CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
LAHONTAN REGION

MEETING OF JULY 10, 2019
BISHOP

ITEM 8
SURFACE WATER AMBIENT MONITORING PROGRAM (SWAMP) CORE PROGRAM REVIEW

CHRONOLOGY	
2000	The Surface Water Ambient Monitoring Program (SWAMP) was created to coordinate surface water quality monitoring conducted by the State Water Board and Regional Water Boards.

BACKGROUND

The Surface Water Ambient Monitoring Program (SWAMP) was founded in 2000 with a charge to collect data for assessing ambient water quality conditions and regulatory program effectiveness. SWAMP consists of a state-wide program in the State Water Board Office of Information Management and Assessment (OIMA) and Regional Water Board programs. The state-wide SWAMP develops monitoring and data management protocols and implements four state-wide monitoring programs (Bioaccumulation, Stream Pollution Trends, Bioassessment, Freshwater Harmful Algae Blooms). The Regional SWAMP focuses on region-specific monitoring priorities identified by the individual Regional Water Boards.

The Lahontan Regional Water Quality Control Board's SWAMP (Regional SWAMP) has spent the past 20 years: 1) determining if ambient water quality at selected sites complies with regional and site-specific water quality objectives contained in the *Water Quality Control Plan for the Lahontan Region* (Basin Plan); 2) developing and implementing tools to assess the biological integrity of the State's streams and rivers based on instream benthic macroinvertebrates and algae; and 3) collecting and analyzing fish tissue data to support the Office of Environmental Health Hazard Assessment's development of fish consumption advisories for specific waterbodies.

After nearly two decades of following the current program model, Water Board staff proposes modifying the Regional SWAMP to respond to new challenges and priorities.

ISSUES

How can SWAMP adapt its monitoring and data management efforts to emerging challenges and priorities?

DISCUSSION

The Regional SWAMP has spent nearly two decades creating a water quality dataset, tools to quantify biological health, and contributed data for several fish consumption advisories. Program design has focused on collecting data for assessing compliance with water quality objectives. SWAMP data is the primary source of information used to assess if surface waters in the Lahontan Region comply with Basin Plan water quality objectives. These assessments, performed in satisfaction of Clean Water Act sections 303(d) and 305(b) requirements, help to prioritize where to investigate and address water quality impacts, focus regulatory actions, evaluate water quality objectives, and confirm the high quality of the Region's waters. SWAMP, as designed, has been effective at collecting data for these evaluations. Another role of SWAMP has been to support collection of fish tissue data to test for bioaccumulating contaminants, such as mercury and PCBs, which has supported the Office of Environmental Health Hazard Assessment's (OEHHA) development of waterbody-specific fish consumption advisories. Additionally, SWAMP has supported the development of biological monitoring protocols.

During the past year, Regional SWAMP staff has been reevaluating program design. Staff identified key considerations to incorporate into the program review. These considerations include:

- The Clean Water Act's objective to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters"
- The Water Board should address emerging challenges such as Climate Change
- Core regulatory programs can compel monitoring. The value of third-party monitoring can increase with Water Board support
- There is opportunity to meet Water Board needs with new technologies and monitoring methods.

As part of the evaluation process, staff solicited input from Water Board management, staff from other Water Board programs, and SWAMP staff at other Regional Water Boards, the State Water Board, and their SWAMP partners. SWAMP incorporated these discussions into the program evaluation, and developed the following recommendations:

1. Re-evaluate monitoring to improve the program and address new challenges, including the following:
    a. Evaluate the health of the Region's waters and watersheds, including special studies;
    b. Adjust monitoring to adapt to climate change; and

c. Analyze and report on the trends of water quality changes in the Region, including the prior 20 years of SWAMP data.

2. Identify opportunities to improve program efficiency, such as:
   a. Improved internal coordination and support between the Water Board's SWAMP and Regulatory and Enforcement Programs; and
   b. Increase stakeholder partnerships to improve monitoring efforts.
3. Maximize data access and uses of analytical tools through the use of new technology, and report our on trends and other observations.
4. Integrate Water Board priorities in SWAMP more effectively.

The Staff Report and presentation provide a depth of knowledge about the current Regional SWAMP design and statewide monitoring programs, and provide more detail about proposed program revisions.

PUBLIC OUTREACH/INPUT
None

PRESENTER
Kelly Huck, Environmental Scientist, SWAMP Program Manager, Lahontan Regional Water Quality Control Board

RECOMMENDATION
This is an informational item only. The Water Board may provide direction to staff as appropriate.

ENCLOSURE	ITEM	BATES NUMBER
1	SWAMP Core Program Review	**8 - 5**
2	Water Board staff presentation	**8 - 57** (to be submitted under separate cover)

ENCLOSURE 1

SURFACE WATER AMBIENT MONITORING PROGRAM CORE PROGRAM REVIEW

STATE WATER RESOURCES CONTROL BOARD LAHONTAN REGION

June 2019

CALIFORNIA
Water Boards
STATE WATER RESOURCES CONTROL BOARD
REGIONAL WATER QUALITY CONTROL BOARDS

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List of Acronyms

Term	Definition
SWAMP	Surface Water Ambient Monitoring Program
SPoT	Stream Pollution Trends Monitoring Program
FHAB	Freshwater Harmful Algae Bloom
OEHHA	Office of Environmental Health Hazard Assessment
SSO	Site-specific Objective
IR	Integrated Report
OIMA	Office of Information Management and Assessment
EPA	Environmental Protection Agency
SCCWRP	Southern California Coastal Water Research Project
SPARC	Scientific Planning and Review Committee
USGS	United States Geological Survey
CSCI	California Stream Condition Index
IPI	Index of Physical Integrity
PSA	Perennial Streams Assessment
RCMP	Reference Condition Management Program
CLAM	Continuous Low-level Aquatic monitoring
BOG	Bioaccumulation Oversight Group
TIE	Toxicity Identification Evaluation
MST	Microbial Source Tracking
QA	Quality Assurance
QC	Quality Control
CEDEN	California Environmental Data Exchange Network
CEC	Contaminants of Emerging Concerns
PPCP	Pharmaceuticals and Personal Care Products
EDC	Endocrine Disruptors
TKPOA	Tahoe Keys Property Owners Association

Executive Summary

The Surface Water Ambient Monitoring Program (SWAMP) was created in 2000 to provide resource managers, decision makers, and the public with timely, high-quality information to evaluate the condition of all waters throughout California. SWAMP accomplishes this through carefully designed, externally reviewed monitoring programs, and by assisting other entities statewide in the generation of comparable data that can be brought together in integrated assessments intended to answer resource management questions [SWAMP Mission Statement].

The State Water Resources Control Board (State Water Board) and the nine Regional Water Boards implement SWAMP on statewide and regional levels, respectively. The State Water Board manages four statewide programs [The Bioaccumulation Monitoring Program (BOG), The Stream Pollution Trends Monitoring Program (SPoT), The Bioassessment Monitoring Program, and The Freshwater Harmful Algae Bloom Program (FHAB)]. The Regional Water Boards develop and manage SWAMP activities reflecting regional priorities, and monitoring goals and objectives.

The Lahontan Regional Water Quality Control Board SWAMP's (Regional SWAMP) primary objective from the program's beginning has been determining if ambient water quality at selected sites complies with water quality objectives contained in the *Water Quality Control Plan for the Lahontan Region*. The results of this monitoring effort have and will continue to provide the foundational data for the Water Board's Integrated Report, in addition to aid in identifying the need for additional investigation and special studies. The Water Board has also dedicated substantial SWAMP resources to developing and implementing tools for assessing the biological integrity of the Region's streams and rivers based on benthic macroinvertebrates and algae. Many of these assessment tools have since been incorporated into the statewide Bioassessment Monitoring Program. Regional SWAMP has also assisted in collecting fish tissue data to support the Office of Environmental Health Hazard Assessment's (OEHHA) program to develop fish consumption advisories for specific waterbodies, and a limited number of special studies. More recently, Water Board SWAMP resources have also been directed to the State Water Board's developing Freshwater Harmful Algae Bloom Program.

Over the past nearly 20 years, the Regional SWAMP has met its primary objective and made contributions to the statewide SWAMP. However, after almost 20 years, it is time to reassess the Regional SWAMP taking into consideration available resources, changing Water Board priorities and informational needs, answering new questions, and addressing new challenges such as increasing freshwater harmful algal blooms, contaminants of emerging concern, and climate change and its impacts on access to safe drinking water and maintaining adequate instream flows while demand for the State's water resources continues to increase.

Key Recommendations

Water Board staff has conducted a programmatic review of the Water Board's SWAMP Program taking into consideration what staff has learned over the years regarding what has worked, where there are opportunities to be had, and where there is need for change. Based upon this review, staff has the following recommendations:

- Re-evaluate monitoring to improve the program and address new challenges and new questions, such as:
  - What is the health of the Region's surface waters and watersheds?
  - Is climate change affecting the Region's waters? If so, how?
  - What are the water quality trends?
- Identify opportunities to improve program efficiency, such as:
  - Improved internal coordination and support between the Regional SWAMP and the Water Board's Core Regulatory and Enforcement Programs; and
  - Increase stakeholder partnerships to improve monitoring efforts.
- Maximize data access and uses of analytical tools by incorporating new technology into the program, and report out on water quality trends and other observations.
- Integrate Water Board priorities (e.g., protecting public health and aquatic life, addressing climate change, addressing the challenges the Region's disadvantaged communities are encountering) more effectively into SWAMP.

The Regional SWAMP also plans to continue its role in key statewide SWAMP activities while also working towards answering new management and monitoring questions in support of regional priorities. As regional priorities shift and as new issues arise, Regional

SWAMP will respond by developing new management/monitoring questions to keep the regional monitoring program current and relevant.

Introduction

The Lahontan Water Board is modifying its Surface Water Ambient Monitoring Program (SWAMP) to reflect new priorities, make greater use of new assessment tools, and to ensure that monitoring data produced by the program are addressing current regional priorities and questions. Due to resource constraints and new management questions, the program must adjust its monitoring and assessment activities. Below, this report provides historical information regarding the Statewide and Regional SWAMP programs, information regarding what nearly 20 years of data collection has provided, and the planned revisions of the Regional SWAMP, as the Lahontan Region encounters new questions to answer changing climatic conditions and new technologies. For the purpose of this report "SWAMP" refers to both State Water Board and the Regional SWAMP program. If referring specifically to the State Water Board or the Lahontan Regional SWAMP program, the distinction will be made.

Chapter 1: History of SWAMP

SWAMP Overview

SWAMP was created in 2000 in response to Assembly Bill 982 (Ducheny, Chapter 495, Statutes of 1999). The legislation mandate required a unifying program that coordinates all water quality monitoring conducted by the State Water Board and Regional Water Boards. However, available resources have not been sufficient for SWAMP to monitor all waterbodies for all beneficial uses, so efforts have been focused on a few statewide assessments of key beneficial uses, complemented by regional monitoring programs that address more localized management questions. State Water Board SWAMP, part of the Office of Information Management and Assessment (OIMA), coordinates statewide monitoring programs, ensures data consistency and quality, and develops new assessment tools and standard operating procedures. Each Regional Water Board also has SWAMP staff that focuses on monitoring priorities unique to each region.

Since its creation, SWAMP has continually been evolving in response to external and internal reviews (see Figure 1). Collaboration between State and Regional Water Board staff, and university, federal, and state agency experts in chemistry, toxicology, ecology, and hydrology have supported the program's evolution. In its infancy, State Water Board SWAMP directed all its resources to support the Regional Water Boards' programs by developing the monitoring infrastructure and tools necessary to enhance data comparability and data sharing (e.g., Standard Operating Procedures, Quality Assurance Program, and Data Management Program). Current efforts focus on collaboration and integration with various State Water Board and Regional Water Board programs and assisting citizen monitoring groups to collect and use monitoring data. There is also a focus on enhancing monitoring and data assessment and effectively integrating the results more cohesively into the Water Boards' planning and implementation activities. These current program priorities and efforts are very much in line with the Water Board's Regional SWAMP's evolving direction, which include expanding coordination with and support of the Water Board's Regulatory and Enforcement Programs and increased collaboration with the Region's stakeholders and their monitoring efforts. Such evolution will allow Statewide and Regional SWAMP programs to continue providing high quality, relevant data to evolving Water Board programs and information requests.

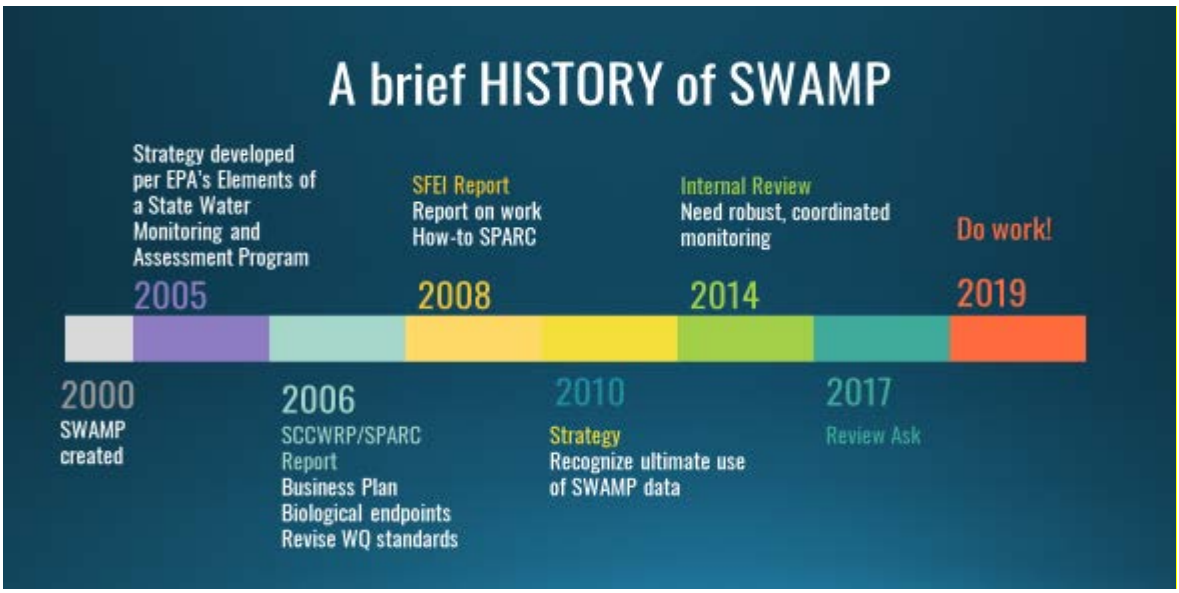

Figure 1. Timeline of SWAMP's program evolution

Chapter 2: Regional and State Water Board SWAMP (2000-2020)

Current Regional and State Water Board Program Components

The current Regional and State Water Board SWAMPs include the following components:

1. Water Quality Monitoring: To determine (1) whether ambient water quality at selected sites complies with the water quality objectives contained in the *Water Quality Control Plan for the Lahontan Region* ("Basin Plan"), the "California Toxics Rule", and (2) if water flowing from the Lahontan Region into the State of Nevada meets Nevada's water quality objectives (Regional effort).

2. Bioassessment Monitoring: To assess the biological integrity of the Region's streams and rivers based on instream assemblages of benthic macroinvertebrates and algae (Regional and State effort).

3. Fish Tissue Monitoring: To collect data on fish tissue chemistry as needed by the California Office of Environmental Health Hazard Assessment (OEHHA) to develop fish consumption advisories for specific water bodies (Regional and State effort).

4. Toxicity Monitoring: To determine the impacts of unknown pollutants or pollutant combinations on aquatic life (State effort).

5. Special Studies: To further investigate conditions discovered through Regional SWAMP water quality monitoring, or by other parties, or to meet specific data needs of other Water Board programs (Regional effort).

6. Data Management: To continue implementing Quality Assurance/Quality Control protocols and fulfilling other data management responsibilities to ensure the program produces high-quality comparable data (Regional and State effort).

These program elements help to support and interact with multiple efforts at the statewide and regional levels, as shown in Figure 2, below.

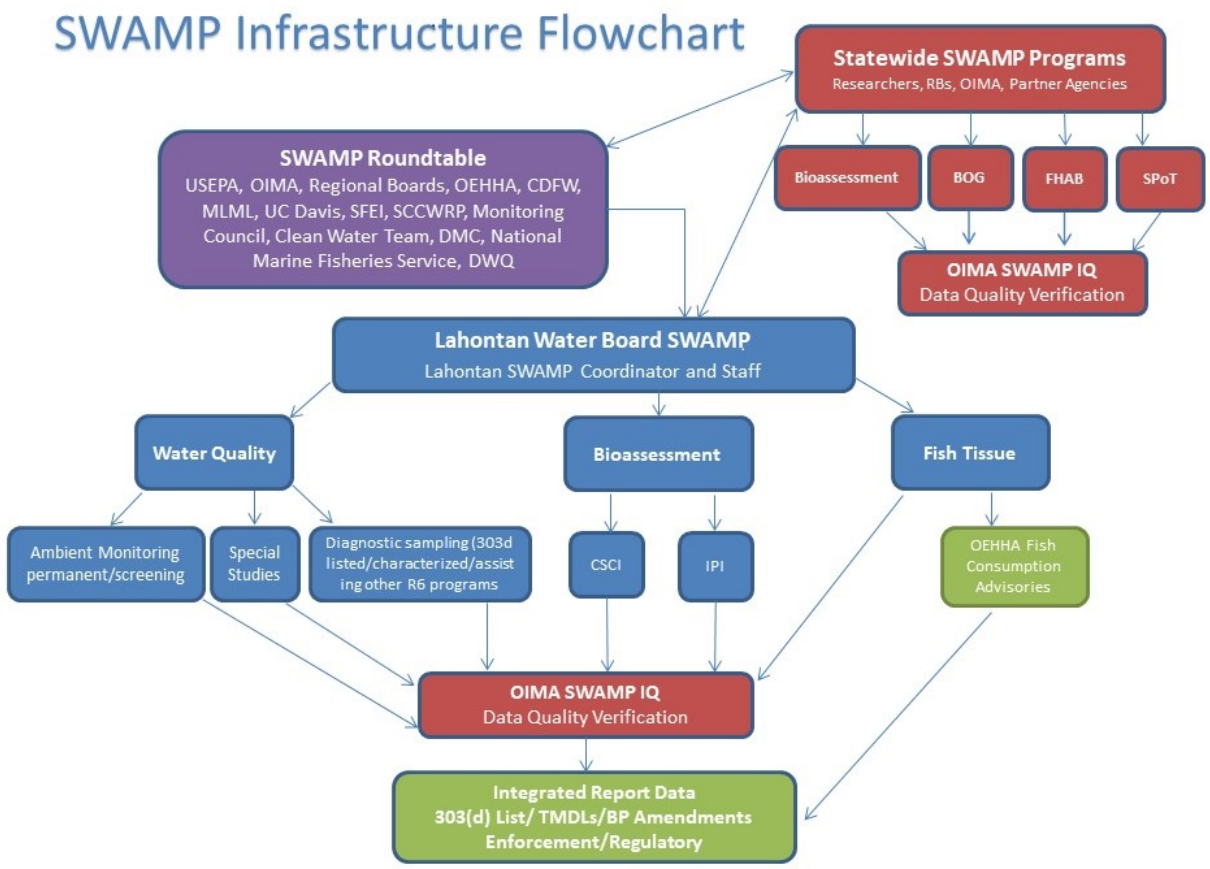

Figure 2. SWAMP Infrastructure Flowchart

Water Quality/Chemistry Monitoring

The Lahontan Region is unique in that its *Water Quality Control Plan for the Lahontan Region* (Basin Plan) contains more than one thousand site-specific numeric water quality objectives. Most of those site-specific objectives (SSOs) were adopted in the early 1970s based on very limited data and are not explicitly linked to any specific beneficial uses. Another unique feature of the Lahontan Region is that it has several interstate waters (most of which flow from California into the state of Nevada; a few small watersheds drain from the Region into the state of Oregon). Prior to the creation of the SWAMP program, most water bodies in the Region had never been monitored for compliance with the Basin Plan's SSOs. SWAMP gave the Water Board the opportunity to begin assessing the Region's surface water quality, and the Water Board made determining if ambient water quality at selected sites complied

with the Basin Plan's SSOs and with State of Nevada water quality objectives the Regional SWAMP's primary objective.

From 2000–2005, a total of 30 surface water sites within the Lahontan Region were sampled through a Regional SWAMP-funded contract with the United States Geological Survey (USGS). Sampling was generally conducted from one to four times per calendar year at each site. After the first five years of sampling by USGS (2000-2005), monitoring was suspended while staff developed a comprehensive report, finalized in 2007. Analysis of the USGS data indicated that surface waters at the sampled sites were generally in compliance with numeric water quality objectives contained in the Basin Plan. However, the report documented a potential exceedance rate of about 11 percent. Based upon the results presented in the report, the Regional SWAMP paradigm was modified to include the following four elements:

1. **"Permanent"** sites are located on large rivers/streams, generally as close to the bottom of the watershed as logistics and access allow. "Permanent" sites are sampled approximately quarterly, on a long-term (i.e., permanent) basis, to evaluate trends over time. Waterbody fact sheets were created for each permanent site, with sufficient data, and are included in Appendix 1.
2. **"Screening"** sites are "screened" for compliance with the Basin Plan's SSOs, generally sampled on a quarterly basis for a period of 2-5 years, to evaluate compliance with Basin Plan SSOs;
3. **"Diagnostic"** sampling is conducted where data from permanent or screening sites indicate potential exceedances of SSOs or other potential issues. Diagnostic sampling is designed to characterize the magnitude and/or extent of exceedances of SSOs or other potential water quality issues. Diagnostic sampling often is conducted more frequently than the routine sampling at permanent and screening sites (i.e., up to 10-12 times per year at "diagnostic" sites, compared to 3-4 times per year at "permanent" and "screening" sites). The greater sampling frequency allows calculation of more precise annual average analyte concentrations, and better characterization of seasonal variations; and
4. **"Special studies"** are conducted occasionally to address unique issues and/or to assist other programs with their monitoring needs. Examples are presented in the Special Studies section, below.

Regional Findings of Water Quality/Chemistry Monitoring

The modified Regional SWAMP monitoring paradigm expanded the number of waterbodies staff sampled beginning in the late 2000s. Available funding has generally allowed for water-column monitoring of "conventional" chemical constituents[1] and physical parameters[2] at about 20-30 sites throughout the Region on a quarterly basis (See Appendix 2 for all current and past water quality sites). Regional SWAMP data has been the primary data source for the Water Board's surface water assessment activities that support the Water Board's Integrated Report (IR). The Region's current IR, last adopted in 2012, provides the most comprehensive assessment of the Region's waters and beneficial use impairment (e.g., evaluating sources of drinking water to the Basin Plan's beneficial use of MUN). Regional SWAMP data, largely water chemistry data, supported 92 percent of the Lines of Evidence used to list and delist waterbodies. Of the 136 Category 5 waterbodies (standards are not being met and require a TMDL), 58 of the listings were based upon Regional and State Water Board SWAMP data. Staff is currently preparing the Lahontan Region's 2018 IR and preliminary results indicate that approximately 75 percent of the Lines of Evidence being used for the 2018 IR are supported by Regional and State Water Board SWAMP data.

Bioassessment Monitoring

Bioassessment monitoring allows staff to look directly at the biological condition of a waterbody and the integrity of aquatic life within a given aquatic system by collecting and assessing assemblages of benthic macroinvertebrates, algae, physical habitat data, and instream flow. During the first ten years of SWAMP (2000-2010), the Water Board invested a substantial portion (about half) of its Regional SWAMP resources in bioassessment. This funded numerous tasks, including: 1) extensive bioassessment monitoring of wadeable perennial streams throughout the Region; 2) coordinating freshwater bioassessment approaches by the Water Boards throughout California; and 3) developing new bioassessment tools for streams and rivers. The Region's multi-year bioassessment coordination efforts contributed substantially to what is now a statewide bioassessment program at the Water Boards, including consistent field and laboratory methods and data reporting templates for use throughout California. The statewide program has also been

[1] Chemical analytes generally include boron, calcium, chloride, fluoride, magnesium, potassium, sodium, sulfate, and a suite of nutrients (i.e., nitrogen-and phosphorus-containing compounds).
[2] Physical parameters generally include: alkalinity, conductivity, pH, salinity, temperature, total dissolved solids, and turbidity.

successful in designing interpretive scoring tools such as the California Stream Condition Index (CSCI) and the Physical Habitat (PHAB) Index of Physical Integrity (IPI) to assess status and trends, vital to supporting Clean Water Act goals.

In addition to the work discussed, above, the Water Board also participates in SWAMP's statewide bioassessment program, which is comprised of two key elements: (1) the Perennial Streams Assessment (PSA), and (2) the Reference Condition Management Program (RCMP). The PSA is an ongoing, long-term statewide survey of the ecological condition of wadeable perennial streams and rivers throughout California. The PSA works with many partners to help create a statistically robust, yet cost-effective and efficient approach to answering important water quality monitoring questions. The RCMP establishes and maintains a network of reference sites for wadeable streams and rivers throughout California. This network is vital to the establishment of reference conditions, which define the biological conditions expected in healthy streams when human activity in the environment is absent or minimal.

Regional Findings of PSA and RCMP Studies:

According to the 2017 summary of PSA and RCMP data, SWAMP has calculated a total of 361 CSCI scores in the Lahontan Region. A total of 215 have been identified as reference sites. 271 sites are considered likely intact, 50 sites are possibly altered, 29 sites are likely altered, leaving only 11 sites very likely altered. The PSA reports the North Coast and Sierra Nevada as having the highest percentage of sites in good condition within the state.

Fish Tissue Monitoring

While the activities described, below, represent a relatively small component of the Regional SWAMP, they are critical to the Water Board's efforts to protect the Region's public health. Fish tissue from numerous lakes in the Lahontan Region has been shown to be contaminated by mercury, PCBs, and/or pesticides. OEHHA is the State agency responsible for developing fish consumption advisories. The Water Board assists by providing the fish tissue data needed by OEHHA's toxicologists to develop fish consumption guidelines/advisories for specific water bodies. As Regional SWAMP funding allows, the Water Board employs contractors to obtain fish samples and perform lab analysis. This requires the strategic capture and analysis of multiple individuals of each sport fish species from water bodies in question.

Regional Results of Bioaccumulation Monitoring Program Studies

The Water Board also participates in and benefits from SWAMP's statewide Bioaccumulation Monitoring Program managed by the Bioaccumulation Oversight Group (BOG).

- In the 2007/2008 *Statewide Lake and Reservoir Survey,* elevated concentrations of mercury were found at Fallen Leaf Lake, Lake Arrowhead, Lake Gregory, Little Rock Reservoir, Silverwood Lake, Topaz Lake, and Upper Twin Lake. Elevated concentrations of PCBs were also found at Silverwood Lake.
- In the 2011 *Rivers and Streams Study,* elevated levels of mercury were found at Big Pine Creek, East Walker River, Independence Creek, and Virginia Creek.
- In the 2012/2013 *Wildlife Study,* results found birds at risk, with greater than or equal to 50 percent of grebes exhibiting a moderate risk of reproductive impairment at Topaz Lake, Bridgeport Reservoir, and Lake Crowley, and between 1-49 percent of grebes in Eagle Lake were at risk. The study also revealed strong correlations between mercury concentrations in fish-eating birds and prey fish.
- In the 2014 *Survey of California Lakes and Reservoirs with Low Concentrations of Contaminants in Sport Fish,* the two lakes surveyed in Region 6 were Lake Gregory and Palmdale Lake. Lake Gregory showed an increased concentration of mercury since 2007 and Palmdale Lake showed an increased concentration of PCBs since 2007.

As a follow up to SWAMP's 2010 statewide lakes survey, the Water Board used a portion of its Regional SWAMP funding to support development of OEHHA fish consumption advisories at Silverwood Lake in 2013, Little Rock Reservoir in 2014, and Lake Gregory in 2016. Additional advisories for East Walker River, Fallen Leaf Lake, Big Pine Creek, Independence Creek, Bishop Creek, Palmdale Lake, Bridgeport Reservoir, Lake Topaz, Upper Twin Lake, and Mammoth Creek are awaiting completion using data from Regional SWAMP and other Water Board funding sources.

Currently, SWAMP's Bioaccumulation Monitoring Program is focusing on a long-term study (initiated in 2015) that will continue to monitor long-term trends in mercury concentrations in lakes dominated by bass (a sportfish species known to accumulate high levels of mercury). This study will provide updated information on the status of these lakes

and a statewide perspective on long-term trends to evaluate effectiveness of management actions (e.g., mercury control plans) as well as the impacts of factors such as increases in global emissions or climate change on fish mercury levels. Table 1 shows the sampling schedule for the Lahontan Region for 2017-2023.

Table 1. Lahontan Region Survey Schedule

Sample Year	Lake	On 2012 303 (d) List as mercury impaired
2017	Palmdale, Lake	No
2017	Silverwood Lake	Yes
2019	Tahoe, Lake (Tahoe Keys)	No
2019	Little Rock Reservoir	Yes
2021	Arrowhead, Lake	Yes
2021	Pete's Valley Reservoir	No
2023	Haiwee Reservoir	No
2023	Gregory, Lake	Yes

Stream Pollution Trends Monitoring Program

Toxicity testing has been used to assess effluent and surface water quality in California since the mid-1980s. When combined with chemical analyses and other water quality measures, results of toxicity tests provide information regarding the capacity of water bodies to support aquatic life beneficial uses.

State Water Board SWAMP's Stream Pollution Trends Monitoring Program (SPoT) monitors trends in sediment toxicity and sediment contaminant concentrations in selected large rivers throughout California and relates contaminant concentrations and toxicity to watershed land uses. It is designed to improve understanding of watersheds and water quality by monitoring changes in both over time, evaluating impacts of development, and assessing the effectiveness of regulatory programs and conservation efforts at the watershed scale. The overall goal of this long-term trend assessment is to detect meaningful change in the concentrations of contaminants and their biological effects in large watersheds at time scales appropriate to management decision making. Sediment toxicity and a suite of

pesticides, trace metals, chemicals of emerging concern, and industrial compounds have been analyzed from up to 100 sites annually since 2008.

Regional Findings of SPoT and Other Studies:

In 2012, SWAMP's toxicity researchers preformed a thorough review of all available Water Board toxicity data from 2001-2010. This study revealed that although only a few instances of toxicity were seen in freshwater and sediment sites, the limited number of samples collected indicate a relatively high frequency of toxicity. Fifty percent of sampling sites showed moderate water toxicity, with twenty-five percent of sites showing some toxicity, and twenty-five percent of sites showing no toxicity. Most of the sediment sites were nontoxic, with only seventeen percent showing some toxicity. None of the sites tested were highly toxic. Water and sediment toxicity in the Lahontan Region were elevated in agricultural, urban, and mixed agricultural-urban areas compared to surrounding undeveloped lands. Toxicity was attributed to herbicides and insecticides.

Besides SPoT studies, few water column toxicity studies have been conducted in the region since the publication of the 2012 Report. SPoT has monitored sites statewide for sediment toxicity and contaminants. Results from the 2008-2014 SPoT sampling shows no toxicity in the Lahontan Region. Although there is no toxicity in the region, concentrations of pyrethroid pesticides have been detected in nine of ten samples, but at lower concentrations than previously reported. Samples sites included: Bishop Creek, at East Line St; Lower Owens River, near mouth; Deep Creek, above Warm Springs; West Walker River, at Topaz; West Fork Carson River, at Paynesville; Upper Truckee River, near inlet to Lake Tahoe; Martis Creek, near mouth; Lower Truckee River, near CA/NV state line; Trout Creek (Truckee), near mouth; and Susan River, near Litchfield.

Identifying the likely causes (e.g., herbicides and insecticides) and more prominent locations (e.g., urban and agricultural areas) of the Region's surface water toxicity is very useful information. The Water Board's Regulatory staff, when provided such information, can begin to address the toxicity through the appropriate regulatory program, such as the Non-Point Source Program for agricultural areas and sources, or the NPDES Municipal Storm Water Program for municipal areas and sources.

Special Studies

When funding allows and relevant questions arise, the Regional SWAMP program funds special studies. Historically, such studies were conducted by Water Board staff or through contracts managed by Water Board staff.

Past studies included:

Susan River Toxicity Project 2016 - The Susan River is on the 303(d) list of impaired waters for unknown toxicity. In 2003/2004 follow up sampling was done, and it was determined that synergistic effects of Transline® and surfactants was the cause of toxicity. In 2016, SWAMP conducted a follow-up to these initial studies. Continuous low-level aquatic monitoring (CLAM) passive samplers were deployed and water samples were collected at three sites along the Susan River for a total of three sample events. The toxicity observed was at low enough levels that toxicity identification evaluations (TIEs) were not conducted. Analytical chemistry on the CLAM passive samples demonstrated the presence of the herbicide Hexazinone in every sample collected during the study, although concentrations were not able to be quantified and fell well below those documented to cause acute toxicity. Susan River appears to show less toxicity compared to earlier studies. Further investigation would be necessary to determine if Hexazinone is an ongoing issue.

Microbial Source Tracking (MST) at Bacteria-Impaired Waters of the Lahontan Region - Analyses conducted for this report indicate that streams in Bridgeport Valley, Long Valley, Round Valley, and the Bishop Creek watershed are characterized by high levels of fecal contamination; these levels commonly exceed the EPA criteria of 100 and 126 CFU per 100 mL of *E. coli*. Results from membrane filtration and MST assays provide compelling evidence that cattle are a major contributor to fecal contamination of these streams and those located across a large portion of the Lahontan Region.

Lake Tahoe Tributary Study - The Lake Tahoe Tributary Study was conducted in 2013-2014 to determine the bacteria levels entering Lake Tahoe from its numerous tributaries. The study consisted of monthly bacteria (*E. coli* and fecal coliform) monitoring in the summer months at 30 sites around the lake basin. While most monitoring sites proved to have low bacteria counts, Griff Creek on the North Shore exhibited large bacteria counts. These high bacteria counts led staff to further investigate the issue. After extensive monitoring was conducted, Placer County Environmental Health Department issued a health advisory to avoid water contact with Griff Creek due to elevated levels of bacteria. Placer Environmental Health also initiated its own sampling efforts.

Bacterial Water Quality in the Lahontan Region - More than 700 samples were collected at 111 sites during 2012-2014. *E. Coli* concentrations in streams from the headwaters of the East Walker River to the lower Owens River were generally low. However, a few areas were characterized by high *E. coli* concentrations. These areas included Bridgeport Valley, Owens River above Crowley Reservoir, Round Valley, and in and around the City of Bishop. The primary drivers of *E. coli* concentrations in the study area were the presence of livestock (primarily cattle) and calendar day of the year. Day of the year correlations were probably due to a consequence of day serving as a surrogate for seasonal patterns of livestock and human use in the study area. Findings from this report helped to develop Statewide policy to protect recreational users from the effects of pathogens in California water bodies.

Regional SWAMP special studies have proven very effective at identifying extent and causes of a number of water quality problems across the Region. Some of them (e.g., *Bacterial Water Quality in the Lahontan Region Study*) have also played a critical role in supporting the Water Board's involvement with statewide policy issues, such as the State Water Board's bacteria water quality objectives for protecting the Water Contact Recreation beneficial use. Additional studies and reports can be found on the Region 6 SWAMP webpage.

Data Management

All data collected for studies funded wholly or partially by SWAMP must follow strict guidelines established in the SWAMP Quality Assurance Program Plan. The purpose of the Program Plan is to clearly define quality assurance (QA) and quality control (QC) standards and procedures in order to produce data that are scientifically valid and defensible. Regional SWAMP staff play a critical role in the data verification process by conducting field data entry, completeness checks, and follow-up on data reporting errors. This is a very time-consuming and tedious process, but it is necessary to produce data that are of known and documented quality.

Once data passes rigorous data verification steps the monitoring results (and associated metadata) are routinely loaded into the SWAMP database or the California Environmental Data Exchange Network (CEDEN). Once data is in CEDEN, the Region's SWAMP data can be queried and downloaded (directly from CEDEN) by Water Board staff and other interested persons, in addition to data CEDEN houses from other sources, providing a convenient warehouse for water and environmental data. Some examples of data application include the development of the CSCI and IPI scores, Algae Stream Condition

Index Score (currently being developed), Bioassessment Regional Snapshot Dashboard, and the Status of Nutrients in California Waterways Dashboard.

Chapter 3: Regional SWAMP in Transition

Regional SWAMP has provided information supporting the Water Board's 2012 and 2018 Integrated Reports, provided information leading to fish consumption advisories for multiple Lahontan Region waterbodies, as well as assisted in producing bioassessment tools that are now part of the statewide Bioassessment Monitoring Program. However, after nearly 20 years, the Region's SWAMP resources and monitoring needs are changing, as is the environmental landscape. These changes are creating new questions that cannot be answered by the current Regional SWAMP, and there are increasing demands being put upon the Water Board's SWAMP staff. Moreover, the Regional SWAMP staffing has been reduced by approximately 30 percent, resulting in a reduction in the program's permanent, screening and diagnostic monitoring sites. This combination of conditions is making it necessary to revise the Regional SWAMP. Below is a discussion of the key conditions requiring the Regional SWAMP program revisions discussed in Chapter 4.

Evolving Water Quality Standards and Questions

Until recently, the State has assessed the quality of its waters through monitoring their water chemistry. That is because the tools have existed to collect samples and analyze them for a variety of constituents for which the State Water Board and Regional Water Boards have established numerical water quality standards. However, water chemistry, alone, does not provide a complete assessment of a waterbody's overall condition or health. Fortunately, the Water Boards have developed additional tools to assess the actual biological health of the State's surface waters and are now preparing water quality standards based upon biological indicators. These new tools will now allow the Water Boards to more completely assess a waterbody's condition and begin answering a new question:

> What is the health of the Region's surface waters and watersheds?

Answering this question will also assist the Water Board in better evaluating if the waterbodies identified in the Water Board's IR as being impaired, are actually impaired. To date, exceeding the Water Board's numerical water quality standards has provided the primary basis for identifying waterbodies as impaired. However, the Water Board's water quality standards are in large part, based upon limited historical data that is not linked to the

water quality necessary to support beneficial uses. In many cases, the water quality standards are more stringent than what is required to support beneficial uses. Answering the question, above, could provide the basis for delisting many of the Region's waterbodies that are currently identified as impaired. Developing new biologically-based standards and now being able to more fully assess the conditions of the Region's waters, provides support for revising the Regional SWAMP.

New Challenges

The Region is facing a number of challenges that did not exist 20 years ago. Addressing these new challenges also provides support for revising the Regional SWAMP at this time. Below are the more prominent of the new challenges that can, in part, be addressed by an evolving Regional SWAMP.

1. *Freshwater Harmful Algae Blooms (FHABs)* - New challenges continually arise, and the program strives to meet these emergent needs. The most time consuming and relevant issue is Freshwater Harmful Algal Blooms in our region. The Regional Monitoring Coordinator has been the lead contact on this emerging concern, while Regional SWAMP staff has played a supporting role in monitoring, training, and reporting efforts. These additional responsibilities have to date come without additional resources, placing additional strain on Regional SWAMP's already tight resources. The Regional Monitoring Coordinator and SWAMP's organization of regional HAB workshops in 2018 and the recent training held in May 2019 have helped to reduce the demand on staff responding to suspected HAB events by building the capacity of local partners to respond. The successful outcome of these trainings has been realized, especially when local partners have been able to respond on Water Board staff's behalf for several reported HABs in surface waters greater than 100 miles from either of the Water Board's regional offices. Continued collaborative efforts and trainings are important to help staff conserve resources in the future and respond timely to these events.

2. *Contaminants of Emerging Concerns (CECs)*- Contaminants of emerging concern (CECs), including pharmaceuticals and personal care products (PPCPs), are increasingly being detected at low levels in surface waters, and there is concern that these compounds may have an impact on aquatic life. There are many CECs and PPCPs that act as endocrine disruptors (EDCs). EDCs are compounds that alter the normal functions of hormones resulting in a variety of adverse health effects upon aquatic organisms. Determining what, if any, impacts CECs are having in the

Region's waters would be crucial in the protection of aquatic life and aquatic resources.

3. *Climate Change* - Another concerning issue worldwide is climate change. The Lahontan Region is not immune to changing climatic conditions and monitoring the impacts on the Region's water quality and health of its surface waters will be critical in responding to the changing climate. While Regional SWAMP's limited resources cannot address the impacts, certain steps can be taken to collect relevant data that can be used in larger data assessments, and to inform the Water Board and others as they strive to continue providing the Region with safe drinking water, to maintain adequate instream flows, and to identify the best opportunities for internal and external coordination on adapting to and mitigating the impacts of climate change.

4. *Data Management* – Data management is a critical to SWAMP successfully meeting its goals and objectives. As discussed, above, SWAMP has been an evolving program, including its data management component. In 2014, the SWAMP Information Management and Quality Assurance Center (SWAMP IQ) took over all data management and quality assurance tasks for SWAMP, previously managed by outside contractors. Currently SWAMP IQ is working to update and improve current database structures and tools necessary to enhance data comparability and data sharing. This will make it easier for non-SWAMP programs to use SWAMP tools, providing higher quality data across multiple Water Board programs. It will also create an efficient mechanism for all Water Board programs to manage their data and for data users to find Water Boards data in one convenient location. While there is tremendous value to centralizing data management and accessibility, this effort will incur a significant amount of time and staff resources to successfully accomplish this goal. Region-wide, staff needs to consistently use specific templates, data reporting requirements, and quality assurance protocols to ensure the data is of high quality and is available on the California Open Data Portal and CEDEN. Regional SWAMP staff will be the liaison during this transitional period, adding an additional workload.

Chapter 4: Program Revisions

New Program Management Questions and Holistic Approach

As discussed, above, Regional SWAMP's primary management question for the past nearly 20 years has been:

Is ambient water quality complying with the Basin Plan's water quality objectives?

The Regional SWAMP has gone about answering this question largely through monitoring water chemistry for numerous surface waters across the region and reporting the results most recently in the Water Board's 2012 Integrated Report, and soon again, in the Water Board's 2018 Integrated Report. This has given a good look at how the Region's waters compare to the Basin Plan water quality objectives, but it does not provide a complete picture or assessment of the Region's waters.

Upon reflecting upon the Regional SWAMP over the past 20 years, and looking into the future, staff believes that the Regional SWAMPs management questions need to be revised to better reflect current and future informational and programmatic implementation needs. Staff recommends the Regional SWAMP design be developed to answer two new management questions. To respond to the changing informational needs and new challenges discussed, above, and to support the developing statewide focus on increasing watershed resiliency, staff has developed the following management question for the Regional SWAMP.

Are the Region's surface waters and watersheds healthy (i.e., support beneficial uses)?

Answering this question will require a more holistic approach than what was provided by the past water chemistry-based monitoring approach. To fully understand how to proceed forward, staff must analyze the water quality trends of the past and the future. Staff needs to understand if the Region's water quality is improving or getting worse. This new holistic approach will involve expanding the Regional SWAMP's emphasis on bioassessment monitoring, physical habitat monitoring, and algal monitoring, in combination with water chemistry-based monitoring. Conducting the monitoring required to answer this question will also tie in well with the statewide effort to develop biological indicator-based water quality objectives. In combination with the past 20 years of water chemistry-based data,

biological data will provide a more complete suite of data for staff to evaluate if beneficial uses are supported, not just determining whether water quality standards are being met.

The second new management question for the Regional SWAMP also reflects current and future needs. That question is:

Is climate change impacting the Region's waterbodies? If so, how?

Climate change is one of the State's top priorities, affecting the priorities and operations of all state agencies. The Lahontan Region is fortunate that through the Regional SWAMP, the Water Board has developed 15(+)-year baseline datasets for several surface waters across the Region. Additionally, the Water Board and State Water Board has conducted bioassessment monitoring, establishing reference sites across the Region. Continuing water chemistry-based monitoring and expanding biological-based, physical habitat-based, and algal-based monitoring should allow Water Board staff to more fully evaluate the impacts of climate change and the effectiveness of mitigation and adaption measures on the Region's waters.

Increased Efficiencies Through Better Coordination and Collaboration

Internal Coordination

There is opportunity to increase program efficiency through improved internal coordination. To date, Regional SWAMP has fully identified the extent, causes, and in many cases, the responsible parties related to adverse water quality conditions through the program's screening and diagnostic monitoring. Moving forward, there will be increased coordination and collaboration where Regional SWAMP staff are more frequently sharing SWAMP-generated data with the Water Board's Regulatory and Enforcement staff. Through this increased coordination, Regulatory and Enforcement staff will have the information it needs to have those responsible for adversely impacting the Region's water quality conduct the additional investigative monitoring that is necessary to fully assess impacts, and to develop and implement corrective actions. Limited Regional SWAMP resources will be extended through this improved internal coordination.

Additionally, improved coordination between Regional SWAMP and Regulatory and Enforcement Programs will lead to more efficiently providing Regulatory and Enforcement staff with the information it needs to effectively meet its program goals and objectives. The overall effect of such coordination will be improved water quality and beneficial use protection. As Regional SWAMP advances into the future, SWAMP staff will regularly

solicit input from all Water Board programs, but especially the Water Board's Regulatory and Enforcement Programs, which are key to increasing compliance with the State's water quality laws, policies, and regulations for the protection of public health and the environment.

Such coordination will rely upon regularly scheduled meetings involving Regional SWAMP staff, the Regional Monitoring Coordinator, staff from other Water Board programs, and supervisors and managers. It is through such meetings that Water Board staff can identify, prioritize, development, and schedule Special Studies and other monitoring activities in coordination with the Regional SWAMP staff. These efforts will require staff to identify and set aside the resources necessary to see such efforts to fruition.

Working with the Region's Stakeholders

Both the Statewide and Regional SWAMPs are looking to support the Water Boards' external partners, such as citizen monitoring groups and watershed groups, with their monitoring efforts. The Water Board's Regional Monitoring Coordinator will be responsible for coordinating such efforts, with Regional SWAMP staff providing technical support as necessary. Such external efforts will also include implementing SWAMP special studies, again where the Regional Monitoring Coordinator will play the lead role in coordinating and Regional SWAMP staff providing technical support. Though special studies initiated through the Regional SWAMP program will rely partly on SWAMP resources, the goal is to collaborate with outside partners to meet some of the data collection and management needs associated with the monitoring project.

Such coordination will likely require significant staff time, over an extended calendar period, to develop working relationships, provide technical guidance, and maintain partner proficiency, but the benefits of those efforts and local knowledge they leverage, are especially important in such a geographically large and diverse area as the Lahontan Region.

Two recent examples of such efforts include:

Eagle Lake Special Study - This is a collaborative monitoring effort with the Eagle Lake Guardians to determine current water quality conditions in Eagle Lake. The project includes testing for nutrients, bacteria, and pigments chlorophyll-a and phycocyanin (specific to cyanobacteria) at four discreet in-lake sampling locations to capture water quality conditions in the north, middle, and south basins of the lake. Findings will inform

the need for improved grazing practices on public and private lands along the shoreline. The Water Board's Regional Coordinator and Regional SWAMP staff have both been involved with coordination and providing technical support (e.g., sampling techniques, monitoring plan design, etc.), so that the Eagle Lake Guardians can begin independent sampling and generating California Environmental Data Exchange Network (CEDEN)-compliant data in an area that is a 3-1/2 hour drive from the Water Board's South Lake Tahoe office.

Tahoe Keys Property Owners Association (TKPOA) Laminar Flow Aeration Study - This is a collaborative monitoring effort with the TKPOA to evaluate the effectiveness of laminar flow aeration technology (non-chemical control measure) to manage harmful algal blooms. For this effort, the Water Board has assisted with (1) developing the monitoring design, (2) preparing samples for analysis, (3) funding analysis of chemicals, pigments, and cyanobacteria, and (4) training TKPOA field crew on proper data uploads to the California Environmental Data Exchange Network (CEDEN). TKPOA's water quality department will contribute to the monitoring effort by (1) collecting water samples; (2) recording probe measurements and field observations; (3) surveying aquatic plant composition, cover, and density; (4) covering additional monitoring including measuring nutrient changes in bottom sediments; and (5) field data uploads into CEDEN.

New Tools and Technology

Over the past nearly 20 years, SWAMP has developed tools to help assess our State's waters. These include guidance documents, Standard Operating Procedures, scoring tools, Watershed Condition interactive data portals, and Watershed Health assessment tools. There have also been advances in technology such as auto-samplers, passive samplers, in situ data loggers (e.g., HOBO temperature sensors), drones, satellite imagery, and data visualization platforms. One challenge of using new technology is that it tends to require funding for equipment, software, and training for staff (or contract funds), which has proven to be difficult to procure. Regional SWAMP monitoring designs moving forward will aim to take advantage of these tools and technologies that have been developed over the last 20 years. One of SWAMP's proposed initial steps to integrate new tools will involve deployment of remote data loggers to track temperature in select waters throughout the region.

Assess Data More Frequently

Staff is looking at ways to automate the data analysis process to fulfill the request for increasing data assessment frequency. Currently, Regional SWAMP staff is working with OIMA to create an online dashboard of all SWAMP sampling sites and associated water quality assessments. The effort is in the beginning stages, but it looks like a promising tool to examine and display region-wide water quality. Building an online dashboard will require a tremendous effort and large time commitment on the front end but could require less of a time commitment once a product is created. The Regional Monitoring Coordinator is also working on a Regional Data Map that would include data from multiple sources, including SWAMP. Staff is also working on updating the SWAMP website to modernize it and make it more user friendly, therefore making SWAMP data more accessible and useable. If individual programs have more specific data analysis needs, SWAMP will ensure they have access to the data they need to perform those analyses.

Alignment with Water Board Priorities

A main goal of Regional SWAMP as the program transitions into the future is to better align its monitoring priorities, strategies, and activities with the Water Board's overarching priorities. Currently, the Water Board priorities are:

- Protect Human Health and Aquatic Life
- Protect/Improve Aquatic Resources & Surface Water Quality
- Support Disadvantaged Communities
- Respond to Climate Change

At this time, the elements of the evolving Regional SWAMP are set up to directly support these priorities. These priorities will have an overarching role in assisting staff when determining the nature and location of Regional SWAMP monitoring programs, including special studies.

Recommendation Summary

The Regional SWAMP has been meeting its original primary goal of monitoring the ambient water chemistry of many of the Region's major surface waters and assessing compliance with water quality standards over the past nearly 20 years. That objective made effective use of the monitoring and assessment tools that were available at the time. However, nearly 20 years have now passed, and the Region has new informational needs

and is encountering a number of new challenges requiring the Water Board's SWAMP Program to evolve. Moving forward, Water Board staff will continue to build upon its work of the past, and make some key recommendations so the Regional SWAMP will be able to respond to new questions and new challenges. Those key recommendations include:

1. Re-evaluate monitoring to improve the program and address new challenges, including the following:

    a. Evaluate the health of the Region's waters and watersheds, including special studies;

    b. Adjust monitoring to adapt to climate change; and

    c. Analyze and report on the trends of water quality changes in the Region including the prior 20 years of SWAMP data.

2. Identify opportunities to improve program efficiency, such as:

    a. Improved internal coordination and support between the Water Board's SWAMP and Regulatory and Enforcement Programs; and

    b. Increase stakeholder partnerships to improve monitoring efforts.

3. Maximize data access and uses of analytical tools through the use of new technology and report out on trends and other observations.

4. Integrate Water Board priorities in SWAMP more effectively.

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Appendix 1: Waterbody Specific Fact Sheets

Focus on Susan River

Ambient monitoring is an integral part of the Region's SWAMP. This fact sheet focuses on ambient monitoring on the Susan River near Litchfield (SWAMP Station Code 637SUS001)

The Susan River is located along the northern boundary of the Sierra Nevada Mountains. It begins at over 6500 feet in volcanic highlands and runs approximately 67 miles along the Great Basin Divide into the intermittent Honey Lake. The Susan River watershed includes U.S. Bureau of Land Management, U.S. Forest Service, and private lands. Land uses in the Susan River include agriculture, commercial, logging, ranching, and recreation.

Susan River Watershed

Parameter*	Site Specific Objective (mg/L annual average)	Exceedances/ Annual Averages (AA)	Total Sampling Events	Percent AA Exceeded and Range of Exceedance
TDS	185	11/12	40	92% 207-296
Cl	8.0	2/12	40	50% 8.5-8.6
SO4	25	5/7	24	71% 32-51
B	0.10	5/7	23	71% 0.12-0.17
TN	0.65	2/12	40	17% 0.74-0.79
TP	0.25	0/12	48	0%
Turbidity	5** (NTU)	32/36**	36	89% 5.37-34.7

***Only Parameters that are 303(d) listed as impaired, have multiple exceedances or site-specific objectives are presented in the table. Data presented 2001-2014.*

**Single value event

Sampling Frequency: 2001-2005 (3-4 times/year), 2008-2011 (2-3 times/year), 2012 (6 times), 2013-Current (Quarterly)

Current Analytes: alkalinity, turbidity, pH, salinity, conductivity, specific conductance, temperature, DO, B, Ca, Mg, K, Na, TDS, Cl, F, SO4, TP, TN, NO3+NO2, Fecal Coliform, E. Coli

Beneficial Uses: MUN, AGR, IND, GWR, FRSH, NAV, REC1, REC2, COMM, WARM, COLD, WILD, MIGR, SPWN

303(d) Listed as Impaired: Mercury, TDS, Turbidity, and unknown toxicity.

Summary: The Susan River consistently exceeds objectives for B, SO4, TDS and Turbidity.

Focus on Truckee River

Ambient monitoring is an integral part of the Region's SWAMP. This fact sheet focuses on ambient monitoring on the Truckee River (SWAMP Station Code 635TRK002)

The Truckee River originates at the north west outfall of Lake Tahoe. It travels 121 miles, ending in Pyramid Lake, Nevada. The Truckee River delivers 75% of the municipal water supply to the Reno/Sparks communities. Much of the Truckee River is located within the Tahoe and Toiyabe National Forest. Land uses in the California section of the Truckee River include commercial, mining, recreation, residential, and timber harvest.

Parameter*	Site Specific Objective (mean of monthly means)	Total Sampling Events	Exceeds mean of monthly means for the period of record?	Percent and Range of Exceedance
TDS	75	2	Yes	Percent and Range of Exceedance was not analyzed because the SSOs for the Truckee River are mean of monthly means for the period of record. This is a mean of all sample events, resulting in only one number.
Cl	8.0	2	Yes	
SO4	5.0	2	No	
TP	0.05	2	No	
B	1.0	2	No	
TN	0.40	2	No	
Turbidity	3 (NTU)	4	No	

***** *Only Parameters that are 303(d) listed as impaired, have multiple exceedances or site-specific objectives are presented in the table. Data presented for 2014.*

Sampling Frequency: September 2014-Current (Quarterly)

Current Analytes: alkalinity, turbidity, pH, conductivity, specific conductance, temperature, DO, B, Ca, Mg, K, Na, TDS, Cl, F, SO4, TP, TN, SRP, NO3+NO2, TSS, SSC, Fecal Coliform, E. Coli

Beneficial Uses: MUN, AGR, IND, GWR, FRSH, POW, REC1, REC2, COMM, COLD, WILD, RARE, MIGR, SPWN

303(d) Listed as Impaired: Sedimentation/Siltation

Summary: Due to the fact that sampling did not begin until 2014 there is insufficient data to make any meaningful conclusions.

Foucus on East Fork Carson River

Ambient monitoring is an integral part of the Region's SWAMP. This fact sheet focuses on ambient monitoring on the East Fork Carson River below Markleeville (SWAMP Station Code 632ECR005)

The East Fork Carson River originates in the Sierra Nevada mountain range at an elevation of over 10,000 feet, in Alpine County. It travels through lands managed by the U.S. Forest Service, U.S. Bureau of Land Management, as well as private lands. Before reaching Nevada, it joins the West Fork Carson River to become the Carson River. Possible factors impacting water quality include mining, grazing, geothermal hot springs, logging, channelization, rural communities, recreation, and water diversions. Non-native brown and rainbow trout have been stocked in the East Fork Carson River since the early 1900's.

Parameter*	Site Specific Objective (mg/L annual average)	Exceedances/ Annual Averages (AA)	Total Sampling Events	Percent AA Exceeded and Range of Exceedance
TDS	80	10/14	74	71 % 81-112 mg/L
Cl	4.0	0/13	71	0%
SO4	4.0	12/13	100	92% 4.2-7.5 mg/L
Total P	0.02	13/14	103	93% 0.03-0.16 mg/L
B	0.12	5/12	69	42% 0.14-0.20 mg/L
Total N	0.20	3/14	75	21% 0.21-0.30 mg/L

*****Only Parameters that are 303(d) listed as impaired, have multiple exceedances or site-specific objectives are presented in the table. Data presented 2001-2014.*

Carson River Watershed

Sampling Frequency: 2001-2005 (1-5 times/year), 2006-2007 (Monthly), 2008-Current (Quarterly)

Current Analytes: alkalinity, turbidity, pH, salinity, conductivity, specific conductance, temperature, DO, B, Ca, Mg, K, Na, TDS, Cl, F, SO4, TP, TN, SRP, NO3+NO2, Fecal Coliform, E. Coli

Beneficial Uses: MUN, AGR, GWR, FRSH, NAV, REC1, REC2, COMM, COLD, WILD, RARE, SPWN

303(d) Listed as Impaired: TDS, SO4, TP, B

Summary: The East Fork Carson River consistently exceeds the SSOs for TDS, SO4 and TP.

Focus on West Walker River

Ambient monitoring is an integral part of the Region's SWAMP. This fact sheet focuses on ambient monitoring on the West Walker River (SWAMP Station Code 631WWK001)

The West Walker River is a tributary to the Walker River which terminates at Walker Lake. It originates high in the in the Emigrant Wilderness, part of the Stanislaus National Forest. Several sections of the West Walker River are popular fishing destinations. Land uses include agriculture, grazing, dispersed recreation, and residential.

West Walker River Watershed

Sampling Frequency: 2002-2005 (1-4 times/year), August 2007-September 2011 (Monthly), 2012-Current (Quarterly)

Current Analytes: alkalinity, turbidity, pH, salinity, conductivity, specific conductance, temperature, DO, B, Ca, Mg, K, Na, TDS, Cl, F, SO4, TP, TN, SRP, NO3+NO2, Fecal Coliform, E. Coli

Beneficial Uses: MUN, AGR, GWR, FRSH, NAV, REC1, REC2, COMM, COLD, WILD, MIGR, SPWN

303(d) Listed as Impaired: Boron and Chloride

Summary: The West Walker River consistently exceeds every SSO. TDS and TP are exceeded 100% of the time. Diagnostic monitoring for TP was done from 2009 to 2012 and it is suspected the high concentrations are natural sources from Hot Creek.

Parameter*	Site Specific Objective (mg/L annual average)	Exceedances/ Annual Averages (AA)	Total Sampling Events	Percent AA Exceeded and Range of Exceedance
TDS	60	12/12	66	100% 65-117
Cl	3.0	7/12	70	58% 3.3-5.5
B	0.10	6/12	68	50% 0.13-0.24
TN	0.2	2/12	70	17% 0.36-0.53
TP	0.01	12/12	72	100% 0.017-0.330

***Only Parameters that are 303(d) listed as impaired, have multiple exceedances or site specific objectives are presented in the table.*

Focus on East Walker River

Ambient monitoring is an integral part of the Region's SWAMP. This fact sheet focuses on ambient monitoring in the East Walker River at CA/NV state line (SWAMP Station Code 630EWK001)

The East Walker River begins on the eastern slope of the Sierra Nevada mountains, in the Sawtooth Range. It is a tributary of the Walker River which flows into Walker Lake, Nevada. The river runs through U.S Bureau of Land Management, U.S. Forest Service, and private lands. Land uses within the watershed include agriculture, cattle ranching, historical mining, and residential. Many recreationalists visit the region to fish, hike, camp, and visit the geothermal hot springs. Historically, the River is known to be one of finest cutthroat fisheries in the Eastern Sierra, but often due to low snow pack, the higher water temperatures provide poor habitat.

Parameter*	Site Specific Objective (mg/L annual average)	Exceedances/ Annual Averages (AA)	Total Sampling Events	Percent AA Exceeded and Range of Exceedance (mg/L)
TDS	145	3/13	55	23% 149-167
Cl	4.0	0/13	44	0%
B	0.12	2/12	37	17% 0.13-.14
Total N	0.50	7/13	57	54% 0.6-1.5
Total P	0.06	12/13	57	92% 0.07-0.21
Turbidity	5 NTU** (MCL)	20**	67	30% 5.12-16 (NTU)

***Only Parameters that are 303(d) listed as impaired, have multiple exceedances or site-specific objectives are presented in the table. Date presented 2001-2014.*

***Single event value (standard not based on an annual average)*

East Walker River Watershed

Sampling Frequency: 2001-2005 (2-4 times/year), August 2007-August 2011 (Monthly), 2012-Current (Quarterly)

Current Analytes: alkalinity, turbidity, pH, salinity, conductivity, specific conductance, temperature, DO, B, Ca, Mg, K, Na, TDS, Cl, F, SO4, TP, TN, SRP, NO3+NO2, TSS, Fecal Coliform, E. Coli

Beneficial Uses: MUN, AGR, IND, GWR, FRSH, NAV, REC1, REC2, COMM, COLD, WILD, RARE, SPWN

303(d) Listed as Impaired: Manganese, Sedimentation/Siltation, Turbidity, Fecal Coliform

Summary: The East Walker River consistently exceeds the SSOs for TN and TP. There are also some issues with TDS and turbidity.

Focus on Mammoth Creek

Ambient monitoring is an integral part of the Region's SWAMP. This fact sheet focuses on ambient monitoring on Mammoth Creek at Hwy 395 (SWAMP Station Code 603MAM006)

Mammoth Creek originates at the outflow of Twin Lakes above the town of Mammoth Lakes in Mono County. The mountain stream drains from the Eastern Sierra into the Long Valley Caldera. It flows through the community of Mammoth Lakes before joining several geothermal springs and officially becomes Hot Creek downstream of Hot Creek Fish Hatchery. The area surrounding Mammoth Creek is geologically active. Land uses include commercial, Forest Service activities, grazing, residential, and recreation.

Mono Watershed

Parameter*	Site Specific Objective (mg/L annual average)	Exceedances/ Annual Averages (AA)	Total Sampling Events	Percent AA Exceeded and Range of Exceedance
TDS	75	13/14	76	86% 77-122
Cl	1.0	0/14	58	0%
SO4	6.0	3/13	34	23% 6.4-493.3
F	.10	4/13	34	31% 0.17-0.25
B	.03	1/14	50	7% 0.05
NO3	0.4	0/10	31	0%
TN	0.6	0/13	44	0%
PO4	0.11	0/14	67	0%

*****Only Parameters that are 303(d) listed as impaired, have multiple exceedances or site-specific objectives are presented in the table. Data presented 2000-2014*

Sampling Frequency: 2000-2005 (1-4 times/year), August 2007-August 2011 (Monthly), 2012-Current (Quarterly)

Current Analytes: alkalinity, turbidity, pH, salinity, conductivity, specific conductance, temperature, DO, B, Ca, Mg, K, Na, TDS, Cl, F, SO4, TP, TN, SRP, NO3+NO2, Fecal Coliform, E. Coli

Beneficial Uses: MUN, AGR, GWR, FRSH, REC1, REC2, COMM, COLD, WILD, RARE, MIGR, SPWN

303(d) Listed as Impaired: Manganese, Mercury, TDS

Summary: Mammoth Creek regularly exceeds SSOs for TDS.

Focus on Lower Owens River

Ambient monitoring is an integral part of the Region's SWAMP. This fact sheet focuses on ambient monitoring on the Lower Owens River below Warm Springs Road (SWAMP Station Code 603LOW011)

The Lower Owens River runs through the Owens Valley and terminates at Owens Lake. Since 1913 the Owens River has been diverted to Los Angeles causing Owens Lake and parts of the Owens River to dry up. A move to restore the Owens River Watershed in 2006 has led to re-watering 62 miles of river and floodplain and has resulted in the largest river restoration of its kind in the United States. Today the Lower Owens River is a year round destination for camping, fishing, kayaking, hiking, and hot spring enthusiasts. Land uses include agriculture, commercial, livestock management, municipal, residential, and recreation.

Owens River Watershed

Parameter*	Site Specific Objective (mg/L annual average)	Exceedances/ Annual Averages (AA)	Total Sampling Events	Percent AA Exceeded and Range of Exceedance
TDS	215	1/2	7	50% 217
Cl	20.0	2/2	7	100% 20.5-27.6
SO4	14.0	2/2	7	100% 21.0-23.4
F	0.73	2/2	7	100% 0.86-1.09
B	0.76	2/2	7	100% 0.84-1.01
TN	1.0	0/2	7	0%
PO4	0.56	0/2	7	0%

**Only Parameters that are 303(d) listed as impaired, have multiple exceedances or site-specific objectives are presented in the table. Data presented 2013-2014.*

Sampling Frequency: 2013-2018 (Quarterly)

Current Analytes: alkalinity, turbidity, pH, salinity, conductivity, specific conductance, temperature, DO, B, Ca, Mg, K, Na, TDS, Cl, F, SO4, TP, TN, SRP, NO3+NO2, Fecal Coliform, E. Coli

Beneficial Uses: MUN, AGR, GWR, FRSH, NAV, REC1, REC2, COMM, COLD, WILD, RARE, SPWN

303(d) Listed as Impaired: No current listings, possible listings in next Integrated Report cycle (see below).

Summary: The Owens River consistently exceeds SSOs for Cl, SO4, F and B. Only two years of data have been evaluated.

Focus on Mojave River at Upper Narrows

Ambient monitoring is an integral part of the Region's SWAMP. This fact sheet focuses on ambient monitoring on the Mojave River at Upper Narrows (SWAMP Station Code 628MOJ001)

The Mojave River primarily flows underground with the exception of a few miles near the Upper and Lower Narrows. Impermeable rock forces the Upper Narrows section of the Mojave River to the surface where it originates in a drainage ditch and flows between Victorville and Apple Valley. Land uses include commercial, Forest Service activities, residential, and recreation. This area is highly urbanized which could affect water quality.

Parameter*	Site Specific Objective (mg/L annual average)	Exceedances/ Annual Averages (AA)	Total Sampling Events	Percent AA Exceeded and Range of Exceedance
TDS	312**	28**	31	90% 315-496
Cl	75	0/12	31	0%
SO4	40	12/12	31	100% 43-96
F	0.2	10/11	29	91% 0.3-1.2
B	0.2	1/12	27	8% 0.3

***Only Parameters that are 303(d) listed as impaired, have multiple exceedances or site-specific objectives are presented in the table. Data presented 2001-2014.*

*** Single value event (standard not based on an annual average)*

Mojave Watershed

Sampling Frequency: 2001-2005 (2-4 times/year), 2008-Current (1-3 times/year)

Current Analytes: alkalinity, turbidity, pH, salinity, conductivity, specific conductance, temperature, DO, B, Ca, Mg, K, Na, TDS, Cl, F, SO4, TP, TN, SRP, NO3+NO2

Beneficial Uses: MUN, AGR, GWR, REC1, REC2, COMM, WARM, COLD, WILD

303(d) Listed as Impaired: Fluoride, Sulfates, TDS

Summary: The Mojave River at Upper Narrows consistently exceeds SSOs for TDS, SO4 and F. Further diagnostic investigation is needed to determine more meaningful annual averages.

Focus on Mojave River below Reservoir

Ambient monitoring is an integral part of the Region's SWAMP. This fact sheet focuses on ambient monitoring on the Mojave River below Forks Reservoir (SWAMP Station Code 628MOJ002)

The Mojave River originates in the San Bernardino Mountains at an elevation of 3000 feet. The Mojave River is the largest river in the Mojave Desert. The Forks Reservoir is located at the confluence of the West Fork Mojave River and Deep Creek. The dam is used strictly for flood management therefore it remains dry most of the time. There are no gates on the dam and therefore flow is directly dependent on the water storage. Land uses within the watershed include commercial, Forest Service activities, residential, and recreation.

Mojave Watershed

Parameter*	Site Specific Objective (mg/L annual average)	Exceedances/ Annual Averages (AA)	Total Sampling Events	Percent AA Exceeded and Range of Exceedance
TDS	312**	6**	31	19% 330-386
Cl	55	1/12	31	8% 87
SO4	35	5/12	31	42% 37-95
F	1.5	6/12	29	50% 1.7-4.6
B	0.2	1/12	30	8% 0.3
Turbidity	5** NTU (MCL)	3**	16	19% 6.1-19.8 NTU

***Only Parameters that are 303(d) listed as impaired, have multiple exceedances or site-specific objectives are presented in the tab. Data presented 2001-2014.*

***Single value event (standard not based on an annual average)*

Sampling Frequency: 2001-2005 (2-4 times/year), 2008-Current (1-3 times/year)

Current Analytes: alkalinity, turbidity, pH, salinity, conductivity, specific conductance, temperature, DO, B, Ca, Mg, K, Na, TDS, Cl, F, SO4, TP, TN, SRP, NO3+NO2

Beneficial Uses: MUN, AGR, GWR, REC1, REC2, COMM, WARM, COLD, WILD

303(d) Listed as Impaired: Fluoride

Summary: The Mojave River below Forks Reservoir continues to have issues with F. There are also several TDS and SO4 exceedances.

In 2017 and 2018 staff worked with external contractors to create a template fact sheet better able to inform the public about water quality at the “permanent” monitoring sites.

Staff used data from the East Fork Carson River to create this example of an expanded and accessible fact sheet. That four-page fact sheet is presented below.

Lahontan Regional Water Quality Control Board
Surface Water Ambient Monitoring Program - Fact Sheet 2018

East Fork Carson River

Watershed Profile

Description

The East Fork Carson River originates in the Sierra Nevada mountain range at an elevation of over 10,000 feet in Alpine County. It travels through lands managed by the U.S. Forest Service and U.S. Bureau of Land Management, as well as private lands. The East Fork Carson River eventually joins the West Fork Carson River to become the Carson River in Nevada. The watershed is mostly remote and rural and known for rangeland and recreation, especially fishing, camping, hiking, rafting, and kayaking. There is also legacy mining in the area.

Beneficial Uses

Present and potential beneficial uses are defined and designated for surface waters, groundwaters, and wetlands in *The Water Quality Control Plan for the Lahontan Region* (Basin Plan). Beneficial uses for the East Fork Carson River are:

- Agricultural Supply
- Cold Freshwater Habitat
- Commercial and Sport Fishing
- Freshwater Replenishment
- Groundwater Recharge
- Municipal and Domestic Supply
- Navigation
- Noncontact Water Recreation
- Rare, Threatened, or Endangered Species
- Spawning, Reproduction, and Development
- Water Contact Recreation
- Wildlife Habitat

Data Collection

Parameters

- Alkalinity
- Boron
- Calcium
- Chloride
- Dissolved Oxygen
- E. coli
- Electrical Conductivity
- Fecal Coliform
- Fluoride
- Magnesium
- Nitrate
- Nitrite
- Nitrogen
- Orthophosphate
- pH
- Phosphorus
- Potassium
- Salinity
- Sodium
- Specific Conductivity
- Sulfate
- Temperature
- Total Dissolved Solids
- Turbidity

Sampling Frequency

- 2001 - 2005: 1-5 times annually
- 2006 - 2007: Monthly
- 2008 - Present: Quarterly

FEATURED INSIDE

ASSESSING A HEALTHY RESOURCE

Why Water Quality Monitoring is Important

The East Fork Carson River is fed primarily from high-quality headwaters minimally affected by anthropogenic sources. This creates a unique ecosystem and a high-value resource for agricultural and municipal water supply as well as recreation. The segment between Hangman's Bridge and the Nevada state line is designated as a State Wild and Scenic River and is popular for rafting and fishing. This state-designated Wild Trout Stream also supports two subspecies of threatened trout: the Lahontan and Paiute cutthroat.

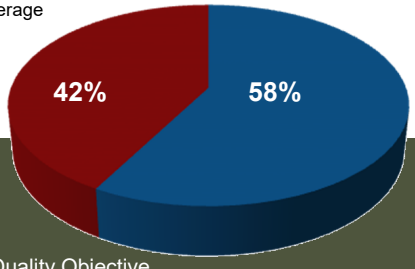
To ensure its continued health, the East Fork Carson River has numerical and narrative water quality objectives in its Basin Plan. These objectives were developed from historical data to define background levels. Water quality objectives define the upper concentration or other limit that the Regional Board considers protective of beneficial uses. The highly protective water quality objectives in the Lahontan Region are often more stringent than anywhere else statewide.

Regional SWAMP data is routinely evaluated to determine water quality in watersheds and inform listing or delisting from the federal list of impaired waters. The East Fork Carson River is on the federal list of impaired waters for boron, total dissolved solids, phosphorus, and sulfates, but is in compliance for the twenty other parameters that SWAMP has collected. Ongoing biological studies confirm that the East Fork Carson River is a high-quality headwater.

BORON

Boron is a non-metallic element that reacts with metals to form borides. It is an essential plant nutrient, but levels of 1.0 ppm or even lower can become toxic to sensitive plant species. While boron occurs in the environment mainly through natural processes, releases can also occur from industries producing or using it, particularly glass producers. Boron is also released from burning wood or coal.

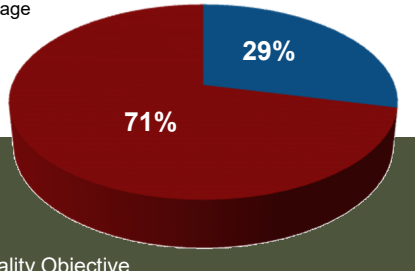
Water Quality Objective*: 0.12 mg/L
Sampling Events: 69
Annual Averages Calculated: 12
Annual Averages Exceeding Objective: 5
Range of Exceedances: 0.14 - 0.20 mg/L
*Based on Annual Average



TOTAL DISSOLVED SOLIDS

Total dissolved solids are the inorganic salts and small amounts of organic matter present in solution in water. Total dissolved solids at the correct levels are necessary to aquatic life, but elevated levels could affect all forms of aquatic life, as well as municipal and domestic water supplies. Total dissolved solids are found naturally and in runoff from storm water, agriculture, erosion, and road de-icing.

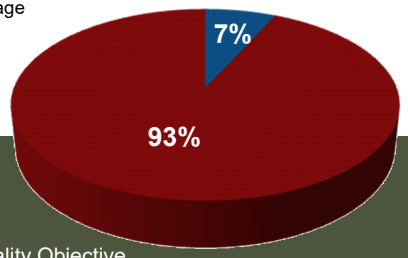
Water Quality Objective*: 80 mg/L
Sampling Events: 74
Annual Averages Calculated: 14
Annual Averages Exceeding Objective: 10
Range of Exceedances: 81 - 112 mg/L
*Based on Annual Average



PHOSPHORUS

Phosphorus is a nutrient that is vital to human, animal, and plant growth. It is one of the most common substances found in nature. Phosphorus occurs naturally at low levels in water, plants, and animals. Unnatural sources include cleaning products, wastewater, agricultural runoff, and erosion. Elevated levels of phosphorus in nature can create algal blooms, decreasing sunlight and dissolved oxygen levels crucial to aquatic life.

Water Quality Objective*: 0.02 mg/L
Sampling Events: 103
Annual Averages Calculated: 14
Annual Averages Exceeding Objective: 13
Range of Exceedances: 0.03 - 0.16 mg/L
*Based on Annual Average

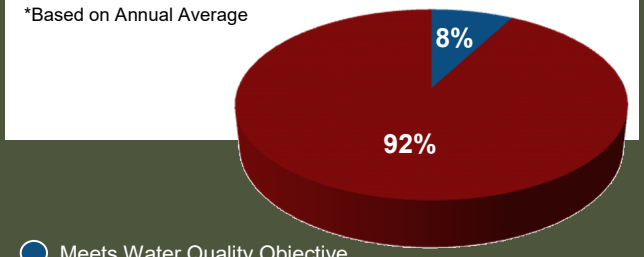


SULFATES

Sulfates are highly soluble salts of sulfuric acid that are found in most water. They combine sulfur and oxygen and are a part of naturally occurring minerals in some soil and rock formations. Sulfates are found in soil, sediments, and rocks as a result of both natural processes and human activities (e.g., mining). Sulfates may form strong acids that can change the pH of their surroundings.

Sulfates can be deposited into water from agricultural, urban, and industrial runoff. Other sources include fire, drought, dry deposition, and road de-icing, as well as wastewater and groundwater infiltration. Sulfates may affect cold freshwater habitat as well as municipal and domestic water supplies. They may also result in aesthetic and nuisance problems.

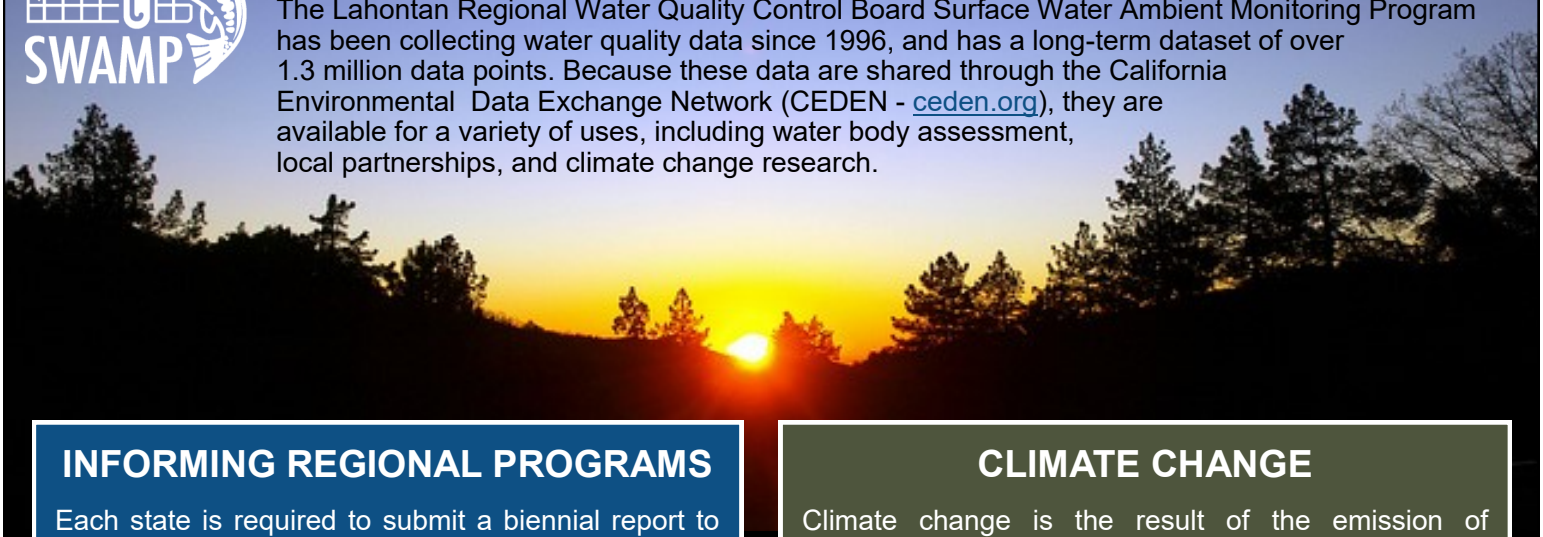
Water Quality Objective*: 4.0 mg/L
Sampling Events: 100
Annual Averages Calculated: 13
Annual Averages Exceeding Objective: 12
Range of Exceedances: 4.2 - 7.5 mg/L
*Based on Annual Average



BIOLOGICAL INTEGRITY
California Stream Condition Index

Water quality analyses in the East Fork Carson River are supplemented by bioassessment studies, which evaluate the condition of a water body based on the organisms living within it. The California Stream Condition Index is applied to Regional SWAMP data to score the condition of benthic macroinvertebrate communities. Results have shown that the biotic community in the East Fork Carson River is demonstrative of a healthy river system. Anglers agree that where there are good bugs, there are good fish.

Applications of Regional SWAMP Data



The Lahontan Regional Water Quality Control Board Surface Water Ambient Monitoring Program has been collecting water quality data since 1996, and has a long-term dataset of over 1.3 million data points. Because these data are shared through the California Environmental Data Exchange Network (CEDEN - ceden.org), they are available for a variety of uses, including water body assessment, local partnerships, and climate change research.

INFORMING REGIONAL PROGRAMS

Each state is required to submit a biennial report to the U.S. Environmental Protection Agency to provide a status update on the quality of its surface waters. In the last report submitted by the Lahontan Regional Water Quality Control Board, 92% of the regional data evaluated were from the Regional SWAMP. The data evaluation for these reports continually updates the federal list of impaired waters.

The Regional Board has used its Regional SWAMP data as a basis for regulatory enforcement actions, monitoring components of regulatory permits, and prioritization of policy development. The Regional SWAMP has also assisted other regional programs by providing follow-up monitoring to isolate or identify water quality issues and specialized studies.

CLIMATE CHANGE

Climate change is the result of the emission of greenhouse gases, primarily carbon dioxide and methane, which are causing an overall increase in temperatures, reduced snowpack, greater fluctuations in temperature and precipitation, changes in timing and volume of peak runoff, and more frequent extreme weather events. Long-term ambient water quality monitoring is important to document watersheds that may be changing and to track watershed resiliency.

Since 1996, the Regional SWAMP has been collecting data for a variety of climate change parameters (3,457 data points for temperature alone). The public may query and download this data from CEDEN, or contact Kelly Huck, Environmental Scientist (kelly.huck@waterboards.ca.gov) for more information.

COLLABORATION

The Lahontan Regional Water Quality Control Board actively collaborates with partners such as:

- Alpine Watershed Group
- Carson River Subconservancy District
- Washoe Tribe
- Federal Land Managers
- State Land Managers
- Private Land Owners

To assess the safety of swimming and recreation in Woodfords, Markleeville, and surrounding communities, the Regional SWAMP has actively assisted the Alpine Watershed Group (AWG) in its collection and analysis of bacteria water samples. In addition to analyzing AWG-collected samples, Lahontan staff collects and analyzes its own supplementary samples. To ensure that resulting data are available to the public, Regional SWAMP has supported the AWG with data management, input to CEDEN, upload trainings, and regional data center funding.

More regional information may be found online:

Lahontan Region Homepage: www.waterboards.ca.gov/rwqcb6
Regional SWAMP Homepage: www.waterboards.ca.gov/lahontan/water_issues/programs/swamp
Regional Basin Plan: www.waterboards.ca.gov/lahontan/water_issues/programs/basin_plan

MPSL

CalEPA California Environmental Protection Agency

CEDEN CALIFORNIA ENVIRONMENTAL DATA EXCHANGE NETWORK

CALIFORNIA WATER QUALITY MONITORING COUNCIL

Appendix 2: Water Quality Monitoring Locations

Long-term Permanent Sites

Site Name	Site Code	Latitude[3]	Longitude[3]
Susan River, near Litchfield	637SUS001	40.37771	-120.39514
Truckee River, above Farad	635TRK002	39.42259	-120.03391
West Fork Carson River, at Paynesville Bridge	633WFCB02	38.80889	-119.77714
East Fork Carson River, below Markleeville	632ECR005	38.71542	-119.76440
West Walker River, near Coleville	631WWK001	38.51337	-119.44880
East Walker River, at CA/NV state line	630EWK001	38.41399	-119.16574
Mammoth Creek, at Hwy 395	603MAM006	37.63799	-118.90771
Lower Owens River, at Warm Springs Rd[4]	603LOW011	37.32534	-118.31365
Mojave River, at Upper Narrows	628MOJ001	34.53176	-117.28534
Mojave River, below Forks Reservoir	628MOJ002	34.34462	-117.23852

Permanent sites include the major waterbodies of the Lahontan Region. Permanents sites are sampled quarterly for alkalinity, turbidity, pH, salinity, electrical conductivity, specific conductivity, temperature, boron, calcium, magnesium, potassium, sodium, total dissolved solids, chloride, fluoride, sulfate, total phosphorus, total nitrogen, nitrate +nitrite, soluble reactive phosphorus, fecal coliform bacteria, and *E. coli* bacteria. Waterbody fact sheets were created for each permanent SWAMP site and are included in Appendix 1.

[3] All coordinates are in NAD 83
[4] Currently not monitored (since 2018) due to staffing constraints.

Temporary Screening Sites

Site Name	Site Code	Latitude[5]	Longitude[3]
Bidwell Creek, near former DWR gage site[6]	641BID001	41.88246	-120.17444
Mill Creek, above Lake City[4]	641MIL002	41.64084	-120.21895
Cedar Creek, above Cedarville[4]	641CDR002	41.52993	-120.18924
Susan River at Lassen at Lassen St[7]	637SUS002	40.41374	-120.66476
Susan River, at Commercial Road	637SUS004	40.39705	-120.62122
Susan River, above confluence w/ Willard Cr	637SUS003	40.39603	-120.78140
Bear Creek, lower (moraine)	635BER001	39.18996	-120.19825
Squaw Creek, above Truckee River	635SQLB01	39.21145	-120.19955
West Fork Carson River, below Willow Creek	633WCR002	38.77806	-119.91611
West Fork Carson River, at Woodfords Bridge	633WFCB03	38.77504	-119.82301
Mill Creek above Hwy 395[4]	631MIL002	38.51323	-119.4714
Mill Creek at USFS boundary[4]	631MIL008	38.48682	-119.48451
Bishop Cr Canal at East Line St[5]	603BPS002	37.36156	-118.38606
South Fork Bishop Creek, above Bishop Cr Canal[4]	603BPS004	37.36786	-118.38625
North Fork Bishop Creek, above Bishop Cr Canal[4]	603BSP021	37.38011	-118.40472
Bishop Creek, at national forest boundary[4]	603BSP111	37.33030	-118.49583
Deep Creek, above Deep Creek Lake	628DEP001	34.21949	-117.07175
Deep Creek, upstream Deep Creek Lake	628DEPDCL	34.21427	-117.08533
Deep Creek, downstream of Hot Springs	628DEPDHS	34.34078	-117.20949

[5] All coordinates are in NAD 83
[6] No longer sampled due to limited staff resources.
[7] Replaced by new screening site.

Site Name	Site Code	Latitude[5]	Longitude[3]
West Fork Moiave River. Silverwood Lake outfall	628MRWSLO	34.30944	-117.31678
Holcomb Creek. at Crab Flats Rd[5]	628HOL001	34.27546	-117.05047
Sheep Creek, below Scout Camp[5]	628SHP001	34.25364	-117.12391
Crab Creek, at Crab Flats Rd[5]	628CRB001	34.25885	-117.08406

Temporary sites (see Table 3 for locations) are sampled quarterly for alkalinity, turbidity, pH, salinity, electrical conductivity, specific conductivity, temperature, boron, calcium, magnesium, potassium, sodium, total dissolved solids, chloride, fluoride, sulfate, total phosphorus, total nitrogen, nitrate +nitrite, soluble reactive phosphorus, fecal coliform bacteria, and *E. coli* bacteria. With the exception of Boron at Bear Creek and Squaw (not Basin Plan Objectives).

Follow-up Diagnostic Sites

Site Name	Site Code	Latitude[8]	Longitude[3]
Truckee River, above Farad[(a)]	635TRK002	39.42259	-120.03391
General Creek, above Hwy 89[(b)]	634GENB10	39.05180	-120.11800
East Fork Carson River, above Hangman's	632ECRB10	38.68959	-119.76394
West Walker River, above Little Walker River	631WWK007	38.37927	-119.45112
West Walker River at Topaz	631WWK008	38.61051	-119.51758
West Walker River above Pack Station	631WWK010	38.32316	-119.54865
Little Walker River abv West Walker River	631LWK003	38.37932	-119.45073
Little Walker River abv Hot Creek	631LWK004	38.34170	-119.45089
Hot Creek abv Little Walker River	631HOT001	38.34206	-119.45074
Hilton Creek, at Lake Crowley[(c)]	603HIL001	37.57948	-118.74150
Rock Creek, above diversion[(c)]	603RCK002	37.54984	-118.68665
Mammoth Creek, above Horsecamp[(c)]	603MAM014	37.63480	-118.96759
Mammoth Creek, at Twin Lakes[(c)]	603MAM008	37.62389	-119.00472

(a) Monthly at Truckee River: total suspended solids, suspended sediment concentration, turbidity.

(b) Monthly at General Creek: total phosphorus, soluble reactive phosphorus, fecal coliform.

(c) Quarterly (where indicated): total dissolved solids, fecal coliform (Past quarterly screening has revealed potential exceedances of Basin Plan SSOs for total dissolved solids. As time allows, continue quarterly monitoring for total dissolved solids and fecal coliform to discern trends, if any).

[8] All coordinates are in NAD 83

ENCLOSURE 2
(to be submitted under
separate cover)