

Mancos Watershed Plan

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Mancos Valley Watershed Group



Headwaters of the Mancos River

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Contents

Figures.....	4
Tables.....	4
Overview.....	5
Background:	6
Mancos Valley Watershed Group.....	6
Mancos River Geography	8
Land ownership:.....	10
Land Cover.....	11
Impacts	15
Studies.....	16
San Juan National Forest, U.S.D.A Forest Service.....	11
Mancos Conservation District.....	12
Mesa Verde National Park	13
Ute Mountain Ute Indian Reservation	13

Element A: An identification of the causes and sources or groups of similar sources that will need to be controlled to achieve the load reductions	17
Issues to be researched:.....	18
Element B: An estimate of the load reductions expected for the management measures implemented.....	19
Element C: A description of the non-point pollution source management measures that will be implemented to achieve the load reductions.	25
Element D: An estimate of the amounts of technical and financial assistance needed	28
Element E: An information/education component that will be used to enhance public understanding of the project.....	29
Element G: A description of interim, measurable milestones for determining whether non-point source pollution management measures or other control actions are being implemented	35
Element H: A set of criteria that will be used to determine whether loading reductions are being achieved	36
Element I: A monitoring component to evaluate the effectiveness of the implementation efforts	39
Follow-up.....	40
Key implementation activities:	40
Appendix 1. Prioritized diversion structures for reconstruction to improve structure and functioning/assimilative capacity of the river.....	41
Bibliography.....	54

Figures

Figure 1. Mancos Watershed (see Figure 2 for details of upper basin).**Error! Bookmark not defined.**

Figure 2. Map of the East Mancos showing mine sites and Rush Basin, a relatively un-mined area where much of the poor water quality emanates from. 10

Figure 3. Inventoried diversion structures. Red dots are those that were documented with photos, location, descriptions, and problems associated with the diversions. Prioritized diversions for repairing are illustrated below. 41

Tables

Table 1. Ambient water quality data for the East Mancos Mancos River (concentrations are given as 85th %). Exceedances are highlighted in bold. Difference column indicates levels (ug/l) necessary to reduce concentrations attain standards.	20
Table 2. Discharge (cfs) characteristics of the Mancos River from the TMDL document.	20
Table 3. Pounds per day of dissolved copper that needs to be removed in order to meet the goal of the TMDL/ or, the last column shows the additional cfs that needs to be left in the stream in order to meet the TMDL.	21
Table 4. Cost estimates from local experience, EPA databases (i.e. Guidebook of Financial Tools: Paying for Sustainable Environmental Systems and Plan2Fund, accessed February 2011)	29
Table 5. Educational and informational projects completed to date and funding sources to date.	30
Table 6. Implementation schedule for management measures and responsible parties. .	34
Table 7. Interim milestones to monitor for the specific management measures to be implemented.....	35
Table 8. Criteria and monitoring schedule to determine whether loading reductions are being achieved.	39

Overview

The goals of the Mancos Valley Watershed Group (MVWG) were to develop a cold water fishery, improve diversion structures for agriculture, improve the functioning capacity of the river through improving riparian communities and wetlands and meet the goals of the State’s draft total maximum daily load (TMDL) for dissolved copper.

The cold water fishery is impacted primarily by metals originating in the headwaters of the East Mancos. As per the State of Colorado’s water quality standards, the East Mancos River is water quality impaired for dissolved copper. The headwaters of the East Mancos and the sources of the dissolved copper are located in a remote area with difficult access. The exact sources of the dissolved copper are unknown although the prevalent thought is that the copper comes from exposed outcrops in the upper part of the basin. In the basin there exists some abandoned mines and one active mine and it has been suggested that copper levels may be exasperated by the underground mine workings contaminating ground water that eventually reaches the river. To further investigate these issues it has been suggested that a loading study and perhaps a tracer study be completed.

The functioning capacity of the Mancos River is impacted by historic channeling due to levee construction and poorly designed irrigation diversion structures.

To realize as many of these overlapping goals as possible the MVWG will be required to implement projects that replace irrigation diversion structures that currently require substantial amounts of annual maintenance, are clearly impacting the functioning capacity of the river, inhibit fish migration, and if replaced, would have the potential to include substantial amounts of

improvement to the surrounding riparian community and functioning/assimilative capacity of the river. It will also be necessary to utilize the work completed by the Colorado Water Trust to begin the process of enhancing in-stream flows. This will improve the riparian community and act as dilution to the high levels of dissolved copper from the East Fork. A further area of focus for the Mancos Valley Watershed Group will be repairing stream reaches that have been impacted by historical levees (Stacey 2007).

The Mancos Watershed Plan was based on the EPA's nine minimum elements and includes methods to develop an educational/informational component, to finance the work required and monitoring methods to assess the effectiveness of the programs implemented. Much of the planning was completed in 2 studies: a Functional Assessment by Dr. Peter Stacey and a Rapid Assessment by the Natural Resource Conservation Service and several well attended stakeholder meetings.

Background:

Mancos Valley Watershed Group

The Mancos Valley Watershed Group was formed in 2006 and has brought together riverfront landowners, farmers, ranchers, environmentalists, irrigation companies, recreationalists, government agencies and concerned members of the community to address several goals that include:

- Improve fishing, primarily from the confluence of the East Mancos River with the West Mancos River downstream;
- Reduce the loading of dissolved copper from the East Mancos River either through reductions at the source, increasing assimilative capacity, or through dilution;
- Work with irrigators/irrigation companies and landowners along the Mancos River to restore the functioning capacities of the river system;
- Work with irrigators to rebuild diversion systems that are in need of constant maintenance and that have major impacts on river functions;
- Improve the riparian ecosystem and thus the functioning capacity of the river;
- Improve in-stream flows throughout the summer months through the town of Mancos and downstream when irrigation tends to dewater the river.

From meetings, deliberations and studies completed over the last 5 years by the MVWG 4 pieces of critical information have arisen.

First, there was the need to upgrade the aging, 19th century-vintage irrigation infrastructure that is taking its toll on the functioning capacity of the river and on the farmers ability to efficiently divert water. The structures are degrading the river channel, the riparian community and result in inefficient and poorly measured water delivery.

There has been much speculation as to why trout can no longer live in the East Mancos River as they were once thought to. Possible interpretations include:

- The illegal breach and consequent spill in 1986 from the Gold Dollar Mine that impacted the ecosystem which cannot recover under current conditions.
- A drying climate leading to less dilution and thus to higher metal and acid concentrations which prevent the fish from recovering;
- Acidified precipitation from air pollution dissolving more metals into the stream;
- The trout population reported from the 60s to 80s may have been atypical for this stream due to a cycle of improved local conditions right at the threshold for fish requirements;
- The fish were being stocked and living on some minimal food chain and not actually reproducing because the fry are far more sensitive to dissolved metals than are the adults;
- The current “dead” river could be closer to the normal condition.

The lack of a historic description of the East Mancos’ aquatic community leaves much of this open to speculation.

Second, was the need to address the historical levees from just above the town of Mancos for six miles downstream. The levees have resulted in down-cutting of the river channel, disconnecting the river from its floodplain, interfering with the health of the riparian corridor, exacerbated flood conditions, weakened the capacity of the floodplains to bank water and exacerbated water quality issues.

The third issue was that East Mancos River (segment COSJLP04a) has been identified as water-quality impaired for dissolved copper on the 2002 and subsequent 303(d) lists, as approved by the Colorado Water Quality Control Commission. Dissolved copper and other metals in high concentration are the primary reason for a lack of a cold water fishery on the East Mancos River.

A 303(d) list is a list of stream segments created for each state that do not meet water quality standards for stream health and the United States Environmental Protection Agency (EPA) requires all implementation, demonstration, and outreach-education projects funded under Section 319 of the Federal Clean Water Act to be supported by a Comprehensive Watershed Plan which includes nine listed elements. The Colorado Department of Public Health and Environment provided the Mancos Valley Watershed Group with a Colorado Nonpoint Source Watershed Planning Grant to draft a watershed plan for the purpose of addressing the impacts of dissolved copper on the Mancos River as well as for addressing other goals identified by the MVWG.

The fourth identified issue was the low flows during late summer irrigation season (*i.e.* Figure 1). These low flows result in elevated water temperatures, isolated fish and populations, and further isolation of the stream water from the riparian community



Figure 1. Typical late summer flows below the town of Mancos

area of approximately 800 square miles.

There are 3 reservoirs: Jackson Lake, Bauer Lake and Weber Reservoir which are used primarily for irrigation water storage, hydroelectric generation, recreation and municipal water supply.

The Mancos River watershed is divided into two main parts: an upper watershed of approximately 527 km² (203 miles²) that includes the Mancos Valley and surrounding mountains (Figure 3), and a lower area that begins with the beginning of the Mancos Canyon at the confluence of Weber Creek (Figure 2) which drains the mesa and desert lowland country of Mesa Verde National Park, the Ute Mountain Ute Indian Reservation, and surrounding areas.

Four main tributaries begin among the ridges and peaks of the upper watershed in the La Plata Mountains: East Mancos, Middle Mancos, West Mancos and Chicken Creek. The East Mancos and West Mancos rivers retain separate nomenclatures until their confluence. From there downstream it is named the Mancos River. A fifth major tributary of the upper watershed includes Mud Creek which drains the lower elevation regions in the northwestern part of the watershed.

In the lower watershed, numerous small side canyons and ephemeral washes enter the river as it moves through the Mancos Canyon. The river then flows through relatively flat desert country until it enters the San Juan River. Navajo Wash is the only major drainage system that joins the river in the lower watershed.

Geography

The Mancos River originates in the western flanks of the La Plata Mountains a western sub-range of the San Juan Mountains in southwestern Colorado. The river spans elevations from 13,000 ft. to 4,000 ft. and flows southwest through the Mancos Valley, the town of Mancos through eastern edge of Mesa Verde National Park, through the Ute Mountain Ute Reservation and onto the Navajo Nation before emptying into the San Juan River in NW New Mexico (Figure 2). The river is 116 miles long and drains an

Mancos River Watershed

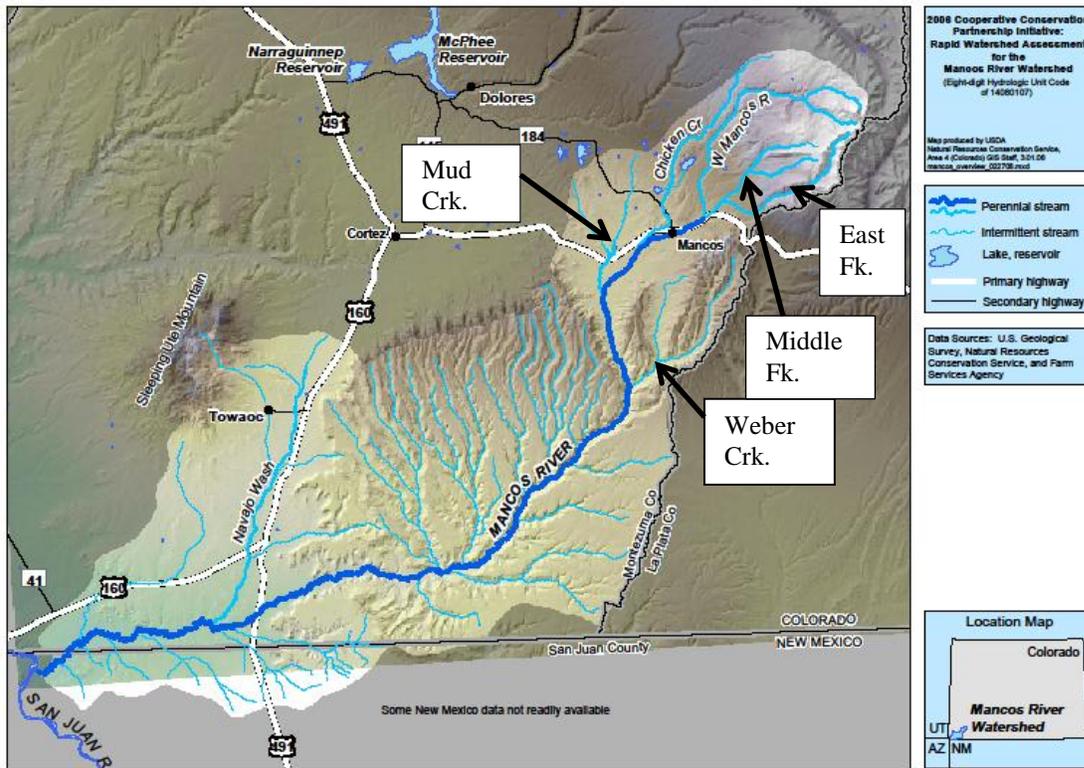


Figure 2. Mancos River watershed and perennial tributaries.

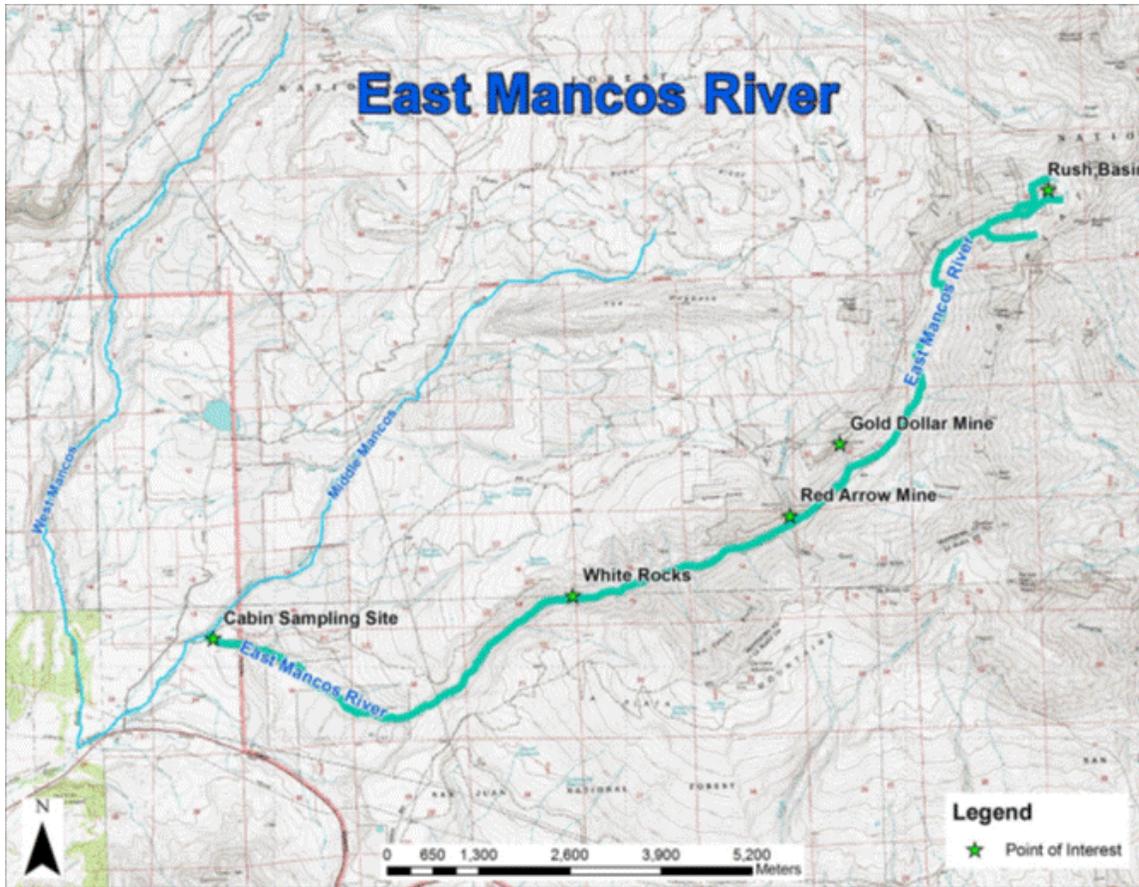


Figure 3. Map of the East Mancos River showing mine sites and Rush Basin, a relatively un-mined area from which much of the poor water quality emanates.

Land Ownership:

In the upper part of the watershed the Forest Service owns 44,500 acres. In the middle part of the watershed there is 62,000 with the BLM owning 24,000 acres. In the top of the lower part of the watershed the National Park Service owns 47,200 and below that the Ute Mountain Ute Indian Tribe owns 33,200 acres.

The town of Mancos is a small rural community historically inseparable from agriculture in a semi-arid climate that is dependent upon irrigation and hard work. The community also recognizes that the character of the valley is changing and that it must deal with an increasing population less involved with agriculture. The National Park Service recognizes the important role that the Mancos River provides to fish and wildlife and has taken steps to protect this value. The Ute Mountain Utes utilize the Mancos for farming and also recognize the role the Mancos River has in providing critical habitat to native fish and wildlife that depend on healthy riparian habitats.

Mancos River Watershed Land Ownership/Jurisdiction

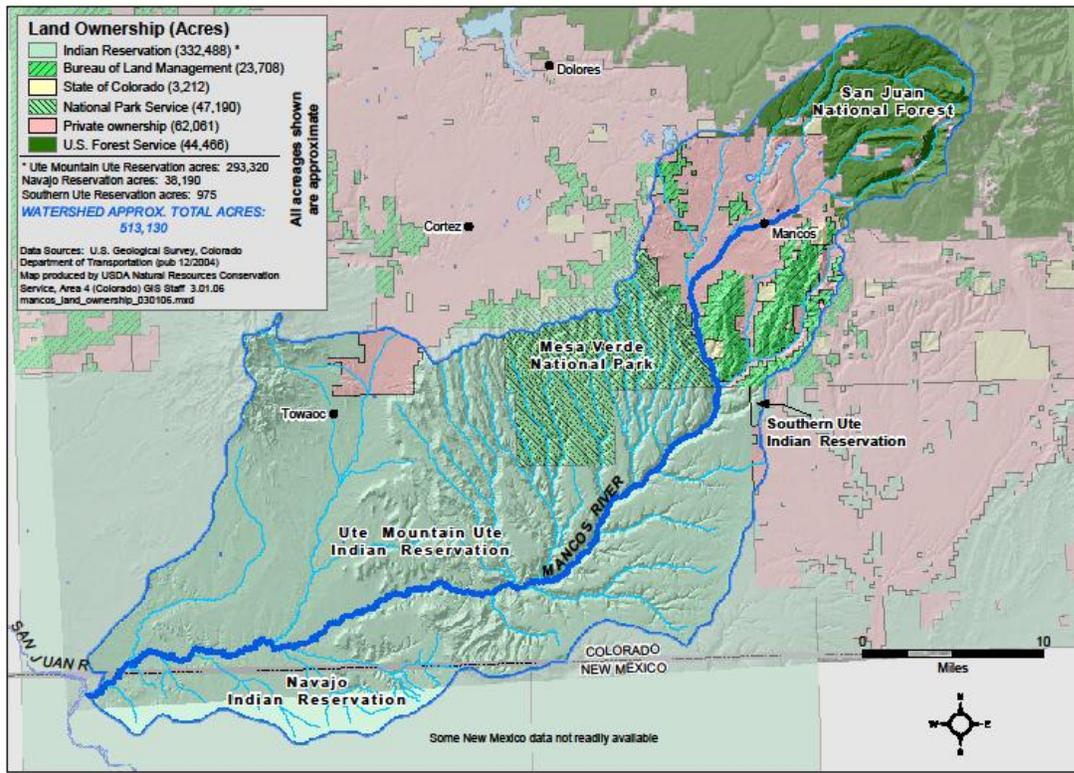


Figure 4. Land ownership in the Mancos Watershed.

The major landowners in the Mancos Watershed, other than owners of private property, include the U.S. D. A. Forest Service, Mesa Verde National Park, and the Ute Mountain Ute Indian Tribe. Each entity is addressing watershed and water quality issues within their portion of the watershed. The Forest Service is addressing sediment issues with a Travel Management Plan, MVNP is addressing native fisheries, water quality and riparian habitat issues as is the Ute Mountain Ute Indian Tribe. The issues that the Mancos Conservation District is addressing best represent the private property owners and the primary users of water in the watershed and their efforts to protect and best utilize the water. Efforts for each entity are described below.

San Juan National Forest, U.S.D.A Forest Service

(Adapted from Mancos - Cortez Travel Management Plan <http://www.fs.fed.us/nepa/fs-usda-pop.php/?project=17318>)

The purpose of the travel management plan was to provide for an area transportation strategy that addresses current and future anticipated needs for a variety of summer recreation opportunities and administrative demands. The goals for this plan include:

1. Improved management of public seasonal motorized vehicle use on a system of trails, roads, and areas;
2. Management of public motorized recreation in a way that meets the need of forest users while reducing soil erosion and impacts to wetlands, wildlife habitat, and cultural resources, and;

3. Respond to the goals and objectives outlined in the Amended San Juan Land and Resource Management Plan (Forest Plan, 1992) and San Juan/San Miguel Resource Management Plan (RMP, 1985).

Specific needs of the project are to:

1. Develop a transportation system of roads, trails, and areas that meets the increasing demand for recreational travel opportunities, both motorized and non-motorized. A wide variety of public land visitors desire a spectrum of quality experiences including loop opportunities, quiet uses, different challenges, and access to trails from campsites.
2. Reduce adverse resource impacts caused by road and trail usage in order to maintain and restore the health of ecosystems, watersheds, and wildlife habitats. Maintenance and restoration of healthy ecosystems and watersheds is a national goal articulated by the Chief of the Forest Service. Resource impacts include, but are not limited to, increased sedimentation, lack of wildlife security areas, and impacts to riparian and wetland areas.
3. Coordinate with various users in developing sustainable recreational transportation systems that provide a variety of settings and experiences. Emphasis will be placed on public involvement, including coordination with state, local, and tribal governments.
4. Specify the uses allowed on road and trail infrastructure, make improvements where needed, and provide explicit guidelines for off-road travel, dispersed camping, and day-use parking in order to comply with the Forest Service's 2005 Travel Management Rule (36 CFR 212) and with BLM's current motor use policies.

Mancos Conservation District

(Modified from NRCS Rapid Assessment)

In 2003 the Mancos Conservation District began to explore the possibility of having the Mancos Valley designated as a Salinity Control area by the NRCS as a way to fund an irrigation water conservation project for the valley. The designation was achieved in late 2004 and water users began applying for financing from the CWCB and partial grant funding from NRCS to convert irrigation delivery ditches to underground pipelines. The purpose of the projects was to increase the application efficiency of water to crops in the valley to reduce water losses and reduce the quantity of salts leached from the underlying Mancos Shale into the Mancos River. There was widespread support for the project in the valley and seven ditch companies were incorporated and dozens of citizens attended dozens of meetings. To date, 13 irrigation pipelines that carry approximately 30% of the irrigation water diverted in the valley are completed or in progress. This amounted to approximately 35 miles of pipelines and about \$5 million in total cost.

Numerous conservation wildlife and on-farm irrigation projects including pipelines and irrigation equipment have also been undertaken. The total of the grant contributions for salinity control measures in the valley made by NRCS for the years 2004-2007 is \$6M. The water conservation project has significantly improved the way irrigation water is used in the valley.

The District was awarded \$75,000 from the Colorado Water Conservation Board for restoration sites on two parcels of land: the Perry and Wolcott ranches. The projects took place on ranches that have been grazing cattle along the waterway for 50 to 60 years and over 2000 feet of stream reaches were restored.

Finally, the District was awarded a grant to rebuild 3 diversion structures and to evaluate the potential for in-stream flows, primarily during the summer irrigation season when the river is dewatered in several reaches.

Mesa Verde National Park

(Modified from NRCS Rapid Assessment)

The Mancos River passes through 5 miles of the eastern edge of Mesa Verde National Park. This area contains the Park's only perennial stream, the only fishery, and the only significant riparian habitat consisting of discontinuous wooded stands of cottonwood, willow and buffaloberry. The fishery still is composed mostly of native species including roundtail chub, flannelmouth sucker and speckled dace. The aquatic and riparian habitats provide a critically important oasis and migration route for wildlife in a semiarid ecosystem thus supporting a biological diversity disproportionately much higher than upland areas of similar acreage. The unique character of the Mancos Canyon river corridor means that its natural resource value is exceptionally high.

Despite the high value of the Mancos River to Mesa Verde National Park, the river has suffered numerous anthropogenic and natural impacts to its ecological health. Chief among these influences is the heavy diversion of the Mancos River for irrigation and other uses above the park boundary. As a result the river flows in the park have been drastically altered - now experiencing dampened spring floods and only minimal summer base flows. These flow changes have led to a more incised channel, a lowered channel, a lowered water table in the floodplain and less robust riparian woodland. A past history of livestock grazing has also contributed to the presence of many non-native plant species. Wildfire in the year 2000 left the clay-layered slopes of the Mancos Canyon denuded, resulting in several years of sedimentation that tainted the river's water quality and smothered riverbed habitat for aquatic insect life.

The National Park Service's Southern Colorado Plateau Inventory and Monitoring Network (SCPN) is monitoring water quality and aquatic macroinvertebrate communities in the Mancos River within park boundaries. There is relatively little information available on the condition of Mancos River aquatic ecosystems in Mesa Verde. SCPN recognizes the value of aquatic macroinvertebrates as an overall indicator of aquatic ecosystem integrity (Thomas et al. 2006) and in 2007 the network implemented aquatic macroinvertebrate monitoring at two sites on the Mancos River in Mesa Verde National Park (Stumpf and Monroe 2009). SCPN implemented water quality monitoring of the Mancos River in 2009. In 2008, Taylor Joyal completed an investigation into the embedded cobbles within the park's reach of the Mancos River.

Ute Mountain Ute Indian Reservation

(Modified from NRCS Rapid Assessment)

The main surface water body on the Ute Mountain Ute Reservation is the Mancos River. Tribal data have indicated exceedances of aquatic selenium criteria from ten sampling events. Although not enough events have detected selenium to show a trend in the Mancos River at this time, selenium is most likely coming from Mancos Shale and shale related soils that are irrigated

in the Mancos Valley. The Mancos River riparian zone is heavily infested with tamarisk (salt cedar) and efforts have been undertaken to address the issue. Perennial stream flows on the Reservation vary widely. The Mancos River has a range of annual mean stream flow based on 76 years of USGS data from 3.35cfs (2002 drought conditions) to 125 cfs (1979). Due to upstream irrigation diversions the lower Mancos typically dries up during late June. Late summer rains often restore flow. Minimum flows at the stream gauge on the lower Mancos have been zero and maximum flow has reached 5,500 cfs.

A partnership between the Colorado Division of Wildlife, the Tribe's Brunot Wildlife Department, the Tribe's Environmental Programs Department and Mesa Verde National Park has provided a significant ecological restoration to the Mancos River watershed. The combination of massive severe-intensity forest fires in the watershed in 2000 and a 5-year drought caused the demise of most of the Mancos River fish. This stream segment is unique because it is populated by almost entirely by native fish because of a barricade to migration on the San Juan River upstream of the Tribe's irrigation diversion dam near Highway 491/666 in Colorado. An effort was made in 2002 to salvage some of the last Mancos River roundtail chubs – a fish species of 'special concern' in Colorado and listed as threatened in New Mexico. Through a successful captive breeding program thousands of these fish were returned to the Mancos in September 2003. Also, in April 2004 two other native fish species were reintroduced to the river, the flannelmouth sucker and the bluehead sucker. In most subsequent years since 2003 roundtail chubs and both native sucker species have been stocked on the Reservation and upstream in Mesa Verde National Park.

Tamarisk (salt cedar) removal and treatment has been undertaken in the Mancos River Canyon. A small (4-5 acre) project was undertaken in 2003, utilizing Bureau of Indian Affairs weed control funding to cut and treat tamarisk at the northern boundary of the Reservation.

Forest fire impacts in the Mancos River resulting from drought had temporary impacts to the system following the 2000 Bircher/Pony Fires. Primarily the ashy sediment flowing from post-fire storm events suffocated cobble macroinvertebrate habitat and filled in pools that provided fish habitat.

Land Cover

The Mancos River travels through almost all of the major vegetation life zones found in the Colorado Plateau region including the Alpine tundra, subalpine, spruce-fir forest, aspen forest, ponderosa pine forests, pinyon-juniper forests, plains-mesa grasslands, savannah (now primarily converted to agriculture) and desert scrublands (Figure 5). Very little of the watershed is urban.

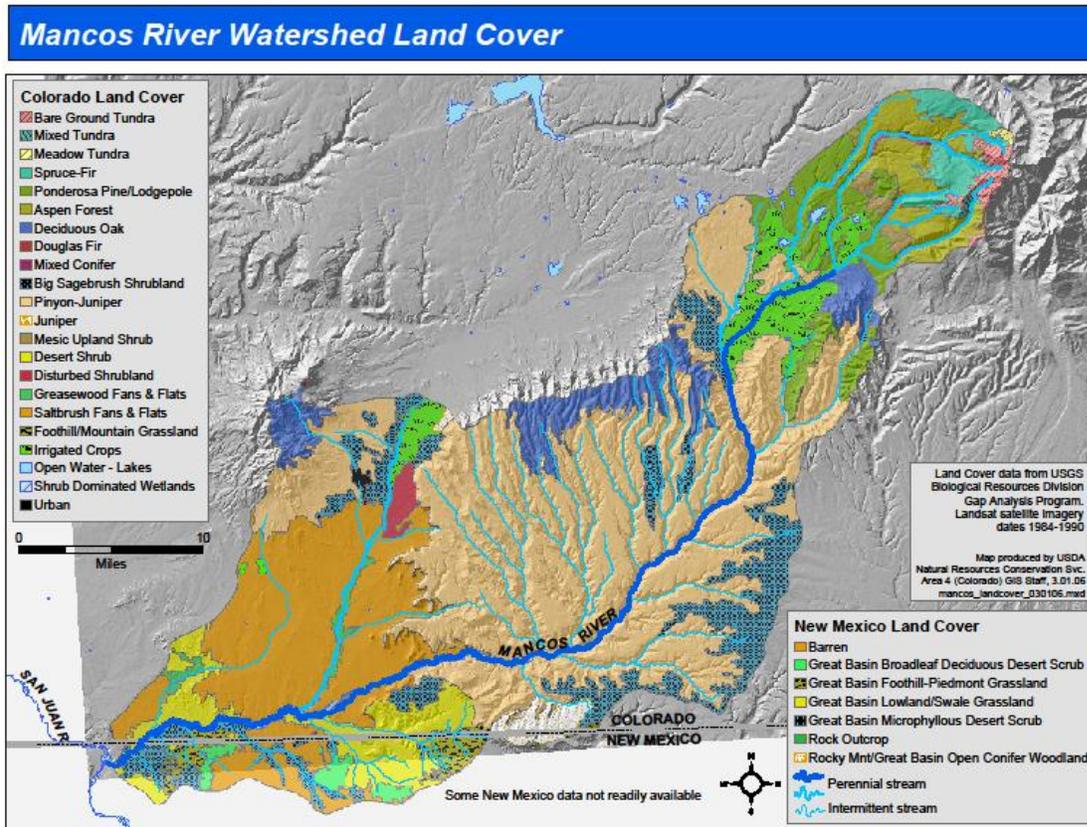


Figure 5. Vegetation cover of the Mancos Watershed.

Impacts

Along with its tributaries, the river supplies water to the town of Mancos and outlying residents, to ranchlands and farms for irrigation, to Mesa Verde National Park for municipal water, and the Ute Mountain Ute Tribe for their agricultural interests, as well as providing and supporting essential habitat for wildlife.

Both the land and water composing this watershed suffer from divergent needs and piece-meal management with the watershed area being fractioned into, tribal, national park, Forest Service, Bureau of Land Management, municipal, ranch, and small family farm lands. Some of the primary issues affecting the watershed include: the recent drought that has stressed all of the systems: conifers at multiple elevations experiencing beetle infestations, aspens dyeing from sudden aspen decline, invasive weeds that are gaining a stronghold in the overly dry and disturbed soils in the lower watershed and runoff from hillsides struck by forest fires carrying heavy sediment loads into the streams and river. During the summer months, dewatering of the stream in the Mancos Valley when water is diverted for irrigation is hard on fish, wildlife and riparian ecosystems. Other types of degradation can be seen in the severe braiding in the lower watershed, heavy stream bank erosion, diminished flood plain areas, and the spread of Russian olive and tamarisk in the Mancos Valley and the lower part of the watershed.

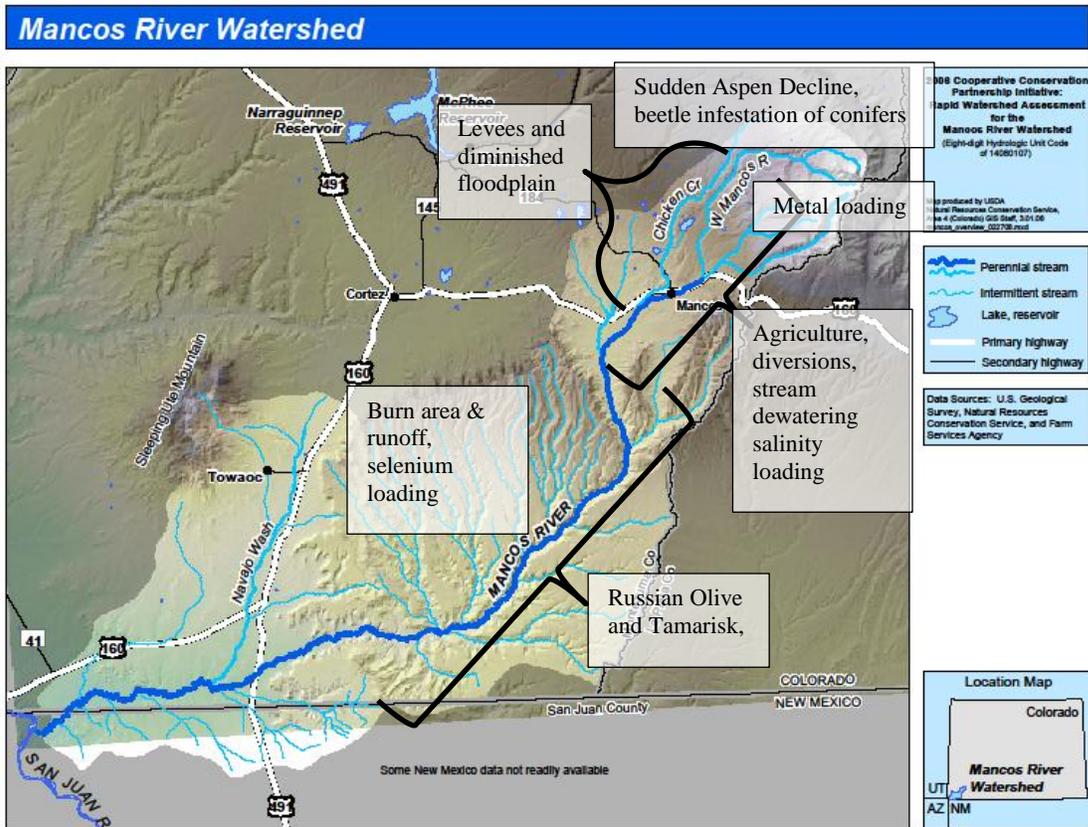


Figure 6. Major impacts to Mancos River

Watershed Studies

In 2007, the MVWG hired Dr. Peter Stacey of the University of Arizona to complete a Functional Assessment of the watershed (Stacey 2007). Dr. Stacey detailed impacts to the hydro-geomorphology and riparian ecology of the river. The focus of the Assessment was to examine the functional condition of the ecological health of the Mancos River Watershed. The U.S. Department of Agriculture Natural Resource Conservation Service completed a Rapid Assessment of the watershed in 2008. This Rapid Assessment provided details on watershed characteristics such as economic, social, demographic, vegetation cover, soils, and land-use (Mancos Conservation District, 2010). The Yochum report (2004) was completed to assess salinity contributions from the Mancos to the Lower Colorado River Basin. Since the Rapid Assessment, the NRCS along with the Mancos Conservation District has accomplished much in converting flood irrigation practices to sprinkler irrigation systems and reducing runoff from agricultural lands into the Mancos River. In 2009 the Watershed Group hired B.U.G.S. Consulting to complete a benthic macroinvertebrate assessment of the river (B.U.G.S. Consulting 2010). Along with the Bioassessment, a Sampling and Analysis Plan was completed (B.U.G.S. Consulting 2009). The bioassessment provided baseline data with which the effectiveness of best management practices implemented may be evaluated. National Park Service Southern Colorado Plateau Network also monitors benthic macroinvertebrates and water chemistry in Mesa Verde National Park (Stumph and Monroe 2008) as does the Ute Mountain

Ute Tribe. In 2005 the tribe produced the “Nonpoint Source Assessment for the Ute Mountain Ute Reservation of Colorado, New Mexico and Utah, 2005 Revision” (Clow and Daniel B. Steffens and Ass. Inc.). They found that 16-17 miles of the Mancos River (of the 67 miles on the Reservation) are moderately impaired for chemical, physical and biological parameters. Navajo Wash (approximately 16 miles on the Reservation) is severely impaired for chemical, physical and biological parameters. In 2009 the Colorado Division of Mining and Reclamation (DRMS) completed a water chemistry survey of the East Mancos that replicated much work completed by the Water Quality Control Division in their TMDL (see PowerPoint by Kirsten Brown, DRMS, 2010). This work resulted in a Sampling and Analysis Plan (SAP) and a Quality Assurance Project Plan (QAPP) completed by the Mancos Valley Watershed Group (2008) that may be used to guide future monitoring and evaluation of best management practices. Barb Horn of the Colorado Division of Wildlife completed a review of fish stocking and sampling of the Mancos River that may also be used as baseline information to evaluate the effectiveness of best management practices to be implemented in the watershed to meet the goals of the Mancos Valley Watershed Group (Horn, 2011). The Mancos Conservation District also inventoried and prioritized a large number of diversion structures, looking at factors such as barrier to fish migration, head and bank cutting. Lastly, the District hired Colorado Water Trust (2011) to assess potential areas where water could be obtained and left in the stream to enhance in-stream flows. In addition the U.S. Geological Service, the Bureau of Reclamation and the Colorado State Water Engineers Office all measure stream flow and monitor the amount of water diverted from river.

Element A: An identification of the causes and sources or groups of similar sources that will need to be controlled to achieve the load reductions

The East Mancos River’s headwaters are in Rush Basin along the crest of the La Plata Mountains. This part of the watershed contains several historic mines inclusive of the Red Arrow, Gold Dollar, Outwest, Florence W., Thunder, Silver Falls, Lady Stafford, Kimball, Georgia Girl, Doyle Group and additional unnamed, inactive, or abandoned mine workings. The Red Arrow Mine is the only mine that currently is active (Figure 3).

The source of dissolved copper in the East Mancos River was originally thought to be predominately related to historic mining, either inactive or abandoned. Currently, the sources are thought to originate from erosive, exposed outcrops as well.

The most pronounced feature of the La Plata mining district is a domal uplift of sedimentary beds measuring fifteen miles in diameter. A well-defined, horseshoe shaped hinge fold that opens toward the south outlines the dome. Rocks within the fold are altered and are thoroughly silicified. The sedimentary rocks present outside the fold are unaltered and several strong faults have uplifted the rocks near the center of the dome. During the formation of the dome, numerous short, discontinuous faults of small displacement formed. After intrusion of the non-porphyrific stocks many of these faults reopened and subsequently became the location of the ore deposits

Significant quantities of sulfide minerals also crop out in the rocks of the headwaters of the East Mancos River. Measurable quantities of acid drainage are generated as the East Mancos River flows over outcrops of these mineralized volcanic rocks, and a significant amount of acid rock drainage develops (USFS, 1991). The result is a rapid depression in pH and an increase in iron and sulfide concentrations as surface waters interact with these features (Meyer, 1993 as cited in Cheney, 1995).

The predominate thought continues to be that the sources of copper come primarily from these natural outcrops and not the mine workings themselves. Contamination of groundwater sources, however, could be exacerbated by the mine workings (DRMS, 2010).

Poor water quality also comes from the “Allard Stock” which is a sub-economic copper deposit. Water quality is also degraded in Bedrock Creek in La Plata Canyon, a watershed just to the east of the Mancos, due to “Allard Stock.” The Doyle Group mines are located high on the north-side slopes of Rush Basin. The mines are closed with no sign of surface drainage. The river in this area has extremely high copper levels of from 5,200 to 5,700 micrograms per liter ($\mu\text{g/L}$) or parts per billion, where the standard for cold water fishes is 20 $\mu\text{g/L}$ and very low pH values. The source of the acid is the pyrite (iron sulfide – FeS_2) in the Allard Stock, which forms sulfuric acid (H_2SO_4) and oxides of iron (rust) in contact with oxygen in water. The acid dissolves the copper into the water which flows into the East Mancos headwaters. As further evidence of this process rusty iron deposits are found in the headwaters.

Below the Allard Stock, most of the East Mancos drainage flows through sedimentary formations, including limestone, such that tributary flows have more basic or neutral pH levels.

During the spring high water season when dilution by snow melt is high, only copper (40-300 $\mu\text{g/L}$) exceeds standards for cold water acute contact for fish (a year around violation) in the main stem, while the East Mancos’ tributaries are clean. During the summer low water flow season the concentrations of other metals also exceed standards including zinc, cadmium, and aluminum. Arsenic levels remain below the standard most of the time but copper increases up to an average of 1,200-1,800 $\mu\text{g/L}$. The pH ranges around 4.5 and decreases to 3 in Rush Basin while the pH in the tributaries is around 7.

Calcium in the limestone layers tends to buffer the acid. When a tributary enters the main stem, the pH suddenly rises which causes the metals to precipitate out resulting in the white coating on the rocks. During low flows when acidity is at its greatest, the precipitates dissolve back into the river and are re-deposited farther downstream. During high water periods when pH is higher, the opposite occurs and the deposition of precipitates is found higher in the watershed.

Issues to be researched:

- Groundwater as the transport mechanism of contaminated mine water;
- Grazing by livestock that exposes minerals to more oxygen which promotes the mobilization of the metals into the water;
- Groundwater sampling and tracer studies that could answer whether the Red Arrow and Gold Dollar mines are contributing to the problem and if the Allard Stock is the main source;
- Creating a loading model for the East Mancos flow gradient.;

- Tree ring analysis to recreate a metals contamination history where sampling of wood layers may show metal concentration trends over time in different parts of the drainage;
- Review the East Mancos' draft Total Maximum Daily Loads (TMDL) if the Water Quality Control Division decides to finalize the report;
- If the sources source cannot be pinpointed, mitigated, and the condition is irreversible consider the appropriate process for changing the classification of the stream from Aquatic Life 1 to reflect the local conditions to the extent practicable.;
- Or the current standard could remain to argue for applying for reclamation funding.

To address the change in pollution with precipitation hypothesis, the Watershed Group looked at atmospheric data collected at Mesa Verde National Park. The data set included wet deposition data from 1979 – 2009. If acid rain were increasing, it might dissolve more metals from the outcrops and wash them into the stream. The data was graphed and illustrated the following trends:

- Calcium: downward trend
- Magnesium: downward trend
- Potassium: downward trend
- Sodium: downward trend
- Ammonia: no up or down trend
- Nitrate: no up or down trend
- Chloride: downward trend
- Sulfate: downward trend
- Hydrogen Ions (acid rain): no up or down trend
- PH: no up or down trend

Conclusion: it does not appear that changes in wet deposition have affected water quality and the ability of fish to survive.

Element B: An estimate of the load reductions expected for the management measures implemented

Table 1 illustrates: the average concentration of dissolved copper in the East Mancos River; the 85th percentile of dissolved copper that is the goal set by the draft TMDL; the amount of copper (Difference (ug/l)) that needs to be removed to meet the goal of the draft TMDL; and the percent reduction necessary to meet the goal of the TMDL. Measurement of the TMDL was based on a sampling point on the East Mancos above the confluence with the West Mancos. The largest reduction in copper needs to occur in June and no reduction is required for the month of October. The average copper load reduction for the East Mancos River would be approximately 50%. The highest load reductions occur in the higher flow months of April through June, with necessary reductions around 70%. Load reductions drop to as low as 0% in October and 12% in July. Reductions increase again in the months of August and September with reductions of 63% and 74%, respectively, most likely due to the effect of summer precipitation events.

Table 1. Ambient water quality data for the East Mancos River (concentrations are given as 85th percentile). Exceedances are highlighted in bold. Difference column indicates levels (ug/l) necessary to reduce concentrations to attain standards.

Month	Avg. Hardness	Cu-D, TVS (µg/L)	85th % Cu-D (µg/L)	Difference	% Reduction
Jan	180	14.8	25	10.1	41%
Feb	167	13.9	15	1.4	9%
Mar	139	11.9	29	17.3	59%
Apr	100	9.0	26	17.4	66%
May	67	6.4	21	14.8	70%
Jun	141	12.0	33	20.7	63%
Jul	141	12.0	14	1.6	12%
Aug	124	10.8	29	18.5	63%
Sep*	134	11.5	45	33.5	74%
Oct	140	11.9	11	-0.9	-9%
Nov	158	13.2	22	8.4	39%
Dec	163	13.6	22	8.7	39%

Table 2 shows the hydrological characteristics of the East Mancos River. Combined with Table 1 the total loading of copper to the East Mancos is calculated (Table 3). The result is a maximum of 4,079 lbs/day of copper needing to be removed from the system in May and no copper needing to be removed in October.

Table 2. Discharge (cfs) characteristics of the Mancos River from the TMDL document.

Month	Mean Flow (cfs)	25th Percentile Flow (cfs)	Median Flow (cfs)	75th Percentile (cfs)	1E3 Acute Flow (cfs)	30E3 Chronic Flow (cfs)
January	1.3	0.5	1.2	1.5	0.5	0.5
February	1.5	1.0	1.4	1.8	0.6	0.5
March	4.0	2.2	2.8	4.0	0.8	0.6
April	25.6	9.5	18.0	35.0	1.8	0.9
May	51.1	24.0	43.0	70.0	5.6	3.5
June	27.9	9.0	17.0	36.0	1.6	0.8
July	6.5	2.3	4.1	7.8	0.4	0.4
August	2.9	1.0	2.0	3.5	0.1	0.4
September	2.6	0.8	1.5	3.2	0.1	0.4
October	3.5	1.1	1.7	2.6	0.1	0.4
November	2.2	1.0	1.5	2.3	0.3	0.4
December	1.5	0.6	1.2	1.5	0.4	0.4

Table 3. Pounds per day of dissolved copper that needs to be removed in order to meet the goal of the TMDL/ or, the last column shows the additional cfs that needs to be left in the stream in order to meet the TMDL.

Month	Reduction required to meet TMDL						Additional cfs for dilution to meet TMDL
	Mean (lbs/d)	25th Percentile (lbs/d)	Median (lbs/d)	75th Percentile (lbs/d)	1E3 Acute (lbs/d)	30E3 Chronic Flow (lbs/d)	
January	71	27	65	82	27	27	0.5
February	11	8	11	14	5	4	0.1
March	373	205	261	373	75	56	1.7
April	2403	892	1689	3285	169	84	11.9
May	4079	1916	3432	5588	447	279	30.1
June	3115	1005	1898	4019	179	89	10.7
July	56	20	35	67	3	3	0.5
August	289	100	200	349	10	40	1.3
September	470	145	271	578	18	72	1.1
October	-17	-5	-8	-13	0	-2	(0.2)
November	100	45	68	104	14	18	0.6
December	70	28	56	70	19	19	0.5

Attainment of Mancos watershed goals is partially met after the East Mancos mingles with water from the West Mancos. Upstream of this confluence, to the confluence with the Middle Mancos, both trout and sensitive species of invertebrates are essentially absent. The most immediate method for attainment of goals set by the watershed group within this reach would be to implement water conservation practices in the Middle Mancos that would result in more water being left in the stream or more water returning to the stream downstream of the confluence of the East Mancos with the Middle Mancos. These potential water saving projects are listed and discussed in Colorado Water Trust (2011). This is not a particularly long reach of river so implementing projects that improve the functioning capacity of the stream would unlikely help much in meeting the watershed goals.

Downstream of the confluence of the East Mancos and the West Mancos sensitive species of macroinvertebrates and a few trout live in the stream (B.U.G.S. 2010 and Horn 2011). In this reach, there are several diversions that need to be replaced that have significant impacts on the functioning capacity of the river and that require significant amounts of maintenance (Appendix 1).

Assuming a couple of pounds a day of dissolved copper are removed by increasing the functioning capacity (BMP database, accessed 2010) of the river at each diversion, then a large number of restoration projects and diversions would have to be completed to meet the goals of the TMDL. But the reaches where restoration projects are planned are also downstream of the TMDL measurement site where much of the metals have been removed from the system or diluted to where they are less toxic. So any improvements would facilitate meeting watershed goals but not reducing loading of copper or other metals upstream of the increased, in-stream flows (i.e. upstream of the confluence of the East Mancos and the Middle Mancos).

The goal of Dr. Stacey's project (Stacey 2007) was to determine at each survey location which components of the ecosystem were functioning either well or poorly at the present time when compared to what would be found in an unimpacted system of similar ecological and geomorphological characteristics. This information can be used as a guide to determine which management measures can be implemented and where they would have the most benefit to help improve the health of the river and thus the cold water fishery and the riparian community. The surveys can also serve as a baseline description that can be used to objectively monitor the impact of any restoration program and/or change in land management practices that are undertaken on that particular reach or section of the river.

The condition of each reach in the Mancos River was measured using the protocol described in the *User's Guide for the Rapid Assessment of the Functional Condition of Stream-Riparian Ecosystems in the American Southwest* (Stacey et al. 2006). The following are adapted from Stacey's report and are the most relevant factors that address the goals of the Watershed Group.

Hydrogeomorphology

The hydrogeomorphology section of the Rapid Stream-Riparian Assessment (RSRA) protocol examined the current physical structure of the channel and associated floodplain. It evaluated the extent to which fluvial processes in the stream riparian system were in dynamic equilibrium, allowing the ecosystem to function in a productive way as well as absorb and recover from the stresses of exceptional events (such as major flooding). The first indicator in this group, **Floodplain Connection and Inundation**, was a measure of the likelihood that the stream will be able to escape its banks and flow into the flood plain during typical high flow events (every 2-5 years). Periodic flooding is important for many reasons to the health of the riparian zone. Flooding helps to maintain a high water table and moist soils. It adds nutrients to riparian soils, can encourage the germination and productivity of riparian plants, and can filter out pollutants.

Conversely, when a stream or river is either down-cut in a deeply incised channel, or it is isolated from the adjacent flood plain by artificial structures like levees, periodic flooding becomes impossible. Lack of flooding tends to dry out the riparian zone, prevent the germination of new native plants, and encourage the invasion of upland and non-native plants like many exotic weeds and tamarisk.

The survey reaches of the Mancos received uniformly low scores for floodplain connectivity. This was the result of both intentional levee construction and in a few cases an unintentional consequence of other construction activities (*i.e.* Webber diversion structure (Figure 14)). A consequence of this situation is that the historic flood plain of the Mancos River in most of the Mancos Valley and the adjacent areas is no longer flooded by the river except during extreme run-off events.

Hydraulic Habitat Diversity

Different types of hydraulic features result from the interaction of the moving water column and the underlying physical substrate(s), and they provide habitats for different species of aquatic life as well as for different life-history stages of the same species. Highly modified or disturbed stream systems are often structurally simple: the channels are often straight and narrow, with a

uniform depth and bottom. As a result, these streams and rivers often lack the diversity of hydraulic habitats necessary to support a diverse complement of aquatic species.

The scores for the Mancos River in the survey area were variable, but they generally declined as one moves farther downstream. In many cases, the combination of leveed banks, a cobbled bottom, and the absence of woody debris (which can create local erosion and increased structural diversity) were responsible for the lower scores. However, the fact that several of the downstream reaches did have very good scores for this variable indicates that there is the potential to increase hydraulic habitat diversity throughout the Valley in the future.

The final variable in the hydrogeomorphology sections was for beaver activity. Beavers are keystone species in most stream-riparian ecosystems, and they once occurred in almost all of the small and medium-sized streams and rivers in the western United States. Beavers alter many hydrogeomorphological and ecological processes; their dams and the ponds behind them reduce flooding and the annual variation in water flows, collect silt, and reduce erosion. Beaver ponds provide important habitat for fish, amphibians, and many other types of aquatic wildlife, and the marshes and wet areas on the edges of the ponds provide germination sites and adult habitat for many different species of riparian plants. We observed no beaver activity in any of the reaches for the trend analysis, although there were beavers present in Chicken Creek and adjacent to several of the other survey locations.

Almost all of the reaches could support beavers, except perhaps those where woody riparian vegetation is limited at the current time. Their presence would have a major positive impact on the overall health of the stream-riparian ecosystem within the survey area.

Fish and Aquatic Habitat

This section of the RSRA survey examined the suitability of the stream-riparian ecosystem as habitat for native fishes and other aquatic species. The mean scores for fish and aquatic habitat were generally good in the reaches above the town of Mancos, although there were a few problems in this area. With minor restoration, this part of the river would likely provide good habitat for native cold water fish species, including native trout. In addition, the RSRA only considers conditions at the time of the survey, which would not account for periods when the streamflow may drop to zero, adversely affecting all aquatic life. However, non-native brook trout presently dominate the upper part of the Middle and West Forks and they will often out-compete native cutthroat trout. (Behnke 1992, Harig et al. 2000).

The condition of reaches in the lower part of the valley below Mancos was not as good. Establishing native fish populations in this area would be more problematic, although still potentially possible. There was slight improvement of the fish and aquatic habitat in the last reach, the Mesa Verde/Ute Reservation reach in Mancos Canyon, although there were specific problems in that reach that made it currently unsuitable for many native species, including the absence of stream flow during some summers.

The pool to riffle distribution were highly variable throughout the Mancos Valley. Pools and riffles were rare or absent in reaches where the banks had been leveed, where the channel was uniformly straight, and where there was an absence of woody debris. Fish use the pools to rest,

feed and hide from predators. Many species use the gravel-bottomed riffles to lay their eggs because the water contains high amounts of dissolved oxygen needed by the developing embryos as it is aerated as it moves over the shallow bottom. The riffles also are where many aquatic insect larvae attach to rocks in order to develop. Restoration of those reaches lacking quality pool riffle ratios could greatly improve fish habitat.

Under-bank Cover

Fishes and many other aquatic species such as crayfish and frogs often use undercut banks as a place to escape from predators. Undercuts develop when the roots of healthy riparian vegetation growing along the bank of the channel stabilizes the soil above the water line while part of the bank that is below the roots and underwater erodes away. Conversely, undercut banks are absent in areas where there is little vegetation and the entire bank is rapidly eroding or where the banks have been armored by artificial levees.

There was only limited under-bank cover for fishes and other aquatic species throughout the Valley, as well as in the upstream reaches. This was primarily a result of levee construction (including in parts of the upstream reaches), although in a few areas downstream it was also the result of a wide and shallow channel morphology combined with only limited riparian vegetation along the banks.

Large Woody Debris

LWD was defined as pieces of wood that were at least 15 cm (6") in diameter and at least 1m (3 ft) in length. Large woody debris that is resting in the stream channel or along the banks and at least partially submerged provides important fish and amphibian habitat, for nursery cover, feeding areas, and protection from predators. LWD also plays an important role in shaping channel morphology and capturing silt, particularly in small and medium sized streams and rivers like the Mancos. Streams with adequate amounts of large woody debris tend to have greater habitat diversity, a natural number of meanders, and has greater resistance to negative impacts of high water flow.

Most of the reaches in the upper parts of the survey area had adequate or better amounts of LWD, although there were exceptions in the agricultural areas just above the town of Mancos. There was significantly less woody debris in the reaches in the lower parts of the Valley; this probably was the result of both fewer trees along the banks that could fall into the river, as well as reduced water flows that would carry LWD that entered the channel in the upper parts of the area farther downstream. The addition of LWD to the middle and lower reaches could result in a significant improvement in fish habitat and overall channel morphology.

Stream Bank Terrestrial Vegetation

The final variable in the Fish and Aquatic Habitat sections examines the amount of terrestrial vegetation on the stream bank that actually overhangs the water and is also important for fish production and survival. Both the plant material itself and the insects that live on the vegetation can drop directly into the channel, providing a critically important source of food, energy and nutrient input into the stream for fish and other aquatic species. Overhanging vegetation also provides shading, bank protection, and sediment trapping during high flow events.

The scores for overbank cover were generally excellent in the tributaries and upper parts of the valley. Below the town of Mancos, the scores fell to low levels in some reaches, where there was little vegetation at all along the stream banks. However, two of the three farthest downstream reaches again achieved excellent scores, indicating that this component of fish habitat quality could recover in the lower scoring areas with appropriate management.

Riparian Vegetation

This section of the RSRA survey examines the presence and composition of the vegetation within the historic floodplain adjacent to the stream channel. Although there are numerous ways to define “riparian” plant species, in general riparian species are those that require higher levels of moisture in the soil than would be available in the surrounding upland areas, and which receive that moisture primarily from water moving through the stream and adjacent areas, either as surface flows during high water events (overbank flooding) or as underground flows beneath the floodplain. In many cases riparian species need moist conditions for seed germination and the roots of the adult plants may reach directly into the water table. Outside of the riparian zone the roots of plants may not always be able to reach directly into the water table and they do not require underground or surface water to grow or for their seeds to germinate. The latter area is called, in contrast to the riparian zone, the upland zone. For the RSRA evaluation, the riparian zone is further divided into two parts.

The condition of the riparian vegetation was generally very good in the survey reaches above the town of Mancos (including several agricultural areas), declined somewhat in the lower parts of Mancos Valley, and then began to improve again as the river left the valley and entered the Mancos Canyon. The mean cover scores for the lower riparian zone (the zone directly adjacent to the active stream channel) were generally only good, even in the most upstream reaches. Grass cover in this zone was usually less than 70% except at the reach that was located within the town of Mancos. This was due primarily to the presence of levees in many of the reaches which were made of cobble and did not provide good growing sites for grasses and forbs. There was also some effect from livestock use in several of the reaches in the lower part of Mancos Valley. Because the amount and the condition of the riparian vegetation currently found in the floodplain is not consistent with the channel geomorphology of the Mancos River in this area, and the apparent lack of frequent overbank flooding due to channel incision and the presence of levees in many reaches, there must be some other input of surface and underground water flow into the floodplain. This flow must be from sources adjacent to, but outside the floodplain. From the field observations made during the surveys, including the presence of wet meadows at the upper edge of the flood plain that is farthest from the stream channel, as well as a number of small streams and wet areas that are adjacent to and below the irrigated fields above the floodplain, it appears that the source of the water that is maintaining the current health of the riparian vegetation along this section of the Mancos River is leakage and possibly run-off from the numerous irrigation ditches that run parallel to the river throughout most of the valley.

Element C: A description of the non-point pollution source management measures that will be implemented to achieve the load reductions.

Key questions to address in evaluating candidate management measures and practices include:

1. Are the site features suitable for incorporating the practice (i.e., is the practice feasible)?
2. How effective is the practice at achieving management goals and loading targets?
3. How much does it cost (and how do the costs compare between alternatives)?
4. Is it acceptable to stakeholders?

Management measures and practices can be implemented for various purposes, such as

- Protecting water resources and downstream areas from pollution;
- Conserving, protecting, and restoring priority habitats;
- Setting aside permanent aquatic and terrestrial buffers;
- Establishing hydrologic reserve areas (in-stream flows);
- Acquiring ground water and surface water rights;
- Reducing the availability of pollutants (e.g., reducing the dissolution of metals in the upper basin);
- Reducing the pollutants generated (source reduction such as erosion control);
- Slowing transport or delivery of pollutants by causing the pollutant to be deposited or assimilated near the point of origin (e.g. improving the functioning capacity of the river);
- Causing deposition of the pollutant off-site before it reaches the water-body;
- Treating the pollutant before or after it is delivered to the water resource through chemical or biological transformation.

The Group has considered several management measures to reduce the impact of the non-point source pollution emanating from the East Mancos watershed that include:

1. Phytoremediation of exposed outcrops in the East Mancos watershed;
2. Source control at the mine sites, especially treating the ground water;
3. Copper plating technologies within the river;
4. Installing a dam in Rush Basin;
5. Installing an active water treatment plant in the East Mancos;
6. Installing excelsior erosion control blankets to minimize runoff from the outcrop area;
7. Increasing stream flow to dilute the concentration of dissolved copper;
8. Improving assimilative capacity in lower reaches.

Primarily, due to the unknown effectiveness of the management measures, the elevation and remoteness of the area, maintenance and costs, all but the last 2 BMPs could be seriously considered. Because of snow loads, the East Mancos watershed is nearly impossible to access 9 months of the year and because of remoteness it is very difficult to access for the other 3 months.

Other solutions that have been cited and used include some type of off channel passive treatment system such as a constructed wetland, or an active treatment that increases pH and precipitates the metals, or, a sulfate reducing bioreactor. Some of these systems can be very effective (as high as 99% removal rates) and the ability of these processes to recover some of these metals in a purified form can make them attractive economically. Also, Vertical Flow Reactors (VFR), Successive Alkalinity-Producing systems (SAPS), Vertical Flow Ponds, Vertical Flow Wetlands, and Reducing and Alkalinity-Producing Systems (RAPS)-exist as passive treatment systems that incorporate the benefits of anoxic limestone drains and anaerobic wetlands.

Some drawbacks of these systems are:

A list of currently available cost references is given below. Most of these references are available for free download, but some might be available only at a university library or by purchase.

EPA Management Practice Fact Sheets This comprehensive list of BMP fact sheets contains information on construction and maintenance costs, as well as other monetary considerations. Information is provided on both structural and non-structural management practices. Go to <http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm>.

National Management Measures to Control Nonpoint Source Pollution from Agriculture This EPA document provides cost information on a number of management options for agricultural land. Go to www.epa.gov/owow/nps/agmm.

USDA Natural Resources Conservation Service Some state NRCS offices publish cost information on agricultural practices. Some cost data are published to support the Environmental Quality Incentives Program (EQIP). For an example of this cost information, go to the “cost lists” section of the following Web site: www.nc.nrcs.usda.gov/programs/EQIP/2005Signup.html.

Center for Watershed Protection The Center for Watershed Protection has published numerous support documents for watershed and management practice planning. The Web site has documents available for free download and purchase. Go to www.cwp.org.

1. Size of the passive treatment system- if the efforts are focused at a lower point in the watershed, the discharge will be higher and the need for a larger system will be necessary;
2. Obtaining enough capacity when the load reductions are most necessary during spring discharges;
3. What to do with the byproducts (*i.e.* precipitates);
4. How to pay for operation and maintenance on these systems;
5. Dealing with the legal complexities of diverting water through these systems.

Monitoring the work the Animas River Stakeholder’s Group (a nearby watershed group working at high elevations) investigating active treatment systems for metals that are affordable would be prudent for the MVWG.

A survey completed of the diversion structures that photo-documented each structure, identified each with a GPS measurement and compiled all information into a couple of binders that are kept at the offices of the Mancos Conservation District and the NRCS in Cortez. Specifically, this scope of work identified the tasks necessary to reconstruct the most infirm and inefficient in-stream diversion structures. The structures were prioritized based on the characteristics that appear to have a major impact on the river system such as: downgrading of the river, cut-banks, drying of the riparian area, structures that require substantial amounts of maintenance with a backhoe or trackhoe, and those that inhibit fish passage (Appendix 1).

There exists some literature and data indicating that metals may be removed from river systems by increasing the assimilative capacity of a stream. Increasing assimilative capacity occurs when there is an increase in the connection between the surface water and the hyporeic (ground water underneath and surrounding streamwater) water. This occurs with increasing sinuosity of the stream, decreasing fine sediments and increasing riparian health and riparian wetlands. Along with repairing diversion structures, significant improvements in stream function could also be achieved (see Abandoned Mine Reclamation Clearinghouse - AMRClearinghouse.org for more information).

Another aspect of the project is working with Colorado Water Trust to evaluate the potential of a water leasing program for increasing in-stream flow and diluting the concentration of the dissolved copper.

Element D: An estimate of the amounts of technical and financial assistance needed

The Mancos Valley Watershed Group and the Mancos Conservation District have tapped into a number of local, state and federal funding sources (Table 5). For a list of other federal funding sources see: Catalog of Federal Domestic Assistance (www.cfda.gov). This website provides access to a database of all federal programs available. Also, visit www.epa.gov/watershedfunding to view the Catalog of Federal Funding Sources for Watershed Protection. This interactive Web site helps match watershed project needs with funding sources. More information on funding sources for watershed programs is posted at EPA's Sustainable Finance website at www.epa.gov/owow/funding.html. For locating private funding see: www.rivernetnetwork.org for the Directory of Funding Sources for Grassroots River and Watershed Conservation Groups. It lists private and corporate sources as well as federal sources.

Administration and management services, including salaries, regulatory fees, and supplies, as well as in-kind services efforts, such as the work of volunteers and the donation of facility use, information/education components, the installation, operation, and maintenance of management measures, monitoring, and data analysis, and data management activities have all been considered in the cost estimates shown in

Table 4. Much of the cost is expected to be covered by in-kind work completed by staff of the various agencies within the watershed (see: Guidebook of Financial Tools: Paying for Sustainable Environmental Systems, at www.epa.gov/efinpage/guidbkpdf.htm).

For establishing baseline data and for other sources of monitoring, most geographic areas have some associated background spatial data in the public domain such as digital elevation models, stream coverage, water quality monitoring data, and land cover data in the form of imagery like orthophoto quads or raster satellite image files. Other methods of leveraging resources include: using existing studies where agencies have reports of previous analyses, providing useful baseline information and data, such as delineated sub-watersheds or a historical stream monitoring record. The analyses might have been done for another purpose, such as a study on fish health in a particular stream, but they can contribute to understanding the background of the current concerns.

State, county, tribal, or federal agencies working as technical assistance providers and implementing natural resource program initiatives can offer computer services and expertise, such as performing GIS analysis or weaving together elements of different programs that might apply to the local area. For example, staff time to assemble needed elements, supplies, and meeting rooms for a stakeholder or scoping meeting can all be donated.

Plan2Fund was developed by the Environmental Finance Center (EFC) at Boise State University to help organizations determine the amount of outside funding necessary to achieve the goals and objectives of their watershed management plan. The Plan2Fund tool leads organizations through the process of estimating implementation costs for their goals and objectives, evaluating local funding options, and finally identifying gaps in funding. With the output from Plan2Fund, users can then search EFC's Directory of Watershed Resources database for federal, state, and private

funding sources based on identified funding needs:

http://sspa.boisestate.edu/efc/Tools_Services/Plan2Fund/plan2fund.htm

Table 4. Cost estimates from local experience, EPA databases (i.e. Guidebook of Financial Tools: Paying for Sustainable Environmental Systems and Plan2Fund, accessed February 2011, see Table 6 for time line)

MVNP = Mesa Verde National Park, NRCS = Natural Resource Conservation Service, MCD = Mancos Conservation District, MVWG = Mancos Valley Watershed Group, CWCB = Colorado Water Conservation Board, EPA = Environmental Protection Agency, CSCB = Colorado State Conservation Board, CO319 = Colorado Water Quality Control Commission Nonpoint Source Program

Management Measure	Responsible Parties	Costs
Restoring reaches in valley impacted by historical levees (Stacey 2007)	MVWG	\$250,000 total
Diversions 1-12 with riparian restoration and improving hydrogeomorphology	MVWG and MCD CSCB, CWCB, SWCD, CO319	\$9,000 per design, \$21,000 per diversion for construction
Purchasing water for in-stream flows	MCD, CWCB instream flow program	\$30,000- \$50,000 total
Reduce salinity loads	NRCS EQUIP	\$45,000 per year, per irrigation system for 10 years
Reduce Selenium, especially in the Navajo Wash tributary	Ute Mountain Ute Tribe, NRCS EQUIP	\$45,000 year per irrigation system for 10 years
Close, improve and maintain roads in National Forest lands	SJNF	\$30,000/year for 10 years
Reduce sediment loads from burn areas	MVNP, Ute Mtn. Ute Tribe	\$10,000/year for 10 years
Habitat rehabilitation in Mancos Canyon	MVNP	\$25,000/year for 3 years
TOTAL COST ~ \$2,250,000.00		
(does not include in-kind work completed by staff of the various responsible parties).		

Element E: An information/education component that will be used to enhance public understanding of the project.

The purpose of this element is to develop an information/education component that the watershed group can use to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the non-point source pollution management measures that will be implemented.

In 2008, the Mancos Valley Watershed Group launched a Water Literacy Campaign aimed at engaging residents of Mancos in the effort to protect the Mancos fresh water supply. The Mancos Conservation District meets monthly and the Watershed Group meets quarterly. Local

opportunities for educational activities in the watershed occur at water-fairs held each year in the surrounding towns: Cortez, CO, Durango CO and Farmington, NM. The group has held several tours within the watershed and can continue to do so.

A Watershed Coordinator may participate in State and National conferences to keep current on watershed policies and opportunities as well as to inform others on the unique aspects of the Mancos River Watershed. Table 5 illustrates the large number of activities that have occurred in the watershed to date.

Table 5. Implementation, educational, implementational and informational projects completed to date and funding sources to date.

MVNP = Mesa Verde National Park, NRCS = Natural Resource Conservation Service, MCD = Mancos Conservation District, MVWG = Mancos Valley Watershed Group, CWCB = Colorado Water Conservation Board, EPA = Environmental Protection Agency.

Project Completed	Funding Source
On-Farm pipelines installed throughout the year via EQIP and Basin States Funding.	NRCS EQIP program and Basin States Funding Cost Share Programs
Diversion Point River Stabilization Project	CWCB, SW Basin roundtable, SW Water Conservancy District
Two river restoration projects with a third planned for 2010	CWCB, NRCS, CSNR
Monitor water use at Echo Basin Dude Ranch and follow up on compliance with the water decree the state granted them.	Mancos Conservation District
Water sampling of Mancos River	Via: Colorado RiverWatch
Sudden Aspen Decline volunteer monitoring	National Forest Foundation, Mancos Valley Sustainability Initiative, Mancos Conservation District.
EDUCATION/OUTREACH SERVICES RELATED TO ACTIVITIES	
Irrigation Water Management Seminars were held in the District office. Three Seminars were held during the irrigation months. These seminars were open to all landowners.	Private donations, MCD, Colorado Nonpoint Source Program
Mancos River Day held September 12 and open to the general Public. The event brought in the children from the Mancos School District, landowners from the watershed and anyone who saw the advertising.	Private donations, MCD, Colorado Nonpoint Source Program
Held a watershed tour of on-going	Private donations, MCD, Colorado Nonpoint Source

projects in the Mancos Valley.	Program
Held a lower watershed tour on May 8 th and an upper watershed tour on October 2nd	Private donations, MCD, Colorado Nonpoint Source Program
MEETINGS, SEMINARS, CONFERENCES HOSTED/ATTENDED RELATED TO ACTIVITIES	
Hosted seven watershed stakeholders meetings to include and inform all stakeholder of the progress being made on the project.	Colorado Nonpoint Source Watershed Planning Grant; Private Donations; National Forest Foundation
Attended the Durango Children's Water Festival	Colorado Nonpoint Source Watershed Planning Grant; National Forest Foundation
Attended San Juan Basin Watershed	State
Attended six Southwest Basin Roundtable meetings	Western Watershed Assessment
Attended Mancos Source Water Protection meetings	Colorado Nonpoint Source Watershed Planning Grant; National Forest Foundation
Hosted Watershed Steering Committee meeting	
Attended State-wide Teachers Project Wet training	
Attended Climate/Drought seminar	
Attended/Presented at the Sustaining Colorado's Watershed annual conference	
Hosted 4 Diversion Project meetings June	
Attended meetings w/Town of Mancos	
Hosted East Mancos Task Force meeting	Colorado Nonpoint Source Watershed Planning Grant; National Forest Foundation
Draft of website completed	(http://www.sustainablemancos.com/watershed_project)
Brochures with basic information completed	

There are several steps in developing an information/education (I/E) program that include: Defining I/E goals and objectives beginning with the determining the driving forces that include for the Mancos River watershed:

- developing a cold-water fishery;
- maintaining surface water in each reach, year round;
- meeting the target goals of the draft TMDL;
- improving irrigation diversion structures;

- improving the functioning capacity of the stream.

The Watershed Group will want to: create awareness, provide information, and encourage action among the target audience. To facilitate this process, the EPA has developed a “Nonpoint Source Outreach Digital Toolbox,” which provides information, tools, and a catalog of more than 700 outreach materials that state and local agencies and organizations can use to launch their own nonpoint source pollution outreach campaign. The toolbox is available online and as a CD at www.epa.gov/nps/toolbox/. Colorado also has a Keep it Clean campaign that is a water quality educational toolkit (<http://npscolorado.com/h2ojo.htm>).

During the early stages of the I/E campaign, it will be necessary to generate basic awareness of watershed issues. As problems are identified during the final aspect of the watershed characterization the Group’s objectives will be to focus on educating target audiences on the causes of the problems. Next, the objectives will be to focus on actions that the target audience can take to reduce or prevent adverse water quality impacts or improve existing water quality conditions. Finally, the group’s objectives will be to focus on reporting progress of the I/E campaign.

In later stages of the campaign, the group should identify the target audiences that need to be reached to meet the objectives. After gathering information on the target audience, the group will be ready to craft a message to engage and enlist target audience to achieve the watershed planning objectives. To be effective, the message must be understood by the target audience and appeal to people on their own terms, articulating what actions the audience should take.

The actions should tie directly back to the goals of the watershed plan, be doable by the target audience, and may include such things as: fencing off the stream corridor, minimizing grazing along the stream corridor, installing guzzlers to keep cattle off the stream corridor, using less water to irrigate, participating in the NRCS EQUIP program to install sprinkler irrigation systems, planting cottonwoods and willows along the stream corridor, becoming involved with the Stakeholder Group to implement larger activities that further the goals of the Watershed Group. In addition, the message should be tied directly to something the target audience values, such as: enhancing public values; improving ecosystem function; enhancing quality of life and environmental amenities; and improving economic development opportunities.

Once the message is crafted it will be time to determine the best package or format for delivery of the message to the target audience. For example, a farming community such as which surrounds Mancos, might respond more positively to door-to-door visits or articles in farm publications than to an Internet and e-mail campaign. By far the most popular format for outreach campaigns is print. Printed materials include fact sheets, brochures, flyers, booklets, and posters. These materials can be created easily, and the target audience can refer to them again and again. In addition to print material, the group should also consider using activities to spread the Group’s message. A watershed event can be one of the most energizing formats for distributing messages targeted at awareness, education, or direct action. A community event plays into the desire of audience members to belong to a group and have shared goals and visions for the community. In urban areas, where knowing neighbors and other members of the community is the exception rather than the rule, community events can help to strengthen the

fabric of the community by creating and enhancing community relationships, building trust, and improving the relationships between government agencies and the public.

If resources are limited and the message is fairly focused, piggybacking onto an existing event that involves the target audience is a possibility. Trade shows and other events for farmers, developers, fishers, and other groups can often be accessed with a little research and a few phone calls. Once the message has been packaged in the desired format, the next step is distribution. Common means of distribution are by direct mail, door-to-door, by phone, through targeted businesses, and during presentations

Periodically evaluating the I/E program to keep it on course and effective is important. Evaluation provides a feedback mechanism for ongoing improvement. Building an evaluation component into the plan from the beginning will ensure that at least some accurate feedback on the impact of the outreach program is generated. Ideally, feedback generated during the early stages of the project will be used immediately in making preliminary determinations about program effectiveness. Adapting elements of the I/E effort continually as new information is received ensures that ineffective components are adjusted or scrapped while components that are working are supported and enhanced.

Example I/E Indicators include

1. **Programmatic:** number of newspaper stories printed; number of people educated/trained; number of public meetings held; number of volunteers attending activities, or,
2. **Social** • number of calls to hotline; number of people surveyed with increased knowledge of watershed issues; number of people surveyed with changes in behavior; participation at watershed events; number of trained volunteer environmental monitors.

Element F: A schedule for implementing the non-point source pollution management measures identified in this plan that is reasonably expeditious

To provide a clear guide for stakeholders implementing the watershed plan, it was recommended that the basic information be compiled into several matrices. For each selected management option or related management options, the following has been compiled:

- Actions that need to be taken (including any special coordination, education, or public outreach needed to improve the chances of implementation to be completed by the Watershed Coordinator);
- The responsible party(ies) for the action/education (Table 6);
- Time frame for implementing the actions (Table 6);
- Time frame for operation and maintenance requirements (Table 6);

Estimated total cost and annual cost for each action (

- Table 4);

Funding mechanism(s) for each action (

- Table 4);
- Measures or tracking indicators (Table 8).

A schedule is laid out in Table 6 where the responsibility of implementing each management measure is spread out through the entities involved in the watershed. The schedule suggests a single activity for each year per entity over the next 12 years.

Table 6. Implementation schedule for studies and management measures and responsible parties.

MVNP = Mesa Verde National Park, NRCS = Natural Resource Conservation Service, MCD = Mancos Conservation District, MVWG = Mancos Valley Watershed Group, DRMS = Colorado Division of Reclamation and Mining Safety, CDPH&E = Colorado Department of Public Health and Environment.

Management Measure	Time Schedule	Responsible Parties
Loading Study	2012	DRMS
Depending on results of loading study, implement a tracer study	2013	CDPH&E
Restoring reaches in valley impacted by historical levees (Stacey 2007)	Completed over next 10 years, 1000 feet per year.	MVWG
Diversions 1-12 with riparian restoration and improving hydrogeomorphology	Completed over the next 12 years where 1 diversion is completed each year	MVWG and MCD
Purchasing water for in-stream flows	Get funding and willing sellers in place 2011 to 2014. Begin purchasing water in 2014. Continue purchases until the point where the river at the confluence of the East Mancos with the West Mancos is sufficiently dilute and the concentration of dissolved copper is below TMDL levels	MCD
Reduce salinity loads	Install 1 sprinkler system to replace 20 acres of flood irrigation each year over the next 10 years	NRCS
Reduce selenium, especially in Navajo Wash tributary	Install 1 sprinkler system to replace 20 acres of flood irrigation each year over the next 10 years focusing on Navajo Wash	Ute Mountain Ute Tribe, NRCS EQIP
Close, improve and maintain roads in National Forest lands	Over the next 10 years close or improve 10 miles of degraded road each year	SJNF
Reduce sediment loads from burn areas	Reseed 10 acres per year over the next 10 years.	MVNP, Ute Mtn. Ute Tribe
Habitat rehabilitation in Mancos Canyon	Maintain/rebuild/monitor fencing that keeps cattle out of the riparian corridor within Mesa Verde National Park	MVNP

Element G: A description of interim, measurable milestones for determining whether non-point source pollution management measures or other control actions are being implemented

In addition to implementing projects, much of the interim, measurable milestones can be monitored at the same time. Data sheets will be developed for each project and having each staff member will be educated about the data sheets. Also, a public database held on the Group’s website where members can easily access the information will help keep projects on course. The best reason to monitor and document progress is to keep people involved in the project, especially funders. Specific milestones are outlined in Table 7 and include measuring riparian community health utilizing the methods developed by Dr. Stacey in 2007, measuring flows during late summer season, especially downstream of the town of Mancos and comparing the flows to baseline conditions, measuring both water chemistry and benthic macroinvertebrates as outlined in the Sampling and Analysis Project Plans, measuring salinity and selenium downstream in Mesa Verde National Park and on the Ute Mountain Ute Reservation and comparing the data collected to baseline data established by the National Park and the Ute Mountain Utes, measuring trout biomass in the stream reach from the confluence of the East Fork with the Middle Fork to the confluence of the East Fork with the West Fork and compare to baseline data established by the review completed by Barb Horn of the Colorado Division of Wildlife (Horn 2010).

Table 7. Interim milestones to monitor for the specific management measures to be implemented.

Management Measure	Time	Milestones
Restoring reaches in valley impacted by historical levees (Stacey 2007)	1000 feet per year, 10 years	<ul style="list-style-type: none"> • Reaches rebuilt, planted with thriving cottonwoods and willows, fenced off and protected from grazing.
Diversions 1-12 with riparian restoration and improving hydro-geomorphology	12 years (1 each year)	<ul style="list-style-type: none"> • Diversion completed and diverting water each year; • No or little maintenance for each diversion; • Monitoring each diversion to make sure no negative impacts are occurring to the functioning of river system.
Purchasing water for in-stream flows	Begin in 2014	<ul style="list-style-type: none"> • More water left in the river; • Stream does not become dewatered in any stretch in any time of the year; • Monitoring of the stream by a stream walk/drive during the months of July and August; • Walk drive occurring twice each month.
Reduce Salinity Loads	Next 10 years	<ul style="list-style-type: none"> • Installation of sprinkler irrigation systems; • Systems up and running; • Systems maintained and used each

		year.
Reduce Selenium, especially in Navajo Wash Tributary	10 years	<ul style="list-style-type: none"> • Installation of sprinkler irrigation systems; • Sprinkler systems up and running; • Sprinkler systems maintained and used each year.
Close, improve and maintain roads in National Forest Lands	15 years	<ul style="list-style-type: none"> • Enforcement of <i>Travel Management Plan</i>; • Ten miles of degraded road improved or closed each year; • Annual audit.
Reduce sediment loads from burn areas	10 years	<ul style="list-style-type: none"> • Seeding of burn areas and monitoring vegetation biomass; • Completed each year.
Habitat rehabilitation in Mancos Canyon	10 years	<ul style="list-style-type: none"> • Maintain fencing and exclusion of cattle; • planting native trees; • Monitoring of fencing; • Inspecting area for indications of trespassing cattle.

Element H: A set of criteria that will be used to determine whether loading reductions are being achieved

There are both short-term goals and long-term goals to consider (Table 8). The short-term water quality goals would include: measuring the loading of copper (lbs/d) upstream of the confluence of the East Mancos with the Middle Mancos and upstream of the confluence of the East Mancos with the West Mancos and then somewhere below the mixing zone, such as at the Highway 160 bridge. Procedures for monitoring should follow the SAP/QAPP developed by the Mancos Valley Watershed Group and approved by the state WQCC (2008). Another short term goal to measure every 3 years are the benthic macroinvertebrates as outlined in the Sampling and Analysis Plan (B.U.G.S. Consulting 2010) along with a reference the site (Figure 7, Figure 8 and Figure 9).

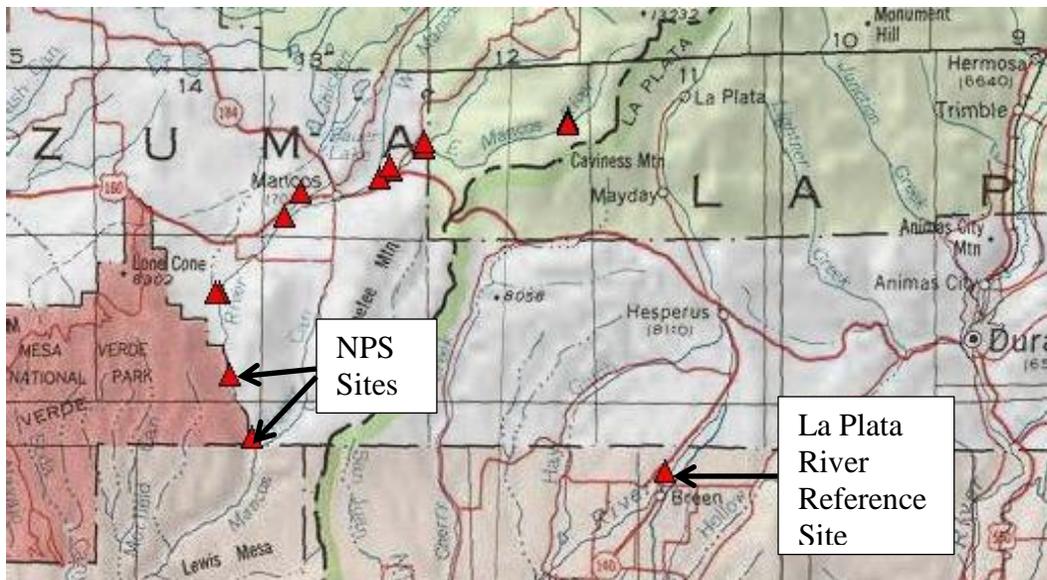


Figure 7. Overview map of the eleven sites collected in the Mancos River Watershed. The two National Park Service (NPS) sites collected in 2007 and 2008 are also shown along the southeast border of Mesa Verde National Park. The La Plata 1 site is also shown north of Breen. Details of sites are found in Figure 8 and Figure 9.

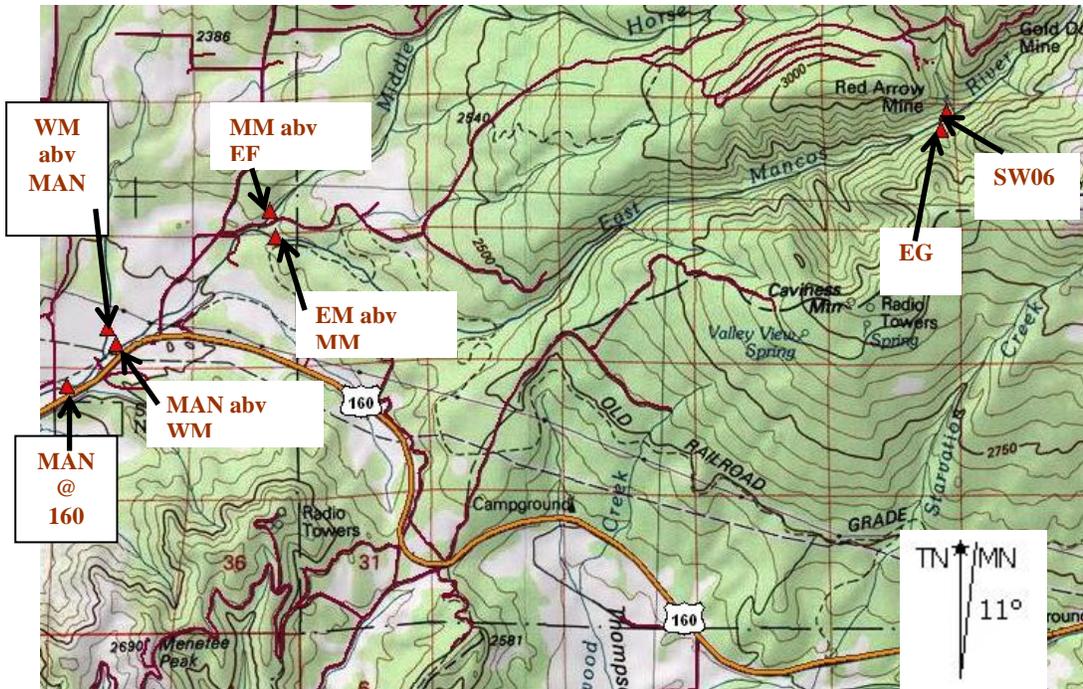


Figure 8. Map of upper seven sites collected in the Mancos River Watershed (MM= Middle Mancos, WM = West Mancos, Man = Mancos River, EG = East Gulch, EM = East Mancos).

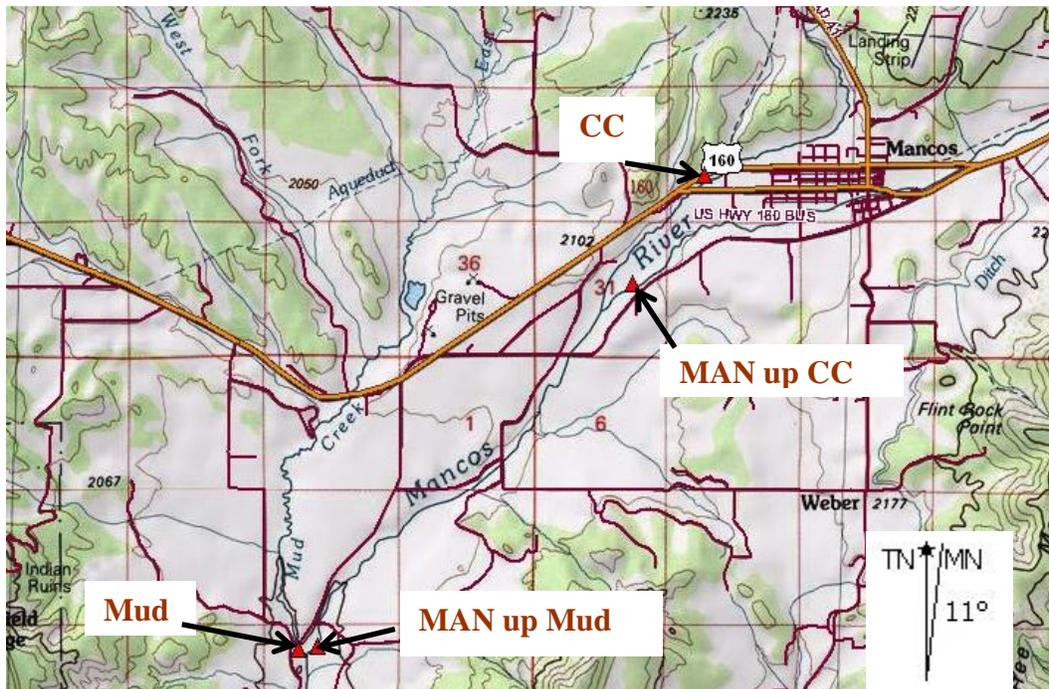


Figure 9. Map of lower four sites collected in the Mancos River Watershed (CC = Chicken Creek, Mud = Mud Creek, MAN = Mancos River,

To monitor for long term water quality goals include measuring the amount of trout in the river in the reach through town and in the reach upstream of the confluence of the East Mancos with the West Mancos and below the confluence of the East Mancos with the Middle Mancos. The Colorado Division of Wildlife and the EPA have both completed fish sampling in these reaches. Other, more nebulous but no less important goals might be the time saved on repairing diversion structures.

Table 8. Criteria and monitoring schedule to determine whether loading reductions are being achieved.

MVNP = Mesa Verde National Park, NRCS = Natural Resource Conservation Service, MCD = Mancos Conservation District, MVWG = Mancos Valley Watershed Group

Management Measure	Time	Monitoring	Responsible Parties
Restoring reaches in valley impacted by historical levees (Stacey 2007)	10 years	Fish, every 3 years	MVWG
Diversions 1-12 with riparian restoration and improving hydrogeomorphology	12 years	Water quality (annually)	MVWG and MCD
Purchasing water for in-stream flows	Begin in 2014	Monitoring water quality, BMIs and fish (every 3 years)	MCD
Reduce salinity loads	Next 10 years	Monitoring water quality (annually)	NRCS
Reduce Selenium, especially in Navajo Wash Tributary	Next 10 years	Monitor water quality (annually in Navajo Wash)	Ute Mountain Ute Tribe, NRCS EQIP
Close, improve and maintain roads in National Forest lands	Next 10 years	Monitor benthic macroinvertebrates (every 3 years)	SJNF
Reduce sediment loads from burn areas	Next 10 years	Monitor benthic macroinvertebrates and native fish (every 3 years)	MVNP, Ute Mtn. Ute Tribe
Habitat rehabilitation in Mancos Canyon	Next 10 years	Monitor benthic macroinvertebrates and native fish (every 3 years)	MVNP

Element I: A monitoring component to evaluate the effectiveness of the implementation efforts

Monitoring land use changes and correlating this with the water quality results obtained in Element H is important to understanding the effectiveness of the management measures implemented. Much of this work can be completed by staff at the county level. Communication between the various entities is vital for this component to be effective. There could be various changes in land use practices that prohibit the establishment of a decent cold-water fishery.

Follow-up

After the plan is completed, the Group will determine how to continue. The Group will look at the planning team and ask the team members if they want to be involved in implementing the plan and identify gaps in skills or resources of the team and find new faces with skills, energy, and enthusiasm to move the ball forward. The Group will then consider creating a watershed implementation team made up of key partners, whose responsibilities will include making sure tasks are being implemented, reviewing monitoring information, identifying or taking advantage of new funding sources, and sharing results, making sure that the new players are committed to the plan and its goals while seeking a balance between bringing in new ideas and energy and allegiance to following through with the plan. To help ensure that the Group can continue to implement the watershed plan for many years, the watershed team will be “institutionalized” by creating several positions that are funded by outside sources to provide continuity and stability. These positions may reside in other organizations but will be tasked with administering the watershed plan. For example, the county might fund a part-time watershed coordinator out of the environmental planning department to assist with implementing the watershed plan. If the Group wants to make partnerships official, there are many guides that explain how to create a nonprofit organization such as a 501(c)3. Having this designation would be useful in applying for funding from foundations. Go to www.501c3.org for information on how to set up a nonprofit organization.

Key implementation activities:

Below is a list of key implementation activities to proceed with implementation of the Watershed Plan:

- Ensuring technical assistance in the design and installation of management measures
- Providing training and follow-up support to landowners and other responsible parties in operating and maintaining the management measures
- Managing the funding mechanisms and tracking expenditures for each action and for the project as a whole
- Conducting the land treatment and water quality monitoring activities and interpreting and reporting the data
- Measuring progress against schedules and milestones
- Communicating status and results to stakeholders and the public
- Coordinating implementation activities among stakeholders, among multiple jurisdictions, and within the implementation team
- To keep the implementation team energized, consider continuing periodic field trips and site visits to document implementation activities in addition to the necessary regular team meetings.

Appendix 1. Prioritized diversion structures. Diversion structures that require reconstruction to improve structure and functioning and assimilative capacity of the river.

Below is a list of 12 diversion structures out of over 50 structures that were inventoried. Based on observations of head-cutting, bank-cutting drying of surrounding riparian area, and obstruction of fish passage, these 12 structures were prioritized as having some of the greatest amount of impact to the functioning capacity of the river and are in a place where they could do the most to benefit the river if repaired properly.

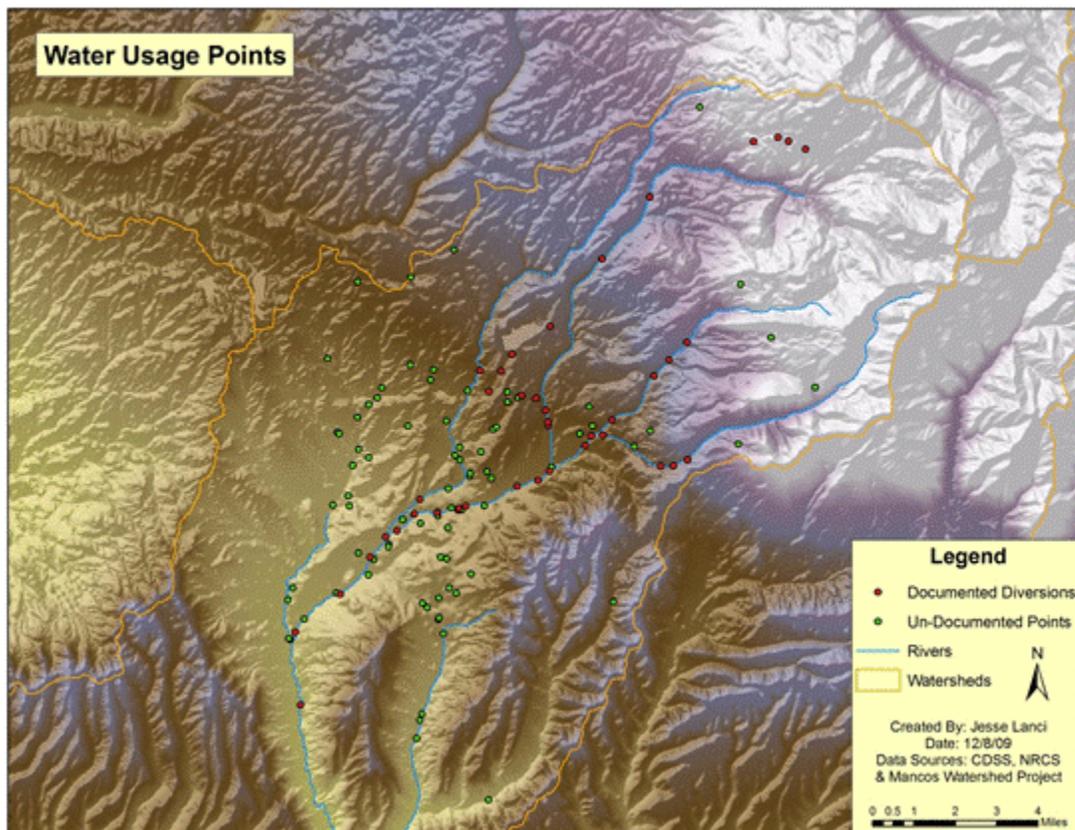


Figure 10. Inventoried diversion structures. Red dots are those that were documented with photos, location, descriptions, and problems associated with the diversions. Prioritized diversions for repairing are illustrated below.

Carpenter Mitchell Diversion (Figure 15)

Mancos

Overview: Owner wants to be notified if there is ever any work being done on the diversion. Relatively new system that involves a weir set up that pipes water.

Barrier: The barrier stops the entire river; only water available is from the trickle the wooden board can't stop. Barrier in use currently drops about 3 feet into a pocket with large boulders; the old barrier is still visible below the boulders. I don't see how fish passage is possible. The exit pipe drops water onto a concrete slab that is about 1 – 2 feet high out of the water.

Head Gate & Ditch: This is a new weir that pipes the water.

River: Below the diversion, the channel has about 10 foot banks. The water is very slow moving above the diversion. The creek makes several turns above the diversion and crosses several properties.

Access: Diversion is right off of highway, once through the gate; one would be able to drive right to the weir and diversion barrier.

Other: N/A

Decreed Rate Total: 11.24 CFS



Field Diversion (Figure 13)

West Mancos

Overview: Looks to be an older diversion.

Barrier: The barrier spans the entire river, looks to be hard for fish passage. The barrier is composed of logs, rocks and concrete; there is a decent sized pool above the barrier. There are two logs below the barrier, possibly for stabilization. Part of the wall on the diversion itself is held up by cables. There exists about 3-4 feet in elevation difference at the barrier.

Head Gate & Ditch: No water is running in the ditch; gate may be closed or debris may be causing a blockage.

River: Above the diversion, the banks are similar to the Town of Mancos diversion, overall mellow with a rock wall on the left side. Below the diversion, the banks are becoming steeper.

Access: Access is really easy; there is a road that brings you right to the diversion.

Other: N/A

Decreed Rate Total: 0.91 CFS



Glassglow & Brewer Diversion (Figure 16)

Mancos

Overview: Newly worked on by the NRCS.

Barrier: The barrier is small, made up of sand bags; it allows fish passage and creates a small pool above it (minnows are noted below the diversion). There are five large tires in the diversion area; 3 above the diversion (probably for bank stabilization) and the other 2 are at the 1st gate (probably also for stabilization).

Head Gate & Ditch: The 1st gate is below the water level. There is also evidence of the old diversion system, which consists of a very big block of concrete (sitting next to the new diversion). There are two gates, one right on the river and 1 about 25 yards down just before the water is piped (new concrete structure); there is a large still pool in between (exposed to cattle).

River: Diversion is located in a heavy cattle area; there is little vegetation along the banks, along with looser soil due to cattle. The river is at a constant gradient; with a cobble bottom, small rapids and pools.

Access: This diversion is easily accessed by passing through some gates and being able to drive and park right at the diversion. I am not sure who owns the ranch.

Other: Fencing around the structure and riparian area, have the ability to keep the cattle out.

Decreed Rate Total: 6.73 CFS



Graybeal Diversion (Figure 14)

Mancos

Overview: N/A

Barrier: The diversion barrier looks to be made up of half trash; other than large logs (held in by cables and metal pipes) and small to medium sized river rocks; it's also composed of concrete chunks (with rebar in it), excelsior rolls; carpeting and a bunch of orange plastic twine (I'm not sure what this originally was). The barrier pushed the low flowing river all to the left; once passed by the barrier, it drops about three feet. If fish could survive in this river (due to water quality), they would have a difficult time passing the barrier.

Head Gate & Ditch: There is no water flowing in the ditch. I am told by Walley and Marty that the gate needs to be replaced, the wheel does not turn and the gate will not open.

River: The surrounding terrain is rather flat, but the left bank above the diversion drops about 2-3 feet (may be less of a cut-bank due to the large cottonwoods); the banks (on both sides) only deepen and steepen below the diversion. The river gradient is fairly mellow, it looks to mainly have low angle drops in between very small little pools, and the current is slow looking. There is a lot of scattered concrete below the diversion (probably from the run-off), it looks to have come from the diversion barrier, just washed down by high run-off.

Access: There is a road that can bring you right near the diversion; you'd have to pass through a barb wire gate in the beginning. For parking, you could park on that road, or there is a possibility one could park closer on a hay field.

Other: N/A

Decreed Rate Total: 2.75 CFS



Lee Diversion (Figure 15)

Overview: N/A

Barrier: The biggest thing is that the manager of the diversion opens and closes the diversion every year; he opens (with heavy machinery) anytime after run-off (sometime as late as June, July and even August). He then pushes the barrier to block off the ditch opening after he is though with irrigation for the year. Jerry tells me the ditch has gotten larger and that the left bank (across and above from the diversion point) has become steeper. When the barrier is opened up, I'm told that it spans $\frac{3}{4}$ ths the river and almost all of the water flows into the diversion, fish passage is blocked and diversion manager says he has a #1 priority and can take all the water, also says river is unregulated.

Head Gate & Ditch: On the ditch itself, there is a blockage (very similar to what's done on the diversion barrier) that is supposedly to prevent any excess water from passing further through the diversion. That excess water has an exit channel that has to travel up-hill (not much of a channel), creating a muddy bog-like area. At the gate the water looks to come in with such force that it's undercutting the concrete gate structure. There is also a very deep channel in the 2nd excess channel below the gate. This in places is blocked, causing excess water to flood onto the property.

River: I has been observed that the river is changing courses and has moved its channel more to the left below the diversion (about 50 – 100 yards), thus creating a very large cut-bank; which has concrete and pipe (used for culverts) to try and help with stabilization. The banks are shallow, only 1 or 2 cut-banks with a height of about 2-3 feet (this of course is excluding the very large cut-bank farther down-stream), mostly composed of medium round-river rocks. Gradient is very constant; there is very easy access to both sides of the river.

Decreed Rate Total: 12.476 CFS



Ratliff & Root along with the Smith Diversion (Figure 15)

Mancos

Overview: There are two ditches that feed off of one diversion barrier; the Smith ditch and the Ratliff & Root ditch.

Barrier: The barrier consists of a small rock wall that spans the entire river. Though it diverts most of the water, some still trickles through; there is evidence of tarp use. It's probably safe to say they have to re-build the barrier every year. There is no elevation drop age before and after the barrier. Fish passage can probably only happen at higher water levels.

Head Gate & Ditch: There is a large concrete structure above the two head gates that has two gates without wheels; I assume this is to stop water from flowing into the pool. Below this concrete structure is a large pool with a large exit channel and the two head gates (this channel and two gates are part of the same concrete structure).

River: The river looks to be at a fairly constant gradient, with no sharp turns and has minor cut-banks.

Other: N/A

Decreed Rate Total : Ratliff & Root: 42.514 CFS
Smith: 1.75 CFS



Sheeks Diversion (Figure 15)

Mancos

Overview: A new diversion system.

Barrier: Diversion has a nice concrete construction. Diversion wall is composed of rock, concrete and some metal pieces; it diverts all the water and only has some trickling through the barrier. This barrier does not allow for fish passage, but I did notice 1 or 2 minnows above the diversion. The elevation difference between the diversion pool and the running water below the barrier is about 4 feet.

Head Gate & Ditch: Puts the water into a piped system.

River: The channel is in a low grade above and below the barrier. The banks are not very steep above the barrier, but are about 4-5 feet below. There are deer, cow and other sign (possibly beaver or otter tracks) along the creek.

Other: N/A

Decreed Rate Total: 13.536 CFS



Smouse Diversion (Figure 14)

East Mancos

Overview: N/A

Barrier: It is a small and thin diversion barrier; it allows water to pass through, and is made out of medium sized river rocks. I have found two shovels (pictured) indicating to me that is how they improve their barrier.

Head Gate & Ditch: No water running through the ditch. I have found no head-gate.

River: The gradient is fairly gentle; there are steep banks, the river right side above the diversion is a cut-bank and is “sloughing” off. The vegetation around the diversion is rather thick.

Access: The access to the diversion looks to be for foot traffic only. The diversion lies within the Forest Service boundary.

Other: N/A

Decreed Rate Total: 3 CFS



Veits/Boss/Number 6 Diversion (Figure 15)

Mancos

Overview: N/A

Barrier: Diversion takes most water from the river. The barrier is made up of medium to small river rocks; it expands all the way across the river. It does seem possible for fish to travel up the uppermost exit channel of the diverted water.

Head Gate & Ditch: Before the water reaches the weir, most of the water is diverted from the diversion channel, being put back into the original river channel. This “gap” is about 30 yards long. The water has what looks to be two exit points, one just above the weir and one that separates the water in the weir. The diversion channel has a fairly fast flow.

River: The area has a gentle gradient even below the diversion barrier. Just up-stream of the diversion is a low fence that is just a few inches above the water. Just below the barrier 2 channels form (creating an island) both are very small.

Access: There is a road that takes you right to the gated weir. You have to walk a short distance to the diversion barrier. I’m not sure who owns the land; everything is right behind the Excelsior Plant.

Other: N/A

Decreed Rate Total: 17.264 CFS (Decreed rates for Veits and Number 6 added together; Boss is recorded as abandoned)



Webber Diversion (Figure 14)

Mancos

Overview: This is one of the larger diversions in the valley located right below the confluence of the West and East Mancos rivers.

Barrier: The barrier consists of 2 tiers of rebar cages (filled with river rock) totaling about 8 – 10 feet of elevation change. There is also a river rock pile that helps to direct the flow into the ditch (created by machinery every year). Fish passage would be impossible.

Head Gate & Ditch: There is a pool about 2-3 feet deep and about 50 yards long (fish were noted in this pool). The pool has 2 exit channels, both walled up with pieces of lumber/wood; the pooled up water flows over both wooden barriers (both drop about 2 feet) into a small channel (which drops another 2 feet) and finally into the channel. The head-gate is made of wood, with open slots; this means that there is no way of completely shutting off the water with the gate alone, it's always flowing.

River: The streams gradient is not constant; there are pools, low angle rapids and high angle rapids (could be from human impacts). There are cut-banks above the diversion (ranging around 2-4 feet) but there are also gentle slopes. Below the diversion the banks reach anywhere between 10 – 12 feet in height; they are mainly steeply angled. There is a lot of river bed and cobble bar disturbance from heavy machinery.

Other: N/A

Decreed Rate Total: 52.064 CFS



Williams Diversion (Figure 14)

East Mancos

Overview: N/A

Barrier: The barrier consists of medium to small rocks, metal pipes (the type that would be used for culverts), excelsior rolls, hay bails, wood piles (possibly from run-off) and tree trunks (most likely placed there). From the top of the barrier to about the bottom is about 8 feet tall.

Head Gate & Ditch: Both look to be functioning just fine.

River: East Mancos has a fine silty white/turquoise precipitate on the bottom of the pool created by the diversion barrier; the surrounding rocks also have a whitish ting to them. On the river right side, the hill slope seems to be “sloughing” off just above the barrier. Below the barrier the river channelises and becomes steeply embanked, at points about 9 to 10 feet.

Access: Access to the diversion is following a Forest Service road that’s rough (especially at the end – fairly steep too) that’s about 1.25 miles long. The diversion lies on Forest Service property.

Other: There are also excelsior rolls that look as if they’re placed as if their trying to slow down high flows.

Decreed Rate Total: 5 CFS



Willis Diversion (Figure 15)

Mancos

Overview: This is one of the three diversions that Marty and Walley say should be a priority.

Barrier: Diversion has a longer barrier that consists of smaller river rocks and looks to have a few metal stakes in place. In larger flows, they would have to come in and re-work/fix the barrier. There are also new tarps on the diversion barrier.

Head Gate & Ditch: A tree is in the gate opening, proving it hard to close gate if necessary.

River: It does provide a gentle gradient of flowing water, to get around the barrier. Up-stream looks to be 2 well-constructed man-made pools; there are segments of the walls that are loose. There does not seem to be much cut-bank issues.

Access: There are two access points; if the barrier were to be worked on both would have to be accessed by foot. One of the points is over the Blue Jays Bridge and the other is through a property owner who has the diversion on their land (there is much confusion on who owns this land).

Other: N/A

Decreed Rate Total: 5.07 CFS



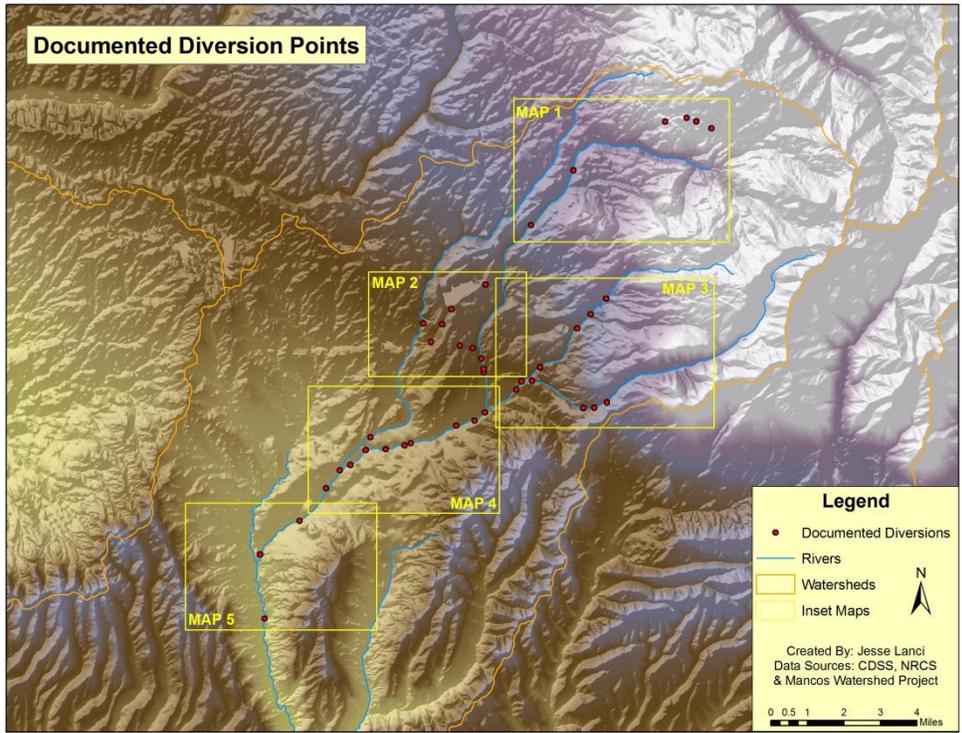


Figure 11. Overview diversion map.

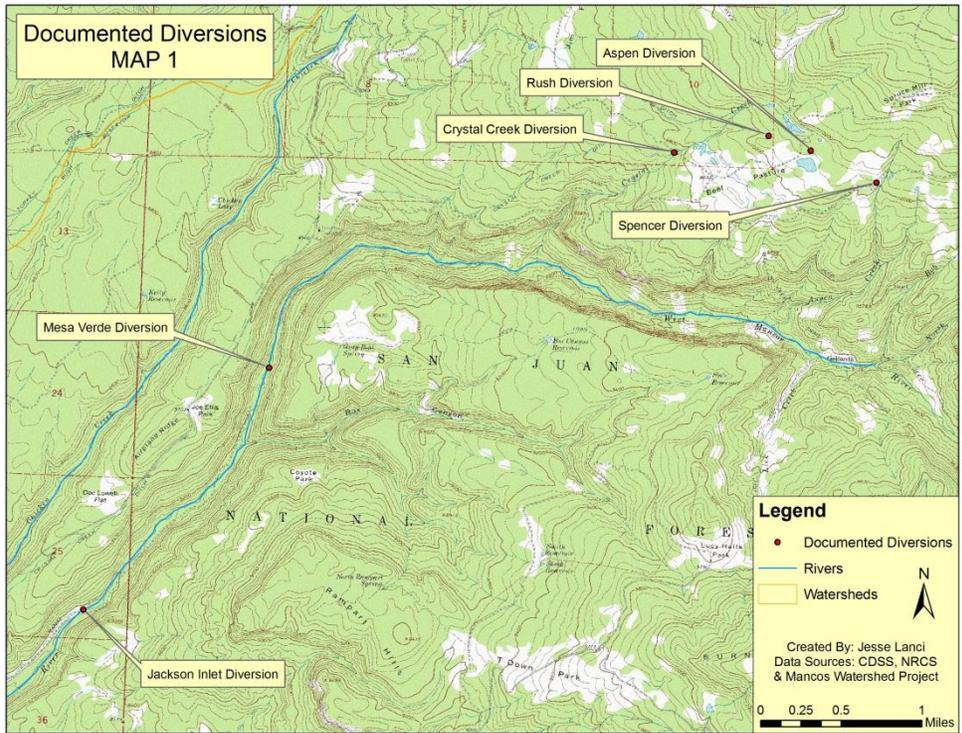


Figure 12. Diversion map 1.

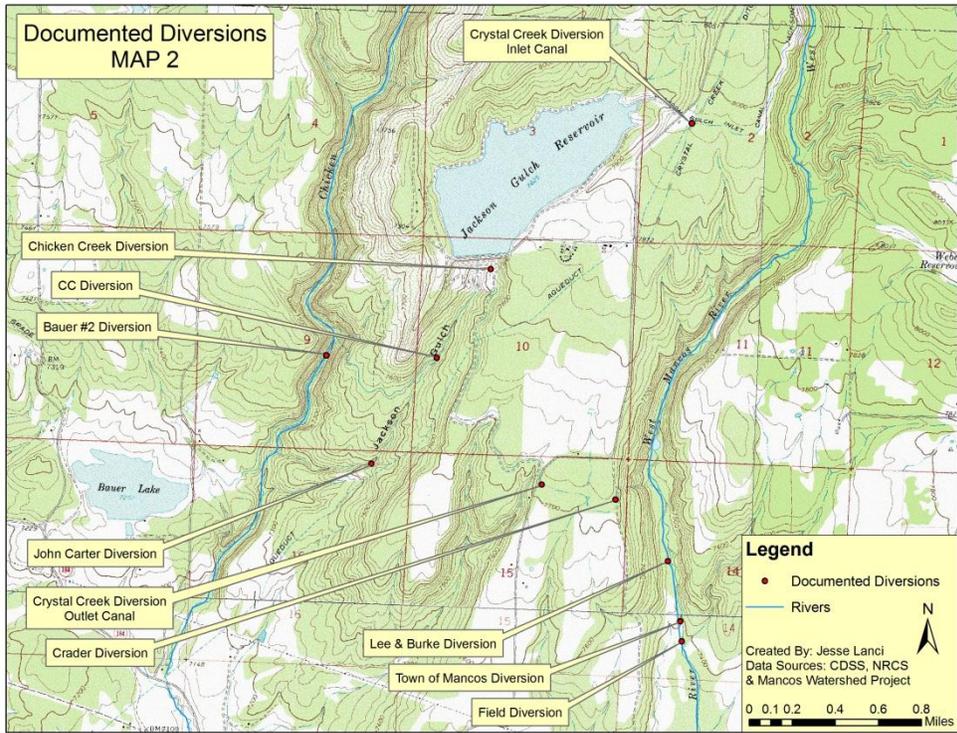


Figure 13. Diversion map 2.

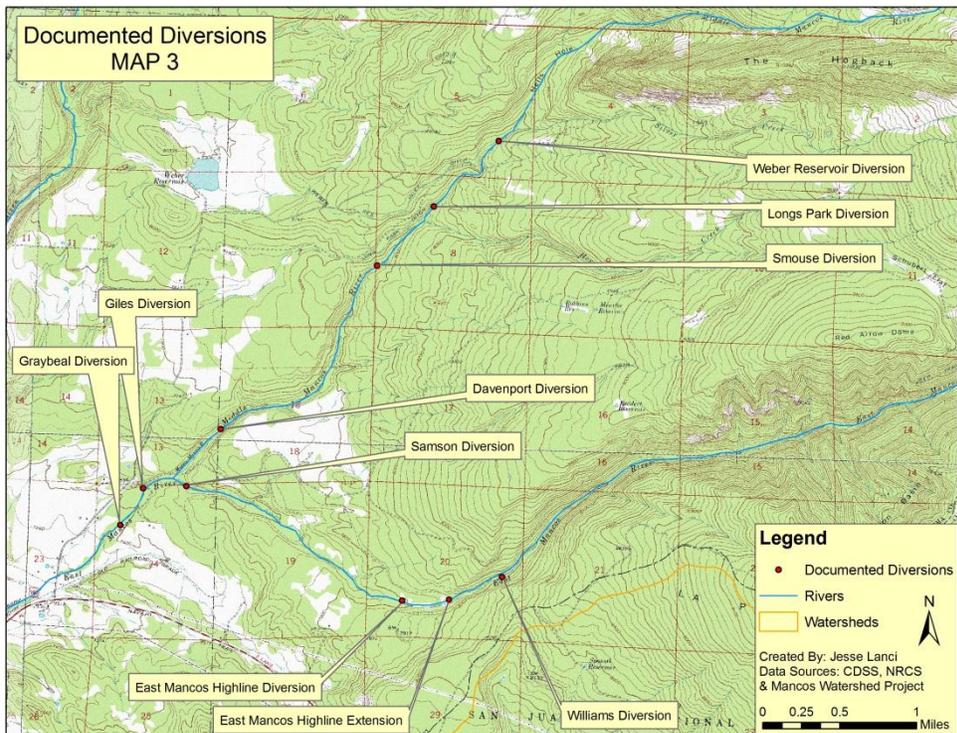


Figure 14. Diversion map 3.

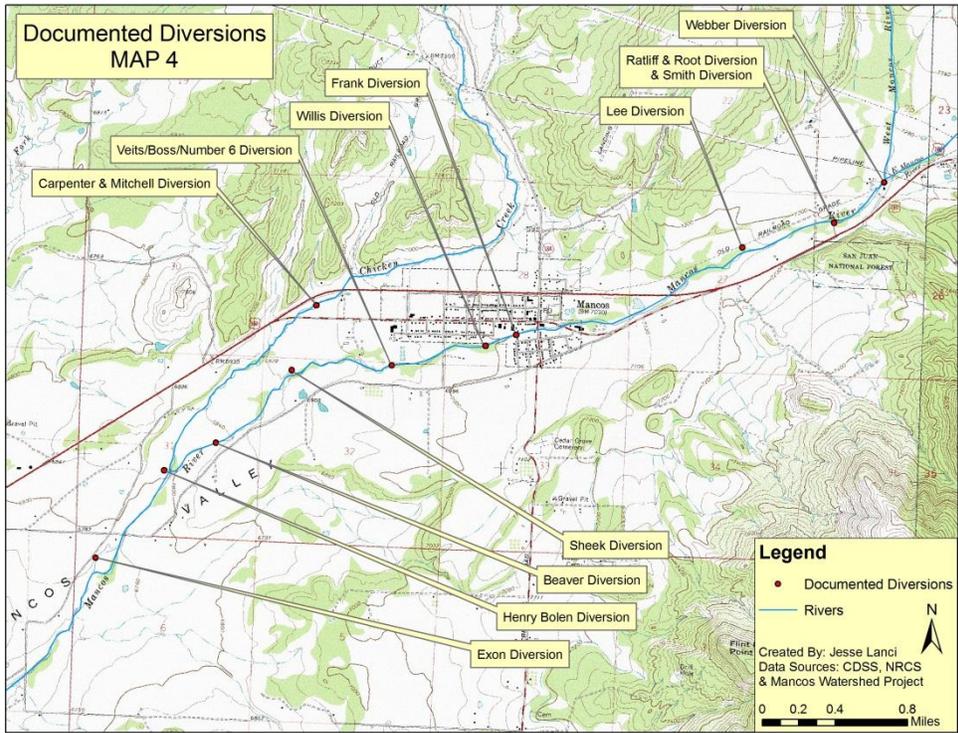


Figure 15. Diversion map 4.

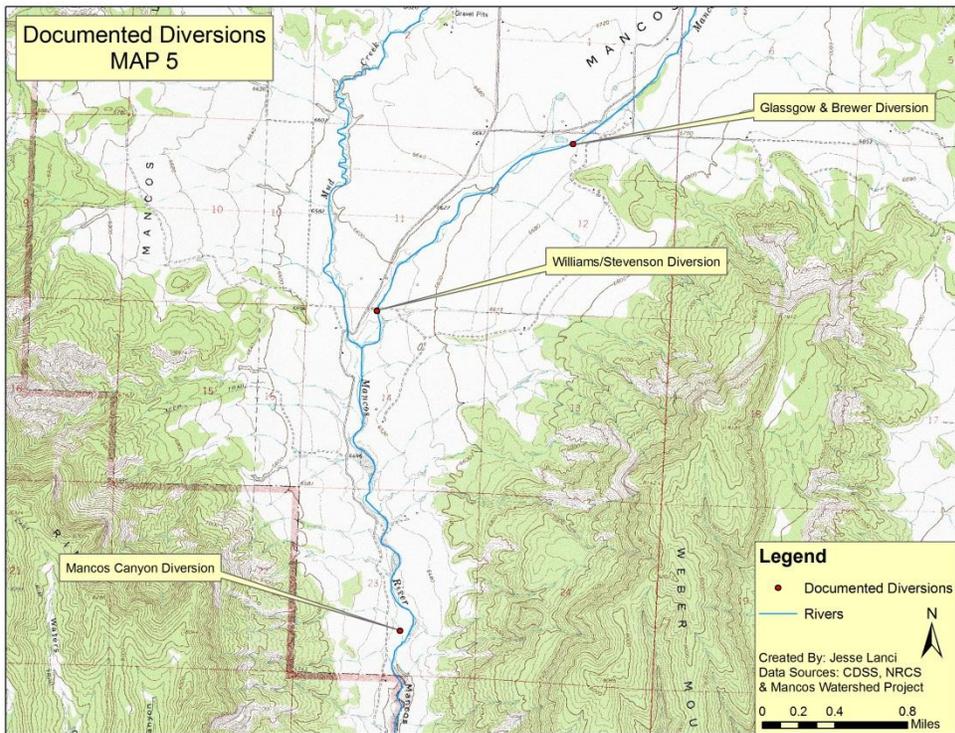


Figure 16. Diversion map 5.

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