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Summary of GRA Conference on Tools for Developing SGMA Groundwater Sustainability Plans

By Brett Wyckoff, Chair; John Lambie and Jim Strandberg, Co-chairs; and Moderators Anona Dutton, Christy Kennedy, Steve Phillips, and Lisa Porta

On May 3–4, 2017, GRA held its latest in a series of events focusing on the Sustainable Groundwater Management Act (SGMA) in Modesto, CA. A critical step for compliance with SGMA is the development of successful Groundwater Sustainability Plans (GSPs). This conference focused on tools and techniques that can support key elements and programmatic considerations for GSP development.

The conference program provided policy-makers, stakeholders, regulators and other government entities, NGOs, consulting professionals and practitioners, growers, and landowners the opportunity to present their work, and to interact and learn about the emerging Best Management Practices (BMPs); quantifying measurable objectives for GSPs under the six criteria defined by the SGMA for groundwater sustainability; and new research on water availability, streamflow depletion, and groundwater-dependent ecosystems (GDEs).

Lead Planners

- Co-chairs of the conference were (Chair) **Brett Wyckoff** of the Department of Water Resources (DWR), **John Lambie** of E-PUR, and **Jim Strandberg** of West Yost Associates
- Other members of the Planning Committee were: **Ryan Alward**, GEI Consultants; **Anona Dutton**, Erler & Kalinowski, Inc.; **Christy Kennedy**, RMC, a Woodard & Curran Company; **Sarah Kline**, Administrative Director of GRA; **Thomas McCarthy**, Anaheim Public Utilities Dept.; **Tim Parker**, Parker Groundwater; **Chris Petersen**, GEI Consultants; **Steve Phillips**, USGS California Water Science Center; and **Lisa Porta**, CH2M.

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Photo Credit: John Karachewski, Ph.D.

The Groundwater Resources Association of California is dedicated to resource management that protects and improves groundwater supply and quality through education and technical leadership.

Photo above: The Sacramento River in the western foothills of the Cascade Range northeast of Red Bluff. The largest river in California, the Sacramento has a length of 327 miles and an average annual runoff of 22,000,000 acre-feet.

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An Exciting Time for Groundwater

By Chris Petersen

Hello Again GRA Members!

Writing this from my hotel room in Monterey at the Spring ACWA conference, it occurs to me that this is an exceptionally exciting time for groundwater. The ACWA Groundwater Committee meeting began at 10am on Tuesday, and by 10:10, it was standing-room only, with close to 200 people packed into the room as more chairs were being wheeled in. Not long ago, ACWA didn't have a Groundwater Committee, and pre-SGMA, there may have only been 15-20 folks attending. Now, this committee meeting is among the top draws at ACWA conferences.

Recent Happenings in Water and Groundwater

As of early May, 2017, the rains have finally slowed, and may have finally come to an end for the year, leaving behind record rainfall totals in Sacramento Valley and nearly double the snowpack seen in an average year. Accolades to all the growers who flooded their fields this winter to increase total recharge! It is too bad California was not able get even more water into the critically-overdrafted groundwater basins in the Central Valley, instead of losing so much of this precious resource to the Pacific Ocean.

As we look to summer of 2017, there are several things I'd like to draw your attention to, including:

- The approaching deadline of June 30th for Groundwater Sustainability Agency (GSA) filings. Missing this deadline, having overlapping GSAs, or areas within a basin not covered by a GSA, all could trigger State-Board intervention. DWR provided the ACWA Groundwater Committee with an update on the status of filings; overall, things are looking good, but a few problem areas persist. The status of filings is available on an interactive mapping tool at this link.
- DWR has released the long-anticipated draft proposal solicitation package guidelines for the Sustainable Groundwater Management Plans and Projects grant requirements. GRA's technical committee will likely review and provide comments, which are due back to DWR by June 19, 2017. For more information on how to review and provide DWR with comments, please visit this link.

Status of GRA's 2017 Program

I'm happy to report that GRA is having another successful year with the implementation of our program to protect groundwater quantity and quality through education and information. Here are a few highlights:

- We've had two well-attended conferences, including our Legislative Symposium in Sacramento on March 29th, and Tools for Developing GSP's in Modesto on May 3-4, 2017. Warm thank-yous go to Chris Frahm, Rosanna Carvacho, Tim Parker, Brett Wyckoff, John Lambie, Jim Strandberg, Sarah Kline and others on these event planning teams, and to the exhibitors and sponsors.
- Continued focus on Branch coordination and expansion, including kicking-off our new San Diego Branch with an inaugural meeting on February 28th – Adam Hutchison continues to lead our Branches Committee, which helps to increase coordination

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Gordon Burns, Undersecretary, California Environmental Protection Agency, speaking at GRA's 2017 Legislative Symposium in Sacramento, CA

between Branches and provides leadership in the formation of new ones – thanks Adam! For more information on our Branches, including how to get plugged-in to a Branch near you, please visit our website and select the "Branches" tab.

- Seven GRACasts so far this year – Remember that GRA records these events, and we encourage you to visit our GRACast store to purchase GRACasts on topics of interest by visiting this link.
- Continued strong financial performance – GRA is a non-profit organization and we generate income to cover our expenses through membership dues and event fees. We maintain a cash reserve to cover the organization in lean periods and to complete special projects, such as the formation of new Branches, updating our website and member database, introducing and promoting groundwater legislation, etc. If you have ideas for a special GRA project, please contact me or any of our Board members using the contact information at this link.
- 2017 Member Survey – We conducted a member survey in March and April, and will consider your feedback as we develop our 2018 program. Planning for this program begins this summer.

Looking Forward

Each year our Directors spend 2 full days together during our annual planning retreat. This year we will gather in Santa Barbara on May 20-21. That Saturday is our spring Board meeting, where we will focus our 2017 program. On Sunday, we'll consider the results of the recent member survey as we begin shaping the future of the organization. Here's a sampling of topics we're likely to discuss during this strategic planning session:

- How does GRA continue to deliver top-quality technical conferences while at the same time reach a more diverse audience and provide SGMA stakeholders with the information needed for successful outcomes locally?
- How does GRA partner with local, state and federal entities to significantly increase managed aquifer recharge in California during the SGMA implementation timeline? What specific actions can we take to introduce or influence new legislation, assist in the development and review of regulations, and shape water policy?
- What informational tools can GRA develop as helpful resources available to GSAs and groundwater stakeholders to aid in the successful implementation of SGMA?
- Where should we consider adding Branches? What can we do to grow our existing Branches?

In my next President's message, I'll update you on our answers to these questions and what actions we plan to take to address these and other groundwater topics.

I want to close by thanking all of you who are working hard and contributing to GRA's success. If you are new to GRA, or maybe have just been on the sidelines for a while, consider the words of John Heywood, the English playwright and poet, who said "Many hands make light work." I encourage you to get into the game, and will welcome your support as active Members, Branch Officers, and/or committee members. Please join us in achieving GRA's mission; you'll find that, at the same time, you are expanding and enhancing your own career as a water professional.

Until Next Time!

Chris

Summary of GRA Conference on Tools for Developing SGMA Groundwater Sustainability Plans – *Continued*

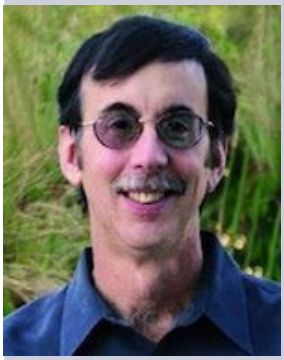
Conference Summary

Following is a summary of the presentations during the conference. GRA thanks John Diodati of the San Luis Obispo County Dept. of Public Works for his lunchtime presentation on Options and Risks to Consider for Funding SGMA!

Keynote Speaker

The keynote speaker, William "Bill" Alley, is the Science and Technology Director for the National Ground Water Association, and served as Chief of the USGS Office of Groundwater for almost two decades, authoring over 100 scientific publications and receiving a number of awards. Based on his recent book, coauthored by his wife Rosemarie, Bill gave the keynote lecture Lessons for SGMA Plans from Around the World. He showed many international and U.S. examples of the various ways groundwater issues like those we face in CA have been approached.

GRA Member and His Wife Team-up on New Groundwater Book



GRA member Bill Alley and his wife, Rosemarie, have published a new book, *High and Dry: Meeting the Challenges of the World's Growing Dependence on Groundwater* through Yale University Press. A first-of-its kind for a broad audience, the book draws on examples from around the world, including the United States, Canada, Australia, India, and sub-Saharan Africa, to examine groundwater in an engaging narrative format. The book includes stories of people who are making a difference in protecting this critical resource. The Alley's previously coauthored *Too Hot to Touch* on the science and politics of nuclear waste.

Streamflow Depletion and Groundwater Dependent Ecosystems

*Moderated by **John Lambie**, E-PUR*

Five presentations on the topic of interconnected surface water and groundwater provided an excellent start to the technical sessions of the conference. Adverse impacts on local habitat and streamflows are to be evaluated by DWR under SGMA as one of the conditions of groundwater-basin assessment. Further, SGMA regulations define an undesirable result caused by groundwater conditions in a basin as "depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water." Finding effective tools to assess and manage interconnected surface-water issues is a challenge under the law, and the presenters did an excellent job of presenting prospective assessment methods, forecast tools and management tools and processes.

Deborah Hathaway of S.S. Papadopulos & Associates Inc. provided a stream-conditions management approach for the timing and quantity of groundwater extractions, and estimated streamflow depletion using a spreadsheet tool programmed to incorporate the outcomes from a more detailed numerical groundwater model. **Derrik Williams** of HydroMetrics presented some of their work on using temperature signals and groundwater elevations to estimate surface-water depletion due to groundwater conditions. **Bob Abrams** of Jacobsen James & Associates provided some concepts and outcomes of comparing analytical models to numerical models that his group used to provide Stanislaus County protection zones for surface-water flows from new groundwater extraction wells. **Jean Moran** of California State University, East Bay provided a large overview of geochemical and isotopic tracer tools for assessing surface-water/groundwater interaction, such as temperature, dissolved solids concentrations and radon levels in groundwater and surface water, a very sophisticated tool set for the practitioner. **Keith Rainville** and **Bob Harrington** of Inyo County Water Department provided an insightful presentation of how their department has developed an effective Groundwater Management Framework for Protecting Groundwater Dependent Ecosystems using a CEQA process for identifying potential adverse impacts and mitigating for those through established criteria on conditions and flow outcomes in two different watersheds.

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Moderator Anona Dutton, EKI.

Speaker Joe Hughes, USGS (left), and moderator Steve Phillips, USGS.

Emin (Can) Dogrul, DWR.

Groundwater Data & Modeling – Setting Measurable Objectives

*Moderated by **Anona Dutton**, PG, CHg, of Erler & Kalinowski, Inc (EKI).*

SGMA mandates the formation of GSAs and the development and implementation of GSPs. However, the real test of SGMA compliance is the definition and achievement of groundwater sustainability within each basin. Fundamental to this challenge is the identification of appropriate *sustainability criteria* that allow a GSA to assess whether a basin is being managed to avoid the *undesirable results* defined in the legislation. In order to maintain or achieve sustainability, *minimum thresholds* and *measurable objectives* must be defined for each applicable sustainability criteria, which together essentially define the operating range for a basin.

A variety of data, models, methodologies, and tools can be used to define and monitor performance against these sustainability criteria, either directly or by proxy. **John Lindquist** of United Water Conservation District presented how they had used an in-house model to help develop a GSP-lite, and decided to bisect a basin into four areas and two depths to assess vulnerability to multiple sustainability criteria (e.g., seawater intrusion and subsidence), the critical-threshold water levels, and pumping allocations that could achieve sustainability. **Sean Culkin** of Hydrometrics presented two case studies that showed how water levels could be used as a proxy to develop minimum thresholds to avoid impacts from seawater intrusion in a coastal aquifer system. **Michelle Sneed** of the USGS presented some of the complexities associated with measuring and establishing thresholds for subsidence, especially given the long lag-time that dewatering and compaction can have in thick, fine-grained layers. **Mike Tietze** of Jacobson James & Associates offered a perspective on how the establishment of thresholds can feed into policy implementation, using the well-permitting process adopted by Stanislaus County to avoid stream depletion as an example.

Groundwater Data & Modeling (continued)

*Moderated by **Steve Phillips**, US Geological Survey*

Joseph Hughes of the USGS presented *Use of MODFLOW 6 to Simulate Demand-Based Boundary Flows*. Joe described MODFLOW 6 as a consolidation of former versions, with an improved solution technique and a modernized structure to allow greater flexibility and direct coupling with other model codes. Key additions for SGMA purposes are the new Mover and Demand packages. Mover allows for transfer of water from one model component to one or more other components, which enables direct simulation of various water management actions. The Demand package enables distribution of available water to supply multiple simulated demands. Both packages can be assigned constraints to mimic real-world rules or physical limits. The beta version is scheduled for release in May 2017.

Emin (Can) Dogrul of DWR presented *IWFM and C2VSim: Two Modeling Tools to Aid GSAs Comply with SGMA Requirements*. IWFM is an integrated hydrologic model code developed by DWR, and serves as the basis for their Central Valley application, C2VSim, and for other modeling efforts by local groups. Ongoing development of IWFM is focused on developing features for SGMA purposes, including provision of extensive water-budget output options. There is a focus on clear, consistent terminology and units for budget output, and on post-processing tools for exporting outputs to spreadsheet tools. A graphical user interface is expected to be released in June 2017. C2VSim development is ongoing, including a fine-grid version; public release is expected in late 2017.

Enrique Lopezcalva of RMC, a Woodard & Curran Company, presented *Progressive Development of Decision Support Tools and Groundwater Models for Groundwater Sustainability Plans*. Enrique described a general roadmap for development of GSPs, beginning with data collection and management, and ending with modeling tools and their use as part of decision support systems to help evaluate water-management alternatives.

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Speaker Dick Moss at a special meeting of GRA's San Joaquin Valley Branch associated with the conference. The intriguing subject was the response of agribusiness to SGMA.

Joel Kimmelshue of Land IQ presented *California Statewide Agricultural Land Use Mapping for Informed Decision Making and Temporal Change Assessment*. Joel presented progress on DWR-supported mapping of statewide agricultural land use, and related products of use to GSAs, including retrospective crop maps, determination of irrigation methods, estimates of consumptive use and crop age, and groundwater recharge potential. The land-use maps include about 45 crop categories, urban areas and managed wetlands; independent ground-truth data indicate 95% accuracy of the mapping. A key purpose of this work is to provide consistent data for all GSAs. The statewide land-use map for 2014 will be available in June/July 2017; that for 2016 will be available in late 2017/early 2018.

Best Management Practices for Sustainable Management of Groundwater Basins

*Moderated by **Lisa Porta**, PE, CH2M*

This session provided some practical examples of Best Management Practices (BMPs) implementation. The DWR Sustainable Groundwater Management Team released a set of 5 BMPs at the end of 2016, accompanied by 2 guidance documents. These documents were prepared to help GSAs with the preparation of their GSPs, and are available on the BMP website.

Christina Babbitt of the Environmental Defense Fund (EDF) presented *The Right Tools for the Job: Case Studies to Inform Groundwater Management in California*. The team developed a ***compilation of groundwater management case studies*** covering California, Colorado, Oregon, Arizona, Texas, and Nebraska. As part of the presentation, Christina discussed several types of management tools: regulatory, incentive-based, agency supply augmentation and protection, and outreach and education. She provided a detailed overview of a case study in Nebraska and provided some valuable lessons learned. A report that describes these case studies is due out later this year.

Todd Hillaire of DWR presented *Water Budget Framework for California*. He reviewed DWR's vision for a comprehensive and defensible approach to develop water budgets. The ***Water Budget Framework*** was developed as a mechanism and tool for GSAs to use in their own water-budget calculations. This Framework provides consistency in water-budget calculations across basins and develops common terminology and definitions. Todd presented a live demonstration of the complete online "dashboard" tool developed in the Tableau platform. Data currently incorporated into the dashboard include C2VSim model results for the entire Central Valley.

Abishek Singh of INTERA Inc. presented *Addressing Hydrogeologic Conceptual Model Uncertainty within the SGMA Planning Framework*. The GSP regulations mention uncertainty in several areas, as related to data, analysis, and modeling, and provide a definition. Abishek summarized three aspects of uncertainty under SGMA: ***conceptual*** uncertainty related to basin setting and data gaps, ***water budget*** uncertainty related to future projections, and ***planning*** uncertainty related to future projects based on current data. Abishek proposed a five-step framework to define uncertainty: uncertainty identification, characterization, propagation, importance analysis (sensitivity analysis) and reduction.

Todd Hillaire, DWR.

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Best Management Practices for Sustainable Management of Groundwater Basins (continued)

*Moderated by **Brett Wyckoff**, Department of Water Resources*

John Fio, HydroFocus, Inc.

Conference Chair Brett Wyckoff, DWR, and speaker Rick Cramer, Burns and McDonnell.

John Fio of HydroFocus, Inc., talked about achieving technical consensus in multi-party sustainability planning within the overdrafted Westside groundwater basin on the San Francisco peninsula. John described how stakeholder input was used to initiate a project to model the Westside Basin, and how the model was refined and improved over time by model review and acquisition of additional data. The model greatly improved the estimate of historical groundwater storage change, and the associated water budget, and also was used to assist with evaluating management actions.

Rick Cramer of Burns and McDonnell discussed using groundwater sequence stratigraphy for developing accurate and representative hydrogeologic conceptual models for successful GSPs. Site conceptual models (SCMs) are a fundamental component of a GSP, and the more accurate the description of lithology within the SCM, the better we can understand the occurrence and movement of groundwater. Rick showed how resolution of lithologic information can be greatly improved by taking into consideration the depositional environment of stratigraphic sections. The vertical grain-size distribution is developed, and the horizontal distribution of lithologic conditions can be estimated away from the lithologic data points; the key is recognizing patterns in the grain-size sequence. Rick showed several examples of how improved lithologic detail using this technique has benefitted groundwater assessment and management.

John Lambie of E-PUR, LLC, talked about the multiple roles for environmental data in sustainable groundwater management. John demonstrated the importance of empirical data, and effective and efficient monitoring and data-collection practices, in sustainable groundwater management. Under SGMA, models will be used to analyze conditions and to help make important management decisions; the quality and effectiveness of the models are highly dependent on the empirical data that go into them. Groundwater-level data were used to illustrate their importance to the modeling effort. John discussed factors to consider in groundwater-level monitoring before presenting several tools for monitoring-program design.

George Paul of Formation Environmental, LLC, talked about the California Actual Evapotranspiration (CalETa) Mapping Program and how its data are critical for groundwater modeling applications. The CalETa Mapping Program collects statewide ETa data, at 30-meter spatial resolution, on a daily basis. The integration of satellite- and land-based data has resulted in more accurate ETa data at an unprecedented spatial and temporal scale. The ETa data will be of tremendous value to SGMA planning and related groundwater-management elements, such as surface and groundwater modeling, land-use planning, drought and water-conservation planning, groundwater banking, and water-transfer planning and implementation.

Water Available for Groundwater Replenishment

*Moderated by **Christy Kennedy**, RMC, a Woodard & Curran Company*

This session was born out of the anticipation and interest around DWR's Draft Water Available for Replenishment (WAFR) Report released in January 2017. SGMA directed DWR to prepare a report that presents an estimate of water available across the state for replenishment. The WAFR report provides a planning-level estimate and ranges for each of the state's 10 hydrologic regions. Given the attention on this subject, this session was designed to highlight projects implementing recharge strategies to bring basins into sustainability.

Adam Questad and **Maygan Cline** of Geosyntec discussed the connection between Storm Water Resource Plans (SWRPs) and GSPs. SWRPs are a required element to receive Prop-1 funding and are underway in many areas of the state. Using a Ventura County case study, they highlighted methods for developing and screening stormwater recharge projects, along with public communication tools and the link from SWRP project work to the City's developing GSP.

Michael Milczarek of GeoSystems Analysis, Inc. presented on stormwater capture and recharge systems,

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such as drywells. Using case studies from semi-arid urban watersheds, he showed the importance of incorporating appropriate temporal and spatial variability into stormwater modeling with the system design.

Tim Leo of Montgomery & Associates followed with a case study for Tulare Irrigation District that pointed to the criticality of site-specific investigations for assessing recharge feasibility, and bolstering recharge effectiveness through careful site planning.

Jill Weinberger of Dudek discussed climate variability and related effects on groundwater replenishment. Additionally, she linked the development of an understanding of this variability to establishing appropriate sustainability goals for groundwater basins, and thoughtful communication around these goals.

What Resources are Available to Help with Groundwater Sustainability Planning?

*Moderated by **Jim Strandberg**, PG, CHG, West Yost Associates*

This important question was addressed by six panelists with diverse backgrounds and perspectives for groundwater sustainability planning required by DWR's regulations for development of GSPs. The panelists represented a local agency (non-GSA), agriculture, state and federal government, academia, and NGOs.

Amy Woodrow, Water Resources Hydrologist with Monterey County Water Resources Agency, began with an overview of groundwater use in the Salinas Valley (roughly 90:10 ratio of agriculture to urban) and MCWRA's significant groundwater programs. She outlined the substantial resources available for GSP development by four major areas: HCM, groundwater conditions, monitoring networks, and water budget.

Jack Rice, Associate Counsel of the California Farm Bureau Federation, expressed the viewpoints and concerns of farmers and ranchers, summarizing with the essential question "How can agriculture engage with GSAs?" The agricultural industry may be most affected by SGMA, yet the law does not provide for unique engagement of this community. This challenge is aggravated by the technical, legal, and administrative complexities of groundwater management. County farm bureaus are serving an important role by engaging in SGMA processes and providing critical outreach to the agricultural community.

Dane Mathis, Supervising Engineering Geologist, Division of Integrated Regional Water Management, Southern District of DWR, outlined currently available resources, including financial assistance for GSA facilitation support services and Proposition 1 SGMA grant funding for counties with stressed basins, and technical assistance with the SGMA portal, guidance documents (2), and BMPs (5). Future financial assistance will include Proposition-1 SGMA grant funding for planning, and Proposition-1 IRWM grant funding for planning and DAC involvement. Future technical assistance will include the final WAFR report, three new GSP guidance documents (Stakeholder Communications and Engagement, Engagement with Tribal Governments, and Establishing Sustainable Management Criteria), and direct technical support.

Sam Boland-Brien, Manager of the Groundwater Management Program, State Water Resources Control Board, noted the State Water Board's temporary permit process passed during the drought to capture flood flows for groundwater storage, key components of water-rights applications, and significant data in GeoTracker. The State Water Board is continuing to evaluate the integration of overlapping regional programs.

Steve Phillips, Hydrologist with the USGS CAWSC, showed three key features of a new USGS SGMA website currently in development, but available. He showed a set of links to obtain real-time and periodic groundwater, surface-water and water-quality data; a tool for searching USGS resources by SGMA Sustainability Indicator; and an interactive map for direct access to completed USGS models and associated files with SGMA relevance. Models in development, and other resources, will be available in the future. He also described a tool on the site that allows the public to interact with USGS scientists by asking questions.

Tara Moran, Program Lead for Stanford University's Water in the West Sustainable Groundwater Program, described SGMA-related work being done at Stanford University, as well as at many academic institutions throughout the state. She also provided a quick overview of work by many NGOs. Her presentation was framed around two key questions: (1) how do we best make existing and developing resources available, and (2) what additional resources are needed?

Photos taken by Chris Petersen.

Closing panel (from left), moderator Jim Strandberg, Amy Woodrow, Sam Boland-Brien, Jack Rice, Steve Phillips, Tara Moran, and Dane Mathis.

Summary of GRA's 16th Annual Legislative Symposium

By Tim Parker, Parker Groundwater, and Chair of GRA's Legislative Committee

On March 29th, GRA hosted its Annual Legislative Symposium at the Citizen Hotel in Sacramento. The topic was *California's Groundwater Future: Decision Time*? The Symposium was again hosted in cooperation with the California Groundwater Coalition, and sponsored by Alta Environmental, Brownstein Hyatt Farber Schreck, Cadiz Inc., Dudek, GEI Consultants Inc., Gordon Hess & Associates Inc., Southwest Strategies, and Water Resources Consultants Inc.

Our 16th Legislative Symposium featured a wide-ranging group of speakers, including Legislators and other state officeholders, such as John Laird, Secretary of California Natural Resources Agency; Armando Quintero, Chairman of the California Water Commission; and CalEPA Undersecretary Gordon Burns. Each of our renowned speakers shared with symposium attendees their perspective on recent and ongoing developments in state water policy, including SGMA implementation with new agency funding challenges, recent flooding associated with record-breaking rainfall on the tail of the record drought, and California's aging infrastructure in the face of Oroville's near failure and emergency evacuation of nearby communities.

Natural Resources Secretary **John Laird** gave an update on the statewide hydrology and Oroville dam. California has the most variable climate in the nation, and this continues to be a fundamental issue with water-supply and flood management. Oroville dam suffered major damage to its flood control and emergency spillways, which has been stabilized with work underway to design the reconstruction of the structures. It may take two years to fully repair the structures. The California Water Action Plan continues to be implemented, with all the pieces fitting together; this formed the basis for the Proposition-1 Water Bond.

Natural Resources Secretary John Laird.

Armand Quintero, California Water Commissioner Chair, and Executive Director of the University of California, Merced Sierra Nevada Research Institute.

Although the latest drought is over, we are still experiencing its impacts, including groundwater depletion and associated significant land subsidence that has affected infrastructure and 100 million dead trees in California's forests. The Administration is moving forward with many items in the Action Plan, and Sites Reservoir will get built in the future. Groundwater management is also moving forward under the new law, and there are many good examples of progress.

Armand Quintero, California Water Commissioner Chair, and Executive Director of the University of California, Merced Sierra Nevada Research Institute, provided some history on the CWC and an update on some key water issues. The CWC, originally established in the 1950s, active until the late 1990s, and reestablished with the 2009 Delta Reform Act legislation, provides advice to the Department of Water Resources (DWR) and helps supervise the State Water Project. DWR was formed to build the State Water Project, resulting in large part from a series of hearings and subse-

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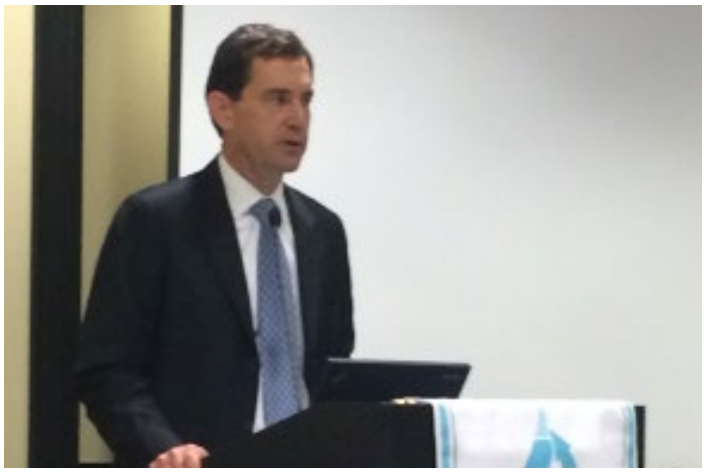
quent legislation led by Caspar Weinberger, then-Chairman of the California Assembly Government Organization Committee. The 1956 legislation merged the then Division of Water Resources of the Department of Public Works with the State Engineer's office and Water Project Authority into the new DWR, and formed a new State Water Resources Board (now State Water Resources Control Board). The CWC was given the charge to determine how to distribute the $2.7B in storage funds with the passage of Proposition 12 in 2014. Both surface water and groundwater storage projects are eligible under Proposition 1, and this is straight out of CalFED. The application period to apply for the $2.7 B in funds for storage is open until mid-August, and supports small and large projects. Groundwater is important for supply, and a continuing challenge is how to show and educate the public on the complexity of our groundwater basins and importance for supply. Armando also discussed Assembly Bill 1755 Dodd – Open and Transparent Water Data Act, intended for the state to develop an effective data management system to provide access to, and inform all water (and groundwater) users of, all supplies. A statewide data management system is needed for decision-making, state collaboration is occurring to develop this tool, and the timeline matches SGMA requirements, which include establishment of local data-management systems.

Gordon Burns gave an overview of the State Water Resources Control Board's intervention plans under SGMA. If GSAs are not formed in a high- or medium-priority basin, as required under the new law, then the entire basin may be subject to monitoring and reporting. The law is designed to get locals to take steps and actions to succeed, and if they do not, intervention by the state is a worse scenario. The state expects most areas to meet the June 30th deadline, and is ready to take action if they do not. If GSAs overlap in jurisdiction, then this will have to be resolved by the locals, or there will be intervention. A county GSA is not automatic, and the county must file, indicating whether it will be the GSA for unmanaged areas; the Water Board will be checking with counties to see what they are doing. If there is overlap of a local GSA with a county, different rules apply. The state will be looking at basins, and considering their status:

1. Missed deadline but have a path forward towards formation
2. Not clear governance will be successful
3. Clearly a basket case that needs intervention.

The state will assess the challenges in the basin with regard to basin coverage by the GSA(s), the amount of pumping, general coordination between management entities, and if basin problems are acute. GSAs should consider several factors moving forward, including:

1. Not too early to focus on data – validate quality and then agree on basin-condition facts



Gordon Burns, Undersecretary, California Environmental Protection Agency.

2. It will be crucial for GSAs to take the time to do outreach and talk with the public about how to move forward, and to try to reach consensus on solutions to the challenges they may face
3. If the Water Board intervenes, they will not consider management alternatives; their only action will be to reduce pumping, and fees will be charged for their work. The locals will still have to develop and implement a plan beyond any actions the Board takes.

The Symposium keynote was given by Dennis O'Connor, Chief Consultant to the Natural Resource and Water Committee on behalf of the Committee Chair Senator Robert Hertzberg. Senator Hertzberg thinks big thoughts: real problems and real solutions. He has five principles guiding water policy:

1. Water conservation – the cheapest source
2. Water recycling – toilet flushing and gone
3. Stormwater capture and recharge
4. Desalination – not a major part, but an important one, especially brackish water
5. Water markets – not being taken advantage of enough.

The Senator has two bills:

- SCA-4 is a constitutional amendment to provide a program that would ensure affordable water to all Californians and that water conservation plays a permanent role in California's future
- SB-231 refines the definition of "sewer" to include services necessary to collect, treat, or dispose of sewage, industrial waste, or surface or storm waters; any entity that collects, treats, or disposes of any of these necessarily provides sewer service.

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Dennis O-Connor, Chief Consultant to the Natural Resource and Water Committee.

The Senate Committee is trying to have a hearing on Oroville to find out more and identify ongoing problems. The cost or repairs will be $100s of millions. There is concern about the backlog of infrastructure repairs that are needed. What's the real problem out there?

Legislators who presented during the symposium include **Assemblymembers Acosta, Dahl, Garcia, Gray** and **Quirk;** and **Senators Hueso** and **Nielsen**. Attendees heard directly from the legislators regarding their broad recognition of the importance of groundwater in securing a reliable and resilient supply of water for the people of California, and how climate variability has made things so unpredictable; that the Proposition-1 $7B water bond is a drop in the bucket for what is needed to address the challenges facing the state; the need to share and collaborate, and not compete; the necessity for long-term funding to repair and maintain aging infrastructure; how viable and long-term solutions have to involve private-sector partners; recognition that conservation can do a lot, and that recycled water can increase, and will have to, across the state; consideration of whether cannabis as a cash crop will become a threat to manage in terms of water demand and water-quality protection; efforts to address the Salton Sea and consideration of a bond measure; and the varying perspectives on the $2.7B for storage—whether it is all destined for surface-water projects, or groundwater solutions will get a piece of the pie. Those in attendance got first-hand updates on pending legislation from authors of the various bills and key committee chairs.

Art Hinojosa, Division Chief, Integrated Regional Water Management, DWR, briefed attendees on the status of SGMA implementation efforts. DWR has published an interim update of Bulletin 118; developed the GSP regulations, a web portal on SGMA activities, an adjudicated-basin portal, and GSA application portal; published five best management practices and two guidance documents; and completed review and finalized the basin boundary modifications submitted by local agencies. The Water Available for Replenishment (WAFR) report will be out in final form soon. The GSA formation process is looking good in many areas, but not everywhere. Over 150 GSAs have been formed; 73 with overlap and 60 exclusive. Staff have been assisting, and DWR has been providing facilitation services with $1.8 M allocated; 47 basins are using facilitation services. DWR also issued $6.7M in Prop-1 grants for stressed counties. In the future, DWR plans to provide more planning and technical assistance to new GSAs. There will be a draft proposal solicitation package issued for the remaining SGMA planning grants.

Scott Cantrell, Water Branch Chief for the Department of Fish and Wildlife, discussed the DFW's current focus and actions on water and groundwater. A major focus is surface-water depletion and maintaining adequate supply for groundwater-dependent ecosystems (GDEs). The DFW can and will provide input on GSPs, and notes that the GSP regulations outline important factors on surface-water depletion and GDEs. There has been significant loss of habitat and wetlands in the state over the last many decades. Where there is interconnected surface water and groundwater, the gaining, losing and disconnected stream segments will need to be identified. There is also a requirement to identify GDEs in GSPs. The Nature Conservancy has developed a statewide map of GDEs that should be released soon; this is the starting point for GDE mapping in basins.

Scott Slater is a Brownstein Hyatt Farber Schreck Shareholder, and CEO and General Counsel for Cadiz, Inc., a publicly-traded company that owns 70 square miles of property in the Mojave Deserts' Cadiz and Fenner Valleys. Cadiz has been operating an agricultural production facility for more than 20 years, including a wide variety of fruits and vegetables. The proposed approach of the "Cadiz Valley Water Conservation, Recovery and Storage Project" is to capture and conserve groundwater flowing beneath the property that is currently estimated to be lost to evaporation at nearby playa lakes. Cadiz Valley is not subject to SGMA, as it is a low-priority basin, and Scott indicates that this is really a model of public-private partnership with San Bernardino County the lead agency on the EIR, and Cadiz providing capital and consulting services, with over $50M invested in characterization and monitoring. The Cadiz basin is estimated to have 20 MAF in storage with approximately 32TAF in annual recharge; Cadiz Inc. proposes to extract 50TAF annually, dependent upon on the monitoring program and results, which can be adaptively managed and adjusted by the county. There have been nine lawsuits, all of which have been resolved and won by Cadiz; the most recent outcome

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(Left to Right) Ron Stork, Joe Countryman, Deven Upadhyay, Gary Bardini, Chris Frahm.

received support from the Trump Administration via a reversal on a previous BLM decision to not allow use of the railroad right-of-way for a pipeline to convey the water from Cadiz basin to interested groundwater purchasers to the west. The project now appears poised to provide water supplies to southern California water agencies.

In the afternoon, a panel of experts discussed the challenges Californians face with aging and vulnerable water-resources infrastructure and some possible approaches and solutions to ensure reliable supplies and reduced flood risk. Panel participants included **Gary Bardini**, Deputy Director, DWR; **Joe Countryman**, Member, Central Valley Flood Protection Board; **Ron Stork**, Senior Policy Advocate, Friends of the River; and **Deven Upadhyay**, Group Manager, Metropolitan Water District of Southern California.

Southern California continues to develop and expand large-scale recycled water supplies, and stormwater-capture and recharge facilities. The uncertainty of imported water supplies has driven the south to develop more reliable supplies at greater initial cost, and recycled water will continue to be a more significant supply component. Flood control and groundwater intersection in the Central Valley was also discussed. The East Side Bypass is subsiding by 1 to 2 feet per year, due to groundwater pumping, and this is having a significant impact on system capacity. It is currently not possible, with existing infrastructure, to recharge high flood flows, because the local aquifers cannot be recharged quickly. As an example, at the Oroville dam, the top 20 percent of the reservoir is designed for flood capacity—if the water is drawn down lower than that, there is no capacity to move water out. The solution would be to redesign the reservoir with a lower outlet capacity. Forecasts could be integrated into flood operations, as is currently being done at Folsom dam. This includes a joint project with an auxiliary spillway with greater flow-release capacity, allowing more conservation storage and carryover. There was a new flood-control design developed for Oroville in the 1970s, but a lawsuit for National Environmental Policy Act found violations. The federal government has not been providing funding to address NEPA on these reservoirs. That lawsuit resulted in none of the reservoirs in the state having flood-control manuals updated since the 1970s; these manuals were designed basically with a slide rule and without the advantage of computers, or advances in hydrology, meteorology, engineering and climate research. The manual for Folsom dam was recently updated, and the dam will now be operated at state-of-the-art. The CWC is responsible for how $2.7B in storage funds will be awarded, and it appears that groundwater storage is an unlikely recipient. Yet surface-water storage behind dams will not help much and will make the water relatively expensive. It appears that SGMA, the most important piece of legislation to come along in many decades, will drive the issues, including a push to enhance recharge statewide and increase storage underground. Resolving the "dam manual" issue, and redesigning dams for more flexible operation, will be key to integrating flood control with groundwater recharge.

The 16th Legislative Symposium was another success, providing attendees with timely information on what is being discussed in the Capitol. The GRA Legislative Committee and our Legislative Advocates, Rosanna Carvacho and Chris Frahm with Brownstein Hyatt Farber Schreck, were praised for providing attendees with timely information on what is being discussed in the Capitol. The GRA Legislative Committee has been lauded for delivering another outstanding program. Thank you, GRA members, for again supporting this event, making it the "go-to" groundwater legislative event in the Capitol. GRA would again like to thank our sponsors and our partner for this event, the California Groundwater Coalition. Together we are educating policymakers through sound science.

Photos taken by Chris Petersen.

26th Groundwater Resources Association Annual Meeting

Call for Abstracts

Abstract Submittal Deadline – Monday, June 19, 2017

SUBMIT AN ABSTRACT

MORE INFO

OCTOBER 3-4, 2017 – SACRAMENTO

This two-day conference will feature a plenary session, two to three concurrent technical sessions, lunch presentations, GRA's 2017 Northern and Southern California David Keith Todd Lecturers, the Collegiate Colloquium, panel(s) of industry leaders, GRA President's Reception, exhibit hall, and poster presentations. Featured sessions and topics for podium and poster presentations include the following categories:

- *SGMA Data Gathering and Management*
- *SGMA Planning*
- *Financial Aspects of SGMA Implementation*
- *SGMA Modeling and Other Tools*
- *Groundwater Replenishment / Recharge*
- *Tools for Visualization and Analysis*
- *Surface Water/Groundwater Interactions and Groundwater-Dependent Ecosystems*
- *Advances in Site Remediation*
- *Contaminant Trends and Site Cleanup Objectives*
- *Innovative Site Characterization Methods*
- *Regional Water Quality Issues*

Collegiate Groundwater Colloquium:

GRA seeks to increase participation by university and college students in its events. The Collegiate Groundwater Colloquium is a venue for student presentations in the general areas of the conference theme. The colloquium and reception provide students with an excellent opportunity to showcase their research, and attendees an opportunity to learn about state-of-the-art groundwater science and engineering. For more information, including student scholarship opportunities, please contact Dr. Jean Moran at jean.moran@csueastbay.edu.

Additional Information:

For additional conference information, please contact Sarah Kline at skline@grac.org (916-446-3626) or Jim Strandberg at jstrandberg@westyost.com (925-949-5825).

Groundwater Resources Association of California
in cooperation with the
California Department of Water Resources
Present

Stream Depletion through the SGMA Lens: Practical Solutions for a Complex Problem

SAVE THE DATE – August 29, 2017
Sacramento, CA

The Groundwater Resources Association and the California Department of Water Resources present a workshop exploring the regulatory, policy, and technical aspects of depletions of interconnected surface water and practical solutions by water management agencies. Expert panels will provide the necessary background and plenty of time is reserved for questions. Panel topics include:

- Regulatory Framework
- Measuring and Monitoring Stream Depletion
- Using Integrated Hydrogeologic Models to Evaluation Future Stream Depletion
- Practical Solutions by Groundwater Sustainability Agencies

More info coming soon! Watch for details!

Groundwater Resources Association of California
in cooperation with the
Arizona Hydrological Society
Present

Recharge to the Rescue! Managed Aquifer Recharge as a Water Management Tool.

SAVE THE DATE – March 5-7, 2018
San Diego, CA

The Sixteenth Biennial Symposium on Managed Aquifer Recharge, Recharge to the Rescue!, Managed Aquifer Recharge as a Water Management Tool, will take place on March 5-7, 2018 in San Diego, CA. This event continues a long-standing series of symposia originating in Arizona in 1978. The Fifteenth Biennial Symposium on Managed Aquifer Recharge was combined with the Ninth International Symposium on Managed Aquifer Recharge (ISMAR 9) held in Mexico City in 2016. The Groundwater Resources Association of California and the Arizona Hydrological Society have teamed up to hold the BSMAR event with the location alternating between California and Arizona.

More info coming soon! Watch for details!

The 28th Symposium in GRA's Series on Groundwater Contaminants

Assessment and Remediation of Dry Cleaner Sites

SAVE THE DATE – November 2, 2017, Concord, CA

More details coming soon, watch the website for details!

Wells and Words

By David W. Abbott, P.G., C.Hg., Consulting Geoloist

The Hydrologic Budget – Part 1

The hydrologic budget is an accounting of the inflows to, outflows from, and changes in storage in a hydrologic unit (HU), such as a groundwater basin, watershed, lake, reservoir, aquifer, or soil zone. As such, the hydrologic budget provides the relative numerical relationships between precipitation, evaporation and transpiration (ET), runoff, and the change in water storage; synonyms for hydrologic budget include *water budget, water balance,* and *hydrologic balance*.[1] Water-budget calculations approximate the water inventory in a watershed or catchment[2] through the documentation, as feasible, of all water (precipitation, surface water, groundwater, and ET) stored and used in a watershed[3]. A water budget for a groundwater basin is a key element of the local Groundwater Sustainability Plans (GSPs) required by the Sustainable Groundwater Management Act (SGMA) of 2014 in California (CA). The water budget often plays an important role in evaluating the optimal conjunctive use of surface water and groundwater that both meets water demands and protects these resources. The hydrologic-balance equation is a seemingly simple mass-balance equation that inventories water inflows and outflows, and any change in storage in, for example, a watershed[4]. Its most basic form is:

INFLOW = OUTFLOW ± CHANGE IN STORAGE
(Income) *(Expenses)* *(Financial Assets)*

This equation, representing the Law of Mass Conservation[2], recognizes that (under most natural and undeveloped states) a balance exists for the hydrologic conditions in an area[5]; a parallel is often drawn to personal income, expenses, and changes in financial assets. This simple but potentially deceiving equation can become extremely complex[6] when considering the interaction and feedback loops between individual elements within the basic components. In addition to the regional and local geologic framework of the HU, the major INFLOW elements can be precipitation, surface water, subsurface flow across boundaries, and imported water. The major OUTFLOW elements can be consumptive-use (including ET), surface water, subsurface flow across boundaries, groundwater pumping, and exported water. The CHANGE IN STORAGE elements can include changes in the volumes of surface water (lakes, ponds, surface-water reservoirs), groundwater, and soil moisture[7].

The water budget can be calculated for a HU over different time periods (i.e., daily, monthly, yearly, decadal, etc.) or for average conditions over a specific time-frame. Many water budgets use the water year (WY), defined in CA as the beginning of the wet season on October 1. For example, WY1971 begins October 1, 1970, and ends September 30, 1971.

The water-budget analysis involves measurements or estimations of the relevant and significant elements of INFLOW, OUTFLOW, and CHANGE IN STORAGE of a HU, and balancing of these elements in the equation. These elements are reported in volume of water per unit time[6]. In the U.S., volume is usually expressed in acre-feet (AF). One AF is equal to one acre (43,560 square feet) covered with one-foot depth of water, or 43,560 cubic feet (325,851 gallons); one AF per year (AFY) is equivalent to 0.62 gallons per minute (gpm)—enough water to supply about two average homes for one year. For comparison, a garden hose with a ¾-inch nozzle will yield about 5 gpm)[8]. A water-budget analysis usually includes a net-error term. To help the reader to follow the calculations, water-budget quantities generally are reported in AFY to several significant digits, even though the quantities are likely far less accurate.

Development of a water budget for an area begins by defining the lateral and vertical boundaries of the HU of interest, and often of a more regional HU that affects the boundary conditions of the HU of interest. For purposes of this discussion, the HU of interest is the sub-HU, and the surrounding HU is the regional-HU. In many investigations, the drainage (catchment) basin that contributes to a sub-HU (i.e., groundwater basin) is defined as the regional-HU. The drainage basin is a region or area bounded by drainage divides and occupied by a drainage system[1]. The areal extent of the sub-HU can then be adjusted based on the type, quantity, and quality of hydrologic data that are readily available.

Careful design of the regional- and sub-HU can reduce the number of variables assigned in the hydrologic balance equation, and therefore its complexity. For example, if surface-water drainage divides (ridgetops) represent the boundaries of the regional-HU, and one can assume that groundwater divides coincide with surface-water divides (which often is the case[6]), then surface-water inflow and groundwater inflow become zero in a catchment. Likewise, if the sub-HU is defined from downstream and upstream surface-water gaging stations, then the hydrologic-balance equation can be simplified, because the net surface-water term for the sub-HU can be estimated from the two gages.

Collection of data sets for the elements of the water budget is usually begun after the regional-HU is defined. Many of these data sets can be freely downloaded from local, state, or federal government websites. Review of the duration, timing, consistency, and overlapping of the data sets, and consideration of climatic fluctuations, allows a better definition of the appropriate time-frame for the water budget. This review

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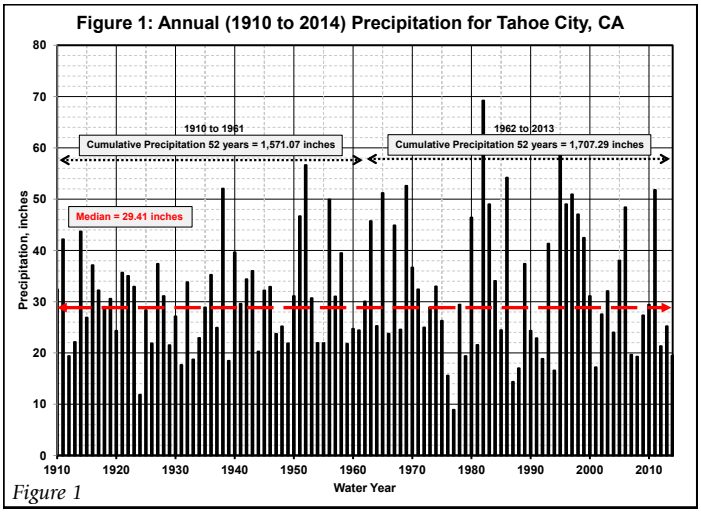

Figure 1

of related data is recommended in order to verify the consistency and variability of the available data. Long data records at a site, or of one type, can sometimes be used to extrapolate and fill gaps within shorter records of another site or type.

The contribution of precipitation to a HU can be estimated from local private and governmental precipitation gages, or various interpretations of these and related data, including isohyetal maps; an isohyet is a line connecting points of equal precipitation[1]. S.E. Rantz[9] (1969 and 1972) prepared a useful but outdated isohyetal map for the entire State of CA. Several county and water agencies in CA have developed local and more recent isohyetal maps. The isohyetal map is superimposed over the HU, and weighted averages between isohyets are measured and summed to provide an estimate of the total precipitation that falls on the HU.

There are many sources of raw or processed precipitation data (see ***Figure 1*** for an example) for CA, including: the National Oceanic Atmospheric Administration[10] (NOAA); U.S. Geologic Survey[11] (USGS); CA Irrigation Management Information System[12] (CIMIS); the Department of Water Resources (DWR) CA Data Exchange Center[13] (CDEC); PRISM Climate Group[14], Oregon State University; Western Regional Climate Center[15] (WRCC); Natural Resources Conservation Service[16] (NRCS); and local water agencies—for example, a map of mean annual precipitation by the Santa Clara Valley Water District and USGS[17]. A valuable historical document is an out-of-date DWR Bulletin[18] that can be downloaded here; this publication lists older monitoring sites for precipitation, streamflow, and groundwater levels, and some surface-water-quality stations, for which data are stored in pre-computer databases (boxes), older computer formats, or microfiche.

Most, if not all, of the inflow of water into an undeveloped drainage basin is from precipitation, which is often measured using a network of precipitation gages within the HU. More recently, the possible adaption of weather-radar technology (in some areas) can be used to evaluate more precisely the spatial distribution of precipitation in a drainage basin. The gage data are normalized to a common unit (i.e., annual average inches) with a similar period of record. The network is then contoured to produce an isohyetal map.

Additional water inflow elements to a HU may include surface water (SW) inflow, groundwater (GW) inflow, and imported water (non-local surface water). If the water budget is conducted for an entire drainage basin, then it can be assumed that GW inflow between catchments is zero (i.e., groundwater divides coincide with surface water drainage divides[6]). If the catchment is undeveloped, then imported water is zero and the primary source of water in a native and undeveloped catchment must be precipitation. The hydrologic balance equation becomes[3]:

$$\text{Inflow} = \text{Precipitation} + \text{SW Inflow} + \text{GW Inflow} + \text{Imported Water}$$
$$\text{Precipitation} = \text{Outflow} \pm \text{Change in Storage}$$

If the HU does not coincide with the drainage-basin boundaries, the SW Inflow can be measured with upstream and downstream gaging stations; the GW Inflow can be computed using Darcy's Law[6] (Q = KiA); and Imported Water is usually measured by local water agencies. Upcoming Wells and Words installments will discuss sources of data for ET, streamflow, groundwater levels, soil characteristics, and other elements of the hydrologic-balance equation.

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Legislative Update – February 2017

By Timothy K. Parker, PG, CEG, CHG, GRA Director and Legislative Committee Chairman

Spring has been busy at the Legislature (it is always busy in California!).

Late winter and springtime events at Oroville dam have cast a renewed spotlight on the need to address aging infrastructure. The Legislative Analysts Office notes "how quickly statewide concerns can turn from the devastating impacts of too *little* water during a prolonged drought, to the comparably destructive effects of too *much* water and resulting floods. Flood management is a complicated and expensive undertaking in California, given the state's size, its extensive and aging infrastructure, the number of agencies involved, and the magnitude of its flood risk. The LAO released a report in March that provides basic information about floods and flood management in California, and notes that flooding can increase groundwater recharge.

The California Department of Water Resources has been providing information on causes of, and updates on managing, the Oroville dam failure, including the recent "Preliminary Findings Concerning Candidate Physical Factors Potentially Contributing to Damage of the Service and Emergency Spillways at Oroville Dam."

This infrastructure issue is also a national issue; the American Society of Civil Engineers released the 2017 Infrastructure Report Card, grading the nation with a D+. Drinking-water needs in California are an estimated $44.5 billion, and wastewater needs total $26.2 billion. 678 dams are considered to be high-hazard potential, according to the ASCE report.

On April 16, Governor Edmund G. Brown Jr. ended the drought state of emergency in most of California, and state agencies released a long-term plan to better prepare the state for future droughts and make conservation a California way of life. Building on the successes and lessons learned from California's five-year drought, the plan establishes a framework for long-term, efficient water use that reflects the state's diverse climate, landscape and demographic conditions. Achieving the plan's goals will help all of California better prepare for longer and more severe droughts caused by climate change, as directed by the Governor's May 2016 May Executive Order B-37-16. The California Water Action Plan, first released in 2014 and updated in 2016, is the five-year roadmap used by the Brown Administration to bring resilience and reliability to our water systems and to restore important ecosystems. Ten principles define California's Water Action Plan, including "Make Conservation a California Way of Life."

Governor Brown released a revised state budget on May 11th that continues to plan for tougher times ahead, while maintaining spending on core programs such as education and child care. Under the May Revision, the $5.8 billion revenue shortfall forecast in January is now a $3.3 billion shortfall, based primarily on higher capital gains. Even so, the budget is considerably more constrained than in any year since 2012. Some cuts from the January Budget remain, but the modestly-improved fiscal outlook allows the May Revision to advance several key priorities, including:

- Increased funding for schools – $1.4B
- Keeping child-care funding on track – maintain $500M from 2016 budget
- Maintaining county fiscal health – $400M from general fund
- Improving California's transportation system – SB-1 provides $58B over next decade
- Reducing pension liabilities – $6B supplemental payment to CalPERS
- Natural Resources – increase of 12.34% (+$590M) over January revise, including 11.54% increase (+$390M) for DWR and 2.16% increase (+$11M) for DFW
- CalEPA – increase of 4.52% (+$132M) over January revise, including 1.03% increase (+$6.2M) for SWRCB and 2.25% increase (+$5.3M) for DTSC.

The state hexavalent chromium standard, established in 2014, was set back by a lawsuit. A petition was granted to the California Manufacturers and Technology Association on May 5th remanding the California State Water Resources Control Board-Division of Drinking Water with orders to withdraw the current hexavalent chromium maximum contaminant level of 10 parts per billion and establish a new MCL. The court determined that the Department did not comply with the Legislature's directive to consider the economic feasibility of compliance, paying particular attention to small water systems and their users, and to set the MCL as close as economically feasible to the public health goal of 0.02 parts per billion.

On May 8th, the California Natural Resources Agency released a draft of the Safeguarding California Plan: 2017 Update and seeks public comment on the state's strategy for adapting to a changing climate. The draft report describes progress since the release of the first California Climate Adaptation Strategy in 2009, and provides recommendations and next steps to advance adaptation in 10 sectors that

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include water, agriculture, public health and biodiversity. As California continues to experience rising average temperatures, shrinking mountain snowpack, warmer storms, and higher sea levels, the state must consider climate change in its planning, investment, and public outreach.

Pertinent Legislation

AB18 Garcia (D) - California Clean Water, Climate, Coastal Protection, and Outdoor Access For All Act of 2018 – This bill would enact the California Clean Water, Climate, Coastal Protection, and Outdoor Access For All Act of 2018, which, if approved by the voters, would authorize the issuance of bonds in an amount of $3,105,000,000 pursuant to the State General Obligation Bond Law to finance this program. GRA would like to see language connecting flood control with groundwater and recharge. The Senate has been sitting on this two-year bill since March; this bill should merge with SB-5, the Senate parks bond. GRA has taken a watch position.

AB 313 Gray (D) – Water – This bill would establish a Water Rights Division within the Office of Administrative Hearings (OAH) in the Department of General Services (DGS), consisting of no less than four full-time Administrative Law Judges, beginning July 1, 2018; it includes other provisions. GRA has taken a watch position.

AB 574 Quirk (D) – Potable reuse – This bill would remove certain references to "direct potable reuse," "indirect potable reuse for groundwater recharge," and "surface water augmentation," and would instead specify the four different types of potable reuse projects as "groundwater augmentation, reservoir augmentation, raw water augmentation, and treated water augmentation." This bill contains other related provisions, and is in the Appropriations suspense file. GRA is considering a support position.

AB 577 Caballero (D) – Disadvantaged communities – This two-year bill would expand the definition of a disadvantaged community to include those with annual per-capita income less than 80% of the statewide average. GRA has taken a watch position.

AB 968 Rubio (D) – Urban water use efficiency – This bill would establish a collaborative process to develop certain methodologies for water-use efficiencies, allow locals to have more control over local programs and supports the premise that local management is the best approach, and should not be dictated by state. The bill would also require water-use efficiency targets be developed in urban water management plans. GRA is considering a support decision.

AB 1009 Gallagher (R) – SGMA and GSAs – This two-year bill would make a non-substantive change in these provisions. GRA has taken a watch position.

AB 1271 Gallagher (R) – Dams and reservoirs – Under existing law, whenever the Department deems that a condition endangers a dam or reservoir, it is required to order the owner to take action the Department deems necessary to remove the resultant danger to life and property. This two-year bill would require the Department, as soon as possible, to order the owner to take action. This bill contains other related provisions and other existing laws. GRA has taken a watch position.

AB 1427 Eggman (D) – Water and underground storage – Under existing law, the right to water, or to the use of water, is limited to that amount reasonably required to serve a beneficial use. Existing law provides for the reversion of water

Continued on the following page…

State Water Resources Control Board Actions

SWRCB is responsible for intervention in medium- and high-priority basins that do not comply with SGMA by: (1) forming GSAs by June 30, 2017; (2) Developing and submitting GSPs by January 31, 2020 (critically overdrafted basins) or January 31, 2022 (all other medium- and high-priority basins, or DWR fails GSP; (3) achieve groundwater sustainability within 20 years of plan adoption; or (4) DWR fails plan and the basin has significant surface-water depletions by February 1, 2025.

SWRCB has posted an interactive State Intervention Compliance Map application that allows users to view Geographic Information Systems (GIS) layers showing the compliance status of California's high- or medium-priority groundwater basins with respect to SGMA deadlines and requirements. Unmanaged areas are shown in RED; managed areas are shown in GREY.

All well owners in a basin subject to state intervention must file annual groundwater extraction reports to SWRCB and pay filing fees. On May 16, 2017, the State Water Board passed a resolution to adopt the Emergency Regulation for Implementation of the Sustainable Groundwater Management Act. The emergency regulations, required by SGMA, incorporate filing fees to cover the costs of State intervention and groundwater extraction reporting requirements. More information is available on the SWRCB website.

rights to which a person is entitled when the person fails to beneficially use the water for a period of 5 years. Existing law declares that the storing of water underground, and related diversions for that purpose, constitute a beneficial use of water if the stored water is thereafter applied to the beneficial purposes for which the appropriation for storage was made. This bill would revise the above declaration to additionally provide that certain uses of stored water while underground constitute beneficial use. The bill would provide that the forfeiture periods of a water right do not apply to water being beneficially used, as provided, or being held in storage for later beneficial use. GRA supports the concept of groundwater recharge and storage as a beneficial use of water, and is considering this bill with its member organizations, as there are issues still to be resolved within the bill.

AB 1654 Rubio (D) – Water shortage – urban water management planning – This bill would add requirements and additional reporting to urban water management plans. Additional reporting would include annual reporting of whether there are sufficient water supplies to meet demands, and monthly reports when implementing mandatory demand-reduction measures. The bill also requires that DWR provide a web portal for report submittal. GRA is considering a support position.

SB 5 De Leon (D) – California Drought, Water, Parks, Climate, Coastal Protection, and Outdoor Access For All Act of 2018 – Under existing law, programs have been established pursuant to bond acts for, among other things, the development and enhancement of state and local parks and recreational facilities. This two-year bill would enact the California Drought, Water, Parks, Climate, Coastal Protection, and Outdoor Access For All Act of 2018, which, if approved by the voters, would authorize the issuance of bonds in an amount of $3,000,000,000 pursuant to the State General Obligation Bond Law to finance this program. GRA has taken a watch position.

SB 246 Hertzberg – Local government – fees and charges - Articles XIIIC and XIIID of the California Constitution generally require that assessments, fees, and charges be submitted to property owners for approval or rejection after the provision of written notice and the holding of a public hearing. Existing law, the Proposition 218 Omnibus Implementation Act, prescribes specific procedures and parameters for local jurisdictions to comply with Articles XIIIC and XIIID of the California Constitution and defines terms for these purposes. This bill would define the term "sewer" for these purposes. The bill would also make findings and declarations relating to the definition of the term "sewer" for these purposes.

SB 252 Dodd (D) – Water wells – This bill would require, in an action alleging liability for interference with a well used primarily for domestic use, the reasonableness of each party's beneficial use of water to be determined through consideration of specified factors. This bill would also require an applicant for a new well permit in a critically-overdrafted basin to perform several actions as part of the application, which must also include specified information, to the extent that it can be reasonably known, about the new well. Additionally, this bill would require a city or county, including a charter city, that receives an application for a well permit in a critically overdrafted basin, to make certain information available to the GSA for the basin where the well is located, and to the public, in an easily-accessible manner. The city or county must also allow for a notice and comment period on that well application that includes a public hearing that follows the existing procedure for notice and public hearing in the planning and zoning law. GRA is considering a support position.

SB 541 Allen (D) School facilities – Water capture design standards – Existing law requires the Energy Resources Conservation and Development Commission, in consultation with the State Department of Education, the Division of the State Architect, and the Office of Public School Construction within the Department of General Services, to recommend best design practices that include energy-efficiency measures for all new public schools, and to report the recommendations to the Governor and the Legislature by October 1, 2003. This bill would require the above consulting agencies to recommend best design practices that include water-capture design standards for all new, reconstructed, or altered public schools, including school grounds. The bill would require these recommendations to be reported to the Governor and the Legislature on or before January 1, 2019, and would define "water capture" for these purposes. GRA is considering a support position.

SCA4 Hertzberg (D) – Water conservation – The California Constitution requires that the water resources of the state be put to beneficial use to the fullest extent of which they are capable, and that the waste, unreasonable use, or unreasonable method of use of water be prevented. This measure would declare the intent of the Legislature to amend the California Constitution to provide a program that would ensure that affordable water is available to all Californians and to ensure that water conservation is given a permanent role in California's future. This bill is unlikely to happen this year. GRA has taken a watch position.

We would like to recognize the valuable time and efforts of **GRA's Legislative Committee**: Tim Anderson of Sonoma County Water Agency, Pete Brown of the Water Replenishment District of Southern California, Alicia Dunkin of Orange County Water District, Robert Ennis of the City of Riverside, Thomas Harter of UC Davis, Paul Hendrix of Tulare Irrigation District, Abigail Madrone of West Yost Associates, Chris Petersen of GEI/GRA President, R.T. Van Valer of Roscoe Moss, and Tim Parker of Parker Groundwater/ GRA Director and Chairman.

The Federal Corner

By Jamie Marincola, U.S. EPA

EPA & Water Board Cleaned or Tested 381 Abandoned Storage Tanks, Reducing Groundwater Threats

Since 2013, U.S. EPA, along with the SWRCB, has taken action on 381 tanks located on 157 properties to prevent groundwater contamination and enable redevelopment. EPA and the Water Board worked with property owners and local regulatory agencies to inspect the sites and remove tanks or their hazardous contents where owners were unable or unwilling to take action. Cleaning up these tanks costs from $10,000 to $1.5 million. Click here for more information.

EPA Hosts Groundwater High-Resolution Site Characterization Training in San Francisco from June 13–14

The training course will focus on groundwater characterization and the impacts of subsurface heterogeneity on the investigation and cleanup of groundwater and related media, the need for scale-appropriate measurements and adequate data density, and related tools and strategies. The course is aimed to improve subsurface investigation approaches and develop more realistic and comprehensive conceptual site models. Recommended audience includes EPA, federal, state, tribal and private-industry technical project managers, practitioners and other stakeholders involved in groundwater investigation and remediation. Click here for more information.

USGS Locates Nine San Joaquin Valley Extensometers from the 1950s and 60s

Extensometers measure the compaction and expansion of the aquifer system, providing depth-specific data that can help California Water Science Center scientists better understand the rate, extent, and at what depths in the system subsidence is occurring. Extensometers in the San Joaquin Valley are some of the first ever built in the U.S. and are hundreds of feet deep. USGS was able to locate 9 extensometers at 8 sites to determine their condition and assess if they can be refurbished for future use. To read more, go here.

EPA Kicks-Off Cleanup at West Oakland Superfund Site

In March, EPA joined local leaders and community members in Oakland to celebrate the installation and start-up of a new groundwater and soil treatment system at the AMCO Chemical Superfund Site. The AMCO Superfund site was owned and operated by AMCO Chemical as a distribution facility from 1960 to 1989; bulk chemicals were offloaded, stored and transferred at the facility, and ultimately contaminated the soil and groundwater. Since 1997, EPA has overseen two previous cleanup actions at, and adjacent to, the site. For the current cleanup, EPA has installed 69 underground electrodes throughout the site. These electrodes heat the soil and groundwater to temperatures of up to 100°C (212°F) to vaporize and capture contaminants, such as trichloroethylene (TCE) and vinyl chloride. The contaminated material is then collected and transported offsite for safe disposal. Cleanup status can be found here: https://response.epa.gov/AMCONPL.

USGS Interactive Map Provides a Long-term Look at Changes in the Quality of Our Nation's Rivers and Streams

A new USGS interactive map provides a comprehensive, long-term look at changes in the quality of our Nation's rivers and streams over the last four decades. For the first time, monitoring data collected by 74 organizations at almost 1,400 sites have been combined to provide a nationwide look at changes in the quality of our rivers and streams in the 40 years since passage of the Clean Water Act. Tracking changes in the quality of these waterways over multiple decades is crucial for evaluating the effectiveness of pollution control efforts and protecting the Nation's water resources into the future. The interactive map can be used to track trends of 51 water-quality constituents and 38 aquatic-life metrics at nearly 1,400 sites during four time periods within 1972–2012. This map was developed by the USGS National Water-Quality Assessment Project.

Explore Other USGS interactive maps:

- Trends in Groundwater Quality: https://nawqatrends.wim.usgs.gov/Decadal/
- Status of the Nation's Rivers and streams: https://cida.usgs.gov/quality/rivers/home

Jamie Marincola is an Environmental Engineer at the U.S. Environmental Protection Agency Region 9 Water Division. For more information on any of the above topics, please contact Jamie at 415-972-3520 or marincola.jamespaul@epa.gov.

Is E-waste Really a Threat to Groundwater?

By Bart Simmons

Groundwater contamination is frequently given as a reason for regulating e-waste. The threat of regulation as a hazardous waste has forced additional recycling of e-waste. The Toxicity Characteristic Leaching Procedure (TCLP) captures cathode-ray tubes (CRTs) because of the leaded glass, and the Waste Extraction Test captures many more e-wastes, depending on how the sample preparation is done. Previous columns have discussed the TCLP and WET methods; suffice it to say that neither is an accurate predictor of threats to groundwater *(Disclosure: I participated in one study of the WET and TCLP)*.

E-waste is regulated by a set of arcane and esoteric state and federal regulations *(further disclosure: I participated in the writing of some of those regulations)*. California regulations include an elemental metal exemption, which exempts elemental metals unless "friable, powdered, or in a finely-divided state." However, there are no test methods specified to determine whether an elemental metal is friable, powdered, or in a finely-divided state. There are also no explicit directions for testing a sample which contains elemental metal. Thus, the question of whether an e-waste is hazardous is subject to debate. Federal regulations exempt metals if they are recycled. The threat of a hazardous classification has undoubtedly increased recycling of e-waste.

Laboratory studies have been done on the extraction of regulated substances from e-waste. When extracted with municipal solid-waste leachate (MSW), CRTs can leach lead at levels exceeding the EPA limit of 5 mg/L. The source of the lead is largely the leaded glass, although there is some concern for leaching it from solder in printed wiring boards. A University of Florida study found that lab-leaching of electronic components resulted in exceeding the limit of 5 mg/L. However, when e-waste was mixed with municipal solid waste and extracted with MSW leachate, there was no significant difference between the MSW e-waste combination, and MSW alone.

In developing countries, sites used for metal recycling, including incineration, have had gross soil and surface-water contamination, but little groundwater contamination, except for cadmium. In Ghana, elevated arsenic levels in urine were found in workers, but not from groundwater consumption. Cadmium, unlike most of the regulated elements, has leached from soil in laboratory tests. A study of former incineration sites in China concluded that groundwater and drinking water were not significant sources of exposure for workers and nearby residents.

When compared with MSW leachate, the California WET method is overly aggressive to elements that form cations in solution, e.g., lead, cadmium, nickel, copper, and zinc. Although lead is the most likely cause for an e-waste to be classified as hazardous, there is little in the literature to implicate e-waste as a source of lead in groundwater. Of the regulated substances, cadmium appears to pose the greatest potential for leaching to groundwater.

Contamination of groundwater is often cited as a reason to require recycling of e-waste. However, laboratory and field studies have largely failed to find a connection between e-waste disposal and groundwater quality.

Thus, the recycling of e-waste is an example of doing the right thing for the wrong reason.

Bart can be reached at bartonps@aol.com.

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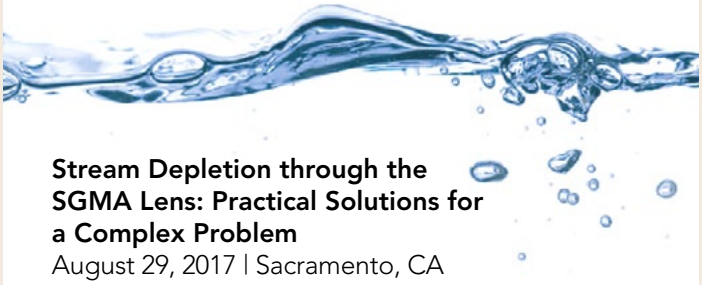
(Please visit www.grac.org for detailed information, updates and registration unless noted)



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CENTRAL COAST

By Bryan Bondy, Branch Secretary

On February 22, the Central Coast Branch was excited to have Dr. Hugo Loaiciga from UCSB present *The Carpinteria Valley Groundwater Basin Hydrogeologic Analysis*. The presentation provided an overview of SGMA requirements and the hydrogeology of the Carpinteria Valley Basin, which straddles the Santa Barbara/Ventura County line. Dr. Loaiciga described the findings from historical investigations of local structural geology, recharge sources, and other aspects of the groundwater-flow system. Dr. Loaiciga also described a mass-curve analysis approach he developed for estimating the "safe yield" of a basin, and its application to the Carpinteria Valley Basin. He noted that although the Carpinteria Valley Basin is a very-low-priority basin under SGMA, there is a risk of seawater intrusion and the basin could benefit from a groundwater sustainability plan. The presentation engendered considerable and lively discussion on a number of topics, which made for an entertaining evening. Our Branch members very much enjoyed Dr. Loaiciga's presentation. The meeting was very well attended.

SOUTHERN CALIFORNIA

By Herbert (Bert) Vogler, Branch Secretary

The Southern California Branch, focusing on Los Angeles and Orange Counties, held a meeting on Tuesday, March 14, featuring GRA's southern California David Keith Todd Lecturer, Dr. Claudia Faunt, who presented *California Climate, Groundwater, and Their Interrelated Future*. Dr. Faunt began by noting how critical proper management is to ensure the sustainability of California's water resources. She pointed out that groundwater is a vital but invisible resource that serves as a crucial buffer against land-use change effects, water restrictions, drought, and impacts of climate change, including depletion of the mountain snowpack that provides much of the state's water supply. Despite this essential role of the groundwater system, it is under great strain, and until recently was largely unregulated; now, California's Sustainable Groundwater Management Act of 2014 (SGMA) provides a framework to comprehensively measure and manage the state's groundwater. Dr. Faunt explained that SGMA empowers local agencies to assess hydrologic issues that may cause undesirable results. Much of the rest of her talk focused on California's approximately 20,000-square-mile Central Valley, which she noted is one of the most productive agricultural regions in the entire world. She pointed out that the Central Valley has many basins with undesirable results, and that most of them are also considered to be critically overdrafted. Because of the Central Valley's semi-arid climate, surface-water availability varies substantially, and agricultural demand for irrigation is thus heavily reliant on both surface water and groundwater.

Dr. Faunt told us that in parts of the valley, groundwater pumping practices have caused severe groundwater-level declines resulting in as much as 30 feet of land subsidence. Starting in the 1950s, water distribution systems in the valley began relying more on diverted surface water, and groundwater levels consequently recovered, with land subsidence virtually ceasing for a few decades. In the last 20 years, however, land-use changes and limitations on surface-water availability caused by drought and required maintenance of environmental flows have resulted in increased pumping. This increased pumping has caused declines in groundwater levels and storage capacity, renewed subsidence (with rates as much as 2 feet per year), decreased stream flows, and ecosystem changes. Dr. Faunt noted that this subsidence has even affected the integrity of surface-water distribution infrastructure, and emphasized that as these trends continue, monitoring and modelling are critical to understanding groundwater-use dynamics and developing management strategies. She explained that modeling tools, such as the USGS's Central Valley Hydrologic Model, are enabling Groundwater Sustainability Agencies (GSAs) to get a head start in meeting requirements for key elements of their Groundwater Sustainability Plans, and that the tools will also aid in optimizing water availability. Such capabilities are critical for successful SGMA implementation. Upon completion of the presentation, there was a question-and-answer discussion that focused largely on subsidence-related issues, including use of extensometers for monitoring subsidence rates and characteristics.

The Southern California Branch again thanks Dr. Faunt for presenting her informative and interesting talk to us; and as always, we thank all GRA Members who participate in the Branch.

The Parting Shot

The Tuolumne is the largest watershed (more than 1,600 square miles) in the San Joaquin system. It begins at Mount Lyell and Mount Dana (named for geologists by the Whitney survey) in Yosemite National Park at over 13,000 feet and ends at its confluence with the San Joaquin River, 50 feet above sea level on the Central Valley floodplain. In an average year, about 1.8 million acre-feet of water run off the watershed, which supplies the needs of 2.4 million people in the Bay Area and 550,000 people within the watershed itself. Its waters also irrigate more than 300,000 acres of agricultural land and support a complex but degraded ecosystem, both within the watershed and downstream in the Delta. Its two hydropower systems, Hetch Hetchy and New Don Pedro, supply roughly 1.5% of the state's demand for electricity. The middle and upper watershed receive over 1 million visitors per year to Yosemite National Park and for challenging whitewater rafting trips (overall technical difficulty: class IV).

The upper Tuolumne River is a critical hydrologic component of the watershed. The relatively thin soils do not retain much water, except in Tuolumne Meadows. In addition, the groundwater system within the fractured granite has limited storage capacity. The combination of high precipitation, thin soils, and limited groundwater storage leads to very high runoff, making it the most important source of water in the watershed.

Water management in California is dynamic and will change in future decades. Climate warming may cause fundamental changes in the hydrology of the Tuolumne and other Sierran rivers, including: more precipitation as rainfall instead of snowfall, earlier snowmelt at higher elevations altering the timing of runoff, and changes to the mean annual flow of the river—although scientists are still uncertain as to whether the region will experience long-term increased or decreased flows.

This Parting Shot essay is based on Confluence: A Natural and Human History of the Tuolumne River Watershed, edited by Jeffrey Mount and Sabra Purdy, Department of Geology and Center for Watershed Sciences at the University of California at Davis, 2010; see: https://watershed.ucdavis.edu/tuolumne/resources/ConfluenceTuolumneV1.pdf.

This photograph was taken during a drought, in April 2008, at Rancheria Falls in Yosemite National Park. Low water levels and a subtle bathtub-ring of exposed rock can be seen at Hetch Hetchy reservoir in the middle background. By John Karachewski, Ph.D.