SALINITY CONTROL ON BUREAU OF LAND MANAGEMENT (BLM)-ADMINISTERED PUBLIC LANDS IN THE COLORADO RIVER BASIN

A REPORT TO CONGRESS

December 2004

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EXECUTIVE SUMMARY

Public Law 106-459, Amendment of the Colorado River Basin Salinity Control Act, requires the Secretary of the Interior to prepare a report to Congress on the status of implementation of a comprehensive program for minimizing salt contributions to the Colorado River from lands administered by the Bureau of Land Management (BLM). This report describes salinity sources on BLM-administered public lands and the BLM's role and accomplishments in controlling point and nonpoint sources of salinity on those lands. The report updates a previous report on Colorado River Basin salinity submitted to the Congress by BLM in 1987 (BLM, 1987). This report also recommends actions necessary to implement future salinity control activities and additional research needed to better understand salt mobilization and transport in arid ecosystems.

Salinity, or the total dissolved solids concentration, in the Colorado River has increased as a result of water-resources development in two major ways: (1) the addition of salts from water use (salt loading); and (2) the consumption and evaporation of water (salt concentrating). The combined effects of salt loading and water consumption have had a significant impact on salinity in the Colorado River Basin.

Nearly half of the salt loading in the Colorado River Basin comes from natural geologic sources, including both point and nonpoint sources. Saline springs and seeps, erosion of marine geologic formations, groundwater discharge to streams, and surface runoff all contribute to this background salt loading. The majority of this natural salt load enters the Colorado River and its tributaries from groundwater and saline springs.

The BLM administers approximately 53 million acres of public lands in the Basin above Yuma, Arizona, including 48 million acres above Imperial Dam. The BLM uses a comprehensive, three-pronged approach to salinity control that incorporates: (1) the control of point sources of salinity such as saline springs and seeps and abandoned flowing wells that yield saline water; (2) the control of nonpoint sources of salinity through cost-effective land management techniques that result in multiple-resource benefits; and (3) the control of nonpoint source salt mobilization through land-use planning, permit stipulations, land-use authorizations, best management practices, watershed protection strategies, and ecological restoration.

The BLM is committed to further the understanding of naturally-occurring, diffuse sources of salt on arid and semiarid rangelands. Very little is known about salt mobilization and transport in these environments.

DESCRIPTION OF THE SALINITY CONTROL ISSUE

The Colorado River Basin

The Colorado River and its tributaries (Figure 1) provide municipal and industrial water to about 27 million people and irrigation water to nearly 4 million acres of land in the western United States (Bureau of Reclamation (BOR), 2001). About 2.3 million people and one-half million acres of land in Mexico are also served by the River. Salinity, or the total dissolved solids (TDS) concentration of water, is a major concern of water users, especially in the Lower Colorado River Basin. Saline water results in increasing capital costs for the operation and maintenance of municipal water-supply equipment. High levels of salinity in water reduce the effective life of water pipes, pumps, filters, fixtures, and water-using household appliances. Salinity affects irrigated agriculture by increasing production costs, decreasing crop productivity, and limiting the types of crops that can be grown. High levels of salinity also affect industry. Minerals in boilers and cooling systems reduce the effective life of component equipment, causing operators to replace equipment more frequently or to obtain higher quality of water at additional expense.

Average annual TDS concentrations are below 50 milligrams per liter (mg/L) in the Colorado River headwaters but gradually increase in the downstream direction. The average annual salinity at Imperial Dam was reported to be 681 mg/L in 1999 (BOR, 2001). Salinity of the Colorado River has increased as a result of water-resources development in two major ways: (1) the addition of salts from water use (salt loading); and (2) the consumption and evaporation of water (salt concentrating). The combined effects of salt loading and salt concentrating have had a significant impact on salinity in the Colorado River Basin. The Environmental Protection Agency (EPA) estimated the salinity concentrations at Hoover Dam would have averaged 334 mg/L under natural conditions for the period 1942-1961 (EPA, 1971).

Nearly half of the salt loading in the Colorado River Basin comes from natural geologic sources (Figure 2). It is estimated that of the natural sources, eight percent of the total salt loading is due to point sources of salt and 39 percent is due to diffuse sources (Blackman et al., 1973). Saline springs and seeps, erosion of marine geologic formations, groundwater discharge to streams, and surface runoff all contribute to this background salt loading. Irrigation (37 percent), reservoir evaporation (12 percent), municipal and industrial sources (3 percent), and out-of-basin water transfers (1 percent) make up the balance of the salt contributions in the Colorado River Basin.

Figure 1. Map of Colorado River Basin.

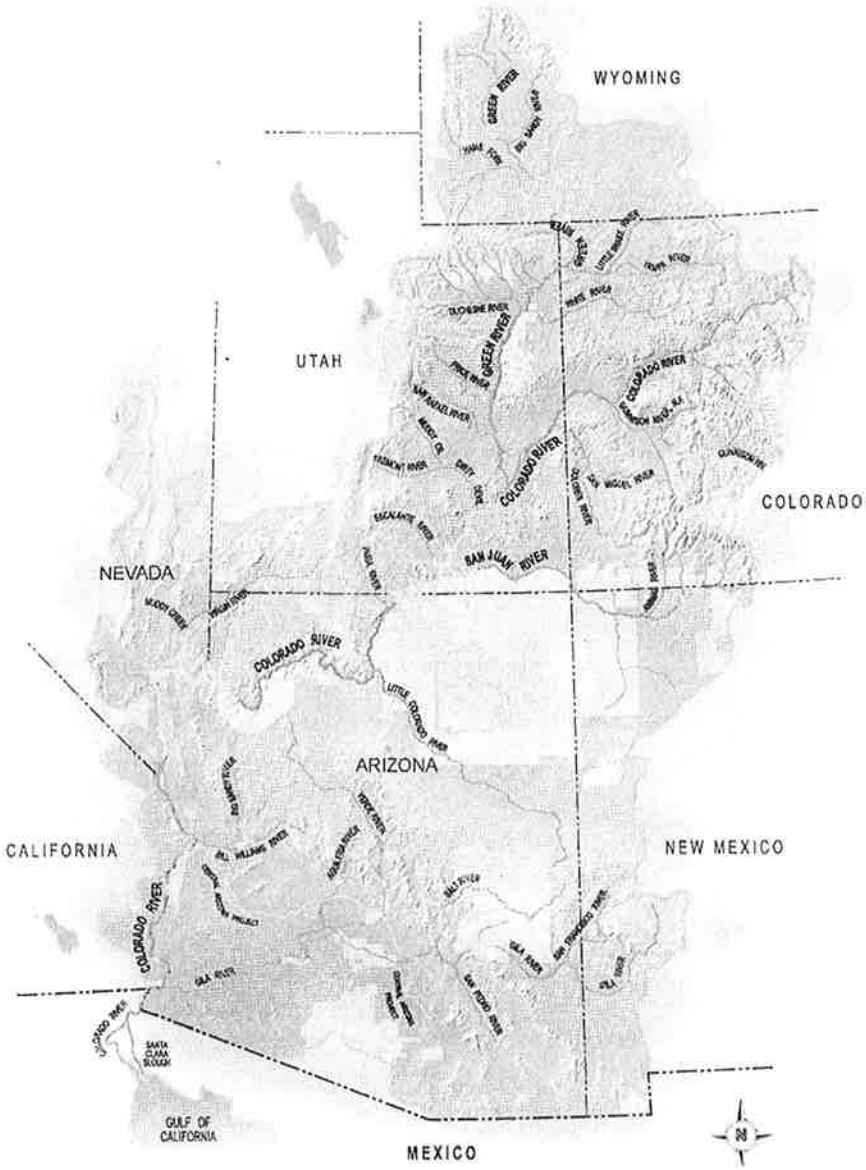
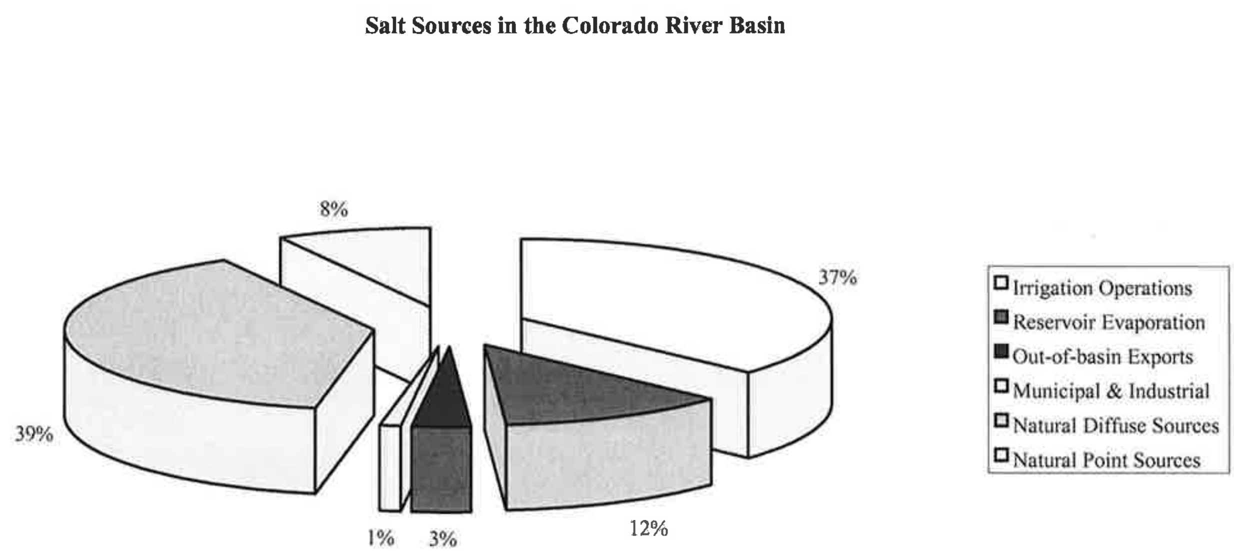


Figure 2. Salt sources in the Colorado River Basin.



The majority of the natural salt load enters the Colorado River and its tributaries from groundwater and saline springs (Bentley et al., 1980; Warner et al., 1984). Dissolution of evaporite deposits in the Upper Colorado River Basin results in highly-saline groundwater that ultimately contributes over 900,000 tons of salt per year to the Colorado River System (Chafin and Butler, 2002). Much of the background salinity in the upper Basin is likely the result of groundwater contributions to baseflow (Bentley et al., 1980). Warner et al., (1984) concluded that 55 percent, or approximately 3.8 million tons, of the total annual salt load of the upper Basin was due to baseflow. Diffuse groundwater discharge to streams, including irrigation return flows, accounted for the majority of the baseflow salt load. It was estimated that groundwater contributions from natural sources is 38 percent, with the remaining 17 percent coming from irrigation return flows during the baseflow period (Bentley et al., 1980). Irrigated agriculture is the largest anthropogenic source of dissolved solids loading in the Upper Colorado River Basin (Mueller and Osen,1988).

Public Law 93-320, the Colorado River Basin Salinity Control Act (the "Act") passed by Congress in 1974, established a program to control salinity levels in the Colorado River Basin (see Appendix A for a legislative history). The goal of the Colorado River Basin Salinity Control Program is to maintain the flow-weighted average annual TDS of the Colorado River at or below the numeric criteria specified in the water quality standards for salinity in the Colorado River system (Colorado River Basin Salinity Control Forum, 1999). The numeric criteria are:

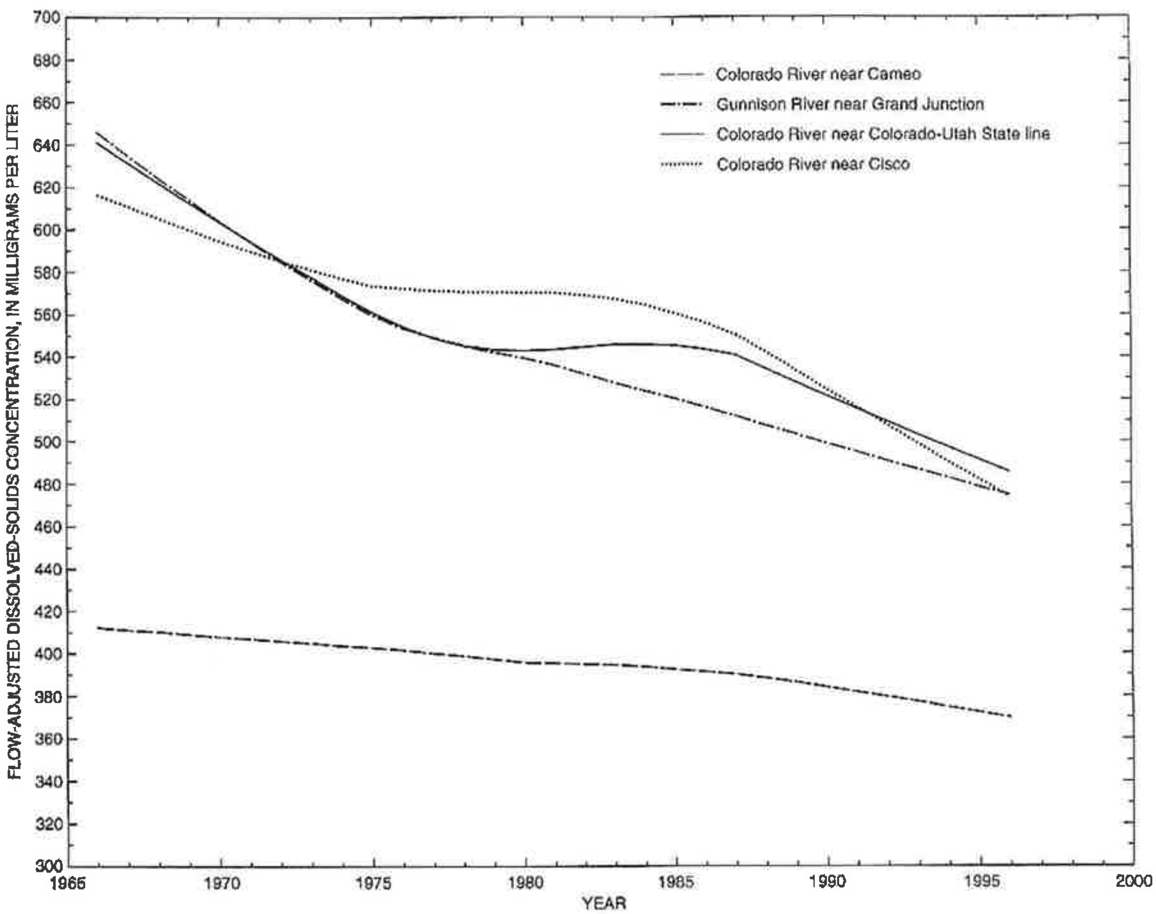
Colorado River below Hoover Dam	723 milligrams per liter
Colorado River below Parker Dam	747 "
Colorado River at Imperial Dam	879 "

The Act was passed in part to enable 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), concluded pursuant to the Treaty of February 3, 1944.

Salinity Trends in the Colorado River Basin

The U.S. Geological Survey (USGS) has conducted several studies of trends in TDS concentrations and salt loads in the Colorado River basin (Kircher, 1984; Kircher et al., 1984; Moody and Mueller, 1984; Mueller and Moody, 1984; Liebermann et al., 1989; Butler, 1996; Bauch and Spahr, 1998; Butler, 1998; and Vaill and Butler, 1999). These studies generally show significant downward trends in TDS concentrations and loads in the Colorado River and in many tributaries (Figure 3). The general declining trends in TDS at gaging stations in the Upper Basin may be reflecting several causative factors. Butler (1996) could not establish a direct connection to salinity-control projects but he did conclude that a relation was "plausible." Butler (1996) also stated that "Climatic-induced changes in dissolved solids during the period of the salinity-control projects could mask or overwhelm the human-induced changes."

Figure 3. Flow-adjusted total dissolved-solids concentrations at four stations in the Upper Colorado River Basin (from Vaill and Butler, 1999).



Some salinity trends date back to the mid-1940's, which would predate the implementation of the Colorado River Basin Salinity Control Program in the mid-1970's. Gellis et al. (1989, 1991) suggest that sediment and salt loads have been declining in the Colorado River and its tributaries since the mid-1940's in response to changing climatic and hydrologic regimes. Graf (1986) came to a similar conclusion for sediment in studying the relation between erosion and grazing on lands within the Navajo Nation, which occupies about 26,000 square miles in the Colorado River Basin in northeast Arizona, northwest New Mexico, and southern Utah. Thus, another plausible reason for declining trends in TDS is an increased storage of salt in the alluvium of Colorado River tributaries (Gellis et al., 1989, 1991). Several more years of data are now available and the trends in TDS should be re-evaluated.

Sources of Salinity on BLM-administered Public Lands

The BLM administers approximately 53 million acres of public lands in the Basin above Yuma, Arizona, including 48 million acres above Imperial Dam. Approximately, 7.2 million acres of BLM-administered lands in the Basin above Imperial Dam contain saline soils. Of that total, about 180,000 acres contain strongly-saline soils, more than 1.5 million acres have moderately-saline soils, and the remainder (roughly 6.3 million acres) have weakly-saline soils (BLM, 1987).

Point sources of salt on public lands include saline springs, saline seeps from marine sedimentary formations (primarily Upper Cretaceous shales), and abandoned flowing wells.

Nonpoint sources of salt include surface runoff, eroded soil, stream sediments, and groundwater discharge to streams. Salt concentrations on public lands are highest in the marine shales and mudstones where annual precipitation averages less than 12 inches. The greatest volume of salt comes from lands that are relatively well-covered with perennial vegetation and receive more than 12 inches of annual precipitation (Bentley et al., 1978). These lands comprise 67 percent of all BLM-administered public land in the upper Basin and contribute more than half of the annual salt load (Bentley et al., 1978). Salt concentrations of runoff water from these lands are low but total water yield is high, resulting in high salt loading (Bentley et al., 1978). This low-TDS water also provides dilution capacity for higher-salinity waters entering the system from highly-saline areas (Bentley et al., 1978).

Highly-saline soils generally occur in rangeland areas that receive low annual precipitation (less than 8 inches) (Bentley et al., 1978). While salt concentrations can be very high in runoff water from these lands, the frequency and volume of runoff is very low due to the ephemeral nature of the stream system. Runoff from highly-saline soils in the upper Basin contributes about one-third of the annual salt load from BLM-administered public lands (Bentley et al., 1978). About one-half of the salt load comes from slightly-saline soils (BLM, 1987) and the remaining salt load, approximately 15 percent, comes from moderately-saline soils (Bentley et al., 1978).

Salt transport mechanisms on arid rangelands include overland runoff, rill flow, channel flow by ephemeral and intermittent streams, and saturated flow through valley alluvium. Salts may be transported either in solution or attached to eroded soil particles and sediments. Salt loading in these environments is closely associated with sediment loading (Jackson et al., 1985; Schumm and Gregory, 1986; BLM, 1987; Gellis et al., 1989; BOR, 2001). Less sediment and salt is produced from pediments and alluvial valley floors than is produced from steep terrain, unless the pediments and alluvium are being eroded (Schumm and Gregory, 1986). Any practices that reduce erosion and store sediment in highly-saline arid landscapes, especially in headwater areas, will have the effect of retaining salt in the trapped sediment. Little is known about the ultimate disposition of the retained salt. Schumm and Gregory (1986) concluded that gully plugs and water retention dams are effective for trapping sediment and salt, provided that the structures are designed to be impermeable to water and that they do not fail. Such structures also reduce the high flows that erode downstream channels and transport sediment.

Very little is known about salt mobilization and transport in ephemeral and intermittent stream systems. A typical scenario in the arid portions of the Basin suggests that intense, localized rainstorms may fall on highly-saline soils in the headwaters, causing runoff, surface soil erosion, and possibly gully erosion. Sediment- and salt-laden water then flows across alluvial fans or moves downstream into larger stream channels having somewhat flatter gradients. As flow velocities decrease, the sediment drops out and the water infiltrates into the alluvium. Since this scenario occurs more often than not several miles from the nearest perennial stream, runoff from isolated storms may never reach Colorado River tributaries. Since the 1940's, sediment storage has been increasing in the Colorado Plateau region (Hereford, 1986; Graf, 1987). At least one study has shown that deep alluvial fills in Mancos shale terrain lacked high salt concentrations (Laronne, 1977). The salt was apparently leached out, perhaps during times when the alluvium is saturated with water. Once it is in the solution, the salt may move into the groundwater system in response to hydraulic or osmotic gradients.

The BLM has initiated investigations of salt storage and mobilization in alluvium to learn more about this issue. For example, the BLM in Utah is studying transit sources of salinity loading in the San Rafael River. The objective is to determine the major transit source of salt loads that accounts for the potential of salt to reach perennial streams from ephemeral tributaries and groundwater.

LAND MANAGEMENT ACTIONS TO IDENTIFY AND CONTROL SALINITY

The BLM is committed to identifying, understanding, and controlling point and nonpoint sources of salinity on BLM-administered lands within the Colorado River Basin. The BLM will continue to use a comprehensive, three-pronged approach to salinity control:

- Control of point sources such as saline springs and seeps and abandoned flowing wells that yield saline water (larger projects are referred to the BOR);

- Control of nonpoint sources through cost-effective land management techniques that result in multiple-resource benefits; and

- Control of nonpoint-source salt mobilization through land-use planning, permit stipulations, land-use authorization, best management practices,[1] watershed protection strategies, and ecological restoration.

The BLM is also committed to further the understanding of naturally-occurring, diffuse sources of salt on arid and semiarid rangelands. Although much is already known about the occurrence of diffuse sources on BLM-administered public lands, very little is known about salt mobilization and transport in these environments.

Watershed Assessments

The BLM is participating in, and fully supports, the *Unified Federal Policy for Ensuring a Watershed Approach to Federal Land and Resource Management.* The goal of the Policy is to develop a science-based approach to watershed assessment for Federal lands. Watershed assessment information will become part of the basis for identifying management opportunities and priorities and for developing alternatives to protect or restore watersheds on public lands. Included in the Policy is the commitment among signatory agencies to use watershed assessments, where available, to improve management of Federal lands and resources and to use a watershed management approach when protecting and restoring watersheds. This approach focuses on managing watersheds for the benefit of water bodies through a variety of land management actions. The watershed approach will be used to identify and establish priorities for controlling nonpoint sources of salinity on BLM-administered public lands.

[1] The Environmental Protection Agency defines best management practices (BMP's) as "methods, measures, or practices selected by an agency to meet its nonpoint source control needs." The BMP's include but are not limited to structural and nonstructural controls and operation and maintenance procedures.

Water Quality Management

The BLM is mandated to comply with Federal, State, and tribal water quality standards. Water quality standards are considered for each and every resource management plan prepared on BLM-administered public lands within the Colorado River Basin. The BLM field offices cooperate with states, tribes, and local entities to identify specific watersheds that do not meet water quality standards, to seek opportunities for watershed improvement and protection, and to develop best management practices (BMP's) for meeting water quality standards. With the one exception of Utah, the Colorado River Basin States do not establish salinity standards separately. The basin States manage salinity on a regional (Basin-wide) basis, reviewing progress through a triennial review, as required by the Clean Water Act.

Point-source Salinity Identification and Control

The BLM has placed a very high emphasis on point-source salinity control and will continue this approach. Through its water-source inventory process, in which water sources and uses are identified and characterized, BLM identifies saline springs and seeps. The BLM also works in collaboration with others to identify saline springs and seeps. Containment and other control options are analyzed through the land management planning process. Larger springs are referred to the BOR for an engineering assessment.

Occasionally, old or improperly abandoned oil and gas wells deteriorate and discharge saline waters to the surface. Where the operator is not known or no longer exists, these wells are referred to as "orphan wells." The BLM routinely plugs abandoned flowing wells that yield highly-saline water. Plugging the wells stops the saline water from reaching the surface. However, the long-term effects of well-plugging on the groundwater system are not known.

Nonpoint-source Salinity Identification, Understanding, and Control

The BLM uses the results of the interagency priority watershed identification project, soil salinity maps, watershed assessments, watershed analysis tools, and reconnaissance water quality studies to identify salinity "hot spots." Under the assumption that trapping water and sediment in highly-saline landscapes results in salt retention, BLM field offices have constructed grade-control structures ("gully plugs"), water-spreader dikes, and water detention or retention dams in headwater areas. Salt carried in solution and salt adhered to sediment particles is assumed to be retained in a structure, as long as the structure's capacity is not exceeded and the structure does not leak or fail.

Resource Management Plans

The Federal Land Policy and Management Act of 1976 requires the BLM to prepare land use plans that provide management direction for the public lands it manages. The BLM's planning process is the principle mechanism for making land-use decisions and the first step in implementing salinity-control actions. The BLM has developed a resource management planning process to make basic land-use decisions. Although all resource values and land uses on BLM-administered public lands are included, the development of solutions to specific planning issues is emphasized in resource management planning. Planning issues, such as water quality, are identified through a scoping process that includes input from the public and dialogue with land users.

The BLM's planning process is used to develop resource management plans (RMP's) that examine management alternatives for all resources and land uses on BLM-administered public lands. All resource management programs must utilize the planning system to identify management options. Salinity control on BLM-administered public lands must first be addressed as a land use or resource management issue, along with many other issues in RMP's.

Rangeland Health Standards and Grazing Management

Livestock grazing affects vegetation by influencing species composition, vigor, production, and plant cover. Proper livestock grazing techniques can increase cover in most areas. However, livestock grazing near streams may be detrimental to water quality. Rangeland condition is carefully monitored and assessed to evaluate the impacts to soil, vegetative, and water resources. Management adjustments are made if resources are impacted at an unacceptable level.

The National Research Council's Committee on Rangeland Classification reported that three criteria should be used to determine whether a rangeland is healthy, at-risk, or unhealthy: the degree of soil stability and watershed function, the integrity of nutrient cycles and energy flows, and the presence of functioning recovery mechanisms (National Research Council, 1994). The Committee concluded that soil stability and watershed function should have greater weight than the other criteria in determining rangeland health (National Research Council, 1994). They recommended that an evaluation of soil stability and watershed function, as determined by the use of soil surface characteristics as indicators of soil erosion and runoff, become a fundamental component of all inventories and monitoring programs for Federal and nonfederal rangelands.

Based on the National Research Council report, BLM developed the four fundamentals of rangeland health for application to BLM-administered public rangelands: watershed function, ecological processes (nutrient cycles and energy flows), water quality, and wildlife habitat. These fundamentals were published in the Federal Register and codified in 43 CFR 4180.1.

The BLM developed land health standards for all the public rangelands it manages, as well as other areas such as the BLM-administered forests in the Pacific Northwest. Standards describe the physical and biological condition or degree of function necessary to sustain the health, diversity, and productivity of the lands. The BLM's land health standards for the public rangelands it manages were developed over several years in consultation with 24 chartered Resource Advisory Councils located throughout the West and was approved by the Secretary of the Interior in accordance with established regulatory requirements. The BLM assesses the current condition and evaluates whether standards are being achieved, or whether significant progress is being made towards the achievement of standards. The standards are also useful for determining under what conditions proposed uses should be authorized. These standards provide the basis for assessments and restoration goals and help BLM determine whether local management is achieving sustainable results.

The water quality standard refers to complying with Federal, State, and Tribal water quality standards and achieving, or making significant progress toward achieving, established BLM management objectives, such as meeting wildlife or fishery habitat needs.

Ecosystem Restoration

The BLM is moving in the direction of restoring ecological structure and function at the watershed and regional landscape scales (Van Haveren et al., 1997). The emphasis is on correcting the primary causal factors that degrade landscapes in the first place. Relevant goals are to improve watershed condition and enhance the health of long-term sustainable vegetation communities.

The BLM's Strategic Plan for 2001-2005 includes the goal of restoring at-risk resources and maintaining functioning ecosystems. Restoration actions are a key element in achieving healthy rangelands. Many rangelands do not meet current standards. Restoration often requires complex, multi-faceted sets of actions that require investments in land treatments, wildlife habitat enhancement measures, weed eradication, fire fuels reduction, or riparian zone rehabilitation. Restoration activities carried out in areas containing saline soils might help prevent salt from reaching perennial streams.

Wild Horse and Burro Management

The proper management of wild horse and burro (WH&B) herds can significantly benefit water quality. As with livestock grazing, wild horses and burros may damage soils and vegetation through their physical movements and by the removal of ground cover through grazing. The BLM reduces such damage by capturing animals suitable for adoption, by influencing WH&B movements, or by protecting fragile or vulnerable areas with fenced exclosures.

In Arizona, over 1275 burros were removed from the Cibola-Trioga and Black Mountain Herd Management Areas in the Lower Colorado River corridor and in the Black Mountains. Based on previous estimates, the long-term improvement in plant communities resulting from these removals increase infiltration and reduce runoff from these areas.

In Nevada, nearly 600 burros were removed from the Gold Butte Herd Management Area. The removals were conducted under the National Park Service plan to reduce the number of animals at Lake Mead by 82 percent. An appropriate management level for the Gold Butte Herd Management Area has been achieved.

National Energy Policy Implementation

The National Energy Policy was released by the Department of Energy on May 17, 2001. The Policy calls for increased exploration, production, and infrastructure support for domestic oil, natural gas, and renewable energy sources. The Policy points out that most new electric generation facilities are natural gas-fired. The increased demand for natural gas has fueled extensive exploration activities in the West, including the Upper Colorado River Basin. Currently, coalbed methane is a convenient and relatively inexpensive source of natural gas. The BLM administers the leasing of all federally-owned energy mineral resources. Coal, oil, gas and oil shale development in the Colorado River Basin all have the potential to contribute salt to the Colorado River (Bureau of Land Management, 1987). For example, coalbed methane development and production requires an extensive network of roads. Best management practices, developed and applied at the state and field office level, ensure that energy mineral development activities comply with state, tribal, and Federal water-quality standards.

Roads and Off-road Vehicle Management

The BLM is working on individual roads and trails throughout the Colorado River Basin to allow public access and use for appropriate activities, while adopting improved trail location, design, maintenance, and improvements that meet social and resource needs. Where specific resource concerns exist, a range of strategies are available. Water quality improvement measures, road and trail relocation or reconstruction, restoration of spur trails, and improvements in runoff-control and drainage structures are all tools that can be employed. The elimination of specific roads and trails is another option. Reducing off-highway vehicle (OHV) access, closing and reclaiming selected roads, resurfacing dirt roads, and improving road maintenance practices have all been utilized.

Protected Lands

The Grand Staircase-Escalante National Monument in southern Utah was designated by presidential proclamation in September, 1996. Established from existing public lands, the Monument encompasses approximately 1.9 million acres within the Upper Colorado River Basin to be administered by the BLM in a manner compatible with the purposes of the Monument, subject to existing prior rights. While there are no immediate and direct benefits for salt retention, the curtailment or restrictions on future development within the Monument, together with more intensive management, will likely have significant and positive results for salinity control.

The Grand Staircase-Escalante National Monument is only one example of BLM-administered lands protected under the National Landscape Conservation System. Other protected public lands within the Colorado River Basin include:

- Colorado Canyons National Conservation Area in west-central Colorado - 122,000 acres, including 75,000 acres of designated wilderness immediately adjacent to the Colorado River;
- Gunnison Gorge National Conservation Area in western Colorado - 58,000 acres;
- Canyons of the Ancients National Monument in southwestern Colorado - 164,000 acres;
- Grand Canyon-Parashant National Monument in northern Arizona - 1,014,000 acres; and
- Vermillion Cliffs National Monument in northern Arizona - 293,000 acres.

SUMMARY OF BUREAU OF LAND MANAGEMENT SALINITY CONTROL ACCOMPLISHMENTS

The BLM initiated its involvement in Colorado River Basin salinity control by creating and staffing a Salinity Team in 1975. Reconnaissance investigations, studies and research, and feasibility studies were conducted by the Team. Beginning in the early 1980's, BLM planned and implemented pilot salinity-control measures on BLM-administered public lands throughout the Colorado River Basin. The BLM's fundamental philosophy has been to integrate salinity control with the rest of its land management responsibilities. Often, one or more best management practices may be implemented for salinity control. Best management practices for BLM-administered public lands include any measure that will retain salt on-site indefinitely and reduce salt loadings to tributary waters. Salinity reports produced by BLM are listed in Appendix B.

BLM Salinity Control Accomplishments

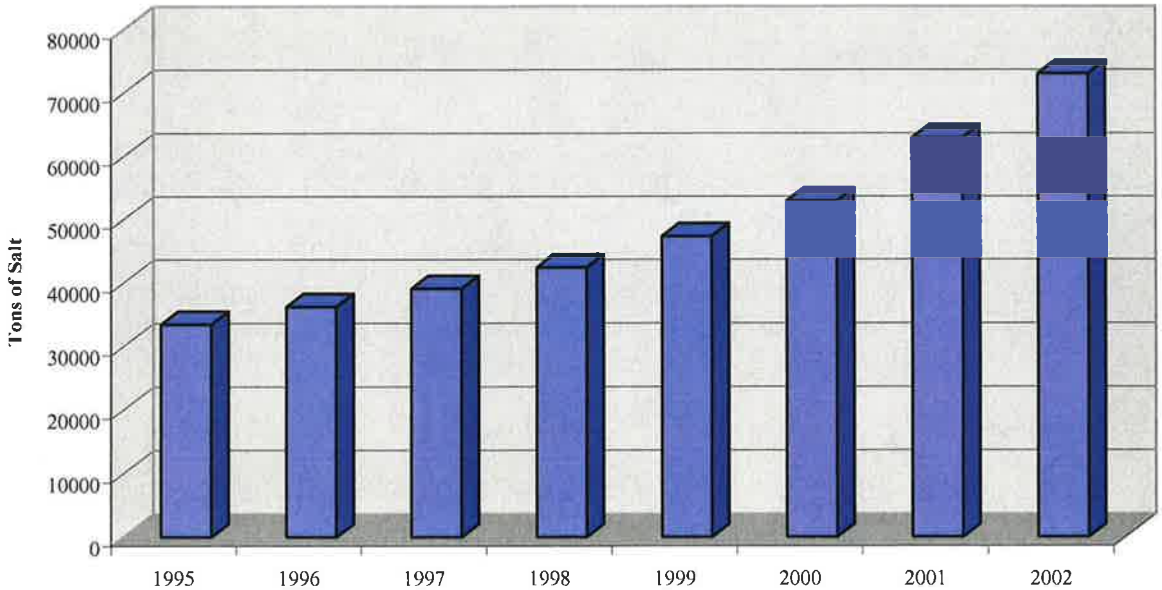
The BLM has implemented over 270 salinity control measures in six states. Appendix C lists the number of control measures by state and by type of measure. The estimated salt retention from BLM control actions prior to 1996 is 33,400 tons per year (Department of Agriculture et al., 1996). Figure 4a illustrates the estimated annual salt retention for the period 1996-2002, based on existing salinity-control measures. Figure 4b shows the percentage of salt retained by state.

Point-source Salinity Control–Wells and Springs

Eleven point-source control measures have been implemented, including eight plugged wells and three saline springs and seeps. Well-plugging activities on BLM-administered public lands from 1987 through 2002 stopped the discharge of between 7000 and 9600 tons of salt per year (Table 1).

Figure 5 illustrates a flowing saline well in northern New Mexico and Figure 6 illustrates a saline spring in Disappointment Valley in western Colorado.

Figure 4. (a) Estimated salt retention (tons) on BLM-administered public lands, 1995-2002; and



(b) Salt retention on BLM-administered public lands, percent by state.

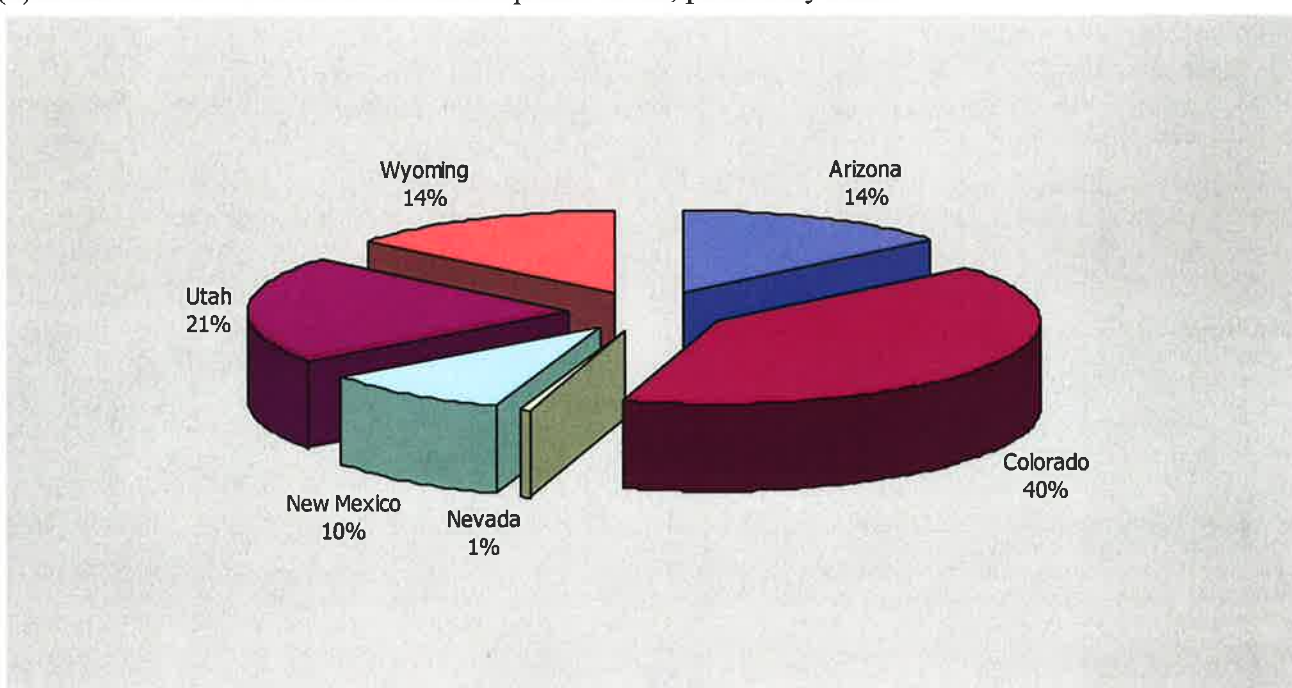


Table 1. Salt retained (tons) by plugged saline wells on BLM-administered public lands in the Colorado River Basin since 1987.

1987	1988	1989	1990	1991	1992	1993	1994
7000	7000	7000	7600	8000	8000	8400	8400

1995	1996	1997	1998	1999	2000	2001	2002
8400	8400	8400	9600	9600	9600	9600	9600

Figure 5. Flowing saline well, northern New Mexico.

Figure 6. Saline spring in Disappointment Valley, Colorado.

Nonpoint-source Salinity–Watershed Restoration and Land-use Management

A sample list of nonpoint-source salinity-control actions is shown in Appendix C. The types of measures include water and sediment retention and detention structures, gully plugs, prescribed burns and burn rehabilitation, streambank stabilization, road maintenance, water-spreader dikes, range reseedings, willow plantings, and riparian restoration.

The Lower Wolf Creek Watershed in northwestern Colorado is an example of a salinity-control initiative that involved cost-effective structural measures and multiple resource benefits (Figure 7). Several hundred retention dams, reservoirs and gully plugs were installed in the mid-1980s and have required very little maintenance. The Lower Wolf Creek watershed restoration project is retaining an estimated 147 tons of salt annually. Wolf Creek is a tributary to the White River. The impact of the Lower Wolf Creek Watershed practices, including sediment and salt retention, on water quality in the White River is unknown.

The Little Egypt Retention Dam in central Utah, completed in 2001, is shown in Figure 8. This structure was built in an area containing strongly-saline soils. It is predicted to retain five to ten tons of salt annually.

Funding for BLM Salinity Control Activities

Annual funding for BLM salinity-control activities has remained constant at $800,000 for several years. Table 2 shows the BLM salinity-control funding breakdown by state for the period 1996-2002. These amounts do not include a tabulation of funding for related and auxiliary actions that contribute to the assessment and control of salinity, including planning, wetlands restoration, wild horse and burro management, etc.

Figure 7. Lower Wolf Creek Retention Dam, Colorado.

Figure 8. Little Egypt Retention Dam, Utah.

Table 2. Salinity funding allocations by state, 1996-2002, thousands of dollars.

	Arizona	Colorado	New Mexico	Nevada[2]	Utah	Wyoming	NSTC[3]
1996	60	200	100	30	180	150	80
1997	60	200	100	30	180	150	80
1998	60	200	100	30	180	150	80
1999	60	200	100	30	180	150	80
2000	60	200	100	30	180	150	80
2001	60	200	100	30	180	150	80
2002	60	230	100	0	180	150	80

[2] Funding for salinity control projects in Nevada was discontinued in 2001
[3] National Science & Technology Center

ANTICIPATED FUTURE ACTIONS

The BLM will continue its three-pronged approach of controlling point sources (saline springs, seeps and abandoned wells), controlling nonpoint sources through cost-effective land management techniques, and minimizing nonpoint-source salt mobilization through land-use planning, permit stipulations, land-use authorizations, best management practices, watershed protection strategies, and ecological restoration.

BLM Strategic Plan and Resource Management Plans

The BLM's 2000-2005 Strategic Plan includes the goal of restoring at-risk resources by 2005, including the implementation of water quality improvement prescriptions and maintaining functioning systems on BLM-administered public lands in those watersheds that do not meet State/Tribal/Federal water quality standards. In addition, by 2005, BLM will achieve proper functioning condition (or an upward trend) on BLM-administered riparian/wetland areas in 80 percent of the watersheds within priority subbasins and an upward trend in the condition of uplands in 50 percent of the watersheds within priority subbasins. Priority subbasins incorporate the strategic goal of resource protection, including watershed conservation and restoration objectives. Priority subbasins are currently being identified by BLM field offices. Ultimately, priority subbasins will represent those areas where the BLM will focus multiple program funds to accomplish integrated objectives consistent with the long-term achievement of the Strategic Plan.

Point-source Salinity Control

The BLM will continue to identify saline springs, seeps, and abandoned flowing wells. Control feasibility and cost effectiveness will be determined for new point sources. Larger projects will be referred to the Bureau of Reclamation.

Nonpoint-source Salinity Control

The BLM field offices will complete watershed analyses in selected watersheds to identify additional nonpoint-source control opportunities. The focus will be on the following activities:

- apply management practices (BMP's, allotment management plans, watershed plans, grazing prescriptions) to control erosion, sediment movement, and salt mobilization;

- prevent gully incision and channel erosion in marine geologic formations;

- as appropriate, install grade-control structures (gully plugs) and retention/detention structures to trap sediment and encourage channel aggradation on headwater tributaries; and

- promote research and scientific synthesis activities, in collaboration with others, that lead to a better understanding of salt mobilization and transport on arid and semiarid rangelands.

The greatest salt retention benefits, in terms of minimizing future salt loading from BLM-administered public lands, will be achieved through land management practices that minimize disturbances to soils and stream channels, repair and restore disturbed lands, and protect critical watershed areas. Structural solutions will be utilized only where they are feasible and cost-effective.

The BLM will explore creative new technologies and management practices for controlling nonpoint sources of salt. The EPA remarked in 1971 that "the greatest lack of available technology is in the area of natural diffuse sources" (EPA, 1971). This statement is still true 30 years later. The BLM will collaborate with its science partners in the research community to achieve a better understanding of salt mobilization and transport in arid, geologically-unstable environments. As an example, Sheep Creek, a tributary to the Paria River in southern Utah, was intensively studied during 2002 to identify saline springs and seeps (Figure 9). The Sheep Creek Watershed Stabilization Project, an interagency watershed improvement project initiated in the 1950's, has successfully reduced erosion, healed gullies, and trapped sediment behind spreader dikes and detention dams. The Sheep Creek watershed is an example of integrating salinity-control objectives with broader land-use management goals. The BLM's Gunnison Gorge National Conservation Area, in collaboration with the USGS, is developing best management practices to reduce erosion and associated salinity and selenium loading in Mancos shale landscapes. The work focuses on solutions that can be transferred to other BLM lands with Mancos shale.

Basin-wide Salinity Coordination

The BLM has established a Salinity Coordinator position to coordinate salinity-control activities in the Basin states that receive funding for salinity control on BLM-administered public lands. The Salinity Coordinator will develop better estimates of salt retained from BLM salinity-control projects, identify research and monitoring needs associated with the salinity-control program on BLM-administered public lands, and develop best management practices for salinity control on arid and semiarid rangelands. The Salinity Coordinator will work closely with BLM managers, the Bureau of Reclamation's Salinity Program Manager, the Natural Resource Conservation Service's Salinity Coordinator, and the Colorado River Basin Salinity Control Forum to create an appropriate salinity-control program for BLM-administered public lands and work with States, tribes, and other partners to complete salinity control projects.

Figure 9. Sheep Creek watershed, upper Paria River basin, Grand Staircase-Escalante National Monument, Utah.

RESEARCH, INVENTORY AND MONITORING NEEDS

The BLM has identified the following research, inventory, and monitoring needs critical to understanding salt mobilization and transport on arid and semiarid rangelands. Groundwater contributions to salinity levels in Colorado River tributaries must also be better defined.

Salt mobilization and transit mechanisms in headwater areas of arid and semiarid rangelands. The BLM needs information on how solutes and saline sediments move from source areas to ephemeral channels.

Solute and sediment transport in ephemeral channels. The BLM needs information on how solutes and saline sediments move through ephemeral channel systems to perennial streams.

Salt behavior in valley alluvium. Solute distribution and movement within alluvial deposits of intermittent and perennial stream channels should be investigated.

Updated information on the extent of highly-, moderately-, and slightly-saline soils. New soil surveys and improved geographic information system (GIS) coverage will lead to improved estimates of the aerial extent of saline soils and sources of salt loading on BLM-administered public lands in the Colorado River Basin. The results should be compared in a GIS environment with estimates of water runoff potential.

Quantification of TDS concentrations in surface runoff and groundwater inflows. Currently, little data exists on the TDS concentrations of surface runoff and groundwater inflows originating on BLM-administered public lands.

Investigation of Yampa River salinity trends. The Yampa River has been identified by the USGS as having statistically-significant increasing salinity trends. The sources of the increased salinity should be located. The current drought conditions experienced throughout the Colorado River Basin represent a unique opportunity to study salinity levels and salt loading at very low flows.

The BLM will work in cooperation with its science partners and the Colorado River Basin Salinity Control Forum Working Group to further define these science needs and develop study plans.

Following general funding priorities and approximate costs have been identified in a survey of all salinity control opportunities in key Colorado River Basin States. Specific projects that will be prioritized work on allocations of projects, maintenance, challenge grants, and other funds included in annual work plans include:

1. Small demonstration watersheds for investigating salt loading and salt transport in headwater areas ($1,500,000) – Colorado, New Mexico, Utah, Wyoming;

2. The GIS mapping of saline soils ($150,000) – Colorado, New Mexico, Utah, Wyoming;

3. Salt mobilization and transport in alluvium ($350,000) – Colorado, New Mexico, Utah, Wyoming; and

4. Intensive monitoring to determine transit sources of salt loading in perennial streams ($500,000) – Colorado, New Mexico, Utah, Wyoming.

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APPENDIX A

COLORADO RIVER BASIN SALINITY CONTROL LEGISLATIVE HISTORY

Federal Water Pollution Control Act (1956)	Public Law 84-660
Water Quality Act (1965)	Public Law 89-234
Federal Water Pollution Control Act Amendments (1972)	Public Law 92-500
Colorado River Basin Salinity Control Act (1974)	Public Law 93-320
Clean Water Act (1977)	Public Law 95-217
Colorado River Basin Salinity Control Act, Amendment (1984)	Public Law 98-569
Clean Water Act (1987)	Public Law 100-4
Amendment of the Colorado River Basin Salinity Control Act (2000)	Public Law 106-459

The Colorado River Basin Water Quality Control Project was established in 1960 by the Public Health Service. In 1963, the Project initiated investigations to address several salinity issues. The Water Quality Act of 1965 directed the States to establish water quality standards for all interstate waters. Water quality standards were not established for salinity in the Colorado River Basin primarily due to a lack of information about water quality requirements for water uses, the feasibility of salinity control, and the economic impacts of various salinity levels.

The enactment of the Federal Water Pollution Control Act Amendments of 1972 affected salinity control, in that the legislation was interpreted by the EPA to require numerical standards for salinity in the Colorado River. In response, the seven Colorado River Basin States founded the Colorado River Basin Salinity Control Forum (Forum) to develop water quality standards, including numeric salinity criteria, and a basin-wide 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 average 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. The standards are to be reviewed at 3-year intervals. All of the Basin States adopted the 1975 Forum-recommended standards and EPA subsequently approved the standards.

The B LM began salinity-control activities in 1973 when the Assistant Secretary of the Interior for Land and Water Resources directed the BLM and the BOR to establish a working relationship that integrated reclamation and public land management programs to reduce salinity in the Colorado River Basin. Point-source controls were implemented beginning in Fiscal Year 1974. The BLM created a four-person salinity team to evaluate landscape processes and land management actions relevant to Colorado River Basin salinity during the period 1975-1984. Nonpoint-source control activities began in 1980, following intensive studies of salt occurrence and salt behavior on arid rangelands.

Public Law 93-320, the Colorado River Basin Salinity Control Act, authorized the construction of four salinity-control units in the Basin and required planning reports for 12 other units. Increased demands for water use, partially due to projected energy development in the Basin, created new water quality concerns for the Colorado River. Because Public Law 93-320 authorized the construction of only four salinity-control units, salinity management efforts at the time were deemed insufficient to control projected salt yields in the Basin.

In 1982, the seven Basin States became concerned that the salinity standards established by the Forum could be exceeded. As a result, the Forum and the States supported the 1984 amendment to Public Law 93-320. Section 3 of Public Law 98-569 amended Section 203 (b) of the Act by adding a subsection (3), directing the Secretary of the Interior to:

> ". . .develop a comprehensive program for minimizing salt contributions to the Colorado River from lands administered by the Bureau of Land Management and submit a report which describes the program and recommended implementation actions to the Congress and to the members of the advisory council. . . ."

The report *Salinity Control on BLM-administered Public Lands in the Colorado River Basin–A Report to Congress* was submitted in July, 1987. The report concluded that point sources of salinity on BLM-administered public lands–saline springs and flowing wells–were being controlled where appropriate and described three point-source salinity-control measures. Major point sources, requiring extensive engineering, were brought to the attention of the BOR. Under the assumption that controlling salinity from nonpoint sources was closely related to controlling sediment yields, the report summarized the results of 12 implemented watershed activity plans that included sediment and salt reductions.

The Colorado River Basin Salinity Control Act was amended again in 2000. Section 2 of Public Law 106-459 directed the Secretary of the Interior to:

> "... prepare a report on the status of implementation of the comprehensive program for minimizing salt contributions to the Colorado River from lands administered by the Bureau of Land Management. . . ."

Section 2 specifically states that the:

> "report shall provide specific information on individual projects and funding allocation."

APPENDIX B

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APPENDIX C

SALINITY-CONTROL MEASURES IMPLEMENTED BY BLM, 1996-2002

(numbers of measures)

	Arizona	Colorado	New Mexico	Nevada	Utah	Wyoming	Total
Type of Measure							
Disturbed Area Rehab			1		3	1	5
Erosion Control	1	1	4		8	3	17
Grazing Management	2		6		6	2	16
Habitat Management					1		1
OHV Management			2		1		3
Prescribed Fire	2		3		3	1	9
Retention/detention Dams & Reservoirs[4]	1		8		158	5	172
Road Maintenance	2		4		1	1	8
Vegetation Treatment	3	8	6				17
Watershed Structures		10	1		2	2	15
Well Plugging		2	4		2	2	10
WH&B Management	3						3

[4] Retention/detention dams and reservoirs include small gully plugs and large detention dams with outlet works