Section 319 Nonpoint Source Control Program

Watershed Project Final Report

Gunnison River Basin Selenium Targeting

By

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This project was conducted in cooperation with the State of Colorado and theUnited States Environmental Protection Agency, Region VIII.

Grant # WQC 99-01497

Executive Summary

Project Title: Gunnison River Basin Selenium Targeting

Project Start Date: May 15, 1999 Project Completion Date: June 15, 2002

Funding	Total Budget:	$222,833
	Total EPA Grant:	$133,700
	Total Expenditures of EPA Funds:	$133,700
	Total Section 319 Match Accrued:	$ 91,019.46
	Budget Revisions:	$ none
	Total Expenditures:	$ 224,719.46

Project Goal

The goal of this project is to provide the groundwork for finding ways to reduce selenium loading from non-point sources to segments of the Gunnison and Uncompahgre Rivers while maintaining the viability of current land uses within the basins, and thereby improving water quality so as to meet state standards for protection of fish and wildlife, including some threatened and endangered species.

Summary of Accomplishments

1) Water sampling by the project defined the following drainages as being major contributors to the selenium loads in the Uncompahgre River:
    a. Loutzehizer Arroyo; in particular the reach between the junction of 6400 road and one mile below that junction.
    b. Cedar Creek; southeast of the City of Montrose
    c. Montrose Arroyo; southeast of the City of Montrose
    d. Sunflower Drain; east of the City of Delta
2) The project led to the completion of detailed soil maps of all of the areas determined to contain elevated levels of selenium and to the discussion of the importance and role of soils in the natural geochemical cycle of selenium

3) 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.
4) As a result of the project all of the following situations were identified as 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.
5) The project informed the public in the Gunnison River Basin of all aspects of the selenium issue via: a) newspaper articles; b) regular monthly public meetings; c) involvement of local business, government organizations and private citizens in the activities of the Gunnison Basin Selenium Task Force (GBSTF); d) hosting public meetings where experts on selenium discussed the issue from the scientific, industrial, and agricultural viewpoints; e) by writing, publishing and distributing several thousand educational brochures; and f) by the creation of a web site (seleniumtaskforce.org) focused on the activities of the GBSTF and the importance of the selenium issue to the community.
6) This grant and the ensuing project were the catalysts for developing cooperation and collaboration between numerous diversified organizations (Federal, State, County, City, and private) and also individual citizens that comprise the GBSTF; all of which had their own agendas and opinions as to how and if to deal with the selenium issue. Such cooperation was essential to the operations of the GBSTF and its current recognition as the most important single forum for dealing with selenium in western Colorado.
7) The project also stimulated and fostered efforts by the GBSTF to obtain additional selenium related grants that, (to date), have led to more than $700,000 of additional funding for demonstration projects, best management practices, monitoring, facilitation of meetings, the effects of urbanization of agricultural and range land on selenium loading, and outreach and education.
8) The project provided the data and information base necessary for the identification and evaluation of BMPs and of possible selenium remediation methods. These evaluations are currently ongoing but are outside of the scope of the projects objectives and tasks.

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1.0 Introduction

1.1 Background

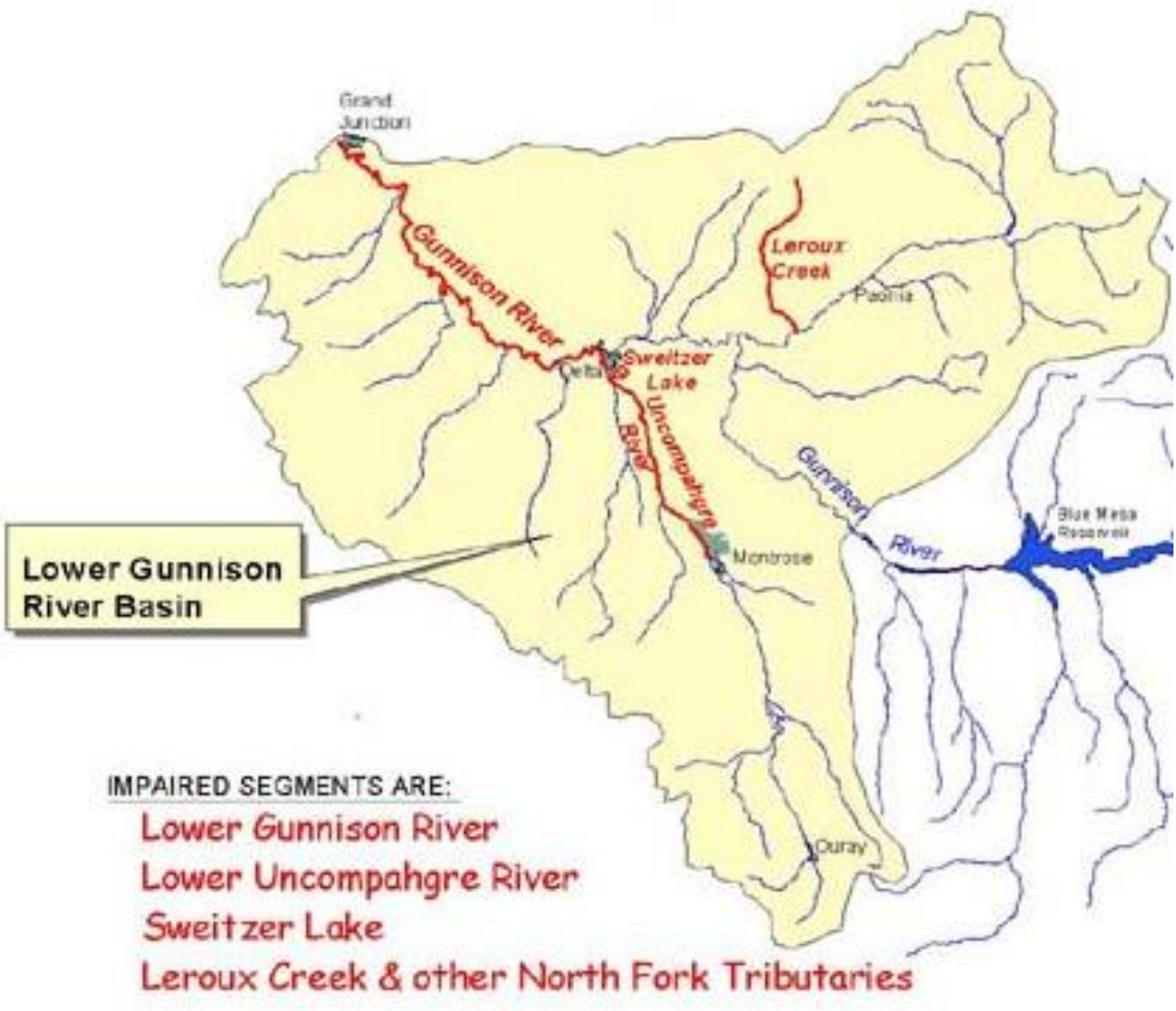
On July 14, 1997 the Colorado Water Quality Control Commission amended the Classifications and Numeric Standards for the Gunnison and River Basin (Regulation No. 35). This amendment included the adoption of new standards in four river segments of the basin, which are now included on the State of Colorado's 303D list of impaired waters.

The Gunnison Basin Selenium Task Force (GBSTF) was established to collaboratively undertake prevention and remediation measures to reduce the levels of selenium in the four segments with temporary modifications. The GBSTF further determined that additional data collection was needed to identify areas within the basin where remediation efforts or application of various BMPs would have the most effect on reducing selenium loads to the four segments. It was thus decided to apply for a 319-funded grant to address these issues. Some data has been collected for the purposes of identifying selenium sources, but none of these data for the tributaries to the Gunnison, the North Fork of the Gunnison, and the East side of the Uncompahgre River were collected for the purposes of identifying specific areas of selenium loading. The project that resulted from the above actions was designed to identify the areas of the highest selenium loading so that remediation efforts and application of BMPs can be focused in those areas where efforts will have the most impact on reducing selenium loading to the waters of the Gunnison Basin.

The areas that need further characterization include the tributaries to the Gunnison River upstream of the City of Delta upstream to the North Fork of the Gunnison River, tributaries to the North Fork of the Gunnison River upstream to Somerset, the Uncompahgre River downstream from Colona, and the Gunnison River between Delta and the Colorado River (fig. 1.1).

Further remediation efforts will concentrate on the areas identified by this project to improve the selenium concentrations in the four segments with temporary modifications, consequently reducing selenium loading throughout the system to protect various fish and wildlife species.

Figure 1.1 Lower Gunnison River Basin Targeting Project Area



Irrigated agriculture in the project area is concentrated in Delta, Mesa and Montrose Counties and also some acreage in Ouray County. Farms and ranches in this area of the lower Gunnison River Basin produced a market value in 2001 of all crops and livestock of $181,044,000 with a total economic impact on the area of $550,618,520. There are a total of 3,475 farms and ranches with a total of 262,018 irrigated acres (Colo. State Univ. Coop. Extension, 2001, Agriculture Fact Sheet). About one half of this acreage is underlain by the Mancos Shale formation or by soils derived from the Mancos Shale. There are a total of 156,472 acres of irrigated ground in Delta and Montrose Counties with the Uncompahgre Valley Waters Users Association supplying irrigation water for approximately 86,000 acres. Major crops produced include corn (feed, silage, sweet), beans, alfalfa, wheat, barley, oats, onions, peaches, apples, apricots, grass forage, and pasture forage. Other important crops are peppers, broccoli, squash, lettuce, melons, grapes (wine and table), pears, and cherries. Livestock produced include beef cattle, dairy cattle and products, sheep, chickens, hogs, horses, mules, and elk.

Selenium is a trace metal that bioaccumulates in aquatic food chains and has been known to cause reproductive failure, deformities and other adverse impacts in birds and fish, including some listed threatened and endangered fish species. The elevated level of selenium in some waters of western Colorado is considered to be a significant water quality problem. Selenium naturally exists in the Mancos Shale derived soils in parts of the basin. Sources of selenium loading in the basin include; deep percolation irrigation water (both agricultural and domestic), septic systems, seepage from ponds, wetlands, and canals, urban runoff, and natural erosion and weathering of Mancos Shale and derived soils.

Agricultural practices in the basin have provided one of the main means for transport of the selenium in the soils to waters in the basin. It is therefore believed that application of Best Management Practices (BMPs) may contribute significantly to reduction of selenium concentrations in the listed segments.

The study area is located along the Gunnison and Uncompahgre Rivers where they pass through the Mancos shale formation at elevations ranging from approximately 4,800 feet to 6,500 feet above sea level. The study will identify the areas within these Mancos soils contributing the highest levels of selenium to the rivers.

Agriculture is the main industry within the basin. However, recent trends toward more urbanization, and smaller farm operations, have populated the area much heavier in recent years.

Selenium loading in the Uncompahgre River increases about 96 percent between the towns of Colona and Delta. Median selenium concentrations in the Uncompahgre River at Colona are <1 microgram per liter, while in the

Uncompahgre River at Delta they are 20 micrograms per liter. Loutsenhizer Arroyo has some of the highest selenium concentrations (median concentration of 56 micrograms per liter and a maximum of 190 micrograms per liter) of any of the drainages (Butler and others, 1994, 1996).

1.2 Project Description

The Gunnison River Basin Selenium Targeting Project will gather water quality data necessary to characterize the selenium loads that are being contributed from within the basin. Evaluation of the variability of selenium loading in the basin will guide the future implementation of Best Management Practices and will provide additional insight into how watershed conditions and land use practices affect selenium loading from a particular area or drainage. In addition to identifying the sources of selenium loading the project will also develop an educational program for land users in the area about the selenium issue, its potential impacts on human activities, fish, and wildlife, and also on current land practices. It will also initiate efforts to examine remediation methods whose application may reduce the amount of selenium entering the rivers thereby improving water quality.

2.0 Project goals, objectives, and activities

2.0.1 Project Goal

The goal of this project is to provide the groundwork for finding ways to reduce selenium loading from non-point sources to segments of the Gunnison and Uncompahgre Rivers while maintaining the viability of current land uses within the basins, and thereby improving water quality so as to meet state standards for protection of fish and wildlife, including some threatened and endangered species. To achieve this goal the project required more detailed knowledge as to the locations of soils and waters with the greatest concentrations of soluble selenium. The project also required the participation of several Federal, State, and Local agencies and also the general public. Thus outreach, education and collaborative efforts are a major approach to the various project tasks.

2.0.2 Objectives, Tasks and Activities

Objective 1: Characterize the selenium loads for the tributaries of the Gunnison and the North Fork of the Gunnison Rivers.
Water-quality samples collected at the 47-station network and for the intense synoptic sampling in Cedar Creek and Loutsenhizer Arroyo has been compiled in a U.S. Geological Survey Water Resources Investigation Report 02-4151 “Characterization of Selenium in the Lower Gunnison River Basin, Colorado, 1988-2000” Butler and Leib (2002),. A preliminary presentation of the data was made at the September 2000 meeting of the Selenium Task Force. Data have been distributed to the Selenium Task force. Two additional sites were visited throughout the sampling period were never observed to have stream flow. Water-quality samples were collected during periods of base stream flow

and during the irrigation season. Also rainfall and snowmelt runoff samples were collected at sites that were normally dry.

Annual selenium loads were computed for the sites listed below. These loads were compared as a percentage of the total selenium loading for the Gunnison River at Whitewater.

Sampling site	Percentage of selenium loading at the Gunnison River near Whitewater
Gunnison River below the Tunnel	5
North Fork of the Gunnison River	7
Gunnison River at Delta	46
Uncompahgre River at Delta	41

Selenium concentrations are usually below the reporting limit. Selenium loads are estimated using an approximated selenium concentration of 0.5 ppb.

Task 1: Selenium loads will be characterized at the outflow of selected tributaries to the Gunnison River and the North Fork of the Gunnison River. Potential sites for characterization include tributaries to the North Fork of the Gunnison River near Paonia, Colorado downstream to the confluence with the Gunnison River and on the Gunnison River from the confluence of the North Fork of the Gunnison downstream to the USGS stream gage 09152500 Gunnison River near Grand Junction. Site selection will be done after evaluation of available data and existing and planned data collection by other programs. To define the seasonality of selenium loads, samples will be collected for selenium analysis and stream flow measured at these sites up to 3 times during base stream flow (November, January, and April) and up to 3 times during the irrigation season (May, June, and August).

Activities and results - task 1 (*for detailed discussions see Appendix 12.1*)

Objective 2: Characterize the selenium loads for 3 tributaries on the east side of the Uncompahgre River downstream from Colona. This characterization will identify areas where implementation of Best Management Practices would provide the largest reduction of selenium loading.

Task 2: This task will be accomplished by spatially intensive synoptic sampling in three drainage basins on the East side of the Uncompahgre River, Loutsenhizer Arroyo, the unnamed drainage to the southwest of Loutsenhizer Arroyo, and the Cedar Creek basin. Samples will be collected for selenium analysis and stream flow measured at these sites three times during (November,

January, and March). The samples collected will represent the period when the system is draining after irrigation ceases for the season. Sampling will be done during base stream flow because, based on previous investigations, the source of selenium is expected to be resulting from the deep percolation in the system. Also, during this time the influence of the dilution effects of tail water is eliminated and hydrologic conditions are most static.

Activities and results – task 2 (*for detailed discussions see Appendix 12.1*)

Objective 3: Establish an outreach and education program for water users and residents in the area to inform them of the selenium problem, and provide them with the information necessary to formulate and implement BMPs and remediation practices for reducing selenium loading.

Task 3: Prepare an educational package that can be presented to local interest groups.

Activities and results – task 3 *(see also Appendix 12.6)*

Educational Brochures

The Project developed a general educational brochure that is distributed at conferences, seminars, public meetings and also at Federal, State, and Local offices. The initial printing of the brochures was for 5,000 units at a cost of $1,285. The brochure gives basic background information on Task Force activities and attempts to address the following subjects:

- What is selenium/ Why is selenium a problem?
- Selenium Task Force - Targeted Segments
- What is begin done about the selenium problem?

Task 4: Present the selenium problem in displays at water festivals throughout the area.

Activities and results – task 4

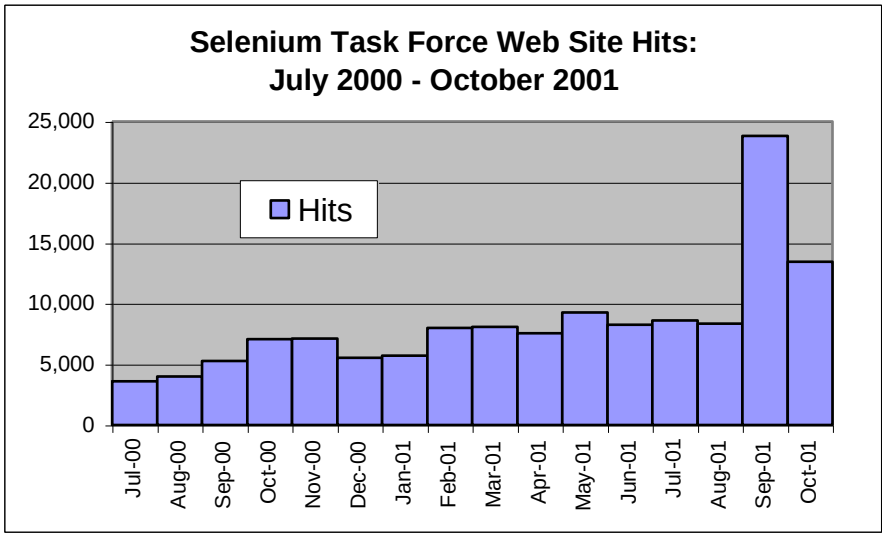
A "Selenium Station" was constructed for the Children' s Water Festivals that take place each Spring. They are held separately in Mesa, Delta, and Montrose Counties. Over 1200 fifth grade students annually attend these daylong festivals addressing various water issues. At the Selenium Station, children play "selenium plinko" and learn about the fate of selenium in the environment, as it moves through the soil and into local waterways. The Selenium Station was used in the 2000, 2001, and 2002 water festivals, and will continue to be presented in coming years.

Task 5: Get selenium information out on a website, either on one of our own or in cooperation with one of the participating organizations on the Selenium Task Force.

Activities and results – task 5

In July 2000, the Project and GBSTF created a web page at www.seleniumtaskforce.org. Interested parties can email their questions about the site to info@seleniumtaskforce.org. These emails go directly to the Task Force Coordinator. The purpose of this site is to provide information regarding various topics such as selenium in the environment, the current issues and activities of the Task Force, and summaries from our latest meetings.

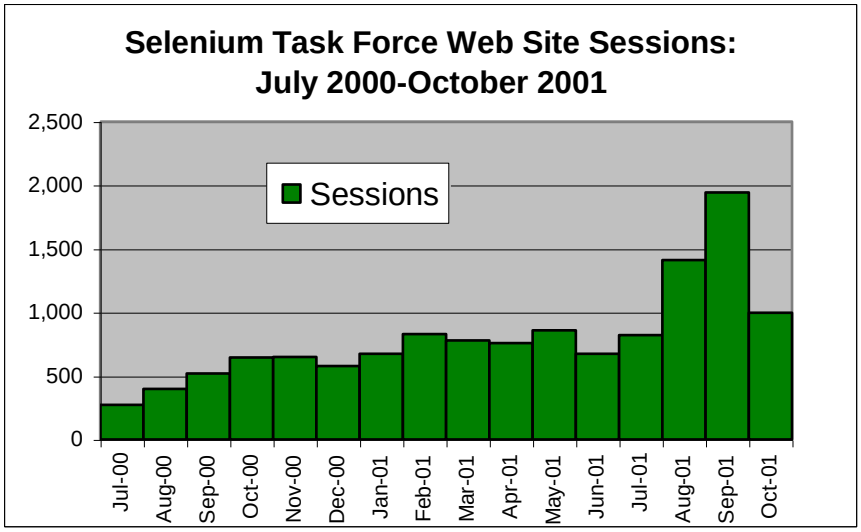
Figure 2.1



On average, the site receives 9,684 hits per month. A hit is defined as any request for data such as a Web page, bitmap, CGI gateway, or file. The number of hits the web site receives each month has been steadily increasing since its inception. Every month, we get hits from all over the world, from far-flung places such as China, Tanzania, and Austria. This table shows how our number of hits has increased over time.

We have also tracked our performance by the number of actual sessions

Figure 2.2



that individuals conducted at our site. Sessions are tracked by an individual IP address, and indicate that the viewer logged onto the site and may have reviewed the material. The following chart shows how the number of sessions has also increased over time.

Objective 4: Information exists that suggests that the Mancos Shale and soils derived from it have characteristics that differ within the Gunnison/Uncompahgre River basins. This objective will involve collecting and reviewing available published and unpublished data to determine the existing soil types and will also include new soil mapping, sampling, and analysis to determine the relationship of soil types to selenium levels in the soil.

(See Appendix 12.2 for details of the activities and results of tasks 6-9)

Task 6: Compile and review existing geological and soil maps and associated literature to establish critical areas for new mapping, extent and nature of available soil analyses, and summarize what is currently known concerning the distribution of selenium in soils of the Uncompahgre/Gunnison River basins.

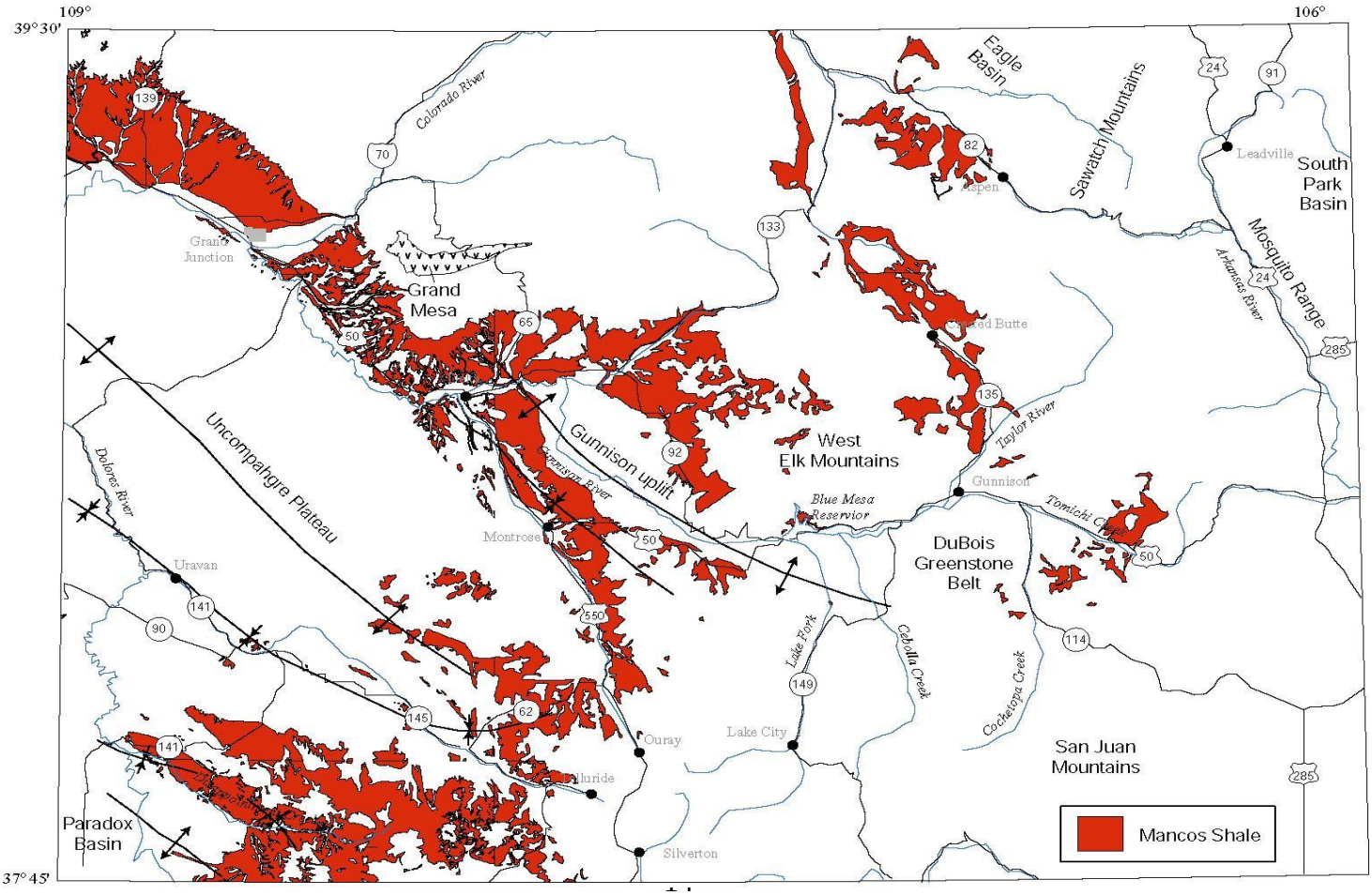
Activities and results – task 6

Initial water data collected in the valley indicated that elevated selenium levels were occurring in tributaries east of the Uncompahgre River. Review of existing soil and geological maps and literature shows that the Uncompahgre River effectively divides the valley into two very distinct geologic areas (fig 2.3). To the west immediately adjacent to the river system, are large beds of glacial-fluvial deposits, some of which contain local areas of sandstone alluvium. Further to the west is the Uncompahgre Plateau, which is a northeast tilting, sandstone bedrock (mostly the Dakota Sandstone formation), controlled questa. This sandstone bedrock underlies the glacial fluvial outwash, which predominately makes up the western agricultural area of the valley. This western area and the soils

contained therein are relatively low in soluble and total selenium levels. The terrain to the east of the river is composed primarily of Mancos Shale-derived alluvial and residual soils (figs. 2.4 and 2.5). Landforms in this area consist of some basin floor remnants adjacent to the riverene soils. Soils in this basin floor area were dominantly originally (pre-irrigation) residual in nature, with some areas of alluvial soils where drainage systems enter the main river channel. East of the Basin Floor area, further from the river, is a moderately large region of dominantly alluvial soils derived from local Mancos Shale sources and traversed by the Loutsenhizer Arroyo.

Many of the irrigated agriculture crops on the east side of the basin are grown on soils derived from the weathering of the Mancos Shale. These soils are fine textured silty to sandy clay and clay loams. They are moderately alkaline (pH 8+) and commonly contain concretions of calcium carbonate and veinlets and crystals of calcium sulfate (gypsum). Observations suggest that selenium is generally present in these soils but is somewhat erratically distributed both geographically and within soil profiles. Geographic distribution of selenium is apparently due in part to differences in selenium concentrations in the parent Mancos shale and also in part to distribution and transportation of selenium by deep percolation waters.

Figure 2.3 Geologic map Mancos Shale, western Colorado



Task 7: Develop a soil sampling plan and determine the types of chemical and physical analyses to be conducted; locate laboratories capable of doing the analytical work.

Activities and results – task 7

The NRCS Soil Survey Office assisted the Project in its efforts to identify known and potential sources of selenium in the soil and to help in the planning of remediation efforts, within that portion of the Project study area that falls within the Ridgway Soil Survey Area. The Ridgway Soil Survey Area encompasses the Uncompahgre River Valley from just south of Ridgway to just north of Delta, CO. The collection of selenium samples was done to coincide with the project soil survey office's primary goal of conducting and completing the soil survey of the aforementioned area according to NCSSP (National Cooperative Soil Survey Program) standards and procedures.

The soil sampling plan involved adjusting the soil survey project's focus to target those areas initially identified as having elevated selenium levels for soils mapping and sampling. Both soils mapping and sampling will be of importance to analyzing data and subsequent remediation efforts. Examination of initial data provided by the water monitoring subgroup of the task force and plotting of data sites from a USGS report on corresponding topographical maps (USDI-USGS open file report 93-507, entitled, "Chemical results and variability assessment of selected water-extractable constituents from the soils of the Uncompahgre Project area, west-central Colorado", by K.C. Stewart, J.G. Crock, and R.C. Severson - 1993), resulted in a tentative separation of three areas of higher, moderate, or lower levels of selenium. The area encompassed within the, "higher" category will be NRCS' focus of detailed soil mapping and sampling for the field season 1999, with the area designated as "moderate" for the field season 2000.

Sampling densities will initially average 1 to 2 sites per square mile. Site selection will be determined in the field by qualified NRCS soil scientists as they complete the soils mapping of the area. Sample sites will be chosen from dominate or sub-dominate soil types within the immediate area being considered. Sample sites will be chosen to be as representative as possible of the selected soil type, as the pedon information will also be used as documentation to support mapping concepts for the soil survey project. Mapping and sampling will be conducted on approximately 50,000 acres for 1999 and 50,000 acres for 2000.

Figure 2.4 Map showing soil sample locations in the Uncompahgre River Valley

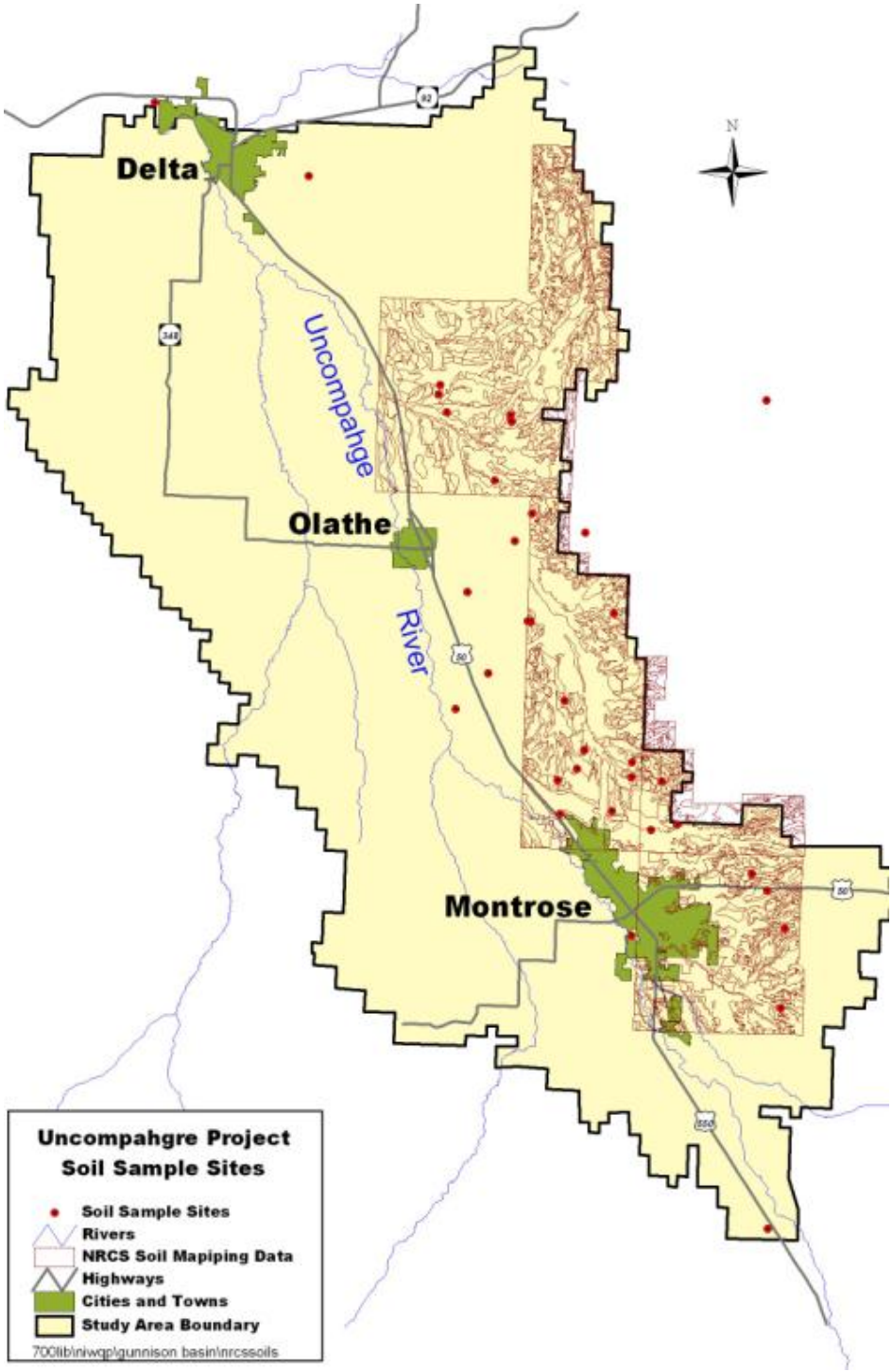
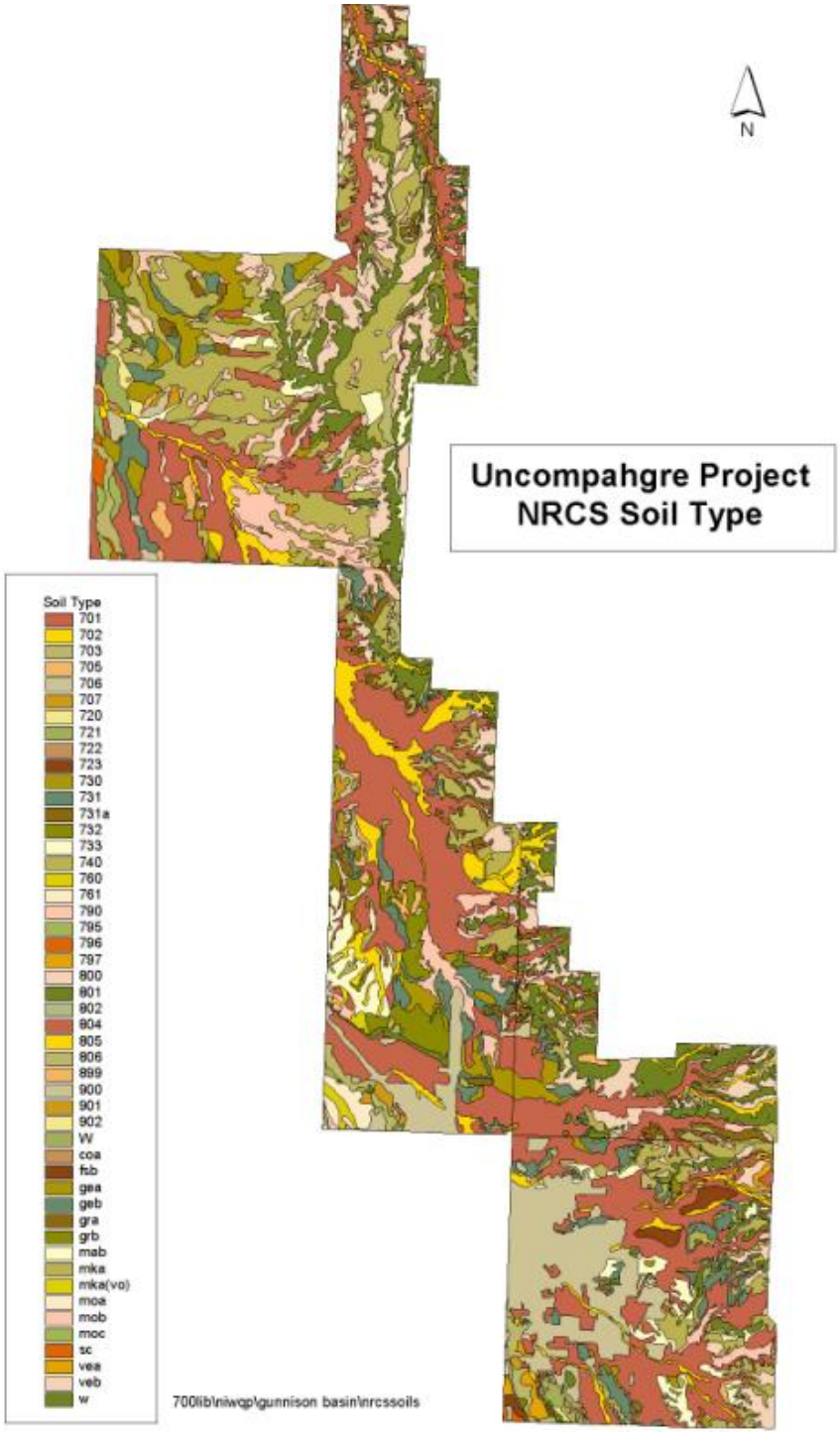


Figure 2.5 Preliminary Soils Map of the eastern side of the Uncompahgre River Valley – NRCS Uncompahgre Project



Task 8: Conduct soil mapping and studies of water movement in selected soil horizons.

Activities and results – task 8

For the past 3 1/2 years, the Ridgway Soil Survey Team has been providing technical assistance to the Gunnison Basin Selenium Task Force and the Shavano Soil Conservation District. This assistance has been provided in the forms of prioritizing and targeting the update and re-mapping of Mancos Shale soils east of the Uncompahgre River and south of the Gunnison River, within the Ridgway Project Soil Survey area. In addition, the Ridgway Soil Survey Team, at the request of the Task Force and Shavano SCD, collected selenium soil samples for analysis. This was done in conjunction with the gathering of supporting soil survey component documentation for the Ridgway Soil Survey. The following report contains the background, sampling activities and procedures, and findings to date concerning soil selenium levels and locations within the aforementioned geographic area.

Task 9: Collect soil samples and submit to laboratories for analysis.

Activities and results – task 9

Forty-four sites were excavated for sampling (fig. 2.4). Sites were selected based upon required soil survey documentation and sampling opportunities in such areas. Depths of excavations were based on soil type and availability of a backhoe. Excavations ranged from slightly over 2 feet to greater than 9 feet in depth. Shale bedrock was sampled at applicable sites. At the 44 sites, 211 soil samples were collected for analysis. These samples were collected on a horizon basis. Soils were described using the standard Colorado NRCS soil description form and done in accordance with NCSSP (National Cooperative Soil Survey Program) standards and procedures. Box samples consisting of undisturbed cores were also collected at most sites. Selenium soil samples were collected and stored in sealed sample bags. The samples were transported the same day and stored at the NRCS office in a controlled temperature environment. Samples were then transported, on a periodic basis, to Denver for preparation, processing, and chemical analysis at laboratories of the Bureau of Reclamation and the U.S. Geological Survey.

2.1 Planned and actual Milestone, Products, and Completion dateS

Table 2.1 shows the project milestones associated with each of the projects objectives and underlying tasks. All milestones were completed as scheduled with no major changes in timing or planned activities. All products were completed as scheduled and are discussed in either the body of this report or in the report appendices.

Table 2.1 – Targeting Project Milestones

TASK/RESPONSIBLE ORGANIZATIONS	OUTPUT	YEAR 1 fiscal(Oct/Sept)	YEAR 2 fiscal(Oct/Sept)	YEAR 3 fiscal(Oct/Sept)
OBJECTIVE 1				
TASK 1 - Characterize selenium loading in tribs to NF Gunnison & Gunnison GROUPS 2, 4, 5	Selenium loading data set*	> Feb	through July * <	
OBJECTIVE 2				
TASK 2 - Characterize selenium loading and identify sources in Loutsenhizer Arroyo, unnamed trib to Louts. Arroyo, and Cedar Creek GROUPS 2, 4, 5	Data set* and fact sheet summarizing findings		> Oct through	Oct* <
OBJECTIVE 3				
TASK 3 - Prepare an educational package that can be presented to local interests GROUPS 1, 2 ,4, 5, 10	Educational presentations*	> Oct	through	Sept * <
TASK 4 - Present the selenium problem at water festivals GROUPS 1, 2, 4, 5, 10		> April	through	Sept * <
TASK 5 - Get selenium information onto a website GROUPS 1, 2, 7, 10	Website*	> April through Sept* <		
OBJECTIVE 4				
TASK 6 - Compile and review existing geological and soil maps GROUPS 1, 10, 11	Summary report*	> Dec through Sept* <		
TASK 7 - Develop a soil sampling plan and determine analyses to be performed GROUPS 1, 6, 9, 10	Sampling plan*	> June	through Sept* <	
TASK 8 - Conduct soil mapping and studies of water movement GROUPS 1, 9	Summary report*		> Dec through	Nov* <
TASK 9 - Collect soil samples and conduct analysis GROUPS 1, 6, 9, 10	Summary report*		> Feb through	Jan* <

GROUP 1 - Shavano Soil Conservation District; **GROUP 2** – Selenium Task Force; **GROUP 3** – Uncompahgre Valley Water Users Association; **GROUP 4** – U.S. Geological Survey; **GROUP 5** – U.S. Fish and Wildlife Service; **GROUP 6** U.S. Bureau of Reclamation; **GROUP 7** – Colorado Water Quality Control Division; **GROUP 8** – Colorado River Water Conservation District; **GROUP 9** – Natural Resource Conservation Service; **GROUP 10** – Colorado State University Cooperative Extension Service; **GROUP 11** – Gunnison River/Grand Valley Water Quality Forum

2.2 Evaluation of goal achievements and relationship to the State NPS management plan

The goals, objectives, and associated tasks of this project were completed as planned and on schedule. They directly address irrigated agriculture and selenium loading in ground and surface waters in western Colorado, which are identified as high priority issues in the State NPS management program.

2.3 Supplemental Information

None

3.0) Best Management Practices (BMPs) Developed and/or Revised

The development of BMPs was not an objective or task of this project however the soil and water data collected while completing the different tasks of the project will provide important information for the creation of BMPs under a recently initiated 319 Grant being carried out by the Colorado State University Extension Service in collaboration with the GBSTF.

4.0) Monitoring Results

4.1 TMDL implementation effectiveness

TMDL implementation was not a goal or objective of this project. However, water monitoring and sampling results discussed by Butler and Leib, 2002, (see appendix 12.1) will be of use in future efforts to establish TMDLs within the project area

4.2 BMP effectiveness evaluations (Not applicable)

4.3 Surface water improvements, including separate sections for chemical, biological, and physical/habitat (Not applicable)

4.4 Groundwater improvements, including separate sections on metals, chemistry, nutrients, and sediment (Not applicable)

4.5 Other monitoring

North Fork of the Gunnison River basin: The following is a summary of selenium concentrations for tributaries to the North Fork of the Gunnison River.

Selenium < part per billion (ppb)	North Fork of the Gunnison River at Somerset

Selenium <5 ppb	Hubbard Creek, Terror Creek, Minnesota Creek, Rotcap Creek, and sites on Alum Creek
Some samples > or = 5ppb	Reynolds Creek, Bell Creek, and Big Gulch
Most samples > 5ppb	Jay Creek, Cottonwood Creek, Short Creek, Leroux Creek

Gunnison River Basin from the confluence of the North Fork of the Gunnison to the Gunnison River at Delta: In this portion of the study area, concentrations of dissolved selenium ranged from less than 1 microgram per liter to 102 micrograms per liter. Lawhead Gulch and Sulpher Gulch had concentrations that ranged from 4 to 21 ppb. Except for Tongue Creek all other tributary sites had selenium concentrations >5ppb. Dissolved selenium concentrations for the Gunnison River at Delta ranged from 2 to 5 micrograms per liter.

Gunnison River from the confluence of the Uncompahgre River to Whitewater: In this portion of the study area concentrations of dissolved selenium ranged from less than 1 microgram per liter to 150 micrograms per liter. Selenium concentrations for the Uncompahgre River at Delta ranged from 6 to 23 micrograms per liter. Dissolved selenium concentrations for samples collected from Dominguez Creek and Escalante Creek that drain the North side of the Uncompahgre were less than 1 microgram per liter. Several rainfall and snow melt runoff samples were collected at ephemeral streams. Concentrations in runoff samples ranged from less than 1 microgram per liter in Bangs Canyon (on the south side of the Gunnison River to 150 micrograms per liter in Alkali Gulch (on the North side of the river. The additional sampling done at sites between Delta and Whitewater in late January 2000 during snowmelt and rain events, which caused some runoff in normally dry Deer Creek and Wells Gulch. Stream flow was never observed nor evidence of stream flow observed (high-water marks) in Beaver Creek. Maximum concentration in samples from Deer Creek and Wells Gulch was 11 micrograms per liter at flow of 0.04 cubic feet per second. Much of the snowmelt appeared to infiltrate a few inches into the clay soils and did not appear to reach the stream. Most of that water probably is lost to evapotranspiration. Additional runoff samples also collected from Alkali Creek. Selenium concentrations are much higher in Alkali Creek than in adjacent sites. A maximum concentration of 150 micrograms per liter (load 0.14 lbs/day) occurred on Jan. 19 at Alkali Creek during snowmelt. The selenium levels in Alkali Creek are higher in 1999-2000 than when first sampled in 1996.Concentrations for the Gunnison River at Whitewater ranged from 2 to 7 micrograms per liter.

Leroux Creek selenium synoptic studies**:** At the request of some North Fork/Leroux Creek area residents and organizations 4 sites were sampled on March 28, for selenium in and above the Jessie Ditch area. A more comprehensive synoptic sampling was done June 20 when 12 stream sites, 1 canal, 1 seep, and 1 well were sampled. All samples were sent to lab for selenium analysis. Flow measurements were made on all stream sites for analysis of selenium loading along Leroux Creek. Laboratory results from March 28 sampling show a high selenium inflow between the Fire Mountain Canal and Jessie Ditch. Sampling done June 20 indicates that above the irrigated area there was no detectable selenium. The sampling identified high selenium inflows below the Fire Mountain canal that were identified during the reconnaissance done in March. In Leroux Creek downstream from the Fire Mountain canal selenium inputs were from groundwater discharge that had selenium concentrations ranging from 5 to 10 ppb.

Cedar Creek Tracer, Nov.16-17, 1999: A total of 35 samples were collected from the AB lateral to near the mouth of Cedar Creek. Twenty-eight samples were taken from Cedar Creek, the rest were from tributary ditches and drains. In the reach downstream from the AB lateral, the mainstem concentrations were in a narrow range of 13-17 micrograms per liter, and there was no single large selenium inflow. The largest input may have been seepage water collected by the AM lateral, which dumps into Cedar Creek in this reach. The AM lateral may pick up high selenium ground water in the Montrose Arroyo basin. In Cedar Creek, there is a significant loading inflow (at least in November 1999) from the upper basin above AB lateral. There are canals and ditches and irrigated areas throughout the upper basin that use water that initially came from the Cimarron River.

In the lower reach, mainstem concentrations ranged from 16-28 micrograms per liter. About 50% of the selenium gain in the lower reach was from Montrose Arroyo. Preliminary analysis of the total load in Cedar Creek, in November 1999, shows that roughly 1/3 of load was from above AB lateral, 1/3 from the Montrose Arroyo, and 1/3 from everywhere else in basin.

Loutsenhizer Arroyo Tracer, Feb.28-29, 2000: Three tracers were initially planned, but only two actually done because of access problems (landowner denied access) on part of the west tributary. On the mainstem of the arroyo, a total of 30 sites were sampled. The upper reach (14 sites) was between the Selig Canal and Carnation Rd.; the lower reach (16 sites) was from Carnation to the mouth. On the west tributary, a 7-site synoptic sampling was done.

In the upper reach for the Loutsenhizer Arroyo tracer, the selenium concentrations ranged from 184-344 micrograms per liter on mainstem sites. A significant increase from 184 to 331 micrograms per liter occurred between 6400 Road (site 2) and the next site 1 mile downstream (site 3). A small drain ditch was discharging into the arroyo between sites 2 and 3 with 655 micrograms per liter selenium. That reach is immediately down gradient from the Selig Canal, which cuts through weathered shale in this area. Concentrations were in the 310-344 micrograms per liter range below site 3 to the confluence with the west tributary, and concentrations did not vary much between sites. Inflow from the west tributary dilutes the main arroyo selenium concentration back to 183 micrograms per liter (the flow in west tributary was greater than the flow in the main arroyo above the west tributary).

There was a gradual decline in selenium concentrations in the lower study reach from Carnation Road to the mouth. Concentrations ranged from 180 micrograms per liter at Carnation to 157 at the mouth. Apparently, drainage water in the lower reach has lower overall selenium concentrations than in the upper reach, although there was considerable variation. Tributary concentrations in the lower reach (3 sites) ranged from 8 to 600 micrograms per liter.

For the west tributary synoptic, 6 mainstem sites and 1 drain ditch were sampled. Selenium ranged from 125-149 micrograms per liter for mainstem sites (130 micrograms per liter at confluence with Loutsenhizer Arroyo vs. 310 in the main arroyo above west tributary). Although the concentrations are much less in the west tributary, the selenium loading from the west tributary was almost 1/2 of the load at the confluence with the main arroyo. This increase in loading was a result of the flow for west tributary was more than double what was in the main arroyo above the confluence.

There is also some selenium-loading entering the Loutsenhizer Arroyo from above the Uncompahgre Project service area (above Selig Canal). Using measured flows, comparing the upper injection site (above Selig) to the mouth, about 10 percent of the selenium load at the mouth was accounted for the site at Selig Canal (the non-project load). This does not account for what appears to be some more loading coming out of the north branch of the arroyo(sampled recently) which discharges into the main arroyo in the Falcon Rd area. This non-Uncompahgre Project loading appears to be reuse of tail-water from Bostwick Park in the upper Loutsenhizer Basin.

4.6 Quality assurance reporting

The objectives of this project are:

1) To characterize sources of selenium in the North Fork of the Gunnison River and the Gunnison River from the Smith Fork downstream to Whitewater Colorado.
2) To further characterize sources of selenium in the Uncompahgre River Basin, especially from the East Side of the valley. This work will build upon the sampling that has been done to date by a variety of entities.
3) To determine the occurrence of selenium in cultivated soils derived from Mancos Shale in the lower Gunnison River basin.

To determine sources of selenium loading in the lower Gunnison River Basin, the GBSTF will use data collected by this project. The soils information will be collected by the NRCS and will be used to prioritize areas for the implementation of management practices to reduce selenium loading in the lower Gunnison River Basin. Water-quality data will be collected by the Water Resources Division of the USGS and will be compared to Colorado water-quality standards. The data will be of sufficient quality to allow the GBSTF to evaluate sources of selenium in the study area and to prioritize the implementation of management practices to reduce selenium loading in the study area.

The Natural Resources Conservation Service (NRCS) in Montrose, Colorado will conduct the soil sampling associated with this project. Field collection and laboratory procedures are described below and in Appendix 12.2

4.6.1 Water Sampling

Some data has been collected for the purposes of identifying selenium sources, but none of these data for the tributaries to the Gunnison, the North Fork of the Gunnison, and the East side of the Uncompahgre River were collected for the purposes of identifying specific areas of selenium loading. This project will identify the areas of the highest selenium loading so that remediation efforts and application of BMPs can be focused in these areas where efforts will have the most impact on reducing selenium loading to the Gunnison.

Project/Task Description: The Gunnison and Uncompahgre River Basins Targeting Project will gather water quality data necessary to characterize the selenium loads that are being contributed from within the basins. Water-quality data collection is planned to begin in the summer of 1999 and continue through the spring of 2000. Additional sampling may be done through 2000 if resources are available. Evaluation of the variability of selenium loading in the basins will guide the implementation of Best Management Practices and will provide additional insight into how watershed conditions and land use practices affect selenium loading from a particular area.

Documentation and Records: The USGS project coordinator will identify and maintain all of the field and laboratory records required for this project. The project coordinator will oversee field-data collection and meter calibration and corresponding electronic database. The USGS laboratory will provide analytical results and will maintain Quality Control data for the laboratory analyses.
Sampling Design: The sampling effort will consist of synoptic runs over the life of the project beginning in June 1999. Sampling will include the following:

1) Streamflow measurements will be made in conjunction with each water-quality sample collected.
2) Water-quality samples will be collected for dissolved selenium. At selected sites, samples also will be collected for major ions and dissolved solids. Field measurements of water-temperature, pH, and specific conductance will be obtained (Table 4.1).
3) Samples will be collected using depth- and width-integrating techniques. For samples collected in streams too shallow for use of depth-integrating techniques, samples will be dipped from multiple points along the width of the stream.
4) Replicate samples and field blanks will be collected on each sampling trip. Field blanks for field equipment, filters, and containers will be collected during every sampling trip at a site to be chosen by the sampling personnel.

Sample locations for the characterization work in the Uncompahgre River Valley have not been chosen to date. This task will occur at a later date in the project. The locations will be chosen after review by the Selenium Task Force monitoring sub-group of existing data in the basin.

Sampling Methods Requirements: All water samples will be collected using standard methods of the U.S. Geological Survey (Ward and Harr, 1990). For streams that can be waded, a hand-held sampler (model DH-81) will be used. For larger rivers, samples will be collected from bridges or cableways (at USGS gauging stations) using either a DH-77tm sampler or a DH-95 sampler. Depth-integrated, equal-width (EWI) samples will be collected unless the stream is too shallow or the flow too small to use samplers. EWI samples will be composited in the 1 or 3-liter plastic bottles used to collect the sample. In situations of small flows, a 1-liter bottle will be used to hand collect water sample from the centroid of flow or from multiple points across the channel. All sampling equipment will be cleaned in detergent, dilute hydrochloric acid, and deionized water prior to each field trip. Equipment will be field rinsed with native water at the site prior to sample collection.

Water temperature will be measured in-stream using a digital thermometer that will be calibrated using ASTM thermometers. Conductivity and pH measurements will be made on a subsample of the stream sample. Conductivity will be measured using an Orion model 122 Meter, and pH was measured using a

Beckman model 200 meter. Except at sites with a USGS gage, stream flow will be measured at all sites using standard methods of the U.S. Geological Survey (Rantz and others, 1982). For sampling sites located at gauging stations, the stream flow will be determined using the gage height at the time of sample collection and determining stream flow from a rating curve. If appropriate, determination of stream flow for the characterization work in the Uncompahgre River Valley will be done using tracer dilution techniques described in Kimball (1997). If stream reaches to be characterized are gaining stream flow the technique will allow for accurate determination of stream flow (and diffuse groundwater inflows) at a larger number of sites than using conventional techniques.

Water samples for dissolved selenium analysis were filtered using 0.45 um Gelman capsule filters and a peristaltic pump into a 250 ml acid rinsed bottle. Selenium samples will be acidified to pH 2 or less using 1 ml of ultrex nitric acid. For sites where samples for major ions and dissolved solids also will be collected, an additional 250 ml filtered, unacidified sample and a 250 ml unfiltered sample also will be collected.

During each week that sampling will be done, a blank sample will be processed for selenium analysis. The blank was prepared using deionized water and will be processed using the same procedure as for the stream samples.

Sample Handling and Custody Requirements: The USGS personnel collecting the samples will be the custodians of all samples prior to shipment to the USGS National Water Quality Laboratory. All samples will be brought to the USGS office in Grand Junction prior to shipment. Analytical services request forms required by the NWQL will be completed and sent with each sample. At the lab all samples are logged into NWQL sample tracking system and are assigned a laboratory ID. The samples are in custody of the analytical section that performs the analysis until all determinations are done. Then samples are returned to logistical support section for storage in warehouse in case reruns are needed.

Table 4.1 Summary of field parameters and constituents to be analyzed from samples collected in the lower Gunnison River basin. [mg/L, milligrams per liter; µg/L, microgram per liter]

Parameter or constituent	Preservative and Container type	[1]Holding time	Method	Reporting limit
Water Temperature degrees Celsius	Measured insitu	Analyze immediately	Digital Thermometer	0.1 degrees Celsius
Specific Conductance µsiemans per square centimeter at 25 degrees Celsius	Measured insitu	Analyze immediately	Orion meter model 122 meter	1 µsieman
pH standard units	Measured insitu	Analyze immediately	Beckman meter model 200 meter.	.01 standard unit
Dissolved calcium	Filtered Acidified 250 ml poly bottle	28 days	[1]I-1472-85	0.02 mg/L
Dissolved sodium	Filtered Acidified 250 ml poly bottle	28 days	[1]I-1472-87	0.06 mg/L
Dissolved magnesium	Filtered Acidified 250 ml poly bottle	28 days	[1]I-1472-87	0.004 mg/L
Dissolved chloride	Filtered untreated 250 ml poly bottle	28 days	[1]I-2057-85	0.10 mg/L
Dissolved sulfate	Filtered untreated 250 ml poly bottle	28 days	[1]I-2057-85	0.10 mg/L
Alkalinity	Filtered untreated 250 ml poly bottle	7 days	[1]I-2034-86	1.0 mg/L
Dissolved fluoride	Filtered untreated 250 ml poly bottle	28 days	[1]I-2057-85	0.10 mg/L
Dissolved silica	Filtered untreated 250 ml poly bottle	28 days	I[1]-2700-85	0.10 mg/L
Dissolved selenium	Filtered Acidified 250 ml poly bottle	42 days	[2]I-2668-98	1.0 µg/L
Dissolved Nitrite and Nitrate	Filtered acidified with sulfuric acid	8 days	[3]I254590	0.037 mg/L

Analytical Methods Requirements: All samples will be analyzed by the NWQL in Lakewood, Colorado. Selenium will be analyzed using graphite furnace-atomic absorption spectrometry. Major ions will be analyzed using methods described in Fishman and Friedman (1989).

Quality Control Requirements: The USGS will keep records in the USGS Grand Junction office of all water-quality samples collected. These records are reviewed for future publication of the data in the USGS annual data reports for Colorado.

Quality Control acceptance criteria laboratory analyses: (*Dissolved chloride, sulfate, silica, and nitrite plus nitrate)* There is a minimum of 1 reference (QC) sample per 10 unknown samples. All BQS QC samples in a run must fall within the limits set by BQS for the data from that run to be acceptable (see below).

The analyst is trained to watch for carryover problems, abnormal peak shapes, interference peaks, and mis-pours. It is standard procedure that if there is any question about the validity of the data, the samples must be rerun. Duplicates are included on each protocol. Duplicates must match within the precision of the method.

The following are acceptance criteria and calibration curves for specific Lab Codes.

Dissolved chloride and silica:

Calibration Standards: 0.1,0.5,1.0,5.0,25.0,50.0,100.0,200.0,300.0 mg/L

Acceptance Criteria for on-line BQS QC samples =mpv +/- 1.5 s.d

mpv= most probable value

s.d. = standard deviation

Calibration curves for every run must have an R2 value (correlation coefficient) of at least 0.999 to be accepted.

Dissolved silica:

Calibration standards = 60,40,10,5,1,0.1 mg/L

Acceptance criteria for BQS QC samples = mpv +/- 1.5 s.d. Calibration curves for every run must have an R^2 value (correlation coefficient) of at least 0.999 to be accepted.

Alkalinity: Instrument is set using the pH 4 and 7 buffers. There is no way to provide acceptance criteria. Two blanks are analyzed per set, one at the beginning, and one at the end. The acceptance criteria is +/- the LRL. One SRWS is analyzed after every 10 samples. The acceptance criteria is +/- 1.5 SD from the mpv.

Dissolved fluoride: Standards are 0.1, 0.2, 0.5, 1,2,3 mg/L. Acceptance criteria is a correlation coefficient of >0.999. One blank is analyzed per set. The acceptance is +/- the LRL. One SRWS is analyzed after every 10 samples. The acceptance criteria is +/- 1.5 SD from the mpv. One duplicate is analyzed for every set (normally 90 cups). The acceptance criteria is +/- 15% difference.

Dissolved selenium: The standards are blank, 10, 25, and 50 ug/L. Acceptance criteria is a correlation coefficient of >0.999. One blank is analyzed per set. The acceptance is +/- the LRL. One SRWS is analyzed after every 10 samples. The acceptance criteria are +/- 1.5 SD from the mpv. One duplicate is analyzed for every set (normally 90 cups). The acceptance criteria are +/- 15% difference.

The acceptance criteria and calibration curves for specific Lab Codes for magnesium, sodium, calcium, and potassium are summarized in Table 4.2

Table 4.2 Dissolved magnesium, sodium, calcium, potassium

	663 magnesium ICP	675 sodium ICP	659 calcium ICP	54 potassium AA
Calibration Curve range (low curve-ICP)	0.0, 10.0 mg/L	0.0, 10.0 mg/L	0.0, 10.0 mg/L	0.1, 1.0, 2.0, 5.0, 10.0 mg/L
(high curve-ICP)	10.0, 50.0 mg/L	10.0, 50.0 mg/L	10.0, 50.0 mg/L	N/A
Correlation Coefficient	N/A	N/A	N/A	≥0.995
Blank Frequency/run	1/run	1/run	1/run	1/run
QC Frequency/run	1/8-10 samples	1/8-10 samples	1/8-10 samples	1/8-10 samples
Acceptance Criteria for SR Mpv +/-	3 f-pseudosigma *	3 f-pseudosigma*	3 f-pseudosigma*	1.5 f-pseudosigma**
Acceptance Criteria for blanks	+/- 0.002 mg/L	+/- 0.056 mg/L	+/- 0.01 mg/L	+/- 0.1 mg/L
	*Based on On-line historical Data			
	**Based on SRWS Round-Robin Data			

Instrument Calibration and Frequency: Digital thermometers are calibrated using an ASTM thermometer. Conductivity and pH meters are calibrated or checked each day during sampling runs. Often, meters will be checked more than once during the day. The conductivity meter will be calibrated using known standards that bracket the conductivity of the field samples. pH meters will be calibrated using 7.0 and 10.0 standards. Filters are 0.45 micron capsule filters. Conductance and pH standards and capsule filters will be obtained from the USGS laboratory in Ocala, Florida.

Assessment and Response Actions: All field and laboratory activities are subject to internal reviews in the USGS by water-quality specialists or other water-quality personnel. Identified procedural problems are corrected based on comments and recommendations by reviewers.

Records are kept on individual meters used in the field. If meters do not calibrate properly, probes, batteries, or meters are replaced. PH probes are occasionally cleaned with pH probe cleaning solution.

Data Review, Validation & Verification Methods and Requirements: USGS water-quality specialist (D.L. Butler) in the Grand Junction office will review all field and analytical data. Questionable analytical results will be reported to the

NWQL for the lab's review and for possible reruns of the analysis. Results of the water-quality sampling and stream flow data will be summarized by USGS for presentation to the STF. All field and chemical data will be stored in the USGS NWIS database, and the data eventually will be transferred to EPA's STORET system.

Reconciliation with Data Quality Objectives: Immediately after sampling trips are completed, D.L. Butler of USGS will review field forms and data. Questions or discrepancies will be noted and brought to the attention of the sampling personnel. Not all sites listed in the sampling design (section B1) may have flow, therefore, samples can not be collected. The lack of stream flow at ephemeral sites falls within the objectives of this study, which is to document selenium loads, or the lack of selenium loads, from tributary streams in the study area. Calculations and/or determinations for precision, completeness, and accuracy will be made and corrective action taken if needed. If data quality indicators do not meet the project specifications, data may be discarded and resampling may occur. The cause of failure will be evaluated and corrected.

4.6.2 Soil Sampling (*see also Appendix 12.2, Soils Report, p. 3-7*)

Field sampling: At each sample site, a detailed pedon description will be taken according to NSSH guidelines (National Soil Survey Handbook). Each site will be mechanically or hand excavated to a minimum depth of 60 inches, or contact with bedrock, or skeletal layer prohibitive to further excavation. Deeper sampling than 60 inches will be done wherever possible. Equipment used will include backhoe, soil probe truck, tile spade, and hand auger. A detailed pedon description will be made on site. Each profile will be separated into layers (horizons) according to guidelines from NSSH, Soil Survey Manual, and Soil Taxonomy. A representative sample will be collected from each individual horizon identified in the profile. Each sample (approximately 2 pounds) will be stored in a new sample bag with appropriate labels and designators.
Samples will be transported to and stored at the NRCS office in Montrose, CO. All or a portion of the collected samples will periodically be sent to the BOR (Bureau of Reclamation) in Denver for lab preparation and analysis. A copy of the corresponding pedon description(s) will accompany samples (National Soil Survey Handbook (430-VI-NSSH, 1996).

Upon receipt of the laboratory analysis information, NRCS soil scientists and soils subgroup Task Force participants will review and attempt to assimilate, qualify, and quantify assembled data and information to narrow target areas/soils/ soil horizons for future sampling and review.

As sufficient data is gathered and evaluated, correlation efforts will be made to identify specific soil types and areas of elevated selenium levels to start/assist the process of remediation efforts on selected sites

Laboratory Procedures for the Analyses of Soil Samples: Samples were delivered to the Soils Lab at the Bureau of Reclamation in Denver. Most samples arrived at the lab in "field moist" conditions. The samples were air dried at room temperature, 70^{o} F or less. After drying, the samples were dispersed as much as possible by hand and any gravel or large pieces of plants and other extraneous material removed. They were then further disaggregated by the use of a hammer mill or ceramic grinder, and the disaggregated material passed through a #10 (2 mm) sieve. It was possible to disaggregate almost entire samples of soil, with very little loss of material. Material passing the #10 sieve was used for all analyses. Each sample was thoroughly mixed. Representative sub-samples (i.e. those that will give a value acceptably similar to any other taken from the larger sample in the same way) were obtained by fractional shoveling.

Chemists at the United States Geological Survey office in Denver, Colorado analyzed all soil samples. Procedures were as follows: Digestion of whole soil material (*Totals*) for chemical analyses is done using approximately 50 g. of the disaggregated <2 mm (<#10 sieve) material. The sub-sample should be pulverized to approximately minus 100 mesh (<150 um) and mixed to ensure homogeneity. Approximately 0.25 g. of the pulverized sample is digested using a mixture of hydrochloric, nitric, perchloric, and hydrofluoric acids at low temperatures in an open Teflon vessel to obtain a liquid for analysis. ***This procedure is dangerous & requires the use of gloves, goggles, lab coat, & a special perchloric acid hood & ventilation system, and should not be performed without them.*** Virtually all of the original sample material is dissolved.

Procedure:

1. Weigh 0.25 g. of <100 mesh sample into a 30 ml Teflon vessel, add 9 ml HNO_3 & 0.25 ml of 10 % HCl. Allow to stand for 3 hours.
2. Add 2 ml $HClO_4$, 2 ml H_2SO_4, 10 ml HF, and heat overnight at 125^{o}C.
3. Cool, add 25 ml 6N HCl and let stand for half an hour.
4. Transfer the sample solution to a 60 ml polyethylene bottle & bring up to 55 g with DI water
5. Sample solutions should then be analyzed by Hydride Generation-Atomic Absorption Spectrophotometry (**HG-AAS**). The use of Graphite Furnace (GFAAS) or Inductively Coupled Plasma (ICP) should be avoided, as they do not have the sensitivity or the accuracy of the HG-AAS, & will therefore not produce comparable results. At the end of the digestion period, the selenium samples are reduced to the +4 oxidation state and sodium borohydride is added to the solution, resulting in the rapid formation of hydrides. The gaseous hydrides are stripped from the analytical stream and transported with inert gas to a heated quartz furnace ($2{,}000^{o}$ C). Calibration is performed by standardizing with digested, certified (usually NIST) soil and rock materials, and calibration standards in solutions of similar matrix.

4.7 Results of BMP operation and maintenance (O&M) reviews

No BMP operations were established by this project

5.0) Coordination Efforts

5.1 Coordination from other State agencies

Shavano Soil Conservation District - The lead organization for the project which entered into contracts for the GBSTF. They are regular attendees of the monthly meetings of the GBSTF and provided technical assistance to the targeting project and also coordination of project activities with local landowners.

Colorado Water Quality Control Division - Provided personnel and technical assistance in the planning, management, and implementation of the project. They are regular attendees of the monthly meetings of the GBSTF.

Colorado River Water Conservation District - Provide personnel and technical assistance for planning and implementation. They are regular attendees of the monthly meetings of the GBSTF.

Colorado State University Cooperative Extension Service – Provided personnel and technical assistance for implementation and planning of all of the project activities. Attended all project and GBSTF meetings and precipitated in public outreach activities and special symposia. On several occasions gave presentations concerning the selenium issue to various public organizations within the project area. They were especially effective in public outreach and education.

Delta Soil Conservation District - Promoted the development and implementation of Best management Practices designed to minimize non-point source pollution. Provide personnel and technical assistance for implementation and planning of the project. They are regular attendees of the monthly meetings of the GBSTF.

5.2 Other State Environmental Program Coordination (none)

5.3 Federal Coordination

United States Geological Survey - Provided personnel and technical assistance in planning and implementation of project activities. Attended all project and GBSTF meetings. Planned and conducted all of the water sampling and chemical analyses of all of the water samples. Precipitated in public outreach activities and special symposia. Responsible for, and are the principal authors of major parts of the project's final report, which includes the interpretation of all of the water sampling and monitoring carried out by the project.

Natural Resource Conservation Service - Provided personnel and technical assistance in planning and implementation of project activities. Planned and

implemented all of the soil mapping and sampling in the project area. Attended all project and GBSTF meetings and precipitated in public outreach activities and special symposia. On several occasions gave presentations concerning the selenium issue to County Commissioners and other City and County officials. Are the principal authors of the soils part of the projects final report and collaborated closely with the USBR in all of the soil related activities.

United States Fish and Wildlife Service - Provided personnel during the planning and implementation of the project. Attended all project and GBSTF meetings precipitated in public outreach activities and special symposia.

United States Bureau of Reclamation - Provided personnel and technical assistance in the planning and implementation of all project activities. Provided coordination between the project and the National Irrigation Water Quality Program (NIWQP), which is also conducting selenium reduction efforts in the region. Provided laboratory support for the preparation of soil samples for chemical analyses. Joined with the NRCS in the interpretation and statistical analyses of all of the soils data. Made important contributions to the project's final report.

5.4 USDA Programs
No USDA Programs were involved with the project.

5.5 Accomplishments of Agency Coordination Meetings
All of the regular coordination meetings between the numerous Federal, State, and Local Agencies were accomplished through the monthly meeting of the GBSTF. Special meetings of the various project subgroups were held on an "as needed" basis. Accomplishments resulting from these meetings are discussed throughout this report and are broadly described in sections **5.2, 5.3, and 5.8** of this report.

5.6 Resources/Coordination from Federal Land Management Agencies
Personal from the Bureau of Land Management were not materially involved in the project. BLM personal are occasional attendees at the monthly meeting of the GBSTF. Personal from the NRCS provided significant amount of time, skill, and work in completing soil maps and soil sampling of the project area. They also participate regularly in the monthly GBSTF meetings and are important contributors in all special public meetings.

5.7 Other sources of funds (None)

5.8 Other local Agency Coordination
Uncompahgre Valley Water Users Association - Provided personnel and technical assistance in the planning and implementation of the project. They also participate regularly in the monthly GBSTF meetings and are important contributors in all special public meetings.

Gunnison Basin Selenium Task Force - A voluntary group of local interest groups, local, state, and federal agencies, and local landowners who have organized to collaboratively deal with the selenium issue in the Gunnison Basin. All of the organizations that are mentioned in section 5 are participants in the GBSTF. Participants of the GBSTF assisted in all aspects of the planning and implementation of this project. In kind match for this project was mainly supplied from participants of this task force.

Gunnison River/Grand Valley Water Quality Forum - Will provide personnel and technical assistance in implementation of the project. The Gunnison/ Grand Valley Water-Quality Forum is a group of local residents, local, State, and Federal agencies working together for the purpose of raising awareness of non-point source pollution issues.

High Country Citizens Alliance - Provided an environmental overview for consideration of project activities. They participate regularly in the monthly GBSTF meetings.

Delta County Commissioners – Individual members of the Delta County Commissioners are regular attendees of the monthly meeting of the GBSTF. They provided important input on land use management and needs to the project.

6.0 Summary of Public Participation

The project informed the public in the Gunnison River Basin of all aspects of the selenium issue via: a) newspaper articles; b) regular monthly public meetings; c) involvement of local business, government organizations and private citizens in the activities of the Gunnison Basin Selenium Task Force (GBSTF); d) hosting public meetings where experts on selenium discussed the issue from the scientific, industrial, and agricultural viewpoints; e) by publishing and distributing several thousand educational brochures; and f) by the creation of a web site (seleniumtaskforce.org) focused on the activities of the GBSTF and the importance of the selenium issue to the community.

Local Presentations: Throughout 1999, Project collaborators made presentations to local organizations regarding the selenium issue. Marc Catlin, Uncompahgre Valley Water Users, and Wayne Cooley, CSU Cooperative Extension, made PowerPoint presentations on general selenium issues to the Lions Club, Chamber of Commerce, local farmer cooperatives, soil conservation districts, the Cattlemen's Association, and other interest groups. Several hundred individuals were contacted via this outreach effort. Interest in these presentations was high, and the presenters felt this was an effective means to target concerned members of the community.

In 2000 and 2001, the Project and its partners conducted public meetings to gather input from the local community. These meetings differ from the regular monthly meetings of the GBSTF, which are also open to the public, in that at these additional meetings are meant to engage the general public who may not be active in water issues on a regular basis.

The first public meeting was held on November 1, 1999 in Delta, Colorado. This workshop was aimed at giving the public an opportunity to learn more about selenium and its origins, and to address public questions. At the meeting, participants broke into focus groups. Each group was assigned with creating a list of all possible remediation options for dealing with selenium. After the meeting, these ideas were tabulated, and are part of the pre-feasibility assessment being conducted by the GBSTF and the National Irrigation Water Quality Program of the Bureau of Reclamation. Approximately 100 people attended this meeting.

The second public meeting was held on November 15, 2000. The purpose of this meeting was to update the public about what remediation demonstration projects the Task Force had underway, as well as results of recent activities, such as the Selenium Symposium (see below). In addition, we included a significant amount of time for questions and answers with the audience. Approximately 50 local people attended this meeting.

Selenium Symposium 2000 *(see also Appendix 12.7)***:** On June 28, 2000, the Project and the GBSTF hosted a distinguished panel of specialists in selenium remediation and biotechnology for a one-day technical symposium in Montrose, Colorado. Seven speakers from around the nation were invited to present on various topics including selenium phytoremediation, plant selenium metabolism and biotechnology, flow-through wetlands, and other selenium remediation techniques. The Symposium was designed to assist the Project and the GBSTF and also to educate the interested public about the research findings of other scientists and professionals working in the areas of water treatment and selenium remediation. Of primary concern, was the applicability of those findings and strategies to the environmental and economic situation in the Lower Gunnison Basin. Dr. John Letey, Director at the University of California Center for Water Resources, Riverside, California, provided background on selenium problems in the western San Joaquin Valley, describing how various water management options have been pursued to deal with both the salt and selenium toxicity problems of that area.

Speakers at the Symposium were as follows:

- Dr. Norman Terry, from the Department of Plant and Microbial Biology, University of California Berkeley, presented a

multidisciplinary review of selenium phytoremediation, including the use of constructed wetlands for selenium removal from agricultural and industrial wastewater, the role of microbes, and the use of genetic engineering in developing superior plants for selenium phytoremediation.

- Dr. Gary Bañuelos, from the USDA Water Management Research Lab in Fresno, California, presented the results of phytoremediation technology that their Water Management Research Lab has investigated since 1989 for managing soluble selenium from central California soils.
- Dr. Elizabeth Pilon-Smits, from the Department of Biology at Colorado State University, provided an overview of plant selenium metabolism using a combination of plant physiology, biochemistry, and biotechnology to create plants that are better phytoremediators of selenium.
- Tryg Lundquist from the Environmental Engineering & Health Sciences Lab, at the University of California, Berkeley. His research group has developed an Algal-Bacterial Selenium Removal (ABSR) facility that has been treating agricultural drainage water in the San Joaquin Valley since 1997.
- Dr. Jack Adams from the Center for Bioremediation at Weber State University in Ogden, Utah, presented the results of a low-cost Se reduction/removal process that has been validated under a recent EPA Mine Waste Technology Demonstration Program.
- Carla R. Scheidlinger of the Agrarian Research and Management Company, located in Bishop, California, discussed the results of a low-tech flow-through wetland environment that has removed up to 80% of selenium from highly contaminated (up to 350 ppb) drain water

7.0) Aspects of the Project that did not work well

Overall there were no major parts of the project that were troublesome. At the very start of the project four major sub-groups were formed (water, soils, outreach/education, and administration). Individuals and organizations from the GBSTF participated in one or more of the sub-groups and the progress of each of the sub-groups was summarized and reviewed as needed at the monthly meeting of the GBSTF. Each sub-group had its own leader who saw that the project tasks were addressed and product schedules were met.

8.0) Future Activity recommendations

1) Continued efforts should be made to inform public of Se issue in the Gunnison River Basin.

2) Establish BMPs that address irrigated commercial agriculture, new subdivision developments on Mancos derived soils that have never been irrigated, irrigation practices on small acreage properties, and urban runoff and irrigation practices,

3) Selenium mobilization, transport, and deposition in the soils of the Uncompahgre River Basin is an exceedingly complex and difficult problem with no single easy solution. Therefore additional geological studies focused on, a) the stratigraphy and structural geology of the Mancos shale, b) the relationship of Mancos rock types to the different types of soils formed from the Mancos shale, c) Se mobility in soils and partitioning in soil horizons, d) and the effect of nitrogen, potassium, and phosphate fertilizers on Se mobility in the groundwater; would be of considerable value in addressing these complex issues.

8.1) Information and education outputs

(*See above summaries under Objective 3, Tasks 3, 4, and 5*)

9.0) Literature Cited

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10.0) List of Tables

11.0) List of Figures

12.0) List of Appendices