# Selenium Management Program

# Program Formulation Document
# Gunnison River Basin, Colorado

**Prepared by Selenium Management Program Workgroup**
**Compiled by Bureau of Reclamation December 2011**

South Canal – Uncompahgre Valley

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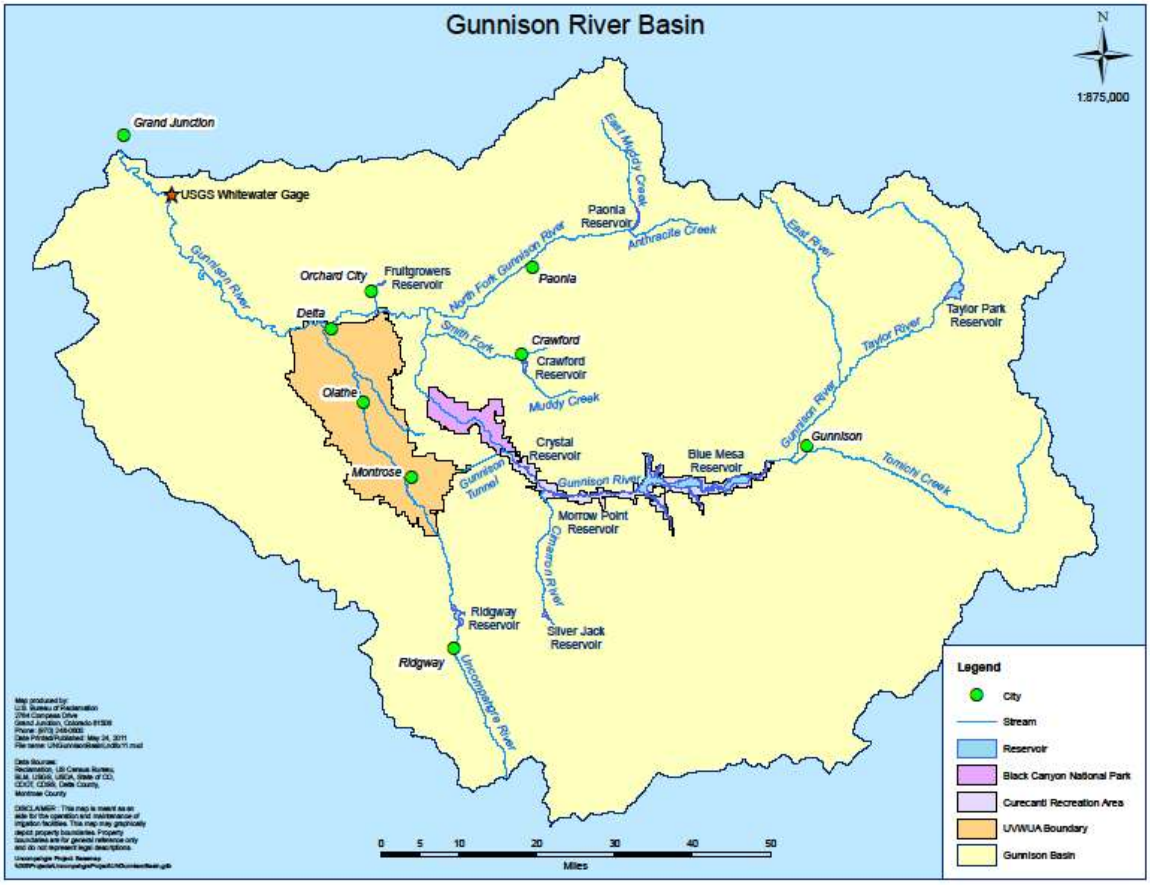


**Gunnison River Basin**

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# EXECUTIVE SUMMARY

This Selenium Management Program (Program) has been developed as part of a broad-based cooperative effort to provide water security, environmental compliance and regulatory certainty for water users in the Gunnison Basin of western Colorado. The Program is in response to the December 2009 Fish and Wildlife Service Gunnison Basin Programmatic Biological Opinion (PBO - described in Chapter 2). The Program will guide the efforts of public and private agencies and organizations in controlling selenium to meet dual objectives: complying with Clean Water Act requirements and assisting in the recovery of several endangered fish species to comply with the Endangered Species Act.

The Program will benefit water users and regional economies by protecting existing and future water uses through the acceleration of the improvement of irrigation system infrastructure and related on-farm irrigation improvements that reduce selenium (and associated salinity) loading and enhance agricultural productivity. The Program will also expand efforts to control selenium from non-agricultural sources and to improve scientific understanding of selenium fate and transport.

Selenium is a trace element that can accumulate in food chains and lead to reproductive failure and adverse impacts in fish and wildlife. Selenium is found in Mancos shale, a geological formation common in the lower Gunnison Basin. Deep percolation of water from unlined canals, laterals, and agricultural and domestic irrigation can mobilize selenium from Mancos-derived soils and transport it to area streams and rivers. Upstream from the major irrigated areas in the lower Gunnison and Uncompahgre River Basins, selenium concentrations are generally less than 1 part per billion (ppb), but downstream from irrigated areas, the selenium concentrations in surface waters can exceed 4.6 ppb (dissolved), the state instream standard for protection of aquatic life.

Although selenium levels in the lower Gunnison and Uncompahgre rivers and several tributaries exceed Colorado water quality standards, there is strong statistical evidence that there is a downward trend in selenium concentrations and loads over the last 20 years. To date, activities associated with the following programs -- Colorado River Basin Salinity Control Program, National Irrigation Water Quality Program and the Selenium Task Force -- as well as basin-wide changes in land and water use have reduced selenium loading in the Lower Gunnison Basin.

According to the Fish and Wildlife Service, several federally listed endangered fish, including the Colorado pikeminnow and razorback sucker, have been adversely impacted in the Gunnison River by water quality and other habitat issues. These issues are generally associated with historical water development in the basin. Thus, the potential for conflicts between water

development and the Endangered Species Act has developed. This Program is designed to minimize such conflicts by meeting clean water and endangered species act requirements while allowing water development to continue.

This report provides background justification for developing the Program (Chapter 2), the linkages between selenium and the health of fish and wildlife and between selenium loading and water quality trends (Chapter 3). It details the components of an Action Plan, which is the core of the Program (Chapters 4 and 5) and discusses monitoring needs, potential funding sources for implementation, and program activities (Appendices A-C).

# CHAPTER 1—INTRODUCTION

## A. PURPOSE

The purpose of this document is to describe the Selenium Management Program (Program). The Program is designed to reduce selenium concentrations in the lower Gunnison River Basin of western Colorado to assist in the recovery of federally listed endangered fish and to improve basin water quality. Implementation of the Program should ensure that selenium levels in the Gunnison River and Colorado River do not impede the achievement of recovery goals and the eventual downlisting and/or delisting of endangered fish. Successful steps towards the recovery of endangered fish species benefit water users and regional economies by providing Endangered Species Act compliance for existing and future water use.

In the 2009 Programmatic Biological Opinion (PBO), discussed later in this report, it is stated that "Reclamation will develop and implement a Selenium Management Program (SMP), in cooperation with the State of Colorado and Gunnison River basin water users to reduce adverse effects of selenium on endangered fish species in the Gunnison and Colorado rivers…"

The Program has been developed as a joint public/private partnership of agencies, organizations and water interests.[1] It is a cooperative effort with substantial involvement of the stakeholders that maximizes the cost-effectiveness of federal, state and local investments while maximizing multiple benefits. The Bureau of Reclamation (Reclamation) serves in a leadership role in coordinating and managing the implementation of the Program.

## B. REPORT

This report presents the framework for the Program including background material and recommended actions.

- Chapters 1 & 2: Introduction material including the purpose of the report and the cooperative development of the program.
- Chapter 3: Water-quality and endangered species goals are presented.

[1] Includes the State of Colorado, Bureau of Reclamation, Natural Resources Conservation Service, U.S. Geological Survey, Fish and Wildlife Service, Bureau of Land Management, Colorado River Water Conservation District, Uncompahgre Valley Water Users, Upper Gunnison River Water Conservancy District, local conservation districts, and local governments

- Chapter 4: Water-quality and biological data are summarized; irrigation systems are described; and ongoing studies are presented.
- Chapter 5: Potential selenium control components and funding opportunities are described along with a recommended strategy.
- Appendix A-B: The water-quality monitoring program is described. Multiple potential funding sources for the Program are discussed.
- Appendix C: The selenium management action plan of work activities and schedules, designed to be updated annually, is presented.

## C. PROBLEM

Selenium is a trace element that can accumulate in food chains and lead to reproductive failure and other adverse impacts on fish and wildlife. The Selenium Task Force summarized early investigations into potential adverse effects of selenium on fish and wildlife resources (Selenium Task Force 2010):

> "In 1983, incidences of mortality, deformities, and decreased reproduction in fish and aquatic birds were first discovered by the U.S. Fish and Wildlife Service at the Kesterson Wildlife Refuge in the western San Joaquin Valley, California, where irrigation drainage waters with high concentrations of selenium were collected. Due to concerns that problems with selenium toxicity may not be confined to the Kesterson Refuge, in 1985, the U.S. Department of the Interior began a program to study the effects of irrigation drainage on the water quality of the Western United States.
>
> Subsequent investigations by the National Irrigation Water Quality Program (NIWQP) and the United States Geological Survey (USGS) in 1987-88 indicated that irrigation drainage from the Uncompahgre Project along the Western Slope of Colorado, a Bureau of Reclamation (BOR) irrigation project, might be a primary source of selenium, dissolved solids and other constituents to the Gunnison and Uncompahgre rivers, and Sweitzer Lake. Additional studies conducted in 1991-93, found that about 64 percent of water samples collected from the lower Gunnison River and about 50 percent of samples from the Colorado River near the Colorado-Utah line exceeded the U.S. Environmental Protection Agency (EPA) selenium criterion of 5 ug/L (micro grams per liter) for protection of aquatic life."

The Fish and Wildlife Service (Service) summarized concerns about selenium levels in the Gunnison and Colorado rivers (Fish and Wildlife Service 2009):

> "Colorado pikeminnow, humpback chub, bonytail, and razorback sucker are being harmed from the continuation of discharge of selenium related to the Uncompahgre Project and other water uses in the Gunnison Basin. Approximately 60% of the selenium load measured in the Gunnison River near Whitewater comes from loading sources in the Uncompahgre River Basin (Reclamation 2006). The continued operation of the

> Uncompahgre Project and other water uses is associated with continued loads of salt and selenium in irrigation drain-water being carried to the Gunnison River by adjacent tributaries. Selenium concentrations in designated critical habitat in the Gunnison River between Delta, Colorado and the Colorado River confluence, as well as the Colorado River downstream of the Gunnison River confluence, exceed the state water quality selenium standard for the protection of aquatic life. Selenium concentrations exceed toxic effect threshold concentrations and are indicative of reproductive impairment occurring in endangered Colorado River fish and migratory birds. Selenium from the female's diet is incorporated into eggs, and high concentrations may result in reduced production of viable eggs, and/or post-hatch mortality due to metabolism of egg selenium by developing larval fish (deformities and altered physiology) (Lemly 2002, Sorensen 1991). Implementation of the Selenium Management Program is intended to reduce adverse effects of selenium on endangered fish by reducing selenium loads, concentrations, and exposure to selenium."

A toxicity threshold for selenium in whole fish of 4 parts per million (ppm) dry weight (DW)) has been recommended for the protection of freshwater fish (USDOI 1998, Lemly 1996a, Lemly 1996b, Skorupa 1998; Hamilton 2002b). The mean selenium concentration of 7.1 ppm DW was calculated for whole body fish samples (various not-endangered species) collected during 1992 from the Gunnison River Basin. Selenium concentrations in about 71% of the fish samples from the Gunnison and North Fork of the Gunnison Rivers, 64 % of the fish from the Uncompahgre River, and about 55% of the fish samples from the Colorado River exceeded the 4 ppm DW whole body fish selenium toxicity guideline.

In 1997, the Colorado Water Quality Control Commission (CWQCC) adopted a 5 parts per billion (ppb) aquatic life protection standard for total selenium (4.6 ppb dissolved) in the Gunnison River Basin. Several stream segments, including about 57 miles of mainstem Gunnison River between Delta and the Colorado River confluence do not meet this standard, and appeared on the 1998 Clean Water Act (CWA) 303(d) list of impaired water bodies for the State of Colorado. These 57 miles, including the 100-year floodplain, are designated critical habitat for the Colorado pikeminnow and the razorback sucker. Exceedences in the mainstem Gunnison River range from 6-9 ppb. In 2002, the CWQCC adopted the 5 ppb aquatic life protection standard for selenium in the Colorado River. A 38 mile segment of the mainstem Colorado River below the Gunnison River confluence downstream to the Colorado-Utah state line was placed on the CWA 303(d) list.

## D. PROGRAM GOALS

The Selenium Management Program is designed to reduce selenium levels in the lower Gunnison and Colorado Basins to comply with state instream water quality standards. Achieving

this goal will assist in the recovery of endangered fish, thus providing water security, environmental compliance and regulatory certainty for water users and the citizens of the basin.

### Water Quality

The initial goal of the Program as recommended in the PBO is to meet the state water-quality standard for dissolved selenium of 4.6 ppb as measured at the Whitewater Gage[2] and as determined by the Colorado Water Quality Control Division methodology. In addition, the Program will endeavor to maintain or improve the existing downward trend in the lower Gunnison River selenium concentrations. The downward trend between 1986 and 2010 is depicted in Figure 7 and discussed in Section 3.B.

### Endangered Fish

The long term goal of the Program is to sufficiently improve water-quality conditions to assist in the recovery of the Colorado pikeminnow and razorback sucker by reducing selenium concentrations. Recovery happens when naturally occurring, reproducing populations are self sustaining, with all life stages present and there is natural recruitment into the adult population. The goal of the Program with respect to endangered fish in the Gunnison River is to ensure that selenium levels in the lower Gunnison and Colorado rivers do not impede the achievement of recovery goals and down-listing and delisting of endangered fish.

### Water Resources

Another long-term goal of the program is to support continued water uses in the Basin. The Program fulfills a critical requirement of the PBO and thereby protects historical water uses by ensuring public and private water users benefit from regulatory certainty. The PBO and its benefits are described in Chapter 2.

[2] USGS Gage No. 9152500 Gunnison River near Grand Junction

# CHAPTER 2—BACKGROUND ACTIVITIES

## A. PROGRAMMATIC BIOLOGICAL OPINION

In 2009, Reclamation released a draft Environmental Impact Statement on modifying the water release patterns from the Aspinall Unit in order to assist in the recovery of downstream endangered fish (Reclamation 2009). The Aspinall Unit consists of Blue Mesa, Morrow Point, and Crystal dams, reservoirs, and powerplants on the Gunnison River in west-central Colorado. In general, the new operations proposed include a higher spring release and moderate base flows during the remainder of the year.

Reclamation worked with the Service to evaluate the new operations under the Endangered Species Act (ESA). The State of Colorado, Colorado River Water Conservation District and water users requested that the Service and Reclamation expand their analysis beyond Aspinall Unit operations and cover effects of all public and private water uses in the Gunnison Basin, with a goal of avoiding future adversarial endangered species consultations. They requested that Reclamation and the Service prepare a programmatic biological assessment and programmatic biological opinion (PBO). Consequently the programmatic biological assessment (Reclamation 2008) and the PBO (Fish and Wildlife Service 2009) were prepared.

The PBO addresses the modified Aspinall Unit operations and in addition it addresses other public and private water uses in the Gunnison Basin. In summary, the PBO provides ESA coverage for existing and specified future water uses and depletions in the Gunnison River Basin, as well as completes ESA consultation on the Dallas Creek and Dolores Projects.

Two main elements of the PBO are:

- The reoperation of the Aspinall Unit and
- The preparation and implementation of the Selenium Management Program.

The Program, as described in the PBO, calls for reducing selenium levels in the Gunnison and Colorado rivers. The Service describes the selenium issue in the PBO as follows:

> "The ongoing operation of irrigation projects and other water uses in the basin will continue to contribute selenium to the Gunnison and Colorado Rivers at levels that adversely affect the endangered fishes and their designated critical habitat and are inhibiting the survival and recovery of the endangered fishes. Reclamation will develop and implement a Selenium Management Program (SMP), in cooperation with the State of Colorado and Gunnison River

basin water users to reduce adverse effects of selenium on endangered fish species in the Gunnison and Colorado rivers (see Effects of the Proposed Action section). The SMP will incorporate and accelerate ongoing selenium reduction efforts in the Uncompahgre Valley and other areas of the Gunnison Basin and will add several new elements. The overall long-term goal of the program is to assist in species recovery per the Recovery Goals. The SMP will use the best available scientific information for all elements of the program. Elements of the SMP will include:

- Accelerated implementation of salinity/selenium control projects for irrigated agriculture
- Reduction of other non-point source selenium loading
- Technology development
- Water-quality monitoring
- Monitoring of endangered fish populations
- Coordination with lower Gunnison River Basin watershed management plan
- Regulatory support
- Public information and education
- Adaptive management
- Institutional support"

Successful implementation of the Program has been recognized as providing local and regional benefits as well as avoiding water-quality and regulatory problems. In general, the PBO provides the following benefits to the basin's public and private water uses:

- Provides ESA compliance, especially "take" coverage, for existing and new private/public water uses, including the Aspinall Unit and the Uncompahgre, Smith Fork, Paonia, Fruitgrowers, Bostwick Park, and Dallas Creek Projects. The PBO recognizes that depletion of water and existing selenium concentrations harm the endangered fish. Harm is considered "take" of an endangered species and this "take" is covered by the PBO as long as certain measures are implemented, including the Program.

- Shifts responsibility from individual water users to the Colorado River Endangered Fish Recovery Program to address depletion impacts to endangered species.

- Provides water security, environmental compliance and regulatory certainty in the Gunnison Basin. The PBO greatly reduces the chances of major conflicts between the ESA and water uses in the basin.

- Provides ESA compliance for the Upper Gunnison Subordination and provides compliance for depletions from new augmentation contracts throughout basin.

- Assists in endangered fish recovery--which supports continuing and future water uses in the basin.

- Enhances or supplements existing programs and thus may facilitate improvement of irrigation systems, crop production, and local economies; and may reduce operation and maintenance costs of irrigation systems and make more efficient use of water.
- Facilitates ESA compliance for future Clean Water Act 402 and 404 permits, land use permits, or other regulatory approvals.
- Completes ESA compliance for the Dolores Project by offsetting mainstem depletions.
- Improves water quality for many uses in Colorado and downstream.

Because implementation of the Program is a key part of the PBO, it is essential that the Program be fully implemented in a timely manner in order for Reclamation and water users in the basin to comply with the ESA. If the assessment from annual progress reports indicates that the Program, as specified in the PBO, has not been implemented as proposed, Reclamation will be required to reinitiate consultation to specify additional measures to be taken by Reclamation or the Recovery Program to avoid the likelihood of jeopardy and/or adverse modification of critical habitat for depletions and water quality. Also, if the status of endangered fish species has not sufficiently improved, as determined by the Service in a formal "sufficient progress finding" under provisions of the Recovery Program, Reclamation will be required to reinitiate consultation[3].

The PBO calls for the Program to include goals, timeframes, and a Long Range Plan (termed the Selenium Management Action Plan in this report). This Plan (Appendix C) is to include implementation schedules, benchmarks, responsible or contributing entities, monitoring needs, and coordination with ongoing Recovery Program Activities (Fish and Wildlife Service 2009).

## B. RECOVERY PROGRAM

In 1988, the Upper Colorado River Endangered Fish Recovery Program (Recovery Program) was established to assist in the recovery of four species of endangered fish found in the Colorado River: the humpback chub, bonytail, Colorado pikeminnow, and razorback sucker. The pikeminnow and razorback are found in the Gunnison River. The Recovery Program; which is a partnership of local, state, and federal agencies, water and power interests, and environmental groups; provides ESA compliance for continued operation of water and power projects in accordance with project purposes.

The goal of recovery is to achieve natural, self-sustaining populations of the endangered fish so they no longer require protection under the ESA. The Recovery Program will monitor

[3] Re-initiation of consultation essentially means the ESA compliance process would be redone, possibly with new requirements and provisions.

endangered fish populations in the Gunnison River to determine responses to various recovery activities and the implementation of the Program. In addition the program will collect fish tissue samples for selenium analysis. A Study Plan (Recovery Program 2011) has been prepared to recommend to the Recovery Program monitoring and/or research projects necessary to evaluate effects of the proposed operations of the Aspinall Unit described in the PBO, to determine how those operations improve habitat contributing to recovery of the endangered fishes, and to evaluate effects on critical habitat in the Gunnison River and in the Colorado River from the Gunnison River confluence to Lake Powell.

## C. PREVIOUS AND ONGOING ACTIVITIES RELATED TO SELENIUM CONTROL

As discussed later in this report, infiltration of water into selenium and salt rich soils and formations is the primary factor in both salt and selenium loading in the Gunnison Basin. To date, activities associated with the following programs --- Colorado River Basin Salinity Control Program, National Irrigation Water Quality Program and the Selenium Task Force --- as well as basin-wide changes in land and water use have reduced selenium loading in the Lower Gunnison Basin.

### Colorado River Basin Salinity Control Program

The Colorado River Basin Salinity Control Program (Salinity Program) is designed to reduce upper Colorado River basin salt loading primarily for the benefit of water users in the lower basin states of Arizona, California, and Nevada. Salinity-control techniques adopted by the Salinity Program are generally thought to reduce selenium loading because seepage and deep percolation of water into the local Mancos Shale and associated soils is the primary source of both salt and selenium loading. The 1974 Salinity Control Act, as amended, authorizes the Department of the Interior (Reclamation and Bureau of Land Management [BLM]) and the Natural Resources Conservation Service (NRCS) to undertake actions to reduce salinity loading in the upper basin. Generally, Reclamation works to improve the irrigation water delivery systems (typically known as the “off-farm” systems), NRCS works with individual landowners to improve on-farm irrigation practices and the BLM addresses runoff from public lands. Although the 1996 amendment eliminated the mandated USDA authorities under the Colorado River Basin Salinity Control Act, Environmental Quality Incentives Program (EQIP) authorities include water-quality improvements such as salinity control and continue to govern NRCS’s implementation of salinity control assistance to eligible producers on eligible land.

In the mid 1970’s, Reclamation began studies of the Lower Gunnison Basin Unit (LGBU) as directed by the Salinity Control Act. Investigations focused in the Uncompahgre Project

area because of its highly concentrated salt loading. A plan was developed for lining canals and laterals east of the Uncompahgre River and eliminating use of open ditches for winter stock water deliveries throughout the Project area.

Reclamation implemented the "Winter Water Program" in the Uncompahgre Valley between 1992 and 1995. This effort eliminated flows in 407 miles of canals and laterals during the late fall and winter that had been required for livestock watering and replaced that source with piped domestic water deliveries. The project was constructed in cooperation with the Uncompahgre Valley Water Users Association (UVWUA) and local domestic water providers. This reduced salinity loading by an estimated 41,330 tons/year and, most likely, selenium loading by some un-estimated amount.

In 1995, further amendments to the Salinity Control Act provided for Reclamation's "Basinwide Program" which selects off-farm projects proposed by irrigation companies and other water user entities on a cost-competitive basis. In the early years of that program, proposals for the Uncompahgre Valley were not cost effective and thus not selected for funding. Later, others assisted in providing cost sharing which allowed funds to be secured for a number of projects in that area.

The NRCS provides cost-share assistance to agricultural producers who voluntarily implement improved land management and on-farm irrigation practices that reduce salt loading. Participants are provided incentive payments and share in the cost for measures that reduce on-farm salt loading. NRCS also provides technical assistance to producers to plan, design, and install these more efficient water systems. Examples of NRCS activities include use of gated pipe and sprinkler systems for field irrigation, land leveling for more efficient irrigation, and development of irrigation water management plans. The NRCS works in partnership with Conservation Districts to assist farmers to install improved irrigation systems in the Lower Gunnison salinity control area under the various Colorado River salinity control initiatives. There is a greater trend toward conversion of existing improved surface systems to highly efficient, advanced irrigation technology (AIT), in particular center pivot sprinkler systems. Currently, this trend is primarily occurring in Delta County of the project area. As mainstem delivery systems are piped it usually creates pressurized flow delivery systems encouraging the conversion of existing improved surface on-farm systems to AIT.

On-farm salinity control in the Lower Gunnison area has been primarily made possible through the EQIP and the Parallel Program (PP). The PP is terminating and the new Basin States Program (BSP) that was authorized in the 2008 Farm Bill, Public Law 110-246, that amended the Salinity Control Act, will be another potential source of funding. The emphasis of the BSP will be to fund improved land management and irrigation practices that do not qualify under EQIP and small off-farm canal and lateral delivery systems that are too small to compete in the Basinwide Program's cost-competitive process.

On-farm Gated Pipe

The BLM has a program on public lands to improve vegetation cover, assist in better use of onsite precipitation, and facilitate stronger plant root systems. In turn, a more stable runoff regime and reduced soil loss should result and improve water quality. The BLM is revising the Resource Management Plan for BLM-administered lands within the Uncompahgre Planning Area. The plan details the current state of resources and guides management actions for the next twenty or more years under the BLM's dual mandate of multiple use and sustained yield. As part of the process, the BLM will consider a set of alternatives for addressing public land contributions to selenium loading in aquatic environments. Activities identified as having the greatest potential to impact selenium transport include recreation, grazing, fluid mineral development, and land disposal. For each of these activities, a preferred alternative will be selected that balances resource protection, including selenium control, with the impacts of a growing population and expanding urban interface in accordance with the National Environmental Policy Act and the ESA. For more information about the Uncompahgre Resource Management Plan, please visit: http://www.blm.gov/co/st/en/fo/ufo/uncompahgre_rmp.html.

Mancos Shale lands managed by Bureau of Land Management

## National Irrigation Water Quality Program

The National Irrigation Water Quality Program (NIWQP) was initiated in 1986 in response to concerns about the impact of elevated levels of selenium in western waterways. Data was collected between 1987 and 2003 in the Gunnison River Basin. Water, sediment, food chain items, fish, birds, and eggs were sampled for many potential contaminants including selenium, which was the major concern. Based on the data, the combined lower Gunnison River Basin and Grand Valley in western Colorado was one of 5 areas selected in the western United States as significant selenium problem areas for fish and wildlife that warranted remediation.

The NIWQP began planning for remediation in the lower Gunnison Basin in 1994. In1999, a proposal was formulated by the UVWUA and NIWQP to fund a demonstration project in the Montrose Arroyo area, southeast of Montrose. The purpose of the project was to show how the NIWQP and the Salinity Program could work cooperatively to reduce both selenium and salinity loading. This project, later known as Phase 1 of the East Side Lateral Project, was very successful, reducing selenium loading by 27% and salinity loading by 11%. Based on these results, several members of the Gunnison Basin Selenium Task Force pursued Congressional write-ins to the NIWQP budget in the early 2000's to support Phases 2 and 3 of the East Side

Lateral Project. Those phases were eventually funded by the Salinity Program and NIWQP with construction completed in 2011.

## Selenium Task Force

In July 1997, the State of Colorado Water Quality Control Commission (WQCC) amended the Classifications and Numeric Standards for the Lower Gunnison and Lower Dolores River Basins. These amendments included the adoption of a new chronic water-quality standard of 4.6 ppb for dissolved selenium and the adoption of temporary modifications for selenium standards. The adoption of the new standard meant that a number of segments in the lower Gunnison Basin were placed on the State of Colorado's 303(d) List of Impaired Waters which requires the development of Total Maximum Daily Loads (TMDLs) for selenium.

In February 1998, the Gunnison Basin Selenium Task Force was formed to address exceedence of the selenium standard in a number of segments in the lower Gunnison Basin and to assist in developing local solutions to reduce selenium loading in affected segments. The Selenium Task Force is "a group of private, local, state and federal interests committed to finding ways to reduce selenium in the affected reaches while maintaining the economic viability and lifestyle of the lower Gunnison River basin" (Selenium Task Force 2010). Following its formation, the Selenium Task Force immediately joined forces with the NIWQP.

In 2006, the NIWQP and Reclamation's Technical Assistance to States Program working in conjunction with the Selenium Task Force produced a report entitled "Evaluation of Selenium Remediation Concepts for the Lower Gunnison & Lower Uncompahgre Rivers, Colorado" (Reclamation 2006). This report documented a planning process that developed and evaluated remediation concepts and provided the Selenium Task Force and other decision makers with information needed to assess the potential for significantly reducing selenium loading. It serves as a significant resource on background and historical selenium reduction planning efforts for formulation of the Program.

Today, the Selenium Task Force meets and works collaboratively to address selenium loading in affected reaches. Members of the Selenium Task Force provide technical expertise, monitoring and evaluation of projects, grant writing expertise, and a forum for education and outreach. Background information is available at (http://seleniumtaskforce.org/). Members include:

- City of Delta, CO
- City of Montrose, CO
- City of Grand Junction, CO
- Colorado Department of Health and Environment
- Colorado Division of Water Resources
- Colorado Division of Parks and Wildlife
- Delta Conservation District
- Shavano Conservation District
- Colorado River Water Conservation District
- Colorado Soil Conservation Board
- Colorado State University Extension
- Colorado Water Institute
- Commercial farmers, ranchers, and dairymen
- Delta County Commissioners
- Delta County Health Department
- High Country Citizens Alliance / Sierra Club
- Montrose County Commissioners
- Natural Resources Conservation Service
- Towns of Hotchkiss, Paonia, CO
- U.S. Fish and Wildlife Service
- U.S. Bureau of Reclamation
- U.S. Bureau of Land Management
- Uncompahgre Valley Water Users Association
- U.S. Geological Survey

Over its years of existence, the Selenium Task Force and its members have been effective in securing funding for various selenium-related studies and demonstration projects. As mentioned above, members have secured funding for the NIWQP and from Colorado's Non-Point Source Program (NPS Program) (CWA Section 319 funds) to support construction of the East Side Lateral Project. The Selenium Task Force is presently preparing a Lower Gunnison River Basin Selenium Watershed Management Plan to help to assist in the implementation of selenium reduction projects with NPS funds in order to meet selenium water-quality standards. It is anticipated that the Watershed Plan will mirror activities displayed in the Program Action Plan (see Section 5).

## Major Accomplishments

Major accomplishments of the aforementioned programs that are believed to have reduced selenium loading in the lower Gunnison River Basin are listed below. Limited information is available to provide good estimates of selenium load reductions, so, although selenium is likely reduced by these accomplishments, load reduction estimates are not generally provided[4].

- 1995: The "Winter Water Program" eliminated the carriage of water in Uncompahgre Project canals and laterals during the non-irrigation season and thus reduced seepage and subsequent salt and likely selenium loading. Estimated salt load reduction was 41,330 tons/year.
- 2000: The Montrose Arroyo Demonstration Project placed 8.5 miles of open laterals into pipe reducing salt and selenium loading and allowing documentation of the effects in a published U.S. Geological Survey (USGS) report. The USGS data collection produced an estimated selenium load reduction of 210 pounds/year and salt load reduction of 2,500 tons/year.
- 2004 thru early 2011: Following the Montrose Arroyo demonstration project, approximately 47 additional miles of laterals in the Uncompahgre Valley have been

[4] As discussed later in this report, although there are indications of a relationship between salt and selenium loading, the actual fate and transport relationships are not fully understood at this time. So no numeric selenium reduction can be deduced from the predicted salinity reductions for any of these reported accomplishments.

placed in pipe or lined to reduce salt and selenium loading and another 4 miles are approved and funded. Estimated salt load reduction is 12,082 tons/year.

- 1988-2010: Through fiscal year 2010, the NRCS reports implementing 57,588 acres of on-farm irrigation system improvements in the lower Gunnison Basin with an estimated salinity reduction of 105,502 tons/year. An estimated 49,705 acres are improved flood systems, 6,765 acres are sprinkler systems, and 1,067 acres are micro-spray or subsurface drip systems. These numbers do not include work done prior to 1989, and none would include work done by landowners without federal assistance or through other programs or with other non-salinity funds (NRCS 2011).
- 1988-2010: The BLM implemented Best Management Practices to reduce erosion of saline and selenium-bearing soils.
- 2010-2011: Approximately 9.8 miles of canal and associated laterals in the North Fork and Smith Fork drainages were piped to reduce salinity loading. Estimated salt load reduction is 4,588 tons/year.
- 2011: Six additional lower Gunnison Basin projects to pipe irrigation canals and laterals were selected under Reclamation's 2010 Basinwide Program FOA. Agreement negotiations are underway.

Unlined lateral being placed in pipe.

# CHAPTER 3--BACKGROUND DATA

## A. SELENIUM LOADING

Selenium occurrence in the lower Gunnison Basin is a function of geologic formations and properties of those formations. Occurrence of selenium in ground and surface water in dissolved forms is a function of oxidizing or reducing conditions which exist as a product of the biogeochemical environment and physical processes such as coprecipitation and adsorption. These processes are complex and governed by many physical and geochemical factors of which many are not fully understood. A summary of the general factors controlling the sources of selenium and its mobilization are presented here. A more extensive accounting of these factors can be found in the work cited throughout this report.

Selenium enrichment of geologic materials occurred during the Cretaceous age and was related to volcanic eruptions of element-rich gases and ashes (Butler and others 1996). During the Cretaceous age, a vast interior seaway called the Cretaceous Sea covered most of North America. The depositional setting in this seaway was an organic rich environment capable of reducing selenium in the crystalline structure of sulfide minerals (Coleman and Delevaux 1957). Additional sources of selenium to the seaway may have come later in the Cretaceous age as the seaway evolved and became an interior sea. Trace elements such as selenium and major ions were concentrated in the sediments as the interior sea eventually receded. The geologic formation in the lower Gunnison Basin associated with the Cretaceous Sea is called the Mancos Shale Formation. Outcrops of this formation are shown in Figure 1. Figure 2 rates the potential of lands from a very high to low potential to contain soluble selenium. Mancos Shale outcrops tend to occur in the valleys of the lower Gunnison Basin. This is as a result of regional uplift of the Uncompahgre Plateau in the south western portion of the basin, the Black Canyon of the Gunnison uplift in the central region of the Basin, and the West Elk Mountains to the east. Geologic ages associated with the uplift sequences are older than the Mancos Shale and are not associated with the Cretaceous Sea. Erosion rates were higher in areas of uplift and the younger formations, such as the Mancos Shale, were consequently eroded away at a faster rate than those in the Valley floors. Selenium occurs in other geologic formations but is most prevalent in the Mancos Shale as a result of the unique conditions and timing of events that occurred during the Cretaceous period. The amount of total selenium contained in different areas of the Mancos Shale Formation is highly variable and governed by the depositional environment during formation. Butler and others (1996) found that concentrations of selenium in Mancos Shale Bedrock were higher in samples cored near ash layers. They also found that weathered layers of Mancos Shale (residuum and alluvium) were higher in total selenium, perhaps as a result of the preferential displacement due to adsorption or capillary effects.

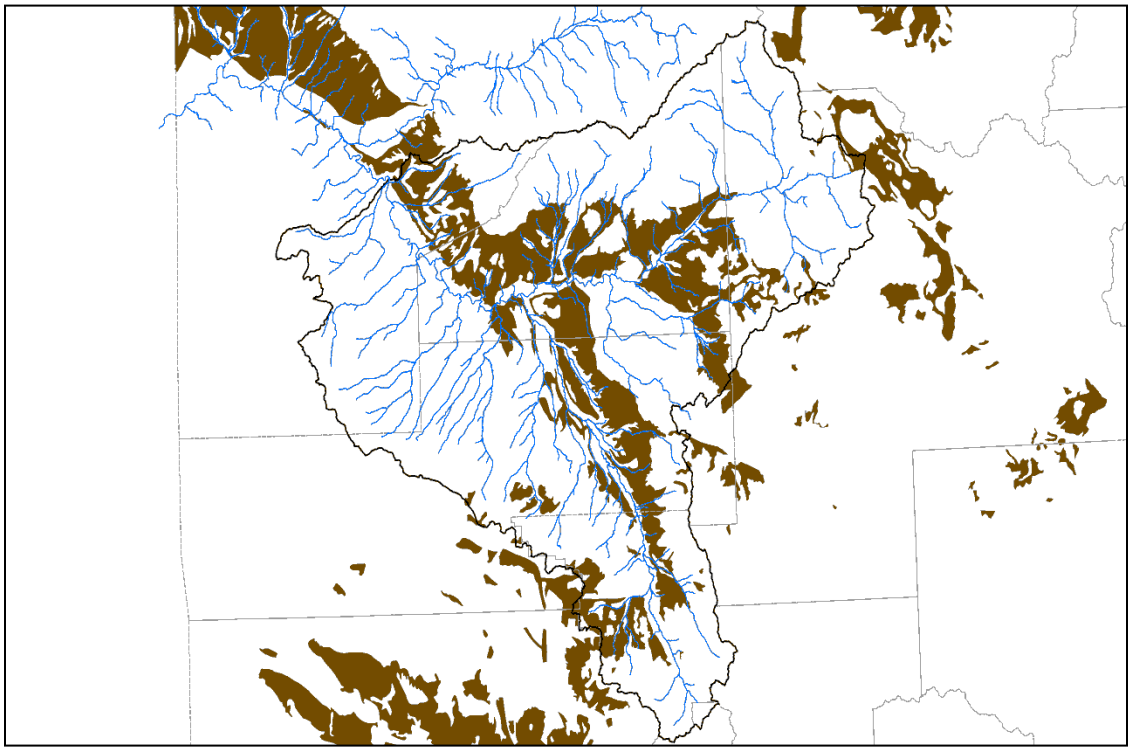

Figure 1. Map showing approximate areal extent of surface outcrops of Mancos Shale highlighted in brown in the lower Gunnison Basin and portions of western Colorado.

Selenium enrichment in ground and surface waters has always occurred via the same physical and chemical processes; however, modern land use practices have changed the rate and quantity at which enrichment occurs. Selenium is sourced from the soils and parent material and mobilized by waters of various origins. The geochemical processes that govern the rate of selenium mobilization are complex, but are generally tied to source abundance and redox state. In the presence of low oxygen conditions, selenium will be reduced and exist in a less mobile form; whereas, oxic conditions will create more mobile forms of selenium.

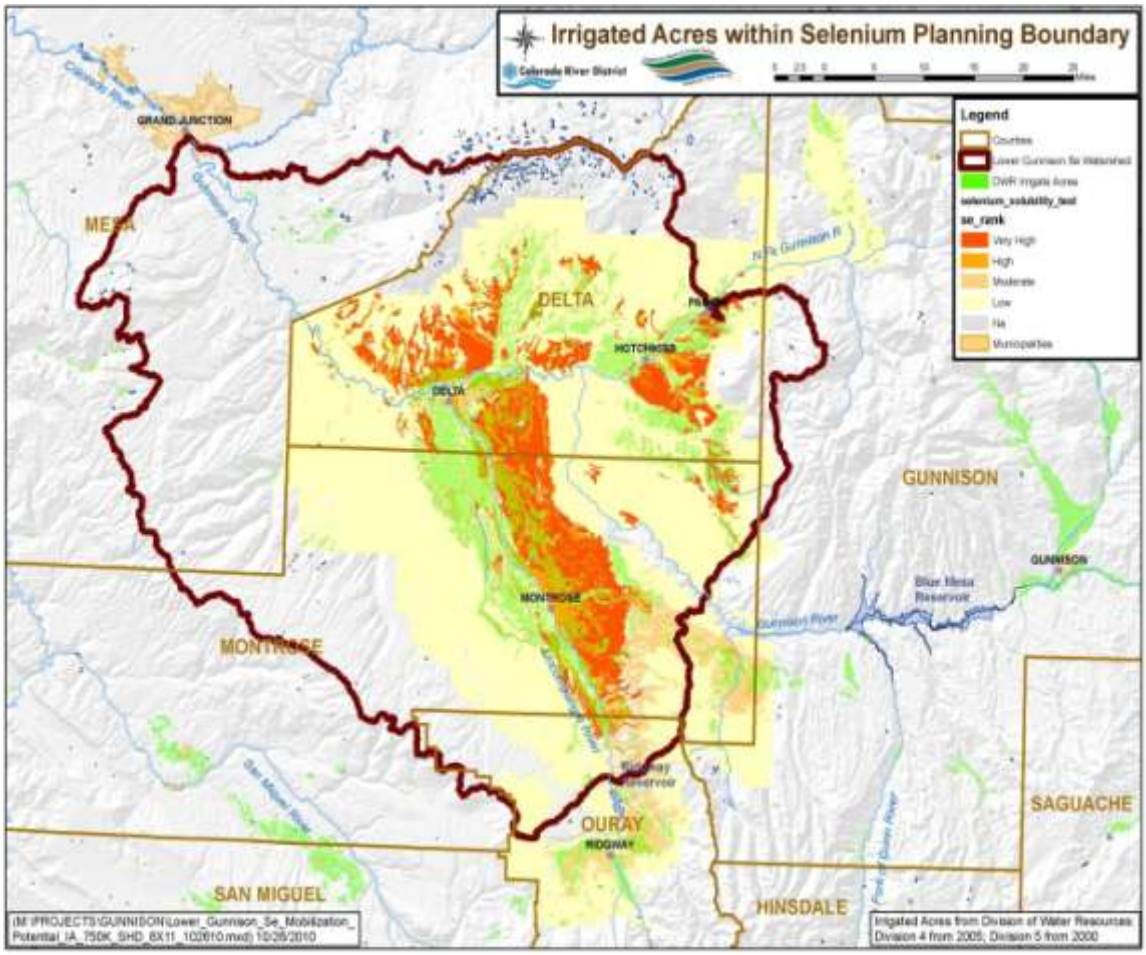


Figure 2. Primary selenium source areas in Gunnison Basin with potential to load selenium rated from very high to low.

Anoxic conditions occur when oxygen availability is limited. Oxygen is limited when microbial demand exceeds availability. This is common in, but not limited to, some depositional environments such as oxygen deprived ground water, and organic rich but poorly drained soils such as wetlands. Through the span of geologic time, uplift and erosion has exposed reduced forms of selenium in the Mancos Shale Formation to meteoric and applied sources of water. The reducing environment that existed during deposition can be shifted to an oxidizing environment as a result. Sources of applied water identified here generally consist of irrigation, residential, and industrial water use. Applied water accelerates the process in which anoxic environments become oxic. The water provides oxygen (and potentially other oxidizing agents), resulting in a higher potential to mobilize selenium than was otherwise present prior to water application. In the lower Gunnison Basin, the type of applied water that has the most impact on selenium mobilization is irrigation water for agriculture. Precipitation rates in the lower valley are typically on the order of 6-12 inches (Doesken 2011), whereas irrigation rates add an additional 24-60 inches ( Written Communication, Uncompahgre Valley Water Users Association 2011).

Additionally, canals and laterals used to deliver the irrigation water to agricultural fields can seep and add more oxygen rich water to the ground water system. Approximately 170,000 acres of irrigated land exists in the lower Gunnison Basin of which approximately 57,000 irrigated acres are situated on Mancos Shale outcrops (Tweto and Ogden 1976; Techni Graphic Systems, Inc. 2003).

Water from unlined laterals percolates into the ground water and picks up selenium.

Other sources of water that may have an increasing impact on selenium mobilization are industrial and residential sources. Industrial applications are primarily limited to energy extraction in the form of natural gas, oil, and coal bed methane. A byproduct of these types of energy development is water produced as a result of drilling and extraction. The water may be displaced to evaporation ponds or local drainages. This displaced water could move into a regional ground water system or increase selenium yield via increased sedimentation rates. The quantity of selenium released from activities associated with energy development is not fully understood; however, energy development in the lower Gunnison Basin is limited.

Residential sources of water to the ground water system typically result from individual septic disposal systems (isds's) and turf irrigation. Mayo (2008) found that there is a reduction in ground water recharge when converting previously irrigated agricultural land to residential land. These results suggest a decreased potential for salinity and perhaps selenium mobilization as a result of this type of land use change. The impact to selenium mobilization potential from converting previously non-irrigated land to residential land and septic systems is not fully understood. However, the addition of water for landscape irrigation, ponds, runoff from hard surfaces, and water from septic systems on lands that have not been irrigated previously, are likely to introduce potential new sources for both salinity and selenium loading.

New residences in Mancos Shale Area. Precipitated salt appears as white covering of soils.

Irrigation history affects selenium levels in soils. According to Fisher (2003) "Soil mapping and sampling of Mancos derived soils determined that soils that have never been irrigated contain an average of 34 times the amount of selenium remaining in irrigated soils that have been leached; also of significance is that soluble selenium levels do not increase with depth in irrigated soils; this correlation supports the hypothesis that a large part of the original soluble selenium, pre-irrigation, has been leached from the soil profile."

Fisher (2003) identified potentially important sources of selenium loading: "…deep percolation irrigation water (both agricultural and domestic); septic system drainages; seepage from ponds, wetlands, and canals; the natural erosion of Mancos Shale, and soils derived from the Mancos shale; and the irrigation of golf courses, parks, cemeteries, and urban lawns."

## B. WATER QUALITY AND TRENDS

Selenium levels are monitored by various agencies and organizations in the Gunnison Basin. For the Program, the key monitoring point is the USGS Gunnison River gage at Whitewater. The primary objective of the selenium monitoring program in the lower Gunnison Basin is to document selenium trends in support of endangered species issues and state standards, TMDL development and implementation, modeling efforts, and fish studies.

The goal of monitoring is to build a more robust database for salinity and selenium that will provide the basis for better statistical analysis of salinity and selenium using regression modeling at various scales. The information gained from the models will enhance decision making processes by improving planning models and scientific understanding.

The strategy is to expand and optimize the existing water-quality monitoring network in the lower Gunnison Basin in partnership with a variety of stakeholders. For example, the Colorado River Water Conservation District, the Colorado River Salinity Control Forum, the USGS, and Reclamation have teamed up to add three real-time specific conductance and temperature monitors at existing USGS real-time flow stations. Knowing real-time continuous specific conductance allows for the development of correlations between flow and major ion concentrations. To further leverage these data, there is coordination with the USGS, River Watch, and the State Water Quality Control Division (WQCD) to acquire selenium samples at these and other existing monitoring sites. With a well-designed program, additional selenium samples collected at strategic times and locations will be cost-effective and provide vital information that can be used for trend analyses, CWA compliance, listing/de-listing, TMDL development and implementation, and support modeling efforts and endangered fish studies.

Additional information on monitoring is included in Appendix A.

Data presented in this section were collected by the USGS and can be accessed at http://co.water.usgs.gov/. Additional data was available for sites listed in this analysis http://rmgsc.cr.usgs.gov/cwqdr/Piceance/SPiceance.shtml but was not included because only USGS data was used for the trend analysis presented in this section. USGS data was used exclusively for the trend analysis to eliminate potential bias from differing sampling techniques, laboratory methods, and detection limits that could indicate a false trend. Dissolved selenium is defined by the State of Colorado Department of Public Health and Environment as the portion of total selenium in unfiltered water that passes through a 0.45 micron filter. Selenium concentrations described herein were processed by the USGS using a 0.45 micron filter and all results are presented as dissolved. Specific methods used to collect, preserve, and analyze these data are available in the USGS National Field Manual http://water.usgs.gov/owq/FieldManual/ and on the USGS National Water Quality website http://nwql.usgs.gov/.

Selenium data collected at two USGS streamflow gaging stations are presented in this section. The two stations are the Gunnison River near Grand Junction (Whitewater) and the Colorado

River at the Colorado-Utah State Line (State Line)[5]. These stations represent the integration of selenium from multiple land use types. The majority of selenium from Western Colorado passes these two stations. Selenium loads (selenium concentration multiplied by streamflow with units of pounds per unit of time) at the State Line gage represent roughly 60% of the selenium load that enters Lake Powell annually. Both stations are outflow points for critical habitat segment of endangered fish species. The gaging stations are also end points for stream reaches that are on the State of Colorado 303(d) list of impaired streams for selenium. The State of Colorado's chronic standard for aquatic life warm water class one is 4.6 ppb. If the 85$^{th}$ percentile of selenium values in a representative data set exceeds 4.6 ppb, then the reach is out of compliance and is assigned to the State of Colorado 303(d) list.

Selenium concentrations analyzed periodically from 1986-2008 are shown in Figures 3 and 5. This period was chosen because it begins with the completion and filling of Ridgway Reservoir and coincides with the onset of the NRCS cost-share for irrigation system improvements for salinity control and Reclamation's salinity program. These events are significant in regards to the selenium trend analysis results presented later in this section. Several patterns in the distribution of dissolved selenium concentration exist at each station. Selenium concentrations at both stations tend to vary inversely with streamflow. When streamflow levels are high, selenium concentrations tend to be lower and the opposite is true for low streamflow levels. At both stations, the lowest period of streamflow was in 2000-2005. Selenium concentrations at Whitewater were highest during 2000-2005 and selenium concentrations at State Line were approximately the same as the highest historical concentrations (late 1980's) for the period. Selenium at State Line appears to follow a similar temporal distribution as Whitewater. Generally, when selenium concentrations are high at Whitewater, they are high at the State Line. This indicates that selenium levels at Whitewater are controlling selenium levels at the State Line to some degree and processes controlling selenium at each station are similar. Raw data from Figures 3 and 5 show a range of selenium concentration from 1 to 16.2 ppb at Whitewater and from 1 to 11 ppb at the State Line.

While not evident from Figures 3 and 5, selenium concentrations at both stations are typically higher during the non-irrigation season (November to March) when ground water is a larger component of streamflows. Lower concentrations during the irrigation season are a function of snowmelt flows providing dilution and release of stored water during the growing season (April to October). During the non-irrigation season, less water is available to dilute selenium enriched ground water entering the stream system.

Dissolved selenium loads are shown in Figures 4 and 6 as daily loads (lbs/d) that were calculated from periodic samples. Selenium load varies with streamflow and is generally higher during wetter periods than dry periods. Butler (1996) reported that the lower Gunnison Basin was the source of approximately 43% of selenium load at the State Line for water years 1991-92. Leib (2008) found the lower Gunnison Basin contributed around 52% of the selenium load at the State Line for the period 1997-2006. The residual loads from each study were attributed to the Grand

[5] USGS Gaging Station No.9152599, Gunnison River near Grand Junction (Whitewater gage)
USGS Gaging Station No.9163500 Colorado River near Colorado-Utah State Line (State Line gage)

Valley, and to a lesser extent (7-9%), areas draining land upstream of the Grand Valley. Median loads shown in Figures 4 and 6 indicate that about 52% of the selenium load at the State Line is from the lower Gunnison Basin. Selenium loads for both stations were approximately 15% higher for water-years 1986 to 1997 indicating a possible trend in dissolved selenium.

Mayo and Leib (2011) analyzed trends in dissolved selenium at Whitewater and the State Line for the period 1986 to 2008. This period brackets the period of major selenium and salinity control work in the lower Gunnison Basin and Grand Valley. Mayo used a streamflow adjustment technique to account for fluctuations in streamflow. This was done to account for fluctuations of selenium concentration and load that may occur as a result of dilution or trends in streamflow. When streamflow is taken into account, the remaining variability in the selenium data can be associated with possible land use or selenium/salinity control measures in the area of interest. This method uses regression techniques to estimate trends in dissolved selenium concentrations and loads from a normalized annual hydrograph for the period of record. The regression represents the average condition for the period analyzed and will not represent wet or dry periods as well as the long term period analyzed.

The trend analysis was considered to primarily represent changes in the lower Gunnison Basin and the Grand Valley due to the fact that selenium levels above the lower Gunnison Basin and the Grand Valley are typically below or near detection limits. The low selenium concentrations make further analysis unnecessary. Butler (1996) reported selenium concentrations from the upper Gunnison Basin (USGS streamflow gaging station 0912800, Gunnison River below Gunnison Tunnel) were all below current detection limits (1 ppb). Leib (2008) reported median dissolved selenium concentrations above the Grand Valley (USGS streamflow gaging station 0905500, Colorado River near Cameo) to be 0.5 ppb for the periods 1994-95 and 2005-06. Due to the low concentration of dissolved selenium upstream from the lower Gunnison Basin and Grand Valley, no analysis of selenium trends was done.

The trend analysis showed decreasing trends in selenium concentration and load at both stations during the study period. Selenium concentrations at the 85$^{th}$ percentile went from 7.2 ppb to 5.1 ppb at Whitewater and from 7.8 ppb to 4.6 ppb at the State Line. Loads at Whitewater decreased 28.6% from about 23,000 to 16,560 pounds annually. Selenium loads at the State Line decreased 40.3% from 56,600 pounds to 33,600 pounds annually.

The calculated trend in selenium concentration from 1986 to 2008 is shown in Figure 7 as the "flow adjusted trend" line. It has been extrapolated to show the potential future trend for the years 2009-2016. The trend is flow adjusted which means the trend in selenium concentration appears as it would if the variability due to variations in streamflow is removed. The solid black trend line shows a reduction in selenium concentration of approximately 2 ppb between 1986 and 2008 or about 29%. These results may not be reflected in unusually wet or dry years and are only representative of the average hydrologic condition for the period of record analyzed. The green line represents the 85th percentile for the last 5-year period as it would be calculated by the

State of Colorado to determine impairment as defined by the EPA. The 2010 value was 6.0 ppb. The State's selenium standard is 4.6 ppb.

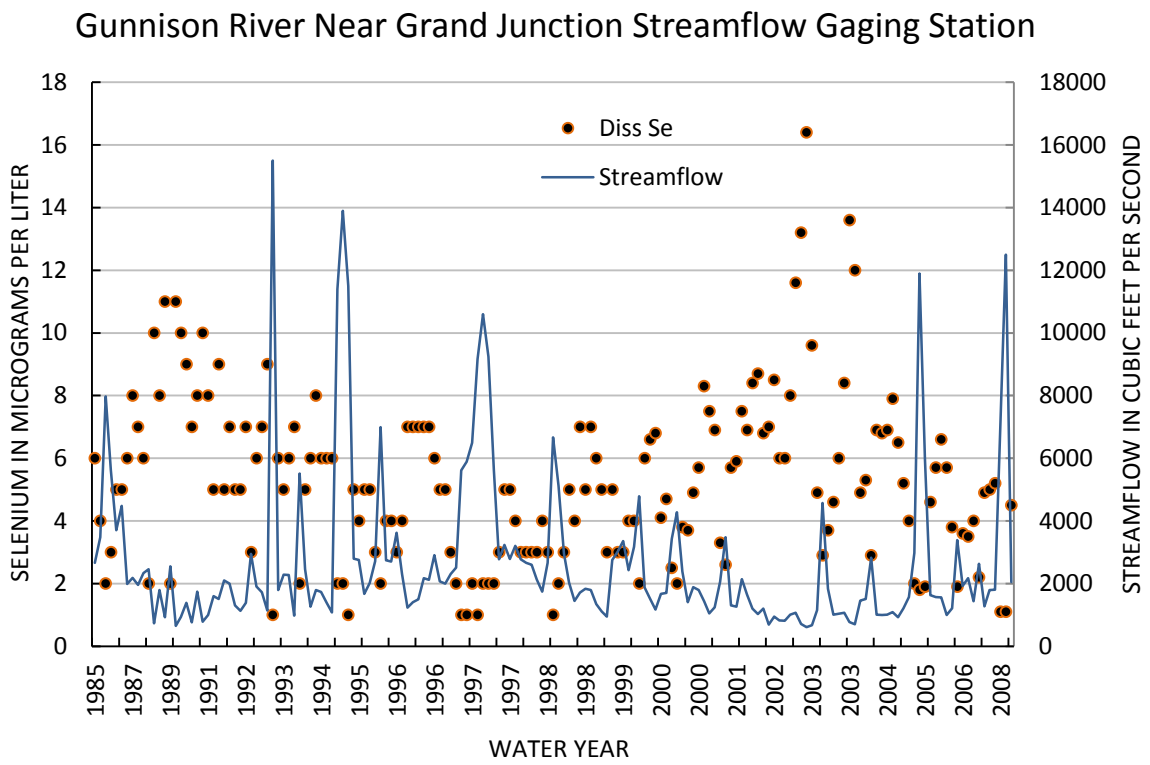


Figure 3. Dissolved selenium concentrations from water years 1986-2008 for the Gunnison River near Grand Junction (Whitewater) streamflow gaging station.

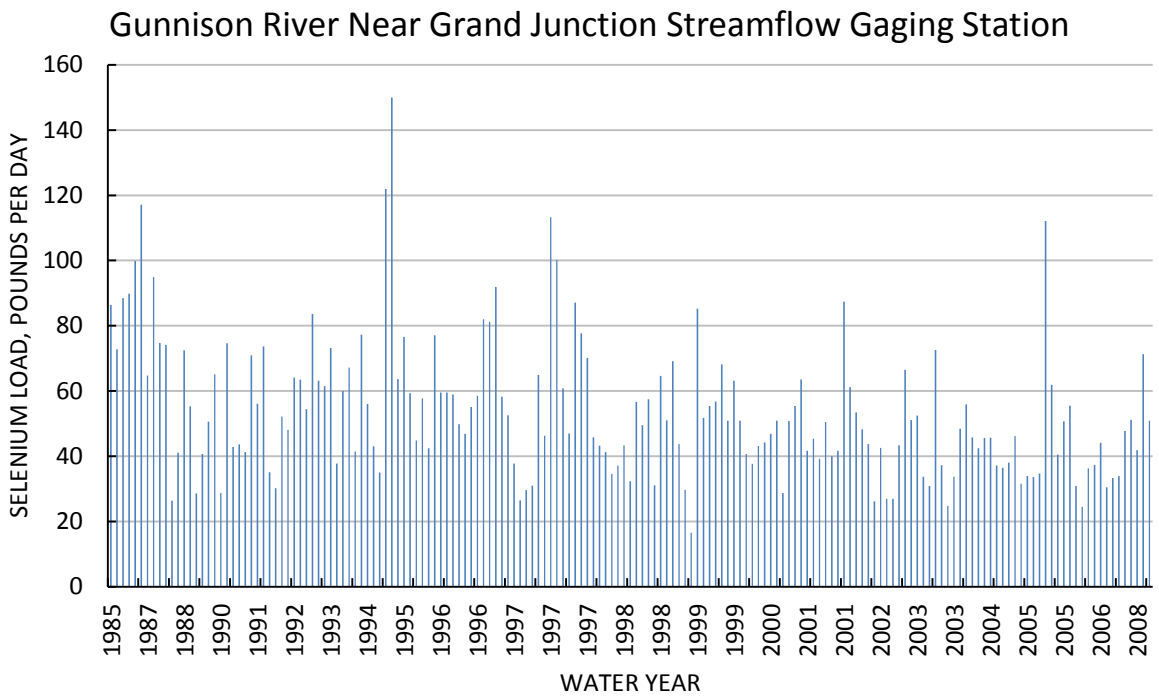


Figure 4. Selenium load from water years 1986-2008 for the Gunnison River near Grand Junction (Whitewater) streamflow gaging station.

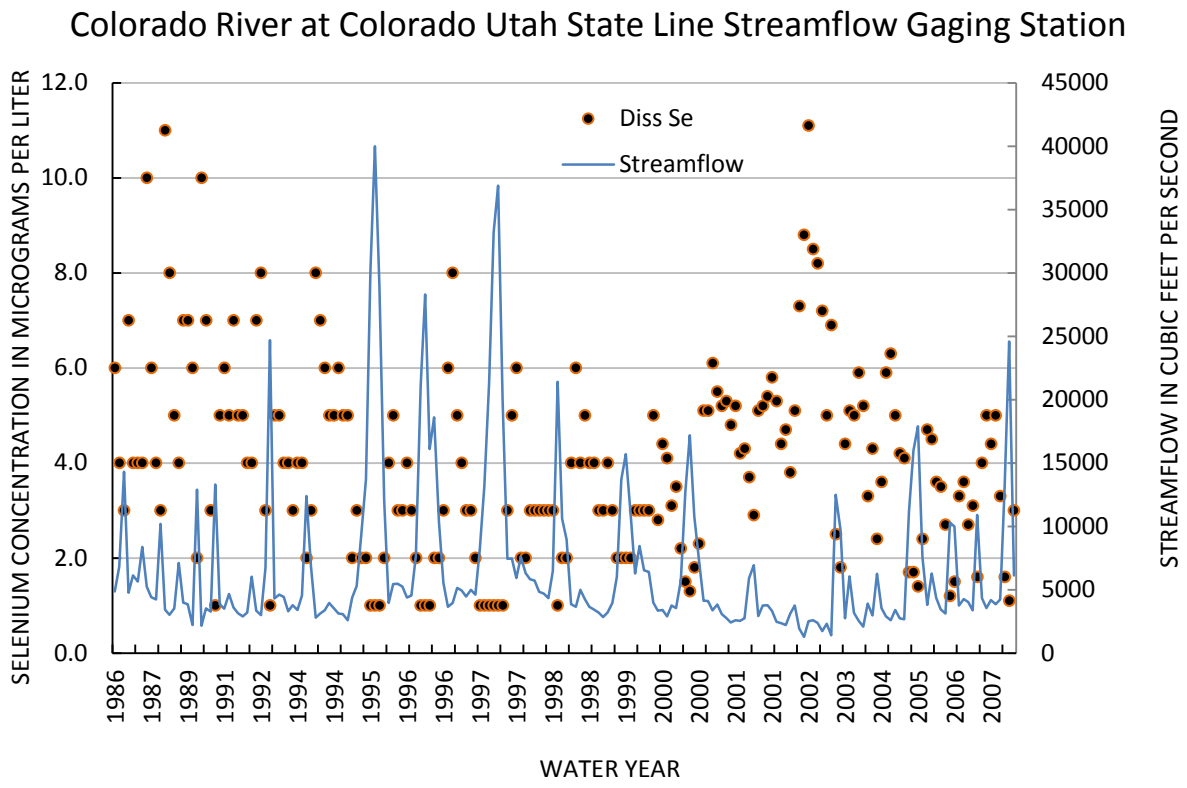


Figure 5. Dissolved selenium concentrations from water years 1986-2008 for the Colorado River at Colorado Utah state line streamflow gaging station.

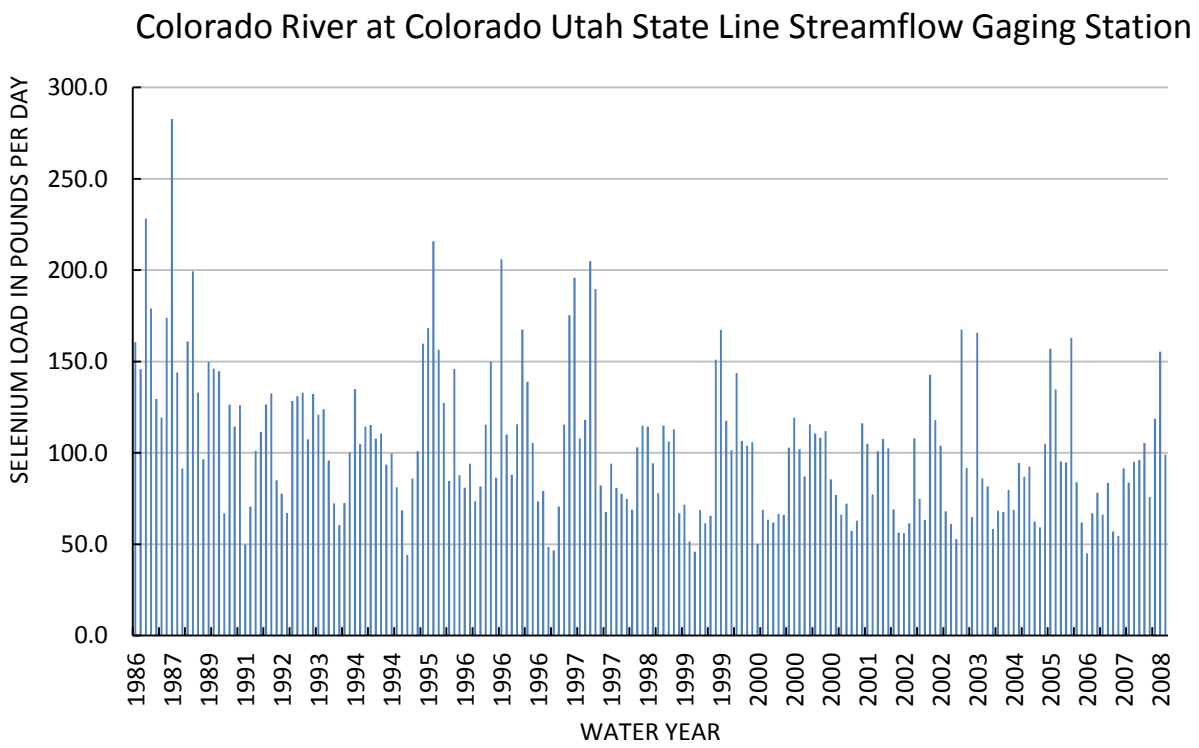


Figure 6. Selenium load from water years 1986-2008 for the Colorado River at Colorado Utah state line streamflow gaging station.

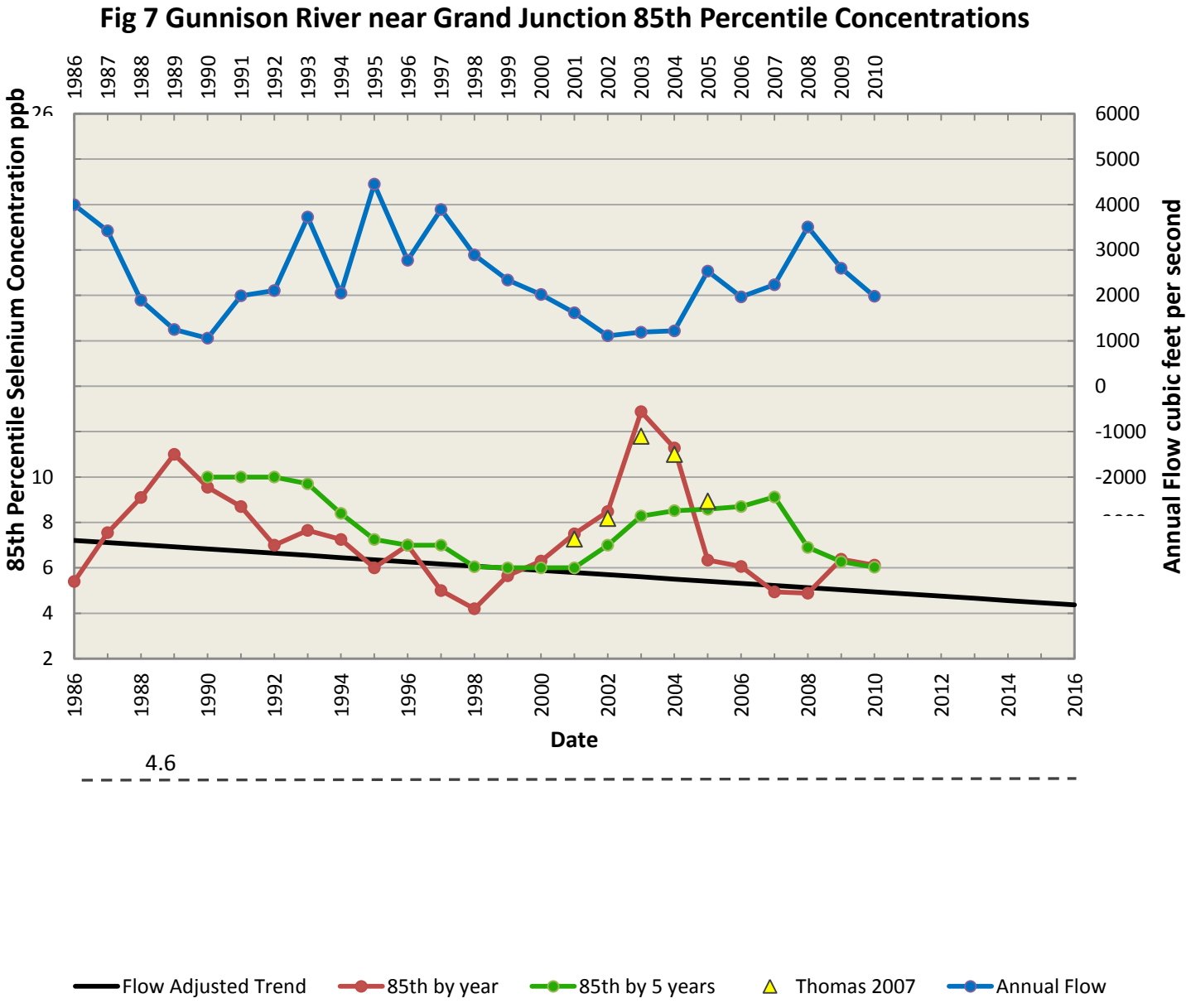
Fig 7 Gunnison River near Grand Junction 85th Percentile Concentrations
85th Percentile Selenium Concentration ppb
Annual Flow cubic feet per second
Date
4.6
Flow Adjusted Trend
85th by year
85th by 5 years
Thomas 2007
Annual Flow

## C. BIOLOGICAL DATA

Historical information on the Gunnison River's fish populations is limited and was summarized by Burdick (1995):

> "Jordan (1891) collected both Colorado squawfish and razorback sucker from the Gunnison and Uncompahgre Rivers near Delta. He also reported collecting one "bonytail"; however this specimen may have been confused with the more numerous roundtail chub, since they were considered subspecies until 1970 (Holden and Stalnaker 1975). Chamberlain (1946) reported razorback sucker as common in the Gunnison River downstream from Delta, and also reported Colorado squawfish from the lower Gunnison River. Kidd (1977) reported that a commercial fisherman frequently collected both Colorado squawfish and razorback sucker from 1930 until 1950 near Delta. Some razorback sucker were collected by CDOW during the 1950's, and one was collected near Delta in 1975 (Wiltzius 1978). Anecdotal accounts also suggest razorback sucker may have been abundant in the Delta area. Quartarone (1993) cites local Delta residents reporting both Colorado squawfish and razorback sucker as common in the Delta area and that razorback sucker used to enter the Hartland Diversion Ditch where they became stranded. Kenneth and Wendell Johnson (Personal communication 1993), long-time residents of Delta, indicated that they commonly caught razorback sucker in homemade traps in a flooded oxbow that was connected to the Gunnison River during spring runoff. They also added that they noticed that razorback sucker numbers declined rapidly in the late 1950's. Wiltzius (1978) believed that the Redlands Diversion Dam reduced Colorado squawfish numbers in the Gunnison River by preventing upstream movement from the Colorado River."

While data is scarce, it does appear that the Gunnison historically supported a population of pikeminnow (formerly named squawfish) that at some point in time declined markedly. Wiltzius (1978) summarized written and anecdotal reports on this species; information on the relative abundance of the species was not consistent within these reports. Surveys since 1980 revealed only a very small remnant population in the Gunnison River (Valdez et al. 1982a; and Wick et al. 1985).

It appears that razorback suckers were once abundant in the Gunnison River, yet significantly declined in the second-half of the 20$^{th}$ century, perhaps becoming totally expatriated from the river by the 1990's. Historical distribution of razorback sucker in the Gunnison River is not known, but fish probably occurred at least upstream to the North Fork confluence. Prior to

Recovery Program activities, the last wild adult razorback suckers were captured near Delta in 1981 (Holden et al. 1981). Extensive sampling after that failed to capture any more individuals of the species in the Gunnison (McAda 2003). Approximately 27,000 razorback suckers were stocked in the Gunnison River between 1994 and 2007 (Osmundson and Seal 2009).

Hamilton (1999) presented a hypothesis that very high selenium concentrations (55 to >2000 ppb) found in tributaries and major rivers of the Colorado River basin in the mid 1930's, combined with the disappearance of adult endangered fish and striking absence of young endangered fish suggests that their decline was at least in part caused by selenium contamination.

Burdick (1995) provided an excellent summary of fish community structure in the lower Gunnison River during 1992-1993. He found a total of 21 fish species and three sucker (Catostomidae) hybrids in the lower 75 river miles from the confluence of the North Fork and the mainstem downstream to the confluence with the Colorado River. Burdick identified the 8 most common fishes collected by electrofishing as bluehead sucker (36%), flannelmouth sucker (29%), roundtail chub (14%), common carp (7%), white sucker (6%), brown trout (3%), rainbow trout (2%), and white sucker x bluehead sucker hybrids (1%). These eight species accounted for 98% of the total fish caught by electrofishing. Of the 21 total fish species encountered, 7 were native and 14 were nonnative. Of the 7 native species, 3 are endemic to the Colorado River Basin: Colorado pikeminnow, humpback chub, and flannelmouth sucker.

Burdick (1995) found the Gunnison River contained healthy populations of native fishes. Native species comprised 79% of the 34,985 individual fishes collected in 1992 and 1993. A small population of adult Colorado pikeminnow was found to occur in the Gunnison River upstream of the Redlands Diversion Dam. A total of 13 adult Colorado pikeminnow were captured up- or downstream of Redlands Diversion Dam in the Gunnison River. Five of these were found upstream of the dam. The reach between Bridgeport and Escalante Bridge was most used by adult Colorado pikeminnow. No young-of-year Colorado pikeminnow were collected upstream of Redlands Diversion Dam in 1992, 1993, or 1994. Two larval Colorado pikeminnow were collected in mid-July, 1992 immediately downstream of Redlands Diversion Dam. Burdick did not collect any razorback suckers in his sampling.

The larval and post-larval fish community structure of the Gunnison River was different in 1993 from 1992. Riverwide in 1992, nonnative fishes collected with hand nets comprised 85% of the total catch as opposed to only 21% in 1993. Burdick (1995) attributed the decrease in nonnative larval fish during 1993 to higher flows.

Twenty northern pike were caught in 1992 and 1993, with thirteen of these captured immediately downstream of Hartland Diversion Dam (river mile 60), and Burdick (1995) thought that these were most likely downstream migrants from Paonia Reservoir. Other nonnative fishes encountered infrequently were green sunfish (0.06%), black bullhead (0.03%), and single specimens of smallmouth bass and largemouth bass caught in the Redlands Diversion Dam plunge pool. One adult channel catfish was captured upstream of Redlands Diversion Dam

(river mile 17). No evidence of successful reproduction of catfish was observed in the Gunnison River.

The Colorado Division of Wildlife sampled the Gunnison River in July, 2010 to monitor fish populations (Jones 2011). The first section included the reach just downstream of the Uncompahgre River and Gunnison River confluence downstream for a distance of 4.3 miles. In this reach, 71% of the total fish sampled were native fish, with flannelmouth sucker comprising 27%, bluehead sucker comprising 24%, speckled dace comprising 15%, and roundtail chub comprising 5% of the total catch. Of nonnative species, common carp comprised 9%, brown trout comprised 3%, and white sucker comprised 11% of the total catch. Jones expressed concern with the presence of hybrid suckers because of the potential threat from white suckers to swamp the native suckers' gene pool. These results are similar to what Burdick found in 1992 and 1993 almost 20 years ago, but with an increased occurrence of hybrid suckers.

The second section sampled in July runs through portions of Escalante State Wildlife Area, from River Mile 48.1 to River Mile 44.1. Results of fish species composition were similar to those found in the first stretch, with native species comprising 79% of the total catch. Again, hybrid white suckers were found, causing concern for the native sucker populations. These results are similar to what Burdick found after sampling in 1992 and 1993 almost 20 years ago.

Ongoing activities are designed to assist in recovery of the Gunnison's endangered fish. The Redlands fish ladder has been in operation since 1996 and selectively allows only native fish to move past the Redlands Diversion Dam into the Gunnison River near its mouth. Razorback suckers have been stocked in recent years and bonytail were stocked in one year. Very small numbers of razorback larval fish have been sampled in the river in recent years (Osmundson and Seal 2009) but actual recruitment to the population has not been verified.

Fish tissue selenium concentrations have been sampled in the Gunnison River. A mean selenium concentration of 7.1 ppm DW was calculated for fish samples collected during 1992 from the Gunnison River Basin (Butler et al. 1994, 1996). Selenium concentrations in about 71% of the fish samples from the Gunnison and North Fork of the Gunnison Rivers, 64 % of the fish from the Uncompahgre River, and about 55% of the fish samples from the Colorado River exceeded a toxicity guideline suggested by Lemly (1996) of 4 ppm DW whole body fish tissue. The mean selenium concentrations for speckled dace collected from the two lower Gunnison River Basin sites at Delta and Whitewater were 9.7 ppm DW and 14 ppm DW, respectively. The selenium concentrations in speckled dace from the lower Gunnison River sites were significantly higher than those found in speckled dace collected at the North Fork-Gunnison River confluence, which had a mean of 6.4 ppm DW. The mean selenium concentrations for roundtail chub collected from the two lower Gunnison River Basin sites at Delta and Whitewater were 8.1 and 6.3 ppm DW, respectively. Selenium concentrations in some whole body fish samples collected from Gunnison River tributaries in the Uncompahgre Project area exceeded 20 ppm DW, and were

over five times the toxicity guideline concentration suggested by Lemly (1996) of 4 ppm DW whole body.

Muscle plugs taken from endangered Colorado pikeminnow in the Colorado River within the Grand Valley during 1994 had selenium concentrations that ranged from 3 to 30 ppm DW. Sixteen Colorado pikeminnow muscle plugs taken from fish collected at Walter Walker State Wildlife Area along the Colorado River below the Gunnison River confluence in Grand Junction contained a mean selenium concentration of 17 ppm, more than twice the toxicity threshold of 8 ppm. More Colorado pikeminnow muscle plugs were collected during 1995 and 1996. Eleven muscle plugs taken in 1995 were from fish previously sampled in 1994, and were significantly lower than 1995. Reduced selenium in fish may in part be attributed to higher in stream flows in 1995 and lower water selenium concentrations in the Colorado River in the Grand Valley.

## D. LAND USE AND IRRIGATION

Agriculture is the dominant contributor to economies of the lower Gunnison Basin, generating approximately 18 million dollars (NASS 2007) of net farm income per year. Irrigation is responsible for about 40,128 acres of harvested cropland in Delta County and 55,860 acres in Montrose County (NASS 2007). An additional 55,837 of pasture is also irrigated throughout the region (NASS 2007). Most commercial farms include corn, wheat, forage (alfalfa or grass), and sometimes barley or pinto beans in their rotations. The region is also renowned for specialty crops such as sweet corn, onions, apples, cherries, peaches, grapes, and now hops.

The lower Gunnison Basin also includes a number of federal irrigation projects, the largest of which is the Uncompahgre Project, authorized in 1903 by congress under the Reclamation Act of 1902. Today the project is managed by the UVWUA. The Uncompahgre Project relies largely on the 1,100 cfs Gunnison Tunnel diversion, completed in 1909, to divert most of its 365,000 af of annual diversions to approximately 74,000acres of irrigated land within the Uncompahgre Valley. The project area spans the width of the valley from just south of Montrose to north of Delta at the confluence of the Gunnison and Uncompahgre rivers.

Traditionally, open ditches have delivered water for flood irrigation in the lower Gunnison Basin. Deep percolation is inherent in open-ditch irrigation, though raising deep-rooted perennials such as alfalfa, good irrigation water management, and correct use of surge valves can minimize it. While local topography, soil variability, and ongoing conversion of commercial agricultural land to urban uses inhibits incentives to adopt more efficient technology, interest in sprinkler, micro-spray, and drip systems is slowly growing.

The North Fork of the Gunnison River Valley has seen a noticeable increase in the number of center pivot sprinklers and micro-spray systems. Center pivots work well on North Fork valley ranches due to the good availability of static pressure and the economics of raising pasture and hay with pivots as part of a livestock operation. Micro-sprays are a good fit for orchard and

vineyard crops that typically have a high cash value and respond well to the increased precision of micro-irrigation.

The sweet corn, onion, and specialty crop growers of the Uncompahgre Valley have found some success with sub-surface drip systems, and center pivots are also starting to show some positive returns. The lack of natural relief in the valley means pumps are required to generate sufficient pressure for more efficient systems. The costs associated with a pump currently struggle to outweigh the benefits of using the system. Producers that have adopted center pivot technology have had best results when coupling sprinkler irrigation with a conservation tillage approach. The decrease in machine hours reduces fuel costs and compaction, resulting in improved water holding capacity with less runoff and deep percolation. Conservation tillage also enhances retention of organic matter in the soil which boosts productivity.

Future irrigation outreach efforts intend to focus on enhancing access to piped pressure, and demonstrating the benefits of a holistic approach to irrigated agriculture which includes modern agronomic techniques in addition to traditional irrigation water management practices.

## E. PREVIOUS AND ONGOING STUDIES AND RESEARCH

In conjunction with multiple federal (e.g., USGS, Reclamation, NRCS, Fish and Wildlife Service) and local agencies and districts (e.g., State of Colorado, local land and water conservation and conservancy districts), several significant studies related to selenium in the lower Gunnison River Basin have been initiated. These studies continue to increase the understanding of the science related to selenium concentration, loading and potential impacts:

- Water-quality and biological studies of the lower Gunnison Basin (Butler et al 1991, 1996, 2000)
- Selenium concentrations in the Colorado pikeminnow (Ptychocheilus lucius): relationship with flows in the Upper Colorado River. Arch. Environ. Contam. Toxicol. 38: 479-44485.
- Effects of urbanization of agricultural lands (Mayo 2008)
- Loutzenhizer Wash Study: The USGS is contracted to do water-quality monitoring for a lateral piping project in the Loutzenhizer Arroyo sub-basin. A final report for the project including results from the water-quality monitoring program will be available June of 2012.
- Effects of urbanization on salinity and selenium loading in Montrose Arroyo from 1998-2008-in progress
- Selenium Trend Analysis (Mayo 2011)
- Uncompahgre River Basin selenium phytoremediation study (Fisher 2005)
- Passive selenium bioreactor pilot scale testing (Walker 2010)
- Ongoing water quality monitoring

- Selenium Trend Analysis
- Model Development (USGS) – LOGUN, SPARROW models loading by sub-basin
- Montrose Arroyo Land Use change study
- Reclamation canal mapping
- Salinity program studies within the basin – Lower Gunnison Salinity Planning Study (funded by Basin States)

# CHAPTER 4—PROGRAM FORMULATION AND INSTITUTIONAL ARRANGEMENTS

## A. MEMORANDUM OF UNDERSTANDING

In 2010, a Memorandum of Understanding (MOU) was signed by the following organizations to facilitate the development of a cooperative Program in a manner consistent with the Gunnison River Basin PBO:

- U.S. Bureau of Reclamation
- Colorado Water Conservation Board
- Uncompahgre Valley Water Users Association
- Colorado River Water Conservation District
- U.S. Fish and Wildlife Service
- Upper Gunnison River Water Conservancy District
- U.S. Geological Survey
- Natural Resources Conservation Service
- U.S. Bureau of Land Management

The MOU called for an appointed Work Group as part of an overall Selenium Management Team to develop the Program Report.

## B. SELENIUM MANAGEMENT TEAM

The Selenium Management Team was established to formulate the Program and was organized as described below. The Selenium Management Team will continue to work on implementation of the plan following its completion.

Management Committee: The Program Management Committee addresses policy issues, assures that adequate progress is being made by the Program Team, provides and pursues resources, provides input and oversight to the Work Group, and selects the preferred strategy. The Area Manager of the Reclamation's Western Colorado Area Office serves as the Management Committee lead. Additional members of the Management Committee include:

- U.S. Bureau of Land Management
- Colorado Water Conservation Board
- Gunnison Basin Colorado Water Conservation Board Representative
- U.S. Fish and Wildlife Service
- Colorado River Water Conservation District
- Natural Resources Conservation Service
- Uncompahgre Valley Water Users Association

Work Group: The Program Work Group is responsible for: directing and reviewing the work performed by the subcommittees, recommending a preferred alternative, developing the draft implementation plan and report documentation, identifying and pursuing resources, planning and implementing interim reduction and prevention measures, and reporting to the Management Committee. Reclamation serves as the Work Group lead. Additional members of the Work Group include:

•Uncompahgre Valley Water Users Association

•Colorado River Water

Conservation District

•Gunnison Basin / Task Force

•Colorado Water Conservation Board

•Shavano Conservation District

•Delta Conservation District

•U.S. Geological Survey

•Natural Resources Conservation Service

•Colorado State University Extension

•Colorado Water Institute

• U.S. Fish and Wildlife Service

•Colorado State Conservation Board

•U.S. Bureau of Land Management

The following subcommittees operate under guidance of the Program Work Group:

- The Technical Review Subcommittee is responsible for the identification and technical review of potential load reduction measures for existing selenium sources and prevention measures for "new" sources of loading and the formulation of alternatives.
- The Science and Research Subcommittee is responsible for identifying science and research needs of the Program. The subcommittee recommends priorities, required timing, funding needs and mechanisms for projects. They develop criteria and screen proposals and carryout a cooperative monitoring program with Program stakeholders.
- The Outreach and Education Subcommittee is responsible for identifying, prioritizing, and implementing public education and outreach needs related to the Program. Activities include, but are not limited to, developing clear and consistent outreach messages, promoting and encouraging public participation and involvement, developing outreach materials, giving presentations, and organizing and sponsoring outreach events.
- The Program Advanced Planning Team is responsible for carrying out advanced planning needs related to specific components of the Program formulation document.

## C. PUBLIC INVOLVEMENT

An initial group of stakeholders composed of Gunnison Basin / Grand Valley Selenium Task Force members and Reclamation, started to develop a list of Program pre-planning activities that needed to take place in order to be prepared to start the Program planning process. The first identified pre-planning activity was to ensure strong public involvement by assembling a representative group of stakeholders to participate in the Program Work Group and the Program subcommittees as described in Section 4.B. The Outreach and Education subcommittee was responsible for carrying out the following activities:

- Conduct public presentations about selenium, elements of the PBO, and the Program planning process to stakeholders such as local governments, conservation districts, irrigators, water providers, and the general public;
- Develop webpage on Reclamation's website dedicated to Program activities and education http://www.usbr.gov/uc/wcao/progact/smp/
- Develop informational brochures and pamphlets;
- Publish newspaper articles to educate the public, encourage public involvement, and publicize Program implementation activities;
- Plan for public education forums to help educate stakeholders on the PBO and Program processes; and
- Plan for public open houses to receive public input on the Program.

## D. FUTURE IMPLEMENTATION

The Program described in this Program Formulation Document provides a framework for presenting and implementing measures to reduce selenium loading and assist in the recovery of endangered fish in the Gunnison River. The Program will be implemented by the Selenium Management Team identified in Section 4.B with individual actions completed by parties with appropriate responsibilities and authorities. Reclamation will serve a leadership role in coordinating and tracking program implementation

The Team will continue to include a Management Committee and Work Group. The Work Group will establish subcommittees, as needed. Each partner represented on the Team will have an important role to play in ensuring the successful implementation of the Program. All partners recognize that their efforts are voluntary and subject to appropriations, budgets, and other factors. Additionally, Reclamation recognizes its long-term obligation under the PBO and on behalf of the Gunnison Basin water users and other stakeholders to assure implementation of the Program and its Action Plan (Appendix C) in order to accomplish the program goals in a timely manner.

The Work Group will meet regularly and will annually update the Action Plan which will be approved by the Management Committee. The Work Group will assist in preparing annual progress reports to be submitted to the Service as required under the PBO.

# CHAPTER 5-ACTION PLAN FORMULATION AND DEVELOPMENT

## A. STATUS OF SELENIUM REMEDIATION IN THE LOWER GUNNISON BASIN

In preparing to continue and accelerate ongoing and new selenium control efforts, it is important to review current accomplishments and status of funded projects. (See section 2.C for details on programs and their accomplishments that have reduced selenium loading through Fiscal Year 2011.)

Salinity Control Program implementation began in 1988 in the lower Gunnison River Basin; and by the end of FY2010, total salinity load reductions of over 150,000 tons/year have been estimated by the Federal agencies (BLM, NRCS, and Reclamation). This is approximately 12% of the overall average annual Gunnison River Basin salinity load of 1.26 million tons/year. The USGS has also estimated overall salinity reductions in the basin of about 201,000 tons/year or 16% between 1986 and 2003.

As discussed in Section 4, the USGS also estimates that selenium concentrations have been reduced by 29% during the period 1986 to 2008 under average flow conditions. The trend line shows positive progress. Selenium loads appear to be decreasing at a faster rate than salinity. The strategy and activities discussed in this chapter and displayed in the Action Plan in Appendix C are designed to accelerate that progress.

## B. TOOLBOX OF POTENTIAL SELENIUM CONTROL MEASURES

Potential measures to reduce selenium loading in the Gunnison Basin include both structural and non-structural concepts. Various measures could be incorporated into plans to reduce existing selenium loading and/or to prevent or reduce new selenium loading. Table 1 lists some measures that have been suggested and could be evaluated and possibly employed now or in the future in higher selenium loading areas. It should be noted that these suggested measures have not all been shown to be economically or physically feasible, nor publicly acceptable.

Table 1. Toolbox of potential selenium control measures

| ***Potential structural measures*** | ***Potential non-structural measures*** |
|---|---|
| Pipe or line open laterals | Improve irrigation water management |
| Line or pipe open canals | Employ Best Management Practices |
| Combine canals/laterals | Increase xeriscaping |
| Improve on-farm water use efficiency using gated pipe, sprinklers, drip, land leveling, etc | Treat canals/laterals/tailwater ditches with some type of sealant (i.e. PAM or other) |
| Line perched ponds | Institute Soil Health Initiative |
| Fill-in perched ponds | Control erosion on public Mancos shale lands |
| Treat high selenium waters | Implement price of water incentives |
| Reduce point source discharges | Retire high selenium lands from irrigation |
| Reduce septic tank leaching; increase sewer system coverage | Education to reduce excess water use and deep percolation; Wise Water Use |
| Evaporate collected drainage in ponds | Reduce use of high nitrate fertilizers |
| | Dilution flows from upstream reservoirs |
| | Obtain conservation easements |
| | Reduce/eliminate new unlined ponds in selenium problem areas |
| | Implement special provisions for developments on previously non-irrigated high selenium areas |
| | Avoid new irrigation on selenium problem areas |
| | Mitigate effects of new depletions in the basin |
| | Re-use irrigation drainage water |
| | Grow crops with less potential for deep percolation |
| | Grow crops that remove selenium (phyto-remediation) |
| | Limit use of septic leach fields |
| | Focus zero discharge development in high selenium loading areas |

## C. SELENIUM REDUCTION STRATEGY

A strategy has been adopted by the Selenium Management Team that will focus on continuing and accelerating existing irrigation improvement activities which are believed to be successful in reducing selenium loading. Activities will be proactive to accelerate ongoing off- and on-farm salinity control programs. This will continue reducing selenium concentrations. Activities or projects will be selected based on a proven track record of success and on support by the lower Gunnison Basin water users. The Program will encourage and support local water users in their efforts to continue and maximize use of these existing on- and off-farm programs.

This approach will be supplemented by actions to address non-agricultural loading and to learn more about selenium mobilization and transport processes. Information dissemination and incentives will be stressed to maximize stakeholder and elected representatives willingness to undertake infrastructure improvements and to improve water management and non-agriculture source control. Research findings will be used to help identify the most cost effective actions and locations for selenium control projects.

This strategy takes full advantage of existing programs and local action and initiative. By employing this strategy, selenium loads will be reduced in a timely manner.

Selenium loading will be monitored and strategies adjusted as necessary under an adaptive management concept. It is recognized that in order to ultimately accomplish the goals of the Program, other measures may have to be evaluated and included in the Action Plan, depending on the success of this strategy.

## ACTION PLAN COMPONENTS

Appendix C contains the first edition of an "Action Plan" which will be subject to annual evaluations and refinements by the Selenium Work Group and Management Committee. A breakdown of the Plan follows:

Part A – **Reduce Existing Selenium Load**.

This section covers actions that will control selenium loading from existing sources, such as current irrigated agricultural (off- and on-farm) and current non-agricultural water use by municipal, residential and industrial users.

**Irrigated Agriculture—Off-Farm Projects**

The first grouping addresses irrigated agriculture. Individual off-farm projects, either completed or underway and funded (only ones with funding in place by Dec. 2011), are presented in Section A.1. Next, activities to target, define, and help plan future off-farm projects are listed in Section A.2:

1. *Participate in the Salinity Program – Lower Gunnison Comprehensive Plan effort*. The Salinity Control Program is planning to conduct a study to evaluate salinity-control opportunities in the lower Gunnison River Basin and how to best implement future Salinity Program actions. The work will culminate in a comprehensive plan. This planning exercise presents an opportunity for the SMP to cooperate with and potentially supplement those studies which hopefully will lead to more numerous and effective Salinity Program projects in this basin along with their associated selenium reduction benefits.

2. *Identify and prioritize target areas and potential projects*. Work Group members will work with sub-basin level data being developed by USGS to determine where to encourage/support projects that accomplish selenium reduction goals.
3. *Encourage/facilitate remaining phases of piping/lining East Side Laterals*. The first step under this activity is to accomplish the planning needed to pipe or line these laterals and ultimately provide the best functioning system for the UVWUA to operate. This will help the UVWUA prepare proposals to submit in future Reclamation Basinwide Program Funding Opportunity Announcements (FOA) which typically occur every 2-3 years.
4. *Encourage/facilitate off-farm projects in other high selenium loading areas in the Basin*. Working in other targeted areas, the SMP would aid in formulation of proposals that could be competitive in future FOA processes.

**Irrigated Agriculture—On-Farm Programs**

On-farm programs are described in A.3 and A.4. NRCS irrigation efficiency improvement projects are aimed towards a long term goal of treating 50 to 60% of acreage needing treatment and are funded under the ongoing Farm Bill, which is subject to annual appropriations. The Basin States Program will continue to fund on-farm projects but also some off-farm opportunities with annual funding from the Upper Colorado River Basin Fund and the Lower Colorado River Basin Development Fund (Basin Funds), which are derived from mill levies on power revenues from the large Colorado River hydroelectric facilities.

**Non-Agricultural Sources**

The next major grouping in Section A.5 involves controlling existing recreational, farm, and aesthetic pond seepage.

Past efforts to address ponds by the Salinity Program were unsuccessful. There was a high variability in seepage volumes from different ponds and initial public interest in treating ponds was low. The effort was concluded because funding was inadequate for the necessary control measures. After additional studies of pond seepage, the SMP will work with local interests to formulate a program to address pond seepage and the associated selenium and salinity loading. This effort would identify and evaluate reasonable measures that should be implemented.

Control of other existing non-agricultural sources of loading from municipal and industrial sources will be explored in Section A.6. Public land issues are being addressed by BLM in an update of Resource Management Plans.

The last major grouping (Sections A.8 & A.9) involves *e*xisting sources and how they can be affected through outreach and education programs. It includes identifying how the SMP can support, facilitate and encourage lower Gunnison water users and their representative entities to undertake selenium control projects of their own.

Part B -- **Actions that prevent/minimize/mitigate new selenium loading**. As was learned from experience with the Devils' Thumb, a newer golf course near Delta that had significant selenium loading, new selenium loading from land use changes can nullify or offset accomplishments in reducing loading from irrigated agriculture. Such new sources must be addressed. The initial activities where efforts will be focused are:

1. Developing and refining existing BMPs, distributing them to the proper audiences and promoting their use.
2. Conducting well thought-out public information/education and wise water use programs which increase awareness, provide technical assistance, and possibly, identify and promote suitable incentives.
3. Implementing management actions to control new loading. Federal and local agencies will develop methods to prevent/minimize/mitigate new loading in all local decisions and actions.

Part C -- **Monitoring and support activities.**

1. *Expand knowledge base*. Learn more about the mobilization and transport of selenium in hopes that a better understanding will yield better, more focused control measures. The potential loading impacts of other water uses, such as ponds and septic systems and potential solutions should be investigated.

2. *Monitor water quality*. Selenium concentrations will be monitored as part of the Program. Scientifically acceptable techniques will be used to cooperatively monitor selenium concentrations and loads under the guidance of the USGS.

   Six sites in the basin serve as the core of the selenium monitoring network. These sites are listed in Appendix A and are all co-located at USGS streamflow gaging stations. These streamflow gages measure the naturally-occurring flow variability (temporal and seasonal). Periodic selenium sampling occurs generally between 6-9 times per year and these sites. Together these flow and selenium concentration are utilized in the calculation of selenium mass load and flux. Such data are also used to analyze, quantify and track statistically significant selenium trends. In addition to enabling long term selenium trend analysis, the core monitoring network is designed to assess the 85$^{th}$ percentile of selenium concentrations at these locations. This important calculation is used by regulators to assess compliance with the dissolved selenium standard of 4.6 ppb.

   The core monitoring network is enhanced by additional periodic selenium sampling throughout the basin by Program cooperators as part of ongoing or intermittent monitoring that is associated with specific selenium investigations. Such monitoring is being done by various entities, such as the Selenium Task Force using Volunteer in Service to America (VISTA) personnel and regulators including the Colorado

Department of Health and Environment and helps leverage the quality of the core monitoring network. These additional sampling sites are listed in Appendix A. The sampling matrix in Appendix A will be updated, as necessary, to reflect relevant changes in the sampling regime. Additionally a seventh USGS sampling site at the Colorado-Utah State line streamflow gage is also part of the network and to help assess the influence of lower Gunnison River Basin selenium loading on the lower Colorado River.

The USGS has characterized trends in flow-adjusted dissolved selenium concentrations in the Gunnison River Basin (at the Whitewater gage) from 1986 through 2008 (Mayo and Leib 2011). These data show selenium concentrations decreasing over time with statistically significant downward trend. It is anticipated that with the implementation of the Program, selenium levels will continue to decrease in the Gunnison River. The statistical trend for selenium will be assessed every 5 years based on requirements listed in the USFWS Programmatic Biological Opinion. The next assessment is due in water year 2013.

Such data and trend analysis is performed to ensure the efficacy of the Program. Should monitoring data indicate that selenium concentrations and loads are not decreasing as anticipated based on a statistical analysis of field data, the Service will coordinate with USGS, Reclamation and the SMP Partners to determine an appropriate course of action.

3. *Monitor endangered fish*. Population changes and levels of whole-body selenium concentrations in both endangered fish and surrogate fish species will be monitored by the Service and Recovery Program personnel to assist in judging the effectiveness of the Program.

4. *Obtain funding for program activities*. SMP member agencies will utilize authorities and funding to support program activities within priorities; other outside sources will be identified and pursued.

5. *Develop new technology*. Use existing programs such as Reclamation's Science and Technology Program to investigate and demonstrate environmentally friendly technologies that assist in selenium control.

6. *Report annual progress*. An annual report will present and discuss water-quality changes, updated load and concentration trend plots, biological monitoring, construction progress, and outreach/education activities.

## AUTHORITIES AND LEGISLATION

At this time, Federal agencies have no directed authorities to expend funding for selenium control in the lower Gunnison River Basin. Projects can continue to be pursued for their

salinity control benefits under the 1974 Salinity Control Act, as amended, and other authorities as appropriate and these projects have been effective in selenium control.

Examples of federal, state, and local authorities follow:

**Federal Authorizations:**

| | |
|---|---|
| NRCS – | Salinity Control Act and Farm Bill, EQIP to address water quality |
| BLM – | Salinity Control Act and organic enabling legislation |
| FWS - | Endangered Species Act |
| EPA - | Clean Water Act |
| Reclamation – | Salinity Control Act and Project authorizations |
| USCOE – | Clean Water Act Sec 404 |

**State Authorizations:**

| | |
|---|---|
| State of Colorado Water Quality Control – | Clean Water Act |
| CWCB – | Conservancy District Act |
| CRWCD - | Conservancy District Act |

**Local Authorizations:**

Land use planning and permitting authorities

## UNCERTAINTIES

Selenium concentrations as measured at the Whitewater gage are affected by streamflow levels. In times of high runoff, the selenium loads are diluted and concentrations are reduced. In extended dry periods, there is less water available for dilution and concentrations increase. It is uncertain to what extent extended wet or dry periods will occur in the future, but when they occur they may have significant effects on the ability to meet targeted selenium concentrations.

There remain questions on the chemistry of selenium mobilization and loading. As measures are implemented to reduce seepage and deep percolation and as soil moisture and anaerobic conditions are lowered, selenium chemistry and mobilization may be affected. This may affect selenium loading. While a reduction in salt loading is generally accompanied by a reduction in selenium loading in the lower Gunnison Basin, there are differences in the salinity and selenium cycles that need to be understood.

The importance of land use change and the location and rate of land use change is uncertain; for example, monitoring of the Montrose Arroyo area has shown a decrease in selenium loading later followed by an increase. Septic tank and leach field effects on selenium loading have not

been quantified and the importance of these and other features of development are not well understood.

The level of funding available for the Salinity Control Program and other funding sources may vary in the future and is thus uncertain.

## ADAPTIVE MANAGEMENT

Because the Program recognizes uncertainties, the program will use adaptive management to respond to new knowledge. Data collected from monitoring events will be used to assess water quality change and biological response to program implementation. Management strategies will be revised based on data assessments, as needed. Essentially, the long-term response of endangered fish to the Program and other Recovery Program actions are uncertain and future monitoring will be used to make adjustments in implementing the Program and other activities under the Recovery Program.

## REPORTING

In July of each year, an annual report will be provided to the Service summarizing biological and water-quality data collected the previous water year (October 1-September 30). Selenium load and concentration trends, construction progress, and outreach and education activities will be included. In addition, an evaluation of progress and updates to the Program Action Plan will be provided at that time.

## ENVIRONMENTAL COMPLIANCE

Implementation of some aspects of the Program will require reliance on existing or new compliance documents covering the National Environmental Policy Act, Endangered Species Act, National Historic Preservation Act, or other environmental regulations. Federal agencies, such as Reclamation, NRCS, or BLM, will complete their own compliance documents for actions and programs under their authority and funding.

## FUNDING OPPORTUNITIES

One of the basic tenets of this Program is that assuring success is a cooperative responsibility. A variety of funding sources will have to be utilized to successfully implement the program. Although, many diverse potential funding opportunities exist for the Program, at present there are no permanently authorized or appropriated monies that are dedicated for Program activities. The potential funding sources for Program activities can be generally put into broad categories by funding source (federal versus state and local) by availability (program-related versus competitive grant-funded) and even by use (planning versus implementation). Potential funding opportunities for Program activities are categorized and described in Appendix B

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# APPENDIX A – MONITORING

The primary objective of the selenium monitoring program in the lower Gunnison Basin is to document selenium trends in support of endangered species issues and state standards, TMDL development and implementation, support of modeling efforts, and fishery studies.

The goal of the program is to build a more robust database for salinity and selenium that would provide the basis for better statistical analysis of salinity and selenium using regression modeling at various scales. The information gained from the models will enhance decision making process by improving planning models and scientific understanding.

**Core Monitoring (Trend Monitoring) Sites**

The core monitoring network listed in Table A-1 includes the sites that represent the best locations to monitor for trends in selenium. In additional, these sampling sites represent water-quality conditions from major tributaries in the LGRB and/or bracket areas of particular interest (e.g., agricultural areas) and/or significant salinity/selenium control projects.

## Partners (in alphabetical order)

Colorado Water Quality Control Division (WQCD)

US Geological Survey (USGS)

Colorado Healthy Rivers Fund

Colorado River Watch

Colorado Watershed Assembly

Colorado River Water Conservation District

Uncompahgre Watershed Partnership (UWP)

Gunnison Basin/Grand Valley Selenium Task Force

NFRIA / WSERC Conservation Center

Uncompahgre Valley Water Users Association

**Table A-1 SMP Core monitoring network**

| Station | Station Number(s) | Data type | Participating Agency |
|---|---|---|---|
| North Fork Gunnison above mouth near Lazear | 09136100 | Water quality monitor, continuous streamflow, periodic samples | USGS,WQCD |
| Gunnison River at Delta | 09144250 | Water quality monitor, continuous streamflow, periodic samples | USGS,WQCD |
| Gunnison River near Grand Junction | 09152500 | Water quality monitor, continuous streamflow, periodic samples | USGS,WQCD |
| Uncompahgre River at Delta | 09149500 | Water quality monitor, continuous streamflow, periodic samples | USGS,WQCD |
| Gunnison River below Gunnison Tunnel | 09147500 | Continuous streamflow, periodic samples | USGS |
| Uncompahgre River at Colona | 09147500 | Water quality monitor, continuous streamflow, periodic samples | USGS |
| Colorado River near Colorado-Utah State Line | 09163500 | Water quality monitor, continuous streamflow, periodic samples | USGS |

**Archived Data Sources**

1. WQCD Long-Term Trend Sites (Data maintained / archived in WQCD/EPA database)
2. River Watch Volunteer Water Monitoring Sites (Data maintained in the River Watch database at DOW)
3. USGS Trend Monitoring – Water Quality (Data maintained in http://waterdata.usgs.gov/nwis)
4. USGS Real-Time Data – Flow, Specific Conductivity, Temperature (Data maintained in http://waterdata.usgs.gov/nwis)

**Coordination**

The SMP workgroup coordinates selenium sampling with all related selenium data generators, such as the USGS, WQCD, the Selenium Task Force, the NFRIA / WSERC Conservation Center and other partners in the affected watersheds (e.g., local governments, downstream interests including Grand Valley entities) to ensure uniformity and data inter-comparability. Of particular significance are issues related to sample timing, frequency, protocols, QA/QC and data sharing. For instance, selenium sampling events are coordinated such that the timing can be staggered to try to get up to 9 sampling events per year at sites in the core monitoring network. Each year,

WQCD and USGS sampling schedules in the Lower Gunnison are compared and adjusted to minimize sampling overlap and / or redundancy. This coordination is primarily facilitated by the Selenium Task Force. If and when potential data sampling gaps are identified, the SMP workgroup will coordinate with cooperators, as appropriate, such as VISTA volunteers to collect samples to attempt to fill the identified data gaps.

The primary constituents collected by the SMP Monitoring Program include dissolved selenium, streamflow, and specific conductivity. The parameters monitored may vary by agency and station depending on individual site objectives, some of which may address objectives outside the scope of the SMP program. Table A-2 summarizes the data typically collected by each identified SMP partner and/or data generator.

Although selenium and specific conductivity in the Lower Gunnison and Colorado River Basins are generally monitored as part of a long-term baseline and trend monitoring program, selenium sampling in these basins are also monitored for regulatory, Clean Water Act compliance purposes (e.g., TMDL and 303d listing/delisting purposes).

**Table A-2. SMP sampling groups and constituents**

| Entity | Parameters Monitored |
|---|---|
| WQCD | Field parameters, Metals, Nutrients, Dissolved Selenium |
| NSIP/USGS | Field parameters, SC, pH, Temperature, Metals, Nutrients, Dissolved Selenium, streamflow, major ions |
| River Watch | Field parameters, Metals, Nutrients, Dissolved and Total Selenium, SC* |
| Others | As above but parameters may vary |
| * at specific stations | |

**Continuous water-quality monitors**

In order to assist with trend monitoring and statistical analyses continuous water-quality monitors have been funded and deployed in seven locations. These monitors provide crucial long term information that is essential to understanding temporal fluctuations in selenium concentration and loads. The monitors are typically co-located along with USGS real-time discharge stations. The list of continuous water-quality and parameters are listed in Table A-3.

**Table A-3. Continuous water-quality monitors**

| Station | Funding Sources * | Notes |
|---|---|---|
| Uncompahgre at Mouth | USGS, CRWCD, UVWUA | Real-time SC/Temp/Discharge |
| Gunnison above Uncompahgre | USGS, CRWCD | Real-time SC/Temp/Discharge |
| North Fork at Mouth | USGS, CRWCD | Real-time SC/Temp/Discharge |
| Uncompahgre at Colona | USGS, CRWCD | Real-time SC/Temp/Discharge |
| Gunnison Tunnel | USGS | Real-time Discharge |
| Gunnison at Whitewater (Hwy 141) | NSIP, USGS, USBR | Real-time SC/Temp/Discharge |
| Colorado River at State Line | NSIP, USGS | Real-time SC/Temp/Discharge |
| Loutzenhizer Arroyo at N. River Road | USGS, UVWUA | Real-time SC/Temp/Discharge |

*****Annual

**Ancillary Sampling Sites**

Other sampling sites exist to fill gaps in the dataset or to conduct specific research. These sites are shown in table A-4 and are not a part of the core monitoring network. It is anticipated that this list may change annually as data gaps are filled, operations change and cooperator research is completed.

**Table A-4. Ancillary sites where selenium is sampled for water years 2011-2012**

| Station | Station Number * | Data type | Participating Agency |
|---|---|---|---|
| Loutzenhizer Arroyo at North River Road | 383946107595301 | Water quality monitor, continuous streamflow, periodic selenium samples, salinity/selenium | USGS,WQCD |
| Montrose Arroyo at East Niagra St. | 382802107513301 | periodic selenium/salinity/nutrient samples | USGS,WQCD |
| Montrose Arroyo at 6700 Rd. | 382711107500501 | periodic selenium/salinity/nutrient samples | USGS, |
| Montrose Arroyo at Ogden Rd. | 382702107493701 | periodic selenium/salinity/nutrient samples | USGS |
| Tongue Creek at Cory | 09144200 | periodic selenium/salinity samples | USGS,WQCD |
| Gunnison River at Austin | 384624107570701 | periodic selenium/salinity samples | USGS |
| Gunnison River at Cory | 09137500 | periodic selenium/salinity samples | USGS |
| Gunnison River below Hartland Dam | 384556108024601 | periodic selenium/salinity samples | USGS |

*** Stations may have multiple numbers based upon participating agency (USGS station numbers shown above)**

# Appendix A

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# APPENDIX B – POTENTIAL FUNDING SOURCES

### *A. Federal Sources*

1. Reclamation

Colorado River Basinwide Salinity Control Program
In 1974, Congress enacted the Colorado River Basin Salinity Control Act which directed the Department of the Interior to establish a program to protect water quality in the Colorado River in the United States and the Republic of Mexico. In 1995, the Secretary of the Interior through the Bureau of Reclamation enacted a Basinwide Salinity Control Program. Reclamation can make grants; enter into contracts, memoranda of agreements, cooperative agreements; or advances of funds to non-federal entities to carry out salinity control projects. In the lower Gunnison Basin of Colorado, selenium is often (but not always) found in association with salts in Mancos shale derived soils. In high salinity areas, programs such as the CRBSCP can provide up to 100% funding for implementing off-farm Best Management Practices such as piping irrigation delivery systems. The CRBSCP is a competitive program.

Basin States Program (BSP)
The BSP was authorized in the 2008 Farm Bill, Public Law 110-246, that amended the Colorado River Basin Salinity Control Act, and is administered by Reclamation through an agreement with the Colorado State Conservation Board. The emphasis of the BSP will be to fund improved land management and irrigation practices that do not qualify under EQIP and small off-farm canal and lateral delivery systems that are too small to compete in the Basinwide Program's cost-competitive process.

Specific Project Funding for Operation and Maintenance
In some cases, annual operation and maintenance funds for Reclamation projects may support activities that will assist in meeting selenium reduction goals.

Science and Technology Grants (S&T)
The S&T Program is administered by Reclamation's Research and Development Office and is a competitive Reclamation-wide funding program. Project efforts must be proposed and led by Reclamation staff to be eligible for funding. The S&T Program seeks innovative solutions for Reclamation water managers and western water stakeholders that can be applied widely across the agency. Approximately $1.7 to $2.7 million dollars are estimated to be available for new research projects in FY12. New proposals should fall within the following categories: 1)

environmental stewardship for water delivery and management, 2) water and power infrastructure and reliability, 3) water operations decision support, and 4) conserving and expanding water supplies.

Water Conservation Field Service Program Grants (WCFSP)
Reclamation administers the Water Conservation Field Service Program for this area. The objective of the WCFSP is to improve water use efficiency, encourage water management planning by water purveyors, promote the basic technical understanding of water conservation and water management practices by water users, and promote the basic understanding of water use issues by the public. Activities included for financial assistance include water management planning, implementation of efficiency measures, demonstration projects, and water conservation education and training.

Upper Colorado River Basin Fund MOA (see State and Local section).

Water Smart Program (WSP)
The WSP was established to address concerns with adequate water supplies for our nation. Under the WSP, several potential grant opportunities have been identified for the purpose of implementing the Program:

Water and Energy Efficiency Grants are available for projects that save water, improve energy efficiency, address endangered species and other environmental issues, and facilitate transfers to new uses. A 50% cost share is required. The grant is open to States, Indian Tribes, irrigation districts, water districts, and other organizations with water or power delivery authority (http://www.usbr.gov/WaterSMART/watersmartgrants.html).

System Optimization Review Grants take a broad look at system-wide efficiency. The grants focus on improving efficiency and operations of water delivery system, water districts, or water basins. The Review results in a plan of action that focuses on improving efficiency and operations on a regional and basin perspective. A 50% cost share is required. The grant is open to States, Indian tribes, irrigation districts, water districts, or other organizations with water or power delivery authority (http://www.usbr.gov/WaterSMART/system.html). The maximum funding amount is $300,000 per agreement.

Advanced Water Treatment and Pilot and Demonstration Project Grants are for pilot and demonstration projects that address the technical, economic, and environmental viability of treating and using brackish ground water, seawater, impaired waters, or otherwise creating new water supplies within a specific locale. A 50% cost share is required. The grant is open to States, Indian tribes, irrigation districts, water districts, or other organizations with water or power delivery authority (http://www.usbr.gov/WaterSMART/system.html). The maximum funding amount is $600,000 per agreement.

2. United States Geological Survey (USGS)

Cooperative Water Program (CWP)
The CWP is a cost sharing program between the USGS and States, local governments, and tribes. The CWP combines federal and non-federal resources to address water resource issues and provide a shared cost and benefit to States. The CWP directly supports USGS's Science Strategy and focuses on providing scientific information on water availability and quality in the United States as a means to inform the public and decision makers about the status of its freshwater resources and how they are changing. Areas of focus for CWP funding include water availability, drinking water, ecosystem services and hydrologic hazards (http://water.usgs.gov/coop/). The CWP program provides water-quality assessment support through the Lower Gunnison Basin Water-Quality Monitoring Program

3. United States Department of Agriculture

Natural Resources Conservation Service - Environmental Quality Incentives Program (EQIP)
EQIP was reauthorized in the Farm, Conservation, and Energy Act of 2008 (2008 Farm Bill) to provide a voluntary conservation program for farmers and ranchers that promotes agricultural production and environmental quality as compatible national goals. EQIP offers financial and technical help to assist eligible participants install or implement on-farm structural and management practices on eligible agricultural land. In high salinity and selenium areas, the EQIP program can assist the Program in reducing selenium loads and concentrations to local waterways.

Natural Resource Conservation Service Conservation Innovation Grant (CIG)
Colorado State Component
The CIG is authorized as part of EQIP. The purpose of the CIG is to stimulate the development and adoption of innovative approaches and technologies while leveraging federal investment in environmental enhancement and protection, in conjunction with agricultural production. CIG projects are expected to transfer conservation technologies, management systems, and innovative approaches back to NRCS or the private sector. CIG does not fund research projects. It does fund innovative on-the-ground conservation including pilot and field demonstration projects.

### *B. State and Local Funding Opportunities*

1. State of Colorado

*Colorado Department of Agriculture*

Colorado Basin States Salinity Program
The Basin States Program administered by the Colorado State Conservation Board provides financial assistance of up to 75% to landowners in order to improve the efficiency of irrigation systems on their land in western Colorado through their Farm Assistance funds. Farm Assistance funds are also known as Financial Assistance (FA) or cost-share funds. FA funds are made available to participating individuals and entities owning and/or operating irrigated land or providing irrigation water to land, as a direct payment to implement the Basin States Salinity Control Program. The funds can therefore be used for *on-farm* and *near-farm* projects. By implementing the program, rural landowners can help to reduce the amount of salt entering the Colorado River (Colorado Basin States Program Policy) http://www.colorado.gov/cs/Satellite/Agriculture-Main/CDAG/1183672493429?rendermode=preview). In high salinity areas, the Basin States Program can assist the Program in reducing selenium loads and concentrations to local waterways.

*Colorado Water Conservation Board (CWCB)*

Colorado Species Conservation Trust Fund (SCTF)
Colorado Senate House Bill 11-203 appropriates money from the SCTF for programs submitted to the Colorado Department of Natural Resources (DNR) for the conservation of native species listed as threatened or endangered under State or Federal law or species likely to become candidate species for listing by the United States Fish and Wildlife Service. The DNR, after consulting with the Colorado Division of Parks and Wildlife, Colorado Water Conservation Board (CWCB), Colorado State Parks and Wildlife Commission, prepares and delivers to the Colorado General Assembly a species conservation eligibility list describing programs and costs that are eligible to receive SCTF. The Program would be eligible to receive funding under the Upper Colorado Recovery Program (Section 24-33-111).

Col9orado River Storage Project MOA
In 2011, a Memorandum of Agreement was entered into by the States of Colorado, New Mexico, Utah and Wyoming; Colorado River Energy Distributor Association (CREDA); Department of the Interior, Reclamation; and the Department of Energy, Western Area Power Administration (WAPA). Under the Colorado River Storage Project Act (CRSPA) Section 5(e), power revenues from hydroelectric power can be used to aid in the development and repayment of certain irrigation costs of participating projects within the Upper Colorado River Basin 43 U.S.C. §620d(e). The Memorandum of Agreement provides for the non-federal parties to identify projects that could be funded with revenues from the Basin Fund, consistent with

existing authorities. As described in the MOA, approximately $11.5 million dollars will be collected annually with 46% of the revenues being assigned to Colorado. Funding may be used for water conservation activities; replacements, additions, and extra-ordinary maintenance; environmental compliance activities; stream gaging; consumptive use and water quality; salinity control, and climate change.

CWCB HB1177/ Gunnison Basin Roundtable

Colorado Healthy River Fund (CHRF)
The CHRF (formerly the Colorado Watershed Protection Fund) was established in 2002 by the Colorado General Assembly (Senate Bill 02-087) and authorized the CHRF to be added to the Colorado River Tax Check Off Program to allow Colorado taxpayers the opportunity to contribute to watershed protection efforts in Colorado. The legislation provides that funds donated by taxpayers be made available through a grant program administered jointly by the Colorado Water Conservation Board, the Water Quality Control Commission, and the Colorado Watershed Assembly. Two categories of grant funds are available: project grants (maximum $50,000, in-kind or cash match 20%, cash match required) and planning grants (maximum $25,000, in-kind or cash match 20%) (http://www.coloradowater.org/cwpf.php). The CHRF has provided financial assistance for implementing the Lower Gunnison Basin Water-Quality Monitoring Program.

*Colorado Department of Public Health and Environment*

Non-Point Source Program (NPS)
The amendments to the Federal Clean Water Act in 1987, Section 319(h) authorized the creation of a Nonpoint Source Program (NPS). The State of Colorado Water Quality Control Division of the Colorado Department of Public Health and Environment has the responsibility of administering the Colorado NPS Program. Each year the State of Colorado receives a federal appropriation of funds to implement its NPS Program. The NPS Program in its FY2011 Funding Announcement states that it will support projects that address “water-quality impairment due to nonpoint source pollution, develop or update watershed plans, provide education and outreach programs that help maintain or restore water quality impacted by nps pollution”. The document also indicates that approximately half of its federal appropriation (estimated to be approximately $1 million dollars) will be used for implementation projects in watershed with impaired water due to nonpoint source pollution.

### *C. Local and Regional Land and Water Conservancy / Conservation Districts*

1. Colorado River Water Conservation District (CRWCD)

The mission of the CRWCD is, "*To lead in the protection, conservation, use, and development of the water resources of the Colorado River basin for the welfare of the District, and to safeguard for Colorado all waters of the Colorado River to which the state is entitled.*"

The CRWCD makes grant funding available on a yearly basis (subject to annual appropriations) to assist applicants with the implementation of water resources projects and related activities that promote the responsible and efficient use of Colorado's Colorado River Compact entitlement. Grant recipients are limited to a maximum of $150,000 in a five year period and require in-kind match and/or cash contributions of at least 50% of the project cost (http://www.crwcd.org/page_193).

The CRWCD makes additional contributions by providing technical, political, and in-kind contributions to the Program through the following:

Technical, Political, and Administrative Support
The CRWCD has been a member of the STF since its inception in 1998 and has been an active stakeholder in the Program development process and is a technical resource to both. They also provide political support through active involvement in state and federal legislative activities in support of selenium and salinity control and water resources activities. CRWCD administrative staff provides support by serving as a fiscal sponsor for numerous selenium reduction grant projects occurring in the lower Gunnison Basin.

Gunnison Basin & Grand Valley Selenium Task Force (STF)
The CRWCD has been the main funding source in support of the STF coordinator position. The STF coordinator is responsible for facilitating and coordinating activities, grant writing, grant administration, project management, technical support, coordination of research projects or studies, and education and outreach. The STF coordinator has been actively involved in the development of the Program by providing technical assistance and ensuring public involvement through the STF membership.

Lower Gunnison Basin Water-Quality Monitoring Program
The CRWCD serves as the lead entity establishing and overseeing the Lower Gunnison Basin Water-Quality Monitoring Program (WQMP). The CRWCD provides significant financial and administrative support to the WQMP.

2. Upper Gunnison River Water Conservancy District (UGRWCD)

The mission of the UGRWCD is, "*To be an active leader in legal, policy, and management issues affecting the water resources of the Upper Gunnison River Basin, protecting the in-basin beneficial uses and maintaining high quality standards for those water resources*." The

UGRWCD is a basin stakeholder committed to the Program process and has therefore committed funding to the Selenium Task Forces in support of the STF and Program related activities. The UGRWCD Board of Directors provided $10,000 of support in 2010-11 with the opportunity for additional potential future support.

### *D. Others (including private and charitable sources)*

1. Private Foundations

The stakeholders of the Program should consider pursuing private foundation funding to implement elements of the Program Long-Term Plan. Possible foundations to consider include the Altria Foundation, Walton Family Foundation, to name a few.

# Appendix B

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# APPENDIX C -- PROGRAM ACTION PLAN

Current activities for the Selenium Management Program are indentified in the following tables. Separate tables are provided for activities that:

A. Reduce existing selenium load from existing sources
B. Prevent, minimize or mitigate potential new selenium loading from new activities
C. Provide for support for the Program or monitoring

Entities cooperating to complete an activity are identified, typically with the lead entity identified first. Schedules are shown where they have been identified by placing an "X" in the appropriate Federal fiscal year column. When funding has not been secured for a specific fiscal year, an "*" will appear below the X. Funding sources are only identified when funding has been committed or assurances have been provided by an organization.

The following acronyms and abbreviations are used in the tables:

| | |
|---|---|
| BR | Bureau of Reclamation |
| BSP | Basin States Salinity Control Program administered by Colorado Department of Agriculture's State Conservation Board (on- and off-farm projects) |
| BWP | Basinwide Salinity Control Program administered by Reclamation (off-farm projects) |
| CDPHE | Colorado Department of Public Health and Environment |
| CO | State of Colorado |
| Company | refers to an unidentified irrigation water provider; once contract is signed, a specific entity will be identified |
| CRSP MOA | Colorado River Storage Project Memorandum of Agreement |
| CRWCD | Colorado River Water Conservation District (AKA River District) |
| CWCB | Colorado Water Conservation Board |
| EQIP | Environmental Quality Incentives Program administered by NRCS (on-farm projects) |
| ESL | East Side Laterals Project located on the east side of the Uncompahgre Project area near Montrose & Delta |
| FOA | Funding Opportunity Announcement - Reclamation's Basinwide Salinity Program |
| LG | Lower Gunnison |
| NRCS | USDA Natural Resources Conservation Service |
| NWCC | North Fork River Improvement Association-Western Slope Environmental Resource Council (NFRIA-WSERC) Conservation Center |
| SCP | Colorado River Basin Salinity Control Program (composite organization including BR, NRCS, BLM, representatives of the 7 Colorado River basin states) |
| SMP | Gunnison Basin Selenium Management Program |
| STA | subject to appropriation |
| STF | Gunnison Basin Selenium Task Force |
| TBD | to be determined |
| USGS | United States Geological Survey |
| UVWUA | Uncompahgre Valley Water Users Association |
| UP | Uncompahgre Irrigation Project |
| WWUC | Lower Gunnison Basin Wise Water Use Council |
| WNTSC | NRCS West National Technology Support Center, Portland |

## PART A – REDUCE EXISTING SELENIUM LOAD

| ID | Activity | Cooperating entities/program | Status (start date) | FY 12 | FY 13 | FY 14 | FY 15 | FY 16 | Out years | Est. funding needs | Funding sources | Funds in place? | Comments (with shortcomings highlighted) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **ACCELERATE SE CONTROL PROJECTS FOR IRRIGATED AGRICULTURE** | | | | | | | | | | | | |
| A.1 | **Off-farm – projects completed or underway** | | | | | | | | | | | | |
| A.1.1 | Uncompahgre Project - Winter Water Program | UVWUA/BR | Complete | Eliminated winter flows in 407 miles of Uncompahgre Project canals & laterals 1992-1995 | | | | | | | | | |
| A.1.2 | Uncompahgre Project - East Side Laterals Phase 1 | UVWUA/BWP/ NIWQP | Complete | Piped 8.5 miles of laterals from 1998-2000; ESL Project is 0.4% complete. | | | | | | | | | |
| A.1.3 | Uncompahgre Project - East Side Laterals Phase 2 | UVWUA/BWP/ NIWQP | Complete | Piped 20.5 miles of laterals from 2004-2009; ESL Project is 14.9% complete. | | | | | | | | | |
| A.1.4 | Uncompahgre Project - East Side Laterals Phase 3 | UVWUA/BWP/ NIWQP | Complete | Piped 10.5 miles of laterals from 2007-2011; ESL Project is 20.3 % complete. | | | | | | | | | |
| A.1.5 | Uncompahgre Project - East Side Laterals Phase 4 | UVWUA/BWP CDPHE | Underway (2009) | X | Scheduled to be completed in 2012 | | | | | $2.8M | BWP/ CDPHE | Yes | Piping of 7.5 of the planned 11.4 miles is complete; Overall ESL Project is 24% complete |
| A.1.6 | Lower Grandview Canal & Laterals | Company/ BWP | Underway (2010) | X | Scheduled to be completed in 2012 | | | | | $5.4M | BWP | Yes | 10 miles of pipe in Alum Gulch drainage; all pipe installation complete Spring 2011 |
| A.1.7 | Uncompahgre Project - East Side Laterals Phase 5 | UVWUA/BWP | Underway (2011) | X | X | X | X | | | $4.3M | BWP | Yes (STA) | Plan is to pipe 16.8 miles of laterals |
| A.1.8 | Uncompahgre Project - East Side Laterals Phase 6A | UVWUA/BR/ CWCB/BSP | Underway (2010) | X | X | Scheduled to be completed in 2013 | | | | $2M | CWCB/ BSP | Yes | Initial 0.3 mile section of 1.6 mile project completed March 2011 |
| A.1.9 | Uncompahgre Project - East Side Laterals Phase 7 | UVWUA/BWP | Underway (2011) | X | X | X | X | X | | $3.2M | BWP | Yes (STA) | Plan is to pipe 11.9 miles of laterals |
| A.1.10 | Lower Stewart Pipeline Project (North Fork area) | Company/ BWP | Underway (2011) | X | X | X | | | | $6.0M | BWP | Yes (STA) | Plan is to pipe 11.5 miles of lower Stewart Ditch & its laterals |
| A.1.11 | Minnesota Ditch – Project 1 (North Fork area) | Company/ BWP | Underway (2011) | X | X | X | | | | $3.9M | BWP | Yes (STA) | Plan is to pipe 5.2 miles of upper Minnesota Ditch |
| A.1.12 | Potential North Fork area project 3 | Company/ BWP | In contract negotiations | | | | | | | | BWP | No | This is one of 6 new lower Gunnison projects selected in the 2010 BSP-FOA |
| A.1.13 | Potential North Fork area project 4 | Company/ BWP | In contract negotiations | | | | | | | | BWP | No | This is one of 6 new lower Gunnison projects selected in the 2010 BSP-FOA |
| A.1.14 | Uncompahgre Project - East Side Laterals Phase TBD (from CRSP MOA) | BR/UVWUA | 2012 | | | | | | | $2.65M | BR | Yes | Consideration of which laterals or canals to pipe or line and schedule is underway. |

| ID | Activity | Cooperating entities/program | Status (start date) | FY 12 | FY 13 | FY 14 | FY 15 | FY 16 | Out years | Est. funding needs | Funding sources | Funds in place? | Comments (with shortcomings highlighted) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A.2 | **Off-farm – future projects** | | | | | | | | | | | | |
| A.2.1 | Participate in Salinity Control Program - Lower Gunnison Comprehensive Plan effort | CRWCD/ BR/ CWCB/ NRCS/ BSP/SMP | Developing study plan | X * | X * | | | | | | | Not for SMP partici-pation | Study will examine how to best promote & implement future salinity control projects in LG Basin |
| A.2.2 | Identify & prioritize target areas & potential projects | BR/USGS/SMP | Underway (2011) | X * | X * | | | | | | BR | Partial | Includes examination of influence of Bostwick Park water use on UP loading |
| A.2.3 | Encourage/facilitate remaining phases of Uncompahgre Project - East Side Laterals | | | | | | | | | | | | |
| A.2.3.1 | Step 1 of East Side - Uncompahgre Project optimization planning | CWCB/Cal Poly/UVWUA | Complete | Rapid Assessment completed in 2010 | | | | | | | | | |
| A.2.3.2 | Remaining steps of East Side - Uncompahgre Project optimization planning | consultant/STF/ UVWUA/BR/ CWCB | Underway | X | X | | | | | ~$300K | CDPHE/ CWCB | Yes | Study will seek to identify how best to pipe & line east side delivery system & provide more manageable facilities for UVWUA |
| A.2.3.3 | Formulate proposals for future FOAs | UVWUA/BR/ SMP | Not begun | X * | X * | | | X * | X * | | UVWUA / BR | No | |
| A.2.4 | Encourage/facilitate off-farm projects in other high selenium loading areas | | | | | | | | | | | | |
| A.2.4.1 | Assist in formulation of proposals for next FOA | SMP/TBD | Not begun | X * | X * | | | X * | X * | | | No | |
| | | | | | | | | | | | | | |
| A.3 | **On-farm -projects completed** | Landowners/ NRCS/BSP | Completed | 1,803 acres treated in FY10 with cumulative effort totaling 57,588 acres since 1988; figures include all accomplishments of Parallel & Basin States Programs; overall plan is 43% complete | | | | | | | | | NRCS (2011) |
| A.4 | **On-farm – underway & future projects** | | | | | | | | | | | | Plan is to treat 50-60% of remaining acreage |
| A.4.1 | Participate in SCP- LG Comprehensive Plan effort | (same as A.2.1; see detail above) | | | | | | | | | | | |
| A.4.2 | Implement EQIP-funded irrigation efficiency improvements | Landowners/ NRCS | Underway (1988) | X * | X * | X * | X * | X * | X * | | NRCS | Partial (STA) | |
| A.4.3 | Implement BSP-funded irrigation efficiency improvements | Landowners/ BSP/ CWCB | Underway | X * | X * | X * | X * | X * | X * | | Basin Funds | Partial | |
| A.4.4 | Improve Irrigation Water Management | Landowners/ conservation districts | Underway | X * | X * | X * | X * | X * | X * | | Basin Funds | Partial | Delta District & Shavano District staff help landowners improve water management |

| ID | Activity | Cooperating entities/program | Status (start date) | FY 12 | FY 13 | FY 14 | FY 15 | FY 16 | Out years | Est. funding needs | Funding sources | Funds in place? | Comments (with shortcomings highlighted) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **SE CONTROL PROJECTS FOR EXISTING PONDS** | | | | | | | | | | | | |
| A.5 | **Ponds (recreational, farm, aesthetic)** | | | | | | | | | | | | |
| A.5.1 | Formulate program to address pond seepage | SMP | Not begun | | X * | | | | | | | No | Studies (see C.1.) are proposed to examine loading impacts of ponds and develop selenium control concepts. |
| | **SE CONTROL PROJECTS FOR OTHER EXISTING NON-AG SOURCES** | | | | | | | | | | | | |
| A.6 | **Municipal & industrial** | | | | | | | | | | | | |
| A.6.1 | Explore options for load reduction from sewage treatment plants | Operators/ CDPHE | Not begun | | | | | | | | | No | |
| A.6.2 | Explore options for load reduction from Individual Sewage Disposal Systems | Operators/ CDPHE | Not begun | | | | | | | | | No | |
| A.6.3 | Explore options for load reduction from gravel pits | Operators/ CDPHE | Not begun | | | | | | | | | No | |
| A.7 | **Public lands (administered by BLM)** | BLM | Underway | X | X | X | | | | | BLM | Yes | Addressing selenium in new Resource Management Plan |
| | **OUTREACH AND EDUCATION INITIATIVES TO ADDRESS ALL EXISTING SELENIUM SOURCES** | | | | | | | | | | | | |
| A.8 | **Conduct public information and education program** | SMP | Underway | X * | X * | X * | X * | X * | X * | | | Partial | Will work with Wise Water Use Council |
| A.9 | **Develop strategies to support, facilitate, encourage LG water users to undertake projects that have Se control benefits** | SMP | Not begun | X * | | | | | | | | No | |

## PART B – PREVENT/MINIMIZE/MITIGATE NEW SELENIUM LOADING (primarily for potential municipal, residential, & industrial sources)

| ID | Activity | Cooperating entities/ program | Status | FY 12 | FY 13 | FY 14 | FY 15 | FY 16 | Out years | Est. Funding needs | Funding sources | Funds in place? | Comments (with shortcomings highlighted) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B.1 | **Refine, distribute, & promote Best Management Practices (BMPs)** | SMP/STF/ WWUC | Underway | X * | X * | X * | X * | X * | X * | | BR/ CRWCD | Partial | Existing BMPs can be found at http://seleniumtaskforce.org/other resources |
| | | | | | | | | | | | | | |
| B.2 | **Conduct public information & education program** | | | | | | | | | | | | |
| B.2.1 | Present information/education activities | SMP/ WWUC/STF | Underway | X * | X * | X * | X * | X * | X * | | BR/ CRWCD | Partial | Lower Gunnison Wise Water Use Program underway. Funding through 2012. |
| B.2.2 | Coordinate & provide technical assistance for counties & cities | SMP/ WWUC/STF | Underway | X * | X * | X * | X * | X * | X * | | BR/ CRWCD | Partial | Lower Gunnison Wise Water Use Program underway. Funding through 2012. |
| B.2.3 | Implement Wise Water Use program (including development & use of incentives) | WWUC/STF /SMP | Underway | X * | X * | X * | X * | X * | X * | | BR/ CRWCD | Partial | Lower Gunnison Wise Water Use Program underway. Funding through 2012. |
| | | | | | | | | | | | | | |
| B.3 | **Implement management actions to control loading from new proposals concerning:** | | | | | | | | | | | | |
| B.3.1 | Reclamation projects and actions | BOR | Ongoing | X * | X * | X * | X * | X * | X * | | BR | Partial | |
| B.3.2 | BLM managed lands | BLM | Ongoing | X * | X * | X * | X * | X * | X * | | BLM | Partial | |
| B.3.3 | Other Federal actions | USFWS/ TBD | Ongoing | X * | X * | X * | X * | X * | X * | | USFWS/ TBD | Partial | |
| B.3.4 | Counties/cities | Counties/ cities | Not begun | X * | X * | X * | X * | X * | X * | | | | |

## PART C – SUPPORT ACTIVITIES

| ID | Activity | Cooperating entities | Status | FY 12 | FY 13 | FY 14 | FY 15 | FY 16 | Out years | Est. Funding needs | Funding sources | Funds in place? | Comments (with shortcomings highlighted) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C.1 | **Expand knowledge base** | | | | | | | | | | | | |
| C.1.1 | Investigate **loading and fate & transport mechanisms** | | | | | | | | | | | | |
| C.1.1.A | Effects of Recharge and Dissolved Nitrate | BR/USGS | Underway | X | X | | | | | | | Yes | Funding from BR Science & Technology Program & USGS |
| C.1.1.B | Continuing study of Montrose Arroyo | USGS/BR | Underway | X * | | | | | | $98K | | Partial | |
| C.1.2 | Investigate **loading impacts of Non-Ag sources** including ponds, ISDS & other point/non-pt. sources | SMP | Proposed | | | | | | | | | No | ISDS = individual septic disposal systems |
| C.1.3 | Investigate **solutions & BMPs for Non-Ag** sources | SMP | Proposed | | | | | | | | | No | |
| C.1.4 | Development of soil selenium interpretation | WNTSC | Underway | X | | | | | | | | Yes | |
| C.2 | **Monitor water quality** | | | | | | | | | | | | |
| C.2.1 | Collect periodic samples at core monitoring network (e.g., 6-9/yr.) | CRWCD/ USGS/BR/ CDPHE/ NWCC | Underway | X * | X * | X * | X * | X * | X * | | | Partial | See Appendix A |
| C.2.2 | Operate continuous WQ monitors | CRWCD/ USGS/BR | Underway | X * | X * | X * | X * | X * | X * | | | Partial | See Appendix A |
| C.2.3 | Collect periodic samples at ancillary sites | USGS,CRWCD, CDPHE,NWCC, others | Underway | X * | X * | X * | X * | X * | X * | | | Partial | See Appendix A |
| C.3 | **Monitor endangered fish** | | | | | | | | | | | | |
| C.3.1 | Population | Recovery Program | Underway | X * | X * | X * | X * | X * | X * | | | Partial | |
| C.3.2 | Fish tissue selenium concentrations | FWS | Underway | X | X | | | | X * | | | Partial | |
| C.4 | **Obtain funding for SMP activities** | SMP/STF | Underway | X * | X * | X * | X * | X * | X * | | | Partial | |
| C.5 | **Develop new technology** | | | | | | | | | | | | |
| C.5.1 | Investigate canal sealants | BR/ UVWUA | Underway | X | ? | ? | | | | | BR | Partial | Working with EPA on application rates. Programmatic NEPA underway. |

| ID | Activity | Cooperating entities | Status | FY 12 | FY 13 | FY 14 | FY 15 | FY 16 | Out years | Est. Funding needs | Funding sources | Funds in place? | Comments (with shortcomings highlighted) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C.6 | **Report annual progress** | BR | Due July of each year | X | X * | X * | X * | X * | X * | | BR | Partial | Report will address water quality, updated load & concentration trend plots, biological monitoring, construction progress and outreach/education activities. |