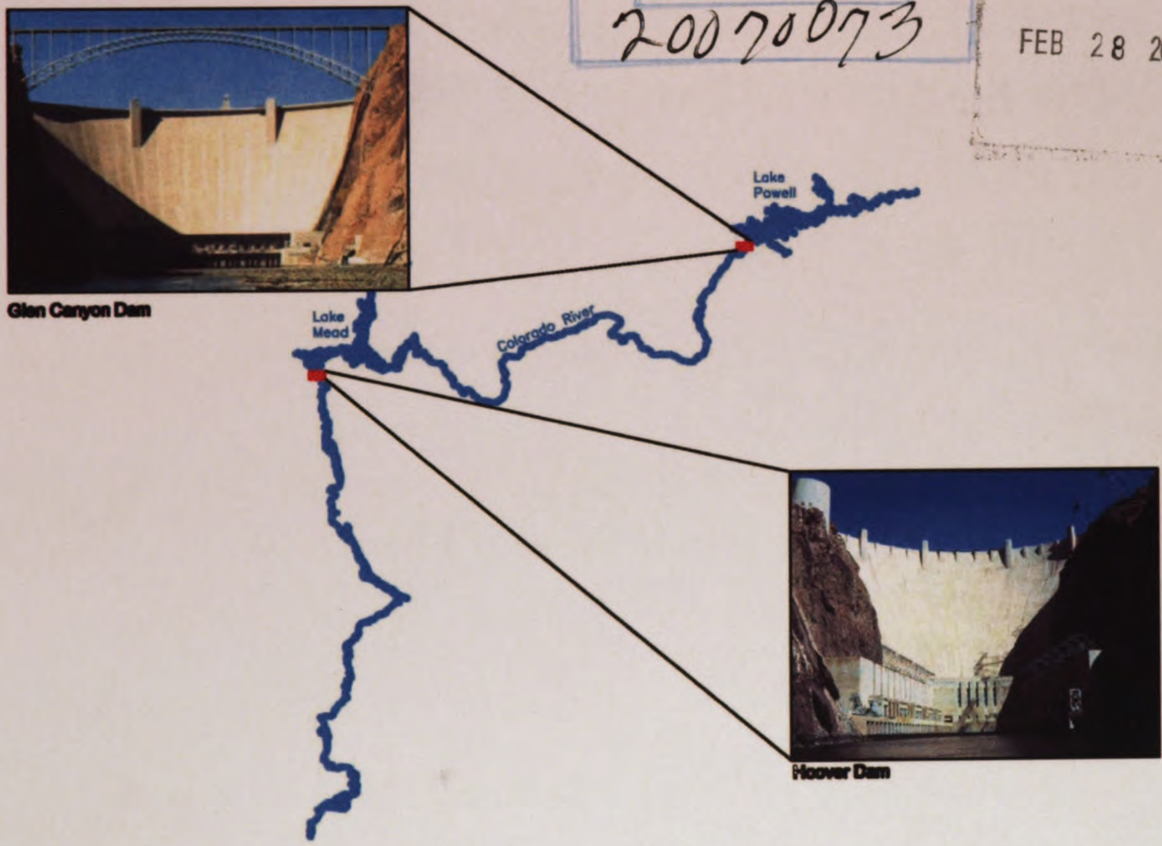
RECLAMATION

Managing Water in the West

Draft

Environmental Impact Statement



Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead

Volume I

U.S. Department of the Interior
Bureau of Reclamation
Upper and Lower Colorado Regions

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3.5 Water Quality

This section describes the existing water quality constituents that could potentially be affected by the alternatives. These water quality constituents of concern include:

- salinity;
- temperature;
- sediment;
- nutrients and algae;
- dissolved oxygen;
- metals; and
- perchlorate.

While other water quality-related issues and parameters were also considered, they were determined unlikely to be affected by the alternatives and are therefore not discussed here.

3.5.1 Salinity

Increased salinity levels are a primary water quality concern in the Colorado River because of its effects on agricultural, municipal and industrial users. With increased salinity levels, agricultural water users may suffer economic damage due to reduced crop yields, added labor costs for irrigation management, and added drainage requirements. Urban or municipal users must replace plumbing and appliances more often, or spend increased money on water softeners or bottled water. Industrial users and water and wastewater treatment facilities incur reductions in the useful life of infrastructure (Colorado River Basin Salinity Control Forum 2002). Water treatment plants face increased costs when salinity is elevated, and results in disinfection byproducts that exceed drinking water standards.

Salinity occurs naturally in the Colorado River Basin due to the erosion of saline sediments and rocks; however, human activities such as agriculture, irrigation, and energy production may increase the rate of natural salt movement to the system (Colorado River Basin Salinity Control Forum 2002; USEPA 1971). Consumptive use of system water also reduces the dilution capacity of the watershed, increasing the salinity concentrations.

In 1972, the United States Environmental Protection Agency (USEPA) suggested the development of water quality criteria for salinity in the Colorado River following passage of the Clean Water Act (CWA). In 1973, the seven Basin States formed the Colorado River Basin Salinity Control Forum (Forum) to develop salinity criteria and an implementation plan to provide compliance while allowing the Basin States to continue to develop their Compact-allocated water. The Forum specifies flow-weighted average annual salinity criteria for three locations on the lower Colorado River (Table 3.5-1). The criteria, first established in 1975, are reviewed every three years; the latest review was completed in 2005.

Table 3.5-1
Numeric Salinity Standards for the Colorado River

Station	Flow-weighted average annual salinity (mg/L)[1]
Below Hoover Dam (to Parker Dam)	723
Below Parker Dam (to Imperial Dam)	747
At Imperial Dam	879

(Colorado River Basin Salinity Control Forum, 2005)

1 mg/L – milligram per liter

Salinity below Glen Canyon Dam has varied between 390 to 660 mg/L. Historic salinity concentrations and flows, and the criteria specified by the Forum by location for the lower reaches of the Colorado River below Hoover Dam are illustrated in Figures 3.5-1 through 3.5-3. As shown, increases in salinity typically correspond to decreases in flow. Diluting effects of record high flows during the 1980s resulted in lower salinity levels. Conversely, low flows from 1988 to 1992 and 2000 to 2004 caused relatively higher salinity levels. While the salinity concentrations vary from year to year, concentrations have not exceeded the criteria, even during the recent drought. Although salinity at Hoover Dam has approached the criteria of 723 mg/L on several days during the current drought, the salinity criteria would not be violated unless the annual average salinity exceeds the salinity criteria.

Figure 3.5-1
Historic Salinity Concentrations and Flows below Hoover Dam from 1941 to 2005

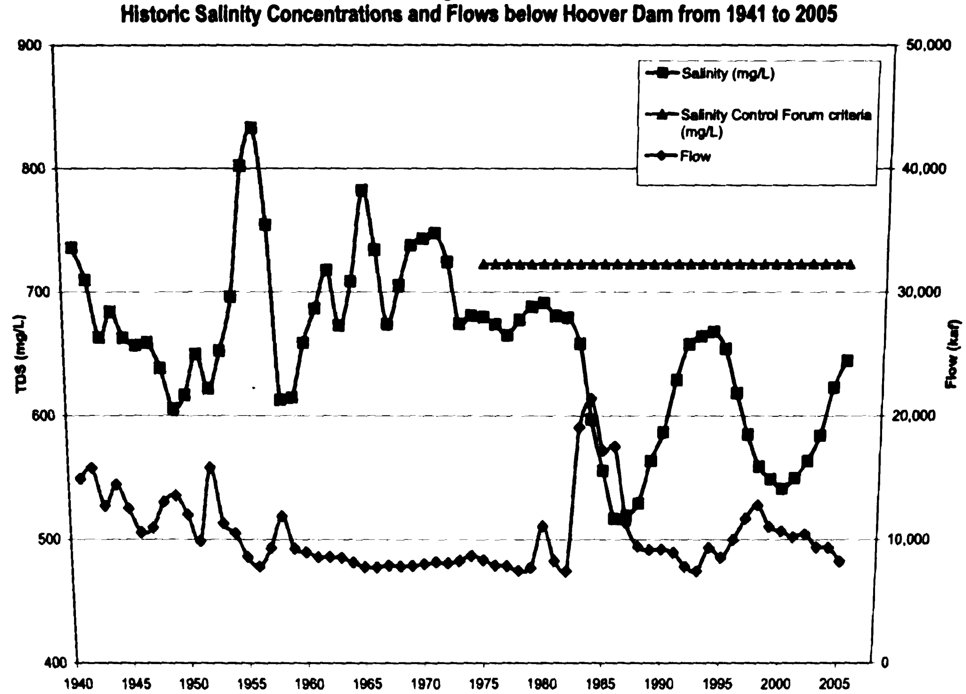


Figure 3.5-2
Historic Salinity Concentrations and Flows below Parker Dam from 1941 to 2005

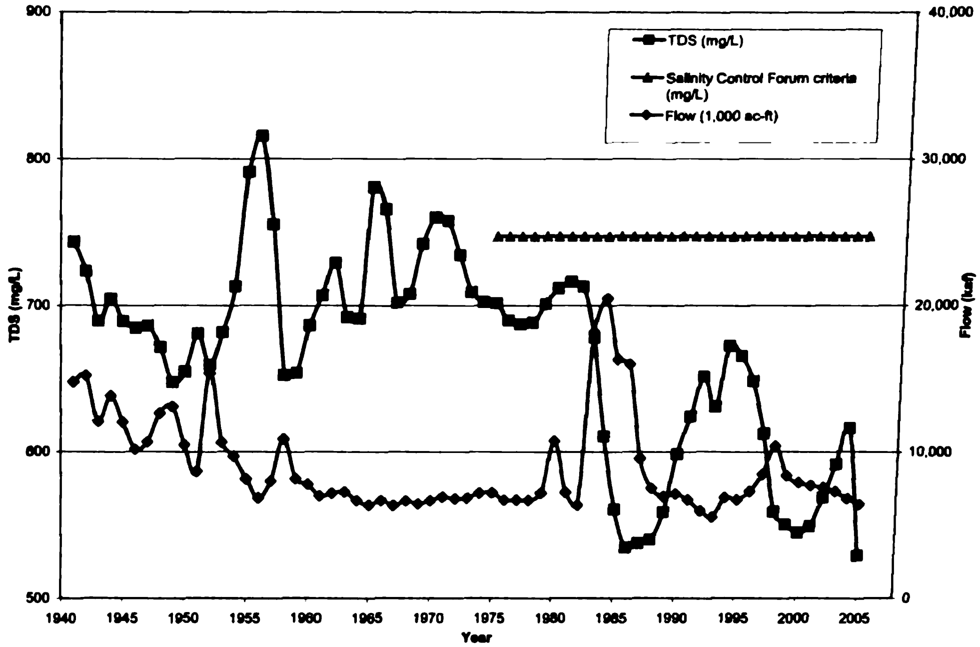
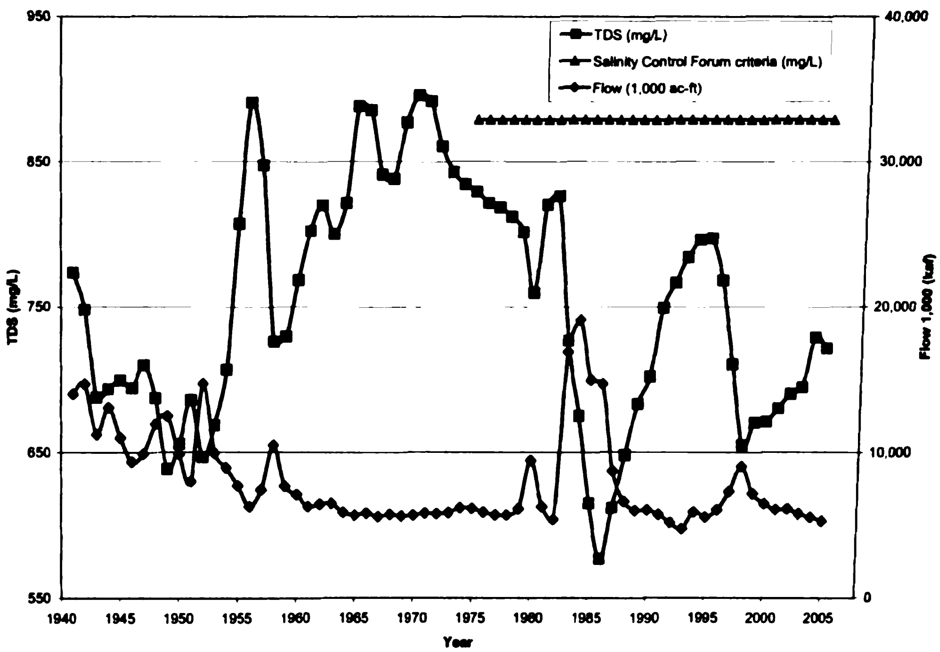


Figure 3.5-3
Historic Salinity Concentrations and Flows at Imperial Dam from 1941 to 2005



To address Mexico's concerns with regard to salinity, Minute 242 (Section 3.4) was developed in 1973 pursuant to the 1944 Treaty. Minute 242 limits the differential in annual salinity between Imperial Dam and the NIB to 115 parts per millimeter (ppm) $\pm$ 30 ppm. In addition, the Colorado River Basin Salinity Control Act of 1974 was authorized to implement desalting and salinity control projects to improve river water quality. Salinity control projects that have been implemented include projects to control irrigation seepage and reduce transport of groundwater salt loads to the Colorado River.

3.5.2 Temperature

Impounding water in reservoirs affects the water temperatures of dam releases due to stratification. The surface layer (epilimnion) of Lake Powell and Lake Mead warms as a result of inflows, ambient air temperature, and solar radiation. For example, during the summer, both Lake Powell and Lake Mead epilimnions reach temperatures as high as 30° degrees Celsius(C) or 86° degrees Fahrenheit (F) (LaBounty and Horn 1997). Lake Mead's deeper layer (hypolimnion) remains around 12° C (54° F) year-round and Lake Powell's ranges from 6 to 9° C (43-48° F) (LaBounty and Horn 1997), resulting in cold dam release temperatures.

Water temperatures downstream of Lake Powell are influenced by Lake Powell elevations and release volumes. Figure 3.5-4 illustrates that Lake Powell release temperatures have varied from 7 to 11° C (46 to 52° F) until 2002. Between 1999 and 2005, Lake Powell elevations have dropped more than 140 feet as a result of a basin-wide drought. While winter release temperatures remained cold, Lake Powell release temperatures increased to 16° C (61° F) in the summer of 2005. The drop in Lake Powell elevation has resulted in the warmer epilimnion being closer to the penstock withdrawal zone and the warmer water being released downstream. Release temperatures from Glen Canyon Dam during 2004 and 2005 were the highest since August 1971 when the reservoir was filling.

As water travels between Glen Canyon Dam and Lake Mead, water temperatures in the Colorado River can increase by 7° C (14.4° F). The amount of warming is affected by season and release volume, with highest warming rates occurring in mid-summer and at low release volumes (Vernieu et. al. 2005). Generally, during late fall and winter, as air temperatures decrease, water released from Glen Canyon Dam cools as it moves downstream towards Lake Mead. Figure 3.5-5 illustrates that historic water release temperatures at Lake Mead have typically been approximately 13°C (58°F).

3.5.3 Sediment

After Glen Canyon Dam and Hoover Dam were constructed, the reservoirs retained the vast majority of the inflowing sediment. Following dam closure, large sediment deltas formed near the inflow areas. When the reservoirs are drawn down during droughts, the Colorado River must cut a new channel through these sediments into the reservoirs. Generally the greater the reservoir drawdown, the greater the sediment delta headcut and the finer the sediment exposed. The resuspended sediments have a significant oxygen demand and also temporarily release nutrients which can result in greater algal growth.

Figure 3.5-4
Historic Elevation and Dam Release Temperatures at Lake Powell

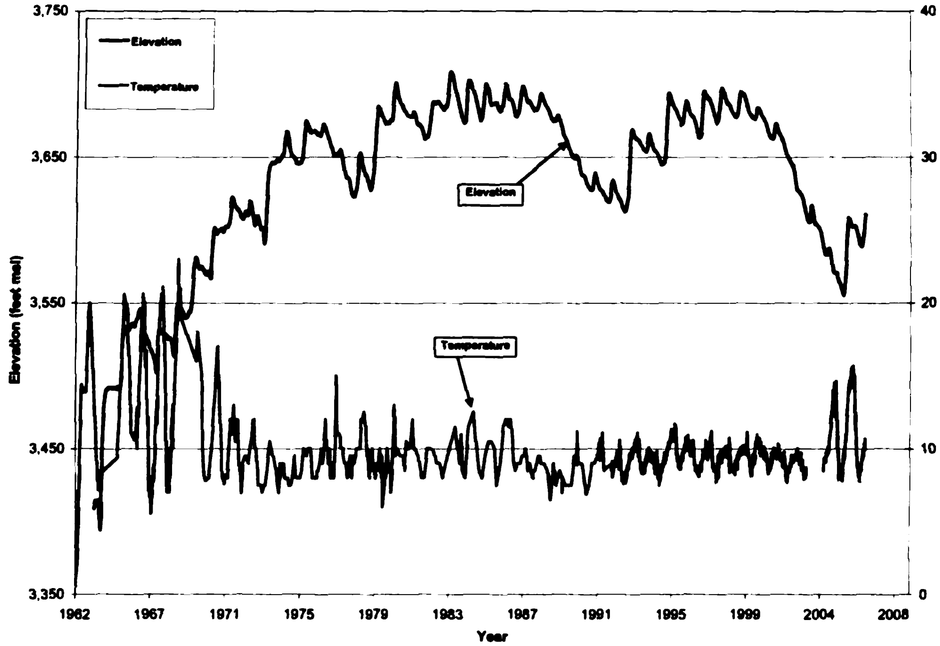
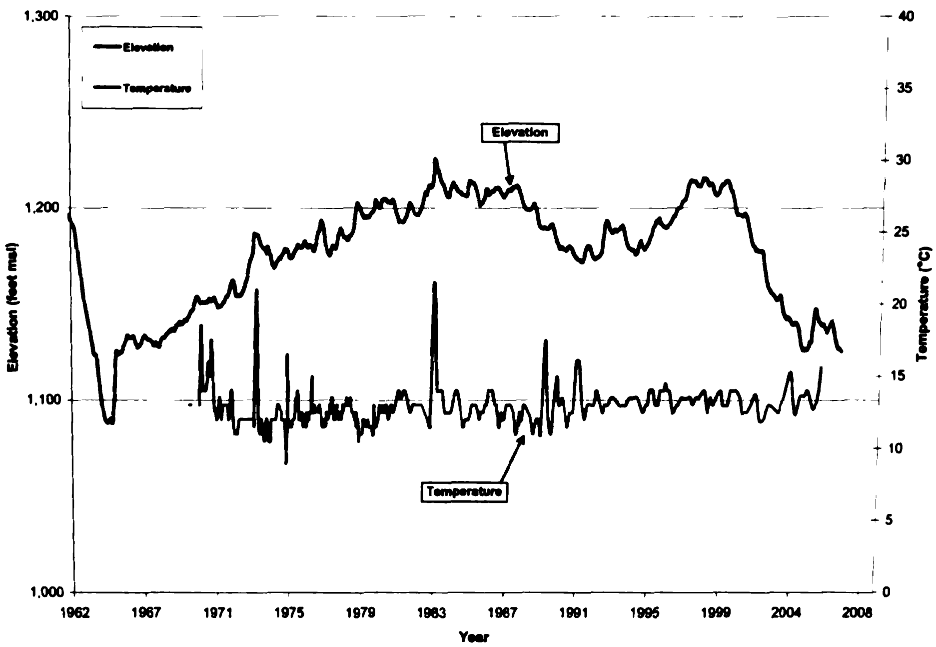


Figure 3.5-5
Historic Elevation and Dam Release Temperatures at Lake Mead



Riverine sediment transport is an important concern in the Glen Canyon Dam to Lake Mead reach due to recreation and biological resource impacts, and is addressed in the AMP. Beach sediment volumes have declined since closure of Glen Canyon Dam eliminated annual replenishment by sediment-laden spring runoff. Recent efforts by the AMP have focused on making BHBF releases from Glen Canyon Dam timed with downstream tributary inputs from the Paria and Little Colorado rivers.

Downstream of Hoover Dam the only significant sediment inputs are produced by large, infrequent events on the Bill Williams River and the Gila River, affecting the reaches from Parker to Imperial Dam and from Imperial Dam to the NIB. On-going Reclamation dredging operations remove this sediment at and upstream of Imperial Dam as well as upstream of Morelos Diversion Dam to improve diversion capability and to efficiently convey water to downstream users (Figure 3.3-5). These operations will continue and therefore the action alternatives would have no significant impact.

3.5.4 Nutrients and Algae

Nutrients are a group of chemical elements and compounds such as carbon, nitrogen, and phosphorus. When nutrient concentrations rise above certain thresholds or levels (usually measured in mg/L) they impair water quality. Nitrogen and phosphorous are nutrients of concern because they foster algal growth. Excess algal growth can affect drinking water treatment operations and can contribute to taste and odor problems and potentially toxic disinfection by-product (DBP) formation. Noxious and toxic blue-green algae blooms may also be a concern.

Large, long reservoirs like Lake Powell are very efficient at retaining nutrients (nitrogen and phosphorus) through biological processes and settling. Paulson and Baker (1983) found phosphorus to be the limiting nutrient for primary biological activity in both reservoirs. More than 95 percent of the phosphorous reaching Lake Powell is in particulate form or associated with suspended sediment particles, and a large percentage of the particulate phosphorous load settles out of the water column in the upstream portion of the reservoir. Therefore, primary biological activity is phosphorous-limited by the time the water reaches Glen Canyon Dam. A similar storage effect is repeated in Lake Mead. This settling process can be reversed when the reservoirs are drawn down and deltaic sediments are re-suspended by the inflows. Nutrient concentrations remain elevated in the hypolimnion where the lack of light limits primary biological activity. Consequently, hypolimnetic releases from Glen Canyon Dam are relatively nutrient rich whereas periods of epilimnetic releases may cause a reduction in the amount of nutrients available to the downstream ecosystem.

Tributary inflows (Paria River and Little Colorado River) are important sources of phosphorus in the Colorado River between Glen Canyon Dam and Lake Mead (Maddux et. al. 1987). However, most phosphorus arrives in particulate form adsorbed to fine sediment. This fine sediment causes high turbidity and restricts primary biological activity due to limited light penetration.

Lake Mead receives nutrient loads primarily from Las Vegas Wash and the Colorado River. A Total Maxium Daily Load (TMDL) has been developed by the Nevada Division of Environmental Protection (NDEP) and USEPA to reduce ammonia and phosphorous concentrations in Las Vegas Wash. Boulder Basin, the receiving body of Las Vegas Wash, has the highest nutrient concentrations in the Lake Mead system (Paulson and Baker 1981; Prentki and Paulson 1983). Except for the algae growth in Boulder Basin of Lake Mead, substantial algae growth along the rest of the system is not common.

3.5.5 Dissolved Oxygen

Dissolved oxygen concentrations in the reservoirs are affected by variations in inflow volume and temperature, seasonal reservoir circulation, and biological production and decomposition. In years of high inflows when the reservoir elevations are low, tributary inputs cut through deltaic sediments, resuspending organic matter and nutrients that contribute to both chemical and biological oxygen demand as the inflow water passes down the reservoir water column. The resulting plumes of low oxygen water cause the release of oxygen-poor water. When deltaic sediments and organic matter are not resuspended, oxygen demand is lower and dissolved oxygen concentrations remain higher. Downstream of dams, turbulence, exposure to the atmosphere, and primary productivity reaerate the water.

To date, low dissolved oxygen has only been an issue in Lake Powell and at Glen Canyon Dam. The dissolved oxygen concentration reaches saturation downstream of Glen Canyon Dam before the confluence with the Little Colorado River (Gloss et. al. 2005)) after passing through several major rapids.

In Lake Mead, dissolved oxygen concentrations decrease in Boulder Basin as a result of nutrient contributions from Las Vegas Wash and algae growth. However, dissolved oxygen has not been documented to have dropped below acceptable minimum levels. Further, dissolved oxygen has not been documented as an issue in downstream reaches.

3.5.6 Metals

Metals of concern in the study area are selenium, chromium, and mercury. Selenium is an essential trace element, but can be bioconcentrated in a complex aquatic food chain to potentially hazardous levels to wildlife. A chronic standard to protect wildlife has been adopted by the Lower Basin states of 2 micrograms per liter (µg/L). This is a higher standard than the USEPA criteria for selenium. The drinking water standard for selenium is 50 µg/L, therefore selenium is not a human health concern from drinking water.

Selenium present in marine sedimentary rocks dissolves in runoff and groundwater flows to the Colorado River and its tributaries. Concentrations along the Colorado River in the Lower Basin indicate that the selenium loads to the Colorado River are from the Upper Basin and Lower Basin tributaries only (U.S. Department of the Interior and The Metropolitan Water District of Southern California 2004). The Colorado River from Hoover Dam to Lake Mohave inlet and from Parashant Canyon to Diamond Creek, and reaches of the Gila River, Las Vegas Wash, and the Virgin River have all been designated as impaired waterbodies due to selenium. To date, TMDLs have not been drafted or approved for selenium in these waterbodies.

The Forum established a selenium sub-committee in 2004 (U.S. Department of the Interior 2005). The long term average selenium concentration is 2.4 µg/L below Glen Canyon Dam, greater than the Lower Basin states selenium standard of 2 µg/L (Department of the Interior 2005).

The USEPA's drinking water standard for the soluble hexavalent form of chromium, (Cr(VI)) is 100 parts per billion (ppb); at this concentration, it is considered dangerous to human and environmental health. The Cr(VI) is impacting groundwater in two known locations in the lower Colorado River Basin, at the Pacific Gas & Electric (PG&E) Compressor Station near Needles, California, and at the former McCulloch manufacturing plant in Lake Havasu City, Arizona. The plume of contaminated groundwater from the PG&E facility has concentrations of Cr(VI) as high as 700 ppb and has traveled several hundred feet from its source to within 60 feet of the Colorado River. Investigation and mitigation efforts are ongoing and under direction of the California Environmental Protection Agency Department of Toxic Substances Control (DTSC).

The Cr(VI) plume in Lake Havasu City has been delineated and it is being monitored by the current land owner. Concentrations have been detected as high as 240,000 ppb Cr(VI) and the plume is approximately 3,800 feet from the Colorado River.

Mercury is naturally occurring in the Colorado River Basin and has been mobilized as a result of historic mining activities. Mercury can be toxic to both humans and wildlife and has been shown to bioaccumulate and biomagnify up the food chain. High levels of methylmercury have been detected in fish tissue at Alamo Lake in the Bill Williams Watershed, a tributary to Lake Havasu. Mercury is present in the discharge from Alamo Lake and may also be entering the Colorado River from the Little Colorado River and between Lake Mead and Lake Havasu. Mercury is highly regulated with the Safe Drinking Water Act maximum contaminant level of 2.0 ppb.

3.5.7 Perchlorate

Perchlorate in the form of ammonium perchlorate is a concern when found in drinking water because of its potential adverse effect on human thyroid function. No final USEPA standards for perchlorate have been developed. Perchlorate contamination in water supplies in the lower Colorado River was traced to Lake Mead and Las Vegas Wash from a groundwater plume from the Kerr McGee Chemical Company in Henderson, Nevada. Containment, control and mitigation activities are ongoing to reduce perchlorate concentrations in Lake Mead and downstream.