2.7 Comment Letters Received after Deadline

TABLE 2-9
COMMENT LETTERS RECEIVED AFTER DEADLINE

Commenter	Date of Comment	Signatory and Title
Rancho Cucamonga Chamber of Commerce	04/12/2012	Joe Schumacher Chairman of the Board
Larry Witt, Individual	04/26/2012	–
NPCA-CBD *et al.*	05/04/2012	Adam Lazar
Tetra Technologies, Inc. via Rutan & Tucker,	05/07/2012	Robert S. Bower
Metropolitan Water District of Southern California	05/14/2012	Joseph Vanderhorst Sr. Deputy General Counsel
Lozeau Drury LLP on behalf of Laborers International Union of North America LaborersLocal Union 783 (4 submissions)	05/23/2012 (2), 05/25/2012 and 06/22/12	Christina Caro Attorney for Local 783
Diane Allison, Individual	05/24/2012	–
MC and Lorenzo Hagerty, Individuals	02/24/2012	–
Jean Marie Naples, Individual	05/24/2012	–
Anthony Nicolau, Individual	05/24/2012	–
Danielle Bower, Individual	05/25/2012	–
J. Capozzelli, Individual	05/25/2012	–
David A. Brunetti, Individual	05/26/2012	–
Phyllis Jacoby, Individual	undated	–
Steve Jacoby, Individual	undated	–
Heather Hahn, Individual	05/29/2012	–
Benjamin and Jennifer Valentine, Individuals	05/29/2012	–
Center for Biological Diversity	05/31/2012	Adam Lazar, Staff Attorney
Pam Nelson, Individual	06/01/2012	–
Greta Loeffelbein, Individual	undated	–
Anuj Shaw, Individual	06/20/2012	--
The Wildlands Conservancy	06/24/2012	Claudia Sall

04/12/2012 17:18 909-987-5917 RC CHAMBER

O_OCCC

Rancho Cucamonga Chamber of Commerce

9047 Arrow Route, Suite 180 • Rancho Cucamonga, CA 91730 • (909) 987-1012 • FAX (909) 987-5917 • www.ranchochamber.org

Date April 12, 2012

Board of Directors
Santa Margarita Water District
P.O. Box 7005
Mission Viejo, CA 92690-7005
Fax: (949) 459-6463

Dear Directors,

The Rancho Cucamonga Chamber of Commerce is proudly represents the business community in and around the City of Rancho Cucamonga. Our membership is made up of small and large businesses representing one of the strongest Chambers of Commerce in the Inland Empire region.

As part of our advocacy to encourage economic development and job creation Rancho Cucamonga and in San Bernardino County, we have taken a position of support for the Cadiz Valley Water Conservation, Recovery, and Storage Project.

Water supplies will continue to be a crucial factor in the success of the Southern California economy for the foreseeable future. The reliability and availability of water is important to businesses that need to know that they will have the water they need year to year at a predictable cost. Alternative supplies that can be found locally are greatly valued by water suppliers who rely on imported water to meet their customer demands.

The Cadiz Valley Water Conservation and Recovery Project would make available 50,000 acre-feet of clean drinking water available in Southern California every year. This water would be available when needed by participating water agencies. We applaud your efforts to pursue the Cadiz Valley Water Conservation and Recovery Project as an alternative local supply.

The Cadiz Valley Water Conservation, Recovery, and Storage Project would directly benefit job creation in our area and the economic recovery of San Bernardino County. Inland Empire economist John Husing estimated this total benefit at approximately $878 million in San Bernardino County, in part due to the location of local pipe manufacturers such as NOV Ameron which has a plant here in Etiwanda. Use of local vendors and hiring local workers would have an immediate benefit to our local economy.

Our organization stands in support of the Cadiz Valley Water Conservation Recovery and Storage Project based on its benefits for local water supply reliability and positive economic impact. This project has so many advantages for our area is very worthy of support.

Sincerely,

Joe Schumacher
Chairman of the Board

Michelle Alonzo, IOM
President/CEO

1

I_Witt

Sarah Spano

From: Tom Barnes
Sent: Thursday, April 26, 2012 9:37 AM
To: Sarah Spano
Cc: Leslie Moulton
Subject: FW: Cadiz Hearing

Follow Up Flag: Follow up
Flag Status: Flagged

From: Larry Witt [mailto:noreply@jotform.com]
Sent: Thursday, April 26, 2012 7:27 AM
To: Customer Service
Subject: Message from Larry Witt (Contact Us Form)

Message from smwd.com (Contact Us Form)

Question	Answer
Full Name:	Larry Witt
E-mail:	lwitt@aaimllc.com
Your Questions of Comments:	When is the hearing on the proposed project for Cadiz water project? Has it been scheduled?

1

CENTER *for* BIOLOGICAL DIVERSITY *Because life is good.*

VIA email and U.S. Mail

May 4, 2012

Tom Barnes
ESA
626 Wilshire Boulevard, Ste. 1100
Los Angeles, CA 90017
FAX: 213-599-4301
Email: cadizproject@esassoc.com

RE: Cadiz Valley Water Conservation, Recovery, and Storage Project Draft Environmental Impact Report State Clearinghouse #2011031002 ("Cadiz Project")

Submission of Water Quality Studies for Colorado River and Impacts to Cadiz Aquifer

Dear Mr. Barnes,

The Center and partnering organizations submitted extensive comments on the Draft Environmental Impact Report for the Cadiz water project. These comments addressed the need for the EIR to assess water quality impacts to the groundwater when Colorado River is stored in the groundwater basin as envisioned by the project.

In order to demonstrate the critical need to study water quality impacts to groundwater for the Cadiz project, I am enclosing studies on the water quality of the Colorado River. These studies indicate high levels of salinity and nitrates, sediment, selenium and perchlorate in the Colorado river, which would negatively impact water quality in the existing aquifer if recharged with Colorado water, while raising the necessary treatment level (and treatment cost) of water that would be eventually exported (or "recovered") from the project. Subsumed within the larger problem of sediment loads is the added problem of toxic chemicals residing within that sediment, including selenium, mercury and perchlorate. Based on these studies, directly importing Colorado River water into the groundwater aquifer would cause violations of state water quality standards and State Anti-degradation Policy 68-16, and may also create a long-term nuisance to local users of the shared aquifer, who will be forced to use additional filtration on their well water.

Attached references to water quality concerns of Colorado River water and Cadiz groundwater:

1

Arizona • California • Nevada • New Mexico • Alaska • Oregon • Minnesota • Vermont • Washington • Washington, DC
Adam Lazar, Staff Attorney • 351 California St., Suite 600 • San Francisco, CA 94104
Phone: (415) 436-9682 x320 • Fax: (415) 436-9683 • E-mail: alazar@biologicaldiversity.org

O_NPCA-CBD et al 2

American Rivers (2004)
- High concentrations of nitrates and fecal matter (13)
- High concentration of perchlorate (14)

CCRA (2006):
- Impacts of low Colorado water quality on agricultural and municipal users (p.15)
- Excessive nutrients (p.17)
- Metals incl. hexavalent chromium (p.36), and mercury (p.40)
- High salinity in Colorado river and its effects (p. 66-68 and 70-71);
- High sedimentation (p.77); sedimentation impacts on drinking water (80) (noting problems during high-sedimentation periods)

USBR (2004):
- Data on high salinity concentrations in lower Colorado River (p.71, 76)
- Negative economic impacts of high salinity concentrations (p.10)

USGS (2000):
- High Salinity (p. 1)

Southwest Hydrology (2004)
- High concentrations of salinity (p.18)
- High concentrations of selenium (p.18)

Colorado RWQCB Basin Plan (2006 rev.)
- General water quality objectives (p.3-1)
- Groundwater quality objectives (p.3-7 and 3-8)

Taken together, these studies support our comments that water quality impacts associated with the Cadiz project are significant and detrimental, must be analyzed in detail in the EIR, and must be mitigated to a less-than significant effect.

Sincerely,

Adam Lazar

Attachments

Attachments

1. American Rivers, "America's Most Endangered Rivers of 2004: Colorado River" (2004)
2. Clean Colorado River Alliance, "Recommendations to Address Colorado River Water Quality" (January 2006)
3. Jaqueline García-Hernández, "Water Quality in the Colorado River" (Southwest Hydrology, Jan/Feb 2004, pp. 18-19)
4. United States Bureau of Reclamation, "Quality of Water, Colorado River Basin: Progress Report No. 23," (2011)
5. United States Geological Service, "Monitoring the Water Quality of the Nation's Large Rivers: Colorado River NASQAN Program" (February 2000)
6. Colorado River Basin Regional Water Quality Control Board, "Water Quality Control Plan: Colorado River Basin, Region 7" (2006)

O_NPCA-CBD et al 2

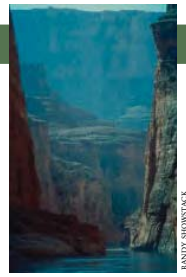
Attachment 1:
American Rivers, "America's Most Endangered Rivers of 2004: Colorado River" (2004)

O_NPCA-CBD et al 2

Colorado, Utah, Nevada, Arizona, California

#1 Colorado River

Threat: Looming pollution crisis



RANDY SHOWSTACK

Summary

While conflict over Colorado River water allocations has grabbed headlines for years, water pollution problems from human waste, toxic chemicals, and radioactive material have been largely overlooked and threaten to get much worse. Unless Congress and the federal government step in to bolster local cleanup efforts, the drinking water for 25 million Americans will remain at risk.

The River

The Colorado River starts as melting snow in the Rocky Mountains. Covering almost 250,000 square miles, the river basin includes portions of seven states and more than 20 Indian nations. Despite the vastness of its

BOB SCHULZ

watershed, the Colorado is a small river, annually averaging only about 1 percent of the Mississippi River's yearly flows.

As the river winds across the Colorado Plateau, the ranches, mines, and reservations of the Old West uneasily share the landscape with the national parks, ski resorts, and suburban sprawl of the New West. When the river pours out of the Grand Canyon in Arizona it enters the Sonoran Desert, where a shortage of water has failed to curb explosive population growth in recent decades.

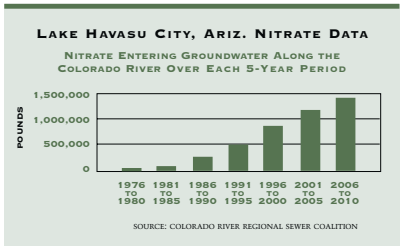
The Colorado is one of the most intensively used — and abused — river basins in America. More than 40 major dams and diversions siphon water from the river and its tributaries. As much as 20 percent of the river's water evaporates from the reservoirs behind the dams each year. Several of the river's native wildlife species are extinct, and others nearly so. Most years, the river literally evaporates shortly after crossing the border into Mexico. The once vast and rich delta at the river's mouth in the Gulf of California has virtually disappeared as a result.

The Risk

Three major sources of pollution are seeping into the Colorado River via contaminated groundwater. Some efforts are being made to address each of them, but more aggressive and better-coordinated action is needed to protect the health of the river, the 25 million Americans who drink its water, and the wildlife and parks found along it.

Human waste from riverfront boomtowns in California and Arizona contaminates the river below Hoover Dam. This area has the largest concentration of people in the United States using septic tanks. The overloaded septic systems allow increasing quantities of nitrates to seep into groundwater and the Colorado River. Monitoring wells in the Lake Havasu area have recorded nitrate levels four times higher than the limits set by the Environmental Protection Agency (EPA) to protect the public health. High nitrate levels in drinking water can deplete oxygen in infants' blood ("blue baby" syndrome) and are suspected to cause certain types of cancer. An estimated 1.2 million pounds of nitrates will seep into the regional aquifer between 2001 and 2005.

Riverfront communities in Arizona and California recognize the problem and are raising capital on their own to upgrade wastewater treatment capacities. They could use some help, but in recent years federal assistance to states for



Left: Communities along the lower Colorado River are struggling to provide wastewater treatment to their booming populations.

BUREAU OF RECLAMATION

Polluted water from Colorado River water is used to irrigate crops — trace amounts of the toxic chemicals can be measured in produce on supermarket shelves across the country (below).

wastewater treatment facilities has been cut by more than 10 percent, and the current administration proposes slashing some 30 percent — half a billion dollars — from loan programs for facility upgrades.

A second type of contamination is an ingredient in rocket fuel called perchlorate, which has been measured in Lake Mead at concentrations as high as 24 parts per billion. Although no federal health standard for perchlorate has been set, low concentrations can interfere with proper thyroid function and disrupt the body's normal hormonal balance. The potential health effects of perchlorate are especially significant for children because disturbances in thyroid levels during development can lead to lowered IQ, mental retardation, and the loss of hearing, speech and motor skills. The Las Vegas Valley Water District is unable to remove perchlorate from water piped to its residential customers. Lettuce and other leafy vegetables irrigated with Colorado River water contain trace amounts of the chemical — and are found on supermarket shelves across the country during winter months.

The source of perchlorate in the river is a facility in Henderson, Nev., where the government produced missile fuel during the Cold War. The plant is now operated by Kerr-McGee Corporation, which has already spent $80 million to reduce the volume of polluted groundwater reaching the river. However, more than 400 pounds of perchlorate still flow from the facility toward Lake Mead each day.

ERIC SCHLEISNER

The third pollution source is radioactive mill waste from a defunct facility along the Colorado River near Moab, Utah. With almost 12 million tons of radioactive material stored in a crude, unlined impoundment on the riverbank, the former Atlas Minerals Corporation site is the fifth largest and single most dangerous uranium tailings pile in the country. An estimated 110,000 gallons of radioactive groundwater seep into the river each day from this site. Uranium is one of the few carcinogens considered dangerous at any level, and levels in the river increase by 1,660 percent in the vicinity of the Atlas site.

Although the precise contribution from the Atlas site is unknown, Southern California's Metropolitan Water District has measured gradually increasing levels of radioactivity in the river hundreds of miles downstream at its Lake Havasu intake, where the drinking water for 16 million people is withdrawn from the river. The National Academy of Sciences has warned that it is "nearly certain that the river's course will run across the Moab site sometime in the future," flooding about a half ton of radioactive material for every man, woman, and child that drinks Colorado River water.

The 12-Month Outlook

The Colorado River is at a crossroads, and the next 12 months will determine whether these problems will continue to fester or a vigorous cleanup effort will begin. The situation as a whole warrants a massive, coordinated federal effort, and there are immediate steps that should be taken to address these pollution sources.

The Department of Energy (DOE) will finalize its plans for the radioactive mill tailings at the Atlas site before the end of 2004. Conservationists believe the best option is to completely remove the mill tailings and contaminated soil from the river floodplain, but the DOE has signaled that it will likely choose less protective options that would not provide sufficient security in the event of a major flood. DOE should not allow cost to dictate its choices. It should commit to the most thorough cleanup possible with current technology.

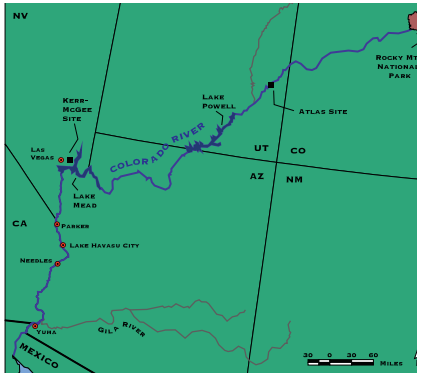
In the 2004 session of Congress, lawmakers will consider proposals to expand exemptions from environmental laws for the Department of Defense. Conservationists fear these could let the military off the hook for its share of the

cleanup responsibilities at the Kerr-McGee site and elsewhere. Congress should reject those bills and direct EPA to set a scientifically valid drinking water standard for perchlorate that will protect human health.

Also in the 2004 session of Congress, lawmakers will consider President Bush's proposal for sharp cuts in EPA's "State Revolving Loan Funds" program that assists state efforts with loans to upgrade drinking water and wastewater treatment. Funding shortages are the leading reason that communities struggle to meet their obligations to protect water they send downstream. Congress should fully fund this vital program.

In addition, Congress should recognize that the interstate nature of pollution problems in the Colorado River warrant a stronger federal role in cleanup. Congress should direct federal and state agencies to develop a binding action plan and authorize federal funding to restore water quality throughout the river basin — including addressing nitrates, perchlorate, and radioactive materials.

The lingering contamination and staggering remediation costs at the Kerr-McGee and Atlas sites provide a stark reminder that preventing pollution in the first place or cleaning it at the source is always preferable to cleaning it later. Congress should step up its oversight of the Bush administration's enforcement and interpretation of the Clean Water Act and pass the Clean Water Authority Restoration Act in the 2004 session to end the lingering debate over which waters are protected by federal law.



TOM TILL

It may be only a matter of time before a flood or earthquake sends 11 million tons of radioactive waste from the Atlas Uranium Mill into the Colorado River.

Contacts

Eric Eckl, American Rivers, (202) 347-7550 ext. 3023, eeckl@americanrivers.org
Brent Blackwelder, Friends of the Earth, (877) 843-8687, bblackwelder@foe.org
Terry Bracy, Bracy Tucker Brown, (202) 429-8855, tlbracy@aol.com
Bill Hedden, Grand Canyon Trust, (928) 774-7488, hedden@grandcanyontrust.org
Eric Wesselman, Sierra Club, (510) 622-0290 ext. 240, eric.wesselman@sierraclub.org
Robert Glennon, University of Arizona, (520) 621-1614, glennon@law.arizona.edu
The Honorable Bob Whelan, Mayor, Lake Havasu City, Ariz., Chair of the Colorado River Regional Sewer Coalition, (928) 453-4140, whelanb@ci.lake-havasu-city.az.us
Bill Walker, Environmental Working Group, (510) 444-0973, bwalker@ewg.org

For more information or to take action:
www.americanrivers.org/colorado2004.html

O_NPCA-CBD et al 2

Clean Colorado River Alliance

Recommendations to Address Colorado River Water Quality

January 2006

Table of Contents

O_NPCA-CBD et al 2

Acknowledgment

Much appreciation goes to those members of the Clean Colorado River Alliance and other participants who traveled across Arizona to participate in meetings throughout 2005. A special “thank you” goes to those participants who diligently researched these issues and drafted this report. Much credit for this publication goes to Doyle Wilson of the Lake Havasu City staff, and to the excellent staff at the Arizona Department of Environmental Quality, including Susan Craig, Diana Marsh, and Melanie Ford of the Hydrologic Support and Assessment Section of the Water Quality Division, and to Phil Amorosi and Tom Marcinko of the Communications Department.

Clean Colorado River Alliance Membership

Dean Barlow, Lake Havasu Park Board
Charles Bedford, The Nature Conservancy of Colorado
Don Butler, Arizona Department of Agriculture
Peter Culp, Sonoran Institute
John Earle, US Fish and Wildlife, Havasu National Wildlife Refuge
Bob Erickson, Water Conservation District member and President of Topock Civic Association
L. Elena Etcity, Colorado River Indian Tribes
Gene Fisher, LaPaz County Supervisor
Peter Frank, Kerr McGee
John Gall, Lake Havasu City realtor
Maureen George, Law Offices of Maureen Rose George
Randall Gerard, The EOP Group
Susan Gerard, Arizona Department of Health Services
Roger Gingrich, City of Yuma
Tom Griffin, Griffin & Associates
Herb Guenther, Arizona Department of Water Resources
Jack Hakim, Bullhead City Councilman
William Hirt, Ft. Yuma-Quechan Tribe
Rodney Lewis, Gila River Indian Community
Patty Mead, Mohave County Department of Public Health
Doug Mellon, Member Yuma Area Agricultural Advisory Council
Dave Modeer, City of Tucson
Mayor Larry Nelson, City of Yuma
Wade Noble, Attorney
Steve Olson, Arizona Municipal Water Users Association
Linda Otero, Director, Ft. Mohave Tribes
Steve Owens, Arizona Department of Environmental Quality
Gary Pasquinelli, Pasquinelli Produce
Don Pope, Yuma Water Users Association
Nicolai Ramsey, Grand Canyon Trust
Duane Shroufe, Arizona Game and Fish Department
Robert Shuler, Ryley, Carlock & Applewhite
Paul Soto, Cocopah Indian Tribe
John Sullivan, Salt River Project
Ken Travous, Arizona State Parks
Mayor Diane Vick, Bullhead City
Former Mayor Robert Whelan, Lake Havasu City
Jeff Smith, Environmental Specialist, Lower Colorado River Office
Ron Wilson, Golden Shores realtor
Sid Wilson, Central Arizona Water Conservation District

Executive Summary

The Colorado River is one of the most significant rivers of the American Southwest, providing drinking water, power and irrigation for the states of Wyoming, Colorado, Utah, New Mexico, Arizona, Nevada and California and the country of Mexico. Its watershed area covers nearly 244,000 square miles of land. Many water quality issues threaten this vital western water source, and concerns about the potential environmental, social and economic impacts of River pollutants are growing as population in the Southwest increases exponentially.

In response to these growing concerns, in February 2005, Arizona Governor Janet Napolitano appointed a group of stakeholders, the Clean Colorado River Alliance, to produce an action plan to address water quality issues in the River. Governor Napolitano directed the Alliance to investigate water quality in the Colorado River and develop recommendations for protecting and improving the River, including regional approaches. The activities of the Alliance were coordinated by the Arizona Department of Environmental Quality (ADEQ).

Pollutants of Concern

While a large number of water quality issues have the potential to impact the Colorado River, the Alliance identified several pollutants as being of particular concern in this effort: *nutrients, metals, endocrine disrupting compounds, perchlorate, bacteria and pathogens, salinity/total dissolved solvents and sediment.* This report describes the impacts of these pollutants, discusses current mitigation efforts to address them, and sets forth a number of recommendations aimed at them.

Nutrients

Industrial and municipal wastewater treatment facilities and landfills are potential point sources of nutrient pollution in the Colorado River. Potential nonpoint sources of nutrients include marinas, wastewater lagoons and other surface impoundments, irrigated agriculture, urban run-off, animal feed lots, septic tanks, fertilizer or manure applications to landscape, vehicle exhaust, atmospheric deposition and nitrogen fixation from natural processes. The impact of growth on wastewater treatment facilities coupled with aging infrastructure is of particular concern. Overloaded and aging treatment facilities can discharge significant quantities of nitrogen, including through overflows and leakage. Large numbers of septic tanks along the River especially contribute to the nitrate load of the shallow groundwater system that is hydrologically connected to the River. Excessive intake of nitrate can cause serious health effects. In infants, nitrate can reduce blood's ability to carry oxygen, resulting in asphyxiation, bluing of the skin (a condition known as "blue baby syndrome"), and potentially death. In others, nitrate has also been linked to increased rates of cancer, birth defects, miscarriage, reduced body growth and thyroid problems.

Metals

A wide variety of sources and activities, both natural and man-made, and activities contribute to the presence of metals in the Colorado River. All surface waters contain metals, generally appearing in colloidal, particulate, and dissolved states. However, where these metals are present in water in more than very small quantities, there is a risk of adverse health and environmental effects. The Alliance has focused on four metals: *selenium, chromium, mercury and uranium.* These metals threaten the Colorado River and can present serious health risks in humans and wildlife.

Endocrine Disrupting Compounds

Endocrine Disrupting Compounds (EDCs) have a wide variety of origins, both natural and synthetic, with the pharmaceutical and chemical industries leading the way in synthetics production. EDCs are often found in common household items, pesticides, and food and tobacco products. Additional research is necessary to characterize the occurrence of EDCs in the Colorado River and determine the impacts of exposure to EDCs on humans and ecosystems.

Perchlorate

Perchlorate was discovered in water supplies in the lower Colorado River in 1997. The contamination was traced to Lake Mead and the Las Vegas Wash, and eventually to a Kerr McGee Chemical Company (Kerr McGee) plant in Henderson, Nevada. This finding prompted US EPA, the Nevada Division of Environmental Protection (Nevada) and Kerr McGee to initiate efforts to control the source and reduce perchlorate releases to the Las Vegas Wash. The Alliance believes that appropriate containment, control and cleanup efforts are being implemented and are improving the concentrations and potential risk of perchlorate in and to the Colorado River. These ongoing efforts continue to reduce the low levels of perchlorate in the Colorado River. While it may take several years to achieve non-detect status (defined as less than 4 ppb), the current concentrations in the Colorado River are below current health standards and do not pose any threat to public health, provided that remedial activities continue.

Bacteria and Pathogens

Coliform bacteria are a large group of bacterial species and are most commonly associated with water quality. The two most likely pathogens that will be found in recreational waters are Cryptosporidium and Giardia. Potential causes of bacteria and pathogens in the Colorado River include the high density of on-site wastewater systems in River communities, storm water run-off during monsoons and other rain/storms events, and the inadequate number of sanitary facilities in recreational areas along the Colorado River. Bacterial contamination can result wherever there are high concentrations of people or animals.

Salinity

Increased salinity levels in the Colorado River affect agricultural, municipal and industrial users. Agricultural water users suffer economic damage due to reduced crop yields, added labor costs for irrigation management and added drainage requirements. Urban users must replace plumbing and water-using appliances more often, or spend money on water softeners or bottled water. Industrial users and water and wastewater treatment facilities incur reductions in the useful life of system facilities and equipment. Nearly half of the salinity in the Colorado River system is attributable to natural sources. Other potential sources of salinity in the Colorado River Basin include irrigated agriculture, energy exploration and development, and municipal and industrial facilities such as wastewater treatment plants. Treated wastewater is a source of salinity, so as population continues to increase in the Colorado River region, the amount of treated effluent will multiply, contributing to an increase in salinity.

Sediment

The Colorado River suffers from excess sediment in some areas of the watershed, and decreased sediment in others. Stream bank erosion, a natural source of sediment loading to the Colorado River, can be accelerated by human alteration of water flow and channel morphology. Dams, on the other hand, can decrease sediment below normal levels, altering wildlife habitat and causing the disappearance of natural sandbars and beaches.

O_NPCA-CBD et al 2

Recommendations

The Alliance submits the following recommendations for action by Governor Napolitano and other leaders to address and improve water quality in the Colorado River. In addition to the specific recommendations below, throughout this report the Alliance has called for increased public outreach and education efforts to enhance the public's awareness and understanding of water quality concerns in the Colorado River and ways to reduce the presence of pollutants in the River. Moveover, in the text of the report, the Alliance has identified potential funding sources that should be considered for the improvement of water quality in Colorado River and implementation of the Alliance's recommendations.

The Alliance recommends:

- Governor Napolitano should convene a summit of the Governors of the seven Basin States – Arizona, California, Colorado, Nevada, New Mexico, Utah and Wyoming – to address the issue of water quality in the Colorado River.

- The water quality administrators of the seven Basin States should convene in advance of the Governors' summit to share existing information, identify water quality issues affecting the Colorado River that are not adequately addressed by existing institutions and regulations, coordinate an inventory of water quality concerns, develop a watershed-based, coordinated monitoring strategy, and develop an electronic repository of information related to Colorado River water quality. Follow-up meetings of the water quality administrators also should be held on a regular basis.

- Governor Napolitano and Arizona's congressional delegation should actively support the effort of the Colorado River Regional Sewer Coalition (CRRSCo) to obtain federal funding for wastewater infrastructure in communities along the River. The completion of wastewater infrastructure projects in River communities, such as Bullhead City and Lake Havasu, will help improve the quality of groundwater adjacent to the Colorado River and, ultimately, the River itself.

- Continued substantial financial support must be provided for wastewater infrastructure improvement projects adjacent to the River. Additional wastewater infrastructure improvement needs should be identified and potential locations of nitrate and bacterial contamination should be monitored. These identified needs should be prioritized based on contamination risk and expense.

- Governor Napolitano, ADEQ and other officials should closely monitor the potential water quality impacts of the proposal by the "Clean Water Coalition" in Nevada to discharge up to 450 million gallons per day of treated effluent from Las Vegas, Henderson and Clark County, Nevada, into Lake Mead, directly upstream of Hoover Dam.

- The investigation, monitoring and remediation of chromium contamination at both the Pacific Gas & Electric (PG&E) Compressor Station on the California side of the River at Topock (I-40 crossing) and at the former McCulloch manufacturing plant in Lake Havasu City in Arizona must continue. Officials must continue to require remediation of hexavalent chromium impacts to the groundwater system adjacent to the Colorado River and include hexavalent chromium analyses in all Colorado River water sampling programs.

- ADEQ should continue to monitor the U.S. Department of Energy's (DOE) plan to move the 12 million tons of radioactive uranium tailings at the Atlas Mill site near Moab, Utah, away from the Colorado River to a permanent disposal location 30 miles away at Crescent Junction, Utah, and press DOE to move the tailings as quickly as possible. Governor Napolitano and ADEQ also should continue to press DOE to ensure that DOE conducts active remediation of contaminated groundwater at the Moab site and prevent further releases of contaminated groundwater into the Colorado River.

- ADEQ and other agencies should conduct a coordinated effort to identify and investigate abandoned mines and other potential sources of mercury and other metals along the River, including surveying and sampling to detect areas with existing metals contamination. ADEQ also should seek additional air deposition monitoring stations in Arizona to help assess the impact of airborne mercury emissions on mercury levels in the Colorado River.

- Governor Napolitano and Arizona's congressional delegation should support full federal funding of salinity control projects implemented under the Colorado River Basin Salinity Control Act. Salinity control projects funded under Title II of the Act have served to reduce the total salt load on the River (with the added benefit of reducing the metal selenium). The Colorado River Basin Salinity Control Forum has set a goal of 1 million tons of additional salt removal by the year 2020. While most of the new salinity controls will be implemented in the Upper Basin states, they will improve water quality throughout the Colorado River. Further, any National Pollutant Discharge Elimination System (NPDES) or Arizona Pollutant Discharge Elimination System (AZPDES) permits authorizing surface water discharges to the Colorado River should be consistent with Colorado River Basin Salinity Control Forum policy.

- In coordination with designated planning agencies, ADEQ should review and establish a process to adjust, if necessary, the regional water quality management planning program in regard to wastewater planning along the Colorado River. The review should include planning for discharge locations, wastewater facility design, adequate treatment and disposal capacities and methods and effluent water quality. ADEQ also should make certain that all new sewage treatment facilities meet performance requirements and that existing facilities are upgraded to meet best available demonstrated control technology standards.

- ADEQ, the Arizona Department of Water Resources (ADWR) and other appropriate agencies should develop coordinated monitoring activities to determine trends of selenium concentrations in the Colorado River and in target species in the River. ADEQ also should regularly monitor fish tissue for selenium concentrations in the River.

- ADEQ should work with relevant entities, including universities, to compile and assess data on the potential impacts of endocrine disrupting compounds in the River.

- ADEQ should continue to monitor the ongoing remediation and mitigation efforts at the Kerr McGee facility in Nevada to ensure that perchlorate levels in the Colorado River continue to decline.

O_NPCA-CBD et al 2

- ADEQ should work with other appropriate state, local and federal agencies and stakeholders to develop a data gathering and monitoring network to identify "hot spots" for bacterial contamination in the Colorado River, including conducting a concentrated survey along the River at high use areas and during busy seasonal periods.

- State and local agencies should conduct aggressive education and outreach efforts to promote the use of best management practices to address soil erosion and sedimentation, reduce urban and construction run-off and decrease the use of off-road vehicles in sensitive areas in order to reduce levels of sediment in the Colorado River.

Chapter 1
Introduction

Chapter 1 - Introduction

In February, 2005, Arizona Governor Janet Napolitano asked a group of key stakeholders in the state to develop recommendations to address existing water quality problems and assist her in working with fellow states towards solutions for improving Colorado River water quality (see Appendix 1). In her letter, Governor Napolitano states the following:

"The Colorado River serves as the lifeblood of the American West providing drinking water to more than 25 million people and irrigation water to support 2 million acres of agricultural production. For years the focus of the Colorado has been on water quantity and indeed, I will continue to fight to secure our share of this critical resource. However, we can no longer focus on water quantity alone, we must address water quality as well if we are to truly meet the needs of the state.

There are several major issues currently threatening the quality of water in the Colorado River. Unfortunately, the problems tend to accumulate with movement downstream, and Arizona is the last State to divert flows from the Colorado before it crosses into Mexico. While many of the problems manifest themselves most severely in Arizona due to geographic location, the problems are, in fact, regional issues and cannot be tackled on solely a state level.

Effectively cleaning up the Colorado River will require a regional approach involving federal, state, tribal and local governments as well as other key stakeholders including agricultural, municipal, business and conservation sectors. Therefore, I have decided to name a stakeholder group, the Clean Colorado River Alliance (CCRA), to develop recommendations to address existing water quality problems."

Clean Colorado River Alliance Mission

Develop recommendations to address existing water quality issues to ensure Colorado River water quality meets the needs of Arizona- now and in the future.

Objectives

The goals of the Alliance include:

- Develop a plan to create a regional approach to address Colorado River water quality issues
- Document and prioritize water quality improvement projects to be implemented (short-term and long-term)
- Document funding needs and sources and identify processes to secure funding
- Develop an action plan to secure and direct funding and implement identified water quality improvement projects

Approach

Joined by Governor Janet Napolitano in April 2005, the Alliance met for the first time to discuss the mission and the timeline for completion of this report. From April to December, the Alliance met five times at locations throughout Arizona. Meeting notes from each of the meetings and other items of information are on the CCRA Web site: www.azdeq.gov/environ/water/ccra.html.

First, the Alliance identified pollutants of concern (see the draft pollutant list – Appendix 2) and then developed eight criteria for deciding and prioritizing which pollutants the Alliance would address in the report. The criteria are listed below in no particular order of importance:

- "Current problem, exceed/violate water quality standards and number of locations" and "instances the pollutant exceeds standards"
- "Public/aesthetic consideration" or "public perception"
- "Causing or anticipated to pose human or ecosystem health concern" and "acute risk of public and/or environmental risk"
- "Clearly defined location of pollutant removal"
- "Identified sources"
- "Hard data, i.e. monitoring threshold"
- "Quantity of pollutant or threat/risk"
- "Upward trend"

After developing the criteria and voting, the Alliance decided to address seven pollutants. In order, based on the number of votes, the following pollutants were selected:

1. Nutrients (nitrogen, nitrates, ammonia, phosphorus)
2. Metals (chromium, uranium, copper, mercury, arsenic)
   Note: The metals originally selected were evaluated on June 17, 2005 and on October 21, 2005, the Alliance decided to change the focus on: selenium, chromium, mercury and uranium.
3. Endocrine disrupting compounds
4. Perchlorate
5. Bacteria/pathogens
6. Salinity/total dissolved solids
7. Sediment/turbidity

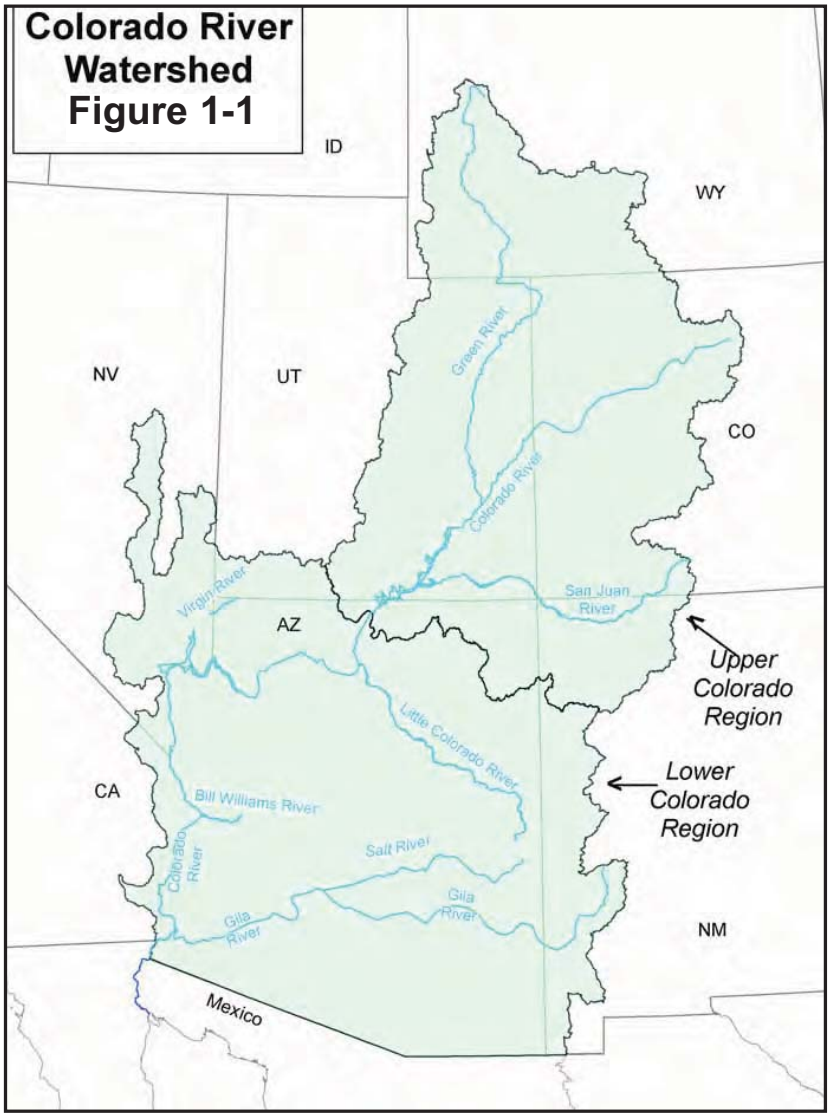
Pollutant workgroups were established (Appendix 3) and each workgroup was responsible for drafting a pollutant chapter of the report.

Colorado River Watershed & Water Quality

The 244,000 square mile Colorado River Watershed stretches from the mountains of Colorado and Wyoming south and west through the states of Utah, New Mexico, Arizona, Nevada, and California. Crossing into Mexico (see Figure 1-1, page 13), the watershed encompasses parts of Sonora and Baja California. About 85 percent of the Colorado's water originates in the mountains of Colorado, yet communities and ecosystems as far south as Mexico rely on its flow. More than 25 million people depend on its water for drinking and irrigation. "The river irrigates 1.8 million acres of land, producing 15 percent of U.S. crops and over 80 percent of the winter vegetables consumed in the United States are grown with its water." (Project WET International, 2005).

Throughout this report agriculture is often mentioned as a potential source of water quality problems. However, Arizona agriculture is at the "bottom" of the Colorado River system. According to the 2004 Arizona Agricultural Statistics Bulletin, issued September 2005 and published by the United States Department of Agriculture, 339,550 acres were harvested in 2004 in the Colorado River counties of Mohave, La Paz, and Yuma. Accordingly, approximately 17% of the total acres irrigated by the Colorado River are in Arizona. Notably, Arizona and its agencies have enacted laws and regulations to minimize or eliminate and monitor Arizona agriculture's impact on river water quality.

The Colorado River enters Arizona at Lake Powell, flows through the Grand Canyon National Park, and leaves the state at the Mexico border near Yuma. As shown in Figure 1-1, the entire state of Arizona can be considered part of the Colorado River drainage. However, the focus of this report was on the main stem of the Colorado River along the western boundary of the state (see Figure 1-1, page 13). The Colorado River Watershed in Arizona contains spectacular incised canyons formed by erosion of sedimentary formations (e.g., sandstone), as well as volcanically formed mountains and high plateaus. Except for Kingman, Williams, and communities along the lower Colorado River (Yuma, Bullhead City, Lake Havasu City), most of this 30,896 square mile watershed is sparsely populated with only 255,200 people (2000 census).



The Grand Canyon National Park, Kaibab National Forest, Lake Mead National Recreation Area, and Glen Canyon National Recreation Area are all located within the watershed. Six wildlife refuges and three wilderness areas have been established in this watershed, along with several military bases with live-fire exercise areas. All of these have restricted land uses.

In Arizona, elevation in the Colorado River Watershed ranges from 10,400 feet above sea level near Flagstaff to 80 feet above sea level along the Colorado River as it enters Mexico. The area contains high and low desert fauna and flora and includes coldwater and warmwater aquatic communities where perennial waters exist.

Portions of the Colorado River Watershed in Arizona are impaired (not attaining water quality standards under the Clean Water Act) due to copper, Escherichia coli, boron, selenium and suspended sediment concentration, boron, DDT metabolites, toxaphene and chlordane in fish tissue, and dissolved oxygen. A full description of these and other water quality impairments can be found in Arizona's 2004 Integrated 305(b) Assessment and 303(d) Listing Report.

Other known issues in the Colorado River Watershed include: nitrogen or nitrates, chromium, uranium, perchlorate, and bacteria. These pollutants are discussed below in Chapters 2 through 8.

Economic and Environmental Sectors Impacted*

Water quality impacts broad areas of Arizona's economy and environment. The following sectors of Arizona's economy and environment are vulnerable to impacts from poor water quality:

- Irrigated Agriculture
- Municipal and Industrial Water Users
- Public Health
- Aquatic Life
- Livestock and Wildlife
- Environmental Health and Watershed Management
- Commerce and Recreation
- Tourism

Water quality is vital to business and industry, wetlands and forests, energy producers, fish and wildlife, recreation, and agriculture. The Colorado River and its tributaries carry the water that makes life possible in the arid southwestern United States and northwestern Mexico. The river and its tributaries are essential to the functioning of diverse ecosystems, communities, and economies throughout a vast region. General economic and environmental sectors and potential impacts are identified in Table 1-1.

Table 1-1: Economic and Environmental Sectors and Potential Water Quality Impacts

Sector	Potential Impacts of Poor or Reduced Water Quality
Irrigated Agriculture	• Reduced agricultural production • Crop damage • Increased pest outbreaks • Increased water supply costs • Increased management applications (fertilizer, herbicides, pesticides) • Problems with soil structure, infiltration, and permeability and aeration rates
Municipal and Industrial Water Users	• Damage to pipes, fixtures, and appliances • Disrupted filtration and treatment processes • Unpalatable mineral tastes • Additional treatment • Higher costs for treatment • Reduced quality water supplies
Public Health	• Increased illnesses and metabolic and hormonal dysfunction • Increased potential of disease transmission • Physiological effects
Aquatic Life	• Decline in native fish and aquatic life populations • Fish kills • Reduced growth rates • Decreased resistance to disease • Modification of natural migration and predation
Livestock and Wildlife	• Increased illnesses and mortality rates • Increased supplemental watering costs • Increased disease outbreaks • Reductions in herd size
Environmental Health and Watershed Management	• Reduction in forage production • Reduction in riparian habitat • Increased groundwater contamination
Commerce and Recreation	• Increased risk to swimmers • Recreation closures • Reduced sales and use of outdoor recreation equipment • Reduction in rural recreation economy • Reduced migration of new businesses
Tourism	• Reduced visitations to parks • Decreased number of winter visitors • Decrease in conventions and hospitality events

*Portions of this section are based on the Arizona Drought Preparedness Plan - Background & Impact Assessment Section.

In Chapters 2 through 8, water quality impacts from each pollutant addressed by the Alliance are described in more detail.

O_NPCA-CBD et al 2

In each of the following chapters, the Alliance makes a number of recommendations regarding the specific pollutant(s) discussed therein. The Alliance points out, however, that the recommendations for a specific pollutant should not be viewed in isolation from recommendations elsewhere in this Report, and instead should be seen as part of an overall strategy for dealing with water quality issues in the Colorado River. In fact, some recommendations address more than one pollutant and are set forth in more than one chapter.

By the same token, while this report and the recommendations herein are addressed primarily to Governor Napolitano and Arizona policymakers, the problems facing the Colorado River are, as the Governor stated in her February 2005 charge to the Alliance, "regional issues and cannot be tackled on solely a state level."

Accordingly, in addition to the recommendations regarding specific pollutants, the Alliance recommends that Governor Napolitano convene a summit of the Governors of the seven Basin States – Arizona, California, Colorado, Nevada, New Mexico, Utah and Wyoming – to address the issue of water quality in the Colorado River. The involvement and cooperation of the other Basin States is essential to developing a successful long-range strategy for protecting and improving water quality in the Colorado River. This report can serve as a framework for the issues to be discussed at such a summit.

To ensure the Basin States' Governors summit is as productive as possible, the Alliance further recommends that the water quality administrators of the seven Basin States convene in advance of the summit to share existing information, identify water quality issues affecting the Colorado River that are not adequately addressed by existing institutions and regulations, coordinate an inventory of water quality concerns, develop a watershed-based, coordinated monitoring strategy, and develop an electronic repository of information related to Colorado River water quality. This work will lay a strong foundation for a meeting of the Governors and help them tackle the issues affecting water quality in the River in a meaningful way. Similarly, follow-up meetings of the water quality administrators also should be held on a regular basis to ensure that work on Colorado River water quality issues moves forward with the coordination and collaboration of all the Basin States.

Chapter 2
Nutrients

Pollutant Description of Nutrients

Nutrients are a special group of chemical elements and compounds that supply plants with the necessary potential energy that is utilized during metabolic processes, along with sunlight, to convert carbon from carbon dioxide into organic carbon compounds. Important nutrients such as compounds of carbon, nitrogen, phosphorus, and sulfur are common at some concentration in the environment. Phosphorus, organic carbon, and sulfur do not pose direct health concerns, yet concentrations above 1.0 mg/l of mobile ortho-phosphate compounds in the aquatic environment can lead to algal blooms, which lead to low dissolved oxygen levels and fish kills when dead algae decompose. Concentrations of phosphate approaching 1.0 mg/l in surface and ground water are generally absent in the Lower Colorado River system. Among the U.S. Environmental Protection Agency (EPA) and the three states bordering the lower Colorado River, only Nevada's Department of Conservation and Natural Resources has mandated water quality standards in Lake Mead and along the Colorado River for phosphate (0.05 mg/l).

Arizona Department of Environmental Quality (ADEQ), U. S. Geological Survey, and U. S. Fish and Wildlife Service water analyses for phosphate over the past 15 years on the Colorado River main stem and the Bill Williams River have yielded up to 0.7mg/l in the Bill Williams River and up to 0.45 mg/l in the Colorado River above Diamond Creek in the Grand Canyon. Phosphate concentrations on the main stem between Lake Mead and Morelos Dam north of Yuma have been consistently below 0.1 mg/l.

Organic carbon and sulfur, usually as sulfate, are generally found at modest quantities in surface and ground water along the River system, although a few samples have yielded sulfate at levels above its 250 mg/l secondary Maximum Concentration Level (MCL) for safe drinking water. The secondary MCL is a non-enforceable aesthetics-based guideline of the federal Safe Drinking Water Act. Total organic carbon levels measured in the Colorado River by the Central Arizona Water Conservation District and other surface water users generally have been less than 10mg/l, but may have higher concentrations during flooding events. There are no direct federal regulations in place on its concentration, yet dissolved organic carbon compounds in surface water may react with chlorine-based disinfectants to yield trihalomethane and haloacetic acid by-products, which are regulated by the EPA.

Role of Nitrogen

Nutrients like nitrogen are necessary for healthy waters, but high levels of nutrients can cause a number of problems, ranging from nuisance algae blooms and cloudy water to threatening drinking water and harming aquatic life.

Nitrogen can exist in several forms (i.e. nitrate, nitrite, organic nitrogen, and ammonia nitrogen), two of which, nitrite and nitrate, are harmful to humans, livestock and wildlife when present in sufficient quantities. Both forms may pose a potential health threat. In addition to causing deleterious health effects on humans and livestock, elevated concentrations of nitrogen (and phosphorus) can cause eutrophication of receiving streams and

lakes. Elevated concentrations of nitrate can also be accompanied by higher than normal counts of fecal-indicator bacteria, which may indicate the presence of pathogenic bacteria, viruses, and protozoa. Since nitrate impacts are more widespread than other forms of nitrogen, the following sections are dedicated to a summary description of nitrates, their potential sources, their influence along the lower Colorado River, and mitigation efforts to minimize nitrate concentrations in the aquatic environment.

Nitrogen gas composes 78% of the earth's atmosphere in the form of N_2, which is converted or fixed to either an oxygenated compound like nitrate (NO_3) or nitrite (NO_2), a hydrogen compound like ammonia (NH_3), or a nitrogen-bearing organic compound, by plants, natural atmospheric processes (lightning), or by industrial processes. The nitrogen cycle in nature includes the fixation of nitrogen by plants and the atmosphere into the above mentioned compounds and denitrification (a series of chemical reactions to reduce nitrogen) back to nitrogen gas into the atmosphere via bacterial metabolic processes. This cycle has been altered on a global basis with the advent of agriculture and industrial manufacturing.

Nitrogen in surface or ground water can be reported in terms of total nitrogen, nitrate-nitrogen, nitrite-nitrogen, ammonia nitrogen, and Kjeldahl nitrogen (the sum of organic and ammonia nitrogen). The last two nitrogen forms are important as indicators of nearby organic sources such as septic tanks where microorganisms produce ammonia while decomposing organic matter. Ammonia is highly mobile and is easily oxidized so that ammonia levels far away from the source are usually low in groundwater. Nitrites, usually an intermediate product of ammonia oxidation, also are oxidized when exposed to aerobic groundwater and are converted rapidly to nitrates. Nitrite levels are usually low in the groundwater system, but may be elevated near organic sources. Chemically, nitrates are soluble in groundwater and are very mobile, traveling far from their source. They may persist in surface water if high enough levels are brought to the surface in sufficient quantities.

Sources

In pristine natural environments, free nitrogenous compounds such as ammonia, nitrite and nitrate are extremely scarce, virtually all the available nitrogen is 'locked away' as plant or animal protein. But today, even natural environments, such as lakes or rivers can be affected by high levels of ammonia, nitrite or nitrate.

Potential sources for nitrates in the Colorado River and adjacent shallow groundwater may be grouped into point sources (places that can be specifically identified) such as industrial and municipal wastewater treatment facilities and landfills, or as non-point sources (broad areas of impact) such as marinas, wastewater lagoons and other surface impoundments, irrigated agriculture, urban run-off, animal feeding operations, septic tanks, fertilizer or manure applications to landscape, vehicle exhaust, atmospheric deposition, and nitrogen fixation from natural processes. Nitrates are also found in uncooked and cooked vegetables and nitrites in cured meats, but in much greater concentrations.

The impact of growth on wastewater treatment facilities coupled with aging infrastructure is of particular concern. Overloaded treatment facilities, even those that include treatment processes specifically designed to remove nutrients can discharge significant quantities of

O_NPCA-CBD et al 2

nitrogen to surface waters. Effected surface impoundments like percolation ponds, can contribute large quantities of nitrogen to groundwater. Aging infrastructure can contribute nitrogen to both ground and surface water through Sanitary Sewer Overflows (SSO) and leakage.

Large numbers of septic tanks along the River, both in rural and semi-urban areas, contribute to the nitrate load of the shallow groundwater system that is hydrologically connected to the River. Lake Havasu City, Bullhead City, Parker, and smaller communities along the River either have or have had high septic tank densities where the potential for nitrate influx into the River system is high. Effluent from a septic tank system can have a total nitrogen content of 25 to 60 mg/l, most of which is ammonia and less than 1% is nitrate. Ammonia is rapidly oxidized in the leach fields, however, producing significant quantities of nitrate. Nitrates will migrate in groundwater and enter drinking water wells down slope that are tapping the same aquifer, which leads to consumption (Figure 2-1).

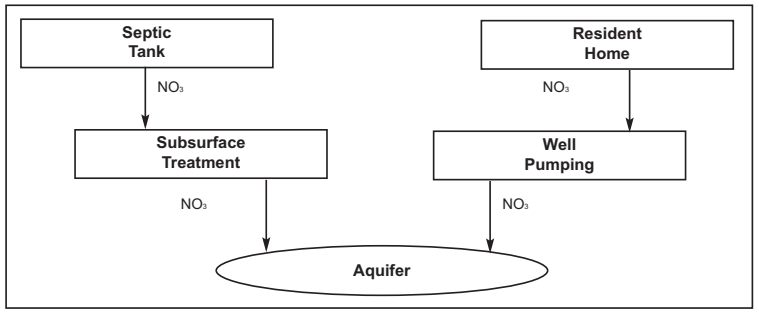


Figure 2-1: Potential nitrate pathway in a domestic water use system.

Agriculture along the Colorado River in Mohave County occurs in Mohave Valley, north of Topock to Bullhead City. Southward along the River agriculture is more widespread in La Paz and Yuma counties in Arizona and San Bernardino, Riverside, and Imperial counties in California. ADEQ studies in the 1990s along the river from Mohave Valley to Yuma found nitrate concentrations as high as 122 mg/l in well water from agricultural sources adjacent to the River. Fertilizer and pesticide applications as well as decomposing organic matter (unused crops, animal feed grains, and manure from farm animals) may contribute nitrogen in the form of nitrates that percolate to the shallow groundwater system, which is connected to the River, and that are caught in runoff directly to the River during precipitation events and/or continuously from drainage ditches.

The California Regional Water Quality Board's Colorado River Basin Region is placing a strong emphasis on surface and groundwater monitoring and protection. One of their high priority issues from the 2004 Triennial Review is to develop guidelines for sewage disposal from land developments. The Regional Board currently only regulates approximately 3,000 of 28,000 systems known to be in existence.

Effluent from percolation ponds or infiltration beds at wastewater treatment plants is a source of a certain amount of nitrate to the subsurface that migrates to the River system. Cities that dispose effluent in this way include Lake Havasu City, Bullhead City, and Blythe, California. Some facilities such as at Las Vegas and Laughlin, Nevada, Needles, California, Quartzite and Yuma, Arizona, and St. George, Utah have obtained variations of the NEPES permit to dispose treated effluent directly into the Colorado River System.

Las Vegas releases A+ treated effluent into Las Vegas Wash, part of which has been transformed into a wetland filtering system. The water eventually flows into Lake Mead. Two Nevada cities (Las Vegas and Henderson) and Clark County, Nevada (the "Clean Water Coalition") also have proposed to discharge up to 450 million gallons per day of treated effluent directly into Lake Mead. St. George's treated waste water is disposed into the Virgin River, which also empties into Lake Mead. The permits for disposal include regulations to keep nitrate concentrations as low as possible and always below the EPA's 10 mg/l MCL. These plants may also distribute the effluent for irrigation to golf courses and other landscape properties where nitrates may undergo fixation to organic nitrogen compounds.

Landfills, if unlined or not lined properly, can also be a source of ammonia-nitrogen from decomposing organic matter, such as food spoils, which, under oxidizing conditions is, converted to nitrate. Landfills such as those at Lake Havasu City, Mohave Valley, Needles, and Quartzite occur adjacent to the Colorado River, but their affect on the River system with respect to nitrates is not currently known.

Fertilizers have application beyond agricultural practices. They are used for landscape activities, such as keeping grass green for golf courses, ball fields and municipal/commercial/ school/ government landscaping. Heavy applications can lead to elevated levels of nitrates in shallow groundwater that are not consumed by plants.

Ammonia-nitrogen associated with the uranium tailings near Moab, Utah also threatens Colorado River water quality. Ammonia concentrations near the source may be as high 2 mg/l, which is dangerous to fish and other aquatic life in the river. Local fish kills may result at and just downstream from the source. The threat decreases downstream as the ammonia oxidizes into nitrates in the River.
Recreation along the River, including boating and camping, contributes relatively small, dispersed quantities of human waste, yet increased recreation use through population growth will lead to greater impacts on the aquatic system.

A natural potential source of nitrates in the surface and ground water systems in the desert Southwest is from the subsoils or alluvium (gravel and sand) covering the bedrock of the mountains adjacent to the River. This source may be only significant during very wet years when the alluvium is thoroughly saturated and nitrates are leached into the shallow groundwater system. Nitrate salts blown from playa lakes further west may be picked up into the atmosphere by high winds and deposited in the region. These salts are carried into the subsoil and accumulate until a period of water saturation leaches the nitrates into mobile form and they are carried down slope in shallow groundwater or by surface runoff. This hypothesis is supported by regional studies that have detected elevated nitrate levels in subsoils of the Mojave and Sonoran deserts. Studies at the City of Tucson's Sweetwater surface recharge facility also indicate residual nitrates unused by plant roots in the vadose zone are mobilized by infiltrating water.

O_NPCA-CBD et al 2

Water Quality Impacts

Health Concerns

Health impacts from consumption of high nitrate-bearing water mostly involve infants less than six months old. Children this young have not yet developed the hydrochloric stomach acid used to help digest food. The lack of acid and the abundance of nitrate in the stomach act to support nitrate-reducing bacteria that convert nitrate to nitrite, which combines with hemoglobin in the blood stream to form methemoglobin. This substance cannot carry enough oxygen to the rest of the body, resulting in asphyxiation, a chocolate brown color to the blood, and bluing of the skin (a condition known as "blue baby syndrome"), and eventually could lead to death. Pregnant women, adults with reduced stomach acid, and people deficient in the enzyme that changes methemoglobin back to normal hemoglobin are also at risk in developing nitrite-induced methemoglobin. Nitrates are metabolized in the body and passed through the system without being reduced to nitrites. Nitrate has also been tentatively linked to increased rates of stomach cancer, birth defects, miscarriage, leukemia, Non-Hodgkin's lymphoma, reduced body growth, slower reflexes and increased thyroid size. Prolonged exposure to very high nitrate levels can produce gastric problems and even cancer in laboratory animals.

Nitrites are generally worrisome for all children because they can interact with other substances in the body to form a potential cancer-causing chemical called nitrosamine. Livestock and wildlife are also susceptible to the same nitrite and nitrate toxicity. Young cattle and sheep, including desert bighorn sheep, are especially vulnerable as are all ages of horses, yet their tolerated consumption levels are about ten fold above those for humans.

Ecological Concerns

In addition to its health effects on humans, nitrates have significant impacts on waterbodies. Eutrophication is the natural aging process of lakes and rivers. As these waterbodies become better nourished with the input of nutrients and sediment through erosion and precipitation, they gradually become shallower, warmer and more biologically active.

The aging process is accelerated when high levels of nitrogen found in untreated or poorly treated residential, municipal and industrial wastewaters is discharged to the River. The excess nitrogen over stimulates the growth of aquatic weeds and algae. Excessive growth of these types of organisms consequently clogs waterways. Algal blooms block light to deeper waters and deplete dissolved oxygen as they decompose. This proves very harmful to aquatic organisms as it affects the respiration ability of fish and other invertebrates that reside in water. Fish kills as well as changes in the types and numbers of aquatic species are not uncommon in lakes and rivers where eutrophication is accelerated by such discharges. Ultimately, eutrophication will fill the lake or water way with sediment and plant material.

EPA and ADEQ Regulations

The EPA through the 1974 Safe Drinking Water Act, has set standards for nitrogen compounds in surface and ground waters that are used in public drinking water supplies. MCLs are enforceable regulations that limit the amount of nitrate-nitrogen and nitrite to 10 mg/l and 1 mg/l, respectively. ADEQ, California EPA, and the Nevada Department of Conservation and Natural Resources have adopted these standards at the state level.

In addition, Title 18, Chapter 11, Article 4 of the Arizona Administrative Code (R18-11-405) contains a narrative for aquifer water quality standards. The narrative standard may be applied to an aquifer if nitrate "impairs" existing or reasonably foreseeable uses of water in an aquifer.

Detected Nitrate Concentrations

Nitrate impacts on the Colorado River channel are largely unknown. Groundwater samples from wells adjacent to the river, however, show variable levels of nitrates up to ten times the MCL standard. Nitrate concentrations exceeding these standards have been detected in Bullhead City, Mohave Valley, Lake Havasu City, Cibola, and in the Yuma region.

Nitrate levels from wells in Lake Havasu City steadily rose from 1 mg/l in the1970s to as high as 40 mg/l in 2001, and leveling off since then to highs in the 20mg/l range in 2005. Elevated nitrates also have been detected in wells adjacent to tributaries of the lower Colorado River, particularly along the Gila River in Yuma County, Sacramento Wash near Kingman, and in Detrital Valley in northwestern Mohave County.

Shallow groundwater systems adjacent to the River or reservoirs are directly connected, with groundwater flow directions changing as the surface water rises and falls in response to water delivery requirements. Computer modeling of the aquifer adjacent to the shoreline of Lake Havasu has shown that fluctuating groundwater flow has a direct impact on the transport of nitrates. Although slow, net flow of groundwater and nitrate migration is towards Havasu Lake. Lower River and lake conditions due to the drought will speed the migration of nitrates from groundwater to lake water.
Runoff from the Mohave and Bill Williams mountains east of Lake Havasu City after precipitation events that took place from July 2004 through February 2005, had dissolved nitrates with concentrations as high as 25 mg/l and averaging between 5-10 mg/l. There is no land development in these areas and nitrates are probably leached from subsoils containing naturally fixed concentrations of nitrate compounds.

Water samples collected and analyzed by the U. S. Geological Survey and EPA along the Colorado River over the past 30 years can be found at the following Web sites:

http://nwis.waterdata.usgs.gov/az/nwis/qw and
http://www.epa.gov/STORET/dw_home.html

O_NPCA-CBD et al 2

Current Mitigation Efforts

Treatment options for nitrate removal from municipal and industrial wastewater include Biological Nutrient Removal (BNR), reverse osmosis, ion exchange, electrodialysis, distillation and blending. The first four methods are approved by the EPA.

Biological nutrient removal (BNR) is the process whereby nutrients are removed from wastewater in addition to the organic content (historically the focus in conventional municipal wastewater treatment). BNR for nitrogen is generally accomplished in two steps: The first step is nitrification during which non-photosynthetic bacteria, usually of the nitrosomonas genus, convert ammonia to nitrites. Nitrification is accomplished by the extending the aeration time in a conventional wastewater treatment system to encourage the growth of nitrogen-consuming bacteria. The second step is denitrification. Denitrification is accomplished by adding a tank that operates under anoxic conditions to encourage the growth of nitrite-converting bacteria, generally the nitrobacter genus, which convert nitrite to inert nitrogen gas.

Enhanced Nutrient Removal or ENR takes water that has gone through the Biological Nutrient Removal (BNR) process and further refines the effluent physically, bio-chemically or chemically to reduce nitrogen and phosphorus levels. ENR can reduce nitrogen to 3 mg/L and phosphorus 0.3 mg/L respectively, whereas BNR is generally only effective for nitrogen down to 5 mg/L.

Reverse osmosis forces water through a membrane to segregate salts such as nitrates. Ion exchange replaces nitrates in water with chlorides when water is run through an exchange resin. Individual reverse osmosis systems are commonly used in residences to remove the high dissolved solids and minerals and to improve water taste. Electrodialysis employs electricity to drive ions through a semi-permeable membrane from one solution to another and compartmentalizes the water into a low electrolyte treated water area and a high electrolyte brine area. Distillation boils water to steam and collects the steam to turn back to water, thus purifying it. Blending water simply means diluting nitrate laden water with water in which nitrate concentrations are very low.

Since these treatments are expensive on a community size basis, elimination of the source is the most cost effective alternative. Lake Havasu City and Bullhead City have instituted sewer expansion programs to reduce the number of septic tanks and drain fields along the Colorado River. There are twenty-two other entities along the River with wastewater improvement projects that have been recently completed, are currently under construction, are scheduled, or are proposed within the next 20 years that will increase cumulative treatment capacities by tens of millions of gallons per day. The cumulative project costs may be more than $2.9 billion.

A major share (80%) of the improvement costs will occur along the reach of the River between Davis and Parker Dam. The continued rapid growth along the Colorado River, particularly in Mohave and Yuma counties in Arizona and all along the California side of the River, will challenge mitigation efforts if the developments are not well planned with respect to wastewater disposal. Ultimate disposal and quality of effluent produced from these projects will determine their effectiveness in reducing nitrate threats to the River.

Fertilizer application on agricultural fields is regulated in Arizona according to Arizona Administrative Code R18-9-402, as directed by Arizona Revised Statute §49-247, which require best management practices. These best management practices include the timing and amount of application, ground preparation, and irrigation after application. Implementation of these best management practices is intended to minimize nitrate leaching to the subsurface and periodic soil testing is required to monitor the progress of nutrient accumulation.

Some agriculture along the River has been curtailed, where fields have been laid to fallow or are in the process of being converted to wildlife habitat or are included in planned developments. Over 1300 acres of adjacent River property on the Arizona side at Cibola, south of Interstate 10 in La Paz County, will be used by the Multi-Species Conservation Program to develop riparian and upland habitat over the next 10 to 20 years. Further south on the California side of the river, an additional 3300 acres is also being considered for conversion at the Palo Verde Irrigation District. Other farmers have fallowed their land in cooperation with other state and federal programs. Developments are appearing where agriculture was once practiced in Mohave Valley and at scattered parcels in La Paz County. Less cropland means less fertilizer application, reducing the potential for nitrate introduction to the shallow groundwater and the River, however developments that include residential septic systems in their plans will continue to contribute nitrates to the shallow groundwater and the River.

Basin-wide watershed approaches through interagency coordination efforts concerning land-use are underway to study the effects of nutrients on the Colorado River system. ADEQ has conducted groundwater baseline studies with the help of the Arizona Department of Water Resources. The Multi-Species Conservation Program, administered by the Bureau of Reclamation, is an integration of federal, state, and local agencies and non-profit and private organizations to develop comprehensive, working programs for restoring or generating habitat along the lower Colorado River to protect endangered species. Part of the program's mandate is to monitor and mitigate contaminant problems that may affect restoration efforts.

Recommended Solutions for Implementation and Funding

Water quality monitoring efforts by the various agencies with respect to nutrients (in particular nitrate and phosphate) along the River system, including groundwater supplies, by federal, state and local agencies should continue. This is a cost effective measure to gauge any impacts from known problem areas and to identify any new areas of concern.

Current mitigation in the form of septic to sewer conversions in Bullhead City and Lake Havasu City should continue to eliminate their nitrate sources. Similar work needs to be done in other River communities. Conventional sewage treatment methods denitrify wastewater that otherwise would load nitrates to the subsurface and potentially to the lake. Those wastewater infrastructures already in place along the River should also be reviewed and evaluated as to their condition, efficiency and capacity. Some of these systems have been in place for many years. Upgrades and repairs should be implemented to those systems identified. Annual reports could be sent to the Colorado River Regional Sewer Coalition (CRRSCo), a diverse group of state and local agencies, Native American tribes and other organizations that have been formed to study regional sewer issues, protect and enhance water quality in the area of the lower Colorado River, and obtain federal funding for water quality improvements in the River.

O_NPCA-CBD et al 2

To ensure that wastewater systems in new developments are built to accommodate future growth and provide adequate treatment and disposal capacities, ADEQ should:

- Coordinate with the state designated planning agencies to review and establish a process, to adjust, if necessary, the regional water quality management planning program in regard to wastewater planning. Particularly, planning for discharge locations, wastewater facility design, adequate treatment and disposal capacities, adequate treatment and disposal methods and effluent water quality should be addressed in the review.
- Make certain that treatment performance requirements for all new sewage treatment facilities (R18-9-B204) are met and require existing facilities to be upgraded to meet best available demonstrated control technology (BADCT)

ADEQ and other agencies should continue to monitor Nevada's Clean Water Coalition project to discharge up to 450 million gallons per day of effluent directly to Lake Mead immediately upstream of Hoover Dam. Further, ADEQ and other agencies should continue to monitor the U.S. Department of Energy's (DOE) action to move the 12 million tons of radioactive uranium tailings away from the Colorado River to a holding site 30 miles away at Crescent Junction, Utah. Moving the uranium tailings will reduce the threat of ammonia-nitrogen to the Colorado River. DOE plans to begin the move in the spring of 2006.

The types of fertilizers and methods of fertilizer applications on golf courses should be reviewed and recommendations developed to minimize excess nitrate available to the underlying aquifers. This may be accomplished through state and local agencies and university or private research.

Lastly, educating the public is an important aspect to minimize nutrient (nitrate) leaching into the River. Many small developments with residential septic tank systems will probably not be converted to a collection system in the near future, so imparting knowledge of wise septic maintenance will help minimize septic failures. Similarly, alerting the public to wise recreational practices concerning human waste (such as through boating safety courses) will help reduce direct impact on the River.

Potential Funding Sources

The CRRSCo has been involved in assessing the nutrient conditions of the River system and has acted to seek federal funding. As a result of their lobbying efforts, Lake Havasu City was awarded in 2005 a federal earmark grant of $1.5 million to help their sewer expansion program. This group is working to secure more federal funding for water quality improvement projects along the lower Colorado River.
Colorado River communities formed CRRSCo to educate federal government leaders about and advocate for federal resources to address water quality issues on and near the Colorado River, particularly the potential problems posed by high concentrations of residential septic tank use and potential nitrate contamination in communities along the River. In accordance with a draft Bureau of Reclamation study regarding the nitrate problem along the Colorado River, CRRSCO estimates more than $2.4 billion is needed to construct infrastructure to alleviate the water quality problem. Taking into account current and planned activity along the River, CRRSCO estimates that there is a $2 billion gap between available funding and the amount required to meet the wastewater infrastructure needs along the river. CRRSCO proposes a federal funding solution to these water quality issues employing a model similar to the Great Lakes Initiative or the Chesapeake Bay Program, and the Alliance strongly believes that

federal involvement and funding is needed. State and local governments simply do not have the resources to fully fund the infrastructure needed to protect the Colorado River from further degradation from nitrate concentration caused by inadequate sewage treatment.

The U. S. Department of Agriculture, through their Rural Information Center (RIC), provides extensive information and referral services to local, tribal, state and federal government officials, community organizations, rural electric and telephone cooperatives, libraries, businesses and citizens working to maintain the vitality of America's rural areas (http://www.nal.usda.gov/ric/ruralres/funding.htm). An example of RIC's listings is the Small Community Water Infrastructure Exchange (SCWIE), which is a network of water funding officials. Under the auspices of the Council of Infrastructure Financing Authorities (CIFA), a group of public and non-profit environmental funding and technical assistance officials have come together to create SCWIE. Within the SCWIE there is the Environmental Finance Center Network, a unique program of university-based Technical Assistance Centers that provide environmental finance outreach services to help regulated communities create innovative solutions to help manage the cost of environmental protection covering a wide array of environmental concerns, including water-related issues. Among these water-related issues are: financing issues for water quality, quantity, erosion control, preservation and infrastructure.

State level funding is available to help with infrastructure construction and maintenance. In Arizona, funding in the form of low interest loans are available through the Water Infrastructure Finance Authority (WIFA), an independent state agency authorized to finance the construction, rehabilitation and/or improvement of drinking water, wastewater, wastewater reclamation, and other water quality facilities/projects. The Greater Arizona Development Authority (GADA), an agency to provide financial assistance to political subdivisions, special districts and Indian tribes to finance or refinance infrastructure projects, is another potential funding source that is appropriate for wastewater expansion and repair projects.

In California, the Division of Financial Assistance (DFA) administers the implementation of the State Water Resources Control Board's (WRCB) financial assistance programs, which includes loan and grant funding for construction of municipal sewage and water recycling facilities, remediation for underground storage tank releases, watershed protection projects, and nonpoint source pollution control projects. DFA also administers the Office of Water Recycling and the Water and Wastewater Operator Certification Program. The WRCB also is the lead agency that administers the 319 Program of the Clean Water Act Section 319(h) nonpoint source Implementation Grant in California. In Arizona, ADEQ's Water Quality Division administers 319(h) funds. The goals of the funding program are to reduce, eliminate, or prevent water pollution resulting from polluted runoff (i.e., nonpoint sources of pollution) and to enhance water quality in impaired waters. Funds available through the 319 Program are directed towards nonpoint source implementation projects that will achieve those goals. Also within California is the Clean Water Team Citizen Monitoring Program, which provides funding resources and a list of foundation and governmental grants for projects dealing with the environment and water quality monitoring.

In Nevada, the Drinking Water State Revolving Fund is a federal program administered by the Bureau of Water Pollution Control Nevada Division of Environmental Protection, to provide free technical assistance and low-interest loans to private and public water systems in Nevada to ensure compliance with regulations of the federal Safe Drinking Water Act.

O_NPCA-CBD et al 2

Projects, which may include wastewater construction projects if effluent is reused, are funded either as a loan out of the "account for the revolving fund" or as a non-construction project out of the "account for set-aside programs."

Other agencies that are stakeholders in water quality of the lower Colorado River and may be a source of funding are the Metropolitan Water District of Southern California and the Central Arizona Project.

Action Plan for Implementation and Funding

Following the recommendations from above, an action plan outline is offered:

- Continue existing wastewater improvement projects, with continued extensive search for outside funding sources to help pay for these projects.
- Identify areas of wastewater infrastructure improvement needs where improvement projects are not ongoing.
- Identify risk areas where nitrate contamination may exist or have a potential to develop.
- Prioritize those areas of 2) and 3) in terms of greatest needs based on contamination risk and expense of implementation.
- Search for funding to carry out the mitigating programs.
- Have ADEQ review (and revise if needed) their wastewater standards and practices to ensure that new developments have adequate sewage treatment capacity.
- Advocate for federal funding and support the efforts of CRRSCo to obtain federal funding.

Chapter 3
Metals

Pollutant Description

Metals as a Water Pollutant

A metal is a basic chemical element that readily forms ions and metallic bonds. Metals are one of the three principal groups of elements, along with the metalloids and nonmetals. On the periodic table, a diagonal line drawn from boron (B) to polonium (Po) separates the metals from the nonmetals. Nonmetal elements are more abundant in nature than are metallic elements, but metals in fact constitute most of the periodic table. Some well-known metals are aluminum, copper, gold, iron, lead, silver, titanium, uranium, and zinc.

All surface waters contain metals, generally appearing in colloidal, particulate, and dissolved states. Metals in surface water can result from both human activities and natural sources. Dissolved concentrations of metal ions are generally low, with most metals appearing in various oxidized forms, in combination with other elements, or adsorbed to clay, silica, or organic matter. The solubility of metals in surface waters is predominately controlled by the water chemistry (including pH), the type and concentration of other materials on which metals can adsorb (including substrate sediments and suspended sediments), the oxidation state of the minerals in which the metal is found, and other environmental factors. For example, sediment composed of fine sand and silt will generally have higher levels of adsorbed metal than will quartz, feldspar, and detrital carbonate-rich sediment. Metals have a high affinity for humic acids, organo-clays, and oxides coated with organic matter.

Water chemistry controls the rate of adsorption and desorbtion of metals to and from sediment. Adsorption removes free-floating metals from the water column and stores the metal in substrate. Desorption returns the metal to the water column, where recirculation and bioassimilation may take place. Metals may be desorbed from the sediment if the water experiences increases in salinity, decreases in redox potential (such as under oxygen deficient conditions), or decreases in pH.

Several metal ions such as sodium, potassium, magnesium, and calcium are essential to sustain biological life. At least six additional metals also are essential for optimal growth, development, and reproduction, i.e. manganese, iron, cobalt, copper, zinc, and molybdenum. However, where these metals are present in water in more than very small quantities, there is a danger of overdose, which can have toxic effects. In addition to the metals that are essential for life, water may also contain toxic metals like mercury, lead, cadmium, chromium, silver, selenium, aluminum, arsenic, and barium. These metals can cause chronic or acute poisoning as well as a host of other health problems in humans and wildlife. Arsenic and cadmium, for instance, can cause cancer. Mercury can cause mutations and genetic damage, while copper, lead, and mercury can cause brain and bone damage.

Metals can be transmitted to the environment through direct use of mining in ores, the burning of fossil fuels, leaching from landfills, or industrial discharges. Agriculture can also contribute to metal pollution as these elements are contained in some pesticides and as trace constituents in fertilizer. The trace elements end up in water systems through

atmospheric rain, agricultural run-off, mining wastes and domestic sewage. The hazardousness of metals can be dramatically increased as a result of bioaccumulation in the food chain.

One the key factors of metal pollution is that metals are not biologically or chemically broken down in nature. This stability also lets them be carried long distances through air and water. Most metals are hazardous for any aquatic ecosystem as well as for human health if they are present in any significant concentrations, although their ultimate polluting potential depends not only on their concentration in water but also on the form in which they are present. With the exception of mercury, the toxicity of metals is generally due to their presence in ionic form; combined forms and precipitated forms are generally less hazardous, although they can be liberated from these forms if water chemistry is unfavorable. As a result, conditions that favor the formation of metal ions (such as high salinity, low dissolved oxygen, or low pH values) generally increase the risk of metals contamination.

After reviewing available water quality information for the lower Colorado River Basin, the Alliance decided to focus on the following four metals: selenium, chromium, mercury and uranium. Each of the four metals are discussed separately.

Pollutant Description of Selenium

Selenium is a metalloid, having characteristics of both metals and nonmetals. It occurs in nature either as a cation in compounds of sulfide, arsenide, and oxygen, or as an anion, replacing sulfur. Selenium's mobility in the subsurface is limited by the large stability fields of the selenide anion and elemental selenium and is further limited by the strong sorption of the Se(IV) oxyanion to hydrous oxides. Selenium is mobile under high oxidation and low pH conditions.

In the Colorado Grand Canyon Watershed, the following stream segments are impaired due to selenium concentrations in excess of water quality standards: the Colorado River - Parashant Canyon to Diamond Creek and in the Virgin River - Beaver Dam Wash to Big Bend Wash. In the Colorado/Lower Gila Watershed, the following stream segments are impaired: the Colorado River - Hoover Dam to Lake Mohave and in the Gila River - Coyote Wash to Fortuna Wash.

Sources

Marine sedimentary rocks and deposits of the Late Cretaceous and Tertiary are generally seliniferous in the Western United States. Irrigation of these rocks and deposits where exposed can result in concentrations of selenium in water (Seiler, *et al.,* 1999). In the Colorado River Basin, seliniferous deposits, as sources of selenium in downstream water, have been investigated in the Grand Junction and Montrose areas of Western Colorado, near the San Juan River in Northwestern New Mexico and associated tributaries in Southwestern Colorado, and in areas along the Green River in Utah (Seiler, *et al.,* 1999). Selenium oxy-compounds are concentrated in ores together with uranium roll front deposits in Wyoming near the head waters of the Colorado River.

Water Quality Impacts

Human Health Effects

Trace amounts of selenium in the human diet is essential as a nutrient that is incorporated into an enzyme, glutathione peroxidase, that protects cells from oxidation. Selenium can also help in breast cancer treatment and retard the toxicity of cadmium, mercury, thallium, and silver by altering the way they react with the body. Selenium deficiency, although rare in humans, can lead to Keshan disease, which can lead to congestive heart failure. However, some studies indicate a possible correlation of high selenium diets with cancer, although not all such studies confirm this relationship. One case history of selenium poisoning from the People's Republic of China in the 1960s noted that patients' symptoms included disorders of the skin, nervous system, and teeth. That incident was related to eating food grown in high selenium soils, which were contaminated from nearby weathered coal containing high selenium concentrations.

Most selenium problems appear to be related to farm animals, but may also affect wildlife. Two major disorders with farm animals are blind staggers and alkali disease. Animals with blind staggers show acute symptoms of impaired vision, a depressed appetite, and wandering in circles after consuming plants with high selenium content.

Alkali disease develops after chronic exposure in which animals exhibit emaciation, loss of hair, deformation and shedding of hooves, loss of vitality and erosion of the joints of long bones.

Elevated concentrations of selenium was identified as the cause of mortality, congenital deformities, and reproductive failure in aquatic birds at Kesterson Reservoir on the Kesterson National Wildlife Refuge in the San Joaquin Valley in California in 1983 (Ohlendorf, *et al.,* 1988). Investigation of sources of selenium in soil in the Western United States began in the 1930s after discovery that selenium in pasturage was the cause of a fatal disease afflicting cattle and horses (Seiler, *et al.,* 1999). Selenium is also known to be detrimental to mammalian life when exposed to higher than trace levels.

A recent study conducted in the Colorado River Delta in Mexico (García-Hernández, 2005) found elevated levels of selenium in bird eggs throughout the Delta ecosystem. The mean concentration found in samples of marsh wren eggs exceeded the U.S. level of concern for selenium levels in aquatic ecosystems (generally 5 parts per billion). Based on comparisons of concentrations between wetland-inhabitant birds and birds nesting in terrestrial environments, and previous studies that have found elevated selenium levels in birds along the lower Colorado River (including the Cibola and Havasu National Wildlife Refuges) the study concluded that the likely source of this contamination is from the U.S. portion of the Colorado River as opposed to local soils in Mexico.

Current Mitigation Efforts

In general, two approaches are used to manage selenium pollution. First, management of irrigation of seleniferous deposits can reduce mobilization of selenium. Secondly, avoidance of concentration of river water containing selenium to problematic levels can avoid exposing aquatic biota to harmful levels. Additionally, the ADEQ includes discharge limits for selenium in its point source discharge permits based on chronic criteria of 2 parts per billion.

Another potential approach involves flushing flows through systems affected by selenium accumulation. In the upper Colorado River this practice has proved to remove selenium concentrations in the water, sediments and biota (Hamilton, et al., USGS, 2003), however this may not be feasible throughout areas affected in the Lower Colorado River.

Following the identification of selenium as a problem at Kesterson Reservoir, the United States Department of the Interior implemented, in 1985, the National Irrigation Water Quality Program to study the effects of irrigation drainage on water resources. Seiler, *et al.,* 1999 reported findings of investigations of that program. The U.S. Fish and Wildlife Service has sampled biota on the Havasu, Cibola, and Imperial National Wildlife Refuges on the lower Colorado River to determine if selenium toxicity was problematic in those areas. Combined, these efforts reveal the bioaccumulation of selenium in the aquatic food chain in these areas is evident in vegetation, invertebrates, birds and fish to levels that may be affecting eco-system productivity. Tissue sampling trends suggest continued accumulation over time may impact species diversity, and human health through regular bird or fish consumption (Rusk, 1991, King, et. al. 1993, Andrews et. al. 1997, Lemly et. al. 1996, Welsh et. al. 1994). A summarization of studies to mediate selenium food chain

impacts concludes toxic thresholds for waterborne selenium concentrations should be established at less than or equal to .003 mg/L in water (Maier et. al. 1994)

The Salinity Control Act of 1974 created the Colorado River Basin Salinity Control Program to plan and construct projects to reduce salt loading to the Colorado River (see Chapter 7 - Salinity). Improvements to irrigation infrastructure in seleniferous areas can reduce selenium loading significantly (Butler, D.L. 2001). In management of backwater areas along the lower Colorado River, such as through the Lower Colorado River Multi-Species Conservation Program, management of circulation, including funding, to avoid concentration of selenium to problematic levels is a design consideration, with monitoring to determine effectiveness.

Recommended Solutions for Implementation and Funding

Support continued funding for the Colorado River Basin Salinity Control Program to reduce salt loading in areas with sources associated with seleniferous deposits.

Encourage the Colorado River Basin Salinity Control Forum to address the constituents of salinity in areas where there are water quality impacts due to those individual constituents. Local officials should avoid development projects or programs that will result in further concentrations of selenium in areas that will affect local drinking water sources or will be frequented by birds and other wildlife (such as evaporation ponds, isolated backwaters without adequate circulation, or concentrated agricultural drains).

Develop coordinated monitoring activities, potentially through the Lower Colorado River Multiple Species Conservation Program (MSCP) to determine trends of selenium concentrations in both the water column and target species throughout the lower Colorado River.
Monitor fish tissue for selenium concentrations of species most commonly consumed by humans on a revolving three year basis from Lake Havasu to the international border.

Action Plan for Implementation and Funding

Support continued funding for the Colorado River Basin Salinity Control Program. (see also Chapter 7 - Salinity) Engage the services of the Lower Colorado River Resource Conservation and Development Council (RC&D) to seek financial support of selenium monitoring efforts.

Pollutant Description of Chromium

Chromium is a multi-valent metal found naturally in all igneous rocks, but is more concentrated in ultramafic igneous rocks, sometimes as an ore of iron or lead. Chromium is also present in soils, mobilizing under aerobic conditions. The most common forms of chromium in groundwater are the relatively insoluble trivalent form, Cr(III), which occurs in anaerobic conditions and is usually precipitated as chromium hydroxide ($Cr(OH)_3$), and the soluble hexavalent form, Cr(VI), which occurs as either the chromate (CrO_4^{2-}) or dichromate ($Cr_2O_7^{2-}$) ion. Both forms usually occur naturally in low concentrations, but may be higher near geologic sources or through introduction by human activities. Of the two forms, only Cr(VI) is considered dangerous to human and environmental health.

The transport of chromium in groundwater is highly dependent on the interplay of the pH, the organic matter, mineral, and clay content, and the oxidation conditions. Chromium adsorption to organic matter, clay mineral, ferrous iron, or sulfide mineral surfaces and subsequent reduction to Cr(III), occurs under anaerobic and lower pH conditions. As groundwater becomes more oxidized and alkaline, chromium must compete for adsorption with more common ions, keeping it in the mobile Cr (VI) form. The presence of manganese oxides and hydroxides, which may be common in groundwater along the Colorado River, also helps to stabilize Cr(VI), giving the opportunity for long transport paths.

Sources

Hexavalent chromium, in the form of chromate (CrO_4^{2-}) and dichromate ($Cr_2O_7^{2-}$) salts, is used in a wide variety of industrial activities and products such as its use as a pigment in paints, printing inks, and plastics, and as a constituent in metal alloys, hard chrome plating, corrosion inhibitors, refractory bricks, photographic film, wood preserving, and leather tanning. Industrial applications such as spraying, plating, and welding release chromium dust to the atmosphere.

Disposal of fly-ash from coal combustion is the largest release to soils by human activity. Illegal dumping of chromate solutions and sewage sludge disposal to the land surface are other significant sources of chromium to soils. Wood preserving solutions containing chromated copper arsenates carry an added threat of arsenic contamination if such solutions were released into the environment.

Water Quality Impacts

Health Concerns

Chromium enters the body by ingestion or by inhalation, although direct contact on the body can lead to systemic poisoning, dermatological ulcer generation, and if eyes are exposed, permanent eye damage may result. Chromium inhalation can cause lung cancer and respiratory tract ailments that could lead to nasal septum piercing and asthma. Air borne chromium dust has the double threat for direct inhalation and settling into a drinking water body to be later consumed. Chromium has even been known to accumulate onto cigarettes, which when smoked, is inhaled by the smoker. Long term ingestion of chromium in water or foods can lead to kidney and liver dysfunctions, nerve tissue damage, and internal hemorrhaging.

Environmental Concerns

The environmental effects to the biological community include toxicity to plants and aquatic life, yet chromium does not appear to bioconcentrate in food chains. Chromium is more toxic in soft water than in hard water. The acute toxic effects may be observed within two to four days of contact include the death of animals, birds, or fish, and death or low growth rate in plants. Chronic toxic effects may include shortened lifespan, reproductive problems, lower fertility, and changes in appearance or behavior. Soils containing high concentrations of chromium have become sterile.

EPA and State Regulations

The U. S. EPA's and ADEQ's maximum concentration level (MCL) in drinking water is 100 ppb for chromium. Arizona's surface water quality standards for hexavalent chromium to protect the domestic water source use is 21 ppb; while the chronic aquatic life standard is 1 ppb.

Detected Chromium Concentrations

Total chromium concentrations in the Colorado River and its associated reservoirs are and have been below the MCL standards for drinking water; however, there are two locations where hexavalent chromium is impacting groundwater adjacent to or near the river. These occur at the highly publicized Pacific Gas & Electric (PG&E) Compressor Station site on the California side of the river at Topock (I-40 river crossing) and at the former McCulloch manufacturing plant in Lake Havasu City (LHC), Arizona. The plume of hexavalent chromium bearing groundwater contains as much as 700 ppb and has traveled several hundred feet from its source to within 60 feet of the Colorado River. Investigatins and mitigation efforts are underway to define the extent of the Cr(VI) presence under order of the California Department of Toxic Substances Control. ADEQ is monitoring these efforts.

The second plume of chromium 6+ in LHC is being monitored by the current land owner and a monitoring well drilling program has identified most of its extent. Manufacturing operations at the old McCulloch chainsaw and outboard motor plant used chromium 6+ for plating metals. Hexavalent chromium occurs in the vadose zone above the water table where the chromium solutions were released; however a 1,200 feet long and 275 feet wide plume extends towards the River below the water table. The known downstream edge of the plume is about 3,800 feet from the River. Total chromium concentrations measured thus far range up to 240,000 ppb.

Current Mitigation Efforts

Both known hexavalent chromium sites in the lower Colorado River area are being monitored, and mitigation efforts are underway at the Topock location. Groundwater extraction wells adjacent to the River channel at Topock began pumping in early 2004 to help remove the impacted water and to create a reverse groundwater flow field that effectively deflects the groundwater from entering the river. Injection wells also have been drilled to re-inject treated water back into the aquifer. A sediment coring project in the River channel up and down stream of the facility will be conducted to determine the extent of contamination underneath the River channel. Officials from the California Environmental Protection Agency, the Arizona Department of Environmental Quality, and

the U.S. EPA have been following the mitigation work. ADEQ has initiated a groundwater study on the Arizona side of the River to help in determining whether chromium contaminated groundwater has reached Arizona.

Installation of additional monitoring wells and continued monitoring near the McCulloch site in Lake Havasu City is expected to better define the extent of that plume. Calcium polysulfide has been injected into a test well to convert hexavalent chromium to trivalent chromium.

Recommended Solutions for Implementation & Funding

Continued monitoring and mitigation efforts should continue at the two known sites to remediate the impact in the groundwater systems adjacent to the Colorado River. More work is needed at the Lake Havasu City site to determine the full extent of the hexavalent chromium contamination and what methodologies are most prudent to remediate the situation.

Hexavalent chromium analyses should be included in all River water sampling programs, particularly downstream from the PG&E Topock site. A GIS-based review of other industry activities, past and present, along the Colorado River should be instituted to determine any other potential sites that threaten the River system. If any are identified, environmental Phase I investigations are warranted, and if necessary, Phase II on-site investigations to determine the extent and degree of contamination. The next step in the process is Phase III remediation to clean the site(s).

Potential Funding Sources

In most cases, the land owner of the toxic contamination site pays for the investigations and remediations, which has been the case for the two known chromium VI contaminated sites. The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) or Superfund program administered by the U. S. EPA has helped to pay for hexavalent chromium remediation at sites in the past.

The Arizona Water Quality Assurance Revolving Fund (WQARF) also might be a potential source of clean-up funds although WQARF has not been fully funded by the Arizona legislature in recent years.

Action Plan for Implementation & Funding

- ADEQ should continue to monitor clean-up of the two known sites on the river.
- Investigate other potential sites along the River.
- Prioritize and address any potentially additional threatened sites.

Pollutant Description of Mercury

Mercury is a naturally occurring element found most often in the form of mercury sulfide (HgS) in volcanic rocks such as cinnabar, or in liquid form as “quick-silver”. Mercury also occurs as an accessory element in many common rock types such as granite or shale and is found in elevated amounts in some coal deposits. Because mercury can undergo two types of chemical reactions (oxidation-reduction and methylation-demethylation), in the environment, mercury may be found as elemental mercury (Hg 0), inorganic mercury (Hg +1 or Hg+2), or organic mercury [monomethyl mercury: $HgCH_3+$ or dimethyl mercury: $Hg(CH_3)_2$).

Sources

Naturally occurring mercury can be mobilized in the environment through excavation, hard rock mining/ore processing, or volcanic activity. Because of its amalgamating capacity, mercury was used extensively during the gold rush, particularly in placer mining, but also in lode operations prior to the use of cyanide in the 1920s. Arizona and the surrounding states share a history of extensive mining, including both lode and placer gold mining. Figure 3-1 shows existing mining activity in Arizona; note the gold mine sites within the Colorado River drainage. Aerial sources of mercury may include waste incineration, coal fired power plants, cement and lime kilns, smelters, pulp and paper mills, chlor-alkali factories, and forest fires. Figure 3-2 shows both potential regional aerial sources and mercury-contaminated lakes in Arizona as of 2003.

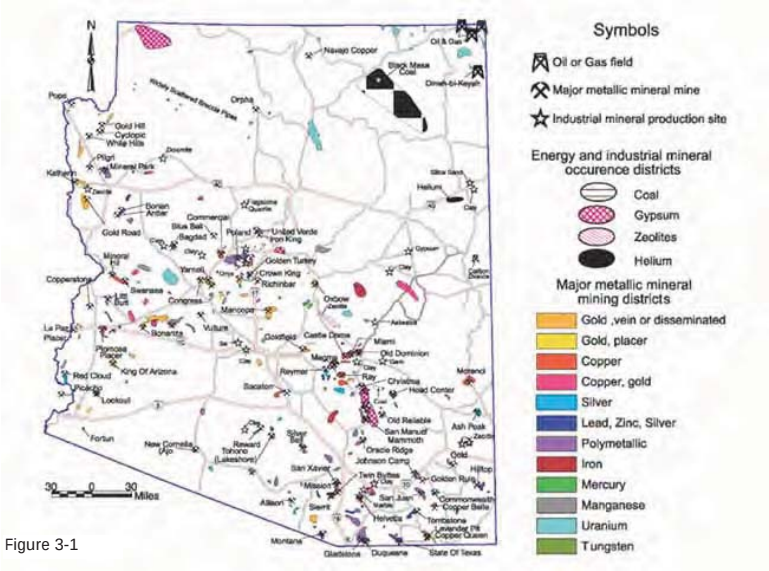


Figure 3-1

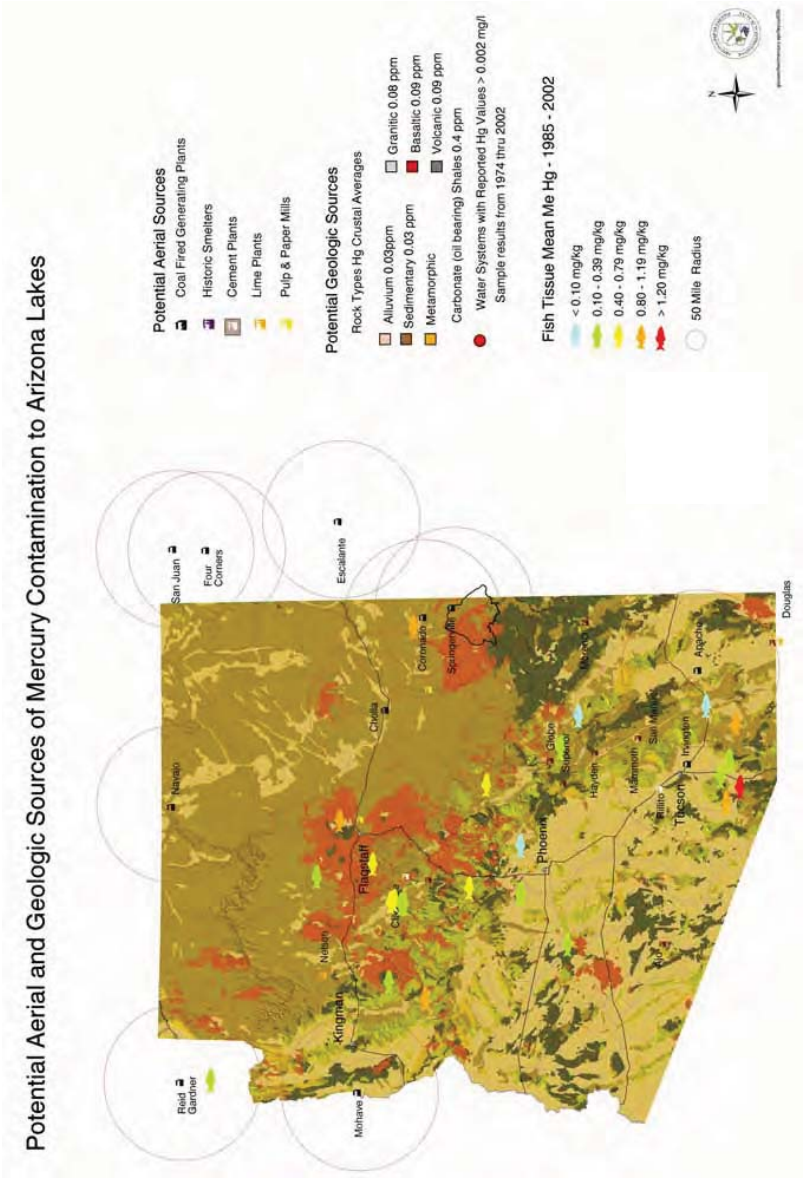


Figure 3-2

Uses of Mercury

Mercury has been extracted and used in manufacturing and industry for centuries. Among the various uses are: pigments, light bulbs, dental fillings, batteries, thermometers, electrical equipment (switches), chemical processing (e.g., chlorine and caustic soda), pesticides, and such things as the manufacture of felt hats or pharmaceuticals. Anthropogenic sources of mercury have become a global phenomenon and therefore its environmental fate and transport have become a global concern because of potential toxicity and its tendency to bio-accumulate.

Human Health and Environmental Concerns

Mercury can be toxic when inhaled, eaten, or placed on the skin. Depending on the chemical form and the dose received, mercury can be toxic to both humans and wildlife. In people, toxic doses of mercury can cause developmental defects in the fetus, as well as kidney and nervous system damage. High level exposures can be lethal, such as occurred in Minamata, Japan (1953-1960) from consumption of contaminated fish, or in Iraq (1971-1972) from ingestion of fungicide-tainted bread. Mercury has been shown to bioconcentrate up aquatic and marine food chains increasing the risks to top predators, including humans.

Increasingly, Arizona lakes and reservoirs are being listed as impaired due to high levels of methyl-mercury in fish tissue. One pertinent example is Alamo Lake in the Bill Williams watershed, which drains to the Colorado River system at lower Lake Havasu just above Parker Dam and the Central Arizona Project (CAP) intake structure.. The Clean Water Act requires that a Total Maximum Daily Load (TMDL) analysis be conducted on impaired surface waters to achieve standards compliance. TMDL sampling and analysis for Alamo Lake (ADEQ, (2004-2005) has revealed specific areas within the watershed that show elevated sediment and suspended sediment mercury that correlates with historic gold mining and a massive sulfide deposit. The contribution of aerial deposition (both wet and dry) has been estimated to be less than 20% of the total mercury load reaching Alamo Lake. For a more accurate analysis of mercury deposition in general, ADEQ has committed funds to support the first Mercury Deposition Network (MDN) site in Arizona.

Detected Mercury Concentrations

As mentioned, mercury has been detected in water and sediment in the Alamo Lake watershed using ultra-clean, low-level analytical methods. Mercury is present in the Alamo Lake discharge to the Bill Williams River downstream (tributary to the Colorado River near Parker), and there are also abandoned mines below Alamo Lake (e.g., Mineral Hill Mine) that drain to the Bill Williams National Wildlife Refuge. Mercury may also be entering the Colorado River between Lake Mead and Lake Havasu from areas such as Gold Road or Gold Hill. The threat of mercury contamination from other potential sources within the Colorado River drainage has not been determined with any certainty.

In the Bill Williams Watershed, the following segments are impaired due to mercury in excess of water quality criteria: in Burro Creek from Boulder Creek to Black Canyon and in Boulder Creek from an unnamed tributary to Butte Creek.

Waters also may be impaired due to mercury in fish tissue in excess of the standard. In the Bill Williams Watershed, Alamo and Coors lakes are impaired due to mercury in fish tissue. In the Little Colorado River Watershed, Upper Lake Mary, Lower Lake Mary, Soldiers Lake, and Soldiers Annex Lake are impaired due to mercury in fish tissue.

U.S. Fish and Wildlife studies published in 1993 and 1997 cite mercury detections in largemouth bass collected along the Colorado River corridor. The highest level of mercury detected was found in a fish from the Bill Williams National Wildlife Refuge (0.13 ug/g wet weight) but still well below fish levels found by AGFD/ADEQ in Alamo Lake (0.3 – 1.1 ug/g wet weight). Higher trophic-level birds such as eagles, osprey, or grebes that eat fish are particularly at risk.

Clark's grebes also showed the highest mercury level in an individual collected at the confluence of the Bill Williams and Colorado River (3.65 ug/g in liver; 5.38 ug/g in kidney, as compared to the "extremely hazardous" concentration of 20 ug/g suggested in the literature).

EPA and State Regulations

Mercury is regulated through the Clean Air Act and the Resource Conservation and Recovery Act, as well as the Safe Drinking Water Act and the Clean Water Act. It is one of approximately 120 priority pollutants. Because mercury is emitted as a byproduct of coal and oil combustion, emissions from power plants constitute about 40 percent of total U.S. mercury emissions annually.

The Safe Drinking Water Act establishes Maximum Contaminant Levels (MCLs) for mercury at 2.0 ppb (total mercury). Arizona Surface Water Standards cite this standard under Domestic Water Source, along with more stringent standards for aquatic and wildlife use (0.01 ug/L dissolved mercury for chronic exposure; 2.4 ug/L dissolved mercury for acute exposure).

Current Mitigation Efforts

Within the Bill Williams watershed, efforts are being mobilized to contain and cap the three tailings piles at Hillside Mine (Boulder Creek). Sampling for the Alamo Lake TMDL identified additional areas where further investigation is needed (Copper Basin/Skull Valley Wash; middle Santa Maria River, and upper Big Sandy River) to focus mining source attribution.

Recommended Solutions for Implementation & Funding

- Conduct a detailed mine survey, focusing on gold mining operations.
- Conduct further fish and wildlife testing along the Colorado River.
- Conduct clean mercury sampling with low-level detection in the main stem of the Colorado River and backwaters (if fish and wildlife levels warrant).
- Support additional air deposition monitoring stations in Arizona.

Potential Funding Sources

- Clean Water Act Nonpoint Source/TMDL Implementation grants (§ 104(b)(3) & §319).
- Federal agencies including: USFWS; BLM, USFS.
- State agencies: AGFD, ASLD, Mines & Minerals.

Action Plan for Implementation & Funding

- Interagency coordination to develop and implement further investigation.
- Identify localized mercury sources and prioritize remedial projects.

Pollutant Description of Uranium

Uranium is a natural and commonly occurring radioactive element. Rocks, soil, surface and underground water, air, and plants and animals all contain varying amounts of uranium. It is a reactive metal, so it is not found as free uranium in the environment. Typical concentrations in most materials are a few parts per million (ppm). Some rocks and soils may also contain greater amounts of uranium.

Natural uranium is a mixture of three types (or isotopes) of uranium: U-234, U-235, and U-238. U-234 is by far the most radioactive of the three isotopes and has the shortest half-life (the time it takes for half of the isotope to give off its radiation and change into a different element). Uranium decays through a series of different radioactive materials, eventually transforming into lead. The half-lives of uranium isotopes are very long (244 thousand years for 234U, 710 million years for 235U, and 41/2 billion years for 238U). Because U-235 and U-238 have such long half-lives, the uranium found in the earth today is the same metal that was present when the planet was formed.

Uranium is usually found only in very small amounts in nature, but where the concentrations of uranium in rock are high enough, the rock is considered a uranium ore and may be mined. After the uranium is extracted from ore, it is converted into uranium dioxide or other chemical forms. The residues remaining after uranium has been extracted are called mill tailings. Mill tailings normally contain a small amount of uranium, as well as other radioactive waste products such as radium and thorium. Uranium in mill tailings can combine with other chemicals in the environment to form various uranium compounds. Each of these uranium compounds dissolves to a different extent in water, ranging from not soluble to very soluble. The solubility of these compounds determine how easily the compound can move through the environment, as well as how toxic they are.

Sources

Uranium is found at low levels in virtually all rock, soil, and water. Significant concentrations of uranium occur in some substances such as phosphate rock deposits, granitic rocks (a source of radon gas), and minerals such as uraninite and carnotite in uranium-rich ores. sulfide and selenium deposits are associated with uranium ore bodies.

Anthropogenic sources include uranium ore body mill tailings from which precipitation runoff leaches the uranium compounds and the settling of uranium dust out of the air (in addition to soil dusts, coal-fired power plants normally emit some level of uranium dust). The levels of uranium in water in different parts of the United States are extremely low in most cases, and water containing normal amounts of uranium is usually safe to drink. Plants can absorb uranium from the soil onto their roots without absorbing it into the body of the plant. Therefore, root vegetables like potatoes and radishes that are grown in uranium- contaminated soil may contain more uranium than if the soil contained levels of uranium that were natural for the area.

Uses of Uranium

Uranium ore can be mined by underground, open-cut methods, or subsurface solution-leaching, depending on its depth and type of geologic environment. After mining, the ore is crushed and ground up. Then it is treated with acid to dissolve the uranium, which is then recovered from solution. Uranium may also be mined by in situ leaching, where it is dissolved from the orebody in situ and pumped to the surface. The end product of the mining and milling stages, is uranium oxide concentrate (U_3O_8), the conventional form in which uranium is sold. These mining and refining processes produce wastes such as mill tailings which may be introduced back into the environment by wind and water if they are not properly controlled.

When refined, uranium is a silvery white, weakly radioactive metal. Uranium in ores can be extracted and chemically converted into uranium dioxide or other chemical forms usable in industry. Depleted uranium is used by the military as shielding to protect Army tanks and also in parts of bullets and missiles. The military also uses enriched uranium to power nuclear propelled Navy ships and submarines, and in nuclear weapons.

The main civilian use of uranium is in nuclear power plants, helicopters and airplanes. Very small amounts are used to make some ceramic ornament glazes (added for color), light bulbs, photographic chemicals, and household products. Phosphate fertilizers often contain high amounts of natural uranium, because the mineral material from which they are made is typically high in uranium.

Human Health & Environmental Concerns

The release of radiation during the decay process raises health concerns. However, unlike other kinds of radiation, the alpha radiation ordinarily given off by uranium cannot pass through solid objects, such as paper or human skin. To be exposed to radiation from uranium, humans have to eat, drink, or breathe it, although some uranium transformation products produce more dangerous levels and types of radiation.

Because of the relatively weak radioactive character of uranium, uranium's chemical effects are likely more dangerous than the radiation it emits, although some of the transformation compounds associated with uranium (such as radium) are potentially hazardous. Some studies have suggested a correlation between kidney disease and exposure to large doses of uranium in both people and animals, as well as correlations to a type of bone cancer known as sarcoma. Since uranium tends to concentrate in specific locations in the body, risk of cancer of the bone, liver cancer, and blood diseases (such as leukemia) are also increased. Inhaled uranium increases the risk of lung cancer. Very high doses of uranium have caused reproductive problems (reduced sperm counts) in some experiments with laboratory animals. Very high doses of uranium in drinking water can also affect the development of a fetus in studies of laboratory animals.

Waste generated from uranium mining operations and rainwater runoff, if not properly managed, can contaminate groundwater and surface water resources with heavy metals and traces of radioactive uranium. The toxicity of uranium to fish varies with water quality particularly total hardness and alkalinity. It accumulates in soils and sediment and enters the food chain by adsorption on surfaces of plants and animals and by ingestion of sediments and contaminated food. Therefore, bottom-feeding fish have a higher risk due to accumulation than higher order predator fish.

O_NPCA-CBD et al 2

EPA and State Regulations

EPA standards under the Clean Air Act limit uranium in the air. The maximum dose to an individual from uranium in the air is 10 millirems. Uranium in drinking water is covered under the Safe Drinking Water Act. This law establishes Maximum Contaminant Levels, or MCLs, for radionuclides and other contaminants in drinking water. The current standards are: combined radium 226/228 of 5 pCi/L; a gross alpha standard for all alphas of 15 pCi/L, not including radon and uranium; a combined standard of 4 mrem/year for beta emitters. The MCL for uranium is 30 ppb.

In 1978, Congress passed the Uranium Mill Tailings Radiation Control Act (UMTRCA) in response to public concerns regarding potential health hazards of long-term exposure to radiation from uranium mill tailings. UMTRCA requires DOE to establish a remedial action program and authorizes DOE to stabilize, dispose of and control uranium mill tailings and other contaminated material at uranium-ore processing sites and associated properties. EPA has issued special regulations for cleaning up uranium mill tailing sites in Title 40 Code of Federal Regulations 192, Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings. The cleanup of contaminated sites to be released for public use, must meet EPA's risk-based criteria for soil and ground water. EPA's site cleanup standards limit a person's increased chance of developing cancer to between 1 in 10,000 to 1 in 1,000,000 from residual uranium on the ground.

Detected Uranium Concentrations

ADEQ has reviewed over 20 years of available water quality data for the Colorado River from the Utah border to the border with Mexico and found no exceedances of the surface water quality standard for uranium of 35 μg/l. However, there are a number of active or abandoned uranium millsites located along the Colorado River and its tributaries; of these, one Utah site, near Moab, in particular represents a significant potential source of uranium contamination in the Basin.

Among its provisions, UMTRCA charged DOE with reclaiming nine abandoned uranium millsites located within the floodplain of the Colorado River or its tributaries. Typically the tailings wastes at these sites were increasing radon levels in the local air and had seeped into the groundwater, where plumes of contamination threatened to enter the rivers. In each case, DOE decided to move the tailings to new disposal cells away from surface and ground-water, investing nearly $2 billion in the program by the late 1990s. Only ongoing groundwater treatment remains to be done in this effort.

The 1978 Act also provided for the Nuclear Regulatory Commission (NRC) to oversee eventual owner-funded reclamation of uranium mills still actively in business. This included the Atlas Mill along the Colorado River near Moab, Utah, formerly Uranium Reduction Company (URC) ore processing facility. This mill was the first commercial uranium mill in the U.S. and the largest ever built beside a river. The mill ceased operations in 1984 but over its many years of operation, approximately 10.5 million tons of uranium mill tailings have accumulated on site as a nearly 100 foot tall, 130-acre tailings pile. While the milling process removed approximately 95% of the uranium, the tailings contain several naturally occurring radioactive elements, including uranium, thorium, radium, polonium and radon as well as other pollutants.

The Atlas tailings pile averages 94 feet above the Colorado River floodplain and is about 750 feet from the Colorado River. The pile was constructed in a series of terraces and also contains

debris from dismantling the mill buildings and other structures. Radiation surveys indicate the tailings contain radioactive contaminants at concentrations above the EPA standards. Besides tailings and contaminated soils, other areas with environmental issues include unlined ponds used during ore-processing activities, disposal trenches, and other locations used for waste management during facility operation.

Initially, Atlas proposed, and the NRC approved, a plan to simply cover the unlined wastes in the River's floodplain. However, this proposal generated objections from the local government and a full EIS was prepared. During the course of preparing the EIS, it was discovered that leakage from the tailings pile and other hotspots on the mill property had contaminated the groundwater and the Colorado River into which it discharges. Studies showed that tailings seepage into groundwater had averaged 57,000 gallons/day during the 40-year life of the mill and that approximately 110,000 gallons of this tainted groundwater were reaching the River daily. The underground plume is more than 5,000 feet wide and extends more than 40 feet below the surface. Contaminants present in high amounts include uranium, molybdenum, selenium, ammonia, nitrates and sulfates among many others, with ammonia levels high enough to be immediately lethal to fish.

Faced with unexpected water treatment costs, Atlas Corporation declared bankruptcy in 1997, leaving behind a reclamation bond of approximately $5 million. A coalition of environmentalists, politicians and water districts with more than 25 million consumers of this water succeeded in getting legislation passed in 1999 transferring responsibility for the site to the DOE.

DOE prepared another EIS and found that the tailings pile is built in the center of an alluvial fan, vulnerable to possible failure during a large flood. The Arizona Department of Environmental Quality expressed its serious concerns about the impact of the tailings pile on water quality in the Colorado River to urge DOE to move the waste by rail, thirty miles north to a new disposal cell near Crescent Junction, Utah. Actual tailings removal is scheduled to begin in 2007 and continue until 2017.

Current Mitigation Efforts

In addition to moving the tailings, DOE will also implement active ground water remediation at the Moab milling site. Groundwater in the shallow alluvium at the site was contaminated by the milling operations. As ADEQ expressed in its comments to DOE, the Colorado River adjacent to the site has been negatively affected by site-related contamination, mostly because of groundwater discharge. The primary contaminant of concern in both the ground water and surface water is ammonia, which is highly toxic to aquatic life. Other contaminants of concern are manganese, copper, sulfate, and uranium. The reclamation plan calls for a pump and treat system that would extract groundwater and treat it to standards. It is anticipated to take between 75-80 years to remediate the groundwater at an estimated cost of nearly $500 million. Removal of the tailings produces a secondary benefit of reducing seepage of ammonia-nitrogen from the tailings, either subsurface or through surface discharge into the Colorado River.

O_NPCA-CBD et al 2

Figure 3-3. Aerial view of the Moab site in 2001 identifying the locations of the tailings pile, Moab Wash, Colorado River, upstream background sampling location and the Matheson Wetlands Preserve.

Recommended Solutions for Implementation and Funding

ADEQ should continue to monitor the U.S. Department of Energy's (DOE) action to:

- Move the 12 million tons of radioactive uranium tailings away from the Colorado River to a permanent disposal location 30 miles away at Crescent Junction, Utah
- Conduct active groundwater remediation on-site. Until the project becomes a permanent DOE budget line item, it will be necessary to assure each year that sufficient federal appropriations are made to keep the work on schedule.

Action Plan for Implementation and Funding

ADEQ should continue to monitor the U.S. Department of Energy's (DOE) removal of the uranium tailings pile and groundwater remediation at the former Atlas Minerals facility near Moab, Utah. Moving the uranium tailings will reduce the threat of uranium, ammonia and other pollutants to the Colorado River.

Chapter 4
Endocrine Disrupting Compounds

Pollutant Description

Endocrine disrupting compounds (EDCs) are an emerging group of potential water contaminants about which relatively little is known. EDC is a descriptive phrase for a broad group of natural and synthetic organic compounds that block or mimic normal receptor-activating hormones in the human endocrine system. They also may act as triggers activating the hormone system at undesired times and at undesired levels. The endocrine system plays an important role in maintaining the body's internal steady state (e.g. nutrition, metabolism, excretion, water and salt balance), regulation of growth, reaction to outside stimuli, and production and storage of energy. Normally, hormones produced from the endocrine glands carry messages to various parts of the body in response to nerve cell or gland stimuli and they attach themselves to a receptor cell. The receptor cell carries out the hormone's instructions and can either turn on genes to create new proteins for long-term effects (e.g. growth or sexual maturity) or can alter the activity of existing proteins to respond to the stimuli (e.g. faster heart beat, vary blood sugar levels).

Endocrine disrupting compounds can mimic the body's hormones and slip into receptor sites, but they do not carry the intended messages, effectively blocking the normal endocrine process, or altering it in a negative way. Some chemicals called environmental estrogens, can act like estrogen or androgen, altering sexual maturity in some fashion. Such changes include low sperm counts, early puberty in females, possible breast cancer increased incidents, and higher rates in testicular cancer. Those chemicals that block or alter hormonal binding to the receptor cells are called anti-estrogens. Still other chemicals can alter production and breakdown of natural hormones or modify the development and function of receptor cells. Exposure to EDCs may not result in a direct effect on the living organism, but may significantly alter the reproductive process with devastating results: the disruption of community structure and the ecosystem process.

Pharmaceuticals (prescription or not) are a category of possible EDCs. They affect the body because they are designed to specifically influence human receptors and many are lipophilic, which readily dissolve in fatty tissue, but not in water. The body uses the necessary part of the drug, and the rest is eliminated, eventually ending up in the environment. Most research has gone into two major classes of pharmaceutical effects: the promotion of pathogen resistance to antibiotics and the disruption of endocrine systems by natural and synthetic sex steroids. Other classes of concern to the EPA are anti-depressant selective serotonin reuptake inhibitors (SSRIs), calcium-channel blockers, efflux-pump inhibitors, antiepileptics, and genotoxic chemotherapeutic agents.

EDCs also may be a threat to the natural environment. Most EDCs, can accumulate within organisms and may negatively impact aquatic ecosystems by affecting various physiological processes in organisms. Preliminary studies indicate increased cancer rates, reproductive abnormalities, impaired reproduction, and development of bacteria with antibiotic resistance. Concerning the last issue, bacteria in the environment is exposed to antibiotic-bearing effluent and adapts to these chemicals, making them harder to destroy with antibiotics if they infect a person.

Sources

EDCs have a wide variety of origins both natural and synthetic with the pharmaceutical and chemical industries leading the way with synthetic production. Some EDCs are naturally occurring, such as phytoestrogens produced by plants. The pharmaceutical industry intentionally creates EDCs (i.e. health related drugs such as antibiotics, codeine, and acetaminophen) to correct the body's health problems, effectively restoring the body's normal behavior. The advent and increased use of contraceptives has also contributed to the amount of pharmaceutical EDCs released into the environment. In addition, the chemical industry unintentionally produces EDCs as byproducts of manufacturing or in agricultural applications. EDCs such as nonylphenol, alkylphenol ethoxylates (APEs), and phthalates are often found in common household items, such as detergents, cosmetics, personal care products, household cleaners, and even in plastic food containers. Several pesticides contain known or suspected endocrine disrupting compounds that enter our bodies through residues on food, which may be eliminated from the body and into the aquatic environment. Food and tobacco products also contain chemicals such as caffeine and nicotine derivatives that persist in the aquatic environment. Heavy metals like lead, mercury and cadmium are also byproducts of manufacturing and enter waterways via disposal from these facilities.

Pharmaceuticals in waste water effluent are a growing source of concern as more and more drugs are produced and consumed, and as the population increases along the Colorado River. The body utilizes the drugs, but eventually excretes unused portions, which make their way into septic or sewer systems, all of which eventually lead to groundwater infiltration that migrates to the River or is directly discharged to the River. Household cleaners and personal care products also end up either in groundwater or sewage treatment plants. Las Vegas is currently discharging effluent that eventually drains into Lake Mead, and along with Henderson and Clark County, Nevada has proposed to directly discharge up to 450 million gallons per day of treated effluent into the deeper parts of Lake Mead. There also are locations on the River where effluent is disposed through percolation or natural infiltration from effluent use. Table 4-1 gives a partial list of EDC sources and the type of EDC associated with the source.

Table 4-1: Types of and potential sources of EDCs

EDC Sources	EDC Category	EDCs
Landfill	Polychlorinated compounds	Polychlorinated dioxins and biphenyls
Agricultural runoff	Organochlorine pesticides	DDT, dieldrin, lindane
Industrial effluent	Alkylphenols and Phthalates	Nonylphenol, dibutyl phthalate, butylbenzyl phthalate
Municipal Effluent	Natural hormones, synthetic steroids, pharmaceuticals	Estradiol, estrone, testosterone, ethynyl estradiol
Atmospheric/ Combustion Emissions	Androgenic	Oxygenated organic species

Water Quality Impacts

Much research is being conducted to understand the role of EDCs in water quality issues. This group of chemicals was not considered a problem in the 1970's through much of the 1990's as their concentration levels in surface and ground water were and still are in most cases below detection limits of analytical procedures. New technology has pushed the detection limit to the fraction of a microgram per liter (parts per trillion) level. EDCs, including pharmaceutical and personal care products, are introduced into surface waters via treated wastewater inputs, confined animal facilities, runoff of terrestrial pesticide formulations, household cleaning products, industrial processes, and direct application with tank- mixed aquatic pesticides. The US Environmental Protection Agency (EPA) has put maximum concentration level limits (MCLs) concerning drinking water quality on several EDCs; however, most chemicals within the EDC family have not been studied enough to ascertain their health affects and currently are not regulated.

EDC's Measured in Colorado River Water

Generic sampling of river and lake water related to EDCs along the Colorado River (particularly in Lake Havasu) do not indicate any immediate threats from EDCs, yet a 2000-2001 U.S. Geological Survey study of Lake Mead and Las Vegas Wash focusing on pharmaceuticals and food derivatives, found detectable levels of 13 such compounds. Only six of the 13 compounds were detected in Lake Mead, which was sampled twice, once in the spring and once in the summer. All 13 compounds were present in Las Vegas Wash at one time or another during six sampling periods spread throughout a year's cycle. Caffeine, cotinine, and 1,7 dimethylxanthine were the most widespread compounds detected. Cotinine is a metabolite of nicotine, which is present in tobacco products, and 1,7 dimethylxanthine is used in dietary and appetite suppressants. Caffeine increased its concentration in lake water from early spring to summer in response to recreational activity on Lake Mead. The low number of detections of these compounds in Lake Mead probably reflects the dilution factor within a large water body. The study also suggests that increased water temperature during summer months may amplify biodegradation (analgesics and anti-inflammatories) or biological uptake (antibiotics) of some of these compounds.

The effects of long-term exposure to low levels of individual or combinations of EDCs are being addressed through extensive research efforts in the United States and Europe. A potential non-health related problem is the negative affect that EDCs may have on bacteria beds used to purify water in waster water treatment facilities.

Current Mitigation Impact

There are no regulations specifically aimed at EDC mitigation on the Colorado River system. The EPA has released preliminary reports discussing steroid and other EDC removal strategies from drinking water treatment processes. Results indicate that granular activated carbon adsorption and forms of biodegradation may be useful in removing some steroids, DDT, PCBs, endosulfan, methoxychlor, diethylphthalate, diethylhexylphthalate, and bisphenol A. The EPA is currently focusing on alkylphenolic compounds which result from waster water treatment processes. Current technology can be employed to remove EDCs from both water and wastewater, as the need dictates.

Summary

EDCs, including pharmaceuticals and personal care products, come from many different sources and represent many classes of chemical compounds. Limited work on the lower Colorado River system has detected the presence of a few of these compounds, and the issue of effects on overall human health remains uncertain. The detected compounds are predominantly antibiotics, prescription drugs, human waste metabolites, and pesticides.

Recommended Solutions for Implementation and Funding

Additional research is recommended to augment the limited data on the impact(s) of EDCs to humans and wildlife. Characterizing the occurrence of the compounds as well as the impacts will guide water managers to determine if EDC removal is warranted. The water industry will benefit from these studies, as this is a nation-wide issue, not just a local point of interest. Specific recommendations include the following:

- Perform a literature search and compile all available studies, reports, and data on EDCs in the ecosystem and their impacts. Identify opportunities to collaborate with on-going research teams such as University of Arizona, Arizona State University, Colorado School of Mines, University of California – Berkeley, Southern Nevada Water Authority, and WateReuse Foundation.

- Characterize the occurrence of EDCs along the Colorado River by developing and implementing a Water Quality Sampling Program (WQSP) at selected locations including the following:
    - Up-gradient and down-gradient of sources of EDCs
    - Influent to water treatment plants
    - Recreational areas

- Prioritize issues identified from the reports on the literature search and WQSP to direct future research programs.

- Implement research programs to determine the impacts to humans as well as the ecosystem.

- Communities with household hazardous waste programs should provide education about the proper disposal of unused prescription medications and should accept unused prescription medications in their programs.

Funding sources for the WQSP include the US Environmental Protection Agency, Centers for Disease Control, AWWA Research Foundation, and Water Environment Research Foundation. Analysis of the data and studies specific to the ecosystem can be funded through US Fish & Wildlife Services, Wildlife Conservation Fund, the Heritage Grant Fund and ADEQs Waste Reduction Assistance Program.

O_NPCA-CBD et al 2

Action Plan for Implementation and Funding

ADEQ is recommended to perform the literature search and to manage the WQSP by developing a program similar to *Perchlorate in Arizona; Occurrence Study of 2004*. Management would include utilizing the expertise of organizations skilled in collecting EDC samples and performing the analytical work, such as the US Geological Survey. ADEQ is recommended to assemble a team composed of the impacted stakeholders and selected experts to characterize and prioritize the salient issues based on the results of the two reports.

Chapter 5
Perchlorate

Pollutant Description

Perchlorate (ClO_4^-) is a negatively charged ion composed of chlorine and oxygen. It combines with ammonium, potassium, or sodium ion to form perchlorate salts. Perchlorate salts have very low volatility, but high solubility. In addition, perchlorate sorbs poorly to mineral surface and organic material, which leads to high mobility in aqueous systems (i.e. surface water and groundwater).

Sources

Perchlorate salts are naturally occurring or they can be man-made. Naturally occurring perchlorate is suspected in certain regions like the southern high plains of the Texas Panhandle. Detection of perchlorate in rain and snow samples suggests that a natural perchlorate background of atmospheric origin may exist. Man-made perchlorate salts, particularly ammonium perchlorate, is used by the military and aerospace industries as an ingredient in solid rocket fuels and propellants. Perchlorate is also found in explosives, pyrotechnics, blasting operations, dry batteries, and auto air bag inflators. There are other non-military/industrial uses and sources of perchlorate including use as a therapeutic drug in the treatment of thyroid disease, most notably hyperthyroidism associated with Graves disease, and in fertilizers derived from Chilean caliche, an ore containing nitrates. However, a 2001 survey of fertilizer composition conducted by the US Environmental Protection Agency (EPA) concluded that "fertilizer use would probably not be a major source of perchlorate contamination and would be possible only where fertilizers derived from Chilean caliche were used."

Water Quality Impacts

Because of concerns about the possibility that perchlorate ingestion could interfere with thyroid function in a sub-group of the population (i.e., pregnant women with iodine deficiency), some scientists, health officials and the general public have recently questioned the safety of affected drinking water supplies, including the Colorado River.

Current Regulatory Guidance

In January 2005, the National Academy of Sciences (NAS) issued a report on the health effects of perchlorate. It recommended a reference dose of 0.0007 milligrams per kilogram of body weight per day (mg/kg per day). In light of the NAS report, the U.S. Environmental Protection Agency (EPA) established 0.0007 mg/kg per day as the official reference dose for perchlorate in February 2005 EPA's reference dose represents a daily oral exposure level to the human population, including the most sensitive sub-groups, that is not expected to cause adverse health effects during a lifetime. At this time, EPA has not determined whether a drinking water standard, or Maximum Contaminant Level (MCL), for perchlorate is appropriate. If EPA decides that a perchlorate MCL is necessary, the agency may use this reference dose to establish the MCL. This regulatory process likely will take several years.

In the absence of a federal MCL, some states have already adopted or are in the process of adopting health goals for perchlorate. On March 11, 2004, California Environmental Protection Agency's Office of Environmental Health Hazard Assessment (OEHHA), adopted a Public Health Goal (PHG) of 6 ppb, and the state re-affirmed this PHG after the publication of the NAS report. More recently in August 2005, California's Developmental and Reproductive Toxicant (DART) Identification Committee, a panel of independent scientists administered by OEHHA, concluded that available scientific information on perchlorate was not sufficient for placing the substance on the Proposition 65 list of chemicals that cause birth defects or other reproductive harm. California Department of Health Services (DHS) is progressing towards establishment of an MCL in drinking water based on OEHHA's PHG.

Other states like Nevada and Arizona have similar cleanup levels or health goals for perchlorate. Nevada uses a perchlorate "provisional action level" of 18 ppb based upon interim guidance provided by U.S. EPA on June 18, 1999 and reaffirmed on January 22, 2003. Arizona established a Health Based Guidance Level (HBGL) of 14 ppb for perchlorate in drinking water. HBGLs represent concentrations of contaminants in drinking water that are protective of public health during long-term exposure. Both Nevada's cleanup level and Arizona's HGBL for perchlorate were established several years before the NAS study and EPA's subsequent adoption of the current perchlorate reference dose.

Colorado River

In 1997, the Metropolitan Water District of Southern California discovered perchlorate in their water supply from the lower Colorado River. This discovery was made possible because of a new and more sensitive test method than was available in earlier years. The contamination was traced to Lake Mead and the Las Vegas Wash, and eventually to a Kerr McGee chemical plant in Henderson, Nevada. This finding prompted US EPA, the Nevada Division of Environmental Protection (Nevada) and Kerr McGee Chemical Company (Kerr McGee) to initiate immediate efforts to control the source and reduce perchlorate releases (mass loading) to the Las Vegas Wash.

Perchlorate-contaminated groundwater flows north about three miles from the Kerr McGee facility to the Las Vegas Wash. It is the most significant source of perchlorate entering the Las Vegas Wash. Prior to implementing any control measures, groundwater and surface water discharges to the Las Vegas Wash from all sources resulted in approximately 900 - 1,000 pounds per day of perchlorate loading. This load has been reduced to approximately 100 – 160 pounds per day by mid 2005.

O_NPCA-CBD et al 2

Current Mitigation and Remediation Efforts

Control Strategy

Kerr McGee, EPA, and Nevada cooperated in the development of a containment and remediation strategy for the Kerr McGee facility. The current strategy focuses on capture and treatment of perchlorate-impacted water at three discrete locations. The first location is at the Kerr McGee facility where perchlorate is most concentrated; the second is about midway between the facility and the Las Vegas Wash where there is a narrow subsurface channel that makes effective capture possible; and the third is proximate to the Las Vegas Wash where capture will have the most immediate impact on reducing the flow to the Las Vegas Wash. Each of these discrete locations reduces the load deposited into Lake Mead and correspondingly, the load present in the lower Colorado River.

In addition to the Kerr McGee facility, there is another contributing plume that is both smaller and much less concentrated. This plume, attributed to a former PEPCON perchlorate plant, is being investigated and will be remediated. American Pacific Corporation (AMPAC) is the parent corporation for PEPCON. In December 2002, AMPAC initiated a pilot study to determine the feasibility of an in-situ bioremediation (ISB) program to reduce perchlorate contamination. The ISB Pilot Study was successful in reducing perchlorate concentrations from about 500 parts per million (ppm) to less than 2 ppb. Nevada is requiring AMPAC to install a remediation system at the leading edge of its plume by the end of 2005. An ISB system will be installed and activated in two phases. The first phase is scheduled for activation by the end of 2005. The second phase will allow for activation of the full-scale long-term ISB system by early 2006.

Current Status

The Kerr McGee control strategy has eliminated perchlorate-impacted groundwater from the facility. This has been achieved through the installation of a slurry wall (1,700 feet long and 60 feet deep) and 22 corresponding extraction wells. In 2004, these wells captured approximately 950 lbs/day of perchlorate. As of May 2005, nearly 940 lbs/day of perchlorate were removed by these wells.

The control strategy employed at the Athens Road Well field, the midpoint between the facility and the Las Vegas Wash consists of eight extraction wells, which began regular operation in October 2002. They capture residual perchlorate-impacted groundwater midway between the facility and the Las Vegas Wash. In 2004, these eight wells removed 760 lbs/day of perchlorate, or an estimated 90 - 98% of the mass flow approaching this well field. As of May 2005, monitoring data indicates approximately 775 lbs/day of perchlorate were removed.

The controls near the Las Vegas Wash, which consist of both surface water and groundwater capture via a seep intercept system and 10 wells, capture an estimated 70 - 90% of the mass flow. Amounts are decreasing and have dropped from about 500 lbs/day in early summer 2003 to about 190 lbs/day in 2004 and have continued to drop to about 150 lbs/day through the first half of 2005.

Lake Mead

Perchlorate concentrations are monitored at two different locations in Lake Mead. Samples are taken from monitoring sites in Las Vegas Bay and near Saddle Island. Surface water sampling reveals seasonal variations from 10 - 100 ppb over the last five years. The sample values tend to peak in spring/summer and dip in the fall/winter, corresponding with the seasonal variations in water elevations.

Monitoring results at the Las Vegas Bay site showed no clear trend (except seasonal variation) from 2000 to 2003; summer time peak in 2004 shows a decrease of about 60% compared to 2002 and 2003.

At Saddle Island, concentrations began to decline in late 2003 and continued to decline through the first half of 2005. In late 2003, the monthly average peaks were 10.5 ppb, (about 35% lower than previous 3 year's peaks). In 2004, the monthly average concentrations ranged from 4.2 ppb to 4.7 ppb between July and November. The annual average for 2004 was 5.6 ppb, a decrease of about 40% from the 2003 annual average of 9.8 ppb, and a decrease of almost 60% from the 2000 annual average of 13.1 ppb. The Saddle Island monthly average perchlorate concentrations continue to show declines through the first half of 2005 as the groundwater remediation system operated by Kerr-McGee continues to limit the amount of perchlorate entering Las Vegas Wash and Lake Mead.

Since mid 2003, concentrations of perchlorate at Saddle Island in Lake Mead ranged from about 3 to 11 ppb. These levels are well below the EPA reference dose. EPA established a reference dose of 0.0007 mg/kg/day of perchlorate. This reference dose translates to a Drinking Water Equivalent Level (DWEL) of 24.5 ppb. A DWEL is the concentration of a contaminant in drinking water, including a margin of safety, which will have no adverse health effect. A DWEL is not a drinking water enforcement standard. These levels are less than the Nevada cleanup level and Arizona's HBGL.

Lower Colorado River

The lower Colorado River is also sampled at two locations. The first location is below Hoover Dam at Willow Beach and is intended to measure perchlorate concentrations in water entering the Colorado River. Annual peak concentrations have declined gradually at this location from approximately 10 ppb to about 6 ppb in early 1999 to less than 4 ppb through the first half of 2005. According to the Nevada Division of Environmental Protection, the average annual concentrations continue to decline and have been reduced approximately 40% from 2000 to 2004. In 2005 this trend is continuing and perchlorate concentrations have declined to below 2.00 ppb in the last few months (1.8 ppb in July 2005 and 1.9 in August 2005).

The lower Colorado River is also sampled at the Colorado River Aqueduct at Lake Havasu. This site is intended to measure the perchlorate concentrations as they enter the southern California drinking water supply system. Here, peak concentrations also have shown gradual decline from 9 ppb to less than 4 ppb since control strategies were initiated in November 1999. In the 2004 sampling year, nine out of the twelve monthly samples were non-detect (Method 314 Reporting Detection Limit (MDL) = 4 ppb). All monthly samples for the first half of 2005 also have been non-detect using a 4 ppb detection limit.

For risk assessment purposes, all non-detect samples were recorded and graphed as 4 ppb. The average annual concentrations have been reduced approximately in half, from 6.4 ppb in 2000 to less than 4 ppb in 2004 and are expected to remain at less than 4 ppb throughout 2005.

Separate from the Kerr McGee cleanup efforts, the State of Arizona conducted a perchlorate occurrence study in 2004. Seventeen surface water samples along the lower Colorado River mainstem were taken. Sample results indicate perchlorate concentrations ranged from non-detect to 6 ppb. The study also concluded that there is a "slow, steady decline in perchlorate concentrations in both surface and groundwater along the Colorado River as well as in areas using Colorado River water in central and southern Arizona."

System Recovery

It will take time for the groundwater and surface water system of the Las Vegas Wash through Lake Mead and into the lower Colorado River to recover from the mass loading that has occurred historically in this region. Even after the source of perchlorate is eliminated, it will require additional time for clean water to flush out the contaminated groundwater and surface water systems. Ongoing remedial efforts are reducing the perchlorate concentrations and mass. In an effort to estimate how long it would take Colorado River perchlorate concentrations to reach target levels under various perchlorate control strategies and hydrologic conditions (time necessary to flush the system), Flow Science, a consulting firm from Pasadena, California, was engaged by the Metropolitan Water District of Southern California (MWD) to provide a predictive tool for MWD to understand how perchlorate concentrations in the lower Colorado River could be expected to decline over time. Flow Science conducted a perchlorate modeling effort and presented a final report in March 2004. Assuming 90% of all perchlorate sources to Las Vegas Wash are captured by October 2002, the modeling predicted that perchlorate concentrations at the Colorado River Aqueduct intake (where California sources its water from the Lower Colorado) would reach 4 ppb by mid-2004 and 2 ppb by mid-to late-2005. The modeling predictions have been borne out to date by the 2004 annual average concentration at this location which was less than 4 ppb, the consistent set of sample results demonstrating concentrations at this location have remained less than 4 ppb since June 2004, and the July and August 2005 Willow Beach concentrations which are less than 2 ppb.

Recommended Solutions for Implementation and Funding

Current efforts to reduce perchlorate concentrations in the Colorado River should continue. These include the industry and government efforts to arrest and mitigate the sources of perchlorate which migrate to Lake Mead and the Colorado River through the Las Vegas Wash. These ongoing efforts continue to reduce the levels of perchlorate in the Colorado River.

Action Plan for Implementation and Funding

Appropriate containment, control and cleanup efforts have been and are being implemented and are improving the River. Consistent with the recommendation in *Perchlorate in Arizona Occurrence Study of 2004*, the State of Arizona is encouraged to continue monitoring the cleanup and mitigation efforts of the Colorado River.

Chapter 6
Bacteria and Pathogens

Introduction

Bacteria are microscopic organisms that have existed for a very long time. Geologic record shows bacteria to have existed 3.2 billion years ago. Some researchers believe that the first oxygen that appeared on Earth, 2 billion years ago, was created by bacteria. The discovery of bacteria in 1676 is credited to Antony van Leeuwenhoek. In 1,876 it was discovered that bacteria could cause disease.

Bacteria are very diverse and many can multiply quickly depending on surrounding conditions. Some bacteria are extremely hearty and can remain dormant while conditions are not good. Still other bacteria can be carried in the air. Bacteria are at the bottom of the food chain and are known as decomposers. They play a very important role in recycling organic materials that plants and animals need to survive. There is a proportional tie between nutrients, sediments and bacteria that should be recognized. Because bacteria are living organisms that have a preferred habitat, more nutrients and/or more sediment probably means more bacteria.

The human body is home to many kinds of bacteria. Bacteria can cause disease two ways. First, the bacteria can multiply itself inside the human or animal body and second, it can produce a toxin which makes the victim ill.

Pollutant Description

Coliform bacteria are a large group of bacterial species and are most commonly associated with water quality. The group includes both fecal coliform and non-fecal coliform. Fecal coliforms can include disease-causing and non-disease causing species. *Escherichia coli (E. coli)* is one species of fecal coliform bacteria present in the fecal matter of warm blooded animals. E.coli is used in water quality sampling as an indicator of fecal contamination and the potential presence of other harmful organisms.

One other form of bacteria worth mentioning here is *cyanobacteria*. Cyanobacteria were once mistaken for blue-green algae; however, further research suggested that the composition of cyanobacteria did not agree with the make-up of algae. Cyanobacteria have been shown to cause toxic blooms in freshwater. They produce toxins that can be very harmful to animals and possibly, to humans. Cyanobacteria have been implicated as a likely cause of fish kills in freshwaters. The two most likely pathogens that will be found in recreational waters are *Cryptosporidium* and *Giardia*.

Figure 6-1: Above is a picture of fecal coliform bacteria.

According to the CDC, cryptosporidium is a parasite that lives in the intestine of animals and humans. It is able to live outside the body for extended amounts of time and is

very resistant to chlorine disinfectants. Cryptosporidium is now recognized as one of the most common sources of disease in drinking and recreational water in the United States and the world.

CDC describes *Giardia* as a one-celled parasite that lives in the intestine of both animals and humans. Like *Cryptosporidium, Giardia* can live outside the body for a very long time. It, too, is found all over the world and has become known as one of the most common sources of waterborne disease.

Sources

All natural water (rivers, lakes, wetlands) contain bacteria. Ground water usually has fewer bacteria than surface water because of its long travel time in the sub-surface environment. However, ground water can become contaminated by sewage – via septic systems or sewer outfalls, fertilizer and surface runoff, as well as other pollution sources. Potential sources in Arizona include high density of on-site wastewater systems, storm water run-off from the monsoons during the summer and rain/storms during the winter and inadequate number of sanitary facilities in recreational areas along the Colorado River. Bacterial contamination is an issue that is linked with high concentrations of people and animals, whether it is recreational or residential.

Some of the communities along the Colorado River were developed with the use of on-site wastewater systems. As discussed in Chapter 2 on Nutrients, in the past few years, communities such as Bullhead City and Lake Havasu City have been sewering their cities in order to avoid bacterial and other contamination of the River. Effluent from a septic system may have bacteria which then has the potential of contaminating the ground-water (see Figure 6-2). Wastewater treatment plants also have potential for contaminating the River via release of untreated effluent due to a failure in the treatment system or a broken pump or line.

Several communities do release effluent directly into the Colorado River including, both Laughlin and Las Vegas, Nevada. Moreover, Las Vegas, Henderson and Clark County, Nevada, has proposed to discharge substantially increased quantities of effluent (up to 450 million gallons per day) into Lake Mead. This is treated effluent; however, the risk remains for a break in the system which could result in detrimental effects on the river.

Storm water run-off also occurs when enough rain falls to cause flow. With the large drainages and washes that dot the Arizona desert, the potential for bacterial contamination of the River is present. During these events, the storm water runs over and mixes with organic material that is available in the washes and drainage areas. The drainage patterns are constantly changing with the explosive development along the Colorado River. Each time the drainage pattern changes, a new set of challenges are encountered. It should be noted that the Bill Williams and Gila Rivers are the only perennial tributaries in the lower Colorado River that can introduce substantial flood influence on the main stem Colorado.

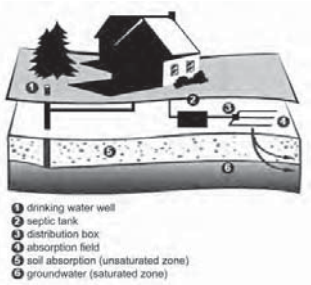


Figure 6-2: Diagram of how effluent eventually enters the groundwater.

Recreational activity along the Colorado River also increases bacterial contamination potential. With inadequate numbers of sanitary facilities (both restrooms and trash facilities), tourists and recreationalists will consistently contaminate the shoreline of the River. Trash along the shoreline of Lake Havasu has increased substantially over the last several years as evidenced by the volume collected. When sanitary facilities are not available, those using the River will contaminate the shoreline with trash (containing all matter of material including diapers) and excrement which is eventually washed into the River. Potential for pollution also exists due to the boat pumping stations along the River. Any malfunction at these stations could introduce bacteria to the River again.

Water Quality Impacts

Health Issues

Elevated levels of bacterial and protozoan contamination in the Colorado River may cause a variety of illnesses including, but not limited to, E. coli, cholera, shigella, salmonella and campylobacter. According to the CDC, each year an estimated four billion diarrheal episodes occur and an estimated two million deaths, the majority of which occur in third-world countries, with a smaller percentage occurring here in the United States. CDC believes that at least half of these illnesses and deaths are a result of waterborne diseases. The symptoms of the diseases caused by contaminated water include nausea, vomiting, diarrhea (bloody and/or dehydrating), and in some cases, death. Animals are also susceptible to becoming ill from contaminated water. Sickness and death may occur in both humans and animals due to both enterobacteria (E.coli, etc.) and cyanobacteria found in the Colorado River.

Water Quality Testing

Bacterial testing of water quality along the Colorado River has been taking place. Each summer Lake Havasu is tested a minimum of twice per month at carefully selected beaches for bacterial counts. When a limit is exceeded, the water is tested once again, within 24 hours. It is the policy of Mohave County that if the second test results in an exceedance the affected beach is posted and closed. The Arizona Department of Environmental Quality (ADEQ) has also contracted with USGS in order to conduct periodic testing along the Colorado River for bacterial levels along with other contaminants.

Bacterial Concentrations in the Colorado River

Several agencies test the River's water quality. Agencies involved in testing include ADEQ, Mohave County Department of Public Health, USGS, National Park Service, the State of Nevada and sometimes, Indian Health Services. Although there have been a few recorded spikes in bacterial testing along the Colorado River, specifically, in Lake Havasu, follow-up testing has not indicated a chronic problem. However as development and recreation along the River continues, potential for increase of bacterial contamination will continue.

Current Mitigation Efforts

As stated earlier, a few communities along the Colorado River are beginning or have been sewering their cities and reducing the number of septic tank and leach field systems due to contamination of groundwater and future concerns that the groundwater could no longer be drinkable or useable.

There has been a concentrated effort to eliminate old privies in the Lake Havasu area of Mohave County and replace these units with more sanitary restroom facilities. As part of this effort, there have been several new restroom facilities added to beaches along Lake Havasu. Trash containers have also been added to aid in the collection of refuse and items such as dirty diapers which would have, in years past, eventually been washed into the lake. This effort at trash collection has met with limited success.

Lake water sampling and sampling along the Colorado River continues to take place and procedures are in effect which prevent swimmers from entering water that is deemed unhealthy for recreating.

Mohave County is preparing to propose a local ordinance that will require more homes along the Colorado River to connect to sewage treatment plants. This area is known for having very shallow groundwater and sandy soils which makes for a very difficult area to install septic systems. Although the communities of Lake Havasu and Bullhead City have taken great strides towards connecting to community sewer, the county area in between these communities is still installing septic systems.

The National Park Service (NPS), on September 21, 2005, issued a press release which indicated that an Environmental Assessment for the Replacement of Water and Sewer Systems had been released for the Lake Mead National Recreational Area. According to the referenced press release, the systems are extremely old and in need of constant maintenance.

Along the lines of sanitation, in March of 2003 the NPS published their Lake Management Plan/Final Environmental Impact Statement for the Lake Mead National Recreation Area. This plan addresses sanitation issues and proposes rules requiring all overnight boating campers to possess a portable toilet and to prohibit the use of glass and Styrofoam containers. The NPS recognizes that education and proper notification of campers and visitors is an integral part of this process.

Recommended Solutions for Implementation and Funding

- Coordinate a monitoring network operated and maintained to improve data gathering and analysis efforts to identify hot spots or periods of violation, pursue remedies and keep the feedback loop going perpetually, aiming to always improve efficiency. One way to begin this would be a concentrated survey along the River in areas of high use and during busy seasonal periods. The monitoring network should include all agencies that currently conduct surface water testing along the Colorado River and interested stakeholders. Regular communication among the monitoring network is recommended.

- ADEQ should support local jurisdictions as they aim to pass local ordinances requiring abandonment of on-site wastewater systems along the Colorado River. This would not require any extra funding on the part of the State.

- Installation and maintenance of more sanitary facilities along the Colorado River to include restrooms, trash locations and educational materials such as signage. This may require more substantial funding.

- ADEQ and other officials should closely monitor the proposal by Las Vegas, Henderson and Clark County, Nevada, to discharge up to 450 million gallons a day of treated effluent directly into Lake Mead.

- Environmental education beginning in schools and expanding to community service groups, etc. Public Service Announcements conducted in association with education.

Action Plan For Implementation and Funding

Action plan for the above-mentioned recommendations:

- ADEQ should dedicate resources to coordinate a monitoring network on the mainstream of the Colorado River. ADEQ should survey existing monitoring activities and review and prioritize the establishment of future monitoring in coordination with interested federal and local agencies. Monitoring network to produce quarterly monitoring data reports.

- Conduct research to find what potential funding sources (grant programs) are available for water quality projects. City Councils/local jurisdictions approached for recommendations on what local groups could help with in this type of activity (e.g. “Keep Havasu Beautiful”). ADEQ continue to encourage applications to the Water Quality Improvement Grant Program for eligible sanitary facilities and education along the River.

- Local governments along the River may apply for grant with Legacy Foundation for educational grant-funded program.

- Support the effort of the Colorado River Regional Sewer Coalition to obtain federal funding for sewer infrastructure projects in communities along the Colorado River.

Chapter 7
Salinity/Total Dissolved Solids

Pollutant Description

For purposes of this report, the terms “total dissolved solids” and “salinity” will be equivalent, although there are slight differences between the two:

- “Total dissolved solids” (TDS) are generally associated with freshwater systems and consist of inorganic salts, small amounts of organic matter, and dissolved materials.
- Salinity was originally an oceanographic term, generally describing the total salt content, but is also used for freshwater systems.

Both terms are used to describe the sum of the inorganic cations and anions dissolved in water: sodium, potassium, calcium, magnesium, carbonates, chlorides, sulfates, and nitrate.

The saline sediments of the Colorado River Basin were deposited in prehistoric marine environments. Sedimentary rocks are easily eroded and dissolved, transporting their salts into the river system. Human activities such as irrigated agriculture and energy exploration can influence and accelerate this process (Colorado River Basin Salinity Control Forum, 2002).

Increased salinity levels in the Colorado River affect agricultural, municipal and industrial users. Agricultural water users suffer economic damage due to reduced crop yields, added labor costs for irrigation management and added drainage requirements. Urban users must replace plumbing and water-using appliances more often, or spend money on water softeners or bottled water. Industrial users and water and wastewater treatment facilities incur reductions in the useful life of system facilities and equipment (Colorado River Basin Salinity Control Forum, 2002). Damages in the United States are estimated at $330 million per year, and economic damage in Mexico is not quantified but also a significant concern (Department of the Interior, 2003).

Water Quality Standards

Surface Water

In 1972, EPA required development of water quality standards for salinity in the Colorado River in accordance with Clean Water Act (CWA) Section 303. The seven Colorado River basin states formed the Colorado River Basin Salinity Control Forum (the Forum) in 1973. The Forum has been the vehicle that has allowed the states to cooperate in developing the standards which included numeric criteria at three locations in the lower Basin as well as a basin-wide plan of implementation. The seven states each adopted the standards and plan of implementation through their individual administrative processes, and the standards were approved by EPA. The implementation of the salinity control plan has ensured compliance with the numeric criteria while the Basin states have committed to develop the water allocated to them by the Colorado River Compact.

Arizona's Surface Water Quality Standards establish a flow-weighted average annual salinity standard that must be maintained on the lower Colorado River at the following locations:

Arizona Colorado River Salinity Standards	
Location	Salinity
Below Hoover Dam (to Parker Dam)	723 mg/L
Below Parker Dam (to Imperial Dam)	747 mg/L
At Imperial Dam	879 mg/L

These standards were established by the Forum based on data collected in 1972, and the conditions present in 1972 became the standard to be attained for the future. The Forum emphasizes that this should not create any inference that 1972 represents a typical year from either a hydrologic or water quality perspective. Rather, the purpose of the numeric criteria and the Forum's Plan of Implementation for Salinity Control is to mitigate the effects of water resource development and human activities in the Colorado River Basin after 1972. The Plan is not intended to address human-caused salinity prior to this date. The standards are also not intended to address any other designated uses of the Colorado River (human health and aquatic and wildlife); however, the Forum states that projected future salinity concentrations, with or without salinity controls, have not been shown to have adverse effects on human health or wildlife (Forum, 2002).

Impacts of natural variations in the hydrologic cycle have a significant impact on salinity levels. Therefore, the Forum's plan for maintaining the criteria is developed using a long-term mean annual water supply of 15 million acre-feet per year at Lee's Ferry, Arizona. When River flows are at or above this level, concentrations are typically below the numeric criteria. Conversely, when flows are significantly below the long-term mean, and reservoirs are depleted, salinities are expected to increase (Forum, 2002). Fluctuating salinity levels are shown in Figure 7-1.

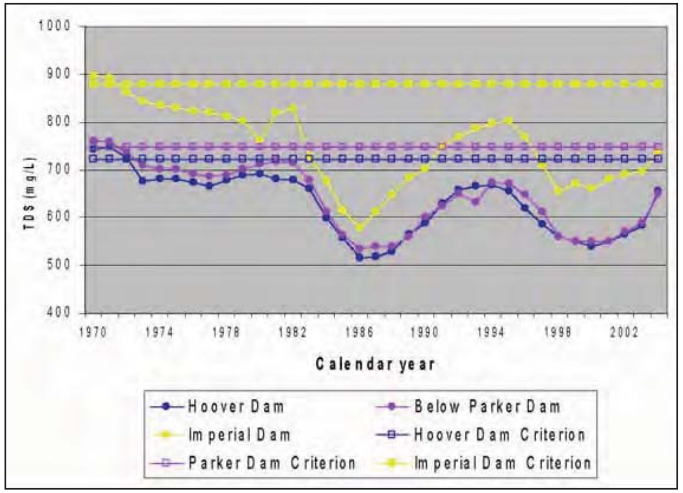
The diluting effect of record high flows during the mid-1980s caused lower salinity levels, followed by an extremely dry period from 1988 to 1992 with rising salinity concentrations. Moderately high flows later in the 1990s once again resulted in decreasing salinity. Recognizing the effects of variable hydrologic cycles, the Forum considers natural increases to be in conformance with standards, provided that concentrations are at or below the criteria when river flows and reservoir conditions return to normal. Federal regulations also allow for temporary increases due to additional water development projects until salinity control projects are brought on line (Forum, 2002).

Groundwater

There is no salinity standard for groundwater quality in Arizona; however, EPA has recommended a Secondary Maximum Contaminant Level (SMCL). SMCLs are non-enforceable, aesthetics-based guidelines that define the maximum concentration of a contaminant that can be present without imparting unpleasant taste, color, odor or other aesthetic effect on the water. See Figure 7-2.

O_NPCA-CBD et al 2

Figure 7-1: Salt Concentrations at Numeric Criteria Stations expressed as annual flow-weighted averages



*see Appendix 4 for data used to create this graph and explanation of flow-weighted average calculations.

Table 7-1: EPA's SMCLs for Public Drinking Water Systems	
Pollutant	SMCL
Total dissolved solids	500 mg/L
Sulfate	250 mg/L
Chloride	250 mg/L

Sources

The Department of the Interior (2003) along with other members of the Colorado River Basin Salinity Control Forum have spent 30 years investigating sources of salinity and have identified the following major sources:

Natural Sources - Nearly half of the salinity in the Colorado River system is from natural sources. Saline springs, precipitation runoff, and associated erosion of saline geologic formations all contribute to this background salinity. The erosion process and associated salinity problems can be accelerated by human activities such as grazing and energy exploration and development.

Irrigated Agriculture - Agriculture is the largest user of water in the Colorado River Basin, and agricultural return flows contribute to the salinity of the system. Irrigation water dissolves salts found in the underlying saline soils and geologic formations, usually marine shale. Deep percolation mobilizes these salts found naturally in the soils, especially if the lands are over irrigated.

Groundwater quality often deteriorates in arid irrigated areas due to salt buildup as a result of evaporation and evapotranspiration. The portion of irrigation water that is actually consumed by plants or lost to evaporation is virtually free of salts, therefore, the vast majority of salts in the original irrigation water percolate through the soil, eventually to recharge the underlying aquifer. This contaminated groundwater is then pumped for irrigation use and will percolate to the underlying aquifer again. Thus, the recycling of groundwater will continue to increase dramatically the salinity of the aquifer over time. As the salinity of the groundwater increases, so too does salinity of surface water in the Colorado River as irrigation tail waters flow back into the River.

Development of Energy Resources - The development of coal, oil and gas, and oil shale, also contribute significant quantities of salt to the Colorado River. The Forum recognizes that the salinity of surface water can be increased in these operations through the following means:

- Mobilization of saline groundwater - There are many static, saline aquifers located throughout the Colorado River Basin confined within impermeable shales, which have prevented the transport of their saline water. Drilling and mining can provide a path for the saline aquifer water to reach the surface.

- Mineral dissolution and uptake in surface runoff – The location of fossil fuels is associated with marine-derived geology. Any disturbance to the land increases contact surfaces and allows water to dissolve previously unavailable minerals.

- Production of saline water – Oil and gas production in the Basin can produce saline water in amounts several times greater than the amount of oil produced, depending upon the geology of the area. Disposal techniques include evaporation, injection and discharge to local drainages.

- Consumption of higher quality water – Consumption during energy development can reduce the amount of water available to dilute Colorado River salinity.

Municipal and Industrial Sources - Municipal and industrial users contribute some additional salinity, though the Forum estimates the relative amount is small (about 1% of the salt load). The use of residential water softeners can contribute salt to wastewater, and if untreated, result in saline discharge from treatment plants that discharge to the Colorado River.

O_NPCA-CBD et al 2

Water Quality Impacts

Plant Growth - Excess dissolved solids negatively impacts plant growth. As shown in Table 7-2 below, as salinity increases above 500 mg/L, the effects on crops increase, reducing agricultural production. Above 500 mg/L, crops that are sensitive to salinity cannot be grown. Rapid salinity changes can cause changes in osmotic pressure, resulting in plasmolysis (cell shrinkage) of tender leaves and stems. In addition, sodium is toxic to certain plants, especially fruits, and frequently causes problems in soil structure, infiltration and permeability rates. Clay soils, with their high percentage of exchangeable sodium, will swell when wet and can further limit water movement and plant growth.

In its Water Quality Report, the Salt River Project (SRP, 1998) references guidelines for total dissolved solids (salinity) and its separate constituents in water used for agricultural irrigation purposes. These general guidelines can be applied to Colorado River water to evaluate its suitability for use based on salinity concentrations.

Table 7-2: SRP Dissolved Solids Guidelines for Agricultural Purposes

Parameter	Effects on crops	Range of concentrations		
		No Problems (mg/L)	Increasing Problems (mg/L)	Severe Problems (mg/L)
TDS	General effects on crop yield	<500	500 – 2000	>2000
	De-flocculation of clay and reduction in infiltration	>320	<320	<128
Sodium	Effects when water is absorbed by leaves	<69	>69	--
Chloride	Effects when water is absorbed by roots	<142	142-355	>355
Chloride	Effects when water is absorbed by leaves	<106	>106	--
Bicarbonate	Effects when water is applied by sprinklers (causes white deposits on fruits and leaves)	<90	90-520	>520

* Deflocculation refers to the dispersion of clay particles that occurs when the positive charges of the clay particles are covered and attractive forces are greatly reduced. This process results in reduced soil permeability.

Drinking Water - In the *Quality Criteria for Water*, 1986, the US Environmental Protection Agency (EPA) indicates that excess dissolved solids are objectionable in drinking water because of possible physiological effects, unpalatable mineral tastes and higher costs. These increased costs are caused by corrosion and encrustation of metallic surfaces and the necessity for additional treatment. Primary maximum contaminant levels for TDS and associated anions and cations have not been set for drinking water, because they do not present a human health concern for the general public.

Infrastructure Damage - High salinity levels mean that water users must replace plumbing and water-using appliances more often, or spend money on water softeners or bottled water. Industrial users and water and wastewater treatment facilities incur reductions in the useful life of system facilities and equipment (Colorado River Basin Salinity Control Forum, 2002).

Current Mitigation Efforts

In 1974, Congress enacted the Colorado River Basin Salinity Control Act which authorized the construction, operation, and maintenance of salinity control works throughout the Basin. Title I of the Act addressed the US commitment to Mexico regarding the quality of water deliveries to Mexico pursuant to the Treaty of 1944. It authorized the construction and operation of a desalting plant located in Yuma, brine discharge canal and other features to ensure that the average salinity concentration of water delivered to Mexico does not exceed 115 parts per million (ppm), plus or minus 30 ppm, above the annual average salinity at Imperial Dam (US Department of the Interior, 2003).

Title II of the Act created the salinity control program, which has allowed for the construction of salinity control projects by both the Bureau of Reclamation (BOR) and US Department of Agriculture (USDA) that have resulted in more efficient use of water. It also directed the Departments of Interior and Agriculture and the EPA to manage salinity, including salinity contributed from public lands. BOR's Basinwide Salinity Control Program is now open to allow competition and has reduced the cost of salinity control from approximately $70 per ton to $30 per ton (US Department of the Interior, 2003).

Since the 1970s, the Department of the Interior, through BOR, has been working with USDA, the Bureau of Land Management (BLM), and the Forum to build and operate cost effective salinity control projects on the Colorado River. Irrigation improvements allow for better water management that reduces deep percolation and the transport of shallow salt-laden ground water back to the river system. Point sources are controlled by Forum policy and the Nation Pollutant Discharge Elimination System (NPDES) program, when the source is from man-induced discharges, and by various means when the source is from saline springs. One unique project is the Paradox Valley project where BOR collects brines that were discharging into the bed of the Dolores River in southwestern Colorado and injecting those brines into a 16,000 foot injection well. This project accounts for about 20% of the salinity control to date.

The Central Arizona Salinity Study (CASS) was initiated in 2001 by the US Bureau of Reclamation in a partnership with several major municipal water providers located in central Arizona. The purpose of CASS was to identify and evaluate salinity issues in central

Arizona. Phase 1 concluded that 1.5 million tons of salt per year are imported into the Phoenix metropolitan area with 1.1 million tons per year accumulating in the area. Likewise, 130,000 tons of salt per year are imported into the Tucson area with an accumulation of 107,000 tons per year. The Tucson figures are expected to increase over time as the amount of Colorado River water imported into the Tucson area increases (US Bureau of Reclamation, 2003).

The economic impacts of increased salinity in the raw water supplies of central Arizona are significant in absolute terms, primarily in the Phoenix area. The main concern is that increased concentrations of salinity in treated wastewater effluent may result in limiting the future reuse of this important future source of water supply in central Arizona. While the technology exists to desalt the surface water supplies in central Arizona, the cost of implementing these technologies, at the present time, is greater than the economic costs associated with the increased salinity levels. Moreover, the nature of the technologies involved results in a net loss of 20 percent to 30 percent of the raw water. On a preliminary basis, CASS Phase II has concluded that management of salinity discharges into the sanitary sewer system at the wastewater treatment plant, public education of how water users can voluntarily reduce salinity, and additional consideration of localized treatment of brackish groundwater is warranted. CASS has also strongly endorsed the continued implementation of the salinity control projects funded through Title II of the Colorado River Basin Salinity Control Act of 1974.

The Forum continues as a working group to provide interstate and interagency coordination and guidance for the salinity control program to ensure that those projects which are the most cost-effective be given preference for funding, as directed by the Colorado River Basin Salinity Control Act. The Department of the Interior issues regular progress reports with detailed descriptions of mitigation efforts throughout the basin. These reports should be consulted for further information.

The Forum also reviews the numeric salinity standards on the Colorado River every three years. In 2002, it concluded that the standards provide protection from long-term increases in economic damage to downstream uses. However, even current levels of salinity are cause for concern. A study conducted by BOR and the Metropolitan Water District of Southern California estimates salinity damage in Arizona, California and Nevada to be nearly $200 million per year at the 1999 salinity level of 669 mg/L. They estimate this would increase to $500 million per year if salinity were allowed to return to the level of the numeric standard at Imperial Dam (879 mg/L).

The 2002 review also cautions that water use patterns have begun to shift in the lower mainstem of the River. Within the agricultural sector, there has been a shift to growing more vegetables which are less salt tolerant. Basin states also indicate there will be a continued shift from use by the agricultural sector to the municipal and industrial sector. They predict more pressure in the future to reduce salinity levels even further.

The Bureau of Reclamation, who oversees the Salinity Control Program, indicates that:

- Salinity control measures installed with USDA assistance control over 300,000 tons of salt annually. Measures installed with Bureau of Reclamation assistance control nearly 500,000 tons each year.

- The Natural Resources Conservation Service (NRCS) currently uses the Environmental Quality Incentives Program (EQIP) funds to implement on-farm salinity control measures in six project areas in western Colorado, eastern Utah, and southwestern Wyoming.
- The Forum has adopted policies for salinity criteria for municipal and industrial discharges (see Appendix 5).

Recommended Solutions for Implementation and Funding

Treated municipal wastewater can contain significant amounts of total dissolved solids. As the growth in population continues to increase in the Colorado River region, the amount of treated effluent discharged to the River will increase. The State of Arizona should continue monitoring effluent discharges to the River and their potential effects as a source of increasing salinity. Arizona Pollutant Discharge Elimination System (AZPDES) or NPDES permits authorizing surface water discharges to the Colorado River should be consistent with the Forum policy entitled "NPDES Permit Program Policy for Implementation of Colorado River Salinity Standards," (see Appendix 6) adopted in October 2002 (Forum, 2002).

In its 2003 Progress Report, the Department of the Interior concluded that the Salinity Control Program has successfully controlled 800,000 tons of salt per year. However, to meet the target of 1.8 million tons per year by 2020, additional funding will be needed to implement new salinity control measures that will remove approximately 59,000 additional tons each year. The review identifies the following capital funding needed to meet this goal:

- BOR appropriation – $10.5 million per year, bringing the total Reclamation program with cost-sharing to $15 million per year.
- USDA EQIP appropriation – $13.8 million per year, bringing the total on-farm program to $19.7 million per year with Basin states parallel program.
- No new measures for BLM were proposed due to questions raised regarding verification of rangeland salinity control. When measures are identified, they will be included in the Salinity Control Program and would reduce the amount of salinity control and funding needed for BOR and USDA projects.

Implementation of the Title II salinity control program has been a documented success in preventing salinity from increasing beyond 1972 levels. The projects and control measures which have been implemented are responsible for the decrease in salinity concentrations in the lower Basin while significant new growth has occurred. However, federal spending cuts have reduced the Bureau of Reclamation's efforts to implement the rest of the Title II program.

Most of the salinity control measures are implemented in the upper Basin states. However, it is important for the State of Arizona, working with the other Basin states and the Forum, to continue to encourage the President and the US Congress to fully fund Title II so that the program continues to be implemented as originally intended.

O_NPCA-CBD et al 2

Action Plan for Implementation and Funding

The Forum develops action plans for implementation and funding on a regular basis, and should be consulted for further information.

Chapter 8
Sediment and Suspended Solids

Pollutant Description

Suspended solids consist of organic (algae and other biological matter) and inorganic (sands, silts, etc) particulates held in water.

Sedimentation occurs when wind or water runoff transports soil particles from land surfaces and deposits them in a waterbody. As the energy and flow of a stream decreases, the amount of particulates that a water column can hold decreases and particulates drop to the stream or lake bed. Changes in channel form, such as streambank stability and amount of stream sinuosity (curves or turns), can also increase sedimentation (aggradation) or erosion (degradation).

Water Quality Standards

Suspended Sediment Concentration (SSC) – Arizona adopted a surface water quality standard for suspended sediment concentration (SSC) in 2002 to protect fish populations. This is the dry weight of sediment from a known volume of water-sediment mixture. It is applied only to flowing waters (perennial and intermittent streams). It does not apply to lakes, ephemeral streams or waters classified as effluent dependent waters. It does not apply during runoff events. The SSC standard states:

> *The geometric mean of a minimum of four Suspended Sediment Concentration samples cannot exceed 80 mg/L. The standard applies to a stream that is at or near base flow and does not apply to a stream during or soon after a precipitation event (A.A.C. R18-11-109(D)).*

Narrative Bottom Deposits Standard – Whereas the SSC standard addresses sediment suspended in the *water column*, the narrative bottom deposit standard is intended to prevent excessive *bottom deposits* of sediment in amounts that adversely affect aquatic life. It states:

> *A surface water shall be free from pollutants in amounts or combinations that settle to form bottom deposits that inhibit or prohibit the habitation, growth, or propagation of aquatic life A.A.C. R18-11-108(A)(1)).*

Proper Functioning and Condition of Riparian and Wetland Areas – Riparian vegetation is very effective in reducing sediment and suspended solids, by increasing deposition before runoff water reaches a surface water (Engineering Science, 1994). Greater plant density means more suspended sediments can be removed. The Bureau of Land Management, in conjunction with the US Forest Service, developed a field protocol known as "proper functioning and condition of riparian and wetland areas" to assess whether a riparian-wetland area is functioning properly in terms of vegetation, landform and amount of large woody debris present to dissipate stream energy associated with high water flows. A properly functioning riparian area will reduce erosion, filter and capture sediment load, and aid in floodplain development. It has additional benefits including providing good wildlife habitat and facilitating groundwater recharge. While federal

agencies use this visual-based qualitative tool to assess long stream reaches, ADEQ uses this information as supporting evidence when assessing a stream's physical condition.

Turbidity – ADEQ repealed its turbidity criteria in 2002 because it is a surrogate measurement for estimating the amount of suspended particles in water. Although no longer an enforceable standard, the old turbidity criteria can be used as a guideline to evaluate suspended particles in water. Turbidity is measured in terms of nephlometric turbidity units (NTU), which is an index of light refraction when light strikes suspended particles in water. For reference, the following old turbidity criteria were established to protect aquatic life and wildlife:

	Rivers, streams, and other flowing water	Lakes, reservoirs, and other non-flowing water
A&W warmwater fishery (below 5000 ft. elevation)	50 NTU	25 NTU
A&W effluent-depended water	50 NTU	25 NTU
A&W coldwater fishery (above 5000 ft. elevation)	10 NTU	10 NTU

In the Colorado/Grand Canyon Watershed, the following segments are impaired due to suspended sediment concentrations in excess of water quality standards: the Colorado River from Parashant Canyon to Diamond Creek, the Paria River from the Utah border to the Colorado River, the Virgin River from Beaver Dam Wash to Big Bend Wash. In the Little Colorado River Watershed, the Little Colorado River from Porter Tank Draw to McDonalds Wash is impaired due to suspended sediment concentrations in excess of water quality standards.

Sources

There has not been a detailed study of sediment sources along the Colorado River. However, several likely sources can be identified. Natural stream erosion, in the absence of human activities, is affected by water flow and channel morphology, in combination with type of catchment bedrock, soil profiles and vegetation (Leopold et al, 1964). Arizona's arid conditions, relatively low plant coverage and erodible soils make some degree of suspended solids and sedimentation a natural phenomenon in the state. Natural sources of suspended solids may be difficult to control.

Human activities increase suspended sediment loads beyond natural background levels. The causes of excess sediment in streams are similar across the country: urban runoff, construction/development, agriculture and forestry are the largest contributors. In the arid Southwest, wildland fires, grazing and off-highway vehicle use must also be considered. How these sources contribute sediment in the Colorado River Watershed is summarized below.

Construction and Urban Runoff

The construction of buildings or roads can result in soil loss and sediment transport to nearby surface waters (Waters, 1995). Much of the Colorado River watershed in Arizona would not be considered urbanized; however, there are several cities between Lake Mead and Arizona's border with Mexico. Other areas, while not "urbanized," have been developed for vacation homes. Urban runoff and construction should be considered a probable source of some sediment.

Nationally, in urban areas, suspended solids constitute the largest volume of pollutant loadings. Nonporous urban landscapes, such as roads, bridges, parking lots, and buildings prevent runoff from percolating slowly into the ground. Water remains above the surface, accumulates, and runs off in large amounts, usually carrying large loads of sediment with it (http://www.epa.gov/owow/nps).

Further contributing to the problem are stormwater systems that channel runoff from roads and other impervious surfaces (http://www.epa.gov/owow/nps). In Arizona, torrential monsoon events can produce large volumes of storm flow runoff which, when the stormwater enters the stream channels, can erode streambanks and remove protective streamside vegetation. This erosion contributes sediment to the streambed.

Agriculture and Grazing

When agricultural lands are not properly managed for soil erosion, excessive amounts of sediment can enter stream channels and lakes (http://www.epa.gov/owow/nps).

Further, overgrazing in the past by livestock on arid rangelands has been responsible for damage to streams in the western United States.

Grazing does not occur along the Colorado River mainstem; however, open rangeland (grazing) occurs across the watershed.

Forestry

Nationally, timber harvesting and forest road activities are potential sources of sediment loading to surface water. The most detrimental effects of harvesting are related to the access and movement of vehicles and machinery (forest roads), and the dragging and loading of trees or logs. Silviculture effects include soil disturbance, soil compaction, and direct disturbance of stream channels (http://www.epa.gov/owow/nps).
Silviculture occurs in a relatively small portion of the Colorado River Watershed, primarily in the Kaibab National Forest. Therefore, forestry practices are probably not a significant source of sediment in the Colorado River.

Wildland Fires

Wildland fire is a natural process in a forest ecosystem; however, suppression of fires and improper forest management practices can create an accumulation of fuels, such as brush and vegetative litter, on the forest floor. The additional fuel can result in hotter fires, extensive burn areas and severe damage to forest soils. (http://www.epa.gov/owow/nps).

The deposition of burned debris and sediment into streams and lakes during the fire can have immediate and acute effects on water quality and aquatic life. However, as U.S. Geological Survey (USGS) research has shown, the loss of ground-surface cover, such as needles and small branches, and the chemical transformation of burned soils after a fire can have long-lasting effects on the watershed as well. Watersheds become more susceptible to erosion and excess sediment from rainstorms after the burn and before the soils are stabilized.

Off-Highway Vehicles

The use of off-highway vehicles, especially in sensitive areas, can increase erosion and create long-term environmental damage. This is particularly a concern within the riparian area (the channel and vegetated border along the stream) which acts as a natural filter for sediments being transported during rain events. The extent of use and damage caused by off-highway vehicles has not been documented in this watershed; however, the potential for damage is large due to erodible soils and various recreational opportunities along the Colorado River corridor.

Water Quality Impacts

Impacts on Aquatic Life - Excessive amounts of sediment can have the following adverse effects on aquatic life:

- Kill fish or reduce their growth rate and resistance to disease primarily by clogging or abrading gill membranes
- Prevent the successful development of fish eggs and larvae by covering spawning areas
- Modify the natural movements and migrations of fish
- Reduce the abundance of food available to fish and fish larva
- Impair the ability of sight feeding fish to locate their prey
- Reduce the amount of light available to aquatic plants, thus reducing photosynthesis and primary production in surface water and shifting algal composition from green algae to the more toxic blue-green algae
- Degrade or eliminate habitat through sedimentation and filling in of pool habitat
- Introduce toxic pollutants that can be attached to soil particles (e.g., metals, pesticides)

Some suspended sediment is natural in the Colorado River due to the sandstone formations in the Grand Canyon area. Native fish, such as the humpback chub (a federally listed endangered species) are adapted to these high levels of particulates; however, sport fish such as rainbow trout that hunt by sight, are negatively impacted by suspended sediments.

Impacts to Recreation - In addition to the fact that recreation may be a cause of sediment pollution, suspended sediment can interfere with recreational use and aesthetic enjoyment of surface water. Turbid waters can be dangerous to swimmers and boaters because of unseen submerged hazards. The less turbid the water, the more desirable it becomes for swimming and other water contact sports. Thus, increased suspended sediment may have potential impacts to the economy where water recreation provides a source of revenue for a community or city.

Sediment accumulation will also reduce the capacity of a reservoir and may impact navigation in channels. Dredging to remove built up sediments is costly. It is best to prevent sediment loads from entering reservoirs or channels rather than pay for removing them later.

Impacts to Agriculture - Agriculture can be both the cause and victim of suspended sediments in surface water. EPA's suspended sediment criteria document identifies the following negative effects of suspended solids on agricultural irrigation use:

- Formation of crusts on top of the soil that can inhibit water infiltration and plant emergence
- Decrease in soil aeration
- Formation of films on plant leaves which blocks sunlight and impedes photosynthesis, and which may reduce the marketability of some leafy crops
- Reduction in reservoir capacity and negative effects on delivery canals and other distribution equipment

Impacts to Drinking Water - Drinking water is filtered by public water systems, but high levels of suspended solids that may occur during flood events can overload and disrupt the filtration and treatment process. Accelerated sedimentation can also reduce the capacity of reservoirs used for drinking water supplies.

Impacts Related to Dams - Dams along the Colorado River must also be considered when discussing sedimentation. As the water slows its movement through a reservoir, the water loses its energy and drops its sediment load. As discussed above, this reduces the capacity of a reservoir to support recreation and drinking water storage. The more sedimentation coming into the reservoir, the faster the sediments accumulate.

The discharges from the dams along the Colorado River are both colder and clearer than the water entering the reservoirs. The water is colder because the water is taken from the deeper part of the reservoir, and clearer because sediment is retained behind the dam. The clearer water has more energy to scour the streambed downstream of the dam. These changes have significantly altered aquatic habitats.

For example, Glen Canyon Dam traps about 66 million tons of sediment per year that once flowed through the Grand Canyon. When the dam was built, the release of clear water into a canyon that once carried extremely high sediment loads resulted in substantial environmental change. Intermittent high flows and a tremendous supply of sediment historically resulted in sand beaches throughout the canyon that were used for recreation and wildlife habitat. On the other hand, sediment retention within Lake Powell prolongs the life of Lake Mead and other lakes formed by the series of dams along the river.

Streamside and channel sedimentary deposits are critical. Too much sediment causes channels to aggrade, causing flooding problems. Too little sediment load can result in habitat degradation and decrease in recreational use. Scientists have been trying to determine what would be the ideal dam release flows from Lake Powell -- what level of flow and how often the flow is needed to build beaches and to maintain habitat. Research to date indicates that beach-building flow may benefit some resources while simultaneously degrading others. Some beaches would be enlarged, others would shrink. (Collier *et al*, 1996).

Current Mitigation Efforts

Sediment Loading Studies Scheduled - Three reaches are included on the 2004 303(d) List of Impaired Waters due to suspended sediment concentration (SSC) and are scheduled for development of a Total Maximum Daily Load study to determine sources of suspended sediment and load reductions needed to meet SSC standards.

- The Colorado River, from Parashant Canyon to Diamond Creek
- Paria River, from Utah border to the Colorado River
- Virgin River, from Beaver Dam Wash to Big Bend Wash

It is likely that the TMDL process will be used to establish site-specific standards due to natural conditions, as sandstone formations in these areas contribute significant suspended solids loadings. The loading analyses would then address any potential added contributions from human activities.

Turbidity Loading Studies in the Little Colorado River Watershed - ADEQ has completed two suspended sediment loading studies (TMDLs) in the Little Colorado River Watershed due to turbidity impairment – the Little Colorado River near Nutrioso Creek, and Nutrioso Creek. The Little Colorado River is a major tributary to the Colorado River. Both studies provided a list of best management practices that need to be implemented to reduce sediment loading and attain water quality standards.

New Construction Permits - A Stormwater Pollution Prevention Plan (SWPPP) must be developed for any construction that disturbs one acre or more. This plan is required under the Arizona Pollution Discharge Elimination System (AZPDES) Construction General Permit Program (Arizona Administrative Code R18-9-A902), administered by ADEQ. The plan must address and mitigate potential erosion and sediment transport that could occur during construction activities. More information concerning this permit can be found at ADEQ's Web site: http://www.azdeq.gov/environ/water/permits/stormwater.html.

AZPDES is an Arizona program delegated to Arizona by the U.S. EPA under the Clean Water Act. On August 22, 2005, the 9th Circuit Court of Appeals issued a decision in the case of *Defender's of Wildlife v. U.S. Environmental Protection Agency* ruling that EPA's delegation to Arizona violated the Endangered Species Act. That decision is not in effect unless and until the 9th Circuit issues an order and ADEQ continues to administer the program. Arizona and the EPA have petitioned the 9th Circuit to rehear the case.

Best Management Practices - The U.S. Natural Resources Conservation Service (NRCS) has taken the lead in developing effective technologies to prevent soil loss due to land uses such as: animal feeding operations, forestry, crop irrigation and cattle grazing. Information concerning recommended practices and funding opportunities to demonstrate improved technologies can be obtained through their Web site at http://www.az.nrcs.usda.gov.

Glen Canyon Dam Release Studies - To address concerns about beach erosion and native fish habitat, Congress passed the Grand Canyon Protection Act in 1992 to protect and restore natural and cultural resources and visitor use in the Grand Canyon National Park and Glen Canyon National Recreation Area. To that end, an experimental flood was released from the Glen Canyon Dam in 1996 in hopes of re-suspending sediment that had settled to the stream bed to reform beach areas.

O_NPCA-CBD et al 2

According to USGS (http://geology.usgs.gov/connections/bia/ls-grand_canyon.htm), the hypothesis was that sediment supplied by tributaries accumulates in the stream channel during normal dam operations and can be re-suspended at any time by flood flows. However, results of the experimental flood showed that tributary sand imports are carried downstream rapidly and deposited in Lake Mead and do not remain available for re-suspension at a later time. The flood was not successful in rebuilding beaches.

After studying the 1996 flood, scientists hypothesized that the flood must occur soon after tributaries have deposited a large load of sediment in order to be successful. In the fall of 2004, river managers determined that sufficient sediment had been recently deposited by tributaries to release another flood flow. Observations made after this flood confirmed that some beaches had been restored along the river. The longer-term results of the flood are still being studied.

Recommended Solutions for Implementation and Funding

The control of anthropogenic sediment can be accomplished at one of three levels:

- Prevention – not causing erosion or preventing the sediment from leaving the site
- Interdiction – capturing and retaining sediment between the site of origin and the surface water. Two principal means:
  - Buffer strips of vegetation to filter and retain sediment, generally as part of a riparian area
  - Sediment traps or sediment basins
- Restoration – removing sediment from the surface water:
  - Dredging
  - Dam releases to transport sediments downstream or establish desired beaches

The cost to society increases when intervention occurs further from the source; therefore, resources are best spent to prevent erosion. The most costly corrections occur when we attempt to restore an area.

- Promote the use of best management practices to address erosion and sedimentation primarily through education and outreach.

  A. Develop watershed-based plans to identify and implement sediment load reducing practices.

  B. Develop and make available a list of best management practices for sediment control that evaluates their costs and effectiveness.

  C. Develop additional outreach for ADEQ's General Construction Permit.

  D. Encourage best management practices to reduce urban and construction runoff.

- Educate and potentially regulate off-highway vehicles.

  Local governments and land management agencies should be encouraged to develop and enforce restrictions of off-highway vehicles in sensitive areas such as within a riparian area, including the stream channel. As this is a popular form of recreation, education and outreach materials should be developed so that the public is aware of the need to protect riparian areas and how off-highway vehicle drivers can be involved in this protection effort.

- Advocate projects and funding that properly manage forests and other public lands to minimize wildfire impacts.

  The U.S. Forest Service and other land management agencies should be supported in their efforts to reduce the potential for uncontrolled wildfires. Encourage funding projects that reseed and replant vegetation after a fire to reduce destructive runoff of soil during rain events, especially in vulnerable areas such a along steep slopes.

- Continue revision of water quality standards related to erosion and sedimentation based on sound science.

  A. Several revisions to Arizona's narrative and numeric water quality standards are being proposed in the current Triennial Review of standards. ADEQ needs to continue the development of physical integrity criteria for surface waters that are appropriate for the varying ecoregions in this state, including those represented in the Colorado River Watershed.

  B. Develop site-specific standards and suspended sediment concentration loading analyses in the Colorado River and its tributaries. These TMDLs are scheduled to be initiated in 2010, but before loadings can be calculated ADEQ must:

     - Estimated natural background loading attributed to sandstone formations throughout the Grand Canyon, including natural background contributions from its tributaries and

     - If natural background loading alone would exceed the SSC standard, establish a site-specific suspended sediment concentration standard. This standard would need to balance aquatic life protection and downstream sedimentation with other concerns, such as the desire for sandy recreational beaches.

  C. Support and help fund research to identify sediment tolerant macroinvertebrates. To properly interpret biocriteria assessments based on macroinvertebrate communities, Arizona should support research being conducted by the Western Bioassessment Center to identify sediment tolerant macoinvertebrates. If sediment tolerant macroinvertebrates are present and others are not, this would provide supporting evidence that sediment is the cause of aquatic impairment.

O_NPCA-CBD et al 2

- Continue evaluation of the Glen Canyon Dam operations impacts to sedimentation.

  Encourage continuation of federal investigations to determine the sediment loadings and dam discharges that best supports recreational opportunities and habitat downstream of the dam. Such scientific investigations are necessary to properly establish site-specific standards for suspended sediment concentration in the Colorado River below Glen Canyon Dam.

Action Plan for Implementation and Funding

The following action plan is based on the recommendations identified above:

- Local governments, land and resource management agencies, and ADEQ should collaborate on efforts to implement erosion/sedimentation control best management practices, primarily through the development of education and outreach materials.

- ADEQ should develop educational materials that compare the unit cost, applicability, limitations and effectiveness of best management practices that control erosion and reduce sedimentation.

- ADEQ should provide more outreach for development of Stormwater Pollution Prevention Plans to control erosion at construction sites.

- The State should support the U.S. Forest Service and other land management agencies in implementing procedures that reduce the potential for uncontrolled wildland fires. Support funding projects to reseed and replant after destructive wildland fires occur, especially in vulnerable areas.

- Arizona should support science-based development and revisions of sedimentation-related narrative and numeric water quality standards through ADEQ's Clean Water Act Triennial Review process.

- ADEQ should re-evaluate its suspended sediment concentration standard in the Grand Canyon area where sandstone formations and natural erosion are probably contributing sediment loads above existing water quality standards.

- ADEQ should work with stakeholders to develop site-specific standards for suspended sediment that account for natural background conditions. These site-specific standards are needed before the requirement TMDL loading analyses can be completed.

- Arizona should support and help fund research into sediment tolerant macroinvertebrates, so that biocriteria can be a more effective tool to assess water quality impairment.

Conclusions

Conclusions

Governor Napolitano and other elected officials, community leaders, local stakeholders and concerned citizens, throughout Arizona are encouraged to consider the recommendations provided herein for the protection and improvement of Colorado River's water quality. The Colorado River provides drinking water to more than 25 million people and irrigation water to support two million acres of agricultural production. The recommendations proposed in this report, if implemented, can reduce the threat posed to the Colorado River by pollutants such as nutrients, metals, endocrine disrupting compounds, perchlorate, bacteria, salinity and sediment.

Recommendations range from addressing the pollutants through regulatory and structural change to staying the course by continuing to provide funding and support for essential programs. Many of the recommendations deal with improving information dissemination, existing regulatory processes and structures. Public education and outreach programs such as public service announcements, presentations to service organizations, councils, and schools need improvements, funding and staff. For example, providing information regarding proper waste disposal for recreational users along the river may decrease the amount of bacteria threatening the Colorado River. Controlling runoff or nonpoint source pollution by planting vegetation, buffer strips and other best management practices can control pollutants such as sediment, nutrients, metals, bacteria and salinity. Through the design of regulatory and structural controls and pollution prevention control strategies, pollutants may be reduced.

While many of the recommendations contained in this report deal with on-the-ground implementation, there are some recommendations for additional monitoring and characterization to determine the occurrence or potential impacts to the River. Before specific recommendations can be developed for metals and endocrine disrupting compounds, the Alliance believes that additional information is needed for characterization and sampling to determine the concentration in the River and potential sources. In addition, studies on aging and inadequate wastewater systems should be conducted to identify wastewater needs and prioritize locations for implementation to control bacteria and nutrients.

The Alliance also concluded in some cases that current efforts by private industry, federal and state entities should continue to be supported. For instance, continued — and increased — funding and support is needed for governmental agencies to provide proactive measures and prompt response to control and remediate existing pollution.

In many cases (five of the seven pollutant chapters), funding is an essential element to implement the recommendations. For example, capital investment recommendations and facility maintenance require funding. Funding must be identified, directed and secured for many of the recommendations identified in the report. Potential funding sources include but are not limited to: U.S. EPA, Center for Disease Control, Metropolitan Water District, Southern Nevada Water Authority, municipal providers, U.S. Fish and Wildlife Service, Wildlife Conservation Fund, Heritage Grant Funds, Legacy Funds, State Lake Improvement Fund, ADEQ's Water Quality Improvement Grant Program, Water Infrastructure Finance Authority, U.S. Department of Agriculture's Environmental Quality Incentives Program, Rural Development Assistance, ADWR's Water Protection Fund. Refer to the individual pollutant chapters for funding sources related to controlling each of the specific water quality issues identified by the Alliance. A variety of potential funding sources should be sought to implement the recommendations of the Alliance.

Focusing on a sustainable future for the citizens of Arizona with assured Colorado River water quality requires a regional approach. As Governor Janet Napolitano stated in her Clean Colorado River Alliance invitation to serve, the water quality issues identified in this report "are, in fact, regional issues and cannot be tackled on solely a state level." Without a regional approach, the Colorado River's water quality will remained threatened.

These recommendations are tools that should be used to maintain adequate water quality in the Colorado River and mitigate impacts in water quality. The Clean Colorado River Alliance recommends that implementation of the recommendations in this report begin in 2006. Funding should be sought for priority recommendations. This report is the first step to a much larger, regional approach to address water quality issues in Colorado River Watershed. To improve Colorado River's water quality for all 25 million people who depend on the River for everyday use, more watershed-scale collaboration on monitoring and research must be initiated. Addressing water quality issues is essential in the protection and improvement of the Colorado River, the lifeblood of the American West.

O_NPCA-CBD et al 2

Appendix 1

STATE OF ARIZONA

JANET NAPOLITANO
GOVERNOR

OFFICE OF THE GOVERNOR
1700 WEST WASHINGTON STREET, PHOENIX, AZ 85007

MAIN PHONE: 602-542-4331
FACSIMILE: 602-542-7601

February 8, 2005

Greetings:

The Colorado River serves as the lifeblood of the American West providing drinking water to more than 25 million people and irrigation water to support 2 million acres of agricultural production. For years the focus of the Colorado has been on water quantity and indeed, I will continue to fight to secure our share of this critical resource. However, we can no longer focus on water quantity alone; we must address water quality as well if we are to truly meet the needs of the state.

There are several major issues currently threatening the quality of water in the Colorado River. Unfortunately, the problems tend to accumulate with movement downstream, and Arizona is the last State to divert flows from the Colorado before it crosses into Mexico. While many of the problems manifest themselves most severely in Arizona due to geographic location, the problems are, in fact, regional issues and cannot be tackled on solely a state level.

Effectively cleaning up the Colorado River will require a regional approach involving federal, state, tribal and local governments as well as other key stakeholders including agricultural, municipal, business and conservation sectors. Therefore, I have decided to name a stakeholders group, the Clean Colorado River Alliance (CCRA), to develop recommendations to address existing water quality problems.

I ask you to serve on this important stakeholders group and assist me in working with our fellow states towards solutions. A full list of people being asked to serve on the CCRA is attached.

I hope you will be able to personally participate on the CCRA, and I look forward to your advice on the Colorado River water pollutions issues.

Yours very truly,

Janet Napolitano
Governor

Appendix 2

Draft Pollutant List			
Pollutant	Discussed at April Meeting	CCRA Input	Basin States Input
Discussed at April Meeting			
Uranium	X	X	
Nitrogen/Nitrates	X	X	
Perchlorate	X	X	
Chromium VI	X	X	
Salinity/Total Dissolved Solids	X	X	X
Pesticides/herbicides	X	X	
Selenium	X	X	X
Sediment/turbidity	X	X	X
Bacteria/pathogens	X	X	X
Boron	X		X
Additional Pollutants from CCRA			
Endocrine Disrupting Compounds (personal pharmaceutical products)		X	
Mercury		X	X
PAH (Benzo pyrene)		X	
MTBE (methyl-t-butyl ether)		X	
PCB (Polychlorinated bi-phenyls)		X	
Dioxin		X	
Hydrocarbons		X	
Carbon Monoxide		X	
Nutrients		X	X
Dissolved oxygen		X	X
Additional Pollutants from Basin States			
Phosphorus			X
pH			X
Aluminum			X
Ammonia			X
Chlorine			X
Temperature			X
Cadmium			X
Copper			X
Zinc			X

Appendix 3

Pollutant Workgroups

Chapter 2 - Nutrients

Workgroup Participants

Dean Barlow, Lake Havasu Park Board
Kathy Carroll, City of Yuma
Val Danos, Arizona Municipal Water Users Association
Bob Ericson, Water Conservation District Member
Gene Fisher, LaPaz County Supervisor
Maureen Rose George, Law Offices of Maureen Rose George
Roger Gingrich, City of Yuma
Jack Hakim, Bullhead City Councilman
Patty Mead, Mohave County Health and Social Services
Rachel Patterson, Mohave County Health and Social Services
Robert Shuler, Ryley, Carlock & Applewhite
John Sullivan, Salt River Project
Mayor Robert Whelan, Lake Havasu City
Doyle Wilson, Lake Havasu City

Chapter 3 - Metals

Workgroup Participants

Peter Culp, Sonoran Institute
Susan Fitch, Arizona Department of Water Resources
Kirk Koch, Bureau of Land Management
Linda Taunt, Arizona Department of Water Resources
Bill Werner, Arizona Department of Water Resources
Doyle Wilson, Lake Havasu City

Chapter 4 - Endocrine Disrupting Compounds

Workgroup Participants

Peter Culp, Sonoran Institute
Marie Light, City of Tucson
Hsin-I Lin, Arizona Department of Health Services
Dave Weedman, Arizona Game and Fish Department
Doyle Wilson, Lake Havasu City

Chapter 5 - Perchlorate

Workgroup Participants

Aubrey Baure, US Air Force / Department of Defense REC 9
Randall Gerard, EOP Group
Hsin-I Lin, Arizona Department of Health Services
Doug Mellon, Doug Mellon Farms
Mayor Larry Nelson, City of Yuma
Gary Pasquinelli, Pasquinelli Produce
Robert Shuler, Ryley, Carlock & Applewhite
Sid Wilson, Central Arizona Project

Chapter 6 – Bacteria

Workgroup Participants

Dean Barlow, Lake Havasu Park Board
Maureen Rose George, Law Offices of Maureen Rose George
Kirk Koch, Bureau of Land Management
Patty Mead, Mohave County Health and Social Services
Rachel Patterson, Mohave County Health and Social Services

Chapter 7 - Salinity/Total Dissolved Solids

Workgroup Participants

Joan Card, Arizona Department of Environmental Quality
Val Danos, Arizona Municipal Water Users Association
Peter Culp, Sonoran Institute
Marie Light, City of Tucson
Frank Putman, Arizona Department of Water Resources
Sid Wilson, Central Arizona Project

Chapter 8 - Sediment and Suspended Solids

Workgroup Participants

Joan Card, Arizona Department of Environmental Quality
Diana Marsh, Arizona Department of Environmental Quality
Tom Griffin, Griffin and Associates
Nick Ramsey, Grand Canyon Trust

O_NPCA-CBD et al 2

Appendix 4

Observed Flow-Weighted Average Salinity at the Numeric Criteria Stations
(Total Dissolved Solids in mg/L)[9]

Calendar Year Below (Numeric Criteria)	Hoover Dam (723 mg/L)	Below Parker Dam (747 mg/L)	At Imperial Dam (879 mg/L)
1970	743	760	896
1971	748	758	892
1972	724	734	861
1973	675	709	843
1974	681	702	834
1975	680	702	829
1976	674	690	822
1977	665	687	819
1978	678	688	812
1979	688	701	802
1980	691	712	760
1981	681	716	821
1982	679	713	827
1983	659	678	727
1984	598	611	675
1985	556	561	615
1986	517	535	577
1987	519	538	612
1988	529	540	648
1989	564	559	683
1990	587	600	702
1991	629	624	749
1992	657	651	767
1993	665	631	785
1994	667	673	796
1995	654	671	803
1996	618	648	768
1997	585	612	710
1998	559	559	655
1999	549	550	670
2000	539	549	661
2001	550	549	680
2002	564	569	691
2003	583	589	697
2004 provisional	655	649	737

* Determined by the U.S. Geological Survey (USGS) from data collected by the U.S. Bureau of Reclamation and USGS and published in Quality of Water, Colorado River Basin, Progress Report No. 22, 2005.

The flow-weighted average annual salinity is the concentration determined from dividing the annual total salt load passing a measuring station by the total annual volume of water passing the same point during a calendar year. The flow-weighted average annual salinity is calculated by first multiplying the daily concentration values by the daily flow rates. These values are then summed over a calendar year and divided by the sum of the daily flow rate (Forum, 2002).

Appendix 5

POLICY FOR IMPLEMENTATION OF
COLORADO RIVER SALINITY STANDARDS
THROUGH THE NPDES PERMIT PROGRAM

Adopted by
The Colorado River Basin Salinity Control Forum

February 28, 1977
Revised October 30, 2002

In November 1976, the United States Environmental Protection Agency Regional Administrators notified each of the seven Colorado River Basin states of the approval of the water quality standards for salinity for the Colorado River System as contained in the document entitled "Proposed Water Quality Standards for Salinity Including Numeric Criteria and Plan of Implementation for Salinity Control, Colorado River System, June 1975, and the supplement dated August 25, 1975. The salinity standards including numeric criteria and a plan of implementation provide for a flow weighted average annual numeric criteria for three stations in the lower main stem of the Colorado River: below Hoover Dam, below Parker Dam, and at Imperial Dam.

In 1977, the states of the Colorado River Basin adopted the "Policy for Implementation of Colorado River Salinity Standards through the NPDES Permit Program." The plan of implementation is comprised of a number of Federal and non Federal projects and measures to maintain the flow weighted average annual salinity in the Lower Colorado River at or below numeric criteria at the three stations as the Upper and Lower Basin states continue to develop their compact apportioned waters. One of the components of the Plan consists of the placing of effluent limitations, through the National Pollutant Discharge Elimination System (NPDES) permit program, on industrial and municipal discharges.

NPDES Policy for Municipal and Industrial Discharges of Salinity in the Colorado River

The purpose of this policy is to provide more detailed guidance in the application of salinity standards developed pursuant to Section 303 and through the NPDES permitting authority in the regulation of municipal and industrial sources. (See Section 402 of the Federal Water Pollution Control Act.) The objective of the policy, as provided in Sections I.A. and I.B., is to achieve "no salt return" whenever practicable for industrial discharges and an incremental increase in salinity over the supply water for municipal discharges. This policy is applicable to discharges that would have an impact, either direct or indirect on the lower main stem of the Colorado River System. The lower main stem is defined as that portion of the River from Hoover Dam to Imperial Dam.

NPDES Policies Separately Adopted By The Forum

The Forum developed a separate and specific policy for the use of brackish and/or saline waters for industrial purposes on September 11, 1980. The Forum addressed the issue of intercepted ground water and adopted a specific policy dealing with that type of discharge

on October 20, 1982. On October 28, 1988, the Forum adopted a specific policy addressing the water use and discharge associated with fish hatcheries. Each of these separately adopted policies is attached hereto.

NPDES Policies For Specified Industrial Discharges

On October 30, 2002, the Forum amended this policy for implementation of Colorado River salinity standards through the NPDES permit program in order to address the following three additional types of industrial discharges: (1) water that has been used for once through non-contact cooling water purposes; (2) new industrial sources that have operations and associated discharges at multiple locations; and (3) "fresh water industrial discharges" where the discharged water does not cause or contribute to exceedances of the salinity standards for the Colorado River System. This policy was also amended to encourage new industrial sources to conduct or finance one or more salinity offset projects in cases where the permittee has demonstrated that it is not practicable to prevent the discharge of all salt from proposed new construction.

Discharges Of Once Through Noncontact Cooling Water

Section I.C. of this policy has been added to address discharges of water that has been used for once through noncontact cooling water purposes. The policy for such discharges shall be to permit these uses based upon a finding that the returned water does not contribute to the loading or the concentration of salts in the waters of the receiving stream beyond a de minimis amount. A de minimis amount is considered, for purposes of this policy, as an average annual increase of not more than 25 milligrams per liter (mg/L) in total dissolved solids measured at the discharge point or outfall prior to any mixing with the receiving stream in comparison to the total dissolved solids concentration measured at the intake monitoring point of the cooling process or facility. This policy is not intended to supersede any other water quality standard that applies to the receiving stream, including but not limited to narrative standards promulgated to prohibit impairment of designated uses of the stream. It is the intent of the Forum to permit the return of once through noncontact cooling water only to the same stream from which the water was diverted. Noncontact cooling water is distinguished from blowdown water, and this policy specifically excludes blowdown or any commingling of once through noncontact cooling water with another waste stream prior to discharge to the receiving stream. Sections I.A. and I.B. of this policy govern discharges of blowdown or commingled water.

New Industrial Sources with Operations and Discharges at Multiple Locations under Common or Affiliated Ownership or Management

Recently there has been a proliferation of new industrial sources that have operations and associated discharges at multiple locations. An example is the recent growth in the development of energy fuel and mineral resources that has occurred in the Upper Colorado River Basin. This type of industrial development may involve the drilling of relatively closely spaced wells into one or more geological formations for the purpose of extracting oil, gas or minerals in solution. Large scale ground water remediation efforts involving multiple pump and treat systems operating for longer than one year may share similar characteristics. With such energy and mineral development and ground water remediation efforts there is the possibility of a single major industrial operation being comprised of numerous individual point source discharges under common or affiliated ownership or management that produce significant quantities of

water as a waste product or byproduct over a long period. Given the large areal scope of these types of major industrial sources and the often elevated concentrations of salinity in their produced water, the total amount of salt loading that they could generate may be very large in comparison to the Forum's past and present salt removal projects. Relatively small quantities of this produced water could generate one ton per day in discharges to surface waters. Since salinity is a conservative water quality constituent, such discharges of produced water, if uncontrolled, could have an adverse effect on achieving the adopted numeric salinity standards for the Colorado River System.

These kinds of major industrial sources strain the conventional interpretation of the industrial source waiver for new construction set forth in Section I.A.1.a. of this policy, which authorizes a discharge of salinity from a single point source of up to one ton per day in certain circumstances. The Forum adopted this provision in 1977, well before most of the new major industrial sources that have operations and discharges at multiple locations began to appear in the Colorado River Basin. A new category of industrial sources is, therefore, warranted. NPDES permit requirements for New Industrial Sources with Operations and Discharges at Multiple Locations under Common or Affiliated Ownership or Management are set forth in Section I.D. of this policy. These new requirements are intended to apply to new industrial sources with operations that commence discharging after October 30, 2002.

For purposes of interpreting this policy, "common or affiliated ownership or management" involves the authority to manage, direct, superintend, restrict, regulate, govern, administer, or oversee, or to otherwise exercise a restraining or directing influence over activities at one or more locations that result in a discharge of salinity into the Colorado River System. Common or affiliated ownership or management may be through the ownership of voting securities or may be indicated where individual sources are related through one or more joint ventures, contractual relationships, landlord/tenant or lessor/lessee arrangements. Other factors that indicate two or more discharging facilities are under common or affiliated ownership or management include: sharing corporate executive officers, pollution control equipment and responsibilities, common workforces, administrative functions, and/or payroll activities among operational facilities at different locations.

Fresh Water Industrial Discharges

Sections I.A. and I.B. of this policy have been amended to allow the permitting authority to authorize "fresh water industrial discharges" where the discharged water does not cause or contribute to exceedances of the adopted numeric salinity standards for the Colorado River System. Different end of pipe concentrations of salinity as shown in Table 1 of the policy, are appropriate for discharges to tributaries depending upon their location within the Basin. The concept of "benchmark concentrations" has been developed in order to address this need for different end of pipe concentrations. These benchmark concentrations are not to be interpreted as water quality standards. Rather, they are intended to serve solely for the establishment of effluent limits for implementing the waiver for "fresh water discharges." The allowance for freshwater discharges is intended to preserve flows from discharges in the Basin, which do not cause significant degradation of existing ambient quality with respect to salinity. Operations or individual discharges that qualify for the freshwater waiver shall not be subject to any further limitation on salt loading under this policy.

Salinity Offset Projects

This policy has been amended to allow the permitting authority to authorize industrial sources of salinity to conduct or finance one or more salinity offset projects when the permittee has determined that it is not practicable: (i) to prevent the discharge of all salt from proposed new construction; (ii) to reduce the salt loading to the Colorado River to less than one ton per day or 366 tons per year; or (iii) the proposed discharge is of insufficient quality in terms of TDS concentrations that it could be considered "fresh water" as defined below. Presently, the permitting authority can consider the costs and availability of implementing off site salinity control measures to mitigate the adverse impacts of the permitted salt load. It is not intended that the applicant be required to develop or design an off site salinity control project or establish a salt bank, but rather to assess the costs of conducting or buying into such projects where they are available. In the future the Forum or another entity may create a trading/banking institution to facilitate the implementation of a salinity offset program, basin wide. This would allow industrial sources to conduct or finance the most cost effective project available at the time an offset project is needed regardless of the project's location in the Basin.

Appendix 6

NPDES PERMIT PROGRAM POLICY FOR IMPLEMENTATION OF COLORADO RIVER SALINITY STANDARDS

I. Industrial Sources

The Salinity Standards state that "The objective for discharges shall be a no salt return policy whenever practicable." This is the policy that shall be followed in issuing NPDES discharge permits for all new industrial sources, and upon the reissuance of permits for all existing industrial sources, except as provided herein. The following addresses those cases where "no discharge of salt" may be deemed not to be practicable.

A. New Construction

1. "New construction" is defined as any facility from which a discharge may occur, the construction of which is commenced after October 18, 1975. (Date of submittal of water quality standards as required by 40 CFR 120, December 11, 1974.) Appendix A provides guidance on new construction determination. "A new industrial source with operations and discharging facilities at multiple locations under common or affiliated ownership or management" shall be defined for purposes of NPDES permitting, as an industrial source that commenced construction on a pilot, development or production scale on or after October 30, 2002.

a. The permitting authority may permit the discharge of salt upon a satisfactory demonstration by the permittee that:

i. It is not practicable to prevent the discharge of all salt from the new construction or,

ii. In cases where the salt loading to the Colorado River from the new construction is less than one ton per day or 366 tons per year, or

iii. The proposed discharge from the new construction is of sufficient quality in terms of TDS concentrations that it can be considered "fresh water" that would have no adverse effect on achieving the adopted numeric standards for the Colorado River System. The permitting authority may consider a discharge to be fresh water if the maximum TDS concentration is: (i) 500 mg/L for discharges into the Colorado River and its tributaries upstream of Lees Ferry, Arizona; or, (ii) 90% of the applicable in stream salinity standard at the appropriate benchmark monitoring station for discharges into the Colorado River downstream of Lees Ferry as shown in Table 1, below:

Table 1

Benchmark Monitoring Station	Applicable Criteria	Freshwater Discharge (mg/L)
Colorado River at Lees Ferry, Arizona	N/A	500
Colorado River below Hoover Dam	723	650
Colorado River below Parker Dam	747	675
Colorado River at Imperial Dam	879	790

b. Unless exempted under Sections I.A.1.a.ii. or iii., above, the demonstration by the applicant must include information on the following factors relating to the potential discharge:

(i) Description of the proposed new construction.

(ii) Description of the quantity and salinity of the water supply.

(iii) Description of water rights, including diversions and consumptive use quantities.

(iv) Alternative plans that could reduce or eliminate salt discharge. Alternative plans shall include:

(A) Description of alternative water supplies, including provisions for water reuse, if any;

(B) Description of quantity and quality of proposed discharge;

(C) Description of how salts removed from discharges shall be disposed of to prevent such salts from entering surface waters or groundwater aquifers;

(D) Costs of alternative plans in dollars per ton of salt removed; and

(E) Unless the permitting authority has previously determined through prior permitting or permit renewal actions that it is not practicable to prevent the discharge of all salt from the new construction in accordance with Section I.A.1.a.i., the applicant must include information on project options that would offset all or part of the salt loading to the Colorado River associated with the proposed discharge or that would contribute to state or interstate salinity control projects or salt banking programs.

(v) A statement as to the one plan among the alternatives for reduction of salt discharge that is recommended by the applicant and also information as to which of the other evaluated alternatives are economically infeasible.

(vi) Such other information pertinent to demonstration of non practicability as the permitting authority may deem necessary.

c. In determining what permit conditions shall be required under I.A.1.a.i., above, the permit issuing authority shall consider, but not be limited to the following:

(i) The practicability of achieving no discharge of salt from the new construction.

(ii) Where "no discharge" is determined not to be practicable:

(A) The impact of the total proposed salt discharge of each alternative on the lower main stem in terms of both tons per year and concentration.

(B) Costs per ton of salt removed from the discharge for each plan alternative.

(C) Capability of minimizing salinity discharge.

(D) If applicable under I.A.1.b.(iv)(E), costs and practicability of offsetting all or part of the salt load by the implementation of salt removal or salinity control projects elsewhere in the Colorado River Basin. The permittee shall evaluate the practicability of offsetting all or part of the salt load by comparing such factors as the cost per ton of salt removal for projects undertaken by the Colorado River Basin Salinity Control Forum and the costs in damages associated with increases in salinity concentration against the permittee's cost in conducting or buying into such projects where they are available.

iii. With regard to subparagraphs, (b) and (c) above, the permit issuing authority shall consider the compatibility of state water laws with either the complete elimination of a salt discharge or any plan for minimizing a salt discharge.

B. Existing Facilities or any discharging facility, the construction of which was commenced before October 18, 1975

1. The permitting authority may permit the discharge of salt upon a satisfactory demonstration by the permittee that it is not practicable to prevent the discharge of all salt from an existing facility.

2. The demonstration by the applicant must include, in addition to that required under Section I.A.1.b the following factors relating to the potential discharge:

a. Existing tonnage of salt discharged and volume of effluent.

b. Cost of modifying existing industrial plant to provide for no salt discharge.

c. Cost of salt minimization.

3. In determining what permit conditions shall be required, the permit issuing authority shall consider the items presented under I.A.1.c.(ii), and in addition; the annual costs of plant modification in terms of dollars per ton of salt removed for:

a. No salt return.

b. Minimizing salt return.

4. The no salt discharge requirement may be waived in those cases where:

a. The discharge of salt is less than one ton per day or 366 tons per year; or

b. The permitting authority determines that a discharge qualifies for a "fresh water waiver" irrespective of the total daily or annual salt load. The maximum TDS concentration considered to be fresh water is 500 mg/L for discharges into the Colorado River and its tributaries upstream of Lees Ferry, Arizona. For discharges into the Colorado River downstream of Lees Ferry the maximum TDS concentration considered to be afresh water shall be 90% of the applicable in stream standard at the appropriate benchmark monitoring station shown in Table 1, above.

C. Discharge of Once Through Noncontact Cooling Water

1. Definitions:

a. The terms "noncontact cooling water" and "blowdown" are defined as per 40CFR 401.11 (m) and (n).

b. "Noncontact cooling water" means water used for cooling that does not come into direct contact with any raw material, intermediate product, waste product or finished product.

c. "Blowdown" means the minimum discharge of recirculating water for the purpose of discharging materials contained in the water, the further buildup of which would cause concentration in amounts exceeding limits established by best engineering practice.

d. "Salinity" shall mean total dissolved solids as the sum of constituents.

2. Permits shall be authorized for discharges of water that has been used for once through noncontact cooling purposes based upon a finding that the returned water does not contribute to the loading of salts or the concentration of salts in the waters of the receiving stream in excess of a de minimis amount.

3. This policy shall not supplant nor supersede any other water quality standard of the receiving stream adopted pursuant to the Federal Clean Water Act, including but not limited to impairment of designated uses of the stream as established by the governing water quality authority having jurisdiction over the waters of the receiving stream.

4. Noncontact cooling water shall be distinguished from blowdown, and Section 1.C. of this policy specifically excludes blowdown or any commingling of once through non-contact cooling water with another waste stream prior to discharge to the receiving

stream. Sections I.A. and I.B of this policy shall in all cases govern discharge of blow-down or commingled water.

5. Once through noncontact cooling water shall be permitted to return only to the same stream from which the water was diverted.

6. Because the increase in temperature of the cooling water will result in some evaporation, a de minimis increase in the concentration of dissolved salts in the receiving water may occur. An annual average increase in total dissolved solids of not more than 25 milligrams per liter (mg/L) measured at the intake monitoring point, as defined below, of the cooling process or facility, subtracted from the effluent total dissolved solids immediately upstream of the discharge point to the receiving stream, shall be considered de minimis.

7. At the time of NPDES discharge permit issuance or reissuance, the permitting authority may permit a discharge in excess of the 25 mg/L increase based upon a satisfactory demonstration by the permittee pursuant to Section 1.A.1.a.

8. Once through demonstration data requirements:

   a. Description of the facility and the cooling process component of the facility.

   b. Description of the quantity, salinity concentration and salt load of intake water sources.

   c. Description of the discharge, covering location, receiving waters, quantity of salt load and salinity concentration of both the receiving waters and the discharge.

   d. Alternative plans for minimizing salt discharge from the facility which shall include:
      (i) Description of alternative means to attain no discharge of salt.

      (ii) Cost of alternative plans in dollars per ton of salt removed from discharge.

      (iii) Such other information pertinent to demonstration of non practicability as the permitting authority may deem necessary.

9. If, in the opinion of the permitting authority, the database for the salinity characteristics of the water source and the discharge is inadequate, the permit will require that the permittee monitor the water supply and the discharge for salinity. Such monitoring program shall be completed in two years and the permittee shall then present the once through demonstration data as specified above.

10. All new and reissued NPDES permits for once through noncontact cooling water discharges shall require at a minimum semiannual monitoring of the salinity of the intake water supply and the effluent, as provided below.

    a. The intake monitoring point shall be the point immediately before the point of use of the water.

   b. The effluent monitoring point shall be prior to the discharge point at the receiving stream or prior to commingling with another waste stream or discharge source.

   c. Discrete or composite samples may be required at the discretion of the permitting authority, depending on the relative uniformity of the salinity of the water supply.

   d. Analysis for salinity may be either total dissolved solids or electrical conductivity where a satisfactory correlation with total dissolved solids has been established. The correlation shall be based on a minimum of five different samples.

D. Discharges of Salinity from a New Industrial Source with Operations and Discharging Facilities at Multiple Locations

   1. The objective for discharges to surface waters from a new industrial source with operations and discharging facilities at multiple locations shall be to assure that such operations will have no adverse effect on achieving the adopted numeric salinity standards for the Colorado River System.

   2. NPDES permit requirements for a new industrial source with operations and discharging facilities at multiple locations shall be defined, for purposes of establishing effluent limitations for salinity, as a single industrial source if these facilities meet the criteria:

      a. The discharging facilities are interrelated or integrated in any way including being engaged in a primary activity or the production of a principle product; and

      b. The discharging facilities are located on contiguous or adjacent properties or are within a single production area e.g. geologic basin, geohydrologic basin, coal or gas field or 8 digit hydrologic unit watershed area; and

      c. The discharging facilities are owned or operated by the same person or by persons under common or affiliated ownership or management.

   3. The permitting authority may permit the discharge of salt from a new industrial source with operations and discharging facilities at multiple locations if one or more of the following requirements are met:

      a. The permittee has demonstrated that it is not practicable to prevent the discharge of all salt from the industrial source. This demonstration by the applicant must include detailed information on the factors set forth in Section I.A.1.b of the Policy for implementation of Colorado River Salinity Standards through the NPDES permit program; with particular emphasis on an assessment of salinity off set options that would contribute to state or interstate salinity control projects or salt banking programs and offset all or part of the salt loading to the Colorado River associated with the proposed discharge.

b. In determining what permit conditions shall be required under I.A.1.a.i., above, the permit issuing authority shall consider the requirement for an offset project to be feasible if the cost per ton of salt removal in the offset project options (i.e. the permittee's cost in conducting or buying into such projects where they are available) is less than or equal to the cost per ton of salt removal for projects undertaken by the Colorado River Basin Salinity Control Forum or less than the cost per ton in damages caused by salinity that would otherwise be cumulatively discharged from the outfalls at the various locations with operations controlled by the industrial source; or

c. The pemittee has demonstrated that one or more of the proposed discharges is of sufficient quality in terms of TDS concentrations to qualify for a "fresh water waiver" from the policy of "no salt return, whenever practical." An individual discharge that can qualify for a fresh water waiver shall be considered to have no adverse effect on achieving the adopted numeric salinity standards for the Colorado River System.

4. For the purpose of determining whether a freshwater waiver can be granted, the quality of water discharged from the new industrial source with operations and discharging facilities at multiple locations, determined as the flow weighted average of salinity measurements at all outfall points, must meet the applicable benchmark concentration in accordance with Section I.A.1.a.iii., as set forth above.

5. Very small scale pilot activities, involving 5 or fewer outfalls, that are sited in areas not previously developed or placed into production by a new industrial source operations and discharges at multiple locations under common or affiliated ownership or management, may be permitted in cases where the discharge of salt from each outfall is less than one ton per day or 366 tons per year. However, no later than the date of the first permit renewal after the pilot activities have become part of a larger industrial development or production scale effort, all discharging facilities shall be addressed for permitting purposes as a single industrial source with operations and discharges at multiple locations under common or affiliated ownership or management.

6. The public notice for NPDES permits authorizing discharges from operations at multiple locations with associated outfalls shall be provided promptly and in the most efficient manner to all member states in the Colorado River Basin Salinity Control Forum in relation to this policy.

II. Municipal Discharges

The basic policy is that a reasonable increase in salinity shall be established for municipal discharges to any portion of the Colorado River stream system that has an impact on the lower main stem. The incremental increase in salinity shall be 400 mg/L or less, which is considered to be a reasonable incremental increase above the flow weighted average salinity of the intake water supply.

F. The permitting authority may permit a discharge in excess of the 400 mg/L incremental increase at the time of issuance or reissuance of a NPDES discharge permit, upon

satisfactory demonstration by the permittee that it is not practicable to attain the 400 mg/L limit.

G. Demonstration by the applicant must include information on the following factors relating to the potential discharge:

1. Description of the municipal entity and facilities.

2. Description of the quantity and salinity of intake water sources.

3. Description of significant salt sources of the municipal wastewater collection system, and identification of entities responsible for each source, if available.

4. Description of water rights, including diversions and consumptive use quantities.

5. Description of the wastewater discharge, covering location, receiving waters, quantity, salt load, and salinity.

6. Alternative plans for minimizing salt contribution from the municipal discharge. Alternative plans should include:

a. Description of system salt sources and alternative means of control.

b. Cost of alternative plans in dollars per ton, of salt removed from discharge.

7. Such other information pertinent to demonstration of non-practicability as the permitting authority may deem necessary.

H. In determining what permit conditions shall be required, the permit issuing authority shall consider the following criteria including, but not limited to:

1. The practicability of achieving the 400 mg/L incremental increase.

2. Where the 400 mg/L incremental increase is not determined to be practicable:

a. The impact of the proposed salt input of each alternative on the lower main stem in terms of tons per year and concentration.

b. Costs per ton of salt removed from discharge of each alternative plan.

c. Capability of minimizing the salt discharge.

D. If, in the opinion of the permitting authority, the data base for the municipal waste discharger is inadequate, the permit will contain the requirement that the municipal waste discharger monitor the water supply and the wastewater discharge for salinity. Such monitoring program shall be completed within 2 years and the discharger shall then present the information as specified above.

E. Requirements for establishing incremental increases may be waived in those cases where the incremental salt load reaching the main stem of the Colorado River is less than one ton per day or 350 tons per year, whichever is less. Evaluation will be made on a case-by-case basis.

F. All new and reissued NPDES permits for all municipalities shall require monitoring of the salinity of the intake water supply and the wastewater treatment plant effluent in accordance with the following guidelines:

Treatment Plant Design Capacity	Monitoring Frequency	Type of Sample
<1.0 MGD*	Quarterly	Discrete
1.0 - 5.0 MGD	Monthly	Composite
>5.0 - 50.0 MGD	Weekly	Composite
50.0 MGD	Daily	Composite

1. Analysis for salinity may be either as total dissolved solids (TDS) or be electrical conductivity where a satisfactory correlation with TDS has been established. The correlation should be based on a minimum of five different samples.

2. Monitoring of the intake water supply may be at a reduced frequency where the salinity of the water supply is relatively uniform.

References

Chapter 1 - Introduction

Discover a Watershed – The Colorado, (Project WET International Foundation, 2005).

American Rivers Report, America's Most Endangered Rivers of 2004, (American Rivers, Washington D. C., 2004).

Governor Janet Napolitano's Drought Task Force, Arizona Drought Preparedness Plan, October 8, 2004.

Arizona's 2004 Integrated 305(b) Assessment and 303(d) Listing Report (ADEQ, 2005).

Chapter 2 - Nutrients

America's most endangered rivers of 2004, 2004, American Rivers, Washington D. C., 33 p.

Burns & McDonnell, 1999, Regional watershed planning document, final report for the Colorado River Regional Sewer Coalition, Project No. 98-763-4.

Burns & McDonnell, 2004, Watershed planning document update for the Colorado River Regional Sewer Coalition, Project No. 36911.

Canter, L. W., 1977, Nitrates in Groundwater: CRC Press, Lewis Publishers, Boca Raton, 263 p.

Colorado River watershed sanitary survey, 2000 update, 2001, Metropolitan Water District of Southern California, 368 p.

Conservation practice standard, Arizona: Nutrient Management, 2002, U. S, Department of Agriculture, Natural Resources Conservation Service, Code 590, 8 p.

Dorsch, M.M., and others, 1984, Congenital malformations and maternal drinking water supply in rural South Australia—A case-control study: American Journal of Epidemiology, v. 119, p. 473-480.

Fan, A.M., Wilhite, C.C., and Book, S.A., 1987, Evaluation of the nitrate drinking water standard with reference to infant methemoglobinemia and potential reproductive toxicity: Regulatory Toxicology and pharmacology, v. 7, p. 135-137.

Forman, D., Al-Dabbagh, S., and Doll, R., 1985, Nitrates, nitrites, and gastric cancer in Great Britain: Nature, v. 313, p. 620-625.

National Research Council, 1985, The health effects of nitrate, nitrite, and N-nitroso compounds: National Academy Press, Washington, D.C., 723 p.

Towne, D. C., 2003, Ambient groundwater quality of the Detrital valley basin: A 2002 baseline study: Arizona Department of Environmental Quality Report 2003-03, 65 p.

Towne, D. C., 2005, Ambient groundwater quality of the Meadview basin: A 2000-2003 baseline study: Arizona Department of Environmental Quality Report 2005-01, 32 p.

Towne, D. C. and Freark, M. C., 2001, Ambient groundwater quality of the Sacramento Valley basin: A 1999 baseline study: Arizona Department of Environmental Quality Report 01-04, 78 p.

Walvoord, M. A., Phillips, F. M., Stonestrom, D. A., Evans, R. D., Hartsough, P. C., Newman, B. D., and Steigl, R. G., 2003, A reservoir of nitrate beneath desert soils: Science, Vol. 302, p. 1021 – 1024.

Wastewater treatment needs along the Lower Colorado River, February 11, 2005, Office of Resources Management, Lower Colorado River Regional Office, Bureau of Reclamation.

Chapter 3 - Metals

Agency for Toxic Substances and Disease Registry - http://www.atsdr.cdc.gov/about.html.

Selenium

Butler, D.L. 2001. Effects of piping irrigation laterals on selenium and salt loads, Montrose Arroyo Basin, Western Colorado. U.S. Geological Survey, Water Resources Investigations Report 01-4204.

Ohlendorf, H.M., Kilnes, A.W., Simmons, J.L., Stroud, R.K., Hoffman, D.J., and Moore, J.F., 1988. Selenium toxicosis in wild aquatic birds. J. Toxicology and Environmental Health, 24:67-92.

Seiler, R.L., J.P. Skorupa, and L.A. Peltz. 1999. Areas susceptible to irrigation-induced selenium contamination of water and biota in the Western United States. U.S. Geological Survey Circular 1180.

Chromium

Bartlett, R., and James, B., 1979, Behavior of chromium in soils, Journal of Environmental Quality, Vol. 8, p. 31-35.

Deutsch, W. J., 1997, Groundwater Geochemistry: Fundamentals and applications to contamination., Lewis Publishers, Boca Raton, 221 p.

Eary, L. E., and Rai, D., 1987, Kinetics of chromium, (III) oxidation to chromium (VI) by reaction with manganese dioxide: Environmental Science Technology, Vol. 21, p. 1187- 1193.

Harte, J., Holdren, C., Schneider, R., and Shirley, C., 1991, Toxins A to Z: A guide to everyday pollution hazards., University of California Press, Berkley, p. 479 p.

Pacific Gas and Electric Company (PG&E) Topock Project begins interim measure No. 3 treatment operations: Fact Sheet – July 2005, California Department of Toxic Substances Control, 3 p.

Rai, D., and Zachara, J. M., 1984, Chemical attenuation rates, coefficients, and constants in leachate migration: A critical review., Vol. 1, Electric Power Research Institute, Palo Alto.

Schroeder, , D. C., and Lee, G. F., 1975, Potential transformations of chromium in natural waters:, Water, Air, and Soil Pollution, Vol. 4, p. 355-365.

Mercury

ADEQ and AGFD, 2001. Alamo Lake fish tissue results for mercury (Largemouth Bass, Catfish, and Crappie)

ADEQ and Tetra Tech, Inc., 2005. Alamo Lake Mercury TMDL.

ADEQ, 2002. Water Quality Assessment & Listing Report.

Environmental and Energy Study Institute, November 17, 2003. Congressional Briefing Summary on Mercury Contamination. House Committee on Science and Florida Department of Environmental Protection.

Figure1, Arizona Department of Mines and Minerals www.admmr.state.az.us/deptpub.htm

Figure 3, taken from MADEP Files, Chapter 2 – Mercury: Forms, Fate & Effects, August 19, 2005. http://www.mass.gov/dep/files/mercury/fig22.gif

Leslie Ruiz, 1994. Contaminants in Water, Sediment, and Biota from the Bill Williams River National Wildlife Refuge, Arizona. U of A MS Thesis.

USFWS, 1993. Contaminants in Sediment and Fish from National Wildlife Refuges on the Colorado River, Arizona. K. King et al.

USFWS, 1997. Environmental Contaminants in Fish and Wildlife of Havasu National Wildlife Refuge, Arizona. B. Andrews et al.

USFWS, 2002. Contaminants in Southwestern Willow Flycatcher Eggs and Prey Items, Arizona (1998-2000). K. King et al.

Uranium

http://www.epa.gov/radiation/radionuclides/uranium.htm

Federal Register: September 21, 2005 (Volume 70, Number 182), pages 55358-55365

U.S. Department of Energy, Office of Environmental Management, Remediation of the Moab Uranium Mill Tailings, Grand and San Juan Counties, Utah, Draft Environmental Impact Statement (DEIS), November, 2004.

Jaqueline García-Hernández , Yelena V. Sapozhnikova, Daniel Schlenk, Andrew Z. Mason, Osvel Hinojosa-Huerta; Centro de Investigación en Alimentación y Desarrollo A.C. (CIAD) Unidad Guaymas, University of California Riverside, California State University Long Beach, Institute for Integrated Research in Materials, Environment and Society, Pronatura Noroeste, Dirección de Conservación Sonora, 2005, Concentration of contaminants in breeding bird eggs from the Colorado River Delta, Mexico

Chapter 4 - Endocrine Disruption Chemicals

ASU and SNWA website: Removal of EDCs and Pharmaceuticals by Water Treatment, Web Site: www.tntech.edu/wrc/PPCPWebcast/Snyder/Snyder.html

Barnes, K.K., Dana W. Kolpin, Michael T. Meyer, E. Michael Thurman, Edward T. Furlong, Steven D. Zaugg, and Larry B. Barber, 2002. Water-Quality Data for Pharmaceuticals, Hormones, and Other Organic Wastewater Contaminants in U.S. Streams, 1999-2000. U.S. Geological Survey, Open-File Report 02-94.

Boyd, R. A. and Furlong, E. T., 2002, Human-health pharmaceutical compounds in Lake Mead, Nevada and Arizona, and Las Vegas Wash, Nevada October 2000-August 2001: U. S. Geological Survey, Open-File Report 2002-385, 18 p.

Erickson, B. E., 2002, Analyzing the ignored environmental contaminants: Environmental Science and Technology, Vol. 36, No. 5, p. 140A-145A.

Jesperson, K., Endocrine disruptors-What are they doing to you?: West Virginia University, Web site address: www.nesc.wvu.edu/ndwc/articles/OT/WI03/endocrine_disrupt.html.

U. S. Environmental Protection Agency Web site: Endocrine Disruptors Research Initiative: www.epa.gov/endocrine

U. S. Environmental Protection Agency Web site: Pharmaceuticals and Personal Care Products (PPCP's) as Environmental Pollutants: Pollution from Personal Actions, Activities, and Behaviors; www.epa.gov/esd/chemistry/pharma/index.htm.

Chapter 5 - Perchlorate

Dasgupta, P.A., Martinelango, P.K., Jackson, W.A., Anderson, T.A., Tian, K., Tock, R.W., & Rajogopalan, S. The origin of naturally occurring perchlorate: the role of atmospheric processes. Environ. Sci. Technol. 2005, 39, 1569-1575.

National Research Council of the National Academies. (January 2005). Health Implications of Perchlorate Ingestion. Washington DC: The National Academies Press.

EPA Region 9 Waste Management Division. (June 2005). Perchlorate Monitoring Results Henderson, Nevada to the Lower Colorado River.

Arizona Perchlorate Taskforce. (December 2004). Perchlorate in Arizona Occurrence Study of 2004.

Chapter 6 - Bacteria

1. MedFriendly, October 31, 2005, http://www.medfriendly.com/feces.html#bacteria.

2. University of Northern Iowa, College of Natural Sciences, October 31, 2005.

3. http://www.cns.uni.edu/LakeStudy/cyano__enteric_bacteria.htm, Bacteria and Iowa Beaches.

4. Center for Disease Control, October 31, 2005, http://www.cdc.gov/ncidod/dpd/parasites/cryptosporidiosis/factsht_cryptosporidiosis.htm#_What_is_Cryptosporidium?, Parasitic Disease Information, Cryptospordium Infection, August 19, 2005.

5. Center for Disease Control, October 31, 2005, http://www.cdc.gov/ncidod/dpd/parasites/giardiasis/factsht_giardia.htm#what, Parasitic Disease Information, Giardia, September 17, 2004.

6. National Environmental Services Center, October 31, 2005, http://www.nesc.wvu.edu/nsfc/pdf/septic%20news/Septic_Tank1.pdf, "So, Now You Own A Septic Tank".

7. Center for Disease Control, October 31, 2005, http://www.cdc.gov/ncidod/dbmd/diseaseinfo/waterbornediseases_t.htm, "Preventing Bacterial Waterborne Diseases", October 25, 2005.

8. National Park Service, U.S. Dept. of the Interior, October 31, 2005, http://www.nps.gov/lame/05-054.html, Press Release: "Lake Mead National Recreation Area Announces Release of Environmental Assessment for the Replacement of Water and Sewer Systems", September 21, 2005.

9. National Park Service, U.S. Dept. of the Interior, October 31, 2005, http://www.nps.gov/lame/lmp_feis_rod.pdf, "Lake Management Plan/Final Environmental Impact Statement Lake Mead National Recreation Area Record of Decision", March 12, 2003

10. Barry A. Long and Rebecca A. Smith, U.S. Department of the Interior, National Park Service, Water Resources Division, "Bacteria Water Quality Data Analysis and Interpretation Glen Canyon National Recreation Area", 1995

Chapter 7 - Salinity/Total Dissolved Solids

Colorado River Basin Salinity Control Forum. 2002 Review, Water Quality Standards for Salinity, Colorado River System. 2002.

Salt River Project. SRP 1998 Annual Water Quality Report. 1998.

US Bureau of Reclamation. Central Arizona Salinity Study, Phase I Report. 2003.

US Department of the Interior. Quality of Water, Colorado River Basin, Progress Report No. 21. 2003.

US Department of the Interior. Quality of Water, Colorado River Basin, Progress Report No. 22. 2005.

US Environmental Protection Agency. Quality Criteria for Water. 1986.

Chapter 8 - Sediment

Draft Narrative Bottom Deposits implementation Procedures (ADEQ, 2005) Documents ADEQ's policy and procedures for determining whether the narrative bottom deposits standard (R18-11-108(A)(1)) is being violated.

Riparian Area Management -- Process for Assessing Proper Functioning Condition (BLM, 1993) documents a process for assessing the physical function of a lotic (flowing water) ecosystem and the associated riparian or wetland area.

Riparian Area Management -- Process for Assessing Proper Functioning Condition for Lentic Riparian-Wetland Areas (BLM, 1999). This guidance modifies the process for assessing lentic systems (open waters such as lakes and marshes).

Riparian Area Management -- Process for Assessing Proper Functioning Condition for Lotic Riparian-Wetland Areas (BLM, 1998). This guidance modifies the process outlined in 1993 for assessing lotic systems (flowing water).

Riparian Area Management -- Grazing Management for Riparian and Wetland Areas (BLM, 1997) provides Best Management Practices for grazing to protect riparian and wetland areas.

Management for Enhancement of Riparian and Wetland Areas of Western United States (BLM and USFS, 2000). This document provides Best Management Practices to preserve riparian and wetland areas in the Western United States.

Clarkson, R. W., O. T. Gorman, D. M. Kubly, P. C. Marsh, and R. V. Valdez. 1994. Management of discharge, temperature, and sediment in Grand Canyon for native fishes.

Collier, M., R. H. Webb, and J. C. Schmidt. 1996 Dams and Rivers. A primer on the downstream effects of dams. USGS, Circular 1126, Denver, CO

DeBano, L. F., P. F. Folliott, and K. N. Books. 1996 Flow of water and sediments through southwestern riparian systems. Pages 128-134 in D. W. Shaw and D. M. Finch, editors. Desired future conditions for Southwestern riparian ecosystems: bringing interests and concerns together. September 18-22, 1995. U.S. Forest Service Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-GTR-272, Ft, Collins, CO.

Riparina responses to grazing practices. Pages 442-457 in R. J. Naiman, editor. Watershed management: balancing sustainability and environmental change. Springer-Verlag, New York, NY

Heede, B. H. 1990. Vegetation strips control erosion in watersheds. US Forest Service Rocky Mountain Forest and Range Experiment Station, Research Note RM-499, Ft, Collins, CO.

Heede, B. H., and R. M. King. 1990. State of the art timber harvest in an Arizona mixed conifer forest has minimal effect on overland flow and erosion. Hydrological Sciences 36(6):623-635.

Johnson, J. E., and r. T. Hines. 1998. Effect of suspended sediment on vulnerability of young razorback sucker to predation. Proceedings of the Desert Fishes Council XXX:23.

Karr, J.R., and I. J. Schlosser. 1977. Impact of nearstream vegetation and stream morphology on water quality and stream biota. EPA Ecological Research Series. EPA-600/3-77-097. Athens, GA

Ligon,F. K., W. e. Dietrich, and W. J. Trush. 1995. Downstream ecological effects of dams. BioScience 45(3):183-192.

Miller, A. S. and W. A. Hubert. 1990 Compendium of existing knowledge for use in making habitat management recommendations for the upper Colorado River Basin. U.S. Fish and Wildlife Service, Denver, CO.

Newcombe, C. P., and D. D. MacDonald. 1991. Effects of suspended sediment on aquatic ecosystems. North American Journal of Fisheries Management 11:72-83.

Richter., B.D., P. Braun, M.A. Mendelson, and L.L. Master. 1997. Threats to imperiled freshwater fauna. Conservation Biology 11(5):1081-1093

Engineering Science, Inc. 1994. Analysis of water quality functions of riparian vegetation. Prepared for ADEQ.

Shaw, E. A., and J. S. Richardson. 2001. Direct and indirect effects of sediment pulse duration on stream invertebrate assemblages and rainbow trout (Oncorhynchus mykiss) growth and survival. Canadian Journal of Fisheries and Aquatic Sciences 58:2213-2221.

Rosgen, Dave. 1996. Applied River Morphology. Printed Media Companies, Minneapolis, Mn,

Waters, Thomas. 1995. Sediment in Streams – Sources, Biological Effects and Control. American Fisheries Society Monograph 7. 251 pp.

Collier, Michael, Robert H. Webb, and John C. Schmidt. 1996. Dams and Rivers – Primer on the Downstream Effects of Dams. USGS Circular 1126, Denver, CO. 94 pp.

ADEQ, 1997. Urban Runoff – Pollution Prevention Practices.

O_NPCA-CBD et al 2

Attachment 3:
Jaqueline García-Hernández, "Water Quality in the Colorado River" (Southwest Hydrology, Jan/Feb 2004, pp. 18-19)

O_NPCA-CBD et al 2

Water Quality in the Colorado River Delta

***Jaqueline García-Hernández, Ph.D**. – Centro de Investigación en Alimentación y Desarrollo, Guaymas Unit*

The health of the riparian ecosystem of the Colorado River Delta depends not only on the quantity of water available, but also on its quality. For many years, the lower Colorado River has experienced high salinity and elevated concentrations of selenium, a nutrient that can be toxic to wildlife. These problems are exacerbated as the river flows south, and concentrations increase. Where the Colorado River reaches the Imperial Dam, about 20 miles north of the United States-Mexico border, concentrations of salinity and selenium are the highest measured in the United States, with specific conductance reaching 2,600 microseimens per cubic centimeter ($\mu S/cm^3$) and selenium at 2.0 micrograms per liter (µg/l, ppb) in water and 7.1 micrograms per gram (µg/g, ppm) in sediments (Radtke et al., 1988). In 1984, concentrations of selenium in sediments were five times higher than the geochemical baseline for soils from the western United States, which range from less than 0.39 to 1.4 µg/g (Shacklette and Boerngen, 1984). At the Colorado River Delta in Mexico, the terminus of the river, we would therefore expect salinity and selenium concentrations to be at their maximum. Measurements along the mainstem of the river in Mexico have shown salinity as high as 4,000 ppm and selenium up to 6.3 ppb (Valdéz-Casillas et al., 2000), supporting this argument. However, the associated riparian areas and wetlands in the delta area are supported primarily by irrigation runoff, and several studies have shown that agricultural practices do not appear to exacerbate salinity and dissolved selenium concentrations there (Radtke et al., 1988; García-Hernández et al., 2000; García-Hernández et al., 2001).

Salinity Sources

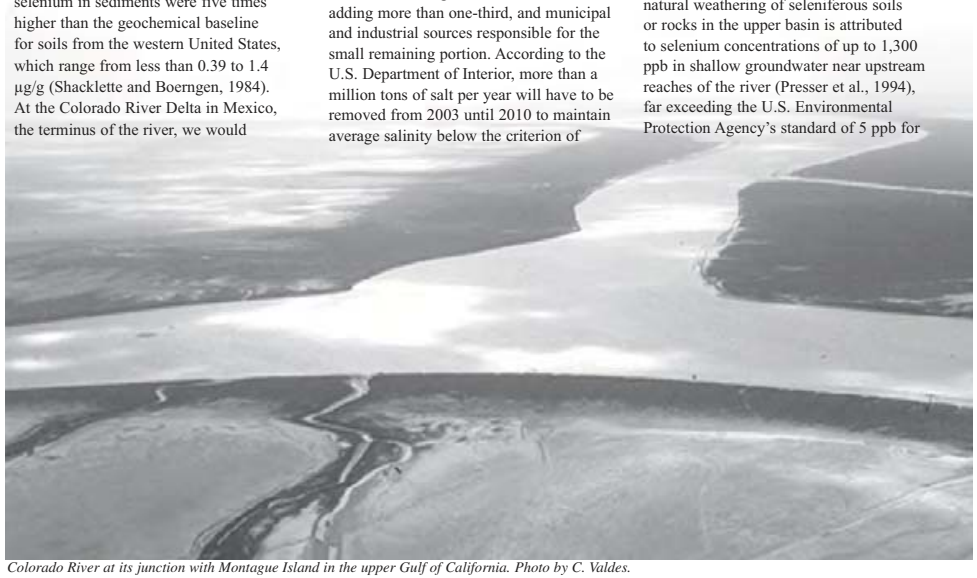
Salinity in the Colorado River primarily originates from geologic sources, saline springs, and agricultural sources. Almost half the total salt load is from natural sources, with irrigation return flows adding more than one-third, and municipal and industrial sources responsible for the small remaining portion. According to the U.S. Department of Interior, more than a million tons of salt per year will have to be removed from 2003 until 2010 to maintain average salinity below the criterion of 880 mg/L at Imperial Dam set by the U.S. Bureau of Reclamation Colorado River Basin Salinity Control Program.

...riparian areas and wetlands in the delta area are supported primarily by irrigation runoff, and several studies have shown that agricultural practices do not appear to exacerbate salinity and dissolved selenium concentrations there.

Selenium

Dissolved selenium concentrations in water from the lower Colorado River appear to have multiple origins. The natural weathering of seleniferous soils or rocks in the upper basin is attributed to selenium concentrations of up to 1,300 ppb in shallow groundwater near upstream reaches of the river (Presser et al., 1994), far exceeding the U.S. Environmental Protection Agency's standard of 5 ppb for wildlife protection. Additional sources of dissolved selenium in the river may include the combustion of seleniferous coal at electric generating stations and the extraction of seleniferous ore deposits. All of these sources may contribute to the downstream loading and transport of selenium and hence its distribution and availability for biaccumulation in the ecosystem (Radtke et al., 1988). The construction of dams, mining, and intensive agriculture activities may also increase the concentrations of salinity and selenium in the lower Colorado River.

In the Colorado River Delta, selenium is found in greater concentrations in aquatic organisms compared to terrestrial wildlife (see table). The selenium cycle is enhanced in aquatic ecosystems due to selenium's solubility and bioaccumulation first in sediments, then plants, fish, and birds. Despite elevated selenium concentrations found in birds and bird eggs in the delta wetlands, no evidence of deformed embryos has yet been found. However, continued monitoring will be necessary to promptly detect any toxic changes that may occur.



Colorado River at its junction with Montague Island in the upper Gulf of California. Photo by C. Valdes.

Species	N	Se (ppm)	Reference
BACKGROUND LEVELS		**<2.0**	
Double-crested cormorant	9	16.7	Mora & Anderson, 1995
Cattle egret	15	4.6	Mora & Anderson, 1995
Red-winged blackbird	8	5.1	Mora & Anderson, 1995
Great-tailed grackle	14	5.3	Mora & Anderson, 1995
Mourning dove	15	2.3	Mora & Anderson, 1995
Tilapia (*Tilapia zilli*)	6	6.8	Mora & Anderson, 1995
Largemouth bass (*Micropterus salmoides*)	11	5.1	García-Hernández *et al*., 2000
Marsh wren (*Cistothorus palustris*) eggs	18	5.3	García-Hernández, unpublished data, 2002
Mourning dove eggs	27	1.7	García-Hernández, unpublished data, 2002

Concentrations of selenium (Se) in fish and birds from the Colorado River delta wetlands, in ppm dry weight (N = number of samples).

Other Contaminants

Water quality in the Colorado River Delta is affected not only by salinity and natural elements such as selenium, but also by raw sewage from the city of San Luis and numerous agrochemicals, including organophosphorate and carbamate pesticides. Most delta wetland ecosystems are supported, however, by irrigation runoff from the local agricultural valleys. Although agricultural practices do not appear to increase dissolved selenium concentrations in water from the lower Colorado River and its delta, agricultural runoff can carry other contaminants such as pesticides, fecal coliforms, and other metals.

Concentrations of dichlorodiphenyl-dichloroethylene (DDE, a degradation product of DDT) in aquatic organisms and birds have been reported in several studies conducted in the Colorado River Delta, but show a marked decrease over time. However, fish-eating birds like cormorants still show elevated concentrations of DDE. The presence of organochlorine compounds in wildlife is possibly due to the past intensive use of DDT in agriculture in the Mexicali Valley.

The wetlands of the delta are inhabited by a wide variety of wildlife, including the largest population of the endangered Yuma clapper rail in the Ciénega de Santa Clara. For the protection of the wetlands and its inhabitants, it is important to maintain an inventory of the chemicals present in delta wetlands, their behavior in the system, and their effects on wildlife. Studies on concentrations of chemicals in different matrices (water, sediment, soil, and wildlife), cholinesterase inhibition in birds exposed to pesticides, nest success of different species, and other studies will be necessary to protect the environmental health of this rich and unique delta.

Contact Jaqueline García-Hernández at Jaqueline@cascabel.ciad.mx.

References

García-Hernández, J., E.P. Glenn, J. Artiola, and D.J. Baumgartner. 2000. Bioaccumulation of selenium (Se) in the Cienega de Santa Clara Wetland, Sonora, Mexico, Ecotoxicology and Environmental Safety 45: 298-304.

García-Hernández, J., K.A. King, A.L. Velasco, E. Shumilin, M.A. Mora, and E.P. Glenn. 2001. Selenium, selected inorganic elements, and organochlorine pesticides in bottom material and biota from the Colorado River Delta, Journal of Arid Environments 49(1): 65-89.

Mora, M.A., and D.W. Anderson. 1995. Selenium, boron, and heavy metals in birds from the Mexicali Valley, Baja California, Mexico, Bulletin of Environmental Contamination and Toxicology 54: 198-206.

Presser, T. S., M.A. Sylvester and W.H. Low. 1994. Bioaccumulation of selenium from natural geologic sources in western states and its potential consequences, Environmental Management 18(3): 423-436.

Radtke, D.B., W.G. Kepner, and R.J. Effertz. 1988. Reconnaissance investigation of water quality, bottom sediment, and biota associated with irrigation drainage in the lower Colorado River Valley, Arizona, California, and Nevada, 1986-87. Tucson, AZ, U.S. Geological Survey, Water-Resources Investigation Report 88-4002.

Shacklette, H.T., and J.G. Boerngen. 1984. Element concentrations in soils and other surficial materials of the conterminous United States. U.S. Geological Survey Professional Paper 1270.

Valdés-Casillas, C., O. Hinojosa-Huerta, E.P. Glenn, Y. Carillo-Guerrero, J. García-Hernández, F. Zamora-Arroyo, M. Briggs, and E. Chavarria-Correa. 2000. Demonstration sites for wetland management in the Colorado River delta. Reporte final para el Consejo para la Conservación de Humedales de Norteamérica Guaymas, Sonora, México.

Attachment 4:
United States Bureau of Reclamation, "Quality of Water, Colorado River Basin: Progress Report No. 23," (2011)

O_NPCA-CBD et al 2

RECLAMATION
Managing Water in the West

QUALITY OF WATER
COLORADO RIVER BASIN
Progress Report No. 23

U.S. Department of the Interior
Bureau of Reclamation
Upper Colorado Region

2011

Mission Statements

The U.S. Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

O_NPCA-CBD et al 2

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

TABLES

FIGURES

FIGURES (Continued)

O_NPCA-CBD et al 2

SUMMARY

The Colorado River and its tributaries provide municipal and industrial water to about 33 million people and irrigation water to nearly 4 million acres of land in the United States. The river also serves about 3 million people and 500,000 acres in Mexico. The effect of salinity is a major concern in both the United States and Mexico. Salinity damages in the United States are presently about $383 million per year at 2009 salinity concentrations. This biennial report on the quality of water in the Colorado River Basin is required by Public Laws 84-485, 87-483, and the Colorado River Basin Salinity Control Act (Salinity Control Act) (Public Law 93-320, as amended by Public Laws 98-569, 104-20, 104-127, and 106-459).

Salinity damages to municipal water pipe.

The Salinity Control Act authorizes the Secretaries of the U.S. Department of the Interior (Interior) and U.S. Department of Agriculture (USDA) to enhance and protect the quality of water available in the Colorado River for use in the United States and the Republic of Mexico.

Title I of the Salinity Control Act authorized the construction and operation of a desalting plant, brine discharge canal, and other features to enable the United States to deliver water to Mexico having an average salinity no greater than 115 parts per million (ppm) plus or minus 30 ppm over the annual average salinity of the Colorado River at Imperial Dam. The Title I program (administered by the Bureau of Reclamation [Reclamation]) continues to meet the requirements of Minute No. 242 of the International Boundary and Water Commission, United States and Mexico.

Salinity damages to crop production.

Title II of the Salinity Control Act authorizes the Secretary of the Interior (Secretary) and the Secretary of Agriculture to implement a broad range of specific and general salinity control measures in an ongoing effort to prevent further degradation of water quality to meet the objectives and standards set by the Clean Water Act.

In 1995, Public Law 104-20 authorized an entirely new way of implementing salinity control. Reclamation's Basinwide Salinity Control Program opened the program to competition through a "Request for Proposal" process, which greatly reduced the cost of salinity control by selecting the most cost effective projects. However, the price of salinity control will increase in the future as the less cost effective projects are left.

The Colorado River Basin Salinity Control Forum (Forum) in accordance with the requirements of the Clean Water Act, prepared the "2008 Review, Water Quality Standards for Salinity, Colorado River System" (Review). The Review reported that by 2030 a target of 1.85 million tons per year of salt will need to be diverted from entering the Colorado River in order to meet the water quality standards in the Lower Basin, below Lees Ferry, AZ. The combined Reclamation, USDA & BLM salinity reduction reported for 2010 shows that the Colorado River Basin Salinity Control Program (Program) has controlled over 1,192,000 tons of salt per year. In order to meet the 1.85 million tons of salt per year goal, it will be necessary to fund and implement potential new measures which ensure the removal of an additional 657,950 tons by 2030. The Forum stated that in order to achieve this level of salt reduction, the federal departments and agencies would require the following capital funding: Reclamation appropriation - $17.5 million per year (bringing the total Reclamation program with $7.5 million cost-sharing to $25 million per year); and USDA EQIP appropriation - $13.8 million per year (bringing the total on-farm program to $19.7 million per year with Basin states parallel program). Beginning in 2005, BLM began a comprehensive program to minimize the salt loading from BLM lands in the Colorado River basin. BLM salinity funding from Congress began in FY 2006.

With the reported existing salt controlled, and assuming no reduction of the existing salinity control projects, then nearly 32,900 tons of new or additional controls will need to be implemented each year to maintain the standards with increased future water development. This Program goal is the combined target for the participating agencies within Interior and USDA. The participating agencies reported to the Colorado River Basin Salinity Control Advisory Council, showing that the agencies efforts have been able to exceed the program's target over the past several years.

The Upper Colorado River Basin continues to experience a protracted multi-year drought. Since 1999, inflow to Lake Powell has been below average in every year except water years 2005 and 2008. The overall reservoir storage in the Colorado River Basin, as of October 1, 2010, is 33.05 million acre-feet or 55.6 % of capacity. Salinity concentration has increased during this time period (while salinity loading has decreased), but has not exceeded the numeric salinity criteria on the Colorado River below Hoover Dam, Parker Dam and at Imperial Dam; 723, 747 & 879 mg/L respectively. Reclamation's short term future salinity modeling scenarios indicate that the numeric salinity criteria should be maintained even with an additional 1-2 years of drought. However, the uncertainty of the prediction is within reach of the salinity criteria. The salinity criteria could have been exceeded in 2003 or 2004 without the salinity control program and other salt reductions. Nevertheless, salinity damages are still very high at the 2009 salinity levels. This is the first observation of this level of reservoir draw down. This drought is providing new data, which will eventually reduce the uncertainty in salinity forecasting.

O_NPCA-CBD et al 2

CHAPTER 1 - INTRODUCTION

The Bureau of Reclamation (Reclamation) of the U.S. Department of the Interior prepared this report in cooperation with State water resource agencies and other Federal agencies involved in the Colorado River Basin Salinity Control Program (Salinity Control Program). This Progress Report is the latest in a series of biennial reports that commenced in 1963. This report, Progress Report 23, should have been published in 2007, but due to long review times for the past Progress Reports 21 and 22, the time line has been delayed enough to include the 2007 and 2009 data in this report.

AUTHORIZATION FOR REPORT

The directive for preparing this report is contained in four separate public laws.

Public Law 84-485 states:

> Section 15 –"The Secretary of the Interior is directed to continue studies and make a report to the Congress and to the States of the Colorado River Basin on the quality of water of the Colorado River,"
>
> Section 5c – "All revenues collected in connection with the operation of the Colorado storage project and participating projects shall be credited to the Basin Fund, and shall be available, without further appropriation, for (1) defraying the costs of operation, maintenance, & replacement of, and emergency expenditures for, all facilities". The ongoing water quality monitoring, studies, and report are considered part of the normal operation of the project and are funded by the Basin Fund."

Public Law 87-483 states:

> Section 15 - "The Secretary of the Interior is directed to continue his studies of the quality of water of the Colorado River System, to appraise its suitability for municipal, domestic, and industrial use and for irrigation in the various areas in the United States in which it is used or proposed to be used, to estimate the effect of additional developments involving its storage and use (whether heretofore authorized or contemplated for authorization) on the remaining water available for use in the United States, to study all possible means of improving the quality of such water and of alleviating the ill effects of water of poor quality, and to report the results of his studies and estimates to the 87th Congress and every 2 years thereafter."

Public Law 87-590 states that January 3 would be the submission date for the report.

Public Law 93-320 states:

> "Commencing on January 1, 1975, and every 2 years thereafter, the Secretary shall submit, simultaneously, to the President, the Congress, and the Advisory Council created in Section 204(a) of this title, a report on the Colorado River salinity control program authorized by this title covering the progress of investigations, planning, and construction of salinity control units for the previous

fiscal year; the effectiveness of such units; anticipated work needed to be accomplished in the future to meet the objectives of this title, with emphasis on the needs during the 5 years immediately following the date of each report; and any special problems that may be impeding progress in attaining an effective salinity control program. Said report may be included in the biennial report on the quality of water of the Colorado River Basin prepared by the Secretary pursuant to section 15 of the Colorado River Storage Project Act (70 Stat. 111; 43 U.S.C. 602n), section 15 of the Navajo Indian Irrigation Project and the initial stage of the San Juan-Chama Project Act (76 Stat. 102), and section 6 of the Fryingpan-Arkansas Project Act (76 Stat. 393)."

LEGAL ASPECTS

Water Quantity

Colorado River water was apportioned by the Colorado River Compact of 1922, the Boulder Canyon Project Act of 1928, the Water Treaty of 1944, the Upper Colorado River Basin Compact of 1948, and the United States Supreme Court (*Arizona* v. *California et al*., 1963).

The Colorado River Compact divided the Colorado River Basin between the Upper and Lower Basins at Lee Ferry (just below the confluence of the Paria River), apportioning to each use of 7.5 million acre-feet (maf) annually. In addition to this apportionment, the Lower Basin was given the right to increase its beneficial consumptive use by 1 maf per year. The compact also contains provisions governing exportation of Colorado River water. The Water Treaty of 1944 obligates the United States to deliver to Mexico 1.5 maf of Colorado River water annually, absent treaty surplus or shortage conditions.

Upper Colorado Use - The Upper Colorado River Basin Compact of 1948 divided and apportioned the water apportioned to the Upper Colorado River Basin by the Colorado River Compact, allocating to **Arizona** 50,000 acre-feet annually, with the remaining water allocated to Upper Colorado River Basin States as follows:

- **Colorado** 51.75 percent
- **New Mexico** 11.25 percent
- **Utah** 23 percent
- **Wyoming** 14 percent

Lower Colorado Use - States of the Lower Colorado River Basin did not agree to a compact for the apportionment of waters in the Lower Colorado River Basin; in the absence of such a compact Congress, through Secretarial contracts authorized by the Boulder Canyon Project Act, allocated water from the mainstem of the Colorado River below Lee Ferry among California, Nevada, and Arizona, and the Gila River between Arizona and New Mexico. This apportionment was upheld by the Supreme Court, in 1963, in the case of Arizona v. California.

As confirmed by the U.S. Supreme Court in 1963, from the mainstem of the Colorado River (i.e., The Lower Basin):

O_NPCA-CBD et al 2

- **Nevada** was apportioned 300,000 acre-feet annually and 4 percent of surplus water available,
- **Arizona** was apportioned 2,800,000 acre-feet annually and 46 percent of surplus water available,
- **California** was apportioned 4,400,000 acre-feet annually and 50 percent of surplus water available.

Water Quality

Although a number of water-quality-related legislative actions have been taken on the State and Federal levels, several Federal acts are of special significance to the Colorado River Basin: the Water Quality Act of 1965 and related amendments, the Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500), commonly referred to as the Clean Water Act and related amendments, and the Colorado River Basin Salinity Control Act (Salinity Control Act) of 1974 as amended. Also, central to water quality issues are agreements with Mexico on Colorado River System waters entering that country.

The Water Quality Act of 1965 (Public Law 89-234) amended the Federal Water Pollution Control Act and established a Federal Water Pollution Control Administration (now Environmental Protection Agency [EPA]). Among other provisions, it required States to adopt water quality criteria for interstate waters inside their boundaries. The seven Basin States initially developed water quality standards that did not include numeric salinity criteria for the Colorado River primarily because of technical constraints. In 1972, the Basin States agreed to a policy that called for the maintenance of salinity concentrations in the Lower Colorado River System at or below existing levels, while the Upper Colorado River Basin States continued to develop their compact-apportioned waters. The Basin States suggested that Reclamation should have primary responsibility for investigating, planning, and implementing the proposed Salinity Control Program.

The enactment of the Federal Water Pollution Control Act Amendments of 1972 affected salinity control, in that it was interpreted by EPA to require numerical standards for salinity in the Colorado River. In response, the Basin States founded the Colorado River Basin Salinity Control Forum (Forum) to develop water quality standards, including numeric salinity criteria and a basinwide plan of implementation for salinity control. The Basin States held public meetings on the proposed standards as required by the enacting legislation. The Forum recommended that the individual Basin States adopt the report, *Water Quality Standards for Salinity, Including Numeric Criteria and Plan of Implementation for Salinity Control, Colorado River System*. The proposed water quality standards called for maintenance of flow-weighted annual averaged total dissolved solids concentrations of 723 milligrams per liter (mg/L) below Hoover Dam, 747 mg/L below Parker Dam, and 879 mg/L at Imperial Dam. Included in the plan of implementation were four salinity control units and possibly additional units, the application of effluent limitations, industrial use of saline water, and future studies. The standards are to be reviewed at 3-year intervals. All of the Basin States adopted the 1975 Forum-recommended standards. EPA approved the standards.

The Salinity Control Act of 1974 (Public Law 93-320) provided the means to comply with the United States' obligations to Mexico under Minute No. 242 of the International Boundary and Water Commission, United States and Mexico, which included, as a major feature, a desalting plant and brine discharge canal for treatment of Wellton-Mohawk Irrigation and Drainage District (WMIDD) drainage water. These facilities enable the United States to deliver water to Mexico having an average salinity of 115 parts per million (ppm) plus or minus 30 ppm (United States' count) over the annual average salinity of the Colorado River at Imperial Dam. The act also authorized construction of 4 salinity control units and the expedited planning of 12 other salinity control projects above Imperial Dam as part of the basinwide salinity control plan.

In 1978, the Forum reviewed the salinity standards and recommended continuing construction of units identified in the 1974 act, placing of effluent limitations on industrial and municipal discharges, and reduction of the salt-loading effects of irrigation return flows. The review also called for the inclusion of water quality management plans to comply with section 208 of the Clean Water Act. It also contemplated the use of saline water for industrial purposes and future salinity control.

Public Law 98-569, signed October 30, 1984, amended Public Law 93-320. The amendments to the Salinity Control Act authorized the U.S. Department of Agriculture (USDA) Colorado River Salinity Control Program. The amendments also authorized two new units for construction under the Reclamation program.

In 1993, the Dept. of Interior Inspector General concluded that the lengthy congressional authorization process for Reclamation projects was impeding the implementation of cost-effective measures. Consequently, a public review of the program was conducted in 1994. In 1995, Public Law 104-20 authorized Reclamation to implement a basinwide approach to salinity control and to manage its implementation. Reclamation completed solicitations in 1996, 1997, 1998, 2001, and 2004 in which Reclamation requested proposals, ranking the proposals based on their cost and performance risk factors, and awarded funds to the highest ranked projects. The awards from the first three solicitations consumed the available appropriation ceiling of $75 million authorized by Congress to test the new program. In 2000, Public Law 106-459 amended the Colorado River Basin Salinity Control Act to increase the appropriation ceiling for Reclamation's basinwide approach by $100 million ($175 million total). This appropriation authority allowed Reclamation to continue to request new proposals under its Basinwide Salinity Control Program.

In 1996, Public Law 104-127 significantly changed the authorities provided to USDA. Rather than carry out a separate salinity control program, the Secretary of Agriculture was directed to carry out salinity control measures in the Colorado River Basin as part of the Environmental Quality Incentives Program established under the Food Security Act of 1985. Public Law 104-127 also authorized the Secretary of Agriculture to cost share salinity control activities from the basin funds in lieu of repayment. Cost sharing has been implemented for both USDA and Reclamation programs. Under this new authority, each dollar appropriated by the Congress is matched by $0.43 in cost sharing from the basin funds.

O_NPCA-CBD et al 2

In 2002, Public Law 107-171, Title II, Subtitle D reauthorized the USDA's Environmental Quality Incentives Program (under which the Secretary of Agriculture carries out salinity control measures). In 2008, Public Law 110-246, again authorized the USDA's Environmental Quality Incentives Program. PL110-246 also amended the Salinity Control Act to clarify the authority and implementation of the "Basin States Program".

Nothing in this report is intended to interpret the provisions of applicable federal law including, but not limited to, The Colorado River Compact (42 Stat. 171), The Upper Colorado River Basin Compact (63 Stat. 31), The Utilization of Waters of the Colorado and Tijuana Rivers and of the Rio Grande, Treaty Between the United States of America and Mexico (Treaty Series 994, 59 Stat. 1219), the United States/Mexico agreement in Minute No. 242 of August 30, 1973, (Treaty Series 7708; 24 UST 1968), the 1964 Decree entered by the Supreme Court of the United States in Arizona v. California et al. (376 U.S. 340), as amended and supplemented, The Boulder Canyon Project Act (45 Stat. 1057), The Boulder Canyon Project Adjustment Act (54 Stat. 774; 43 U.S.C. 618a), The Colorado River Storage Project Act (70 Stat. 105; 43 U.S.C. 620), The Colorado River Basin Project Act (82 Stat. 885; 43 U.S.C. 1501), The Colorado River Basin Salinity Control Act (88 Stat. 266; 43 U.S.C. 1571), The Hoover Power Plant Act of 1984 (98 Stat. 1333), The Colorado River Floodway Protection Act (100 Stat. 1129; 43 U.S.C. 1600), or The Grand Canyon Protection Act of 1992 (Title XVIII of Public Law 102-575, 106 Stat. 4669).

CHAPTER 2 – SALINITY CONDITIONS

CAUSES OF SALINITY

The Colorado River System is naturally very saline. At the USGS gauge below Hoover Dam, between 1940 and 1980 an average of approximately 9.4 million tons of salt were carried down the river every year. Since 1981, on average, approximately 8.8 million tons of salts have been measured in the river each year, including years of floods and drought, with the trend going down. The flow of the river dilutes this salt, and depending upon the quantity of flow, salinity can be relatively dilute or concentrated. Since climatic conditions directly affect the flow in the river, salinity in any one year may double (or halve) due to extremes in runoff. Because this natural variability is virtually uncontrollable, the seven Basin States adopted a non-degradation water quality standard.

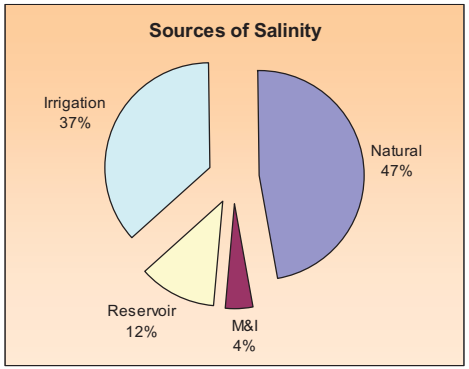


Figure 1 - Sources of Salinity

Nearly half of the salinity in the Colorado River System is from natural sources. Saline springs, erosion of saline geologic formations, and runoff all contribute to this background salinity. Irrigation, reservoir evaporation, and municipal and industrial (M&I) sources make up the balance of the salinity problem in the Colorado River Basin. Figure 1 shows the relative amount each source contributes to the salinity problem. The Environmental Protection Agency (EPA, 1971) estimated that the natural salinity in the Lower Colorado River at Imperial Dam was 334 milligrams per liter (mg/L). For 2009 the average annual flow weighted salinity at Imperial Dam was 717 mg/L, a 383 mg/L increase over the estimated natural salinity. Table 1, on the following page, quantifies the salinity from several of these known sources.

Salinity of the Colorado River has increased with the development of water resources in two major ways: (1) the addition of salts from water use and (2) the consumption (depletion) of water. The combined effects of water use and consumption have had a significant impact on salinity in the Colorado River Basin. The basin-wide drought, since 1999, has also had an influence on the present salinity of the Colorado River.

Current information indicates that the present salt levels in the Colorado River system have few if any negative health effects and the EPA's primary drinking water standards

O_NPCA-CBD et al 2

Table 1 - Quantified Sources of Salt Loading

Source	Type of Source	Salt Loading (tons per year)
Paradox Springs	Springs / point	205,000 [1]
Dotsero Springs	Springs / point	182,600
Glenwood Springs	Springs / point	335,000
Steamboat Springs	Springs / point	8,500
Pagosa Springs	Springs / point	7,300
Sinbad Valley	Springs / point	6,500
Meeker Dome	Springs / point	57,000 [1]
Other minor springs in the Upper Basin	Springs / point	19,600
Blue Springs	Springs / point	550,000
La Verkin Springs	Springs / point	109,000
Grand Valley	Irrigation / non-point	580,000
Big Sandy	Irrigation / non-point	164,000
Uncompahgre Project	Irrigation / non-point	360,000 [1]
McElmo Creek	Irrigation / non-point	119,000
Price-San Rafael	Irrigation / non-point	258,000 [1]
Uinta Basin	mostly irrigation / non-point	240,000
Dirty Devil River Area	non-point	150,000
Price-San Rafael Area	non-point	172,000 [1]
Other, non regulated areas	Various	5,200,000
Total		8,724,000

1- Values listed are pre salinity control project loading

are not exceeded (see Progress Report 21, Health section). However, the EPA secondary drinking water standards of 500 mg/L for TDS (salinity) and 250 mg/L for sulfate may be exceeded. A regression of sulfate versus TDS shows that sulfate exceeds 250 mg/L when the TDS exceeds 612 mg/L. During dry cycles the secondary drinking water standards for TDS and sulfate are exceeded at many places in the Colorado River in both the Upper and Lower Basins, including the three salinity criteria sites.

The primary negative impact of the Colorado River salinity presently is seen as economics. Reclamation has developed a model which calculates damages from a given level of salt. Economic damages have been shown to begin at salinity levels above 500 mg/L and a change of 1 mg/L TDS equates to 10,000 tons of salt per year. Present annual economic damage using the 2008 & 2009 average annual salinity level at Imperial Dam (717 mg/l, latest data available) has been modeled at over $350 million dollars. This impact comes out at a cost of $173 per ton of salt or $1,733,000 per mg/L TDS per year, over the 500 mg/L base point. Even though the salinity level has fluctuated slightly over the last few years, the salinity impact cost has increased primarily due to increased agricultural damage costs (increase in acreage and crop prices).

Salinity related damages are primarily due to reduced agricultural crop yields, corrosion, and plugging of pipes and water fixtures in housing and industry. Figure 2 breaks down the percentage of total damages. The seven Basin States have agreed to limit this impact and adopted numeric criteria, which require that salinity concentrations not increase (from the 1972 levels) due to future water development. Salinity levels measured in the river may be low or high due to climatic conditions, but the goal of the Water Quality Criteria for the Colorado River Basin and the Colorado River Basin Salinity Control Program (Salinity Control Program) is to offset (eliminate) the salinity effects of additional water development.

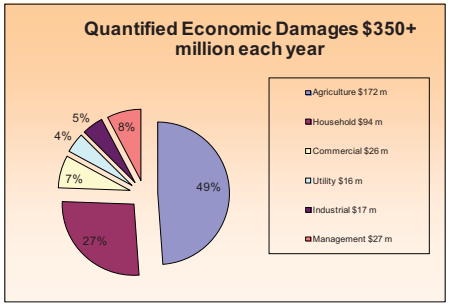


Figure 2 – Percentage of Salinity Damages

HISTORIC SALINITY CONDITIONS

Salinity in the Colorado River is monitored at 20 key stations throughout the Colorado River Basin. Salt loads and concentrations are calculated from daily conductivity and flow records using methods developed jointly between Reclamation and USGS (Liebermann et al., 1986). Historical annual streamflow, and salinity concentrations from 1940 through 2009 are included in graphical form in Appendix A. Monthly and annual data may be obtained by request from Reclamation, Salt Lake City, Utah or by going to Reclamation's Upper Colorado Regional Office Salinity Program web page; http://www.usbr.gov/uc/progact/salinity/index.html. The salinity of the 3 lower basin compact points since 1940 is shown in Figure 3. As Figure 3 shows, the last time the TDS exceeded or reached the salinity criteria at any of the compact points, was in 1972 – the year that the salinity standard was established for the Colorado River.

FACTORS INFLUENCING SALINITY

Stream flow, reservoir storage, water resource development, salinity control, climatic conditions, and natural runoff directly influence salinity in the Colorado River Basin. Before any water development, the salinity of spring runoff was often below 200 mg/L throughout the Colorado River Basin. However, salinity in the lower mainstem was often well above 1,000 mg/L during the low flow months (most of the year), since no reservoirs existed to catch and store the spring runoff.

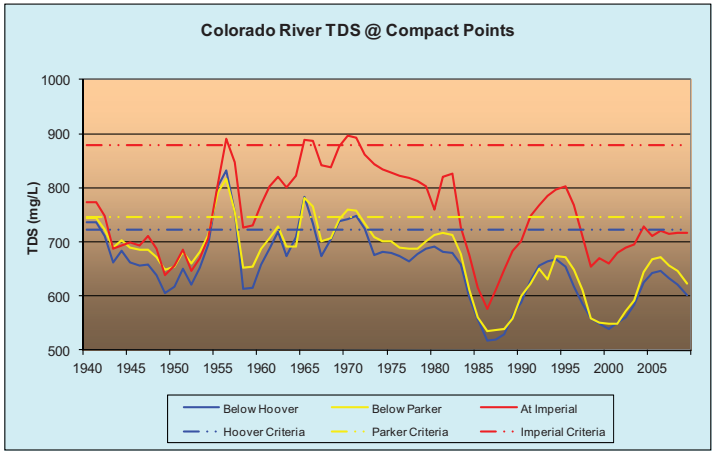


Figure 3 - Colorado River Salinity at Lower Basin Compact Points

Streamflow

Streamflow directly influences salinity. For the most part, higher flows (or reservoir releases) dilute salinity. The top graph in Figure 4 shows streamflow at two key points in the mainstem. In 1980, Lake Powell (Glen Canyon Dam) filled for the first time and spilled.

This spill went through Lake Mead (Hoover Dam) and on downstream through Imperial Dam. In 1983 and on through 1987, flows in the system were again extremely high and sustained, reducing salinity to historic lows. As shown in the bottom graph of Figure 4, more average flows in the system after 1987 returned the salinity in the reservoir system to more normal levels.

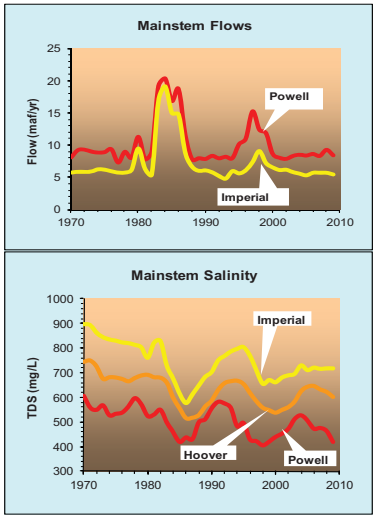


Figure 4 - Mainstem Flow and Salinity.

Reservoir Storage

The Colorado River Storage Project Reservoirs produce not only major hydrologic modifications downstream, but they also significantly alter the salinity variability of the downstream river. The overall long term salinity affects of the reservoirs are beneficial and have greatly reduced the salinity peaks and annual fluctuation (Figure 5). The high concentration low flow waters are mixed with low concentration spring runoff, reducing the month-to-month variation in salinity below dams (Mueller et al., 1988). At Glen Canyon Dam, the pre and post dam peak monthly salinity has been reduced by nearly 600 mg/L. Similar effects can be seen below Flaming Gorge, Navajo, and Hoover Dams, greatly improving the quality of water during the summer, fall and winter.

Large reservoirs like Lake Powell selectively route less saline water while holding more saline waters during low inflow periods. The poorer quality waters are then slowly released after the inflows have begun to increase, which helps to prevent exceeding the salinity criteria during drought years. The large reservoirs selectively retain higher salinity winter inflows in the bottom of the pool and route lower salinity overflow density currents from the spring runoff. The seasonal and long term affects of this selective retention and routing of salt has been shown below Glen Canyon Dam in Figure 5.

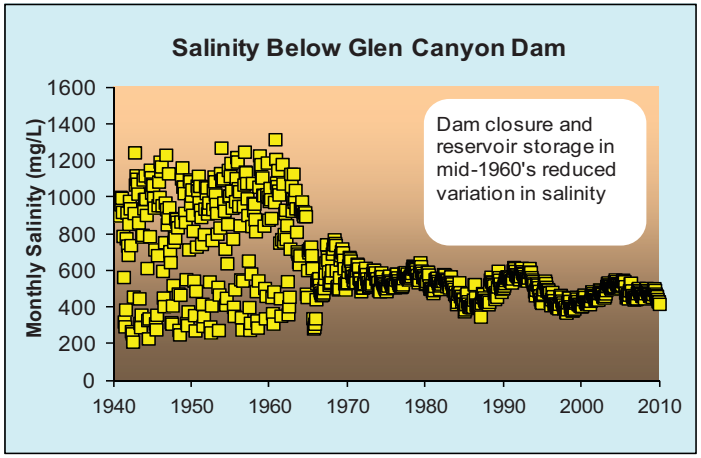


Figure 5 - Effects of Glen Canyon Dam on Colorado River Salinity at Lees Ferry.

Figure 6 further displays this retention. A long-term depth vs. time profile of salinity in the forebay of Glen Canyon Dam is a pictured history of salinity. The Y (vertical) axis is

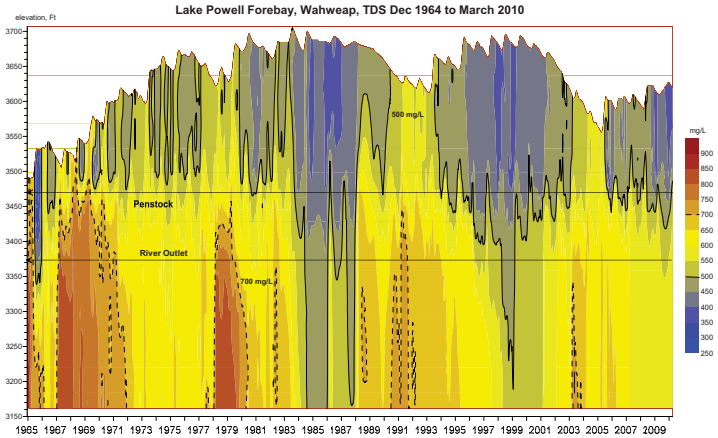


Figure 6 - Lake Powell Forebay, near Dam, Dec 1964 to March 2010 Salinity Concentration, mg/L

depth in the water column and the X axis is time in years. The color scale is the change in salinity.

Two things are demonstrated by this graphic: 1) Glen Canyon Dam selectively retains higher TDS water, especially during initial years of drought, and then routes those waters later, usually during wetter cycles. 2) Lake Powell has selectively retained higher salinity water during drier years, and then routed it with the increased mixing and shorter hydraulic retention times of wetter cycles as seen particularly in 1983 and 1999. During these wetter cycles these is a significant mixing and dilution of these previously stored salts.

There are 4 periods or trends which can be seen in the Colorado River salinity for the inflow to and outflow from Lake Powell which can be seen in Figure 7 (white and yellow trend lines). The overall inflow line (blue) in Figure 7 is the sum of TDS for the inflow stations to Lake Powell; Colorado River at Cisco, Green River at Green River, UT, San Rafael River near Green River and San Juan River near Bluff. The overall outflow line (red) is the TDS at the USGS gauge at Lee's Ferry below Glen Canyon Dam. There was the pre dam period, 1940 – 1964, where the average salinity trend was increasing with some divergence between the average annual inflow and outflow salinity levels and the inflow concentration generally being less than the outflow concentration. This difference between outflow and inflow may be impacted by the beginning hydraulic conditions, since the actual annual levels appear to track each other fairly closely. Next there was the dam filling period where Lake Powell and the upper basin reservoirs were completed and filling, 1965-1980. The average annual salinity during this time decreased with a convergence occurring between the inflow and outflow concentrations. The outflow

concentration decreased more than the inflow concentration, which could be due to the reservoir storing the higher TDS waters. Then there was the period, 1980 to present, when the basin hydrology went through both wet and dry periods and the salinity control projects in the upper basin were coming online. The declining trend of the average annual salinity concentration over this time is seen to be constant between the inflow and outflow stations. Since 1980 there appears to be an equilibrium between the salt entering the reservoir and what is being released. The last period, since 2000, covers the basinwide drought. The trend shows that the inflow TDS has declined, while the outflow TDS from Lake Powell has stayed constant with the 1980 to present TDS trend.

Lake Powell (and other reservoirs in the basin) went through an initial filling salt leach out which actually began with temporary water retention behind the coffer dam during construction in the mid 1950's. Long-term linear regression trend lines on the inflow and outflow salinity concentrations at Lake Powell indicate that internal salt leaching seems to have declined to a minimum by the mid-1990's suggesting a long-term salinity leach out which is approaching a dynamic equilibrium (Figure 7, red and blue trend line).

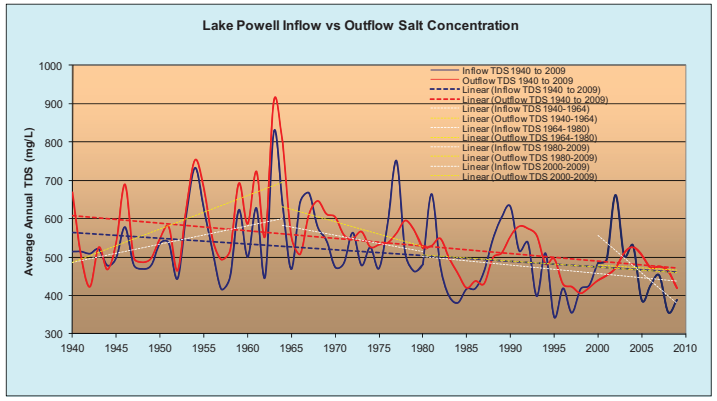


Figure 7 - Lake Powell Inflow and Outflow Salt Concentration, mg/L

NATURAL VARIATION IN SALINITY

Although seasonal swings in salinity have been greatly reduced, annual fluctuations in salinity are still observed. Natural climatic variations in rainfall and snowmelt runoff continue to cause large year-to-year differences in both flow and salinity and in some cases nearly doubling the salinity in the river.

The water quality standards require that the flow-weighted average annual salinity not to rise above the 1972 levels using a long-term mean water supply of 15 maf (2008 Review). This means that depending on the hydrology (drought conditions) salinities may

actually increase above the numeric criteria and it is not a violation of the standards, but is due to natural variations in the hydrologic conditions. Even with full compliance with the standards, the actual salinities at Imperial Dam (and elsewhere in the Colorado River Basin) will continue to fluctuate with hydrologic conditions in the future. The Salinity Control Program is designed to offset the effects of development, even as salinity varies from year to year in response to the climatic and hydrologic conditions. Assuming continued salinity control and full compliance with the standards, the potential range of annual salinities that might be observed in the future at Imperial Dam is quite wide. With Colorado River basin reservoir storage tempering the natural variability of the system, the range between the high and low salinity values at Imperial Dam has dropped to a monthly average of about 479 mg/L and an annual average around 266 mg/L since 1973.

AGRICULTURAL SOURCES OF SALINITY

Irrigated agriculture is the largest user of water in the Colorado River Basin and a major contributor to the salinity of the system. Iorns (Iorns et al., 1965) found that irrigated lands in the Upper Colorado River Basin contributed about 3.4 million tons of salt per year (37 percent of the salinity of the river). Irrigation increases the salt concentration of the source water by consuming water (evapotranspiration) and by dissolving salts found in the underlying saline soil and geologic formations, usually marine (Mancos) shale.

Irrigation mobilizes the salts found naturally on the soil surface as well as in the soil profile, especially if the lands are over irrigated. Many subbasins experienced significant changes in irrigation following development of available reservoir storage. For example, once late season irrigation supplies were assured, less water was applied to per unit of farmland during the snowmelt runoff, and overall irrigation efficiency increased.

Irrigation development in the Upper Colorado River Basin took place gradually from the beginning of settlement in about 1860, but was hastened by the purchase of tribal lands in the late 1800's and early 1900's. About 800,000 acres were being irrigated by 1905. Between 1905 and 1920, the development of irrigated land increased at a rapid rate, and by 1920, nearly 1.4 million acres were being irrigated. The "Upper Colorado Region Comprehensive Framework Study, June 1971", reported that more than 1.6 million acres were in irrigation in 1965. Since that time, development of new agricultural lands has leveled off because of physical, environmental, and economic limitations. Reclamation's latest "Colorado River System Consumptive Uses and Losses Report 2006-2010" estimated an average of 1.57 million acres was irrigated in the Upper Colorado River Basin in 2006 (latest data available).

Irrigation development in the Lower Colorado River Basin began at about the same time as in the Upper Colorado River Basin, but was slow due to the difficulty of diverting water from the Colorado River with its widely fluctuating flows. Development of the Gila area began in 1875 and the Palo Verde area in 1879. Construction of the Boulder Canyon Project in the 1930's, and other downstream projects, has provided for a continued expansion of the irrigated area. In 1970, an additional 21,800 acres were irrigated by private pumping either directly from the Colorado River or from wells in the flood plain. In 1980, nearly 400,000 acres were being irrigated along the Colorado River mainstem.

Total irrigated lands for the entire Lower Colorado River Basin is around 1.4 million acres.

Reclamation and the U.S. Geological Survey (USGS) continuously monitor the flow and salinity of the river system through a network of 20 gauging stations (See Appendix A, Figs. A1 & A2). Reclamation evaluates the data collected to determine if sufficient salinity control is in place to offset the impact of water development. In 2009, the actual salinity in the Colorado River was below the numeric criteria at the established monitoring stations. However, as the impacts of recent and future basin developments work their way through the hydrologic system, or as drought conditions persist, salinity would increase without salinity control to prevent further degradation of the river system. Through salinity control practices, excess salt loading to the river system can be reduced significantly, helping maximize the future beneficial uses of the river.

Most of the irrigation projects that deplete water and increase salt loading to the river were in place before 1965. Moreover, like the newly inundated soils in reservoirs, newly irrigated lands are subject to a leach-out period. In cases where lands with poor drainage stored salt, these areas were taken out of production. In addition, irrigation practices changed significantly with the introduction of canal and lateral lining, sprinkling systems, gated pipe, trickle systems and tile drains (initial operation of tile drains increase salt loading, which decreases after time). These changes have resulted in reduced return flows and salt loading.

WATER USE BY MUNICIPAL & INDUSTRIAL USERS

Salinity levels are directly influenced by depletion (consumption) of water flowing in the river system and salt loading. Agriculture increases salinity by consuming water through evapotranspiration and leaching of salts from soils by irrigation. Municipal and industrial (M&I) use increases salinity by the consumption of the water, thus reducing the dilution of salts in the river or by disposal on land.

Another source of salinity from municipal & industrial use is from an increase in the housing developments within the basin. This brings with it an associated increase in water softening needs, due to the hard water found throughout the basin. One result of the increase of water softening is an increase in the sodium chloride salt discharged into the Colorado River. Another impact of the increased population in the basin is that more roads are paved and developed. During the winter this increase in road mileage impacts the salt discharged into the basin due to the addition of salt on the roads in order to help keep the snow and ice off of the roads. The amount of salt added to the basin from new municipal development has not yet been quantified.

Reclamation continues to monitor water use and adjusts their future salinity control needs as water development plans may be postponed, delayed, or canceled. The depletion schedules used to project salinity conditions have been updated so that the implementation needs for the Salinity Control Program can be planned to offset the impacts of additional water development (see Tables 2 & 3).

O_NPCA-CBD et al 2

ENERGY DEVELOPMENT

The large amounts of water use once forecasted for steam power generation, coal gasification, oil shale, and mineral development have not yet occurred. The few coal-fired power plants that have been constructed recently have obtained their water from existing agricultural rights rather than from developing additional water. This conversion of use reduces the salt loading to the Colorado River by eliminating the pickup of salt from canal seepage and on farm deep percolation.

Many of the geologic formations of the Colorado River Basin were deposited in marine (saline) or brackish water environments. Sulfates and sodium chloride are prevalent salts in most of these formations. Many of the formations were deposited in drier periods and are capable of transmitting water, but these aquifers are frequently sandwiched between hundreds or even thousands of feet of impermeable shale (aquicludes). These aquifers are, therefore, static and often saline. Many static and saline aquifers are present in the Colorado River Basin. When a path of flow is provided by drilling or mining, these aquifers are mobilized, and brackish or saline waters flow back to the surface.

The development of energy resources, specifically coal, oil, gas, oil shale, and coal bed methane, in the Colorado River Basin may contribute significant quantities of salt to the Colorado River. Salinity of surface waters can be increased by either mineral dissolution or uptake in surface runoff, mobilization of brackish groundwater, or consumption of good quality water. The location of fossil fuels is associated with marine-derived formations. Any disturbance of these saline materials will increase the contact surfaces, allowing for the dissolution of previously unavailable soluble minerals.

Salinity increases associated with mining coal can be attributed to leaching of coal spoil materials, discharge of saline groundwater, and increased erosion resulting from surface-disturbing activities. Spoil materials have a greater permeability than undisturbed overburden, allowing most of the rain falling on the spoils to infiltrate instead of running off. The water percolates through the spoils, dissolving soluble minerals.

Studies conducted on mining spoils in northwestern Colorado indicate that the resulting salinity of spoil-derived waters ranges from approximately 3,000 mg/L to 3,900 mg/L (Parker, et al., 1983; McWhorter, et al., 1979; and U.S. Department of the Interior, 1985). The variability in concentration depends on water residence time and the chemical and physical properties of the spoil.

Saline water is also a byproduct of oil and gas production in the Colorado River Basin. It is not uncommon to produce several times the amount of saline waters as oil. In one month the oil and gas operators in Colorado produced approximately 25 million barrels of saline water. The salinity of production waters varies greatly from location to location and depends upon the producing formation. Common disposal techniques include evaporation, injection, and discharge to local drainages.

The future development of the oil shale resources in Colorado, Utah, and Wyoming has the potential to increase salt loading to the Colorado River. Salt increases can be attributed to the consumptive use of good quality water, mine dewatering, and, if surface retorting is used, the leaching of spoil materials similar to those of surface coal mining.

Reclamation, BLM and state agencies are attempting to identify abandoned exploration wells that are leaking and develop plans to control the leaks. The Meeker Dome Salinity Control Unit identified and plugged several abandoned wells along the White River to prevent a salt dome (a geologic formation) from discharging saline water into the river.

Coal Bed Methane - The increase of the price of natural gas has led to an increase in the interest of developing the methane gas, which is found with coal, in the plentiful coal formations of the Upper Colorado River Basin. This coal bed methane (CBM) development could result in an increase in the salt loading of the Colorado River if the water associated with this type of drilling is discharged on the ground surface and allowed to get into waterways.

In Utah, coal bed methane wells are located in Emery, Carbon, Duchesne, and Uinta counties. The State allows up to 4 wells per section. Most (99%) of existing product wastewater from the CBM wells is reinjected and 1 % is impounded for evaporation. No surface discharges have presently been permitted. It is projected that even with greater development of CBM wells, the handling of the produced wastewater will not change.

Figure 8 - Photo of Coal Bed Methane Well.

In Colorado, all the product water from CBM development in the San Juan Basin in southwest Colorado is presently, and in the foreseeable future will be, reinjected. New CBM wells are permitted in the northwest part of the State and in Moffat and Rio Blanco Counties, where new CBM developments are being considered. The State averages for product wastewater in the western part of the State are 90 % reinjected, 9.5 % impounded, and 0.5 % surface discharged. Any surface discharged water has to meet the water quality criteria of no more that 1 ton/day salt.

In Wyoming, new CBM well development is beginning in the Little Snake River drainage (Carbon County) with only a handful of wells permitted. This CBM development has the potential to spread into the whole southwest corner of the State (Sweetwater, Uinta, and Lincoln Counties) if the price of natural gas stays high. This part of the State could have over 10,000 new CBM wells if development takes off as it has in the Powder River Basin. Presently, the State will allow surface discharge of up to 1 ton/day per operator (not per well). CBM development in the southwest part of the State will most likely involve reinjection of most if not all of the waste water since the quality of the groundwater found in these coal beds is highly saline and of poor quality.

The recent push for increased development of coal bed methane and other energy sources in the Rocky Mountain area poses a potential for increased salinity due to the brine or saline ground water discharged from the wells into the Colorado River Basin.

O_NPCA-CBD et al 2

FUTURE WATER DEVELOPMENT

Tables 2 and 3 summarize the projected depletions used by Reclamation to evaluate the effects of water use and depletions for this progress report. These water use estimates were compiled as the first step in the evaluation process.

Table 2 summarizes the projected future depletions by water uses in the Upper Colorado River Basin as adopted for planning purposes by the Upper Colorado River Commission in December 2007. Figure 9 illustrates the historic annual consumptive use by water uses in the Upper Basin as reported in Reclamation's *Colorado River System Consumptive Uses and Losses Reports* (CUL), and the projected future total depletions by water uses in the Upper Basin that are included as input into Reclamation's Colorado River System Simulation (CRSS) model. The consumptive uses or depletions shown in figure 9 exclude evaporation losses from Lake Powell, Flaming Gorge Reservoir and the Aspinall Unit reservoirs, which along with evaporation losses from Colorado River mainstem reservoirs in the Lower Basin are modeled within CRSS.

The annual depletions for the Lower Colorado River Basin shown in Table 3 include only depletions resulting from the use of water from the mainstem of the Lower Colorado River. Reclamation's CRSS model does not model or include as input consumptive uses made from tributaries to the Colorado River within the Lower Colorado River Basin. Fixed inflow values are used in the CRSS model for the Lower Basin tributaries. More detailed data on historic Colorado River Basin consumptive uses and losses (including tributary uses in the Lower Basin and reservoir evaporation losses) may be found in Reclamation's *Colorado River System Consumptive Uses and Losses Reports* or on the web at: www.usbr.gov/uc/library/envdocs/reports/crs/crsul.html

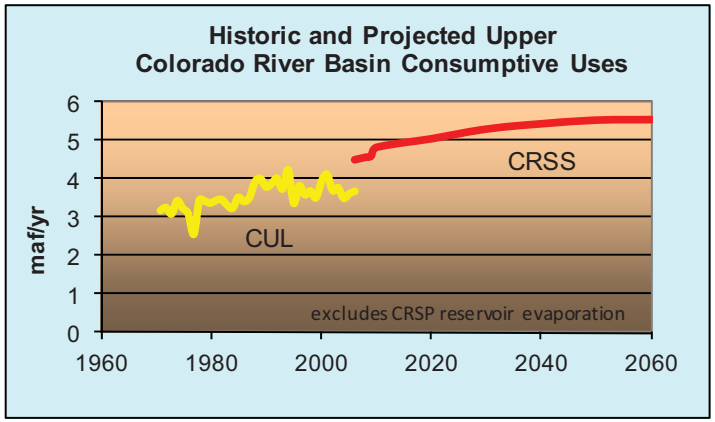


Figure 9 - Historic and Projected Water Uses.

Table 2 - Upper Basin Depletion Projections (1000 af/yr)

UPPER BASIN	2010	2020	2030	2040	2050	2060
Arizona						
Total scheduled depletion	50	50	50	50	50	50
Share of 2007 Hydro-Det Amount (5.76 maf)	50	50	50	50	50	50
Remaining available	0	0	0	0	0	0
Colorado						
Total scheduled depletions	2,796	2,842	2,891	2, 919	2,955	2,955
Share of 2007 Hydro-Det Amount (5.76 maf)	2,955	2,955	2,955	2,955	2,955	2,955
Remaining available	159	113	64	36	0	0
Percent unused	5	4	2	1	0	0
New Mexico						
Total scheduled depletions	539	608	635	642	642	642
Share of 2007 Hydro-Det Amount (5.76 maf)	642	642	642	642	642	642
Remaining available	103	34	7	0	0	0
Percent unused	16	5	1	0	0	0
Utah						
Total scheduled depletions	907	955	1032	1118	1163	1163
Share of 2007 Hydro-Det Amount (5.76 maf)	1313	1313	1313	1313	1313	1313
Remaining available	406	358	281	195	150	150
Percent unused	31	27	21	15	11	11
Wyoming						
Total scheduled depletions	560	621	719	735	750	763
Share of 2007 Hydro-Det Amount (5.76 maf)	799	799	799	799	799	799
Remaining available	239	178	80	64	49	36
Percent unused	30	22	10	8	6	5

Note 1: This depletion schedule does not attempt to interpret the Colorado River Compact, the Upper Colorado River Basin Compact, or any other element of the "Law of the River." This schedule should not be construed as an acceptance of any assumption that limits the Upper Colorado River Basin's depletion.

Note 2: This depletion schedule is for planning purposes only. This estimate does not constitute an endorsement of the Bureau of Reclamation's 2007 Hydrologic Determination and should not be construed as in any way limiting the Upper Division States use of Colorado River water in accordance with the Commission's resolution of 6/5/06.

Note 3: The yield determined in the 2007 Hydrologic Determination excluding shared CRSP evaporation.

O_NPCA-CBD et al 2

Table 3 - Lower Basin Depletion Projections (1000 af/yr)

LOWER MAINSTEM	2010	2020	2030	2040	2050	2060
Nevada						
Robert B. Griffith Water Project	264	264	280	280	280	280
Other users above Hoover Dam	7	7	7	7	7	7
Southern California Edison	16	16	0	0	0	0
Ft. Mohave Indian Reservation	9	9	9	9	9	9
Laughlin and users below Hoover Dam	4	4	4	4	4	4
Total	300	300	300	300	300	300
Arizona						
Imperial Wildlife Refuge	10	9	10	10	10	10
Lake Havasu Wildlife Refuge	5	5	5	5	5	5
Fort Mohave Indian Reservation	73	73	73	73	73	73
City of Kingman	0	0	0	0	0	0
Mohave Valley I&D District	23	17	17	17	17	17
Bullhead City and other M&I	4	5	6	6	6	6
Cibola Valley I&DD, Parker and others	24	27	30	32	34	34
Lake Havasu I&D District	13	12	12	12	12	12
Central Arizona Project	1425	1419	1406	1398	1395	1395
Colorado River Indian Reservation	414	463	463	463	463	463
Cibola Wildlife Refuge	8	8	16	16	16	16
Gila Project	505	477	476	476	476	476
City of Yuma	27	30	35	41	41	41
Yuma Project - Valley Division	248	234	229	229	230	230
Cocopah Indian Reservation	12	12	12	12	12	12
Other users below Imperial Dam	9	9	10	10	10	10
Total	2800	2800	2800	2800	2800	2800
California						
City of Needles	1	1	1	1	1	1
Metropolitan Water District	855	852	852	852	802	802
Fort Mohave Indian Reservation	12	12	12	12	12	12
Chemehuevi Indian Reservation	5	8	8	8	8	8
Colorado River Indian Reservation	19	39	39	39	39	39
Palo Verde Irrigation District	373	366	366	366	366	366
Yuma Project Reservation Division	47	54	54	54	54	54
Imperial Irrigation District	2711	2641	2611	2611	2661	2661
Coachella Valley Water District	376	426	456	456	456	456
Other uses Davis to Parker Dam	1	1	1	1	1	1
Other uses below Imperial Dam	0	0	0	0	0	0
Total	4400	4400	4400	4400	4400	4400
Unassigned						
Phreatophyte and native vegetation	515	515	515	515	515	515
Yuma Desalting Plant	120	120	52	52	52	52
Total	635	635	567	567	567	567

Note: In the LC Basin, depletions are from mainstem diversions of the Colorado River only. Does not include depletions from diversions of Colorado River tributaries or evaporation from mainstem reservoirs. The Figures represent measured diversions less measured and estimated, unmeasured return flow that can be assigned to a specific project. The evapotranspiration from the vegetation along the riparian zone is a constant unassigned depletion since the vegetation is permanent.

COMPLIANCE WITH THE SALINITY STANDARDS

Reclamation and the Basin States conducted salt-routing studies for the *2008 Triennial Review of the Water Quality Standards for Salinity, Colorado River Basin.* As part of the

triennial review process, Reclamation used the Colorado River Simulation System (CRSS) river system model to evaluate whether sufficient salinity control measures are in place to offset the effects of development. The information provided in the next two sections of the report was used to evaluate compliance with the water quality standards.

In response to the Clean Water Act, the States have adopted water quality (salinity) criteria for the Colorado River Basin and the Environmental Protection Agency (EPA) has approved them at all three locations in the Lower Colorado River Basin. The standards call for maintenance of flow-weighted average annual salinity concentrations (numeric criteria) in the lower mainstem of the Colorado River and a plan of implementation for future controls.

The water quality standards are based on the *Water Quality Standards for Salinity, Including Numeric Criteria and Plan of Implementation for Salinity Control, Colorado River System,* prepared by the Colorado River Basin Salinity Control Forum, June 1975. The document was adopted by each of the Basin States and approved by EPA. A summary of the report follows:

> The numeric criteria for the Colorado River System are to be established at levels corresponding to the flow-weighted average annual concentrations in the lower mainstem during calendar year 1972. The flow-weighted average annual salinity for the year 1972 was used. Reclamation determined these values from daily flow and salinity data collected by the USGS and the Bureau of Reclamation. Based on this analysis, the numeric criteria are 723 mg/L below Hoover Dam, 747 mg/L below Parker Dam, and 879 mg/L at Imperial Dam.
>
> It should be recognized that the river system is subject to highly variable annual flow. The frequency, duration, and availability of carryover storage greatly affect the salinity of the lower mainstem; and, therefore, it is probable that salinity levels will exceed the numeric criteria in some years and be well below the criteria in others. However, under the above assumptions, the average salinity will be maintained at or below 1972 levels.
>
> Periodic increases above the criteria as a result of reservoir conditions or periods of below normal long-time average annual flow also will be in conformance with the standards. With satisfactory reservoir conditions and when river flows return to the long-time average annual flow or above, concentrations are expected to be at or below the criteria level.
>
> The standards provide for temporary increases above the 1972 levels if control measures are included in the plan. Should water development projects be completed before control measures, temporary increases above the criteria could result and these will be in conformance with the standard. With completion of control projects, those now in the plan or those to be added subsequently, salinity would return to or below the criteria level.
>
> The goal of the Salinity Control Program is to maintain the flow-weighted average annual salinity at or below the numeric criteria of the salinity standards. The program is not, however, intended to counteract the salinity fluctuations that

O_NPCA-CBD et al 2

> are a result of the highly variable flows caused by climatic conditions, precipitation, snowmelt, and other natural factors.

SALINITY CONTROL

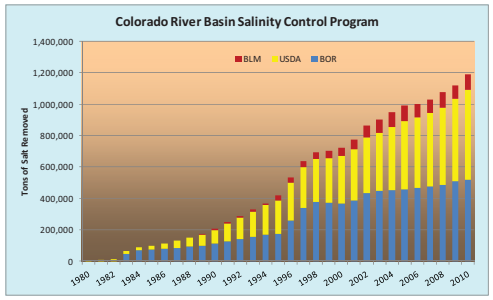


Figure 10 – 2010 Est. Salinity Control Progress: BOR, NRCS & BLM

Existing salinity control measures will prevent over a million tons of salt per year from reaching the river. By 2010 the salinity control program for Reclamation has controlled approximately 520,600 tons of salt, while the USDA NRCS (NRCS) program has reduced around 571,500 tons of salt, and the BLM has controlled an estimated 99,900 tons of salt per year from entering the Colorado River (Figure 10). Discussions within the Colorado River Salinity Control Forum have determined that salinity control units will need to prevent nearly 1.85 million tons of salt per year from entering the Colorado River by 2030, in order to meet the standard and keep the economic damages minimized. To reach this objective, as shown in Table 4, the program needs to implement 657,900 tons of new controls beyond the existing 1,192,000 tons of salinity control presently in place (2010) as reported by Reclamation, USDA & BLM. About 32,900 tons per year of new salinity control measures must be added each year if the program is to meet the cumulative target of 1,850,000 tons per year by 2030.

To achieve this goal, a variety of salinity control methods are being investigated and constructed. Saline springs and seeps may be collected for disposal by evaporation, industrial use, or deep-well injection. Other methods include both on-farm and off-farm delivery system and irrigation improvements, which reduce the loss of water and reduce salt pickup by improving irrigation practices and by lining canals, laterals, and ditches. See Progress Report #21 for a more detailed description of each salinity control project and the salinity controlled by Reclamation, NRCS and BLM.

Table 4 - Salinity Control Requirements and Needs Through 2030

Salinity control needs (2030)	1,850,000 tons
Measures in place (2010)	- 1,192,100 tons
Plan of Implementation Target	657,900 tons

CHAPTER 3 – TITLE I SALINITY CONTROL PROGRAM

The Colorado River Basin Salinity Control Act (Salinity Control Act), Public Law 93-320, as amended, authorized the Secretary of the Interior (Secretary) to proceed with a program of works of improvement for the enhancement and protection of the quality of water available in the Colorado River for use in the United States and the Republic of Mexico. Title I enables the United States to comply with its obligation under the agreement with Mexico of August 30, 1973 (Minute No. 242 of the International Boundary and Water Commission, United States and Mexico [Minute No. 242]), which was concluded pursuant to the Treaty of February 3, 1944 (TS 994).

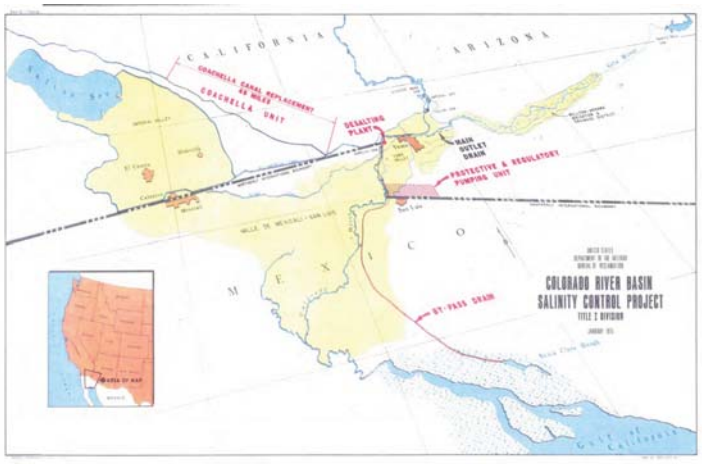


Figure 11 - Map of Title I Projects.

These facilities enable the United States to deliver water to Mexico with an average annual salinity concentration no greater than 115 parts per million (ppm) plus or minus 30 ppm (United States count) over the average annual salinity concentration of the Colorado River water at Imperial Dam.

The background and history of the Title I projects (Coachella Canal Lining, Protective and Regulatory pumping, Yuma Desalting Plant, Wellton-Mohawk Irrigation & Drainage District) can be found in Progress Report 22, chapter 4 at; http://www.usbr.gov/uc/progact/salinity/pdfs/PR22.pdf

O_NPCA-CBD et al 2

Updates for the Title I projects since Progress Report 22 are as follows:

Coachella Canal Lining

No new activity or change since last progress report.

Protective and Regulatory Pumping

No new activity or change since last progress report.

Yuma Desalting Plant

The Yuma Desalting Plant (YDP) was constructed under the authority of the Colorado River Basin Salinity Control Act of 1974 to recover through desalination, the majority of the Wellton-Mohawk Irrigation and Drainage District agricultural return flows which bypass the Colorado River, thereby allowing the treated water to be delivered to Mexico as part of the 1.5 million acre-feet of Colorado River water that the U.S. must deliver to Mexico under the 1944 Water Treaty. Due to the high cost of operating the plant and general agency budget constraints, as well as surplus and normal conditions in the lower Colorado River Basin prior to the current drought, the YDP has not been operated; however, the facility has been maintained.

The U.S. has met the Treaty's salinity requirements by bypassing an average of 107,000 acre-feet of saline agricultural flows and then releasing additional water from Lake Mead. Since the diverted agricultural flows bypass the Colorado River, they are not counted as part of the 1.5 million acre-feet of Treaty water delivered annually to Mexico.

Metropolitan Water District of Southern California, Southern Nevada Water Authority, and Central Arizona Water Conservation District, collectively referred to as the Municipal Utilities, have jointly requested that Reclamation conduct a Pilot Run of the YDP to consider long term, sustained operation as a means to extend water supplies on the lower Colorado River during an unprecedented drought. Such consideration requires: 1) collecting performance and cost data; 2) identifying any remaining equipment improvements that are needed; and 3) testing changes that have already been made to the plant. Reclamation has developed a plan for a Pilot Run, in which the plant will operate for 365 days within an 18 month period at 1/3 capacity.

The Pilot Run began in May, 2010 and ran about a year, adding approximately 30,000 acre-feet of water to Colorado River system storage for a cost of under $23 million, of which a little more than ½ the cost was provided by the Municipal Utilities. Based on the Intentionally Created Surplus (ICS) provisions of the Colorado River Interim Shortage Guidelines of December 2007, the entities received ICS credits in proportion to their capital contributions to the Pilot Run. The Pilot Run was conducted in full compliance with all United States (U.S.) statutes. Reclamation finalized an Environmental Assessment with the Finding of No Significant Impact. Reclamation received a

discharge permit from the Arizona Department of Environmental Quality in accordance with the Clean Water Act.

Plant operation reduces the volume and increases the salinity of the flow to the Ciénega de Santa Clara (Ciénega) wetland in Mexico. Reclamation consulted with Mexico through the International Boundary and Water Commission which resulted in an agreement of joint cooperative actions including providing 30,000 acre-feet of water to the Ciénega. This water was provided in equal one-third increments by the U.S., Mexico, and a bi-national coalition of non-governmental organizations. In addition, the Municipal Utilities are collaborating with the bi-national coalition to develop a monitoring program for the Ciénega.

Through a Cooperative Research and Development Agreement (CRADA) with the Municipal Utilities alternative configurations of the YDP began to be tested in 2010 including alternative methods of pretreatment, low energy reverse osmosis membranes, and different feed water for the plant. The results of the Pilot Run and this CRADA should provide enough information to evaluate the YDP's potential as a means to augment water supplies on the lower Colorado River.

Wellton-Mohawk Irrigation and Drainage District (WMIDD)

All permanent measures implemented by WMIDD are still in use, although the Federal program has been discontinued. The original program was named the Irrigation Management System Program (IMS) which was Federaly funded and manned. The Federal funding was discontinued in the late 90's and the Irrigation District had the option of dropping the program or continuing. The District (Board of Directors) chose to continue with the program. The original program required the use of a neutron probe to measure the soil moisture content. WMIDD no longer uses a soil moisture probe, but does monitor observation wells, which allows the district to maintain optimum soil moisture conditions.

Total crop acres have remained relatively stable since the early 1970's because more acreage is double-cropped than when the program was initiated. In particular, more vegetable crops are being grown in the district than in the past. Irrigation efficiency levels and return flow levels for 1990-2010 are shown on the following page, in Table 5.

Reclamation believes that the impacts of Gila River flows in 1992, 1993, and 1995 make irrigation efficiency and return flow data from the district questionable for 1992, 1993, 1994, 1995, and 1996. In 1993, the Gila River flood destroyed much of the WMIDD Main Conveyance Channel**;** so most of the drainage pumping went into the Gila River during 1993 and 1994 until these facilities could be repaired.

With the use of monthly groundwater table monitoring using observation well measurements as well as input from land users, WMIDD is able to maintain a drainage-pumping program that sufficiently maintains the agriculture root zone. Land users continue to maintain water efficient farming techniques with the use of dead level, high heads, and short runs.

O_NPCA-CBD et al 2

Table 5 - WMIDD Irrigation Efficiency

Year	Pumped Drainage Return Flow (acre-feet)	Irrigation Efficiency, % (note: data provided by WMIDD)
1990	138,200	-
1991	144,900	68.8
1992	116,200	70.4
1993	8,970	68.8
1994	49,820	65.4
1995	121,500	64.3
1996	119,600	60.4
1997	91,695	62.2
1998	98,972	61.9
1999	94,869	63.0
2000	110,287	59.7
2001	107,908	60.9
2002	119,410	61.2
2003	116,477	57.8
2004	106,002	63.3
2005	110,770	64.6
2006	103,810	62.3
2007	112,910	62.6
2008	120,190	63.0
2009	105,482	62.7
2010	111,170	66.1

CHAPTER 4 - TITLE II SALINITY CONTROL PROGRAM

Title II of the Salinity Control Act authorizes the Secretary of the Interior (Secretary) and the Secretary of Agriculture to implement a broad range of specific and general salinity control measures in an ongoing effort to prevent further degradation of water quality in the United States. These efforts are shown on the map below. The USDA, BOR and BLM have a combined goal of controlling 1.9M tons of salt/per year, by the year 2025. These federal agencies are required to work together under, Public Law 93-320, "Colorado River Basin Salinity Control Act," as amended; with the Bureau of Reclamation being the lead federal agency. The Act also calls for periodic reports on this effort. The report is to include the effectiveness of the units, anticipated work to be accomplished to meet the objectives of Title II with emphasis on the needs during the 5 years immediately following the date of each report, and any special problems that may be impeding an effective salinity control program. Title II also provides that this report may be included in the biennial Quality of Water Colorado River Basin, Progress Report. The history and background of the Title II projects can be found in Progress Report 21 at: http://www.usbr.gov/uc/progact/salinity/pdfs/PR21.pdf . Ongoing and active projects are listed in this report.

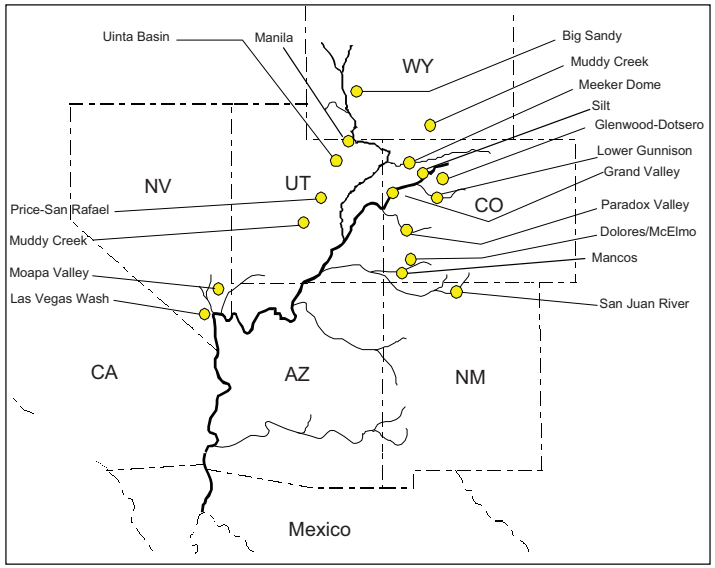


Figure 12 - Map of Title II Salinity Control Project Areas.

U.S. Bureau of Land Management

The Bureau of Land Management (BLM) administers 48 million acres in the Colorado River Basin above Imperial Dam, or 40 percent of the Colorado River Basin's area. Of the 48 million, approximately 7.2 million acres, or about 15 percent, contain saline soils (slightly, moderate, and strongly saline soils). Soil salinity is usually greatest where surface geology reflects saline marine shale and annual precipitation averages less than 12 inches. In depositional settings, soil salinity may also be high, even where the underlying geology is relatively non-saline.

The BLM is committed to its role in reducing the mobilization of salt on public lands. The BLM undertakes this responsibility through the multitude of individual management decisions that are made within each BLM jurisdiction. Progress in preventing salt from moving off BLM land is achieved through efforts to minimize the impacts of grazing, protect riparian areas, reduce off-road vehicle impacts, conduct prescribed burns, and generally manage vegetative cover and reduce erosion. As such, in the past, it has been difficult to single out salinity-control efforts for many of the projects that did have salt savings. In a step to strengthen our reporting effort, a restructuring of the allocation of salinity funding was done and new tracking and accounting systems were put in place in FY 2006. Thus, FY 2010 is the 5th year of reporting under the re-structured system.

For FY 2010 $850,000 was allocated for BLM's salinity-control program. Funding goes to 4 major areas: Program administration (ADMIN); Planning (PLAN); Science (SCI); and On-the-ground implementation projects (OTG) (see Figure 13 for FY 2006 - 2010).

Tons of salt retained can not be calculated for program administration, planning, and science projects. However, one of the goals for the re-structured program in FY 2006 was to develop an accounting system to begin calculating more reliable 'tons of salt retained' for on-the-ground implementation projects.

Program Administration

During FY 2003, BLM created a new full-time, salinity coordinator position. The salinity coordinator began work in FY 2004. FY 2006 was the first full year of the newly re-structured program. The re-structured plan consists of 3 main parts: 1) Allocation of funds to the Upper Basin States (AZ, CO, NM, UT, and WY) based on submittal of project proposals; 2) A tracking system for projects that fit into BLM's Rangeland Improvement Project System (on-the-ground implementation projects); 3) Annual reporting consisting of narratives for on-going and current year, and a worksheet to determine 'tons of salt retained' for on-the-ground implementation projects. The objective for FY 2007 - 2010 program administration was a continuation of the framework put into place during FY 2006; however, there has been an increased emphasis on capturing the amount of salt loading for implementation projects (OTG spreadsheet). Projects that have been science or planning can become implementation projects in future years.

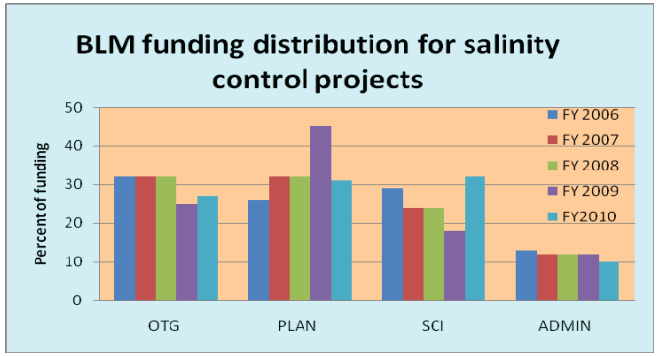


Figure 13 – BLM Salinity Control Program Funding Distribution

Planning

Planning is an important part of natural resource management. Resource management plans become the 'blueprints' for BLM's near future. As such, this is an opportunity to plan for salinity control, especially for some of our most important activities on public land such as grazing, recreation, and energy development. Planning projects that successfully captured salinity funding for FY 2009 include:

Colorado
- San Luis Valley wetlands salinity study - $20,000

Utah
- Factory Butte OHV impact and soil study (Planning/Science) – ongoing - $35,000
- Pariette water-quality monitoring - ongoing - $80,000

Wyoming
- Progressive soil surveys managed from the State Office - ongoing - $100,000
- Erosion sediment transport modeling - ongoing - $30,000

Science

Salt loading from public lands is often episodic and can be dependent on factors such as: precipitation amount and intensity; topography; content and texture of soils; and the types, amount, and architecture of vegetative ground cover. The transit mode of salt loading can be surface-water runoff, or it can be ground-water recharge to streams and rivers. In a watershed, understanding, through study, which factors are most important and what is the main transit mode of salt loading aids in determining the proper on-the-ground implementation project for good salinity control. The following science projects that investigated salt loading factors were funded during FY 2010:

O_NPCA-CBD et al 2

Colorado
- Piceance salinity-loading dynamics including conductivity monitoring at Piceance Cr. With USGS Water Sciences - $60,000
- Vegetation and soil stability project with USGS Biological Resources Discipline (BRD) in Badger Wash (central-western Colorado) to investigate grazing impacts on vegetation and sediments - ongoing - $50,000
- Coal mine impact study with USGS on mine outside of Grand Junction in Big Salt Wash watershed - $30,000

Utah
- Factory Butte OHV impact and soil study. LiDAR survey (Planning/Science) – ongoing $10,000
- Salinity – Mancos shale wind erosion (with USGS BRD) - $20,000

Wyoming
- Salinity baseline Muddy Creek - $65,000

Upper Colorado River Basin Regional project
- Forecasting phenological plant stage in the Upper Colorado River Basin - ongoing - $40,000

On-the-ground Implementation

When mechanisms of how salt loading occurs are understood and once planning is done, on-the-ground implementation projects follow. The success of an on-the-ground project is very much tied to understanding system mechanics and proper planning. The success is also tied to sufficient funding and trained natural resource personnel to go out in the field and construct or carry out the plan.

On-the-ground projects funded by salinity program allocations during FY 2010 include:

Arizona
- Rock Crossing dike system in Ft. Pierce Wash that is tributary to the Virgin River southeast of St. George, Utah – on-going - $50,000

Colorado
- Gunnison Gorge National Conservation Area (NCA) Salinity Management - $30,000

New Mexico
- Crow Mesa sage treatment - $35,000
- La Manga Canyon watershed restoration - ongoing - $35,000
- San Juan River salt/sediment retention structures - ongoing - $30,000

Utah
- Reducing OHV impacts on saline soils near Moab, Utah - $20,000
- Grazing exclosures in the Moab Field Office - $20,000
- Nine Mile Canyon Fencing/Range Improvement Project - $10,000

Table 6 – BLM Salt Retention Estimates for Fiscal Years 2006 – 2010

Project Category	SALT RETAINED IN TONS/YEAR[1]				
	FY 2006[4]	FY 2007[4]	FY 2008	FY 2009	FY 2010
POINT SOURCE[2]	14,600	14,600	14,600	14,600	14,600
NONPOINT SOURCE[3]	71,900	71,900	81,900	71,900	85,300
ALL PROJECTS	86,500	86,500	96,500	86,500	99,900

1. Rounded to the nearest 100 tons.
2. BLM's Salinity Report to Congress through the year 2002, plus the plugging of 2 wells in Utah during FY 2004 (approximately 5,000 tons/yr).
3. Amount that could be calculated, i.e., this is a minimum.
4. When the program was re-structured in FY 2006, we did not have a complete accounting the 1st year or even the 2nd year. As a result, the tons-of-salt-retained number on BLM administered land in the Upper Colorado River Basin (UCRB) was low. FY 2006 and FY 2007 numbers have been changed to reflect tonnage retained in FY 2009, because after 4 years on the new system, FY 2009 tonnage is probably a better estimate. Projects can become less effective in retaining salt over the years, but there is enough erosion control going on constantly in the UCRB on public land, that the tonnage is probably closer to FY 2009 than it was to the low incomplete numbers originally reported for FY 2006 and FY 2007.

U.S. Department of Agriculture (USDA)

The Natural Resource Conservation Service (NRCS) of the United States Department of Agriculture (USDA) conducts Colorado River Basin Salinity Control activities under the authorities of the Environmental Quality Incentives Program (EQIP). EQIP was enacted with passage of PL104-127, Federal Agricultural Improvement Act of 1996, a.k.a. "1996 Farm Bill" and reauthorized by PL 107-171, The Farm Security and Rural Investment Act of 2002, the "2002 Farm Bill" and by PL 110-246, The Food, Conservation, and Energy Act of 2008, the "2008 Farm Bill." The 2008 Farm Bill expires September 30, 2012.

Through EQIP, NRCS offers voluntary technical and financial assistance to agricultural producers, including Native American tribes, to reduce salt mobilization and transport to the Colorado River and its tributaries. Within the eleven approved salinity project areas, producers may be offered additional financial incentives to implement salinity control measures with the primary goal of reducing offsite and downstream damages and to replace wildlife habit impacted as a result of the salinity measures.

In fiscal year 2010, $18.2 million of appropriated EQIP funding was allocated for financial and technical assistance to agricultural producers in eleven project areas in Colorado, Utah, and Wyoming to share the cost with landowners and operators to install conservation systems that provide salinity control and wildlife habitat replacement.

O_NPCA-CBD et al 2

New Salinity Projects and Investigations

Expansion of Lower Gunnison, Colorado, Project Area

In October, 2009, NRCS Colorado undertook to include about 15,000 acres of irrigated lands in Ouray County into the Lower Gunnison Project Area. The original Lower Gunnison study considered these lands and their salt load contribution, but the selected alternative did not include Ouray County. The Ouray County Commissioners and the Shavano Conservation District petitioned NRCS to incorporate these lands into the Lower Gunnison project. NRCS's partners recommended that the expansion preceed.

Plateau Creek, Colorado

The Plateau Valley Pilot Project was initiated in 2009 by NRCS and the Colorado State Conservation Board. The Pilot Project was developed to determine if a combination of general EQIP and additional incentives from the Basin States program would accelerate the installation of high-efficiency irrigation systems that would provide salinity control. By the May, FY 2010, 807 acres had been enrolled. A verbal report on the Plateau Creek Project will be given during the Federal Advisory Council meeting in November.

McKinnon - Lone Pine - Burnt Fork, Wyoming

Throughout 2010, NRCS-Wyoming conducted inventories, public scoping meetings, and analysis of data leading to preparation of a salinity control project plan for the agricultural areas served by the Henrys Fork of the Green River. Local producer interest in a salinity control project is high. Alternatives will be presented to the local producers and upon selection of a preferred plan, the appropriate National Environmental Policy Act (NEPA) documents (either an Environmental Impact Statement (EIS) or Environmental Assessment (EA)) will be prepared for public comment. A maximum of about 20,000 irrigated acres could ultimately be treated in Wyoming and Utah if the project is adopted.

West Black's Fork, Wyoming

An area of some 28,000 acres of irrigated pasture and hayland near Lyman, Wyoming, contribute salt to the Blacks Fork River, tributary to the Green River. While a large portion of the geology contributes little salt, about 10,000 acres may contribute significant amounts of salt from canal and ditch seepage and deep percolation from water applied to fields.

The Wyoming Water Development Commission has provided a significant grant to the Austin-Wall Canal Company to conduct a Level II plan to modernize the irrigated areas within their service area. Local interest in upgrading the irrigation delivery infrastructure is high. NRCS-Wyoming anticipates that improvement of these large delivery systems will enable extensive implementation of on-farm salinity control.

Plateau Creek, Colorado

The Plateau Valley Pilot Project was initiated in 2009 by NRCS and the Colorado State Conservation Board. The Pilot Project was developed to determine if a combination of general EQIP and additional incentives from the Basin States program would accelerate the installation of high-efficiency irrigation systems that would provide salinity control.

By May 2010, 807 acres had been enrolled. A verbal report on the Plateau Creek Project was given during the Federal Advisory Council meeting in November.

White-Yampa Basin, Colorado

Narrow bands of irrigated pasture and hay land are found along the Yampa River near Craig, Colorado, and along the White River, near Meeker, Colorado. Extensive areas of dry cropland that is often summer fallowed also drain into these tributaries of the Green River. Recent salinity concentrations have trended upward. A hydrosalinity analysis is planned to determine if salt loading from agricultural lands is significant and cost effective to control.

San Juan Basin, New Mexico and Arizona

In the 1990's, a salinity study indicated that the Fruitland, Hogback and Cudei Irrigation Districts contribute an annual load of 157,000 tons of salt to the San Juan River. "Salinity Verification – Phase 1 Final Report, San Juan County, New Mexico, July 1993".

The San Juan River Dineh Water Users, Inc. (SJRDWU) has entered into a cooperative agreement with Reclamation to pilot the replacement of an earthen-lateral with pipeline. The necessary clearances for construction have been obtained from the Navajo Nation as well as support from the local chapters. Work has begun in designing the system, including the settling and regulating reservoir. The pipeline route is being cleared in anticipation of construction that will begin as soon as the irrigation season ends this October. A plan and location for wildlife habitat replacement has also been developed. With the assistance of Reclamation's Office of Native Affairs, the Arizona NRCS has hired a native-speaking civil engineer and placed him in Shiprock, New Mexico, to assist with the completion of the off-farm portion of the pilot and to assist the local farmers with the on-farm application system installation and operation.

Areas Beyond Current Project Boundaries

NRCS has undertaken to identify salt loading and salinity control from irrigated crop, pasture and haylands scattered widely throughout the Upper Colorado River Basin but outside of the existing project areas.

With the assistance of the U.S Geological Survey (USGS) and the Bureau of Reclamation, NRCS has been able to make use of the SPARROW model to assess salt loads outside of the existing salinity project areas. While the assessment is ongoing and will require considerable refinement, preliminary analysis indicates that as much as 50,000 tons of salt control has occurred in Utah and Colorado outside the project areas.

In 2010, Colorado, Utah and Wyoming all developed EQIP contracts providing salt control outside of the approved project areas but within the Colorado River Basin.

- Colorado, new contracts for 100 tons of control.
- Utah, new contracts for 877 tons of control.
- Wyoming, new contracts for 29 tons of control.

O_NPCA-CBD et al 2

Monitoring and Evaluation

Project offices continue to monitor and evaluate the effectiveness and quantity of salinity control, wildlife habitat, and economic performance replacement in order to improve the overall performance and management of the program. Generally, the program continues to function effectively and economically, though the overall cost per ton of salt control continues to rise in some areas. It is also noted that additional efforts are needed to identify and implement valuable, low-maintenance, sustainable wildlife habitat replacement. The individual Monitoring and Evaluation reports for each project can be found on the world-wide-web at; http://www.usbr.gov/uc/progact/salinity/index.html

Active Salinity Control Projects

Table 7 – Active Salinity Control Projects

Project Area State	Project	Potential Irrigated Acres	USDA Servicing Office
Colorado	Grand Valley	50,000	Grand Junction
	Lower Gunnison River	171,000	Delta and Montrose
	McElmo Creek	29,000	Cortez
	Mancos Valley	11,700	Cortez
	Silt	7,400	Glenwood Springs
Utah	Uinta Basin	226,000	Roosevelt, Vernal, Ft. Duchesne
	Price/San Rafael Rivers	66,000	Price, Castle Dale
	Muddy Creek	6,000	Castle Dale
	Manila-Washam	8,000	Vernal
	Green River	2,600	Price
Wyoming	Big Sandy River	18,000	Farson
	Total	**595,700**	

Grand Valley, Colorado

Implementation has been underway in this unit since 1979. In 2010, $501,000 was obligated into new EQIP contracts to control 457 tons at a cost of $121 per ton.

The NRCS, in cooperation with the Colorado State Conservation Board and the Mesa County Conservation District conducted a field survey in 2010 of current progress in implementing off-farm and on-farm irrigation system improvements with attendant salt control. Some key findings were:

- Approximately 12,500 acres of farmland has been converted to residential leaving 47,000 acres of irrigated farmland.
- NRCS has treated about 42,500 acres plus an additional 2,500 acres have been treated resulting in over 95% of all irrigated farmland acres receiving treatment.
- The original goal to reduce salt loading by 132,000 tons has been exceeded.
- Wildlife habitat replacement stands at about 71% of the original goal.

NRCS intends to publicize the results of the survey and conduct aggressive outreach over the next two years to provide every opportunity for the remaining producers to participate in the program. NRCS will also seek the remaining needed habitat. Beginning in 2013,

NRCS intends to offer general EQIP in lieu of salinity EQIP to producers within the project area. General EQIP may provide additional incentives and incentives for a wider array of conservation practices that does salinity EQIP.

Lower Gunnison Basin, Colorado

This project encompasses the irrigated farmland in the Gunnison and Uncompahgre River valleys and is located predominantly in Delta and Montrose counties. The Lower Gunnison project has more tons of potential remaining on-farm salt control than all the other projects combined. In early FY 2010, irrigated areas in Ouray were also included in the Lower Gunnison project.

Implementation was initiated in 1988 in this unit. Nearly 50 percent of the salt control goal has been achieved but the rate of application and implementation has slowed. In 2010, $1.5M was obligated in salinity EQIP contracts that will control 1,322 tons at a cost of $126 per ton. New sprinklers were installed on 215 acres while new surface systems were installed on 1,579 acres. Drip or micro-spray systems were installed on 9 acres.

NRCS is cooperating with the Colorado Conservation Commission, the county conservation districts, the Colorado Water Conservancy District, Reclamation and the U.S. Geological Survey to acquire a highly detailed survey of the irrigation delivery infrastructure, the status on on-farm application systems, and local salt loading. Such data should assist the partners to develop tactics to accelerate salt control measures.

Mancos River, Colorado

This project, near the town of Mancos, Colorado, was initiated and approved for funding and implementation by the NRCS in April 2004. The first EQIP contracts were signed in 2005 and implementation of improved irrigation systems is proceeding on schedule. Currently, about 596 contracts on 2,732 acres have been developed with EQIP and Basin States Parallel funds or about 51% of the project acres. One large wildlife habitat replacement project has been installed. It is anticipated that approximately 5,400 acres of improved irrigation systems with salt control benefits will be installed over the project life. To date, 1,649 acres of sprinkler systems and 605 acres of improved surface irrigations systems have been installed resulting in salt control of 2,339 tons. An additional 1,706 tons have been controlled by replacing off farm laterals with pipeline.

McElmo Creek, Colorado

Implementation was initiated in this unit in 1990. Application of salinity reduction and wildlife habitat replacement practices continue to be implemented in this area with sprinkler systems, underground pipelines, and gated pipe being installed.

Development and use of automatic shutoff valves for sprinkler systems continue to be widely implemented in the project to achieve water management. This project planned to install predominantly sprinkler systems with a small number of improved irrigation systems. Currently about two thirds of improved systems are sprinklers and one third are improved surface systems. In 2010, 378 acres of sprinklers were installed and 237 acres of improved surface systems were installed. Of a goal of 46,000 tons of salt control,

O_NPCA-CBD et al 2

about 26,000 tons or 56% has been implemented. Applications have declined compared to previous years likely due to recessionary pressures. This area is also experiencing the conversion of agricultural lands to residential properties.

Silt, Colorado

The first applications were funded in 2006. The cumulative cost effectiveness for these new contracts is $72 per ton which falls midway among the other active project areas. Several wildlife projects have been identified. Applications are a mix of improved surface and sprinkler irrigation systems.

Uinta Basin, Utah

Implementation began in this unit in 1980. More than 91 new irrigation contracts and nine new wildlife habitat contracts were developed in 2010. A significant number of systems have reached or are nearing the end of their useful life. While these systems are a lower priority than first-time improvements, NRCS has begun providing incentives for replacement or up-grading. Sprinkler irrigation systems remain, by far, the preferred type of system. Producer participation is exceeding the original projections. Recently awarded off-farm delivery system grants by the Bureau of Reclamation should enable additional on-farm gravity sprinkler systems. While more than 120,000 tons of on-farm salt control have occurred in the Uinta Basin (second only to the Grand Valley) and the original goal has been exceeded, the potential exists for an additional 46,000 tons to be controlled.

Price-San Rafael, Utah

Implementation of salinity control continues at a rapid pace in the Price-San Rafael Project area. More than 94 contracts of new irrigation systems and two wildlife habitat contracts were authorized in 2010. The Huntington-Cleveland Project is proceeding as planned and may ultimately lead to the improvement of 16,000 acres. The first phase of the Cottonwood Project is expected to initiate construction in late 2010 and will enable additional EQIP in future years. The Price-San Rafael project area has achieved about 51% of its salt control goal in the 16 years since the project began.

Muddy Creek, Utah

NRCS received and funded the first project in the Muddy Creek area for about $106,000. The local irrigation district has replaced their old and deteriorated diversion structure and has constructed a large sediment-settling structure as the necessary first phase towards ultimately providing pressurized water delivery to its water users.

Green River, Utah

This project is the most recently authorized by NRCS. Funds for salinity control were allocated to the Green River project in FY 2010. The timing of the start of project activity is important as newly irrigated lands are being brought into production for the first time in this area.

Two contracts for salinity control were enacted in FY 2010. These two contracts will install high-efficiency sprinkler systems on 114 acres to result in 350 tons of annual salt control. The annualized cost per ton is $47.

Manila-Washam, Utah/Wyoming

Astride the Utah-Wyoming border, and adjacent to the shores of Flaming Gorge Reservoir, the Manila-Washam Project is the newest, authorized project area. This area of 11,000 acres of irrigated pasture and hayland contributes about 53,000 tons of salt annually to the Green River. Nearly 2000 acres have been treated or contracted since the first plans were developed in 2007. All new irrigation systems have been some form of sprinkler system, such as side roll, pods, or center pivots.

Big Sandy River, Wyoming

Implementation has been underway in this unit since 1988. The application of salinity reduction and wildlife habitat replacement practices continues to be implemented. In this area, farmers are converting from surface flood irrigation to low-pressure center pivot irrigation systems for salinity control. Approximately 13,500 acres of the planned 15,700 acres have been treated (86 percent). Producers also report that the water savings from improvements in irrigation systems now allows a full irrigation season of water for the entire irrigation district. In 2010, NRCS developed six new contracts on 926 acres for about $139,000 of financial assistance. NRCS also continued to provide technical and financial assistance to all interested producers to up-grade sprinkler nozzle packages. Sprinklers were re-nozzled on 880 acres for a financial expenditure of $28,832. These latest nozzles, along with more intensive soil-moisture monitoring, provide additional irrigation efficiencies and salt savings.

Table 8 - USDA Salinity Control Unit Summary Through 2010

Unit	Controls[1] (tons)	Goal (tons)	Percent of Goal	Costs	Annualized Costs	Projected Total Cost	Cost/ton[2]
Uinta Basin, UT	149,030	140,500	106%	$ 99,575,982	$8,254,849	$ 93,876,572	$55
McElmo Creek, CO	25,862	46,000	56%	$ 18,901,097	$1,566,901	$ 33,618,841	$61
Silt, CO	4,038	3,990	101%	$ 3,489,154	$ 289,251	$ 3,447,678	$72
Muddy Creek, UT	0	11,677	0%	$ 0	$ 0	$ 11,655,523	$75[3]
Lower Gunnison, CO	105,502	186,000	57%	$ 66,417,187	$ 5,505,985	$117,093,484	$52
Manila-Washam, UT	7,087	17,430	41%	$ 6,202,656	$ 514,200	$ 15,255,015	$73
Grand Valley, CO	170,028	132,000	129%	$ 51,817,220	$ 4,295,648	$ 40,227,922	$25
Price/San Rafael, UT	75,507	146,900	51%	$ 31,174,675	$ 2,584,381	$ 60,650,797	$34
Mancos, CO	4,045	11,940	34%	$ 6,140,175	$ 509,021	$ 18,214,522	$126
Big Sandy, WY	56,637	83,700	68%	$ 13,431,318	$ 1,113,456	$ 19,849,238	$20
Green River, UT	0	6,540	0%	$ 0	$ 0	$ 8,700,000	$47[3]
TOTALS	**597,736**	**786,677**	**71%**	**$297,149,464**	**$24,633,691**	**$410,844,069**	**$41**

[1] Includes off-farm control funded with EQIP or Basin States Parallel funds.

[2] Cost per ton based on amortization over 25 years at 6.625% interest

[3] Estimate based on project plan.

Grand Valley includes 47,500 tons for on-farm ditches, not part of in-field control.

O_NPCA-CBD et al 2

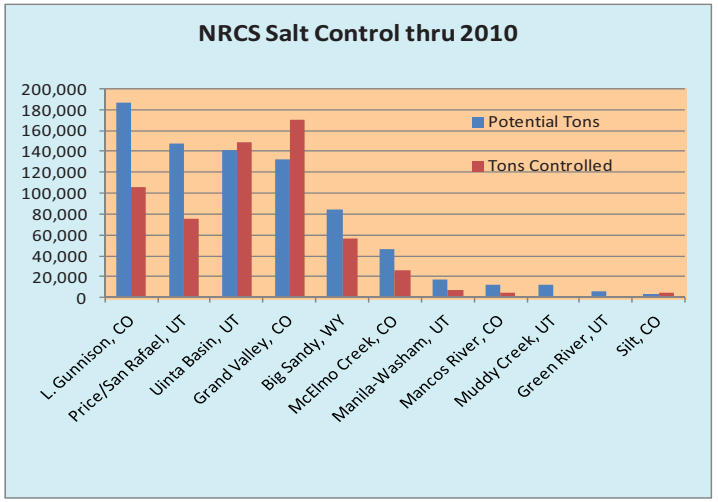


Figure 14 – NRCS On-Farm Salt Control Through 2010

U.S. Bureau of Reclamation

Program Summary

Background -- The Bureau of Reclamation involvement in the Colorado River Basin Salinity Control Program dates back to the early 1960's when salinity levels in the river started to rise. In 1968, Reclamation initiated a cooperative reconnaissance study in the Upper Colorado Basin. Study objectives were to identify feasible control measures and estimate their costs. This investigation evolved into several salinity control units. In 1974, Public Law 93-320 authorized the construction of the Grand Valley, Paradox, Crystal Geyser, and Las Vegas Wash Units. In 1984, Public Law 98-569 authorized the construction of the Lower Gunnison and McElmo Creek Units.

By 1993, Reclamation had gained 20 years of experience with the program and identified new and innovative opportunities to control salinity, including cooperative efforts with USDA, BLM, and private interests, which would be very cost effective. However, these opportunities could not be implemented because the Congress did not specifically authorize them. The Inspector General's audit report (1993) noted the Salinity Control Act directed that "the Secretary shall give preference to implementing practices which reduce salinity at the least cost per unit of salinity reduction." The Inspector General concluded that the congressional authorization process for Reclamation projects impedes

the implementation of cost-effective measures by restricting the program to specific, authorized units (specific areas).

The Inspector General recommended that Reclamation seek changes in the Salinity Control Act to simplify the process for obtaining congressional approval of new, cost-effective salinity control projects. Specifically, the Inspector General recommended Reclamation seek authorities similar to those provided to USDA in the 1984 amendments to the act, wherein USDA was empowered with programmatic planning and construction authority. At the time, USDA had only to submit a report to Congress and wait 60 days before it could proceed if Congress did not object. In contrast, Reclamation was required to seek approval of its projects through legislation. This had proved to be a cumbersome way to manage the program. With broader authorities, Reclamation would be able to take advantage of opportunities as they presented themselves, thus reducing costs.

Reclamation agreed with the Inspector General and wanted to explore any other innovative ideas, which would help improve the effectiveness of its program and take advantage of opportunities that were not envisioned 20 years earlier. With most of the cost-effective portions of the authorized program nearing completion, this was a pivotal moment for the program. It would either be reauthorized or end in 1998 due to appropriation ceiling limits. From Reclamation's point of view, it seemed a very appropriate time to reassess the direction of the program.

In 1994, Reclamation and the Basin States developed legislation to broaden Reclamation's authorities so that it could manage the implementation of the program without further congressional approval. This legislation was introduced in Congress late in 1994 and was approved and signed into law (Public Law 104-20) in 1995. Congress retained its fiscal oversight, but leaves the program's management to Reclamation. The 1995 amendments to the Salinity Control Act authorized Reclamation to pursue salinity control throughout the Colorado River Basin and required Reclamation to develop guidelines on how it would implement this new, basinwide approach to the program.

Guidelines -- Reclamation has prepared guidelines for its new Basinwide Salinity Control Program, which implements the recommendations made in the review of the program. As an alternative to adopting new, specific regulations, Reclamation administers the program through existing procurement techniques and established Federal regulations. Since February 1996, the program has been made available to the general public through this competitive process.

In 1984, Public Law 98-569 directed the Secretary to give preference to those projects which reduce salinity at the least cost per ton of salinity control. Since that time, cost effectiveness (cost per ton of salt removed) has been used to prioritize the implementation of salinity controls. However, cost effectiveness is only an estimate (prediction) of the project's cost and effectiveness at controlling salinity. Depending upon the project, there can be a degree of uncertainty in either of these values. Given the diversity of proposals that Reclamation may receive, an evaluation of the proposal's risks has been included in the current selection process.

All proposals (including those studied by Reclamation) are first ranked on their cost per ton of salt removed. This ranking is then adjusted for risk factors that might affect the project's performance. The performance risk evaluation considers both financial and

O_NPCA-CBD et al 2

effectiveness risks. For example, the Government is interested in limiting its risk of cost overruns. One way that performance risk could be reduced would be for the proponent to accept some risk through contractual limits on the Government's payments. Another method of limiting the costs would be to have the work bonded through a private bonding agency. The other major area of performance risk is in the amount of salinity control realized versus projected. Some types of salinity control are inherently more predictable or consistent than others. For example, industrial processes might have very little salinity control performance risk if the payments were based on a measurable product. On the other hand, the effectiveness of water management is often highly variable from farmer to farmer. Automation would be one way a farmer might propose to reduce this type of risk.

Ultimately, there is a tradeoff between risk and cost. In the end, eliminating risk may cost more than accepting some risk. A ranking committee is assembled to evaluate the tradeoffs between cost effectiveness and performance risks. The ranking committee is made up of representatives from the two cost-sharing partners, the Basin States and Reclamation. After the committee ranks the proposals, Reclamation attempts to negotiate the final terms of an agreement with the most highly ranked proponents. The first awards under this new process began in FY 1997.

Performance Review -- Past projects (Grand Valley, Paradox, Lower Gunnison, Dolores) have averaged slightly over $70 per ton. For a number of reasons, the new projects are much more cost effective, ranging between $20 and $35 per ton (see Tables 7 and 8).

One of the greatest advantages of the new program comes from the integration of Reclamation's program with USDA's program. Water conservation within irrigation projects on saline soils is the single most effective salinity control measure found in the past 30 years of investigations. By integrating USDA's onfarm irrigation improvements with Reclamation's off-farm improvements, significantly higher efficiencies can be obtained. If landscape permits, pressure from piped delivery systems (laterals) may be used to drive sprinkler irrigation systems at efficiency rates far better than those normally obtained by flood systems. The new authorities allow Reclamation much greater flexibility (in both timing and funding) to work with USDA to develop these types of projects.

The new authorities also allow Reclamation to respond to opportunities that are time-sensitive. Cost-sharing partners (State and Federal agencies) often have funds available at very specific times.

Another significant advantage of the program is that projects are "owned" by the proponent, not Reclamation. The proponent is responsible to perform on its proposal. Costs paid by Reclamation are controlled and limited by an agreement. Yet, unforeseen cost overruns can occur. The proponent has several options: the project may be terminated or the proponent may choose to cover the overruns with their own funds or borrow funds from State programs. The proponent may also choose to reformulate the project costs and recompete the project through the entire award process. For example, pipeline bedding and materials costs for the Ferron Project were underestimated in the proposal and subsequent construction cooperative agreement. The proponent was denied

permission to award materials contracts for the pipeline, since the costs were beyond those contained in the agreement. After months of negotiations and analysis, the proponents elected to terminate the project, reformulate it, and recompete against other proposals the following year. Their project was found to be competitive at the reformulated cost and was allowed to proceed. Since this project ran into difficulties, none of the other projects have shown any problems.

Due to several issues that had arisen in the recent years from managing the Salinity Program, the Upper Colorado Regional Director, Reclamation, requested that an evaluation and review (Review) be completed of the Colorado River Basin Salinity Control Program (Salinity Program) administered by the Upper Colorado Region. A Project Management Plan for the Review was prepared and approved in May 2007, by the Regional Director and the Chairman of the Colorado River Basin Salinity Control Forum Work Group. Initial and Draft Review Documents were prepared during calendar year 2007 by a Project Team, comprised mostly of Reclamation's Salinity Coordinators and provided to the Review Team, comprised of Reclamation staff outside of the Salinity Control Program and members of the Work Group, to review and provide comments. The Final Review Document was prepared during the spring of 2008 and sent to the Review Team and all members of the Work Group, June 27, 2008.

The Review served the following purposes:

1. Documented all existing procedures and policies
2. Sought recommendations to improve the Program, particularly in the areas where issues have arisen recently:
    a. Reimbursement requirement for operation and maintenance (O&M) for salinity control improvements
    b. Procedures for determining the tons of salt claimed
    c. The Request for Proposals (RFP) and agreement processes
    d. Differing standards and requirements for habitat replacement
    e. Salinity control improvements on Federal facilities versus non-Federal facilities
    f. The use of funds from Basin Funds
3. Identified areas where new procedures and policies need to be developed
4. Created a Standard Operation Procedure manual that can serve as guide for the future management and execution of the Program

The Review Document is a living document and will be subject to updating and revisions as the program progresses.

Basinwide Salinity Control Program (Basinwide Program)

In July 1995, Public Law 104-20 was signed into law. It authorizes the Secretary of the Interior to implement a basinwide salinity control program, directs the Secretary of the Interior to prepare a planning report on the new program, and authorized $75,000,000 to be appropriated. Additional authority was provided in November 2000 which increased the appropriation ceiling to $175,000,000. With cost sharing from the Upper and Lower Colorado River Basin Funds, the program has authority to expend up to $250 million

O_NPCA-CBD et al 2

within the Basin. In FY 2007 Reclamation obligated and/or expended approximately $8.9 million in appropriations and approximately $3.8 million in up-front cost-sharing from the Basin Funds for a total Basinwide Program of $12.7 million and $11.4 million in 2008. Since the authorization of the Basinwide Program in 1996, approximately $105.6 million in appropriations and approximately $45.3 million in up-front cost sharing from the Basin Funds have been expended for a total program of $150.9 million. Through the last Request for Proposals (RFP) process in FY 2006, five new project proposals were selected for funding totaling about $22 million and the cost effectiveness ranged from $27 to $33 per ton of salt. Construction on four of the projects and a project from the previous RFP were completed in FY 2008. The fifth proposal selected in 2006 has encountered problems with increases in pipe prices and was advised to reformulate their proposal and submit it again in the future.

In 2007, it was determined that instead of soliciting proposals through the RFP process, they would be solicited through a process for financial assistance agreements called Funding Opportunity Announcements (FOA). Instead of evaluating the proposals in the Technical Proposal Evaluation Committee (TPEC) process, they would be evaluated in a process common to negotiated procurement procedures where an evaluation committee would be organized that would be chaired by the Program Manager and have representatives from the Work Group and Reclamation area offices. This process would not follow the construction contract procedures and should allow more flexibility in the evaluation and agreement process.

In order to have projects ready to utilize the Basinwide Program funding in 2008 and beyond, an FOA was released in February 2008 soliciting applications to be submitted by May 2008. Twenty-five applications totaling over $167 million in salinity control projects were received. An Application Evaluation Committee (ARC) was organized that was chaired by the Program Manager and had representatives from the Work Group and Reclamation area offices. The applications were reviewed, evaluated, and ranked by the ARC under the criteria set forth in the FOA. Applications receiving highest rankings within the competitive range of less than $57 per ton of salt were selected and proposers were notified of the selection and negotiations were begun to execute an agreement. The proposers of the unsuccessful applications were also notified. If agreements are executed for all of the successful applications, $27 million worth of salinity control projects could be installed over the next 3-4 years.

American Recovery and Reinvestment Act of 2009, P.L. 111-5, (ARRA)

The purposes of the ARRA are, among others, to quickly and prudently commence activities that preserve and create jobs promoting economic recovery and to invest in infrastructure providing long-term economic benefits.

Reclamation's Upper Colorado Region solicited applications for reducing salinity contributions to the Colorado River through a Funding Opportunity Announcement (FOA) announced in the spring of 2009. Applications were evaluated and ranked by an Application Review Committee with representatives from the Colorado River Basin States and Reclamation. Reclamation awarded grants in August 2009 totaling more than $11.1 million in ARRA funds and $4.8 million in cost share funds from the Basin Funds

to irrigation companies in Colorado, Utah, and Wyoming. These projects when constructed will help control nearly 12,000 tons of salt loading.

The projects were projected to be completed by September 30, 2010. By the spring of 2010 four of the projects had the majority of the construction completed by the time irrigation water was turned in and the remaining construction was completed by September 30, 2010. However, these four projects requested and were granted additional time to complete habitat replacement measures and other minor tasks and were completed by December 30, 2010. The Cortez, CO area encountered an unusually high snowfall and winter conditions during the winter of 2009 and 2010 and construction of the Lone Pine Project was hindered. The sponsors of the project requested and were granted additional time to complete the construction during the upcoming winter. The project was completed by March 31, 2011.

Parallel Program

Section 205 of the Act authorizes Reclamation to expend amounts from the Basin Funds to repay the Treasury the reimbursable cost allocation of salinity projects or provide a cost share amount. This includes appropriations expended by the NRCS in their salinity program. The NRCS has questioned its ability to accept Basin Funds for cost sharing directly into its salinity program. Rather than repay the Treasury, the Colorado River Basin States (Basin States), NRCS, and Reclamation developed a "Parallel Program" (PP). Cost share funds from the Basin Funds have been used to accelerate and supplement implementation of the NRCS salinity measures by funding – through state agencies in Colorado, Utah, and Wyoming – salinity control measures that are separate, but parallel to, the salinity control measures implemented by the NRCS. Reclamation, with recommendations from the Basin States, had interpreted the Act to allow funds from the Basin Funds to be expended in the PP to further the general purposes of the Act.

To clarify authority for the administration of the PP, the Basin States prepared and put forth legislation through then-Senator Salazar's office into the 2008 Farm Bill to amend the Act that has now created the Basin States Program (BSP). Public Law 110-246 amended the Act and established the BSP. The BSP is explained in more detail later in the report.

With the creation of the BSP, the PP is in the process of being phased out and all funds not used in the PP will become part of the BSP. As of October 15, 2010, the state agencies are no longer authorized to enter into contracts under the PP. Contracts that the state agencies have executed must have all practices installed, constructed, or implemented by September 30, 2012, in order to receive reimbursement. The state agencies may request reimbursement from Reclamation until December 30, 2012.

New Reclamation Salinity Projects

O_NPCA-CBD et al 2

Gunnison Basin, Colorado

Uncompahgre Valley Water Users Association (UVWUA) Phase 3 Project: In FY 2010, the UVWUA continued construction of Phase 3 of their East Side Laterals (ESL) project which involves the piping of 10.5 miles of laterals under the South and Selig Canal systems and the reduction of about 2,300 tons of salt loading annually. This phase is utilizing $1.3 million of salinity-control funding as well as funding from the Reclamation's Departmental Irrigation Drainage (selenium) Program. Construction of Phase 3 will be completed in 2011.

UVWUA Phase 4 Project: As a result of the 2008 Basinwide Program FOA, the UVWUA was awarded a cooperative agreement for Phase 4 of the ESL in December 2008. This phase involves an additional 11 miles of laterals under the Selig and East Canal systems and the reduction of about 3,700 tons of salt loading annually. Approximately $2 million of salinity-control funding will be supplemented with approximately $800,000 from a Section 319 grant obtained through the Colorado Division of Public Health and Environment. Construction of one short lateral was completed in FY 2009. Additional laterals were completed in FY 2010 and the remaining portions of Phase 4 will be completed in 2012.

Grandview Canal and Irrigation Company Project: Awarded from the 2008 FOA, this project involves piping a portion of the Grandview Canal and several laterals in an area tributary to the North Fork of the Gunnison River near Crawford in Delta County. In July 2009, Reclamation entered into an agreement to provide $5.3 million to pipe 4.8 miles of main canal and 5 miles of laterals and convert about 900 acres of currently flood-irrigated farmland to sprinkler irrigation. Construction began in September 2010 with completion expected by late 2011. The project is expected to reduce salt loading by 6,400 tons/year.

Grand Valley Unit, Colorado

Grand Valley Irrigation Company (GVIC) Project: As a result of selection under the 2008 Basinwide Program FOA, the GVIC was awarded a $3 million cooperative agreement to line about 2.9 miles of their main canal within the city of Grand Junction. A salt loading reduction of approximately 4,500 tons annually is expected. The canal lining will consist of a PVC membrane with a shotcrete cover. Construction began in November 2008 and approximately 2.0 miles of canal lining have been completed. The remaining 0.9 miles of canal lining will be completed in 2011. The habitat replacement work was completed this past summer.

San Juan River Basin, New Mexico

San Juan River Demonstration Project: The San Juan River Dineh Water Users, Inc. operates the Hogback and Fruitland irrigation projects located on both sides of the San Juan River near Shiprock, NM. The projects consist of about 50 miles of lined main canals and over 250 miles of unlined laterals that provide water to about 13,000 acres of irrigated land. The average irrigated parcel size is about 13 acres. This $194,000 demonstration project would replace about a lateral about 7,900 feet long with an

approximately 2 acre settling pond and about 5,000 feet of PVC pipe. The estimated salt savings for this activity is about 199 tons/year and the project will be completed in 2011. The purpose of the demonstration is to determine if the NRCS EQIP can be successfully implemented on the Navajo Reservation. This lateral provides water to about 167 acres of irrigated land consisting of 12 separate parcels. Successful implementation of land leveling and installation of gated pipe would result in an estimated salt savings of 384 tons/year. Combined cost effectiveness of this project is about $43/ton. The majority of the habitat replacement work was completed in 2010 and construction of the salinity features will begin this fall with completion scheduled later this winter.

Ongoing Reclamation Salinity Control Projects

Big Sandy River Unit

The Big Sandy River Unit is located near Farson and Eden in Sweetwater County in southwestern Wyoming. The purpose of the Big Sandy River Unit investigation was to determine the feasibility of lowering the salt inflow to the Big Sandy River. The study was specifically directed toward reducing salt pickup from seeps and springs along a 26-mile reach of the Big Sandy River west of Eden, Wyoming. Feasibility planning was authorized by the Colorado River Basin Salinity Control Act (Public Law 93-320) of 1974 and the Water Resource Development Feasibility Investigations Act (Public Law 96-375) of October 1980.

Investigations indicate that seeps, which surface in the Bone Draw and Big Bend areas, produce saline water at a rate of about 27 cubic feet per second (ft^3/s). The salinity here varies from 1,000 to 6,000 mg/L along the Big Sandy River, with a total annual contribution of more than 164,000 tons of salt. Indications are that salt is picked up by water contacting the shale of the Green River Formation beneath the surface and eventually seeping into the river. Irrigation was identified as a significant contributor to the water source recharging the springs.

Reclamation has studied alternatives to intercept the springs and seeps and then transport, treat and use, or dispose of the saline water. In the irrigated area, off-farm solutions such as selective lining of canals and laterals were studied.

Studies conducted in cooperation with USDA indicated that control of onfarm irrigation is the most cost-effective alternative for controlling salinity from the Big Sandy River Unit. Because of past selective lining programs, the canals and laterals showed relatively low seepage rates, offering little room for improvement.

In 2006 the local water district applied for funding for a new salinity control project. This funding was to be supplemented by the state of WY. In 2006 & 2007 new seepage tests were conducted by Reclamation to determine if the linings on various canals and laterals were still functioning. It appears that at some locations as the canals were cleaned the clay lining was removed and deposited along the bank.

Eden Valley, Farson/Eden Pipeline Project: The Farson/Eden Pipeline Project is located in Sweetwater County, in the vicinity of Farson, Wyoming. It was selected from

O_NPCA-CBD et al 2

the applications received in the 2008 FOA. A Cooperative Agreement was executed in February of 2009 for the amount of $6,453,072. This project will replace approximately 24 miles of earthen laterals with irrigation pipe resulting in the annual reduction of 6,594 tons of salt in the Colorado River at an anticipated cost of approximately $52.57 per ton of salt. This project is about half complete and will be completed by 2012.

Lower Gunnison Basin Unit

The Lower Gunnison Basin Unit is located in west-central Colorado in Delta and Montrose Counties. The unit was authorized for investigation by the Colorado River Basin Salinity Control Act (Public Law 93-320) of 1974. An amendment to the act, Public Law 98-569, authorized construction of the unit to begin in 1984.

An estimated 360,000 tons of salt is added to the Colorado River annually from the Uncompaghre Project, a Reclamation irrigation project built in the early 1900's. Studies indicate that salt loading occurs when irrigation conveyance system seepage and irrigation return flows pass through highly saline soils and the underlying Mancos Shale Formation. By reducing the amount of groundwater percolating through these saline soils, salt loading to the Colorado River is being reduced.

With Reclamation funding, the water districts have completed the winter water facilities. Reclamation has completed plans for local improvements to the irrigation delivery systems. USDA is implementing onfarm improvements, including upgrading irrigation systems and improving irrigation management.

The Uncompaghre Project is a Federal development constructed in the early 1900's for irrigation of approximately 86,000 acres. Approximately 34 percent of the total 86,000 irrigated acres are on Mancos-Shale-derived soils. These soils are naturally high in both salt and selenium. Reclamation and USDA have implemented various salinity control measures in the area.

The Salinity Control Act authorizes the construction of winter water replacement facilities in the Uncompaghre River Valley and irrigation delivery system improvements on the more saline, east side of the valley. The plan of development includes the winter water replacement and lateral lining programs. Although authorized for construction, the canal lining has not been competitive with other, lower cost alternatives within the Salinity Control Program. The canal lining construction program remains in a deferred status.

The objective of the winter water replacement program is to eliminate winter livestock watering from the unlined canal and lateral system. Water is made available for livestock through an expansion of the existing culinary water system using relatively small, 2- to 6-inch polyvinyl chloride pipe. This modification reduces canal seepage during the non-irrigation season, reducing salinity from the system by about 50 percent. Work on this portion of the unit was completed in 1995.

The remaining portion of the project, the East Side Lateral portion, will compete for funding in Reclamation's Basinwide Salinity Control Program under the authorities of Public Law 104-20. In FY 1998, Reclamation solicited proposals for salinity control efforts under its basinwide authorities. The Uncompaghre Valley Water Users Association (UVWUA) submitted a proposal for a project which would cost share

salinity control activities with the Department of the Interior's National Irrigation Water Quality Program (NIWQP). Cost sharing from the NIWQP enabled this project to be competitive with other projects. The project was recommended for implementation by Reclamation's salinity control evaluation committee. The project reduces salinity in the Colorado River by about 2,300 tons of salt per year. The Salinity Control Program has contributed $890,000. The NIWQP has contributed $730,000. Environmental compliance for this project was completed in 1995 as part of Reclamation's Lower Gunnison Basin Unit, Environmental Assessment/Finding of No Significant Impact. The UVWUA has replaced approximately 7.5 miles of unlined earthen irrigation laterals with buried pipe in the Uncompaghre Project's South Canal system. Construction of this portion of the project was completed in 2000. A report titled *Effects of Piping Irrigation Laterals on Selenium and Salt Loads, Montrose Arroyo, Western Colorado,* WRI Report 01-4204 by the USGS shows the project reducing both salinity and selenium. It is anticipated that in the future more joint projects will be pursued between the two programs.

Lower Gunnison Basin Unit, Colorado

In FY 2007, the Uncompaghre Valley Water Users Association continued with Phase 2 of the East Side Laterals piping project in the Cedar Creek area, southeast of Montrose. The current effort, which began in FY 2005, is piping a total of 20.5 miles of laterals under the South Canal system using $2.1 million of Basinwide Salinity Program funding supplemented by $2.2 million of Departmental Irrigation Drainage Program (DIDP) funding for selenium remediation. Phase 2 was completed in 2009.

Phase 3 involves the piping of another 11 miles of laterals. This phase has salinity-control funding as well as funding from DIDP and also from an EPA Section 319 grant. Construction of Phase 3 began in November 2007 and is scheduled for completion by the end of 2011.

Mancos Valley Unit

The Mancos Valley Unit is a 9,200-acre-irrigated area along the Mancos River, a tributary to the San Juan River. The area is very saline (Mancos shale) and should respond well to joint Reclamation/USDA irrigation efficiency improvements similar to those being implemented in Utah. Planning studies of this unit, which began in 2002, continue.

O_NPCA-CBD et al 2

Paradox Valley Unit

The Paradox Valley Unit was authorized for investigation and construction by the Salinity Control Act (Public Law 93-320) of 1974. The unit is located in southwestern Colorado along the Dolores River in the Paradox Valley, formed by a collapsed salt dome (Figure15). Groundwater in the valley comes into contact with the top of the salt formation where it becomes nearly saturated with sodium chloride. Salinities have been measured in excess of 250,000 mg/L, by far the most concentrated source of salt in the Colorado River Basin. Groundwater then surfaces in the Dolores River. Studies conducted by Reclamation show that without salinity controls the river would pick up more than 205,000 tons of salt annually as it passes through the Paradox Valley. This project intercepts the high saline water (brine), before it reaches the Dolores River, and disposes of it by deep well injection (injection interval about 14,000 feet below ground surface) (Figure 16).

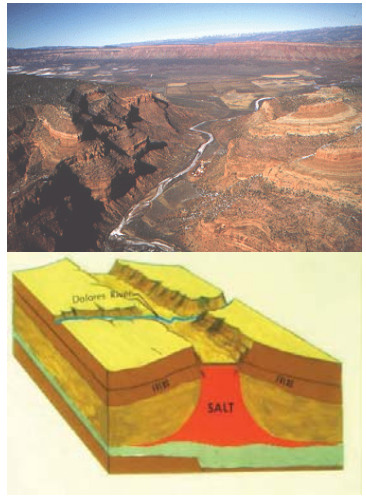


Figure 15 - Paradox Valley.

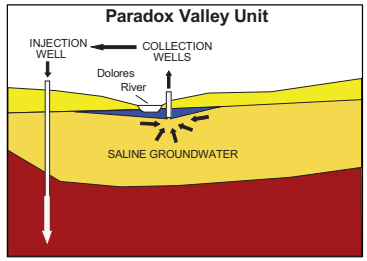


Figure 16 - Schematic of Paradox Project.

In its definite plan report (September 1978), Reclamation recommended that a series of wells be drilled on both sides of the Dolores River to intercept the brine before it reached the river. The brine would then be pumped to an evaporation pond in Dry Creek Basin. A draft environmental statement was prepared for this plan and made public on May 11, 1978; a final statement was filed with EPA on March 20, 1979. Due to the potential for environmental impacts, EPA recommended that Reclamation investigate deep-well injection as an alternative method of disposal.

A private consulting firm completed a feasibility study of deep-well injection and concluded it to be technically, economically, and environmentally feasible. Reclamation then contracted with a second consulting firm to do a more detailed study of injection and to design the disposal system including injection well and surface facilities. A final design for the test injection well was completed in August 1985.

Facilities have been installed and mechanical tests performed. Over the years numerous mechanical and electrical problems with the facilities have been identified and solved. Several new technologies were developed to overcome the extremely high pressures created by the injection pumps. In fiscal year 2000, the Paradox Valley Seismic Network (PVSN) showed seismic activity at the injection site reached levels and frequencies that were unacceptably high. Restricting the maximum injection rate to 230 gpm in July 2000 has reduced seismic activity, but has also reduced the effectiveness of the injection facility to about 76,000 tons per year.

In January 2002, a test to inject 100 percent brine was implemented after temperature logs of the well showed that the area around the well bore and injection zone had cooled sufficiently to prevent precipitation problems near the well bore. Since January, facility disposal has increased by approximately 35,000 tons per year and there is no indication of apparent adverse effects from 100 percent brine injection. Reclamation will continue to carefully monitor injection pressures for buildups that might suggest plugging of the aquifer near the well bore. Seismic activity remained low during fiscal year 2002 and remains at a very low frequency and magnitude. Table 9 lists the number of seismic events measured on the Paradox Valley Seismic Network from 1998-2010 and the pressure and tons of salt injected.

The project continues to intercept and dispose of 100,000+ tons of salt annually, but the pressure necessary to inject the brine into the disposal formation at 14,000 feet is increasing. Modification of the current facility to operate at a higher injection pressure to extend the life of the current injection well is under way. Reclamation has also initiated a Plan of Study to investigate the feasibility of other salt removal alternatives to augment the project, including a second injection well. As part of the Plan of Study, an investigation of alternative salinity control methods was completed in June in 2008. The results of the investigation indicated a need for a current characterization of the regional groundwater flow to determine the appropriate strategy for future salinity control efforts. The groundwater study started in 2009 and is ongoing.

This project intercepts extremely saline brine (260,000 mg/l total dissolved solids) before it reaches the Dolores River and disposes of the brine by deep well injection (injection interval about 14,000 feet below ground surface). Seismicity associated with the injection process has diminished since the injection rate reduction in FY 2000 and remains at a low frequency and magnitude.

The project continues to intercept and dispose of 100,000+ tons of salt annually, but the pressure necessary to inject the brine into the disposal formation at 14,000 feet is increasing. Modification of the facility to operate at a higher injection pressure to extend the life of the current injection well was completed in 2009. Reclamation has initiated a Plan of Study to investigate the feasibility of other salt reduction alternatives to augment the project, including a second injection well. As part of the Plan of Study, an investigation of alternative salinity control methods was completed in June, 2008. The results of the investigation indicated a need for a current characterization of the regional groundwater flow to determine the appropriate strategy for future salinity control efforts. An interagency agreement was initiated with the USGS to conduct a hydro geologic study, and investigations for Phase I of the study began in the second quarter of FY 2009. Phase I was essentially completed in the third quarter of FY 2010, resulting in a

O_NPCA-CBD et al 2

Table 9 - Paradox Well Injection Evaluation

Injection Period	Operational Days[1]	Pressure Start	Pressure End	Pressure Increase	Tons of Salt Injected[2]	No. of Induced Seismic Events	Maximum Magnitude of Induced Seismic Events	Estimated Tons of Salt Entering the River[3]
Jan-May '02[4]	148	1609	4432	2823	52,860	25	2.9	8,877
June-Dec '02[5]	178	929	4593	3664	58,953	34	2.2	9,801
Jan-May '03[5]	144	1172	4627	3455	53,173	27	2.1	18,077
June-Dec '03[5]	184	1154	4675	3521	59,530	106	2.3	11,055
Jan-May '04[6]	140	1201	4640	3439	51,449	47	2.4	19,484
June-Dec '04[7]	160	1091	4541	3450	51,589	57	3.9	6,515
Jan-May '05[5]	140	1038	4736	3698	55,024	69	2.4	12,571
June-Dec '05[8]	148	1203	4750	3547	46,551	31	2.6	38,163
Jan-June '06[9]	138	375	4680	4305	44,779	10[10]	2.4	50,148
July-Dec '06[5]	162	1084	4797	3713	56,920	13[10]	2.1	21,625
Jan-June '07[5]	159	1066	4796	3730	56,068	7[10]	1.1	18,777
July-Dec '07[5]	163	1232	4712	3480	57,395	31	2.6	10,571
Jan-June '08[12]	160	1152	4813	3661	54,720	47	1.3	14,933
July-Dec '08[5]	162	1263	4822	3559	56,734	61	2.1	15,874
*Jan-Mar '09[5]	84	1246	4756	3510	29,163	20	2.6	20,716
Apr-Sept '09[13]	160	1157	4891	3734	55,083	70	2.7	17,611
Oct '09-Mar '10[5]	153	970	4930	3960	51,589	91	2.9	32,260
Apr '10-Sep '10[5]	162	1347	4990	3643	55,747	75	2.7	14,364

1. Operational days include partial days of operation which accounts for variations in tons of salt injected
2. Tons of salt injected based on 260,000 mg/L. Brine concentration varies slightly due to seasonal and environmental fluctuations
3. Tons of salt entering the river based on regression equations (Ken Watts, USGS Administrative Report – "Estimates of Dissolved Solids Load of the Dolores River in Paradox Valley, Montrose County, CO, 1988-2009, August 5, 2010")
4. Begin 100% brine injection
5. No problems
6. Down from 3/1/04 through 3/7/04 for mechanical problems
7. Implemented quarterly 10-day shutdown schedule from 9/22 to 10/22; M3.9 earthquake on 11/7; plant shut down until 11/18; discontinued 10-day shutdown schedule
8. Down from 11/13/05 through 12/31/05 for mechanical problems
9. Down from 1/1/06 through 1/19/06 and 2/16/06 through 3/2/06 for mechanical problems
10. Seismic data for 2006 and the first half of 2007 is likely incomplete due to seismic network problems
11. Down from 4/16-17/08 for mechanical problems
12. Down from 5/18-19/09 for mechanical problems

* Biannual shutdown schedule changed from winter/summer to spring/fall

preliminary conceptual flow model of groundwater flow in the stream-aquifer system in the Paradox Valley. The preliminary conceptual flow model indicates that alternatives to reduce the amount of brine being produced, identified in the 2008 investigation, may not be feasible. Some additional work is necessary to verify the results of Phase I. If the Phase I results are verified, Phase II of the study may not be implemented.

Price-San Rafael Rivers Unit

Huntington Cleveland Irrigation Company (HCIC) Project: The Project is located in northern Emery County, in and around the towns of Huntington, Lawrence, Cleveland, and Elmo. The Project was selected in the 2004 Request for Proposals (RFP) and awarded a cooperative agreement in September 2004. A new cooperative agreement was executed in November 2006 and was modified again in September 2009. Approximately 350 miles of open earthen canals and laterals are being replaced with a pressurized pipeline distribution system (Distribution System) to accommodate sprinkler irrigation on about 16,000 acres. Funding for this project is being shared between Reclamation's Basinwide Program, HCIC, NRCS's EQIP, the Parallel Program, and Rocky Mountain Power, formally known as Utah Power and Light. The last of Reclamation's share of $17.1 million for the Off-farm Distribution System was obligated in 2008. Reclamation can provide up to an additional $6.0 million in funding equally 50/50 with HCIC funds for completion of the Distribution System. Since 2009 Reclamation has provided about $2.0 million in additional funding. The Project, scheduled to be completed in 2012, will result in the annual reduction of 59,000 reportable tons of salt in the Colorado River at an anticipated cost of approximately less than $100/ton. Of the 59,000 tons of salt, 13,000 are attributed to the Off-Farm

Figure 17 - Salinity from Canal Seepage.

Figure 18 - Price-San Rafael Irrigation Improvements.

O_NPCA-CBD et al 2

Distribution System and 46,000 tons are attributed to the On-Farm Distribution System and the on-farm salinity control measures (sprinklers).
Cottonwood Creek Irrigation Improvement Project: The $6.5 million Cottonwood Creek Irrigation Improvement Project is located in Emery County, west of Castledale, Utah. It was selected from the applications received in the 2008 FOA. A Cooperative Agreement was executed in February 2010. Construction is expected to begin late in 2010. This project will replace approximately 31 miles of earthen canals and laterals with a pressurized pipeline system resulting in a reduction of 2,094 tons of salt in the Colorado River. It is expected that the pressurized pipeline will induce on-farm improvements resulting in the annual reduction of an additional 9,100 tons of salt. It is anticipated that the project will result in the total annual measurable reduction of 11,194 tons of salt in the Colorado River at an anticipated cost of approximately $59 per ton of salt.

Uinta Basin Unit

The Uinta Basin Unit is located in northeastern Utah. The area includes portions of Duchesne and Uinta Counties and is situated between the Uinta Mountains on the north and the Tavaputs Plateau on the south. The principal communities within the area are Duchesne, Roosevelt, and Vernal.

Figure 19 - Salinity in Uinta Basin Unit Area.

Reclamation has conducted extensive studies in the area. Most of the salt pickup from the unit area is from the dissolution of salts from the soil and subsurface materials, principally from soils of marine origin that underlie most of the Uinta Basin. Seepage from conveyance systems and deep percolation resulting from irrigation are the primary processes that dissolve salts from the soils and shale and convey the salts through the groundwater system to natural drainages and ultimately to the Colorado River. The Uinta Basin contributes an estimated 450,000 tons of salt per year to the Colorado River.
Reclamation has a total of 14 projects in the Uinta Basin Unit area. The projects are funded jointly by Reclamation's Basinwide Program and cost sharing from the Basin States. The water conservation based projects include the Burns Bench, BIA-Ute Tribe, Duchesne County, Farnsworth, Lower Brush Creek, Western Uintah, South Lateral, River Canal, Union Canal, Hicken, Dry Gulch Class E, Dry Gulch Class C, Ouray Park, and Duchesne Water Conservancy District projects. These projects will reduce salinity by improving the efficiency of existing irrigation projects. Several will pipe selected canals and laterals to gain pressure to run high-efficiency sprinkler irrigation systems.

Verification Studies - In their "National Water Summary 1990-91, Water Supply Paper 2400", the USGS reported a downward trend in dissolved solids concentration (salinity) in the Duchesne River, immediately downstream of the project area. They pointed out that much of the base flow of the river was from irrigation return flows. Salinity discharge has dropped from 206,000 tons in 1981 when USDA first started irrigation improvements to 169,000 tons in 1993 - a 37,000-ton reduction. Based on the amount of irrigation improvements installed, USDA estimates that irrigation improvements through 1992 have reduced the salinity discharge by about 55,500 tons per year (*1993 Joint Evaluation Report*). Recent studies have also shown a downward shift in the salt/flow relationship (for a given flow, salinity is lower). These data support the theory that onfarm irrigation practices can be effective at reducing salt loading. Monitoring and analysis will continue.

Uinta Basin Unit, Utah

The Duchesne County II Salinity Reduction Project is located in Duchesne County, in and around Roosevelt, Utah. A total of 51.9 canal miles serving 13,350 acres is being replaced to accommodate pressurized pipeline systems, in order to facilitate sprinkler irrigation. The K2 and Pleasant Valley phases of the project are completed, but land easements from the Business Committee of the Ute Tribe of the Uintah and Ouray Agency need to be obtained in order to complete the last and final phase (TN Dodd) of the project. It is anticipated that the off-farm portion of this project will result in the annual reduction of 42,800 tons of salt in the Colorado River at $25 per ton of salt.

The Moffat-Ouray Pipeline Salinity Project near Gusher, Utah was completed in 2008. This project replaces approximately 30.2 miles of canals with pipelines and 15,900 tons of salt will be reduced annually to the Colorado River at a cost of $28 per ton. The abandoned canals have been replaced by pipelines which provide a pressurized irrigation system.

Colorado River Basin Salinity Control Program Summary Data

Table 10 – Summary of Federal Salinity Control Programs (2010)

Salinity Unit		Tons / Year Removed
MEASURES IN PLACE BY RECLAMATION		
Basinwide Program		176,000
Basin States Program	1/	7,000
Meeker Dome		48,000
Las Vegas Wash Pitman		4,000
Grand Valley		122,000
Paradox Valley	2/	113,000
Lower Gunnison Winter Water (USBR)		41,000
Dolores		23,000
Reclamation Subtotal		534,000

O_NPCA-CBD et al 2

MEASURES IN PLACE BY USDA/BSP	3/	
Grand Valley		144,000
Price-San Rafael		76,000
Uinta Basin		149,000
Big Sandy River		57,000
Lower Gunnison		106,000
McElmo Creek		26,000
Mancos		4,000
Muddy Creek		0
Manila		7,000
Silt		4,000
Green River		0
USDA/BSP Subtotal		573,000
MEASURES IN PLACE BY BLM		
Nonpoint Sources	4/	85,000
Well-Plugging		15,000
BLM Subtotal		100,000
Measures in Place Total		1,207,000
GOALS TO REACH TARGET		
Reclamation Basinwide Program		368,000
Price-San Rafael (USDA/BSP)		71,000
Grand Valley (USDA/BSP)	5/	0
Uinta Basin (USDA/BSP)	6/	11,000
Big Sandy River (USDA/BSP)		27,000
Lower Gunnison (USDA/BSP)		80,000
McElmo Creek (USDA/BSP)		20,000
Mancos River (USDA/BSP)		8,000
Muddy Creek (USDA/BSP)		12,000
Manila (USDA/BSP)		10,000
Silt (USDA/BSP)	5/	0
Green River (USDA/BSP)		7,000
Tier 2 (USDA)	7/	20,000
New Well Plugging and Nonpoint Source (BLM)		10,000
Goals Subtotal		644,000
Target Total		1,851,000

1/ Off-farm projects funded by Basin States Program
2/ Paradox injection well capacity estimated to decline beginning in 2020; assumed continuation of well or alternative control methods after 2020
3/ MayInclude off-farm controls that were not goaled.
4/ BLM Non-point source are estimates.
5/ Original goal attained
6/ EstimatedOriginal goal attained.
7/ Potential new measures in areas outside approved projects

O_NPCA-CBD et al 2

Table 11 – Summary of Colorado River Basin Salinity Control Program Funding for Federal Agencies (In 1,000 Dollars)

Federal Fiscal Year	Bureau of Reclamation	USDA - NRCS	Upfront Cost Sharing from Basin Funds[1]	Bureau of Land Management[2]	Total
1988	20,783	3,804		500	25,087
1989	16,798	5,452		500	22,750
1990	14,185	10,341		700	25,226
1991	24,984	14,783		873	40,640
1992	34,566	14,783		873	50,222
1993	33,817	13,783		866	48,466
1994	32,962	13,783		800	47,545
1995	13,622	4,500		800	18,922
1996	17,420	9,561	0	800	27,781
1997	3,464	3,100	4,197	800	11,561
1998	12,306	2,894	5,749	800	21,749
1999	15,651	4,016	7,432	800	30,948
2000	16,637	3,805	16,372	800	37,614
2001	14,136	5,785	1,100	800	21,821
2002	14,944	10,451	8,196	800	34,391
2003	11,315	12,714	11,845	800	36,674
2004	12,409	19,488	13,064	800	45,761
2005	11,301	19,798	8,523	800	40,422
2006	11,953	19,661	14,465	751	46,830
2007	12,223	19,667	14,685	800	47,375
2008	11,630	17,611	12,184	800	42,225
2009	21,363	18,551	16,601	800	57,315
2010	12,015	14,697	7,405	800	34,917

1. Prior to 1996 Basin Funds were used to repay the reimbursable portion of Reclamation's Salinity Control Projects within a fifty-year period or within a period equal to the estimated life of the project, whichever is less.
2. Funds expended by BLM for salinity control cannot accurately be determined. This amount reflects what has been reported as having been designated within the BLM budget.

Table 12 – Reclamation Salinity Control Unit Summary (P.L. 93-320 and 98-569)

Unit/Study	Implementation	Controls (tons/y)	Reclamation Capital Cost	Annual O&M Costs	Cost per Ton[1]
Meeker Dome	1980-1983	48,000	$3,100,000	$0	$5
Las Vegas Wash	1978-1985	3,800	$1,757,000	$0	$28
Grand Valley	1980-1998	127,500	$160,900,000	$1,417,000	$83
Paradox Valley	1988-1996	110,000	$66,199,000	$2,497,000	$60
Dolores Project	1990-1996	23,000	$44,700,000	$613,000	$185
Lower Gunnison	1991-1995	41,380	$24,000,000	$0	$35
Total		353,680	$300,656,000	$4,016,000	$66

1. Cost per ton based on amortization over 50 years at the project authorized interest rate.

Table 13 - UCRB Agriculture Salinity Control Summary (tons) - 2010

Project Area	Total Salt Load	Total Ag. Load	Total Controls	Remaining Ag. Load
Big Sandy	157,500	124,900	68,357	56,543
Grand Valley	580,000	559,100	270,641	288,459
Green River	15,700	15,700	0	15,700
Lower Gunnison	1,440,000	840,000	166,701	673,299
Mancos	43,000	26,000	4,045	21,955
Manila	49,000	40,000	12,640	27,360
McElmo	164,075	99,960	49,815	50,145
Muddy Creek	90,000	14,980	0	14,980
Price-San Rafael	430,000	244,000	126,354	117,646
Rifle - Silt	NA	24,700	4,038	20,662
San Juan[1]	NA	62,530	48,329	14,201
Uinta	500,000	328,120	178,938	149,182
Paria (Tropic)[1,2]	NA	1,829	1,829	0
Total	3,469,275	2,381,819	931,687	1,450,132

1. Off-farm load shown only. On-farm loads have not been estimated for the San Juan and Paria areas
2. Agricultural load for Paria only represents the conveyance systems which were piped as part of the Tropic Project

REFERENCES CITED

American Heart Association (AHA). 2000. Sodium. AHA Recommendation. http://www.americanheart.org/Heart_and_Stroke_A_Z_Guide/sodium.html.

Amrhein, C. and M.A. Anderson. 2005. Geochemistry of the Salton Sea and Agricultural Evaporation Basins. International Salinity Forum Conference, April 25-28, 2005. Riverside, CA.

Anderson, J.C., and A.P. Kleinman. 1978. *Salinity Management Options for the Colorado River*. Water Resources Series Planning Report No. P-78-003, Utah Water Resources Laboratory, Logan, Utah.

Bolke, E.L. and K.M. Waddell. 1975. Chemical Quality and Temperature of Water in Flaming Gorge Reservoir, Wyoming and Utah, and the Effect of the Reservoir on the Green River. Geological Survey Water-Supply Paper 2039-A. US Government Printing Office, Washington DC.

Bolke, E.L. 1979. Dissolved-Oxygen Depletion and Other Effects of Storing Water in Flaming Gorge Reservoir, Wyoming and Utah. Geological Survey Water-Supply Paper 2058. US Government Printing Office, Washington DC.

Bureau of Reclamation. 1999. Salinity management study final report: Long term strategy & recommended action plan. Metropolitan Water District of Southern California.

Bureau of Reclamation. 2003. *Colorado River System Consumptive Uses and Losses Report 1996-2000*. Upper Colorado Regional Office, Salt Lake City, Utah.

Bull, R.J. and F.C. Kopfler. 1991. Health Effects of Disinfectants and Disinfection By-products. AWWA Research Foundation and American Water Works Association.

Butler, D.L., 2001. Effects of Piping Irrigation Laterals on Selenium and Salt Loads, Montros Arroyo Basin, Western Colorado. U.S. Geological Survey Water Resources Investigations Report 01-4204, 14p.

Butler, D.L. 1996. Trend Analysis of Selected Water-Quality Data Associated With Salinity-Control Projects in the Grand Valley. In the Lower Gunnison River basin, and at Meeker Dome, Western Colorado. Water Resources Investigation Rep. No. 95–4274, United States Geological Survey, Denver.

Holdren, G.C. and A. Montano. 2002. Chemical and Physical Limnology of the Salton Sea, California – 1999. Technical Memorandum No. 8220-03-02, U.S. Department of the Interior, Bureau of Reclamation, Denver, CO.

Iorns, W.V., C.H. Hembree, and G.L. Oakland. 1965. *Water Resources of the Upper Colorado River Basin - Technical Report*. U.S. Geological Survey, Professional Paper 441.

Kleinman, A.P., and B.F. Brown. December 1980. *Colorado River Salinity, Economic Impacts on Agricultural, Municipal, and Industrial Users*. Bureau of Reclamation,

Engineering and Research Center, Colorado River Water Quality Office, Denver, Colorado.

Kurtzweil P. 1995. Scouting for sodium and other nutrients important to blood pressure. Washington, DC: U.S. Food and Drug Administration, FDA Consumer.

Laronne, J.B. 1977. *Dissolution Potential of Surficial Mancos Shale and Alluvium*. Unpublished Ph.D. dissertation, Department of Earth Resources, Colorado State University.

Liebermann, T.D., and B.D. Nordlund. 1986. Estimates of Dissolved Solid and Major Constituents for 70 Streamflow-Gaging Stations in the Upper Colorado River Basin. U.S. Geological Survey draft report.

Lohman, L.C., et al. 1988. *Economic Impacts of Salinity of the Colorado River*. Bureau of Reclamation, Denver, Colorado.

McWhorter, D.B., J.W. Rowe, et al. 1979. *Surface and Subsurface Water Quality Hydrology in Surface Mined Watersheds, Part I.* Text Interagency Energy/Environment R&D Program Report, EPA-600/7-79-193.

Midgley JP, Matthew AG, Greenwood CMT, Logan AG. 1996. Effect of reduced dietary sodium on blood pressure. A meta-analysis of randomized controlled trials. JAMA 275:1590-1597.

Mueller, D.K., and L.L. Osen. 1988. *Estimation of Natural Dissolved-Solids Discharge in the Upper Colorado River Basin, Western United States*. U.S. Geological Survey, Water Resources Investigation Report 87-4069.

Mueller, D.K., and T.D. Liebermann. 1988. *Extension of Streamflow and Dissolved Solids Records at Selected Sites in the Colorado River Basin: Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming, 1940-83.* U.S. Geological Survey, Water Resources Investigations Report 87-4203.

Parker, R.S., and J.M. Norris. 1983. *Simulated Effects of Anticipated Coal Mining on Dissolved Solids in Selected Tributaries of the Yampa River, Northwestern Colorado.* U.S. Geological Survey, Water Resources Investigation Report 83-4084, Lakewood, Colorado.

Ponce, S.L. 1975. *Examination of a Non-Point Source Loading Function for the Mancos Shale Wildlands of the Price River Basin, Utah.* Ph.D. Thesis, Utah State University, Logan, Utah.

Prairie, J., Rajagopalan, B., Fulp, T., and Zagona, E., (2005). "Statistical Nonparametric Model for Natural Salt Estimation." Journal of Environmental Engineering, 131(1), 130-138.

Riley, J.P., et al. 1982. *Potential of Water and Salt Yields from Surface Runoff on Public Lands in the Price River Basin*. Water Resources Planning Series UWRL/P-82/01, Utah Water Research Laboratory, Logan, Utah, 94 pp.

Reclamation. 1982. Grand Valley Salt Pickup Calculations. Colorado River Basin Salinity Control Project, Colorado. U.S. Bureau of Reclamation. Grand Junction, Colorado. June, 1982.

Riley, J.P., et al. 1982. *Salt Uptake in Natural Channels Traversing Mancos Shales in the Price River Basin, Utah*. Water Resources Planning Series UWRL/P-82/02, Utah Water Research Laboratory, Logan, Utah, 194 pp.

Sacks FM, Svetkey LP, Vollmer WM, Appel LJ, Bray GA, Harsha D, Obarzanek E, Conlin PR, Miller ER III, Simons-Morton DG, Karanja N, Lin PH. 2001. Effects on blood pressure of reduced dietary sodium and the dietary approaches to stop hypertension (DASH) diet. New England Journal of Medicine 344(1):53-55.

Schumm, S.A., and D.I. Gregory. 1986. Diffuse-Source Salinity: Mancos Shale Terrain. U.S. Department of the Interior, Bureau of Land Management, Technical Note No. 373, Denver Service Center, Denver, Colorado.

Sowers, JR, Lester M. 2000. Hypertension, hormones and aging. Lab Clin Med 135:379-386.

Stephens, D.W., B. Waddell, L. Peltz, J. Miller. 1992. Detailed Study of Selenium and Selected Elements in Water, Bottom Sediment, and Biota Associated with Irrigation Drainage, in the Middle Green River Basin, Utah, 1988 – 1990. U.S.Geological Survey Water-Resources Investigations Report 92-4084.

Svetkey LP, Sacks FM, Obarzanek E, Vollmer WM, Appel LJ, Karanja N, Harsha D, Bray GA, Aickin M, Proschan M, Windhauser MM, Swain JF, McCarron PB, Rhodes DG, Laws RL. 1999. The DASH diet, sodium intake and blood pressure trial (DASH-Sodium): rationale and design. J Am Diet Assoc 99:S96-S104.

Taubes, G. 1998. The (political) science of salt. Science 281:898-907.

Treuman, D. 1995. Land Retirement – Alternative for salinity control. Bureau of Reclamation.

Uintex Corp. 1982. A Study of Runoff and Water Quality Associated with the Wildlands of the Price River Basin, Utah. Bureau of Land Management Contract No. YA553-CT1-1064.

U.S. Department of Agriculture (USDA). 1976. Grand Valley Salinity Study, Investigation of Sediment and Salt Yields in Diffuse Areas. Soil Conservation Service, Memorandum, March 5, 1976. Mesa County, Colorado.

U.S. Department of Agriculture (USDA). 2000. Nutrition and your health: Dietary guidelines for Americans, 5th ed. Home and Garden bulletin No. 232. U.S. Department of Health and Human Services, Washington, DC.

U.S. Department of the Interior. 1984. Status Report, Bureau of Land Management, Technical Note No. 364, Denver Service Center, Denver, Colorado.

U.S. Department of the Interior. 1985. Draft Environmental Impact Statement, James Creek Coal, Preference Right Lease Application. Bureau of Land Management, Craig District, Colorado.

U.S. Department of the Interior. 1990. Colorado River Damage Estimate Program. Bureau of Reclamation, Chief, Analysis, Contracts, and Lands Division, Denver Office, Memorandum, October 25, 1990, Denver, Colorado.

O_NPCA-CBD et al 2

U.S. Environmental Protection Agency (EPA). 1971. The Mineral Quality Problem in the Colorado River Basin, Summary Report, EPA Regions VIII and IX.

U.S. Environmental Protection Agency (EPA). 1999. Health effects from exposure to sulfate in drinking water workshop. Office of Water. Washington, DC. EPA 815-R-99-002.

Vaill, J.E., and Butler, D.L. (1999). "Streamflow and Dissolved-Solids Trends, Through 1996, in the Colorado River basin Upstream from Lake Powell- Colorado, Utah, Wyoming." Water Resources Investigation Rep. No. 99-4097, United States Geological Survey, Denver.

World Health Organization (WHO). 1993. Guidelines for drinking water quality, 2nd ed. Vol. 1. Recommendations. Geneva, Switzerland.

GENERAL REFERENCES

Agricultural Research Service. 1982. *Minimizing Salt in Return Flow Through Irrigation Management*. Report No. PUB-744; EPA-600/2-82-073, 181 pp.

Battelle Pacific Northwest Labs. 1982. *Western Oil-Shale Development: A Technological Assessment. Vol. 6: Oil-Shale Development in the Piceance Creek Basin and Potential Water- Quality Changes.* Department of Energy, Report No. PNL-3830-VO2.6, 22 pp.

Bentley, R.G., K.O. Eggleston, and E.B. Janes. 1980. *Salinity Status Report, 1978-79, Control of Salinity from Point Sources Yielding Groundwater Discharge and from Diffuse Surface Runoff in the Upper Colorado River Basin.* Report No. BLM-YA-TR-80-01, Bureau of Land Management, Denver Service Center, Denver, Colorado, 37 pp.

Bowles, D.S., et al. 1982. *Salt Loading From Efflorescence and Suspended Sediments in the Price River Basin*. Water Resources Planning Series UWRL/P-82/05, Utah Water Research Laboratory, Logan, Utah, 142 pp.

Brenniman, G.R. 1981. *Relationship Between High Sodium Levels in Municipally Softened Drinking Water and Elevated Blood Pressures*. Water Resources Center, Illinois University, Research Report 158, NTIS PB81-212615, 27 pp.

Bulke, E.L., and K.M. Waddell. 1975. *Chemical Quality and Temperature of Water in Flaming Gorge Reservoir, Wyoming and Utah, and the Effect of the Reservoir on the Green River.* U.S. Geological Survey, Water Supply Paper 2039-A.

Burdge, Irelan. 1971. *Salinity of Surface Water in the Lower Colorado River, Salton Sea Area*. U.S. Geological Survey, Professional Paper 486-E.

Bureau of Land Management. 1978. *The Effects of Surface Disturbance on the Salinity of Public Lands in the Upper Colorado River Basin, 1977 Status Report.* U.S. Department of the Interior, Denver Service Center, Denver, Colorado, 208 pp.

Bureau of Reclamation. 1981. *Saline Water Use and Disposal Opportunities: Colorado River Water Quality Improvement Program*. Special Report, Bureau of Reclamation, Denver, Colorado, 167 pp.

Bureau of Reclamation. 1981. *Water Assessment for the Lower Colorado River Region, Emerging Energy Technology Development.* Bureau of Reclamation, Boulder City, Nevada, 170 pp.

Bureau of Reclamation. 2003. *Colorado River System Consumptive Uses and Losses Report 1996- 2000*. Upper Colorado Region, Salt Lake City, Utah.

Bureau of Reclamation. 1984. *Development, Verification, and Use of Methods to Model Chemical and Thermal Processes for Lakes Powell and Mead.* Engineering and Research Center, Colorado River Water Quality Office, Denver, Colorado.

Bureau of Reclamation. May 1985. *Colorado River Simulation System Documentation System Overview.* USBR Engineering and Research Center, Denver, Colorado.

Bureau of Reclamation. 1986. *Etiwanda Ion-Exchange Pilot-Plant Testing. Denver, Colorado*. CH_2M Hill. 1982. Salinity Investigation of the Price-San Rafael River Unit, Colorado River Water Quality Improvement Program. Bureau of Reclamation, Contract No. 1-07-40-51637, Utah Projects Office, Provo, Utah.

Cissell, Jeffery A., V. Dean Adams, Joel E. Fletcher, Daniel S. Filip, and Dennis B. George. 1982. *Water Requirements and Pollutant Potential in the Gasification of Carbonaceous Shales*. Report Nos. UWRL/Q-82/04; W83-02211; OWRT-A-043-UT(1), Utah Water Research Laboratory, Logan, Utah, 68 pp.

Colorado Water Resources Research Institute. 1981. *A Five Year Plan for Water Research in Colorado*. Office of Water Research and Technology, Report No. W82-05531, 133 pp.

Cowan, Michael S., R. Wayne Cheney, and Jeffrey C. Addiego. 1981. *Colorado River Simulation System: An Executive Summary*. Bureau of Reclamation, Engineering and Research Center, Denver, Colorado, 19 pp.

Dean, A.V. and Lamarra, V.A. (editors). 1981. *Aquatic Resources Management of the Colorado River Ecosystem (Proceedings of the Symposium)*. Ann Arbor Science Publication, Ann Arbor, Michigan, 697 pp.

DeLon, L.L. 1982. *Water Quality of Streams and Springs, Green River Basin, Wyoming.* U.S. Geological Survey, Water Resources Investigations Report 82-4008.

Eisenhauer, R.J. 1983. *Characterization of Glenwood Springs and Dotsero Springs Water*. Bureau of Reclamation, Engineering and Research Center, Report No. 83-10, Denver, Colorado, 58 pp.

Eisenhauer, R.J. 1986. *Characterization of Glenwood Springs and Dotsero Springs Source Aquifers*. Bureau of Reclamation, REC-ERC-86-1, Denver, Colorado.

Eisenhauer, R.J. 1987. *Characteristics of Big Sandy River Drainage Basin Water and of Salty Aquifer Water*. Bureau of Reclamation, REC-ERC-87-2, Denver, Colorado.

Evans, R.G., W.R. Walker, and G.V. Skogerboe. 1982. *Defining Cost-Effective Salinity Control Programs*. Journal of the Irrigation and Drainage Division, Proceedings of the American Society of Civil Engineers, vol. 108, No. 4, pp. 265-272.

French, Richard H. (Ed.). 1984. *Salinity in Watercourses and Reservoirs*. Proceedings of the 1983 International Symposium on State-of-the-Art Control of Salinity, July 13-15, 1983, Salt Lake City, Utah, Butterworth Publishers, Stoneham, Massachusetts.

Gloss, S., and D.E. Kidd. *Application of the Nutrient Loading Concept and Effects of Nutrient Perturbations on Phytoplankton Productivity.* Lake Powell Research Project, Bulletin No. 59.

Green, S.L. 1981. Water Resources Investigations of the U.S. Geological Survey in Wyoming, Fiscal Year 1980. U.S. Geological Survey, Open-File Report 81-201, 118 pp.

Haselhoff, Donald A. 1983. *Water for Las Vegas Metropolitan Area*, Journal of Environmental Engineering, vol. 109, No. 3, pp. 700-715.

Holburt, M.B. 1982. *Colorado River Water Allocation*. Water Supply and Management, vol. 6, No. 1-2, pp. 63-73.

Howells, L., et al. 1987. *Base of Moderately Saline Groundwater in the Uinta Basin, Utah*. U.S. Geological Survey, Open-File Report 87-397.

Hyatt, M.L., J.P. Riley, M.L. McKee, and E.K. Israelson. 1970. *Computer Simulation of the Hydrologic-Salinity Flow System Within the Upper Colorado River Basin*. PRWG54-1. Utah Water Research Laboratory, Utah State University, Logan, Utah, 255 pp.

Israelsen, C. E., et al. 1980. *Use of Saline Water in Energy Development*. Water Resources Planning Series UWRL/P-80/04, Utah Water Research Laboratory, Logan, Utah, 128 pp.

Jackson, W.L., R.G. Bentley, and S. Fisher. 1984. *Results of BLM Studies on Public Lands in the Upper Colorado River Basin*. BLM Technical Note YA-PT-84-008-4340, Bureau of Land Management, Denver Service Center, Denver, Colorado.

Johnson, D.H., C.M. Leboeuf, and D. Waddington. 1981. *Solar Pond-Driven Distillation and Power Production System*. Solar Energy Research Institute, Report No. SERI/TR-631-1248, Department of Energy, Golden, Colorado, 24 pp.

Johnson, R.K., and S.A. Schumm. 1982. *Geomorphic and Lithologic Controls of Diffuse-Source Salinity, Grand Valley, Western Colorado*. National Technical Information Service, PB82-256587, 99 pp.

Kidd, D.E., E. Hansmann, and S. Gloss. *Trophic Status Investigations at Lake Powell Reservoir*. Lake Powell Research Project Bulletin No. 60.

Koch, R.W., T.G. Sanders, and H.S. Morel-Seytoux. 1982. *Regional Detection of Change in Water Quality Variables*. Water Resources Bulletin, vol. 18, No. 5, pp. 815-821.

Laronne, J.B., and S.A. Schumm. l977. *Evaluation of the Storage of Diffuse Sources of Salinity in the Upper Colorado River Basin*. Environmental Resources Center, Colorado State University, Completion Report Series No. 79, 111 pp.

Laughlin, J.K. 1984. *Appraisal Study of Saline Water Use Equipment for Power Plant Cooling.* Bureau of Reclamation, Denver, Colorado.

Laughlin, J.K. 1985. *Final Report - Study of Saline Water Use at Jim Bridger Power Plant.* Bureau of Reclamation, Denver, Colorado.

Laughlin, J.K. 1986. *Final Report - Study of Saline Water Use at Harry Allen Generating Station.* Bureau of Reclamation, Denver, Colorado.

Laughlin, J.K. 1987. *Final Report - Study of Saline Water Use at the Etiwanda Generating Station.* Bureau of Reclamation, Denver, Colorado.

Law, J.P., Jr., and A.G. Hornsby. 1982. *The Colorado River Salinity Problem*. Water Supply and Management, vol. 6, No. 1-2, pp. 87-104.

O_NPCA-CBD et al 2

Liebermann, T.D., et al. 1987. *User's Manual for Estimation of Dissolved-Solids Concentrations and Loads in Surface Water*. U.S. Geological Survey, Water Resources Investigations Report 86-4124.

Liebermann, T.D., D.K. Mueller, J.E. Kircher, A.F. Choquette, and R.A. Bell. 1986. *Characteristics and Trends of Dissolved Solids in the Upper Colorado River Basin, Arizona, Colorado, New Mexico, Utah, and Wyoming.* U.S. Geological Survey, Open-File Report 87-568.

Lindskov, K.L., and B.A. Kimball. *Quantity and Quality of Streamflow in Southeastern Uinta Basin, Utah and Colorado*. U.S. Geological Survey, Water Supply Paper 2224.

Martin, R.G., and R.H. Stroud. 1973. *Influence of Reservoir Discharge Location on Water Quality, Biology, and Sport Fisheries of Reservoirs and Tailwaters, 1968-71.* U.S. Army Corps of Engineers, Waterway Experiment Station, Contract No. DACW31-67-C-0083.

Mayer, L.M. 1977. *The Effect of Lake Powell on Dissolved Silica Cycling in the Colorado River.* Lake Powell Research Project Bulletin No. 42.

Maynard, D.P., and Caputo, R. 1982. *Assessment of Saline Water Use in Coal Transport and Multipurpose Systems*. Jet Propulsion Laboratory, Report No. JPL-D-425, Pasadena, California, Bureau of Reclamation, Engineering and Research Center, Denver, Colorado, 156 pp.

Merritt, D. and Johnson, N. 1977. *Advective Circulation in Lake Powell, Utah-Arizona.* Lake Powell Research Project Bulletin No. 61, Institute of Geophysics and Planetary Physics, University of California, Los Angeles, California, 72 pp.

Miffin, M.D. 1983. *Reuse Versus Return Flows: Considerations for Selecting a Water Supply Strategy*. University of Nevada, Desert Research Institute, Reno, Nevada.

Miller, J.B., D.L. Wegner, and D.R. Bruemmer. 1980. *Salinity and Phosphorus Routing Through the Colorado River/Reservoir System*. Bureau of Reclamation, Salt Lake City, Utah.

Moody, C.D., and D.K. Mueller. 1984. *Water Quality of the Colorado System: Historical Trends in Concentration, Load, and Mass Fraction of Inorganic Solutes.* Bureau of Reclamation, Report No. EC-ERC-84-9.

Mueller, D.K., and L.L. Osen. 1988. *Estimation of Natural Dissolved Solids Discharge in the Upper Colorado River Basin, Western United States*. U.S. Geological Survey, Water Resources Investigations Report 87-4069.

Mundorff, J.C. 1972. *Reconnaissance of Chemical Quality of Surface Water and Fluvial Sediment in the Price River Basin, Utah.* Utah Department of Natural Resources Technical Publication 39.

Mundorff, J.C., and K.R. Thompson. 1980. *Reconnaissance of the Quality of Surface Water in the San Rafael River Basin, Utah*. U.S. Geological Survey, Open-File Report 80-574.

Narayanan, R., and D.R. Franklin. 1982. *An Evaluation of Water Conservancy Techniques in the Upper Colorado River Basin*. Water Resources Planning Series UWRL/P-82/07, Utah Water Research Laboratory, Logan, Utah.

Paulson, L.J. 1981. *Nutrient Management with Hydroelectric Dams on the Colorado River System*. Technical Report No. 8, Lake Mead Limnological Research Center, University of Nevada, Las Vegas, Nevada, 39 pp.

Paulson, L.J., and J.R. Baker. 1981. *The Effects of Impoundments on Salinity in the Colorado River: Proceedings of the Symposium on the Aquatic Resources Management of the Colorado River Ecosystem, November 16-19, 1981, Las Vegas, Nevada.* Ann Arbor Science, Ann Arbor, Michigan.

Paulson, L.J., and J.R. Baker. 1983. *The Limnology in Reservoirs on the Colorado River*. Technical Report No. 11, Lake Mead Limnological Research Center, University of Nevada, Las Vegas, Nevada.

Paulson, L.J., J.R. Baker, and J.E. Deacon. 1980. *The Limnological Status of Lake Mead and Lake Mohave Under Present and Future Powerplant Operation of Hoover Dam*. Technical Report No. 1, Lake Mead Limnological Research Center, University of Nevada, Las Vegas, Nevada.

Prentki, R.T., L.J. Paulson, and J.R. Baker. 1981. *Chemical and Biological Structure of Lake Mead Sediments*. Technical Report No. 6, Lake Mead Limnological Research Center, University of Nevada, Las Vegas, Nevada, 89 pp.

Rittmaster, R.L., and D.K. Mueller. 1985. *Solute Loading Sources in the Dirty Devil River Basin, Utah*. Bureau of Reclamation, REC-ERC-85-5, Denver, Colorado.

Robson, S.G., and G.J. Saulnier, Jr. 1981. *Hydrogeochemistry and Simulated Solute Transport, Piceance Basin, Northwestern Colorado*. U.S. Geological Survey, Professional Paper 1196, 65 pp.

Sandberg, G.W., and L.G. Sutlz. 1985. *Reconnaissance of the Quality of Surface Water in the Upper Virgin River Basin, Utah, Arizona, and Nevada, 1981-82.* Utah Department of Natural Resources, Technical Publication No. 83.

Schumm, S.A., and D.I. Gregory. 1986. *Diffuse-Source Salinity: Mancos Shale Terrain*. U.S. Department of the Interior, Bureau of Land Management, Technical Note 373, Denver Service Center, Denver, Colorado.

Seiler, R.L., and R.L. Baskin. 1987. *Hydrology of Alkali Creek and Castle Valley Ridge Coal-Lease Tracts, Central Utah, and Potential Effects of Coal Mining.* U.S. Geological Survey, Water Resources Investigations Report 87-4186.

Shacklette, H.T., and J.G. Boerngen. 1984. *Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States*. U.S. Geological Survey, Professional Paper 1270.

Shen, H.W., et al. 1981. *Role of Sediment in Non-Point Source Salt Loading Within the Upper Colorado River Basin*. Colorado Water Resources Research Institute Completion Report No. 107, 213 pp.

O_NPCA-CBD et al 2

Skogerboe, G.V., and G.E. Radosevich. 1982. *Future Water Development Policies*. Water Supply and Management, vol. 6, No. 1-2, pp. 221-232.

Skogerboe, G.V., W.R. Walker, and R.G. Evans. 1982. *Salinity Control Measures for Grand Valley*. Water Supply and Management, vol. 6, No. 1-2, pp. 129-167.

Trueman, D.P. 1998. *Colorado River Basin Salinity Control Program, 1998 Review*. Proceedings of the Shared Rivers Conference, U.S. Committee on Irrigation and Drainage, Park City, Utah.

U.S. Department of the Interior. 1984. *Aquatrain Corridor Study Report*. Bureau of Reclamation, Denver, Colorado.

U.S. Environmental Protection Agency. l971. *The Mineral Quality Problem in the Colorado River Basin*. Summary Report. Regions VIII and IX, 65 pp.

Warner, J.W., and F.J. Heimes. 1979. A Preliminary Evaluation of Groundwater Contributions to Salinity of Streams in the Upper Colorado Basin in Colorado and Adjacent Parts of Wyoming and Utah. U.S. Geological Survey, Denver, Colorado, contract to Bureau of Land Management.

Water Resources Council. 1981. *Synthetic Fuels Development in the Upper Colorado Region: Section 13(a) Water Assessment Report.* Technical Report, 138 pp.

Whittig, L.D., et al. 1983. *Salinity Investigations in West Salt Creek, Colorado*. California Water Resources Center Completion Report, University of California, Davis, California, 161 pp.

Yahnke, J. 1982. *Fryingpan River and Rued Reservoir Water Quality Studies*. Part I, Bureau of Reclamation, Working Paper, Engineering and Research Center, Denver, Colorado.

APPENDIX A – SALINITY DATA

The historical flow and quality of water data have been calculated using the U.S. Geological Survey (USGS) database and computer techniques developed jointly by the Bureau of Reclamation (Reclamation) and USGS. The purpose of the analysis was to develop a consistent, documented methodology for the calculation of monthly salt loads in the Colorado River Basin.

The salinity computation method was originally developed for the trend studies conducted by Reclamation and USGS (Liebermann, et al., 1986). Several procedures were evaluated. A 3 year moving regression was determined to be the best overall method in terms of providing the most complete record, preserving short-term fluctuations, and being insensitive to minor errors in the data. Using this method, daily salt load (L) was computed from discharge (Q) and when available, conductivity (S): $L = aQ^bS^c$. For days without specific conductivity data, a slight variation of the equation for load as a function of discharge was used: $L = a'Q^{b'}$.

The coefficients a, b, and c for each year of record were typically estimated by regression analysis using data from a 3 year period surrounding the year of interest. For example, coefficients for 1990 were derived with data from l989 through 1991. The last year of salinity data computed for this report uses two years of data for obvious reasons. It is subject to change and will be updated in the next report as data become available to complete the analysis for that year.

Daily loads were added to yield the monthly values given. Monthly values were then added to yield annual values. All values shown are rounded but were computed using un-rounded values.

For this analysis, salt-load data were based on total dissolved solids (TDS) as the sum of constituents, whenever possible. Sum of constituents was defined to include calcium, magnesium, sodium, chloride, sulfate, a measure of the carbonate equivalent of alkalinity and, if measured, silica and potassium. If a sum-of-constituents value could not be computed, TDS as residue on evaporation (at 180 degrees Celsius) was substituted.

Extensive error analyses were performed on the data. Suspect values were corrected according to published records or deleted. The resultant data set is considered by Reclamation and USGS to be the best available for stations in the Colorado River Basin. Annual values based on the new method were compared to values in previous Quality of Water Colorado River Basin Progress Reports for selected stations. The observed differences were between plus or minus five percent, with mean differences approximately zero. Changes in the progress report database can, therefore, be considered generally insignificant and unbiased.

MONITORING STATIONS

1 Green River near Green River, WY
2 Green River near Greendale, UT
3 Yampa River near Maybell, CO
4 Duchesne River near Randlett, UT
5 White River near Watson, UT
6 Green River near Green River, UT
7 San Rafael River nr Green River, UT
8 Colorado River nr Glenwood Springs, CO
9 Colorado River near Cameo, CO
10 Gunnison River near Grand Jct, CO
11 Dolores River near Cisco, UT
12 Colorado River near Cisco, UT
13 San Juan River near Archuleta, NM
14 San Juan River near Bluff, UT
15 Colorado River at Lees Ferry, AZ
16 Colorado River near Grand Canyon, AZ
17 Virgin River at Littlefield, AZ

Numeric Criteria Stations:
18 Colorado River below Hoover Dam
19 Colorado River below Parker Dam
20 Colorado River at Imperial Dam

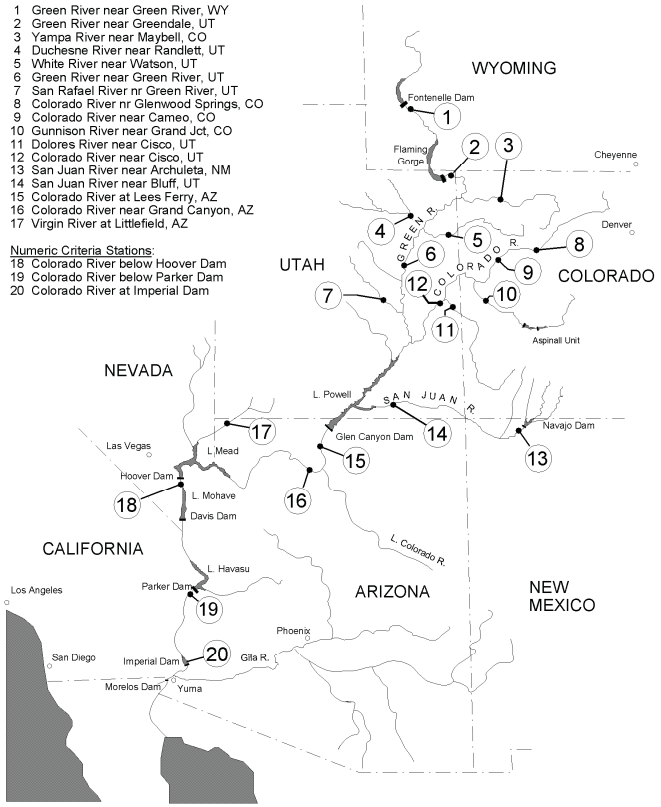


Figure A1 - Colorado River Water Quality Monitoring Stations.

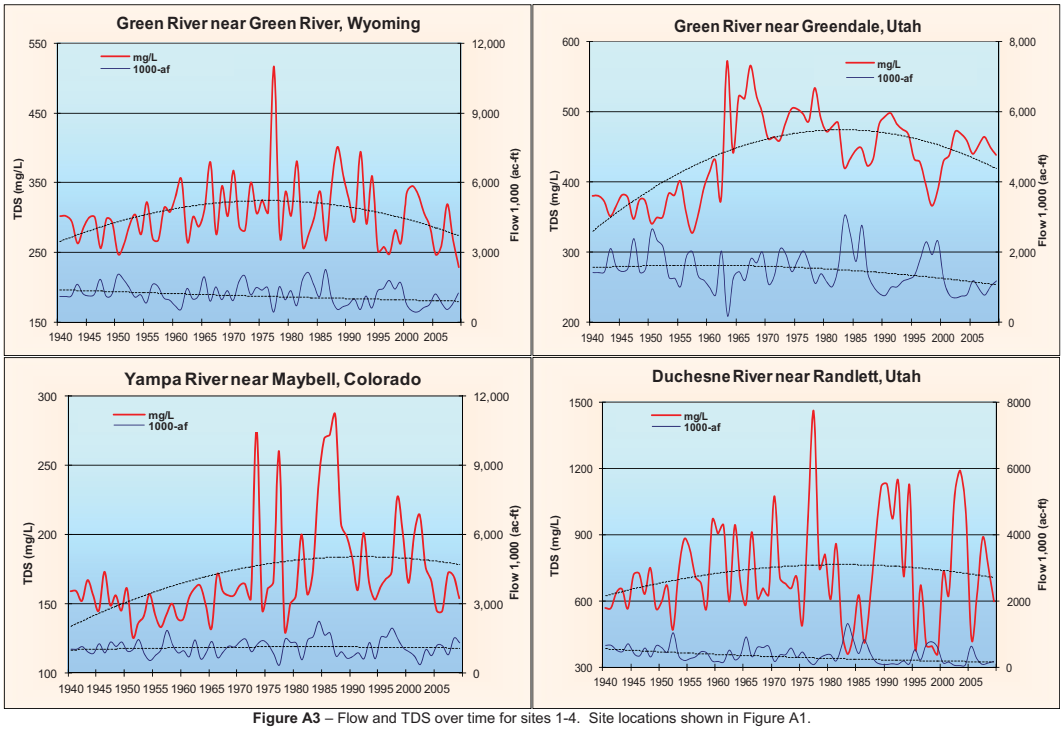


Figure A3 – Flow and TDS over time for sites 1-4. Site locations shown in Figure A1.

O_NPCA-CBD et al 2

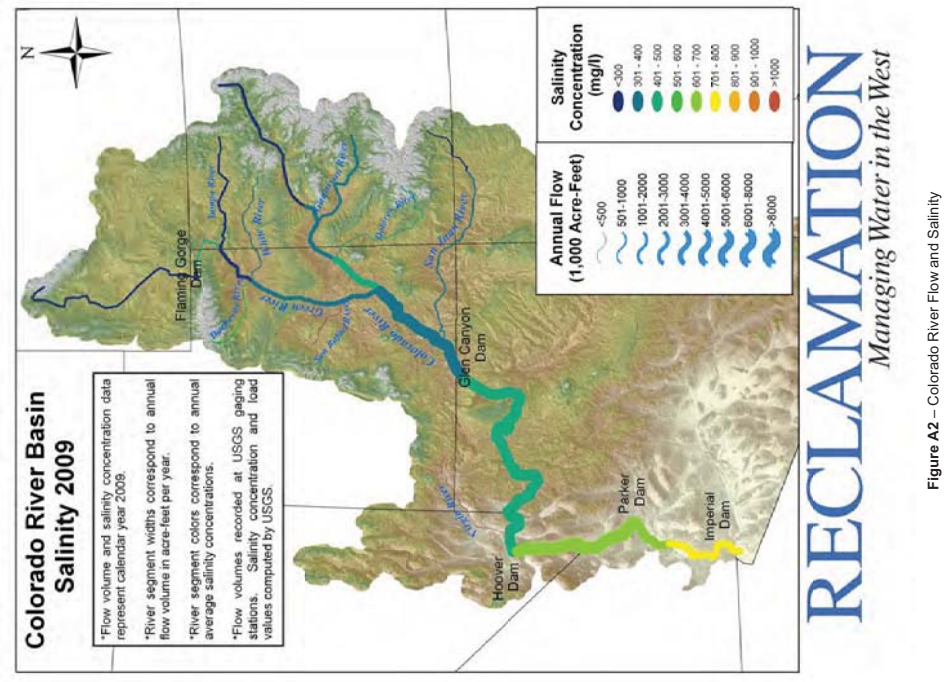


Figure A2 – Colorado River Flow and Salinity

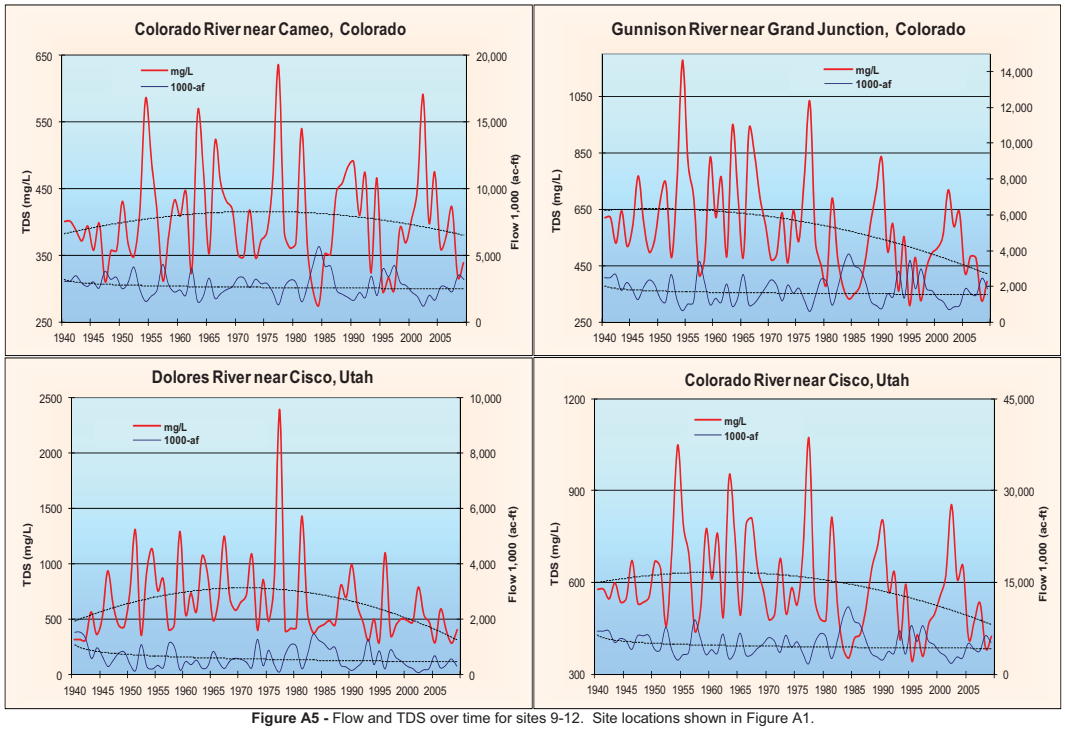


Figure A5 - Flow and TDS over time for sites 9-12. Site locations shown in Figure A1.

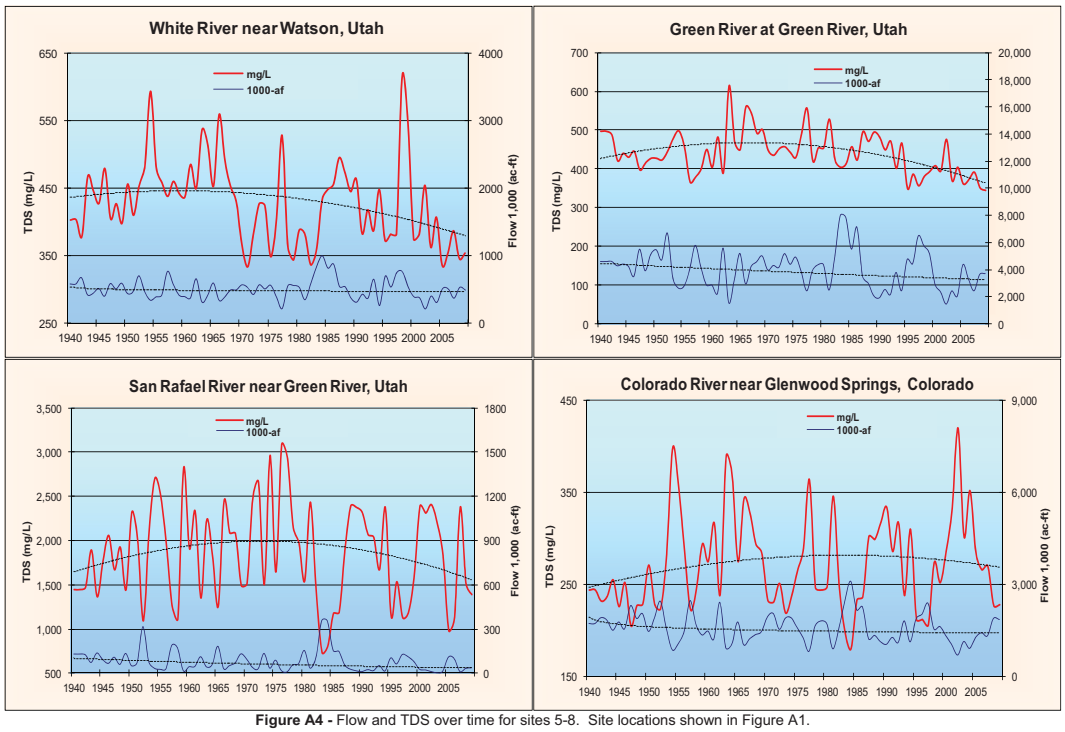


Figure A4 - Flow and TDS over time for sites 5-8. Site locations shown in Figure A1.

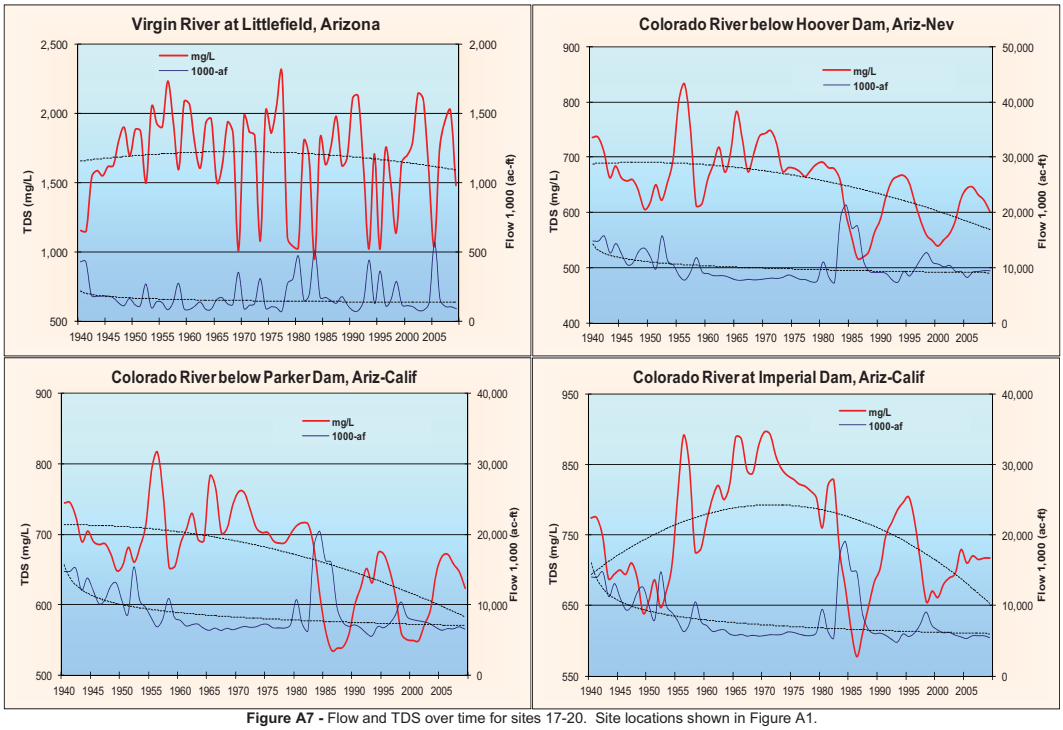


Figure A7 - Flow and TDS over time for sites 17-20. Site locations shown in Figure A1.

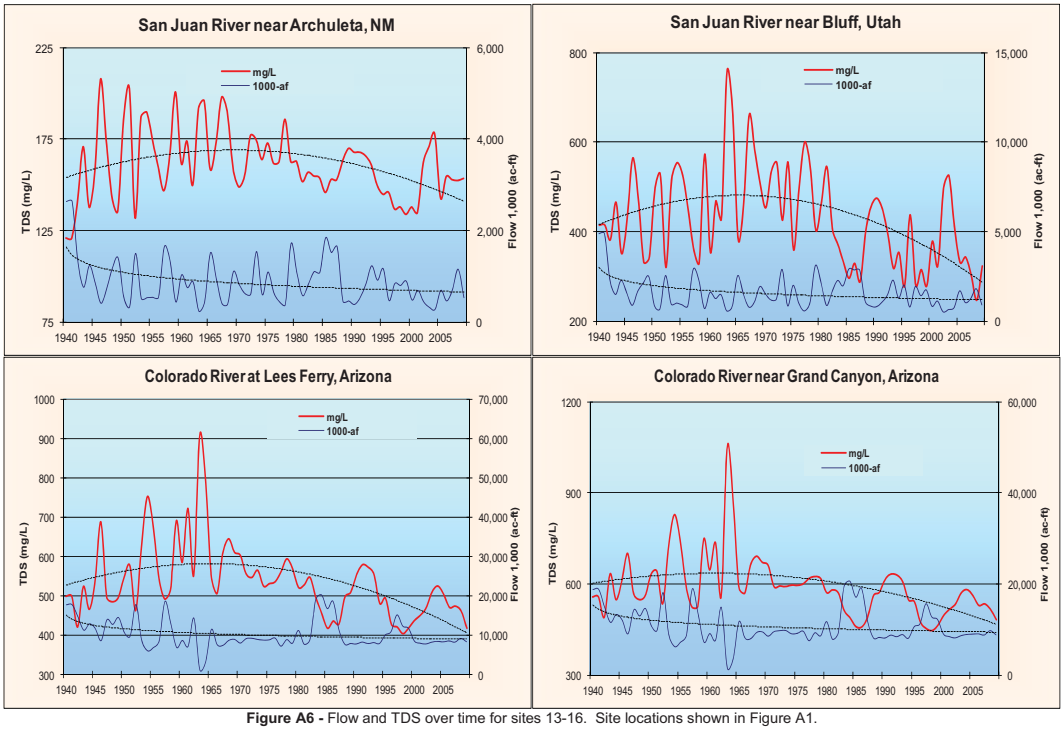
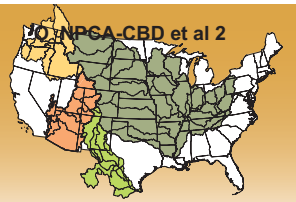


Figure A6 - Flow and TDS over time for sites 13-16. Site locations shown in Figure A1.

Attachment 5:
United States Geological Service, "Monitoring the Water Quality of the Nation's Large Rivers: Colorado River NASQAN Program" (February 2000)

O_NPCA-CBD et al 2

USGS
science for a changing world



Monitoring the Water Quality of the Nation's Large Rivers

Colorado River NASQAN Program

Since 1995, the National Stream Quality Accounting Network (NASQAN) of the U.S. Geological Survey (USGS) has focused on monitoring the water quality of the Nation's largest rivers including the Colorado, Columbia, Mississippi, and Rio Grande. The NASQAN program in the Colorado River Basin consists of eight stations that span seven basin States including Colorado, Wyoming, Utah, New Mexico, Arizona, Nevada, and California. Data collected from these stations are used to quantify the transport of chemical constituents and evaluate trends in water quality of the river. Currently, the NASQAN program in the Colorado River Basin is providing necessary data and information required by resource managers of the river who are responsible for meeting long-standing legal agreements that regulate the flow and quality of the river water.

ENVIRONMENTAL SETTING

The Colorado River often is described as the most controversial and regulated river in the United States. The river currently provides 25 million people with drinking water and also provides enough water to keep 3.5 million acres of farmland in production. Other uses include industrial, recreation, and electric-power generation. The river is highly regulated with 83 reservoirs in the upper basin and 10 reservoirs in the lower basin that are capable of storing 4 years of flow. Twelve legal agreements, compacts, contracts, and State and Federal legislation apportion and regulate the use, management, and quality of water for the Colorado River water among the seven States in the basin and Mexico (Newcom, 1998).

The Colorado River drains about 250,000 square miles (fig. 1). Annual flows in the river fluctuated greatly before the big dams were built on the river because of winter snowmelt and summer thunderstorms. Water, sediment, and chemical transport from the upper basin are greatest in June. Daily fluctuations in the lower basin are caused by irrigation and water-supply diversions, power generation, losses to evaporation and transpiration from riparian vegetation, and irrigation return flows (fig. 2).

WATER-QUALITY ISSUES

Salinity of the Colorado River probably is the biggest water-quality issue in the basin. The major sources of salinity are the saline soils of the Colorado Plateau and agricultural irrigation-return flows. Salinity concentrations in the headwaters of the basin generally are less than 50 milligrams per liter but increase in concentration to about 900 milligrams per liter at the international boundary between the United States and Mexico. Urbanization, population growth, mining, agricultural practices, and recreation affect salinity concentrations and other chemical constituent concentrations in the Colorado River.

River modifications, such as dams and irrigation diversions, probably are the most significant factors that affect the quality of the Colorado River system. Reservoirs potentially harbor many chemicals in their sediments and water and can retain chemical constituents for years (retention time). Dams have reduced sediment transport from the system, have contributed to the decline or loss of native fish species, and affected physical properties such as flow (fig. 3) and water temperature (fig. 4). Alteration to the natural system generally has been unfavorable to native fish such as the humpback chub. Cold, clear waters below the reservoirs generally provide good habitat for nonnative fish such as the rainbow trout.

SITE SELECTION

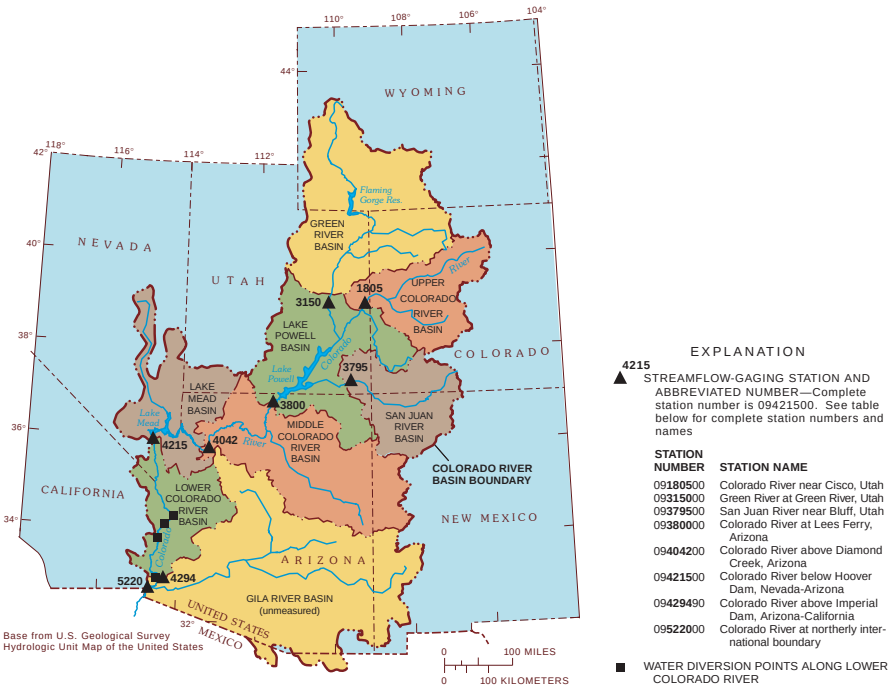
Eight streamflow-gaging and water-quality stations in the NASQAN program provide flow and water-quality data for the Colorado River Basin. These sites were selected to provide information on the transport of chemical constituents and sediment through the river system. Sites upstream and downstream from Lakes Powell and Mead are used to measure inflows to and outflows from these major reservoirs. Subwatershed characteristics also were important site-selection factors. A description of each site follows in downstream order (fig. 1 and table 1).

Colorado River near Cisco, Utah, provides data on inflows to Lake Powell.

Green River at Green River, Utah, is a major tributary to the Colorado River and provides data on inflows to the Colorado River upstream from Lake Powell.

U.S. Department of the Interior
U.S. Geological Survey

USGS Fact Sheet FS–014–00
February 2000



EXPLANATION

▲ 4215 STREAMFLOW-GAGING STATION AND ABBREVIATED NUMBER—Complete station number is 09421500. See table below for complete station numbers and names

STATION NUMBER	STATION NAME
09180500	Colorado River near Cisco, Utah
09315000	Green River at Green River, Utah
09379500	San Juan River near Bluff, Utah
09380000	Colorado River at Lees Ferry, Arizona
09404200	Colorado River above Diamond Creek, Arizona
09421500	Colorado River below Hoover Dam, Nevada-Arizona
09429490	Colorado River above Imperial Dam, Arizona-California
09522000	Colorado River at northerly international boundary

■ WATER DIVERSION POINTS ALONG LOWER COLORADO RIVER

Figure 1. Location of Colorado River Basin, subbasins, NASQAN sites, and diversion points. NASQAN sites are at or near streamflow-gaging stations shown.

San Juan River near Bluff, Utah, is a major tributary to the Colorado River and also provides data on inflows to Lake Powell. This site and the sites at Cisco and Green River can have sediment-laden flows because of storm runoff.

Colorado River at Lees Ferry, Arizona, represents outflow from Lake Powell and is used to determine flows for the Colorado River Compact Point of 1922, which defines the dividing point between the upper and lower basins. The flow at this site is clear and cold.

Colorado River above Diamond Creek, Arizona, measures inflow to Lake Mead and also provides information on the 250-mile reach of the river between Lake Powell and Lake Mead. Unlike Lees Ferry, the flow at this site can be sediment-laden because of storm runoff.

Colorado River below Hoover Dam, Nevada, represents outflow from Lake Mead. The flow is cold and clear at this site.

Colorado River above Imperial Dam, Arizona, is upstream from the diversion to the All-American Canal and diversions for other water needs. Flow in the Colorado River below this site and into Mexico is greatly reduced because of these diversions.

Colorado River at the northerly international boundary represents outflow to Mexico. At this point, the United States is required under treaties with Mexico to deliver 1.5 million acre-feet of water to Mexico during a typical water year (October 1 to September 30). The quality of water delivered to Mexico also is monitored at this site (U.S. Environmental Protection Agency, 1999).

SAMPLING STRATEGY

A broad range of chemical constituents is measured at the eight stations in the network. These constituents include water-soluble pesticides, suspended and dissolved trace elements, major ions, nutrients, carbon, trihalomethanes, and suspended sediment (table 2). Samples are collected 6 to 10 times per year, depending on the local site characteristics. At the upper-basin sites, samples are collected on the basis of reservoir releases to cover a broad range of river discharge.

O_NPCA-CBD et al 2

QUESTIONS TO BE ANSWERED

Specific local questions that can be answered using NASQAN data include:

1. What are the effects of Lakes Powell and Mead on the sediment and chemical concentrations and fluxes downstream from these lakes? Chemical-flux calculations made at NASQAN sites above and below Lakes Powell and Mead provide this information on an annual and possibly seasonal basis.
2. What are the contributions of subbasins to the sediment and chemical concentrations and fluxes to Lakes Powell and Mead? Trend analysis of specific constituents yield information on storm-runoff characteristics of each subbasin and human and

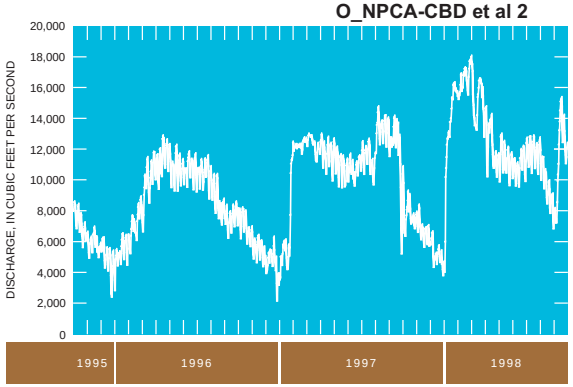


Figure 2. Daily mean discharge at Colorado River above Imperial Dam, Arizona-California, 1996–98 water years.

Table 1. Description of NASQAN sampling stations in the Colorado River Basin

Station number	Station name and location	Period of record[1]	Drainage area		Incremental increase in drainage area (square miles)	Mean stream-flow (cubic feet per second)
			Square miles	Percentage of total drainage area		
09180500	Colorado River near Cisco, Utah	1922 present	24,100	10	0	19,200
09315000	Green River at Green River, Utah	1905 present	40,590	17	0	15,400
09379500	San Juan River near Bluff, Utah	1928 present	23,000	10	0	5,280
09380000	Colorado River at Lees Ferry, Arizona	1895 present	107,800	45	83,700	30,900
09404200	Colorado River above Diamond Creek, Arizona	1989 present	144,600	60	36,860	19,500
09421500	Colorado River below Hoover Dam, Nevada-Arizona	1934 present	167,700	69	22,400	13,900
09429490	Colorado River above Imperial Dam, Arizona-California	1934 present	184,500	76	16,800	11,100
09522000	Colorado River at northerly international boundary	1950 present	242,700	100	58,200	5,040

[1]Some miscellaneous record exists for most stations before the period of record.

Table 2. Physical and chemical measurements made at NASQAN stations in the Colorado River Basin

Measurement class	Examples
Pesticides	Water-soluble pesticides such as atrazine
Suspended and dissolved trace elements	Including but not limited to lead, uranium, cadmium, and selenium
Major ions	Calcium, sulfate, and chloride
Nutrients	Total and dissolved nitrogen and phosphorus
Carbon	Dissolved and suspended organic carbon, dissolved inorganic carbon by incremental alkalinity titration
Trihalomethanes	Byproducts of disinfection of drinking water
Suspended sediment	Concentration of fine sediment particles
Support variables	Water temperature, specific conductance, pH, dissolved oxygen, and alkalinity

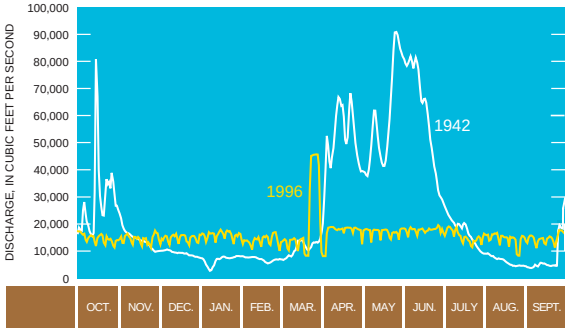


Figure 3. Daily mean discharge at Colorado River at Lees Ferry, Arizona, 1942 and 1996 water years.

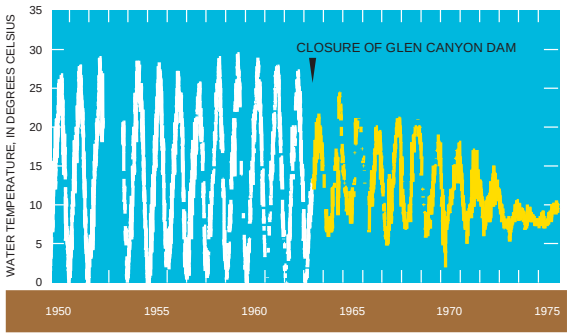


Figure 4. Daily instantaneous water temperature at Colorado River at Lees Ferry, Arizona, 1950–75.

natural activities characteristics of each subbasin.

3. What water-quality criteria for public supply and aquatic life are exceeded and if so, where? The network and frequency of sampling provides information to resource managers and regulatory agencies on this important question.

NATIONAL NASQAN PROGRAM

The NASQAN program in the Colorado River Basin is part of a national program that was redesigned in 1995 to focus on monitoring water quality in four of the Nation's largest rivers—the Columbia, Colorado, Mississippi, and Rio Grande. About 40 streamflow-gaging stations in the program are used to determine the transport of selected chemical constituents and sediment through the river systems. NASQAN, together with the National Water-Quality Assessment (NAWQA) program, provide water-quality information on both large and small rivers. NAWQA is focused on the smaller basins with an emphasis on the effects of land use on water quality. The programs use comparable data; therefore, regional hydrologic models can be developed from the information collected.

O_NPCA-CBD et al 2

PRODUCTS AND THE EVOLUTION OF THE NASQAN PROGRAM

Each year, data collected and analyzed for the NASQAN program are published in State basic-data reports published by the USGS. Recently, NASQAN data have been made available through the World Wide Web at URL http://water.usgs.gov/public/nasqan. Future products for the Colorado River Basin may include annual fact sheets that will describe specific water-quality issues and related data analysis.

As of 1999, data are being analyzed for the Colorado River that may result in modification of the existing program to better meet the information needs of the basin. Chemical-flux calculations are being made at each site along with interpretations of reservoir effects on mass transfer of chemicals within the river system. Results for each constituent are being evaluated to determine the importance of the constituents in the program, and new constituents and site-specific studies may be added.

REFERENCES CITED

Newcom, Josh, 1998, Layperson's guide to the Colorado River: Sacramento, California, Water Education Foundation, 28 p.

U.S. Environmental Protection Agency, 1999, Office of water, Current drinking water standards, accessed July 21, 1999, at URL http://www.epa.gov/ogwdw/wot/appa.html.

—Robert J. Hart and Richard P. Hooper

For more information, contact:

NASQAN Colorado River Basin Coordinator

2255 N. Gemini Drive

Flagstaff, Arizona 86001

Telephone: (520) 556-7136

E-mail: bhart@usgs.gov

USGS Fact Sheet
FS–014–00

O_NPCA-CBD et al 2

Attachment 6:
Colorado River Basin Regional Water Quality Control Board, "Water Quality Control Plan: Colorado River Basin, Region 7" (2006)

CHAPTER 3 - WATER QUALITY OBJECTIVES

Section 13241, Division 7 of the California Water Code, specifies as follows:

> "Each regional board shall establish such water quality objectives in water quality control plans as in its judgement will ensure the reasonable protection of beneficial uses and the prevention of nuisance; however, it is recognized that it may be possible for the quality of water to be changed to some degree without unreasonably affecting beneficial uses..."

"Water quality objectives", as defined in said Division 7 are "limits or levels of water quality constituents or characteristics which are established for the reasonable protection of beneficial uses of water or the prevention of nuisance within a specific area". Water quality objectives contained herein are designed to be in accordance with all pertinent State and Federal requirements.

Existing Statewide Plans and Policies of the State Water Resources Control Board that must be considered in establishing and implementing water quality objectives in the Colorado River Basin Region are listed in Chapter 5. Some of these statewide plans contain water quality objectives that apply to waters in this Region. However, most statewide objectives are not listed in this chapter but can be obtained by referring to the text of the statewide plans. In the event that statewide and regionwide objectives conflict the most stringent objective will apply.

The water quality objectives contained in this Plan supersede and replace those contained in the Water Quality Control Plan, dated May 1991, and any amendments thereto.

Controllable water quality factors shall conform to the water quality objectives contained herein. When other factors result in the degradation of water quality beyond the levels or limits established herein as water quality objectives, the controllable factors shall not cause further degradation of water quality. Controllable water quality factors are those actions, conditions, or circumstances resulting from people's activities which may influence the quality of the waters of the State and which may feasibly be controlled.

Actions to be taken by the Regional Board to achieve compliance with water quality objectives are described in the Implementation section of this Plan (see Chapter 4). Implementation actions directed toward nonpoint source discharges will be in conformance with the State Board's Nonpoint Source Management Plan, will be reasonable, and will consider economic and technical feasibility.

I. GENERAL OBJECTIVES

The following objective shall apply to all waters of the Region:

Wherever the existing quality of water is better than the quality established herein as objectives, such existing quality shall be maintained unless otherwise provided for by the provisions of the State Water Resources Control Board Resolution No. 68-16, "Statement of Policy with Respect to Maintaining High Quality of Waters in California".

II. GENERAL SURFACE WATER OBJECTIVES

Regarding controllable sources of discharge, in the absence of site specific objectives established herein, the following objectives apply to all surface waters of the Colorado River Basin Region:

A. AESTHETIC QUALITIES

All waters shall be free from substances attributable to wastewater of domestic or industrial origin or other discharges which adversely affect beneficial uses not limited to:

- Settling to form objectionable deposits;
- Floating as debris, scum, grease, oil, wax, or other matter that may cause nuisances; and
- Producing objectionable color, odor, taste, or turbidity.

B. TAINTING SUBSTANCES

Water shall be free of unnatural materials which individually or in combination produce undesirable flavors in the edible portions of aquatic organisms.

C. TOXICITY [1]

All waters shall be maintained free of toxic substances in concentrations which are toxic to, or which produce detrimental physiological responses in human, plant, animal, or indigenous aquatic life. Compliance with this objective will be determined by use of indicator organisms, analyses of species diversity, population density, growth anomalies, 96-hour bioassay or bioassays of appropriate duration or other appropriate methods as specified by the Regional Board. Effluent limits based upon bioassays of effluent will be prescribed where appropriate, additional numerical receiving water objectives for specific toxicants will be established as sufficient data become available, and source control of toxic substances will be encouraged.

The survival of aquatic life in surface waters subjected to a waste discharge or other controllable water quality factors, shall not be less than that for the same water body in areas unaffected by the waste discharge, or other control water which is consistent with the requirements for "experimental water" as described in Standards Methods for the Examination of Water and Wastewater, 18th Edition. As a minimum, compliance with this objective as stated in the previous sentence shall be evaluated with a 96-hour bioassay.

As described in Chapter 6, the Regional Board will conduct toxic monitoring of the appropriate surface waters to gather baseline data as time and resources allow.

D. TEMPERATURE

The natural receiving water temperature of surface waters shall not be altered by discharges of waste unless it can be demonstrated to the satisfaction of the Regional Board that such alteration in temperature does not adversely affect beneficial uses.

E. pH

Since the regional waters are somewhat alkaline, pH shall range from 6.0-9.0. Discharges shall not cause any changes in pH detrimental to beneficial water uses.

F. DISSOLVED OXYGEN

The dissolved oxygen concentration shall not be reduced below the following minimum levels at any time:

Waters designated:	
WARM	5.0 mg/l
COLD	8.0 mg/l
WARM and COLD	8.0 mg/l

G. SUSPENDED SOLIDS AND SETTLEABLE SOLIDS

Discharges of wastes or wastewater shall not contain suspended or settleable solids in concentrations which increase the turbidity of receiving waters, unless it can be demonstrated to the satisfaction of the Regional Board that such alteration in turbidity does not adversely affect beneficial uses.

H. TOTAL DISSOLVED SOLIDS

Discharges of wastes or wastewater shall not increase the total dissolved solids content of receiving waters, unless it can be demonstrated to the satisfaction of the Regional Board that such an increase in total dissolved solids does not adversely affect beneficial uses of receiving waters.

Additionally, any discharge, excepting discharges from agricultural sources, shall not cause concentration of total dissolved solids (TDS) in surface waters to exceed the following limits:

[1] Certain exceptions for herbicides apply to irrigation supply canals which are discussed under the heading "Irrigation Supply Canals" in this Chapter.

	TDS (mg/L)	
	Annual Ave.	Maximum
New River	4000	4500
Alamo River	4000	4500
Imperial Valley Drains	4000	4500
Coachella Valley Drains	2000	2500
Palo Verde Valley Drains	2000	2500

I. BACTERIA

In waters designated for water contact recreation (REC I) or noncontact water recreation (REC II), the following bacterial objectives apply. Although the objectives are expressed as fecal coliforms, E. coli, and enterococci bacteria, they address pathogenic microorganisms in general[1] (e.g., bacteria, viruses, and fungi).

Based on a statistically sufficient number of samples (generally not less than five samples equally spaced over a 30-day period), the geometric mean of the indicated bacterial densities should not exceed one or the other of the following:

	REC I	REC II
E. coli	126 per 100 ml	630 per 100 ml
enterococci	33 per 100 ml	165 per 100 ml

nor shall any sample exceed the following maximum allowables:

	REC I	REC II
E. coli	400 per 100 ml	2000 per 100 ml
enterococci	100 per 100 ml	500 per 100 ml

except that for the Colorado River, the following maximum allowables shall apply:

	REC I	REC II
E. coli	235 per 100 ml	1175 per 100ml
enterococci	61 per 100 ml	305 per 100 ml

In addition to the objectives above, in waters designated for water contact recreation (REC I), the fecal coliform concentration based on a minimum of not less than five samples for any 30-day period, shall not exceed a log mean of 200 MPN per 100 ml, nor shall more than ten percent of total samples during any 30-day period exceed 400 MPN per 100 ml.

[1] Fecal coliforms and E. coli bacteria are being used as the indicator microorganisms in the Region until better and similarly practical tests become readily available in the region to more specifically target pathogens.

J. BIOSTIMULATORY SUBSTANCES

Waters shall not contain biostimulatory substances in concentrations that promote aquatic growths to the extent that such growths cause nuisance or adversely affect beneficial uses. Nitrate and phosphate limitations will be placed on industrial discharges to New and Alamo Rivers and irrigation basins on a case-by-case basis, taking into consideration the beneficial uses of these streams.

K. SEDIMENT

The suspended sediment load and suspended sediment discharge rate to surface waters shall not be altered in such a manner as to cause nuisance or adversely affect beneficial uses.

L. TURBIDITY

Waters shall be free of changes in turbidity that cause nuisance or adversely affect beneficial uses.

M. RADIOACTIVITY

Radionuclides shall not be present in waters in concentrations which are deleterious to human, plant, animal or aquatic life or that result in the accumulation of radionuclides in the food web to an extent which presents a hazard to human, plant, animal or aquatic life.

Waters designated for use as domestic or municipal supply (MUN) shall not contain concentrations of radionuclides in excess of the limits specified in the California Code of Regulations, Title 22, Chapter 15, Article 5, Section 64443, as listed below:

Constituent	Maximum Contaminant Level, pci/L
Combined Radium-226 and Radium-228	5
Gross Alpha particle activity (including Radium-226 but excluding Radon and Uranium)	15
Tritium	20,000
Strontium-90	8
Gross Beta particle activity	50
Uranium	20

O_NPCA-CBD et al 2

N. CHEMICAL CONSTITUENTS

No individual chemical or combination of chemicals shall be present in concentrations that adversely affect beneficial uses. There shall be no increase in hazardous chemical concentrations found in bottom sediments or aquatic life. Waters designated for use as domestic or municipal supply (MUN) shall not contain concentrations of chemical constituents in excess of the limits specified below:

Maximum Contaminant Levels* (MCLs)
for Organic and Inorganic Chemicals

Inorganic Chemical Constituents:	MCL*, mg/L
Arsenic	0.05
Barium	1.0
Cadmium	0.010
Chromium	0.05
Lead	0.005
Mercury	0.002
Nitrate (as Nitrogen)	10.0
Selenium	0.01
Silver	0.05

Organic Chemical Constituents	MCL*, mg/L
(a) Chlorinated Hydrocarbons	
Endrin	0.002
Lindane	0.004
Methoxychlor	0.1
Toxaphene	0.005
(b) Chlorophenoxys	
2,4-D	0.1
2,4,5-TP Silvex	0.01

Limiting Concentrations of Fluoride

Annual Average of Maximum Daily Air Temperature		Fluoride Concentrations mg/l			
Degrees Fahrenheit	Degrees Celsius	Lower*	Optimum	Upper*	MCL
below 53.8	below 12.1	0.9	1.2	1.7	2.4
53.8 to 58.3	12.1 to 14.6	0.8	1.1	1.5	2.2
58.4 to 63.8	14.7 to 17.6	0.8	1.0	1.3	2.0
63.9 to 70.6	17.7 to 21.4	0.7	0.9	1.2	1.8
70.7 to 79.2	21.5 to 26.2	0.7	0.8	1.0	1.6
79.3 to 90.5	26.3 to 32.5	0.6	0.7	0.8	1.4

O. PESTICIDE WASTES

The discharge of pesticidal wastes from pesticide manufacturing processing or cleaning operations to any surface water is prohibited.

III. SPECIFIC SURFACE WATER OBJECTIVES

A. COLORADO RIVER

1. Colorado River (Above Imperial Dam)

In response to requirements in Section 303 of the Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500), the Seven States Colorado River Salinity Control Forum developed water quality standards in 1975 for salinity consisting of numeric criteria and a basinwide plan of implementation for salinity control. The Forum recommended that each of the Basin States adopt the proposed standards. California along with the other Basin States adopted the Forum's recommended standards which were subsequently approved by the U.S. Environmental Protection Agency. The standards were reviewed in 1978, 1981, 1984, 1987, and 1990. While the numeric criteria have not changed, the plan of implementation was updated in those years to reflect changes in the salinity control program since 1975.

The flow-weighted average annual numeric criteria for salinity (total dissolved solids) were established at three locations on the lower Colorado River:

	Salinity in mg/l
Below Hoover Dam, AZ-NV	723
Below Parker Dam, AZ-CA	747
Imperial Dam, AZ-CA	879

The plan of implementation consists of a number of federal and non-federal measures throughout the Colorado River system to maintain the adopted numeric criteria while the Basin states continue to develop their compact apportioned waters. There are four areas of the implementation plan which have direct applicability to California. The first is the control of the discharge of total dissolved solids from point sources through the NPDES Permit program on industrial and municipal discharges. The plan's policy has as its primary objective no-salt return from industrial sources wherever practicable. Reasonable incremental increases of salinity from municipal sources shall be permitted so long as they do not exceed 400 mg/l above the flow-weighted average salinity of the supply water. The second recommends that each state encourage and promote the use of brackish and/or saline waters for industrial purposes. The third deals with an improved water delivery system and on-farm water management system. Finally, the plan encompasses those portions of the 208 Water Quality Management plans dealing with salinity control once adopted by the State and approved by USEPA.

2. Colorado River (Below Imperial Dam)

Below Imperial Dam, the River's salinity will be controlled to meet the terms of the agreement with Mexico on salinity in Minute No. 242 of the International Boundary and Water Commission, entitled "Permanent and Definitive Solution to the International Problem of the Salinity of the Colorado River". This agreement states that measures will be taken to assure that the waters delivered to Mexico upstream from Morelos Dam will have annual average salinity concentration of no more than 115 ppm (± 30 ppm) total dissolved solids greater than the annual average salinity concentration of Colorado River water arriving at Imperial Dam. Title I of Public Law 93-320 is the legislation which implements the provisions of Minute No. 242. Minute No. 242 and Title I constitute a federal numeric criterion and plan of implementation for the River below Imperial Dam.

B. NEW RIVER

Minute No. 264 of the Mexican-American Water Treaty titled "Recommendations for Solution of the New River Border Sanitation Problem at Calexico, California - Mexicali, Baja California Norte" was approved by the Governments of the United States and Mexico effective on December 4, 1980. Minute No. 264 specifies qualitative and quantitative standards for the New River at the International Boundary and upstream of the International Boundary in Mexico.

The quantitative standards of Minute No. 264 are contained in Table 3-1. Following are the qualitative standards of Minute No. 264 for the New River at the locations specified below (interim solution).

1. The waters of the River shall be free of untreated domestic and industrial waste waters.

2. The waters shall be free from substances that may be discharged into the River as a result of human activity in concentrations which are toxic or harmful to human, animal or aquatic life or which may significantly impair the beneficial uses of such waters.

3. The waters of the River shall be essentially free from trash, oil, scum, or other floating materials resulting from human activity in amounts sufficient to be injurious, unsightly, or to cause adverse effects on human life, fish, and wildlife. Persistent foaming shall be avoided.

4. The waters of the River shall be free of pesticides in concentrations which could cause harmful effects to human life, fish, and wildlife.

5. The channel of the River shall be free of residual sludge deposits from domestic or industrial wastes.

O_NPCA-CBD et al 2

TABLE 3-1: NEW RIVER AT INTERNATIONAL BOUNDARY

Quantitative Standards per Minute 264[1] of the Mexican/American Water Treaty
(Applicable at Indicated Sampling Location)

Sampling Locations:	New River at Boundary[2]	Lagoon Discharge Canal	New River Upstream of Discharge Canal
Parameters			
BOD_5	-	30 mg/l filtered (Monthly grab sample)	30 mg/l unfiltered (Monthly 12-hr. composite sample)[3]
COD	-	70 mg/l filtered	100 mg/l unfiltered (Monthly 12-hr. composite sample)[3]
pH	6.0 to 9.0 (Weekly grab sample)	-	-
DO	5.0 mg/l (Daily grab sample)	- (weekly grab sample)	-
Fecal Coliform Organisms	-	-	30,000 colonies per 100 ml, with no single sample to exceed 60,000 colonies per 100 ml.

Footnotes for Table 3-1

1. It is the intent of the Regional Board to pursue long-range quantitative water quality standards for New River at the International Boundary beyond those contained in Minute No. 264. Such standards are anticipated to include further reduction of fecal coliform organisms and of pesticidal and toxic discharges.

2. For necessary and adequate monitoring, samples should be taken of the New River waters at the International Boundary monthly or more frequently if necessary, and these should be analyzed for BOD_5, COD, pH, DO, and fecal coliform organisms. Samples should also be analyzed for toxic substances as considered necessary.

3. Twelve consecutive hourly samples once a month (24-hour composite to be taken as needed to establish correlation with 12-hour composite).

Monitoring data collected by the Regional Board and the United States section of the International Boundary and Water Commission indicate that with the exception of pH, all quantitative and qualitative standards of Minute No. 264 have been violated since they were established. Moreover, with the exception of pH and DO, the standards do not protect or achieve the New River water quality given that: (1) they are inconsistent with the General Surface Water Objectives of this Basin Plan (p. 3-1), and (2) they are actually applicable to the New River in Mexico, not at the International Boundary. It is therefore appropriate for the Regional Board, as the agency responsible for protecting the quality of the waters in this region of the United States, to develop and enforce water quality objectives for the New River that are consistent with State and USEPA criteria for surface waters and that protect the waters of the region as follows:

Bacteria Water Quality Objectives

1. The bacterial standards identified in the General Surface Water Objectives section of this Basin Plan (p. 3-3) are applicable to the entire stretch of the New River in the United States.

2. The Pathogen Total Maximum Daily Load (TMDL) and associated implementation actions are described in Chapter 4, Section V(A). Compliance Monitoring activities for the TMDL are described in Chapter 6, Section II(B).

C. SALTON SEA

1. Total Dissolved Solids (Salinity)

   The total dissolved solids concentration of Salton Sea in 1992 was approximately 44,000 mg/l.

   The water quality objective for Salton Sea is to reduce the present level of salinity, and stabilize it at 35,000 mg/l unless it can be demonstrated that a different level of salinity is optimal for the sustenance of the Sea's wild and aquatic life (California Department of Fish and Game is attempting to make this determination). However, the achievement of this water quality objective shall be accomplished without adversely affecting the primary purpose of the Sea which is to receive and store agricultural drainage, seepage, and storm waters. Also, because of economic considerations, 35,000 mg/l may not be realistically achievable. In such case, any reduction in salinity which still allows for survival of the sea's aquatic life shall be deemed an acceptable alternative or interim objective. Because of the difficulty and predicted costliness of achieving salinity stabilization of Salton Sea, it is unreasonable for the Regional Board to assume responsibility for implementation of this objective. That responsibility must be shared jointly by all of the agencies which have direct influence on the Sea's fate. Additionally, there must be considerable public support for achieving this objective, without which it is unlikely that the necessary funding for Salton Sea salinity control will ever be realized.

2. Selenium

   The beneficial use of the Salton Sea for recreation has been impaired due to elevated levels of selenium in tissues of resident wildlife and aquatic life (See page 4-10 for a more detailed discussion of this). The following objectives apply to all surface waters that are tributaries to the Salton Sea:

   a. A four day average value of selenium shall not exceed .005 mg/L;

   b. A one hour average value of selenium shall not exceed .02 mg/L.

   These numerical limits are based on the United States Environmental Protection Agency's National Ambient Water Quality Criteria.

D. IRRIGATION SUPPLY CANALS

Herbicide spraying in irrigation canals must be conducted in coordination with the County Agricultural Commissioner, California Department of Fish and Game (DFG), and California Department of Health Services. In canals used for domestic supply, no herbicides shall be applied in concentrations which are toxic or otherwise harmful to humans; also no herbicides shall be applied in concentrations which are toxic or otherwise harmful to aquatic life, except that herbicides may be used in cases where the herbicide only impacts the targeted species, is a legally registered product, and is used in accordance with label requirements and in accordance with all applicable laws and regulations.

IV. GROUND WATER OBJECTIVES

Establishment of numerical objectives for ground water involves complex considerations since the quality of ground water varies significantly with depth of well perforations, existing water levels, geology, hydrology and several other factors. Unavailability of adequate historical data compounds this problem. The Regional Board believes that detailed investigation of the ground water basins should be conducted before establishing specific ground water quality objectives.

O_NPCA-CBD et al 2

Ideally the Regional Board's goal is to maintain the existing water quality of all nondegraded ground water basins. However, in most cases ground water that is pumped generally returns to the basin after use with an increase in mineral concentrations such as total dissolved solids (TDS), nitrate etc., that are picked up by water during its use. Under these circumstances, the Regional Board's objective is to minimize the quantities of contaminants reaching any ground water basin. This could be achieved by establishing management practices for major discharges to land. Until the Regional Board can complete investigations for the establishment of management practices, the objective will be to maintain the existing water quality where feasible.

A. TASTE AND ODORS

Ground waters for use as domestic or municipal supply shall not contain taste or odor-producing substances in concentrations that adversely affect beneficial uses as a result of human activity.

B. BACTERIOLOGICAL QUALITY

In ground waters designated for use as domestic or municipal supply (MUN), the concentration of coliform organisms shall not exceed the limits specified in California Code of Regulations, Title 22, Chapter 15, Article 3.

C. CHEMICAL AND PHYSICAL QUALITY

Ground waters designated for use as domestic or municipal supply (MUN) shall not contain concentrations of chemical constituents in excess of the limits specified in California Code of Regulations, Title 22, Chapter 15, Article 4, Section 64435, Tables 2, 3, and 4 as a result of human activity.

D. BRINES

Discharges of water softener regeneration brines, other mineralized wastes, and toxic wastes to disposal facilities which ultimately discharge in areas where such wastes can percolate to ground waters usable for domestic and municipal purposes are prohibited.

E. RADIOACTIVITY

Ground waters designated for use as domestic or municipal supply (MUN) shall not contain radioactive material in excess of the limits specified in California Code of Regulations, Title 22, Chapter 15, Article 5, Sections 64441 and 64443. The limits contained in Section 64443 are included under item "II.M. Radioactivity", in this Chapter.

F. GROUND WATER OVERDRAFT

A number of ground water basins in the Region are in overdraft, and in some areas there have been indications of possible increase of mineral content of the ground water. Investigative studies will be conducted to develop ground water objectives and implementation plans for the following ground water basins:

- Indio Subarea of the Whitewater Hydrologic Unit
- Warren Subunit of the Joshua Tree Hydrologic Unit
- Twentynine Palms Subunit of the Dale Hydrologic Unit
- Borrego Subarea of the Anza-Borrego Hydrologic Unit
- Lucerne Hydrologic Unit
- Terwilliger Subarea of the Anza-Borrego Hydrologic Unit
- Ocotillo Subunit of the Anza-Borrego Hydrologic Unit

O_Tetra7

RUTAN
RUTAN & TUCKER, LLP

Robert S. Bower
Direct Dial: (714) 641-3440
E-mail: rbower@rutan.com

May 7, 2012

VIA E-MAIL AND
FIRST CLASS MAIL

Santa Margarita Water District
Attn.: Board of Directors' Administration
Office
26111 Antonio Parkway
Rancho Santa Margarita, CA 92688

Re: Request for Notification of Hearings

Dear Sirs:

On behalf of Tetra Technologies, Inc., I hereby request that you provide me with reasonable written notification whenever the Santa Margarita Water District, its staff, or its Board of Directors is scheduled to consider any item related to the Santa Margarita Water District Cadiz Valley Water Conservation, Recovery and Storage Project ("Project"), or any item/approval/project concerning that Project, including, but not limited to, memoranda of understanding, contracts, groundwater management, monitoring, and mitigation plans, etc.

Thank you for your consideration of this request, and please provide me with confirmation that you have received this request and that it complies with all District rules and regulations to constitute an effective request.

1

Very truly yours,

RUTAN & TUCKER, LLP

Robert S. Bower

RSB:sa

A_MWD 2

THE METROPOLITAN WATER DISTRICT
OF SOUTHERN CALIFORNIA

Office of the General Counsel

VIA E-MAIL & U.S. MAIL

May 14, 2012

Mr. Scott Slater
Brownstein Hyatt Farber Schreck, LLP
2029 Century Park East, Suite 2100
Los Angeles, CA 90067-3007
E-mail: sslater@bhfs.com

Re: Cadiz Valley Water Conservation, Recovery, and Storage Project

Dear Mr. Slater:

Following our April 3 meeting, Metropolitan's staff has been reviewing the issues discussed.

First, you suggested that Metropolitan consider whether its participation in the project is ministerial rather than discretionary so that Metropolitan would not be acting as a responsible agency for purposes of CEQA. We have reviewed the project description in the Draft EIR and concluded that the actions required of Metropolitan cannot be considered ministerial. As noted in our March 30, 2011 comment letter on the Notice Of Preparation (copy attached), Metropolitan would be required to approve the use of its lands for project facilities, approve the construction and operation of the tie-in structure between the project and the Colorado River Aqueduct, approve the introduction of new source water into the Colorado River water delivery system, and approve the acquisition of power supplies to convey the water through the system. These same issues were raised in Metropolitan's March 12, 2012 comment letter on the Draft EIR (copy attached). Each of these approvals is discretionary, not ministerial. Metropolitan asserted that it is a responsible agency in each of the comment letters, and our further review has not changed that position.

Second, you requested that Metropolitan work with Steven DeCou to review a proposal to eliminate the regulating reservoir included in the project description and replace the reservoir with a direct tie-in between the project pipeline and the Colorado River Aqueduct. Mr. DeCou provided a narrative description of this proposal by e-mail on April 4. Metropolitan's engineering staff has reviewed the proposal and found that the direct tie-in is not acceptable. Metropolitan's objections to a direct tie-in were stated in its March 12, 2012 comment letter in addressing the project description in the Draft EIR: "The water conveyance pipeline should not

1

be connected directly to the CRA and discharge directly into the CRA. A stabilization reservoir must separate the CRA from the conveyance pipeline, and include valves/gates which allow complete isolation of the equalization reservoir from the CRA." After review of the proposed direct tie-in, Metropolitan has not changed its position on the use of a direct tie-in.

Very truly yours,

Joseph Vanderhorst
Senior Deputy General Counsel

Attachments

A_MWD 2

MWD
METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

Executive Office

March 30, 2011

Via Electronic and Federal Express
cadizproject@esassoc.com

Tom Barnes, ESA
626 Wilshire Boulevard, Ste 1100
Los Angeles, CA 90017

Dear Mr. Barnes:

Cadiz Valley Water Conservation, Recovery, and Storage Project, Notice of Preparation

The Metropolitan Water District of Southern California (Metropolitan) received the Notice of Preparation (NOP) of a Draft Environmental Impact Report (DEIR) for the Cadiz Valley Water Conservation, Recovery, and Storage Project (Project). The Santa Margarita Water District (SMWD) is acting as the Lead Agency under the California Environmental Quality Act (CEQA) for this proposed Project.

Metropolitan is a public agency and regional water wholesaler, comprising 26 member cities and water agencies charged with providing a reliable supply of high quality drinking water to more than 19 million people in six counties (San Diego, Orange, Riverside, Los Angeles, San Bernardino, and Ventura) in Southern California. One of Metropolitan's primary water supplies is the Colorado River. Metropolitan owns and operates the Colorado River Aqueduct (CRA) to bring water from the Colorado River to its service area.

The NOP describes the proposed Project as including use of "the CRA delivery system owned and operated by the Metropolitan Water District of Southern California (Metropolitan)." (NOP, p. 4.) The NOP notes that Metropolitan's approval is required for the construction and operation of any modifications to the CRA, and for the use of Metropolitan facilities to deliver water for the proposed Project. (NOP, p. 6.) As a public agency that must approve aspects of the Project, Metropolitan is a responsible agency for purposes of CEQA. (Public Resources Code § 21069.) This letter provides Metropolitan's comments on the scope and content of the environmental information that is germane to Metropolitan's role as a responsible agency in the CEQA process. (Public Resources Code § 21080.4.)

On the basis of the Project description in the NOP, the environmental information pertinent to Metropolitan's role in the proposed Project includes:

700 N. Alameda Street, Los Angeles, California 90012 • Mailing Address: Box 54153, Los Angeles, California 90054-0153 • Telephone (213) 217-6000

- Identification and description of the environmental impacts from construction and operation of any Project facilities (e.g., turn-out structure, pipeline) that would be constructed on Metropolitan property,
- Environmental effects of construction and operation of any water treatment facilities that may be required to introduce the water supply into Metropolitan's conveyance system, and
- Environmental effects of the construction and operation of any electric power generating or transmission facilities that may be required to deliver the water supply through Metropolitan's conveyance system.

We appreciate the opportunity to provide input to your planning process and we look forward to receiving the Draft EIR for the proposed Project. Please direct all further communications related to the proposed Project to Dr. Marty Meisler at (213) 217-6364.

Very truly yours,

John Shamma

John Shamma
Manager, Environmental Planning Team

MM:rdl
(J:\Environmental-Planning&Compliance\COMPLETED JOBS\March 2011\Job No. 2011032433)

A_MWD 2

THE METROPOLITAN WATER DISTRICT
OF SOUTHERN CALIFORNIA

March 12, 2012

Via email and Federal Express
tbarnes@esassoc.com

Environmental Science Associates
c/o Tom Barnes
626 Wilshire Boulevard, Ste. 1100
Los Angeles, CA 90017

Dear Mr. Barnes:

Draft Environmental Impact Report for the
Cadiz Valley Water Conservation, Recovery, and Storage Project

The Metropolitan Water District of Southern California (Metropolitan) has reviewed a copy of the Draft Environmental Impact Report (DEIR) for the Cadiz Valley Water Conservation, Recovery, and Storage Project (Project), located in the eastern Mojave Desert portion of San Bernardino County. The Santa Margarita Water District (SMWD) is acting as the California Environmental Quality Act (CEQA) Lead Agency for this project.

Metropolitan is a public agency and regional water wholesaler, comprising 26 member cities and water agencies charged with providing a reliable source of high quality drinking water to more than 19 million people in six counties (San Diego, Orange, Riverside, Los Angeles, San Bernardino, and Ventura) in Southern California. One of Metropolitan's primary water supplies is the Colorado River. Metropolitan owns and operates the Colorado River Aqueduct (CRA) to bring water from the Colorado River to its service area.

The proposed Project, as described in the DEIR, is designed to actively manage the groundwater basin underlying a portion of the Cadiz and Fenner Valleys, and consists of construction and operation of facilities to support the two components of the Project, which is proposed to be developed in phases. The first phase (Phase 1), the Groundwater Conservation and Recovery Component, proposes to utilize Metropolitan's CRA to convey extracted groundwater to SMWD and other Project Participants. The second phase (Phase 2), the Imported Water Storage Component, proposes to convey water to the Fenner Valley via the CRA or other means for in-ground storage and future withdrawal.

The proposed use of Metropolitan's CRA would entail various approvals by Metropolitan for access to Metropolitan's property, an agreement to use the CRA to convey Project water, procedures to ensure sufficient quality of Project water, and design, construction, and operation of the proposed "tie-in" to the CRA; therefore, Metropolitan is a responsible agency for the purposes of CEQA. (Public Resources Code Section 21069.) This letter contains Metropolitan's

comments on the DEIR in its capacity as a responsible agency. (Public Resources Code Section 21153, subd. (a).)

Metropolitan previously provided comments on the Notice of Preparation for the Project in March 2011. That letter is attached hereto, and those comments are incorporated by reference.

Aspects of the proposed Project that have potential to affect Metropolitan encompass a variety of issues, including Project Description, Project Purpose and Objectives, Water Quality, Geology and Soil issues as they relate to impacts to the CRA, proposed use of the CRA and operational considerations, and energy requirements. These concerns are discussed below, with more detail provided in the Specific Comments section. Comments on the two phases of the proposed Project are provided separately.

General Comments:

The following issues are of concern to Metropolitan. Detail regarding these concerns is provided in the Specific Comments section that follows. Additional suggestions for revisions to various statements in the DEIR are also attached for your consideration.

Phase 1. Groundwater Conservation and Recovery Component

1. **Approvals**. As proposed, the Project includes use of Metropolitan property and facilities, physical connection to Metropolitan's water conveyance system, and introduction of groundwater and conveyance of that water through the Metropolitan system. Metropolitan will necessarily be required to both approve and carry out aspects of the Project, and therefore, is a responsible agency for purposes of CEQA. Metropolitan requests that the EIR specifically identify it as a Responsible Agency and describe these necessary approvals.

2. **Project Purpose and Objectives**. The Project description in the DEIR makes it clear that Phase 2, the imported water storage component, is speculative. There are no participants for Phase 2 and the Lead Agency, SMWD, has no rights to the two sources of imported water (Colorado River and State Water Project) identified as providing the water supply for storage. Therefore, the discussion on page 3-14 of the relationship between the two project components should include an analysis of any differences in environmental effects from Phase 1 if Phase 2 is never completed.

   The current text lists three reasons why the storage component is best implemented following initial groundwater extraction (DEIR at page 3-14). The last two reasons are unclear. The second reason is that project participants would have an "opportunity to put conserved water from Phase 1 to beneficial use." But this "opportunity" would exist regardless of whether the storage component of the project is ever implemented. The third reason is that "this approach avoids a practical concern of finding a short-term beneficial use for vast quantities of groundwater simultaneous with the initiation of recharge activity that aims to put imported

A_MWD 2

water in the ground." This reason leads to a question as to whether the purpose and objective of Phase I is not to provide reliable, dry-year water supplies to supplement existing water supplies available to project participants, but rather to allow the creation of storage space within the groundwater basin. The environmental impacts of different operational scenarios for Phase 1, where creation of storage capacity in the groundwater basin is not a factor for implementation of Phase 2, should be considered. As previously noted, the purpose and need for Phase 1 of the project should be analyzed and addressed as a stand-alone project without considering the potential of the speculative Phase 2 storage component.

3. **Project Description.** Aspects of the project are lacking necessary detail to effectively determine potential impacts to Metropolitan and feasibility of the proposed Project. These include hydraulic modeling, specific information on operation of facilities in conjunction with Metropolitan's operations, and sizing and location of facilities.

4. **CRA Capacity Constraints**. The DEIR fails to consider whether there is sufficient capacity available in the CRA to accommodate the Project's needs. As discussed in section 3.1 of Metropolitan's 2010 Regional Urban Water Management Plan, Metropolitan is pursuing programs to maintain a full supply of Colorado River water when needed or in dry years that would make the CRA unavailable to convey water introduced from the Project in those years.

5. **CRA Operations.** Integration of Project operations with CRA operations would be challenging under the presented "tie in" option scenarios described at pages 3-34 to 3-36. Additional detail is requested to more fully understand the ramifications of the proposed Project on Metropolitan's ability to operate the CRA in a safe and cost-effective manner.

6. **Energy and Greenhouse Gas Issues.** The energy use and GHG emissions discussions require further data and analysis to include the energy required to convey the project water through the CRA. Metropolitan's comment letter on the Notice of Preparation included the energy required to convey the water through the Aqueduct as information required. The discussion in the DEIR is limited to energy needed to convey water from the well field to the CRA.

7. **Geology and Soils**. The DEIR does not adequately assess potential impacts to the CRA from construction and operation of new facilities. Potential for seepage from the proposed reservoir and forebay is of particular concern.

8. **Hydraulics Issues.** Metropolitan requests appropriate analyses be performed to identify potential impacts to Metropolitan's facilities, along with measures to ensure these are avoided. Such analyses should include a detailed operating plan, steady-state hydraulic analysis, Hydraulic Plan and Profile, and transient analysis.

9. **Water Quality.** The water quality discussion associated with the proposal to introduce the extracted groundwater into the CRA is inadequate. It should include discussion of the types and levels of contaminants in the groundwater basin along with the potential impacts and

mitigation measures needed to protect Metropolitan's water supplies against degradation. In addition, Metropolitan's comment letter on the Notice of Preparation identified the need to analyze impacts from construction and operation of water treatment facilities that could be required to treat either groundwater or imported water being conveyed through the CRA as part of the Project.

Phase 2. Storage of Imported Water

1. **Project Need and Objectives.** The assumption stated in the Draft EIR that additional water storage is needed requires further analysis to support the purpose and need for the imported water storage component of the project. The assertion that additional Southern California storage is needed, if it is intended to apply to Metropolitan, is not correct.

2. **Project Description**. The imported water storage component of the project is not sufficiently defined to support completion of an environmental impact report, even at a programmatic level. For example, the Draft EIR does not identify a source of imported water that any potential participants would utilize to implement the imported water storage component.

3. **CRA Capacity**. The DEIR does not address CRA operational issues or whether excess capacity exists to transfer imported water to the Cadiz spreading grounds.

4. **Hydraulics**. In order to fully evaluate the hydraulic impacts to the CRA, a detailed operating plan, transient analysis, and steady-state hydraulic analysis is required, accompanied by a Hydraulic Plan & Profile of the proposed conveyance pipeline and system when pumping water from the CRA to the Project spreading grounds.

5. **Water Quality.** Metropolitan is concerned about potential impacts of imported water stored in the desert groundwater basins and potential effects on water quality within the CRA. A detailed water quality analysis should be provided to support the conclusion that impacts are less than significant with no mitigation measures required.

Metropolitan's CRA is a critical water supply facility for southern California. It must be maintained in reliable operating condition and Metropolitan requires unobstructed access to its facilities in order to maintain and repair its system. In order to avoid potential conflicts with Metropolitan's facilities and rights-of-way, any design plans for any activity in the area of Metropolitan's pipelines or facilities must be submitted and approved in writing by Metropolitan. Approval of the project will be contingent on Metropolitan's approval of design plans for portions of the proposed project that would be located on Metropolitan property or could impact Metropolitan facilities.

Detailed prints of drawings of Metropolitan's pipelines and rights-of-way may be obtained by calling Metropolitan's Substructures Information Line at (213) 217-6564. To assist the applicant

A_MWD 2

in preparing plans that are compatible with Metropolitan's facilities and easements, we have enclosed a copy of the *Guidelines for Developments in the Area of Facilities, Fee Properties, and/or Easement of The Metropolitan Water District of Southern California*. Please note that all submitted designs or plans must clearly identify Metropolitan's facilities and rights-of-way.

We appreciate the opportunity to provide input to your planning process and look forward to receiving future plans and documentation for this project. If we can be of further assistance, please contact me at (213) 217-6696.

Very truly yours,

David Clark
for
Deirdre West
Manager, Environmental Planning Team

MRM:rdl
(J:\Environmental Planning-Compliance\COMPLETED JOBS\March 2012\Job No. 2012031201)

Attachments:

Specific Comments
Suggested Revisions and Corrections to the DEIR
Metropolitan Water District Letter on NOP
Guidelines for Development in the Area of Facilities

Suggested Revisions and Corrections to the DEIR

1. On page ES-2, paragraph 2, insert a footnote providing a reference to the specific federal regulations (or guidelines) that may "unlock additional complementary storage opportunities, both within the Basin and in Lake Mead".

2. On page 1-6, paragraph 2, the Draft EIR indicates,

   "In Southern California, Golden State serves customers in cities throughout San Bernardino, Riverside, Los Angeles, Orange and Ventura counties (see **Figure 1-3**)."

   However, Figure 1-3 does not show a Golden State service area in Riverside County.

3. On page 1-23, the Area of Use Assessment shown in Figure 1-4 does not encompass the California Water Service Company service area in Ventura County.

4. On page 2-6, paragraph 3, reference is made to the "2010 California Department of Water Resources (DWR) California Water Plan Update"; however, the footnote for that sentence, 14, cites the *California Water Plan Update 2009, Integrated Water Management,* December 2009.

5. On page 2-6, paragraph 4, the Draft EIR indicates that the Sacramento-San Joaquin River Delta is also known as the Bay Delta. Please note that the State Water Resources Control Board refers to the San Francisco Bay/Sacramento-San Joaquin Delta Estuary as the Bay-Delta at http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/.

6. On page 2-7, Figure 2-1, branches of the California Aqueduct, including the West Branch, are missing from the figure.

7. On page 2-8, paragraph 1, revise the sentence:

   "Between 1990 and 1994, DWR had greater difficulty meeting demand because several years were very dry."

   to read: "Between 1990 and 1992 and in 1994, DWR had greater difficulty meeting demand because these years were very dry." Also, revise the sentence:

   "In recent years, the SWP has been able to deliver full amounts only in wet years;"

   to read: "Between 2000 and 2011, the SWP has been able to deliver 100 percent of the contractors' allocations only in 2006, a wet year;"

8. On page 2-8, paragraph 1, revise the following sentences: "DWR's most recent reliability estimates indicate the system will have 60 percent reliability for delivering Table A requests, depending on hydrologic and environmental factors[15]. DWR currently estimates 60 percent reliability in the future."

A_MWD 2

   to read: "DWR estimates the system will have, on average, 60 percent reliability for delivering Table A requests, depending on hydrologic and environmental factors[15]. DWR estimates 60 percent reliability, on average, in the future."

9. On Page 2-8, Section 2.4.2, paragraph 2, revise the sentence: "SWP deliveries began in 1972."

   to read: "SWP deliveries to Metropolitan began in 1972."

10. On page 2-9, line 1, after the phrase "available surplus water," insert the phrase, "and any water apportioned to but unused in the states of Arizona and Nevada, made available by the Secretary of the Interior."

11. On page 2-9, paragraph 1, revise the sentence:

    "Since 2003, Metropolitan has developed agreements with other Colorado River water rights holders to convey water through the CRA."

    to read: "Since 1988, Metropolitan has entered into agreements with other Colorado River water rights holders to conserve water to permit the Secretary of the Interior to make such water available to Metropolitan for diversion through the CRA."

12. On page 2-9, paragraph 1, revise the sentence:

    "Metropolitan approved the Quantification Settlement Agreement (QSA) in 2003 that provided for additional transfers from agricultural agencies that use Colorado River Water such as the Imperial Irrigation District (IID) and the Coachella Valley Water District (CVWD) to San Diego."

    to read: "Metropolitan executed the Quantification Settlement Agreement (QSA) in 2003, a key component of California's Colorado River Water Use Plan, providing for the transfer of water from the Imperial Irrigation District (IID) to the San Diego County Water Authority (SDCWA) and providing a reliable mechanism for additional agricultural to urban water transfers benefiting Metropolitan. Execution of the QSA restored the opportunity for Metropolitan's access to special surplus water to be provided under the 2001 Interim Surplus Guidelines. The QSA set aside several existing disputes between California's Colorado River water agencies, allowing for the cooperative development of additional Colorado River water supply programs."

13. On page 2-9, footnote 19, revise the sentence:

    "Twelve of the QSA agreements are currently the subject of an appeal pending in the Third District Court of Appeal for which oral argument will occur on November 21, 2011."

    to read: "On December 7, 2011, the judgments in *Imperial Irrigation District v. All Persons Interested, POWER v. Imperial Irrigation District et al.*, and *County of Imperial v. Metropolitan Water District of Southern California et al.* were reversed, and the cases were remanded to the trial court for further proceedings consistent with the Court of Appeal's opinion", and insert it after the second sentence of the footnote.

Also, revise the third sentence of the footnote: "The QSA agreements continue to be implemented while the appeal is being decided."

to read: "The QSA and related agreements continue to be implemented."

14. On page 2-9, the values shown in Table 2-1 do not represent Metropolitan's net diversions of Colorado River water from Lake Havasu as amounts stored have been deducted as indicated in note 2 of Table A. 2-1 of the source document. Also, the value shown for 2010 in the source document was a preliminary estimate. Metropolitan's net diversions as reported by the Bureau of Reclamation at http://www.usbr.gov/lc/region/g4000/wtracct.html are the following for the years shown in Table 2-1:

	acre-feet
1980	817,147
1985	1,269,526
1990	1,214,971
1995	994,373
2000	1,300,014
2005	875,252
2010	1,099,061

Also in 2010, Metropolitan created 100,864 acre-feet of Extraordinary Conservation ICS, storing water it otherwise would have diverted in Lake Mead.

15. On page 3-2, a sentence in the last paragraph indicates:

"Water would be distributed to Project Participants via the CRA."

on page 3-5, a sentence in the third paragraph indicates:

"The water would be conveyed from the Project area to the service areas of the Project Participants shown on Figures 1-2 and 1-3 via the CRA."

and on page 3-15, a sentence in the second paragraph indicates:

"Whether the imported water comes from the Colorado River or the State Water Project, when needed, previously stored surface water would be withdrawn from storage, conveyed to the CRA and delivered through the CRA delivery system to Project participants."

As the CRA terminates at Lake Mathews, it would be necessary for arrangements to be made with Metropolitan and its respective member agency serving a Project Participant to allow for an exchange of water from Metropolitan's distribution system for water discharged into the CRA.

16. On page 3-15, a sentence in the first paragraph indicates:

A_MWD 2

"When water is available by direct delivery or exchange, such as surplus water in wet years, a Project Participant could convey water from the CRA to the Project site via the water conveyance pipeline that would be constructed under the first phase of the Project."

It should be noted in the Final EIR that the CRA delivers water from the Colorado River and none of the Project Participants hold a contract with the Bureau of Reclamation for delivery of Colorado River water.

17. On page 3-21, paragraph 2, revise the sentence referring to California Water Service Company:

"Its 24 separate water systems serve 63 communities from Chico in Southern California to the Palos Verdes Peninsula in Southern California."

to read: "Its 24 separate water systems serve 63 communities from Chico in Northern California to the Palos Verdes Peninsula in Southern California."

18. On page 3-34, paragraph 1, revise the sentence:

"The water conveyance pipeline would terminate at the CRA, a 242-mile water conveyance facility that delivers water from the Colorado River at Parker Dam to water suppliers in Southern California."

to read: "The water conveyance pipeline would terminate at the CRA, a 242-mile water conveyance facility that delivers water from the Colorado River at Lake Havasu to Lake Mathews."

19. On page 3-34, paragraph 5, revise the words "Copper Mountain" to "Copper Basin" in Option 1a:

20. On page 3-53, in the second to last row, right column, revise the sentence:

"Regulatory authority over Golden State and Suburban, the CPUC has approval authority over Golden State's and Suburban Water's agreements if rates are affected."

to read, "Regulatory authority over California Water Service, Golden State and Suburban, the CPUC has approval authority over California Water Service's, Golden State's and Suburban Water's agreements if rates are affected."
(based on information at http://www.calwater.com/rates/set_rates.php)

21. On page 3-54, in the third to last row, center column, revise the sentence:

"Agreement to convey water through the CRA"

To read: "Agreement to exchange water from the distribution system to a Metropolitan member agency for receipt by a Project Participant"

22. On page 3-54, below the third to last row, center column, insert the sentence:

"Approval of aspects of the Project/CEQA"

And right column, insert the sentence:

"CEQA Responsible Agency pursuant to California Public Resources Code section 21069, Metropolitan would evaluate potential environmental impacts within its boundaries and on its facilities"

23. On page 4.1-4, paragraph 2, revise the characterization of Metropolitan lands from "private property" to "water district property."

24. On page 4.5-13, paragraph 5, revise the text: "to the Los Angeles metropolitan Area" to read "to the Southern California coastal plain."

25. On page 4.9-10, the last sentence regarding the U.S. Bureau of Reclamation Regional Study on climate change should be revised as it appears that there are words missing from the sentence:

"However, these trends have many variations and need to consider more at a regional level, as discussed below."

26. On page 4.9-11, paragraph 1, please clarify the geographical area associated with the variation in precipitation discussed in the sentence:

"The data shows large annual variations (less than 9 to more than 20 inches)."

It is not clear whether the area referenced is the Colorado Basin, referenced earlier in the paragraph or another area.

27. On page 4.9-12, revise the sentence:

"Capture of snowmelt runoff traditionally has occurred during thelate spring and early summer seasons."

to read: "Capture of snowmelt runoff traditionally has occurred during the late spring and early summer seasons."

28. On page 4.9-40, paragraph 2, revise the sentence:

"As a result of the Salinity Management Policy, TDS levels in Colorado River water sampled just below Parker Dam have been reduced to below 600 mg/L since 1985."

to read: "With implementation of the Colorado River Basin Salinity Control Program, TDS levels in Colorado River water sampled just below Parker Dam have varied from 620 to 680 since 2005."

Also revise the sentence in footnote 183:

A_MWD 2

"U.S. Bureau of Reclamation, *Quality of Water, Colorado River Basin, Progress Report No. 22*, 2005, Appendix A, page 69."

to read: "U.S. Bureau of Reclamation, *Quality of Water, Colorado River Basin, Progress Report No. 23*, 2011, Appendix A, page 76." found at http://www.usbr.gov/uc/progact/salinity/pdfs/PR23final.pdf.

29. On page 4.9-44, paragraph 3, revise the sentences:

"Presently, California is receiving waters unused by other states. The 2003 Quantification Settlement Agreements created California's "soft landing" by reducing California's Colorado River water usage from 5.2 million AFY to 4.4 million AFY in a normal year over 15 years through the conservation and transfer of water from agricultural to urban uses in San Diego County Water Authority's, Metropolitan's, and Coachella Valley Water District's jurisdictions, through quantifying the agencies' priority water rights to the River and allocating water in times of shortage. This effort was called the "Interim Surplus Guidelines." The Interim Surplus Guidelines adopted rules for deciding when there was surplus water in the Colorado River, and how such a surplus could be used, as California wound down its excess use."

to read: "Presently, California is not receiving waters unused by other states. While the 2003 Quantification Settlement Agreement contemplated a California "soft landing" by reducing California's Colorado River water usage from 5.2 million AFY to 4.4 million AFY in a normal year over 15 years through the conservation and transfer of water from agricultural to urban uses in San Diego County Water Authority's, Metropolitan's, and Coachella Valley Water District's jurisdictions, the California agencies reduced their use to 4.4 million AFY, less the payback of certain amounts of water used in 2001 and 2002, and inadvertent overruns beginning in 2003. Agreements relating to the Quantification Settlement Agreement quantified Imperial Irrigation District's, Coachella Valley Water District's and Metropolitan's priority water rights to River water and allocate water in times of shortage. In addition, execution of these agreements restored the agencies' ability to utilize special surplus water, when available in accordance with the 2001 "Interim Surplus Guidelines." The Interim Surplus Guidelines adopted a methodology for deciding when there was surplus water available from Lake Mead, and for what purposes surplus water could be used".

30. On page 4.9-77, paragraph 1, should the second reference to "CRA water" be revised to "groundwater" in the sentence: "The CRA water would have higher TDS concentrations than the CRA water, whereas the sodium and chloride (salt) concentrations of the CRA water would be slightly lower than the current concentrations in the groundwater in the alluvium in the Fenner Gap area."?

31. On page 4.13-7, footnote 20, revise "*Rive*" to "*River*".

32. On page 5-28, paragraph 2, revise the sentence:

"In contrast, much of the Project infrastructure would be installed underground (43 miles of water conveyance pipelines, possibly power distribution facilities and interconnected wellfield pipelines), on private property (Cadiz Property, ARZC ROW, Metropolitan lands), and in remote areas not generally accessible by the public."

to read: "In contrast, much of the Project infrastructure would be installed underground (43 miles of water conveyance pipelines, possibly power distribution facilities and interconnected wellfield pipelines), on private and water district property (Cadiz Property, ARZC ROW, Metropolitan lands), and in remote areas not generally accessible by the public."

33. On page 6-3, last paragraph, revise the sentence: "The facilities proposed for Groundwater Conservation and Recovery Component of the Project include construction of a wellfield and manifold (piping) system to carry pumped groundwater to a new 43-mile conveyance pipeline that would be constructed along the ARZC ROW, and tie into the CRA, which would distribute water to Project Participants."

    to read: "The facilities proposed for Groundwater Conservation and Recovery Component of the Project include construction of a wellfield and manifold (piping) system to carry pumped groundwater to a new 43-mile conveyance pipeline that would be constructed along the ARZC ROW, and tie into the CRA."

34. On page 6-8, footnote 10, revise the words "Business and Professional Code" to read "Business and Professions Code"

35. On page 6-9, footnote 13, revise the reference to Section 775120 of the California Public Resources Code as there is no Section 775120 of the Code.

36. On page 6-10, paragraph 2, revise the sentence: "Metropolitan imports water from the Colorado River via its CRA and from the Sacramento-San Joaquin Delta via the SWP.

    to read: "Metropolitan imports water from the Colorado River via its CRA and receives water from the California Department of Water Resources which imports it from the Sacramento-San Joaquin Delta via the SWP."

37. On page 6-10, paragraphs 2 and 3, revise the sentences:

    "Metropolitan's water supplies and supply reliability are described in more detail in below but, in summary, Metropolitan is taking several steps to address reliability issues associated with both of its imported supply sources.

    "On the Colorado River system a multi-year drought coupled with the need for Metropolitan to permanently reduce its level of imports, along with litigation over the negotiated multi-party settlement agreement intended to reduce California's reliance on the Colorado River…."

to read: "Metropolitan's water supplies and supply reliability are described in more detail below but, in summary, Metropolitan is taking several steps to address reliability issues associated with both of its imported supply sources.

"On the Colorado River system, litigation over the negotiated multi-party Quantification Settlement and related agreements intended to reduce California's reliance on the Colorado River…."

38. On page 6-10, last paragraph, revise the sentence: "Metropolitan works with local agencies to implement projects to recover and use contaminated groundwater."

    to read: "Metropolitan works with local agencies to implement projects to recover and treat contaminated groundwater to meet potable use standards prior to use."

39. On page 6-16, paragraph 3, revise the clause: "(see further discussion o Metropolitan supplies and reliability issues in Section 6.2.7, below)"

    to read: "(see further discussion of Metropolitan supplies and reliability issues in Section 6.2.7, below)"

40. On page 6-19, paragraph 5, with respect to the sentence: "SMWD is pursuing participation in the proposed Project as part their efforts to address the uncertainties arising over the long-term reliability of, and to offset the need for, imported water.": Project water would be imported water.

41. On page 6-31, Table 6-14, revise footnote a by inserting: "Valley" to read "Upper San Gabriel Valley Municipal Water District."

42. On page 6-42, paragraph 3, revise the sentence: "Metropolitan's service area covers six counties in Southern California region: Los Angeles, Orange, Riverside, San Bernardino, San Diego, and Ventura counties."

    to read: "Metropolitan's service area covers portions of six counties in the Southern California region: Los Angeles, Orange, Riverside, San Bernardino, San Diego, and Ventura counties."

43. On page 6-53, footnote 73, revise the sentence: "The transfer is implemented via Metropolitan infrastructure, whereby Metropolitan receives the IID water and conveys the same amount of CRA water to SDCWA."

    to read: "The transfer is implemented via Metropolitan infrastructure, whereby Metropolitan receives the IID water and exchanges it for an equal amount of water delivered to SDCWA."

44. On page 6-53, paragraph 3, insert a footnote providing a reference for the statement "Metropolitan projects that 16 percent of its total water supply in 2035 will come from the Colorado River."

Also, revise the sentences: "Of California's 4.4 MAF apportionment from the Colorado River, 3.8 MAF, or 86 percent, is delivered to the Imperial Valley and, to a much lesser extent, the Palo Verde Irrigation District near Blythe, the Yuma Project, and the Coachella Valley Irrigation District. The water rights held by these irrigation districts are called "present perfected" rights – they predate the 1922 Colorado River Compact and thus entitle them to receive their water allocation in all years – dry or wet – over other lower priority users, including Metropolitan."

to read: "Of California's 4.4 MAF normal year apportionment from the Colorado River, up to 3.85 MAF, less transfers and use of up to 14,500 acre-feet by holders of Indian and miscellaneous present perfected rights holders, is delivered to Imperial Irrigation District and, to a much lesser extent, the Palo Verde Irrigation District near Blythe, the Yuma Project, and the Coachella Valley Water District. A portion of the water rights held by the first three of the entities listed are called "present perfected" rights – they predate the 1928 Boulder Canyon Project Act and thus entitle them to receive their water allocation in order of their priority date over other lower priority users, including Metropolitan."

45. On page 6-54, paragraph 1, revise the sentences: "California has historically drawn more than its basic apportionment of Colorado River water; its annual use has varied between 4.5 and 5.3 MAF over the last ten years[77,78] with water supplies above California's entitlement of 4.4 million acre-feet typically coming from unused portions of Arizona's apportionment and surplus water on the River in wet years."

    to read: "California has in the past drawn more than its basic apportionment of Colorado River water; its annual use has varied between 4.32 and 5.37 MAF over the last ten years[77,78] with water supplies above California's normal year apportionment of 4.4 million acre-feet typically coming from unused portions of Arizona and Nevada's apportionment and surplus water."

46. On page 6-54, footnote 77, revise: "Aquifonia, The Colorado River, http://aquafornia.com/where-does-californias-water-come-from/the-colorado-river, accessed October 12, 2011.

    to read: "http://www.usbr.gov/lc/region/g4000/wtracct.html."

47. On page 6-54, paragraph 1, revise the sentence: "However, in recent years, increased use by upstream water users (within their allocated rights) has reduced the amount of surplus Colorado River water formerly available to Metropolitan, a 10-year drought in the Colorado River watershed has decreased storage levels in Lake Mead and Lake Powell below 50 percent, record dry conditions in Southern California have reduced groundwater basins and local reservoirs, and consecutive dry years in northern California reduced Lake Oroville (at the starting point of the SWP) in 2008 and 2009 to its lowest and third lowest operating level since the reservoir was filled."

    to read: "However, in recent years, increased use by upstream water users (within their allocated rights) has reduced the amount of surplus Colorado River water formerly available to Metropolitan, a 10-year drought in the Colorado River watershed had decreased storage levels in Lake Mead and Lake Powell below 50 percent before their recovery in 2011, record dry

conditions in Southern California had reduced groundwater levels and local reservoir storage before recovery in 2011, and consecutive dry years in northern California reduced Lake Oroville (an SWP reservoir) in 2008 and 2009 to its lowest and third lowest operating level since the reservoir was filled."

48. On page 6-54, paragraph 1, revise the phrase: "Thus, while California's apportionment of water has priority over Arizona and Nevada,"

    to read, "Thus, while California's apportionment of water has priority over a portion of Arizona and Nevada's apportionment,"

49. On page 6-54, paragraph 4, revise the sentence: "Metropolitan may receive this additional water from unused apportionments, water supplies unused by agricultural districts, supplies unused by the states of Arizona and Nevada classified as Priority 6, and as Intentionally Created Surplus or supplies stored from previous years' extraordinary conservation and efficiency improvements to the operations of the Colorado River system, which are classified as Priority 3(a)."

    to read: "Metropolitan may receive this additional water from water supplies unused by agricultural districts, supplies unused by the states of Arizona and Nevada, and as Intentionally Created Surplus-- supplies stored from previous years' extraordinary conservation and efficiency improvements to the operations of the Colorado River system."

50. On page 6-55, paragraph 1, revise the sentence: "Although this amount is reasonably expected to be available over the next 20 years, water supply reliability is an increasing concern due to increased water use by other states and persistent drought conditions, which are reducing available supply to lower-priority users such as Metropolitan."

    to read: "This amount is reasonably expected to be available over the next 20 years."

51. On page 6-55, paragraph 2, revise the sentences: "The QSA is a set of agreements among IID, CVWD, San Diego County Water Authority (SDCWA), Metropolitan and others intended to reduce California's reliance on the Colorado River. Essentially, the QSA calls for Imperial Valley farmers to make voluntary efficiency and conservation improvements and transfer the conserved water to San Diego."

    to read: "The QSA and related agreements are a set of agreements among IID, CVWD, San Diego County Water Authority (SDCWA), Metropolitan and others intended to reduce California's reliance on the Colorado River. Essentially, the IID-SDCWA transfer agreement calls for Imperial Valley farmers to fallow land and make voluntary efficiency improvements and for IID to make conservation improvements and transfer the conserved water to SDCWA."

52. On page 6-55, paragraph 2, revise the sentences: "As part of the agreement, the State has agreed to bear responsibility for the restoration of the Salton Sea. Specifically, the QSA committed the parties to implementing eight long-term transfer and supply agreements that will shift up to 36 MAF from agricultural to urban use over the life of the agreement and authorize the All American Canal and Coachella Canal Lining Projects."

to read: "As part of the agreement, the State has agreed to bear responsibility for funding mitigation in excess of the $133 million to be funded by IID, CVWD, and SDCWA, collectively. Specifically, the QSA and related agreements committed the parties to implementing eight long-term transfer and supply agreements that will shift up to 36 MAF from agricultural to urban use over the life of the agreement and allocate the use of conserved water from the All American Canal and Coachella Canal Lining Projects."

53. On page 6-55, paragraph 2, revise the sentences: "An appeal was filed and a temporary stay immediately granted, which was later made permanent pending outcome of the appeal. The stay allows the QSA water transfers to continue while the QSA parties appeal its invalidation."

    to read: "On December 7, 2011, the judgments in *Imperial Irrigation District v. All Persons Interested, POWER v. Imperial Irrigation District et al.*, and *County of Imperial v. Metropolitan Water District of Southern California et al.* were reversed, and the cases were remanded to the trial court for further proceedings consistent with the Court of Appeal's opinion."

54. On page 6-55, paragraph 2, revise the sentence: "The stay allows the QSA water transfers to continue while the QSA parties appeal its invalidation."

    to read: "The QSA and related agreements continue to be implemented."

55. On page 6-57, paragraph 2, revise the sentence: "Meanwhile, higher-priority users are beginning to take their full apportionment of Colorado River water, which could eventually reduce the amount of water available to Metropolitan to 550,000 AF, which is its fourth priority right, plus what water can be made available from conservation programs with the IID and other agricultural-to-urban water transfers."

    to read: "Meanwhile, Arizona and Nevada have in the recent past used more of their apportionment of Colorado River water, and California has reduced its use, with Metropolitan using its basic apportionment, plus the amount of water made available from conservation and land fallowing programs with IID, CVWD, and PVID, the storage program with the Central Arizona Water Conservation District, and delivery of Intentionally Created Surplus, minus the use of water by holders of Indian and miscellaneous present perfected rights in excess of 14,500 acre-feet and the creation of Intentionally Created Surplus."

56. On page 6-57, paragraph 3, revise the sentence: "The operational constraint is that this water needs to be blended with SWP supplies to meet the target salinity of 500 mg/L of TDS."

    to read: "While this water is blended with SWP supplies in portions of Metropolitan's distribution system to meet a target salinity of 500 mg/L of TDS, the salinity of Colorado River water is not a constraint in Metropolitan's diversion of Colorado River water."

57. On page 6-58, paragraph 2, revise the sentence: "The guiding principle of the WSDM Plan is to encourage storage of water during periods of surplus and work with its member agencies to minimize impacts of water shortages during periods of shortage."

A_MWD 2

to read: "The guiding principle of the WSDM Plan is to encourage storage of water during periods of surplus and for Metropolitan to work with its member agencies to minimize impacts of water shortages during periods of shortage."

58. On page 7-7, paragraph 1, revise the sentence: "Additionally, Metropolitan in collaboration with Metropolitan Water District of Orange County (MWDOC) and other Metropolitan member agencies is in the process of developing a Long Term Conservation Plan, which seeks an aggressive water use efficiency target in order to achieve a 20 percent reduction in per capita water use by 2020 for the entire Metropolitan service area."

    to read: "Additionally, Metropolitan in collaboration with the Municipal Water District of Orange County (MWDOC) and other Metropolitan member agencies is in the process of developing a Long Term Conservation Plan, which seeks an aggressive water use efficiency target in order to achieve a 20 percent reduction in per capita water use by 2020 for the entire Metropolitan service area."

Specific Comments

Phase I Comments

Issue	Page	Comment
Project Purpose and Objectives		
	7-4, 2nd bullet	This bullet describes a project purpose as reducing dependence on imported water. This description incorrectly assumes that groundwater extracted from the Cadiz Project is not "imported" water. The project description makes clear that the groundwater basin is located outside the service areas of each of the proposed Project Participants, and the water will necessarily have to be conveyed from outside Metropolitan's service area through the Colorado River Aqueduct. The description should be revised to correct the mischaracterization of the Project's water supply.
	ES-4, 3-2, 3-4, 3-15	Different Project delivery rates are referenced throughout the DEIR. These include 50,000 AFY on average over the 50-year term, and a maximum of 75,000 AFY for the Groundwater Conservation and Recovery Component, and 105,000 AFY upon Implementation of the Imported Water Storage Component. The Project Description chapter of the Final EIR should also identify the operating criteria for delivery of Project water, e.g., how often and for how long would the Project deliver water to the CRA and how many years out of the 50-year term would the Project be expected to deliver water. The Final EIR should identify the potential number of years in which capacity would be available in the CRA to take delivery of Project water.
	ES-2	The DEIR indicates that the Project could augment current water supplies for Project participants but some of the Project analyses favor the assumption that the Project would be an alternative to existing water supplies so that impacts can be considered less than significant. This may not be accurate where the Project is providing a new or additional water source. For example on page ES-2, the DEIR indicates *"Moreover, the conservation and resulting water supply augmentation can be achieved independently from the environmental and regulatory conditions that generally constrain the importation of water to Southern California."* On the other hand, on the same page the DEIR indicates "The Project would optimize the reasonable and beneficial use of water within the aquifer system in a sustainable fashion—conserving water that would otherwise be wasted—to create a local water supply alternative for Southern California water providers."
	4.7-24, Section 4.7.3, last paragraph	With respect to the sentence, "The additional storage provided by the Project would make up for the lack of water supplies during drought periods when other water supplies are unavailable," what volumes were assumed for the lacking water supply, and does the Project have sufficient capacity to convey the supplies necessary to make up for

A_MWD 2

	the "lack of water" during drought periods?
6-10, Section, 6.2.1, Paragraph 3	The percentages cited for multi-year wet or dry periods do not correspond to the Department of Water Resources' 2009 Delivery Reliability Report; please clarify what multi-year wet or dry period is being cited. The reliability of the State Water Project (SWP) system is shown as ranging from 71 to 93 percent in a 2-year wet period and 36-38 percent in a 2-year dry period according to the 2009 Delivery Reliability Report.
Project Description	
3-2, paragraph 5	The text indicates the maximum annual volume of water available for export, but does not discuss any potential limitations imposed by CRA capacity availability.
3-5, section 3.1.2, paragraph 2	The statement that all Project facilities will be constructed on private land is incorrect. The Project includes facilities located on land owned by Metropolitan, a government agency.
3-5, paragraph 4	The proposed intertie with the CRA is upstream of the Freda Siphon, which is about 3/4-mile easterly of the railroad. Thus a portion of the pipeline (and all of the intertie facilities) must be constructed on Metropolitan property. To provide adequate setback from the CRA, the Project may require construction on undisturbed land.
3-15, paragraph 1	A pump station at the tie-in with the CRA will require an equalization basin to buffer flows between the Project and the CRA; a direct tie-in between the CRA and the indicated pump station will not be acceptable to Metropolitan's CRA operations.
3-15, paragraph 3	The duration of the operation of the first phase to make the second phase viable should be indicated.
3-34, paragraph 4	In Option 1, the only pumps indicated to convey water to the CRA are at the well head. Since the conveyance pipeline has an intermediate high point near Chubbuck, which is at a higher elevation than the CRA tie-in point, a pressure-control structure must be built in conjunction with the afterbay to match the hydraulic grade line of the CRA and ensure that the CRA is not overtopped.
3-34, paragraph 4	The water conveyance pipeline should not be connected directly to the CRA and discharge directly into the CRA. A stabilization reservoir must separate the CRA from the conveyance pipeline, and include valves/gates which allow complete isolation of the

	equalization reservoir from the CRA.
3-34, paragraph 4	In the event of operational failure of any Project facility or Project element, fail-safe mechanisms and constructed safeguards should exist to preclude any impacts to the CRA. Necessary design and operational safeguards to protect the integrity of the CRA should be addressed. The Project should include operational procedures and facility designs to accommodate water within the conveyance pipeline (storage) if the CRA pumps downstream of the intertie facilities shutdown unexpectedly, such as in a power loss.
3-34 and 3-36	The description of the two options for connecting the Project to the CRA both state that they will provide for two hours of flow at 250 cubic feet per second (cfs); but one is a 5,000 square foot (sq. ft.) reservoir holding 10.7 million gallons, and the other is a 25 acre reservoir holding 32.8 acre-feet. The document should explain how both can hold the same two hours of flow at 250 cfs given the disparity in size; or provide a correct description of the holding capacity of each facility. A 5,000 square foot forebay will not hold the indicated 10.7 million gallons, unless the sides of the forebay were in excess of 275 feet high. The much larger forebay indicated in Option 2 would be required.
3-47, paragraph 3	The construction of the forebay (equalization basin) will be required and should be described.
3-54, paragraph 5	Additional Metropolitan approvals would involve planned operation and coordination protocols for the Project as well as emergency and contingency protocols. Metropolitan would also need to review and approve the design of any modifications to the CRA.
3-13 and Appendix B-1, page 17	Section 1.5.1, last sentence of the 1st paragraph indicates that Project participants can carryover their annual allocations by storing their water in the basin for later extraction and delivery as part of Phase 1. This feature is not described as part of the Groundwater Conservation and Recovery Component in the Project Components section of the Executive Summary.
Appendix B-1, page 28	Table 2-2 includes only select constituents from a single agricultural well on the Cadiz property and Table 2-3 provides data from single samples from four additional wells. A greater characterization of groundwater quality showing multiple well locations and full Title 22 California Code of Regulations constituent list must be provided.

	The text notes that some treatment may be required for hexavalent chromium before the groundwater is introduced into the CRA. The Final EIR should identify and discuss the environmental impacts of the construction and operation of treatment facilities that would need to be included to ensure that the Project can be operated.
Appendix B-1, Chapter 6	The Groundwater Management, Monitoring and Mitigation Plan (GMMP) is proposed for monitoring specific criteria that would trigger review of changes in conditions and identify corrective measures that would be implemented to avoid adverse impacts. In addition to total dissolved solids (TDS), the GMMP should include monitoring of multiple constituents that are regulated or potentially regulated for drinking water supplies.

CRA Operations

4.7-20, W-3	In the third paragraph it is stated that the Project will utilize "excess CRA capacity when available." There is no information provided on how likely the "excess capacity" would be or for how long it would occur. It is stated on page 3-13 that pumping would occur 10 months out of the year. It is unclear if any excess capacity would be available for such long periods or how many years during the term of the Project that excess capacity would be available.
3-22, paragraph 3	The CRA is not pressurized in the area of the planned intertie with the planned conveyance pipeline. Exported water deliveries into the CRA must be compatible with the hydraulic grade line of CRA. A pressure control structure at the CRA tie-in must be included in the first project phase to ensure that the hydraulic grade line of the CRA is not exceeded since it is expected that the conveyance pipeline will be operated under pressure. An equalization reservoir will also be needed at the CRA intertie for the first phase of the Project.
3-22, paragraph 5	A pump station at the tie-in with the CRA will require an equalization basin; a direct tie-in between the CRA and the indicated pump station will not be acceptable for Metropolitan's CRA operations.
3-34, paragraph 4	Operational and control facilities needed to ensure coordinated operations between the CRA and the Project conveyance pipeline should be addressed.
3-36, paragraph 2	Either Option 2 scenario will require the construction of a pressure-control structure in conjunction with the equalization reservoir to match the hydraulic grade line of the CRA and ensure that the CRA is not overtopped.

3-36, paragraph 5	Option 2b requires that the intermediate pump will operate 8 hours a day, 365 days a year. This presumes that the CRA will always be available as source water for the Cadiz Project conveyance pipeline, which may not be consistent with Metropolitan operations.
3-50, paragraph 1	It is indicated that construction traffic for the tie-in facilities would cross the CRA over the Frieda Siphon. Analysis of potential impacts to the CRA as a result of this traffic is needed, as is identification of measures to avoid or minimize impacts. Heavy equipment may require additional protections to be constructed to avoid damaging the facility.
3-36, Option 2B	Option 2b indicates that water would be pumped from an equalization storage reservoir to the CRA 8 hours per day. This option is not feasible as this would impact Metropolitan's operations and require the pump plants to turn on and off their lift pumps every day to chase the flow changes. The operational analysis should be based on delivery to the CRA on a continuous basis for the time period required to deliver all the Project water in any year.
3-14, 3-15, 3-26	Based on the statement on page 3-26 that well pumps are assumed to operate 24 hours a day, 365 days a year, the proposed annual pumping scenario of 50,000 to 75,000 acre-feet would require inflow to the CRA of 83 to 125 cfs for 10 months.
3-34, paragraph 2	The proposed operational strategies are not consistent with Metropolitan's current CRA operational practice of maximizing flow at a set number of pumps.
3-34, Option 1a	Copper Basin inflow reduction would be difficult to achieve. Canal levels are controlled by operators, rather than automatic SCADA controls. The proposed Project inflow point is approximately 45 miles from the Copper Basin Gates. Operators lack the continuous, daily, precision, quick-start-and-stop water control to be able to compensate for increases and decreases in flow originating 45 miles downstream. The CRA is not designed to control frequent large quantity flow changes.
3-34, Option 1b	Pump Discharge Gates Throttle. Pump plant head gates do not have the capacity to throttle such a large input of water as proposed under this scenario. Instead, three downstream pump plants, Iron Mountain, Eagle Mountain and Hinds, would have to start and stop pumps in attempts to synchronize with flow increases and decreases associated with starting and stopping the flow of water from the Project into the CRA. The pumps are not designed for frequent starts. Pump wear and tear would be significant.

3-36, Option 2	It is not clear how the proposed small equalization reservoir would be able to consistently equalize flows along the 60 mile length of canal from Copper Basin to Iron Mountain Pump Plant.
3-50, paragraph 4	The tie-in to the Project facilities with the CRA will require at least one shutdown of the CRA. Shutdowns for the CRA typically occur in February. The Project construction schedule needs to consider this constraint.

Cultural Resources

4.5-25	As noted in the DEIR, the CRA has been determined to be eligible for inclusion in the National Register of Historic Places (NRHP). As such, Metropolitan is concerned that any work in the vicinity of or on the CRA not materially impact characteristics of the CRA that convey its historical significance. Metropolitan will require that materials and aesthetics of new facilities over which it has approval be consistent with those used in the CRA.

Energy Usage and Greenhouse Gas Emissions

4.7-21, paragraph 1	Greenhouse Gas Emissions are discussed. It is indicated that the Project would have direct emissions of over 28,000 million metric tons of CO_2e ($MTCO_2e$)/year. The proposed solution is to purchase carbon offsets to reduce the amount to 10,000 $MTCO_2e$/year. It is unclear from the DEIR whether the Project, as a generator of electricity with direct emissions, would be able to solely use offsets as the emission compliance mechanism. Discussion is needed in the Final EIR whether the Project would have to acquire allowances as other electricity generators are required to do under Cap and Trade (AB 32 of 2006, California Global Warming Solutions Act of 2006).
4.7-22, paragraph 1	The Draft EIR states that the energy required for the groundwater recovery project is 3,112 kWh/MG (1,017 kWh/acre-foot), less than half of the energy required for the SWP West Branch (2,500 kWh/AF). This is the amount of energy needed to move the water from the Project wellfield and into the CRA. The water ties into the CRA prior to the Iron Mountain pump plant and therefore must be conveyed through the Iron Mountain, Eagle Mountain, and Hinds pump plants. Considering lifts of each pump station, then the Project water would require an additional 1,270 kWh/AF (63% of the CRA energy requirement) to be conveyed through the CRA. This equates to approximately 2,290 kWh/AF or nearly that of the SWP West Branch.

Criterion C Table 4.7-4	The Project is justified as being more energy efficient than the State Water Project (SWP) (7,672 kWh/MG). However, analysis does not consider the CRA pumping that would be required to deliver the Project water to Metropolitan's service area. The value provided, 3,112 kWh/MG, only considers the energy needed to convey the Project water to the CRA. Project water would have to be pumped through three CRA pumping plants for an additional 3,763 kWh/MG to reach Metropolitan's service area to be able to displace SWP water. The total, 6,875 kWh/MG is about 90% of the stated energy requirement for SWP water. This value, 6,875 kWh/MG, is what should be utilized when comparing Project energy efficiency to the SWP. In addition, the SWP supplies about 50% of the SWP energy requirements from large hydro and other renewables. If the Project utilizes natural gas generators for its power, there may be a higher greenhouse gas contribution from the Project than from the SWP, even if the SWP requires 10% more energy for the same amount of water.
4.7-20, 4.7-22, 4.13-17	The Draft EIR makes the erroneous assumption that the water could be conveyed without increasing the energy required to operate the CRA. Metropolitan operates its system as efficiently as possible and avoids unused capacity in its system. Regardless of which of the proposed tie-in options (p. 3-34 to 3-36) would be built, the additional water will require additional energy to be conveyed. If Metropolitan reduces flows from Copper Basin to accommodate the Project water, additional energy would be required to convey the displaced Colorado River water at a later time. If the pump discharge gates are throttled, the Draft EIR acknowledges that more energy use would be required. If the Project is designed to provide a single pump flow to be conveyed with any available pump, the energy for that pump is energy that Metropolitan would not otherwise use. The analysis of energy use and GHG emissions also uses the SWP as the only comparison for the impacts of using Project water. Energy use and GHG emissions should be compared to Other Supply Sources identified in Section 7.4.5, and Metropolitan's 2010 Regional Urban Water Management Plan.

Geology and Soils

3-34, paragraph 3	The long-term stability of a large forebay reservoir adjacent to the CRA must be provided; the failure of an adjacent reservoir could undermine and compromise the CRA. It is questionable if an earthen reservoir only lined with hypalon will provide the necessary long-term stability and durability required.
3-47, paragraph 2	Since the conveyance pipeline will also be constructed adjacent to the CRA, construction methods for new structures and facilities that do

	not impact the CRA will be required and should be addressed. Impacts would include induced loads on CRA facilities, induced ground settlement of CRA facilities, and stability of the CRA due to adjacent excavation. In addition, existing drainage facilities that currently protect the CRA and are removed for construction must be rebuilt and/or reconfigured.
3-47, paragraph 5	Although no imported soils are indicated to be required, to ensure proper construction and reliability for the portion of the pipeline built near the CRA, proper bedding and backfill around the conveyance pipeline will be required. To ensure that this occurs, standard pipeline construction practice typically uses processed sandy soils for bedding and backfill. It should be confirmed that suitable soils that can be processed to create these materials exist along the conveyance pipeline alignment.
4.6-35, paragraph 6	The impact analysis does not evaluate any potential Geology and Soil impacts for the intertie facilities or the pipeline portion along the CRA; impacts are only discussed for the well field facilities and conveyance along the ARZC right-of-way.
4.6-35, paragraph 6	The impact analysis does not evaluate any potential Geology and Soil impacts for potential leakage from the necessary equalization basin adjacent to the CRA. Such impacts from leakage would include induced hydroconsolidation and soil collapse potential, erosion potential, and ground saturation potential.
4.9-74, paragraph 6 4.9-78, paragraph 5	The impact analysis should include drainages that will be modified in the area of the tie-in facilities between the CRA and conveyance pipeline, including the pumping plant.
4.13-12, paragraph 2	Since the pipeline and facilities related to the intertie will likely require modification of existing storm flow diversion berms upslope of the CRA, this mitigation measure should be expanded to include the approval of Metropolitan.
4.13-16, paragraph 2	Potential impacts to the existing CRA by the construction of the pipeline and intertie facilities should be addressed.
4.13-19, paragraph 10	Impacts to Metropolitan's existing drainage berms should be addressed by additional construction at the intertie facility to accommodate the Imported Water Storage Project Component if it is considered in the Final EIR.

4.13-21, paragraph 10	Potential impacts to the existing CRA by the construction of additional intertie facilities to accommodate the Imported Water Storage Project Component if it is considered in the Final EIR should be addressed.

Groundwater

ES-24, paragraph 1	Please clarify how impacts to groundwater would be less than significant with mitigation if the Project is drawing down the water table? It is not clear how the proposed measures would mitigate for the identified impacts. Additionally, please include discussion of any effects on Metropolitan's CRA water supplies that might result from implementation of these measures.
	The Final EIR should include discussion of the impacts of pumping and artificial recharge on the water quality of the groundwater basin (i.e., leaching of constituents from subsurface deposits, changes in groundwater chemistry) and subsequent water quality effects of pumping into the CRA.

Hydraulics

	In order to fully evaluate the hydraulic impacts to the CRA, a detailed operating plan and steady-state hydraulic analysis is required, accompanied with a Hydraulic Plan & Profile for the proposed conveyance pipeline and system when pumping water from the well-field to the CRA.
	In order to fully evaluate the hydraulic impacts to the CRA, a detailed operating plan and transient analysis is required for the proposed conveyance pipeline and system when pumping water from the Cadiz well-field to the CRA.
3-13, paragraph 6	The stated objective is to convey up to a maximum of 75,000 acre-feet/year during a 10-month delivery schedule from the Project well field to the CRA for the 50-year life of the Project. Assuming continuous pumping (24/7) during the 10-month delivery schedule, the calculated flow rate delivered to the CRA from the Project well field will be approximately 125 cfs. The CRA is typically shutdown for approximately one month every year for maintenance and repairs, therefore the aqueduct will need to have sufficient capacity above normal deliveries to accommodate the proposed flow delivery year-round. It is not likely the CRA can accommodate such a pumping scheme.
3-26, paragraph 5	The proposed 43-mile pipeline would consist of a single barrel with a nominal design flow capacity of 250 cfs and a pipeline diameter

	between 54 and 84 inches. It is not clear during what period of the year a flow rate of 250 cfs would be pumped from the well field to the CRA. For a flow rate of 125 cfs, the flow velocity would be approximately 7.8 feet per second (fps) for a 54-inch diameter and 3.2 fps for a 84-inch diameter pipeline. For a flow rate equal to 250 cfs, the flow velocity would be approximately 15.7 fps for a 54-inch diameter and 6.5 fps for a 84-inch diameter pipeline. The 15.7 fps velocity is too high for normal operation and would not be acceptable.
3-34, paragraph 4	CRA Tie-in Option 1 includes a small 5,000 square-foot forebay that would be constructed to stabilize and meter flow into the CRA. The approximate capacity of the forebay would be 10.7 million gallons. To accommodate such a small surface area and such a large volume, the forebay would be required to be approximately 286 feet deep. The proposed design is not feasible. Additionally, the DEIR states the sizing of the forebay is based on storing a flow rate of 250 cfs for up to two hours. This translates into a volume of approximately 13.5 million gallons and not 10.7 million gallons as stated in the DEIR.
3-36, paragraph 2	CRA Tie-in Option 2 includes an equalization storage reservoir of approximately 25 acres and a capacity of 32.8 acre-feet that would be constructed to store a flow rate of 250 cfs for up to two hours. The reservoir surface area and capacity would translate to a depth of approximately 1.3 feet. It will not be practical to operate the facility with such a shallow depth. Additionally, the 32.8 acre-foot capacity is equivalent to approximately 10.7 million gallons. A flow rate of 250 cfs for two hours will produce a volume of approximately 13.5 million gallons and not 10.7 million gallons as stated in the DEIR. This option proposes pumping water to the CRA eight hours a day, 365 days a year, at a flow rate between 125 and 220 cfs. The CRA cannot accommodate such a year-round pumping scheme.
3-34 to 3-36	Neither Option 1 nor Option 2 of the CRA tie-in Options addresses the possibility of pump trips along the CRA and the need to be able to contain and/or reject the full flow being pumped from the well field to the CRA.
3-24 to 3-26	Neither Option 1 nor Option 2 of the CRA tie-in options addresses the fact that because of the elevation difference between the wellfield and the CRA, it is likely that a pressure regulating/control structure(s) may be required to break excess head before discharging water into the proposed forebay or equalization storage reservoir when delivering flow to the CRA.

Water Quality

3-53, Last paragraph	Since source water will be impacted by the Project, Metropolitan recommends that the California Department of Public Health (CDPH) be included on the list of agencies whose approval is required for the Project.
4.9-40, paragraph 2; fn. 182	The Draft EIR cites the Vallecito Water District as the source of data on the salinity levels in water delivered through Metropolitan's Colorado River Aqueduct. The salinity figure should be 630 mg/L, rather than 650 mg/L. The correct figure is the long-term average stated in Metropolitan's 2010 Regional Urban Water Management Plan at page 4-3.
4.9-55, Last paragraph	The Draft EIR calculates potential water quality impacts to Metropolitan's Colorado River water supplies based on the delivery of up to 75,000 af of groundwater being only 6% of the total volume of water that can be carried in the CRA. This is an incorrect calculation of the potential impact in the event that the CRA is not operating at full capacity. For example, in recent years Metropolitan has conveyed less than 750,000 acre-feet, meaning that a full delivery of Project water would equal or exceed 10% of the CRA flows. The maximum percent of Project water would be 50%, when the maximum Project flow and the minimum CRA flow are considered, rather than the maximum Project flow and maximum CRA flow. The Final EIR must consider whether water quality impacts may be significant in years when a full delivery of Project water would be added to lower flows of Colorado River water in the CRA.
3-12, Figure 3-3b	Time 4 indicates excess pumping will result in brine near the dry lake moving towards the pumping well. This is a water quality concern for Metropolitan that needs to be addressed in greater detail.
4.9-39	Greater water quality characterization is needed beyond just TDS and general minerals. Discuss specific constituents of concern such as inorganic contaminants (i.e. arsenic, hexavalent chromium, etc.) and radionuclides.
4.9-40, last paragraph	TDS levels in Colorado River have on occasion exceeded 600 mg/L since 1985 (e.g., see Table 4.9-3 which indicates 2007 values of 647 to 673.8) contrary to the statement that TDS levels have been reduced to below 600 mg/L since 1985.
4.9-48, paragraph 1	The environmental impact analysis should include an assessment of the Project's impacts to CRA water quality, which should also be

summarized in Tables ES-1 and ES-2 .

4.9-55, paragraph 2 & 4.9-57, Table 4.9-8	This table shows only 8 of the 180 regulated constituents. Water quality for all constituents should be shown. Also, a section should be included to discuss projected Project water quality and potential impacts to CRA water quality.
4.9-58	Hydro-3 appears to address only issues that are experienced by local landowners. Impacts to water quality can be difficult to reverse. The mitigation measure should include a comprehensive monitoring program by the Project proponent to ensure no impacts to water quality.
Appendix B-1, Table 2.3	Chromium 6 levels are 14-16 µg/L, well above the Office of Environmental Health Hazard Assessment (OEHHA) Public Health Goal (PHG) of 0.02 µg/L. The Project water quality would not be acceptable for pumping directly into the CRA without treatment. The Final EIR must identify and analyze the environmental impacts of constructing and operating the treatment facilities required to introduce the Project water into the CRA.
4.9-55	The water quality analysis in part relies on faulty reasoning. The Draft EIR assumes that "all of the water would be further treated at the water purveyor's treatment facilities," however, deliveries are made from the CRA to other groundwater basins without treatment (e.g., Metropolitan delivers Colorado River water to Coachella Valley Water District by releasing water for storage in groundwater basins in the Coachella Valley).

Additional Analyses

1-8, Jurupa	The Jurupa Community Services District is not identified as an agency that purchases water from Metropolitan; so it would appear that additional water connection facilities would be required for the Project water to be delivered through Metropolitan's CRA to JCSD. Those facilities should be described, and the environmental impacts of their construction and operation analyzed in the Final EIR. The JCSD 2010 Urban Water Management Plan cited as the source for the description of this Project participant notes that JCSD is "pursuing an option" to construct a water delivery connection to Western Municipal Water District, a Metropolitan member agency. (JCSD 2010 Urban Water Management Plan, p. 29). If that connection is to serve as the delivery point for Project water deliveries to JCSD, the Final EIR should consider the environmental effects of construction and operation of that connection.

3-40, paragraph 6	Additional uses of Project water such as washing railcars and controlling vegetation could result in erosion and runoff impacts to source water. Please provide analyses for these proposed uses.
3-48, paragraph 5	The staging area identified within the CRA right of way at the south end of the Project facilities would probably include disturbance of currently undisturbed land.
3-49, paragraph 2	The staging area identified adjacent to the CRA at the south end of the Project facilities could include a temporary housing facility. The environmental effects of such a facility must be analyzed.
3-51, paragraph 2	The diversion structure for the Imported Water Component will require a large equalization reservoir between the pump house and the tie-in with the CRA. This facility should be included in the construction discussion, including construction grading required.
4.13-12, paragraph 4	The forebay/equalization basin at the tie-in location will be required and the air quality analyses should include construction of this facility.
4.4-39, paragraph 3	The discussion of impacts, including land disturbance, for the pipeline construction only refers to the portion on the ARZC right-of-way. The text should also describe the anticipated impacts to the pipeline and tie-in portions of the Project that will be constructed within the CRA right-of-way.
4.4-40, Table 4.4-2	The table should include impacts that will occur on the CRA right-of-way.

PHASE II Comments

Project Description

2-10, 3-15	The Draft EIR does not identify a source of imported water that any potential participants would utilize to implement the Imported Water Storage Component. Rather, the Draft EIR notes that the two potential sources of such water (the State Water Project and Colorado River) are facing reductions in deliveries. The purpose and need for the storage component of the Project must include a discussion of whether, and to what extent, water supplies from these two sources would be available for storage and what other alternatives for storage of these supplies are available that may have lesser environmental impacts. The Draft EIR acknowledges the complete lack of information as to "the sources of imported water, the possibility of banking both Colorado River and other water, and the potential quantity and schedule for spreading, storage and extraction." There is simply insufficient information to consider the storage of imported

	water as a component of the Project at this time.
3-4, paragraph 3	The Imported Water Storage Component proposes to store up to 1 million acre-feet at any given time, yet the purpose of the Groundwater Conservation and Recovery Component is to capture and export waters that are currently being lost to evaporation and/or mixing with saline waters. Since it must be presumed that sufficient waters will be exported (assuming available CRA capacity) to make room for import and storage, the text should indicate the necessary/intended delay between Project components to make the import phase valid, if the Imported Water Storage Component is considered in the Final EIR.
3-41,Paragraph 4	The text indicates that the pump station for the Imported Water Storage Component will pump water directly out of the CRA. An intermediate forebay to buffer withdrawals from the CRA will be required. The Project proponent could consider designing and using the equalization reservoir necessary for the Groundwater Conservation and Recovery Component for this purpose if the Imported Water Storage Component is considered in the Final EIR.
3-42, Figure 3-13	The inclusion of the potential to store water imported from the State Water Project is not sufficiently described in the Draft EIR to allow informed decision-making. For example, the existing natural gas pipelines that would be used to convey the water to the Cadiz property are described as extending to Kern County, but the map of the pipeline only extends to Barstow in San Bernardino County (Figure 3-13). In order to determine potential environmental impacts from the use of these existing pipelines, there should be a discussion (as there is for imported water from the Colorado River) of the required pumping facilities and power demands required to convey the water from the SWP to the Cadiz property. It is not clear from the Draft EIR whether any of the existing pipelines are in proximity to any SWP facility, what distance and topography would be crossed to connect to the SWP facility, and what amount of power would be required to convey the water over the intervening distances and heights.
4.13-22, Last paragraph	The Imported Water Storage Component is described as returning up to"105,000 150,000 AFY" of previously stored water. Should this be 105,000 AFY?
ES-4	The Project proposes to use existing unused natural gas pipelines formerly used for oil and natural gas conveyance. Please describe how the natural gas lines will be cleaned prior to use for drinking water, and the environmental effects associated with doing so.

1-3 to 1-4, 2-10, 3-15, 3-22 The description of the Imported Water Storage Component states that no participants for this component of the Project have been identified, but that such participants must have either Colorado River or State Water Project water rights. Santa Margarita Water District has neither. It is inappropriate for the lead agency for this document to assume the role of lead agency for a project in which it may not be a participant. As lead agency, Santa Margarita would be making decisions about the impacts and appropriate mitigation for the facilities (e.g., spreading basins, pump station) that would be constructed solely for the storage component. The proper lead agency for such analysis of the storage component facilities would be the County of San Bernardino, which has stated in its Land Use Services Department comment letter on the Notice of Preparation that it should have the lead agency role for the Project. (App. A, Attach. 5)

Project Need and Objectives

2-10 In the discussion of the purpose of the Imported Water Storage Component, the Draft EIR makes an assumption that there is "needed water storage space for southern California water providers" and "the ability to store up to 1 million AF of water would greatly enhance water supply reliability." There is no citation or discussion to support this assumption. Since the potential environmental impacts of the Project must be weighed against the available alternatives, the Final EIR must include an analysis of the available water storage capacity for southern California water providers. (California Environmental Quality Act [CEQA] Guidelines, sections 15124(b), 15126.6) The Draft EIR fails to include any such data, which is readily available for both Colorado River and State Water Project supplies.

In 2007, Metropolitan published a survey of groundwater storage within its service area (available at: www.mwdh2o.com/mwdh2o/pages/yourwater/supply/groundwater/GWAS.html). This survey showed the available storage capacity was 3.2 million acre-feet in 2005. In November 2011, Metropolitan updated this information with a report presented to the Water Planning and Stewardship Committee of its Board of Directors, showing that available in-service-area groundwater storage capacity had increased to 3.6 million acre-feet. (Available through the Archived Meetings link on the Metropolitan website at: http://www.mwdh2o.com/mwdh2o/pages/board/videostream/.) In addition to this in-service-area storage, there is out-of-service area storage available as well. For example, in 2007 the Bureau of Reclamation adopted guidelines allowing storage of Colorado River water in Lake Mead by contractors including Metropolitan (called Intentionally Created Surplus), with a cumulative total of 1.5 million

acre-feet of Extraordinary Conservation Intentionally Created Surplus capacity for California. (73 Fed. Register 19873, 19887 (April 11, 2008).) As of 2010, California had only utilized 179,240 acre-feet of this storage (Extraordinary Conservation Intentionally Created Surplus). (U.S. Bureau of Reclamation, 2010 Colorado River Accounting and Water Use Report, p. 44.) Metropolitan estimates that as of December 31, 2011, California has utilized less than 325,000 acre-feet of this storage for Extraordinary Conservation Intentionally Created Surplus based on preliminary information available at: http://www.usbr.gov/lc/region/g4000/hourly/forecast11.pdf. In addition, under an arrangement with Desert Water Agency, and Coachella Valley Water District, Metropolitan can deliver water in advance to those agencies, permitting the storage of 800,000 acre-feet in the Coachella Valley groundwater basin. As of January 1, 2012, 191,000 acre-feet was in storage. These reports show that there is significant unused surface and groundwater storage for imported water supplies that would be available to serve southern California. The assumption stated in the Draft EIR that additional water storage is needed requires further analysis to support the purpose and need for the Imported Water Storage Component of the Project.

Alternatives

In the absence of identification of actual participants in the Imported Water Storage Component, the Final EIR cannot properly identify and analyze feasible alternatives. The discussion of alternatives makes this clear, as alternative storage sites are rejected for analysis because "it involves identifying other programs to satisfy storage needs" (p. 7-50.) That is the purpose of the CEQA requirement to consider feasible alternatives. As previously noted, Metropolitan has documented the existence of over 3 million acre feet of available storage capacity within its service area. Contrary to the unsupported assumption stated in the Draft EIR, it is not reasonable to conclude that there would be greater impacts from utilizing groundwater storage within Metropolitan's service area compared to the pumping facilities required to be constructed and operated to convey water from the CRA to the Cadiz property, the basins required to be constructed and maintained to allow that water to be infiltrated into the groundwater basin, and the power and potential water treatment required to return the water to the CRA for pumping into Metropolitan's service area. The statement that other groundwater storage programs have the potential for greater impacts than Phase 2 of the Project is simply incorrect and unsupportable.

Energy and Greenhouse Gas Emissions

4.12-22 The energy use and related greenhouse-gas emissions analyses are inadequate for the Imported Water Storage Component. The analysis of

energy use notes "approximately twice as much energy" as would be required for the groundwater recovery component. This assumes that the elevations of the CRA and the Project wellfield are the same. However, if the CRA is at a lower elevation, more energy will be required to pump the water from the CRA to the Project wellfield. The analysis of energy use must be more thorough than the unsupported assumption used in the Draft EIR.

The Draft EIR also fails to include any calculation of the energy required to convey the Project water through the CRA. Instead, the document assumes that the water would be moved using no more energy than the CRA would use in moving the existing Colorado River water supplies. This assumption is unsupported by any analysis.

The greenhouse gas emissions analysis includes a statement that the storage component would use twice as much energy, but fails to quantify what GHG emissions would result from this energy use. Instead, the analysis makes a comparison of this energy use to that required to deliver water through the SWP or to build new surface storage. These are false comparisons. First, the alternatives to the use of the Project for storage are not delivery of SWP supplies or construction of surface storage. As already noted, the document fails to consider other available water storage options that may use significantly less energy and create significantly less GHG emissions than the Project would.

To make proper comparisons with other storage options, the energy use and GHG emissions of the storage component should be properly calculated and compared to those options.

Although the delivery of water imported from the SWP is identified as an element of the storage component, there is no data given or analysis of the energy use and greenhouse gas emissions related to conveying the water through the identified abandoned natural gas pipeline. Again, there is so little information provided for this element of the proposed Project that it should not be included in the Project description in the Final EIR.

Geology and Soils

4.6-40, paragraph 2	The impact analysis does not evaluate any potential Geology and Soil impacts to the CRA due to the construction of the intertie facilities for the Imported Water Storage Component.

Groundwater

3-15, paragraph 4	The DEIR states with respect to the Imported Water Storage Component that up to 1 MAF would be stored. Clarify how the volume of pumping

A_MWD 2

Metropolitan Water District
Specific Comments on the Cadiz Draft EIR

for the Groundwater Conservation and Recovery Component (Phase 1) compares to the volume of pumping for the Imported Water Storage Component (Phase 2) and the Conservation and Recovery Component combined and would the Phase 1 and 2 pumping combined affect the groundwater table and whether it induces the migration of brine into the freshwater source?

Water Quality

4.9-76, 2nd bullet	The 2nd bullet indicates that "CRA **or SWP** water.... Would have slightly higher TDS concentration (about 500-600 mg/L)". This is true of CRA water but SWP water TDS is lower (~200-350 mg/L).
4.9-77	A much more detailed water quality analysis should be provided to support the conclusion that impacts are less than significant with no mitigation measures required. As indicated in the DEIR, the Project will be subject to agreement with Metropolitan and its rules, regulations, and fees. Metropolitan would require that the Project not degrade CRA water quality or put responsibility on downstream treatment to address specific concerns. The Final EIR should include discussion of the impacts of pumping and artificial recharge on the water quality of the groundwater basin (i.e., leaching of constituents from subsurface deposits, changes in groundwater chemistry) and subsequent water quality effects of pumping into the CRA.

Additional Analyses

The DEIR does not address CRA operational issues or whether capacity exists to release the water for the Project's Imported Water Storage Component. In order to fully evaluate the hydraulic impacts to the CRA, a detailed operating plan and steady-state hydraulic analysis is required, accompanied with a Hydraulic Plan & Profile of the proposed conveyance pipeline and system when pumping water from the CRA to the Project spreading grounds.

In order to fully evaluate the hydraulic impacts to the CRA, a detailed operational plan and transient analysis is required for the proposed conveyance pipeline and system when pumping water from the CRA to the Project spreading grounds.

From: CHRISTINA CARO [christina@lozeaudrury.com]
Sent: Wednesday, May 23, 2012 2:41 PM
To: michelem@smwd.com
Cc: Cadiz Project
Subject: Cadiz Valley Water Conservation, Recovery, and Storage Project (SCH 2011031002)

Follow Up Flag: Follow up
Flag Status: Flagged

Ms. Miller:

This follows my voicemail to you. I was referred to you by Tom Barnes of ESA to inquire about the planned public release date of the Final EIR for the Cadiz Aqueduct Project (SCH 2011031002), and also to confirm that the Water District will be forwarding our office a copy of the Final EIR once released, pursuant to our December 11, 2011 CEQA and Land Use notice request letter (attached again for reference). I understand that the Draft EIR comment period closed on March 14, 2012, and that a Final EIR is currently being prepared. 1

If you could advise when the Final EIR will be released, and confirm that we will be sent a copy (electronically by email, if possible), I would appreciate it. Thank you.
Regards,
Christina M. Caro
Associate Attorney
Lozeau | Drury LLP
410 12th Street, Suite 250
Oakland, CA 94607
ph: (510) 836-4200
fax: (510) 836-4205
christina@lozeaudrury.com

From: CHRISTINA CARO [christina@lozeaudrury.com]
Sent: Wednesday, May 23, 2012 2:50 PM
To: michelem@smwd.com
Cc: Cadiz Project
Subject: Re: Cadiz Valley Water Conservation, Recovery, and Storage Project (SCH 2011031002)
Attachments: 2011.12.12 Cadiz Aqueduct Notice Request.pdf

Follow Up Flag: Follow up
Flag Status: Flagged

Ms. Miller: I neglected to attach our December 12, 2011 notice request letter to my last email. It is attached here for the District's reference. Thank you. 1

Christina M. Caro
Associate Attorney
Lozeau | Drury LLP
410 12th Street, Suite 250
Oakland, CA 94607
ph: (510) 836-4200
fax: (510) 836-4205
christina@lozeaudrury.com

From: CHRISTINA CARO <christina@lozeaudrury.com>
To: "michelem@smwd.com" <michelem@smwd.com>
Cc: "cadizproject@esassoc.com" <cadizproject@esassoc.com>
Sent: Wednesday, May 23, 2012 2:40 PM
Subject: Cadiz Valley Water Conservation, Recovery, and Storage Project (SCH 2011031002)

Ms. Miller:

This follows my voicemail to you. I was referred to you by Tom Barnes of ESA to inquire about the planned public release date of the Final EIR for the Cadiz Aqueduct Project (SCH 2011031002), and also to confirm that the Water District will be forwarding our office a copy of the Final EIR once released, pursuant to our December 11, 2011 CEQA and Land Use notice request letter (attached again for reference). I understand that the Draft EIR comment period closed on March 14, 2012, and that a Final EIR is currently being prepared.

If you could advise when the Final EIR will be released, and confirm that we will be sent a copy (electronically by email, if possible), I would appreciate it. Thank you.
Regards,
Christina M. Caro
Associate Attorney
Lozeau | Drury LLP
410 12th Street, Suite 250
Oakland, CA 94607
ph: (510) 836-4200

fax: (510) 836-4205
christina@lozeaudrury.com

LozeauDrury4

LOZEAU DRURY LLP
T: 510.836.4200
F: 510.836.4205
410 12th Street, Suite 250
Oakland, Ca 94607
www.lozeaudrury.com
richard@lozeaudrury.com

BY ELECTRONIC MAIL AND US MAIL

December 12, 2011

Mr. John Schatz, General Manager
Santa Margarita Water District Board of Directors
Santa Margarita Water District Administration Office
26111 Antonio Parkway
Rancho Santa Margarita, CA 92688
Email: custservice@smwd.com

CC: Tom Barnes
ESA
626 Wilshire Boulevard, Ste. 1100
Los Angeles, CA 90017
Email: cadizproject@esassoc.com

RE: CEQA and Land Use Notice Request for Cadiz Valley Water Conservation, Recovery, and Storage Project (State Clearinghouse No: 2011031002)

Dear Mr. Schatz, Mr. Barnes:

I am writing on behalf of Laborers International Union of North America, and its members living in San Bernardino County ("Commenters") to request that the Santa Margarita Water District ("District") put us on its notice list for any and all notices issued under California Planning and Zoning Law and/or the California Environmental Quality Act ("CEQA"), referring or related to the Cadiz Valley Water Conservation, Recovery, and Storage Project (State Clearinghouse No: 2011031002), a groundwater extraction project to be executed in two phases: Phase I, the Conservation and Recovery Component; Phase II is the Imported Water Storage Component, during which the Conservation and Recovery Component would be constructed to capture and conserve the average annual natural recharge in the Fenner and northern Bristol Valleys that would otherwise discharge to the Bristol and Cadiz Dry Lakes. The Project would construct extraction wells (wellfield) on property owned by Cadiz and a 42-mile underground water conveyance pipeline within an active railroad right-of-way that intersects the Colorado River Aqueduct (CRA). Phase II, the Imported Water Storage Component, would make available up to one million acre-feet (MAF) of groundwater storage space to be used as part of a conjunctive use project, conveying Colorado River water to recharge basins in the Fenner Valley to percolate into the ground for storage and future withdrawal as a dry-year supply (collectively, "Cadiz Project").

In particular, we hereby request that the District send by mail or electronic mail to our firm at the address below notice of any and all actions or hearings related to activities undertaken, authorized, approved, permitted, licensed, or certified by the District and any of its subdivisions, and/or supported, in whole or in part, through contracts, grants, subsidies, loans or other forms of assistance from the District, including, but not limited to the following:

- Notice of any public hearing in connection with the Project as required by California Planning and Zoning Law pursuant to Government Code Section 65091.
- Any and all notices prepared pursuant to the California Environmental Quality Act ("CEQA"), including, but not limited to:
  - Notices of any public hearing held pursuant to CEQA.
  - Notices of determination that an Environmental Impact Report ("EIR") or supplemental EIR is required for a project, prepared pursuant to Public Resources Code Section 21080.4.
  - Notices of availability of an EIR or a negative declaration for a project prepared pursuant to Public Resources Code Section 21152 and Section 15087 of Title 14 of the California Code of Regulations.
  - Notices of approval and/or determination to carry out a project, prepared pursuant to Public Resources Code Section 21152 or any other provision of law.
  - Notice of approval or certification of any EIR or negative declaration prepared pursuant to Public Resources Code Section 21152 or any other provision of law.
  - Notice of exemption from CEQA prepared pursuant to Public Resources Code section 21152 or any other provision of law.
  - Notice of any Final EIR prepared pursuant to CEQA.

Please note that we are requesting notices of CEQA actions and notices of any public hearings to be held under any provision of Title 7 of the California Government Code governing California Planning and Zoning Law. This request is filed pursuant to Public Resources Code Sections 21092.2, and 21167(f) and Government Code Section 65092, which require local agencies to mail such notices to any person who has filed a written request for them with the clerk of the agency's governing body.

Please send notice by electronic mail to:

Richard Drury
Lozeau Drury LLP
410 12th Street, Suite 250
Oakland, CA 94607
richard@lozeaudrury.com; christina@lozeaudrury.com

Please call should you have any questions. Thank you for your attention to this matter.

Sincerely,

Richard Drury
Christina Caro

From: CHRISTINA CARO [christina@lozeaudrury.com]
Sent: Friday, May 25, 2012 4:20 PM
To: michelem@smwd.com; cadizproject@smwd.com; Cadiz Project
Subject: Public Records Act Request re Cadiz Valley Water Conservation, Recovery and Storage Project
Attachments: 2012.05.25 PRA Request to District re Cadiz Draft EIR Comments.pdf

Follow Up Flag: Follow up
Flag Status: Flagged

Dear Ms. Miller, Mr. Barnes:

Attached please find a Public Records Act request regarding the Cadiz Valley Water Conservation, Recovery and Storage Project. Hard copies of the request will follow by mail.

This also follows my telephone conversation of May 23, 2012 with Ms. Miller. In our conversation, she confirmed that my office would be notified by email and mail when the Final EIR for the Cadiz Project is released, and of the opening of the comment period on the Final EIR, pursuant to our December 2011 Notice Request already on file with the District.

Thank you.

Regards,
Christina M. Caro
Associate Attorney
Lozeau | Drury LLP
410 12th Street, Suite 250
Oakland, CA 94607
ph: (510) 836-4200
fax: (510) 836-4205
christina@lozeaudrury.com

LOZEAU DRURY LLP
T 510.836.4200
F 510.836.4205
410 12th Street, Suite 250
Oakland, Ca 94607
www.lozeaudrury.com
christina@lozeaudrury.com

Via Email and U.S. Mail

May 25, 2012

Ms. Michelle Miller
Public Affairs Coordinator for Cadiz Valley Water Project
Santa Margarita Water District
26111 Antonio Parkway
Rancho Santa Margarita, CA 92688
Email: michelem@smwd.com; cadizproject@smwd.com

Tom Barnes
ESA
626 Wilshire Boulevard, Ste. 1100
Los Angeles, CA 90017
Email: cadizproject@esassoc.com

Re: **Public Records Act Request For Documents Related to Cadiz Valley Water Conservation, Recovery, and Storage Project (State Clearinghouse No. 2011031002)**

Dear Ms. Miller, Mr. Barnes:

I am writing on behalf of Laborers International Union of North America, and its members living in San Bernardino County ("LIUNA") pursuant to the **California Public Records Act**, Government Code Section 6250 et seq. ("PRA" or the "Act"). Pursuant to the Public Records Act, I request that the Santa Margarita Water District and ESA (collectively "District") make immediately available for inspection and copying the following documents referring or related to the Cadiz Valley Water Conservation, Recovery, and Storage Project (State Clearinghouse No: 2011031002), a groundwater extraction project to be executed in two phases: Phase I, the Conservation and Recovery Component; Phase II is the Imported Water Storage Component, during which the Conservation and Recovery Component would be constructed to capture and conserve the average annual natural recharge in the Fenner and northern Bristol Valleys that would otherwise discharge to the Bristol and Cadiz Dry Lakes. The Project would construct extraction wells (wellfield) on property owned by Cadiz and a 42-mile underground water conveyance pipeline within an active railroad right-of-way that intersects the Colorado River Aqueduct (CRA). Phase II, the Imported Water Storage Component, would make available up to one million acre-feet (MAF) of groundwater storage space to be used as part of a conjunctive use project, conveying Colorado River water to recharge basins in the Fenner Valley to percolate into the ground for storage and future withdrawal as a dry-year supply (collectively, "Cadiz Project"):

Any and all documents consisting of, referring, or relating to:

1) **Correspondence and any other documents, including reports, attachments, electronic correspondence or other supporting documentation, submitted by or on behalf of any public agencies, responsible agencies, organizations, individuals, private businesses or any other members of the public regarding, referring or relating to the Draft Environmental Impact Report ("EIR") for the Cadiz Project, including but not limited to documents submitted to the District**

1

pursuant to Cal. Pub. Resources Code §§ 21091, 21092 and 14 Cal. Code Regs. §§ 15000 et seq. ("CEQA Guidelines") §§ 15087, 15105, 15200-209 prior to, during, or after the CEQA comment periods for responsible agencies and the public.

2) **Any and all documents referenced within in the Draft EIR for the Cadiz Project, including but not limited to documents on which District staff or consultants expressly relied upon in preparing the Draft EIR.**

Please include in your response to this request the following examples of "documents," as well as any similar physical or electronic forms of communication: any form of writing such as correspondence, e-mails, legal and factual memoranda, facsimiles, photographs, maps, videotapes, film, data, reports, notes, audiotapes, or drawings.

We request *immediate access* to review the above documents pursuant to section 6253(a) of the Public Records Act, which requires public records to be "open to inspection *at all times* during the office hours of the state or local agency" and provides that "every person has a right to inspect *any public record*." (Gov. Code §6253(a) (emphasis added).)

This request seeks access to the above documents for inspection under Section 6253(a), and does not request that the District provide copies of these documents. Therefore, the ten day response period applicable to a "request for a *copy* of records" under Section 6253(c) does not apply to this request.

If any of the above requested documents are available online, please provide us with the URL web address at which the documents may be downloaded. If any of the requested documents are retained by the District in electronic computer-readable format such as PDF (portable document format), please provide us with pdf copies of the documents via email, or inform us of the location at which we can copy these documents electronically. We reserve the right to have a copy service make copies of any and all of the requested documents depending on the volume. We request, however, that the SWRCB also provide an estimate for the cost of making copies of the requested documents in the event copies are required.

In preparing your response, please bear in mind that you have an obligation under Government Code section 6253.1 to (1) identify all records and information responsive to our request or the purpose of our request; (2) describe the information technology and physical location in which the records exist; and (3) provide suggestions for overcoming any practical basis for denying access to the records or information sought.

In responding to this request, please bear in mind that any exemptions from disclosure you may otherwise believe to be applicable may be narrowed or eliminated by the recent adoption of Proposition 59, which amended article I, section 3(b)(2) of the California Constitution to direct that any "statute ... or other authority ... [that] limits the right of access" to "information concerning the conduct of the people's business" must be "narrowly construed." As for any records that you nonetheless decline to produce on the grounds of an exemption, please bear in mind that the case law under the Public Records Act imposes a duty on you to distinguish between the exempt and the non-exempt portion of any such records, and to attempt in good faith to redact the exempt portion and to disclose the balance of such documents.

1

O_LozeauDrury5

From: CHRISTINA CARO [christina@lozeaudrury.com]
Sent: Friday, May 25, 2012 4:20 PM
To: michelem@smwd.com; cadizproject@smwd.com; Cadiz Project
Subject: Public Records Act Request re Cadiz Valley Water Conservation, Recovery and Storage Project
Attachments: 2012.05.25 PRA Request to District re Cadiz Draft EIR Comments.pdf

Follow Up Flag: Follow up
Flag Status: Flagged

Dear Ms. Miller, Mr. Barnes:

Attached please find a Public Records Act request regarding the Cadiz Valley Water Conservation, Recovery and Storage Project. Hard copies of the request will follow by mail.

This also follows my telephone conversation of May 23, 2012 with Ms. Miller. In our conversation, she confirmed that my office would be notified by email and mail when the Final EIR for the Cadiz Project is released, and of the opening of the comment period on the Final EIR, pursuant to our December 2011 Notice Request already on file with the District.

Thank you.

Regards,
Christina M. Caro
Associate Attorney
Lozeau | Drury LLP
410 12th Street, Suite 250
Oakland, CA 94607
ph: (510) 836-4200
fax: (510) 836-4205
christina@lozeaudrury.com

O_LozeauDrury/LIUNA6

LOZEAU DRURY LLP
T 510.836.4200
F 510.836.4205
410 12th Street, Suite 250
Oakland, Ca 94607
www.lozeaudrury.com
christina@lozeaudrury.com

Via Email and U.S. Mail

June 22, 2012

Ms. Michelle Ouellette
Best Best and Krieger, LLP
3750 University Avenue, Suite 400
PO Box 1028
Riverside, CA 92502-1028
Email: Michelle.Ouellette@bbklaw.com

CC (Via Email only): Ms. Michelle Miller (SMWD) (michelem@smwd.com, cadizproject@smwd.com)
Mr. Tom Barnes (ESA) (cadizproject@esassoc.com)

Re: **Santa Margarita Water District Response to Public Records Act Request For Documents Related to Cadiz Valley Water Conservation, Recovery, and Storage Project (State Clearinghouse No. 2011031002)**

Dear Ms. Oullette:

I am writing to advise the Santa Margarita Water District ("District") that it has failed to provide a timely and legally sufficient response to my office's May 25, 2012 Public Records Act ("PRA") request for documents related to the Cadiz Valley Water Conservation, Recovery, and Storage Project (State Clearinghouse No: 2011031002) ("Cadiz Project"), has failed to provide a further determination on the request, has failed to provide access to any of the requested documents to date, and to request that the District provide an immediate response stating a date, time, and location at which we will be given access to inspect and copy the requested documents within the next five (5) days.

On June 4, 2012, your office wrote on behalf of the District in response to my May 25, PRA request, stating that the District would require additional time to provide a response pursuant to the "unusual circumstances" provision of Government Code § 6253(c). The PRA limits any such extension to a maximum of fourteen (14) days. § 6253(c) provides in pertinent part:

> Each agency, upon a request for a ***copy of records***, shall, within 10 days from receipt of the request, determine whether the request, in whole or in part, seeks copies of disclosable public records in the possession of the agency and shall promptly notify the person making the request of the determination and the reasons therefor. In unusual circumstances, the time limit prescribed in this section may be extended by written notice by the head of the agency or his or her designee to the person making the request, setting forth the reasons for the extension and the date on which a determination is expected to be dispatched. ***No notice shall specify a date that would result in an extension for more than 14 days***. Gov. Code § 6253(c) (emphasis added).

1

O_LozeauDrury/LIUNA6

June 22, 2012
Ms. Michelle Oullette
SMWD Response to Cadiz Aqueduct Project Document PRA Request
Page 2 of 2

Under § 6253(c), a substantive written response to the May 25 PRA request was due no later than June 18, 2012. As of the date of this writing, June 22, 2012, no further response has been provided by the District, and we have not been provided access to any requested documents, nor notified of any Internet weblinks from which we may access any of the requested documents online. The June 4 letter erroneously sought to rely on a thirty-five (35) day extension, which is not permitted under the Public Records Act.

Furthermore, as stated in the May 25 PRA request, the ten day response period applicable to a "request for a *copy* of records" under Section 6253(c) does not apply to this request as it seeks access for inspection of the documents, and does not request that the District make copies of these documents. The PRA requires public records to be "open to inspection *at all times* during the office hours of the state or local agency" and provides that "every person has a right to inspect *any public record*." Gov. Code §6253(a) (emphasis added).

The PRA request seeks access to inspect comments submitted to the District on the Cadiz Project Draft Environmental Impact Report ("EIR"), as well as consultant reports relied upon by the District in preparing the Draft EIR. None of the requested records are subject to privilege, as they are required to be disclosed to the public and constitute part of any subsequent record of proceedings under the California Environmental Quality Act ("CEQA"), Pub. Res. Code § 21000 et seq. Furthermore, the requested documents are part of the District's recent CEQA proceedings on the Draft EIR, for which the comment period closed on March 14, 2012, and should thus be readily accessible in the District's files.

The PRA expressly prohibits "an agency to delay or obstruct the inspection or copying of public records." Gov. Code §6253(d). We request that the District immediately provide a response that identifies the date, time, and location at which we will be given access to inspect and copy the requested documents within the next five (5) days.

Please specify in the District's response whether any of the above requested documents are available online, and if so, please provide us with the URL web address at which the documents may be downloaded. If any of the requested documents are retained by the District in electronic computer-readable format such as PDF (portable document format), please provide us with pdf copies of the documents via email, or inform us of the location at which we can copy these documents electronically. We reserve the right to have a copy service make copies of any and all of the requested documents.

Additionally, if the District intends to withhold any of the requested records from production, LIUNA requests that the District provide a privilege log and/or Vaughn Index of any and all document(s) it withholds, either in part or in their entirety, from its response to this request that clearly identifies the document being withheld and the specific privilege asserted for the withholding.

Thank you for your prompt attention to this request. You may direct any email responses to richard@lozeaudrury.com and christina@lozeaudrury.com.

Sincerely,

Christina Caro
Lozeau | Drury LLP

1

I_Allison

5-24-12

Dear San Bernardino County Supervisors and Santa Margarita Water District
Please reject the Cadiz Water Project. This is misguided. My Son & his family live in Orange County CA where this water would go. There is gross wasting of water in Orange County. I see no reason to deprive the desert of its precious water until Orange County does something to help their own, situation by conserving water. There doesn't seem to be any requirement or incentive for low flow toilets, I see people's sprinkler watering the sidewalks & streets. The hot water heaters are in garages where you need to run the water for 10 minutes at least to get hot water to the upstairs. All these issues should be addressed and conservation measures taken before a fragile ecosystem is robbed of its water. Just say NO. Thanks for listening.

Diane Allison
108 ERVIN RD
PIPERSVILLE PA 18947
6108472085

1

I_Hagerty

May 24, 2012

Dear Sirs,

We are totally against the Cadiz Water Project. Cadiz Inc. is trying to steal water from the desert! We need all that water to remain in the aquifer under Eastern San Bernardino County. The natural wildlife needs it more than a money hungry company only interested in profits!

Additionally the environmental review was done by an agency 200 miles away - not by SB County, as required. They didn't adequately analyze the impacts on water quality, air quality & wild life. Think Owens Lake in the Lone Pine area if you want to see another disaster in the Mojave! And recharge of the aquifer will be extremely slow...

We have enjoyed visiting the Mojave Desert & feel that if you are not doing anything to stop this water grab by profiteers!

Me Hagerty Tonya Hagerty

1

HAGERTY
PO BOX 131133
CARLSBAD, CA
92013

SAN DIEGO CA 920
25 MAY 2012 PM 3 L

FOREVER USA
CELEBRATE

Santa Margarita Water District
26111 Antonio Parkway
Rancho Santa Margarita, CA

I_Naples

Jean Marie Naples, MD-Ph.D.
9 Benson Street
West Haverstraw, New York 10993-1302
email = jnaples@jhsph.edu
May 24 2012

Santa Margarita Water District
26111 Antonio Parkway
Rancho Santa Margarita, CA 92688

Dear Santa Margarita Water District Supervisors,

I am writing to urge you to please stop the Cadiz Water Project. The Cadiz Inc. project will drain an aquifer in the eastern Mojave Desert and pipe it to the lawns of Orange County, reaping billions for the company.

Conspicuously absent from the debate is the government of San Bernardino County, which was required to produce an environmental review but punted it to a water district nearly 200 miles away. Now it has moved to exempt the Cadiz project from the local groundwater law, signing away its enforcement authority for the laughably weak provisions of the exemption agreement, which, among other things, waits an entire decade before even calculating harm to the aquifer.

I urge you to stop this project as an inadequate analysis of impacts on water quality, air quality and wildlife has been assessed for this project. Any environmental review that has been done was managed by the wrong lead agency. In addition, the Cadiz Water Project has an inaccurate project description claiming that its goal is to "conserve" water.

The Cadiz Water Project is bad science that grossly exaggerates "recharge" to the aquifer.

Due to these environmental and wildlife concerns, I urge you to please stop the Cadiz Water Project.

Thank you for your attention to my letter and concerns.

Jean Marie Naples, MD-Ph.D.

Jean Marie Naples, MD-Ph.D.

1

I_Nicolau

Anthony Nicolau
275 Clinton Ave
Brooklyn, NY 11205

May 24, 2012

Santa Margarita Water District
26111 Antonio Parkway
Rancho Santa Margarita, CA 92688

To Whom It May Concern:

I urge you to stop the Cadiz Water Project. There are many reasons this project needs to be put on hold.

- An inadequate analysis of impacts on water quality, air quality and wildlife.
- Environmental review managed by wrong lead agency.
- An inaccurate project description claiming that its goal is to "conserve" water.
- Bad science that grossly exaggerates "recharge" to the aquifer.

1

I hope that you shall re-evaluate this project and reverse course.

Regards,

A. Nicolau

I_Bower

Attention Cadiz Water Project: 5/25/12

I am a resident of Pasadena, and I am disturbed to learn of the potential water diversion from the groundwater aquifer in San Bernardino County to supply Orange County. Urban sprawl must not come at the expense of sensitive water supplies and the local ecosystems and communities that depend on them.

I passionately urge San Bernardino County to stop the Cadiz Corporation from proceeding with their proposed water project and in the very least conduct an accurate, meaningful assessment of the environmental impacts of such a project. The analysis of impacts on water and air quality, local communities, and wildlife was inadequate and inappropriately conducted by the wrong agency. The stated 'refilling' of the aquifer was grossly mis-represented. A true assessment of the impacts of a project is essential before such a project could ever commence.

I greatly urge San Bernardino to consider the irreplaceable value of its local ecosystems and protect the land, water, air, and wildlife rather than sacrifice them to sell water for expanding urban sprawl. Too much water is already being diverted to southern California and enabling continued, unsustainable urban expansion. Please consider the long term consequences, and in the very least, conduct an honest environmental assessment before moving forward with any water project.

1

Sincerely,

Danielle Bower

I_Capozelli

May 25, 2012

Santa Margarita Water District
26111 Antonio Parkway
Rancho Santa Margarita, CA 92688

RE: Cadiz Water Project

I am writing to ask your help because I appreciate and treasure our lands and wildlife in the West. I have read that in the Mojave desert, a company called Cadiz Inc. wants to take water from a place where every drop counts -- to local people, as well as to wildlife like desert tortoises, bighorn sheep, Mojave fringe-toed lizards and other rare species in the region that need that water to survive.

The project would drain a 14-million acre-foot aquifer underlying eastern San Bernardino County and pump the groundwater 200 miles away to suburban Orange County. The water-grab site is just 15 miles away from the Mojave National Preserve, precious protected public land.

I have also read that the environmental review is not only managed by wrong lead agency but there is an inadequate analysis of impacts on water quality, air quality and wildlife, which describes the project's goal as "conserving" water. 1

San Bernardino County was required to lead environmental review for the project, but let a water district nearly 200 miles away do it instead. Worse, in early May the county also exempted the project from its own groundwater law, replacing it with an unenforceable agreement that, among other things, forces the county to wait a decade before even learning of damage to the aquifer.

Surely the San Bernardino County should take control and stop this dangerous water grab.

Please do not let bad science grossly exaggerate "recharge" to the aquifer. Please consider the local people and wildlife that rely on this precious water.

Thank you most sincerely for your help in this urgent matter.

Yours truly,

J. Capozzelli
New York

I_Brunetti

Mr. David A. Brunetti
935 Sherman Farm Rd
Harrisville, RI 02830-1156

May 26, 2012

Santa Margarita Water District
26111 Antonio Parkway
Rancho Santa Margarita, CA 92688
Attention: Cadiz Water Project

To Whom It May Concern,

I have written at this time in order to strongly urge you to stop the Cadiz Water Project.

As you may be aware, this proposed project would drain a 14-million acre-foot aquifer underlying eastern San Bernardino County and pump the groundwater 200 miles away to suburban Orange County. This water-grab site is just 15 miles away from the Mojave National Preserve and would, therefore, steal water from a place where every drop counts – to local people, as well as to desert tortoises, bighorn sheep, Mojave fringe-toed lizards and other rare species in the region that need that water to survive.

The problems associated with this project are many, some of which are as follows:

1. An inadequate analysis of impacts on water quality, air quality, and wildlife.
2. An environmental review that was managed by the wrong lead agency.
3. An inaccurate project description claiming that its goal is to "conserve" water, which is clearly not the case.
4. Bad science that grossly exaggerates "recharge" to the aquifer. 1

As you are well aware, San Bernardino County was conspicuously absent from the debate on this project and although it was required to produce an environmental review of the project, it instead chose to allow a district nearly 200 miles away to do it. Even worse, in early May it also exempted the project from your own groundwater law, replacing it with an unenforceable agreement that, among other things, forces the county to wait a decade before even learning of damage to the aquifer. This is completely unacceptable and you know it!

The groundwater is a public resource and it is being squandered here in order to make a few people rich, while destroying the environment in the process.

From as far away as the state of Rhode Island, I can easily tell that this is grossly unacceptable, surely from your point of reference so can you.

I demand that San Bernardino County take control and stop this dangerous water grab!

Respectfully,

David A. Brunetti

I_Jacoby

Untitled

Santa Margarita Water District
26111 Antonio Parkway
Rancho Stanta Margarita, CA 92688

Dear Water District Manager,

The Cadiz Inc. company water project is unconsionable. It would drain a 14-million acre-foot aquifer under eastern San Bernardino County and pump the groundwater 200 miles away from the Mojave National Preserve. This water is crutial to local people as well as rare species of wildlife.

San Bernardino County was required to lead the environmental review for the project, but unstead let a water district 200 miles away do it. Not only was the environmental review managed by the wrong agency, but bad science that grossly exaggerates recharge to the aquifer was used. Further more, analysis of impacts on water quality, air quality and wildlife were vastly inadequate, and they gave an inaccurate project description that claimed its goal is to conserve water. 1

Please remedy this situation and have SanBernardino County take control and stop this disastrous water grab.

Sincerely,

Dr. Phyllis Jacoby

I_Jacoby2

Untitled

Santa Margarita Water District
26111 Antonio Parkway
Rancho Stanta Margarita, CA 92688

Dear Water District Manager,

The Cadiz Inc. company water project is unconsionable. It would drain a 14-million acre-foot aquifer under eastern San Bernardino County and pump the groundwater 200 miles away from the Mojave National Preserve. This water is crutial to local people as well as rare species of wildlife.

San Bernardino County was required to lead the environmental review for the project, but unstead let a water district 200 miles away do it. Not only was the environmental review managed by the wrong agency, but bad science that grossly exaggerates recharge to the aquifer was used. Further more, analysis of impacts on water quality, air quality and wildlife were vastly inadequate, and they gave an inaccurate project description that claimed its goal is to conserve water. 1

Please remedy this situation and have SanBernardino County take control and stop this disastrous water grab.

Sincerely,

Steve Jacoby
STEVE JACOBY
128 ROMERIA DR.
AUSTIN TX 78757

I_Hahn

May 29, 2012

To: Santa Margarita Water District

Subj: Cadiz Water Project

I'm a long time resident of the Mojave Desert and am writing to oppose the Cadiz water project to pump water from the desert aquifer to Orange County.

This sounds like just another farfetched scheme to send rural water to more populated areas, regardless of the consequences. The environmental review was unfair and deceptive since its goal was to take water, not conserve it. Any project of this magnitude should at least be studied by an impartial, qualified agency.

This aquifer is an integral part of the desert, not some commodity to be sold off. It's wrong to pump water from one of the driest spots on earth to the overpopulated coast. Orange County needs to find another answer to its unsustainable growth.

Please stop the Cadiz water project. Don't further degrade our desert with such an unlikely project with inadequate safeguards and unknown consequences.

1

Sincerely,

Heather Hahn

Heather Hahn
POB 966
Yermo, CA 92398

I_Valentine

SANTA MARG. WATER DIST.
26111 ANTONIO PKWY.
RANCHO SANTA MARG., CA. 92688

Analyze impacts of
Stop the CADIZ WATER
GRAB - THANKS -
Jen Valentine

1

CENTER for BIOLOGICAL DIVERSITY Because life is good.

VIA email and U.S. Mail

May 31, 2012

Supervisor Josie Gonzales, Chair of Board
Supervisor Neil Derry
San Bernardino County Board of Supervisors
385 North Arrowhead Avenue
San Bernardino, CA 92415
supervisorgonzales@sbcounty.gov
supervisorderry@sbcounty.gov

John Schatz, General Manager
Dan Ferons, Chief Engineer
Santa Margarita Water District
26111 Antonio Parkway
Rancho Santa Margarita, CA 92688
johns@smwd.com
danf@smwd.com

Tom Barnes
Environmental Science Associates
626 Wilshire Boulevard, Ste. 1100
Los Angeles, CA 90017
FAX: 213-599-4301
cadizproject@esassoc.com

RE: Cadiz Valley Water Conservation, Recovery, and Storage Project; Draft Environmental Impact Report, State Clearinghouse #2011031002 ("Cadiz Project")

MOU Concerning Cadiz Project Exemption from Groundwater Management Ordinance

Request for MOU Inclusion in Record, EIR Analysis of MOU Definitions and Terms, and Re-Circulation of EIR for Public Comment (Cal. Pub. Resources Code § 21092.1)

Dear Supervisors Gonzales and Derry, and Mssrs. Schatz, Ferons and Barnes:

On May 2, 2012, the San Bernardino County Board of Supervisors approved a Memorandum of Understanding ("MOU") for the Cadiz Water Project, which, when combined with the approval of the related Groundwater Mitigation Monitoring and Management Plan

1

Arizona • California • Nevada • New Mexico • Alaska • Oregon • Minnesota • Vermont • Washington • Washington, DC
Adam Lazar, Staff Attorney • 351 California St., Suite 600 • San Francisco, CA 94104
Phone: (415) 436-9682 x320 • Fax: (415) 436-9683 • E-mail: alazar@biologicaldiversity.org

O_CBD2

("GMMMP"), exempts the Cadiz Project from the County's Desert Groundwater Management Ordinance. The MOU is attached as Exhibit 'A' to this letter, which was subsequently approved by Santa Margarita Water District ("SMWD") on May 11, 2012.

Upon careful review, the MOU appears to contain important additional terms and conditions neither presented nor analyzed in the Cadiz Project's Environmental Impact Report (EIR) and associated Groundwater Management Mitigation and Monitoring Plan (GMMMP). In conjunction with the GMMMP, many of these definitions and terms severely limit the County's monitoring and enforcement abilities. The MOU also reserves 20% of the water (Term 11) and 25,000 initial acre-feet (Term 10) for San Bernardino County, conditions whose existence—and extensive impacts—are also missing from the EIR and GMMMP, as is a description of the presumptive responsible agencies for handling this component of the project.

Many citizens remain unaware that the County's forthcoming approval of the Cadiz EIR (and by association the GMMMP) will also function to fully exempt the project from the County's desert groundwater ordinance. Such ignorance is a shame, because the MOU operates in tandem with the GMMMP to effectively deprive San Bernardino County (or any other local government entity) of effective monitoring and enforcement authority over an aquifer fully within county boundaries and currently supplying critical water to local ranchers, businesses, and the Mojave National Preserve. At best, the move to exempt the project seems deeply unwise.

Because SMWD is currently acting as lead agency for environmental review, the Center requests SMWD include the MOU in the administrative record for the project, fully analyze the definitions and terms in the MOU within the context of the EIR and GMMMP, then re-circulate the EIR for public review and comment pursuant to CEQA (Public Resources Code § 21092.1).

1

"Overdraft" Re-Defined

Safe groundwater extraction is premised on the avoidance of "overdraft." Unfortunately, the MOU fundamentally re-defines "overdraft" to limit the ability of the County to enforce against the concept as it is commonly understood and accepted.

Here is a definition of annual overdraft in the California Water Code:

> **§ 75506. "Annual overdraft"**
>
> "Annual overdraft" means the amount, determined by the board, by which the production of water from ground water supplies within the district or any zone or zones thereof during the water year exceeds the natural replenishment of such ground water supplies in such water year.

Overdraft isn't hard to understand: it simply means extracting more water than is being replenished. Yet when this definition is compared with the tortured version of "overdraft" introduced in the MOU, it becomes clear that the new definition of "overdraft" functions to severely constrain monitoring and enforcement against aquifer drawdown.

1. *"Overdraft"and Reliance on 10-Year Average*

The MOU defines "overdraft" in Definitions (Term (2)(g)) to be spread over a ten year period, and only when "temporary surplus" is exceeded. Overdraft can and should be measured and prevented on an annual basis, not the proposed 10-year period for determination, which will force the County or other enforcement authority to wait for 10 years before finding a condition of overdraft. This means that the project could operate with continual deficits for years without the County or any other enforcement body being able to stop it or even call it "overdraft," creating an effective barrier to enforcement against harm to the aquifer. It appears difficult, if not impossible, to enact Term 8's enforcement of "immediate and irreparable harm" provision if the project requires waiting 10 years to make a finding of overdraft. The 10 year provision must be analyzed at length in both the EIR and GMMMP to assess the effectiveness of Cadiz project enforcement and monitoring. Even better, the MOU should be revised and the term removed.

2. *"Groundwater Safe Yield" and "Overdraft"*

The MOU's defines "Groundwater Safe Yield" (Term 2(e)) as avoidance of the limited "overdraft" concept of Term (2)(g), even though "safe yield" is normally defined by the SWRCB to mean drawdown that adversely impacts the aquifer *levels.* "Groundwater safe yield" also is defined as "not adversely affecting aquifer health," but "aquifer health" (Term 2(a)) is only defined as the *geologic* integrity of the aquifer, its *storage* capacity, and the *quality* of water within the aquifer.

Such a definition begs the question: is greater storage capacity a sign of "good" or "bad" "aquifer health" and why? Of course, an obvious sign of aquifer health would be its level, but this quality is conspicuously absent from the definition. Thus the "safe yield" concept as defined in the MOU (2)(e) does not contemplate aquifer drawdown beyond the strained and extremely narrowly-defined definitions of "overdraft" and "aquifer health" present in the MOU. Clearly, these terms require careful analysis in the EIR and GMMMP.

3. *"Temporary Surplus" and "Overdraft"*

Further, the MOU Term 2(j) limits a finding of "overdraft" to where there is no "temporary surplus." This definition suggests "temporary surplus" is a standard and widely-accepted concept, but it is not. The GMMMP presents the concept of "temporary surplus" within a crude and incorrect legal analysis (page 33), but the concept is not tied to overdraft in the case cited. More importantly, the argument that "temporary surplus" should be allowed is not specified as a *required* criteria in the GMMMP and EIR as a condition that defeats overdraft. In other words, the MOU has taken a stretched interpretation of a Supreme Court case and transformed it into a legally-enforceable limitation on a finding of "overdraft." In fact, the Supreme Court case cited by the GMMMP appears to be considers whether water withdrawn is being beneficially used, and not whether it is creating an overdraft condition. At any rate, the case does not permit a new definition of "overdraft." Further, since re-charge from the Colorado River was not considered a full project component, it is impractical and disingenuous to suggest that it is now part of the "overdraft" equation when SMWD cannot even say whether recharge will occur. Separately, it appears that SMWD could just increase its estimated recharge amount and instantly increase its "temporary surplus" to counter any finding of "overdraft," making it virtually impossible for the condition to be met. Again, the mere possibility of recharge is not sufficient to create "temporary surplus," and the case cited by the GMMMP does not provide for

1

O_CBD2

it to be considered as such. The additional concepts included in "overdraft" in the MOU, both in ten-year measurements and incorporation of a new definition of "temporary surplus," must be considered for their impacts in the ability of the GMMMP to adequately monitor project activities and enforce against aquifer depletion.

4. "*Undesirable Results" Fails to Include Predicted Recharge Rates*

Term 2(k) "Undesirable Results" in the MOU means any of the following: (i) the progressive decline in groundwater levels and freshwater storage below a "floor" to be established by the County through the GMMMP; (ii) the progressive decline in groundwater levels and freshwater storage at a rate greater than the rate of decline to be established by the County through the GMMMP where the decline signifies a threat of other physical impacts enumerated in this subparagraph 2(k); (iii) land subsidence, (iv) the progressive migration of hyper-saline water from beneath the Cadiz or Bristol Dry Lakes toward the Project well sites; (v) increases in air quality particulate matter; (vi) loss of surface vegetation; or (vii) decreases in spring flows.

None of the above terms triggering review under "undesirable results" include the most obvious: a drawdown of the aquifer that provides evidence contrary to the Applicant's claimed recharge rates. In other words, if the Cadiz project is indeed based on the Applicant's scientific recharge studies, then project impact should be judged by whether it meets the recharge rates depicted in those studies. If withdrawal occurs in excess of recharge, the water level will decline, and Cadiz project exports should be adjusted to match. By ignoring the recharge studies in the MOU, the Applicant implies these recharge studies are unreliable and cannot be used as a solid basis for measuring project impacts. Without a scientific basis to determine aquifer health and overdraft, the determination of "undesirable results" is arbitrary and without basis in law.

Likewise, it does not appear that any groundwater "floor" as indicated in Term (2)(k) was established by the County in the GMMMP, despite this term's inclusion in the MOU. If such "floor" is indeed buried somewhere in the EIR and GMMMP, it is also unclear on what basis the County, as a merely responsible agency for the project, has used as its scientific basis for its determination, nor whether alternative "floor" levels were considered. The determination of the "floor" and associated analysis must be included in the GMMMP and EIR. Likewise, the "progressive decline" rate to be determined by the County does not appear to have been set in the GMMMP, but the County may not set such a rate, per the terms of the MOU, beyond that which causes physical impacts such as subsidence; again, the County is not allowed to set a floor or level that would merely place limited use and as a paramount goal—another loss of enforcement discretion that should be analyzed in the EIR and GMMMP.

5. Mandatory Arbitration

As a further severe limit to enforcement ability, Term 8 of the MOU allows judicial review by the County to enforce against drawdown and unsafe yields only in the event that "Overdraft" or "Undesirable Results" occur, which, as explained above, are very limited concepts when considered against their common, accepted use outside the scope of definitions in the Cadiz MOU. Without meeting these two conditions, the MOU requires parties to enter into arbitration, so that, for example, aquifer measurements which provide evidence that scientific estimates of recharge are not being met, would nonetheless be subject to a lengthy arbitration

1

O_CBD2

process without the certainty that the County can limit or enforce against this harm. The use of arbitration is not explained or analyzed in the GMMMP and MOU. The EIR and GMMMP should explain the function of the arbitration and explain if and how the County can enforce against aquifer drawdown in the instance that the arbitration panel decides against the County, or if the County determines there is harm occurring outside of the very limited definitions in the MOU for "Overdraft" and "Undesirable Results."

Role of Inland Empire Utilities Agency

As part of the MOU's additional terms describing a 20% and 25,000 AF reservation of water for San Bernardino County, the MOU describes a role for the Inland Empire Utilities Agency to take 30,000 acre-feet of water (Term 10(d)). Please update the EIR to include the specific role of IEUA in distributing the water allocated to the County, along with an analysis of proposed impacts to its use of 30,000 acre-feet of Project water.

San Bernardino County must act as Lead Agency for EIR, GMMMP, and Exemption

Finally, the Center once again requests a re-assessment of the role of San Bernardino County in the multiple permits and approvals required for the Cadiz project under CEQA. Cadiz is a private project proponent and CEQA requires the County to act as lead agency for the EIR. Further, the County was required to perform CEQA review as lead agency under the County desert groundwater management ordinance; approving an *exemption* to the ordinance requires the same level of discretionary approval, so that the County must act as lead agency under CEQA for the exemption as well. Under both legal regimes, the County is improperly limiting its role to that of a responsible agency, and in doing so, undermining the legality of the EIR, the GMMMP, and the exemption from County law.

1

Thank you for your attention to these matters.

Sincerely,

Adam Lazar

I_Nelson

6/1/12

Dear Santa Margarita Water District staff and Board,

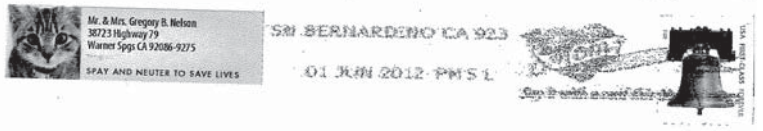
The Cadiz Water Project is just another bandaid that will temporarily fix an undeniable problem... there's not enough water to sustain O.C.'s lifestyle and projected growth.

Draining this aquifer, as will happen, since the hydrology and recharge rate is problematic and the analysis and science is inaccurate and unknown for this basin.

The environmental review was done by the agency with special interests for this project. A more complete analysis is needed by an objective party.

The Mojave and its wildlife are already under pressure from alternative energy,

1



Santa Margarita Water District
26111 Antonio Parkway
Rancho Santa Margarita
CA 9[illegible]

I_Nelson

military and off-roading.

Please reject this proposal and have a more complete study that will come up with correct data. 1

Don't drain this aquifer for a temporary fix for a community 200 miles away.

Sincerely,
Sam Nelson
Conservation Chair
Sierra Club group
(Sta. Margarita)
sierraclub.org/...org

I_Loffelbein

P.O. Box 164
Cottage Grove OR 97424
28 May 2012

Santa Margarita Water District
26111 Antonio Parkway
Rancho Santa Margarita CA 92688

I am writing to ask you to stop the Cadiz Water Project.

The analysis of impacts on air & water quality, & on wildlife, is inadequate, based on bad science that greatly exaggerates recharge to the aquifers. 1

The environmental review is managed by the wrong lead agency, & the project description claiming its goal is to "conserve" water is inaccurate.

Thank you.

Sincerely,
Gita Loffelbein

I_Shah

Sent: Wednesday, June 20, 2012 1:47 PM
To: Cadiz Project
Cc: michelem@smwd.com
Subject: Final Environmental Impact Report

Hi Tom,

We spoke on the phone earlier and you had mentioned that I forward my questions to Michele (cc'd). Michele mentioned that you would be able to put me on he mailing list that will notify me when the Final EIR is released. Could you add me to the list? Also, would I be able to attain the public comments that were made on the last EIR? 1

Best,
Anuj

O_Wildlands2

From: Claudia Sall [sallwildlands@gmail.com]
Sent: Sunday, June 24, 2012 2:38 PM
To: Cadiz Project
Subject: cadiz valley water project

dear mr. barnes
the dec 2011 deir on this project included references citing the cadiz groundwater montoring reports #'s 6, 10, 11, 12, 13.

your contact number is listed on the smwd website. i would like digital copies of these reference documents and request that they are made available. 1

i look forward to your response.

claudia sall