Nevada Irrigation District

Staff Report

TO: Board of Directors

FROM: Doug Roderick, P.E., Engineering Manager

DATE: May 10, 2022

SUBJECT: **Plan for Water – WEST Consultants, Inc. Proposal**

ENGINEERING DEPT

RECOMMENDATION:
Review and discuss WEST Consultants, Inc. proposal for professional engineering services for the Plan for Water. Staff will be bringing the proposal to the May 11, 2022, Board meeting for approval of a consulting contract.

BACKGROUND:
The Plan for Water (PFW) is a long-range decision tool to guide NID's water management. The PFW is an open and comprehensive look by NID and the community at the potential limitations of its available water resources and the impacts of new regulations, changes in land use, climate change and community visions. Part of the PFW process will be to develop a range of potential scenarios for the Board to consider when determining the best ways to meet the community's demand for water for the next 50 years while weighing the impact on NID, the community and the environment. When complete, the PFW will show how a variety of future water supply and demand scenarios could be integrated to ensure our community enjoys the same high-quality, reliable water system that NID has now.

As part of the technical portion of the PFW process, NID requires professional engineering services to review and update the existing unimpaired hydrology and reservoir operations model; development of a land-use-based demand model encompassing a 50-year planning period; development of a supply analysis; and assistance with a strategic alternatives analysis.

On January 10, 2022, a request for proposals (RFP) was posted on CIPList.com, as well as the California Special Districts Association and NID's websites, both of which provided links to the CIPlist.com. In addition, staff sent out emails to

multiple consultants that the District has used in the past letting them know that the RFP was now available on the CIPList. On February 10, 2022, the District received one (1) proposal from WEST Consulting Inc. (WEST). Since only one proposal was received, staff reached out to several consultants inquiring why more did not propose on the project. Most stated that they were either too busy to take on a project like this, or that they would consider proposing on a portion of the project if the District wanted to break up the proposal into separate pieces.

Staff reviewed the proposal from WEST. They have taken a team approach, with WEST being the prime consultant and will be supported by Western Hydrologics Consulting (WHC), Davids Engineering Inc (Davids) and HDR Inc (HDR). WEST Consultants is a water resources engineering firm with extensive experience developing unimpaired hydrology (including snow hydrology and climate change), implementation of reservoir operations models, development of integrated land use-based demand models and supply analysis including multiple drought and climate change scenarios, with a local office in Folsom. WHC is a water supply consulting firm based in Auburn, with extensive water resources and water rights experience in the Sierra Nevada. Davids has provided professional engineering and scientific services to public agencies and is a leader in the development of land surface water budget methodologies and applications based in Davis. HDR has been providing NID with engineering services for over 13 years including several hydrology and operations modeling studies with offices in Folsom and Sacramento.

Staff met with representatives of WEST on March 10, 2022. After internal discussion of the WEST proposal, staff sent out the proposal to a diverse group of stakeholders to review and provide feedback. The proposal was sent to Melinda Booth of SYRCL, Traci Sheehan of Foothills Water Network, Barbara Bashall of the Nevada County Contractors Association, and Joe Fischer of the Placer County Farm Bureau. On March 31, 2022, staff and stakeholders met to discuss the merits of the proposal. Based on that discussion, it was agreed to set up an interview with the WEST team.

On April 20, 2022, staff and stakeholders interviewed the WEST team, which included a presentation followed by a question-and-answer session. After the interview, both staff and stakeholders unanimously agreed that the WEST team was capable of providing the technical expertise necessary for the Plan for Water process. Therefore, it is recommended that the Board award a consulting contract with WEST in the amount of $1,024,291.

BUDGETARY IMPACT: Overall impact is $1,024,291. The approved 2022 budget for this scope of work is $450,000. While some work will start in the summer of 2022, the majority of work will occur in the fall of 2022 and in the spring/summer of 2023. Staff would recommend waiting until later in the year to see if an amendment to the 2022 budget would be necessary. If needed, staff

would bring an amendment forward in the fall. The remainder would be budgeted in 2023.

ATTACHMENTS (2):

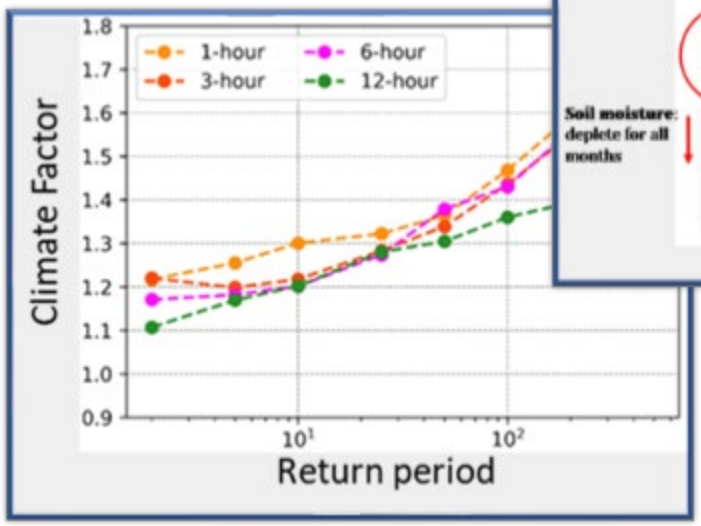
- WEST Consultants Inc. Proposal
- Request for Proposals

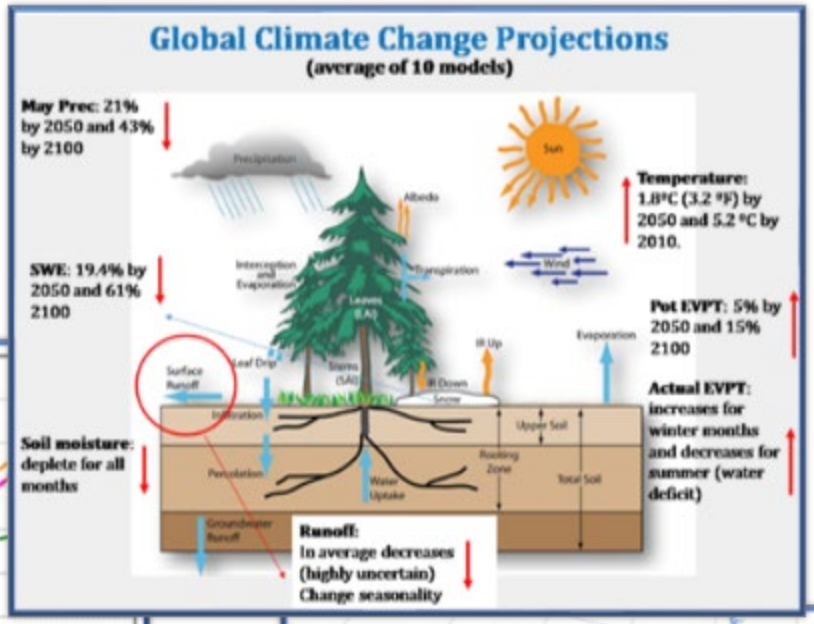
DR

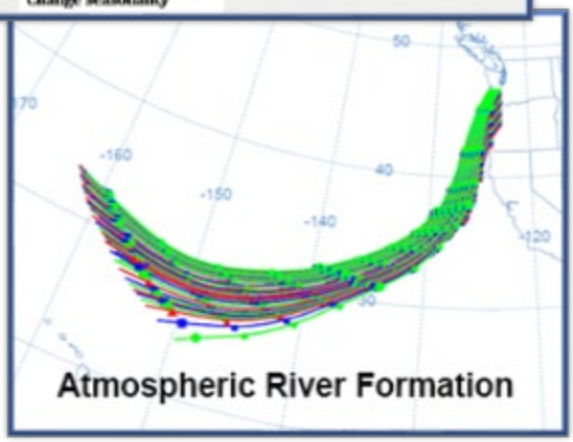
Nevada Irrigation District

Plan for Water Proposal

February 10, 2022







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Folsom, CA 95630-4726

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Tempe, AZ 85284-1043
(480) 345-2155

33244 S. Aguirre Lane
P.O. Box 1267
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(214) 932-3015

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Bellevue, WA 98005-2535
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River Measurement
A Division of WEST Consultants
811 NE 154th Street
Vancouver, WA 98685-1347
(360) 571-2290

February 10, 2022

Nevada Irrigation District
Attn: Doug Roderick, P.E., Engineering Manager

RE: Plan for Water

WEST Consultants presents a highly skilled and specialized team of water resource engineers and scientists to prepare the next NID Plan for Water. Our California-based team includes:

- **WEST Consultants** (Prime), an advanced water resources engineering firm with a local office in nearby Folsom
- **HDR** has been providing engineering services for Nevada Irrigation District (NID) for more than 13 years on 47 projects, which have included several hydrology and operations modeling studies
- **Western Hydrologics**, a water supply and hydropower consulting firm based in Auburn, with extensive water resources and water rights experience in the Sierra Nevada
- **Davids Engineering**, a leader in the development of land surface water budget methodologies and integrated demand applications located in Davis.

This technical team was selected for specific skill sets needed to review and update, as necessary, the existing unimpaired hydrology, the HEC-ResSim reservoir operations model, development of an integrated land use-based demand model encompassing the 50-year planning period, and development of supply analysis including multiple drought scenarios.

Our team's water resources engineering expertise is foundational to the Plan for Water. Any water management plan, particularly in California, must navigate the rocky shoals of competing interests, water rights, regulatory constraints, public perceptions, climate change, and the uncharted territory of Covid-19.

The WEST Consultants team is the right team. Select WEST to deliver your next Plan for Water.

Respectfully submitted,

Dr. David C. Curtis, F.EWRI
Vice President
dcurtis@westconsultants.com

1. Project Overview and Approach

Overview

WEST Consultants, Inc. (WEST) provides specialized water resources engineering services. Our proposed technical team includes experts in hydrology, hydraulics, numerical modelling, technology transfer and have extensive experience with developing unimpaired hydrology, implementation of HEC-ResSim reservoir operations model; development of integrated land use-based demand models, and development of supply analysis including multiple drought and climate change scenarios.

We compiled a team of specialized technical experts that will tackle the required elements for the District's Plan for Water. The WEST team is a valuable resource to support the District's mission of providing a dependable, quality water supply; continue to be good stewards of the watersheds, while conserving the available resources in your care.

WEST Consultants is the prime contractor. WEST's state-of-the-art water resources expertise is frequently engaged to perform advanced hydrologic and hydraulic studies including snow hydrology and climate change, reservoir operations, land use management, water supply, and modeling expertise. The result is an extensive portfolio of successfully completed projects for local, state, and federal agencies.

WEST is supported by Western Hydrologics Consulting; Davids Engineering, Inc; and HDR, Inc, each supplying critical expertise and skills needed for water plan development**. Western Hydrologics** staff are experts in water supply planning and management including developing of unimpaired hydrology and operations modeling in the Sierra Nevada Mountains. **Davids Engineering** provides expertise in sustainable management of surface water and groundwater resources and have extensive experience working with agricultural water suppliers across California to create water management plans and efficient water management practices including the development of integrated water flow demand models.

HDR has been providing engineering services for Nevada Irrigation District (NID) for more than 13 years on 47 projects, which have included several hydrology and operations modeling studies. For NID and Pacific Gas & Electric Company, HDR developed synthesized unimpaired hydrology for over 125 reaches in seven rivers and analyzed the effects of the proposed Yuba-Bear and Drum-Spaulding Hydropower Relicensing project operations on power generation, water deliveries, and stream temperatures. Work included regularly attended public relicensing meetings to discuss hydrology and model development, and present model results of various alternative operating proposals. HDR more recently supported NID's long-range planning efforts by developing 2070-based projections of climate changed historical watershed runoff and forecasted water demands by district customers. This information was used to support a water supply analysis that was presented to the NID Board of Directors and other stakeholders at multiple public meetings.

Project Understanding

The District is requesting professional consulting service to assist the development of the District's Plan for Water. These services include review and updating the existing unimpaired hydrology and HEC-ResSim reservoir operations model and development of a land-use-based integrated demand model. The Plan for Water is a long-range decision tool to guide the District's water management. The Plan for Water process is an open and comprehensive look by the District and the community at the potential limitations of its available water resources and the impacts of new regulations, changes in land use, climate change, and community visions. The planning horizon is 50 years and includes analysis of water supply, unimpaired hydrology, climate change impacts, and potential long-term impacts of Covid-19. The final deliverables will include analysis of strategic alternatives to help the District's Board of Directors determine the best ways to meet the community's demand for water now and in the future. The Plan will show a variety of future water supply and demand scenarios. This final Plan will have an integrated approach to ensure high-quality, reliable water for the District and its constituents

The project includes the following ten task items described in detail in Section 3:

Item 1: Kick-off Meetings
Item 2: Detailed Project Schedule
Item 3: Meetings with District Staff
Item 4: Board of Directors and Public Engagement
Item 5: Unimpaired Hydrology
Item 6: Demand Projection Model
Item 7: Supply Projection
Item 8: Strategy Alternatives Analysis
Item 9: Miscellaneous
Item 10: Optional Work (none)

Approach

The proposed approach centers around three guiding principles:

1. Provide a team of leading experts that can tackle the range of tasks for developing a feasible Plan for Water.
2. Provide continual productive communication with all parties to ensure accurate, effective, and unambiguous messaging
3. Leverage state-of-the-art technology for developing defensible tools and useful information for decision making to support the Plan.

Maintaining excellent communication avenues is critical to any project. Our entire team will be accessible to the District, as needed. We have a technical writing expert on our team to help close the communication gap between the technical experts and the public. We will hold informative meetings including Kick-Off Meetings and bi-weekly status meetings. Additionally, we will have technical meetings as required to communicate important decision points in the planning process. We will maintain a project schedule and communicate the

status of all deliverables with District staff on a regular basis. One thing is assured, the District will always have access to project management information in a real time basis as needed.

The WEST Team is comprised of specialized professional consultants to handle any aspect of the Plan. Our team will develop advanced decision support tools and models. We are experts in hydrologic modeling, including unimpaired flows, snow hydrology, and climate change. Our expertise extends to HEC-ResSIM reservoir operations modeling, water supply analysis, and integrated demand modeling. We will address the 11 considerations outlined in the demand model, including impacts due to COVID-19 Pandemic. The pandemic has impacted our society in major ways. For example, as workers perform from their home more frequently, the source of the water demands drifts from commercial use to domestic uses. This impacts the Plan because we must consider water supply delivery infrastructure to account for these shifts in water demand and use.

With the three guiding principles of public engagement, productive communication, and state-of-the-art technology, the WEST Team will deliver your next comprehensive Plan for Water and help guide the future and meet the water challenges facing the District.

WEST's **contract manager** is **Dr. David C. Curtis, F.EWRI**. For nearly half a century, Dr. Curtis has been on the leading edge of hydro-meteorological and water resources risk management system development. He has overseen several major research-level projects, most to investigate the influence of Atmospheric Rivers on extreme precipitation. He recently led a study to update the rainfall frequency curves for Sacramento County that account for climate change. He was the contract manager for WEST's development of methods to improve the estimation of hydrologic losses and the ability to accurately forecast inflows to reservoirs operated by the U.S. Army Corps of Engineers.

The **project manager** is **Marco A. Bell, PE**. Mr. Bell has long been applying new technologies to develop water resources hydrologic and hydraulic real time models in the San Joaquin basin using HEC-RTS. These optimized models were developed for the Big Creek project at Southern California Edison and for the Merced River Basin at Merced Irrigation District. He served as the water resources engineers for the California Department of Water Resources and for Merced Irrigation District managing water resources programs such as water supply management, reservoir operations, and sustainable groundwater management.

Both Dr. Curtis and Mr. Bell have national and international experience with expertise well suited to manage the consulting services for District's Plan for Water.

Recommendations

There are no new recommendations at this time. We may have additional recommendations in the future as the project moves forward.2. Technical Expertise and Qualifications

Project Team

WEST Consultants, Inc.

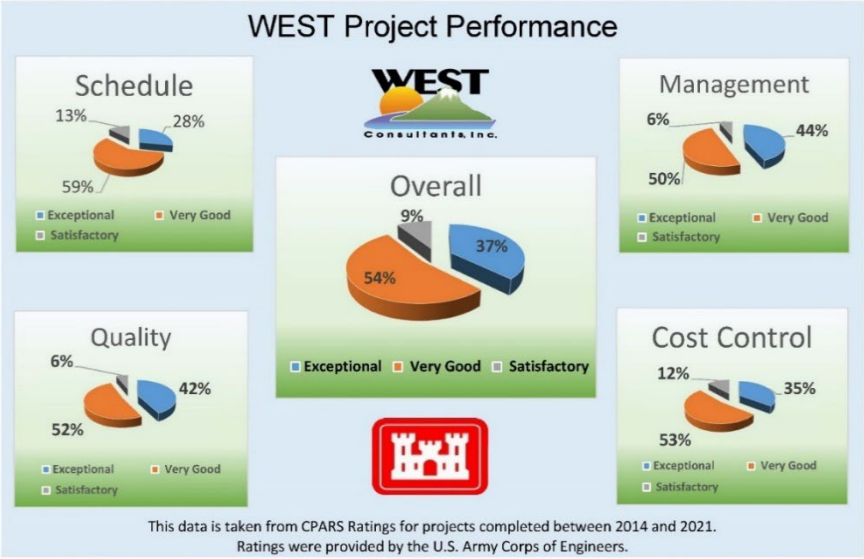
Established in 1988, WEST Consultants, Inc. (WEST), is a firm dedicated to providing specialized water resources engineering services relevant to Water, Environment, Sedimentation, and Technology. WEST personnel are nationally recognized computer modeling experts in hydrology, hydraulics, geomorphology, sediment transport, and water quality. Accordingly, WEST is known for the development of innovative computer modeling tools, expertise in complex modeling situations, and the provision of effective professional training courses.

WEST provides water resources engineering and planning services for our clients requiring advanced numerical modeling and mapping. WEST's portfolio of services includes hydrologic and hydraulic engineering, reservoir studies (dam break, probable maximum flood, dam safety, reservoir operations), flood warning and forecasting, bridge hydraulics and scour analyses, sediment transport and geomorphology, wetland hydrology, surface and groundwater hydrology modeling, flood control, multi-dimensional hydraulic modeling, erosion control and stream stabilization, stormwater management, water quality and contaminant transport modeling, coastal and estuarine modeling, rainfall and stream flow gauging, holistic land management and green infrastructure, applied research, software sales, computer programming, training, and quality assurance.

Staffed by highly qualified hydraulic, hydrologic engineers and scientists with diversified project experience, WEST engineers have strong academic backgrounds, enabling the firm to work on projects involving applied research and state-of-the-art technology as well as traditional methodologies. The personnel at WEST are considered by the engineering community as specialists in the use of many water resources engineering computer models, including: HEC-HMS, HEC-RAS, HEC-6/-6T, HEC-ResSim, FIA, RMA-2, SED-2D, FESWMS, SRH-2D, ADH, XP-STORM, XP-SWMM, FLO-2D, MIKE-11, RiverWare, TUFLOW, MODFLOW, and U.S. Army Corps of Engineers' CWMS and RTS. WEST has strong Geographic Information System (GIS) capabilities for processing and analyzing spatial data that are involved in many aspects of modeling and mapping activities.

WEST currently has **66 employees in eight offices in five states**: Folsom and San Diego, California; Salem, Oregon; Bellevue and Vancouver, Washington; Tempe and Red Rock, Arizona; and Dallas, Texas.

Since its founding, WEST has developed proven management protocols to effectively manage resources; identify and minimize project risks; track project progress, budget, and schedule; ensure quality products and services; and achieve desired project goals and objectives. In recent performance ratings in the U.S. Federal Government's Contractor Performance Assessment Reporting System (CPARS), WEST has consistently received high performance evaluations in our hydraulic, hydrologic, and sediment engineering design and studies. In all



categories, WEST achieved ratings of **Exceptional or Very Good at least 91% of the time** (Schedule 87%, Cost 88%, Management 94%, and Quality 94%).

As witnessed by our CPARS ratings on USACE projects, these protocols have resulted in an excellent reputation for our ability to successfully address complex technical challenges, manage projects, provide responsive services, meet project schedules, and deliver quality products.

Davids Engineering, Inc

Since 1993, **Davids Engineering, Inc. (Davids)** has provided professional engineering and scientific services to public agencies, private entities, and individual landowners responsible for managing water resources in the western United States. They are founded on a commitment to the highest standards of professional integrity and intellectual honesty, and have successfully completed projects in Arizona, California, Nebraska, Nevada, Oregon, Washington, and in a handful of developing nations. They are proud of the fact that most of their work comes by word-of-mouth or through repeat work for past clients.

Davids has been a leader in the development of land surface water budget methodologies and applications for more than 20 years. They provide a broad range of services supporting management of surface water and groundwater supplies. Since 1993, they have assisted dozens of water purveyors, irrigation water suppliers and farmers, across a wide range of agro-climatic, hydrologic, production and water management conditions. DE has prepared water budgets ranging in size from 3,000 acres to 1,000,000 acres, and spatially distributed models to develop time-series data of irrigation and other water demands and return flows to support the management of water supplies. In many instances, the water budgets were prepared specifically to interface with groundwater models or to account for impacts to both water supply and demand due to projected climate change conditions.

Western Hydrologics Consulting

Western Hydrologics Consulting (WHC) specializes in assisting their water supply and hydropower clients develop practical solutions to complex environmental planning, resource management, economic and operational challenges. They have over 40 years of combined experience developing creative, innovative, and comprehensive solutions. WHC utilizes advanced technologies to understand water supply and hydropower project operations, economics, hydrology, and environmental concerns. They use these skills and interdisciplinary studies in economics, water law, and natural resource science to help clients maneuver through "big picture" water resources project planning, management, compliance, and operations. Their technical skills include water supply planning, hydro-economic modeling, FERC licensing support, operations forecasting, water rights, water transfers, and stream gaging. WHC often teams with other firms to complement their skill set and provide geographic assistance, while allowing them to continue to provide strategic planning and client support services.

Certifications: Small Business Certification and Disabled Veteran Business Enterprise (#2020636) State of California.

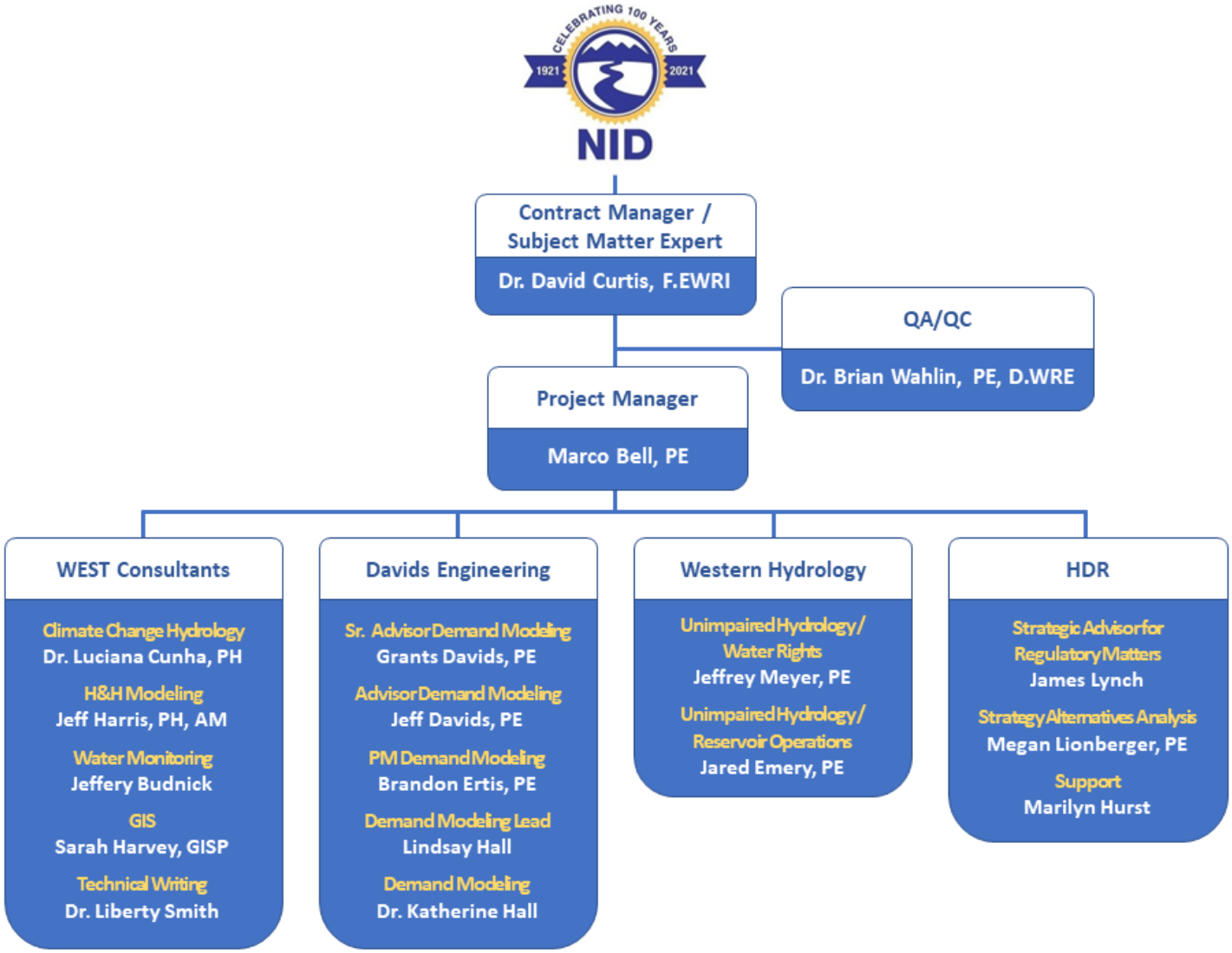
HDR, Inc

For more than a century, **HDR** has partnered with water agencies and local utilities to deliver solutions for their infrastructure that support their operational needs and regulatory responsibilities. As an integrated architectural, environmental, engineering, design, and construction services firm, HDR is adept at partnering on multidisciplinary teams to develop creative strategies and solutions that go beyond the scope of a traditional engineering firm. HDR's solutions run across our spectrum of services for our clients, and HDR's staff of professionals represent hundreds of disciplines in the architecture, energy, environmental, mining, land development, resource and wildlife management, transportation, and water fields. HDR has roughly 500 multi-disciplinary staff in Northern California that can be called upon to help meet any of NID's project needs.

Team Members	Firm	Role	Location	Availability
Dr. David Curtis, F.EWRI	WEST	Contract Manager/Subject Matter Expert (SME)	Folsom, CA	15%
Dr. Brian Wahlin, PE, D.WRE	WEST	Quality Control	Tempe, AZ	15%
Marco Bell, PE	WEST	Project Manager	Folsom, CA	25%
Dr. Luciana Cunha, PH	WEST	Climate Change Hydrology	Folsom, CA	10%
Jeff Harris, PH, AM	WEST	Hydrologic and Hydraulic Modeling	Folsom, CA	30%
Jeffrey Budnick	WEST	Water Monitoring	Vancouver, WA	25%
Sarah Harvey, GISP	WEST	GIS	Bellevue, WA	40%
Dr. Liberty Smith	WEST	Technical Writer	Salem, OR	40%
Grant Davids, PE	DE	Senior Advisor for Demand Modeling	Davis, CA	10%
Jeff Davids, PE	DE	Technical Team/Advisor for Demand Modeling	Davis, CA	25%
Brandon Ertis, PE	DE	Demand Modeling Technical Team/Project Manager	Davis, CA	50%
Lindsay Hall	DE	Demand Modeling Lead	Davis, CA	33%
Dr. Katherine Klug	DE	Demand Modeling Technical Team	Davis, CA	33%
Jared Emery, PE	WHC	Sr. Water Resources Engineer/Reservoir Operations Modeling/Unimpaired Hydrology Development	Auburn, CA	35%
Jeffrey Meyer, PE	WHC	Principal Unimpaired Hydrology Development /Water Rights	Auburn, CA	35%
James Lynch	HDR	SME Regulatory Matters	Sacramento, CA	10%
Megan Lionberger, PE	HDR	SME for Items 5, 6, 7 / PM for Strategy Alternatives Analysis (Item 8)	Sacramento, CA	45%
Marilyn Hurst	HDR	Support for Items 5, 6, 7, & 8	Sacramento, CA	50%

Table 1: Team Structure and Responsibilities

Team Structure & Organization Chart



Resumes for each member of our team are collected in the **Appendix B: Resumes** after the main body of this proposal.

Similar Projects

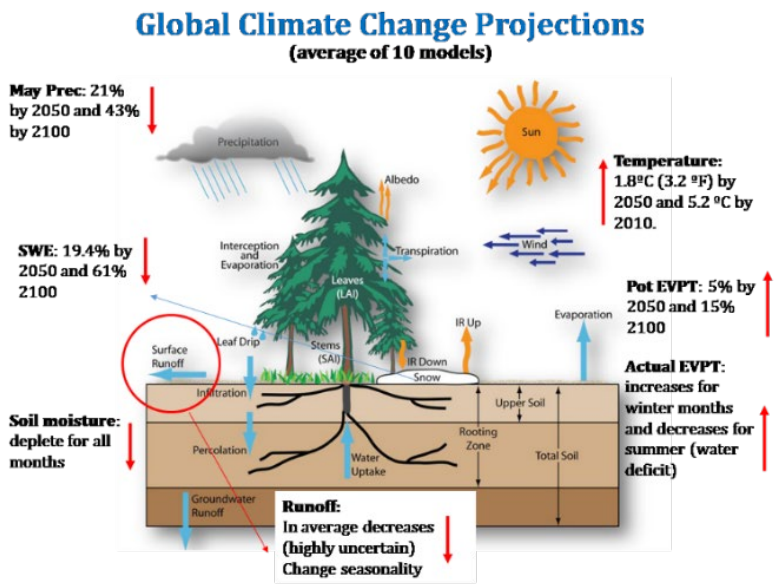
Similar Project #1: Middle Rio Grande Conservancy District Drought Decision Support Tool and Drought Contingency Plan Development

Client: Middle Rio Grande Conservancy District
Location: Albuquerque, NM **Cost:** $102,030
Reference: Ms. Anne Marken | (505) 247-0234 | anne@mrgcd.us
Team Members: Dr. Brian Wahlin, Dr. Luciana Kindl Da Cunha

Relevance

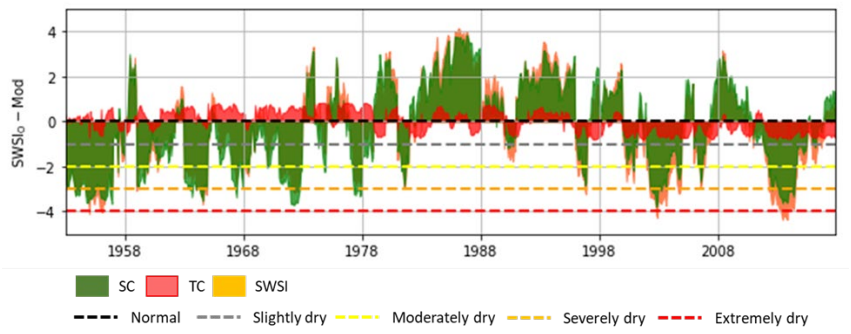
Drought Simulation / Monitoring
Climate Change
Hydrometeorological Decision Support Tool
Drought Contingency Planning

WEST Consultants led the development of a Drought Contingency Plan (DCP) for the Middle Rio Grande Conservancy District (MRGCD). The DCP includes a decision support tool to monitor and forecast droughts based on current and historical soil moisture, runoff, reservoir storage, groundwater, and temperature conditions. Drought intensity is directly linked to drought triggers and response actions. The DCP also includes the identification of current and projected drought vulnerabilities considering climate change, long term mitigation actions, an administrative framework, and a plan update process. Mitigation actions include infrastructure projects and changes in operations.



The MRGCD provides irrigation water to about 60,000 acres along 150 miles of the Rio Grande. The MRGCD is primarily a run-of-the-river system, with the ability to store supplemental water when regulatory conditions allow. Substantial reliance on naturally occurring river flows in the Rio Grande—combined with the natural variability of the climate and potential for increased variability due to climate change—makes the MRGCD vulnerable to water shortages under drought conditions.

The effects of climate change on drought intensity, frequency, and duration were also quantified in the MRGCD DCP. Multiple hydrological and meteorological variables, including precipitation, soil moisture, snow water equivalent, evapotranspiration, and streamflow, were evaluated. An inventory of a possible range of impacts for each variable, and their uncertainties, was presented.



Drought monitoring and triggers in the DCP utilize a modified version of the Surface Water Supply Index (SWSI-MOD) to quantify drought severity. The SWSI-MOD accounts for water supplies and demand components and includes a quantification of the effects of temperature on soil conditions changing conditions. Hydrological conditions are described based on nine different classes varying from extremely wet (SWSI-MOD>4) to extremely dry (SWSI-MOD<-4).

The results provided by the decision support tool, including the drought indicator, are used to define the appropriate drought response and preparedness actions with the goal of minimizing the impact of water shortages on the MRGCD. As an on-going effort, the implementation of long-term mitigation actions proposed in the DCP may be pursued to increase the MRGCD's long-term resilience to drought.

Similar Project #2: Willamette River Bason HHT Extreme Storm Analysis

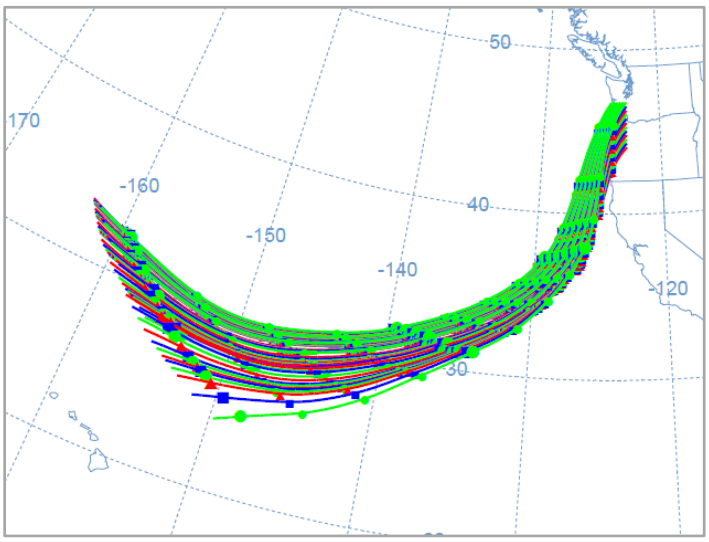
Client: U.S. Army Corps of Engineers, Vicksburg & Portland Districts
Location: North Central Oregon **Cost:** $377,100
Reference: Joey Windham | (601) 631-5587 | Joseph.M.Windham@usace.army.mil
Team Members: Dr. David Curtis, Dr. Brian Wahlin, Marco Bell, Dr. Luciana Kindl Da Cunha, Jeff Harris, Jeffery Budnick, Sarah Harvey, Liberty Smith

Relevance

Water Resources Studies
Extreme Storm Analysis
Hydrologic Risk Assessment
Large-Scale System Analysis
HEC-HMS Model Development
Regional Hydrologic Development

The U.S. Army Corps of Engineers' (USACE) vision is to achieve safe, secure, and more resilient Corps civil works infrastructure by enhancing its protection in order to prevent, deter, or mitigate the potential for dam failure and improve preparedness, response, and rapid recovery in the event of an attack, natural disaster, or other emergency. A major initiative within this effort involves the updating of hydrologic data for the 700 plus USACE dams. It is expected that this effort and its hydrologic results can be utilized to assist in providing more accurate hydrologic, hydraulic, and consequence models and designs for all USACE projects.

WEST was contracted by the USACE to perform extreme storm analyses for seven of the USACE dams located within the Willamette River Basin. WEST estimated the potential wave run-up and wind set-up for the dams during the design event; analyzed the precipitation gages in Oregon, southern Washington, and northern



California to identify key regional storms after the publication of HMR 57; developed the depth-area-duration relationships for the key storm events; assisted in the volume-frequency analysis for the Columbia River Basin using the Expected Moment Algorithm (EMA) in HEC-SSP; developed HEC-HMS hydrologic models of the Willamette River Basin; calibrated the HEC-HMS model to four significant spring and winter events; validated the HEC-HMS model to two season-specific events; developed HEC-WAT models; completed a detailed comparison of the different methodologies in developing the Probable Maximum Precipitation (PMP) using HMR 43 and HMR 57; and completed a regional PMP to define the PMP for the entire Willamette River Basin. WEST documented the methodology and results for each of the above analyses in detailed reports.

Similar Project #3: Sacramento County Rainfall Depth-Duration-Frequency Curve Update

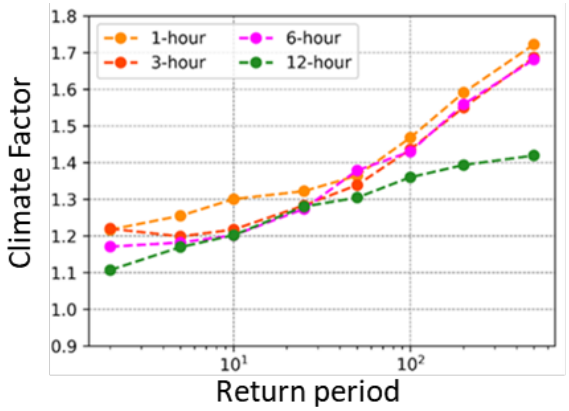
Client: County of Sacramento Department of Water Services
Location: Sacramento County, CA **Cost:** $217,240
Reference: George Booth | (916) 874-6484 | boothg@saccounty.net
Team Members: Dr. David Curtis, Dr. Brian Wahlin, Dr. Luciana Kindl Da Cunha

Relevance
Climate Change Analysis
Stakeholder Involvement

The Sacramento City/County Drainage Manual provides methods for estimating surface water runoff peak flows and volumes for the analysis and design of drainage facilities in the City and County of Sacramento. The previous Manual was published in 1996 and included rainfall intensity-duration-frequency (IDF) curves that were developed in a study concluded back in 1990. Very few gages with sub-daily temporal resolution were included in the study. In addition, the more recent NOAA Atlas 14 included just two sub-daily gages located in Sacramento County in its IDF analysis.

The IDF curves presented in the current manual were re-evaluated by WEST, taking into consideration the additional 28 years of high-resolution rainfall data (1990 to 2018) and recent advances in regional frequency analysis methods that reduce uncertainties in IDF estimates especially for more rare events.

The project involves the following tasks: (1) Rainfall data collection and quality control; (2) Trend analysis in observed and projected data; (3) Climate projection analyses; (4) Generation of at-site depth-duration-



frequency curves; (5) Analysis of the spatial variability in extreme precipitation; (6) Development of the final IDF curves; (7) Development of depth-areal-reduction factor (DARF) based on radar data, and (8) Presentation of a workshop for city and county staff to present the methods used and main results.

For small duration (< 1 day) low frequency storms (<50 years) are currently underestimated, and high frequency storms are overestimated based on the 1996 Manual. For larger duration (1 day or larger), in average rainfall values match well the values proposed in the Manual, even though there are biases (over or underestimation) that are a function of the spatial location within the County.

The NEXRAD WSR-88D Doppler weather radar products were applied to estimate DARFs. Radar rainfall maps provide a more detailed characterization of the spatial distribution of rainfall when compared to rain gauge only maps. WEST generated a rainfall storm database containing quality-controlled rainfall maps for twenty-one major storms that occurred in the area of interest.

DARFs were estimated based on 5-minutes radar data. Twenty-one main rainfall events in the area were applied in the analysis. Five-minute rain rates maps were used as input to generate DARFs for multiple storms and durations. The following durations were included in the project: 5, 10, 15, 30-minute, 1, 3, 6, 12-hour, 1, 2, 3, 5, and 10-day. No modifications were recommended since differences of less than 10% were observed between the DARFs extracted based on historical radar data and the DARFs provided as current standard in the Sacramento City/County Drainage Manual.

Stakeholder & Public Engagement

The WEST team will participate as required on Stakeholder & Public Engagement. We understand that NID will oversee and lead the stakeholder and public engagement process with the support of this team. We have the technical expertise to assist the process.

3. Detailed Project Scope of Work

Item 1: Kick-Off Meetings

The WEST Team will coordinate and facilitate a kickoff meeting with District staff and key players. The contract manager, the project manager, and representatives from each of the subconsultants will attend. Discussion topics will include project objectives, schedule, strategy, project deliverables, communication protocols, and public engagement. Also discussed will be potential risk to success such as potential showstoppers.

The WEST Team will facilitate a second kick-off meeting with representatives of the District and stakeholders to identify goals and objectives for the technical work for the Plan. The contract manager, project manager, and representatives from each of the subconsultants will attend. These kickoff meetings may take place via virtual TEAMS conference if the pandemic prevents in-person attendance to the meetings. The WEST Team will perform due diligence review to identify the process required to achieve the desired goals and objectives. WEST has already started this process, and will share our outlook at the kickoff meetings for a base of discussion.

Item 2: Detailed Project Schedule

See **Section 4: Project Schedule** below and the Gantt chart schedule presented in **Appendix A: Schedule**.

Item 3: Meetings with District Staff

The WEST Team will coordinate and facilitate recurring biweekly meetings with the District. If the District prefers, these meetings may take place via a TEAMS conference call. The contract and project managers will attend at a minimum and representatives from the subconsultants will attend as needed depending on the topic of discussion. During each status meeting, the WEST Team will brief District staff on project status and issues. The meetings will give the project team a chance to collaboratively solve potential challenges and ensure adherence to the schedule and project goals and objectives. WEST will provide meeting minutes that include action items in pdf format for review. WEST will also provide responses in writing to all public comments received and the comments will be logged in a database suitable for the District use.

Item 4: Board of Directors and Public Engagement

Public engagement is an essential component of our proposal. WEST will maintain transparency and remain flexible and open to ideas and feedback from stakeholders. The WEST Team will provide the District full support during the process and for duration of the project. Our team will provide expert consultation and documentation to the District, including preparation of review packages and attend meetings where our expertise is beneficial. We will also provide responses in writing to all public comments received as needed and the comments will be logged in a database suitable for District use. We will maintain communications with the District representatives, and will coordinate and support staff with updates, documents, etc., including documents and information suitable for posting on the project website.

Item 5: Unimpaired Hydrology AND Item 7: Supply Projection

Reservoir Operations Model

Western Hydrologics' (WHC) focus for the Plan for Water will be to address Item 5: Unimpaired Hydrology and Item 7: Supply Projection. Western Hydrologics is familiar with, and has copies of, the Yuba-Bear / Drum Spaulding system Reservoir Operations model and the red-blue model (YB and DS Water Allocation Model.xlsx). During the FERC Relicensing of the Yuba-Bear / Drum Spaulding systems (YB-DS System) WHC staff represented Placer County Water Agency and became part of the FERC modeling team. WHC staff suggested refinements to both the HEC-ResSim and red-blue models to improve performance. The Plan for Water RFP materials indicate the model was expanded on both the Bear River from Rollins Lake (Bear River Canal Diversion Dam) to the inflow to Camp Far West, and now includes Scott's Flat Reservoir and District demands below Scott's Flat Reservoir on Deer Creek. The expansion of the FERC model beyond the FERC boundary adds detail necessary for water supply planning.

In addition to our experience, WHC is on the HDR team that recently won an on-call contract with the State of California Department of Water Resources to develop hydrology for the new and improved water resources planning model, CalSim 3. WHC has a good working relationship with the modeling team at HDR and could call upon them regarding any details about the existing hydrology development or reservoir operations model. WHC will be able to use the knowledge and experience gained from the FERC relicensing along with a review of model updates to become familiar with model improvements.

Unimpaired Hydrology Development

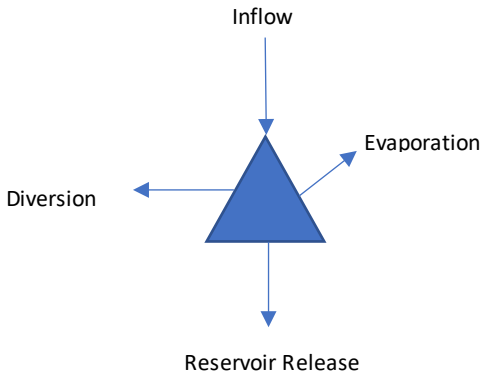
WHC primarily works for water suppliers and utilities on the west slope of the Sierra Nevada and is very familiar with the runoff characteristics of this area. WHC will rely on our experience and known gage data to extend the hydrology to support the anticipated studies. WHC routinely uses statistical methods and Geographic Information Systems (GIS) to fill in data gaps where flow and storage data is missing.

One of the key components to any reservoir operations model is the unimpaired hydrology. The unimpaired hydrology is used to drive the model operations. WHC has reviewed the previous methods used to develop the hydrology through 2011. These methods are techniques employed to prepare hydrology for many of the Sierra Nevada models we have developed. The most pronounced problem in developing the hydrology for the YB-DS system appears to be a lack of gage data. There are two practical approaches for the development of the historic data in the Sierra Nevada watersheds. Those approaches are Mass balance, sometimes referred to as gage summation, and paired basin, described below.

Mass Balance Approach (Gage summation) –

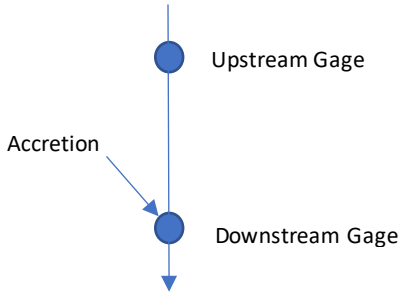
- The Mass Balance approach is typically used to calculate inflows to a reservoir. This method is used to remove the operations of the reservoir by adding diversions, releases, and evaporation while accounting for the change in storage. The resulting calculation provides the inflow.

Inflow = Diversion + Reservoir Release + Evaporation + change in storage



Accretions are calculated by subtracting the flow of an upstream gage from a downstream gage.

Accretion = Downstream gage – Upstream gage



Paired Basin approach - Historical unimpaired runoff can be estimated using a paired-basin approach, with runoff estimated by scaling a reference stream gage or calculated inflow by watershed area to estimate each watershed's runoff. In the example below, a mass balance approach was used to determine the inflow to Lake Valley Reservoir. Since there was no gage data available for Kelly Lake, a paired basin approach was used. GIS Mapping tools were used to delineate watershed areas. The areas and precipitation data were then used to scale the Lake Valley Inflow record for the Kelly Lake inflow.

Equation 1

$$\frac{Kelly\ Lake\ Watershed\ Area}{Lake\ Valley\ Watershed\ Area}\ X\ \frac{Kelly\ Lake\ Avg\ Precipitation}{Lake\ Valley\ Avg\ Precipitation}\ X\ Lake\ Valley\ Inflow$$

Western Hydrologics maintains the Pilot Creek above Stumpy Meadows gage, one of the primary gages used in the development of the mid elevation hydrology for the YB-DS system. We have complete records for that gage and, for consistency, can use those records to extend the mid-elevation hydrology through 2021.

Model Improvements

Additional improvements may be necessary during the Plan for Water process. Our plan is to meet with the Board of Directors and the public to discuss existing model capabilities and elicit suggestions for improvements to meet the goals of the Plan for Water. These suggestions will be discussed with District staff, vetted, and prioritized before implementation. Suggestions for model improvements may require development or refinement of hydrology data. Discussions regarding model improvements should occur early in the process to avoid duplication of efforts.

Climate Change Hydrology

The period of record for the existing climate change hydrology dataset is 1976 through 2011. The availability of stream gage data limits the start date to 1976. The 2011 upper limit was not set by lack of stream gage data, but rather the availability of projected hydrologic data provided by the California Water Commission (CWC) for climate change assessments published in 2016.

This approach estimates flow using climate conditions for California projected climate for thirty years centered on 2030 (2016 – 2045) and projected climate for a thirty-year period centered on 2070 (2056-2085). These CWC data products contain watershed runoff modeling results for three climate conditions, described in Table 2, in six-kilometer gridded cells across California.

Condition	Description
Historical	Historical temperature-detrended conditions for a thirty-year period centered on 1995 (1981-2010)
2030 Future Condition	Future condition projected climate for a thirty-year period centered on 2030 (2016-2045)
2070 Future Condition	Future condition projected climate for a thirty-year period centered on 2070 (2056-2085)

Table 2: Climate Conditions Descriptions

Simulated runoff in all 3 conditions is estimated in each project watershed using a weighted sum of the runoff in each grid cell within the watershed, as shown in Equation 2.

Equation 2

$$Q_i = R_k * A_{i,k}$$

where: Q_i is the flow from watershed i, in units of Acre-Feet, R_k is the Runoff from cell k, converted from mm to feet, and $A_{i,k}$ is the watershed area of watershed i contained within cell k, in Acres.

Monthly watershed runoff modeling results for each watershed is calculated in all 3 climate conditions for 1976 through 2011. Monthly perturbation factors are calculated in each watershed for each future climate condition, as the ratio of future climate watershed runoff modeling results to historical watershed runoff modeling results. These monthly perturbation factors are disaggregated into daily perturbation factors, and these daily perturbation factors are applied to the historical daily inflow hydrology to estimate the daily hydrology under expected climate change conditions at both future climate conditions. The California Water Commission dataset period of record is 1922 through 2011. The result of this application is a shift in the pattern and change in volume. To develop climate change adjusted hydrology for water years beyond 2011, other methods need to be considered.

Input from the public, the Board of Directors, and District staff is considered to develop an approach to extend the climate change hydrology record beyond 2011. Following guidance from the stakeholders, the consultant team will develop recommendations and a path to extend the climate change hydrology record for use with the reservoir operations model.

Assume up to 5 model runs/scenarios

The District faces a number of challenges to the operations of the Yuba-Bear / Drum Spaulding system. The challenges include continued curtailments from the SWRCB, changes in run off patterns and volumes due to climate change, changes in land use and consumptive demand, more restrictive operational requirements due to regulatory changes, and the updated operational agreement with Pacific Gas and Electric Company. WHC is very familiar with Pre 1914 senior water rights and post 1914 appropriative water rights and how each have

been affected by State Water Resources Control Board (SWRCB) curtailments and enhanced reporting requirements. WHC will consider not only the input from the Board of Directors and the public but will also introduce the possibility of dry year curtailments along with the changing climate and consumptive demands in the development of the drought scenarios. In addition, pending regulatory changes like the Bay-Delta Plan Update which considers a framework where there could be a requirement for a bypass of 45% – 65% of the unimpaired flow and anticipated FERC License conditions may have an impact on water supply and hydropower generation, and should be studied. WHC will offer recommendations and guidance on the development of the 5 scenarios based on our experience tackling these issues across the Sierra Nevada water supply systems.

Final Technical Memorandum

For the modeling and hydrology development, the Final technical memorandum where possible will build upon the work done by predecessors while providing detailed descriptions of model improvements including assumptions, changes to the model domain and configuration, hydrology development and summary of results. There is a clear emphasis on public involvement and lay terminology in the RFP materials. The memoranda and presentation materials prepared for this effort will be vetted to ensure materials are in coherent and digestible lay terminology.

Item 6: Demand Projection Model

To develop the demand projection model, **Davids Engineering** will initially design, develop, and calibrate a model that simulates historical and current water demands. The model will consider and incorporate all relevant data (GIS parcel information; land use and zoning; historical water delivery data; treatment plant data; canal flows; cropping and agricultural development; soils parameters; evaporative demand; population; impacts due to COVID-19; mutual water companies; soft service areas; "fill in" areas; and more) and be designed and customized for ease of use by the District with model documentation and staff training. The model design will be preceded by a literature review summarizing demand model options, standards, and procedures, and the demand model selection and design will be influenced by and incorporate feedback and input from the Board of Directors and other stakeholders.

The majority of the District's water demand is for irrigation of agricultural production. Crop water demands will be simulated through a root zone soil water budget. The model developed for this purpose would most likely be DWR's Integrated Demand Calculator (IDC), a module of Integrated Water Flow Model (IWFM), which is DWR's platform for integrated hydrologic modeling. The IDC model will be combined with a custom database application to account for water flow paths not simulated in the root zone model. The custom database application will be designed for users with limited database or water modeling training or experience and could be customized to generate outputs of greatest interest to the user. Davids Engineering has extensive experience in developing custom water accounting databases like this.

Davids Engineering also has a wealth of experience in estimating crop water demands, including numerous applications of root zone soil water budgets (both IDC and a custom remote sensing root zone water budget developed in-house) in different locations and under differing hydrologic, climate, and water supply, demand, and management conditions. A unique feature included in Davids Engineering's approach is use of remote sensing technologies to measure actual consumptive use, or evapotranspiration (through a surface energy balance approach), and then derive crop coefficients for use in the root zone model that are based on measured local data, rather than theoretical values. This approach also provides valuable information about the spatial variability of actual evapotranspiration and crop coefficients. An additional feature of Davids Engineering's approach is the procedure for soils analysis and calibration, which is used to provide the best possible representation of root zone soil properties and processes in the model.

Projected demands would then be determined by applying projected changes in land use (*i.e.*, expansion of agricultural area or shifts in cropping, expansion of urban areas, etc.), planned or projected expansion of the District's conveyance system, climate change projections, and more to the current water demand model. Projected demands would be determined and summarized for multiple scenarios to depict the range and variability of demand under differing future conditions.

Item 7: Supply Projection

This is combined with our response to Item 5: Unimpaired Hydrology above.

Item 8: Strategy Alternatives Analysis

This is a critical deliverable since it will lay a foundation for the Plan for Water. The WEST Team will work closely with the Board, staff, and the public to develop a suite of strategies for each of the main options identified in Stage 8 of the Plan for Water Matrix. The Water Matrix has four main options including Operations, Restoration/Rehabilitation, Management, and Supply. There are eight different scenarios within the four options. The WEST Team is not necessarily limited to these eight scenarios and if needed we are flexible on expanding or reducing the range of alternatives considered to ensure proper consideration of feasible scenarios. WEST will work with the Board, staff, and the public to develop a strategy evaluation matrix to evaluate the various strategy options developed. The evaluation will include measurable performance measures that can be used to evaluate each strategy.

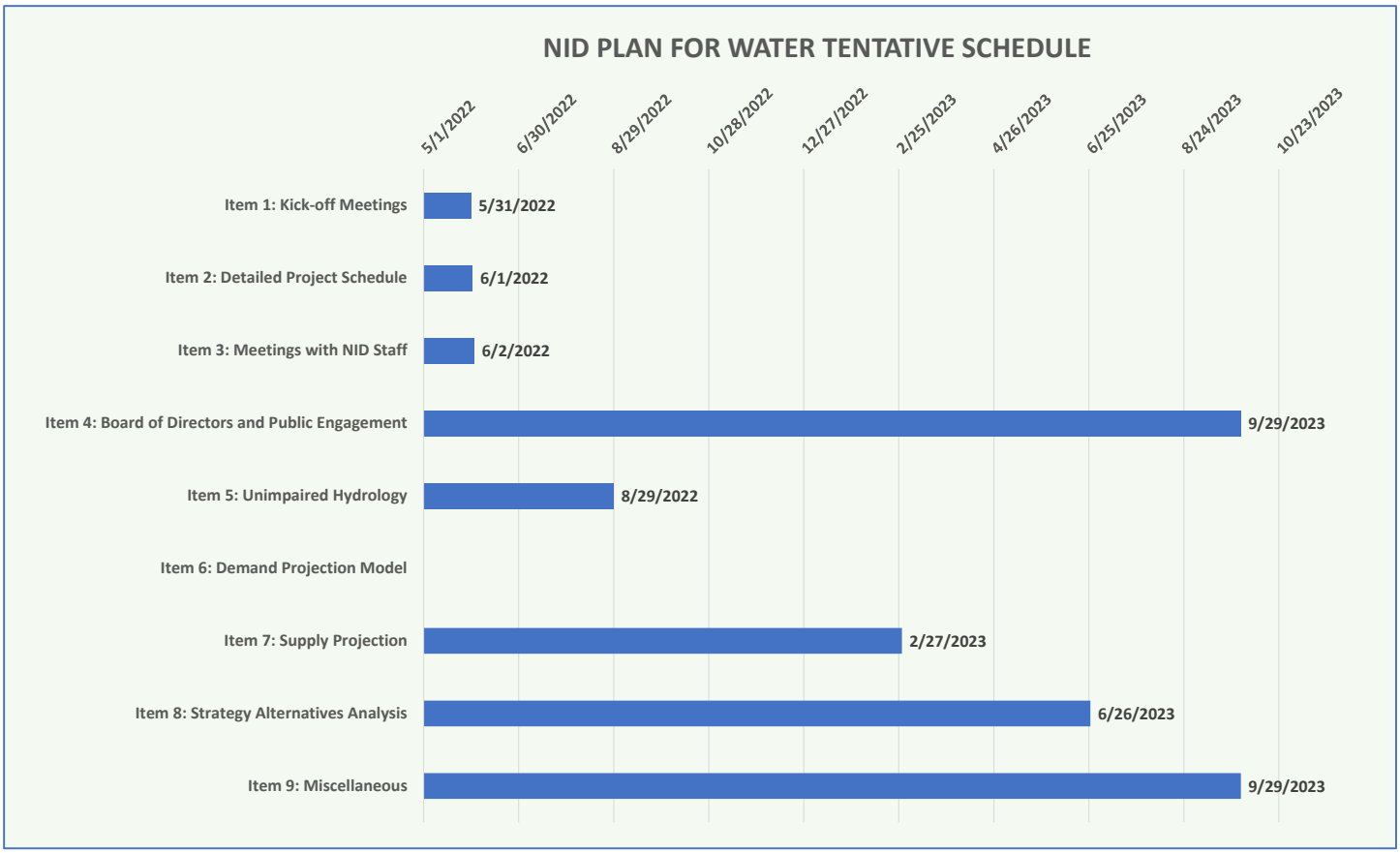
Item 9: Miscellaneous

All Final Technical Memorandums will be stamped by a registered civil engineer licensed in the State of California. The team has licensed several professional engineers qualified to stamp deliverables including Mr. Bell, the Project Manager.

The WEST Team is dedicated to the success of this project and will be appreciative of the opportunity to play an active part in the Board meetings and workshops, as well as meetings with stakeholders in support of NID and this project. We will document and develop meeting notes for all meetings that the WEST team participates in. The WEST Consultants team is the right team for this project.

4. Project Schedule

The tentative schedule of the District Plan for Water is 18 months. The project assumes a start date of April 1, 2022 with an end date of September 30, 2023. This of course is a flexible schedule and can be adjusted to meet District scheduling needs. Some of the task items will be on-going for the duration of the project. Below is a summary schedule. A more detailed Gantt chart schedule is presented in **Appendix A: Schedule**.



5. Cost Proposal

The Cost Proposal was submitted in a separate email.

6. Exception to Standard Contract

The WEST Team takes exception to Articles V, VI, X, and XIX from the standard contract, but these can easily be addressed with a few negotiated word choices.

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Appendix A

Schedule

WEST Consultants, Inc.
101 Parkshore Drive
Folsom, CA 95630-4726

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NID-Plan-20220210-Project.V2.mpp

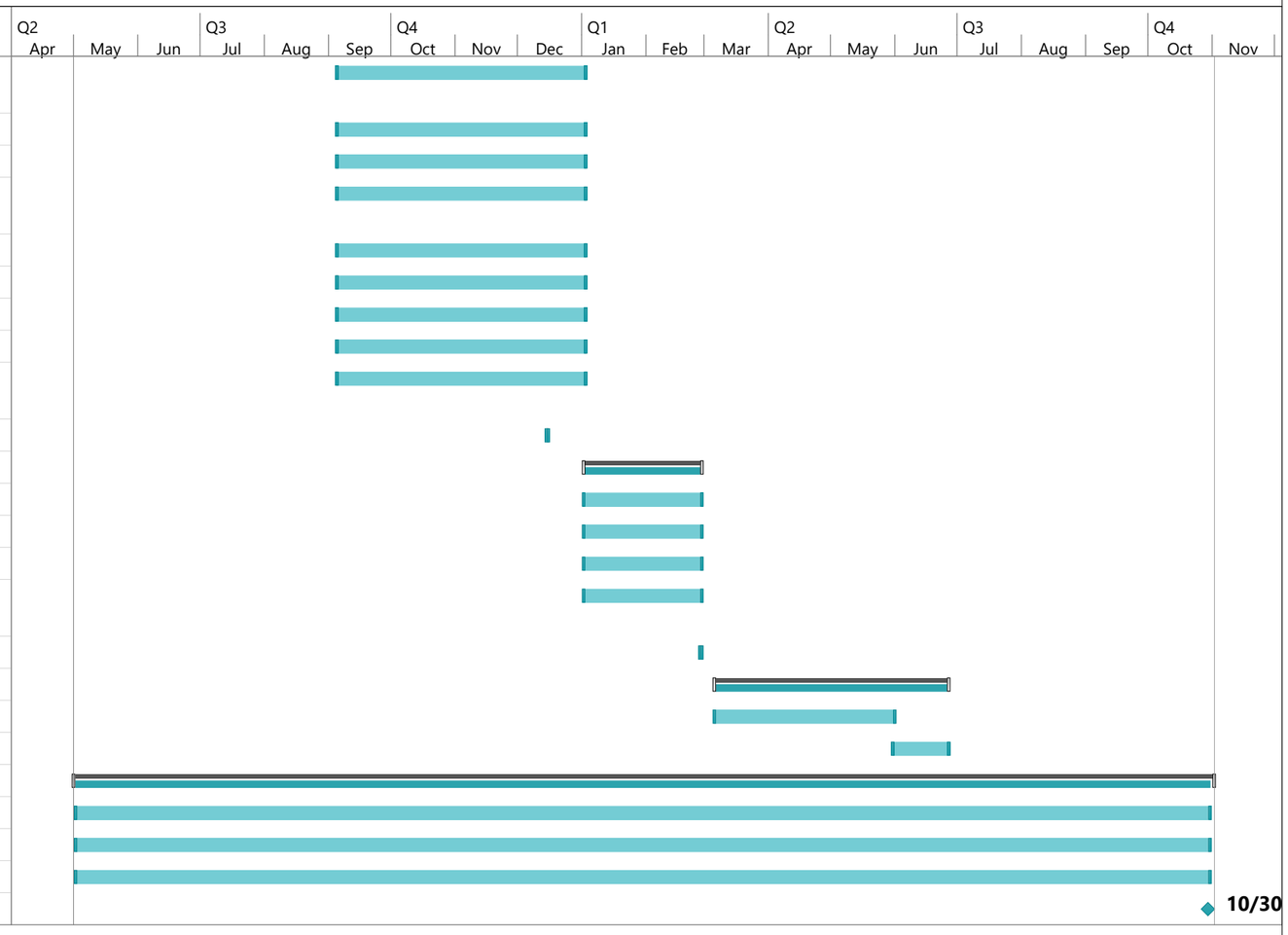
ID	Task Name	Duration	Start	Finish
1	**Item 1: Kick-off Meetings**	**25 days**	**Mon 5/2/22**	**Fri 6/3/22**
2	kick-off meeting with NID staff	25 days	Mon 5/2/22	Fri 6/3/22
3	kick-off meeting with representatives of NID and stakeholder	25 days	Mon 5/2/22	Fri 6/3/22
4	review process to achieve the desired goals and objectives	25 days	Mon 5/2/22	Fri 6/3/22
5	**Item 2: Detailed Project Schedule**	**25 days**	**Mon 5/2/22**	**Fri 6/3/22**
6	Coordinate schedule with District staff	25 days	Mon 5/2/22	Fri 6/3/22
7	Develop a detailed timeline	25 days	Mon 5/2/22	Fri 6/3/22
8	Schedule will include multiple tracks - Coordination of Resou	25 days	Mon 5/2/22	Fri 6/3/22
9	Deliverables and Review Schedule	25 days	Mon 5/2/22	Fri 6/3/22
10	**Item 3: Meetings with NID Staff**	**25 days**	**Mon 5/2/22**	**Fri 6/3/22**
11	Teams and in person bi-weekly meetings	25 days	Mon 5/2/22	Fri 6/3/22
12	15 additional meetings with Board, staff and the public	25 days	Mon 5/2/22	Fri 6/3/22
13	Meeting Minutes for all meetings	25 days	Mon 5/2/22	Fri 6/3/22
14	Respond to public comments	25 days	Mon 5/2/22	Fri 6/3/22
15	**<Milestone> Initial Coordination Completed**	**0 days**	**Mon 6/6/22**	**Mon 6/6/22**
16	**Item 4: Board of Directors and Public Engagement**	**371 days**	**Mon 5/2/22**	**Sat 9/30/23**
17	Provide support, consultation, and documentation	371 days	Mon 5/2/22	Sat 9/30/23
18	Coordinate and support NID staff with updates, documents, etc.	371 days	Mon 5/2/22	Sat 9/30/23
19	Assume 15 Board workshops/meetings (up to 4 hours per workshop/meeting)	371 days	Mon 5/2/22	Sat 9/30/23
20	Assume 120 hours for meetings with NGOs, agencies, public groups	371 days	Mon 5/2/22	Sat 9/30/23
21	Assume 80 hours of written responses to comments receivec	371 days	Mon 5/2/22	Sat 9/30/23
22	**Item 5: Unimpaired Hydrology**	**61 days**	**Mon 6/6/22**	**Mon 8/29/22**
23	Review and become familiar with the existing Reservoir Operations model	30 days	Mon 6/6/22	Fri 7/15/22
24	Perform a literature review and provide summary for public	30 days	Mon 6/6/22	Fri 7/15/22
25	Update historical watershed runoff	30 days	Mon 6/6/22	Fri 7/15/22
26	Receive input from the Board of Directors and the public for the model	30 days	Mon 6/6/22	Fri 7/15/22
27	Update/revise projected climate change conditions	61 days	Mon 6/6/22	Mon 8/29/22
28	Assume up to 5 model runs	61 days	Mon 6/6/22	Mon 8/29/22
29	Final Technical Memorandum	61 days	Mon 6/6/22	Mon 8/29/22
30	Provide summary materials, guides, and other reasonable communications	61 days	Mon 6/6/22	Mon 8/29/22
31	**Item 6: Demand Projection Model**	**86 days**	**Mon 9/5/22**	**Mon 1/2/23**

Project: NID-Plan-20220210-Pr
Date: Fri 3/25/22

Task
Split
Milestone
Summary
Project Summary
Inactive Task
Inactive Milestone
Inactive Summary
Manual Task
Duration-only
Manual Summary Rollup
Manual Summary
Start-only
Finish-only
External Tasks
External Milestone
Deadline
Progress
Manual Progress

NID-Plan-20220210-Project.V2.mpp

ID	Task Name	Duration	Start	Finish
32	Develop demand projection model with Board and stakeholder input	86 days	Mon 9/5/22	Mon 1/2/23
33	Literary Review on Demand model	86 days	Mon 9/5/22	Mon 1/2/23
34	Consideration of 11 model inputs and characteristics*	86 days	Mon 9/5/22	Mon 1/2/23
35	Meet with applicable city/county staff on plans and growth projections	86 days	Mon 9/5/22	Mon 1/2/23
36	output for treated water systems and individual canals	86 days	Mon 9/5/22	Mon 1/2/23
37	Final model shall be in a format that NID can utilize	86 days	Mon 9/5/22	Mon 1/2/23
38	Assume 5 model runs/variations for workshops and discussio	86 days	Mon 9/5/22	Mon 1/2/23
39	Final Technical Memorandum	86 days	Mon 9/5/22	Mon 1/2/23
40	Provide summary materials, guides, and other reasonable communications	86 days	Mon 9/5/22	Mon 1/2/23
41	Training session for staff	1 day	Thu 12/15/22	Thu 12/15/22
42	**Item 7: Supply Projection**	**41 days**	**Mon 1/2/23**	**Mon 2/27/23**
43	revised/updated reservoir model operations	41 days	Mon 1/2/23	Mon 2/27/23
44	Develop 5-year drought scenarios - 5 scenarios	41 days	Mon 1/2/23	Mon 2/27/23
45	Final Technical Memorandum	41 days	Mon 1/2/23	Mon 2/27/23
46	Provide summary materials, guides, and other reasonable communications	41 days	Mon 1/2/23	Mon 2/27/23
47	**<New Milestone> Modeling Tools Completed**	**1 day**	Mon 2/27/23	Mon 2/27/23
48	**Item 8: Strategy Alternatives Analysis**	**81 days**	**Mon 3/6/23**	**Mon 6/26/23**
49	develop a suite of strategies of the Plan for Water Matrix	63 days	Mon 3/6/23	Wed 5/31/23
50	develop a strategy evaluation matrix	19 days	Wed 5/31/23	Mon 6/26/23
51	**Item 9: Miscellaneous**	**394 days**	**Sun 5/1/22**	**Wed 11/1/23**
52	stamped by a Registered Civil Engineer	391 days	Mon 5/2/22	Mon 10/30/23
53	active part in the Board meetings and workshops	391 days	Mon 5/2/22	Mon 10/30/23
54	develop meeting notes	391 days	Mon 5/2/22	Mon 10/30/23
55	**<New Milestone> Project Completed**	**0 days**	**Mon 10/30/23**	**Mon 10/30/23**



Project: NID-Plan-20220210-Pr
Date: Fri 3/25/22

Task
Split
Milestone
Summary
Project Summary
Inactive Task
Inactive Milestone
Inactive Summary
Manual Task
Duration-only
Manual Summary Rollup
Manual Summary
Start-only
Finish-only
External Tasks
External Milestone
Deadline
Progress
Manual Progress

Appendix B

Resumes

WEST Consultants, Inc.
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Folsom, CA 95630-4726

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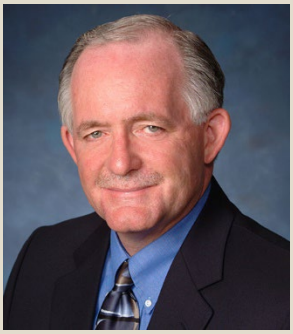

Years of Experience: 49

Years with WEST: 12

Education

- *Ph.D. (Water Resources) Massachusetts Institute of Technology*
- *Graduate Studies (Numerical Science) John Hopkins University*
- *M.S. (Civil Engineering) University of Maryland*
- *B.S. (Agricultural Engineering) Pennsylvania State University*

Professional Affiliations

- *National Hydrologic Warning Council – Past President*
- *American Geophysical Union*
- *American Society of Civil Engineers*
- *Environment and Water Resources Institute*
- *American Meteorological Society*
- *Association of State Flood Plain Managers*
- *Flood Plain Managers Association*
- *California-Nevada Association of ALERT Users*
- *Society of American Military Engineers*

WEST Consultants, Inc.

David C. Curtis, PhD, F.EWRI

Role: Contract Manager / Subject Matter Expert

Since 1993, Dr. Curtis has been applying new weather information technologies such as radar-rainfall estimates to hydrologic analysis and modeling. He developed and maintained a national database of rainfall estimates derived from both civilian and defense Doppler radars in the U.S. He helped develop Florida's statewide program of gage-adjusted radar rainfall estimates that encompasses all five water management districts in the state. With data starting from the mid 1990's, Florida now enjoys the nation's largest and longest archive of high-resolution radar rainfall estimates. The data set is now used in a wide variety of water resources engineering applications including, hydrologic modeling, transportation infrastructure drainage analysis, agriculture, and many others.

He is pioneering methodologies to determine the spatial properties of individual storm cells using large-calibrated radar-rainfall data sets. Examples include the development of a design storm for wastewater collection for the Phoenix, AZ, Sub-Regional Operating Group, and the development of depth-area-reduction factors for Colorado Springs, CO. The Mile-High Flood District in Denver, CO, adapted the Colorado Springs results for use in the Denver Metropolitan Area. Dr. Curtis is leading statewide efforts in Texas and Arizona to develop new design storm standards.

From 2012-15, Dr. Curtis served on the California Department of Water Resources (DWR) Climate Change Technical Advisory Group. Previously, he served on the California DWR Central Valley Flood Protection Plan Climate Change Team. The team evaluated California's Central Valley flood system performance, system resiliency, flood forecasting, and levee stability challenges in the face of climate change.

For the past 48 years, Dr. Curtis has been on the leading edge of hydro-meteorological and flood risk management services. He has supported the design, development, and implementation of award-winning innovations in automated environmental and flood monitoring systems across the U.S., South and Central America, the Caribbean, Asia, and Africa. Fault-tolerant designs, dual redundant computer configurations, and integrated networks are among the concepts advanced by Dr. Curtis. In addition, Dr. Curtis has contributed to the economic analysis of flood warning systems, quantified the communication capacities of ALERT flood warning systems, and developed procedures for designing gage networks. His efforts led to the Connecticut Statewide Flood Warning System, the nation's first statewide system.

Following a career as a research hydrologist, river forecaster, and flash flood hydrologist for the National Weather Service, Dr. Curtis co-founded a hydrologic software company specializing in flood warning, which later merged with a manufacturer of hydro-meteorological instrumentation.

Internationally recognized as an expert on hydrology, Dr. Curtis has authored more than seventy technical articles and reports. In June 1989, Dr. Curtis accepted the Computerworld/Smithsonian Award for Innovative Uses of Information Technology in the "Energy, Natural Resources, and Environment" category. Dr. Curtis also received the U.S. Department of Commerce Bronze Medal for superior service for the development and implementation of the Norwich, CT, flood warning system. Dr. Curtis was named a 2012 Outstanding Alumnus and named to the Henry P. Armsby Honor Society in 2013 by the College of Agricultural Sciences at Pennsylvania State University and received a Climate Services Award in 2014 from the California DWR for his contributions to the DWR Climate Change Technical Advisory Group. In 2013 and 2015 he received Special Service Awards from the National Hydrologic Warning Council for serving as president and board member. In 2017, Dr. Curtis was named Fellow by the Environment and Water Resources Institute. He also received the 2021 California Extreme Precipitation Symposium Special Recognition Award.

Selected Experience

National Committee & Conference Assignments

- Past-President, National Hydrologic Warning Council, 2015-2019
- President, National Hydrologic Warning Council, 2011-2015
- Member, National Hydrologic Warning Council Board of Directors, 2011-2017
- Program Chair, The 9th National Hydrologic Warning Council Training Conference and Exposition, San Diego, CA, May 9-12, 2011
- Vice Chair, American Society of Civil Engineers Environment & Water Resources Institute Radar Rainfall Committee, 2015
- Member, FEMA Flood Insurance Community Rating System 600 Series: Flood Preparedness Committee, 2011-12
- Member, American Meteorological Society Integrated Water Resources Annual Partnership Topic Committee, 2014
- Program Chair, The 11th National Hydrologic Warning Council Training Conference and Exposition, Indianapolis, IN, June 2015
- Chair, American Society of Civil Engineers EWRI Congress, Sacramento, CA, 2017
- Program Chair, The 12th National Hydrologic Warning Council Training Conference and Exposition, Olympic Valley, CA, June 2017
- Program Chair, The 13th National Hydrologic Warning Council Training Conference and Exposition, Louisville, KY, June 2019
- Member, Advisory Committee on Water Information, US Department of the Interior, 2015-2019

Years of Experience: 29

Years with WEST: 18

Registrations

- *Professional Civil Engineer*
  - *Arizona No. 41980*
  - *New Mexico No. 17131*
  - *Iowa No. 21743*
- *Diplomate, American Academy of Water Resources Engineers.*

Education

- *Ph.D., Civil Engineering, Arizona State University*
- *M.S., Civil Engineering, Arizona State University*
- *B.S.E., Mechanical Engineering, Arizona State University*

Professional Affiliations

- *American Society of Civil Engineers*
- *U.S. Committee on Irrigation and Drainage*
- *Arizona Floodplain Management Association*
- *New Mexico Floodplain Managers Association*
- *Arizona Hydrological Society*

WEST Consultants, Inc.

Brian Wahlin, PhD, PE, D.WRE

Role: Quality Control

Dr. Wahlin is a Senior Hydraulic Engineer with WEST Consultants, and manages the firm's Tempe, AZ office. He has 29 years' experience in floodplain and hydraulic studies, hydrologic studies, sediment transport studies, dam breach studies, flow measurement techniques, and hydraulic research laboratory studies. He serves as program manager for on-call contracts to the Flood Control District of Maricopa County, Pinal County Public Works Department, Pima County Regional Flood Control District, the New Mexico Interstate Stream Commission, and the U.S. Bureau of Reclamation in Albuquerque.

Dr. Wahlin has extensive dam break experience. Besides teaching the WEST dam break course, he managed a dam break study on Whitlow Ranch Dam as for the Modeling, Mapping, and Consequences (MMC) Production Center of the US Army Corps of Engineers (USACE). As part of this study, he developed dam break hydrographs for four different hydrologic loading conditions. He then supervised the development of a FLO-2D model to map the inundation area downstream of the dam. This large-scale FLO-2D model covered over 550 square miles. Dr. Wahlin also oversaw the development of four large-scale FLO-2D models for use in a dam break study for the Buckeye Flood Retarding Structures. Recently, Dr. Wahlin oversaw the development of a FLO-2D models for a dam break analysis of Adobe Dam.

Throughout his career, Dr. Wahlin has been involved with unique and challenging projects, such as the development of an Emergency Action Plan (EAP) for the Tres Rios North Levee, the first levee EAP in the State of Arizona. The EAP outlined specific steps to take to support emergency management in the event of flooding within the protected areas of the levee within the City of Avondale and unincorporated areas in Maricopa County. Developed after extensive research and coordination with experts both nationally and internationally, the EAP combines the key elements of the well-established dam failure EAP's specific to the southwest while extending and modifying it to address levee specific issues, such as adjacent river inundation flow patterns, regional evacuation procedures, road closure plans, and emergency services coordination.

Dr. Wahlin is a lead instructor for WEST's HEC-RAS courses (basic HEC-RAS, unsteady HEC-RAS, and dam break analyses using HEC-RAS, and 2-D analyses using HEC-RAS) and WEST's streambank stabilization for restoration and flood control that are taught throughout the country.

Selected Experience

Dam Failure Analysis and Inundation Mapping, Whitlow Ranch, AZ
Dr. Wahlin performed a dam failure analysis and inundation mapping of Whitlow Ranch Dam for the MMC Production Center of USACE. Whitlow Ranch Dam, which is considered a dry flood control dam, is an ungated dam which provides flood control along Queen Creek in south central Arizona. Whitlow Ranch Dam is located just upstream of the small retirement community of Queen Valley in Pinal County and about 50 miles southeast of Phoenix. The drainage area to Whitlow Ranch Dam Reservoir is 143 square miles. Because of its close proximity to the Phoenix metropolitan area, a dam break from Whitlow Ranch Dam could inundate the highly populated areas of Queen Creek, Gilbert, and Chandler. HEC-RAS was used to model the dam breaks under four different hydrologic loading conditions. The dam break hydrographs were developed using HEC-RAS. However, because Queen Creek becomes a shallow, distributary channel system downstream of the dam and many of the inundation areas downstream are urbanized, FLO-2D was used to model the flood wave as it propagated downstream. HEC-FIA was used to estimate flood damages due to the various dam break scenarios and inundation mapping products were prepared for MMC.

Flood Retarding Structures Dam Failure Analysis and Inundation Mapping, Buckeye, AZ
Dr. Wahlin conducted a dam break and inundation analysis of the Flood Retarding Structure (FRS) series protecting the City of Buckeye and Interstate 10. The dam break analysis modeled flood scenarios characterizing the six-hour probable maximum flood (PMF) event and the sunny day event. The analysis provides information about potential consequences of the failure of an FRS structure. This information was used to improve the emergency action plans for the various structures, as well as to inform emergency management efforts. To carry out this analysis, Dr. Wahlin developed six large-scale FLO-2D models of the Buckeye FRS's and the corresponding 135-square-mile potential inundation area. He also developed a 20-mile long unsteady 1-D model of the FRS's impoundment areas for the purpose of generating the potential dam break hydrographs. The hydrographs are used as inputs to the various FLO-2D models. Dr. Wahlin also performed a detailed literature review of flood hazard mapping and developed guidelines for categorizing flood hazards resulting from a dam break. These guidelines were used to map the flood hazards resulting from the various dam break locations along the Buckeye FRSs.

Adobe Dam Inflow Hydrograph and Emergency Spillway and Dam Breach Hydrograph Analysis
Adobe Dam is a high-hazard, earthen dam located in Phoenix. For this study, Dr. Wahlin analyzed the inflow hydrographs into the Adobe Dam impoundment area as well as the outflow hydrographs from emergency spillway, principal outlet, and dam breach releases. The 72-hour tropical storm Probable Maximum Precipitation (PMP) was updated using the statewide PMP tool. A FLO-2D model was developed for the inundation pool using topographic data, structure plans, soils, and land use data. The inundation pool also included the Central Arizona Project (CAP) canal. Several scenarios were run including the PMF with and without breaching of the CAP canal embankment; the ½ PMF with breaching of the CAP canal embankment; 1-foot overtopping at the emergency spillway; 100-year, 24-hour storm event with no breaches; sunny day event breach at two locations; PMF event breaches at two locations; and ½ PMF event breaches at two locations. The results will be used to map flood hazards downstream in a future work assignment.

Years of Experience: 35

Years with WEST: 1

Registrations

- *Professional Civil Engineer, California, 48801*

Education

- *MBA (Environmental Business Management), Florida Atlantic University, Boca Raton, FL*
- *MSc (Civil Engineering, Water Resources), California State University, Sacramento, CA*
- *BS (Civil Engineering, Water Resources), California State University, Sacramento, CA*

Professional Affiliations

- *American Society of Civil Engineers*
- *Floodplain Management Association*
- *The California Water and Environmental Modeling Forum*

WEST Consultants, Inc.

Marco A. Bell, MBA, MSc, PE

Role: Project Manager

For the past 34 years, Mr. Bell has provided positive solutions for a full range of water resources projects, including hydrologic and hydraulic studies for flood control, ecosystem stewardship, water quality and water supply reliability. Project experience includes protecting sensitive water bodies such as the Sacramento-San Joaquin Delta, the Big Creek Project upstream of Millerton Dam in the Central Sierra, The Merced River Basin including the Yosemite National Park, the Mokelumne River Basin in California, the Niagara River in New York, the Colorado Rockies, Florida Bay, Florida Everglades, and the Panama Canal.

Most recently, Mr. Bell has been applying new technologies to develop water resources hydrologic and hydraulic real time models in the San Joaquin Basin using HEC-RTS. These optimized models were developed for the Big Creek Project upstream of Millerton Dam and the Merced River Basin for New Exchequer Dam. The models were optimized for operating multiple reservoirs in tandem. The facilities included 27 dams, miles of tunnels, and 24 generating units in nine powerhouses with a total installed capacity of more than 1,000 MW. Its six major reservoirs have a combined storage capacity of more than 560 TAF.

Mr. Bell served as CA DWR's liaison to the AG's Office, coordinating DWR's administrative testimony for Bay-Delta hearings. In recognition of his achievements, Mr. Bell received a Certificate of Merit by the California Governor's Office as Liaison to Office of Emergency Services. Other awards include the Meritorious Service Award in Natural Disaster Assistance/Floodplain Management by CA Dept of Water Resources and ASCE Best Program Award for his work in the Futures Program with Jaime Escalante. Mr. Bell also served as a member of the Palm Beach County Water Utility Board, where he helped review policy and planning strategies such as the capital project programs and budgets.

Mr. Bell developed and managed nutrient protection programs that significantly reduced the phosphorous content in the Everglades protected areas. Mr. Bell has performed H&H analysis for culverts, weirs, spillways, gates, canals, aqueducts, rivers, and pump stations located in California, Florida, Colorado, New York, and Louisiana.

For the United Nations, completed researched for the primary human uses of fresh water. He also led a delegation to Panama in support of the Panama Canal Expansion Project.

Selected Experience

Hydrologic and Hydraulic Optimization Model for Merced Irrigation District (MID), Merced, CA
MID provides an average of 300,000 acre-feet of water each year to approximately 2,200 growers. At 325,000 gallons per acre foot, it is enough to fill more than six million backyard swimming pools. Mr. Bell directed the development of simulation models for the Merced River basin for the Merced Stream Group. The mode is used for forecasting water supply and to assist in the determination of water allocations for irrigation.

Big Creek Project, Southern California Edison, Fresno and Madera Counties, CA
WEST Consultants developed the HEC-ResSim model for the HEC-RTS implementation of Southern California Edison (SCE) Big Creek system. The Big Creek system 27 dams, many miles of tunnels, and 24 generating units in nine powerhouses with a total installed capacity of more than 1,000 MW. Its six major reservoirs have a combined storage capacity of more than 560,000 acre-ft.

The complex operating rules and Big Creek system configuration required unique innovative solutions to adequately forecast the water volumes including snowmelt in the system. The ResSim model was successfully incorporated into the HEC-RTS framework and provides the utility with a useful new real time tool for reservoir operations and water volume forecasts.

Years of Experience: 19

Years with WEST: 6

Education

- *Ph.D. (Civil and Environmental Engineering – Water Resources) University of Iowa, Iowa*
- *M.S. (Water Resources and Environmental Engineering) Universidade Federal do Parana, Paraná, Brazil*
- *B.S. (Civil Engineering) Universidade Federal do Parana, Paraná, Brazil*

Professional Affiliations

- *American Geophysical Union (AGU)*
- *European Geosciences Union (EGU)*
- *American Society of Engineers (ASCE)*
- *Floodplain Management Association (FMA)*
- *The California Water and Environmental Modeling Forum*

Luciana Kindl Da Cunha, PhD, PH

Role: Climate Change Hydrology

Dr. Cunha is a Climate Change Specialist/Project Technical Lead with WEST Consultants (WEST) and has almost 20 years of international experience in hydrology and water resources engineering. Her primary experience includes hydrological modeling; hydrological risk characterization and assessments; hydro-meteorological data collection and analysis; and trends and climate change analysis. She has developed state-of-the-art methods and tools for hydrological and water resources applications.

At WEST, Dr. Cunha developed and reviewed climate analysis to evaluate increasing vulnerabilities to droughts and floods, at both local and regional levels. She was the main reviewer for the 2017 Central Valley Flood Protection Plan Reservoir Climate Vulnerability Pilot Study developed by CH2M for the California Department of Water Resources. For the US Army Corps of Engineers' Fort Worth District, she evaluated possible effects of climate and land cover changes on hydrological losses. For the Pine Flat Reservoir, she developed a framework for risk and uncertainty analysis of operation deviations that accounts for climate variability and change. For the Middle Rio Grande Conservancy, she identified current and projected drought vulnerabilities, long-term mitigation actions, and administrative framework, and created a plan update process. She also updated the rainfall depth-duration-frequency adopted by Sacramento County by taking climate projections into consideration.

Dr. Cunha has extensive experience in hydrological and climate modeling and the analysis of large volumes of data. Her Ph.D. research, supported by NASA, had the goal of evaluating the potential benefits of remote sensing information for flood forecasting. She developed and implemented a parsimonious hydrological model to simulate floods in Iowa using available radar and satellite-based hydro-meteorological datasets. At Princeton University, she evaluated the recently updated NEXRAD dual polarization radar system and its benefits for rainfall estimates at multiple space-time scales. Also at Princeton, Dr. Cunha implemented a flood simulation model for the Delaware River basin as a spatially explicit characterization of flood events based on a flood index. At the Nature Conservancy, she developed an approach to performing urban drainage cost-benefit analyses in the EPA-SWMM model for the optimization of flood and combined sewage overflow control. She also designed, developed, and implemented a multi-scale, GIS-based tool to

evaluate floodplain condition and to prioritize floodplain restoration activities based on maximum return on investment.

Dr. Cunha has international experience in hydrology and water resources management. At IIASA, the renowned research institute in Wien, Austria, she developed a methodology to evaluate the effects of urbanization on flood intensity and magnitude. In Brazil, she worked for years on the design of drainage, sewage, and water supply networks. She also engineered an integrated system for hydrological forecasting, multi-use reservoir operation optimization, and cooperated in the development of Brazil's action plan for hydro-power generation.

Dr. Cunha's work has been published in multiple peer-review papers.

Selected Experience

Sacramento County Rainfall Depth-Duration-Frequency Curve Update, Sacramento County
Development of depth-duration-frequency curves for Sacramento County taking climate change into consideration. The project involves: (1) Rainfall data collection and quality control; (2) Trend analysis in observed and projected data; (3) Climate projection analyses; (4) Generation of at-site depth-duration-frequency curves; (5) Analysis of the spatial variability in extreme precipitation; (6) Development of the final IDF curves; (7) Development of depth-areal-reduction factor (DARF) based on radar data, and; (8) Presentation of a workshop for city and county staff to present the methods used and main results.

Middle Rio Grande Conservancy District drought decision support tool and drought contingency plan development, Middle Rio Grande Conservancy District
Led the development of a drought contingency plan (DCP) for the Middle Rio Grande Conservancy District (MRGCD). The DCP included a decision support tool to monitor and forecast droughts based on current and historical soil moisture, streamflow, reservoir storage, groundwater, and temperature conditions. Drought intensity is directly linked to drought triggers and response actions. The DCP also includes the identification of current and projected drought vulnerabilities considering climate change, long term mitigation actions, an administrative framework, and a plan update process. Mitigation actions include infrastructure projects and changes in operations.

Rainfall-Runoff Analysis for Reservoirs in the Fort Worth District, USACE Fort Worth District
The goal of the project was to improve the estimation of hydrological losses and the ability to accurately forecast floods in real time. Possible effects of climate and land cover changes on hydrological losses were investigated. A methodology for real time estimation of storm event initial and total loss was implemented. The method took advantage of publicly available land surface model (NLDAS) datasets.

Review Regional 72-hour Precipitation Frequency Analysis for Willamette River and Tributaries, USACE Hydrologic Engineering Center
Review the data, methods, and results of the regionally-based point precipitation frequency estimates for the Willamette watershed. Regional precipitation will be used on the development of Stage Frequency Curves for major reservoirs in the Willamette Watershed. The project was developed by Gregory Karlovits, the Team Leader at the Hydrologic Engineering Center.

Years of Experience: 45

Years with WEST: 8

Registrations
- *Professional Hydrologist, American Institute of Hydrology*

Education
- *BS (Atmospheric Science), University of California, Davis*

Professional Affiliations
- *Environment and Water Resources Institute*
- *American Society of Civil Engineers*

Professional Affiliations
- *Environment and Water Resources Institute*

Corps of Engineers Accomplishments
- *Chief of Hydrology and Hydraulics Technology Division at HEC*
- *Chairman of USACE Committee on Hydrology*
- *Member of Hydrologic Frequency Analysis Work Group*
- *Post Katrina Interagency Performance Evaluation Team Modeling lead*
- *Commanders Award for Civilian Service*

WEST Consultants, Inc.

David Jeffrey Harris, PH, AM, ASCE

Role: Hydrologic and Hydraulic Modeling

David Jeffrey Harris is a senior technical leader in hydrology and hydraulics with 42 years' experience with the U.S. Army Corps of Engineers (USACE). Harris brings national and international expertise to the WEST team including hydrologic modeling, unsteady flow modeling, precipitation analysis, regional analysis, risk analysis, and interior flooding, along with extensive training experience.

Prior to joining WEST, Mr. Harris was Chief of the Hydrology and Hydraulics Technology Division, USACE, Institute for Water Resources, Hydrologic Engineering Center (HEC) in Davis, CA. There, Harris led HEC's development, application, and training for the most widely used hydrology and hydraulics modeling software in the world, including River Analysis Systems (HEC-RAS, HEC-GeoRAS), Hydrologic Modeling Systems (HEC-HMS, HEC-GeoHMS) and the Statistical Software Package (HEC-SSP). While at HEC he extended the USACE H&H software and procedures to many international locations. His USACE career began in 1977 at the Sacramento District Office in the Floodplain Management Section.

Mr. Harris led the development of the Sac-San Joaquin hydraulic models for the Sacramento-San Joaquin Comprehensive Study, led the Interior Modeling Team of the Interagency Performance Evaluation Team after Hurricane Katrina, and worked with three Mississippi River USACE offices on the development of HEC-RAS models for the Lower Mississippi River. He has developed Memorandum's of Agreement for the addition of capabilities to HEC software between HEC and local agencies including Sonoma County Water Agency, South Florida Water Management District, Flood Control District of Maricopa, Tampa Bay Water Authority, United Water Conservation District, and Taiwan Water Resources Agency. Internationally, he assisted in Thailand during the 2011 floods, in Korea at Osan Air Force Base, and represented the USACE at the World Water Forum in Turkey.

He was a member of the USACE Committee on Hydrology where he has served as the Vice Chair and Chair. He was a USACE Subject Matter Expert (SME) in several areas of hydrology and hydraulics and was the lead for the USACE Surface Water modeling Community of Practice.

During his USACE career, Harris received numerous awards including the Meritorious Civilian Service Award, the Commanders Award for Civilian Service, and the 2006 Corps of Engineers Institute for Water Resources Employee of the Year, along with 30 performance awards including Sustained Superior Performance.

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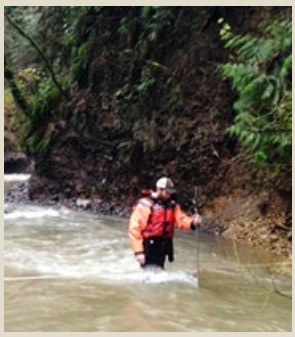

Years of Experience: 14

Years with WEST: 14

Education

- *B.S., Earth Sciences & Geology, Western Oregon University*

Training

- *American Red Cross CPR & First Aid Training*
- *Design Analysis Advanced Equipment Training*
- *NASBLA & USCG Approved Boat Operator*
- *National Hydrologic Warning Council – Field Personnel Training*
- *Permit Required Confined Space Entry*
- *USGS Surface Water Field Methods Training*
- *WISKI Suite (WISKI, SKED, BIBER) Advanced Training*
- *OIT Hydrologic Field Methods Certificate*
- *ALERT Users Group Training*
- *Aquarius Users Group Training*
- *Applied Index Velocity Method and Best Practices Training*

WEST Consultants, Inc.

Jeffery A. Budnick

Role: Water Monitoring

Mr. Budnick is a hydrologist/scientist at WEST Consultants and has 11 years of experience specializing in stream gage construction and operation, continuous record production, and hydrographic surveying.

As a streamflow monitoring specialist Mr. Budnick has experience building and operating stream gages, as well as computing records for a variety of stream gaging stations. Mr. Budnick has installed continuous-record streamflow monitoring stations and tide gages – some of which incorporate near real-time telemetry systems, such as GOES, cell-modem, and land-line communications to transmit data. Mr. Budnick installs stream gaging stations that will withstand high flow events reducing the need for costly repairs. The stations include sensors and data loggers installed to record parameters such as stage, water and air temperature, velocity, precipitation and numerous water quality parameters. Mr. Budnick has experience operating and troubleshooting industry standard equipment made by Campbell Scientific, Design Analysis/Waterlog, Sontek/YSI, and Sutron. Mr. Budnick adheres to U.S. Geological Survey (USGS) protocols and methods for collecting data. He has made hundreds of discharge measurements with conventional and ADCP equipment under a range of flow conditions. Mr. Budnick uses AQUARIUS time-series software to compute continuous surface water records and develop stage-discharge and index-velocity ratings. He also prepares and reviews final reports required by clients at the end of the water or calendar year.

In addition to stream gaging, Mr. Budnick specializes in hydrographic surveying. He has experience as a survey crew chief on a number of hydrographic surveying projects that range in size from only a few -- to several hundred cross sections and structures. As survey crew chief Mr. Budnick has surveyed hundreds of bridges and culverts and thousands of cross sections. Mr. Budnick plans and coordinates field surveying efforts, establishes control points at sites, surveys in the field, and reviews data. He is familiar with industry standard GPS and total station equipment manufactured by Trimble, Nikon, Topcon, and Leica.

Selected Experience

Chehalis Flood Warning System Operations & Maintenance, Chehalis, WA

Hydrologic Technician. Designed and installed gaging stations. Provides operations and maintenance services for the Chehalis River Basin Flood Warning System which includes fifteen observation sites (eight rainfall and temperature, four stage, and three webcams) and the Contrail website.

Stream Flow and Temperature Monitoring Services for Clean Water Services, Washington County, OR
Hydrologic Technician. Repaired and upgraded a number of stream gaging stations previously operated by OWRD. Operates and maintains all equipment at the gaging station to produce continuous flow and temperature record. Makes routine site visits and discharge measurements as needed to compute accurate flow record.

Middle Rio Grande Seepage Run Work Order No. RG-18-03, Albuquerque, NM
Hydrologic Technician. WEST staff measured flows with a SonTek M9 ADCP along the Middle Rio Grande in order to determine river gains and losses between measurement locations. Two sets of flow measurements were taken on successive days at 17 locations over a 60 mile-river reach.

Surveying Services for Interior Drainage Study for Levee Certification Consolidated Diking Improvement District No. 1, Longview, WA
Hydrographic Surveyor. Surveyed 429 cross-sections, 119 culverts, three gates, and two bridges for an interior drainage study for levee certification. Identified additional structures and features impacting modeling efforts.

Geomorphic Study for Flood Risk Management, Fargo, ND and Moorhead, MN
Hydrologic Technician. Collected ADCP discharge measurements and velocity distributions with a WEST-owned Sontek M9 and conventional stream gaging equipment. Collected sediment samples and assisted with geomorphic analysis. Results used to determine impacts of physical modifications to channel and floodplain, including the proposed use of diversion channels on the geomorphic processes of the river.

Years of Experience: 15

Years with WEST: 15

Registrations

- *AutoCAD-LT 2007 Certificate Program SCCC, 2007*

Education

- *B.A. (Geography, GIS Concentration) University of Washington, Seattle, WA*
- *M.A. (GIS) University of Washington, Seattle, WA*

Professional Affiliations

- *Urban and Regional Information Systems Association (URISA)*
- *American Water Resources Association (AWRA)*

Sarah Harvey, MGIS, GISP

Role: GIS Analyst

Ms. Harvey is a Geographic Information Systems Professional Group Lead with WEST Consultants. She has experience with a number of computer modeling programs, including ArcGIS, HEC-RAS and RAS Mapper, HEC-GeoRAS, HEC-GeoHMS, ArcHydro, FIA, HSPF, MicroStation InRoads, AutoCAD, and SMS. Her hydraulics, hydrology, and GIS application experience includes pre- and post-processing hydrologic and hydraulic data; quality control and data management of LiDAR information; creating, maintaining, and QA/QC of geodatabases and GIS data; developing metadata; creating and manipulating DEMs and data layers; and digital inundation mapping. She is also the instructor of the ArcGIS for Hydraulics and Hydrologic Engineering seminar hosted by the ASCE.

Ms. Harvey was GIS and QA/QC lead on multiple CWMS projects in the South, Southeastern, and Northwestern U.S. for the USACE's MMC group. She coordinated the effort to develop and QA/QC HEC-RAS and HEC-HMS model geometry and generate inundation maps using RAS Mapper. Additionally, Ms. Harvey conducted multiple consequences analyses using HEC-FIA and HEC-LifeSim, which facilitate the assessment of flood disaster impacts by estimating structure damage, agricultural flood damage, life loss, area inundated, number of structures inundated, and project benefits.

Ms. Harvey completed a number of Flood Insurance Studies for FEMA Region 10, including redelineation of approximately 180 miles of streams in Snohomish County, WA, and countywide DFIRM conversion projects and flood insurance studies for counties in Oregon and Idaho. This work entailed extensive data collection and manipulation, remapping effective FIS results as well as developing new detailed riverine mapping based on updated HEC-RAS analyses, compiling flood hazard data into FEMA-compliant geodatabases, developing internal QA/QC processes for reviewing geodatabases and FIRM panels, and conducting floodplain mapping audits.

Ms. Harvey has extensive experience pre- and post-processing HEC-RAS models for a variety of projects. She was the GIS Lead for dam breach analysis and inundation mapping of Cedar Falls Dam for Seattle City Light and Seattle Public Utilities and oversaw development of the HEC-RAS geometry. She completed updates to the dam breach inundation maps of the Upriver Dam in the City of Spokane, WA, for submittal to the FERC. Ms. Harvey also led the effort to develop hydraulic model geometry, using HEC-GeoRAS, for more than 500 river miles along the Columbia River and several major tributaries as part of the Columbia River Treaty. She was

the GIS lead for the USACE Seattle District General Investigation study of the Chehalis River Basin in Washington State to update and expand their existing HEC-RAS model for use in a range of investigations including restoration and flood control studies.

Ms. Harvey has utilized ArcHydro and GeoHMS to develop HEC-HMS inputs for many other hydrologic studies, including delineating the watershed and estimating initial hydrologic parameters to determine the Probable Maximum Flood at Libby Dam in northwestern Montana and developing catchment boundaries for a Flood Insurance Study in Spokane County, Washington, in addition to her work on CWMS studies for the Seattle, Little Rock, Mobile, and Savannah Districts of the USACE.

Years of Experience: 22

Years with WEST: 2

Education

- *PhD, Literature – Cultural Studies, University of California, San Diego*
- *MA, English, University of California, San Diego*
- *MLIS, University of Wisconsin, Milwaukee*

Liberty Smith, PhD, MA, MLIS

Role: Technical Writer

Bio

Liberty Smith has been offering research, writing, editing, training, and knowledge management services for more than 20 years. She currently provides technical writing and coordination support to WEST Consultants, Inc.'s (WEST's) corporate headquarters and assists corporate officers and project managers with the preparation of marketing materials, correspondence, and proposals.

An additional focus of her work at WEST is providing technical writing and editing of technical documents, including technical reference manuals, technical memos, technical and legal reports, instructor guides, and standard operating procedures manuals. Recent clients have included the Federal Highway Administration, the Department of Justice, and the Washington Military Department.

Before joining WEST, Dr. Smith presented and wrote widely in the fields of librarianship, education, and American Studies. While coordinating the National Service-Learning Clearinghouse, a federal training and technical assistance project, she was responsible for writing fact sheets and white papers, progress reports, grant proposals, press releases, and website content. She has conducted extensive research, writing, editing, and training for a variety of clients, including the Bureau of Indian Education, the American Association of Community Colleges, the Kenyon College Archaeology project in the Naco basin of Honduras, and the Scientific Research Ethics Program at the University of California, San Diego.

Selected Experience

Urban Drainage Design Reference Manual (Hydraulic Engineering Circular/HEC-22)
Federal Highway Administration, Technical Editor/Program Manager (in progress)

Highway Hydrology (Hydraulic Design Series/HDS 2)
Federal Highway Administration, Technical Editor (in progress)

Emerging Methods, Tools, and Data for Highway Hydrology (HEC-19)
Federal Highway Administration, Technical Editor (in progress)

Highways in the River Environment Technical Reference Manual (HEC-16) and Companion Web-Based Training and Instructor-Led Training
Federal Highway Administration, Technical Writer and Technical Editor (in progress)

WEST Consultants, Inc.

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Grant G. Davids, P.E.
Principal Engineer

Education
B.S., Agricultural Engineering, California Polytechnic University, San Luis Obispo

Registration
Civil Engineer, CA (No. C47199)

Agricultural Engineer, CA (No. AG00431)

Years of Experience:
40+ Years

Distinguishing Qualifications
- Skilled at explaining complicated technical analyses and results related to management of surface water and groundwater supplies to a wide range of stakeholders.
- Specialized in the design and application of water budgets for agricultural lands, in many cases to generate time series of vertical fluxes between the land surface and underlying groundwater for purposes of groundwater modeling
- Familiar with the cultural and irrigation practices associated with most major crops is California, providing a realistic basis for simulating crop growth and irrigation applications, and quantifying the destination of residual applied water depending on irrigation methods and efficiency.

Role: Senior Advisor for Demand Modeling

Summary
Mr. Davids has 40+years of agricultural and irrigation engineering experience in California, several other western states, and overseas. For most of this time, his work has concentrated on assisting irrigation water suppliers and the irrigators they serve to strengthen their water management capacity through integrated water conservation and management planning, irrigation modernization, water conservation, and environmental stewardship initiatives. Technical aspects involved with this work include: integrated water resources planning; formulation of conjunctive surface water and groundwater management programs; water conservation and verification; facilities modernization; modeling and analysis of hydrologic systems from field scale to basin scale; assessing impacts of changing economic and regulatory conditions on agricultural water management; and assessing irrigation efficiency. Mr. Davids is intimately familiar with the wide range of inter-related technical, institutional, legal, and economic factors influencing water supplies, demands and management, with extensive project experience in the Sacramento, San Joaquin, Shasta, and Imperial Valleys of California and beyond.

Relevant Experience
Technical Services to Support SGMA Compliance, County of Colusa, CA. Manager of all technical aspects of the work, including delineating an "Area of Interest" where permanent crops have been expanding and groundwater levels have been declining for a period of more than 10 years. Defined a period of analysis from 1980 through 2015 for the water balance analysis. Prepared and presented results of the analysis to the County Board of Supervisors demonstrating that declining groundwater levels were due primarily to drought-related factors and less due to cropping pattern changes.

SGMA Data Collection and Analysis, County of Madera (acting contractually on behalf of GSAs in the Chowchilla and Madera Subbasins, respectively), Madera County, CA. Assisted is translating DWR GSP regulations into a checklist of data to be collected for purposes of preparing a GSP. Helped to shape conclusions drawn from the data gap analysis. Reviewed final reports and recommendations for high-priority data gap filling tasks.

Sustainable Groundwater Management Program Development, Counties of Colusa and Glenn, CA. Supervised all phases of this project aimed at laying the technical foundation to prepare GSPs in Colusa County according to DWR regulations. Technical elements of the projects included characterizing historical and future agricultural water use, detailed review of available hydrogeologic data, evaluating third-party data management systems, preparing complete initial surface layer and groundwater system water budgets of the subbasins within the County, developing an initial hydrogeologic conceptual model (HCM) for the groundwater subbasins within the County, and comparing and evaluating existing groundwater model codes and calibrated models for possible use in supporting development of a GSP, assessing the adequacy of the County's groundwater monitoring network and identifying monitoring gaps, and defining the requirements of and implementing critical initial elements of a groundwater data management system designed to meet to SGMA requirements.

Feather River Regional Agricultural Water Management Plan. Northern California Water Association, Sacramento, CA. Provided senior review throughout this planning process to assess existing water use and to identify water conservation opportunities for each of the nine participating agricultural water suppliers comprising a total of 470,000 acres. Detailed water budgets were prepared for each supplier to serve as the basis to identify where, when and how water could be conserved and made available for other uses within the Feather River region.

El Dorado County Agricultural Development Feasibility Assessment, El Dorado County Water Agency, El Dorado County, CA. Mr. Davids has served as Principal-in-Charge and manager of all technical work for an agricultural development feasibility assessment for the El Dorado County Water Agency. This was accomplished by developing baseline data regarding historical cropping trends, spatial distribution of crops, and irrigation practices and evaluating historical, current, and projected future cropping and water demands within El Dorado County. Crop water demands were simulated using the root zone water budget model (IWFM IDC). This effort informs an evaluation of the feasibility of developing additional water supplies to expand irrigated agriculture in the County.

Reclamation District No. 108, Water Balance, Colusa and Yolo Counties, CA. Mr. Davids has served as Principal-in-Charge and senior technical reviewer for the agricultural water balance project for RD108. Technical aspects of the project involved estimating agricultural applied water use and using a root zone water budget to estimate evapotranspiration (ET) of applied water and precipitation.

IID/MWD Water Conservation Program Verification. Imperial Irrigation District/Metropolitan Water District, Imperial, CA. Mr. Davids served as one of three consulting engineers invited to verify 105,000 acre-feet of annual water savings under the IID/MWD Water Conservation Program. The team of engineers worked independently under the general direction of a committee comprised of agency members to design and implement procedures to quantify the actual water conservation savings of a variety of system level and on-farm conservation measures, including: canal lining, regulating reservoirs, system automation, delivery flexibility, drip irrigation, and tailwater recovery.

Sacramento Valley Groundwater Assessment. Northern California Water Association, Sacramento, CA. With subcontractors West Yost Associates and Macaulay Water Resources, Davids Engineering led a comprehensive assessment of groundwater quantity and quality conditions at the height of the drought in 2014. The assessment was based on a compilation of existing information, including data extracted from the current version of C2VSim (R374). The main report was written as a call to action to draw attention to localized persistent groundwater level declines in certain areas within the valley. The main report was supported by an additional 80-page technical report.

Groundwater Management Investigation, Dunnigan Water District, Dunnigan, CA. Mr. Davids served as project manager and principal engineer on this AB303 grant-funded project to assess sustainable groundwater yield in the Dunnigan Water District through a detailed assessment of historical land and water use. A detailed water balance model was developed to assess future land use, water demand and water supply availability scenarios, allowing the District to assess the vulnerability of groundwater resources to potential overdraft. This revealed the importance of limiting groundwater pumping through the importation of supplemental surface water supplies. The project involved public outreach and resulted in a robust District groundwater monitoring program and related data management system.

Yolo County IWFM IDC Parameter Development and Calibration, (under subcontract to West Yost Associates), Davis, CA. In collaboration with representatives from DWR, UC Davis, and West Yost, Davids Engineering reviewed the initial parameters in IDC and developed revised parameters to more accurately represent the application of irrigation water and the destinations of water applied but not consumed for crop ET.

Reclamation District No. 108, Yolo and Colusa Counties In-Lieu Groundwater Recharge Investigation. Mr. Davids served as Principal-in-Charge and senior technical reviewer on this project to assess the potential for surface water transfers to and in-lieu recharge in Colusa County Water District and Dunnigan Water District. Mr. Davids assisted with conceptual development of the model used to predict water supply preferences of water users in both districts, based on cost and subject to supply limitations. The project revealed that significant potential exists to increase net recharge in the district service areas, thereby improving groundwater conditions.

Resource Plan Water Supply and Water Transfer Element. Glenn Colusa Irrigation District, Willows, CA. Mr. Davids managed development of Glen Colusa Irrigation District's historical water balance, which serves as the technical foundation for assessing GCID's historical water operations and management, reviewing water management policy, evaluating water allocation decisions, and planning future infrastructure improvements. Development of the water balance began with an assessment of GCID's historical water operations data and related data management processes, discussions with GCID staff regarding system operation and maintenance practices, and inspection of water measurement and control facilities.

DAVIDS ENGINEERING, INC

Jeffrey C. Davids, Ph.D., P.E.

Project Engineer

Education

Ph.D., Civil Engineering, Water Management, Delft University of Technology, Delft, Netherlands

M.S., Hydrology and Hydrogeology, Graduation with Distinction, California State University, Chico, CA, USA

B.Sc., General Engineering, California Polytechnic State University, San Luis Obispo, CA, USA

Registration

Civil Engineer, CA
No. C75656

Years of Experience:

15 Years

Distinguishing Qualifications

- Innovative methods for measurement of hydrologic fluxes (e.g. remote sensing and citizen science)
- Stakeholder capacity building and communication of complex materials to diverse audiences
- Hydrologic data analytics, database development, quality control, and visualization

Role: Technical Team / Advisor for Demand Modeling Summary

Dr. Davids's keenness for water resources and food production blossomed amongst the vast agricultural lands of California's Great Central Valley and pristine streams of the Sierra Nevada Mountains. His educational background, broad consulting experience, and dedication to the development of human resources from diverse backgrounds demonstrate his commitment to improved and sustainable management of the Earth's limited natural resources through appropriate applications of engineering and technology, education, and research. Dr. Davids is a licensed Professional Engineer (PE) in the State of California, and has a Ph.D. in Civil Engineering (Water Management) from Delft University of Technology, an M.Sc. from California State University Chico in Geosciences and Hydrogeology, and a B.Sc. in General Engineering from California State University San Luis Obispo. His interest and experience focus on how sustainable management of water, energy, and food are supported by innovative sources of data (e.g. low cost sensors, remote sensing, citizen science), education, integrated systems thinking, modeling tools, social engagement, story telling, and outreach. He has consulted for a variety of water managers and suppliers (local, state, and federal) in all the major irrigated regions of California, including the Imperial, San Joaquin, Sacramento, and Shasta Valleys. Dr. Davids also consults for the UN Food and Agriculture Organization (FAO) in Afghanistan, Myanmar, and China, along with various clients in Nepal, Ghana, Thailand, and the Netherlands. He has managed diverse international teams and large projects, including the design, installation, calibration, and maintenance of several large flow measurement and data acquisition networks in the US and abroad.

Relevant Experience

Flow Measurement Improvement Projects. Reclamation District No. 108, Colusa County, CA. Since 2008, Dr. Davids has worked with Reclamation District No. 108 to improve their flow measurement, data management, and decision support systems. This work has included drain pump calibrations, testing of alternative turnout flow measurement options, training of water system operators, database development, and development of a wireless acoustic doppler flow measurement device. Dr. Davids led the pilot testing of alternative measurement methods that were potentially capable of achieving heightening regulatory standards, including: existing orifice gates, weirs set in precast boxes, and a recently introduced portable acoustic Doppler flow measurement device. The pilot program included (1) customization of the portable measurement device for District needs, (2) selection and inventory of a test reach, (3) calibration of upstream and downstream measurement devices, (4) development of an automated data transfer process and (5) development of a Water Information System for water accounting and billing.

Flow Measurement Plan Development and Implementation. South San Joaquin Irrigation District, San Joaquin County, CA. Dr. Davids supported the development and implementation of a Flow Measurement Plan (Plan) for the South San Joaquin Irrigation District (SSJID). The goals of the Plan are (1) to provide cost-effective service to customers; (2) generate improved operational records for planning and analysis, and; (3) comply with recently passed California legislation (SBx7-7). As part of this effort, Dr. Davids has designed a range of flow measurement methodologies and site improvements for SSJID involving standard critical depth structures (e.g. flumes and weirs) and acoustic Doppler flow measurement devices. Dr. Davids also participated in the field testing of acoustic Doppler devices.

Drain and Turnout Flow Measurement. Glenn-Colusa Irrigation District, Glenn and Colusa Counties, CA. Dr. Davids designed flow measurement methodology and improvement plans for 12 drain flow measurement sites around the low gradient borders of Glenn-Colusa Irrigation District. Key tasks included selecting appropriate measurement sites, performing detailed hydraulic calculations necessary for the design of the various flow measurement structures, creating conceptual designs, and developing specifications for measurement equipment and materials needed at the various measurement sites.

Glenn-Colusa Irrigation District, Princeton-Codora-Glenn Irrrigation District, Provident Irrigation District, Natomas Central Mutual Water Company, Richvale Irrigation District, Biggs-West Gridley Water District, and Western Canal Water District Turnout Flow Measurement Program Piloting and Implementation. Reclamation District No. 108, Glenn, Yolo, Colusa, Butte, and Sacramento Counties, CA. Dr. Davids led the development, piloting, implementation of an innovative turnout flow measurement solution for the irrigation which is now in use on over 150,000 acres. Dr. Davids has conducted various training

sessions with district operators in the basics of open channel flow measurement, critical flow devices, and hydroacoustics. For each district, Dr. Davids has inventoried district distribution systems, established standardized naming conventions, pilot tested alternative measurement devices, selected preferred measurement alternatives, and developed custom database applications for quality controlling and managing turnout flow data.

Groundwater Monitoring. Reclamation District No. 1004, Butte and Colusa Counties, CA. Dr. Davids worked with RD1004 to collect the necessary groundwater level and quality data to administer groundwater substitution transfers as part of the Department of Water Resources Drought Water Bank. Tasks included regular monitoring, data management, and quality control.

Stream and Canal Flow Measurement Improvements and Environmental Data Acquisition, Shasta County, CA. Over the last 15 years, Dr. Davids has designed, installed, commissioned, and maintained dozens of flow monitoring stations in natural and man-made channels in the Shasta Valley. The flow monitoring stations have employed a range of technologies from low cost solutions like using temperature to monitor the operation of wells, to higher cost hydroacoustic technologies for measuring water velocities directly. Dr. Davids has also employed a variety of techniques to characterize stream-aquifer interactions. Dr. Davids has been involved in hydrogeologic quality investigations looking at stable isotopes and bulk chemical constituents. Stable isotopes of oxygen were used to delineate apparent recharge elevations. Samples were also plotted on the meteoric water line to determine water rock interactions and degree of re-evaporation.

Measurement Improvement Plan Development and Implementation. Yuba County Water Agency, Yuba County, CA. In 2013, the The Yuba County Water Agency (YCWA) developed an agricultural water management plan (AWMP) in 2012 as required by the Water Conservation Act of 2009. As part of the larger AWMP effort, Dr. Davids led the development of a Measurement Improvement Plan to improve customer delivery measurement and quantification of key boundary inflows and outflows. Development of the Measurement Improvement Plan included an inventory and inspection of existing open channel and pipe flow measurement sites, in-situ verification measurements to assess existing measurement site accuracy, in addition to development of designs and cost estimates for improvements required to ensure that YCWA is compliant with the Agricultural Water Measurement Regulation (CCR §597). Part of the implementation included the construction of two concrete lined sections. Dr. Davids led the design, bidding, and construction management process.

Regulating Reservoir and Canal Improvement Design, Plan Preparation and Construction Management. Orland Unit Water Users' Association, Glenn County, CA. Dr. Davids assisted with the design, plan preparation and construction management of a 49 acre-foot regulating reservoir for the Orland Unit Water Users' Association. Dr. Davids compared historical rating curves for a Parshall flume and sharp crested weir with spot flow measurements to validate device accuracy. Dr. Davids performed numerous structure and canal cross section and profile surveys used to design long crested weir and overshot flume gate upgrades to existing check structures. Dr. Davids created 3-D digital terrain models of both the existing and proposed ground surfaces to quantify grading quantities and prepare project cost estimates.

West Adams Conveyance Feasibility Analysis. Yolo County Flood Control and Water Conservation District, Yolo County, CA. Dr. Davids served as the lead data collection specialist in the development of a HEC-RAS calibration data set on the West Adams Canal towards the southern portion of the Yolo County Flood Control and Water Conservation District (YCFCWCD). Davids Engineering was tasked to determine the feasibility of using the West Adams Canal as a conveyance alternative for water to the cooperative Woodland-Davis water treatment facility. This included the development and calibration of a HEC-RAS hydraulic model of the canal to evaluate existing capacity and identify "choke points" and other areas requiring civil improvements. Calibration data collected included water levels, structure dimensions, and flows collected with state-of-the-art hydroacoustic instrumentation.

California State University, Chico, Butte County, CA. Dr. Davids is the Principal Investigator of a U.S. Bureau of Reclamation (USBR) grant at the Irrigation Training Facility (ITF) at the California State University, Chico Farm. Dr. Davids is an Assistant Professor of Water Resources and Agricultural Engineering at California State University, Chico. Dr. Davids teaches classes in both the Department of Civil Engineering and the College of Agriculture. Dr. Davids teaches: GPS and GIS in Agriculture and Natural Resource Management; Irrigation; Water Resources Engineering; and Hydrology and Open Channel Hydraulics. Dr. Davids continues to research the applications of innovative sources of data (e.g. citizen science and remote sensing) in water resources management and agriculture.

Orifice Gate Coefficient Analysis. Imperial Irrigation District, Imperial County, CA. Colorado River water has transformed the Imperial Valley landscape from a barren desert to one of the most agriculturally productive regions in the country. Dr. Davids developed the flow verification methodology for a study aimed at aiding in the verification of historical water use records. Dr. Davids provided training and oversight for field personnel tasked with the collection of verification flow measurement data. The effort was part of a larger project involving the 2003 Quantification Settlement Agreement.

Joint Board SCADA System Development and Implementation. Joint Water District Board, Butte and Sutter Counties, CA. Dr. Davids led the development and implementation of Supervisory Control and Data Acquisition (SCADA) system for the Joint Water District Board. The SCADA uses MODBUS RTU communication protocols between a central ClearSCADA server and the remote sites. The system is comprised of seven Remote Terminal Units (RTUs): five Acoustic Doppler Flow Metering Stations and two critical flow gaging stations. A user friendly Human Machine Interface (HMI) was developed for use by District staff.

Brandon Ertis, M.S., P.E.
Associate Engineer

Education

M.S., Environmental Science, California State University, Chico, CA.

B.S., Civil Engineering, University of California, Davis, CA.

Registration

Civil Engineer, California (No. C84037)

Years of Experience:

10 Years

Distinguishing Qualifications

- Authored and assisted with various major plans and technical reports, including multiple related to water supply and groundwater sustainability
- Assembly and analysis of historical land and water use data for water budget development
- Geographic Information Systems – mapping and spatial

Role: Demand Modeling Technical Team/Project Manager

Experience Summary

Mr. Ertis has provided a variety of water and environmental management services to clients in California for 10 years. These services include environmental data acquisition; designing and completing detailed water budgets; utilizing GIS techniques for a variety of mapping and spatial analysis procedures and processes; development of water management tools for agricultural water suppliers (including tool design, implementation and staff training, and ongoing support); presenting technical information orally to stakeholders and the public, and preparation of technical reports and documents. He has been involved in dozens of successful projects for a variety of clients

Relevant Experience

El Dorado County Agricultural Development Feasibility Assessment, El Dorado County Water Agency, El Dorado County, CA. The El Dorado County Water Agency (EDCWA) engaged Davids Engineering and ERA Economics to complete an agricultural development feasibility assessment by developing baseline data regarding historical cropping trends, spatial distribution of crops, and irrigation practices and evaluating historical, current, and projected future cropping and water demands within El Dorado County. This effort informs an evaluation of the feasibility of developing additional water supplies to expand irrigated agriculture in the County. Mr. Ertis assisted in this project through assembly and evaluation of datasets (including assembly and review of inputs for and results of the water demand model), developing maps and completing spatial analyses in GIS, drafting sections of the report, and presenting project results to an Agricultural Advisory Group comprised of local stakeholders formed to provide feedback and inform the feasibility assessment process.

Feather River Regional Agricultural Water Management Plan, Northern California Water Association, Sacramento, CA. The Northern California Water Association (NCWA) engaged Davids Engineering to develop the Feather River Regional Agricultural Water Management Plan (FRRAWMP). A detailed plan for the 470,000 acre region was developed, including extensive consultation with nine water suppliers, several refuge and wildlife area managers, and representatives of Butte County and the California Department of Water Resources. The FRRAWMP includes a detailed inventory of surface water and groundwater supplies and uses and, through multiple water budget analyses spanning scales of individual suppliers to the region as a whole, characterizes the interaction between surface water and underlying groundwater systems in the region. Mr. Ertis was involved for the duration of the project in a supporting role, developing maps and completing spatial analyses in GIS, assembling supplier infrastructure inventories, identifying potential system improvement projects, preparing conceptual cost estimates for improvement projects, assisting in the preparation and calculation of water balances, drafting sections of the report, analyzing datasets, and meeting with agricultural water suppliers in the region. Mr. Ertis has also led state-mandated periodic updates to AWMPs for individual water suppliers included in the FRRAWMP region.

Sustainable Groundwater Management Act (SGMA) Groundwater Sustainability Plan (GSP) Development, Multiple Locations, CA. Mr. Ertis has both assisted and led multiple components of Groundwater Sustainability Plan (GSP) development in multiple groundwater basins in California including the Madera, Chowchilla, Solano, Colusa, Corning, and Butte Subbasins. His contributions include preparing draft and final GSP documentation, preparing draft and final Annual Report documentation, reviewing and editing all GSP documentation to ensure SGMA compliance; reviewing and responding to public comments, developing water budgets, evaluating sustainable management criteria, evaluating projects and management actions, development of maps and figures, preparing and presenting information to stakeholders and the public, and participation in coordination and meetings.

Groundwater Risk Assessment, Tehama County, CA. Mr. Ertis assisted in a high level risk assessment of SGMA undesirable results, assessing localized groundwater declines, subsidence risks, overdraft, and impacts due to climate change. He prepared maps and figures for public presentation showing historical and recent trends in groundwater conditions using publicly available information provided by state and local agencies.

Water Budget Development and Water Management Planning Oakdale Irrigation District, Oakdale, CA. Mr. Ertis prepared the 2020 Agricultural Water Management Plan (AWMP) update for submittal to the California Department of Water Resources. This preparation included drafting and/or editing all document text; communicating with OID staff to identify District efforts to implement Efficient Water Management Practices (EWMPs); and updating the OID system-wide water budget. The water budget updates involved quantifying agricultural water demand and water use using a daily root zone water balance model on the basis of cropping, soil characteristics, weather (evaporative demand and precipitation), and crop coefficients developed from remotely-sensed surface energy balance results. In addition to meeting state-mandated requirements, the AWMP is used by OID to review the ongoing implementation of their Water Resources Plan.

Colusa and Yolo Counties In-Lieu Groundwater Recharge Investigation, Reclamation District No. 108, Grimes, CA. Mr. Ertis assisted with an analysis of the potential to use RD108 surplus water, when available, to supplement available water supplies in Colusa County Water District and in Dunnigan Water District (Yolo County). An operations model spanning a 65-year planning horizon quantifying water demands, water supplies, and associated costs was developed that simulated the purchase of water by growers in each district. Mr. Ertis assisted in the project effort with data analysis and development of maps and figures using GIS and other software. Based on the model results, the parties have moved forward with a multi-year water transfer pilot program to test the water transfer concept and terms.

Implementation of Delivery Measurement, Data Management and Accounting, and Volumetric Billing, Reclamation District No. 108 (RD108), Richvale Irrigation District (RID), Biggs-West Gridley Water District (BWGWD), Western Canal Water District (WCWD), Butte, Colusa, Glenn, and Sutter Counties, CA. According to California Water Code Section 597 (CWC §597), agricultural water providers over 25,000 acres are required to measure the volume of water delivered to customers with sufficient accuracy to: (1) report aggregated farm-gate delivery data to the state and (2) adopt a pricing structure based at least in part on the volume of water delivered to each field. Mr. Ertis performed surveys of farm-gate deliveries to evaluate existing conditions, assisted in an effort to test alternative measurement methods that are potentially capable of satisfying the accuracy requirements of CWC §597 by performing flow measurements and data acquisition in the field and completing a water balance using different measurement methods on a specific canal reach, processing and analyzing datasets, and developing a report detailing existing conditions and presenting various options of improving flow measurement in order to comply with the accuracy standards presented in CWC §597.

Following this effort, Mr. Ertis has both assisted and led aspects of the development and implementation of a customer delivery measurement program that will satisfy the requirements of CWC §597. This included design and development of customer delivery measurement and water management tools used by district staff to record and manage deliveries and volumetric billing, development of a districtwide inventory and accounting database, implementation of tools and training with district staff members, and ongoing support for the customer delivery measurement program.

Agricultural Water Management Plan and Measurement Improvement Plan Development and Implementation, Yuba Water Agency, Yuba County, CA. Mr. Ertis assisted with development of the original Agricultural Water Management Plan (AWMP) for the YWA and led preparation of the 2020 AWMP update for submittal to the California Department of Water Resources. This preparation included drafting and/or editing document text; communicating with YWA staff to identify Agency efforts to implement Efficient Water Management Practices (EWMPs); and updating the YWA system-wide water budget (which included quantification of water demand and use).

The Yuba Water Agency (YWA) also moved forward to implement measures described in the Agency's Agricultural Water Measurement Plan (AWMP). This effort included the installation of multiple permanent flow measurement stations and the construction of conveyance system infrastructure. Mr. Ertis led the surveying and design of infrastructure improvements, participated in measurement station installations, and contributed to the construction management and inspection of the new infrastructure. Mr. Ertis also performed discharge measurements for velocity indexing purposes.

Lindsay Hall, E.I.T.
Senior Data Scientist

Education
B.S., Agricultural Engineering, University of Arizona, Tucson, AZ

Registration
Engineer in Training, CA (No. 116719)

Years of Experience:
21 Years

Distinguishing Qualifications
- Development of detailed, SGMA-compliant water budgets at multiple scales from individual GSAs to entire groundwater basins.
- Design and programming of custom data management applications to support various processes including import-export, archiving, and quality control of a wide range of land, soil, and hydrologic data.
- Automation of data management processes to support efficient analysis, visualization, and report development.

Role: Demand Modeling Lead
Experience Summary
Ms. Hall has 21 years of agricultural engineering experience at Davids Engineering since graduating from the University of Arizona in 2002. Ms. Hall specializes in water budget investigations for agricultural water suppliers. She is skilled in the design of water budget applications (structures), assembling and applying standard quality control applications to data, and in developing water budget models in spreadsheet and relational database environments. She is highly experienced with a variety of root zone soil water balance models, particularly DWR's Integrated Demand Calculator, a module of Integrated Water Flow Model (IWFM), DWR's platform for integrated hydrologic modeling. In addition to developing models for in-house use supporting Davids Engineering projects, Ms. Hall has developed several semi-automated water budget models to facilitate cost-effective water budget updates (typically annually) by client staff.

Relevant Experience
El Dorado County Agricultural Development Feasibility Assessment, El Dorado County Water Agency, El Dorado County, CA. The El Dorado County Water Agency (EDCWA) engaged Davids Engineering and ERA Economics to complete an agricultural development feasibility assessment by developing baseline data regarding historical cropping trends, spatial distribution of crops, and irrigation practices and evaluating historical, current, and projected future cropping and water demands within El Dorado County. This effort informs an evaluation of the feasibility of developing additional water supplies to expand irrigated agriculture in the County. Ms. Hall was lead modeler in the support of this project. She designed and created a historical model and ran various projected scenarios utilizing DWR's Integrated Water Flow Model (IWFM).

Automated Water Balance Update Procedures and Data Transfer Procedures, Turlock Irrigation District (TID), Turlock, CA. For TID, Ms. Hall designed and programmed a semi-automatic procedure to be used by TID staff in updating the District water balance. The application was developed in Microsoft Access and Excel utilizing visual basic programming modules. Data required to update the water balance is automatically uploaded into the database and processed. A user interface was developed to allow for quality control and review of the various water balance flow paths and input parameters. In addition, Ms. Hall parameterized and calibrated DWR's IWFM Demand Calculator for calculating root zone water balances used in the semi-automated District water balance procedure.

Turlock Irrigation District Water Budget 5-year Update, Turlock Irrigation District (TID), Turlock, CA. For TID, Ms. Hall was lead engineer for the latest update of the TID water budget, including development of cropping patterns based on the District's delivery database and development of tile drainage flows and private pumping times series based on flow data and/or energy consumption data. Lindsay operated a root zone water balance model developed to provide specific information on flow paths through the root zone of irrigated lands including: precipitation; consumptive use of precipitation; consumptive use of applied water; evaporation of precipitation; evaporation of applied water; deep percolation of precipitation; deep percolation of applied water; uncollected surface runoff of precipitation, and uncollected surface runoff of applied water. Data from the above described analyses was loaded into a database, and the monthly water budget was updated.

Stony Creek Fan Conjunctive Water Management Program, Glenn Colusa Irrigation District, Orland Unit Water Users Association, and Orland-Artois Water District, CA. For Glenn-Colusa Irrigation District (GCID), Orland-Artois Water District (OAWD) and the Orland Unit Water Users' Association (OUWUA), Ms. Hall worked on an investigation for development of a sustainable, regional conjunctive use program in order to improve water management efficiency for local and state needs. Ms. Hall main responsibilities involved developing both historical and

future land use and cropping patterns, root zone modeling, and surface water balance analyses in support of project alternative formulations.

Turlock Subbasin GSP, Turlock Groundwater Sustainability Agencies, Turlock, CA. Ms. Hall serves as information system specialist in support of Turlock Subbasin GSP efforts to date. Her focus has been on refining C2VSim surface layer model inputs to better represent local conditions. The main refinements included diversions, land use, crop vapotranspiration, and irrigation related model parameters. The IDC portion of the IWFM model was run and the results were used to validation of model input. To support efficient refinement of water budgets for GSA subareas within the basin, Lindsay developed custom database and spreadsheet applications to summarize and compare incremental water budget refinements resulting from improvement in model inputs.

Water Inventory & Analysis and Butte Basin Groundwater Model Update, Butte County Department of Water and Resource Conservation, Butte County, CA. Ms. Hall assisted the Butte County Department of Water and Resource Conservation by developing a post-processing database tool to reformat and graphically review data from the Butte Basin Groundwater Model, an Integrated Water Flow Model (IWFM) application. The post-processing tool was developed in Access and linked to an Excel spreadsheet. Forms and Visual Basic coding were used to automate the processes in both Access and Excel.

SGMA Technical Support Services and Prop 1 Stressed Basin Grant Project, Counties of Colusa and Glenn, CA. Ms. Hall has served as information system specialist in support of Colusa County's SGMA compliance efforts to date. Her focus has been on development of a Data Management System (DMS) with integrated quality control and assurance routines for various data types including: stream flow, diversions, water quality, subsidence, well logs, and groundwater levels. The DMS is developed as an Access database. Automation of the data importation process is implemented utilizing Visual Basic code. The DMS provides input files to support groundwater modeling efforts and formatted data tables to support GSP development and implementation. In addition, Lindsay developed a semi-automated water budget database for Glenn County. The database links directly to output from an IDC model to complete the water budgets for agricultural, urban, and native lands. Completed water budgets are exported from the database to Excel spreadsheets for graphical review and tabular summaries.

Yuba Groundwater Model Phase I Development-Surface Layer Processes, Yuba County Water Agency, Yuba County, CA. For Yuba County Water Agency (YCWA), Ms. Hall supported the development of an IWFM Demand Calculator (IDC) application to develop a detailed water budgets for agricultural, urban, and native land uses across the North and South Yuba Subbasins. Lindsay developed input files and operated the IDC model. In addition, she developed a post-processing tool to quickly reformat and view results from the IDC model.

Gray Lodge Water Supply Project, Biggs-West Gridley Water District, Gridley, CA. For Biggs-West Gridley Water District, Ms. Hall provided technical support in a number of areas for a critical review of the Gray Lodge Refuge Water District Design Data Report and Seepage Investigation. This included a thorough review of the project data collection plan focusing on data quality control and site calibration. She also performed an independent analysis of historical flows and system capacity, which served as the basis for evaluating proposed design flows. Ms. Hall compiled and reviewed Reclamation's earthen canal design criteria that were used to evaluate the proposed minimum velocity, maximum velocity and canal controllability design criteria. Ms. Hall provided HEC-RAS hydraulic modeling support focusing on review of the model developed by Reclamation's technical contractor, including review of design flow rates, Manning's n (roughness) values, water level set points, boundary conditions, backwater effects, canal velocities, and gate openings.

Time Series Evapotranspiration and Applied Water Estimates from Remote Sensing, Kaweah Delta, Central Valley, CA. Ms. Hall provided model programming and operation to develop and implement a daily root zone water balance model for approximately 8,000 fields representing 300,000 acres in the southern San Joaquin Valley of California. Results of the effort are being used to refine estimates of groundwater extraction and recharge and are expected ultimately to be used to refine an existing groundwater model. The model is driven by remote sensing of crop transpiration, coupled with simulation of irrigation practices to estimate bare soil evaporation and was calibrated and validated using available datasets describing spatially distributed actual evapotranspiration (ET) rates developed using the Surface Energy Balance Algorithm for Land (SEBAL). A key advantage of the model is that it is able to account for actual crop evapotranspiration with limited reliance on detailed information describing cropping patterns over time. Additionally, by leveraging off of existing SEBAL datasets, the model can be applied over long time periods at modest cost. The model was applied on a daily time step for each field and provides estimates of all water budget components at the field scale, including ET of applied water, ET of precipitation, applied irrigation water, deep percolation of applied water, deep percolation of precipitation, tailwater (runoff of applied water), runoff of precipitation, etc.

Katherine Klug, Ph.D.
Associate Engineer

Education

Ph.D., Agricultural & Biosystems Engineering, University of Arizona

B.S., Biosystems Engineering, University of Arizona

Years of Experience:

4 Years

Distinguishing Qualifications

- Wide-ranging experience supporting water demand modeling efforts, from field-level to subbasin-level.
- Authored various major plans and technical reports for diverse audiences and clients, including multiple long-term water management planning documents.
- Instrumental in long-term Groundwater Sustainability Plan (GSP) development and implementation for eleven (11) subbasins.

Role: Demand Modeling
Experience Summary

Dr. Klug is an associate engineer with a strong background in supporting water management planning efforts, including those with a foundational modeling component. Since joining Davids Engineering in early 2018, she has been instrumental in completing all aspects of various Water Management Plans (WMPs), Agricultural Water Management Plans (AWMPs) and Groundwater Sustainability Plans (GSPs) for water districts and public agencies in California's Central Valley. Dr. Klug has also led or supported documentation efforts and modeling analyses for other major plans and studies in California and the Southwestern United States.

Relevant Experience

SGMA GSP Development and Water Demand Modeling, Multiple Locations, CA. Since 2019, Dr. Klug has contributed in varying capacities to Groundwater Sustainability Plan (GSP) development and water demand modeling in the Antelope, Bowman, Butte, Colusa, Los Molinos, Red Bluff, Solano, Sutter, and Turlock subbasins in the Sacramento and San Joaquin Valleys. These subbasins are considered high- or medium-priority according to the SGMA 2019 Basin Prioritization, and were required to complete, adopt, and submit a GSP by January 2022.

Dr. Klug's contributions to GSP development include: preparing model inputs to characterize historical, current, and future water demand; developing and analyzing district-level, subregion-level, and subbasin-level water budgets and model results summaries; developing, documenting, and evaluating projects and management actions to support sustainable water management; preparing model documentation; and presenting on water budgets and related findings to GSA representatives and stakeholders. Dr. Klug has communicated directly with GSA representatives and stakeholders, presenting and discussing presentation materials to make certain that subbasin conditions and input from stakeholders are accurately represented.

Since January 2022, Dr. Klug is also supporting development of annual reports, updates to water demand-related model inputs and/or water budget components, implementation and tracking of projects and management actions, and other efforts to support GSP implementation in the majority of these subbasins.

Agricultural Water Management Planning, Turlock Irrigation District and South San Joaquin Irrigation District, CA. In 2020-2021, Dr. Klug prepared Agricultural Water Management Plans (AWMPs) for submittal to the California Department of Water Resources in separate projects for the Turlock Irrigation District (TID) and the South San Joaquin Irrigation District (SSJID). Each effort included updating the district's system-wide water budget; communicating with district staff to identify recent projects and efforts to implement Efficient Water Management Practices (EWMPs); and preparing reports for District staff and for submittal to DWR. The water budget updates involved quantifying agricultural water demand and water use using a daily root zone water balance model on the basis of cropping, soil characteristics, weather (evaporative demand and precipitation), and crop coefficients developed from remotely-sensed surface energy balance results. Besides supporting the AWMP, these results also provide a technical basis for district policies and help to identify water conservation opportunities.

Water Management Planning and Water Budget Development, Stockton East Water District, Stockton, CA. In 2019, Dr. Klug served as the primary project engineer and point of contact for development of the Stockton East Water District (SEWD) 2019 Water Management Plan (WMP). In this project, Dr. Klug managed communication between Davids Engineering and SEWD to identify all data, relevant project information, and changes to the District's conveyance system, infrastructure, and operating practices between 2010 and 2019. She then integrated this information to narrate the District's implementation of Agricultural and Urban Best Management Practices (BMPs) over the past decade, and to

quantify the SEWD system water budget. The water budget updates involved quantifying agricultural water demand and water use using a daily root zone water balance model on the basis of cropping, soil characteristics, weather (evaporative demand and precipitation), and crop coefficients developed from remotely-sensed surface energy balance results. Dr. Klug led a workshop at SEWD to discuss these efforts, and prepared a final WMP document to SEWD for submittal to the U.S. Bureau of Reclamation.

Agricultural Water Consumptive Use Determination, New Mexico Interstate Stream Commission. In 2018-2020, Dr. Klug supported the analyses to determine agricultural water consumptive use for the lands irrigated along the Rio Grande in New Mexico and Texas by the Rio Grande Project. Her contributions to these efforts included documentation and reporting of all technical analyses, including calculation of reference ET, development of crop coefficients from remotely sensed energy balance analyses, and the application of the ET Demands root zone model to parse crop ET into ET of applied water and ET of precipitation. The reports on these technical analyses were in used in the matter of: *State of Texas v. State of New Mexico and State of Colorado* No. 141, Original Before the United States Supreme Court.

SGMA GSP Development and Implementation, Madera County, Madera, CA. In 2018-2020, Dr. Klug supported SGMA Groundwater Sustainability Plan (GSP) development for the Chowchilla and Madera subbasins in Madera County. Both subbasins are considered critically overdrafted, and were required to complete, adopt, and submit GSPs by January 2020. Her key contributions to these efforts include: preparing draft and final GSP documentation (General/Agency Information, Description of Plan Area, Basin Setting, Projects and Management Actions, Plan Implementation); reviewing and editing all GSP documentation to ensure SGMA compliance; reviewing and responding to public comments; developing historical and current water budgets; and evaluating Projects and Management Actions. Since 2020, Dr. Klug has also supported annual reporting, ongoing water budget development, implementation and tracking of projects and management actions, and other efforts to support GSP implementation among various GSAs in the Chowchilla and Madera subbasins.

Water Management Planning and Water Budget Development, Solano Irrigation District, Vacavilla, CA. In 2018-2019, Dr. Klug prepared the Solano Irrigation District (SID) Water Management Plan (WMP) for submittal the U.S. Bureau of Reclamation. Concurrent with these efforts, Dr. Klug also prepared supporting materials to complete the 2020 Agricultural Water Management Plan (AWMP) for submittal to the California Department of Water Resources. These efforts included drafting and/or editing all document text; communicating with SID staff to identify the district's efforts to implement Best Management Practices (BMPs) and Efficient Water Management Practices (EWMPs); and updating the SID system-wide water budget. The water budget updates involved quantifying agricultural water demand and water use using a daily root zone water balance model on the basis of cropping, soil characteristics, weather (evaporative demand and precipitation), and crop coefficients developed from remotely-sensed surface energy balance results. Besides supporting the AWMP and WMP, these results also provide a technical basis for SID to consider water allocation and annexation policies and to identify water conservation opportunities.

Irrigation Facilities Master Plan, Turlock Irrigation District, Turlock, CA. In 2018-2019, Dr. Klug supported development of the Turlock Irrigation District (TID) Irrigation Facilities Master Plan (IFMP). The IFMP was developed in coordination with TID to identify and evaluate modernization projects for the District's water distribution infrastructure. Projects proposed in the IFMP were designed to modernize TID's infrastructure with the intent of allowing growers to adopt more efficient and productive on-farm irrigation systems, leading to increased water conservation over time as well as increased farm profitability. In her many contributions to this effort, Dr. Klug prepared and/or documented: analyses of existing service levels in the District; descriptions and evaluations of 15 potential modernization projects; systematic analyses and comparisons of project benefits; evaluation of synergistic multi-project packages; and project implantation strategies. Dr. Klug's efforts and participation in meetings with District staff contributed to the creation of more than 50 work products, including technical memoranda, spreadsheets, databases, design drawings, presentations, workshop notes, and other items.

Jared Emery, P.E.

Senior Water Resources Engineer / Reservoir Operations Modeling / Unimpaired Hydrology Development

Mr. Emery has 16 years professional experience as a water resources engineer. His experience includes hydroelectric operations forecasting tools, water rights analysis, FERC Licensing support, drought analysis, flood frequency analysis, hydrology development, and hydroelectric system evaluation.

Education

B.S., Physics; Humboldt State University, California

Registrations, Certifications, Permits and Affiliations

- Registered Professional Engineer, California, License No. 81467

Representative Professional Experience

Water Supply Model for the Yuba Bear Drum Spaulding Hydroelectric Project, Placer County – Placer County Water Agency (2010–2013). Mr. Emery participated in the development of a simulation model of the Yuba Bear Drum Spaulding project using HEC-ResSim for Placer County Water Agency to provide water supply and power production analysis. During this process, Mr. Emery was selected to be on the modeling technical team, a group focusing on operations optimization and detailed analysis of model results. Mr. Emery also participated in the development of a modeling tool that tracked water rights usage and ownership throughout the projects, including the accounting for storage in shared facilities such as Rollins Reservoir and the Bear River Canal system.

American River Basin Study Report, El Dorado County – El Dorado County Water Agency (2018-2021). Mr. Emery participated in the model development team for the United States Bureau of Reclamation's American River Basin Study Report. The Study evaluated stressors to the water supply reliability in the Basin, identified vulnerabilities, identified and screened adaptation measures, and developed groups of measures that would reduce the gap between water supply and consumptive demand. This included developing several modeling scenarios of the upper American River basin.

Mokelumne River Water Supply Study, Calaveras County – Calaveras County Water District (2017–2018). Mr. Emery created a water supply model of the Middle and South Forks Mokelumne River including the surface water diversions, reservoir operations, and treated water distribution of the Calaveras County Water District and Calaveras Public Utility District operations on the Mokelumne River. This effort included developing climate change adjusted hydrology on the Mokelumne River.

Middle Fork Project Water Rights Permit Extension of Time, Placer County – Placer County Water Agency (2010-2021). Mr. Emery performed Middle Fork Project modeling studies in support of an application for an extension of time on Placer County Water Agency's water rights permit on the Middle Fork American River. This effort included detailed analysis of PCWA's water supply yields and the integrated use of various water supply sources. Mr. Emery worked with the modeling team to design Calsim II studies of the effect of the water rights permit extension of time on the Lower American River and Folsom Reservoir. Mr. Emery reviewed all Calsim II studies developed for the project to ensure that they correctly portrayed Placer County Water Agency's diversions in the American River basin.

Integrated Operations Model of the American River and Cosumnes River basins, Placer and El Dorado Counties – El Dorado County Water Agency (2016–2018). Mr. Emery participated in the development of a simulation model of the integrated operations of six independent water and power agencies throughout the American River and North Fork Cosumnes River using OASIS with OCL to be used as a long-term planning tool to provide water supply and hydropower production analysis. The model included development of a hydroelectric scheduling tool and hydroeconomic effects analysis to quantify the effects of changing power markets, minimum instream flow requirements, recreation flow requirements, and changes in water rights. The model included a complete tracking of water rights usage throughout the basin including rediversions at Folsom Reservoir to analyze the effects of water rights utilization strategies.

Water Supply Model for the Middle Fork American River Hydroelectric Project, Placer County – Placer County Water Agency (2006–2011). Mr. Emery participated in the development of a simulation model of the Middle Fork of the American River and Rubicon River using OASIS with OCL for Placer County Water Agency to be used as a long-term planning tool to provide water supply and power production analysis. The model included development of hydrology for the Middle Fork American and Rubicon Rivers, and was used as a tool in the Federal Energy Regulatory Commission (FERC) relicensing process, where Mr. Emery performed model simulations with the stakeholder group.

Potter Valley Project FERC Relicensing, Mendocino County – Pacific Gas and Electric (2018-2019). Mr. Emery participated in the hydrology model development team for the AQ 1 Technical Study. Mr. Emery developed watershed hydrology for the entire Eel River and the East Branch Russian River. Mr. Emery performed an analysis of travel time for various reaches within the Eel River and developed a method to route flows throughout the various study reaches. Mr. Emery participated in the development of a HEC ResSim model of the Potter Valley project and performed modeling studies to analyze various alternative flow programs at Lake Pillsbury.

Jeffrey K. Meyer, P.E.

Principal Unimpaired Hydrology Development / Water Rights

Mr. Meyer has 31 years of experience in environmental engineering and water resources management. His experience includes hydrology development, stream flow gaging, runoff forecasting, water rights analysis, operations model application development, long-term planning, short-term planning using position analysis, alternatives evaluation, operations rules development, hydroelectric system evaluation, computer-aided dispute resolutions, hydro-economic modeling and analysis, and National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA) analysis and review. Mr. Meyer specializes in assisting clients develop practical solutions to complex environmental planning, resource management and operational challenges. This process includes consideration of multiple conflicting goals and integrated system management along with analysis of system resources using simulation modeling techniques. This analysis can test operational strategies without jeopardizing water supply, revenue, or risking damage to facilities.

Mr. Meyer has focused his career on west slope Sierra Nevada and coastal water resources systems and has developed and/or used simulation applications for many of the Mountain Counties Water Resources Association members and California Central Coast operators.

Education

B.S., Civil Engineering; California Polytechnic State University, San Luis Obispo

Registrations, Certifications, and Affiliations

- Professional Engineer, California
- Mountain Counties Water Resources Association
- Association of California Water Agencies

Representative Professional Experience

Placer County Water Agency Relicensing of the Yuba-Bear & Drum-Spaulding Systems, Yuba River, Nevada and Placer Counties (2010-2013). Placer County Water Agency (PCWA) has contracts with Pacific Gas & Electric Company for their Zone 3 and Zone 1 customers totaling 125,400 AF of water, annually. Because of the large supply they receive from the Yuba-Bear & Drum-Spaulding project operations, PCWA retained Mr. Meyer to review model results and to model alternatives in support of the settlement negotiations during the FERC relicensing process. The work efforts of Mr. Meyer and his staff resulted in improving the modeling tools and assisting not only PCWA, but other negotiating parties to better understand the water supply and generation impacts to their respective projects.

El Dorado County Water Agency (EDCWA) / Placer County Water Agency (PCWA), American River Basin Study (2018-2021). Western Hydrologics was part of a consultant team working with the United States Bureau of Reclamation (USBR) to perform the American River Basin Study (Study). The Study evaluated stressors to the water supply reliability in the Basin, identified vulnerabilities, identified and screened adaptation measures, and developed groups of measures that would reduce the gap between water supply and consumptive demand. Mr. Meyer was the project manager for the Upper American River modeling. Upper American River modeling was performed using the American River Integrated Operations (ARIOps) model for

areas above Folsom Lake and included various climate change hydrology and demand scenarios. Adaptation measures include improved demand management, diversification of water supplies, improved operational flexibility, and improved resource stewardship.

El Dorado County Water Agency (EDCWA) / Placer County Water Agency (PCWA), Upper American River Integrated Operations (ARIOps) Model, El Dorado County (2013-Present). Mr. Meyer served as the project manager for the development of the Upper American River Integrated Operations Model known as ARIOps. In support of multiple water supply reliability initiatives, EDCWA requested the construction of a daily time step water operations and hydropower generation simulation model including all American River Basin operations above Folsom Lake. The hydrology dataset built for the model includes both historic and climate change hydrology. The project includes extensive American River Basin specific model documentation and software package. The ARIOps model was used to inform the CalSIm III American River Basin inflow in support of the American River Basin Study as well as ongoing water rights efforts and voluntary settlement agreements.

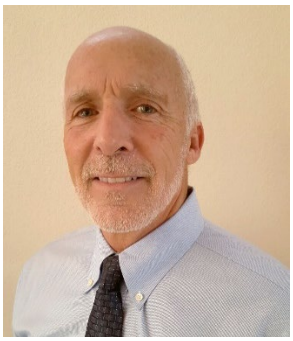
Nevada Irrigation District Hemphill Diversion Structure Project (2021). Western Hydrologics was a subcontractor to ECORP Consulting for the Hemphill Diversion Structure Project. The Hemphill Diversion Structure, located on Auburn Ravine, diverts water to the Hemphill Canal located south of the ravine for delivery to NID raw-water customers. The diversion structure is a impediment to passage of migrating fish species. NID is considering three alternatives to eliminate the impediment while maintaining water deliveries. Mr. Meyer performed the evaluation of the Alternative 3 - Pipeline Alternative which includes the removal of the diversion structure and installation of a pipeline from the NID Placer Yard facility to the Hemphill Canal. The water supply for the pipeline comes from a diversion of raw water from Auburn Ravine at the existing Gold Hill Dam to the AR-1 canal, which would then be connected to the new pipeline. Mr. Meyer developed hydrology and estimated the remaining flow in Auburn Ravine from the Gold Hill Dam to the Hemphill Dam as a result of the change in point of diversion for the Hemphill Canal deliveries.

Nevada Irrigation District Instream Flow and Sediment Studies Nevada County (2012-2013). As a result of Nevada Irrigation District's (NID) desire to license 10 water rights permits, instream flow and sediment studies were requested to determine what flow conditions or other actions might be necessary to provide reasonable protection for aquatic resources and to resolve protests.

Mr. Meyer led the team selected by NID to conduct the studies. The following outlines our scope of work.

- Develop Study Outline approved by NID and Negotiating Parties
- Collect aquatic resource information augmented with existing information
- Develop a thorough understanding of Bear River and Deer Creek aquatic and sediment resources and habitat
- Deliver technically sound and defensible conclusions

An initial site survey assessment was conducted by walking all or most of both reach lengths to identify three (3) representative study sites (one [1] on the Bear River and up to two [2] on Deer Creek). In addition to the team, representatives from NID and the Negotiating Parties attended portions of the initial site survey assessment. Meetings were held to review data collected and to gain consensus on the specific study site selections. The team provided the necessary data to support negotiations.



James M. Lynch

Strategic Advisor

Jim is a Senior Vice President of HDR's Hydropower Practice Group with 47 years of experience in the management of water-related projects. This includes 37 years specifically in Federal Energy Regulatory Commission (FERC)-related projects, during which time he has been involved in the relicensing/licensing of over 40 projects, which have included FERC's Traditional (TLP), Alternative (ALP) and Integrated (ILP) licensing processes as well as related comprehensive settlement agreements. For most of these projects, final license applications (FLAs), many of which have included consensus recommendations from the licensees and collaborative groups in addition to settlement agreements, have been submitted to FERC.

Since 1985, Jim has been involved in hydroelectric and other power projects in California, working closely with agencies such as the FERC, U.S. Forest Service (USFS), U.S. Fish & Wildlife Service, U.S. Bureau of Land Management (BLM), U.S. Bureau of Reclamation (BOR), U.S. Army Corps of Engineers (USACE), California Department of Fish and Wildlife, California State Water Resources Control Board (SWRCB), California Department of Water Resources (DWR), California Department of Parks and Recreation, and State Historic Preservation Office, as well as with Tribal and various public interest groups. In addition to hydropower relicensing/licensing, his areas of expertise include project management, permitting, National Environmental Policy Act (NEPA, California Environmental Quality Act (CEQA) compliance, environmental study design, construction supervision, fisheries and wildlife/botanical resource evaluations, and recreation study and facility design. He is also an experienced facilitator and negotiator and has managed numerous Clean Water Act (CWA) Section 316(a) and (b) cooling water intake projects.

EDUCATION
MS, Ecology and Genetics, Yale University, 1975

BS, Biology, Upsala College, 1973

SPECIALIZED TRAINING AND CERTIFICATIONS
Instream Flow Incremental Methodology (IFIM)

Habitat Evaluation Procedures (HEP)

Natural Resource Negotiations

INDUSTRY TENURE
47 years

RECENT REPRESENTATIVE EXPERIENCE

1,212 MW Helms Pumped Storage Project (P-2735), FERC TLP Relicensing, Pacific Gas and Electric Company (PG&E), North Fork Kings River, *Fresno County, California*
Serving as Lead Consultant/Strategic Advisor providing strategic and technical services. Part of the project is located within the Sierra National Forest managed by USFS and on other federal lands managed by BLM and BOR. Some challenges include pumped storage operations, coordinated operations with other power projects in the watershed, an 80-mile-long transmission line and coordinating the relicensing with PG&E's concurrent relicensing of its Balch Project. Activities to date have included strategic planning, obtaining FERC's approval for use of the TLP, stakeholder outreach, establishing a document management system and an external stakeholder website, preparation and filing of the Notice of Intent to File an Application for a New License (NOI) and Pre-Application Document (PAD), collaborative development of study plans over 20 stakeholder meetings. The NOI and PAD were filed in April 2021 and the FLA is scheduled to be filed in April 2024.

139 MW Balch Hydroelectric Project (P-175), FERC TLP Relicensing, PG&E, North Fork Kings River, *Fresno County, California*
Serving as Lead Consultant/Strategic Advisor providing strategic and technical services. Part of the project is located within the Sierra and Sequoya national forests. Some challenges include coordinated operations with other power projects in the watershed, a 20-mile-long transmission line and coordinating the relicensing with PG&E's concurrent relicensing of its Helms Project. Activities to date are similar to those described above for the Helms Project. The NOI and PAD were filed in April 2021 and the FLA is scheduled to be filed in April 2024.

165 MW Pine Flat Hydroelectric Project (P-2741), FERC Relicensing, Kings River Conservation District (KRCD), Kings River, *Fresno, California*
Supporting KRCD as Lead Consultant/Strategic Advisor. KRCD has not decided on a relicensing process. Part of the project is located on federal lands administered by USACE as part of its Pine Flat Dam and Reservoir. Some challenges include minimizing minimum flows because the project only uses water released from Pine Flat Reservoir by USACE. Activities to date include preparation of a detailed relicensing strategic plan, including cost estimate, and filing amendments to the existing license to reduce the project boundary and add a new unit. The NOI and PAD must be filed by July 2024 and the FLA by July 2027.

6.8 MW Camp Far West Hydroelectric Project (P-2997), FERC TLP Relicensing and CEQA Compliance, South Sutter Water District (SSWD), Bear River, *Nevada, Yuba, and Placer Counties, California*
Serving as Lead Consultant/Strategic Advisor providing strategic and technical services. Some challenges include preserving water supply and Endangered Species Act (ESA)-listed anadromous fish. Activities to date include preparation of strategic plan, NOI, PAD, Draft License Application (DLA), FLA, responding to comments on the FLA, informal Section 7 ESA consultation with USFWS and CEQA Initial Study/Mitigated Negative Declaration. Awaiting FERC's issuance of an Environmental Assessment (EA).

1,349 MW South SWP (P-2426), FERC ILP Relicensing, DWR and Los Angeles Department of Water and Power, Piru Creek, *Los Angeles County, California*
Serving as Relicensing Process manager as a subconsultant to Stantec, providing strategic services. The project is located along DWR's State Water Project and part within the Angeles and Los Padres national forests managed by USFS and on other federal lands administered by BLM. Some challenges include pumped storage operations and coordinating the relicensing with SWP deliveries and DWR's Devil Canyon Project relicensing. Activities to date include filing the NOI, PAD, Preliminary Study Plan (PSP), Revised Study Plan (RSP), Initial Study Report (ISR), Updated Study Report (USR), FLA in January 2020, informal Section 7 ESA consultation with USFWS and responding to comments on the FLA. Awaiting FERC's issuance of an Environmental Assessment (EA).

103.5 MW Merced River Hydroelectric Project (P-2179), FERC ILP Relicensing - Merced Irrigation District, Merced River, *Mariposa County, California*
Serving as Project Manager providing strategic and technical services. Part of the project is located on federal lands administered by BLM. Some challenges include preserving water supply and obtaining a waiver of CWA Section 401 water quality certification. Activities to date include filing the NOI, PAD, PSP, RSP, ISR, USR, FLA in February 2012, informal Section 7 ESA consultation with USFWS, and responding to comments and information requests on the FLA. In addition, work included preparation of an amendment, filed on April 23, 2014, for addition of a 1.8 MW McSwain Energy Recovery Unit to the FERC license. FERC issued its FEIS in December 2015 and remaining activities include FERC's Section 7 ESA consultation with NMFS.

Megan Lionberger, PE (CA)

Senior Water Resources Engineer

Megan is a civil engineer with 19 years of experience in water resources engineering. She has supported hydropower and water supply projects by developing, calibrating, and validating computer models simulating reservoir system operations, sediment transport, and water quality. These include reservoir and stream water temperature models utilizing HEC-1, HEC-HMS, HEC-ResSim,CE-QUAL-W2, HEC-5Q, HFAM, SSTEMP, and custom coded models developed in VBA for Microsoft Excel. Her previous experience includes work for the U.S. Geological Survey's San Francisco Bay sediment transport group where she supported a number of data collection and data analysis efforts.

EDUCATION

MS, Civil Engineering, University of California, Davis, 2003

BS, Civil Engineering, University of California, Davis, 2001

REGISTRATIONS

Professional Civil Engineer, California, C74543

INDUSTRY TENURE

19 years

RELEVANT EXPERIENCE

Nevada Irrigation District, Plan for Water*, California*
Developed a projected (2070) water supply analysis to support NID's long-range planning. The water supply analysis included forecasted water demands by district customers, the effects of runoff on climate change, and anticipated regulatory and environmental flow requirements. Development and results of the water supply analysis were presented to the NID board and the public during multiple stakeholder meetings.

California Department of Water Resources, CalSim 3.0 Module Development*, California*
Helped develop a module for CalSim 3.0 representing the Yuba and Bear River watersheds. The module simulates the coordinated operations of Nevada Irrigation District's Yuba-Bear Hydroelectric Project with Pacific Gas and Electric Company's Drum-Spaulding Project (FERC Project No. 2310).

South Sutter Water District, Camp Far West Hydropower Relicensing, *California*
Lead water quality modeler for the relicensing of the Camp Far West project. In this role, developed a CE-QUAL-W2 model of Camp Far West Reservoir and of the Bear River from Camp Far West Dam to the Feather River confluence. Drafted section of the License Application pertaining to water resources.

Yuba Water Agency, Yuba River Development Hydropower Relicensing Project, *CA*
Analyzed the effects of proposed project operations on project generation, water quality and water deliveries using multiple modeling tools. Also analyzed the effects on generation and water deliveries using a custom reservoir operations model developed in VBA for Microsoft Excel by developing rules for operating upstream reservoirs and diversions, including meeting minimum flow requirements and providing water supply. Developed a CE-QUAL-W2 model of Englebright Reservoir to analyze the effects of proposed project operations on downstream temperatures. This model was linked to upstream and downstream reservoir stream HEC-5Q temperature models. Developed a QA/QC processes to minimize errors associated with using multiple linked modeling platforms and provided general hydrology support for various aspects of the project.

Yuba Water Agency, Narrows Hydropower Relicensing Project, *California*
Analyzed the effects of proposed project operations on project generation, water quality and water deliveries using multiple modeling tools. Provided general hydrology and support for various aspects of the project.

Yuba Water Agency, Yuba River Development Hydropower Project*, California*
Developed a spreadsheet model to optimize for ancillary services or total power generation value on an hourly basis over a seven-day period. Also developed several forecasting tools using publicly available forecasts of reservoir inflow for short-term and long-term reservoir and hydropower operations.

Yuba-Bear and Drum-Spaulding Hydropower Relicensing Project, Pacific Gas & Electric and Nevada Irrigation District, California
Analyzed the effects of proposed project operations on power generation, water deliveries and stream temperatures by linking several reservoir and stream water temperature models (HEC-ResSim, CE-QUAL-W2, HFAM and SSTEMP); developed QA/QC processes to minimize errors associated with using multiple modeling platforms; and provided general hydrology and support for various aspects of the project. Regularly attended public relicensing meetings to discuss model development and present model results of various alternative operating proposals. Developed QA/QC processes for synthesized unimpaired hydrology development for over 125 reaches in seven rivers.

Marilyn B. Hurst

Senior Hydrologist

EDUCATION
Coursework toward Mathematics and Computer Science degrees at University of California, Davis and University of Houston, Downtown

INDUSTRY TENURE
51

HDR TENURE
9

OFFICE LOCATION
US-CA-Sacramento-Gateway Oaks

Marilyn has expertise in design, development, maintenance, and support of U.S. Army Corps of Engineers (USACE) reservoir operations modeling software and watershed applications. She has held staff positions at the Water Resource Systems Division and Training Division of USACE HEC. Her project experience includes adapting watershed characteristics for rainfall-runoff analysis, reservoir system simulation analysis, water quality analysis, and flood risk reduction analysis. She excels at providing training and user support for the USACE's reservoir operation simulation and optimization software.

RELEVANT EXPERIENCE

Nevada Irrigation District, Raw Water Master Plan (RWMP), *California*
NID was in need of an update for the RWMP. The last update to the plan was in 2011. The 2011 RWMP analysis was based on projected 2032 water management practices at the time, which did not include future, projected Federal Energy Regulatory Commission (FERC) license conditions or climate change. An updated plan was needed to support the water supply decisions in current and future years, a. Assisted with preparation of RWMP update, which included a 50-year projection of demands and capital improvements.

Nevada Irrigation District, 2019 FERC Relicensing Contract*, California*
Provided support to NID in its relicensing of the Yuba-Bear hydroelectric project. This task order included general relicensing support and project management and license implementation support.

Sonoma County Water Agency, Hopland Hydrologic and Hydraulic Analysis*, California*
Investigated and identified the historical basis of the operational target of 8,000 cfs at Hopland. Investigated and identified the hydrologic and hydraulic considerations that affect flows and stages on the Russian River at Hopland.

California Department of Water Resources (DWR), Forecast-Informed Reservoir Operations of Lake Oroville and New Bullards Bar Reservoirs*, California*
DWR is partnering with Yuba Water Agency and Scripps Institution of Oceanography at the University of California, San Diego to conduct a study and evaluate implementation and optimization of Forecast-Informed Reservoir Operations (FIRO) of the Lake Oroville and New Bullards Bar (NBB) reservoirs, which are operated in coordination to avoid flooding downstream of the Yuba-Feather River confluence. FIRO is a strategy that leverages advances in forecasting technology to allow for greater flexibility in reservoir operation and in turn, to potentially enhance flood control and water supply benefits. Completed the analysis of FIRO at Oroville as part of the Comprehensive Needs Assessment (CNA) of the Oroville Dam Complex. The scope described in this Task Order would enable DWR and HDR to

build on the analyses performed as part of the CNA effort by working with Yuba Water Agency and Scripps to further evaluate and refine FIRO alternatives. The services provided with this Task Order are critical to integrating DWR's objectives with the FIRO Program and informing USACE's WCM revisions.

DWR, Hydrological Modeling and Analysis, *California*
Performed hydrological modeling and analyses, developed technical memoranda, and prepared and contributed to design reports. Prepared draft responses to comments/questions received from other consultants, regulatory, or other agencies.

NEVADA IRRIGATION DISTRICT

REQUEST FOR PROPOSALS

PLAN FOR WATER

Nevada Irrigation District is seeking proposals from qualified firms to provide professional design services for assistance in the development of the District's Plan for Water, a long term planning document. Work will include review and update as necessary, the existing unimpaired hydrology and HEC-ResSim reservoir operations model; development of an integrated land use based demand model encompassing 50-year planning period; and development of supply analysis including multiple drought scenarios.

The deadline for proposals is **5 p.m. on Thursday February 10, 2022.** No submittals will be accepted after that date and time.

Please send one (1) searchable PDF copy of your proposal to:

Nevada Irrigation District
Attn: Doug Roderick, P.E.
Engineering Manager
1036 W. Main Street
Grass Valley, CA 95945

NEVADA IRRIGATION DISTRICT

PLAN FOR WATER

PROPOSAL PACKET & FORMS

REQUEST FOR PROPOSALS

This is a Request for Proposals (RFP) to provide professional design services for assistance in the development of the District's Plan for Water (Plan), a long-term planning document. Work will include review and update, as necessary, the existing unimpaired hydrology and HEC-ResSim reservoir operations model; development of a land-use-based demand model encompassing a 50-year planning period; development of supply analysis; and assistance with strategic alternatives analysis.

The District requests that your proposal be submitted in conformance with the guidelines contained herein. Please respond to all components of the proposal packet.

The contract will be awarded to the most responsible and cost-effective submitter, whose Proposal is within the competitive price range and determined to be the most advantageous to the District based on the specific evaluation criteria herein specified.

The following items are included in this packet:

1. Overview of the Project
2. Problem Statement/Scope of Work
3. Project Components/Task Descriptions
4. Partial list of work completed to date
5. Proposal Meeting
6. Proposal Criteria, Evaluation, and Content Overview
7. Appendix A - Hydrologic Analysis Technical Memorandum – Final Report
8. Appendix B - Water Demand Projection Model Update – Final Report
9. Appendix C - Water Supply Analysis Technical Memorandum – Final Report
10. Appendix D - Public comments received for Hydrologic Analysis Technical Memorandum, Water Demand Projection Model Update, and Water Supply Analysis Technical Memorandum
11. Appendix E - Memorandum on Water Supply Analysis using alternative 5-year drought based on five consecutive driest years in the 1976-2011 periods of record (Appendix C of Appendix C – Water Supply Analysis TM)
12. Appendix F - Memorandum on Water Supply Analysis using alternative 5-year drought based on the repeated average of the five consecutive driest years in the 1976-2011 periods of record (Appendix D to Appendix C –
13. Appendix G - Plan for Water Planning Matrix
14. Appendix H Copy of Standard Consulting Contract

Your Proposal should follow the order of evaluation criteria established in this RFP.

I. OVERVIEW OF THE PROJECT

The Nevada Irrigation District (NID) is an independent public agency governed by a five-member elected Board of Directors. The District supplies water to nearly 25,000 homes, farms, and businesses in portions of Nevada, Placer, and Yuba counties. NID supplies both treated drinking water and raw water for irrigation. Approximately 90 percent of NID's annual demand is comprised of raw water demand during the irrigation season, April 15 to October 15 annually.

The Plan for Water (Plan) is a long-range decision tool to guide NID's water management. The Plan for Water process is an open and comprehensive look by NID and the community at the potential limitations of its available water resources and the impacts of new regulations, changes in land use, climate change, and community visions. The Plan will develop a range of potential scenarios for the NID's Board of Directors to consider when determining the best ways to meet the community's demand for water for the next 50 years while weighing the impact on the NID, the community, and the environment. When complete, the Plan will show how a variety of future water supply and demand scenarios could be integrated to ensure our community enjoys the same high-quality, reliable water system that NID has now.

NID's water supply comes from four primary sources: natural runoff (including snowmelt) from the contributing watershed areas, reservoir carryover storage, contract water purchases, and recycled water. NID's water supply system is a store-and-release system in that reservoirs store snowmelt and seasonal rains for release during the typically dry irrigation seasons.

The expectation for the Plan is to have robust public participation throughout its development. The Consultant can expect that the NID Board of Directors, staff, stakeholders, and the general public will be part of developing the three technical sections of the Plan, as identified below. It will be done through various workshops and public meetings and is a requirement for the Consultant to incorporate public participation in the development process.

II. PROBLEM STATEMENT/SCOPE OF WORK

The technical goal of the Plan is to assemble hydrologic data sets representative of historical and projected climate change conditions for the next 50 years specific to our watershed and have the flexibility to be updated as new information becomes available. These data sets will cover a range of projected likely outcomes based on various scenarios of greenhouse gas emissions reductions. Hydrologic data sets will be used to develop a supply analysis to quantify how much of the projected runoff is available for water supply. A demand model for both treated water and raw water will be developed to determine future demands for the District. The PFW will use information from the supply and demand analyses to determine if the projected supply will meet projected demands for the next 50 years. If the projected supply cannot meet projected demands, it will be necessary to analyze various reasonable, practical, and feasible demand-side and supply-side alternatives to bridge the gap.

A hydrologic data set representative of projected climate change conditions in 50 years, along with demand projections, is necessary to develop the projected water supply available to the District, which can then be used to develop necessary projects, programs, and processes.

A substantial amount of hydrologic data already exists that can be utilized for unimpaired hydrology development. A HEC-ResSim reservoir operations model was previously developed to support the Yuba-Bear/Drum-Spaulding Project relicensing (YB/DS operations model). Unimpaired hydrology is a fundamental input of the YB/DS operations model. In 2020, NID updated its YB/DS operations model unimpaired hydrology using the California Water Commission (CWC) model, which was the most relevant publicly available data set to support climate change studies in California. The

projections included the median 2070 conditions, drier/extreme warming conditions, and wetter/moderate warming conditions. Unimpaired hydrology data sets were developed for Water Years 1976 through 2011. The upper bound of 2011 is based on the available period of record of projected hydrologic data provided by the CWC. Additionally, unimpaired hydrology was developed in several smaller watersheds that were not part of the original analysis.

Water usage with NID's system consists of several components: raw water demand, treated water demand, environmental flows, system losses, and municipal purchases. The sum of these components equals the total water demand for the NID system. As part of the Plan, NID is looking to develop projects for future water use within its service area. The projections will encompass a 50-year planning period. In addition to utilizing historical water use, future demands will also be projected based on general plans, projected growth patterns, and soft service areas.

NID's first water demand projection model was developed in 2005. NID updated that model in 2020, migrating the previous model to MS Access for better functionality and GIS data integration. Due to some issues related to updating the original model, NID has decided to develop a new demand projection model. NID will be looking to the selected Consultant to recommend and develop the appropriate model approach. This approach will be vetted through the public process prior to developing the actual model.

NID has a complex set of 53 pre and post 1914 water rights utilized to meet its supply needs, along with purchased contract water and recycled water. The reservoir operations model has been developed utilizing NID water rights. As part of the Plan, NID will be updating its projected water supply, which will include multiple 5-year drought scenarios.

III. DESCRIPTION OF PROJECT COMPONENTS

Item 1: Kick-off Meetings

a. Facilitate a kick-off meeting with NID staff to discuss the Plan process
b. Facilitate a kick-off meeting with representatives of NID and stakeholders to identify goals and objectives for the technical work for the Plan
c. Perform a due diligence review to identify the process required to achieve the desired goals and objectives

Item 2: Detailed Project Schedule

d. Collaborate with District staff on proposed milestone project dates and develop a schedule that would need to be implemented to meet those milestones
e. Develop a detailed timeline for each phase identified to achieve the desired goals and objectives
f. Schedule will include having multiple tracks of work happening concurrently
g. Provide anticipated dates for deliverables and allotted District and Stakeholder review time

Item 3: Meetings with NID Staff

a. Assume bi-weekly meetings with Staff throughout the duration of the process. These meetings can be via Zoom or in person. Anticipate that some of these meetings will need to be in person, depending on discussion topics
b. Assume up to 15 additional meetings as necessary to address comments or input received from the Board, staff, and the public
c. Consultant shall develop meeting minutes for all meetings
d. Consultant shall respond to in writing all public comments received

Item 4: Board of Directors and Public Engagement

a. Provide support, consultation, and documentation. Including, at minimum, preparing review packages, attendance of meetings, providing support during the process, incorporation, and response to comments
b. Coordinate and support NID staff with updates, documents, etc. Including documents and information suitable for posting on the project website
c. Assume 15 Board workshops/meetings (up to 4 hours per workshop/meeting)
d. Assume 120 hours for meetings with NGOs, agencies, public groups
e. Assume 80 hours of written responses to comments received

Item 5: Unimpaired Hydrology

a. Review and become familiar with the existing Reservoir Operations model
b. Perform a literature review on current academic literature and industry publications (PPIC, AWWA, etc.) and provide a summary of this review that will be used for engaging and educating the public
c. Update historical watershed runoff to include the most recent data available (the current historical data is only through the year 2011)
d. Receive input from the Board of Directors and the public and develop recommendations to update the model
e. Update/revise projected climate change conditions based on Consultant's recommendation and input from stakeholders and the Board
f. Assume up to 5 model runs/scenarios
g. Final Technical Memorandum memorializing the assumptions, information, process, and procedures
h. Provide summary materials, guides, and other reasonable communications that explain the analytical framework and process and complex ideas in coherent and digestible lay terminology

Item 6: Demand Projection Model

a. Receive input from the Board of Directors and the public. Develop a model based on Consultant's recommendation and input from stakeholders and the Board
b. Perform a literature review on current academic literature and industry publications (PPIC, AWWA, etc.) and provide a summary of this review that will be used for engaging and educating the public
c. The demand model should consider at a minimum the following:
   (1) GIS Parcel Data
   (2) Land Use and Zoning Data provided by local land-use authorities
   (3) Historical Treated and Raw Water Customer Data
   (4) Treatment Plant Data
   (5) Canal Flow Data
   (6) Crop Report Data
   (7) Population (DOF and Regional Census) Data
   (8) Impacts due to COVID-19 Pandemic
   (9) Mutual Water Companies
   (10) Soft Service Areas/Topography
   (11) "Fill in" areas where groundwater wells are currently being used within treated water service areas
d. Meet with applicable city/county staff regarding general plans and growth projections.
e. Demand model will be able to provide specific output for treated water systems and individual canals to allow for master planning

f. Final model shall be in a format that NID can utilize in the future to make adjustments to the various inputs
g. Assume 5 model runs/variations for workshops and discussions with the Board and the public.
h. Final Technical Memorandum memorializing the assumptions, information, process, procedures
i. Provide summary materials, guides, and other reasonable communications that explain the analytical framework and process and complex ideas with coherent and digestible lay terminology
j. Training session for staff on how to utilize the model

Item 7: Supply Projection

a. Utilizing the revised/updated reservoir model operations with updated hydrology/climate change and the newly developed demand model, update the water supply projections
b. Develop 5-year drought scenarios that will be used for long-range planning. Assume 5 drought scenarios to run for workshops and discussions with the Board and the public
c. Final Technical Memorandum memorializing the assumptions, information process, and procedures
d. Provide summary materials, guides, and other reasonable communications that explain the analytical framework and process and complex ideas with coherent and digestible lay terminology

Item 8: Strategy Alternatives Analysis

a. Consultant will work with the Board, staff, and the public to develop a suite of strategies for each of the main options identified in Stage 8 of the Plan for Water Matrix: Operations, Restoration/Rehabilitation, Management, and Supply
b. Consultant will work with the Board, staff, and the public to develop a strategy evaluation matrix to evaluate the various strategy options developed. See Stage 9 of the Plan for Water Matrix.

Item 9: Miscellaneous

c. All Final Technical Memorandums will be stamped by a Registered Civil Engineer licensed in the State of California
d. Consultant will play an active part in the Board meetings and workshops, as well as meetings with stakeholders
e. Consultant shall develop meeting notes for all meetings

IV. PARTIAL LIST OF WORK COMPLETED TO DATE

Below is a partial list of the work completed to date and available under the Project section of the District website at nidwater.com (contains active links to the website)

Appendix A – Hydrologic Analysis Technical Memorandum – Final Report, November 2020

Appendix B – Water Demand Project Model Update – Final Report, November 2020

Appendix C – Water Supply Analysis Technical Memorandum – Final Report, November 2020

Appendix D – Public comments received for Hydrologic Analysis Technical Memorandum, Water Demand Projection Model Update, and Water Supply Analysis Technical Memorandum

Appendix E - Memorandum on Water Supply Analysis using alternative 5-year drought based on five consecutive driest years in the 1976-2011 periods of record

Appendix F – Memorandum on Water Supply Analysis using alternative 5-year drought based on the repeated average of the five consecutive driest years in the 1976-2011 periods of record

APPENDIX G – Plan for Water Planning Matrix

V. PREPROPOSAL MEETING

A preproposal meeting will be held on **Tuesday, January 25, 2022, at 10:00 am**. Due to the COVID-19 Pandemic, this meeting will be held via Zoom.

Meeting Information

Plan for Water RFP – Preproposal Meeting

Webinar ID: **817 0896 2297** Passcode: **056236**

or One tap mobile:

US: +16699006833,,81708962297# or +13462487799,,81708962297#

or telephone:

1 669 900 6833 or +1 346 248 7799
Webinar ID: 817 0896 2297

Additionally, questions will be accepted until Friday, February 4, 2022, at 5:00 pm via email. Please provide all questions via email to Doug Roderick, P.E., at roderick@nidwater.com.

VI. PROPOSAL CRITERIA, EVALUATION, AND CONTENT OVERVIEW

The Proposal shall not exceed twenty (25) pages, excluding resumes and transmittal letter. The Proposal shall be able to be printed on 8-1/2 X 11 paper. Diagrams and schedules will be allowed to be 11X17 paper. CDs of supplemental material will not be considered in the evaluation.

The Proposal shall be sufficient enough to demonstrate the Proposer's understanding of the Project, their approach, and experience. The below criteria will be used to evaluate the content of the Proposal for ranking.

1. **Project Overview and Approach (25%):**
   Provide a narrative overview of the Project understanding and approach based on this RFP. Include any comments or recommendations that would enhance the scope of the Project or overall goal, project schedule, or implementation. Significant items not part of this RFP should be indicated as optional work and quantified separately.

2. **Technical Expertise and Qualifications (30%):**
   Describe the Proposer's experience in completing similar projects. Include descriptions and references of three projects that would demonstrate the experience. The description and reference should include the name and location of the project, scope, key components, how it relates to this Project, cost, and owner's/representative contact information that is familiar with the project to be contacted.

Identify the main contributors to the Project team, their corresponding duties, their key tasks, and their office location. Provide an organization chart, clearly identifying the Project Manager. The Project Manager shall remain the same for the course of the Project unless approved by the District.

Describe the Proposer's experience and techniques for stakeholder and public engagement and in providing innovative communication techniques. Examples should demonstrate an ability to translate complex analytical principles and processes, such as assumptions, sensitivities, hydrologic and demand dynamics, and geographic scope in reasonable lay terminology.

Identify sub-consultants, if any, describing their expertise, experience, and involvement in the Project.

Include Resumes for all project team members (Consultant and all sub-consultants).

Consideration of the accessibility to staff will be included in the evaluation.

3. **Detailed Project Scope of Work (25%):**
   Based on the general scope of work provided in this RFP, Consultant shall provide a detailed scope of work that includes all tasks and subtasks, including proposal deliverables. The scope of work shall illustrate the Consultants unique understanding of the tasks required to complete the effort within the context of the greater Plan for Water effort.

4. **Project Schedule (10%):**
   Provide a detailed Project schedule. The schedule should be represented with time graphs. Tasks and subtasks, including optional work, should detail the time requirements and milestone dates. See below for details on District driven timelines. Please refer to the overall Plan for Water Matrix and timeline when preparing the schedule.

5. **Cost Proposal (10%):**
   The cost proposal is to be submitted in a separate, sealed envelope. The cost proposal will include assigned staff, hourly rates, and the number of hours per task, and critical subtasks. Include in the Proposal a copy of the Proposer's rate sheets.

6. **Exception to Standard Contract (not weighted for ranking):**
   The selected Proposer will be expected to sign the District's standard agreement included in Appendix H. If any exceptions are taken to the Standard Agreement, the Proposer should submit them to the District for review and consideration.

VII. PROJECT SCHEDULE

A pre-proposal meeting will be held on Tuesday, January 25, 2022. This meeting will be via zoom.

Proposals are due by 5:00 pm on Thursday, February 10, 2022. The District will review the proposals and anticipates conducting interviews with a selected group of Proposers during the week of February 21, 2022. Award of contract is anticipated to go before the Board on March 9, 2022.

VIII. GENERAL INFORMATION

1. The Nevada Irrigation District requests interested firms submit one (1) searchable PDF copy to the District until 5:00 pm on Thursday, February 10, 2022. Mail proposals to Doug Roderick, P.E., Engineering Manager, Nevada Irrigation District, via email to roderick@nidwater.com. Please include in the subject the firm's name along with the title of the Project: *PLAN FOR WATER.*

2. The District may consider non-responsive any proposals not prepared and submitted in accordance with the provision hereof and may waive any formalities or reject any/or all proposals.

Any proposal received after the date and time specified above shall not be considered. There will not be a formal public opening of the proposals.

3. The set of proposals must be submitted as described above. Proposers shall comply with all instructions and provide all information requested. Failure to do so may disqualify a proposal. Proposers will receive a confirmation email of receipt. If no confirmation email is received, most likely, the package exceeded the District's mailbox limits of 10 MB, and a "drop" delivery is required.

   The Proposer's cost of services shall be submitted in a separate email, constrained to the same deadline. Please include in the subject line the firm's name and the following title: *Project Costs: PLAN FOR WATER*. A breakdown of where the costs are directed must be included with the project cost.

4. The Proposal should not exceed twenty-five (25) pages, excluding resumes and transmittal letter.

5. The Proposal shall be divided to correspond with the evaluation criteria outlined in this RFP.

6. An authorized officer shall sign all proposals or an employee of the proposing team authorized to contract work for the firm. Proposals may be withdrawn by written notice at any time prior to the Proposal due date.

7. No interpretations of the meaning of the Request for Proposal or other proposal documents will be made orally. Each request for such interpretations should be made in writing and addressed to Doug Roderick, P.E., Engineering Manager, 1036 W. Main Street, Grass Valley, CA 95945-5424 (roderick@nidwater.com).

8. To be considered, any requests for additional information must be received by 5:00 pm on Friday, February 4, 2022.

9. Any and all such interpretations and any supplemental instruction will be in the form of written addenda to the Request for Proposals, which, if issued, shall become part of the Request for Proposals.

10. During proposal evaluation, proposal questions and scope discussions may occur with proposing teams who submit proposals determined to be reasonably susceptible to being selected for award. However, proposals may be accepted without discussion.

11. After their receipt, the proposals will be reviewed and evaluated in accordance with the rating criteria listed in this proposal form. After the proposal evaluations are completed, a memo of recommendation, including the rating summary, will be forwarded to the District Board of Directors. Award of the Proposal is subject to final approval by the District Board. Once the District Board awards the contract, a purchase order will be generated for the work.

NEVADA IRRIGATION DISTRICT

PLAN FOR WATER

APPENDIX A