SWAMP
Surface Water Ambient Monitoring Program

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Surface Water Ambient Monitoring Program (SWAMP) at the Lahontan Region: Summary of Results for Years 2000–2005

July 2007

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SURFACE WATER AMBIENT MONITORING PROGRAM (SWAMP) AT THE LAHONTAN REGION:

SUMMARY OF RESULTS FOR YEARS 2000-2005

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EXECUTIVE SUMMARY

SWAMP at the Lahontan Region from 2000–2005

This report summarizes the activities and findings of the Surface Water Ambient Monitoring Program (SWAMP) at the Lahontan Region from the creation of the SWAMP program (in July 2000) through August of 2005.

SWAMP activities at the Lahontan Region from 2000–2005 included: 1) surface water sampling performed under contract by the U.S. Geological Survey (USGS); 2) bioassessment sampling performed under contract by the University of California's Sierra Nevada Aquatic Research Laboratory (UC-SNARL); and 3) other special studies. The bioassessment projects and special studies are briefly described (at Chapter 2), and links to available reports are provided. The main purpose of this report is to provide (at Ch. 3) a summary and analysis of SWAMP data collected by the USGS within the Lahontan Region from July 2000 through August 2005.

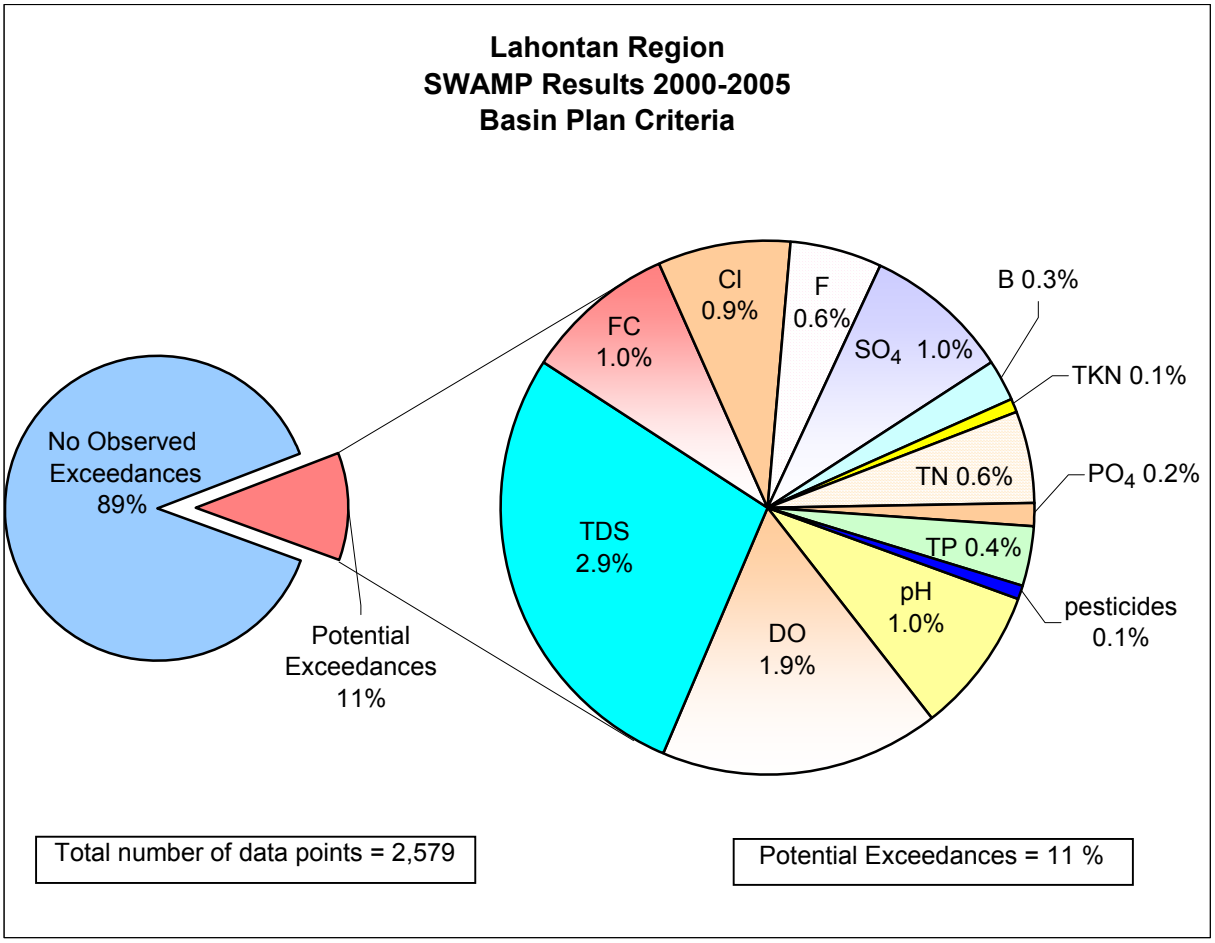
SWAMP Sampling Conducted by the USGS

A total of 30 surface water sites within the Lahontan Region were sampled by the USGS from 2000–2005, as described and summarized in this report. Sampling was generally conducted from one to four times per calendar year at each site.

This report does not contain all of the actual USGS data. Instead, it summarizes the findings by comparing the results to the applicable water quality objectives (i.e., standards) contained in the *Water Quality Control Plan for the Lahontan Region* (Basin Plan), as well as to criteria contained in the USEPA-promulgated California Toxics Rule (CTR) and the California Department of Public Health's Maximum Contaminant Levels (MCLs) for drinking water. The raw data and other interpretive tools (such as graphs of the data compared to Basin Plan, CTR, MCL, and numerous other relevant advisory water quality criteria) are available at the Lahontan Water Board's public website. To view the raw USGS data and other interpretive tools, see the Lahontan Region's website at: http://www.waterboards.ca.gov/lahontan/water_issues/programs/swamp/index.shtml.

Overview of the Results

The USGS data indicate that surface waters at the sampled sites are generally in compliance with the numeric water quality objectives contained in the Basin Plan. However, some potential exceedances of Basin Plan criteria were detected. Specifically, out of 2,579 total "data points," 280 potential exceedances were documented. In other words, while the vast majority of results indicate compliance with relevant Basin Plan criteria, these results indicate a "potential exceedance" rate of about 11 percent. The pie chart below depicts the overall findings:



TDS = total dissolved solids; FC = fecal coliform bacteria; Cl = chloride; F = fluoride; SO_4 = sulfate; B = boron; TKN = total Kjeldahl nitrogen; TN = total nitrogen; PO_4 = phosphate; TP = total phosphorus; DO = dissolved oxygen

Important Considerations Regarding Study Design

Several considerations should be kept in mind when interpreting these results. First of all, the sample locations were selected based on criteria that included:

- Access. Because landowner permission is necessary to enter or cross private property, and because there was limited staff time to locate and contact landowners to obtain permission, most sites included in this study are located on public lands or within public rights-of-way.

- Existence of prior data. Priority was placed on gathering information at sites for which little or no previous monitoring data was known to exist. (For example, no stream sites were included in this study for the Lake Tahoe or Truckee River watersheds, because more data exist for those watersheds relative to other parts of the Lahontan Region.)

- Watershed location. An effort was made to select bottom-of-watershed "integrator" sites. This is based on the assumption that headwater streams, in general, have good water quality, and that any water quality problems should generally appear at downstream locations that are more influenced by human activities. While this assumption will not hold true in all cases, because of funding limitations it was decided that lower-watershed sites were the best places to begin the Region's SWAMP effort. Further, the Lahontan Region has several interstate waters that flow from California into the State of Nevada; it is therefore desirable to know the water quality conditions at or near the state boundary.

It is important to note that the sites sampled for this study were targeted based upon the above criteria. The sites were not randomly selected. Therefore, while the results provide a useful screening of water quality at the selected sites, these results cannot be extrapolated to the entire Region with statistical confidence.

It is also important to keep in mind when interpreting these results that the 11 percent "potential exceedance" rate reported here does not mean that 11 percent of the samples indicate "impairment" or significant problems. For example, many of the numeric criteria contained in the Basin Plan are based on time averages, such as "annual average" or "mean-of-monthly-mean" averaged values. In many cases, only a few samples were collected at a given site per year—and at some sites only a single sample was collected in some years. Such small sample sizes often provide inaccurate annual average values. Nevertheless, wherever the calculated average of a small number of samples exceeds the time-averaged numeric criterion in the Basin Plan, the results are reported here as a "potential exceedance." Evaluated in the proper context, this indicates that further monitoring is needed to accurately characterize water quality at those sites.

Interpretation of the Results

The highest number of potential exceedances of Basin Plan objectives was for total dissolved solids (TDS). There are three plausible explanations for the relatively high rate of potential exceedance of objectives for TDS: (1) The annual average TDS concentrations calculated for 2000–2005 are based on relatively low sample sizes (generally one to four samples per site, per year), and more frequent samples may be needed to obtain accurate annual averages; and/or (2) some of the Basin Plan's site-specific numeric objectives for TDS may not reflect the true annual average TDS concentrations at the time of their adoption in 1974, and in some cases may not be achievable; and/or (3) human activities may be resulting in elevated levels of TDS at the monitored sites. Further investigation would be needed to evaluate these possibilities.

The second highest number of potential exceedances of Basin Plan objectives was for dissolved oxygen (DO). All DO measurements were collected in the field as discrete, single measurements. No continuous (or "time-series") data are available for DO at any of the sites. Due to the wide diurnal and seasonal fluctuations in DO concentrations, the results for DO are largely inconclusive; further investigation would be needed to accurately characterize the oxygen status of these water bodies.

Potential exceedances of other Basin Plan objectives were relatively rare, but in all cases are being further evaluated on a case-by-case basis, together with all other readily available data, as Water Board staff updates the Clean Water Act Section 303(d) list of impaired water bodies. Where the weight of evidence indicates impairment, Water Board staff will recommend inclusion on the 303(d) list. Where the weight of evidence is inconclusive, but significant issues may be present, further monitoring will be conducted as funding allows.

The results were also compared to other relevant water quality criteria, such as the California Toxics Rule (CTR) and the California Maximum Contaminant Levels (MCLs) for drinking water. The CTR criteria for Human Health and Aquatic Life were exceeded in a small number of cases. For example, the CTR Human Health criterion for mercury was exceeded at Mammoth Creek (even though the drinking water MCL was met in all cases). The mercury is believed to originate from natural sources. The local county health department was notified and provided copies of the data. The detected exceedances of MCLs are also believed to be primarily due to natural sources, but indicate that surface waters in some areas should not be consumed without proper treatment.

Summary and Conclusions

Chemical and bacteriological monitoring was conducted by the USGS at 30 surface water sites throughout the Lahontan Region from 2000–2005. The results indicate that surface waters at the monitored sites are generally of high quality. However, some potential exceedances of State water quality standards (i.e., Basin Plan objectives) were observed.

Due to funding limitations, the sampling was neither comprehensive nor exhaustive. Only 30 sites were monitored, and most sites were sampled for conventional water quality parameters only. Metals and organic constituents were sampled at only a few locations.

The highest rates of potential exceedance were documented for total dissolved solids (TDS) and dissolved oxygen (DO). The causes and significance of the potential exceedances for these parameters remains unknown. Potential exceedances of other Basin Plan objectives were relatively rare. Follow-up monitoring at these and other sites will be conducted as funding allows.

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LIST OF ACRONYMS & ABBREVIATIONS

AB 982 – California Assembly Bill 982 (Statutes of 1999)

CTR – California Toxics Rule

DO – dissolved oxygen

FC – fecal coliform bacteria

HU – Hydrologic Unit

IBI – index of biological integrity

MCLs – Maximum Contaminant Levels (for drinking water)

NDEP – Nevada Division of Environmental Protection

NWQL – National Water Quality Laboratory of the U.S. Geological Survey

ONRW – Outstanding National Resource Water

QA – quality assurance

QC – quality control

SC – specific conductance

SWAMP – Surface Water Ambient Monitoring Program

TDS – total dissolved solids

UC-SNARL – University of California, Sierra Nevada Aquatic Research Laboratory

USEPA – United States Environmental Protection Agency

USGS – United States Geological Survey

WMA – Watershed Management Area

CHAPTER 1. *Introduction*

The Lahontan Region—Background

For purposes of regulating water quality, the State of California is divided into nine regions.[1] The Lahontan Region is one of the largest regions in California, second in size only to the Central Valley Region. The Lahontan Region spans eastern California from the Oregon border in the north, to the Mojave Desert, San Bernardino Mountains, and eastern Los Angeles County in the south.[2] The Region is nearly 600 miles long and has a total area of more than 33,000 square miles. It includes the highest point (Mount Whitney, +14,494 ft.) and lowest point (Badwater, Death Valley, –282 ft.) in the contiguous United States, with more than 3,000 miles of perennial streams, and more than 700 lakes. This wide range of topography and latitude creates a variety of habitats, precipitation regimes, and ecosystem types, ranging from snow-packed alpine mountains to low-elevation, dry deserts.

The Region's economy is based largely on recreation and tourism. Other major economic sectors include agriculture (i.e., livestock grazing, silviculture, dairies), resource extraction (i.e., mining, energy production, and timber), and defense-related activities (i.e., Army, Air Force, and naval bases).

The Lahontan Region contains two designated Outstanding National Resource Waters (ONRWs): Lake Tahoe and Mono Lake. The Region also has numerous other high-quality water bodies that may be eligible for ONRW status. Along with the many high-quality water bodies, the Lahontan Region also includes many "ecological islands." Such "islands" result from extreme climatic, glacial, and geologic changes over time, which foster the isolation and/or creation of a variety of subspecies and genetic strains of plants and animals found exclusively in the Region. Particularly notable are several species of fish, such as the Eagle Lake trout, the Lahontan and Paiute cutthroat trout, the Mojave chub, and desert pupfish.

Much of the Lahontan Region is in public ownership, managed by agencies that include the U.S. Forest Service, National Park Service, Bureau of Land Management, military agencies, the California Department of Fish and Game, California Department of Parks and Recreation, and the City of Los Angeles Department of Water and Power. The Lahontan Region's population density is low compared to the other Water Board regions. While some mountain communities are growing rapidly (such as Truckee and Mammoth Lakes), the majority of the Region's residents live in high-density communities in the South Lahontan Basin.

There are several unique factors that affect water quality in the Lahontan Region, including:

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[1] To view a map of the nine regions, see: http://www.waterboards.ca.gov/regions.html.

[2] To view a detailed map of the Lahontan Region, see: http://www.waterboards.ca.gov/lahontan/images/maps/regionmap_detailed.pdf.

- Locally high concentrations of "pollutants" (i.e., arsenic, boron, mercury, etc.) from natural volcanic and geothermal sources, and from evaporative concentration in desert environments;

- Water quality-quantity relationships (i.e., the Lahontan Region includes many naturally ephemeral water bodies, and some waters, such as Mono Lake, have been significantly affected by water diversions);

- Severe impacts to some watersheds in the 1990s and 2000s by wildfires or floods or both;

- Long-distance transport of nutrients, pesticides and other compounds to "pristine" Lahontan Region waters via atmospheric deposition.

The primary water quality standards applicable in the Lahontan Region are found in the *Water Quality Control Plan for the Lahontan Region* (Basin Plan).[3]

The Surface Water Ambient Monitoring Program (SWAMP)

California's Porter-Cologne Water Quality Control Act and the federal Clean Water Act direct that water quality protection programs be implemented to protect and restore the chemical, physical, and biological integrity of the State's waters. California Assembly Bill 982 (Statutes of 1999) required the State Water Resources Control Board (State Water Board) to assess and report on the State's water quality monitoring programs.

AB 982 envisioned that ambient monitoring would be independent of other water quality regulatory programs, and serve as a measure of: (1) the overall quality of the State's water resources, and (2) the overall effectiveness of the prevention, regulatory, and remedial actions taken by the State Water Board and the nine Regional Water Quality Control Boards (Regional Water Boards). To implement this directive, modest funding for ambient surface water quality monitoring was allocated to the State Water Board (and thereby to the Regional Water Boards) beginning in State Fiscal Year 2000–2001.

AB 982 also required the State Water Board to prepare a proposal for a comprehensive surface water quality monitoring program. That proposal, entitled *Proposal for a Comprehensive Ambient Surface Water Quality Monitoring Program*,[4] was transmitted to the State Legislature on November 30, 2000. At this writing, sufficient funding has not been appropriated to fully implement that plan.

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[3] To view the Lahontan Basin Plan, see: http://www.waterboards.ca.gov/lahontan/water_issues/programs/basin_plan/references.shtml.

[4] To view the Report to the Legislature, see: http://www.waterboards.ca.gov/legislative/docs/2000/swrcb_monitoring_rpt1100.pdf.

Using the available funding, the State Water Board created the Surface Water Ambient Monitoring Program (SWAMP). SWAMP is intended (to the extent that funding is available) to provide a measure of the State's ambient water quality and the effectiveness of the State's water quality protection programs. SWAMP relies primarily on contractors, such as the University of California, the U.S. Geological Survey (USGS), and others, to collect information on the quality of the State's waters. Limited Regional Water Board staff time is spent largely on programmatic (i.e., planning, contracting, reporting) tasks.

For the first five years of the SWAMP program (i.e., 2000–2005), the primary goals of SWAMP monitoring at the Lahontan Region were twofold. First, the Region conducted monitoring to determine—to the extent that funding was available and using a region-wide network of sampling stations—whether ambient water quality at the monitored sites (see Figure 1) is in compliance with the chemical and physical water quality objectives contained in the *Water Quality Control Plan for the Lahontan Region* (Basin Plan), the *California Toxics Rule* (CTR), and California's *Maximum Contaminant Levels* (MCLs) for drinking water.[5] Second, the Lahontan Region commenced an effort to develop tools to assess the biological integrity of wadeable streams and rivers based on assemblages of instream benthic macroinvertebrates and periphyton.[6] ("Periphyton" refers to algae, including diatoms and "soft" algae, that are attached to stream substrates.)

The data gathered by the SWAMP program will be utilized for a wide range of the Regional Water Board's regulatory, education and restoration efforts. For example, the data is being used to: (1) *assess water bodies for compliance* with relevant standards; (2) *evaluate effectiveness* of permit conditions, watershed management programs, and nonpoint source programs; and (3) *assist in developing remedial strategies* when necessary.

Monitoring Goals and Objectives

During these first years of the SWAMP program, the primary objectives of surface water monitoring at the Lahontan Region were:

- to determine (to the extent to which funding was available) whether ambient water quality at selected sites is in compliance with the chemical and physical water quality objectives contained in the Basin Plan, and the relevant chemical criteria contained in the CTR and MCLs.

- to determine (to the extent to which funding was available) whether water flowing from California into the State of Nevada meets Nevada's water quality objectives.

[5] The State of Nevada's water quality standards, promulgated by the Nevada Division of Environmental Protection (NDEP), are also used in this report to assess interstate waters (i.e., sites where water flows from California into the State of Nevada).

[6] A small amount of SWAMP funds was used for two other focused studies, as described in Chapter 2 of this report.

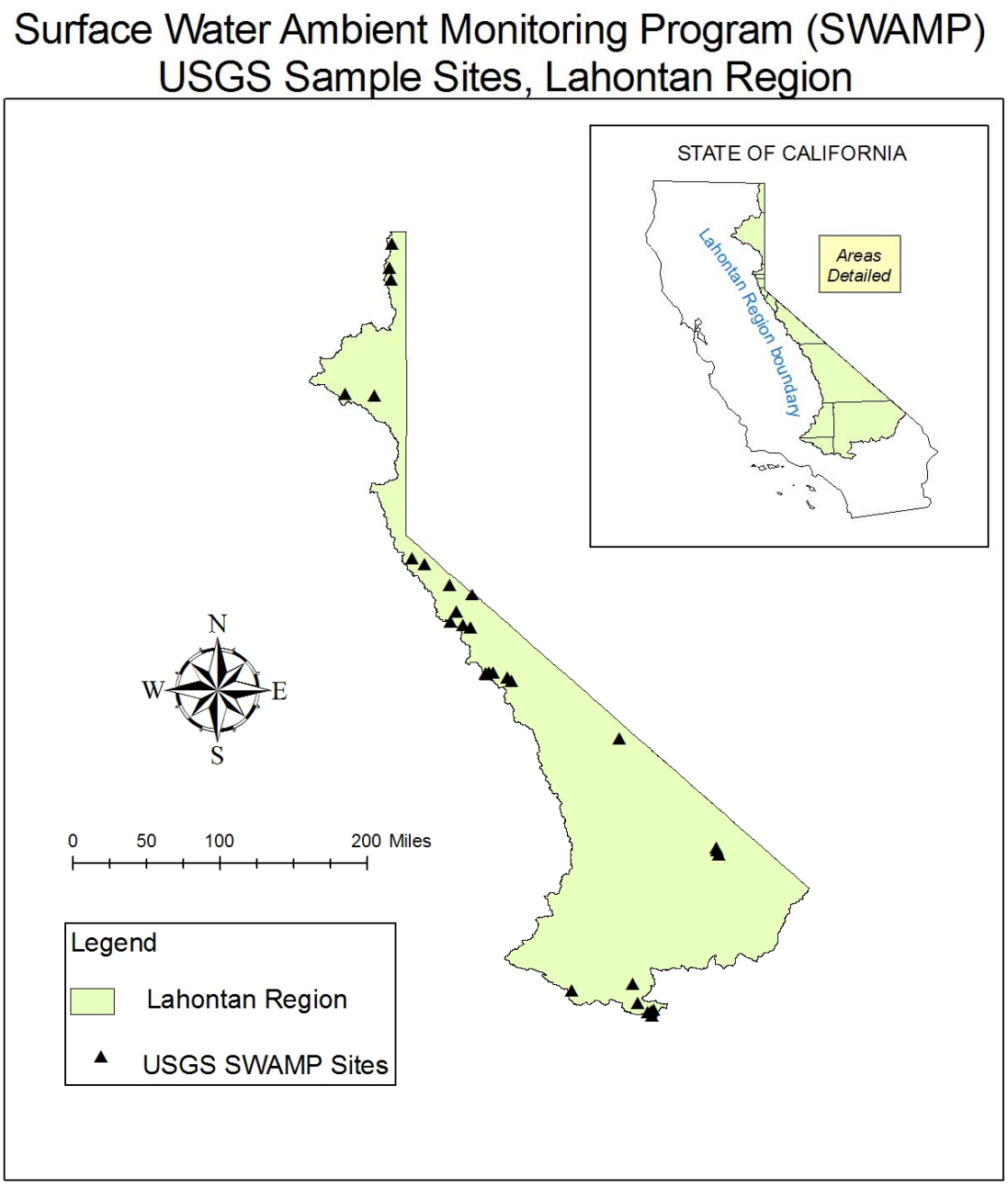

Figure 1. Lahontan Region — Overview of SWAMP sample sites, 2000–2005

- to develop (to the extent to which funding was available) tools to assess the biological integrity of streams and rivers based on assemblages of instream benthic macroinvertebrates and periphyton.

Because of its size and diversity, the limited and unstable funding provided under SWAMP, the time-consuming nature of gaining access to private lands, and because the Lahontan Water Board has adopted discrete numeric water quality objectives that apply to specific locations (as identified in the Basin Plan), the Lahontan Region has elected not to employ the probabilistic or "rotating basin" approaches being utilized by some other (smaller) Regional Water Boards. Instead, the Lahontan Region has implemented a monitoring strategy more similar to other large regions in California. Specifically, the Region used its limited SWAMP funding to establish a network of targeted water monitoring stations throughout the Region. The monitoring goals and objectives described above can and will be re-visited as funding levels change over time.

Scope of Report

This report summarizes SWAMP monitoring activities conducted at the Lahontan Region from the inception of the program (i.e., July 2000) through the end of Water Year 2005 (i.e., August 25, 2005). This report summarizes the results of surface water sampling conducted at 30 sites within the Lahontan Region by the USGS, under contract to the State Water Board. The results of other projects funded partially or fully by SWAMP in the Lahontan Region from years 2000–2005 (i.e., bioassessment and other special studies) are also briefly summarized, and links to those results are provided. (See Chapter 2, "Elements of the SWAMP at the Lahontan Region.")

CHAPTER 2. Elements of the Surface Water Ambient Monitoring Program (SWAMP) at the Lahontan Region

Introduction—The Elements of SWAMP at the Lahontan Region

From year 2000 through year 2005, the SWAMP program at the Lahontan Region consisted of three distinct elements: (1) surface water sampling at sites located throughout the Region (performed by USGS); (2) bioassessment at sites in the eastern Sierra (performed by the University of California, Santa Barbara, Sierra Nevada Aquatic Research Laboratory, "UC-SNARL"); and (3) two special studies.

This summary report focuses on the first activity (i.e., surface water sampling by USGS). The other activities have been reported elsewhere, as follows:

Lake Tahoe turbidity (special study)

In 2000, the SWAMP program contributed $20,000 to a multi-agency special study of turbidity at Lake Tahoe. Also contributing to that monitoring project were the Nevada Department of State Lands and the Desert Research Institute. The objectives of the study were to develop a boat-mounted, continuously recording low-level turbidity probe, and to collect off-shore turbidity transect data to identify turbidity "hot spots." The final report is available at the Region's website.[7]

PAH-induced toxicity in mountain lakes (special study)

In 2000, the SWAMP program allocated $26,000 toward a pilot study of the toxic effects of poly-aromatic hydrocarbons (PAHs) in Lake Tahoe. Samples were collected by Lahontan Water Board staff and analyzed at the University of Nevada, Reno (UNR). The results indicated toxicity in some of the samples collected at marinas. Based on the results of this pilot study, researchers at UNR obtained a much larger grant ($500,000, from non-SWAMP sources) to conduct follow-up research on PAHs in mountain lakes. The final report of that larger study incorporates the findings of the pilot study, and is available at the Region's website.[8]

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[7] See: *Investigation of Near Shore Turbidity at Lake Tahoe*, by Kendrick Taylor, March 2002, at: http://www.waterboards.ca.gov/lahontan/water_issues/programs/swamp/docs/taylor_tahoeturbidity_mar2002.pdf.

[8] See: *Environmental Assessment of the Impacts of Polycyclic Aromatic Hydrocarbons (PAH) In Lake Tahoe and Donner Lake*, by Glenn C. Miller and others, March 2003, at: http://www.waterboards.ca.gov/lahontan/water_issues/available_documents/misc/miller_others_tahoe_pah2003.pdf.

Bioassessment

The Lahontan Region has used a substantial portion of its SWAMP funds to advance the science and application of bioassessment.[9] Several distinct but coordinated bioassessment projects were conducted from year 2000 to present, as described below:

- The Region's contractor (UC-SNARL) completed a rigorous "methods comparison" study that compared the performance characteristics and data comparability of three different bioassessment methods. That study has been published in the *Journal of the North American Benthological Society*.[10] The results were used by the SWAMP program to evaluate the discriminatory power and cost-effectiveness of various methods for bioassessment of wadeable streams in California, and to select consistent methods for ambient bioassessment of freshwater streams in California.[11]

- The Region's contractor (UC-SNARL) is developing a preliminary "index of biological integrity" (IBI) for the eastern Sierra Nevada ecoregion. Completion is expected sometime in 2008 or 2009. When completed, a report describing the IBI will be posted on the Region's monitoring webpage.[12]

- The Region's contractor (UC-SNARL) is conducting a pilot study to explore the potential for using periphyton (i.e., attached algae and diatoms) as an indicator of stream condition in the eastern Sierra Nevada. The reports available on this subject may be viewed at the Region's website.[13]

- The Region's contractor (UC-SNARL) has completed several other reports that were partially funded by, or coordinated with, the Region's SWAMP program, including evaluations of the success of habitat restoration projects and the implementation of management measures for the control of nonpoint source

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[9] Bioassessment is an evaluation of the condition of a waterbody using biological surveys and other direct measurements of the resident biota in surface waters. The most common organisms used in bioassessment are assemblages of macroinvertebrates, periphyton (i.e., algae), and/or fish. For background information and references on bioassessment, see the USEPA's Bioassessment and Biocriteria Homepage at: http://www.epa.gov/waterscience/biocriteria/.

[10] Herbst, David B., and Erik L. Silldorff. 2006. "Comparison of the performance of different bioassessment methods: similar evaluations of biotic integrity from separate programs and procedures," *Journal of the North American Benthological Society* 25(2):513-530. Available for viewing at the Lahontan Region's website: http://www.waterboards.ca.gov/lahontan/water_issues/programs/swamp/docs/herbst_silldorff_methods _comparison_jnabs2006.pdf.

[11] SWAMP's bioassessment protocols (*Benthic Macroinvertebrates & Associated Data for CA Bioassessments - February 2007*) are located at the State Water Board's website: http://www.waterboards.ca.gov/water_issues/programs/swamp/docs/phab_sopr6.pdf.

[12] The Lahontan Region's monitoring webpage may be viewed at: http://www.waterboards.ca.gov/lahontan/water_issues/programs/swamp/index.shtml.

[13] See: http://www.waterboards.ca.gov/lahontan/water_issues/programs/swamp/index.shtml#reports.

pollution, as well as recommendations of numeric targets for TMDLs. All currently available reports may be viewed at the Region's website.[14]

Description of Water Quality Issues by Watershed Management Area

Northern Watershed Management Area (WMA)

The Northern WMA includes the following Hydrologic Units (HUs): Cowhead Lake, Surprise Valley, Bare Creek, Cedarville, Fort Bidwell, Duck Flat, Smoke Creek, Madeline Plains, Susanville, Little Truckee River, and Truckee River.

In the Surprise Valley (Modoc County) and Susan River (Lassen County) watersheds, there are potential impacts from livestock grazing and limited agriculture (alfalfa, some row crops).

In the Susanville area of Lassen County, additional nonpoint source impacts potentially result from urban runoff, construction-related impacts from land development, roads, timber harvest, use of herbicides for silviculture and weed control, and septic systems. Impacts to wetlands and riparian areas from fill or channelization are also a concern.

In the Truckee River watershed (Nevada County), nonpoint source impacts potentially result from transportation corridors (railways and roads), urban runoff and construction-related impacts from rapid land development, ski areas and other recreation developments, livestock grazing, and timber harvests. Sediment resulting from hydromodification activities, such as reservoir management, is also a concern, as are impacts to wetlands and riparian areas from fill or channelization.

Lake Tahoe Basin Watershed Management Area (WMA)

The Lake Tahoe Basin WMA includes the Lake Tahoe HU. In the Lake Tahoe Basin (El Dorado and Placer counties), there are potential nonpoint source impacts from ski areas, marinas, and other recreation; timber harvests; livestock grazing; roads; urban runoff and construction-related impacts from land development. Sediment from shoreline erosion (due to operation of Lake Tahoe as a reservoir) is also a concern, as are impacts to wetlands and riparian areas from fill or channelization.

Carson/Walker Watershed Management Area (WMA)

The Carson/Walker WMA includes the following HUs: West Fork Carson River, East Fork Carson River, West Walker River, and East Walker River.

In the Carson River watershed (Alpine County), there are potential nonpoint source impacts from numerous abandoned mines, livestock grazing, recreation, roads, use of herbicides for weed control, and timber harvests. Also of concern are impacts to wetlands and riparian areas from fill or channelization.

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[14] *ibid*

In the Walker River watershed (Mono County), there are potential nonpoint source impacts from recreation, livestock grazing, roads, use of herbicides for weed control, septic systems, abandoned mines, and timber harvests. Also of concern are impacts to wetlands and riparian areas from fill or channelization, as well as impacts from operation of the Bridgeport Reservoir.

Mono/Owens Watershed Management Area (WMA)

The Mono/Owens WMA includes the following HUs: Mono, Adobe, Owens, Fish Lake, Deep Springs, Eureka, Saline, Race Track, Amargosa, and Pahrump.

In the Mono Basin (Mono County), potential nonpoint source impacts are mainly from livestock grazing, roads, and hydromodification due to water exports. There are some concerns about the operation of Grant Lake as a reservoir, impacts from small hydroelectric plants, recreation (including the ski area at June Mountain), and urban runoff. Also of concern are impacts to wetlands and riparian areas from fill or channelization.

In the upper Owens River watershed (Mono County), there are potential nonpoint source impacts from recreation, livestock grazing, roads, and hydromodification due to water exports and reservoir management. Also of concern are impacts to wetlands and riparian areas from fill or channelization. In the Town of Mammoth Lakes, additional concerns are from urban runoff and construction-related impacts from rapid land development.

In the lower Owens River watershed (Inyo County), there are potential nonpoint source impacts from recreation, livestock grazing, roads, septic systems, and hydromodification due to water exports and reservoir management. Also of concern are impacts to wetlands and riparian areas from fill or channelization. In the City of Bishop, additional concerns are from urban runoff and construction-related impacts from land development.

Mojave Watershed Management Area (WMA)

The Mojave WMA includes the Mojave and Broadwell hydrologic units (HUs). In the Mojave River watershed (San Bernardino County), nonpoint source issues relating to overdraft of the ground water are of concern, including impacts to wetlands and springs. The potential impacts of confined animal facilities (i.e., dairies and chicken farms) and other agricultural activities are of concern. The area is generally in transition from predominantly agricultural to urban land uses. Thus, the nonpoint source concerns are shifting towards urban runoff and construction-related impacts from land development. Other concerns include the use of chemical pesticides to control exotic plants and animals, as well as hydromodification caused by development and flood control projects.

Antelope Valley/Other Southern Watershed Management Areas (WMAs)

The Antelope Valley/Other Southern WMAs include the following HUs: Mesquite, Ivanpah, Owlshead, Leach, Granite, Bicycle, Goldstone, Coyote, Superior, Ballarat, Trona, Coso, Upper Cactus, Indian Wells, Fremont, Antelope, and Cuddeback. In these

watersheds, land development (urban runoff, septic systems) contributes to nonpoint source discharges. At least one confined animal facility is of concern. Historic agricultural use was mainly alfalfa; currently, more common crops are row crops such as carrots. Other potential nonpoint source discharges result from pesticide applications, irrigation return water, and ground water percolation. Ground water overdraft is also an issue. Some timber harvest occurs. Two small ski areas are proposed for expansion. Erosion and habitat loss from deforestation following wildfires is also of concern.

Sampling Design

In order to implement the stated monitoring goals and objectives,[15] the Lahontan Region used an approach that relies on investigator pre-selected sites. This type of monitoring design is termed "directed" sampling.[16] Several factors were considered in selecting the sites, including: site access, existing data, watershed location, availability of site-specific assessment criteria, and potential funding/collaboration partnerships. The sample locations were selected based on the professional judgment of Water Board staff, guided by the following considerations:

- Site access. Because landowner permission is necessary to enter or cross private property, and because there was limited staff time to locate and contact numerous landowners to obtain permission, nearly all of the sites included in this study are located on public lands or within public rights-of-way.

- Lack of existing data. The Lahontan Region contains vast areas for which little or no ambient water quality monitoring data existed prior to the creation of the SWAMP program. Priority was therefore placed on gathering information at sites for which little or no previous monitoring data was known to exist. (For example, no stream sites were included in this study for the Lake Tahoe or Truckee River watersheds, because more data exist for those watersheds relative to other parts of the Lahontan Region.)

- Watershed location. An effort was made to select bottom-of-watershed "integrator" sites. This was based on two assumptions. First, it was believed at the outset of the SWAMP program (in State Fiscal Year 2000–01) that funding for SWAMP monitoring would increase over time. Water Board staff therefore established a region-wide network of stations (many of which were intended to serve as permanent, fixed stations) to begin the process of characterizing long-term trends at the watershed scale. It was believed that additional funds would become available over time to "move up" into the watersheds for additional sampling. While the first assumption (in regard to funding levels) has not to date proven true, the program has nevertheless generated more than four years of data at selected monitoring locations throughout the Lahontan Region for which little

[15] See the "Monitoring Goals and Objectives" in Chapter 1 of this report.

[16] In contrast, monitoring designs based on random site selection are termed "probabilistic" sampling. A probabilistic design was not used for this study.

or no data was available prior to the existence of the SWAMP program. If sampling is continued at those sites, this data will be very useful for establishing trends in water quality over time. The second assumption was that headwater streams, in general, have good-to-excellent water quality, and that any water quality problems should generally appear at downstream locations that are more influenced by human activities. While this assumption may not hold true in all cases, it was decided (based on the limited funding) that lower-watershed sites were the best places to begin the Region's SWAMP sampling efforts. In addition, the Lahontan Region has several interstate waters that flow from California into the State of Nevada; it is therefore desirable to know the water quality conditions at or near the state boundary.

- Availability of site-specific assessment criteria. The sample locations were selected to coincide with locations identified in the Lahontan Basin Plan for which site-specific numeric objectives (i.e., standards) have been adopted for the protection of beneficial uses. This streamlined the assessment process because the results for each site could be directly compared to the numeric criteria in the Basin Plan. Exceptions were made to this site-selection criterion in a few special cases, for example, where partnerships with other stakeholders made it possible to leverage SWAMP funding.

- Potential funding/collaboration partnerships. In a few cases, the Region's SWAMP program collaborated with external partners to leverage SWAMP funds. For example, the federal Bureau of Land Management (BLM) expressed interest in a comprehensive assessment of water quality conditions at the Amargosa River, for which almost no prior data existed. After reviewing available data and potential sites, and discussing funding options, it was agreed that the Region's SWAMP program would fund water chemistry at three sites along the River, while the BLM would match the SWAMP funding with federal funds sufficient to perform detailed bioassessments and habitat measurements. This synoptic data collection allowed a more comprehensive characterization of water quality conditions than either agency could have afforded on its own.

As discussed above, in order to obtain the greatest amount of useful data, the Region's water monitoring stations (sampled under contract by the USGS) were established primarily at locations where discrete numeric water quality objectives are specified in the Basin Plan, and where little or no monitoring has occurred in recent decades. Most major hydrologic units in the Region are represented by at least one sampling station. This approach allows the Region to make more rapid assessments of the extent to which the sampled waters are meeting standards, because sampling results can be directly compared to relevant standards as identified in the Basin Plan.[17]

[17] While staff at the Lahontan Region recognizes that a probabilistic and/or rotating basin sampling approach could provide a statistically rigorous estimate of the proportion of water bodies that meet (vs. violate) standards, such approaches would require substantially more funding and staff resources. Probabilistic sampling would be more expensive for two key reasons: First, randomly selected sites would occur across the landscape, including on private lands and in very remote wilderness areas. Considerably

It is important to note that the sites sampled for this study were selected based upon the above criteria. The sites were not randomly selected. Therefore, while the results provide a useful "snapshot" of water quality in the Lahontan Region, and a useful screening of water quality conditions at the sites that were sampled, these results cannot be extrapolated to the entire Region with statistical confidence.

At each water sampling station, data on chemical and physical water quality were collected. Sampling was generally conducted quarterly (i.e., four times per calendar year), except for some lakes (such as Little Rock Reservoir)[18] and desert springs (such as Mesquite Spring),[19] where samples were generally collected twice per year. However, there are also a few instances where the available resources could only fund annual and/or bi-annual sampling.

The list of parameters and analytes measured at each sample location generally coincide with the applicable region-wide and site-specific water quality objectives contained in the Lahontan Basin Plan. These physical and chemical parameters/analytes are based upon both statewide and/or site-specific criteria adopted by the Regional Water Board in order to protect designated beneficial uses.[20] Due to limited funding, certain constituents (such as metals and organic compounds) were measured at only a very small percentage of the sites. While the data provide useful insights into ambient water quality in the Lahontan Region, this assessment should not be considered comprehensive.

Methods

USGS Field Measurements and Surface Water Sampling Methods

The on-site measurements (e.g., stream flow, barometric pressure, temperature, dissolved oxygen, pH, specific conductivity), and the chemical and bacterial samples analyzed in the laboratory were collected and processed using methods described in the USGS National Field Manual (U.S. Geological Survey, 1999 to present).[21]

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more staff time would be needed to locate access and to obtain permission to sample on private lands, while most sites sampled under the "directed" approach have easy (i.e., public) access. Second, a probabilistic approach would require substantially more staff time for data analysis, which is not currently available.

[18] Lakes are most often sampled during "turnover," when the water column is mixed, which generally occurs during the spring and autumn seasons.

[19] The chemistry of desert springs often changes little over the course of a year, so, given the funding limitations, more information could be gathered by sampling such springs less often for a larger suite of analytes than to sample more often for fewer analytes.

[20] Beneficial uses are established by the Regional Water Board considering both the historical and potential future use(s) of each water body/segment.

[21] U.S. Geological Survey. 1999. National field manual for the collection of water-quality data: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chaps. A1-A9, 2 v., variously paged. (Chapters were originally published from 1997-1999. Revisions are ongoing. The most current version, including updates and revisions can be viewed at: http://www.geo.utexas.edu/courses/376l/usgs_field_manual.htm.

Stream samples were collected using a depth- and width-integrated method, so that the entire cross section of the stream is represented in the final sample. This sampling method is also called "isokinetic" since it produces a velocity-weighted sample. Detailed information regarding the sample collection methods employed by the USGS can be viewed in Chapter 4 of the USGS National Field Manual.[22]

Filtration and other processing methods vary with the constituent of interest. Detailed information regarding the sample processing methods employed by the USGS can be viewed in Chapter 5 of the USGS National Field Manual.[23]

The USGS also takes precautions for preserving samples such that oxidation, reduction, precipitation, adsorption, and ion exchange reactions are minimized. Preservation is achieved through acidification (where appropriate), and refrigeration at 4^{o} C.

The USGS's National Water Quality Laboratory (NWQL) analyzed metals, major ions and organic constituents following standard USGS methods.[24] The High Sierra Water Laboratory (HSWL), located in Truckee, California, analyzed nutrients; phosphorus was determined by the HSWL as described by Hatch (1997), and nitrogen as described in EPA Methods 353.1 and 351.2.

The constituents analyzed by the Region's SWAMP program include conventional, inorganic, and organic water quality parameters. Conventional parameters include those parameters that provide a general physical and chemical characterization of the water column and/or substrate. The USGS measured a variety of conventional parameters in the field: barometric pressure, temperature (air and water), dissolved oxygen, pH, and specific conductivity. Inorganic constituents include such parameters as metals, nutrients, chloride, fluoride, sulfate, arsenic, and boron. All of these were not collected at all sites; rather, to conserve funds the analyte list for each site was generally tailored to match the analytes for which the Basin Plan contains numeric objectives. Organic constituents include, but are not limited to, methyl t-butyl ether (MTBE), dichloromethane, trichloroethylene (TCE), tetrachloroethylene (PCE), chloroform, benzene, ethylbenzene, and a long list of other compounds, including organic pesticides. Due to funding limitations, only a few locations were tested for organic constituents.

Quality Assurance

The State of California's SWAMP program and the U.S. Geological Survey (USGS) have defined data quality objectives and quality control requirements for surface water

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[22] The USGS Surface Water Sampling Methods can be viewed at: http://water.usgs.gov/owq/FieldManual/chapter4.pdf.

[23] To view details regarding the USGS National Field Manual's "Processing of Samples" see: http://water.usgs.gov/owq/FieldManual/chap5.pdf.

[24] To view USGS methods for analyzing inorganic and organic constituents, see: *Determination of inorganic and organic constituents in water and fluvial sediments:* http://nwql.usgs.gov/Public/pubs/OFR94-351/OFR_94-351.html.

chemistry and supporting data. Details of the data quality objectives and corresponding measurement quality objectives are available in the SWAMP *Quality Assurance Management Plan* (Puckett, 2002), the USGS *National Water Quality Laboratory Quality Management System Plan* (Maloney, 2005), and the USGS *National Field Manual for the Collection of Water Quality Data* (1997-1999).

All samples were collected, analyzed, and reported following either SWAMP or USGS quality assurance protocols. The presented data has been verified and validated by both the USGS National Water Quality Laboratory and by SWAMP following standard operating procedures. The data reported herein is the right type, quality, and quantity to meet project and program objectives and has been deemed "sufficient for use."

The SWAMP and USGS quality control samples and procedures ensure production of data that is sufficient to meet project and program objectives. The SWAMP and USGS quality control procedures consist of five elements: precision, accuracy (bias), representativeness, comparability, and completeness. Precision is an assessment of the ability to repeat results. To demonstrate the precision of a method, sample replicates may be analyzed and their results compared. Accuracy, or bias, is a measure of how close the result is to the true or expected value of target analyte in the sample. It may be determined by the analysis of certified reference materials, blank spikes, and matrix spikes, where the result can be compared with a true or expected value. Accuracy and bias may be evaluated holistically, as through systemic mass-balance, or by other appropriate measures of scientific coherence. Representativeness judges how well a single sample can describe the conditions of the entire sample population. Proper study design, artifact-free sampling procedures, and appropriate sample homogenization promote representativeness. Comparability assesses ongoing projects and how variable one set of data is to another. Comparability helps to measure the scientific coherence and validity of a project or program. Completeness is a measure of how many data points collected are usable. SWAMP considers 90% of usable data to be an acceptable value for completeness in water chemistry. In general, the quality of the data presented herein is demonstrated through analysis of:

- Laboratory method blanks
- Surrogate spikes
- Matrix spikes and matrix spike duplicates for organic analytes
- Certified reference materials/laboratory control spikes
- Laboratory replicates
- Inorganic blind samples

Laboratory Method Blanks

Laboratory method blanks are used to assess laboratory contamination introduced during sample preparation and analysis. Method blanks are processed in a manner identical to the associated field samples. The SWAMP *Quality Assurance Management Plan* requires, for both organic and inorganic analyses, at least one laboratory method blank analyzed per 20 samples or per batch, whichever is more frequent.

Surrogate Spikes for Organic Analytes

Surrogate spikes are used in organic analysis to assess analyte losses during sample extraction and clean-up procedures. As per the SWAMP *Quality Assurance Management Plan*, surrogate must be added to every field and quality control sample prior to extraction. Whenever possible, isotopically-labeled analogs of the analytes should be used.

Matrix Spikes and Matrix Spike Duplicates for Organic Analytes

A laboratory-fortified sample matrix (matrix spike, or MS) and a laboratory fortified sample matrix duplicate (MSD) are both used to evaluate the effect of the sample matrix on the recovery of the target analyte(s). Individually, these samples are used to assess the bias from an environmental sample matrix plus normal method performance. In addition, these duplicate samples can be used collectively to assess analytical precision.

Aliquots of randomly selected field samples are spiked with known amounts of target analytes. The percent recovery (%R) of each spike is calculated as follows:

$$\%R = (\text{MS Result} - \text{Sample Result}) / (\text{Expected Value} - \text{Sample Result}) * 100$$

This process is repeated for a subset of field samples to create MSDs. According to the SWAMP *Quality Assurance Management Plan*, at least one MS/MSD pair shall be performed per 20 samples or per batch, whichever is more frequent.

The MS/MSD relative percent difference (RPD) is calculated as

$$RPD = | ((Value1 - Value2)| / (AVERAGE (Value1 + Value2))) * 100$$

Where:

Value1 = matrix spike value

Value2 = matrix spike duplicate value

Certified Reference Materials, Laboratory Control Samples, and Laboratory Control Materials

Certified reference materials (CRMs), laboratory control samples (LCSs), and laboratory control materials (LCMs) are analyzed to assess the accuracy of a given analytical method. As required by the SWAMP *Quality Assurance Management Plan*, one CRM, LCS, or LCM shall be analyzed per 20 samples or per batch, whichever is more frequent.

Laboratory Replicates

Laboratory replicates are analyzed to assess laboratory precision. A replicate of at least one field sample per batch is required by the SWAMP *Quality Assurance Management Plan*. The replicates are compared and an RPD is calculated as described above. If either the sample result (Value 1) or the replicate result (Value 2) is < 3 times the MDL, the RPD is not calculated as these values would be too low to calculate a meaningful difference between them. As specified in the SWAMP *Quality Assurance Management Plan,* RPDs <25% are considered acceptable.

Inorganic Blind Samples

The USGS inorganic blind sample programs are administered by two different organizations, one internal and the other external to the USGS National Water Quality Laboratory. The internal program quantifies bias caused by random laboratory contamination. It also supplements the external blind sample program by submitting double-blind reference samples for those analyses not evaluated externally (e.g., cyanide, whole water recoverable constituents, sediment, tissue). These reference samples are called "double blind" because both the sample origin and constituent concentrations are unknown to the analyst. The external blind sample program is used to evaluate both the National Water Quality Laboratory and the USGS Laboratory in Ocala, Florida.

Quality Assurance Summary

All data meeting specified control limits are considered usable without further evaluation. If data fail any portion of these criteria, they can be cross-checked against other quality control samples. If two of the following criteria are met, then the data are acceptable: laboratory replicate RPD, MS/MSD recovery and RPD, or CRM/LCS/LCM recovery. Therefore, if the laboratory replicate RPD is >25% but the MS/MSD and the CRM for that analyte are acceptable, or if an MS/MSD is unacceptable but the laboratory replicate RPD and CRM for that analyte are acceptable, then the data are acceptable and can be used.

Data that meets all SWAMP measurement quality objectives (MQOs) as specified in its *Quality Assurance Management Plan* are classified as "SWAMP-compliant." Data is classified as "Estimated" if it fails to meet all program MQOs specified in the SWAMP *Quality Assurance Management Plan,* has analytes not covered in that document, or is insufficiently documented such that supplementary information is required for it to be used in reports. "Historical" data batches are generally acceptable for use and represent data collected prior to approval of the SWAMP *Quality Assurance Management Plan*. During the data quality assessment phase of reporting, end users may find that "Estimated" and/or "Historical" data batches meet project data quality objectives.

The data presented has been verified and validated by both the USGS National Water Quality Laboratory and by SWAMP following SWAMP standard operating procedures. All data in this report is stored in the SWAMP database as "Historical," because: (1) much of the data was collected by the USGS prior to adoption of the SWAMP *Quality Assurance Management Plan*, and (2) not all of the quality assurance metadata now required by the SWAMP *Quality Assurance Management Plan* could be cost-effectively obtained from the USGS's National Water Quality Laboratory in electronic formats. Despite the "Historical" classification, the data reported herein has been verified and validated to be of the right type, quality, and quantity to meet project and program objectives and has been deemed "sufficient for use."

Water Quality Assessment Methods

The primary criteria by which water bodies were determined to meet (or not meet) water quality standards can be found in the *Water Quality Control Plan for the Lahontan Region* (Basin Plan),[25] the California Toxics Rule (CTR),[26] and the California Maximum Contaminant Levels (MCLs).[27] This report focuses on the criteria contained in the Basin Plan, the CTR, and the MCLs because those are the primary controlling regulatory criteria that apply to water quality within the Lahontan Region.

Electronic data received from the USGS were transferred into Excel™ workbooks and organized by individual sample location. The data workbooks are not presented in this summary report, but are available at the Region's website.[28] Each workbook contains several worksheets, including raw data as reported by the USGS, a list of beneficial uses for the water body/segment, potential exceedances of Basin Plan criteria, CTR/MCL exceedances, and associated graphs depicting the results. A variety of other state, federal, and international criteria are also presented in the workbooks, such as the California Public Health Goals, USEPA Recommended National Water Quality Criteria for Fish Consumption, United Nations Water Quality for Agriculture, etc.[29] However, comparisons of the SWAMP results to these other criteria are not presented in this summary report, because most of the other criteria presented in the workbooks are "advisory" (i.e., not regulatory), and because the Basin Plan, CTR and California MCL criteria are almost always more protective.

The Basin Plan, CTR, and MCL criteria include instantaneous measurements and a variety of averaging periods. Averaging periods include four-day, seven-day, thirty-day, mean-of-monthly-means and annual averaging. Averaging periods are reported for a host of analytes: total dissolved solids (TDS), chloride (Cl), fluoride (F), boron (B), sulfate (SO_4), nitrate (NO_3), total Kjeldahl nitrogen (TKN), total nitrogen (TN), orthophosphate

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[25] To view the Lahontan Basin Plan, see: http://www.waterboards.ca.gov/lahontan/water_issues/programs/basin_plan/references.shtml.

[26] The CTR was promulgated by the USEPA and includes numeric standards for some constituents (i.e., metals) that are not included in the Lahontan Basin Plan. Therefore, the CTR criteria are used for those analytes not addressed in the Basin Plan. To view the CTR, see: http://www.epa.gov/OST/standards/ctrindex.html.

[27] The MCLs are "end-of-pipe" drinking water standards promulgated by the California Department of Public Health for water that is delivered for domestic uses. According to the Lahontan Basin Plan, certain MCLs also apply to ambient (untreated) surface and ground waters with designated beneficial uses for Municipal and Domestic Supply (MUN), under the Basin Plan's narrative water quality objectives for "Chemical Constituents" and "Radioactivity." Because the MCLs were promulgated for the purpose of regulating treated, delivered drinking water, compliance with MCLs is throughout this report discussed separately from compliance with other types of standards and criteria. The MCLs can be viewed at: http://www.waterboards.ca.gov/centralvalley/water_issues/water_quality_standards_limits/water_quality_goals/index.shtml.

[28] The data workbooks are available at: http://www.waterboards.ca.gov/lahontan/water_issues/programs/swamp/index.shtml#data.

[29] Descriptions of "The Types of Water Quality Limits" can be viewed at: http://www.waterboards.ca.gov/centralvalley/water_issues/water_quality_standards_limits/water_quality_goals/index.shtml.

(PO_4), and total phosphorus (TP). Instantaneous measurements are reported for pH, specific conductance (SC), and dissolved oxygen (DO), as well as some metal and organic constituents.

In order to directly compare each result to the appropriate criterion or criteria, instantaneous results were used where applicable, or, where standards are expressed in terms of time-averages, the appropriate monthly/annual averages were calculated using Excel™ formulas. In order to compile (i.e., quantify) rates of exceedance, this report uses the term "data point" for conveying such results. For example, where a Basin Plan or other criterion is expressed as a time average—such as an "annual average"—each annual average value equals one "data point." While each annual average "data point" is comprised of all samples collected over the period of a single calendar year, the individual sample results are themselves "data points" only when the applicable criterion is an instantaneous value.

Once compiled, the information was entered into a table where the data is directly compared to numeric water quality standards,[30] and an "X" was then placed in any cell where an exceedance or potential exceedance was noted. "Exceedance tables" were then produced to present the *Total Number of Potential Exceedances* versus the *Total Number of Data Points*. Once the exceedance tables were complete, the "percent exceedance" rates were then calculated for each constituent and entered into a pie chart for each hydrologic unit. This report presents a summary of the results, in the form of exceedance tables and pie charts for each hydrologic unit.

The decision criteria contained in the State Water Board's "Listing-Delisting Policy"[31] are <u>not</u> addressed in this report. All SWAMP data assessed here will be fully considered, along with all other readily available data, in the next Clean Water Act Section 303(d) list update. This report also differs in the use of certain terms contained in the Listing-Delisting Policy. For example, the letter "n" as used in the Listing-Delisting Policy refers to exceedance data points (such as annual average values where standards are expressed in terms of time averages), while in this report, "n" generally refers to the actual number of individual samples (not the averaged value).

Readers who want more information, including the actual data, should refer to the Excel™ workbooks at the Region's website.[32]

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[30] To view non-Basin Plan water quality criteria for a constituent of interest, see: http://www.waterboards.ca.gov/centralvalley/water_issues/water_quality_standards_limits/water_quality_goals/index.shtml.

[31] The State Water Board's Listing-Delisting Policy, adopted in September 2004, contains direction for developing California's Clean Water Act Section 303(d) list. To view the Listing-Delisting Policy, see: http://www.waterboards.ca.gov/water_issues/programs/tmdl/docs/ffed_303d_listingpolicy093004.pdf.

[32] The data workbooks are posted at: http://www.waterboards.ca.gov/lahontan/water_issues/programs/swamp/index.shtml#data.

CHAPTER 3. Results & Discussion

Introduction

The data presented in the following section are a summary of all data collected by the USGS for the Lahontan Region's SWAMP program from the inception of the SWAMP program (i.e., July 2000) through Water Year 2005 (i.e., August 2005).

The primary criteria used to evaluate water bodies in this report are those found in the Lahontan Basin Plan,[33] the California Toxics Rule (CTR)[34] and the California Maximum Contaminant Levels (MCLs).[35] This report focuses primarily on the criteria contained in the Basin Plan, the CTR, and the MCLs because those are the controlling regulatory criteria that currently apply to water quality within the Lahontan Region, and because they are often the most protective criteria.

The Basin Plan, CTR, and MCL criteria include instantaneous measurements and a variety of averaging periods. Averaging periods include four-day, seven-day, thirty-day, mean-of-monthly-means and annual averaging. Averaging periods are reported for a host of analytes: total dissolved solids (TDS), chloride (Cl), fluoride (F), boron (B), sulfate (SO_4), nitrate (NO_3), total Kjeldahl nitrogen (TKN), total nitrogen (TN), orthophosphate (PO_4), and total phosphorus (TP). Instantaneous measurements are reported for pH, specific conductance (SC), and dissolved oxygen (DO), as well as some metal and organic constituents.

A note of caution for all users of this report and data: The annual averages presented in this report were obtained from only one to four samples per year, and may not accurately reflect true average concentrations. It is widely accepted that the larger the data set, the more representative an average value becomes. Conversely, where few samples are collected for averaging, the chances increase that the resulting average may not accurately reflect ambient conditions. This must be carefully considered when assessing the Lahontan Region's 2000–2005 SWAMP data, because funding limitations generally

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[33] To view the Lahontan Basin Plan, see: http://www.waterboards.ca.gov/lahontan/water_issues/programs/basin_plan/references.shtml.

[34] The CTR was promulgated by the USEPA and includes numeric standards for some constituents (i.e., metals) that are not included in the Lahontan Basin Plan. Therefore, the CTR criteria are used for those analytes not addressed in the Basin Plan. To view the CTR, see: http://www.epa.gov/OST/standards/ctrindex.html.

[35] The MCLs are "end-of-pipe" drinking water standards promulgated by the California Department of Public Health for water that is delivered for domestic uses. According to the Lahontan Basin Plan, certain MCLs also apply to ambient (untreated) surface and ground waters with designated beneficial uses for Municipal and Domestic Supply (MUN), under the Basin Plan's narrative water quality objectives for "Chemical Constituents" and "Radioactivity." Because the MCLs were promulgated for the purpose of regulating treated, delivered drinking water, compliance with MCLs is throughout this report discussed separately from compliance with other types of standards and criteria. The MCLs can be viewed at: http://www.waterboards.ca.gov/centralvalley/water_issues/water_quality_standards_limits/water_quality_goals/index.shtml.

allowed collection of only one to four samples per site, per calendar year. This means that the calculated annual averages are based on between one and four samples. Because water quality can vary widely over the course of a year (i.e., from winter runoff to spring snowmelt to summer/autumn baseflow), annual averages based on such low sample sizes should not be considered conclusive. Therefore, all users of this data are encouraged to inspect both the raw (i.e., individual sample results) and compiled (i.e., averaged) versions of the data, and to carefully consider the sample sizes before making any decisions based on this data.[36] All data summarized in this report are available at the Lahontan Region's website.[37]

In this section, the results are presented in three different ways: (1) The number of potential exceedances of Basin Plan criteria (per constituent) are discussed in the text by directly comparing either instantaneous, mean-of-monthly-mean or annual average values to the applicable Basin Plan criteria, and by comparing the mean value of all samples collected (per constituent) between 2000 and 2005 to the most closely applicable Basin Plan criteria. (The latter "period-of-record" approach does not provide a direct comparison to any adopted criteria, but is included as a "reality check" to assist the reader in interpreting annual average values that are based on low sample sizes); (2) The percent of potential exceedances are presented in pie charts, representing the total potential exceedances per hydrologic unit (HU); and (3) The number of potential exceedances are presented in HU tables as total number of potential exceedances per total number of data points.

Another feature of the HU tables presented in this report is that there is a dash (-) in columns where no sampling was conducted, although applicable Basin Plan standards do exist. This feature will assist Water Board staff and/or other stakeholders in deciding which analytes to sample if/when more funding becomes available.

[36] For more information about the complex relationships between sample size, effect size and statistical power/error, see the USEPA's CALM guidance (especially Chapter 4 and appendices C and D) at: http://www.epa.gov/owow/monitoring/calm.html.

[37] The data can be accessed at: http://www.waterboards.ca.gov/lahontan/water_issues/programs/swamp/index.shtml#data.

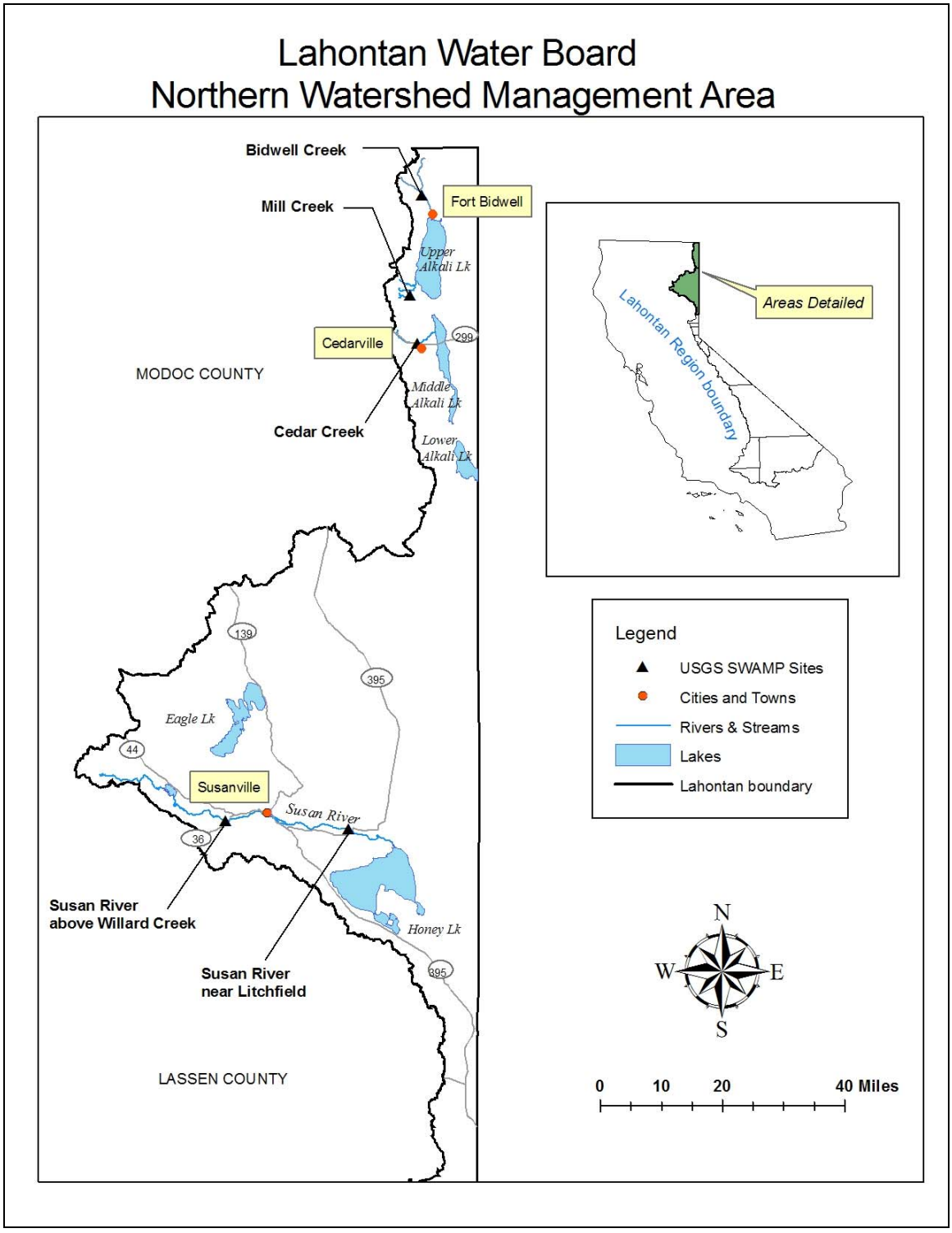

Figure 2. Sample Locations in the Northern Watershed Management Area

Summary of Water Quality by Watershed Management Area (WMA) and Hydrologic Unit (HU)

Northern Watershed Management Area (WMA)

Hydrologic Units sampled within the Northern WMA[38] included the Surprise Valley HU and the Susanville HU. Due to funding limitations, all other HUs within the Northern WMA were not sampled by the SWAMP program during the period of this study (i.e., July 2000 – August 2005). Figure 2 identifies the sample locations within the Northern WMA.

Surprise Valley Hydrologic Unit (HU)

Three sites within the Surprise Valley HU were sampled: Bidwell Creek, Mill Creek, and Cedar Creek. Bidwell and Mill creeks were sampled from 2001 through 2005. Cedar Creek was added in 2003, and sampled from May 2003 through July 2005.

Basin Plan Criteria—Surprise Valley HU

In the Surprise Valley HU there were 124 values comparable to Basin Plan criteria, with a total of 28 potential exceedances, resulting in a 22.6 percent potential exceedance rate. Figure 3 depicts the potential exceedances for total dissolved solids (TDS), fecal coliform bacteria (FC), chloride (Cl), dissolved oxygen (DO), and total nitrogen (TN).

The compiled data suggest that the annual average criteria for TDS were exceeded in each year sampled, at all three sites. Specifically, the annual average TDS results for Bidwell Creek were 73, 75, 71, 65, and 67 mg/L compared to the Basin Plan's objective of 55 mg/L. The annual average TDS results for Mill Creek were 91, 81, 90, 85, and 86 mg/L compared to the Basin Plan's objective of 70 mg/L. And the annual average TDS results for Cedar Creek were 150, 146, and 147 mg/L compared to the Basin Plan's objective of 100 mg/L. However, the annual averages are comprised of only two to four samples per year, which may not accurately reflect average ambient conditions. The mean values for all TDS samples collected over the 5-year period at these sites also appear to be in excess of the Basin Plan criteria. For example, the mean TDS results for Bidwell Creek (n = 15), Mill Creek (n = 14), and Cedar Creek (n = 8) were 70, 87, and 147 mg/L, respectively, with Basin Plan annual average criteria of 55, 70, and 100 mg/L. For the five years sampled, 35 out of the total 37 samples analyzed for TDS at these sites exceeded the Basin Plan's criteria for annual average TDS concentration.

Results for fecal coliform (FC) bacteria indicated 8 potential exceedances out of 21 samples. All of the results are based on single samples, and were compared to the Basin Plan's 30-day log mean criterion of 20 bacteria colonies per 100 mL. Due to funding limitations, samples were collected for FC bacteria at these sites only 2-3 times per year. In contrast, the Basin Plan advises collecting FC samples at least five times in a 30-day period for comparison to the 30-day log mean criterion. Therefore, these results should not be considered conclusive. Of the 8 potential exceedances, one was at Bidwell Creek

[38] The Northern Watershed Management Area is described in Chapter 2 of this report.

(45/100 mL), three were at Mill Creek (60, 68, and 220/100 mL), and four were at Cedar Creek (81, 28, 22, and 80/100 mL). All of the potential exceedances took place during the summer or fall months.

Dissolved oxygen results for the Surprise Valley HU indicate a normal pattern of lower DO concentrations during the summer months. Of the 28 total DO measurements, there were two apparent "exceedances" of the Basin Plan's daily minimum criterion of 8.0 mg/L: in July 2005 at Mill Creek (6.3 mg/L), and in April 2003 at Cedar Creek (6.7 mg/L).

Other applicable Basin Plan standards include chloride (Cl), total nitrogen (TN) and boron (B). The chloride standard was met by all samples collected at both Bidwell and Mill creeks, but Cl samples collected at Cedar Creek in 2003, 2004 and 2005 indicate potential exceedances of the annual average Cl criteria. (Results for Cedar Creek were annual average Cl concentrations of 6.8, 5.7 and 7.7 mg/L, respectively, compared to the Basin Plan standard of 1.0 mg/L.) Bidwell and Cedar creeks also had one potential exceedance (each) for annual average TN concentration (both in 2004). The average TN concentrations at these sites for 2004 were just above the standard (i.e., 0.209 and 0.280 mg/L, respectively, compared to the Basin Plan objective of 0.2 mg/L). It is important to note that the annual averages reported here are comprised of only two to three samples per year, and therefore may not accurately reflect average ambient conditions.

No samples were collected for boron. Because these water bodies are designated for agricultural beneficial uses, sampling for boron should be considered in future years, if funding allows.

California Toxics Rule (CTR) Criteria—Surprise Valley HU

Due to funding limitations, metal and organic constituents were not monitored at the Surprise Valley HU. Therefore, no comparison of the results to the CTR is presented or can be made.

Drinking Water (MCL) Criteria—Surprise Valley HU

A summary of the results compared to the California Primary and Secondary MCLs (i.e., drinking water standards) is presented in Tables 2 and 3. In the Surprise Valley HU, all criteria were met where MCL parameters were measured: nitrate (NO_3), specific conductance (SC), total dissolved solids (TDS), and chloride (Cl).

At this time, metals and organic constituents have <u>not</u> been monitored in the Surprise Valley HU; therefore, waters of the HU cannot be assessed relative to many of the MCL (or CTR) criteria.[39]

[39] Data to assess compliance with most MCLs and CTR criteria are also lacking for most other waterbodies in the Region. The MCLs and CTR criteria are discussed in more detail for the few waterbodies for which data are available. (For example, see the discussion of results for the East Walker River, Owens, Amargosa, and Mojave HUs.)

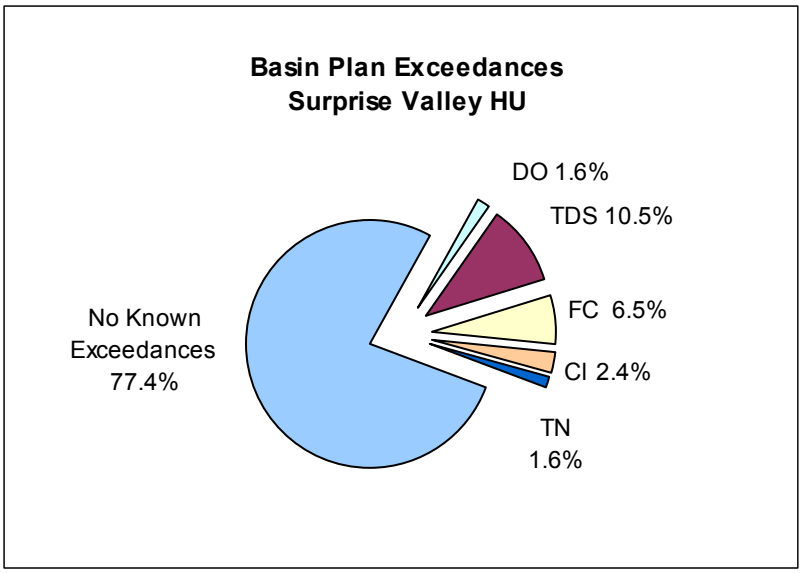

Figure 3. Comparison of Basin Plan Criteria to Results for the Surprise Valley HU

For the Surprise Valley HU, potential exceedances of Basin Plan criteria were 22.6 percent of the results, with 10.5 percent attributed to total dissolved solids (TDS), 6.5 percent to fecal coliform bacteria (FC), 2.4 percent to chloride (Cl), and 1.6 percent (each) to total nitrogen (TN) and dissolved oxygen (DO).

Table 1. Comparison of Basin Plan Criteria to Results for the Surprise Valley HU

Station Name (Site Tag)	pH	DO	TDS	FC	Cl	B	TN	Pesticides	Total Number of Data Points
Bidwell Creek 641BID001	0/15	0/11	5/5	1/7	0/5	-	1/5	-	48
Mill Creek 641MIL002	0/14	1/11	5/5	3/7	0/5	-	0/4	-	46
Cedar Creek 641CDR002	0/8	1/6	3/3	4/7	3/3	-	1/3	-	30
Total Potential Exceedances	0	2	13	8	3	-	2	-	28 / 124

The table above presents a compilation of the total number of potential exceedances of Basin Plan objectives versus total number of data points available for the Surprise Valley HU for years 2001 through 2005. The Surprise Valley HU has a total of 124 data points that are comparable to Basin Plan objectives, with 28 potential exceedances. The (-) symbol indicates that no samples were collected.

Table 2. Comparison of Primary MCL Criteria to Results for the Surprise Valley HU

Station Name (Site Tag)	F	NO_3	Al	Sb	As	Be	Cd	Cr	Cu	Pb	Ni	Hg	Se	Tl	U	Organics	Total Number of Data Points
Bidwell Creek 641BID001	-	0/15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15
Mill Creek 641MIL002	-	0/10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10
Cedar Creek 641CDR002	-	0/8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8
Total Exceedances	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0 / 33

The table above presents a compilation of the total number of exceedances of California Primary MCL criteria versus the total number of data points available for the Surprise Valley HU for years 2001 through 2005. The Surprise Valley HU has a total of 33 data points that are comparable to Primary MCLs, with no observed exceedances. The (-) symbol indicates that no samples were collected.

Table 3. Comparison of Secondary MCL Criteria to Results for the Surprise Valley HU

Station Name (Site Tag)	Al	Cu	Fe	Mn	Ag	Zn	SC	SO_4	TDS	Cl	Organics	Total Number of Data Points
Bidwell Creek 641BID001	-	-	-	-	-	-	0/15	-	0/15	0/15	-	45
Mill Creek 641MIL002	-	-	-	-	-	-	0/14	-	0/14	0/14	-	42
Cedar Creek 641CDR002	-	-	-	-	-	-	0/8	-	0/8	0/8	-	24
Total Exceedances	-	-	-	-	-	-	0	-	0	0	-	0 / 111

The table above presents a compilation of the total number of exceedances of California Secondary MCL criteria versus the total number of data points available for the Surprise Valley HU for years 2001 through 2005. The Surprise Valley HU has a total of 111 data points that are comparable to Secondary MCLs, with no observed exceedances. The (-) symbol indicates that no samples were collected.

Susanville Hydrologic Unit (HU)

Two sites within the Susanville HU—both on the main stem of the Susan River—were sampled by the SWAMP program from June 2001 through July 2005. The two sites are: the Susan River above Willard Creek (above the town of Susanville), and the Susan River near Litchfield (below the town of Susanville).

Basin Plan Criteria—Susanville HU

In the Susanville HU there were 112 values comparable to Basin Plan criteria, with a total of 39 potential exceedances, resulting in a 35 percent potential exceedance rate. Figure 4 depicts the potential exceedances identified for total dissolved solids (TDS), pH, fecal coliform bacteria (FC), total nitrogen (TN), chloride (Cl), dissolved oxygen (DO) and total phosphorus (TP).

Both Susan River sites exhibit potential exceedances of the TDS annual average criteria for all five years sampled. Specifically, the annual average TDS results for Susan River above Willard Creek were 125, 84, 100, 84, and 77 mg/L compared to the Basin Plan's objective of 60 mg/L. And the annual average TDS results for Susan River near Litchfield were 233, 227, 227, 232, and 253 mg/L compared to the Basin Plan's objective of 185 mg/L. However, the annual averages are comprised of only three or four samples per year, which may not accurately reflect ambient conditions. The mean values for all TDS samples collected over the 5-year period at each site also appear to be in excess of the Basin Plan's annual average criteria. Specifically, the average of all TDS results for Susan River above Willard Creek (n = 16), and Susan River near Litchfield (n = 16), were 94 and 234 mg/L, respectively, with Basin Plan annual average criteria of 60 and 185 mg/L.

The Susan River above Willard Creek had one potential exceedance of the Basin Plan's pH objective (March 2004, pH = 8.8). Downstream, below the city of Susanville, the Susan River near Litchfield had six potential exceedances of the Basin Plan's pH objective (pH = 8.9, 9.4, 9.7, 8.7, 8.8, and 8.8). These potential exceedances at the Litchfield site occurred at various seasons throughout the year. Two of the results at the Litchfield site exceeded 9 pH units, which potentially exceeds not only the Basin Plan's objective, but also USEPA advisory criteria for taste & odor and the protection of aquatic life. The cause of the potential pH exceedances is unknown. The Basin Plan acknowledges that some waters of the Region may have natural pH levels outside of the 6.5 to 8.5 range. Further investigation would be needed to accurately characterize ambient pH levels at these sites.

Results for fecal coliform (FC) bacteria indicated 6 potential exceedances out of 16 samples. All of the results are based on single samples, and were compared to the Basin Plan's 30-day log mean criterion of 20 bacteria colonies per 100 mL. Due to funding limitations, samples were collected for FC bacteria at these sites only 2-3 times per year. In contrast, the Basin Plan advises collecting FC samples at least five times in a 30-day period for comparison to the 30-day log mean criterion. Therefore, these results should not be considered conclusive. Of the 6 potential exceedances, two were at Susan River above Willard Creek (24 and 29/100 mL), and four were at Susan River near Litchfield

(170, 58, 52, and 48/100 mL). All but one of the potential exceedances took place during the summer or fall months.

Results for total nitrogen (TN) indicate potential exceedances of Basin Plan criteria at Susan River above Willard Creek for all five years sampled. The Basin Plan's objective for annual average TN concentration at this site is 0.2 mg/L. The annual average results for 2001–2005 were 0.33, 0.31, 0.26, 0.30 and 0.40 mg/L, respectively. However, the annual averages are comprised of only three or four samples per year, which may not accurately reflect average ambient conditions. The mean value for all TN results from this site over the 5-year period (n = 16) is 0.32 mg/L.

Results for TN at Susan River near Litchfield indicate full compliance with Basin Plan criteria for the four years from 2001-2004, but potential exceedance of the Basin Plan's criteria for 2005. The Basin Plan's objective for annual average TN concentration at this site is 0.65 mg/L. The annual average result for 2005 was 0.66 mg/L. The annual average for 2005 is comprised of only three samples, which may not accurately reflect average ambient conditions. Further, the result for 2005 just barely exceeded the annual average criteria (0.66 mg/L vs. 0.65 mg/L). Nevertheless, it is reported here (i.e., in Figure 4, Table 4, and the region-wide summaries) as a potential exceedance.

Both Susan River sample locations exhibit some potential for non-attainment of the Basin Plan's daily-minimum DO criterion of 8.0 mg/L. The results indicate three potential oxygen depressions at Susan River above Willard Creek, however, two of the three potential DO depressions were extremely close to the Basin Plan's threshold of 8.0 mg/L (i.e., 7.2, 7.9, and 7.9 mg/L). These results should not be considered conclusive. At Susan River near Litchfield, one of 13 measurements of DO from 2001–2005 indicated a potential DO depression (DO = 6.6 mg/L on 5/6/03). The four potential exceedances of the Basin Plan's DO criteria at these sites were detected during the months of May, June, July and September. Further investigation would be needed to accurately characterize ambient DO levels at these sites.

The Susan River above Willard Creek exhibited potential exceedances of the Basin Plan's annual average criterion for Cl at this site (0.7 mg/L). Potential exceedances occurred in four out of five years sampled. (Average annual Cl concentrations for 2001–2005 = 0.86, 0.55, 0.77, 1.19, and 0.71 mg/L, respectively). One of the annual averages (for 2005) only marginally exceeded the criteria (0.71 mg/L vs. 0.7 mg/L). Further, the annual averages are comprised of only three or four samples per year, which may not accurately reflect average ambient conditions. The average of all Cl results from this site over the 5-year period (n = 16) is 0.82 mg/L.

The Susan River above Willard Creek exhibited two potential exceedances of the Basin Plan's annual average criterion for TP at this site. However, the two potential exceedances (0.063 mg/L for 2001, and 0.066 mg/L for 2005) only marginally exceeded the criterion of 0.06 mg/L, and should not be considered conclusive. Further, the annual averages are comprised of only three or four samples per year, which may not accurately reflect average ambient conditions.

The Basin Plan also contains site-specific objectives for sulfate (SO_4), and boron (B) for both Susan River sites. These two analytes were not monitored at these sites from 2000 through 2005.

California Toxics Rule (CTR) Criteria—Susanville HU

Due to funding limitations, metal and organic constituents were not monitored at the Susanville HU. Therefore, no comparison of the results to the CTR is presented, or can be made.

Drinking Water (MCL) Criteria—Susanville HU

A summary of the results compared to the California Primary and Secondary MCLs (i.e., drinking water standards) is presented in Table 5 and Table 6. In the Susanville HU, all standards were met where MCL parameters were measured: nitrate (NO_3), specific conductance (SC), total dissolved solids (TDS), and chloride (Cl).

At this time, metals and organic constituents have not been monitored in the Susanville HU; therefore, waters of the HU cannot be assessed relative to many of the MCL (or CTR) criteria.

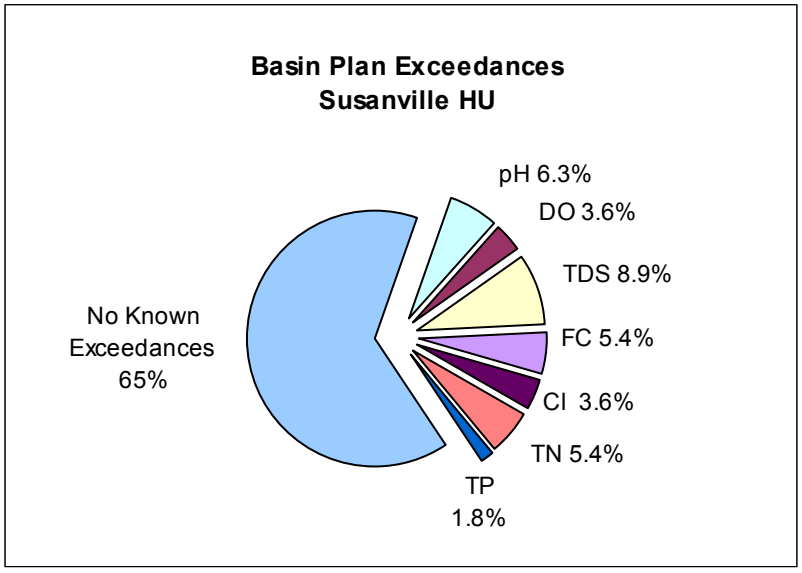

Figure 4. Comparison of Basin Plan Criteria to Results for the Susanville HU

For the Susanville HU, potential exceedances of Basin Plan criteria were 35 percent of the results, with 8.9 percent attributed to total dissolved solids (TDS), 6.3 percent to pH, 5.4 percent (each) to total nitrogen (TN) and fecal coliform bacteria (FC), 3.6 percent (each) to dissolved oxygen (DO) and chloride (Cl), and 1.8 percent to total phosphorus (TP).

Table 4. Comparison of Basin Plan Criteria to Results for the Susanville HU

Station Name (Site Tag)	pH	DO	TDS	FC	Cl	SO_4	B	TN	TP	Pesticides	Total Number of Data Points
Susan River, above Willard Creek 637SUS003	1/15	3/12	5/5	2/8	4/5	-	-	5/5	2/5	-	55
Susan River, near Litchfield 637SUS001	6/16	1/13	5/5	4/8	0/5	-	-	1/5	0/5	-	57
Total Potential Exceedances	7	4	10	6	4	-	-	6	2	-	39 / 112

The table above presents a compilation of the total number of potential exceedances of Basin Plan objectives versus the total number of data points available for the Susanville HU for years 2001 through 2005. The Susanville HU has a total of 112 data points that are comparable to Basin Plan objectives, with 39 potential exceedances. The (-) symbol indicates that no samples were collected.

Table 5. Comparison of Primary MCL Criteria to Results for the Susanville HU

Station Name (Site Tag)	F	NO_3	Al	Sb	As	Be	Cd	Cr	Cu	Pb	Ni	Hg	Se	Tl	U	Organics	Total Number of Data Points
Susan River, above Willard Creek 637SUS003	-	0/16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16
Susan River, near Litchfield 637SUS001	-	0/16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16
Total Exceedances	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0 / 32

The table above presents a compilation of the total number of exceedances of California Primary MCL criteria versus the total number of data points available for the Susanville HU for years 2001 through 2005. The Susanville HU has a total of 32 data points that are comparable to Primary MCLs, with no observed exceedances. The (-) symbol indicates that no samples were collected.

Table 6. Comparison of Secondary MCL Criteria to Results for the Susanville HU

Station Name (Site Tag)	Al	Cu	Fe	Mn	Ag	Zn	SC	SO_4	TDS	Cl	Organics	Total Number of Data Points
Susan River, above Willard Creek 637SUS003	-	-	-	-	-	-	0/16	-	0/16	0/16	-	48
Susan River, near Litchfield 637SUS001	-	-	-	-	-	-	0/16	-	0/16	0/16	-	48
Total Exceedances	-	-	-	-	-	-	0	-	0	0	-	0 / 96

The table above presents a compilation of the total number of exceedances of California Secondary MCL criteria versus the total number of data points available for the Susanville HU for years 2001 through 2005. The Susanville HU has a total of 96 data points that are comparable to Secondary MCLs, with no observed exceedances. The (-) symbol indicates that no samples were collected.

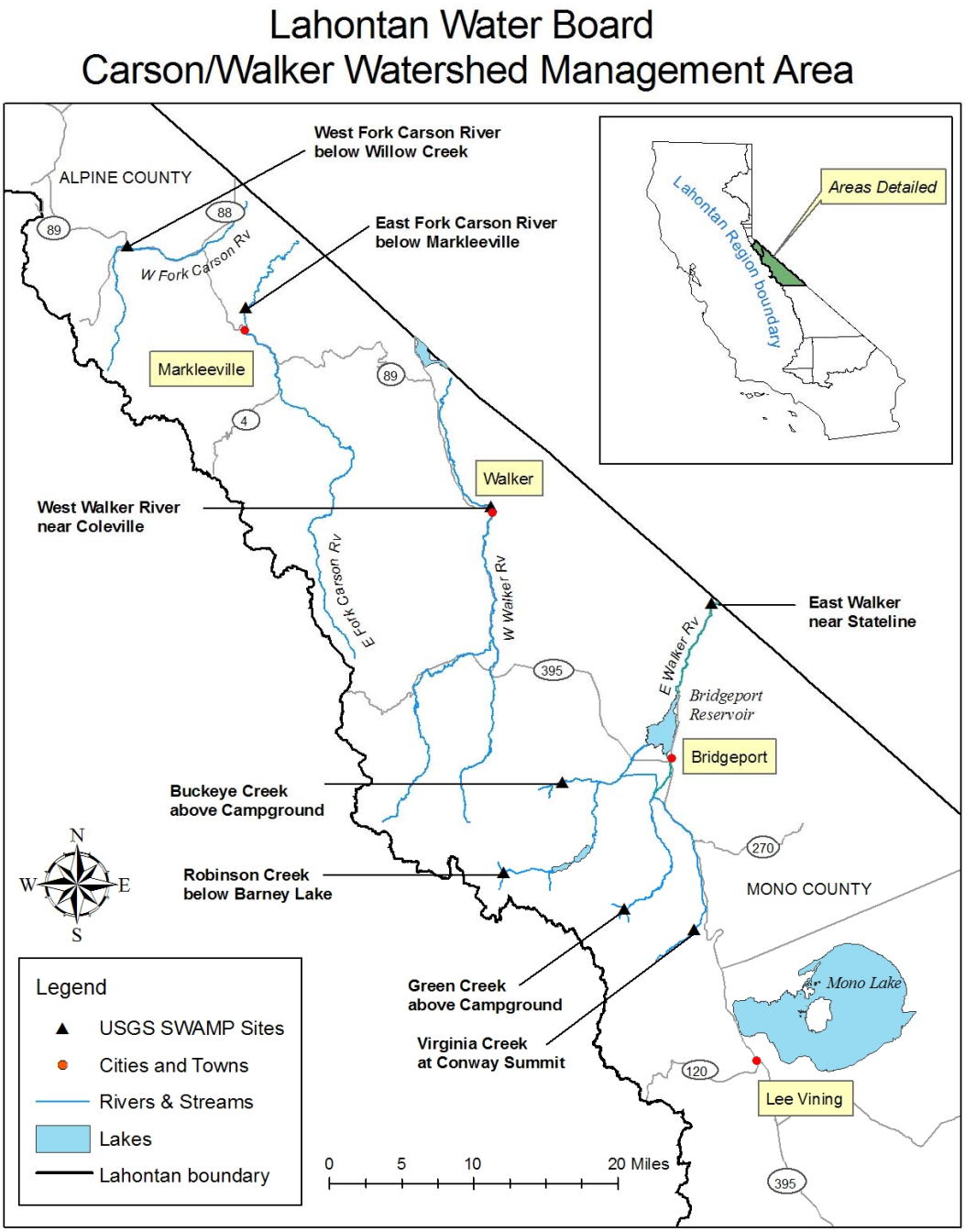

Figure 5. Sample Locations in the Carson/Walker Watershed Management Area

Carson/Walker Watershed Management Area (WMA)

Hydrologic Units sampled within the Carson/Walker WMA[40] included the West Fork Carson River HU, East Fork Carson River HU, West Walker River HU, and East Walker River HU. Specific sample locations are presented in Figure 5.

West Fork Carson River Hydrologic Unit (HU)

One site was sampled in this HU: the West Fork Carson River just below its confluence with Willow Creek (in Hope Valley). Unlike most site-specific criteria in the Basin Plan, the objectives for the West Fork Carson River are expressed in terms of a "mean-of-monthly-means" instead of annual average criteria.[41] This site was added to the SWAMP program in 2003, and data was collected during sample years 2003 through 2005.

Basin Plan Criteria—West Fork Carson River HU

For the West Fork Carson River HU there were 51 values comparable to Basin Plan criteria, with a total of 11 potential exceedances, resulting in a potential exceedance rate of about 22 percent (Table 7). Figure 6 depicts the potential exceedances identified for sulfate (SO_4), chloride (Cl), total Kjeldahl nitrogen (TKN), total nitrogen (TN), total phosphorus (TP), and fecal coliform bacteria (FC).

The mean-of-monthly-means for SO_4 and Cl potentially exceeded the Basin Plan criteria for all three years sampled. Specifically, the mean-of-monthly-means calculated for SO_4 for the 2003–2005 sample years are 2.4, 2.4 and 2.3 mg/L, respectively, compared to the Basin Plan objective of 2.0 mg/L. And the mean-of-monthly-means calculated for Cl for the 2003–2005 sample years are 1.5, 1.6 and 1.6 mg/L, respectively, compared to the Basin Plan objective of 1.0 mg/L.

The mean-of-monthly-means for TKN potentially exceeded the Basin Plan objective for two out of the three years sampled. Specifically, the mean-of-monthly-means calculated for TKN for the 2003–2005 sample years are 0.11, 0.15 and 0.16 mg/L, respectively, compared to the Basin Plan objective of 0.13 mg/L.

The mean-of-monthly-means for total nitrogen (TN) potentially exceeded the Basin Plan objective for one out of the three years sampled. Specifically, the mean-of-monthly-means calculated for TN for the 2003–2005 sample years are 0.136, 0.172 and 0.109 mg/L, respectively, compared to the Basin Plan objective of 0.15 mg/L.

The mean-of-monthly-means for total phosphorus (TP) potentially exceeded the Basin Plan objective for one out of the three years sampled. Specifically, the mean-of-monthly-

[40] The Carson/Walker Watershed Management Area is described in Chapter 2 of this report.

[41] Mean-of-monthly-means are derived by calculating the arithmetic mean of all data for each month of the year over the period of record. For example, the January monthly mean is calculated by averaging all historic January data with current-year January data, creating a rolling average for the month of January. Once all monthly means are calculated this way, the mean of these twelve means are calculated to obtain an annual mean-of-monthly-means based on all historic data. The annual mean-of-monthly-means would be recalculated the following year incorporating any new data for the same station, if there are any.

means calculated for TP for the 2003–2005 sample years are 0.016, 0.017 and 0.022 mg/L, respectively, compared to the Basin Plan objective of 0.02 mg/L. The mean TP concentration for all samples collected (n = 14) is 0.023 mg/L. The single potential exceedance for TP is only very slightly above the standard (i.e., the calculated mean-of-monthly-means for TP for 2005 was 0.022 mg/L compared to the objective of 0.02 mg/L), and would not be considered an exceedance at all if the calculated mean result were "rounded down" to two significant digits. Further, the single potential exceedance for TP is due largely to a single outlier (i.e., TP = 0.061 mg/L during spring runoff in May 2005). All other samples for TP were either below the objective or just barely above the objective, and without this one high "snowmelt" value, all means-of-monthly-means for TP would be in full compliance. This example illustrates the difficulty of interpreting objectives that are expressed in terms of annual or "running" averages when only a few samples are collected per year, especially when the results hover at or near the objective.

All of the above averages for West Fork Carson River are comprised of only three to five samples per year, which may not accurately reflect average ambient conditions. Further, all of the above potential exceedances are only slightly above the Basin Plan thresholds. These data should therefore not be considered conclusive; more detailed investigation would be needed to accurately characterize ambient levels of SO_4, Cl and nutrients at this site.

Results for fecal coliform (FC) bacteria indicated one potential exceedance out of seven total samples. Six of the seven samples were virtually free of FC, while one sample (on 8/19/04) contained 48 FC colonies per 100 mL. Due to funding limitations, samples were collected for FC bacteria at these sites only quarterly (i.e., four times per year at the most). In contrast, the Basin Plan advises collecting FC samples at least five times in a 30-day period for comparison to the 30-day log mean criterion. Therefore, these results should not be considered conclusive. More detailed investigation would be needed to accurately characterize ambient levels of FC bacteria at this site.

California Toxics Rule (CTR) Criteria—West Fork Carson River HU

Due to funding limitations, metal and organic constituents were not monitored at the West Fork Carson HU. Therefore, no comparison of the results to the CTR is presented or can be made.

Drinking Water (MCL) Criteria—West Fork Carson River HU

A summary of the results compared to the California Primary and Secondary MCLs (i.e., drinking water standards) is presented in Table 8 and Table 9. In the West Fork Carson River HU, all standards were met where MCL parameters were measured: nitrate (NO_3), specific conductance (SC), total dissolved solids (TDS), and chloride (Cl).

At this time, metals and organic constituents have <u>not</u> been monitored in the West Fork Carson River HU; therefore, waters of the HU cannot be assessed relative to many of the MCL (or CTR) criteria.

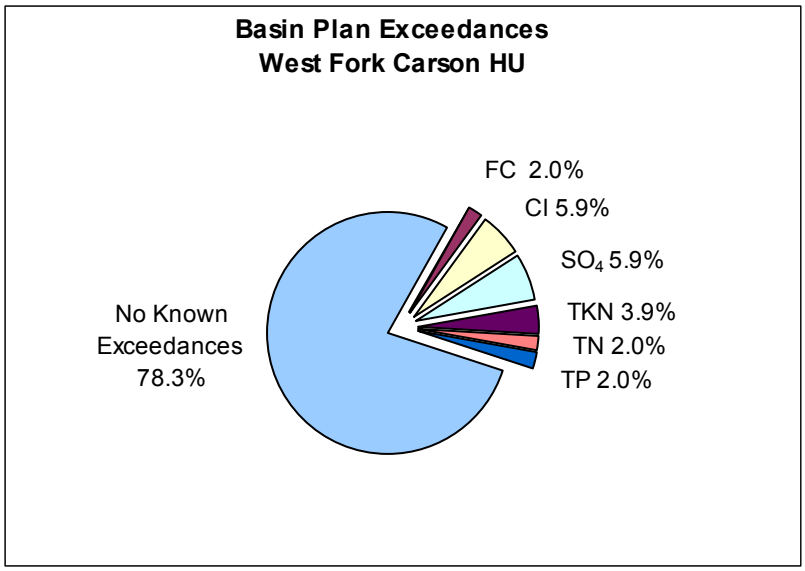

Figure 6. Comparison of Basin Plan Criteria to Results for the West Fork Carson River HU

For the West Fork Carson River HU, potential exceedances of Basin Plan objectives were approximately 22 percent of the results, with 5.9 percent (each) attributed to chloride (Cl) and sulfate (SO_4), 3.9 percent to total Kjeldahl nitrogen (TKN), and 2.0 percent (each) to total nitrogen (TN), total phosphorus (TP), and fecal coliform bacteria (FC).

Table 7. Comparison of Basin Plan Criteria to Results for the West Fork Carson River HU

Station Name (Site Tag)	pH	DO	TDS	FC	Cl	SO_4	B	NO_3	TKN	TN	TP	Pesticides	Total Number of Data Points
West Fork Carson River below Willow Creek 633WCR002	0/10	0/10	0/3	1/7	3/3	3/3	0/3	0/3	2/3	1/3	1/3	-	51
Total Potential Exceedances	0	0	0	1	3	3	0	0	2	1	1	-	11 / 51

The table above presents a compilation of the total number of potential exceedances of Basin Plan objectives versus the total number of data points available for the West Fork Carson River HU for sample years 2003 through 2005. The West Fork Carson River HU has a total of 51 data points that are comparable to Basin Plan objectives, with 11 potential exceedances. The (-) symbol indicates that no samples were collected.

Table 8. Comparison of Primary MCL Criteria to Results for the West Fork Carson River HU

Station Name (Site Tag)	F	NO_3	Al	Sb	As	Be	Cd	Cr	Cu	Pb	Ni	Hg	Se	Tl	U	Organics	Total Number of Data Points
West Fork Carson, below Willow Creek 633WCR002	-	0/10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10
Total Exceedances	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0 / 10

The table above presents a compilation of the total number of exceedances of California Primary MCL criteria versus the total number of data points available for the West Fork Carson River HU for sample years 2003 through 2005. The West Fork Carson River HU has a total of 10 data points that are comparable to Primary MCLs, with no observed exceedances. The (-) symbol indicates that no samples were collected.

Table 9. Comparison of Secondary MCL Criteria to Results for the West Fork Carson River HU

Station Name (Site Tag)	Al	Cu	Fe	Mn	Ag	Zn	SC	SO_4	TDS	Cl	Organics	Total Number of Data Points
West Fork Carson, below Willow Creek 633WCR002	-	-	-	-	-	-	0/10	-	0/10	0/10	-	30
Total Exceedances	-	-	-	-	-	-	0	-	0	0	-	0 / 30

The table above presents a compilation of the total number of exceedances of California Secondary MCL criteria versus the total number of data points available for the West Fork Carson River HU for sample years 2003 through 2005. The West Fork Carson River HU has a total of 30 data points that are comparable to Secondary MCLs, with no observed exceedances. The (-) symbol indicates that no samples were collected.

East Fork Carson River Hydrologic Unit (HU)

One site was sampled in this HU: the East Fork Carson River near the bottom of its watershed, below Markleeville, CA. (See Figure 5.) The Basin Plan's site-specific objectives for this site are currently expressed in terms of annual averages.

Basin Plan Criteria—East Fork Carson River HU

For the East Fork Carson River HU there were 63 values comparable to Basin Plan criteria, with a total of 15 potential exceedances, resulting in a potential exceedance rate of about 24 percent (Table 10). Potential exceedances were observed for total dissolved solids (TDS), sulfate (SO_4), total phosphorus (TP), boron (B) and fecal coliform (FC) bacteria.

The annual averages for TDS potentially exceed the Basin Plan objective for all five years sampled (2001–2005). Note however, that the TDS annual average value for 2001 was comprised of a single data point, and the annual averages for all other years are based on only three to five samples. Such small sample sizes may not accurately reflect average ambient conditions. The annual averages for TDS for 2002–2005 were 85, 88, 89, and 81 mg/L, respectively, compared to a Basin Plan objective of 80 mg/L. For all samples collected over the 5-year period (n = 16), the mean value for TDS is approximately 88 mg/L.

Sulfate (SO_4) also potentially exceeds the Basin Plan's annual average standard for sample years 2002–2005. Note however, that the SO_4 annual average value for year 2002 was comprised of only two samples, the annual averages for 2003 and 2005 were comprised of only three samples each, and the annual average for 2004 was comprised of only four samples. Such small sample sizes may not accurately reflect average ambient conditions. The annual average concentrations for SO_4 for 2002–2005 were 7.5, 5.8, 6.3, and 6.3 mg/L, respectively, compared to a Basin Plan objective of 4.0 mg/L, and the mean value for all SO_4 samples collected over the 5-year period (n = 12) is 6.4 mg/L.

Total phosphorus (TP) was also sampled between 2001 and 2005. No determination can be made about TP data collected at this site during 2001 and 2002 because laboratory minimum detection limits were higher than the Basin Plan objective. For sample years 2003, 2004 and 2005 however, the data indicate potential exceedances for TP. The annual average concentrations for TP were calculated as 0.027, 0.033 and 0.087 mg/L respectively, compared to the Basin Plan objective of 0.02 mg/L. Note however, that the annual average TP values for 2003 and 2005 were comprised of only three samples each, and the annual average for 2004 is based on only four samples. Such small sample sizes may not accurately reflect average ambient conditions. For example, the annual average for 2005 is largely driven by a high value collected during the May snowmelt period. Despite the small sample size for 2003–2005 (n = 10), further investigation is warranted because all but one of the ten samples exceeded (at least marginally) the annual average criteria of 0.02 mg/L.

Annual averages for boron (B) potentially exceeded the Basin Plan objective for 2002 and 2003. However, the annual averages for those years are based on only a single

(170, 58, 52, and 48/100 mL). All but one of the potential exceedances took place during the summer or fall months.

Results for total nitrogen (TN) indicate potential exceedances of Basin Plan criteria at Susan River above Willard Creek for all five years sampled. The Basin Plan's objective for annual average TN concentration at this site is 0.2 mg/L. The annual average results for 2001–2005 were 0.33, 0.31, 0.26, 0.30 and 0.40 mg/L, respectively. However, the annual averages are comprised of only three or four samples per year, which may not accurately reflect average ambient conditions. The mean value for all TN results from this site over the 5-year period (n = 16) is 0.32 mg/L.

Results for TN at Susan River near Litchfield indicate full compliance with Basin Plan criteria for the four years from 2001-2004, but potential exceedance of the Basin Plan's criteria for 2005. The Basin Plan's objective for annual average TN concentration at this site is 0.65 mg/L. The annual average result for 2005 was 0.66 mg/L. The annual average for 2005 is comprised of only three samples, which may not accurately reflect average ambient conditions. Further, the result for 2005 just barely exceeded the annual average criteria (0.66 mg/L vs. 0.65 mg/L). Nevertheless, it is reported here (i.e., in Figure 4, Table 4, and the region-wide summaries) as a potential exceedance.

Both Susan River sample locations exhibit some potential for non-attainment of the Basin Plan's daily-minimum DO criterion of 8.0 mg/L. The results indicate three potential oxygen depressions at Susan River above Willard Creek, however, two of the three potential DO depressions were extremely close to the Basin Plan's threshold of 8.0 mg/L (i.e., 7.2, 7.9, and 7.9 mg/L). These results should not be considered conclusive. At Susan River near Litchfield, one of 13 measurements of DO from 2001–2005 indicated a potential DO depression (DO = 6.6 mg/L on 5/6/03). The four potential exceedances of the Basin Plan's DO criteria at these sites were detected during the months of May, June, July and September. Further investigation would be needed to accurately characterize ambient DO levels at these sites.

The Susan River above Willard Creek exhibited potential exceedances of the Basin Plan's annual average criterion for Cl at this site (0.7 mg/L). Potential exceedances occurred in four out of five years sampled. (Average annual Cl concentrations for 2001–2005 = 0.86, 0.55, 0.77, 1.19, and 0.71 mg/L, respectively). One of the annual averages (for 2005) only marginally exceeded the criteria (0.71 mg/L vs. 0.7 mg/L). Further, the annual averages are comprised of only three or four samples per year, which may not accurately reflect average ambient conditions. The average of all Cl results from this site over the 5-year period (n = 16) is 0.82 mg/L.

The Susan River above Willard Creek exhibited two potential exceedances of the Basin Plan's annual average criterion for TP at this site. However, the two potential exceedances (0.063 mg/L for 2001, and 0.066 mg/L for 2005) only marginally exceeded the criterion of 0.06 mg/L, and should not be considered conclusive. Further, the annual averages are comprised of only three or four samples per year, which may not accurately reflect average ambient conditions.

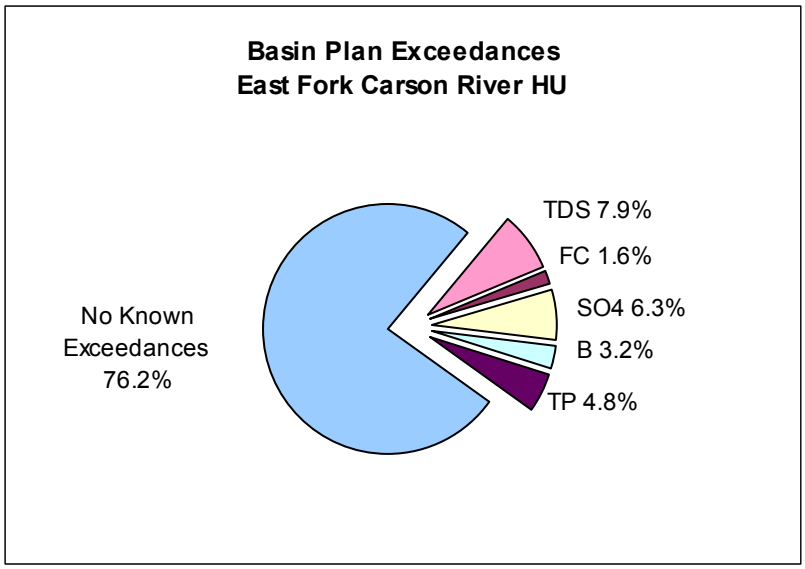

Figure 7. Comparison of Basin Plan Criteria to Results for the East Fork Carson River HU

For the East Fork Carson River HU, potential exceedances of Basin Plan criteria were 23.8 percent of the results, with 7.9 percent attributed to total dissolved solids (TDS), 6.3 percent to sulfate (SO_4), 4.8 percent to total phosphorus (TP), 3.2 percent to boron (B), and 1.6 percent to fecal coliform bacteria (FC).

Table 10. Comparison of Basin Plan Criteria to Results for the East Fork Carson River HU

Station Name (Site Tag)	pH	DO	TDS	FC	Cl	SO_4	B	TN	TP	Pesticides	Total Number of Data Points
East Fork Carson River 632ECR005	0/15	0/14	5/5	1/7	0/4	4/4	2/4	0/5	3/5	-	63
Total Potential Exceedances	0	0	5	1	0	4	2	0	3	-	15 / 63

The table above presents a compilation of the total number of potential exceedances of Basin Plan objectives versus the total number of data points available for the East Fork Carson River HU for sample years 2001 through 2005. The East Fork Carson River HU has a total of 63 data points that are comparable to Basin Plan objectives, with 15 potential exceedances. The (-) symbol indicates that no samples were collected.

Table 11. Comparison of Primary MCL Criteria to Results for the East Fork Carson River HU

Station Name (Site Tag)	F	NO_3	Al	Sb	As	Be	Cd	Cr	Cu	Pb	Ni	Hg	Se	Tl	U	Organics	Total Number of Data Points
East Fork Carson River 632ECR005	-	0/16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16
Total Exceedances	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0 / 16

The table above presents a compilation of the total number of exceedances of California Primary MCL criteria versus the total number of data points available for the East Fork Carson River HU for sample years 2001 through 2005. The East Fork Carson River HU has a total of 16 data points that are comparable to Primary MCLs, with no observed exceedances. The (-) symbol indicates that no samples were collected.

Table 12. Comparison of Secondary MCL Criteria to Results for the East Fork Carson River HU

Station Name (Site Tag)	Al	Cu	Fe	Mn	Ag	Zn	SC	SO_4	TDS	Cl	Organics	Total Number of Data Points
East Fork Carson River 632ECR005	-	-	-	-	-	-	0/16	-	0/16	0/12	-	44
Total Exceedances	-	-	-	-	-	-	0	-	0	0	-	0 / 44

The table above presents a compilation of the total number of exceedances of California Secondary MCL criteria versus the total number of data points available for the East Fork Carson River HU for sample years 2001 through 2005. The East Fork Carson River HU has a total of 44 data points that are comparable to Secondary MCLs, with no observed exceedances. The (-) symbol indicates that no samples were collected.

West Walker River Hydrologic Unit (HU)

One site was sampled in this HU: the West Walker River near Coleville. (The site is located just downstream of the community of Walker, CA; see Figure 5.) The Basin Plan's site-specific objectives for this site are currently expressed in terms of annual averages.

Basin Plan Criteria—West Walker River HU

The West Walker River was sampled between August 2002 and August 2005. Sample collection in this HU was most often performed quarterly (3–4 samples/year), except for 2002 for which all annual averages were comprised of a single sampling event, in August of that year.

For the West Walker River there were 49 values comparable to Basin Plan criteria, with a total of 16 potential exceedances, resulting in a potential exceedance rate of about 33 percent (Table 13). Potential exceedances were observed for total dissolved solids (TDS), total phosphorus (TP), total nitrogen (TN), chloride (Cl), boron (B), fecal coliform (FC) bacteria, and pH. (See Figure 8.)

Annual averages for TDS and TP potentially exceeded Basin Plan objectives for all four years. The annual average concentrations for TDS for 2002–2005 were 93, 88, 75, and 67 mg/L, respectively, compared to a Basin Plan objective of 60 mg/L. And the annual average concentrations for TP for 2002–2005 were 0.03, 0.03, 0.40, and 0.12 mg/L, respectively, compared to a Basin Plan objective of 0.01 mg/L. For all samples collected between 2002 and 2005, the mean value for TDS (n = 12) is 79 mg/L compared to the Basin Plan annual average objective of 60 mg/L, and the mean value for TP (n = 12) is 0.18 mg/L compared to the Basin Plan annual average objective of 0.01 mg/L. None of the TP results were below the Basin Plan's 0.01 mg/L annual average objective. (The lowest TP concentration observed was 0.022 mg/L.)

Both chloride (Cl) and boron (B) exhibited potential exceedances of the Basin Plan's annual average objectives for 2002 and 2003. However, the annual averages for 2002 are comprised of a single data point, and are likely not representative of true average conditions. The 2003 annual average for B is also highly suspect since there were only two samples collected for B in that year. One indication that the small sample sizes may have created a bias in the annual average values is that the average of all values for the entire 2002–2005 period do not exceed the Basin Plan's annual average objectives. Specifically, the mean concentration of all Cl samples collected from 2002–2005 (n = 12) is 2.8 mg/L compared to the Basin Plan's annual average objective of 3.0 mg/L, and the mean of all B samples (n = 10) is 0.10 mg/L compared to the Basin Plan's annual average objective of 0.10 mg/L. Given the limited data, more detailed investigation would be needed to accurately characterize ambient levels of Cl and B at this site.

Total nitrogen (TN) had two potential exceedances, for 2004 and 2005. The calculated annual average for TN during those years was 0.53 mg/L and 0.44 mg/L, respectively, compared to the Basin Plan's annual average objective of 0.20 mg/L. The TN results for August 2004 and May 2005 were an order of magnitude higher than at any other times,

and without those possible "outliers," the annual averages would have complied with the Basin Plan's annual average TN objective for all years. However, it is unknown whether such high values are truly rare versus common occurrences. This illustrates the need for greater sampling frequency in any given year in order to construct accurate annual averages.

The high TN value in August 2004 was accompanied by a fecal coliform (FC) bacteria concentration of >240 colonies per 100 mL. This was the only potential exceedance observed for FC at this site. (However, only seven samples were collected for FC over the course of this multi-year study.) While the August 2004 FC result is reported here as a potential exceedance, it is important to note that the Basin Plan advises collecting FC samples at least five times in a 30-day period for comparison to the 30-day log mean criterion. Therefore, these results should not be considered conclusive. More detailed investigation would be needed to accurately characterize ambient levels of FC bacteria at this site.

One out of twelve samples for pH exhibited a potential exceedance. This measurement was only slightly outside of the Basin Plan objective's range for pH (i.e., pH = 8.7 compared to an objective range of 6.5–8.5). While pH does not appear to be a significant concern at this site, further monitoring would be needed to confirm this.

California Toxics Rule (CTR) Criteria—West Walker River HU

Due to funding limitations, metal and organic constituents were not monitored at the West Walker River HU. Therefore, no comparison of the results to the CTR is presented or can be made.

Drinking Water (MCL) Criteria—West Walker River HU

A summary of the results compared to the California Primary and Secondary MCLs (i.e., drinking water standards) is presented in Tables 14 and 15. In the West Walker River HU, all standards were met where MCL parameters were measured: nitrate (NO_3), specific conductance (SC), total dissolved solids (TDS), and chloride (Cl).

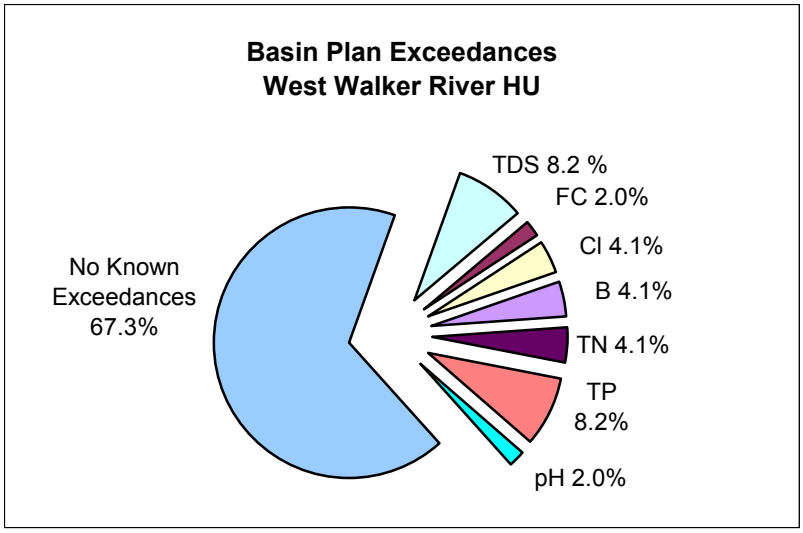

Figure 8. Comparison of Basin Plan Criteria to Results for the West Walker River HU

For the West Walker River HU, potential exceedances of Basin Plan objectives were 32.7 percent of the results, with 8.2 percent (each) attributed to both total dissolved solids (TDS) and total phosphorus (TP); 4.1 percent (each) to chloride (Cl), boron (B) and total nitrogen (TN); and 2 percent to both fecal coliform bacteria (FC), and pH.

Table 13. Comparison of Basin Plan Criteria to Results for the West Walker River HU

Station Name (Site Tag)	pH	DO	TDS	FC	Cl	B	TN	TP	Pesticides	Total Number of Data Points
West Walker River near Coleville 631WWK001	1/12	0/10	4/4	1/7	2/4	2/4	2/4	4/4	-	49
Total Potential Exceedances	1	0	4	1	2	2	2	4	-	16 / 49

The table above presents a compilation of the total number of potential exceedances of Basin Plan objectives versus the total number of data points available for the West Walker River HU for sample years 2002 through 2005. The West Walker River HU has a total of 49 data points that are comparable to Basin Plan objectives, with 16 exceedances. The (-) symbol indicates that no samples were collected.

Table 14. Comparison of Primary MCL Criteria to Results for the West Walker River HU

Station Name (Site Tag)	F	NO_3	Al	Sb	As	Be	Cd	Cr	Cu	Pb	Ni	Hg	Se	Tl	U	Organics	Total Number of Data Points
West Walker River near Coleville 631WWK001	-	0/12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12
Total Exceedances	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0 / 12

The table above presents a compilation of the total number of exceedances of California Primary MCL criteria versus the total number of data points available for the West Walker River HU for sample years 2002 through 2005. The West Walker River HU has a total of 12 data points that are comparable to Primary MCLs, with no observed exceedances. The (-) symbol indicates that no samples were collected.

Table 15. Comparison of Secondary MCL Criteria to Results for the West Walker River HU

Station Name (Site Tag)	Al	Cu	Fe	Mn	Ag	Zn	SC	SO_4	TDS	Cl	Organics	Total Number of Data Points
West Walker River near Coleville 631WWK001	-	-	-	-	-	-	0/12	0/12	0/12	0/12	-	48
Total Exceedances	-	-	-	-	-	-	0	0	0	0	-	0 / 48

The table above presents a compilation of the total number of exceedances of California Secondary MCL criteria versus the total number of data points available for the West Walker River HU for sample years 2002 through 2005. The West Walker River HU has a total of 48 data points that are comparable to Secondary MCLs, with no observed exceedances. The (-) symbol indicates that no samples were collected.

East Walker River Hydrologic Unit (HU)

Five locations were sampled within the East Walker River HU, including the East Walker River (below Bridgeport Reservoir at the CA/NV state line) and four upper-watershed tributaries which flow into the Bridgeport Reservoir: Buckeye, Green, Virginia, and Robinson creeks. (See Figure 5.) The East Walker River was sampled quarterly from August 2001 to August 2005. The four tributaries were only sampled a total of four times each, on a quarterly basis from June 2002 to June 2003.

The Basin Plan does not contain site-specific objectives that apply to the East Walker River site (at state line). Therefore, the criteria used in this report for assessing water quality at that site are the Basin Plan's general "Water Quality Objectives Which Apply to All Surface Waters," and the Nevada Department of Environmental Protection (NDEP) "Standards of Water Quality" established for the East Walker River at the state line.[42] Although the NDEP exceedance rates are not included in Table 16, a discussion of those findings is included in this section.

Basin Plan Criteria—East Walker River HU

For the East Walker River HU there were 77 values comparable to Basin Plan criteria, with a total of 15 potential exceedances, resulting in a potential exceedance rate of about 20 percent. (See Figure 9, and Table 16). Potential exceedances were observed for pH, total nitrogen (TN), and dissolved oxygen (DO).

Six of the 15 potential exceedances are attributed to pH. Specifically, at Buckeye, Green, and Robinson creeks, one out of four samples at each site indicated pH below the Basin Plan daily minimum of 6.5. These three potential exceedances all occurred on the same date (June 5, 2003). Those measurements ranged from 5.3 to 5.7 pH units (i.e., slightly acidic). At the East Walker River (state line site), pH appeared elevated (i.e., alkaline) in three out of 15 measurements taken from 2001–2005. Those three measurements were taken in August of 2001, 2002, and 2003; the pH values were 8.8, 9.7, and 9.0, respectively, compared to the Basin Plan's objective range of 6.5 to 8.5.

For total nitrogen (TN), potential exceedances were observed during 2002 at all four tributary site locations (e.g., Buckeye, Green, Virginia, Robinson creeks), and during 2003 at Green Creek. For 2002, the TN annual averages for Buckeye, Green, Virginia, and Robinson creeks were 0.09, 0.09, 0.12, and 0.12 mg/L, respectively, compared to the Basin Plan's annual average criterion of 0.05 mg/L. For 2003, the TN annual average for Green Creek was 0.09 mg/L. However, it is important to note that all of these annual averages for 2002–2003 are comprised of only two data points each, and therefore may not accurately reflect true average conditions. It should also be noted that TN results for 2003 could not be evaluated for Buckeye, Virginia or Robinson creeks because the total Kjeldahl nitrogen (TKN) results (which are added to the NO_2+NO_3 values in order to calculate TN) had "non-detect" (ND) values greater than the Basin Plan objective.

[42] Nevada's "state line" sampling station for the East Walker River is actually in California, between the Bridgeport Reservoir outlet and the actual state line. To view NDEP's water quality standards for the East Walker River at Stateline Nevada, see: http://ndep.nv.gov/bwqp/standards.htm#NAC445aSec165.

Therefore, the TN results for these sites should not be considered conclusive. More detailed investigation would be needed to accurately characterize ambient levels of TN at these sites.

The East Walker River (state line site) also exhibited four potential exceedances for dissolved oxygen (DO). Of the 15 measurements of DO taken from 2001–2005, four were depressed slightly below the Basin Plan's daily minimum objective of 8.0 mg/L. Those four DO concentrations were 7.3, 7.2, 7.5, and 7.1 mg/L.

The Nevada Division of Environmental Protection (NDEP) has promulgated standards for the East Walker River at the California/Nevada state line.[43] NDEP's criterion for pH (i.e., range of 7.0–8.3 pH units) appears to have been exceeded in 5 out of 15 measurements taken from 2001–2005. TN and TP may also have exceeded the NDEP "annual average" criteria for 2001 and 2002. However, the annual average TN and TP values for 2001 and 2002 were comprised of only 2-3 samples each, and therefore may not accurately reflect true average conditions. (From 2003–2005, when even four samples/year were collected for TN and TP at this site, NDEP's criteria were met. This does not mean that 4 samples/year constitute an accurate annual average, it just adds weight to the conclusion that annual averages comprised of only 2 samples/year should not be considered conclusive.) Finally, the results for 2001–2005 indicate that NDEP's criteria for DO, FC, Cl, and SC are currently being met. NDEP's nitrate (NO_3) and ammonia (NH_4) criteria were not evaluated.

California Toxics Rule (CTR) Criteria—East Walker River HU

As mentioned previously, CTR criteria for Buckeye, Green, Robinson and Virginia creeks have not been evaluated due to the lack of data for metals and/or organics (Tables 17 and 18). In the East Walker River, however, some of the CTR criteria were evaluated. A total of 53 data points (i.e., total and dissolved metals from Al to Zn) are available from 2001 through 2004. No exceedances have been noted for either CTR Human Health or CTR Aquatic Life criteria.

Drinking Water (MCL) Criteria—East Walker River HU

Only two parameters comparable to the California MCLs (e.g., nitrate, SC) were sampled at Buckeye, Green, Robinson and Virginia creeks. No exceedances were found. (See Tables 19 and 20). In the East Walker River (at state line), however, more MCL criteria were evaluated. At that site, a suite of 17 metals (from Al to Zn) was sampled from 2001 through 2002. Of all the samples analyzed for metals, only Mn appears to exceed any California MCL criteria (Figure 10). The four results for Mn (collected quarterly from August 2001 through June 2002) were 119, 82, 111, and 107 µg/L, compared to the California Secondary MCL of 50 µg/L. These levels of manganese may affect the taste and odor of water that is used for drinking, but are not considered a health concern. No sampling was conducted in this HU for organic constituents.

[43] *ibid*

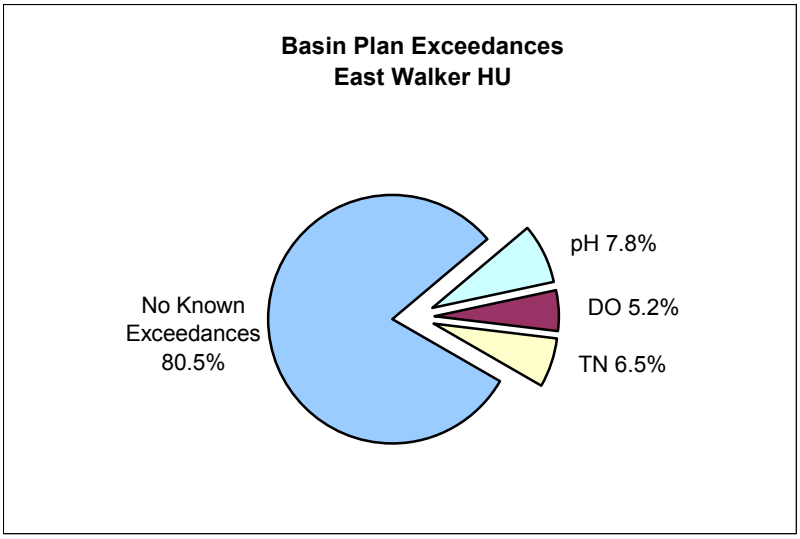

Figure 9. Comparison of Basin Plan Criteria to Results for the East Walker River HU

For the East Walker River HU, potential exceedances of Basin Plan objectives were approximately 20 percent of the results, with 7.8 percent attributed to pH, 6.5 percent attributed to total nitrogen (TN), and 5.2 percent to dissolved oxygen (DO).

Table 16. Comparison of Basin Plan Criteria to Results for the East Walker River HU

Station Name (Site Tag)	pH	DO	TDS	FC	Cl	TN	TP	Pesticides	Total Number of Data Points
Buckeye Creek above Campground 630BUC003	1/4	0/2	-	0/1	-	1/2	0/2	-	11
Green Creek above Campground 630GRN001	1/4	0/2	-	0/1	-	2/2	0/2	-	11
Virginia Creek at Conway Summit 630VIR001	0/4	-	-	0/1	-	1/2	0/2	-	9
Robinson Creek below Barney Lake 630RBS006	1/4	0/1	-	0/1	-	1/2	0/2	-	10
East Walker River at Stateline 630EWK001	3/15	4/15	NA	0/6	NA	NA	NA	-	36
Total Potential Exceedances	6	4	-	0	-	5	0	-	15 / 77

The table above presents a compilation of the total number of potential exceedances of Basin Plan objectives versus the total number of data points available for the East Walker River HU for sample years 2001 through 2005. The East Walker River HU has a total of 77 data points that are comparable to Basin Plan objectives, with 15 potential exceedances. The (-) symbol indicates that no samples were collected. "NA" indicates that there is no numeric objective in the Basin Plan for this constituent.

Table 17. Comparison of CTR Human Health Criteria to Results for the East Walker River HU

Station Name (Site Tag)	Total Sb	Total Cu	Total Ni	Total Hg	Total Tl	Organics	Total Number of Data Points
Buckeye Creek above Campground 630BUC003	-	-	-	-	-	-	0
Green Creek above Campground 630GRN001	-	-	-	-	-	-	0
Virginia Creek at Conway Summit 630VIR001	-	-	-	-	-	-	0
Robinson Creek below Barney Lake 630RBS006	-	-	-	-	-	-	0
East Walker River at Stateline 630EWK001	0/4	0/4	0/4	0/4	0/4	-	20
Total Exceedances	0	0	0	0	0	-	0 / 20

The table above presents a compilation of the total number of exceedances of CTR Human Health criteria for the East Walker River HU for sample years 2001 through 2002. Buckeye, Green, Virginia, and Robinson creeks have not been evaluated at this time. The East Walker River at Stateline has a total of 20 data points that are comparable to CTR Human Health criteria, with no observed exceedances. The (-) symbol indicates that no samples were collected.

Table 18. Comparison of CTR Aquatic Life Criteria to Results for the East Walker River HU

Station Name (Site Tag)	Diss. As	Diss. Cd	Cr (III)	Cr (VI)	Diss. Cu	Diss. Pb	Diss. Ni	Total Se	Diss. Ag	Diss. Zn	Total Number of Data Points
Buckeye Creek above Campground 630BUC003	-	-	-	-	-	-	-	-	-	-	0
Green Creek above Campground 630GRN001	-	-	-	-	-	-	-	-	-	-	0
Virginia Creek at Conway Summit 630VIR001	-	-	-	-	-	-	-	-	-	-	0
Robinson Creek below Barney Lake 630RBS006	-	-	-	-	-	-	-	-	-	-	0
East Walker River at Stateline 630EWK001	0/5	0/4	-	-	0/4	0/4	0/4	0/4	0/4	0/4	33
Total Exceedances	0	0	-	-	0	0	0	0	0	0	0 / 33

The table above presents a compilation of the total number of exceedances of CTR Aquatic Life criteria for the East Walker River HU for sample years 2001 through 2004. Buckeye, Green Virginia, and Robinson creeks have not been evaluated at this time. The East Walker River at Stateline has a total of 33 data points that are comparable to CTR Aquatic Life criteria, with no observed exceedances. The (-) symbol indicates that no samples were collected.

Table 19. Comparison of Primary MCL Criteria to Results for the East Walker River HU

Station Name (Site Tag)	F	NO_3	Al	Sb	As	Be	Cd	Cr	Cu	Pb	Ni	Hg	Se	Tl	U	Organics	Total Number of Data Points
Buckeye Creek above Campground 630BUC003	-	0/4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
Green Creek above Campground 630GRN001	-	0/4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
Virginia Creek at Conway Summit 630VIR001	-	0/4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
Robinson Creek below Barney Lake 630RBS006	-	0/4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
East Walker River at Stateline 630EWK001	-	0/16	0/4	0/4	0/5	0/4	0/4	0/4	0/4	0/4	0/4	0/4	0/4	0/4	-	-	65
Total Exceedances	-	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	0 / 81

The table above presents a compilation of the total number of exceedances of California Primary MCL criteria for the East Walker River HU for sample years 2001 through 2005. The majority of criteria for Buckeye, Green, Virginia, and Robinson creeks have not been evaluated at this time. The East Walker River HU has a total of 81 data points that are comparable to Primary MCLs, with no observed exceedances. The (-) symbol indicates that no samples were collected.

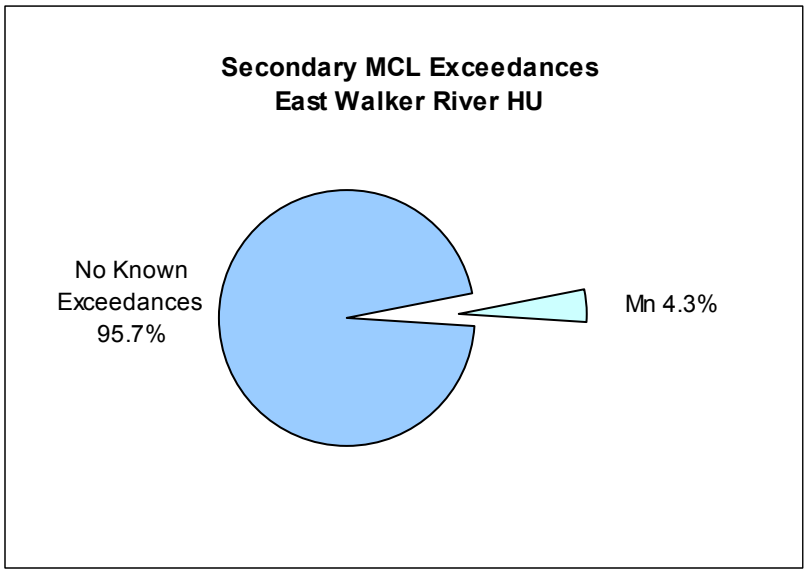

Figure 10. Comparison of Secondary MCL Criteria to Results for the East Walker River HU

For the East Walker River HU, exceedances of California Secondary MCL criteria were 4.3 percent of the results, with manganese (Mn) accounting for all 4.3 percent.

Table 20. Comparison of Secondary MCL Criteria to Results for the East Walker River HU

Station Name (Site Tag)	Al	Cu	Fe	Mn	Ag	Zn	SC	SO_4	TDS	Cl	Organics	Total Number of Data Points
Buckeye Creek above Campground 630BUC003	-	-	-	-	-	-	0/4	-	-	-	-	4
Green Creek above Campground 630GRN001	-	-	-	-	-	-	0/4	-	-	-	-	4
Virginia Creek at Conway Summit 630VIR001	-	-	-	-	-	-	0/4	-	-	-	-	4
Robinson Creek below Barney Lake 630RBS006	-	-	-	-	-	-	0/4	-	-	-	-	4
East Walker River at Stateline 630EWK001	0/4	0/4	0/4	4/4	0/4	0/4	0/16	0/7	0/15	0/16	-	78
Total Exceedances	0	0	0	4	0	0	0	0	0	0	-	4 / 94

The table above presents a compilation of the total number of exceedances of California Secondary MCL criteria for the East Walker River HU for sample years 2001 through 2005. The majority of criteria for Buckeye, Green, Virginia, and Robinson creeks have not been evaluated at this time. The East Walker River HU has a total of 94 data points that are comparable to Secondary MCLs, with 4 observed exceedances. The only exceedances documented were for manganese (Mn). (See discussion above.) The (-) symbol indicates that no samples were collected.

Lahontan Water Board
Owens Hydrologic Unit

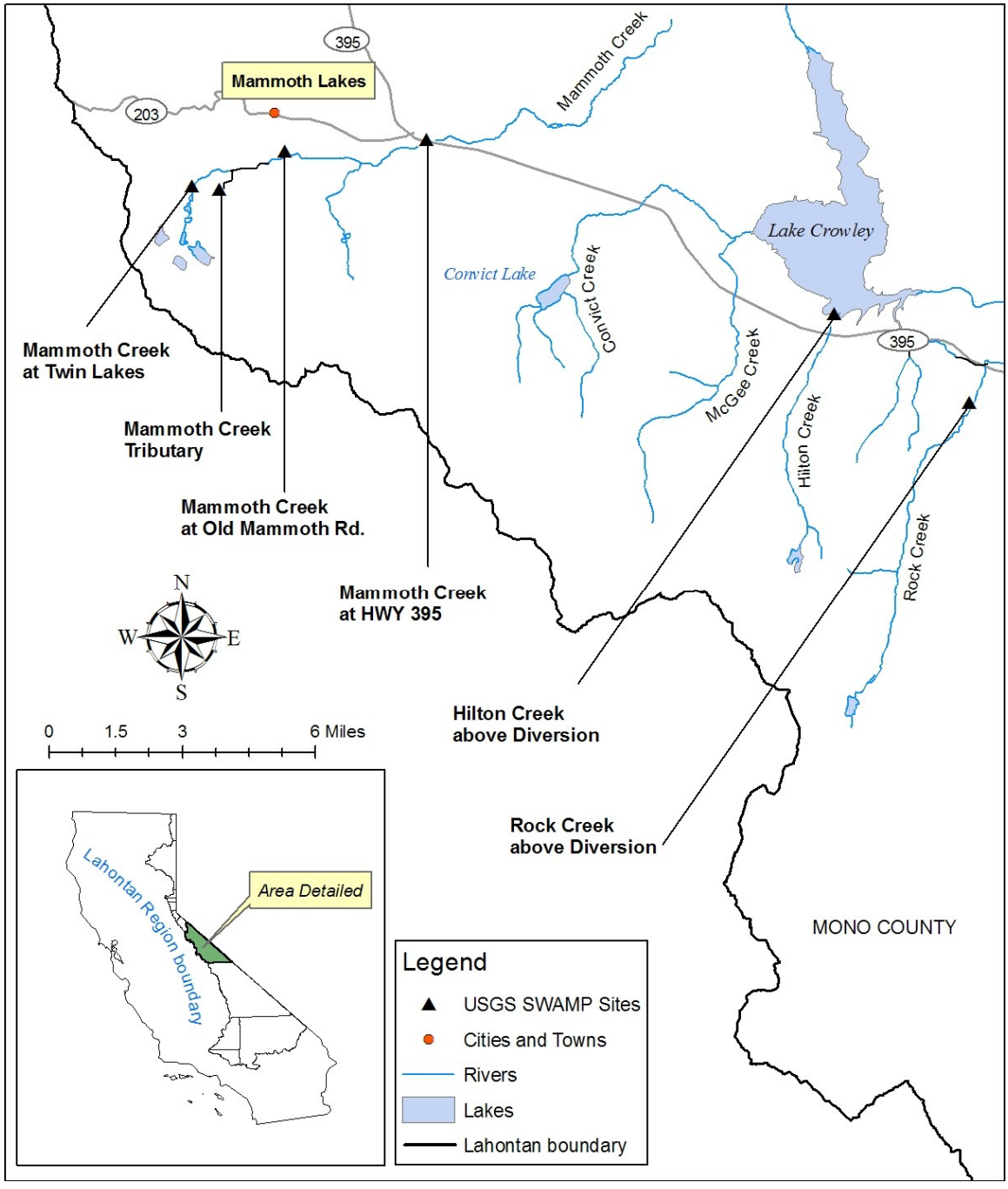

Figure 11. Sample locations in the Owens Hydrologic Unit

Mono/Owens Watershed Management Area (WMA)

Two hydrologic units (HUs) were sampled within the Mono/Owens WMA[44]: the Owens HU and the Amargosa HU. The sample locations are depicted in Figure 11 (Owens HU) and Figure 15 (Amargosa HU).

Owens Hydrologic Unit (HU)

Six locations were sampled within the Owens HU: Hilton Creek, Rock Creek, and four sites along Mammoth Creek: (1) Mammoth Creek at Twin Lakes, (2) a Mammoth Creek tributary, (3) Mammoth Creek at Old Mammoth Road, and (4) Mammoth Creek at Highway 395. Four of the sites (e.g., Hilton Creek, Rock Creek, Mammoth Creek at Twin Lakes, Mammoth Creek at Hwy 395) were sampled between two and four times per year from August 2001 through August 2005. The remaining two sites (e.g., Mammoth Creek tributary, Mammoth Creek at Old Mammoth Road) were sampled less often.

Basin Plan Criteria—Owens HU

For the Owens HU there were 338 values comparable to Basin Plan criteria, with a total of 60 potential exceedances, resulting in a potential exceedance rate of about 18 percent. (See Figure 12, and Table 21). Potential exceedances were observed for total dissolved solids (TDS), dissolved oxygen (DO), fecal coliform bacteria (FC), pH, chloride (Cl), sulfate (SO_4), orthophosphate (PO_4), and fluoride (F).

At **Hilton Creek**, potential exceedances were observed for TDS, DO, and FC. The Basin Plan's annual average criterion for TDS was marginally exceeded in two out of the five years. Specifically, the annual average values for TDS from 2001–2005 were 25, 20, 37, 30, and 28 mg/L, respectively, compared to the Basin Plan's site-specific annual average criterion of 28 mg/L. The TDS results are based on only two to four samples per year, and therefore may not accurately represent true average conditions. Six of 15 measurements for DO at Hilton Creek indicated depressions of DO concentrations (i.e., 6.5, 7.8, 7.5, 7.8, 7.4, and 7.8 mg/L) below the Basin Plan's minimum criterion of 8.0 mg/L. And two of five samples collected for FC potentially exceeded the Basin Plan's 30-day log mean objective of 20 FC bacteria colonies per 100 mL. The FC bacteria concentration in those two samples was 140 and 100 colonies per 100 mL. While these two results for FC are reported here as potential exceedances, it is important to note that they are based on single samples only, and the Basin Plan advises collecting FC samples at least five times in a 30-day period for comparison to the 30-day log mean criterion. Therefore, these results for FC (based on a single sample per calendar quarter from July 2004 through July 2005) should not be considered conclusive. More detailed investigation would be needed to accurately characterize ambient levels of TDS, DO, and FC at this site.

At **Rock Creek**, potential exceedances were observed for TDS and DO. The Basin Plan's annual average criterion for TDS was potentially exceeded in all five years. Specifically, the annual average values for TDS from 2001–2005 were 30, 30, 38, 34, and 35 mg/L,

[44] The Mono/Owens Watershed Management Area is described in Chapter 2 of this report.

respectively, compared to the Basin Plan's site-specific annual average criterion of 21 mg/L. These TDS results are based on only two to four samples per year, and therefore may not accurately represent true average conditions. However, in total, only three of the 16 samples collected for TDS over the 5-year period had concentrations below the Basin Plan's annual average criterion. One of 15 measurements for DO at Rock Creek indicated a DO concentration marginally below the Basin Plan's minimum criterion. Specifically, the DO concentration on 8/14/2001 was 7.8 mg/L compared to the Basin Plan criterion of 8.0 mg/L. Given that there was only a single marginal depression out of 15 measurements, DO does not appear to be a significant concern at this site.

At **Mammoth Creek**, four sites were sampled, with potential exceedances observed for TDS, PO_4, DO, FC, pH, Cl, F, and SO_4.

Results for TDS at Mammoth Creek indicate potential exceedances of Basin Plan objectives at all four sites for nearly every year sampled between 2000 and 2005. At Mammoth Creek at Twin Lakes, annual average TDS values for 2001–2005 were 100, 67, 84, 83, and 72 mg/L, respectively, compared to the Basin Plan criterion of 60 mg/L. At the Mammoth Creek tributary site, annual average TDS values for 2003–2005 were 86, 85, and 82 mg/L, respectively, compared to the Basin Plan criterion of 85 mg/L. At Mammoth Creek at Old Mammoth Road, annual average TDS values for 2001 were 109 mg/L, and for 2003–2005 were 127, 108, and 97 mg/L, respectively, compared to the Basin Plan criterion of 85 mg/L. (No TDS values are available for this site for year 2002.) And at Mammoth Creek at Highway 395, annual average TDS values for 2000–2005 were 117, 100, 81, 94, 92, and 85 mg/L, respectively, compared to the Basin Plan criterion of 75 mg/L.

It is important to note that the annual averages reported for TDS at the Mammoth Creek sites are comprised of only one to four samples each, and therefore may not accurately reflect true average conditions. Further, many of the TDS exceedances are marginal. For example, at the Mammoth Creek tributary site, the annual average TDS values exceeded the Basin Plan's criterion only once (for year 2003), and that annual average was based on a single sample that barely exceeded the criterion (i.e., result of 86 mg/L compared to Basin Plan objective of 85 mg/L). Further, the average of all eight TDS samples collected at the tributary site from 2003–2005 was 84 mg/L, which suggests compliance with the Basin Plan's objective of 85 mg/L. Therefore, while TDS at the tributary site is reported here as a potential exceedance for year 2003, the weight of evidence indicates that TDS is not a significant problem at this site.

For the entire period from 2000–2005, the average TDS concentration at Mammoth Creek at Twin Lakes (n = 16) was 80 mg/L, compared to the Basin Plan's annual average objective of 60 mg/L. The average TDS concentration at Mammoth Creek at Old Mammoth Road (n = 10) was 107 mg/L, compared to the Basin Plan's objective of 85 mg/L. And the average TDS concentration at Mammoth Creek at Highway 395 (n = 19) was 92 mg/L, compared to the Basin Plan's objective of 75 mg/L. These "overall" averages for three sites along Mammoth Creek indicate that TDS may be a significant issue at Mammoth Creek. While these TDS levels are not known to adversely affect the

designated beneficial uses, they may exceed the Basin Plan's numeric objectives. Unless additional data is available from other sources, more sampling would be needed to accurately characterize average TDS concentrations at these sites.

Potential exceedances for orthophosphate (PO_4) were observed at one site (e.g., Mammoth Creek at Highway 395), in four out of six years sampled. In both 2000 and 2001, the annual average value for PO_4 was 0.15 mg/L, compared to the Basin Plan objective of 0.11 mg/L. However, the annual averages for 2000 and 2001 are based on single samples, and therefore probably do not accurately represent true average conditions. Potential exceedances for PO_4 were also observed in two other years during which a few more samples were collected. Specifically, the annual average PO_4 concentrations for 2004 (n = 4) and 2005 (n = 3) were 0.325 and 0.113 mg/L, respectively, compared to the objective of 0.11 mg/L. The latter value (for 2005) is only very marginally above the Basin Plan objective. The unusually high value for year 2004 is due to a possible outlier (PO_4 = 0.981 mg/L on 10/27/04) that was nearly an order of magnitude higher than all of the other PO_4 results for this site over the 5-year period (n = 17). Without this outlier, the annual average for 2004 meets the objective. Overall, the average of all 17 samples collected over the 5-year period is 0.161 mg/L, and the average of all samples minus the outlier (n = 16) is 0.11 mg/L. In sum, the data for PO_4 are inconclusive; more detailed investigation would be needed to accurately characterize ambient levels of PO_4 at this site.

Potential violations of the Basin Plan's region-wide objective for minimum DO concentration (i.e., 8.0 mg/L) were observed at three of the Mammoth Creek sites. Five of 15 measurements at Mammoth Creek at Twin Lakes indicated DO lower than the Basin Plan criterion (potential exceedances = 6.8, 7.0, 6.7, 6.0, and 7.8 mg/L, compared to an objective of 8.0 mg/L). Three of nine measurements at Mammoth Creek at Old Mammoth Road indicated DO lower than the Basin Plan criterion (potential exceedances = 6.5, 7.5, and 7.6 mg/L). And three of 14 measurements at Mammoth Creek at Highway 395 indicated DO lower than the Basin Plan's objective (potential exceedances = 6.6, 7.8, and 7.9 mg/L). Most of the "low" DO measurements occurred during the summer and autumn months. Because of the naturally wide diurnal and seasonal fluctuations in DO concentration, these results should not be considered conclusive. More frequent sampling would be needed to accurately characterize DO concentrations at these sites (and other sites throughout the Region where potential exceedances for DO were observed).

Several potential exceedances of the Basin Plan's objectives for fecal coliform bacteria (FC) were observed at the Mammoth Creek sites. Five samples were collected for FC during 2004–2005 at each of the four Mammoth Creek sites, with two potential exceedances at the tributary site (53 and 56 colonies/100 mL), one potential exceedance at the Old Mammoth Road site (44 colonies/100 mL), and three potential exceedances at the Highway 395 site (79, 41, and 220 colonies/100 mL). All of the potential exceedances were observed during the summer or autumn months. While these results are reported here as potential exceedances, it is important to note that they are based on single samples, and the Basin Plan advises collecting FC samples at least five times in a 30-day period for comparison to the 30-day log mean criterion. Therefore, these results should

not be considered conclusive. More detailed investigation would be needed to accurately characterize ambient levels of FC bacteria at these sites.

Potential exceedances of the Basin Plan's region-wide objective for pH occurred at Mammoth Creek at Twin Lakes in August 2002 and July 2004. Those two pH values were 8.8 and 8.6 pH units, respectively, compared to the Basin Plan's objective of 8.5. The Basin Plan acknowledges that some waters of the Region may have natural pH levels outside of the 6.5 to 8.5 range. Further investigation would be needed to accurately characterize ambient pH levels at this site.

Potential exceedances were also observed for chloride (Cl) at two Mammoth Creek sites, and for fluoride (F) and sulfate (SO_4) at one site, but the results for these three analytes are based on very low sample sizes, and the calculated annual averages probably do not accurately represent ambient conditions.

Specifically, potential exceedances for Cl were observed at Mammoth Creek at Twin Lakes in 2001, and at the Mammoth Creek tributary in 2003. The annual average for Mammoth Creek at Twin Lakes (for 2001) was 1.5 mg/L, compared to the Basin Plan objective of 0.6 mg/L. However, that annual average is based on only two samples, and therefore probably does not accurately represent average conditions. Further, one of the results during 2001 (Cl = 2.86 mg/L, on 11/28/01) was an apparent outlier that was an order of magnitude higher than all of the other Cl results for this site for the 5-year period (n = 16). The annual average Cl concentration for the Mammoth Creek tributary site (for 2003) was 0.87 mg/L, compared to the Basin Plan objective of 0.8 mg/L. This exceedance is very marginal, and the annual average of 0.87 mg/L is based on a single sample and therefore probably does not accurately represent true average conditions. All other Cl results at the Mammoth Creek sites for 2000–2005 suggest compliance with the Basin Plan's objectives. While the two data points discussed above (e.g., Twin Lakes site in 2001, tributary site in 2003) are reported here as potential exceedances, the weight of evidence indicates that Cl is not a significant issue at Mammoth Creek.

One potential exceedance for fluoride (F) and two potential exceedances for sulfate (SO_4) were observed at the Highway 395 site, but in all three cases the annual averages were comprised of a single sample, which probably does not accurately reflect true average conditions. Specifically, the annual average F concentration for 2000 (based on a single sample) was 0.2 mg/L, compared to the Basin Plan objective of 0.1 mg/L. And the annual average SO_4 concentrations for 2001 and 2005 (both based on single samples) were 6.7 and 6.4 mg/L, respectively, compared to the Basin Plan objective of 6.0 mg/L. These single-sample results only marginally exceed the Basin Plan's annual average criteria, and all other results for F and SO_4 at the Mammoth Creek sites for 2000–2005 suggest compliance with Basin Plan objectives. While the three data points discussed above for the Highway 395 site (e.g., fluoride in 2000, sulfate in 2001 and 2005) are reported here as potential exceedances, the weight of evidence indicates that F and SO_4 are not significant issues at Mammoth Creek.

California Toxics Rule (CTR) Criteria—Owens HU

Some of the CTR criteria for metals were investigated at the Mammoth Creek sites; organic constituents were not monitored or evaluated at any sites. Overall, for the Owens HU, 94 percent of all samples comparable to the CTR Human Health criteria exhibited no exceedances (Figure 13), with thirteen exceedances attributable to mercury (Hg). In total, 545 CTR data points (see Tables 22 and 23) were collected between 2001 and 2005. Of these data points, there are no exceedances of the CTR Aquatic Life criteria. However, thirteen of the 42 samples collected for mercury (Hg) exceeded the CTR Human Health criteria. These exceedances were present at three site locations (e.g., Mammoth Creek tributary, Mammoth Creek at Old Mammoth Road, Mammoth Creek at Highway 395). While the CTR Human Health criterion for total Hg (i.e., 0.05 µg/L) was exceeded in thirteen samples (Table 22), the California drinking water standard (Primary MCL = 2 µg/L) was met in all cases (Table 24). The Mono County environmental health department was notified about these mercury results, and the data was provided to the county. Any decision(s) regarding follow-up monitoring will be made in consultation with the county.

Drinking Water (MCL) Criteria—Owens HU

A summary of the results compared to the California Primary and Secondary MCLs (i.e., drinking water standards) is presented in Tables 24 and 25. In the Owens HU, all criteria were met where Primary MCL parameters were measured. Some exceedances of Secondary MCL criteria were observed, for iron (Fe) and manganese (Mn). (See Figure 14.)

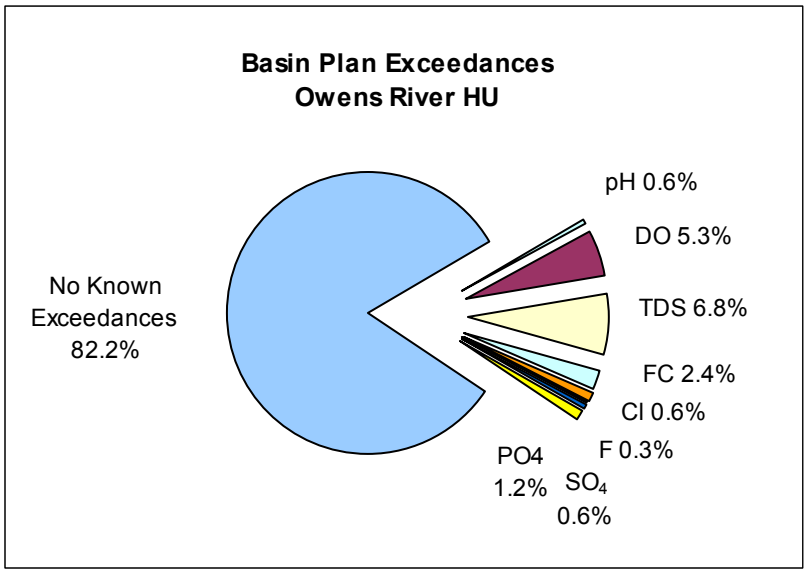

Figure 12. Comparison of Basin Plan Criteria to Results for the Owens HU

For the Owens HU, potential exceedances of Basin Plan criteria were 17.8 percent of the results, with 6.8 percent attributed to total dissolved solids (TDS), 5.3 percent to dissolved oxygen (DO), 2.4 percent to fecal coliform bacteria (FC), 1.2 percent to orthophosphate (PO_4), and less than 1 percent (each) for pH, chloride (Cl), fluoride (F), sulfate (SO_4).

Table 21. Comparison of Basin Plan Criteria to Results for the Owens HU

Station Name (Site Tag)	pH	DO	TDS	FC	Cl	F	SO_4	B	NO_3	TN	PO_4	Pesticides	Total Number of Data Points
Hilton Creek 603HIL001	0/14	6/15	2/5	2/5	0/5	-	-	-	0/5	0/5	0/4	-	58
Rock Creek 603RCK002	0/15	1/15	5/5	0/5	0/5	-	NA	-	0/5	0/5	0/4	-	59
Mammoth Creek tributary 603MAM009	0/8	0/8	1/3	2/5	1/3	NA	NA	NA	0/3	0/3	0/3	-	36
Mammoth Creek at Twin Lakes 603MAM008	2/15	5/15	5/5	0/5	1/5	NA	NA	NA	0/5	0/5	0/4	-	59
Mammoth Creek at Old Mammoth Rd 603MAM007	0/8	3/9	4/4	1/5	0/4	NA	NA	NA	0/4	0/4	0/3	-	41
Mammoth Creek at HWY 395 603MAM006	0/20	3/14	6/6	3/5	0/6	1/5	2/5	0/6	0/6	0/6	4/6	-	85
Total Potential Exceedances	2	18	23	8	2	1	2	0	0	0	4	-	60 / 338

The table above presents a compilation of the total number of potential exceedances of Basin Plan objectives versus the total number of data points available for the Owens HU for sample years 2001 through 2005. The Owens HU has a total of 338 data points that are comparable to Basin Plan objectives, with 60 exceedances. The (-) symbol indicates that no samples were collected. "NA" indicates that there is no numeric objective in the Basin Plan for that particular constituent.

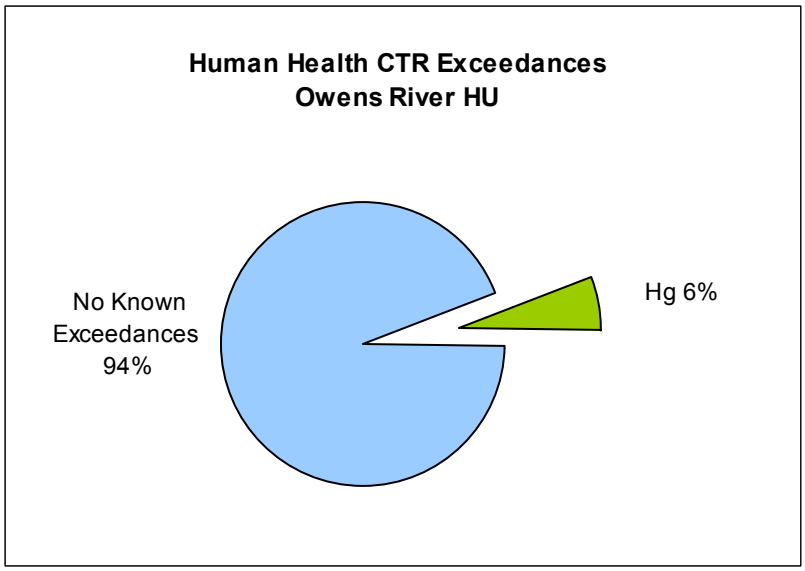

Figure 13. Comparison of CTR Human Health Criteria to Results for the Owens HU

For the Owens HU, exceedances of CTR criteria for Human Health were 6 percent of the results, with the entire 6 percent attributed to total mercury (Hg).

Table 22. Comparison of CTR Human Health Criteria to Results for the Owens HU

Station Name (Site Tag)	Total Sb	Total Cu	Total Ni	Total Hg	Total Tl	Organics	Total Number Data Points
Hilton Creek 603HIL001	-	-	-	-	-	-	-
Rock Creek 603RCK002	-	-	-	-	-	-	-
Mammoth Creek tributary 603MAM009	0/8	0/8	0/8	6/8	0/8	-	40
Mammoth Creek at Twin Lakes 603MAM008	0/8	0/12	0/12	0/12	0/12	-	56
Mammoth Creek at Old Mammoth Road 603MAM007	0/10	0/10	0/10	3/10	0/10	-	50
Mammoth Creek at HWY 395 603MAM006	0/12	0/12	0/12	4/12	0/12	-	60
Total Exceedances	0	0	0	13	0	-	13 / 206

The table above presents a compilation of the total number of exceedances of the CTR Human Health criteria for the Owens HU for sample years 2001 through 2005. The Owens HU has a total of 206 data points that are comparable to CTR Human Health criteria, with 13 exceedances. The (-) symbol indicates that no samples were collected.

Table 23. Comparison of CTR Aquatic Life Criteria to Results for the Owens HU

Station Name (Site Tag)	Diss. As	Diss. Cd	Cr (III)	Cr (VI)	Diss. Cu	Diss. Pb	Diss. Ni	Total Se	Diss. Ag	Diss. Zn	Total Number of Data Points
Hilton Creek 603HIL001	-	-	-	-	-	-	-	-	-		-
Rock Creek 603RCK002	-	-	-	-	-	-	-	-	-		-
Mammoth Creek tributary 603MAM009	0/8	0/8	-	-	0/8	0/8	0/7	0/8	0/8	0/8	63
Mammoth Creek at Twin Lakes 603MAM008	0/12	0/12	-	-	0/12	0/12	0/12	0/12	0/12	0/12	96
Mammoth Creek at Old Mammoth Road 603MAM007	0/10	0/10	-	-	0/10	0/10	0/10	0/10	0/10	0/10	80
Mammoth Creek at HWY 395 603MAM006	0/16	0/12	-	-	0/12	0/12	0/12	0/12	0/12	0/12	100
Total Exceedances	0	0	-	-	0	0	0	0	0		0 / 339

The table above presents a compilation of the total number of exceedances of the CTR Aquatic Life criteria for the Owens HU for sample years 2001 through 2005. The Owens HU has a total of 339 data points that are comparable to CTR Aquatic Life criteria, with no observed exceedances. The (-) symbol indicates that no samples were collected.

Table 24. Comparison of Primary MCL Criteria to Results for the Owens HU

Station Name (Site Tag)	F	NO_3	Al	Sb	As	Be	Cd	Cr	Cu	Pb	Ni	Hg	Se	Tl	U	Organics	Total Number of Data Points
Hilton Creek 603HIL001	-	0/16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16
Rock Creek 603RCK002	-	0/16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16
Mammoth Creek tributary 603MAM009	-	0/8	0/8	0/8	0/8	0/8	0/8	0/8	0/8	0/8	0/8	0/8	0/8	0/8	-	-	104
Mammoth Creek at Twin Lakes 603MAM008	-	0/16	0/8	0/8	0/12	0/12	0/12	0/12	0/12	0/12	0/12	0/12	0/12	0/12	-	-	152
Mammoth Creek at Old Mammoth Road 603MAM007	-	0/10	0/10	0/10	0/10	0/10	0/10	0/10	0/10	0/10	0/10	0/10	0/10	0/10	-	-	130
Mammoth Creek at HWY 395 603MAM006	0/5	0/17	0/12	0/12	0/12	0/12	0/12	0/12	0/12	0/12	0/12	0/12	0/12	0/12	-	-	166
Total Exceedances	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	0 / 584

The table above presents a compilation of the total number of exceedances of California Primary MCLs for the Owens HU for sample years 2001 through 2005. The majority of MCL criteria have not been evaluated at Hilton Creek or Rock Creek this time. The Owens HU has a total of 584 data points that are comparable to Primary MCLs, with no observed exceedances. The (-) symbol indicates that no samples were collected.

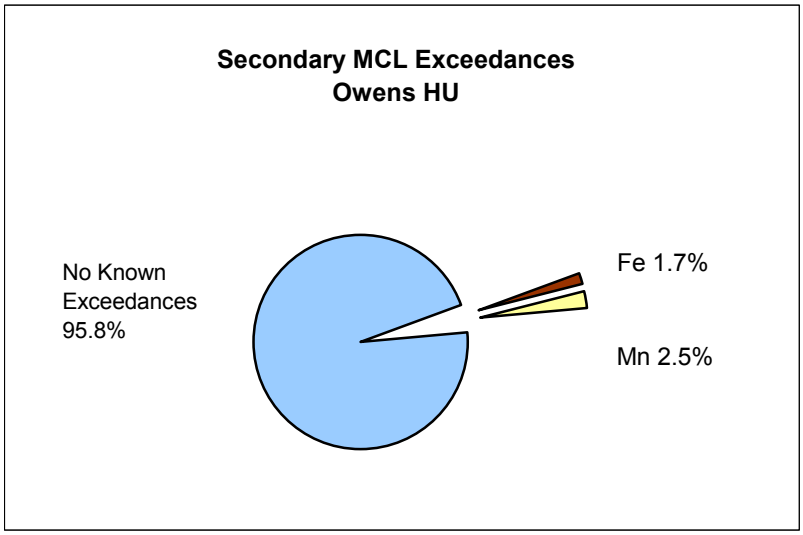

Figure 14. Comparison of Secondary MCL Criteria to Results for the Owens HU

For the Owens HU, exceedances of California Secondary MCL criteria were 4.2 percent of the results, with 2.5 percent attributed to manganese (Mn), and 1.7 percent attributed to iron (Fe).

Table 25. Comparison of Secondary MCL Criteria to Results for the Owens HU

Station Name (Site Tag)				Mn		Zn						Number of Data Points
Hilton Creek 603HIL001	-	-	-	-	-	-	0/15	-	0/16	0/15	-	46
Rock Creek 603RCK002	-	-	-	-	-	-	0/16	-	0/16	0/15	-	47
Mammoth Creek tributary 603MAM009	0/8	0/8	0/8	0/8	0/8	0/8	0/8	-	0/8	0/8	-	72
Mammoth Creek at Twin Lakes 603MAM008	0/8	0/12	4/12	0/12	0/12	0/12	0/16	-	0/16	0/16	-	116
Mammoth Creek at Old Mammoth Road 603MAM007	0/10	0/10	3/10	8/10	0/10	0/10	0/10	-	0/10	0/10	-	90
Mammoth Creek at HWY 395 603MAM006	0/12	0/12	2/12	5/12	0/12	0/12	0/30	0/5	0/19	0/29	-	155
Total Exceedances	0	0	9	13	0	0	0	0	0	0	-	22 / 526

The table above presents a compilation of the total number of exceedances of California Secondary MCLs for the Owens HU for sample years 2001 through 2005. The Hilton Creek and Rock Creek sites showed no exceedances, but were evaluated only for chloride (Cl), specific conductance (SC), and total dissolved solids (TDS). The Mammoth Creek sites were also sampled for metals. The Owens HU has a total of 526 data points that are comparable to California Secondary MCLs, with 22 exceedances. The (-) symbol indicates that no samples were collected.

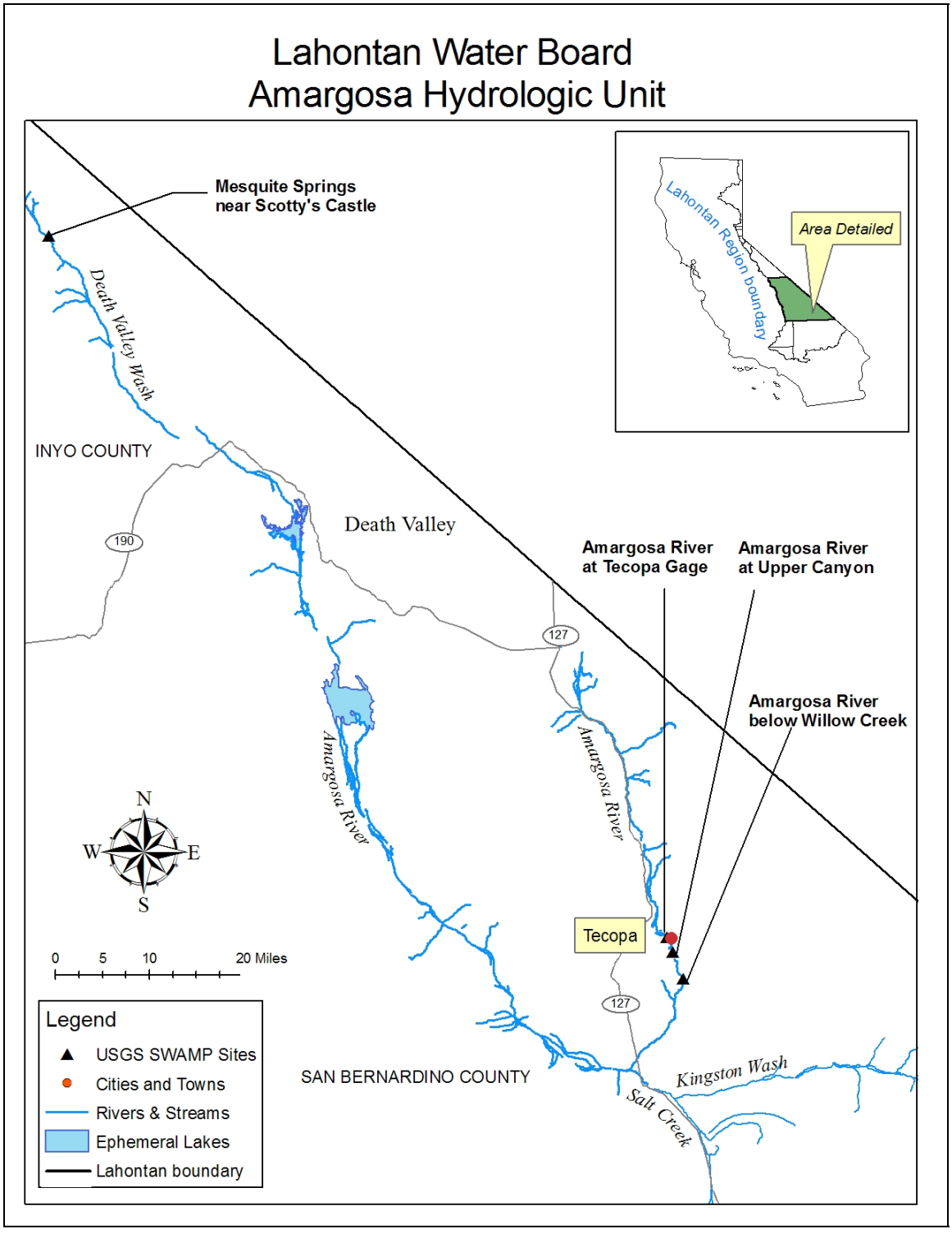

Figure 15. Sample locations in the Amargosa Hydrologic Unit

Amargosa Hydrologic Unit (HU)

Four locations were sampled within the Amargosa HU, including Mesquite Springs (in Death Valley National Park), and three locations along the main stem of the Amargosa River: (1) Amargosa River at Tecopa USGS gage, (2) Amargosa River at Upper Canyon, and (3) Amargosa River below Willow Creek. (See Figure 15.) All four sites in this HU were sampled only two times each. Mesquite Springs was sampled in October 2002 and March 2003, and the three sites along the Amargosa River were each sampled in March 2004 and March 2005.

The Amargosa River sites are the only locations included in this report where large suites of both metal and organic constituents were measured. (Sampling for metals and organic constituents was limited elsewhere due to funding constraints.)

The four sites in this HU were sampled in partnership with the California Desert Managers Group (DMG),[45] including the U.S. Geological Survey (USGS), USDI National Park Service (NPS), and USDI Bureau of Land Management (BLM). Members of the DMG provided matching funds and in-kind services to foster additional sampling, and offered recommendations for maximizing data utility. For example, methods for SWAMP sampling were adapted in some cases to parallel methods used by the DMG at desert springs.[46] And at the Amargosa River sites, SWAMP provided funding for detailed stream water chemistry sampling, while the BLM provided matching funds for synoptic ("same time") bioassessment and quantitative habitat measurements. These interagency collaborations allowed for a more comprehensive assessment and wider utility of the data.

The Basin Plan does not contain site-specific objectives that apply to any of these four sites. Therefore, the criteria used in this report for assessing water quality at these four site are: (1) the Basin Plan's general "Water Quality Objectives Which Apply to All Surface Waters"; (2) the California Toxics Rule (CTR); and (3) the California Maximum Contaminant Levels (MCLs) (i.e., drinking water standards).

Because of naturally high concentrations of salts and metals, the beneficial uses for Municipal and Domestic Supply (MUN) were removed from the Amargosa River via amendments to the Lahontan Basin Plan. (The amendments were adopted in year 2000 by the Lahontan Regional Water Board and took effect in 2002 upon approval by the USEPA.) Therefore, exceedances of the MCLs at the Amargosa River sites do not constitute violations of water quality standards, but they are included in this report for informational purposes. Mesquite Springs has a separate entry in the Basin Plan, and it therefore remains designated for MUN uses.

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[45] For more information about the Desert Managers Group, see: http://www.dmg.gov/.

[46] For example, the USGS recommended a suite of analytes for Mesquite Springs so the results could be compared to other sites sampled by the DMG. In addition, while most routine sampling for dissolved constituents relies on filters with a pore size of 0.45 micrometers, the DMG has been using 0.1-micron filters for studies of California desert groundwater and springs, and recommended that those filters be used by SWAMP, so the data would be comparable. Thus, at Mesquite Springs, 0.1 μm filters were used.

Basin Plan Criteria—Amargosa HU

For the Amargosa HU there were 309 values comparable to Basin Plan criteria, with a total of 9 potential exceedances, resulting in a potential exceedance rate of about three percent. (See Figure 16, and Table 26). Potential exceedances were observed for pesticides, pH, and fecal coliform bacteria.

Mesquite Springs provides drinking water for a campground at Death Valley National Park, and is believed to be connected to the regional aquifer that is down-gradient of the nuclear waste repository proposed for Yucca Mountain, Nevada. Sampling was conducted at Mesquite Springs to confirm the suitability of the spring water for domestic uses at the campground, and to provide "baseline" data to evaluate future trends. No exceedances of Basin Plan objectives were observed.

At the Amargosa River, potential exceedances were observed for pesticides, pH, and fecal coliform bacteria, as discussed below.

Of the 70 organic analytes measured at the Amargosa River, a single pesticide (triclopyr)[47] was detected. According to the BLM, herbicide formulations containing triclopyr had been used in the area to control tamarisk ("saltcedar"). Triclopyr was detected in March 2004 at both the Upper Canyon (0.07 µg/L) and Willow Creek (0.06 µg/L) sites. The Lahontan Basin Plan contains a surface water objective for pesticides (including herbicides) that states: "Pesticide concentrations, individually or collectively, shall not exceed the lowest detectable levels, using the most recent detection procedures available." This objective is violated by the detection of triclopyr in the Amargosa River.

Potential exceedances for pH were observed at all three Amargosa River locations, in both March 2004 and March 2005. The Basin Plan's objective for pH is a range from 6.5–8.5. In 2004, the Tecopa, Upper Canyon, and Willow Creek sites had pH values of 8.9, 8.6, and 8.7 pH units, respectively. In 2005, the results were 9.1, 8.7, and 8.7 pH units, respectively. While most of these values are only slightly above the Basin Plan's target maximum of 8.5 pH units, there was one value above 9 pH units, which potentially exceeds not only the Basin Plan's objective, but also USEPA advisory criteria for taste & odor and the protection of aquatic life. The cause of the potential pH exceedances is unknown. However, the Amargosa River watershed contains naturally saline soils, which likely contribute to the relatively high pH values. The Basin Plan acknowledges that some waters of the Region may have natural pH levels outside of the 6.5 to 8.5 range. Further investigation would be needed to accurately characterize ambient pH levels at these sites and to determine the source(s) of elevated pH.

The three Amargosa River sites were sampled one time each (in March 2004) for fecal coliform bacteria (FC). One potential exceedance was observed, at the Willow Creek site, with an FC concentration of approximately 65 colonies/100 mL, compared to the Basin

[47] Triclopyr is [(3,5,6-trichloro-2-pyridinyl) Oxy]acetic acid. The trade names for herbicides containing this active ingredient are Garlon®, Turflon®, Access®, Redeem®, Crossbow®, Grazon®, and others.

Plan's 30-day log mean objective of 20 colonies/100 mL. While this result is reported here as a potential exceedance, it is important to note that it is based on a single sample, and that the Basin Plan advises collecting FC samples at least five times in a 30-day period for comparison to the 30-day log mean criterion. Therefore, these results for FC should not be considered conclusive. More detailed investigation would be needed to accurately characterize ambient levels of FC bacteria at these sites.

California Toxics Rule (CTR) Criteria—Amargosa HU

At the Amargosa HU, no exceedances of the CTR Human Health criteria were observed (Table 27). Potential exceedances of the CTR Aquatic Life criteria were observed for dissolved arsenic and copper (Figure 17). Dissolved arsenic (As) exceeded the CTR 4-day average (Aquatic Life) criterion at all three Amargosa River sites on both sample dates (Table 28). Specifically, in March 2004, dissolved As concentrations at Tecopa, Upper Canyon, and Willow Creek were 699, 226, and 207 µg/L, respectively, compared to the 4-day average (Aquatic Life) criterion of 150 µg/L. In March 2005, dissolved As concentrations were 495, 166, and 170 µg/L, respectively. It should be noted that these are considered "potential" exceedances of the CTR criterion for dissolved As because that criterion is expressed as a 4-day average, and the results presented here are based on single samples only. The source of the arsenic is unknown, but is most likely due largely or wholly to natural geologic inputs.

The results indicate one potential exceedance of the CTR Aquatic Life criterion for dissolved copper (Cu). Specifically, at the Amargosa River at Tecopa (USGS gage site), the dissolved Cu concentration was 6.6 µg/L on 3/17/04, compared to the 4-day average (Aquatic Life) criterion of 6.5 µg/L.[48] This result only very marginally exceeded the criterion, and it should be noted that the criterion is expressed as a 4-day average, while the result presented here is based on a single sample. This result should therefore not be considered conclusive; further sampling would be needed to characterize copper concentrations at this site relative to the 4-day average criterion. However, due to the very marginal exceedance, the high cost of sampling for metals, the large number of samples that would be needed to precisely evaluate the 4-day average criterion, and other monitoring needs throughout the Region, this issue is not a high priority for follow-up.

No exceedances of any CTR criteria were observed for Mesquite Springs, but it should be noted that (due to funding limitations) Mesquite Springs was not sampled for organic constituents, mercury, or chromium.

Drinking Water (MCL) Criteria—Amargosa HU

Because of naturally high concentrations of salts and metals, the beneficial uses for Municipal and Domestic Supply (MUN) were removed from the Amargosa River via amendments to the Lahontan Basin Plan. (The amendments were adopted in year 2000 by the Lahontan Regional Water Board and took effect in 2002 upon approval by the USEPA.) Therefore, exceedances of the MCLs at the Amargosa River do not constitute

[48] The CTR Aquatic Life criteria for several metals (e.g., cadmium, chromium(III), copper, lead, nickel, silver, zinc) are variable, depending on hardness. The criterion used here for dissolved copper (6.5 µg/L) was derived according to the CTR, based on the hardness.

violations of water quality standards, but they are included in this report for informational purposes. Mesquite Springs has a separate entry in the Basin Plan, and it therefore remains designated for MUN uses.

Exceedances of the California Primary and Secondary MCLs were observed for all four sites sampled in this HU. Overall, about 10 percent of the available data points exceeded Primary MCL criteria (Figure 18), and about 52 percent of the data points exceeded Secondary MCL criteria (Figure 19). The Primary MCL criterion for fluoride (F) was exceeded at Mesquite Springs, while several Primary MCL criteria were exceeded at the Amargosa River sites: aluminum (Al), arsenic (As), fluoride (F), gross alpha radiation (Gross α), and gross beta radiation (Gross β). (See Table 29.) Exceedances of Secondary MCL criteria are presented in Table 30, and include specific conductance (SC), total dissolved solids (TDS), chloride (Cl), aluminum (Al), iron (Fe), sulfate (SO_4), and manganese (Mn). To view the actual data, and/or MS-Excel™ workbooks that include graphs of the data compared to relevant criteria (including MCLs), see the Lahontan Water Board's monitoring webpage. Visit the following link and scroll down to the Amargosa HU: http://www.waterboards.ca.gov/lahontan/water_issues/programs/swamp/index.shtml#data.

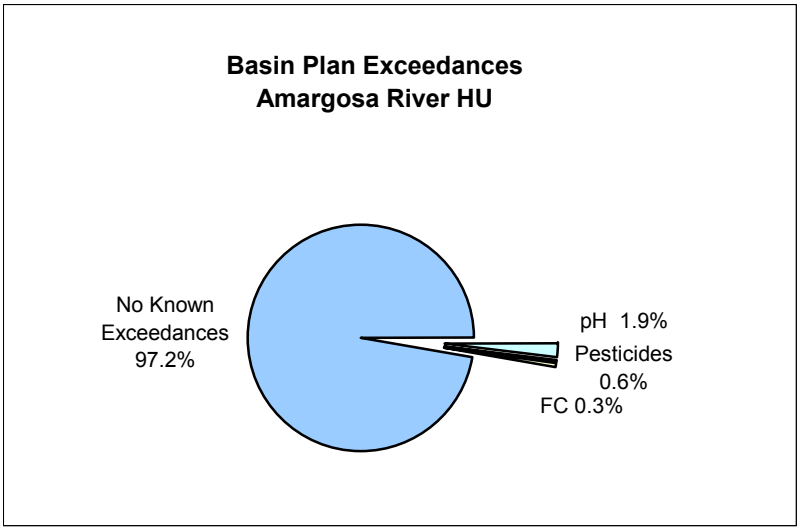

Figure 16. Comparison of Basin Plan Criteria to Results for the Amargosa HU

For the Amargosa HU, potential exceedances of Basin Plan objectives were approximately 3 percent of the results, with 1.9 percent attributed to pH, 0.6 percent to pesticides, and 0.3 percent to fecal coliform bacteria (FC).

Table 26. Comparison of Basin Plan Criteria to Results for the Amargosa HU

Station Name (Site Tag)	pH	DO	FC	Pesticides	Total Number of Data Points
Amargosa River at Tecopa gage 609AMR003	2/2	0/2	0/1	0/96	101
Amargosa River at Upper Canyon 609AMR002	2/2	0/2	0/1	1/96	101
Amargosa River below Willow Cr 609AMR001	2/2	0/2	1/1	1/96	101
Mesquite Springs 609MSQ001	0/2	0/2	0/2	-	6
Total Potential Exceedances	6	0	1	2	9 / 309

The table above presents a compilation of the total number of potential exceedances of Basin Plan objectives versus the total number of data points available for the Amargosa HU for sample years 2002 through 2005. The Amargosa HU has a total of 309 data points that are comparable to Basin Plan objectives, with 9 potential exceedances. The (-) symbol indicates that no samples were collected.

Table 27. Comparison of CTR Human Health Criteria to Results for the Amargosa HU

Station Name (Site Tag)	Total Sb	Total Cu	Total Ni	Total Hg	Total Tl	Organics	Total Number of Data Points
Amargosa River at Tecopa gage 609AMR003	0/2	0/2	0/2	0/2	0/2	0/19	29
Amargosa River at Upper Canyon 609AMR002	0/2	0/2	0/2	0/2	0/2	0/19	29
Amargosa River below Willow Creek 609AMR001	0/2	0/2	0/2	0/2	0/2	0/19	29
Mesquite Springs 609MSQ001	0/2	0/2	0/2	-	0/2	-	8
Total Exceedances	0	0	0	0	0	0	0 / 95

The table above presents a compilation of the total number of exceedances of CTR Human Health criteria versus total number of data points available for the Amargosa HU for sample years 2002 through 2005. The Amargosa HU has a total of 95 data points that are comparable to CTR Human Health criteria, with no observed exceedances. The (-) symbol indicates that no samples were collected.

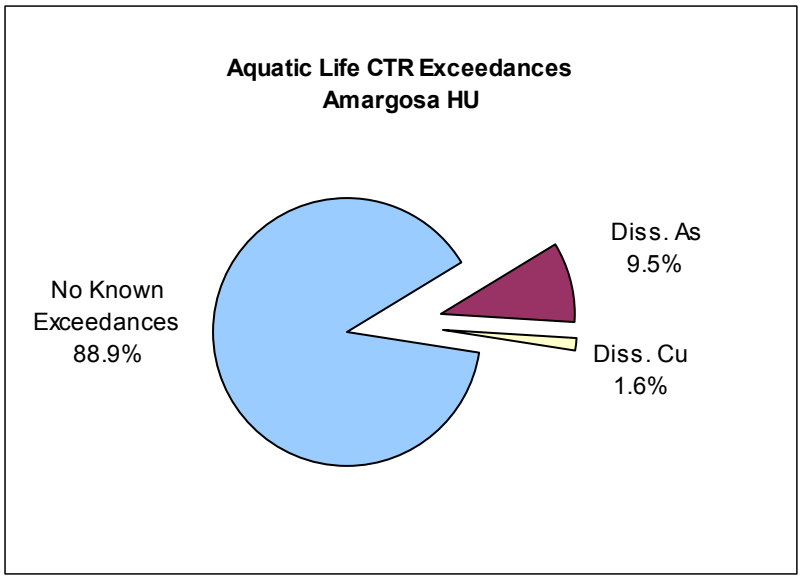

Figure 17. Comparison of CTR Aquatic Life Criteria to Results for the Amargosa HU

Exceedances of the CTR criteria for Aquatic Life were approximately 11 percent overall, with 9.5 percent attributed to dissolved arsenic (As) and 1.6 percent attributed to dissolved copper (Cu).

Table 28. Comparison of CTR Aquatic Life Criteria to Results for the Amargosa HU

Station Name (Site Tag)	Diss. As	Diss. Cd	Cr (III)	Cr (VI)	Diss. Cu	Diss. Pb	Diss. Ni	Total Se	Diss. Ag	Diss. Zn	Total Number of Data Points
Amargosa River at Tecopa gage 609AMR003	2/2	0/2	-	-	1/2	0/2	0/2	0/1	0/2	0/2	15
Amargosa River at Upper Canyon 609AMR002	2/2	0/2	-	-	0/2	0/2	0/2	0/2	0/2	0/2	16
Amargosa River below Willow Creek 609AMR001	2/2	0/2	-	-	0/2	0/2	0/2	0/2	0/2	0/2	16
Mesquite Springs 609MSQ001	0/2	0/2	-	-	0/2	0/2	0/2	0/2	0/2	0/2	16
Total Exceedances	6	0	-	-	1	0	0	0	0	0	7/ 63

The table above presents a compilation of the total number of exceedances of CTR Aquatic Life criteria versus the total number of data points available for the Amargosa HU for sample years 2002 through 2005. The Amargosa HU has a total of 63 data points that are comparable to CTR Aquatic Life criteria, with 7 exceedances. The (-) symbol indicates that no samples were collected.

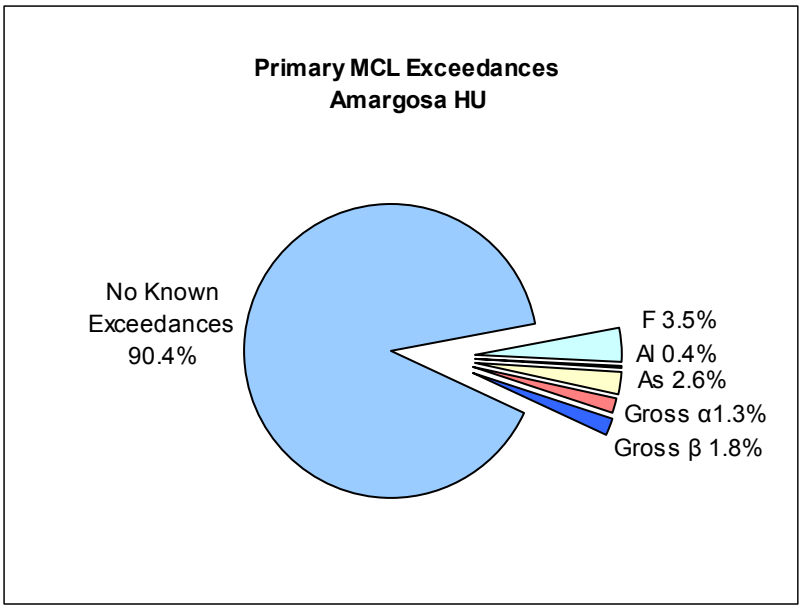

Figure 18. Comparison of Primary MCL Criteria to Results for the Amargosa HU

For the Amargosa HU, exceedances of California Primary MCL criteria were 9.6 percent of the results, with 3.5 percent attributed to fluoride (F), 2.6 percent to arsenic (As), 1.8 percent to gross βeta radiation (Gross β), 1.3 percent to gross Alpha radiation (Gross α), and 0.4 percent to aluminum (Al).

Table 29. Comparison of Primary MCL Criteria to Results for the Amargosa HU

Station Name (Site Tag)	F	NO_3	Al	Sb	As	Be	Cd	Cr	Cu	Pb	Ni	Hg	Se	Tl	U	Gross α	Gross β	Organics	Total Number of Data Points
Amargosa River at Tecopa 609AMR003	2/2	0/2	1/2	0/2	2/2	0/2	0/2	0/2	0/2	0/2	0/2	0/2	0/1	0/2	-	1/2	2/2	0/35	66
Amargosa River Upper Canyon 609AMR002	2/2	0/2	0/2	0/2	2/2	0/2	0/2	0/2	0/2	0/2	0/2	0/2	0/2	0/2	-	1/2	1/2	0/35	67
Amargosa River below Willow Creek 609AMR001	2/2	0/2	0/2	0/2	2/2	0/2	0/2	0/2	0/2	0/2	0/2	0/2	0/2	0/2	-	1/2	1/2	0/35	67
Mesquite Springs 609MSQ001	2/2	0/2	0/2	0/2	0/2	0/2	0/2	0/2	0/2	0/2	0/2	-	0/2	0/2	0/2	-	-	-	28
Total Exceedances	8	0	1	0	6	0	0	0	0	0	0	0	0	0	0	3	4	0	22 / 228

The table above presents a compilation of the total number of exceedances of California Primary MCL criteria versus the total number of data points available for the Amargosa HU for sample years 2002 through 2005. The Amargosa HU has a total of 228 data points that are comparable to California Primary MCLs, with 22 exceedances. The (-) symbol indicates that no samples were collected.

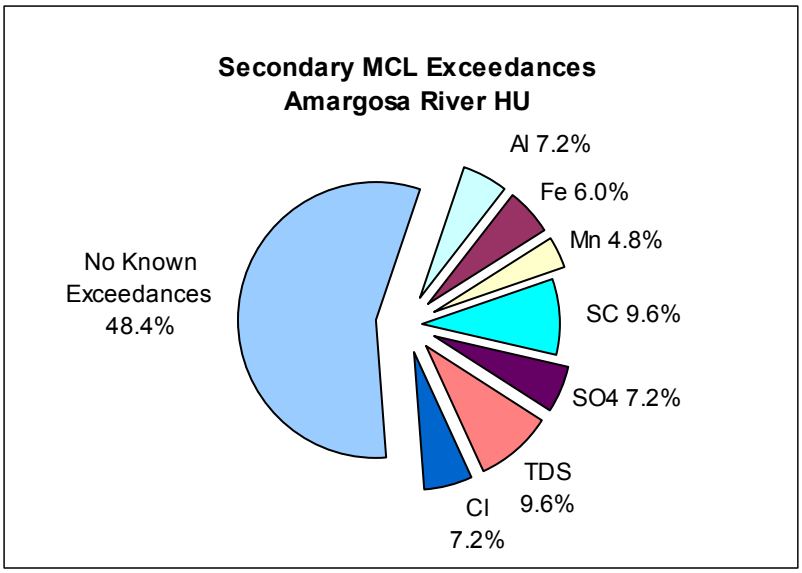

Figure 19. Comparison of Secondary MCL Criteria to Results for the Amargosa HU

For the Amargosa HU, exceedances of California Secondary MCL criteria are approximately 52 percent of the results, with 9.6 percent (each) attributed to specific conductance (SC) and total dissolved solids (TDS); 7.2 percent (each) to aluminum (Al), chloride (Cl), and sulfate (SO_4); 6.0 percent to iron (Fe); and 4.8 percent to manganese (Mn).

Table 30. Comparison of Secondary MCL Criteria to Results for the Amargosa HU

Station Name (Site Tag)	Al	Cu	Fe	Mn	Ag	Zn	SC	SO_4	TDS	Cl	Organics	Total Number of Data Points
Amargosa River at Tecopa gage 609AMR003	2/2	0/2	2/2	1/2	0/2	0/2	2/2	2/2	2/2	2/2	0/1	21
Amargosa River at Upper Canyon 609AMR002	2/2	0/2	1/2	1/2	0/2	0/2	2/2	2/2	2/2	2/2	0/1	21
Amargosa River below Willow Cr 609AMR001	2/2	0/2	2/2	2/2	0/2	0/2	2/2	2/2	2/2	2/2	0/1	21
Mesquite Springs 609MSQ001	0/2	0/2	0/2	0/2	0/2	0/2	2/2	0/2	2/2	0/2	-	20
Total Exceedances	6	0	5	4	0	0	8	6	8	6	0	43 / 83

The table above presents a compilation of the total number of exceedances of California Secondary MCL criteria versus the total number of data points available for the Amargosa HU for sample years 2002 through 2005. The Amargosa HU has a total of 83 data points that are comparable to California Secondary MCLs, with 43 exceedances. The (-) symbol indicates that no samples were collected.

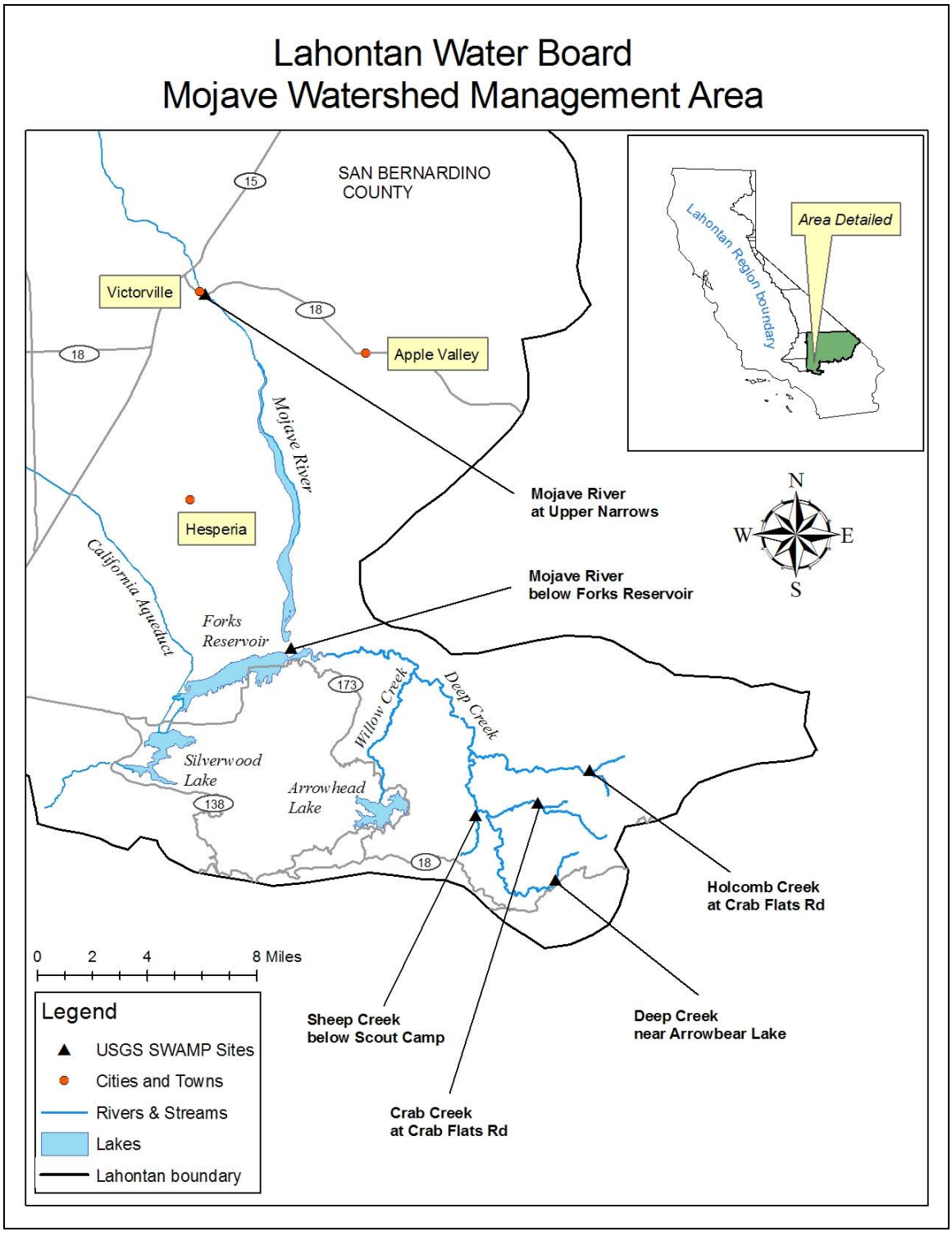

Figure 20. Sample Locations in the Mojave Watershed Management Area

Mojave Watershed Management Area (WMA)

One hydrologic unit was sampled within the Mojave WMA[49]: the Mojave Hydrologic Unit. The sample locations are depicted in Figure 20.

Mojave Hydrologic Unit (HU)

Six locations were sampled within the Mojave HU, including two sites on the main stem of the Mojave River (e.g., Upper Narrows, below Forks Reservoir), and four sites in the San Bernardino Mountains area (e.g., Crab Creek at Crab Flats Road, Holcomb Creek near Crab Flats, Deep Creek near Arrowbear Lake, Sheep Creek below Arrowhead Scout Camp). Samples were collected between one and four times per year from July 2001 to July 2005.

Basin Plan Criteria—Mojave HU

For the Mojave HU there were 1,348 values comparable to Basin Plan criteria, with a total of 65 potential exceedances, resulting in a potential exceedance rate of about five percent. (See Figure 21, and Table 31.) Potential exceedances were observed for: total dissolved solids (TDS), sulfate (SO_4), fluoride (F), chloride (Cl), dissolved oxygen (DO), pH, and boron (B).

Potential exceedances for TDS were observed at Crab Creek, Holcomb Creek and Sheep Creek in all years from 2001 through 2005, and at Deep Creek in four out of the five years.[50] Specifically, at Crab Creek, annual average TDS values for 2001–2005 were 176, 139, 120, 131, and 90 mg/L, respectively, compared to the Basin Plan criterion of 83 mg/L. At Holcomb Creek, annual average TDS values for 2001–2005 were 189, 184, 156, 161, and 87 mg/L, respectively, compared to the Basin Plan criterion of 83 mg/L. At Sheep Creek, annual average TDS values for 2001–2005 were 132, 139, 148, 174, and 112 mg/L, respectively, compared to the Basin Plan criterion of 56 mg/L. And at Deep Creek, annual average TDS values for 2001–2005 were 159, 112, 93, 112, and 80 mg/L, respectively, compared to the Basin Plan criterion of 83 mg/L.

It is important to note that the annual averages reported for TDS at the four Mojave River headwater streams are comprised of only one to four samples each, and therefore may not accurately reflect true average conditions.[51] Unless additional data are available from other sources, more sampling may be needed to accurately characterize average TDS concentrations at these sites. In addition to the apparently consistent exceedances of the Basin Plan's annual average TDS objectives, the "overall" averages of all TDS results for each site also suggest that TDS may be a significant issue that warrants further investigation. Specifically, for the entire period from 2001–2005, the averages of all TDS values for Crab (n = 11), Holcomb (n = 13), and Deep (n = 12) creeks were 128, 158, and

[49] The Mojave Watershed Management Area is described in Chapter 2 of this report.

[50] The two sites on the main stem of the Mojave River were not sampled for TDS.

[51] The low sample size at these sites is partly due to the ephemeral nature of these streams. While each site was visited on a quarterly basis, they were sometimes found to be dry, and were therefore often sampled less than four times per year.

107 mg/L respectively, compared to the Basin Plan's annual average objective of 83 mg/L. And at Sheep Creek (n = 12), the average of all TDS values for 2001–2005 was 143 mg/L, compared to the Basin Plan's annual average objective of 56 mg/L.

Potential exceedances for sulfate (SO_4) were also relatively common at four of the six sites (i.e., Holcomb Creek, Sheep Creek, and both Mojave River sites). Specifically, at Holcomb Creek, potential exceedances were observed in four out of five years, with annual average SO_4 values for 2001–2005 of 1.9, 2.1, 1.7, 2.5, and 0.2 mg/L, respectively, compared to the Basin Plan objective of 1.3 mg/L. At Sheep Creek, potential exceedances were observed in two out of five years, with annual average SO_4 values for 2001–2005 of 1.4, 3.7, 7.5, 3.4, and 2.5 mg/L, respectively, compared to the Basin Plan objective of 3.4 mg/L. At the Mojave River below Forks Reservoir, potential exceedances were observed in three out of five years, with annual average SO_4 values for 2001–2005 of 95, 37, 61, 25, and 14 mg/L, respectively, compared to the Basin Plan objective of 35 mg/L. And at the Mojave River at Upper Narrows, potential exceedances were observed in all five years, with annual average SO_4 values for 2001–2005 of 49, 47, 47, 43, and 54 mg/L, respectively, compared to the Basin Plan objective of 40 mg/L.

It is important to note that the annual averages reported for SO_4 are comprised of only two to four samples each, and therefore may not accurately reflect true average conditions. Unless additional data are available from other sources, more sampling may be needed to accurately characterize average SO_4 concentrations at these sites. In addition to the relatively frequent potential exceedances of the Basin Plan's annual average SO_4 objectives, the "overall" averages of all SO_4 results for each site also suggest that SO_4 may be a significant issue that warrants further investigation. Specifically, for the entire period from 2001–2005, the average of all SO_4 values for Holcomb Creek (n = 13) was 1.8 mg/L, compared to the Basin Plan's annual average objective of 1.3 mg/L. For Sheep Creek, the average of all SO_4 values (n = 12) was 3.7 mg/L, compared to the Basin Plan's annual average objective of 3.4 mg/L. For the Mojave River below Forks Reservoir, the average of all SO_4 values (n = 15) was approximately 43 mg/L, compared to the Basin Plan's annual average objective of 35 mg/L. And for the Mojave River at Upper Narrows, the average of all SO_4 values (n = 15) was approximately 47 mg/L, compared to the Basin Plan's annual average objective of 40 mg/L.

Potential exceedances for fluoride (F) were observed at three sites (e.g., Holcomb Creek, Mojave River below Forks Reservoir, Mojave River at Upper Narrows). Specifically, at Holcomb Creek, potential exceedances were observed in three out of four years sampled, with annual average F values for 2001 of 4.3 mg/L, and for 2003–2005 of 2.3, 1.0, and 0.1 mg/L, respectively, compared to the Basin Plan objective of 0.1 mg/L. (No samples were collected for F at Holcomb Creek in 2002.) At the Mojave River below Forks Reservoir, potential exceedances were observed in four out of five years, with annual average F values for 2001–2005 of 4.6, 2.8, 2.6, 1.8, and 0.7 mg/L, respectively, compared to the Basin Plan objective of 1.5 mg/L. And at the Mojave River at Upper Narrows, potential exceedances were observed in all five years, with annual average F values for 2001–2005 of 0.50, 0.42, 0.46, 0.45, and 0.35 mg/L, respectively, compared to the Basin Plan objective of 0.2 mg/L.

It is important to note that the annual averages reported for fluoride (F) are comprised of only two to four samples each, and therefore may not accurately reflect true average conditions. Unless additional data are available from other sources, more sampling may be needed to accurately characterize average F concentrations at these sites. In addition to the relatively frequent potential exceedances of the Basin Plan's annual average objectives for F at these three sites, the "overall" averages of all F results for each site also suggest that F may be a significant issue that warrants further investigation. Specifically, for the entire period from 2001–2005, the average of all F values for Holcomb Creek (n = 10) was approximately 1.9 mg/L, compared to the Basin Plan's annual average objective of 0.1 mg/L. For the Mojave River below Forks Reservoir, the average of all F values (n = 14) was approximately 2.4 mg/L, compared to the Basin Plan's annual average objective of 1.5 mg/L. And for the Mojave River at Upper Narrows, the average of all F values (n = 14) was approximately 0.4 mg/L, compared to the Basin Plan's annual average objective of 0.2 mg/L.

Potential exceedances for chloride (Cl) were observed at two of the headwater stream sites (i.e., Deep Creek and Sheep Creek). Specifically, at Deep Creek, potential exceedances were observed in four out of five years, with annual average Cl values for 2001–2005 of 28.9, 19.6, 11.8, 17.6, and 5.3 mg/L, respectively, compared to the Basin Plan objective of 9.1 mg/L. At Sheep Creek, potential exceedances were also observed in four out of five years, with annual average Cl values for 2001–2005 of 7.4, 19.8, 25.3, 17.2, and 5.3 mg/L, respectively, compared to the Basin Plan objective of 6.0 mg/L.

It is important to note that the annual averages reported for chloride (Cl) are comprised of only one to four samples each, and therefore may not accurately reflect true average conditions. Unless additional data are available from other sources, more sampling may be needed to accurately characterize average Cl concentrations at these sites. In addition to the relatively frequent potential exceedances of the Basin Plan's annual average objectives for Cl at these two sites, the "overall" averages of all Cl results for each site also suggest that Cl may be a significant issue that warrants further investigation. Specifically, for the entire period from 2001–2005, the average of all Cl values for Deep Creek (n = 12) was approximately 16 mg/L, compared to the Basin Plan's annual average objective of 9.1 mg/L. And for Sheep Creek, the average of all Cl values (n = 12) was approximately 15.6 mg/L, compared to the Basin Plan's annual average objective of 6.0 mg/L.

Potential exceedances for dissolved oxygen (DO) were observed at four of the six sites within the Mojave HU (i.e., Crab, Deep, and Sheep creeks, and the Mojave River at Upper Narrows), primarily during the hot summer months. The designated beneficial uses for Crab Creek include SPWN (Spawning, Reproduction, and Development), and therefore the Basin Plan's instantaneous DO objective for Crab Creek is a minimum of 8.0 mg/L. At Crab Creek, three of ten measurements documented DO concentrations below the 8 mg/L minimum (potential exceedances = 6.7, 7.2, and 7.8 mg/L, on 7/18/01, 6/18/03, and 7/27/05, respectively). All of the other five sites sampled in the Mojave HU are designated for COLD beneficial uses (i.e., Cold Freshwater Habitat), but not for

SPWN, and therefore the DO objective for those sites is a minimum of 4.0 mg/L. At Deep Creek, one of eleven measurements documented a DO concentration below the 4 mg/L minimum (potential exceedance = 3.3 mg/L on 7/18/01). At Sheep Creek, one of ten measurements documented a DO concentration below the 4 mg/L minimum (potential exceedance = 3.7 mg/L on 2/5/02). And at the Mojave River at Upper Narrows, two of 14 measurements documented DO concentrations below the 4 mg/L minimum (potential exceedances = 3.8 and 2.5 mg/L, on 6/19/03 and 7/22/04, respectively).[52] All DO measurements were taken on-site at the time of water sampling; no continuous (i.e., time series) data were collected. Because of the naturally wide diurnal and seasonal fluctuations in DO concentration, these results should not be considered conclusive. More frequent sampling would be needed to accurately characterize DO concentrations at these sites.

Potential exceedances for pH were observed at two sites (i.e., Deep Creek and the Mojave River below Forks Reservoir). Specifically, at Deep Creek, two of 12 measurements documented pH concentrations below the Basin Plan's target range of 6.5–8.5 (potential exceedances = 6.3 and 6.4 pH units on 12/11/02 and 4/20/05, respectively). And at the Mojave River below Forks Reservoir, two of 15 measurements documented pH concentrations above the Basin Plan's target range of 6.5–8.5 (potential exceedances = 8.6 and 8.9 pH units on 8/27/02 and 7/21/04, respectively). The Basin Plan acknowledges that some waters of the Region may have natural pH levels outside of the 6.5 to 8.5 range. Further investigation would be needed to accurately characterize ambient pH levels at these sites.

One potential exceedance was observed for boron (B). Specifically, at the Mojave River below Forks Reservoir, the annual average for B during 2001 was 261 µg/L, compared to the Basin Plan's objective of 200 µg/L. However, the annual average value for 2001 is based on only two samples, and is probably not an accurate representation of average conditions. The two samples were collected in July and October (the dry summer/fall season). For other years, when just three or four samples were collected, evenly spaced throughout the calendar year, the B objective was met at this site. Further, all of the other sites in the Mojave HU were in compliance with the applicable B objectives. The weight of evidence indicates that boron is not a significant issue at the Mojave River or its headwater streams.

California Toxics Rule (CTR) Criteria—Mojave HU

At the two main-stem Mojave River sites, a suite of organic constituents was monitored from 2001 through 2005. No exceedances of the CTR Human Health criteria were found. (See Table 32.) Due to funding limitations, metals were not monitored at the Mojave River sites, and no organics or metals were monitored at Crab, Holcomb, Deep, or Sheep creeks.

[52] All DO measurements at Holcomb Creek (n = 12) and the Mojave River below Forks Reservoir (n = 14) indicated compliance with the 4 mg/L objective for waters designated COLD.

California Toxics Rule (CTR) Aquatic Life—Mojave HU

Due to funding limitations, metal constituents were not monitored at the Mojave HU. Therefore, no comparison to the CTR Aquatic Life criteria can be made.

Drinking Water (MCL) Criteria—Mojave HU

Sample results for the Mojave HU were compared to relevant California MCL criteria for chloride (Cl), fluoride (F), nitrate (NO_3), specific conductance (SC), sulfate (SO_4), total dissolved solids (TDS), and organic constituents. (See Figure 22, and Tables 33 and 34.) Fluoride (F) exceeded the California Primary MCL at Holcomb Creek and at the Mojave River below Forks Reservoir. All other results indicated compliance with California MCLs.

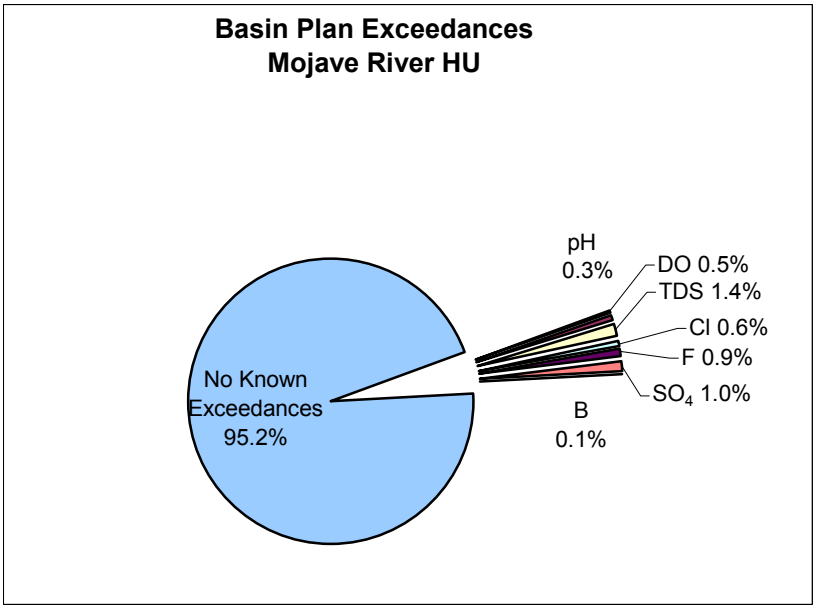

Figure 21. Comparison of Basin Plan Criteria to Results for the Mojave HU

For the Mojave HU, potential exceedances of Basin Plan objectives were 4.8 percent of the results, with 1.4 percent attributed to total dissolved solids (TDS), 1 percent to sulfate (SO_4), 0.9 percent to fluoride (F), 0.6 percent to chloride (Cl), 0.5 percent to dissolved oxygen (DO), 0.3 percent to pH, and 0.1 percent to boron (B).

Table 31. Comparison of Basin Plan Criteria to Results for the Mojave HU

Station Name (Site Tag)	pH	DO	TDS	FC	Cl	F	SO_4	B	NO_3	TN	PO_4	Pesticides	Total Number of Data Points
Crab Creek at Crab Flats Rd. 628CRB001	0/11	3/10	5/5	-	0/5	0/4	0/5	0/4	0/5	0/5	0/4	-	58
Holcomb Creek at Crab Flats Rd. 628HOL001	0/13	0/12	5/5	-	0/5	3/4	4/5	0/4	0/5	0/5	0/4	-	62
Deep Creek near Arrowbear Lake 628DEP001	2/12	1/11	4/5	-	4/5	0/4	0/5	0/4	0/5	0/5	0/4	-	60
Sheep Creek below Scout Camp 628SHP001	0/11	1/10	5/5	-	4/5	0/4	2/5	0/5	0/5	NA	NA	-	50
Mojave River below Forks Reservoir 628MOJ002	2/15	0/14	NA	-	0/5	4/5	3/5	1/5	NA	NA	NA	0/510	559
Mojave River Upper Narrows 628MOJ001	0/15	2/14	NA	-	0/5	5/5	5/5	0/5	NA	NA	NA	0/510	559
Total Potential Exceedances	4	7	19	-	8	12	14	1	0	0	0	0	65 / 1,348

The table above presents a compilation of the total number of potential exceedances of Basin Plan objectives versus the total number of data points available for the Mojave HU for sample years 2001 through 2005. The Mojave HU has a total of 1,348 data points that are comparable to Basin Plan objectives, with 65 potential exceedances. The (-) symbol indicates that no samples were collected. "NA" indicates that there is no numeric objective in the Basin Plan for this constituent.

Table 32. Comparison of CTR Human Health Criteria to Results for the Mojave HU

Station Name (Site Tag)	Total Sb	Total Cu	Total Ni	Total Hg	Total Tl	Organics	Total Number of Data Points
Crab Creek at Crab Flats Rd. 628CRB001	-	-	-	-	-	-	0
Holcomb Creek at Crab Flats Rd. 628HOL001	-	-	-	-	-	-	0
Deep Creek near Arrowbear Lake 628DEP001	-	-	-	-	-	-	0
Sheep Creek below Scout Camp 628SHP001	-	-	-	-	-	-	0
Mojave River below Forks Reservoir 628MOJ002	-	-	-	-	-	0/285	285
Mojave River Upper Narrows 628MOJ001	-	-	-	-	-	0/285	285
Total Exceedances	0	0	0	0	0	0	0 / 570

The table above presents a compilation of the total number of exceedances of the CTR Human Health criteria for the Mojave HU for sample years 2001 through 2005. The Mojave HU has a total of 570 data points that are comparable to CTR Human Health criteria, with no observed exceedances. The (-) symbol indicates that no samples were collected.

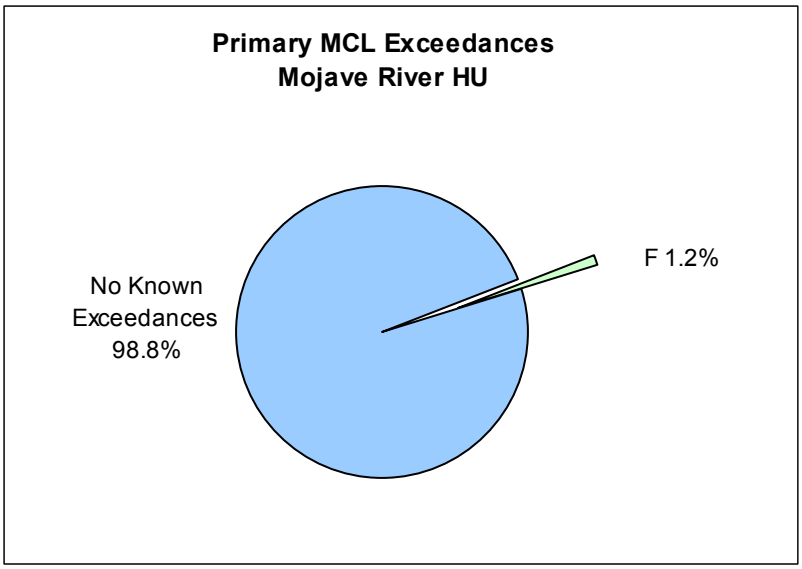

Figure 22. Comparison of Primary MCL Criteria to Results for the Mojave HU

For the Mojave HU, exceedances of California Primary MCL criteria were about 1.2 percent of the results, with all 1.2 percent attributed to fluoride (F).

Table 33. Comparison of Primary MCL Criteria to Results for the Mojave HU

Station Name (Site Tag)	F	NO_3	Al	Sb	As	Be	Cd	Cr	Cu	Pb	Ni	Hg	Se	Tl	U	Organics	Total Number of Data Points
Crab Creek at Crab Flats Rd 628CRB001	0/8	0/11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	19
Holcomb Creek at Crab Flats Rd 628HOL001	3/10	0/13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	23
Deep Creek near Arrowbear Lake 628DEP001	0/9	0/12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	21
Sheep Creek blw Scout Camp 628SHP001	0/9	0/12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	21
Mojave River below Forks Reservoir 628MOJ002	9/14	0/15	-	-	-	-	-	-	-	-	-	-	-	-	-	0/420	449
Mojave River Upper Narrows 628MOJ001	0/14	0/15	-	-	-	-	-	-	-	-	-	-	-	-	-	0/420	449
Total Exceedances	12	0	-	-	-	-	-	-	-	-	-	-	-	-	-	0	12 / 982

The table above presents a compilation of the total number of exceedances of California Primary MCL criteria for the Mojave HU for sample years 2001 through 2005. The Mojave HU has a total of 982 data points that are comparable to California Primary MCLs, with 12 exceedances. The (-) symbol indicates that no samples were collected.

Table 34. Comparison of Secondary MCL Criteria to Results for the Mojave HU

Station Name (Site Tag)	Al	Cu	Fe	Mn	Ag	Zn	SC	SO_4	TDS	Cl	Organics	Total Number of Data Points
Crab Creek at Crab Flats Rd 628CRB001	-	-	-	-	-	-	0/10	0/11	0/11	0/11	-	43
Holcomb Creek at Crab Flats Rd 628HOL001	-	-	-	-	-	-	0/12	0/13	0/13	0/13	-	51
Deep Creek near Arrowbear Lake 628DEP001	-	-	-	-	-	-	0/11	0/12	0/12	0/12	-	47
Sheep Creek blw Scout Camp 628SHP001	-	-	-	-	-	-	0/11	0/12	0/12	0/12	-	47
Mojave River below Forks Reservoir 628MOJ002	-	-	-	-	-	-	0/15	0/15	0/15	0/15	0/15	75
Mojave River Upper Narrows 628MOJ001	-	-	-	-	-	-	0/15	0/15	0/15	0/15	0/15	75
Total Exceedances	-	-	-	-	-	-	0	0	0	0	0	0 / 338

The table above presents a compilation of the total number of exceedances of California Secondary MCL criteria for the Mojave HU for sample years 2001 through 2005. Parameters measured include: specific conductance (SC), sulfate (SO_4), total dissolved solids (TDS), and chloride (Cl). The Mojave HU has a total of 338 data points that are comparable to California Secondary MCLs, with no observed exceedances. The (-) symbol indicates that no samples were collected.

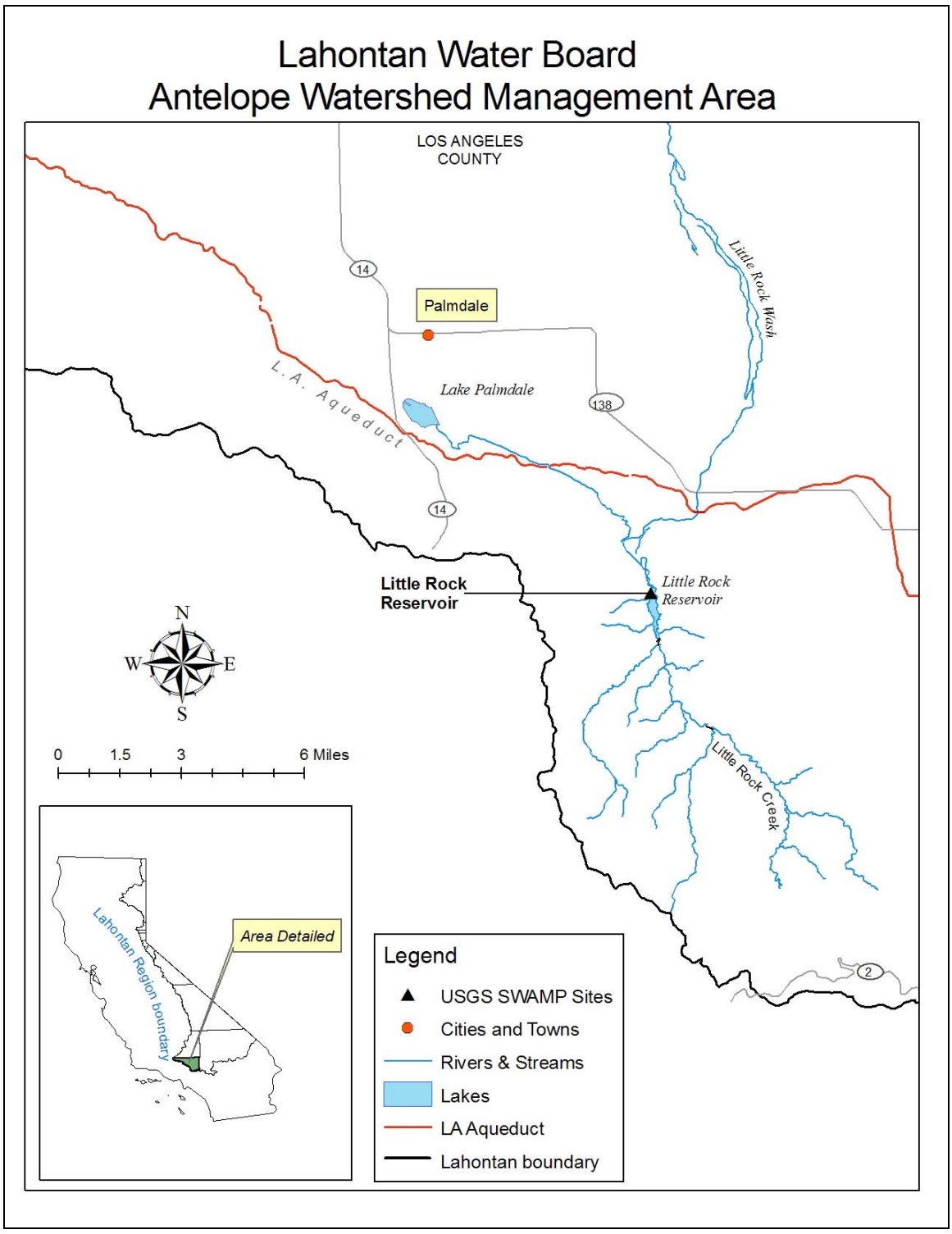

Figure 23. Sample Locations in the Antelope Watershed Management Area

Antelope Valley / Other Southern Watershed Management Area (WMA)

One hydrologic unit was sampled within the Antelope Valley/Other Southern WMA[53]: the Antelope Hydrologic Unit.

Antelope Hydrologic Unit (HU)

One site was sampled within the Antelope HU: Little Rock Reservoir. The lake was sampled a total of four times (in October 2001, May 2002, October 2002, and March 2003). It was intended that the lake would be sampled twice during the autumn months and twice during the spring months, when the lake would have the highest likelihood of being "mixed" (i.e., not thermally stratified). The sampling plan specified that when visited, if the lake was mixed, a single sample would be collected at one meter below the surface, and if the lake was thermally stratified, samples were collected at three discrete depths (i.e., one meter below the water surface, one meter above the lake bottom, and mid-column). Samples were collected for conventional analytes, nutrients, and some metal constituents (e.g., iron, manganese). In addition, depth profiles were measured at 1-meter increments for several parameters (i.e., temperature, dissolved oxygen, specific conductance, and pH). All data are available through the Lahontan Water Board's public website: http://www.waterboards.ca.gov/lahontan/water_issues/programs/swamp/index.shtml#data.

When visited in October 2001, the lake was shallow, and not thermally stratified; one sample was collected. When visited in May 2002, the lake was thermally stratified, and three samples were collected. In October 2002, the lake was mixed, and one sample was collected. In 2003, the lake was visited earlier in the spring (i.e., in March), but was again thermally stratified; three samples were collected.

Basin Plan Criteria—Antelope HU

For the Antelope HU there were 108 values comparable to Basin Plan criteria, with a total of 22 potential exceedances, resulting in a potential exceedance rate of about twenty percent. (See Figure 24, and Table 35.) Potential exceedances were observed for: dissolved oxygen (DO), boron (B), total dissolved solids (TDS), fluoride (F), and sulfate (SO_4).

As presented in Table 35, pH and dissolved oxygen (DO) were measured a total of 43 times (each) during the four sample events. The reason for the relatively large sample size for these parameters is that the USGS used a probe to collect lake depth profiles (at 1-meter increments) for DO, pH, temperature, and conductivity. While 13 of the 43 discrete DO measurements documented DO concentrations lower than the Basin Plan's applicable minimum criteria of 4.0 mg/L, it is important to note that several of the near-bottom DO measurements were duplicates, and all of the potential exceedances were at or near the bottom of the reservoir, where oxygen depressions are not unexpected. Further, the Basin Plan's DO criteria were derived to achieve intergravel DO concentrations based on literature values for flowing waters, and may not be achievable under natural

[53] The Antelope Valley/Other Southern Watershed Management Area is described in Chapter 2 of this report.

conditions at the bottom of many lakes. While the data indicate that the bottom of Little Rock Reservoir does at times approach or reach anoxia, the extent of the anoxia cannot be determined by this data set. In sum, the limited DO data presented here do not by themselves indicate significant issues.

Annual averages for boron (B) concentration from 2001–2003 were 60, 92, and 32 µg/L, respectively, compared to the Basin Plan objective of 30 µg/L. Annual averages for total dissolved solids (TDS) from 2001–2003 were 414, 343, and 136 mg/L, respectively, compared to the Basin Plan objective of 176 mg/L. Annual averages for fluoride (F) from 2001–2003 were 0.30, 0.40, and 0.17 mg/L, respectively, compared to the Basin Plan objective of 0.29 mg/L. And, annual averages for sulfate (SO_4) from 2001–2003 were 37.3, 36.1, and 13.4 mg/L, respectively, compared to the Basin Plan objective of 16.5 mg/L. However, all of these averages are based on a very limited number of (i.e., only one or two) samples each, and therefore probably do not accurately reflect true average conditions. Unless additional data are available from other sources, further investigation would be needed to accurately characterize ambient levels of B, TDS, F, and SO_4 at Little Rock Reservoir.

California Toxics Rule (CTR) Criteria—Antelope HU

Due to funding limitations, metal and organic constituents were not monitored at the Antelope HU. Therefore, no comparison of the results to the CTRs can be made.

Drinking Water (MCL) Criteria—Antelope HU

A summary of the results compared to the California Primary MCLs and California Secondary MCLs (i.e., drinking water standards) is presented in Tables 36 and 37. In the Antelope HU, all Primary MCL criteria were met where parameters were measured, i.e., for nitrate (NO_3) and fluoride (F) at Little Rock Reservoir. The measured Secondary MCL parameters included: chloride (Cl), iron (Fe), manganese (Mn), specific conductance (SC), sulfate (SO_4), and total dissolved solids (TDS). (See Figure 25). The Secondary MCL criteria were also met, except for manganese (Mn). As expected, Mn concentrations were elevated where oxygen levels were depressed. This is just one example of the water quality issues that can arise where DO is depressed in lakes and reservoirs. However, the observed concentrations of Mn exceed Secondary MCLs only, and are primarily of concern regarding taste and odor (i.e., not human health), and such levels of Mn may be removed via treatment before water is delivered for municipal/domestic uses.

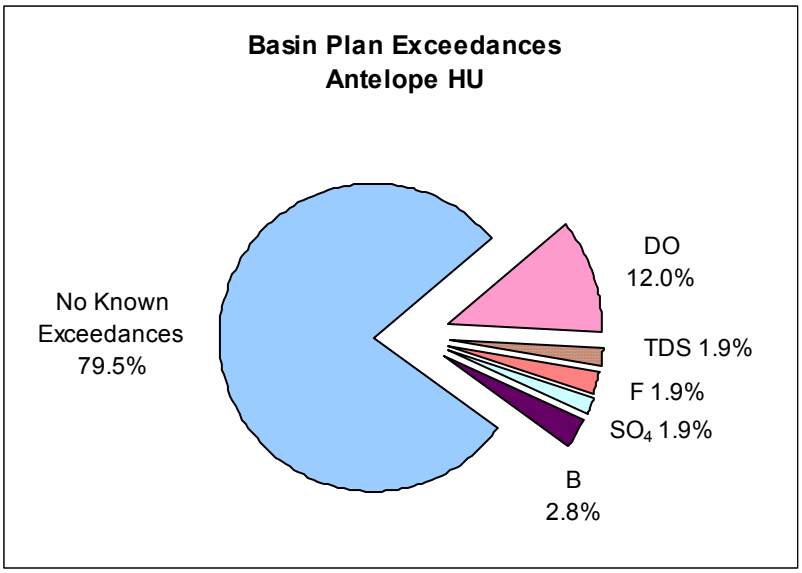

Figure 24. Comparison of Basin Plan Criteria to Results for the Antelope HU

For the Antelope HU, potential exceedances of Basin Plan objectives were 20.4 percent overall, with 12 percent attributed to dissolved oxygen (DO), 2.8 percent to boron (B), and 1.9 percent (each) to total dissolved solids (TDS), fluoride (F), and sulfate (SO_4).

Table 35. Comparison of Basin Plan Criteria to Results for the Antelope HU

Station Name (Site Tag)	pH	DO	TDS	FC	Cl	F	SO_4	B	NO_3	Pesticides	Total Number of Data Points
Little Rock Reservoir 626LRR001	0/43	13/43	2/3	0/4	0/3	2/3	2/3	3/3	0/3	-	108
Total Potential Exceedances	0	13	2	0	0	2	2	3	0	-	22 / 108

The table above presents a compilation of the total number of potential exceedances of Basin Plan objectives versus the total number of data points available for the Antelope HU for sample years 2001 through 2003. The Antelope HU has a total of 108 data points that are comparable to Basin Plan objectives, with 22 potential exceedances. The (-) symbol indicates that no samples were collected.

Table 36. Comparison of Primary MCL Criteria to Results for the Antelope HU

Station Name (Site Tag)	F	NO_3	Al	Sb	As	Be	Cd	Cr	Cu	Pb	Ni	Hg	Se	Tl	U	Organics	Total Number of Data Points
Little Rock Reservoir 626LRR001	0/8	0/8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16
Total Exceedances	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0/16

The table above presents a compilation of the total number of exceedances of California Primary MCL criteria versus the total number of data points available for the Antelope HU for sample years 2001 through 2003. The Antelope HU has a total of 16 data points that are comparable to California Primary MCLs, with no observed exceedances. The (-) symbol indicates that no samples were collected.

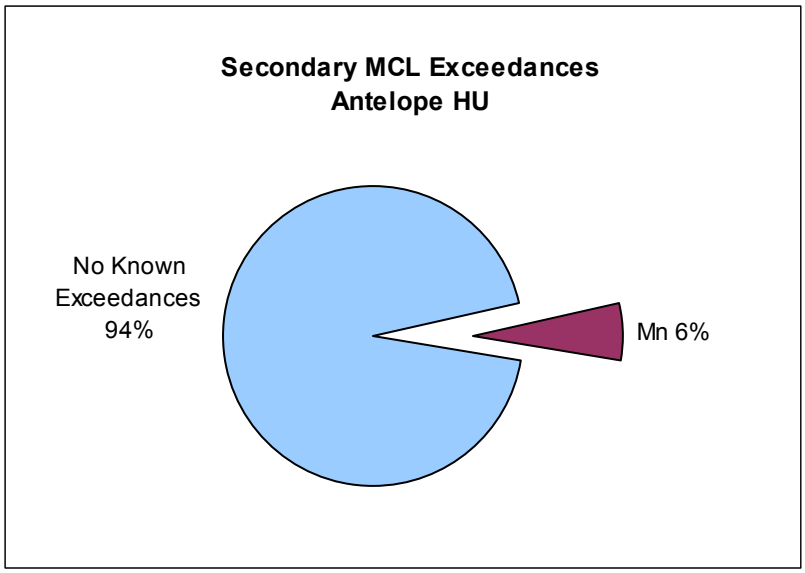

Figure 25. Comparison of Secondary MCL Criteria to Results for the Antelope HU

For the Antelope HU, exceedances of California Secondary MCL criteria were about 6 percent of the results, with all 6 percent attributed to manganese (Mn).

Table 37. Comparison of Secondary MCL Criteria to Results for the Antelope HU

Station Name (Site Tag)	Al	Cu	Fe	Mn	Ag	Zn	SC	SO_4	TDS	Cl	Organics	Total Number of Data Points
Little Rock Reservoir 626LRR001	-	-	0/8	5/8	-	-	0/43	0/8	0/8	0/8	-	83
Total Exceedances	-	-	0	5	-	-	0	0	0	0	-	5 / 83

The table above presents a compilation of the total number of exceedances of California Secondary MCL criteria versus the total number of data points available for the Antelope HU for sample years 2001 through 2003. The Antelope HU has a total of 83 data points that are comparable to California Secondary MCLs, with 5 exceedances. The (-) symbol indicates that no samples were collected.

Region-wide Summary of Hydrologic Unit Results

This section summarizes the results of sampling conducted at the Lahontan Region by the USGS from the creation of the SWAMP program (July 2000) through the end of Water Year 2005 (August 2005). In sum, the USGS data, collected at 30 sites on a quarterly basis over a five-year period, indicate that water quality in the Lahontan Region is generally very good. However, 280 potential exceedances of water quality objectives (as contained in the *Water Quality Control Plan for the Lahontan Region*) have been documented. The available data were assessed, and it has been determined that many of the potential exceedances do not represent significant issues.[54] Remaining issues are being considered along with all other readily available data, as part of the Clean Water Act Section 303(d) "listing process." Where uncertainty exists, further investigation (including additional sampling and analyses) will be performed as funding allows.

The Lahontan Region is unique in that many of the Region's numeric Basin Plan objectives are expressed in terms of annual averages. Because water quality can vary widely over the course of a year (for example, between winter runoff, spring snowmelt, and autumn base flow), annual averages based on small sample sizes may not be representative of true average conditions. Due to funding limitations, the annual averages presented in this report are mostly based on only one to four samples each. The results must be interpreted in this light.

In addition to the small number of samples used to calculate time averages for this study, there are also issues with the water quality objectives themselves. Most numeric water quality objectives for surface waters in the Lahontan Region are based on historic background quality and antidegradation considerations rather than on published criteria for protection of beneficial uses. When the objectives contained in the Lahontan Basin Plan were originally derived (during the early 1970s), sample numbers were very limited. Objectives were in some cases derived using as few as four samples (see State of California 1975, at II-14). Time-averaged objectives based on such small sample sizes may not reflect natural seasonal and annual variation in water quality conditions. Therefore, exceedance of the Basin Plan's time-averaged objectives should not be automatically interpreted as impairment of beneficial uses without additional monitoring to provide site-specific evidence regarding the condition of and support for beneficial uses. Further investigation could lead to revision of applicable water quality standards rather than TMDL development, or other regulatory actions to address exceedance of the numeric objectives.

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[54] For example, the vast majority of the potential exceedances of Basin Plan objectives are related to objectives that are expressed as time averages, and insufficient numbers of samples were collected during this study to derive accurate time-averaged values. This issue is discussed in detail elsewhere in this report. Regarding MCLs, most of the potential exceedances were at the three sites along the Amargosa River. Because of naturally high concentrations of salts and metals, the beneficial uses for Municipal and Domestic Supply (MUN) were removed from the Amargosa River via amendments to the Lahontan Basin Plan. (The amendments were adopted in year 2000 by the Lahontan Regional Water Board, and took effect in 2002, upon approval by the USEPA.) Therefore, the 59 potential exceedances of the MCLs detected at the Amargosa River do not constitute violations of water quality standards, but they are included in this report for informational purposes.

Lahontan Region—All Hydrologic Units (HUs)

The following ten hydrologic units (HUs) were sampled from 2000–2005: Surprise Valley HU, Susanville HU, West Fork Carson River HU, East Fork Carson River HU, West Walker River HU, East Walker River HU, Owens HU, Amargosa HU, Mojave HU, and Antelope HU.

Basin Plan Criteria—Lahontan Region

For the combined total of all results for all HUs, there were 2,579 data points comparable to Basin Plan criteria, with a total of 280 potential exceedances, resulting in a potential exceedance rate of about eleven percent. (See Figure 26, and Table 38.) Potential exceedances were observed for: total dissolved solids (TDS), dissolved oxygen (DO), pH, sulfate (SO_4), chloride (Cl), fluoride (F), boron (B), fecal coliform bacteria (FC), total nitrogen (TN), total phosphorus (TP), total Kjeldahl nitrogen (TKN), ortho-phosphorus (PO_4), and pesticides.

The most frequent potential exceedances of Basin Plan criteria were for TDS and DO. Potential exceedances for TDS appear to be relatively common in all of the Lahontan Region HUs. Of the 86 data points (annual averages) for TDS, there were 76 potential exceedances (Table 38). One key question is whether the annual averages reported here (based on only one to four samples each) accurately represent average conditions. Unless additional data are available from other sources, further investigation may be needed to accurately characterize ambient levels of TDS where potential exceedances have been identified.

Dissolved oxygen may also be a concern at some sites. Of the 305 data points for DO, there are 48 potential exceedances. The East and West Fork Carson rivers, the West Walker River, and the Amargosa River are the only HUs where no potential exceedances of the daily minimum DO criteria were observed.

Potential exceedances for sulfate, pH, and FC were less common than for TDS and DO. The objectives for sulfate are expressed in terms of time averages, and the results will need to be considered on a case-by-case basis, as discussed above. Potential exceedances of the Basin Plan's pH objectives may be a concern at the Amargosa HU, where six out of eight measurements fell outside of the Basin Plan's target range for pH. The data indicate that pH may also be a concern in the Susanville, East Walker, Mojave and Owens HUs. Potential exceedances of the Basin Plan's objectives for fecal coliform bacteria occurred most often in the Owens, Susanville, and Surprise Valley HUs, but the data are inconclusive due to the small number of samples.

Other potential exceedances of Basin Plan objectives were less frequent, but documented for chloride (Cl), fluoride (F), boron (B), total nitrogen (TN), total phosphorus (TP), ortho-phosphorus (PO_4), total Kjeldahl nitrogen (TKN), and pesticides. Potential exceedances for Cl were exhibited in most HUs sampled, excluding the East Fork Carson and Antelope HUs. Potential exceedances for F may be a concern at the Mojave HU and possibly at the Owens and Antelope HUs. Potential exceedances of nutrient objectives

(including TN, TP, TKN and PO_4) were most common at the Susanville, Carson River, and Walker River HUs. There were a few potential exceedances B objectives at the East Fork Carson River, West Walker River, Mojave and Antelope HUs. Only two exceedances of the Basin Plan's pesticide objectives were observed; however, due to funding limitations, eight of the ten HUs reported here were not sampled for pesticides.

California Toxics Rule (CTR) Criteria—Lahontan Region

Overall, exceedances of CTR criteria were rare. (See Figures 27 and 28.) However, the sampling for CTR analytes was not exhaustive. Only a handful of sites throughout the Region were sampled for metal and/or organic constituents. Compilations of the sample results compared to the CTR criteria are presented in Tables 39 and 40.

Drinking Water (MCL) Criteria—Lahontan Region

Summaries of the results compared to the California Primary MCLs and Secondary MCLs (i.e., drinking water standards) are presented below. Exceedances of the Primary MCLs were rare (Figure 29), and were attributed primarily to fluoride (Table 41). Exceedances of the Secondary MCLs were also rare (Figure 30), and were attributed mostly to manganese and iron (Table 42).

Most exceedances of the MCL criteria were at the Amargosa River (i.e., 20 of 34 exceedances of Primary MCLs, and 39 of 74 exceedances of Secondary MCLs were at the Amargosa River sites). Because of naturally high concentrations of salts and metals, the beneficial uses for Municipal and Domestic Supply (MUN) were removed from the Amargosa River via amendments to the Lahontan Basin Plan. (The amendments were adopted in year 2000 by the Lahontan Regional Water Board and took effect in 2002 upon approval by the USEPA.) Therefore, exceedances of the MCLs at the Amargosa River do not constitute violations of water quality standards, but they are included in this report for informational purposes. Mesquite Springs (also located in the Amargosa Hydrologic Unit, but separate from the Amargosa River) has a separate entry in the Basin Plan, and it therefore remains designated for MUN uses.

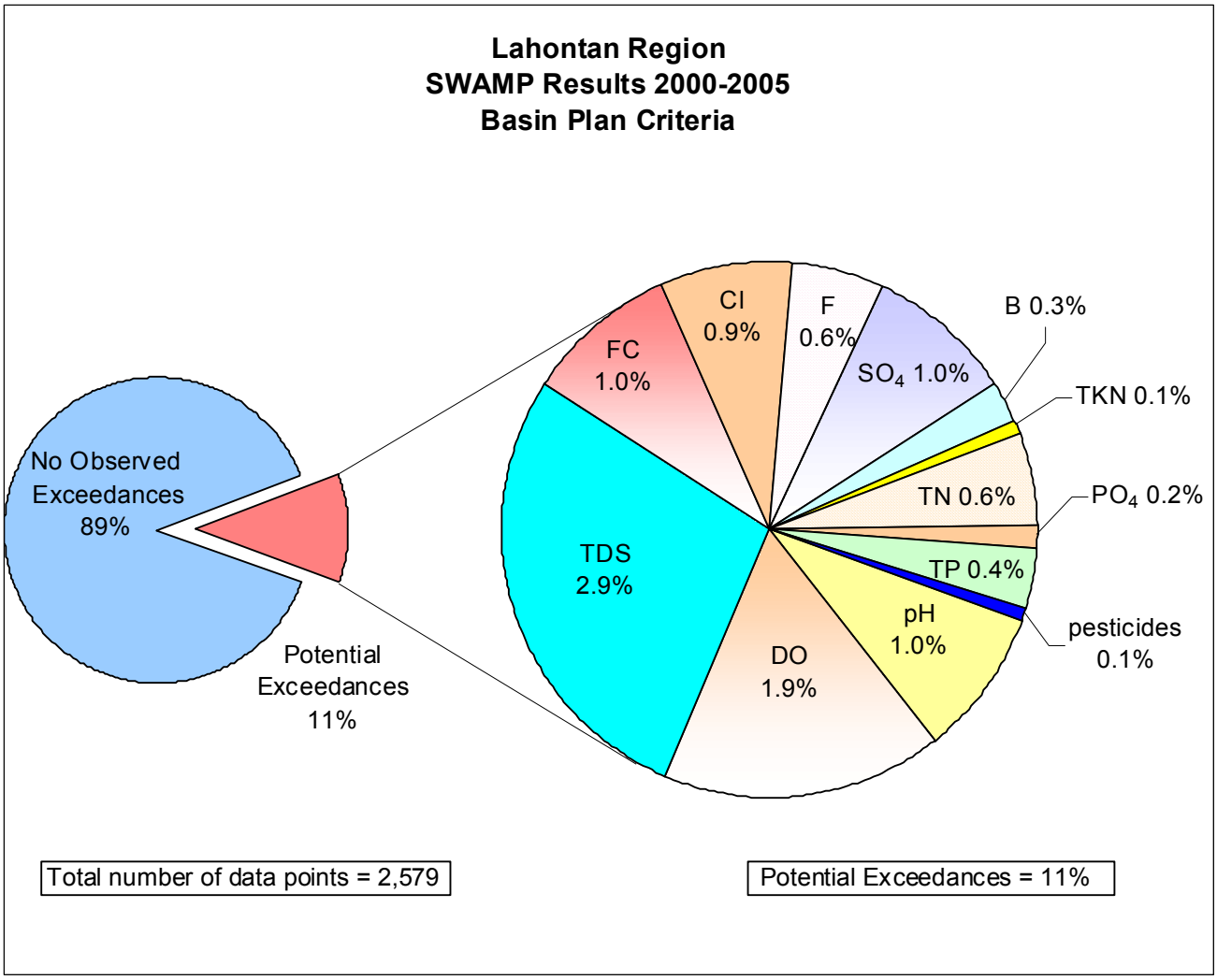

Figure 26. Results for Basin Plan Criteria for the Lahontan Region, 2000–2005

For the Lahontan Region, potential exceedances of Basin Plan objectives were about 11 percent overall, with 2.9 percent attributed to total dissolved solids (TDS); 1.9 percent to dissolved oxygen (DO); 1.0 percent (each) to pH, fecal coliform (FC), and sulfate (SO_4); 0.9 percent to chloride (Cl); 0.6 percent (each) to fluoride (F) and total nitrogen (TN); 0.4 percent to total phosphorus (TP); 0.3 percent to boron (B); 0.2 percent to ortho-phosphorus (PO_4); and 0.1 percent (each) to total Kjeldahl nitrogen (TKN) and pesticides.

Table 38. Results for Basin Plan Criteria for the Lahontan Region, 2000–2005

Hydrologic Unit	pH	DO	TDS	FC	Cl	F	SO_4	B	NO_3	TKN	TN	PO_4	TP	Pesticides	Total Number of Data Points
Surprise Valley HU	0/37	2/28	13/13	8/21	3/13	NA	NA	-	NA	NA	2/12	NA	NA	-	124
Susanville HU	7/31	4/25	10/10	6/16	4/10	NA	-	-	NA	NA	6/10	NA	2/10	-	112
West Fork Carson HU	0/10	0/10	0/3	1/7	3/3	NA	3/3	0/3	0/3	2/3	1/3	NA	1/3	-	51
East Fork Carson HU	0/15	0/14	5/5	1/7	0/4	NA	4/4	2/4	NA	NA	0/5	NA	3/5	-	63
West Walker HU	1/12	0/10	4/4	1/7	2/4	NA	NA	2/4	NA	NA	2/4	NA	4/4	-	49
East Walker HU	6/31	4/20	NA	0/10	NA	NA	NA	NA	NA	NA	5/8	NA	0/8	-	77
Owens HU	2/80	18/76	23/28	8/30	2/28	1/5	2/5	0/6	0/28	NA	0/28	4/24	NA	-	338
Amargosa HU	6/8	0/8	NA	1/5	NA	NA	NA	NA	NA	NA	NA	NA	NA	2/288	309
Mojave HU	3/77	7/71	19/20	-	8/30	12/26	14/30	1/27	0/20	NA	0/15	0/12	NA	0/1020	1348
Antelope HU	0/43	13/43	2/3	0/4	0/3	2/3	2/3	3/3	0/3	NA	NA	NA	NA	-	108
Total Potential Exceedances	26	48	76	26	22	15	25	8	0	2	16	4	10	2	280 / 2,579

The table above presents a compilation of the total number of potential exceedances of Basin Plan objectives versus the total number of data points available for the Lahontan Region for sample years 2000 through 2005. The Lahontan Region has a total of 2,579 data points that are comparable to Basin Plan objectives, with 280 potential exceedances. The (-) symbol indicates that no samples were collected. "NA" indicates that there is no numeric objective in the Basin Plan for this constituent.

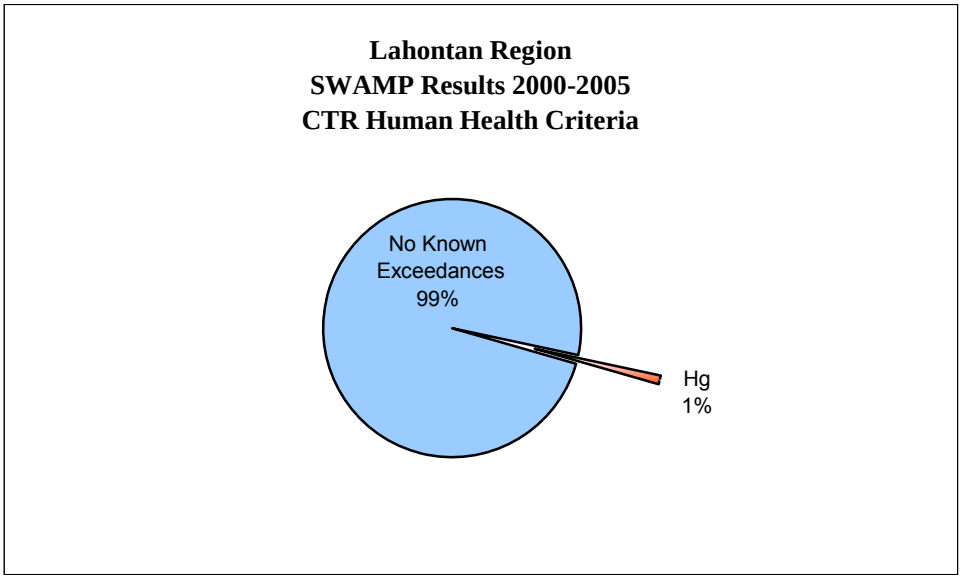

Figure 27. Results for CTR Human Health Criteria for the Lahontan Region, 2000–2005

For the Lahontan Region, exceedances of CTR Human Health criteria were approximately 1 percent of the results, attributed entirely to mercury (Hg) at Mammoth Creek.

Table 39. Results for CTR Human Health Criteria for the Lahontan Region, 2000–2005

Hydrologic Unit	Total Sb	Total Cu	Total Ni	Total Hg	Total Tl	Organics	Total Number of Data Points
Surprise Valley HU	-	-	-	-	-	-	0
Susanville HU	-	-	-	-	-	-	0
West Fork Carson HU	-	-	-	-	-	-	0
East Fork Carson HU	-	-	-	-	-	-	0
West Walker HU	-	-	-	-	-	-	0
East Walker HU	0/4	0/4	0/4	0/4	0/4	-	20
Owens HU	0/38	0/42	0/42	13/42	0/42	-	206
Amargosa HU	0/8	0/8	0/8	0/6	0/8	0/57	95
Mojave HU	-	-	-	-	-	0/570	570
Antelope HU	-	-	-	-	-	-	0
Total Exceedances	0	0	0	13	0	0	13 / 891

The table above presents a compilation of the total number of exceedances of CTR Human Health criteria versus total number of data points available for the Lahontan Region for sample years 2000 through 2005. The Lahontan Region has a total of 891 data points that are comparable to CTR Human Health criteria, with 13 exceedances. The (-) symbol indicates that no samples were collected.

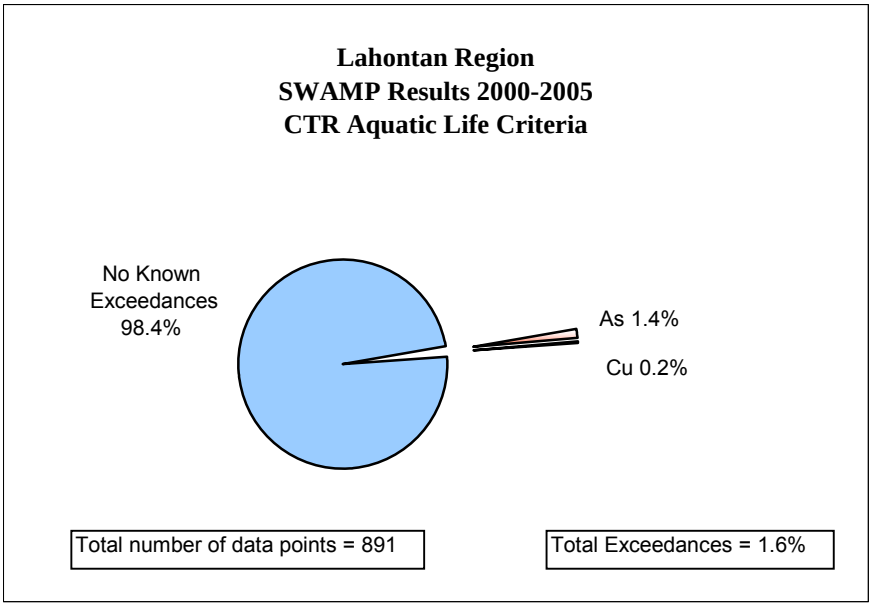

Figure 28. Results for CTR Aquatic Life Criteria for the Lahontan Region, 2000–2005

For the Lahontan Region, exceedances of CTR Aquatic Life criteria were approximately 1.6 percent, with 1.4 percent attributed to arsenic (As), and 0.2 percent to copper (Cu).

Table 40. Results for CTR Aquatic Life Criteria for the Lahontan Region, 2000–2005

Hydrologic Unit	Diss. As	Diss. Cd	Cr (III)	Cr (VI)	Diss. Cu	Diss. Pb	Diss. Ni	Total Se	Diss. Ag	Diss. Zn	Total Number of Data Points
Surprise Valley HU	-	-	-	-	-	-	-	-	-	-	0
Susanville HU	-	-	-	-	-	-	-	-	-	-	0
West Fork Carson HU	0/1	-	-	-	-	-	-	-	-	-	1
East Fork Carson HU	-	-	-	-	-	-	-	-	-	-	0
West Walker HU	-	-	-	-	-	-	-	-	-	-	0
East Walker HU	0/5	0/4	-	-	0/4	0/4	0/4	0/4	0/4	0/4	33
Owens HU	0/46	0/42	-	-	0/42	0/42	0/41	0/42	0/42	0/42	339
Amargosa HU	6/8	0/8	-	-	1/8	0/8	0/8	0/7	0/8	0/8	63
Mojave HU	-	-	-	-	-	-	-	-	-	-	0
Antelope HU	-	-	-	-	-	-	-	-	-	-	0
Total Exceedances	6	0	0	0	1	0	0	0	0	0	7 / 436

The table above presents a compilation of the total number of exceedances of CTR Aquatic Life criteria versus the total number of data points available for the Lahontan Region for sample years 2000 through 2005. The Lahontan Region has a total of 436 data points that are comparable to CTR Aquatic Life criteria, with 7 exceedances. The (-) symbol indicates that no samples were collected.

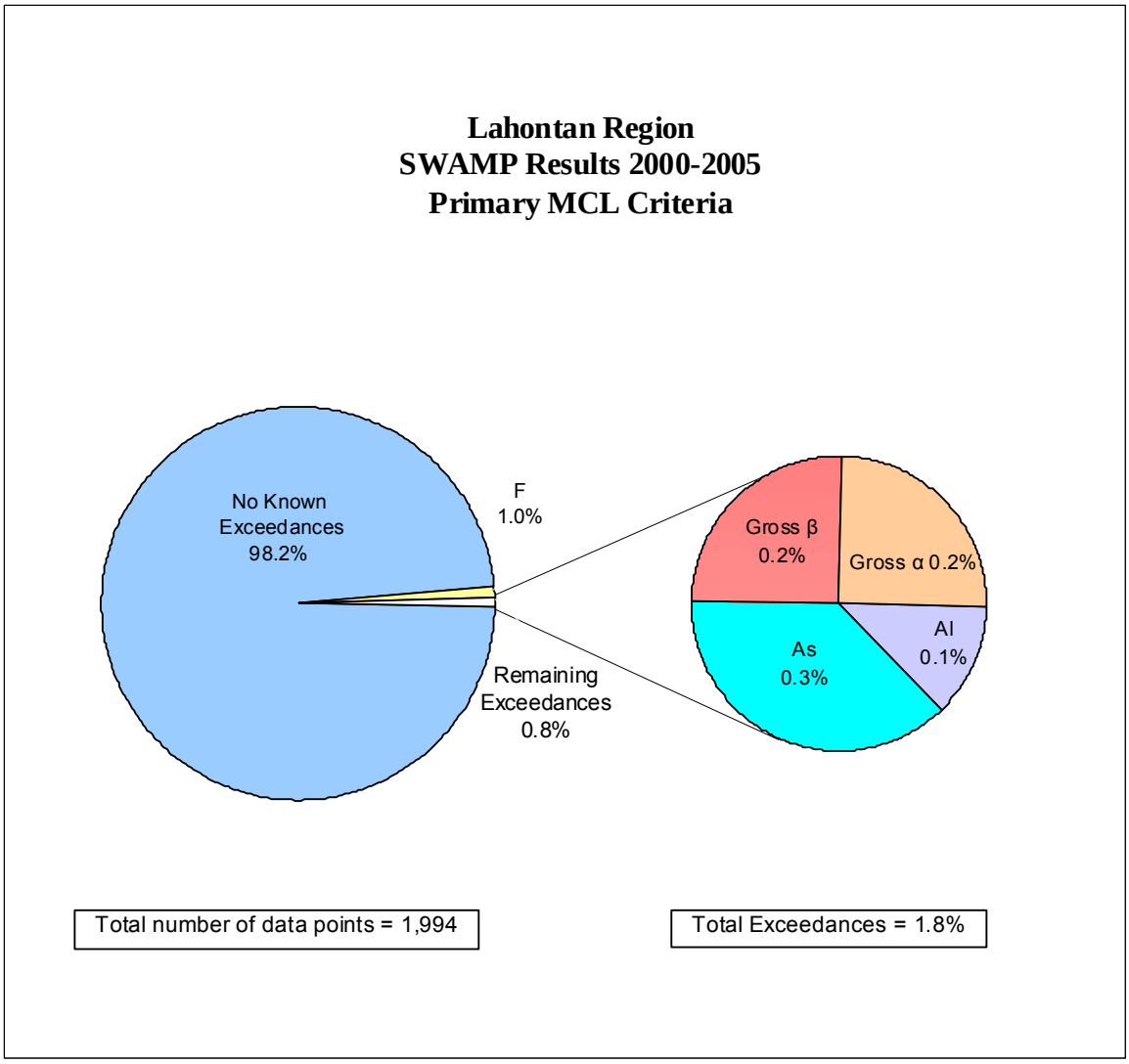

Figure 29. Results for Primary MCL Criteria for the Lahontan Region, 2000–2005

For the Lahontan Region, exceedances of Primary MCL criteria were 1.8 percent, with 1.0 percent attributed to fluoride (F), 0.3 to arsenic (As), and 0.2 percent (each) to gross alpha radiation (Gross α) and gross βeta radiation (Gross β), and 0.1 percent to aluminum (Al).

Table 41. Results for Primary MCL Criteria for the Lahontan Region, 2000–2005

Hydrologic Unit	F	NO_3	Al	Sb	As	Be	Cd	Cr	Cu	Pb	Ni	Hg	Se	Tl	U	Gross α	Gross β	Organics	Total Number of Data Points
Surprise Valley HU	-	0/33	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33
Susanville HU	-	0/32	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	32
West Fork Carson HU	-	0/10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10
East Fork Carson HU	-	0/16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16
West Walker HU	-	0/12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12
East Walker HU	-	0/32	0/4	0/4	0/5	0/4	0/4	0/4	0/4	0/4	0/4	0/4	0/4	0/4	-	-	-	-	81
Owens HU	0/5	0/83	0/38	0/38	0/42	0/42	0/42	0/42	0/42	0/42	0/42	0/42	0/42	0/42	-	-	-	-	584
Amargosa HU	8/8	0/8	1/8	0/8	6/8	0/8	0/8	0/8	0/8	0/8	0/8	0/6	0/7	0/8	0/2	3/6	4/6	0/105	228
Mojave HU	12/64	0/78	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0/840	982
Antelope HU	0/8	0/8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16
Total Exceedances	20	0	1	0	6	0	0	0	0	0	0	0	0	0	0	3	4	0	34 / 1994

The table above presents a compilation of the total number of exceedances of California Primary MCL criteria versus the total number of data points available for the Lahontan Region for sample years 2000 through 2005. The Lahontan Region has a total of 1,994 data points that are comparable to California Primary MCLs, with 34 exceedances. The (-) symbol indicates that no samples were collected.

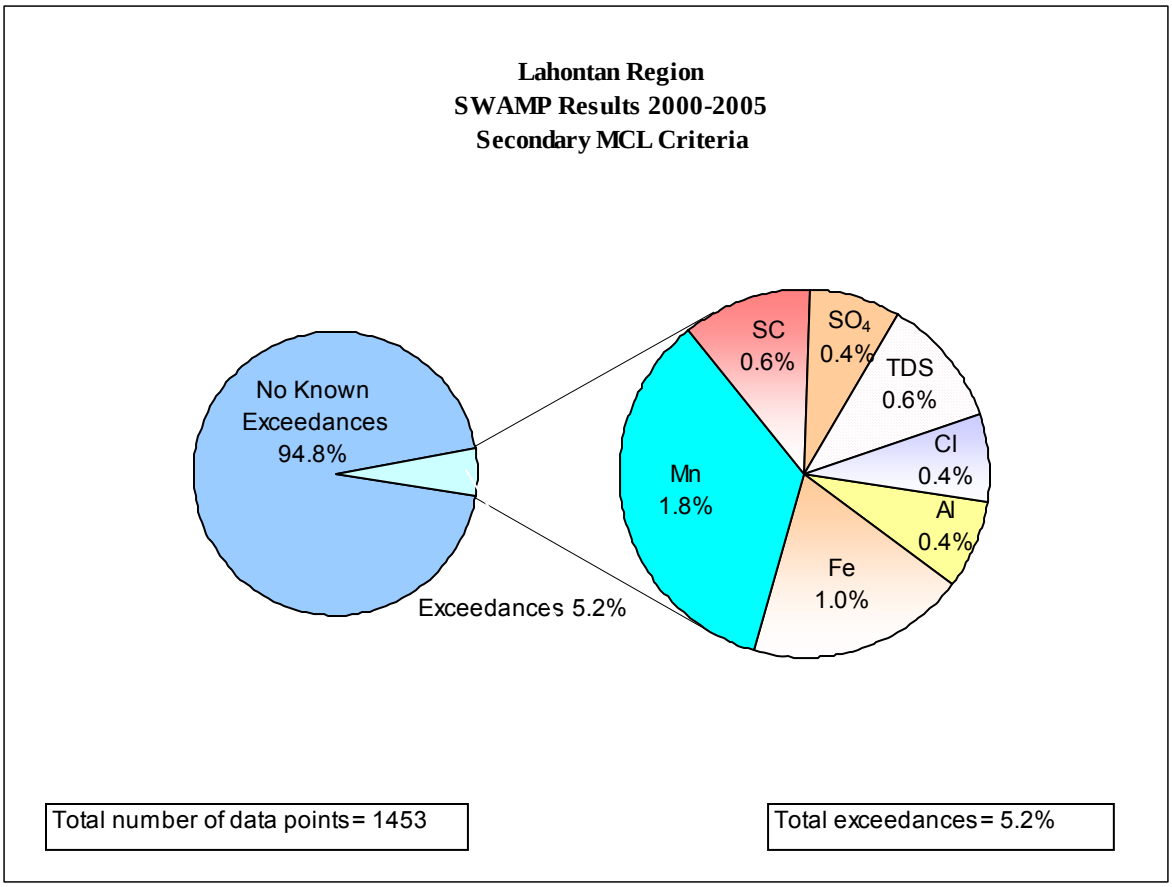

Figure 30. Results for Secondary MCL Criteria for the Lahontan Region, 2000–2005

For the Lahontan Region, exceedances of California Secondary MCL criteria were approximately 5 percent, with 1.8 percent attributed to manganese (Mn), 1.0 percent to iron (Fe), 0.6 percent (each) to specific conductance (SC) and total dissolved solids (TDS), 0.4 percent (each) to sulfate (SO_4), chloride (Cl), and aluminum (Al).

Table 42. Results for Secondary MCL Criteria for the Lahontan Region, 2000–2005

Hydrologic Unit	Al	Cu	Fe	Mn	Ag	Zn	SC	SO_4	TDS	Cl	Organics	Total Number of Data Points
Surprise Valley HU	-	-	-	-	-	-	0/37	-	0/37	0/37	-	111
Susanville HU	-	-	-	-	-	-	0/32	-	0/32	0/32	-	96
West Fork Carson HU	-	-	-	-	-	-	0/10	-	0/10	0/10	-	30
East Fork Carson HU	-	-	-	-	-	-	0/16		0/16	0/12	-	44
West Walker HU							0/12	0/12	0/12	0/12	-	48
East Walker HU	0/4	0/4	0/4	0/4	0/4	0/4	0/32	0/7	0/15	0/16	-	94
Owens HU	0/38	0/42	9/42	13/42	0/42	0/42	0/95	0/5	0/85	0/93	-	526
Amargosa HU	6/8	0/8	5/8	4/8	0/8	0/8	8/8	6/8	8/8	6/8	0/3	83
Mojave HU	-	-	-	-	-	-	0/74	0/78	0/78	0/78	0/30	338
Antelope HU	-	-	0/8	5/8	-	-	0/43	0/8	0/8	0/8	-	83
Total Exceedances	6	0	14	26	0	0	8	6	8	6	0	74 / 1453

The table above presents a compilation of the total number of exceedances of California Secondary MCL criteria versus the total number of data points available for the Lahontan Region for sample years 2000 through 2005. The Lahontan Region has a total of 1,453 data points that are comparable to California Secondary MCLs, with 74 exceedances. The (-) symbol indicates that no samples were collected.

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APPENDIX – Site locations (coordinates) and identification codes ("site tags")

Surprise Valley HU (641)			
Site Name	**Site ID (site tag)**	**Latitude**	**Longitude**
Bidwell Cr, near Fort Bidwell	641BID001	41.88246	-120.17444
Mill Creek	641MIL002	41.64553	-120.21243
Cedar Creek	641CDR002	41.53034	-120.18749
Susanville HU (637)			
Site Name	**Site ID (site tag)**	**Latitude**	**Longitude**
Susan River near Litchfield	637SUS001	40.37903	-120.39813
Susan River, above confluence with Willard Cr	637SUS003	40.39607	-120.78083
West Fork Carson River HU (633)			
Site Name	**Site ID (site tag)**	**Latitude**	**Longitude**
West Fork Carson River, below Willow Creek	633WCR002	38.7180556	-119.91694
East Fork Carson River HU (632)			
Site Name	**Site ID (site tag)**	**Latitude**	**Longitude**
East Fork Carson River, at USGS gage below Markleeville	632ECR005	38.71570	-119.76308
West Walker River HU (631)			
Site Name	**Site ID (site tag)**	**Latitude**	**Longitude**
West Walker River, near Coleville	631WWK001	38.51337	-119.44880
East Walker River HU (630)			
Site Name	**Site ID (site tag)**	**Latitude**	**Longitude**
East Walker River, at CA/NV State line	630EWK001	38.41399	-119.16574
Buckeye Cr, above campground	630BUC003	38.23491	-119.35887
Robinson Cr, below Barney Lake	630RBS006	38.14298	-119.43534
Virginia Cr, at Conway Summit	630VIR001	38.08448	-119.19189
Green Cr, above campground	630GRN001	38.10577	-119.28079
Owens HU (603)			
Site Name	**Site ID (site tag)**	**Latitude**	**Longitude**
Mammoth Cr, at HWY 395	603MAM006	37.63799	-118.90771
Mammoth Cr, at Old Mammoth Rd	603MAM007	37.63489	-118.96625
Mammoth Cr, at Twin Lakes	603MAM008	37.62389	-119.00472
Mammoth Cr tributary	603MAM009	37.62269	-118.99326
Hilton Cr, at Lake Crowley	603HIL001	37.57957	-118.74067
Rock Creek, above diversion	603RCK002	37.55016	-118.68583
Amargosa HU (609)			
Site Name	**Site ID (site tag)**	**Latitude**	**Longitude**
Mesquite Spring, near Scotty's Castle, Death Valley Nat'l Park	609MSQ001	36.96392	-117.36688
Amargosa River below Willow Cr	609AMR001	35.78341	-116.20115
Amargosa River at Upper Canyon	609AMR002	35.82589	-116.21903
Amargosa River at USGS gage (Tecopa)	609AMR003	35.84945	-116.22982
Antelope HU (626)			
Site Name	**Site ID (site tag)**	**Latitude**	**Longitude**
Little Rock Reservoir	626LRR001	34.48468	-118.02220
Mojave HU (628)			
Site Name	**Site ID (site tag)**	**Latitude**	**Longitude**
Mojave River, at Upper Narrows	628MOJ001	34.53320	-117.28597
Mojave River, below Forks Res	628MOJ002	34.34452	-117.23740
Deep Cr, above Deep Cr Lake	628DEP001	34.21787	-117.07336
Holcomb Cr, at Crab Flats Rd	628HOL001	34.27536	-117.04949
Sheep Cr, below Scout Camp	628SHP001	34.25332	-117.12325
Crab Cr, at Crab Flats Rd	628CRB001	34.25893	-117.08319

Note: All latitude-longitude coordinates are in decimal degrees, NAD 83.