



SOUTHERN NEVADA WATER AUTHORITY®

Robust Updates to Advanced Lake Models to Inform Future Drinking Water Treatment Needs

(\$193,085)

WaterSMART - Applied Science Grants for Fiscal Year 2022

R22AS000165

April 6, 2022

Applicant:

Southern Nevada Water Authority

Contact for Further Information:

Julie Schoolmeester
1001 South Valley View Blvd., MS 760
Las Vegas, Nevada 89153

E-mail: julie.schoolmeester@lvvwd.com

Office: (702) 258-7190

Cell: (702) 539-2965

Fax: (702) 258-7146

TABLE OF CONTENTS

SF-424/A/B and SF-LLL Forms SUBMITTED VIA GRANTS.GOV	i
Project Abstract Summary SUBMITTED VIA GRANTS.GOV	ii
Title Page	1
Table of Contents	2
Technical Proposal	
Executive Summary	3
Detailed Project Description	3
Goals	4
Project Location	5
Evaluation Criteria	
Criteria A	5
Criteria B	7
Criteria C	8
Criteria D	11
Criteria E	12
Project Budget	
Funding Plan	14
Budget Proposal	14
Budget Narrative	16
Environmental and Cultural Resource Compliance	17
Required Permits or Approvals	19
Overlap or Duplication of Efforts Statement	20
Letters of Support	20
Official Resolution	20
Conflict of Interest Disclosure	20
Uniform Audit Reporting Statement	20
Certification Regarding Lobbying	20
Unique Entity Identifier	20
Supporting Documents ... SUBMITTED AS ATTACHMENTS VIA GRANTS.GOV	
Appendix A Supporting Figures and References	
Appendix B Letters of Support	
Appendix C Cost Estimates	

1. Technical Proposal: Executive Summary

Date: April 6, 2022

Applicant: Southern Nevada Water Authority (Category A applicant)

Location: 1001 South Valley View Boulevard, Las Vegas, Nevada 89153 (Clark County)

Project Summary: The Southern Nevada Water Authority (SNWA) will expand the forecasting capabilities of the Lakes Mead and Mohave Model (LM3), which is a 3D hydrodynamic and water quality model encompassing the entirety of Lake Mead, the Colorado River below Hoover Dam, and Lake Mohave. This project is novel in that it provides several updates to existing modeling framework utilized by SNWA. The modeling efforts will yield water quality projections not only for raw water drawn from Lake Mead treated by SNWA and distributed to the Las Vegas Valley, but also for raw water drawn by Big Bend Water District (BBWD), a small water utility that services Laughlin, NV. SNWA's Water Resource Plan, which addresses planning for drought, prioritizes this project as a key drought planning action. Funding will allow SNWA to perform modeling efforts to accomplish the proposed work. Project activities will develop modeling tools for communities to evaluate options and implement strategies to address changes to both raw water quality and raw water treatment options as climate change impacts stress the severe, prolonged drought in the region.

Length of Time and Estimated Completion Date: The proposed project encompasses activity from February 2023 through January 2025. All project work will be completed by January 2025.

Federal Facilities: The proposed project is not located on a federal facility. Routine water quality sampling efforts already underway by SNWA and partner agencies will continue in Lake Mead National Recreation Area to support model calibration.

2. Technical Proposal: Detailed Project Description

SNWA maintains a full three-dimensional hydrodynamic and water quality model for Lake Mead that is used to simulate probable future scenarios and aid in management decisions. A coupled model for the Colorado River below Hoover Dam and Lake Mohave has also been developed. This coupled model is implemented in Aquatic Ecosystem Model 3D (AEM3D). AEM3D approximates quantities of interest by solving the Reynolds-averaged Navier-Stokes equations with a turbulent eddy closure. The model solves for hydrodynamic and water quality parameters in each grid cell.

The model grid is based on lake bathymetry and uses a 300x300 meter x-y grid (Lake Mead) and a 100x100 meter x-y grid (Colorado River and Lake Mohave) with depth outputs every two meters. Meteorological parameters acquired from the United States Geological Survey (USGS) and the National Oceanic and Atmospheric Administration (NOAA) are input into the model as boundary forcing values. The model was calibrated to measured data to ensure model accuracy and minimization of error as a future planning tool. The Lake Mead Model has been used by SNWA to quantitatively predict the effects of potential future changes, including climate change and lake drawdown due to drought. The Lake Mohave Model is under development but will be incorporated into this proposed project. Several recent and ongoing projects with the Lake Mead Model include:

- Determining optimal placement for a newly constructed drinking water intake (constructed and brought online in 2016) to ensure system longevity.
- Quantifying inflow concentration from the Las Vegas Wash at different sampling locations to assess future water quality standard compliance.
- Quantifying the effects of climate change and lake drawdown on raw water quality at SNWA's and BBWD's drinking water intakes.
- Determining maximum sediment loads at the drinking water intake to inform future water treatment plant operations.

The goal of this work is to improve water management and identify potential strategies to address drought in the Lower Colorado River Basin by incorporating needed improvements to the Lakes Mead and Mohave Models (LM3) to better plan for drought resiliency. Target improvements to the model include:

- Incorporating projections from the United States Bureau of Reclamation's (Reclamation) Colorado River Mid-term Modeling System–Ensemble Streamflow Prediction (CRMMS-ESP), including inflows and outflows from Hoover Dam and outflows from Davis Dam. This project will set a framework for updates to LM3 each time an CRMMS-ESP update is released. The updates will enable Lower Colorado River Basin water users to improve management of water and the water treatment process by alerting staff to predicted conditions based on the official CRMMS-ESP forecasts used by Reclamation. This will also allow us to provide information to ecosystem managers about predicted conditions that pose a risk to endangered species.
- Continuing to update climate change projections to the inputs to LM3.
- Enhancing LM3 to reflect flow projections based on relevant factors, including the population projections.
- Using LM3 to plan for emergency events that could occur, such as storm events or wildfires, which may cause large turbidity spikes or nutrient loading in the lake.
- Ongoing model calibrations of LM3.
- Incorporating a Reclamation-funded model to optimize SNWA's treatment plant operations (funded by Reclamation agreement R18AC00021).

A flow chart for planned modeling efforts is given in Appendix A. SNWA currently maintains LM3 in-house; however, additional project funds are requested to hire a Postdoctoral Researcher (postdoc) as well as equipment the postdoc will need, such as a computer and relevant software. The postdoc will perform the majority of the outlined modeling updates with guidance from SNWA staff. These modeling updates will be used to improve SNWA's and BBWD's raw water quality projections, which will inform proposed changes to treatment processes. The inclusion of BBWD in this project is of importance as small systems often have less water supply/water quality system redundancies and may be more susceptible to drought impacts.

3. Technical Proposal: Goals

Three measures quantify the benefits of the proposed project. 1) Updating LM3 to project the effects of potential future scenarios in the Lower Colorado River Basin and create more robust projections for raw water quality at SNWA's water treatment plants and BBWD's water treatment plant. 2) Using the LM3 raw water quality projections coupled with the Machine Learning Water Treatment Plant Model to evaluate proposed changes to water treatment plants

before making costly infrastructure changes. 3) Using LM3 to project downstream conditions for Colorado River water managers in Arizona and California.

4. Technical Proposal: Project Location

The technical work for the proposed water quality and treatment modeling project will occur at SNWA's River Mountains Water Treatment Facility, in Henderson, NV. The project study area includes Lakes Mead and Mohave, located in Lake Mead National Recreation Area, NV/AZ, as well as SNWA's two water treatment facilities and Big Bend Water District's water treatment facility. A project location map is included in Appendix A.

5. Technical Proposal: Evaluation Criteria

E.1.1. Evaluation Criterion A—Benefits to Water Supply Reliability

1. Describe in detail the water management issue(s) that are occurring within your project area that your project will address.

Three key water management issues will be addressed in this project, including (1) changes to water quality because of drought and climate change, (2) changes to treatment processes at three existing water treatment facilities in Southern Nevada, and (3) impacts of water quality changes to native species. While the Lower Colorado River Basin has maintained high water quality despite a 20-year drought, continued severe drought could impact water quality. These changes will not only impact Southern Nevada, but also millions of people downstream in California, Arizona, and Mexico. Raw water temperature in Lake Mead is projected to increase as drought and climate change impact that Lower Colorado River basin, and more severe drought will lead to the potential for more issues in the region (Hannoun, Tietjen, & Brooks, 2021). Warmer water will be more difficult and costly to treat. The severity of the drought could yield changes ranging from incurred additional chemical cost to infrastructure changes at the water treatment facilities. Finally, changes to water quality, especially water temperature and dissolved oxygen, may affect native endangered species such as the razorback sucker and humpback chub.

The project will build long-term drought resilience in the Lower Colorado River Basin by expanding modeling capabilities developed by SNWA. These expanded modeling capabilities will lead to more robust projections and allow SNWA and downstream users to better identify and plan for challenges that will arise due to drought. Further, this project will increase the ability of SNWA and BBWD to continue to provide high-quality finished water to their consumers.

Once the project framework is in place, these model updates will become a crucial part of SNWA's routine drought contingency planning and will be updated in conjunction with Reclamation's CRMMS-ESP model releases for the foreseeable future. Therefore, the project's benefits will extend beyond the two-year period available in this funding opportunity. Funding to kickstart this additional modeling framework will lead to long-term improvements to SNWA's drought contingency planning process. Further, SNWA has forged strong connections with other water utilities, and this modeling framework can be used as a guideline for other utilities affected by long-term drought.

2. Explain how your project will address the water management issues identified in your response and provide support for your response.

This project will improve water management by supporting water supply reliability. As the drought continues, SNWA and BBWD's drinking water intakes may withdraw epilimnetic water, which is warmer, higher in nutrients, and consequently more difficult to treat, threatening the water supply for over 2.2 million residents and 43 million annual tourists. Models will be used as future planning tools to understand potential changes to water quality before they occur and will allow water managers to take appropriate action to mitigate changes to water quality and maintain treatment and delivery efforts.

The project will also support drought management activities. SNWA has a long history of innovative conservation practices, including recycling indoor water and banning nonfunctional turf. This model is another piece of SNWA's Water Resource Plan as it acts as an alert to water managers to plan for changes due to drought. This will help SNWA and partner agencies, such as downstream users and wastewater dischargers, mitigate the effects of drought in the Lower Colorado River Basin.

Another water management improvement is the ability to meet endangered species requirements. Water conditions that are not amendable to protecting endangered species that reside in Lakes Mead and Mohave, such as the humpback chub and razorback sucker, will be projected and mitigated before they occur, ensuring compliance with endangered species requirements. These modeling efforts can project changes to water quality and ensure management steps are taken to maintain long-term watershed health.

3. Describe *to what extent* your project will improve water management. Describe the significance or magnitude of the benefits of your project, either quantitatively or qualitatively, in improving water management, with supported details.

The project will increase robustness of SNWA's and BBWD's water treatment plants that supply approximately 90 percent of southern Nevada's annual water deliveries. This project is significant in scope and magnitude as it not only bolsters confidence in water deliveries made to Las Vegas' 2.2 million residents and 43 million annual tourists, but also provides water quality projections for 40 million municipal and agricultural users in Arizona, California, and Mexico. This project increases both the efficiency and operational flexibility of the treatment plants. First, by expanding the capabilities of LM3 to account for numerous potential scenarios that have not been previously considered, SNWA and BBWD can better understand the effects of drought, climate change, and anomalous events on the raw water supply. When these effects are better understood, SNWA's Machine Learning Water Treatment Plant Model will then be used to optimize treatment plant operations. Further, this model increases operational flexibility as it can be used to test alternate treatment scenarios and evaluate alternative treatment technologies before costly infrastructure improvements are made. Also, projected changes to hydrodynamic and water quality parameters will be communicated to stakeholders downstream, including Central Arizona Project (CAP), Coachella Valley Water District (CVWD), and Metropolitan Water District of Southern California (MWD) (see Letters of Support, Appendix B) so they can prepare for potential operational changes.

4. Explain how your project *complements* other similar efforts in the area where the project is located.

This project complements federal water modeling efforts in the Colorado River Basin. Reclamation releases five-year storage and flow projections for the entire basin from the CRMMS-ESP model each month. The goal of this project is to take Reclamation's water quantity projections and couple them with rigorous, robust water quality projections for the Lower Colorado River Basin.

E.1.2. Evaluation Criterion B—Need for Project and Applicability of Project Results
Explain how your project will result in readily useful applied science tools that meet an existing need.

This project will result in both applied sciences tools and information that meets the needs of SNWA and partner agencies in the basin, as well as other utilities prone to the drought effects. The project will result in a modeling framework tool that yields information regarding future water quality in the Lower Colorado River Basin which will better inform decision making processes for water managers. At SNWA, treatment staff and water managers have identified the need for this project. SNWA has a long history of innovating water treatment processes (Ersan & Dickenson, 2022) (Kibuye, et al., 2021) and the source water changes projected as a result of this project will better inform how changes to water treatment may occur at SNWA's three water treatment facilities in the future. These efforts are crucial in SNWA's Water Resource Plan (Southern Nevada Water Authority, 2022).

In the Las Vegas Valley, wastewater dischargers, including Clark County Water Reclamation District (CCWRD), City of Henderson (COH), and City of Las Vegas (COLV) expressed interest in this project to ensure their nutrient removal is adequate to ensure continued recycling of indoor water, which is important for regional drought impact mitigation. Clark County Regional Flood Control District (CCRFCD) supports this effort as it will assist in understanding how stormwater may enter the lake and its effects on water quality. In the Lower Colorado River Basin, MWD and CAP support this project as it will yield a water quality snapshot in the basin and aid in understanding potential changes to water quality downstream. CVWD also supports this project as a tool to aid in decision-making processes regarding salinity. More broadly, Valley Water in Northern California supports these efforts as a model for utilities interested in future drought and climate planning. Letters of support are included in Appendix B.

Who will be involved in the project as project partners? What will each partner or stakeholder's role in the project be? How will project partners and stakeholder be engaged in the project and at what stages?

SNWA staff will be completing the technical work for this project. Wastewater dischargers and local government entities (CCWRD, COH, COLV, and CCRFCD) will assist in not only modeling suite design but also the review of results and applications. This will occur at regularly scheduled meetings attended by these organizations, including the Las Vegas Valley Watershed Advisory Committee, Stormwater Advisory Council, and the Research and Environmental Study Team meeting.

Downstream users will be informed of results through presentations at regional meetings, including the Lower Colorado River Partnership Meeting, which includes SNWA, CAP, and MWD. Utilities concerned with drought and climate change will receive updates via presentations at national conferences and publication in peer-reviewed journals.

Will the results of your project inform water resource management actions and decisions *immediately* upon completion of the project, or will additional work be required? Will the results of your project be *transferrable* to other users and locations?

This project provides a framework for immediate dissemination of results upon completion. The project scope covers not only dissemination of modeling results, but the application of those modeling results to treatment processes, wastewater treatment, and downstream water quality. This project can also serve as a framework for modeling water quality under projected future scenarios for water utilities, irrigation districts, and Tribes outside of the Lower Colorado River Basin.

E.1.3. Evaluation Criterion C—Project Implementation

1. Briefly describe and provide support for the approach and methodology that will be used to meet the objectives of the project.

The Lakes Mead and Mohave Model (LM3): SNWA maintains a full three-dimensional hydrodynamic and water quality model for Lakes Mead and Mohave that is used to simulate probable future scenarios and aid in management decisions. This model is implemented in Aquatic Ecosystem Model 3D (AEM3D). Model calibration indicates that the LM3 provides an excellent fit to collected field data (Hannoun, Tietjen, & Brooks, 2021). The LM3 is used by SNWA to quantitatively predict the effects of potential future changes, including climate change and lake drawdown due to drought. Several recent and ongoing projects with the LM3 include 1) Determining optimal placement for a newly constructed drinking water intake to ensure system longevity; 2) Quantifying inflow concentration from the Las Vegas Wash at different sampling locations to assess future water quality standard compliance; 3) Quantifying the effects of climate change and lake drawdown on raw water quality at SNWA’s drinking water intake; 4) Determining maximum sediment loads at the drinking water intake to inform future water treatment plant operations; and 5) Quantifying the effects of predicted warmer inflows from upstream Glen Canyon Dam.

In this study, robust and necessary updates to LM3 are proposed that will continue to ensure use an applicability at SNWA, the Las Vegas Valley, the Lower Colorado River Basin, and partner utilities.

Colorado River Mid-term Modeling System-Ensemble Streamflow Prediction (CRMMS-ESP): The CRMMS-ESP is managed by Reclamation and yields a model that provides five-year (60-month) projections for reservoir elevations, inflows, and outflows for the chain of reservoirs along the Colorado River Basin, including Lakes Powell and Mead. The model complies with all Colorado River Policies, including the 2007 Interim Guidelines, the Lower Basin Drought Contingency Plan, and Minute 323 (United States Bureau of Reclamation, 2022). Reclamation’s most probable, maximum, and minimum model projections are used in this study to forecast inflow and outflow volumes for Lakes Mead and Mohave.

Downscaled Climate Projections: Downscaled climate projections for Clark County (Kalansky, Sheffield, Cayan, & Pierce, 2018) will be incorporated into LM3 as boundary forcing values. This has previously been done successfully (Hannoun, Tietjen, & Brooks, 2021).

Machine Learning Models: Machine learning models will be used not only to emulate water treatment plant processes, but also to project Colorado River temperature and dissolved oxygen based on date and Lake Powell's elevation. These models will be constructed in validated in MATLAB (Brieman, Friedman, Olshen, & Stone, 1984) (MathWorks, 2021).

2. Describe the work plan for implementing the proposed scope of work.

Task 1: Train Postdoctoral Researcher on SNWA's modeling capabilities, including LM3 and Machine Learning Models (4 months; February 2023-June 2023): This will occur immediately after the postdoc is hired. The postdoc will become familiar with existing SNWA modeling efforts, including scraping and cleaning model input data, performing model simulations, performing model calibrations, and postprocessing model simulations. Projected equipment cost is \$17,351, which includes a computer and software for the postdoctoral researcher. Projected staff costs include \$35,683 for the postdoctoral researcher (692 hours including salary and fringe), \$16,756 for Dr. Hannoun (173 hours including fringe), and \$22,342 for Dr. Tietjen (173 hours including fringe). Please note that salaries for each task are rounded to the nearest integer value. Total cost for Task 1 is anticipated to be \$92,132.

Task 2: Improving existing modeling capabilities (3 months; June 2023-August 2023): This will occur after the postdoc is trained on LM3 and Machine Learning Models. The postdoc, with support from SNWA's technical staff including Dr. Hannoun, will identify how to effectively incorporate the proposed changes to LM3 that will increase the model's robustness. Projected staff costs include \$26,763 for the postdoctoral researcher (519 hours including salary and fringe), \$12,592 for Dr. Hannoun (130 hours including fringe), and \$16,789 for Dr. Tietjen (130 hours including fringe), \$5,650 for Seth Shanahan (50 hours including fringe), and \$4,520 for Keely Brooks (50 hours including fringe). Total cost for Task 2 is anticipated to be \$66,314.

Task 3: Updating model calibrations and input data (ongoing; beginning August 2023): The postdoc and Dr. Hannoun will continue to update model simulations as new data becomes available. Most notably, the updated CRMMS-ESP projections from Reclamation will be incorporated into the model monthly as soon as they become available. Projected staff costs include \$38,004 for the postdoctoral researcher (737 hours including salary and fringe), \$18,790 for Dr. Hannoun (194 hours including fringe), and \$25,054 for Dr. Tietjen (194 hours including fringe). Total cost for Task 3 is anticipated to be \$81,848.

Task 4: Postprocessing model results (ongoing; beginning August 2023): Updated results from LM3 will be postprocessed and prepared for presentation to both technical and non-technical audiences. These presentations will focus on quantifying how raw water coming into SNWA and BBWD's water treatment plants may change. Projected staff costs include \$38,004 for the postdoctoral researcher (737 hours including salary and fringe), \$18,790 for Dr. Hannoun (194 hours including fringe), and \$25,054 for Dr. Tietjen (194 hours including fringe) \$5,650 for Seth Shanahan (50 hours including fringe), \$4,520 for Keely Brooks (50 hours including fringe), \$5,812 for Senior Resource Analyst (50 hours including fringe), \$5,327 for Resource Analyst (50 hours including fringe). Total cost for Task 4 is anticipated to be \$103,157.

Task 5: Determining optimal treatment plant operations (ongoing; beginning September 2023): Machine Learning Models will be used to determine optimal plant operation in consideration of

projected changes to raw water. Projected staff costs include \$38,004 for the postdoctoral researcher (737 hours including salary and fringe), \$18,790 for Dr. Hannoun (194 hours including fringe), and \$25,054 for Dr. Tietjen (194 hours including fringe). Total cost for Task 5 is anticipated to be \$81,848.

Task 6: Dissemination of Results (ongoing; beginning February 2024): Project results will be presented to both technical and non-technical audiences, as well as at local and national meetings, for the duration of the project. Publication of results in peer-reviewed journals is planned. Projected travel costs include \$5,000 for the postdoctoral researcher. Projected staff costs include \$38,055 for the postdoctoral researcher (738 hours including salary and fringe), \$18,887 for Dr. Hannoun (195 hours including fringe), and \$25,183 for Dr. Tietjen (195 hours including fringe) \$11,300 for Seth Shanahan (100 hours including fringe), \$8,500 for Keely Brooks (100 hours including fringe), \$5,812 for Senior Resource Analyst (50 hours including fringe), \$10,654 for Resource Analyst (100 hours including fringe). Total cost for Task 6 is anticipated to be \$123,391.

Tasks 1 and 2 will serve as an introduction to SNWA’s modeling capabilities for new staff and are thus expected to be completed quickly. Tasks 3-6 are expected to be ongoing, and as stated earlier, are expected to continue after Reclamation’s funding of this project is completed and will become an integral part of SNWA’s water resource planning.

3. Provide a summary description of the products that are anticipated to result.

Table 1. Anticipated Products

Product	Audience
Water Quality Projections	SNWA staff, Las Vegas Valley stakeholders (CCWRD, COH, COLV, CCRFCD, Nevada Division of Environmental Protection, Colorado River Commission of Nevada), Lower Colorado River stakeholders (MWD, CAP, Colorado River Indian Tribes)
Presentations at Local Meetings	Stormwater Advisory Council, Research and Environmental Monitoring Study Team, California Lake Management Society, Las Vegas Valley Watershed Advisory Committee
Presentations at National Meetings	North American Lake Management Society, Water Quality Technology Conference, Joint Aquatic Sciences Meeting, Ecological Society of America
Publications in Peer-Reviewed Journals	(Potential) Lake and Reservoir Management, Frontiers in Water, Water, American Journal of Climate Change, AWWA Water Science

Presentations at local meetings are important. The Las Vegas Valley is unique in that there are several existing regular meetings where different municipalities and utilities that have supported this project work collaboratively to solve regional challenges. Drought in the western United States is an important media topic. Some of the local meetings, such as Stormwater Advisory Council and Las Vegas Valley Watershed Advisory Committee, are free and open to the public, providing an opportunity for outreach and education regarding this project.

4. Identify staff with appropriate credentials and experience and describe their qualifications.

Staff with credentials to complete this project include Deena Hannoun, Ph.D., Limnology Modeling Project Manager; Todd Tietjen, Ph.D., Research & Development Manager; Seth Shanahan, Colorado River Programs Manager; and Keely Brooks, Climate Change Policy Analyst; as well as a Senior Resource Analyst; a Resource Analyst; and Postdoctoral Researcher TDB.

Dr. Hannoun has comprehensive knowledge regarding using the AEM3D modeling framework and currently manages the LM3 (Hannoun, Tietjen, & Brooks, 2021), and has also constructed numerous machine learning models in MATLAB and R for a variety of mathematical frameworks. Dr. Tietjen has worked on the limnology and dynamics of Lake Mead for over a decade and will provide and evaluate lake modeling scenarios both in terms of reasonableness and likelihood of occurrence and assist in evaluating the model outputs for environmental factors that could influence the outcome of this work. Mr. Shanahan has extensive knowledge of the Upper Colorado River Basin and will provide guidance on the machine learning model to project temperature and DO entering Lake Mead. Ms. Brooks has an impressive background in climate change and will oversee the addition and interpretation of climate impacts into LM3. The Senior Resource Analyst and the Resource Analyst have extensive knowledge of water allocation and quality in the Las Vegas Valley and will aid in interpretation and dissemination of model results.

As part of this project, a third Postdoctoral Researcher will be hired to assist with modeling efforts. The Postdoctoral Researcher must have obtained a Ph.D. from an accredited university and have demonstrable proficiency in mathematical modeling and computer programming. While experience in applications related to water modeling and hydrology would be helpful, they are not required. Some delays may arise in this project if there is difficulty identifying and hiring a qualified candidate.

E.1.4. Evaluation Criterion D—Dissemination of Results

Describe how the tools, frameworks, or analyses developed under the proposed scope of work will be disseminated, communicated, or made available to water resources managers who may be interested in the results.

Dissemination of results for this project is important to the authors and included in the Scope of Work (Task 6: Dissemination of Project Results). Results will be shared with SNWA's Treatment Division to guide future treatment plant modifications through internal meeting and presentations.

In the Las Vegas Valley, results will be shared with local stakeholders by way of regularly scheduled meetings, some of which are open to the general public. The Las Vegas Valley is unique in that there are several existing regular meetings where different municipalities and utilities work collaboratively to solve regional challenges. The existing interdisciplinary, collaborative meetings where these results will be presented include the Las Vegas Valley Watershed Advisory Committee, the Las Vegas Wash Coordination Committee, the Stormwater Advisory Committee, the WateReuse Association: Nevada Chapter, and the Research and Environmental Monitoring Study Team.

In the Lower Colorado River Basin, results will be shared with SNWA’s stakeholders at the Lower Colorado River Partnership meetings and the Clean Colorado River Sustainability Coalition meetings. More broadly, results from this work will be presented nationally, to both technical and non-technical audiences. Proposed conferences include North American Lake Management Society, Water Quality Technology Conference, Joint Aquatic Sciences Meeting, and Ecological Society of America. Publishing of findings in peer-reviewed journals is also considered by the authors to be a crucial part of this project.

E.1.5. Evaluation Criterion E—Presidential and Department of the Interior Priorities

E.1.5.1. Sub-criterion No. E1. Climate Change

1. Please provide specific details and examples on how the project will address the impacts of climate change and help combat the climate crisis.

Anticipated effects of climate change will be incorporated into LM3 in three ways. First, air temperature projections for Clark County (RCP 4.5 and 8.5) will be incorporated as boundary forcing values. Second, a machine learning model will be developed to account for potential changes to water temperature and dissolved oxygen entering Lake Mead. As the drought becomes more severe, Lake Powell may be making epilimnetic releases downstream, and the water entering Lake Mead will increase in temperature and decrease in dissolved oxygen. Finally, wildfires and floods will be accounted for in the raw water supply through simulating turbidity and storm events using LM3. The effects of these events will be studied at drinking water intakes and changes to water quality parameters of interest will be studied. This project will increase resilience to the effects of climate change by allowing water managers to better prepare for and mitigate effects of climate change, most notably changes to water quality. These modeling efforts will allow SNWA and Lower Colorado River Basin users to protect public health by ensuring continued delivery of high-quality water, and conserve Lake Mead National Recreation Area as a national destination.

2. Does this proposed project strengthen water supply sustainability to increase resilience to climate change?

Yes, by allowing utilities to adapt to projected negative climate effects and mitigate damage before these events occur.

3. Does the proposed project contribute to climate change resiliency in other ways not described above?

The proposed project seeks to capture and mitigate the effects of water pollution. Source water quality parameters are expected to decline as drought and climate effects persist in the desert southwest, and the model will be used to project these changes and inform mitigation of their effects.

To adapt to climate change impacts and be more resilient, more data and information is needed to understand the potential impacts. Water quality and treatment modeling using LM3 will improve understanding of climate change impacts to local water sources to develop adequate adaptation strategies. For instance, if it is found that lower lake elevations and warmer air temperatures cause warm water to enter the distribution system, thereby accelerating the formation of trihalomethanes—a contaminant regulated by the EPA, SNWA can implement a number of adaptations, such as extend the water intake withdrawal point to deeper in the lake to

access cooler water, modify operations to blend groundwater with treated water, and/or add aeration devices strategically throughout the distribution system.

The proposed project will account for projected changes in air temperatures from climate models for Clark County as determined by the RCP 4.5 and RCP 8.5 scenarios. Further climate effects will be incorporated by simulating effects of storm events, wildfires, and projected rises in temperature for water entering Lake Mead from upstream Glen Canyon Dam. It will also incorporate the effects of the Las Vegas Valley’s growing population by accounting for increased flow through the Las Vegas Wash into Lake Mead.

E.1.5.2. Sub-criterion No. E2. Disadvantaged or Underserved Communities

1. Please describe in detail how the community is disadvantaged or underserved based on a combination of variables.

The Las Vegas Valley contains significant underserved and disadvantaged communities. The Nevada median household income is \$60,365 in 2019 dollars (US Census Bureau, 2022). In looking at a breakdown of median household income by race in Las Vegas and surrounding cities or areas of unincorporated Clark County in the SNWA service, it can be surmised that households earning less than 100 percent of the statewide median household income will indirectly benefit from the proposed project.

Table 2. Median Household Income by Race: Cities near Las Vegas

	Las Vegas	Henderson	North Las Vegas	Paradise	Spring Valley	Sunrise Manor
American Indian or Alaska Native	\$40,221	\$62,500	\$54,569	\$43,786	No data	\$43,177
Asian	\$60,836	\$76,752	\$72,679	\$49,527	\$66,747	\$61,319
Black or African American	\$36,464	\$51,813	\$49,574	\$32,528	\$45,752	\$29,365
Hispanic or Latino	\$47,898	\$65,313	\$54,238	\$44,268	\$55,279	\$47,114
Native Hawaiian or Pacific Islander	\$65,859	\$82,730	\$62,024	\$46,433	\$79,625	\$41,339
White	\$62,987	\$76,273	\$65,430	\$54,273	\$59,099	\$45,643

Groups highlighted in yellow have a median household income below Nevada’s state median household income (Data Commons, 2022).

To see which underserved communities will indirectly benefit from the proposed project, consider a snapshot of population demographics in the county. Table 3 below outlines these demographics. Additionally, 31.6 percent of residents in Clark County identify as Hispanic or Latino (US Census Bureau, 2022).

Table 3. Underserved Populations by Race, Percentage of Clark County Population

Black or African American, alone	13.1%
American Indian and Alaska Native, alone	1.2%
Asian, alone	10.4%
Native Hawaiian or Other Pacific Islander, alone	0.9%
Two or More Races	4.9%

2. Please describe how and the extent to which the proposed project will serve or benefit a disadvantaged or historically underserved community. Please focus on any project benefits described in response to other sections of these evaluation criteria.

Water management benefits include better understanding and treating raw water and maintaining high consumer confidence in SNWA and BBWD’s finished water. By planning for continued delivery of high-quality, low-cost water, SNWA continues to ensure that these communities have access to an affordable and reliable water supply.

E.1.5.3. Sub-criterion No. E.3. Tribal Benefits

Does the proposed project directly serve and/or benefit a Tribe? Will the project improve water management for an Indian Tribe?

The proposed project will not directly serve or benefit a Tribe. However, the proposed project will indirectly benefit Indian tribes by projecting water quality along the Colorado River, to which Indian tribes have rights, which include the Fort Mojave Indian Tribe, Colorado River Indian Tribes, Chemehuevi Indian Tribe, Quechan Indian Tribe, and Cocopah Indian Tribe in the Lower Basin. Additionally, the Southern Paiute Tribe will indirectly benefit from the proposed project as the nation is in an SNWA member agency service area.

Does the proposed project support Tribal resilience to climate change and drought impacts or provide other Tribal benefits such as improved public health and safety by addressing water quality, new water supplies, or economic growth opportunities?

This project addresses water quality in the Colorado River Basin and can provide projections for changes to water quality. This will enable the Tribes to better adapt to and mitigate the effects of drought and climate change in the region.

6. Project Budget: Funding Plan

SNWA as an organization is funded by diverse sources, including a quarter-cent sales tax, wholesale delivery charges, connection fees, commodity fees, and reliability charges. Matching contributions for this project will be provided by SNWA, through the salary and fringe benefits of permanent, full-time staff working directly on the project, as well as fringe benefits for the postdoc. No non-Federal funding will be provided by a source other than the applicant, so no letters of commitment are required.

7. Project Budget: Budget Proposal

Table 4. Summary of Non-Federal and Federal Funding Sources

FUNDING SOURCES	AMOUNT
Non-Federal Entities	

1 SNWA	\$347,280
2	
Non-Federal Subtotal	\$347,280
REQUESTED RECLAMATION FUNDING	\$193,085

Table 5. Total Project Cost Table

SOURCE	AMOUNT
Costs to be reimbursed with the requested Federal funding	\$193,085
Cost to be paid by the applicant	\$347,280
Value of third-party contributions	\$0
TOTAL PROJECT COST	\$540,365

Table 6. Budget Proposal

BUDGET ITEM DESCRIPTION	COMPUTATION		Quantity Type	TOTAL COST
	\$/Unit	Quantity		
Salaries and Wages				
Deena Hannoun, PM	\$60	1040	Hour	\$62,400
Todd Tietjen	\$80	1040	Hour	\$83,200
Seth Shanahan	\$70	200	Hour	\$14,000
Keely Brooks	\$56	200	Hour	\$11,200
Senior Resource Analyst	\$72	100	Hour	\$7,200
Resource Analyst	\$66	150	Hour	\$9,900
Postdoctoral Researcher	\$41	4160	Hour	\$170,560
Fringe Benefits				
Deena Hannoun, PM	61.43%	\$62,400	Percentage	\$38,332
Todd Tietjen	61.43%	\$83,200	Percentage	\$51,110
Seth Shanahan	61.43%	\$14,000	Percentage	\$8,600
Keely Brooks	61.43%	\$11,200	Percentage	\$6,880
Senior Resource Analyst	61.43%	\$7,200	Percentage	\$4,423
Resource Analyst	61.43%	\$9,900	Percentage	\$6,082
Postdoctoral Researcher	25.77%	\$170,560	Percentage	\$43,953
Travel				
Postdoc Researcher Conference Presentations	\$1,250	4	Conference	\$5,000
Equipment				

Computer for Postdoctoral Researcher	\$9,443	1	Computer	\$9,443
Mathworks Software	\$7,650	1	Software License	\$7,650
Supplies and Materials				
AEM3D Software	\$432	1	Software License	\$432.00
Contractual/Construction				
N/A	\$0	0		\$0
Other				
N/A	\$0	0		\$0
TOTAL DIRECT COSTS				\$540,365
Indirect Costs				
Type of Rate	percentage	\$base		\$0
TOTAL ESTIMATED PROJECT COSTS				\$540,365

*Fringe benefit breakdown is provided in Table 4.

8. Project Budget: Budget Narrative

All costs included in this proposal are directly related to the project and necessary for its implementation. The non-federal contribution is 64 percent; the federal contribution is 36 percent.

Salaries and Wages: SNWA will contribute in-kind wages for permanent, full-time staff members to this project. Project Manager Deena Hannoun, Limnology Modeling Project Manager (\$60/hour), and the Water Quality Division Manager (\$80/hour), will both commit 10 hours/week for the project duration, totaling 1,040 hours each. Seth Shanahan, Colorado River Program Manager (\$70/hour), and Keely Brooks, Climate Change Policy Analyst (\$56/hour), plan to assist with this project for 100 hours/year each, totaling 200 hours over the project duration. A Senior Resource Analyst (\$72/hour) will assist in total of 100 hours over the course of the project and a Resource Analyst (\$66/hour) will assist in total of 150 hours over the course of the project. A postdoctoral researcher (postdoc) will be hired with Reclamation funds. This postdoc will work 40 hours/week (\$41/hour) on this project for the project duration, totaling 4,160 hours.

Fringe Benefits: 61.43% SNWA benefits for permanent, full-time employees and 25.77% for limited-term employees, including postdocs. The breakdown is provided in Table 4.

Table 7. Fringe Benefit Breakdown

OPEB Expense	1.47%
FICA	8.17%
SIIS Premium	0.74%
Unemployment Premium	0.11%
Group Health Insurance	15.28%

Retirement (excluded for Postdoctoral Researchers)	35.66%
Total	61.43%

Travel: \$5,000 is requested for travel to national conferences for the postdoc.

Equipment: A computer, at a cost of \$9,443, with MathWorks software, at a cost of \$7,650, is requested to aid the postdoc in completing research tasks. A quote for a Dell computer and a quote for MathWorks software are in Appendix C. This high-performance computer is needed to complete multiple simulations in a timely manner.

Supplies and Materials: At a cost of \$432, staff will purchase three additional AEM3D licenses to aid the postdoc in completing research tasks. A previous purchase order is in Appendix C.

Contracts: Not applicable to the proposed project.

Third-Party In-Kind Contributions: Not applicable to the proposed project

Environmental and Regulatory Compliance Costs: Please review responses in the Environmental and Cultural Resources section. SNWA does not anticipate additional costs associated with environmental compliance. If SNWA receives an award, possible costs will be discussed during the development of the financial agreement.

Other Expenses: None anticipated.

Total Direct Costs: Reclamation is requested to contribute \$193,085 toward direct costs. SNWA will provide a match of \$347,280.

Indirect Costs: All direct costs align with eligible categories. SNWA does not have a federally negotiated indirect cost rate agreement. No funds are requested for indirect costs.

9. Environmental and Cultural Resources Compliance

Will the proposed project impact the surrounding environment (e.g., soil [dust], air, water [quality and quantity], animal habitat)? Please briefly describe all earth-disturbing work and any work that will affect the air, water, or animal habitat in the project area. Please also explain the impacts of such work on the surrounding environment and any steps that could be taken to minimize the impacts.

The proposed project consists of water quality modeling supported by routine water quality sampling from Lakes Mead and Mohave. Modeling capabilities would be expanded to determine how raw water quality and raw water treatment may change under the projected drought and population growth in the Las Vegas valley. From February 2023 to January 2025, weekly and monthly water samples would be collected from Lake Mead and Lake Mohave, respectively. The collected water samples would be analyzed at the River Mountains Water Treatment Facility (River Mountains) laboratory and the results used to support the modeling work. The proposed project would not require any earth disturbing work. There would be no impacts to soil, air, or water quality. The proposed project would require removing a combined total of approximately 3,200 liters of water from Lake Mead and Lake Mohave each year for water quality sampling,

which is permitted by an interlocal agreement the Southern Nevada Water Authority (SNWA) has with the National Park Service (NPS). The total quantity of water collected would be insignificant compared to the total volume of water contained in the two lakes. Lakes Mead and Mohave provide designated critical habitat for two federally endangered fish: (1) the bonytail chub (*Gila elegans*) that inhabits Lake Mohave and (2) the razorback sucker (*Xyrauchen texanus*) that inhabits both Lakes Mead and Mohave. The insignificant amount of water removed from the lakes and the staggered collection of the samples over a two-year period would not cause adverse impacts to either species or their designated critical habitat. No new roads would be needed, and no roads would be blocked by the proposed project activities. Vehicles would use existing paved and dirt roads to access boat ramps at Lake Mead and Lake Mohave for water sampling.

Are you aware of any species listed or proposed to be listed as a Federal threatened or endangered species, or designated critical habitat in the project area? If so, would they be affected by any activities associated with the proposed project?

The project area for the proposed action includes the River Mountains Water Treatment Facility and Lakes Mead and Mohave. The River Mountains facility is an existing built facility, and its perimeter has both security and tortoise fencing. There is no critical habitat within the River Mountains facility site. The federally endangered bonytail chub and its designated critical habitat occur within Lake Mohave while the federally endangered razorback sucker and its designated critical habitat occur in both Lake Mead and Lake Mohave. Water sampling for the proposed project would remove a combined total of approximately 3,200 liters of water from Lake Mead and Lake Mohave each year, which is permitted by an interlocal agreement SNWA has with the National Park Service. Therefore, the proposed project would not cause impacts to either species or their designated critical habitat.

Are there wetlands or other surface waters inside the project boundaries that potentially fall under CWA jurisdiction as “Waters of the United States?” If so, please describe and estimate any impacts the proposed project may have.

There are no wetlands or surface waters at the SNWA’s River Mountains facility. The water samples will not be collected from sensitive wetland areas, but Lakes Mead and Mohave are surface waters that fall under Clean Water Act jurisdiction as “Waters of the United States”. The proposed project would require removal of a combined total of approximately 3,200 liters of water from the lakes each year. The total quantity of water collected for the proposed project would be insignificant compared to the total volume of water contained in the two lakes, and therefore no impacts to Waters of the United States would occur.

When was the water delivery system constructed?

In 1991, seven local water and wastewater agencies formed SNWA to address water issues on a regional basis, rather than an individual water purveyor basis. Collectively, the member agencies serve more than 2.2 million residents in southern Nevada. As the wholesale water provider, SNWA is responsible for water treatment and delivery through the Southern Nevada Water System that first began in 1971, as well as acquiring and managing long-term water resources. The Las Vegas Valley Water District commenced operations in 1954 and has served the Southern Nevada region’s largest municipal water provider since that time.

Will the proposed project result in any modification of or effects to, individual features of an irrigation system (e.g., headgates, canals, or flumes)? If so, state when those features were constructed and describe the nature and timing of any extensive alterations or modifications to those features completed previously.

The proposed project would not result in the modification of an irrigation system.

Are any buildings, structures, or features in the irrigation district listed or eligible for listing on the National Register of Historic Places? A cultural resources specialist at your local Reclamation office or the State Historic Preservation Office can assist in answering this question.

There are no known buildings, structures, or features associated with the proposed project or within the proposed project area listed or eligible for listing on the National Register of Historic Places.

Are there any known archeological sites in the proposed project area?

There are no known archaeological sites in the proposed project area.

Will the proposed project have a disproportionately high and adverse effect on low income and minority populations?

The proposed project would not have a disproportionately high or adverse effect on low income and minority populations. Proposed modeling efforts would benefit the entire Las Vegas valley service area.

Will the proposed project limit access to and ceremonial use of Indian sacred sites or result in other impacts to tribal lands?

There would be no direct benefits or adverse effects to Indian tribes by the proposed project. There are no Indian sacred sites or tribal lands within the proposed project area. The proposed project area would not limit access to and ceremonial use of Indian sacred sites and would not result in any impacts on tribal lands.

Will the proposed project contribute to the introduction, continued existence, or spread of noxious weeds or non-native invasive species known to occur in the area?

The proposed project consists of water quality modeling supported by routine sampling efforts from Lakes Mead and Mohave. There are no noxious weeds within the proposed project area. However, the non-native invasive quagga mussel (*Dreissena rostriformis bugensis*) does occur in Lake Mead and Lake Mohave. The proposed project involves boating on both lakes to fill water sample collection bottles. The boat would be launched at the Lake Mead Marina boat ramp in Lake Mead and at the Cottonwood Cove boat ramp in Lake Mohave. The boat and sampling equipment would be free of noxious weeds and non-native invasive species prior to arriving at the two boat launch points and prior to departing. Therefore, the proposed project would not contribute to the introduction, continued existence or spread of noxious weeds or non-native invasive species.

10. Required Permits or Approvals

None.

11. Overlap or Duplication of Effort Statement

This project was submitted to the WaterSMART Drought Response Program Drought Resiliency Project FY22 funding announcement. It was not selected for funding.

12. Letters of Support

Attached in Appendix B.

13. Official Resolution

An official resolution authorizing the submission of this proposal and confirming the subject matching requirements will go before the SNWA Board of Directors at its May 19 meeting as communicated to the Program Coordinator. A copy will be forwarded to Reclamation at that time.

14. Conflict of Interest Disclosure

To the best of our knowledge, no actual or potential conflict of interest exists at the time of submission.

15. Uniform Audit Reporting Statement

SNWA was required to complete a Single Audit for the most recently closed fiscal year (ending June 30, 2021). SNWA's EIN is 88-0278492 and the report is available through the Federal Audit Clearinghouse website.

16. Certification Regarding Lobbying

As this application requests more than \$100,000 in Federal funding, the applicant certifies the statements in 43 CFR Part 18, Appendix A. Standard Form-LLL, "Disclosure Form to Report Lobbying" was submitted with this application.

17. Unique Entity Identifier

SNWA maintains an active registration in SAM.gov. Its Cage Code is 3NRT9. SNWA's unique entity identifier, or DUNS No., is 135965650, and SNWA's SAM Unique Identifier is SM1CPB4X7E88

18. Supporting Documents

Attached as Appendices A-C.

Appendix A

Supporting Figures and References

Figure 1. Project Location Map

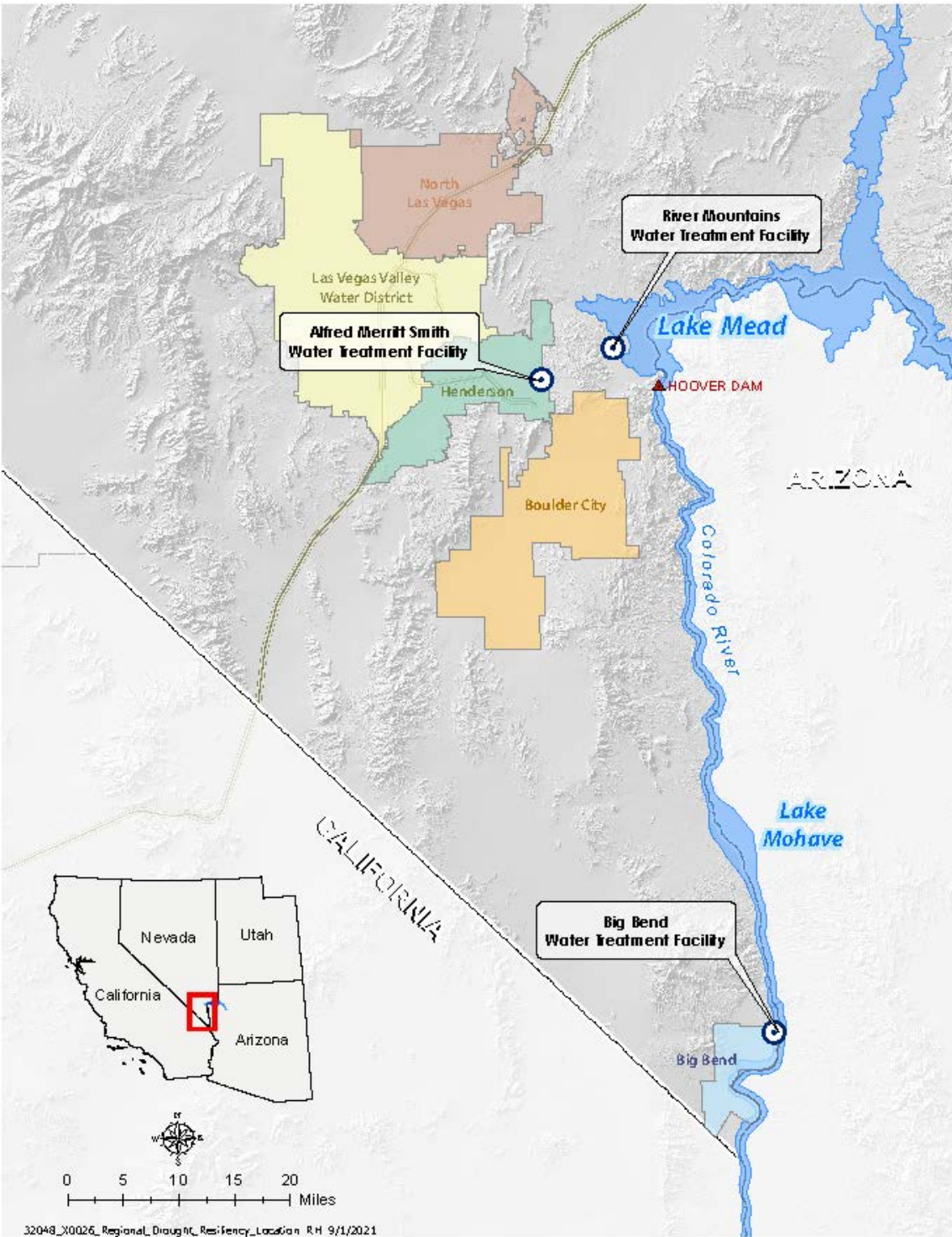
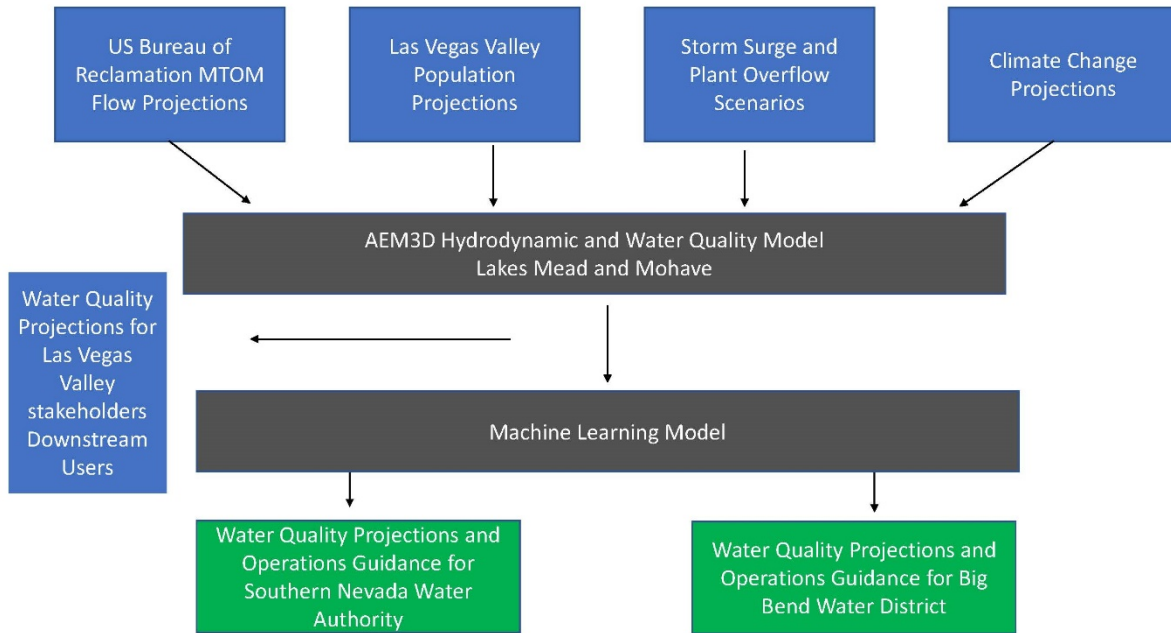


Figure 2. Modeling Workflow



References

- Brieman, L., Friedman, J., Olshen, R., & Stone, C. (1984). *Classification and regression trees*. Boca Raton: CRC Press.
- Data Commons. (2022). *Place Explorer*. Retrieved from https://datacommons.org/place/geoId/3240000?utm_medium=explore&mprop=income&popt=Person&cpv=age%2CYears15Onwards&hl=en
- Ersan, M., & Dickenson, E. (2022). Pretreatment strategies for ion exchange to control brominated disinfection byproducts in potable reuse. *Chemosphere*.
- Hannoun, D., Tietjen, T., & Brooks, K. (2021). The potential effects of drawdown on a newly constructed drinking water intake: study case in Las Vegas, NV. *Water Utility Journal*, 1-11.
- Kalansky, J., Sheffield, S., Cayan, D., & Pierce, D. (2018). *Climate conditions in Clark County, NV: an evaluation of historic and projected future climate change using global climate models*. Las Vegas: Water Utility Climate Alliance.
- Kibuye, F., Almuhtaram, H., Zamyadi, A., Gaget, V., Owen, C., Hofmann, R., & Wert, E. (2021). Utility practices and perspectives on monitoring and source control of cyanobacterial blooms. *AWWA Water Science*.
- MathWorks. (2021). *fitrtree*. Retrieved August 9, 2021, from <https://www.mathworks.com/help/stats/fitrtree.html>
- Southern Nevada Water Authority. (2022). *Water Resource Plan*.
- United States Bureau of Reclamation, L. C. (2022, February 4). *5-Year Probabilistic Projections*. Retrieved February 16, 2022, from <https://www.usbr.gov/lc/region/g4000/riverops/crss-5year-projections.html>
- US Census Bureau. (2022). *Quick Facts*. Retrieved from <https://www.census.gov/quickfacts/fact/table/clarkcountynevada/RHI225219#RHI225219>
- US Census Bureau. (2022). *Quick Facts Nevada*. Retrieved from <https://www.census.gov/quickfacts/NV>

Appendix B
Letters of Support



March 14, 2022

To Whom it May Concern,

The Central Arizona Water Conservation District (a.k.a. Central Arizona Project) is pleased to support the Southern Nevada Water Authority (SNWA) in efforts to obtain funding through the US Bureau of Reclamation for the proposed project: **“Robust Updates to Advanced Lake Models to Inform Future Drinking Water Treatment Needs”**

Central Arizona Project (CAP) is the steward of central Arizona's Colorado River water entitlement and a collaborative leader in Arizona's water community. As Arizona's single largest resource for renewable water supplies, the CAP is designed to bring approximately 1.5 million acre-feet of water from the Lower Colorado River to Central and Southern Arizona every year. More than 5 million people, or more than 80% of the state's population, live in Maricopa, Pima and Pinal counties, where CAP water is delivered.

CAP has great interest in the sustainability of water quality in the Lower Colorado River and we believe that the proposed work will provide much needed information for the future of water quality management in Lake Mead, Lake Mohave, and the Lower Colorado River. The proposed modeling efforts will help to develop essential tools for strategies to address changes in raw water quality as climate change continues stress our water supply.

We appreciate the efforts of SNWA in attempting to expand our understanding of the changing water quality in the lower Colorado River system.

Sincerely,

A handwritten signature in blue ink, appearing to read "T. Cooke".

Theodore C. Cooke, D.B.A.
General Manager





COACHELLA VALLEY WATER DISTRICT

Established in 1918 as a public agency

GENERAL MANAGER
Jim Barrett

ASSISTANT GENERAL MANAGER
Robert Cheng

CLERK OF THE BOARD
Sylvia Bermudez

ASSISTANT GENERAL MANAGER
Dan Charlton

March 14, 2022

VIA EMAIL deena.hannoun@snwa.com

Southern Nevada Water Authority
100 S. City Parkway Suite 700
Las Vegas, NV 89106

RE: Support for “Robust Updates to Advance Lake Models to Inform Future Drinking Water Treatment Needs.”

To Whom It May Concern:

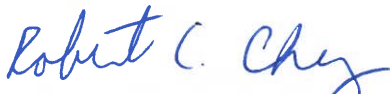
Coachella Valley Water District (CVWD) is pleased to support the Southern Nevada Water Authority (SNWA) in efforts to obtain funding through the US Bureau of Reclamation WaterSMART Applied Science Grants for the proposed project entitled “Robust Updates to Advance Lake Models to Inform Future Drinking Water Treatment Needs.”

CVWD provides multiple water services (irrigation, domestic, wastewater, recycled, stormwater, and water replenishment) to over 300,000 customers in the 1,000 mi² service area of the Coachella Valley. A significant part of CVWD’s imported water supply is the Colorado River (CVWD holds Federally-contracted rights to 330,000 acre-ft (af) of Colorado River Water), which is used for crop production and groundwater replenishment. CVWD recognizes the importance of water quality (especially salinity) and supports projects to better understand the impacts to water quality through the impacts created by drought and climate change.

The funding will take advantage of providing several updates to existing modeling framework utilized by SNWA, which is a beneficial and efficient use of funds. These modeling efforts ensure long-term maintenance of water quality, and serve as a framework for utilities concerned with the effects of drought and climate change.

If you have any questions, please contact me at rcheng@cvwd.org or 760.398.2651.

Sincerely,


Robert C. Cheng, Ph.D., P.E.
Assistant General Manger

File Nos.: 0322.16, 0645.9



THE METROPOLITAN WATER DISTRICT
OF SOUTHERN CALIFORNIA

March 29, 2022

Deena Hannoun, Ph.D.
Limnology Modeling Project Manager
Southern Nevada Water Authority
P.O. Box 99954
Las Vegas, NV 89193

Reply to: 700 Moreno Avenue
La Verne, CA 91750

Dear Ms. Hannoun:

Letter of Support for Proposed WaterSMART Applied Sciences Grant – Robust Updates to Advanced Lake Models to Inform Future Drinking Water Treatment Needs

The Metropolitan Water District of Southern California (Metropolitan) is pleased to support Southern Nevada Water Authority's (SNWA) project, *Robust Updates to Advanced Lake Models to Inform Future Drinking Water Treatment Needs*, for consideration of a U.S. Bureau of Reclamation WaterSMART Applied Sciences Grant.

Metropolitan is the nation's largest wholesale water supplier and supplies treated drinking water to 26 member agencies. Those agencies, in turn, sell that water to more than 300 sub-agencies or directly to their consumers. Metropolitan's service area covers 5,200 square miles in Los Angeles, Orange, Riverside, San Bernardino, San Diego, and Ventura counties, with approximately 19 million residents. Metropolitan owns and operates an extensive water system including the Colorado River Aqueduct, 15 hydroelectric facilities, nine reservoirs, 830 miles of large-scale pipes, and five regional water treatment plants.

Metropolitan works closely with SNWA to monitor Colorado River water quality conditions and supports additional modeling and investigations of Lake Mead and Lake Mohave to adequately assess and respond to changes in water quality. SNWA's Lakes Mead and Mohave Model (LM3) supports this work by forecasting the water quality changes that the agency's water sources will undergo. The forecasting work will become critical as the drought in the Colorado River Basin persists and Lake Mead water draw-downs continue. Overall, the proposed project will provide critical improvements to the LM3 to assist with Colorado River water quality management and planning efforts.

We appreciate SNWA's efforts to pursue this project and forecast water quality changes and their impacts to downstream Lake Mead and lower Colorado River stakeholders.

Deena Hannoun, Ph.D.

Page 2

March 29, 2022

If you have questions, please contact me at (909) 392-5155 or via e-mail at prochelle@mwdh2o.com, or Maria Lopez at (909) 392-5447 or via e-mail at mtlopez@mwdh2o.com.

Sincerely,

A handwritten signature in blue ink that reads "Paul Rochelle". The signature is written in a cursive style.

Paul Rochelle, Ph.D.

Water Quality Section Manager

MJS:ag

H:\Water Quality e-File\MJS LM3 SNWA Letter.docx



March 7, 2022

Re: Support for the Robust Updates to Advance Lake Models to Inform Future Drinking Water Treatment Needs

To whom it may concern:

The Clark County Water Reclamation District (District) is pleased to support the Southern Nevada Water Authority (SNWA) in efforts to obtain funding through the US Bureau of Reclamation WaterSMART Applied Science Grants for the proposed project entitled: Support for the Robust Updates to Advance Lake Models to Inform Future Drinking Water Treatment Needs.”

The District collects and treats wastewater at seven plants in unincorporated Clark County, Nevada, serving visitors to the Las Vegas Strip and one million residents. Our main plant discharges 100 million gallons of reclaimed water per day into the Las Vegas Wash which empties into Las Vegas Bay of Boulder Basin in Lake Mead. Our plant in Laughlin, Nevada discharges 2 million gallons of reclaimed water per day directly into the Colorado River below Davis Dam. The District is The Clean Water Team and we play a critical role in protecting public health and environment related to the to the Wash, Bay, Lake, and the downstream Colorado River.

The important goal of this project is to expand the forecasting capabilities of the Lakes Mead and Mohave Model (LM3), which is a 3D hydrodynamic and water quality model encompassing the entirety of Lake Mead, the Colorado River below Hoover Dam, and Lake Mohave. This project is novel in that it provides several updates to the existing modeling framework utilized by SNWA. The modeling efforts will yield projections not only for raw water drawn from Lake Mead, treated by SNWA, and distributed to the Las Vegas Valley, but also for raw water drawn by Big Bend Water District in Laughlin. The project is supported by SNWA’s Water Resource Plan. Funding will allow SNWA to perform modeling efforts to accomplish the proposed work. Project activities will develop modeling tools for communities to evaluate options and implement strategies to address changes to both raw water quality and raw water treatment options as climate change impacts stress the severe, prolonged drought in the region.

If you have any questions, please contact me at dfischer@cleanwaterteam.com or (702) 668-8455.

Sincerely,

Daniel C. Fischer
Deputy General Manager

DCF:sa

cc: Denna Hannoun, Ph.D., Southern Nevada Water Authority

BOARD OF TRUSTEES
Tick Segerblom, *Chair* • Justin Jones, *Vice Chair*
James B. Gibson • Marilyn Kirkpatrick • William McCurdy II • Ross Miller • Michael Naft
Thomas A. Minwegen, *General Manager*

5857 East Flamingo Road • Las Vegas, Nevada 89122 • (702) 668-8888 • (800) 782-4324
cleanwaterteam.com



**LAS VEGAS
CITY COUNCIL**

CAROLYN G. GOODMAN
Mayor

STAVROS S. ANTHONY
Mayor Pro Tem

MICHELE FIORE
CEDRIC CREAR

BRIAN KNUDSEN
VICTORIA SEAMAN
OLIVIA DIAZ

JORGE CERVANTES
City Manager

PUBLIC WORKS

MIKE JANSSEN, P.E., PTOE

EXECUTIVE DIRECTOR OF
INFRASTRUCTURE

CITY HALL

495 S. MAIN ST.
LAS VEGAS, NV 89101
702.229.6011 | VOICE
711 | TTY



cityoflasvegas
lasvegasnevada.gov

March 29, 2022

RE: Support for "Robust Updates to Advance Lake Models to Inform Future Drinking Water Treatment Needs."

To Whom It May Concern:

The City of Las Vegas is pleased to support the Southern Nevada Water Authority (SNWA) in efforts to obtain funding through the US Bureau of Reclamation WaterSMART Applied Science Grants for the proposed project entitled "Robust Updates to Advance Lake Models to Inform Future Drinking Water Treatment Needs."

The City of Las Vegas relies on the water supplied by Lake Mead for the use of more than 670,000 residents and countless visitors. On a daily basis, our Water Pollution Control Facility effectively treats and discharges over 42 million gallons of reclaimed water, returning this resource safely to the environment and ultimately to Lake Mead. With the continued drought in the west and as lake levels continue to lower, it is of the utmost importance that the necessary modeling of these essential waterbodies continue so that we are able to have an understanding of the hydrology and impact to water quality to be able to sustain the residents and visitors of our iconic city.

The funding will take advantage of providing several updates to existing modeling framework utilized by SNWA, which is a beneficial and efficient use of funds. These modeling efforts ensure long-term maintenance of water quality, and serve as a framework for utilities concerned with the effects of drought and climate change.

If you have any questions, please contact me at ctrushel@lasvegasnevada.gov or by phone at 702-229-2417

Regards,

Charles Trushel
Environmental Manager
Public Works | Environmental Division
Phone (702) 229-2417 | cell (702) 539-5494
6005 Vegas Valley Dr. | Las Vegas, NV 89142

CJT:am

cc: Deena Hannoun, Ph.D., Southern Nevada Water Authority



CITY OF HENDERSON
240 Water Street
P.O. Box 95050
Henderson, NV 89009-5050

DEPARTMENT OF UTILITY SERVICES

March 7, 2022

RE: Support for the Robust Updates to Advance Lake Models to Inform Future Drinking Water Treatment Needs

To Whom It May Concern:

The City of Henderson is pleased to support the Southern Nevada Water Authority (SNWA) in efforts to obtain funding through the US Bureau of Reclamation WaterSMART Applied Science Grants for the proposed project entitled: Support for the robust Updates to Advance Lake Models to Inform Future Drinking Water Treatment Needs.”

The City relies on Lake Mead for drinking water supply for its over 330,000 residents. We both treat raw Lake Mead water, and purvey potable water treated by SNWA. The quality of water coming from Lake Mead is therefore of great importance to us. Increasing the forecasting of Lakes Mead and Mohave will be vital in the coming years as we continue to experience drought and projected lowering lake levels.

The funding will take advantage of providing several updates to existing modeling framework utilized by SNWA, which is a beneficial and efficient use of funds. The further modeling of the Colorado River downstream of Lake Mead will help other purveyors like us to also achieve their missions of providing safe and great quality drinking water to customers throughout Southern Nevada.

If you have any questions, please contact me at Adrian.Edwards@cityofhenderson.com or at (702) 267-2728.

Sincerely,

Adrian J. Edwards, P.O.
Water and Wastewater Operations Manager

AJE:vad

cc: Denna Hannoun, Ph.D., Southern Nevada Water Authority

REGIONAL FLOOD CONTROL DISTRICT



March 17, 2022

Steven C. Parrish, P.E.
General Manager/Chief
Engineer

BOARD OF DIRECTORS

Mayor
Debra March
Chair
City of Henderson

Commissioner
Justin Jones
Vice-Chair
Clark County

Mayor
Carolyn Goodman
City of Las Vegas

Councilman
Isaac Barron
City of North Las Vegas

Councilman
George Gault
City of Mesquite

Mayor Pro Tem
Stavros Anthony
City of Las Vegas

Commissioner
Tick Segerblom
Clark County

Mayor Pro Tem
Claudia Bridges
City of Boulder City

RE: Support for “Robust Updates to Advance Lake Models to Inform Future Drinking Water Treatment Needs.”

To Whom It May Concern:

The Clark County Regional Flood Control District (District) is pleased to support the Southern Nevada Water Authority (SNWA) in efforts to obtain funding through the United States Bureau of Reclamation (Reclamation) WaterSMART Applied Science Grants for the proposed project entitled “Robust Updates to Advance Lake Models to Inform Future Drinking Water Treatment Needs.”

Established in 1986, the District is the regional agency responsible for planning, funding, implementing and maintaining infrastructure in Southern Nevada to protect residents and visitors from the ravages of flooding. The District is also a Permittee to a National Pollutant Discharge Elimination System permit for the discharge of stormwater to the Las Vegas Wash and Lake Mead. The District is particularly interested in greater understanding of the impacts of stormwater quality on the Las Vegas Wash and Lake Mead in the face of drought and climate change. The proposal by SNWA will help better understand the water quality dynamics of climate change and drought on Lake Mead in order to help managers better plan for potential impacts.

The funding will take advantage of providing several updates to existing modeling framework utilized by SNWA, which is a beneficial and efficient use of funds. These modeling efforts ensure long-term maintenance of water quality, and serve as a framework for utilities concerned with the effects of drought and climate change.

I strongly encourage Reclamation to fund the SNWA proposal. If you have any questions, please contact me at (702) 685-0023 or jtennert@regionalflood.org.

Sincerely,

John Tennert (Mar 21, 2022 07:44 PDT)

John Tennert, Ph.D.
Environmental Mitigation Manager

cc: Deena Hannoun, Ph.D., Southern Nevada Water Authority
P:\Letters and Memos\Environmental Mitigation Letters\Ltr SNWA BOR Grant Proposal 03-17-2022.doc



March 8, 2022

RE: Support for “Robust Updates to Advance Lake Models to Inform Future Drinking Water Treatment Needs.”

To Whom It May Concern:


Valley Water is pleased to support the Southern Nevada Water Authority (SNWA) in efforts to obtain funding through the US Bureau of Reclamation WaterSMART Applied Science Grants for the proposed project entitled “Robust Updates to Advance Lake Models to Inform Future Drinking Water Treatment Needs.”

Valley Water (formerly Santa Clara Valley Water District) provides water supply, flood control, and environmental stewardship services to a county of 2 million residents. Relying on a complex system of local and imported ground- and surface water, Valley Water understands the need for innovation in water supply modelling. The efforts of SNWA to improve forecasting capabilities of the Lakes Mead and Mohave Model will provide valuable framework that can be applied to water supply models throughout the West.

The funding will take advantage of providing several updates to existing modeling framework utilized by SNWA, which is a beneficial and efficient use of funds. These modeling efforts ensure long-term maintenance of water quality and serve as a framework for utilities concerned with the effects of drought and climate change.

If you have any questions, please contact me at (jbougeois@valleywater.org, (408) 314-8859.

Sincerely,

DocuSigned by:

E737D84338DA425...

John Bourgeois
Deputy Officer
Division of Watershed Stewardship and Planning
Valley Water

cc: Deena Hannoun, Ph.D., Southern Nevada Water Authority

