Relevant restoration projects • Climate variability • Drought resiliency • Water flowing out of basins; precipitation; drainage capacity; ET • The value of the water in different years • Water rights • Water demand and use (by location) • Hydropower plans (Power markets impacts)—daily into the dams • Water quality: coliform, chloroform, dissolved organic carbon, temperature, ions, dissolved oxygen, turbidity

	• Forest health indicators • Aquatic ecosystem health indices • Greenness, wetness, biomass, productivity, large scale vegetation maps, geology, soil maps • Tree species responses • Cost-benefit analyses • Approaches to stop bark beetles • High severity fire impacts • Snow vs. rain flows in the system (need a distributed monitoring system) • Stream gauge data • Stream location (LIDAR data for vegetation and terrain) Data gaps and key issues: • Forest inventory analysis • Relevant restoration projects • Water pricing data • Willingness to pay for recreation use • Market value of restoration • Soils Data (not well integrated into existing Forest Service decisions) • Predicted hydrological response of headwater om restored vs current state SEE TABLE BELOW for list of data sources with access methods.
Data characteristics Notes about type and form of data	• Data uncertainties pose challenges to accurately describing and assessing project benefits. • The economic market value of restoration is hard to quantify and monetize—can be characterized in different ways related to forests and water (e.g., C02, turbidity, flow, health, water table level) • The data needs facilitate greater understanding of investment needs so that potential investors and other supporters move beyond their comfort zone to try new projects.

	• Timescale of data creation and collection—some daily, some monthly. Data need to be useful at a temporal or spatial scale—potential mismatch to project needs • Some other data gaps/key issues that may arise if new information is required: ○ Case histories of relevant and related restoration projects ○ Survey data ○ Utility data ○ Hard copy data that have yet to be digitized ○ Inaccessible interfaces, systems, and sources gaps ○ Roadwork—longitudinal quantity and flow data ○ Forest health components

Use case 7: Data sources

Topic	Description	Data source description	Access Method
Agriculture	Evapotranspiration	California Irrigation Management Information System (CIMIS)	http://www.cimis.water.ca.gov/
Ecology	Vegetation maps	CDFW Vegetation Classification Program (VegCAMP)	https://www.wildlife.ca.gov/Data/VegCAMP
Ecology	Fire risk assessment	USFS Wildland Fire Assessment System	https://www.wfas.net/index.php/fire-danger-rating-fire-potential--danger-32
Ecology	Forest health indicators	US Forest Service FLAT-Forest Service Data	https://www.fs.usda.gov/treesearch-beta/pubs/53245
Ecology	Forest Service information	US Forest Service Natural Resource Manager (NRM)	https://www.fs.fed.us/nrm/index.shtml
Ecology	Forest data	US Forest Service DATIM	https://www.fs.fed.us/emc/rig/DATIM/index.shtml

Topic	Description	Data source description	Access Method
Ecology	Bark beetle data	USDA Western Bark Beetle Strategy map layers	https://data.fs.usda.gov/geodata/edw/datasets.php?xmlKeyword=western+bark+beetle+strategy
Ecology	High severity fire impacts	TerrainWorks Ecosystem planning and decision support tool	http://www.terrainworks.com/
Ecology	Aquatic ecosystem health indices	SFEI California Aquatic Resources Inventory (CARI)	http://www.sfei.org/data/california-aquatic-resource-inventory-cari-version-02-gis-data#sthash.IC3VT5oB.dpbs
Ecology	Forest drought resiliency	Tree Mortality Task Force	http://www.fire.ca.gov/treetaskforce/
Ecology	Tree species responses	Fei et al 2017: "Divergence of species responses to climate change"	http://advances.sciencemag.org/content/3/5/e1603055.full
Geology and soils	Soil maps	USDA soil survey mapping tool	https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm
Geology and soils	Soil type	USDA soil survey mapping tool	https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm
Infrastructure and utilities	Utility data- Water	SWRCB	http://www.waterboards.ca.gov/resources/data_databases/
Infrastructure and utilities	Hydropower plans	California Energy Commission	http://www.energy.ca.gov/almanac/renewables_data/hydro/
Infrastructure and utilities	Utility data- Energy	California Energy Commission Almanac	http://www.energy.ca.gov/almanac/
Infrastructure and utilities	Roads	Cal Trans GIS DATA	http://www.dot.ca.gov/hq/tsip/gis/datalibrary/#Highway
Socioeconomic	NEPA requirements for USFS	US Forest Service NEPA procedures	https://www.fs.fed.us/emc/nepa/nepa_procedures/
Socioeconomic	Decision-making guidelines	US Forest Service BMPs	https://www.fs.fed.us/biology/watershed/BMP.html#data
Socioeconomic	Cost-benefit analyses	DWR least-cost planning simulation model-Economic Optimization of Water Management Options	http://www.water.ca.gov/economics/downloads/Models/LCPSIM_Draft_Doc.pdf
Water	Stream gauge data	USGS California streamflow data	https://waterdata.usgs.gov/ca/nwis/rt
Water	Stream location (LIDAR data for vegetation and terrain)	USGS LIDAR data collection	https://lta.cr.usgs.gov/lidar_digitalelevation

Topic	Description	Data source description	Access Method
Water	Water rights	SWRCB Water Board Electronic Water Rights Information Management System (eWRIMs)	http://www.waterboards.ca.gov/waterrights/water_issues/programs/ewrims/index.shtml
Water	Urban water demand	SWRCB water conservation reporting	http://www.waterboards.ca.gov/water_issues/programs/conservation_portal/conservation_reporting.shtml
Water	Watershed improvement information (Sierra Nevada specific)	Sierra Nevada Watershed Improvement Program	http://www.sierranevada.ca.gov/our-work/sierra-nevada-wip
Water	Snow analysis	NOAA National Snow Analysis	http://www.nohrsc.noaa.gov/nsa/index.html?year=2017&month=7&day=25&units=e&region=Western_Coastal, https://waterdata.usgs.gov/ca/nwis/current/?type=precip&group_key=huc_cd
Water	Water quality	California Environmental Data Exchange Network (CEDEN)	http://www.ceden.org/
Water	Water quality: coliform/chloroform/dissolved organic carbon/temperature/ions/dissolved oxygen/turbidity	California Environmental Data Exchange Network (CEDEN)	http://www.ceden.org/
Water	Precipitation	NOAA Precipitation Frequency Data Server	http://hdsc.nws.noaa.gov/hdsc/pfds/
Water	Hydrologic conditions	DWR CDEC hydrologic conditions	http://cdec.water.ca.gov/
Weather and Climate	Weather and climate data	Western Regional Climate Center	https://wrcc.dri.edu/
Weather and Climate	Climate variability	California Climate Data Archive	https://calclim.dri.edu/
Weather and Climate	Weather and climate data	NOAA weather service	http://www.weather.gov/
Weather and Climate	Climate patterns	PRISM climate group precipitation data	http://www.prism.oregonstate.edu/mtd/
Ecology	Relevant restoration projects		Data gap- varies by location and by host of restoration project

Topic	Description	Data source description	Access Method
Geology and soils	Soils data		Data Gap- in terms of integration between forest service decision making and soils data
Ecology	Forest inventory analysis		Data gap
Socioeconomic	Water pricing data		Data gap
Socioeconomic	Willingness-to-pay for recreation use		Data gap
Socioeconomic	Market value of restoration		Data gap

Use case 8: Wetland and riparian mitigation and monitoring

Developed at Data for Water Decision Making Workshop 2, May 8, 2017

Objective Decision, goal or desired action	As part of the National Wetland Condition Assessment effort and in compliance with California's No Net Loss Policy on wetlands, the objective of this use case is to produce the "State of the State Wetlands report." This report provides regional estimates of the ecological integrity and biological conditions of wetlands. The overarching goal of compiling the data in the report is to ensure no overall net loss and achieve a long-term gain in the quantity, quality, and permanence of wetland acreage in California. The main questions the report addresses include: • How healthy are California's wetlands? • Is California gaining or losing wetlands over time? What types? • What are the major stressors for wetlands?
Description Important context and background information	In 1993, the administration of Governor Pete Wilson, through the Natural Resources Agency, established the California Wetlands Conservation Policy. This effort established the State's "No Net Loss" Policy, to replace each newly impacted wetland with a replacement wetland of the same size and with similar wetland functions. The State of the State Wetlands Report is a comprehensive assessment of contemporary gains and losses of wetlands in California: (1) net change from permitted impacts to wetlands, wetland mitigation, and wetland restoration projects, (2) change in the ambient extent of wetlands through California's Statewide Wetlands Inventory, and (3) change in wetland extent from conservation programs such as the Natural Resources Conservation Service's Wetland Reserve Program. Background: Wetlands serve California by providing important ecological and human services including flood control, water quality enhancement, recharge of groundwater, habitat for waterfowl, and breeding and feeding areas for resident and migratory fish, birds, and other wildlife. Losses in wetlands should be considered losses in California's plant and wildlife heritage, the economy, and, in some cases, public safety.

	Major services that wetlands provide are outlined below: • SURFACE WATER STORAGE: Wetlands help prevent flooding by temporarily storing water, allowing it to soak into the ground or evaporate. This temporary storage helps reduce peak water flows after rainstorms by slowing runoff into streams, rivers, lakes, and bays. • POLLUTION CONTROL: Wetlands improve water quality by filtering waterborne sediment, nutrients, pesticides, and bacteria. Pollutants are broken down by biological and chemical processes within the wetlands. • GROUNDWATER RECHARGE: Some wetlands slowly release water into the ground, replenishing aquifers. These aquifers provide water for farms and people, and can extend the period of stream flow from the wet season into the dry season. • NUTRIENT CYCLING: Many wetlands are prone to wet and dry cycles that promote the decomposition of organic matter and the recycling of nutrients back into wetland vegetation, the foundation of many food webs. • PROTECT SHORELINES: Wetland vegetation helps protect shorelines and stream banks by increasing their resistance to erosion, dissipating waves and boat wakes, flood protection, and reducing the velocity and turbulence of nearshore currents. This is a highly valued service because it helps protect flood control levees and other shoreline infrastructure which could act as a natural buffer against sea level rise. Some riparian wetlands help reduce flooding of inland systems. • MAINTENANCE OF BIODIVERSITY: Although most of California's historical wetlands have been converted to other land uses, the remaining wetlands comprise a large portion of the State's natural heritage. • MAINTENANCE OF HABITAT: Wetlands provide important habitat for diverse flora and fauna throughout the state. • RECREATION OPPORTUNITIES: Wetlands provide opportunities for boating, fishing, waterfowl hunting, water sports, and other outdoor experiences for the public. • SUSTAIN TRIBAL CULTURAL PRACTICES: Wetlands are important cultural heritage sites for Native peoples in California to sustain cultural and sustenance practices.

Participants The main decision-maker; also note other parties involved or affected	In California, more than a dozen state and federal regulatory programs are involved in wetland protection and/or controlling activities in wetlands. Individual state agencies, including the State Water Board and nine Regional Water Boards, California State Parks, the California Coastal Commission, the Wildlife Conservation Board Department of Water Resources, and the Department of Fish and Wildlife typically track changes in wetland area associated with their programs. **Main decision-maker:** California Natural Resources Agency is responsible for producing the State of the State Wetlands Report every 10 years. The last report was released in 2010. Other participating entities: • Delta Conservancy, Coastal Conservancy, Tahoe Conservancy, Sierra Nevada Conservancy • Santa Monica Bay Restoration Commission • Southern CA Wetland Recovery Project • Joint Powers Authorities (e.g., SF Estuary Institute) • Marine labs • SF Bay Conservation Development Commission • National Marine Sanctuaries • Regional Habitat Joint Ventures—SF Bay, Silicon Valley, Central Valley (funding vehicles)
Regulatory context Legal, regulatory, and reporting requirements	• California Wetlands Conservation Policy (No Net Loss) • Executive Order W-59-93 • National Wetland Condition Assessment • Water Quality Report to Congress • Clean Water Act (Sections 404, 401, 303d, 305b)—maintain and restore chemical, physical, and biological integrity of navigable waters of the US (tributaries). Sections address listing of impaired waters, assessment, and mitigation. • Porter-Cologne Water Quality Control Act—protect existing and probable future beneficial uses of water throughout the state—e.g. vernal pools, groundwater, seeps, springs, ephemeral springs • Fish and Game Code (Section 1600)—streambed/wetland alteration permit

	• California Endangered Species Act • California Land Conservation Act—agricultural land conservation • California Natural Communities Conservation Act Additional information: • Projects trigger EIR/EIS and NEPA/CEQA processes. • Mitigation approaches are different depending on the regulatory context (i.e. federal vs. state). • The goals of these regulations feed into the assessment of wetland conditions and help frame the contents of the report.
Workflow Progression of steps and specific actions taken by participants to accomplish objective	Projects that potentially impact wetlands go through state and federal permitting processes. Permitting processes generally include assessment, mitigation, and monitoring components. Depending on the regulations, state permits are required before federal permits are issued (e.g., Fish and Game Code 1600 permit before Clean Water Act 404 permit).

Data sources
Existing data sources; data gaps. Be as specific as possible
	Data needs and sources are identified and categorized using the framework of the Wetland and Riparian Area Monitoring Plan (WRAMP) of the California Water Quality Monitoring Council.
	
	General Data Types (not an exhaustive list of examples or sources for any type)
	• Level 1—(mostly remotely sensed locational data)
	  ○ California Aquatic Resource Inventory
	  ○ Topography
	  ○ Soils
	  ○ Precipitation
	  ○ Vegetation
	  ○ Wildlife Habitat Relations
	  ○ Special Status Species Occurrence maps

	○ Surrounding historical and current land use (○ Groundwater ○ Water extractions ○ Roads (○ Hydromodifications ○ Climate change: SLR, temp change, precipitation, wildfires, tidal excursion extent ○ Watershed map ○ Riparian Zone Estimator Tool ○ Cultural Resources ○ Sea Level and tidal datums • Level 2 (field-based rapid assessments of condition) ○ California Rapid Assessment Me thod (CRAM) ○ Proper Functioning Condition (PFC) ○ Native Plant Society Rapid Assessment ○ RipRAM (buffer width & condition) • Level 3 (quantitative field measurements and indices calculated from them) ○ Streamflow ○ Invasive and native plant and animal distribution and abundance (presence, numbers, density) ○ Chemistry—water, sediment, and soil quality ○ Physical habitat parameters – habit form, structure, complexity, ○ Soils—- permeability, fertility ○ HEP (Habitat Evaluation Procedure) ○ Annul and storm hydrographs, wetland hydroperiod —formed at site basis ○ Plan community – composition, health Data Sources: • Level 1 ○ USFWS National Wetlands Inventory (NWI) and qualified local datasets ○ USGS and DWSR National Hydrography Dataset (NHD) and qualified local datasets ○ California Aquatic Resources Inventory (CARI) and qualified local datasets ○ USGS National Land Cover Data (NLCD) and qualified local datasets

	○ USFWS Cal-Veg, CDFW VegCAMP and qualified local vegetation datasets USGS LiDar and qualified local datasets ○ NRCS Soil type (SSURGO) ○ USGS, CDEC, DWR streamflow and watersheds ○ SWRCB water extractions, appropriations ○ NOAA, USGS and qualified local vegetation datasets Sea level and tidal datums ○ USGS, NOAA/NWS and qualified local datasets – precipitation ○ Tracking wetland loss ▪ EcoAtlas— creation, restoration, enhancement, mitigation, impacted sites ▪ DWR—well logs ▪ SWRCB—GAMA (groundwater) ▪ DWR—CIMIS stations (mostly for agricultural data, ET, temperature, precipitation) ▪ CALFIRE—wildfires, timber harvest plans ▪ CDFW State Wildlife Action Plan—Companion Plan on wetlands • Level 2 ○ eCRAM (CRAM data) ○ EcoAtlas (CARI) ○ Central Coast Water Board(RipRAM) ○ USFWS (PFC) ○ SFEI-ASC (RipZet) • Level 3 (abundant use of qualified local datasets plus these state sources) ○ DFW—CA Natural Diversity Database (CNDDB) (points & polygons) ○ BIOS—species extent ○ CEDEN, WQX, TMDL, DWR, - Water and sediment quality ○ Point Blue, Audubon. and qualified local datasets —bird counts ○ MAPS—riparian bird mapping ○ USFS FLAT—Forest Service data SEE TABLE BELOW for list of data sources with access methods.

Data characteristics Notes about type and form of data	• Many data sets relating to wetland location, distribution, abundance, kind, and condition are spread out across multiple federal, state, regional, and local program that cannot at this time share data and information. Different wetland definitions and classification systems are in use. Net change in wetlands and the efficacy of wetland protection policies and programs cannot be assessed. • Regional wetland tracking and assessment approaches might be warranted for self-evident regions (e.g. Bay-Delta, Tahoe Basin, Southern California Bight). • There is no comprehensive statewide inventory of wetlands.

Use case 8: Data sources

Topic	Description	Data source description	Access Method
Agriculture	Evapotranspiration	DWR-CIMIS stations-- agricultural data/ET/temperature/precipitation	http://www.cimis.water.ca.gov/
Ecology	Wetlands plans	CDFW State Wildlife Action Plan-Companion Plan on wetlands	https://www.wildlife.ca.gov/SWAP/Final/Companion-Plans
Ecology	Biological data	CDFW Biogeographic data	https://www.wildlife.ca.gov/Explore/Organization/BDB
Ecology	Vegetation classification	CDFW Vegetation Classification Program (VegCAMP)	https://www.wildlife.ca.gov/Data/VegCAMP
Ecology	Biodiversity	CDFW Natural Diversity Database (CNDDB)	https://www.wildlife.ca.gov/Data/CNDDB/Maps-and-Data
Ecology	Species extent	CDFW BIOS (Biogeographic Information and Observation System)	https://www.wildlife.ca.gov/Data/BIOS
Ecology	Invasive species	USDA National Invasive Species Information Center	https://www.invasivespeciesinfo.gov/aquatics/monitoring.shtml
Ecology	Aquatic resources	FWS National Wetlands Inventory	https://www.fws.gov/wetlands/
Ecology	Wetlands	FWS National Wetlands Inventory	https://www.fws.gov/wetlands/
Ecology	Tracking wetland loss	FWS National Wetlands Inventory	https://www.fws.gov/wetlands/
Ecology	Habitat	FWS HEP (Habitat Evaluation Procedure)	https://www.fws.gov/policy/ESMindex.html
Ecology	Physical habitat parameters	FWS geospatial habitat data collection	https://www.fws.gov/gis/data/national/

Topic	Description	Data source description	Access Method
Ecology	Forest ecological conditions	US Forest Service FLAT-Forest Service Data	https://www.fs.usda.gov/treesearch-beta/pubs/53245
Ecology	Wetland boundaries	FWS National Wetlands Inventory	https://map.dfg.ca.gov/metadata/ds2630.html
Ecology	Vegetative health	USDA Forest Service National Forest Health Monitoring Program	https://fhm.fs.fed.us/
Ecology	Aquatic resources	SFEI California Aquatic Resources Inventory (CARI)	http://www.sfei.org/data/california-aquatic-resource-inventory-cari-version-02-gis-data#sthash.IC3VT5oB.dpbs
Ecology	Timber harvest plans	CALFIRE-wildfires/timber harvest plans	http://www.fire.ca.gov/resource_mgt/resource_mgt_forestpractice_thpstatus
Ecology	Wetland health indicators	Rapid Assessment Method (CRAM) Eco Atlas	http://www.ecoatlas.org/regions/ecoregion/statewide?cram=1
Ecology	New mitigation sites	Eco-Atlas	http://www.ecoatlas.org/
Ecology	Native Plant Society Rapid Assessment	California Native Plant Society Sampling Protocol	http://www.cnps.org/cnps/vegetation/protocol.php
Ecology	Riparian habitat	Central Coast Ambient Monitoring Program (CCAMP)	http://www.ccamp.us/ca/view_data.php?org_id=rb3#pagetop
Ecology	Invasive plants	Cal-Invasive Plant Council	http://www.cal-ipc.org/ip/mapping/
Ecology	Riparian birds	IBP MAPS Avian Monitoring program	http://www.birdpop.org/pages/maps.php
Ecology	Invasive plants	UC Davis ICE-invasive plants	http://ice.ucdavis.edu/invasives/sources/species/california-invasive-plant-inventory-cal-ipc-list
Ecology	Bird counts	California Avian Data Center- Collection of citizen science bird counts	http://data.prbo.org/cadc2/index.php?page=citizen-science
Geology and soils	Soil types-toxicity	USDA SSURGO soils database	https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/?cid=nrcs142p2_053627
Geology and soils	Soil type	USDA soil survey mapping tool	https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm
Geology and soils	Soil type	USDA soil survey mapping tool	https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm
Infrastructure and utilities	Central Valley Flood Protection Plan	DWR Central Valley Flood Protection Plan	http://www.water.ca.gov/cvfmp/

Topic	Description	Data source description	Access Method
Infrastructure and utilities	Roads	Cal Trans GIS DATA	http://www.dot.ca.gov/hq/tsip/gis/datalibrary/#Highway
Land use	Hydromodifications	NLCD 1992/2001 Retrofit Land Cover Change	https://www.mrlc.gov/nlcdrlc_data.php
Land use	Land cover data	National Land Cover Dataset	https://www.mrlc.gov/nlcd2011.php
Land use	LIDAR data	USGS LIDAR data collection	https://lta.cr.usgs.gov/lidar_digitalelevation
Land use	Land use surveys	DWR Land Use Surveys	http://www.water.ca.gov/landwateruse/lusrvymain.cfm
Mapping and modeling	Watershed-topo/HUCs (USGS)	USGS hydrologic unit maps	https://water.usgs.gov/GIS/huc.html
Mapping and modeling	Topographic surveys (LIDAR)	USGS Earth Explorer	https://earthexplorer.usgs.gov/
Mapping and modeling	Watershed map	California Department of Conservation	http://www.conservation.ca.gov/dlrp/wp/Documents/California%20Watersheds.pdf
Water	WQX-USGS	EPA water quality database	https://www3.epa.gov/storet/wqx/index_bak.html
Water	NLCD-impervious surfaces (WQ + hydrology)	Multi-Resolution Land Characteristics	https://www.mrlc.gov/finddata.php
Water	Hydrographic data	USGS national streamflow data	https://waterdata.usgs.gov/nwis/rt
Water	Streamflow	USGS California streamflow data	https://waterdata.usgs.gov/ca/nwis/rt
Water	Streamflow	USGS California streamflow data	https://waterdata.usgs.gov/ca/nwis/rt
Water	Chemistry-water quality	USGS water quality data	https://waterdata.usgs.gov/ca/nwis/qw
Water	Hydrographs	NOAA Weather service hydrologic prediction service	https://water.weather.gov/ahps2/area.php?wfo=EKA
Water	TMDLs	US EPA TMDL database	https://ofmpub.epa.gov/waters10/attains_state.control?p_state=CA
Water	Streamflow	DWR CDEC river conditions	https://cdec.water.ca.gov/river/rivcond.html
Water	SWRCB-extractions/licensed appropriations	SWRCB	http://www.waterboards.ca.gov/waterrights/water_issues/programs/applications/#permitting
Water	Water extractions	SWRCB CWA Section 401 Water Quality Certification Program, Annual Reports	http://www.waterboards.ca.gov/water_issues/programs/cwa401/docs/annu
Water	Water quality	Water Data Library (DWR)	http://www.water.ca.gov/waterdatalibrary/

Topic	Description	Data source description	Access Method
Water	Water quality/habitat/sediment chemistry	California Environmental Data Exchange Network (CEDEN)	http://www.ceden.org/
Water	Precipitation	NOAA Precipitation Frequency Data Server	http://hdsc.nws.noaa.gov/hdsc/pfds/
Water	Groundwater quality	SWRCB Groundwater Ambient Monitoring and Assessment Program (GAMA)	http://geotracker.waterboards.ca.gov/gama/
Water	Water flow	DWR CDEC hydrologic conditions	http://cdec.water.ca.gov/
Weather and Climate	Climate Change: Sea level rise	NOAA Sea Level Rise web mapping tool	https://coast.noaa.gov/digitalcoast/tools/slr
Weather and Climate	Climate change: tidal excursion extent	NOAA Coastal Change Analysis Data	https://coast.noaa.gov/digitalcoast/tools/lca
Weather and Climate	Climate change: precipitation	DWR California Data Exchange Center	https://cdec.water.ca.gov/cgi-progs/prevprecip/PRECIPDLY.BSN
Weather and Climate	Climate change: temp change	California Nevada Climate Applications Program (CNAP)	http://meteora.ucsd.edu/cap/
Weather and Climate	Climate change: wildfires	Incident Information/ Cal Fire	http://cdfdata.fire.ca.gov/incidents/incidents_stats
Water	Well logs	DWR Well Completion Reports	Data gap- not readily available. See http://www.water.ca.gov/groundwater/wells/well_completion_reports.cfm

Use Case 9: Central Coast Ambient Monitoring Data Navigator

Developed by Central Coast Water Board

Objective Decision, goal or desired action	The CCAMP Data Navigator[24] is an online data visualization and analysis tool. The tool is used by Water Board staff, decision-makers and the public to inform them about water quality status and trends. The objective is to acquire data from a single source to populate the Data Navigator.
Description Important context and background information	The Central Coast Water Board and the Bay Foundation of Morro Bay have developed an online tool that pulls data from multiple sources and formats into a single visualization tool. This tool displays maps, graphs, and tables of water quality and habitat data. It includes statistical assessments of trend, distributions, and other features. Currently, updating this system is challenging because of multiple data sources, inconsistent source formats, naming conventions, and insufficient level of documentation.
Participants The main decision-maker; also note other parties involved or affected	**Primary decision maker:** Central Coast Water Board Other participants: • Central Coast Regional Data Center at Moss Landing is supporting system and potentially expanding to State. • Ability to keep data flowing to site in a timely way is important for stakeholders, agricultural industry representatives, staff involved in regulatory decision-making.
Regulatory context Legal, regulatory, and reporting requirements	Data displayed on website includes agricultural regulatory data, data used in 303(d) and 305(b) decision-making, TMDL development, and enforcement. Timely access to data of multiple formats (e.g. water and sediment quality, habitat, toxicity, pesticide applications, wetlands assessment, tissue chemical burden) is critical for supporting these various uses.

[24] Available at: http://www.ccamp.us/ca/view_data.php?org_id=rb3

Workflow Progression of steps and specific actions taken by participants to accomplish objective	Currently, when data is brought in from various sources, it requires significant grooming in order to function in the web environment. Language (analyte names, data fields, etc.) must be normalized using cross-walks, units of measurement need to be normalized, site naming conventions need to be expressed in a way that is useful for external users, inconsistent methods of data display need to be rectified, site locations need to be thoroughly documented, etc. If these steps were addressed through the AB1755 Open Data Initiative, support and maintenance of our system would be greatly simplified.
Data sources Existing data sources; data gaps. Be as specific as possible	**Data sources:** CEDEN, DPR Pesticide Use Reporting System, DPR pesticide monitoring database, Geotracker/GAMA (groundwater data), NHDPlus, Watershed Boundary dataset, USGS stream gages, WQX, DWR Groundwater Basin Maps and Descriptions (Bulletin 118), California Healthy Watershed Assessment, National Land Cover Dataset, U.S. EPA Recovery Potential Screening tool, SWRCB Water Quality Goals database, U.S. EPA Aquatic Life Benchmarks, NOAA Screening Quick Reference Tables, NOAA Coastal Change Analysis Data. Data Gaps: • Groundwater quality • Ecological data: EcoAtlas CRAM data (no waterbody documentation) • California Stream Conditions Index: This bio-assessment summary index should be readily downloadable from CEDEN. This is true of other biological indices, flow measurements, and summed terms (like total DDT). To be user friendly, these calculated values should be directly available. SEE TABLE BELOW for list of data sources with access methods.
Data characteristics Notes about type and form of data	• Format should include latitude-longitude and datum (either with each sample or on site list). • Date and time should be mandatory content. • Original source of data should be mandatory content. • Method Detection Limits are necessary to use non-detected values in mathematical formulas. • Zeros should not be acceptable result values for chemical constituents.

	• Analyte naming conventions should be unambiguous (for example, nitrate is ambiguous, nitrate as NO3 is not). • Site documentation should always include NHD reach ID because not all waterbodies are named. • A waterbody name should be included if available. • AB 1755 data normalization should include addition of COMIDs (NHDPlus), waterbody type (ocean, estuary, fresh, storm drain, tile drain, etc.), water type (marine, saline, fresh, tidal) to site descriptors, site type (ambient, discharge).

Use case 9: Data sources

Topic	Description	Data source description	Access Method
Agriculture	Pesticide monitoring	DPR pesticide monitoring database	http://www.cdpr.ca.gov/dprdatabase.htm
Agriculture	Pesticide use	DPR Pesticide use reporting system	http://www.cdpr.ca.gov/docs/pur/purmain.htm
Ecology	Watershed health	US EPA California Healthy Watershed Assessment [static PDF report]	https://www.epa.gov/sites/production/files/2015-11/documents/ca_hw_report_111213_0.pdf
Land use	Land cover data	National Land Cover Dataset	https://www.mrlc.gov/nlcd2011.php
Land use	Coastal land cover change	NOAA Coastal Change Analysis Data	https://coast.noaa.gov/digitalcoast/tools/lca
Mapping and modeling	Watershed boundaries	Watershed Boundary dataset	https://nhd.usgs.gov/wbd.html
Mapping and modeling	Geospatial hydrologic data	NHD Plus geospatial data framework	http://www.horizon-systems.com/nhdplus/
Water	Water quality data	US EPA Water Quality WQX data portal	https://www.epa.gov/waterdata/storage-and-retrieval-and-water-quality-exchange
Water	Impaired watershed indicators	US EPA Recovery Potential Screening tool	https://www.epa.gov/rps
Water	Water quality and ecological impacts	US EPA Aquatic Life Benchmarks	https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/aquatic-life-benchmarks-pesticide-registration
Water	Streamflow	USGS California streamflow data	https://waterdata.usgs.gov/ca/nwis/rt

Topic	Description	Data source description	Access Method
Water	Water quality objectives	SWRCB water quality goals database	http://www.waterboards.ca.gov/water_issues/programs/water_quality_goals/
Water	Groundwater quality	Geotracker/GAMA	http://www.waterboards.ca.gov/gama/geotracker_gama.shtml
Water	Groundwater basin maps	DWR Bulletin 118 basin boundaries	http://www.water.ca.gov/groundwater/bulletin118/gwbasins.cfm
Water	Water quality	California Water Quality Monitoring Council regional water quality monitoring data	http://www.mywaterquality.ca.gov/regional_portals/index.html
Water	Water quality	California Environmental Data Exchange Network (CEDEN)	http://www.ceden.org/
Water	Contaminated water risks	NOAA Screening Quick Reference Tables	http://response.restoration.noaa.gov/cpr/sediment/squirt/squirt.html
Water	California stream conditions	California Stream Condition Index	Data gap-- not readily accessible-- This bio-assessment summary index should be readily downloadable from CEDEN. This is true of other biological indices, flow measurements, and summed terms (like total DDT). To be user friendly, these calculated values should be directly available.
Ecology	Ecological data	EcoAtlas CRAM data	Data gap-- no waterbody documentation
Water	Groundwater quality data	Geotracker/GAMA	Data gap-- insufficient QA data

Use Case 10: Urban Water Efficiency Explorer

Developed by California Data Collaborative

Objective Decision, goal or desired action	The Efficiency Explorer Tool is a data visualization and scenario planning tool that estimates residential water efficiency targets for more than 400 California water retailers. The objective of the Efficiency Explorer is to provide a succinct and clear "common operational picture" to help stakeholders visualize the changing water conditions to enable them to effectively make decisions about adaptations.
Description Important context and background information	Water agencies face numerous uncertainties and challenges to providing supply reliability, such as population and economic growth, increasingly stringent water quality and environmental regulations, aging infrastructure, and climate change (droughts and floods). Water agencies are working to overcome these challenges with water management planning and investments, yet the solutions necessitate involvement of water boards, land use agencies, business associations, and the local community. A succinct and clear "common operational picture" (COP) will help stakeholders visualize the changing water conditions to enable them to effectively make decisions about adaptations. California Governor Brown's Executive Order B-37-16 calls for the development of water use targets customized to the unique conditions of each urban water agency to promote drought resiliency. The CaDC Efficiency Explorer is an integrated data visualization and scenario planning tool that estimates residential water efficiency targets for more than 400 California water retailers. The Efficiency Explorer Tool was developed with publicly available data to offer water managers a first glance at water use compared to potential water efficiency goals. It is for educational and illustrative purposes only. The Efficiency Explorer Tool was not intended and is not able to calculate water agency budgets at a level of accuracy appropriate for establishing policy. The tool provides a rapid first assessment of the residential component of Order B-37-16. The tool is used to educate the California water community on the Governor's new framework.

Participants The main decision-maker; also note other parties involved or affected	**Primary decision-maker**: Local water utilities (audience for the Efficiency Explorer Tool) **Other decision-makers and stakeholders:** The state has an important role in providing leadership on public education and outreach. Local water utilities impact that water use decision through rates, marketing and local ordinances. Cities, counties, regional planning agencies and community groups are also key.
Regulatory context Legal, regulatory, and reporting requirements	There are several bills in the state legislature with varying reporting and compliance requirements. Major local water suppliers (retailers and wholesalers) are required to submit urban water management plans every five years. In addition, major local water retailers are required to submit monthly supplier reports. Lastly, all water suppliers are required to submit information as part of the public water system statistics. This duplicative reporting could be streamlined utilizing modern data infrastructure. For example, Airflow is rapidly becoming the de facto standard in public data infrastructure.[25]
Workflow Progression of steps and specific actions taken by participants to accomplish objective	The Rapid Assessment brought together water managers, academic experts, non-profit leaders and top data scientists from throughout California. The CaDC statewide efficiency data action team is chaired by Elizabeth Lovsted, Director of Water Supply at Eastern Municipal Water District and includes leaders from across the California water industry. The CaDC efficiency explorer tool and CGU landscape area remote sensing was reviewed by leading academics including Frank Loge at UC Davis, Newsha Ajami at Stanford and Bob Wilkenson at UC Santa Barbara. CaDC was able to calculate efficiency targets for 404 of the state's 409 urban water agencies that serve more than 31 million Californians. Using an open source platform and publicly available data, the CaDC evaluated whether local water agencies might be able to meet the Governor's proposed conservation efficiency standards. CaDC built a policy-neutral tool to combine indoor and outdoor water use as well as water lost to leaks. Future

[25] See, for example, a summary of San Diego utilizing Airflow: https://data.sandiego.gov/stories/why-data-automation-matters-data-portals/ See also: https://medium.com/a-r-g-o/installing-apache-airflow-on-ubuntu-aws-6ebac15db211

	assessments can account for changes to conservation targets, improved data reported by local water agencies, or any other data input.
Data sources Existing data sources; data gaps. Be as specific as possible	The data sources utilizing are detailed in the publicly available methodology available here: http://californiadatacollaborative.org/blog/2017/4/28/cadc-statewide-efficiency-explorer-methodology Data Sources: • Potential Evaporation Estimates (PET estimates) from the MACAv2- METDAT (baseline data and future climate data) • Operational Weather forecasts for California • Nevada river seasonal Streamflow Forecasting • VIC Streamflow simulations • Yearly population projections • State Water Project Deliveries There are several important data gaps:[26] • State does not have accurate service area boundaries • State does not have accurate land use information • State evapotranspiration data has suboptimal coverage • State has not developed landscape area definitions or data SEE TABLE BELOW for list of data sources with access methods.

[26] The impact of these data gaps on the accuracy of the estimated efficiency goals are detailed in the following CaDC blog post: http://californiadatacollaborative.org/blog/2017/6/8/residential-water-efficiency-and-the-california-data-quality-landscape

Data characteristics Notes about type and form of data	Most of the data involved is tabular and stored as comma separated value files. The land use characteristics are geospatial. This tool automates data ingestion from the Gov Ops open data portal. There were five data quality concerns identified for our target calculations. These five concerns were evaluated on an agency-by-agency basis. The five concerns are as follows:[27] • CIMIS Proximity • Rural Residential Prevalence • Residential Parcel Accuracy • Census Place Coverage • Service Boundary

Use case 10: Data sources

Topic	Description	Data source description	Access Method
Ecology	PSAV Turf (vegetation conducting photosynthesis)	Office of Planning and Research (OPR) residential parcel dataset	http://services.gis.ca.gov/arcgis/rest/services/Boundaries/Parcels_Residential/MapServer
Ecology	PSAV Trees/Shrubs	Office of Planning and Research (OPR) residential parcel dataset	http://services.gis.ca.gov/arcgis/rest/services/Boundaries/Parcels_Residential/MapServer
Infrastructure and utilities	SCADA flow data	data to detect leaks effectively	https://www.flow-data.com/scada-solutions/
Infrastructure and utilities	Local water utility boundaries	DWR, California Environmental Health Tracking Program (CEHTP).	http://www.cehtp.org/page/water/main

[27] Discussed in detail at http://californiadatacollaborative.org/blog/2017/6/8/residential-water-efficiency-and-the-california-data-quality-landscape

Topic	Description	Data source description	Access Method
Mapping and modeling	Service Area Boundaries	Department of Water Resources and California Environmental Health Tracking Program	http://www.cehtp.org/page/water/main
Socioeconomic	Monthly water production and population for major urban water retailers in CA from mid 2014 - present	SWRCB Supplier Conservation Reporting	http://www.waterboards.ca.gov/water_issues/programs/conservation_portal/conservation_reporting.shtml
Socioeconomic	Yearly population projections at the county level from the CA Department of Finance.	CA DOF population projections	http://www.dof.ca.gov/Forecasting/Demographics/Projections/
Water	Streamflow Simulations for baseline and future scenarios	VIC model simulation output forced by MACAv2-LIVNEH forcing dataset.	https://climate.northwestknowledge.net/IntegratedScenarios/data_catalogs.php
Water	State Water Project water deliveries from California DWR	Historical SWP deliveries	http://www.water.ca.gov/swpao/deliveries.cfm and http://www.mwdh2o.com/
Water	Nevada River seasonal streamflow forecasting data	NOAA CNRFC operational forecast data	http://www.cnrfc.noaa.gov/
Weather and Climate	Operational weather forecasts for California	NOAA CFSv2 Operational forecast data	https://www.ncdc.noaa.gov/data-access/model-data/model-datasets/climate-forecast-system-version2-cfsv2
Weather and Climate	Potential Evaporation Estimates (baseline and future)	NOAA RISA Northwest Climate toolbox, CMIP5 derived PET baseline data/future climate data	https://climate.northwestknowledge.net/METDATA/ , https://climatetoolbox.org/
Agriculture	Evapotranspiration data with optimal coverage	Data Gap	Data Gap
Infrastructure and utilities	Accurate account of service area boundaries	Data Gap	Data Gap
Land use	Accurate land use information	Data Gap	Data Gap
Mapping and modeling	Landscape area definitions/ data	Data Gap	Data Gap

Use case 11: Sacramento River real-time water and fishery coordination decision platform

Developed in collaboration with FlowWest

Objective Decision, goal or desired action	This use case focuses on a demonstration project of an open data platform to support decision-making around fishery management on the Sacramento River. The primary objective of this demonstration project is to integrate diverse flow, water operations, fishery, and water quality data into a single, open data platform that facilitates more data-driven and timely decision making, with the following specific sub-objectives: 1. Improved Sacramento River operation of the CVP and more precise delivery of flows for fishery temperature management and downstream diversions; 2. Improved understanding of the data critical to flow and fish management decisions, and identification of additional monitoring needs or data gaps limiting more effective management; 3. Improved calibration of existing predictive models such as those being developed for temperature and habitat, and contribution of data to drive new predictive models such as those being developed by Reclamation fisheries managers, including expected outcomes that will result in more sustainable water management for meeting the needs of people and nature.
Description Important context and background information	On the section of the Sacramento River immediately below Lake Shasta, the fishery agencies have targeted water temperature as the most critical resource to successful spawning of winter-run Chinook salmon from late April through September. This single parameter controls the operation of Shasta Reservoir, Sacramento River Settlement Contractors (SRSC) diversions, the Central Valley Project (CVP), other project reservoirs, and the Bay Delta. The project will bring real-time and historical data into decision making that is shared between the National Marine Fisheries Service (NMFS), the California Department of Fish and Wildlife (CDFW), and the State Water Resources Control Board (SWRCB) to increase the ability to make informed decisions. In addition, the platform will provide real-time tracking and accounting of operations based on those decisions, and a database of historical operations and decision data that will provide critical information for ongoing decision making.

	Water operations and fishery management decision-making in this area are intricately connected, and having integrated real-time and historical data and information on water and fish would improve decision making for the system and lead to more efficient water management that will be more protective of the fishery, while maximizing water supply for other beneficial uses. The crux of the management decision problem addressed in this demonstration project, especially in dryer years, is that limited water must be delivered for both fish and contracted water demands, but most of the supporting data is not readily available to all involved stakeholders in an easily accessible format to guide these decisions.
Participants The main decision-maker; also note other parties involved or affected	Primary decision-makers: The Sacramento River Settlement Contractors (SRSC) includes various irrigation districts, reclamation districts, mutual water companies, partnerships, corporations, and individuals situated in the Sacramento Valley, and formed under the provisions of California law. Other partners: US Bureau of Reclamation California Department of Fish and Wildlife US Fish and Wildlife Service National Marine Fisheries Service State Water Resources Control Board Other stakeholders: Ducks Unlimited, Northern California Water Association, Golden Gate Salmon Association, Tehama Colusa Canal Authority, Other CVP Water Service Contractors, Feather River Water Users, The Nature Conservancy
Regulatory context Legal, regulatory, and reporting requirements	The SRSC are a group of diverters on the Sacramento River that have prior and senior water rights to the Central Valley Project with some rights dating back to the 1800s. The SRSC currently coordinate closely with Reclamation on the operation and release patterns from Lake Shasta in order to meet temperature targets for salmon (primarily winter-run), diversion needs of the SRSC group, and flows into the Delta to meet the goal of

	operating the system efficiently. The SRSC also coordinate with the set of partners and stakeholders, jointly and independently on river operations, habitat needs, data coordination, education, and accountability.
Workflow Progression of steps and specific actions taken by participants to accomplish objective	Operations and fishery workflow: Key decisions on operations and fishery protection begin in the spring each year and continue through September. The fishery agencies, U.S. Bureau of Reclamation (Reclamation), and the SWRCB meet monthly, or more often if needed, as the Sacramento River Temperature Task Group (SRTTG) to discuss and decide on operations and adjustments. This Project will inform actions from that work group as well as provide members with real-time and historical data that will be useful between meetings, and facilitate more productive meetings. Data platform development workflow: Final analytical and software tools will be selected to best fit the workflow desired by the Steering Committee and Core Team, following the general approach outlined below. a. All data available through open web services (e.g. USGS streamflow) to be accessed directly, maintaining original data in the format of the maintaining agency, unless local integration and storage enhances the decision workflow b. All data not available through open web services (e.g. FWS rotary screw trap data) to be formatted following Federal Open Data standards (https://project-open-data.cio.gov) and made open for this project and to others c. Data integration and management accomplished using a cloud based storage solution (Amazon Web Services) and accompanied by an open source API to make integrated data available for other potential users d. Decision support platform developed and delivered as a web-service with the following analytics and visualization components: i. Mapping / spatial data visualization using Leaflet (open source) ii. Time series data visualization using Plotly (open source) and d3 (open source) to build documents from data

	iii. Predictive modeling integration using Shiny (open source R statistical evaluation web application) iv. Existing algorithms / visualizations from Reclamation's SacPAS Tool v. Relevant links to data portals such as Bay Delta Live and the Sacramento River Watershed Program Project Portal

Data sources
Existing data sources; data gaps.
	Data sources:
	• Water operations
	  • USBR: CVP water and power operations analysis
	  • DWR Operation Control Office (DWROCO): SWR water and power operations analysis
	  • DWROCO Daily Operations: Daily flows
	  • Settlement Contractor Diversions: Diversions, deliveries, losses
	  • Water rights: Diversion point location, volume
	• Instream flows
	• California Data Exchange Center
	• California Nevada River Forecast Center
	• United States Geological Survey (USGS) Streamflow data
	• Water quality
	• USGS
	• CDEC
	• Weather and climate
	• National Oceanic & Atmospheric Administration (NOAA)
	• Applied Climate Information System
	• Natural Resources Conservation Service
	• Fisheries
	• Adult Salmon redd locations
	• Adult salmon carcass surveys
	• Juvenile salmon rotary screw trap monitoring

	• Salmon habitat mapping
	• Salmon habitat restoration sites
	• Adult salmon video monitoring
	• Modeling
	• River Assessment for Forecasting Temperatures: predicted hourly temperatures
	• Portals
	  • Bay Delta Live
	  • Sacramento River Water Quality Data Portal
	
	Data with low ease of use:
	• Settlement Contractor Diversions: Diversions, deliveries, losses
	  • Water rights: Diversion point location, volume
	  • Adult salmon redd location
	  • Adult salmon carcass surveys
	  • Juvenile salmon rotary screw trap monitoring
	  • Adult salmon video monitoring
	
	SEE TABLE BELOW for list of data sources with access methods.

Data characteristics Notes about type and form of data	Currently, flow and temperature data is available in real-time, but is spread across a number of different sites with varied access and data formats. CDFW also conducts aerial redd (i.e. salmon nest) surveys weekly and adult salmon carcass surveys daily during the May to October monitoring season; however, this information, while public, is not made readily available in real-time. Even where subsets of this data have been integrated (e.g. SacPAS http://www.cbr.washington.edu/sacramento/ and Bay Delta Live http://www.baydeltalive.com/), user friendly connections to this data such as Application Program Interfaces (API) have not yet been developed. This severely restricts open access and use of all relevant data. Nearly all of the data is public. However, the "ease of use" varies significantly across data sources. Some data (e.g. USGS streamflows) are readily available in machine-readable formats, while other (e.g. juvenile salmon

	rotary screw trap monitoring) may require some formatting for integration.

Additional comments:

The platform developed through this demonstration project integrates and will provide APIs for all data and information so that flows, water temperatures, redd locations, and a variety of related data can be viewed simultaneously and in real-time (in addition to historically), and operations can be evaluated and managed to protect salmon redds based on a data driven understanding of environmental conditions instead of estimated temperatures at somewhat arbitrary compliance locations.

This demonstration project will also leverage previously developed portals such as Bay Delta Live and DataBasin to the greatest extent possible as they do provide convenient connections to data that will enhance our ability to connect to certain datasets using open data tools and programming languages in this demonstration. When combined with the fisheries data that will be new in the decision-making process served by this demonstration project, we expect that this demonstration project will yield a new open data resource with very high value to this and other fish and flow decision-making processes.

Use case 11: Data sources

Topic	Description	Data source description	Access Method
Ecology	Latitude/Longitude, extend type	Salmon habitat restoration sites	www.sacriver.org/aboutwatershed/DigitalAtlas
Infrastructure and utilities	Water and power operations	DWR Operation Control Office	http://www.water.ca.gov/swp/operationscontrol
Infrastructure and utilities	Water and power operations	USBR	http://www.usbr.gov/mp/cvo
Water	Precipitation snowpack, reservoir status	Natural Resources Conservation SErvice	www.wccnrcs.usda.gov/web_service/awdb_web_service_landing.htm
Water	Water rights- diversion point location, volume	SWRCB	www.waterboards.ca.gov/waterrights/water_issues/programs/ewrims/index.shtml
Water	Daily flows	DWR Operation Control Office	www.water.ca.gov/swp/operationscontrol/docs/mapper/WTRRPT.MON

Topic	Description	Data source description	Access Method
Water	Predicted future hourly temperatures	River Assessment for Forecasting Temperatures Decision Support Tool	www.oceanview.pfeg.noaa.gov/RAFT
Water	Lake Shasta storage. inflow outflow , temperature , cold water pool volume	California Data Exchange Center	www.cdec.water.ca.gov
Water	Sacramento mainstem and tributary streamflows	United States Geological Survey (USGS) Streamflow Waterdata	waterdata.usqs.gov/ca/nwis/current/?type=flow
Water	Temperature, turbidity etc	CDEC	cnrfc.noaa.gov
Water	Predicted future hourly flows	California Nevada River Forecast Center	cnrfc.noaa.gov
Water	Temperature, turbidity etc	USGS	cdec.water.ca.gov
Weather and Climate	Global climate/climate change	Applied Climate Information System	www.rcc-acis.org/docs_datasets.html
Weather and Climate	Air temperature, precipitation, etc	National Oceanic & Atmospheric Administration (NOAA)	radar.weather.gov/ridge/radar/php?rid=bbx&product=NDR&overlay=1110111&loop=no
Ecology	Latitude/longitude, size of fish	Adult Salmon redd locations	Data gap- low ease of accessibility
Ecology	Latitude/longitude, size of fish	Adult salmon carcass surveys	Data gap- low ease of accessibility
Ecology	Daily count of juvenile salmon	Juvenile salmon rotary screw trap monitoring	Data gap- low ease of accessibility
Ecology	Latitude/Longitude, extent type	Salmon habitat mapping	Data gap- low ease of accessibility
Ecology	Timing number, size of fish passing	Adult salmon video monitoring	Data gap- low ease of accessibility
Water	Diversions, deliveries, losses	Settlement contractors	Data gap- low ease of accessibility

Use Case 12: Water availability analysis for curtailments to protect senior water rights

Developed in collaboration with SWRCB Division of Water Rights staff

Objective Decision, goal or desired action	Based on a drought water availability analysis, at what time and to whom would notices of water unavailability (also called curtailment notices or water shortage notices) be issued to protect senior water rights? (Assumptions: Unadjudicated system; not the Delta)
Description Important context and background information	Rights to divert surface water in California have different priorities. In times of drought and limited supply, the most junior right holder in a watershed must be the first to discontinue diversion. During times of severe shortage, even very senior water right holders with riparian or pre-1914 rights may need to stop diverting water. To help ensure that diverters exercise their rights appropriately during droughts, the State Water Resources Control Board (SWRCB) can notify diverters when information about watershed supply and demand indicates that water shortage is likely to occur or that insufficient water is currently available under their priority of right.[28] These are informational notices, but the SWRCB can also issue enforceable curtailment orders to those who continue diverting when water is unavailable under their rights. This use case examines the process the SWRCB uses to answer the question of whether there is likely to be sufficient water to meet diverters' demands.
Participants	**Main decision maker:** SWRCB Division of Water Rights

[28] State Water Board Drought Year Water Actions, Notices of Water Availability (Curtailment and Emergency Regulations) http://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/water_availability.shtml

The main decision-maker; also note other parties involved or affected	**Other impacted parties:** Water right holders for whom water is or will be unavailable; more senior water right holders; environmental users of water
Regulatory context Legal, regulatory, and reporting requirements	The SWRCB is responsible for administering and enforcing the water rights system in California. A right to divert surface water is contingent upon the availability of sufficient water supply under that priority of right and the use must be reasonable. If a water right holder does not curtail their diversions when necessary, the SWRCB can take enforcement action to stop unauthorized diversion and impose penalties. Reporting requirements: Thanks to SB 88, within the next year, all diverters should be measuring their diversions (on a monthly, weekly, daily, or hourly basis, depending on the size and type of the diversion) and annually reporting their monthly totals.[29] The SWRCB can require more frequent reporting "[w]hen flows or projected available supplies in a watershed or subwatershed are sufficient to support some but not all projected diversion demand."[30]

Workflow Progression of steps and specific actions taken by participants to accomplish objective	• First, in January-February the SWRCB obtains projections from the Department of Water Resources (DWR) for snowpack and projected water supplies for the year. If supplies are less than average, this may trigger analysis of water availability in priority watersheds.
	  ○ Other triggers may include a substantial number of complaints about water availability from a particular region; or other indications of a localized water shortage.
	  ○ In 2014, the Governor's drought declaration was a key trigger.
	• If a water availability analysis is triggered, then the SWRCB conducts watershed-wide water availability analyses for all basins of concern. This analysis involves comparing anticipated/actual water supply and anticipated/actual demand to determine whether there is adequate supply to meet demand.

[29] State Water Board - Measurement Regulation, http://www.waterboards.ca.gov/waterrights/water_issues/programs/measurement_regulation/
[30] Cal. Code Regs. tit. 23, § 917.

	○ Supply analysis has been based on DWR's forecasts of Full Natural Flow (FNF), supplemented with daily FNF calculations. ○ Going forward, demand analysis will be based on annual (or more frequent) electronic water use reporting. ○ Data quality control process: Involves automatic and manual screening to identify and "clean up" reporting problems ▪ Look for obviously duplicate reporting (e.g., same diversion under multiple rights) ▪ Compare reported amount to face value (permits, licenses) or crop duty ▪ Remove non-consumptive (power-only) diversions, considering temporary storage ▪ Check for diversion amounts that don't make sense, other flaws in data ○ Determine cutoff priority for notices (e.g., all appropriators with 1903 or later priority dates) • If the analysis shows that there is likely to be insufficient water to meet demand in a given watershed, the SWRCB sends notices of unavailability of water to the affected rights holders. The notices are meant as a reminder that the Water Board has authority and do not impose new obligations on water users. • Enforcement via curtailment orders – in some cases may require more specific and detailed information to demonstrate a particular diverter took water that was not available under their priority of right. ○ SWRCB can use enforcement discretion to provide for minimum supply for basic health and safety needs; for example, by not enforcing against individuals and water purveyors that are supplying a minimum amount (50 gallons per person per day) for health and safety needs.
Data sources Existing data sources; data gaps. Be as specific as possible	Demand: Annual (or more frequent) reports of monthly (or more frequent) water diversion and use Supply: DWR's Full Natural Flow (FNF) monthly forecasts and daily calculations • Monthly projections for water year; also actual (daily) flows considered Gaps: • Return flows

	• Real-time data on water demand/use (to reduce reliance on out-of-date data-- for example, 2014 decisions were based on 2010 data set for demand) • More accurate reporting of diversions • More stream gages, real-time gage data • More accurate characterization of water rights • Over-represented demands due to double/triple counting • Assumed sources • Assumed contract uses • FNF could be a flawed calculation when it is used in some of these contexts as it may not be reflective of actual available water.
Data characteristics Notes about type and form of data	• Water demand data is generally examined on a monthly time step; however, this does not necessarily reflect how users actually divert water (e.g., they may divert for a week and then not for the rest of the month). • To forecast demand, a 4-5 year average is considered. • When storms are forecast, decisions are sometimes delayed for a few weeks. • While watershed-wide analysis informs decisions about who and when to provide notice; more detailed data may be necessary for curtailment enforcement decisions.

Use case 12: Data sources

Topic	Description	Data source description	Access Method
Water	Full Natural Flow	Monthly FNF forecasts from DWR's Bulletin 120 forecasts (50% and 90% exceedance levels)	https://cdec.water.ca.gov/snow/bulletin120/index.html
Water	Full Natural Flow	Daily FNF calculations	https://cdec.water.ca.gov/cgi-progs/selectFNF_ss; https://cdec.water.ca.gov/cgi-progs/snowsurvey_ro/FNF
Water	Water Demand	Projected water needs	From water users

Topic	Description	Data source description	Access Method
Water	Water Demand	Annual (or more frequent) self-reporting of diversionsto State Water REsources Control Board- eWRIMS	eWRIMS database—Reporting data should be available but may be hard to navigate/ not user friendly.
Water	Return Flows		Data gap
Water	Real-time water demand		Data gap
Water	More accurate demand data		Data gap
Water	More accurately characterized water rights		Data gap
Water	Additional Stream gage locations and mesurements		Data gap

Use Case 13: Water rights licensing process

Developed in collaboration with SWRCB Division of Water Rights staff

Objective Decision, goal or desired action	In what circumstances can the State Water Resources Control Board (SWRCB) make the necessary findings to issue a license for a permitted consumptive use of water for a minor agricultural project, where the diversion is not from a subterranean stream or underflow, in an unadjudicated stream system?
Description Important context and background information	The water right process includes several phases: (a) application, (b) permit, and (c) license. An application is a request that the State Water Resources Control Board (SWRCB) Division of Water Rights (Division) consider authorizing development of a water diversion project. A permit is the legal authorization to divert water in accordance with conditions and within a time schedule, and develop the project. When project development is complete, the Division determines whether a water right license can be issued. The license is the final confirmation of the water right and remains effective as long as its conditions are fulfilled and beneficial use continues.[31] A license is only issued for the amount of water that has been placed to beneficial use during the authorized period and in compliance with all terms and conditions of the permit. The license reflects actual use in terms of source, amount, rate of diversion if applicable, season, place of use, point(s) of diversion, and purpose(s) of use, by direct diversion and/or storage. After receiving notification that a permitted project is complete and ready for licensing, Division staff conducts a licensing inspection of the project works and documents the quantities of water directly diverted or stored and put to beneficial use.[32] Division staff also confirms compliance with the permit terms and conditions.[1]
Participants	**Main decision maker:** SWRCB Division of Water Rights

[31] Description from 'State Water Resources Control Board Division of Water Rights: Process for Water Right Licensing'. http://www.waterboards.ca.gov/waterrights/water_issues/programs/applications/docs/licensing.pdf

[32] California Water Code § 1605

The main decision-maker; also note other parties involved or affected	**Other impacted parties:** Permittee (water diverter)
Regulatory context Legal, regulatory, and reporting requirements	The SWRCB is responsible for administering and enforcing the water rights system in California. A right to divert surface water is contingent upon that water being placed to beneficial use. The SWRCB Division of Water Rights is responsible for determining whether a certain amount of water has been put to beneficial use and issuing licenses for beneficial water use that is in compliance with permit terms and conditions. According to California Water Code § 1605, "The board shall as soon as practicable after receiving the report of completion cause to be made a full inspection and examination of the works constructed and the use of water therefrom. The permittee shall furnish the board with such records, data, and information as may be required to enable the board to determine the amount of water that has been applied to beneficial use and whether the construction of the works and the use of the water therefrom is in conformity with law, the rules and regulations of the board, and the permit."

Workflow
Progression of steps and specific actions taken by participants to accomplish objective
	In order to issue a license, the Division of Water Rights must confirm the amount of water that has been actually placed to beneficial use. This process involves significant collection of field data. The process of licensing may include the following steps:
	• A license is requested for a permitted project.
	• A permittee submits reporting and compliance information.
	• Division of Water Rights staff reviews the information and, using staff discretion, inspects the project to determine water use. This often includes a site visit, which allows the Division staff to inspect project details to validate water use. Data used to determine water use may include, but is not limited to, the following:
	  ○ Reservoir survey to document storage
	  ○ Flow discharge measurement

	○ Water use data (place of use, application rate, pumping numbers, crop type, etc.) ○ Documentation of diversion with GPS, camera, etc. ○ Other field data (see data sources below) • The Division of Water Rights staff writes an inspection report. • Project may be licensed if: ○ The project has not changed from the permitted description ○ The project is in compliance with permit terms and conditions • The Division of Water Rights determines whether the full permit amount can be offered or whether a lesser amount of water can be licensed, based on the above evidence. • A license map or e-map may be required depending on the scope of the project. • Finally, a license is issued and recorded. Alternate outcomes include: the permit is revoked, or the permittee files a petition for extension of time; or the permittee files a change petition.
Data sources Existing data sources; data gaps. Be as specific as possible	Depending on the project type, data sources may include a combination of the following in order to determine actual beneficial water use. • Permit and past orders • Reservoir survey • Records of diversion • Calculations of beneficial use under permit • Past field visit reports • Legal decisions, agreements or contracts, compliance or enforcement issues, past complaints • Water rights data • Aerial photos • Parcel information • Field data: ○ Amount of water diverted, at smallest time interval possible ○ Amount of water beneficially used, rather than collected to storage ○ Reservoir water surface elevation changes ○ Annual acreage on which water is applied and crop type

	○ Irrigation schedules ○ Type and spacing of irrigation and frost protection equipment ○ Nozzle sizes and capacities of pumps, conduits, and delivery systems ○ Frost protection and heat control dates, times, and acreage protected ○ Data pertaining to specific types of use (e.g., number and type of animals for stockwatering use; number of persons for domestic use, etc.) ○ Water conserved, reclaimed, and/or conjunctively used ○ Alternate water supply used during periods when diversion not allowed under permit ○ Pump test to document pump capabilities ○ Pump location, type, and specifications ○ Season of diversion and use • Other field measurements used to estimate water use: ○ Reservoir capacity survey ○ Dam measurement ○ Place of use acreage ○ Weir dimensions ○ Locations of points of diversion and re-diversion ○ Stream flow measurements ○ Pipe or channel flow measurements ○ Sprinkler head flow measurements ○ Photographic documentation of project ○ Reservoir drawdown ○ Meter/gage accuracy ○ Water delivery system ○ GPS mapping • Other proxy data to help determine beneficial use: ○ Crop duty data (to compare to others in the area) ○ Stream gage data

	○ Evapotranspiration ○ Dew point, air temperature (for frost), microclimates ○ Water availability (to determine legality of use) ○ Crop tax records ○ Aerial photos ○ Electrical records (to verify pumping)
Data characteristics Notes about type and form of data	Licensing involves significant data collection by the license applicant and the SWRCB Division of Water Rights staff in order to determine the actual beneficial use of water in each individual case. Data collection is highly site-specific. The process typically requires an on-site visit by the Division of Water Rights to verify water use. This makes data collection labor intensive and highly individualized. Data issues include: duplicate reporting of water use (e.g., same diversion under multiple rights); poor record keeping; multiple time extensions that lengthen the process.

Additional comments:

- Licensing currently tends to involve intensive field data collection. This makes it a labor-intensive process. Due to resource limitations, there is a backlog of over 1200 expired permits that are in need of licensing.
- Most licensing is for small agricultural projects that are not controversial. More complicated licensing projects include municipal projects and larger reservoirs.
- The licensing process can be expedited if parties seeking licenses collect and package data (such as a reservoir survey by a licensed surveyor, place of use data, crop type, withdrawals and diversions, etc.). However, a site visit is still likely to be necessary to confirm water use.
- There is no regulatory basis regarding the methods that must be used for licensing, which opens up the potential for use of proxy data such as remotely sensed estimates of ET. Even if proxies were used, however, licensing staff estimate that field visits would still be necessary to confirm water use.
- Given that licensing involves significant data collection, it is worth considering whether this data could be aggregated to be useful in other ways. Potential uses of licensing data include trying to resolve questions of potential over-allocation through

the production of fine-scale water use data; identifying unauthorized diversions; determining whether there may be water available in fully appropriated streams; and making curtailment processes more accurate.

- Permittees can submit information prepared by professional surveyors or engineers: according to the Division of Water Resources website: *Due to limited resources, the Division is unable to promptly inspect all projects reported ready for licensing. Therefore, the Division will allow permittees to submit the information needed for licensing for the Division's review and evaluation. For reservoir projects, the Division will accept certified reservoir surveys prepared by a licensed land surveyor or registered engineer. For all projects, the calculations of diversion and beneficial use of water under the permit must be prepared by a qualified professional acceptable to the Division. In the event a submittal is determined to be unacceptable, the permittee will be required to either address deficiencies or wait until the Division conducts its own inspection of the project. In all cases, the Division will determine if a physical inspection of the project facilities is needed to obtain additional information or confirm the permittee's data and measurements. The Division may issue a license if the licensing requirements are met.*

Use case 13: Data sources

Topic	Description	Data source description	Access Method
Agriculture	Crop duty data	Department of Water Resources land use data	www.water.ca.gov/landwateruse
Agriculture	Crop type and annual acreage on which water is applied	Field data collected by Division of Water Rights	N/A at aggregate level—data collected for each individual case
Agriculture	Crop tax records	Data collected by permittee and Division of Water Rights	N/A at aggregate level—data collected for each individual case
Agriculture	Data pertaining to specific types of use (e.g., number and type of animals for stockwatering use; number of persons for domestic use, etc.)	Field data collected by Division of Water Rights	N/A at aggregate level—data collected for each individual case
Agriculture	Evapotranspiration	California Irrigation Management Information System (CIMIS)	http://www.cimis.water.ca.gov/
Infrastructure and utilities	Records of electricity used for pumping	Data collected by permittee and Division of Water Rights	N/A at aggregate level—data collected for each individual case
Land use	Place of use acreage	Field data collected by Division of Water Rights	N/A at aggregate level—data collected for each individual case

Topic	Description	Data source description	Access Method
Land use	GPS mapping	Field data collected by Division of Water Rights	N/A at aggregate level—data collected for each individual case
Land use	Aerial photos	Satellite imagery – Google Earth	https://www.google.com/earth/
Land use	Historical aerial photos	Google Earth	https://www.google.com/earth/
Land use	Parcel information	Parcel quest on-line service and land patent information	http://www.parcelquest.com/
Water	Beneficial use calculations	Field data collected by Division of Water Rights or reported by diverter	N/A at aggregate level—data collected for each individual case
Water	Amount of water diverted, at smallest time interval possible	Field data collected by Division of Water Rights	N/A at aggregate level—data collected for each individual case
Water	Amount of water beneficially used, rather than collected to storage	Field data collected by Division of Water Rights	N/A at aggregate level—data collected for each individual case
Water	Irrigation schedules	Field data collected by Division of Water Rights	N/A at aggregate level—data collected for each individual case
Water	Type and spacing of irrigation and frost protection equipment	Field data collected by Division of Water Rights	N/A at aggregate level—data collected for each individual case
Water	Nozzle sizes and capacities of pumps, conduits, and delivery systems	Field data collected by Division of Water Rights	N/A at aggregate level—data collected for each individual case
Water	Frost protection and heat control dates, times, and acreage protected	Field data collected by Division of Water Rights	N/A at aggregate level—data collected for each individual case
Water	Water conserved, reclaimed, and/or conjunctively used	Field data collected by Division of Water Rights	N/A at aggregate level—data collected for each individual case
Water	Alternate water supply used during periods when diversion not allowed under permit	Field data collected by Division of Water Rights	N/A at aggregate level—data collected for each individual case
Water	Pump test to document pump capabilities	Field data collected by Division of Water Rights	N/A at aggregate level—data collected for each individual case
Water	Pump location, type, and specifications	Field data collected by Division of Water Rights	N/A at aggregate level—data collected for each individual case

Topic	Description	Data source description	Access Method
Water	Season of diversion and use	Field data collected by Division of Water Rights	N/A at aggregate level—data collected for each individual case
Water	Locations of points of diversion and re-diversion	Field data collected by Division of Water Rights	N/A at aggregate level—data collected for each individual case
Water	Pipe or channel flow measurements	Field data collected by Division of Water Rights	N/A at aggregate level—data collected for each individual case
Water	Sprinkler head flow measurements	Field data collected by Division of Water Rights	N/A at aggregate level—data collected for each individual case
Water	Photographic documentation of project	Field data collected by Division of Water Rights	N/A at aggregate level—data collected for each individual case
Water	Meter/gage accuracy	Field data collected by Division of Water Rights	N/A at aggregate level—data collected for each individual case
Water	Water delivery system	Field data collected by Division of Water Rights	N/A at aggregate level—data collected for each individual case
Water	Water storage-- Reservoir survey	Field data collected by Division of Water Rights or produced by a surveyor	N/A at aggregate level—data collected for each individual case
Water	Reservoir water surface elevation changes	Field data collected by Division of Water Rights	N/A at aggregate level—data collected for each individual case
Water	Reservoir capacity survey	Field data collected by Division of Water Rights	N/A at aggregate level—data collected for each individual case
Water	Dam measurement	Field data collected by Division of Water Rights	N/A at aggregate level—data collected for each individual case
Water	Weir dimensions	Field data collected by Division of Water Rights	N/A at aggregate level—data collected for each individual case
Water	Reservoir drawdown	Field data collected by Division of Water Rights	N/A at aggregate level—data collected for each individual case
Water	Stream flow measurements	Field data collected by Division of Water Rights	N/A at aggregate level—data collected for each individual case
Water	Water availability	USGS web site for gage data to confirm available flows to match reports from diverters	https://wdr.water.usgs.gov/
Water	Stream gage data	USGS California streamflow data	https://waterdata.usgs.gov/ca/nwis/rt

Topic	Description	Data source description	Access Method
Water	Water availability	DWR CA Data Exchange Center data—statewide water conditions; hydrologic conditions	https://cdec.water.ca.gov/
Water	Records of diversion	Annual Reporting to State Water Resources Control Board-- eWRIMS	http://www.waterboards.ca.gov/waterrights/water_issues/programs/ewrims/index.shtml
Water	Water rights data	EWRIMS—State Water Resources Control Board	http://www.waterboards.ca.gov/waterrights/water_issues/programs/ewrims/index.shtml
Water	Accurate annual reporting of withdrawals and diversions	Annual Reporting to State Water Resources Control Board-- eWRIMS	Data gap—data is not always accurate or fine-grained enough. http://www.waterboards.ca.gov/waterrights/water_issues/programs/ewrims/index.shtml
Water	Reservoir surveys by licensed surveyors	Surveys by licensed surveyors	Data gap-- N/A at aggregate level—data collected for each individual case

Use Case 14: Water shortage contingency planning vulnerability assessment

Developed in collaboration with Community Water Center

Objective Decision, goal or desired action	Conduct a vulnerability assessment of a rural community in the San Joaquin Valley using updated, comprehensive data to determine the extent to which water shortage puts it at risk of not having sufficient clean water supplies, especially groundwater, for household use including consumption.
Description Important context and background information	California's last drought took a devastating toll on rural communities. In Tulare County alone, thousands of domestic wells went dry, leaving residents without running water in their homes for drinking, cooking, sanitation, and other needs. California is prone to droughts, and the severity of the last one makes is clear that we need to be as prepared as possible for the next one. Climate change makes it harder to predict when, where, and with what intensity the next drought will hit, making such preparation all the more urgent to have in place. CWC (with the support of a number of environmental- and water-focused organizations) has been advocating for DWR to develop recommended guidelines for county agencies to follow in developing drought contingency plans for small water suppliers and rural communities. A key aspect of these plans would be to conduct a vulnerability assessment to understand which communities are vulnerable to water shortage and in what ways so appropriate plans can be prepared to both reduce vulnerabilities and develop plans for providing emergency water supplies for when shortages do occur.
Participants The main decision-maker; also note other parties involved or affected	• DWR: Once the relevant legislation is passed, DWR will be responsible for developing recommended guidelines. • County agencies: The designated county agencies would be responsible for following them to prepare localized drought contingency plans, the first step of which is to conduct vulnerability assessments.

	● Community members/community-based organizations: Developing the guidelines and creating the contingency plans should be multi-stakeholder processes that community members fully participate in. ● GSAs: Since many SJV communities rely largely on groundwater for their water needs, representatives from the relevant GSAs should be part of the process so they fully understand community water needs as they develop their GSPs. An effective, enforced plan would ideally manage groundwater in such a way that reduces the likelihood of water shortage.
Regulatory context Legal, regulatory, and reporting requirements	● AB 1668 (proposed legislation) ● Executive Order B-37-16 (driver for legislation) ● SGMA (could be the policy vehicle if AB 1668 doesn't pass)

Workflow
Progression of steps and specific actions taken by participants to accomplish objective
	● DWR carries out thorough process (under AB 1668) to develop recommended guidelines based on multi-stakeholder participation
	● DWR and counties work together to facilitate drought planning, including:
	  ○ Demonstrate planning coverage
	  ○ Assess current drought vulnerability
	  ○ Conduct on-going drought risk assessment
	  ○ Prepare response strategies and implementation plans
	  ○ Establish and implement reporting, coordination and communication protocols
	● Recommended guidelines receive legislative approval
	● Relevant rural county agencies identified and time frame developed for completing different steps of drought contingency planning process
	● Rural county agencies conduct vulnerability assessments in partnership with rural communities and with open, transparent water data platform as a source
	● Based on vulnerability assessments, appropriate contingency plans developed for small rural communities in partnership with local group of stakeholders

Data sources Existing data sources; data gaps.	See table below
Data characteristics Notes about type and form of data	Location-related data should be mapped, with the different data sets as layers that can be overlaid so the relationships are clear. This type of geospatial analysis is crucial to conducting an effective vulnerability assessment.

Use case 14: Data sources

Topic	Description	Data source description	Access Method
Infrastructure and utilities	Sources of water/backup connections	SWRCB – DDW This covers what the sources of water are for a particular community, whether there any backup connections, and the TMF capacity of the water provider.	https://www.waterboards.ca.gov/drinking_water/programs/
Infrastructure and utilities	Public water system boundaries	SWRCB	https://www.waterboards.ca.gov/
Land use	Nearby land uses	DWR. information on the operations near a community that use surface and groundwater. Neighboring industrial agricultural operations with deeper well capacities are red flags for vulnerability, for example.	https://gis.water.ca.gov/app/CADWRLandUseViewer/
Socioeconomic	General data on population/demographics	US Census Bureau and other sources. Data on population, growth, race, income to find disparities in water supply, water quality, etc.	https://www.census.gov/data.html
Water	Water quality data	SWRCB contaminants present in water that can become more concentrated and could pass MCLs during times of reduced supply.	https://www.waterboards.ca.gov/resources/data_databases/

Topic	Description	Data source description	Access Method
Water	State small systems boundaries and service connections	SWRCB	https://www.waterboards.ca.gov/
Water	Domestic well data	OEHHA . Households that rely on domestic wells - population parcel data, areas outside public water system boundaries	https://oehha.ca.gov/water
Water	Wells that previously went dry	Household water supply shortage reporting system	https://mydrywatersupply.water.ca.gov/report/publicpage
Water	Well locations and depths	DWR	http://www.water.ca.gov/groundwater/wells/well_completion_reports.cfm
Water	Groundwater levels/water tables	DWR (CASGEM)	http://www.water.ca.gov/groundwater/casgem/
Water	GSA boundaries	DWR (SIGMA Portal)	http://sgma.water.ca.gov/portal/#gsa
Infrastructure and utilities	Schools/NTNC systems	Locations of schools that have their own water systems and other non-transient non-community systems	Data gap

Use Case 15: Decision support system for harmful algal bloom response, communication and mitigation

Developed in collaboration with State Water Resources Control Board Water Quality staff

Objective Decision, goal or desired action	Goal: To manage leading edge of HAB incident verification, communication and mitigation by effectively managing and utilizing data to support and inform decision-making.
Description Important context and background information	Cyanobacteria, also known as blue-green algae, are commonly found in freshwater, brackish, and marine environments throughout the world. Provided adequate light and nutrients, they can form dense blooms in which they outcompete other algal species, deplete dissolved oxygen levels during bloom die-off, and, for some species, release potent toxins which can impact aquatic species, wildlife, livestock, humans, and their pets. Human activities can contribute to harmful algal bloom (HAB) occurrences. Nutrients found in fertilizers, animal waste, and human waste can stimulate blooms, and excessive water diversions can also increase temperatures, reduce flows and stimulate HABs. In addition, HABs toxins from inland waterbodies can be transported to the estuarine environment and bioaccumulate in marine shellfish. Researchers have detected HAB toxins in ambient water and marine shellfish within San Francisco Bay, Monterey, Bay and southern coastal lagoons (Gibble et al., 2016; Miller et al., 2010; Howard et al., 2017). The emergence of HAB toxins accumulation in shellfish has implications for public health and marine fisheries industry, as well as wildlife health. In 2016 the State Board deployed a HAB tracking system collect data on voluntarily reported blooms and presented as an online map. HABs are reported through the Freshwater Bloom Incident Form (Incident Form) to support immediate event response. The Incident Form collects information about observed harmful algal blooms (both suspected and confirmed). Water Board staff review the reports and initiate a coordinated incident response procedure that includes bloom confirmation, notification of appropriate public health and resource management agencies and support for follow up monitoring.

Participants The main decision-maker; also note other parties involved or affected	Main Decision Maker - State Water Board and Regional Water Boards (CA Water Boards) Other Parties Involved - California Department of Public Health, US Environmental Protection Agency, California Department of Fish and Wildlife, Department of Water Resources, Office of Environmental Health and Hazards Assessment, tribes, local agencies and waterbody managers.
Regulatory context Legal, regulatory, and reporting requirements	Currently, there are no federal or state standards for cyanotoxins in drinking water and recreational waters. Participating agencies - State Water Board, OEHHA, and CDPH - have developed and are further refining suggested guidelines for addressing health concerns for cyanotoxins in recreation waters. The Department of Public Health, county health departments, and water body managers are encouraged to use this guidance for posting of water bodies when cyanoHABs pose a health threat.
Workflow Progression of steps and specific actions taken by participants to accomplish objective	1. Data acquisition - When an incident is reported through the Freshwater Incident Report, satellite tool (in future), phone call, email and/or photo submittal, data related to incident is acquired. As part of incident response, initial monitoring may be conducted. Sampling data and lab results are additional source of field data. Sampling may be conducted by various agencies and partners including, but not limited to: Department of Water Resources, California Department of Fish and Wildlife, local public health offices, tribes, local waterbody managers, California Water Boards. Labs most commonly include Bend Genetics, Green Water Labs and EPA. 2. Data Storage - Data and information provided via the Freshwater Incident Report Form populates the Freshwater HAB Tool Access database. Water Board staff update the database with lab results. 3. Public Accessibility of Data - data is published to the CA HABs Portal Map. The map includes a summary of voluntarily reported incidents including lab results, advisory information and agencies involved. Data can be downloaded through an open data link provided on the webpage. Lab data is not currently available, but can be provided through the data.ca.gov webpage. 4. Support informed decision-making - by collecting data through Freshwater Incident Form and initial monitoring, agency staff and local waterbody managers are provided with baseline information to

	confirm presence or absence of HAB, genera identification, potential toxin producing genera, and/or toxins. Based on this information, we can communicate risk to the public through posting of advisory signage (Caution, Warning, Danger), updating CA HABs Portal with latest qualitative and quantitative information, and issue informed press releases and social media posts based on science. Decisions related to mitigation of the bloom require data and information about genera and toxins present. In addition, effective mitigation requires related watershed information including: land uses, water quality impairments, nutrient and sediment loads and historical information (i.e., treatments, species and toxins, monitoring results).
Data sources Existing data sources; data gaps. Be as specific as possible	HABs-related data is collected by a number of local and state agencies; however, there is not one centralized database to collect and gather all data. Data sources include: ● Freshwater HABs Tool - Access database ● One Health Harmful Algal Bloom System (OHHABS) ● CEDEN ○ Phtyoplankton data cannot be stored in existing format ● SWAMP ● Cyanobacteria TMDLs and location of TMDL implementation actions ○ ● Waterbodies listed as impaired for mercury on the 303(d) list ○ http://gispublic.waterboards.ca.gov/arcgis/rest/services/Water_Quality ● ● Local waterbody/watershed monitoring groups ○ Eg. Klamath Basin Monitoring Program, East Bay Regional Parks, Big Valley Rancheria and Elem Tribe

	● Local waterbody manager's datasets
	● Current and proposed wetland restoration projects
	● USGS National Land Cover Database: https://catalog.data.gov/dataset/usgs-national-land-cover-dataset-nlcd-downloadable-data-collection
	● DWR Land Use Survey data
	● California Department of Conservation Farmland Mapping and Monitoring Program (county-level data) http://www.conservation.ca.gov/dlrp/fmmp/Pages/county_info.aspx
	● USDA National Agricultural Statistics Service Cropscape Cropland Data Layer https://nassgeodata.gmu.edu/CropScape/
	● Hydrography (lakes and stream network)
	  ○ http://gispublic.waterboards.ca.gov/arcgis/rest/services/Hydrography
	● DWR stream conditions, precipitation, water supply, etc.
	  ○ California Data Exchange Network: https://cdec.water.ca.gov/
	● USGS daily streamflow: https://waterdata.usgs.gov/ca/nwis/rt
	● Fisheries
	  ○ http://www.cbr.washington.edu/sacramento/data/juv_monitoring.html
	● Watersheds (USGS HUC watershed layer)
	  ○ http://gispublic.waterboards.ca.gov/arcgis/rest/services/Hydrography
	● DWR CDEC reservoir storage by hydrologic region http://cdec.water.ca.gov/cgi-progs/reservoirs/STORAGEW

Data characteristics Notes about type and form of data	HAB monitoring data not available in one centralized location. Lack of regulatory program creates barrier to require monitoring and therefore data acquisition. Various research projects statewide due to relatively 'new' field of HABs research. Data is rarely shared and made available.

Additional comments: Mitigation of HABs related to several Water Board regulatory programs including Irrigated Lands Regulatory Program, Wetlands, NPDES, TMDLs. Treatment of HABs often through use of aquatic herbicide application; however, lack of treatment data availability. Monitoring data collected through aforementioned regulatory programs not currently housed in one central database.

Use case 15: Data sources

Topic	Description	Data source description	Access Method
Agriculture	Crops	USDA National Agricultural Statistics Service Cropscape Cropland Data Layer	https://nassgeodata.gmu.edu/CropScape/
Agriculture	Farmland Mapping	California Department of Conservation Farmland Mapping and Monitoring Program (county-level data)	http://www.conservation.ca.gov/dlrp/fmmp/Pages/county_info.aspx
Ecology	Fisheries	CBR	http://www.cbr.washington.edu/sacramento/data/juv_monitoring.html
Land use	Land Cover	USGS National Land Cover Database	https://catalog.data.gov/dataset/usgs-national-land-cover-dataset-nlcd-downloadable-data-collection
Land use	Land USE	DWR Land Use Survey data	http://www.water.ca.gov/landwateruse/lusrvymain.cfm#landusedata
Mapping and modeling	Watersheds	USGS HUC watershed layer	http://gispublic.waterboards.ca.gov/arcgis/rest/services/Hydrography
Water	Surface Water Ambient Monitoring Program (SWAMP)	SWAMP	https://www.waterboards.ca.gov/water_issues/programs/swamp
Water	Harmful Algal Bloom	One Health Harmful Algal Bloom System (OHHABS)	https://www.cdc.gov/habs/ohhabs.html
Water	Streamflow	USGS daily streamflow	https://waterdata.usgs.gov/ca/nwis/rt
Water	Stream Conditions	DWR stream conditions, precipitation, water supply, etc. CDEC	https://cdec.water.ca.gov/

Topic	Description	Data source description	Access Method
Water	Freshwater Harmful Algal Bloom	Freshwater HABs Tool	http://www.mywaterquality.ca.gov/habs/where/freshwater_events.html
Water	Local waterbody/watershed monitoring groups	Basin monitoring programs such as: East Bay Regional Parks, Big Valley Rancheria and Elem Tribe, Klamath Basin Monitoring Program	http://sfei.maps.arcgis.com/apps/MapSeries/index.html?appid=9b10920b676b4dfebce14f8c4ea70c4d&entry=3
Water	Water bodies impaired for mercury on the 303(d) list	Water Boards California	http://gispublic.waterboards.ca.gov/arcgis/rest/services/Water_Quality
Water	Lakes and Streamflow	Waterboards California	http://gispublic.waterboards.ca.gov/arcgis/rest/services/Hydrography
Water	Phytoplankton	CEDEN	ceden.org/CEDEN_checker/Checker/
Water	Reservoir Storage by hydrologic region	CDEC	http://cdec.water.ca.gov/cgi-progs/reservoirs/STORAGEW
Ecology	Current and proposed wetland restoration projects	Data Gap	Data Gap
Mapping and modeling	Local waterbody manager's datasets	Data Gap	Data Gap
Water	Cyanobacteria TMDLs and location of implementation actions	Data Gap	Data Gap

Use Case 16: Decision support system to track and evaluate mercury control actions

Developed in collaboration with State Water Resources Control Board Water Quality staff

Objective Decision, goal or desired action	Objective: Implement mercury control actions to maximize effectiveness of reducing exposure to humans and wildlife. Evaluate the potential of wetland restoration, salmonid population restoration, and other on-the-ground projects to increase mercury exposure to humans and wildlife. Decision: What are the most effective and efficient management actions to reduce mercury levels in fish in this waterbody? Will this proposed on-the-ground action increase mercury levels in fish in the waterbody?
Description Important context and background information	Mercury is a persistent, bioaccumulative contaminant that is difficult and expensive to control. Elevated levels of mercury in fish pose a risk to people[33] and wildlife that consume them. Some management actions, such as wetlands restoration, may release mercury into the aquatic environment leading to increased levels of mercury in fish. Mercury TMDLs have been established for numerous waterbodies and the State Water Board recently adopted mercury limits to protect beneficial uses related to the consumption of fish by both people and wildlife. The Water Boards must implement actions to reduce mercury levels below, and avoid actions which would increase mercury levels above, TMDL targets and statewide mercury limits. In the Central Valley, where much of the legacy mercury is entrained in the system, there are often operational decisions that pit desired fisheries outcomes (more juvenile salmon, for example) against concerns of creating the right conditions for mercury methylation, which then increases the risk of bioaccumulation of mercury and eventual increased exposure to this compound in human and wildlife populations.

[33] See Office of Environmental Health Hazard Assessment (OEHHA) fish advisories: https://oehha.ca.gov/fish/advisories

Participants The main decision-maker; also note other parties involved or affected	Water Board program managers (decision makers) DWR, CDFW, Delta Science Program restoration specialists and grant programs (decision makers) Wastewater treatment plant permittees, stormwater permittees (affected parties) Reservoir managers (affected parties) Ecosystem restoration grant recipients (affected parties)
Regulatory context Legal, regulatory, and reporting requirements	● Water Board's Mercury Control Program[34] ● Numerous waterbody specific mercury TMDLs[35]
Workflow Progression of steps and specific actions taken by participants to accomplish objective	● The program manager needs access to mercury data in sediment, water and fish; landscape, land use, and climate data; and an understanding of mercury cycling mechanisms in the waterbody or watershed. ● The program manager must be aware of known and potential mercury inputs to the waterbody or watershed, such as permitted discharges, legacy mining impacts, etc. ● The program manager must be aware of beneficial uses, associated water quality objectives, TMDL targets and other applicable mercury limits to the waterbody. ● The program manager needs an understanding of current and proposed actions to reduce mercury (e.g. mine remediation, wastewater treatment plant upgrades, reservoir management, etc.) in the watershed as well as current and proposed actions that may increase mercury levels.
Data sources Existing data sources; data gaps. Be as specific as possible	● Mercury data in water, sediment and fish tissue from CEDEN o https://data.ca.gov/dataset/surface-water-%E2%80%93-aquatic-organism-tissue-samples-%E2%80%93-ceden o https://data.ca.gov/dataset/surface-water-%E2%80%93-chemistry-%E2%80%93-ceden

[34] http://www.waterboards.ca.gov/water_issues/programs/mercury/

[35] http://www.waterboards.ca.gov/water_issues/programs/mercury/other_programs.shtml

	• Mercury data collected by state, federal and local entities not in CEDEN (e.g. USGS, ACOE, BOR, FERC, DWR, CDFW, academic institutions and watershed groups)
	• Mercury TMDLs and location of TMDL implementation actions
	  o http://www.waterboards.ca.gov/water_issues/programs/mercury/
	• Waterbodies listed as impaired for mercury on the 303(d) list
	  o http://gispublic.waterboards.ca.gov/arcgis/rest/services/Water_Quality
	• Current and proposed wetland restoration projects
	• USGS National Land Cover Database: https://catalog.data.gov/dataset/usgs-national-land-cover-dataset-nlcd-downloadable-data-collection
	• DWR Land Use Survey data
	• Hydrography (lakes and stream network)
	  o http://gispublic.waterboards.ca.gov/arcgis/rest/services/Hydrography
	• DWR stream conditions, precipitation, water supply, etc.
	  o California Data Exchange Network: https://cdec.water.ca.gov/
	• USGS daily streamflow: https://waterdata.usgs.gov/ca/nwis/rt
	• Fisheries
	  o http://www.cbr.washington.edu/sacramento/data/juv_monitoring.html
	• Watersheds (USGS HUC watershed layer)
	  o http://gispublic.waterboards.ca.gov/arcgis/rest/services/Hydrography

Data characteristics Notes about type and form of data	Water, sediment and fish tissue data collected for special studies or other research may not be available in a centralized database Locations and information about wetlands restoration projects (grant funded, or mitigation) may not be readily available

Use case 16: Data sources

Topic	Description	Data source description	Access Method
Ecology	Mercury data in water, sediment and fish tissue	CEDEN	https://data.ca.gov/dataset/surface-water-%E2%80%93-aquatic-organism-tissue-samples-%E2%80%93-ceden

Topic	Description	Data source description	Access Method
			https://data.ca.gov/dataset/surface-water-%E2%80%93-chemistry-%E2%80%93-ceden
Ecology	Fisheries	CBR	http://www.cbr.washington.edu/sacramento/data/juv_monitoring.html
Land use	Land Cover	USGS National Land Cover Database	https://catalog.data.gov/dataset/usgs-national-land-cover-dataset-nlcd-downloadable-data-collection
Land use	Land Use	DWR Land Use Survey data	http://www.water.ca.gov/landwateruse/lusrvymain.cfm
Mapping and modeling	stream conditions, precipitation, water supply, etc.	DWR CDEC	https://cdec.water.ca.gov/
Mapping and modeling	Watersheds (USGS HUC watershed layer)	USGS	http://gispublic.waterboards.ca.gov/arcgis/rest/services/Hydrography
Water	Streamflow	USGS	https://waterdata.usgs.gov/ca/nwis/rt
Water	Mercury TMDLs and location of TMDL implementation actions	Waterboards California	http://www.waterboards.ca.gov/water_issues/programs/mercury/
Water	Waterbodies listed as impaired for mercury on the 303(d) list	Waterboards California	http://gispublic.waterboards.ca.gov/arcgis/rest/services/Water_Quality
Water	Hydrography (lakes and stream network)	Waterboards California	http://gispublic.waterboards.ca.gov/arcgis/rest/services/Hydrography
Water	Mercury data collected by state, federal and local entities not in CEDEN (e.g. USGS, ACOE, BOR, FERC, DWR, CDFW, academic institutions and watershed groups)	USGS, ACOE, BOR, FERC, DWR, CDFW, academic institutions and watershed groups	
Ecology	Current and proposed wetland restoration projects	Data Gap	Data Gap

Use case 17: Quantifying groundwater basin water budgets for state intervention

Developed by State Water Resources Control Board

Objective Decision, goal or desired action	Quantify inputs, outputs, and sources within all or part of a groundwater basin so that the State Water Resources Control Board (Water Board, or Board) can determine: 1) whether probationary designation is required; 2) whether an interim plan is needed to manage groundwater in the basin, and if so; 3) how to manage extractions within the basin, consistent with established water rights law, so that the basin progresses toward sustainability. The Board's authority is only triggered in certain circumstances, in accordance with Sustainable Groundwater Management Act (SGMA) intervention triggers.
Description Important context and background information	The Board is considered the "state backstop" for the purposes of SGMA, and has authority and statutory requirements in the event that 1) part of a basin is not under the jurisdiction of a Groundwater Sustainability Agency (GSA); 2) a GSA does not develop a GSP that serves the entire basin, or; 3) the GSP is inadequate or is not being implemented. DWR has regulatory requirements to collect basin information, including water budget information. However, the water budget information collected by the Department is at the basin/GSA scale; individual pumpers are not required to report directly to DWR. For basins that are not in critical overdraft, the Board must first determine whether long-term overdraft exists in the basin (Water Code 10735.2(a)(5)(A)(ii)). The Board may need to develop a reliable water budget for the basin in order to make the determination of whether a condition of long-term overdraft exists. The determination of long-term overdraft can also include analysis of groundwater elevations. If the basin is in long-term overdraft, the Board may look at each individual pumper and their contribution to long-term overdraft in development of an interim management plan, or may take a more general approach in the interim plan. The Board's plan must follow water-right priorities, which furthers the need

	for a data-driven budget. The Board is further required to recover costs associated with intervention and development of a plan.
Participants The main decision-maker; also note other parties involved or affected	The main decision maker is the State Water Resources Control Board. Board intervention can be triggered by the Department of Water Resources in consultation with the Board. However, there are scenarios (e.g. no plan is submitted, no GSA to manage groundwater) where the Board can take action without referral from the Department. Stakeholders include local public agencies, counties, GSAs, and any well owner, including domestic well owners in some circumstances.
Regulatory context Legal, regulatory, and reporting requirements	Reporting requirements are described in Water Code sections 5202 and 5203. Fees associated with reporting this statutory authority are codified in California Code of Regulations Title 23, Sections 1030 to 1046. Intervention authority is described in California Water Code section 10735.2.
Workflow Progression of steps and specific actions taken by participants to accomplish objective	Step 1: Identify legal mechanism by which Board intervention is triggered (e.g. no GSA, no sustainability plan, or plan is referred to Board by the Department). Step 2: Identify appropriate local public agencies. The degree to which the Board interacts with local public agencies will depend on the intervention trigger. For example, areas without a GSA might have less public agency interaction in comparison to a basin where there are several active GSAs. Begin outreach effort and information exchange with those agencies, as appropriate.

	Step 3: Identify groundwater extractors. The Board implements a parcel-based search approach to identify parcels that may have a well. Through mailings, the Board contacts extractors and directs them to report well locations, extraction, point of use, and other information through the Board's on-line portal. Step 4 (implemented at same time as Step 3): Depending on intervention trigger, begin compiling information needed for the Water Budget. Use extraction information from extraction reports to the Board, in combination with data described in the Data section below, to determine basic water input/output parameters for the basin. The type of intervention trigger is significant; if the Board is only evaluating unmanaged areas (without a GSA), it may not be necessary to begin Step 4 until after the scale/scope of groundwater extractions in the basin is better understood. Step 5: Determine whether basin is in long-term overdraft (if necessary; note that some basins, such as those defined by the Department as being in critical overdraft, are by definition already in long-term overdraft). Based on the Board's findings, develop an interim management plan (as needed); consider each extractor's contribution to basin overdraft; assess fees for extractors.
Data sources Existing data sources; data gaps. Be as specific as possible	See attached Excel spreadsheet. Board staff have developed a needs table that extends beyond Water Budgeting and looks at SGMA/Groundwater Management SGMA needs. Water budget components are grouped on the table.
Data characteristics Notes about type and form of data	We presume the necessary water budget data will come in numerous forms. The most critical dataset for the Board is the reporting from individual well extractors. Because the Board is developing its own on-line reporting system, extraction reports will meet certain quality criteria and formatting standards, which will reduce staff review time and ensure consistency within each basin.

Additional comments:

There are considerable uncertainties associated with the Board's water budget needs. Those uncertainties are largely driven by whether State Board intervention is needed to begin with. **The Board lacks funding and authority to collect all of the necessary data until intervention is triggered**. At the same time, once intervention is triggered the Board will need to move quickly to establish a relationship with stakeholders and to address sustainability in the basin.

Use case 17: Data sources

Topic	Description	Data source description	Access Method
Agriculture	Evapotranspiration	METRIC, SIMS, Cal-SIMETAW, ClimateEngine	http://www.water.ca.gov/landwateruse/models.cfm
Agriculture	*Reference ET (define climate change assumptions)	WSIP/SGMA	https://cwc.ca.gov/Documents/2017/WSIP/TechnicalReference.pdf
Ecology	Wildlife (define wildlife measurements)	DFW - BIOS, USFWS, DWR	Updates every year
Geology and soils	Geology (Structure)	USGS, CGS, GSA HCMs, ILRP GARs,AEM	https://ngmdb.usgs.gov/ngmdb/ngmdb_home.html
Geology and soils	Soil	SSURGO	https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/?cid=nrcs142p2_053627
Geology and soils	Hydrogeology (Texture-Specific)	USGS-CVHM, GSA HCMs, DWR-SVSim	https://www2.usgs.gov/science/science.php?thcode=2&term=554&n=37
Land use	Land use	LandIQ, DWR	http://www.landiq.com/portfolios-tags/land-classification
Mapping and modeling	Surface watersheds	WBD	ftp://rockyftp.cr.usgs.gov/vdelivery/Datasets/Staged/Hydrography/WBD/
Mapping and modeling	C2VSim-FG	DWR	http://baydeltaoffice.water.ca.gov/modeling/hydrology/C2VSim/index_C2VSIM.cfm
Mapping and modeling	IWFM	DWR	http://baydeltaoffice.water.ca.gov/modeling/hydrology/IWFM/
Mapping and modeling	Detailed Analysis Units	DWR	http://www.water.ca.gov/landwateruse/anlwuest.cfm
Mapping and modeling	Elevation (DEM, LiDAR)	USGS, NASA, USACOE	https://lta.cr.usgs.gov/NED

Topic	Description	Data source description	Access Method
Mapping and modeling	Township and Section (PLSS)	Modified from BLM	https://nationalmap.gov/small_scale/atlasftp.html
Mapping and modeling	Physical Waterways	NHD+	https://nhd.usgs.gov/
Mapping and modeling	Counties	data.gov	https://www.data.gov/counties/
Mapping and modeling	Assessors Parcel Info	LandVision	https://www.digmap.com/our-products/landvision/landvision-professional/
Mapping and modeling	SVSim	DWR	https://www.grac.org/media/files/files/8119c5d9/3.3_Bond.pdf
Mapping and modeling	Regional Board Boundaries	SWRCB	https://www.waterboards.ca.gov/waterboards_map.html
Mapping and modeling	Imagery	Hexagon geospatial 12" and 6" 4-band, NASA	Need to procure
Socioeconomic	Population/Population Growth	DWR, DOF	http://www.dof.ca.gov/Forecasting/Demographics/Estimates/E-1/
Water	Water Year Type	DWR	http://cdec.water.ca.gov/cgi-progs/iodir/wsihist
Water	Snowpack	DWR, NASA	http://cdec.water.ca.gov/snow/current/snow/
Water	Water quality	CEDEN, GeoTracker, SDWIS, CIWIQS, USGS, DWR	http://www.ceden.org/
Water	Groundwater Basins	DWR	http://www.water.ca.gov/groundwater/bulletin118/gwbasins.cfm
Water	Central Valley Base of Fresh Groundwater Map	DWR, USGS	http://www.water.ca.gov/groundwater/data_and_monitoring/south_central_region/GroundwaterLevel/gw_level_monitoring.cfm
Water	GSA Boundaries	DWR	http://www.water.ca.gov/groundwater/sgm/gsa.cfm
Water	Well Completion Reports	OSWCR	http://www.water.ca.gov/oswcr/
Water	Groundwater Levels	DWR - CASGEM, WDL, USGS, SWRCB	http://www.water.ca.gov/waterdatalibrary/groundwater/index.cfm
Water	Groundwater Storage	DWR, USGS	http://www.water.ca.gov/waterdatalibrary/groundwater/index.cfm

Topic	Description	Data source description	Access Method
Water	Subsidence (InSAR/LiDAR/CGPS)	USGS, NASA, DWR	https://ca.water.usgs.gov/land_subsidence/central-valley-subsidence-data.html
Water	Potential Recharge Areas	SAGBI -UC Davis, Sustainable Conservation	https://casoilresource.lawr.ucdavis.edu/sagbi/
Water	Precipitation	PRISM, NOAA, CIMIS	https://cdec.water.ca.gov/cgi-progs/prevprecip/PRECIPDLY.BSN
Water	SWP/CVP Imports (define climate change assumptions)	WSIP/SGMA	https://cwc.ca.gov/Documents/2017/WSIP/TechnicalReference.pdf
Water	SWP/CVP Diversions (define climate change assumptions)	WSIP/SGMA	https://cwc.ca.gov/Documents/2017/WSIP/TechnicalReference.pdf
Water	SWP/CVP Deliveries (define climate change assumptions)	WSIP/SGMA	https://cwc.ca.gov/Documents/2017/WSIP/TechnicalReference.pdf
Water	SWP/CVP Reservoir Releases (define climate change assumptions)	WSIP/SGMA	https://cwc.ca.gov/Documents/2017/WSIP/TechnicalReference.pdf
Water	Precipitation (define climate change assumptions)	WSIP/SGMA	https://cwc.ca.gov/Documents/2017/WSIP/TechnicalReference.pdf
Water	Runoff (define climate change assumptions)	WSIP/SGMA	https://cwc.ca.gov/Documents/2017/WSIP/TechnicalReference.pdf
Water	SGMA InSAR	NASA or Private Vendor	https://solidearth.jpl.nasa.gov/insar/
Water	Streamflow	DWR, USGS, DFW?, State board?	https://waterdata.usgs.gov/ca/nwis/rt
Water	Water rights	eWRIMS	https://www.waterboards.ca.gov/waterrights/water_issues/programs/ewrims/
Water	Surface Water Deliveries	eWRIMS	https://www.waterboards.ca.gov/waterrights/water_issues/programs/ewrims/
Water	Water movement, exchange, and transfer	DWR, GSAs, DRINC, SMARTs	Needs further development
Water	Well locations	Reported by local well owners	
Water	Extraction volumes from each well	Reported by local well owners	
Weather and Climate	Climate Assumptions	WSIP/SGMA	https://cwc.ca.gov/Documents/2016/07_July/July2016_Agenda_Item_8_Attach_2_Updated_Climate_Change_Requirements.pdf

Topic	Description	Data source description	Access Method
Weather and Climate	Temperature (define climate change assumptions)	WSIP/SGMA	https://cwc.ca.gov/Documents/2017/WSIP/TechnicalReference.pdf
Weather and Climate	Temperature	PRISM, NOAA, CIMIS	radar.weather.gov/ridge/radar/php?rid=bbx&product=NDR&overlay=1110111&loop=no

Data Integration: *Conceptual Categorization for an Online Integrated Geospatial Support Tool for Water Management in California*

Category	Dataset Name	Function	Source	Data Availability	Minimum Update Frequency	Needs Further Development	Need to Procure	Needed for SWRCB Basin Balance and Enforcement
Boundaries Or Other Background Info	Assessors Parcel Info	Identify ownership information and parcel area	LandVision		Every year			X
	Regional Board Boundaries	Delineate the jurisdiction of the nine Regional Water Quality Boards	SWRCB	Currently Available	Static			
	Surface watersheds	Delineate contributory areas to a river, stream, or canal	WBD	Currently Available	Static			X
	Groundwater Basins	Delineate Bulletin 118 basin boundaries	DWR	Currently Available	Every 5 years			X
	Detailed Analysis Units	Delineate DWR DAU boundaries	DWR	Currently Available	Static			
	Counties	Delineate the 58 county boundaries	data.gov	Currently Available	Static			X
	Township and Section (PLSS)	Delineate area based on historical survey methods, locate well logs	Modified from BLM	Currently Available	Static			
	GSA Boundaries	Delineate area based on Groundwater Sustainability Agency Boundaries	DWR	Currently Available	Every year			X
	Physical Waterways	Delineate surface water conveyance features	NHD+	Currently Available	Every year			X
	Imagery	Visual reference for inspections, thermal information	Hexagon geospatial 12" and 6" 4-band, NASA	?	Every year		X	X
	Water movement, exchange, and transfer	Model surface and ground water quantity for water budgets and water markets	DWR, GSAs, DRINC, SMARTs	?	Every year	X		X

	Water rights	Define water allocations according to Water Board records	eWRIMS	Currently Available	Every year	X		
	Snowpack	Define snow-water equivalent stored as snowpack	DWR, NASA	Currently Available	Every year	?		
Water Budget	Precipitation	Define contributions of atmospheric water	PRISM, NOAA, CIMIS	Currently Available	Daily (or monthly)			X
	Temperature	Define surface and atmospheric characteristics	PRISM, NOAA, CIMIS	Currently Available	Daily (or monthly)			X
	Water Year Type	Define water year type for use in GSP development	DWR	Q4 - 2017	Every year			
	Land use	**Define the purpose of land use, estimate impact from use**	**LandIQ, DWR**	**Q2 - 2017**	**Every year**			**X**
	Evapotranspiration	**Define vegetative consumptive use for water budgets**	**METRIC, SIMS, Cal-SIMETAW, ClimateEngine**	**Unknown**	**Every year**		**X**	**X**
	Population/Population Growth	Define population and popultion growth for use in GSP development	DWR, DOF	Currently Available	Every year			
	Climate Assumptions	Define climate change assumptions for GSP development	WSIP/SGMA	Q4 - 2017	Every 5 years			
	*Precipitation							
	*Temperature							
	*Reference ET							
	*Runoff							
	*SWP/CVP Imports							
	*SWP/CVP Diversions							
	*SWP/CVP Deliveries							
	*SWP/CVP Reservoir Releases							
	Well locations	Reported to Board through online system	Reported by local well owners	Per Each Board Intervention	monthly	X		X
	Extraction volumes from each well	Reported to Board through online system	Reported by local well owners	Per Each Board Intervention	monthly	X		X
	Surface Water Deliveries	In addition to SWP/CVP - establish level of gw use in basin	eWRIMS	Per Each Board Intervention	Yearly	X		X
Groundwater Levels	Groundwater Levels	Evaluate groundwater conditions	DWR - CASGEM, WDL, USGS, SWRCB	Currently Available	Variable			
Groundwater Storage	Groundwater Storage	Evaluate Groundwater Storage	DWR, USGS	Currently Available	Variable			

Water Quality and Seawater Intrusion	Water quality	Evaluate surface and ground water quality	CEDEN, GeoTracker, SDWIS, CIWIQS, USGS, DWR	Currently Available	Every year	X		
	Central Valley Base of Fresh Groundwater Map	Estimate extent of freshwater aquifer system	DWR, USGS	Q2 - 2017	Static			
Subsidence	**Subsidence (InSAR/LiDAR/CGPS)**	**Define subsidence measurements**	**USGS, NASA, DWR**	**Currently Available**	**Every year**	**X**	**X**	**Possibly**
	SGMA InSAR	**Acquire InSAR data in high and medium priority basins**	**NASA or Private Vendor**	**Q1 - 2018**	**Every year**	**X**	**X**	**Possibly**
Depletions of Interconnected Streams	Streamflow	Define streamflow	DWR, USGS, DFW?, State board?	?	Every yeaer	X		
HCM	Soil	Define soil characteristics for recharge and runoff calculations	SSURGO	Currently Available	Static			X
	Potential Recharge Areas	Define potential recharge areas in groundwater basins	SAGBI -UC Davis, Sustainable Conservation	Currently Available	Static			
	Wildlife	Define wildlife measurements	DFW - BIOS, USFWS, DWR	Currently Available	Every year	?		
	Elevation (DEM, LiDAR)	Define land surface characteristics	USGS, NASA, USACOE	Currently Available	As needed			
	Well Completion Reports	Define the construction, location, and tapped formation of a well	OSWCR	Q2 - 2017	Every year	X		X
	Geology (Structure)	Define formation characteristics and impediments to flow	USGS, CGS, GSA HCMs, ILRP GARs, **AEM**	Currently Available	Every 5 years	X	**X (AEM)**	
	Hydrogeology (Texture-Specific)	Define hydraulic characteristics of an aquifer	USGS-CVHM, GSA HCMs, DWR-SVSim	Currently Available	Every 5 years	X		
Tools	C2VSim-FG	Model Surface water and Groundwater Conditions and Water Budget	DWR	Q4 - 2017	Ongoing	X		
	SVSim	Model Surface water and Groundwater Conditions and Water Budget	DWR	Q4 - 2017	Ongoing	X		
	IWFM	Model Engine	DWR	Currently Available	Ongoing	X		

Bold Red *characters indicate a data source that must be procured through a contract or otherwise requires state support (ET)*

Use case 18: Agricultural water management plan

Developed by DWR

Objective Decision, goal or desired action	An AWMP is required by the Water Code for agricultural water suppliers that supply water to >25,000 irrigated acres. The purpose of an AWMP is to serve as a water management planning tool for the adopting agricultural water supplier. Furthermore—by looking into various water supply options, balancing water supply and demand, and investigating the implementation of appropriate efficient water management practices (EWMPs)—an AWMP helps improve water management and water use efficiency within the agricultural water supplier's service area. An AWMP also helps the water supplier to plan and adequately prepare for periods of limited water supply and severe droughts.
Description Important context and background information	To comply with the requirements of the California Water Code Section I, Part 2.55 and Part 2.8 and Section 597 of Title 23 California Code of Regulations, agricultural water suppliers with greater than 25,000 irrigated acres are required to adopt and submit AWMPs with specific content to DWR and to implement EWMPs including the measurement and volumetric pricing of water deliveries. Water code section 10826 lists the elements that are required to be discussed and addressed in an AWMP. Agricultural water suppliers are also required to report on EWMPs implemented and planned for implementation, an estimate of efficiency improvements achieved, and efficiency improvements expected in the next five and ten years. An AWMP must addresses the elements listed in section 10826 of the Water Code by including the following: • AWMP preparation, public participation, & adoption • Description of the agricultural water supplier and service area • Description of the quantity of water uses of the agricultural water supplier (demand) • Description of quantity and quality of the water resources and the agricultural water supplier • Water accounting and water supply reliability

	• An analysis, based on available information, of the effect of climate change on future water supplies. • Description of previous water management activities and the implementation of efficient water management practices (EWMPs)
Participants The main decision-maker; also note other parties involved or affected	AWMPs are required to be adopted by agricultural water suppliers and submitted to DWR every 5 years beginning December 31, 2015. The agricultural water supplier is required to make its proposed AWMP available for public review and provide copies of its adopted AWMP to DWR and other entities. Agricultural water suppliers that are Bureau of Reclamation (USBR) contractors can comply with the AWMP requirements by submitting their USBR approved Water Conservation Plans to DWR with applicable addendums. Within 30 days of adoption, the agricultural water supplier must submit copies of the AWMP or amendments to DWR and other specified entities where the agricultural water supplier provides water supplies, including: cities, counties, groundwater management entities, libraries, and others.
Regulatory context Legal, regulatory, and reporting requirements	SBX 7-7 (2009), Water Code § 10608 et seq.; EWMPs § 10608.48 et seq.; Agricultural Water Management Planning § 10800 et seq. • Agricultural water suppliers subject to SB X7-7 must implement the critical EWMPs (measurement and volumetric pricing of water deliveries as outlined in Water Code §10608.48 (b)) and also conditional EWMPs (outlined in 10608.48 (c) if they are locally cost effective or technically feasible. Agricultural Water Measurement Title 23, §597 et seq. • Specifies accuracy of water measurement for agricultural water suppliers that supply water to >25,000 irrigated acres. Specific requirements for water measurement and reporting in the AWMP are identified in CCR §597.3(b)(2), §597.4(b)(2) and §597.4 (e).
Workflow Progression of steps and specific actions taken by participants to	Steps leading to the preparation and adoption of am AWMP include: - AWMP Guidebook—During each AWMP planning cycle, and at least one year prior to the AWMP submittal deadline, DWR prepares and publishes an updated AWMP Guidebook and provide an updated AWMP template to help agricultural water suppliers better understand the Water Code AWMP requirements and assist them in developing an AWMP. The Guidebook also describes how

accomplish objective	Water Conservation Plans submitted to USBR can be supplemented to satisfy the Water Code and the Agricultural Water Measurement Regulation requirements. Prior to finalizing the Guidebook, DWR releases a draft and holds public workshops to give opportunity for stakeholders to comment on the draft guidelines. Additional workshops are also conducted after releasing the final Guidebook. - AWMP Preparation and Adoption—The agricultural water supplier prepares its AWMP in accordance with the process described in the Water Code to include: a notification of AWMP preparation, making the proposed AWMP available for public inspection, and holding a public hearing. The AWMP is then finalized and adopted by the governing board of the agricultural water supplier. - AWMP Submittal—Within 30 days of adoption, the agricultural water supplier must submit copies of the AWMP to DWR and other entities specified above in the 'Participants' section. - AWMP Review—DWR reviews submitted AWMPs for completeness and overall compliance with the Water Code requirements. If DWR's review finds that an AWMP and associated documents do not address the Water Code requirements and Agricultural Water Measurement Regulation documentation, the supplier will be notified that the submittals do not address the requirements. The supplier may revise the submittals and, if needed, amend, adopt and resubmit them to DWR for review. An agricultural water supplier will not be eligible for a water grant or loan awarded or administered by the State unless the supplier complies with the AWMP requirements. The best detailed source for this would be the guidebook "Preparing A 2015 Agricultural Water Management Plan" The guidebook can be found here: http://www.water.ca.gov/wateruseefficiency/sb7/ The guidebook is meant to help agricultural water suppliers better understand the Water Code Agricultural Water Management Plan (AWMP) requirements and assist them in developing an AWMP. It also describes

	how water conservation plans submitted to the U.S. Bureau of Reclamation (USBR) can be supplemented to satisfy the Water Code and Agricultural Water Measurement Regulation requirements.
Data sources Existing data sources; data gaps. Be as specific as possible	The reviews of the 2015 AWMPs from 2014 to present are captured in the program's on line database "WUEdata". WUEdata login can be found here: https://wuedata.water.ca.gov/secure/login_auth.asp?msg=inactivity&referer=%2Fsecure%2FDefault%2Easp? At this time, all of the AWMP data tables included in the guidebook are "optional", hence completion is inconsistent. The only required quantified data per the Water Code (§ 10826(b)(7)(A),(B)&(C)), "Quantifying the water supplier's water supplies; Tabulating water uses; & Overall water budget. Worksheets and data tables included in the AWMP Guidebook can be populated with data and information by the agricultural water supplier and used in the AWMP to complete required elements. Worksheet use, format, and information do not constitute a requirement for the AWMP or compliance with the Water Code. Included as optional are more than 50 worksheets and tables covering: - Water supplier's service area characteristics - Storage, conveyance, and delivery systems - Geographic, topographic, and soil characteristics. - Climate characteristics - Water budget summary - Water allocation policy - Water billing, rate basis, and rate structure. - Surface and other water supplies - Groundwater supplies, recharge, conjunctive use. - Water Transfers and exchanges - Drainage and reuse - Crop information, acreage, irrigation methods, … - Quantification of water use: crop water use, losses, municipal/industrial, environmental, recreational. - Effective precipitation

	- Applied water - Recoverable and irrecoverable water losses - Water quality monitoring
Data characteristics Notes about type and form of data	Currently only the farm gate delivery reports can be exported to Excel spreadsheets for summary or analysis. Even though, the guidebook for preparing an AWMP includes several suggested data worksheets, Their use, format, and information do not constitute a requirement for the AWMP or compliance with the Water Code. Currently WUEdata is inflexible on how the data can be entered. Hence, if there is any variation in how the data are presented in the AWMP from the WUEdata table, data entry may be limited or not possible.

Use case 18: Data sources

Topic	Description	Data source description	Access Method
Water	Quantifying the water supplier's water supplies	DWR	https://wuedata.water.ca.gov/ (mandatory entry, hence high amounts of info)
Agriculture	Crop information, acreage, irrigation methods	DWR	https://wuedata.water.ca.gov/ Partial Data Gap because inclusion is "optional"
Socioeconomic	Water billing, rate basis, and rate structure	DWR	https://wuedata.water.ca.gov/ Partial Data Gap because inclusion is "optional"
Water	Water Transfers and exchanges	DWR	https://wuedata.water.ca.gov/ Partial Data Gap because inclusion is "optional"
Water	Quantification of water use: crop water use, losses, municipal/ industrial, environmental, recreational	DWR	https://wuedata.water.ca.gov/ Partial Data Gap because inclusion is "optional"

Topic	Description	Data source description	Access Method
Water	Applied water	DWR	https://wuedata.water.ca.gov/ Partial Data Gap because inclusion is “optional”
Water	Groundwater supplies, recharge, conjunctive use	DWR	https://wuedata.water.ca.gov/ Partial Data Gap because inclusion is “optional”
Water	Water Quality monitoring	DWR	https://wuedata.water.ca.gov/ Partial Data Gap because inclusion is “optional”
Water	Surface and other water supplies	DWR	https://wuedata.water.ca.gov/ Partial Data Gap because inclusion is “optional”
Water	Recoverable and irrecoverable water losses	DWR	https://wuedata.water.ca.gov/ Partial Data Gap because inclusion is “optional”
Water	Drainage and reuse	DWR	https://wuedata.water.ca.gov/ Partial Data Gap because inclusion is “optional”
Water	Effective precipitation	DWR	https://wuedata.water.ca.gov/ Partial Data Gap because inclusion is “optional”

Notes:

At this time, all of the AWMP data tables included in the guidebook are “optional”, hence completion is inconsistent. The only required quantified data per the Water Code (§ 10826(b)(7)(A),(B)&(C)), “Quantifying the water supplier’s water supplies; Tabulating water uses; & Overall water budget. Even though the guidebook for preparing an AWMP includes several suggested data worksheets, their use, format, and information do not constitute a requirement for the AWMP or compliance with the Water Code.

Use case 19: Urban water management plan

Developed by DWR

Objective Decision, goal or desired action	For California water suppliers to document current and future water supply reliability through the preparation of Urban Water Management Plans (UWMPs).
Description Important context and background information	To ensure that California communities have an adequate water supply especially during times of drought, the Urban Water Management Planning Act was enacted in 1983. The Act requires urban water supplier that serves 3,000 or more end users, or provides over 3,000 acre-feet of water annually to submit an UWMP to DWR every five years. The UWMP estimates water supplies and demands over a 20 year planning period and describes current or planned projects and actions to improve water supply reliability. The required UWMP data is described in this case study.
Participants The main decision-maker; also note other parties involved or affected	• DWR (provides guidance, receives and reviews plans, and maintains UWMP database) • Urban water suppliers (responsible for plan preparation) • Stakeholders, public, and local agencies (provide input during plan preparation)
Regulatory context Legal, regulatory, and reporting requirements	The content of UWMPs is directed by the following sections of Water Code: • Urban Water Management Planning Act of 1983 (CWC §10610-10656, supplemented by §10608) specifies the requirements for UWMPs. • SB X7-7 of 2009 (CWC §10608) mandated a new requirement in the UWMPs. Each water supplier must reduce their per capita water use up to 10% by 2015 and up to 20% by the year 2020.
Workflow	• DWR provides guidance for urban water suppliers on plan preparation. • DWR works with IT consultant to prepare database for incoming UWMPs. • The urban water supplier and/or consultant prepares their UWMP. • DWR reviews each submitted UWMP and determines whether or not the UWMP has addressed the requirements of the Water Code.

UWMP data elements Key data associated with UWMPs	All data from UWMPs is submitted into an online portal, WUEdata (https://wuedata.water.ca.gov). Only water suppliers are allowed to enter data, but once submitted, the data is readily accessible to the public. The following key information is submitted in the UWMPs and available in WUEdata. Data projections are made in five years increments over a 20 year planning time frame. • Population served by the water supplier – historical and projected • Quantity of current and projected use of potable, raw and recycled water use by sector • Current and projected volume and source of supplies for potable, raw, and recycled water. • Volume of distribution system water loss. • Per capita water use – historical and plan year • Progress to achieving the 20% by 2020 reductions in per capita water use • Volume of groundwater pumped, by basin, for the 4 years preceeding the plan year. • Volume of wastewater collected, treated, recycled and discharged in the service area for the plan year. • Projected supply and demand assessments for single dry, multi dry and normal water years • Actions taken in each stages of the agency's water shortage contingency plan. • Minimum water supply available for three years following the plan year.
Data characteristics Notes about type and form of data	All UWMP data is submitted into DWR's online submittal tool, WUEdata (https://wuedata.water.ca.gov) and is immediately available to the public. The available data is: • the full UWMP documents in pdf format • data tables in Excel format DWR's contractor, EcoInteractive, developed and maintains the WUEdata website using a customized version of its proprietary EcoTracker application via Software-as-a-Service.

Use case 19: Data sources

Topic	Description	Data source description	Access Method
Socioeconomic	Actions taken in each stages of the agency's water shortage contingency plan.	DWR	https://wuedata.water.ca.gov
Socioeconomic	Population served by the water supplier – historical and projected	DWR	https://wuedata.water.ca.gov
Water	Quantity of current and projected use of potable, raw and recycled water use by sector	DWR	https://wuedata.water.ca.gov
Water	Volume of distribution system water loss.	DWR	https://wuedata.water.ca.gov
Water	Per capita water use – historical and plan year	DWR	https://wuedata.water.ca.gov
Water	Progress to achieving the 20% by 2020 reductions in per capita water use	DWR	https://wuedata.water.ca.gov
Water	Volume of groundwater pumped, by basin, for the 4 years preceeding the plan year.	DWR	https://wuedata.water.ca.gov
Water	Current and projected volume and source of supplies for potable, raw, and recycled water.	DWR	https://wuedata.water.ca.gov
Water	Volume of wastewater collected, treated, recycled and discharged in the service area for the plan year.	DWR	https://wuedata.water.ca.gov
Water	Projected supply and demand assessments for single dry, multi dry and normal water years	DWR	https://wuedata.water.ca.gov
Water	Minimum water supply available for three years following the plan year.	DWR	https://wuedata.water.ca.gov

Use case 20: Source-water basin water budgets

Developed by R. Bales from multiple conversations & workshops with decision makers

Objective Decision, goal or desired action	Quantify inputs, outputs and changes in storage (i.e. water budget) within a basin, at appropriate spatial and temporal scales, with accuracy sufficient to inform reservoir operations, hydropower generation, downstream water deliveries, allocation decisions, infrastructure investments, flood protection, groundwater recharge and other economic and regulatory decisions.
Description Important context and background information	Water storage behind dams for agricultural, industrial and urban water supply, flood control, recreation, hydropower generation, downstream environmental flows is a central the foundation for California's water security. Operational decisions are made daily, allocation decisions seasonally to annually and investment decisions at annual to decadal time scales. There are dozens to hundreds of decision points along rivers and dams in source-water areas, typically at watershed scales in the 100-10,000 km^2 area. While there is considerable overlap in data used for these, turning that data into information for each use and user requires some degree of custom processing and delivery. Measurement and decision-support systems are in many cases based on technology that was developed in earlier decades, and was based on a relatively stable climate. The skill of forecasts feeding into decision making is generally good when conditions are near the historical mean, with low skill in wet and dry years, and when conditions are warmer than the mean of the past century. Because of declining skill, water decision makers are turning to new decision-support tools, which require new data and information if they are to deliver an increase in forecast skill. It is well recognized that better data are the foundation of better decision making.
Participants The main decision-maker; also note other	**Primary decision makers**: • Reservoir operators: DWR, USACE, USBR, local water agencies, regional agencies, consulting engineers • Electric utilities: PGE, SMUD, SCE, LADWP • Water agencies: This category ranges from the Metropolitan Water District of Southern California, to local irrigation districts, county water agencies, cities and other special districts or private water companies.

parties involved or affected	Others: • GSAs • Family-farm and industrial-agricultural water users • Local urban water agencies • Local government (cities, counties) • Conservation groups • IRWM groups • State agencies (DWR, SWRCH, DFW)
Regulatory context Legal, regulatory, and reporting requirements	Source-water basin water budgets play at least a secondary role in many of the regulatory decisions described in other use cases, including water rights and water quality. Other decisions that are made using these water budgets have very large economic implications, including flood protection, water allocations and infrastructure investments. Some reservoirs are operated based on rule curves, approved by Congress, and there is a need to either update these rule curves or rely more on forecasts for operations.
Workflow Progression of steps and specific actions taken by participants to accomplish objective	The first foundational measurement is precipitation, including rainfall, total precipitation (rain versus snow) and snow accumulation on the ground. Measurement systems for these were initiated in the early 1900s and updated within the last 50 years ago. The historical strategy involves measurements at index sites that are statistically correlated with streamflow. The second foundational measurement is streamflow, typically measured in mountain headwaters below both high-elevation hydropower reservoirs, and below the large rim dams. In undammed areas, streamflow is also typically below the mountain front, in flat areas. Because these measured flows are affected by upstream diversions and changes in reservoir storage, DWR and others develop estimates of full-natural flow, based on measurements or estimates of the diversions and changes in storage. These full-natural flows are also used for forecasting and decision making. Hydrologic models with some degree of spatially explicit representation of the landscape are also used to integrate data and predict streamflow at daily to seasonal time scales in various basins, using the foundational measurements, plus temperature, humidity, wind, radiation and in some cases soil-moisture data. This is still a developing transition in the field, which has traditionally taken a conservative approach to adopting new technology, reflecting a mix of cost, capacity and risk factors.

Data sources Existing data sources; data gaps. **Be as specific as possible**	• Many real-time data to support daily decision making are archived in and delivered through CDEC. The measurements in source-water basins reflect cooperative efforts between DWR and local land owners or managers, and local water agencies. • The USGS provides many streamflow measurements on the main rivers and streams. • The NRCS provides supplemental data in some source water areas. • Hydropower providers and other local agencies also have measurement systems in source-water basins. Some of these data are shared with CDEC, and some are proprietary, shared only on a limited basis. • Weather forecasts come from the NWS It has become apparent that severe data gaps in both foundational and other data limit the ability to upgrade forecast and decision-support tools, reflected in part by the inability to accurately close water budgets a basin scales.
Data characteristics Notes about type and form of data	Most are data are from time-series measurements at a point. At present, CDEC handles mainly time-series data. With the new generation of forecast and decision-support tools, some decision makers are starting to use spatial data, including satellite snowcover, aircraft LiDAR snow depth and other spatial attributes. These data are provided by USGS, NASA and other publicly funded sources. Greater use of spatial data will move water decision-support tools from using spreadsheets to using terabyte-sized images for daily to seasonal forecasts. DWR and other agencies are sources for landscape attributes and other data.

Use case 20: Data sources

Topic	Description	Data source description	Access Method
Water	Real-time precipitation data	DWR	http://cdec.water.ca.gov
Water	Additional daily precipitation data	Western Regional Climate Center	https://wrcc.dri.edu
Water	Real-time snow depth and water equivalent	DWR	http://cdec.water.ca.gov

Water	SNOTEL daily snowpack data	USDA	https://www.wcc.nrcs.usda.gov/snow/
Water	USGS California streamflow data	USGS	https://waterdata.usgs.gov/ca/nwis/rt
Water	Additional real-time streamflow data	DWR	http://cdec.water.ca.gov
Water	Real-time meteorological data	DWR	http://cdec.water.ca.gov
Water	Additional meteorological data	Western Regional Climate Center	https://wrcc.dri.edu
Water	Precipitation forecasts	NOAA	http://www.cnrfc.noaa.gov/
Water	River stage and flow forecasts	NOAA	http://www.cnrfc.noaa.gov/
Water	Seasonal climate outlooks	NOAA	http://www.cnrfc.noaa.gov/
Water	Watershed spatial data	Cal Fire	http://frap.fire.ca.gov/
Land Use	USGS Global Land Cover Characteristics Data Base Version 2.0	USGS	https://lta.cr.usgs.gov/glcc/globdoc2_0