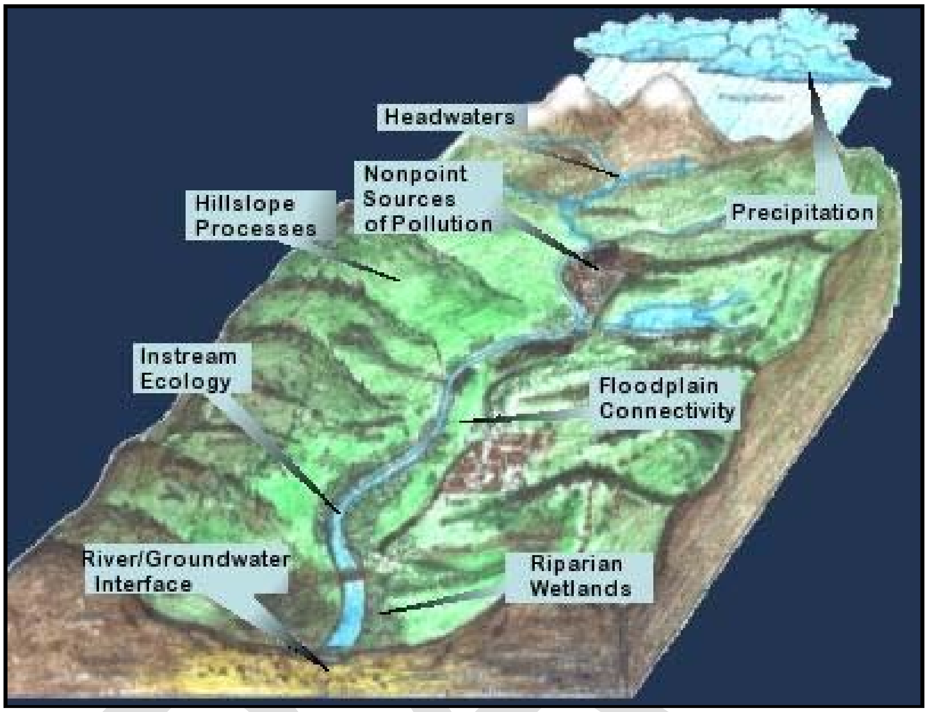
# AnimasRiver
# Watershed Based Plan

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**Animas Watershed Partnership**

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<u>The following stakeholders have participated in the development of this watershed plan</u>

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# Executive Summary

The Animas River is a complex river. The headwaters are at altitudes greater than 12,000 feet, beginning in the alpine life zone and within the highly mineralized San Juan Caldera and ending at 5,500 feet at the confluence with the San Juan River in semi-desert sage-brush scrublands and highly erosive sedimentary strata. Politically, the Animas River begins in the State of Colorado, flows through the Southern Ute Indian Tribe Reservation and into the State of New Mexico, flowing from EPA Region 8 into EPA Region 6.

There are numerous impacts to the Animas River beginning with pollution from historical hard-rock mining in the upper basin. Near Baker's Bridge, diversions of water from the Animas River for irrigation begin and continue with regularity to the confluence with the San Juan River.Just downstream of Baker's Bridge there are the large impacts from current and historical in-stream gravel mining. Near Trimble Lane the effects of eutrophication begin to show up with effluent from Hermosa Sanitation District, runoff from lawns and golf courses and water from leaky septic tanks. Continuing through the Animas Valley the effects of improper grazing practices (both historical and current) sand mining and bank-hardening practices can be seen. In the Durango area the effects of urban runoff begin and immediately below Durango is the historical ore processing smelter (now a Uranium Mill Tailings Remedial Action site), the diversion of the Animas La Plata Project, effluent from the city of Durango's waste water treatment plant, more urban runoff from the Bodo Park commercial/industrial area and effluent from the South Durango sewage treatment plant where the river enters the checkerboard reservation of the Southern Ute Indian Tribe. Within the reservation boundaries and extending into New Mexico is extensive agricultural development that has resulted in a myriad number of inflows to the Animas that are high in nitrogen, phosphorus and sediments. Also in this reach are nutrient and sediment impacts from coal-bed methane extraction due to poorly designed pipeline crossings and poorly designed/maintained roads and well pads. At Aztec, New Mexico there is more urban runoff and effluent from a sewage treatment plant. Continuing through Flora Vista, NM there is more urban runoff as well as leaky septic tanks. At Farmington, NM, where the Animas flows into the San Juan River, there are further impacts from urban runoff.

Work in the upper basin over the last 15 years by the Animas River Stakeholders Group has improved water quality caused by historical, hard-rock mining. The award and maintenance of a Recreational In-Channel Diversion to the City of Durango, CO will help protect water quality along with the restoration work completed by Trout Unlimited and others in the Animas River in Durango, CO. A bank stabilization project in New Mexico also serves as an excellent example of improving the functioning capacity of the river. The river has also recovered from extensive pollution caused by the ore processing in the 1950s and early 1960s just below Durango, CO with the removal of the uranium tailings pile that sat on the banks of the Animas River.

In the Animas Watershed, coordination, research and monitoring among local, state and federal agencies as well as local landowners began in 2002 with the Animas River Nutrient Workgroup (ARNW). The Animas Watershed Partnership, the successor to the ARNW, has numerous partners to work with in its effort to protect and improve the river condition and include the following entities: both the Cities of Farmington, NM and Durango, CO have in place programs to deal with storm-water runoff. The Southwest Wetlands Focus Area and the local Army Corps of Engineers Office has and can help with protecting and improving riparian conditions and functioning capacity of the river. The Animas River Stakeholders Group continues to address impacts from historical mine sites in the upper basin and the Southern Ute Indian Tribe is addressing water quality issues within the boundaries of the Reservation. The Surface Water Quality Bureau of the New Mexico Environment Department (SWQB) and the Water Quality Control Division of the Colorado Department of Public Health and Environment both are instrumental for funding monitoring, research and best management practices.

Coordinating and facilitating research, implementation of Best Management Practices (BMPs) and monitoring and coordinating communication of all the entities working on non-point pollution in the watershed is the best role that the Animas Watershed Partnership can take as well working on improving sites that have been identified as having impacts to the functioning capacity of the river and sites identified as high loaders of nutrients described in this Watershed Plan. It is recommended that the AWP act as a facilitating/communicating entity in the implementation of this Watershed Based Plan. It is highly recommended that each agency and entity completing monitoring, restoration work or resource utilization of the Animas River undertake semiannual reporting to the AWP as part of the coordination/facilitation efforts of the AWP and to help prioritize projects, leverage resources and eliminate duplicate work.

Base funding for the AWP should come from the agencies, businesses, cities, counties and water districts that have an interest in the health of the river. If it left to the AWP to fund itself that is about all that will be accomplished by the organization. Funding for special projects is available from a number of funding entities depending on the type of project.

Educational/information material aimed at reducing pollution to the Animas River should be designed with and distributed through the Water Information Program,San Juan Citizens Alliance, Durango Natures Studies and the Mountain Studies Institute. Research and monitoring work should be coordinated through an independent entity such as the Mountain Studies Institute. Monitoring is currently completed by a number of entities: the local office of the Bureau of Reclamation in coordination with the Colorado RiverWatch, the Colorado Division of Wildlife, Colorado's Water Quality Control Division, the Southern Ute Indian Tribe's Water Quality Program and the Surface Water Quality Bureau within New Mexico.

Beyond coordination and communication, the process for the AWP to implement the Watershed Plan will be:

1. Identify potential best management practices (BMPs) for each top pollution loading site identified in this plan utilizing the data and information in the Animas GIS Database as a starting point,
2. Contact landowners and gage their willingness to participate in implementation of BMPs on their land, emphasizing the advantages to their land,
3. Complete site visits with landowners and stakeholders and finalize strategies to move forward with design and construction of the BMP,
4. Complete design of BMPs,
5. Develop cost estimates for the BMPs,
6. Secure funding for the BMPs,

7. Complete monitoring designs for the BMP's effectiveness,
8. Collect baseline data for monitoring the effectiveness of the BMPs,
9. Complete construction of the BMPs,
10. Complete post-construction monitoring and implement long-term monitoring to measure the effectiveness of the BMPs at reducing pollution loads to the Animas River.

# Section I. Introduction

"The objective of the Federal Water Pollution Control Act, commonly referred to as the Clean Water Act (CWA), is to restore and maintain the chemical, physical, and biological integrity of the nation's waters by preventing point and nonpoint pollution sources, providing assistance to publicly owned treatment works for the improvement of wastewater treatment, and maintaining the integrity of wetlands." The Environmental Protection Agency (EPA) is authorized to oversee the CWA and may give authority to States and Tribes.

***Biological Integrity***
The U.S. EPAs' definition of biological integrity is: the ability of an aquatic ecosystem to support and maintain a balanced adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of natural habitats within a specified region.

Under the CWA, the EPA, States and Tribes must identify waters that are impaired or threatened by nonpoint sources of pollution, develop short and long-term goals for cleaning upthe sources of pollution, and identify best management practices (BMP) that will be implemented to clean up the sources of pollution.

**Non-point source pollution** is a source of pollution from when rainwater or snowmelt runs across land surfaces and picks up pollutants such as sediment, oil, gas, metals and nutrients.

Early in the life of EPA's non-point source program, EPA emphasized development of management strategies, combined with deployment and employment of BMPs for education, demonstration, and research. Recently, EPA has increased emphasis on evaluation of program effectiveness, including attempts to document the water quality benefits of BMPs and other program elements. This emphasis resulted in the *Handbook for Developing Watershed Plans to Restore and Protect Our Waters*(United States Environmental Protection Agency, Office of Water, Nonpoint Source Control Branch 2008)with nine key elements that the EPA requires be addressed in watershed plans funded by Clean Water Act section 319 Non-point Source Program funds.

A **watershed** is the area of land that contributes runoff to a lake, river, stream, wetland, estuary, or bay.

This *Handbook* provides technical tools and sources of information for developing and implementing watershed based plans. A watershed based plan defines and addresses existing or future water quality problems from both point sources and nonpoint sources of pollutants and identifies thebest management practices to mitigate the water quality problems.

**Best Management Practices** are projects designed to mitigate sources of pollution, and may be structural (i.e. stormwater catchmetns and filters) or protection and enhancement of natural areas (i.e. buffer strips) to assimilate and filter pollution ro educational/informational to prevent further sources of pollution from being created

According to the EPA *Handbook*, experience over the past decade has shown that effective watershed management includes active participation from stakeholders, analysis and quantification of the specific causes and sources of water quality problems, identification of measurable water quality goals, and implementation of specific actions needed to solve those problems. The nine, required key elements are:

1. Identification of causes of impairment and pollutant sources or groups of similar sources that need to be controlled to achieve necessary pollutant load reductions and to achieve other goals identified in the watershed plan,
2. An estimate of the pollutant load reductions expected for each best management practice implemented,
3. A description of the best management practices that will need to be implemented to achieve load reductions and a description of the critical areas in which thosemeasures will needed to be implement;
4. An estimate of the amounts of technical and financial assistance needed, associated costs, and thesources and authorities that will be relied upon to implement the plan;
5. An information and education component to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing thenonpoint source best management practice that will be implemented;
6. A schedule for implementing the nonpoint source best management practices identified in the plan that isreasonably expeditious;
7. A description of interim measurable milestones for determining whether nonpoint sourcebest management practices or other control actions are being implemented;
8. A set of criteria that can be used to determine whether loading reductions are being achieved overtime and substantial progress is being made toward attaining water quality standards;
9. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measuredagainst the criteria established under item h immediately above.

## *Animas Watershed Partnership*

The Animas Watershed Partnershipis an expansion of the Animas River Nutrient Workgroup (ARNW) that was formed in December 2002 to assess perceived nutrient enrichment on the Animas River (Figure 1). The AWP is a stakeholder driven workgroupwith representatives fromthe Surface Water Quality Bureau of the New Mexico Environment Department (SWQB), Water Quality Control Division of the Colorado Department of Public Health and Environment (WQCD), Water Quality Program of the Southern Ute Indian Tribe (SUIT WQP), Water Quality Division of the Ute Mountain Ute Tribe, City of Farmington, New Mexico, City of Durango, Colorado, Colorado Division of Wildlife, U.S. Department of Agriculture, the Natural Resources Conservation Services, San Juan Resource Conservation and Development the San Juan Citizens Alliance, the San Juan Water Commission and private individuals and landowners.

### Mission Statement

The mission of the AWP is:“To protect and improve the quality of water resources in the Animas River Watershed.  Values inspire us to create a community-based collaborative processinvolving all stakeholders in which we operate by consensus[1], use all available data sources, and make informed decisions based on sound science."

### Water Quality Goals of the AWP

1) Improve all water quality segments within the watershed that do not currently meet water quality standards.
2) Improve and protect water quality on segments within the watershed that may be affected by emerging concerns.
3) Protect and restore naturally functioning floodplains within the watershed.

## *Watershed Plan*

From 2007 through 2010 stakeholders met monthly todraft a Watershed Based Plan (WBP)for the Animas River Watershed. WBPdevelopment was based on the U.S. Environmental Protection Agency's Handbook for Developing Watershed Plans to Restore and Protect Our Waters and the Colorado's Watershed Cookbook: Recipe for a Watershed Plan. TheEPA's Handbook details nine minimum elements to be included in a watershed plan.The AWP also developed a Sampling and Analysis Project Plan (Appendix 1), implemented a Best Management Practice(BMP) project in Kiffen Creek, New Mexico, and compiled the Animas GIS Data Base, a geographical and water quality database focused on water quality and land use issues that affect water quality.

### Purpose of the Watershed Based Plan

The EPA is working with States, Tribes, and watershedgroups to realign its programs and strengthen support forwatershed-based environmental protection programs. Such programs feature localstakeholders joining forces to develop and implement watershed-based plans that are sensible for the conditions found in local communities. EPA will only help fund efforts to implement Best Management Practices in watersheds that have approved Watershed Based Plans.

Using a watershed approach to restore impaired water-bodies addresses water quality problems in a holistic manner. This is particularly important for the Animas River Watershed since the Animas River flows through 5 jurisdictional boundaries – the State of Colorado, the reservation of the Southern Ute Indian Tribe, the State of New Mexico, EPA Region 8 and EPA Region 6. Stakeholders in the watershed can actively be involved in selecting BMPs to solve the water quality problems.

## *Stakeholders, sources of authorities for:resource use, resource protection, water quality monitoring and design and implementation of BMPs*

Numerous groups have worked in the watershed on various objectives includingresource utilization, resource protection, monitoring, education/information and implementation of BMPs.

[1] An effective consensus decision-making body strives to emphasize common agreement over differences and reaches effective decisions using compromise to resolve mutually exclusive positions within the group. Blocking consensus is considered to be an extreme measure, only used when a member feels a proposal endangers the organization or its participants, or violates the mission of the organization

A critical component of the success of the AWP effort to date and in the future will be the ability to facilitate all of these efforts and provide a forum for communication in order to leverage resources, share data and share information.

## Animas River Stakeholder's Group

The mission of the Animas River Stakeholders Group (ARSG) is to improve water quality and habitats in the AnimasRiver through a collaborative process designed to encourage participation from all interested parties. Participants include mining companies, elected officials, local citizens and interest groups, environmental organizations, and landowners, including federal and state agencies. This innovative process holds open meetings allowing all parties to participate at a level suited to their interest and need. The group usually meets on the third Thursday of every month in Silverton, Colorado.

The ARSG has been collecting water quality data in the upper portion of the watershed since 1994 and has been instrumental in coordinating efforts with private mining companies, Federal, State and local agencies. Over 1,500 mine sites have been assessed by the ARSG, where a subset of these have been prioritized for mitigation work with over 100 sites remediated to date. In addition to physical and chemical water quality data, the ARSG has also collected biological data in order to assess the effectiveness of mine waste remediation.

In addition to physical and chemical water quality data, the ARSG has also collected biological data in order to assess mine waste and ecosystem health.

## Animas River Nutrient Workgroup

The Animas River Nutrient Workgroup (ARNW) was formed in December 2002 to address observations made by staff of the New Mexico Surface Water Quality Bureau and the Southern Ute Indian Tribe's Water Quality Program regarding indicators of nutrient impairment in the AnimasRiver. The ARNW includedpersonnel from the Southern Ute Indian Tribe, New Mexico Environment Department's Surface Water Quality Bureau, State of Colorado Water Quality Control Division, Colorado Division of Wildlife, San Juan Citizens Alliance, City of Farmington New Mexico, City of Durango, Colorado, San Juan Water Commission and other stakeholders in the watershed. Nutrient assessment protocols were developed and implemented throughout the watershed in order that information collected by different agencies would be comparable along with a Sampling and Analysis Project Plan for the project data collection and analyses that was employed(B.U.G.S. Consulting 2009).

The **San Juan Citizens Alliance** interest in the Animas River Nutrient Workgroup was to approach the health of the Animas in a process that was across and beyond political and bureaucratic boundaries. This was an area where the SJCA could operate and that made sense for the health of the river. Although the various staff agency and governmental staffs could not work or spend money across their political boundaries, the ARNW had their support. The sampling and fund raising efforts of the group proved that cooperation could be achieved. The result was a conversation among the various entities that helped them to look forward rather than react in an adversarial, reactive manner and gained the support of funders that realized that this cooperative effort could produce results.

**Chuck Wanner,** Recipient of the Colorado Department of Public Health and Environment's Lifetime Achievement Award for his statewide efforts at preserving streams and rivers.

The ARNW quantified the amount of algae over a 3 year period (2003, 2004 & 2005) at 12 sites from upstream of the City of Durango to the confluence with the San Juan River in Farmington, NM as well as at 4 sites in 2 reference streams (the Piedra and San Juan Rivers) during fall low flows. Synoptic sampling of macroinvertebrates and analysis of water samples for total nitrogen and total phosphorus were also completed to determine the degree, if any, that the Animas River was impaired by nutrients (Anderson, Animas River Nutrient Assessment 2008).

As a result of this effort, coupled with data collected by the New Mexico Environment Department, (Animas River Nutrient Assessment by NMED),the lower reach of the Animas Riverwas put on New Mexico's 303(d) List and a total maximum daily load (TMDL)was prepared to address the impairment on the Animas River(New Mexico Environment Department 2006).

## San Juan Watershed Group

The SJWG has a mission "to protect current and future uses of surface waters in the San Juan watershed (to the Colorado/New Mexico State Line) through identification of water quality concerns and by seeking solutions for problems defined." Their stated goals are to: review water quality standards, identify problem parameters, and assist the New Mexico Environment Department, as needed, in developing total maximum daily loads.

Goals are to:

1. Encourage a balanced approach for bringing problem parameters into compliance,
2. Assist in implementing best management practices to address problems.
3. Develop a comprehensive monitoring strategy,
4. Focus on surface water concerns.

The San Juan Watershed Group was formed in 2001 and includes members from 53 organizations including local, state, federal, and tribal governments, private businesses, non-profit organizations, and one educational institution. In 2005 the SJWG completed a watershed plan (San Juan Watershed Group 2005). During the summer/fall of 2006, the Group performed two intensive synoptic sampling events at 69 tributaries, pipes and inflows and on 31 sites in the Animas River in order to quantify nutrient load inputs, longitudinal nutrient load carried by the Animas River, and algal biomass response. In addition to these synoptic sampling events, the SJWG has performed stormwater sampling and detailed source identification sampling in the Animas River Watershed. These efforts and results are detailed in the 2008 Phase I report to the SJWG (B.U.G.S. Consulting 2008).

A Quality Assurance Project Plan (QAPP), aligned with the New Mexico nutrient assessment protocols, was developed for these sampling events(B.U.G.S. Consulting 2005). A number of irrigation ditch sites were also monitored as follow-up to this nutrient source identification project.

## Southern Ute Indian Tribe Water Quality Program

The Southern Ute Indian Tribe (SUIT) is located in southwestern Colorado and encompasses over 700,000 acres. The Water Quality Program (WQP) of the Southern Ute Tribe has been monitoring surface water at 24 sites across the reservation under a USEPA §106 Water Pollution Control grant since 1992. Data that has been collected by the WQP in the Animas RiverWatershed includes metals, nutrients, macroinvertebrates, algae, temperature and sediment. The WQP also helped form the Animas River Nutrient Workgroup in 2002 in order to address the emerging nutrient concerns in coordination with neighboring water quality management agencies and stakeholders in Colorado, New Mexico and a neighboring Tribe.

## Colorado Department of Health and Environment Water Quality Control Division

The Water Quality Control Division last assessed waters of the San JuanBasin in 2004-2005 as detailed in the 2008 305(b) report for water quality of waters in Colorado (Status of Water Quality in Colorado – 2008. The Update to the 2002, 2004, and 2006 305(b) Reports). Appendix B of the report identifies waterbody segments in the Animas River Watershed in Colorado that are either fully supporting, not supporting, not assessed, or have insufficient information to determine whether or not Designated Uses are being met.Information about Colorado's non-point source program can be found at:http://www.cdphe.state.co.us/wq/nps/index.html.

## New Mexico Environment Department Surface Water Quality Bureau

The New Mexico Environment Department (NMED) non-point source program (http://www.nmenv.state.nm.us/swqb/WPS/) and the Surface Water Quality Bureau published the Final 2008-2010 State of New Mexico CWA §303(d)/§305(b) Integrated Report that identifies water body segment in New Mexico that are not supporting of Designated Uses.NMED, in preparation of the Animas TMDL and as part of their triennial review monitoring, conducted monthly sampling in 2002 and additional sampling between 2003 and 2008.Field observations by SWQB staff in 2002 indicated possible nutrient enrichment during thus prompting collection of additional data in 2003. These data included measurements of nutrient concentrations, algae abundance, dissolved oxygen and pH, limiting nutrient analysis, algal bioassays (algal growth potential analyses), and benthic macroinvertebrate data and were used to apply

SWQB's assessment protocol for plant nutrients. This was part of a coordinated, watershed-based study with the Animas River Nutrient Workgroup that was conducted in Colorado and on Southern Ute lands as well.

## Colorado Division of Water Resources

The Colorado Division of Water Resources (DWR) collects water flow data on a station near Howardsville in the upper Animas River, with 7 other locations measuring flow on tributaries of the Animas River. The DWR collects data including streamflows, lake levels, diversion records, calls, and water rights. This data is available on the DWR website via some data query tools[2].

## Colorado RiverWatch

A cooperative effort between the Colorado Watershed Network[3] and the Colorado Division of Wildlife was initiated in 1989 in response to the need for water quality data and for teachers to find real science efforts to employ in their classrooms.

The Rivers of Colorado Water Watch Network was created with the philosophy of training private and public school teachers and students to collect and analyze samples, because schools will always be in a community and teachers always need to teach concepts related to river ecology. The program began with two primary goals that remain steadfast today. First, to provide a hands-on experience for individuals to understand the value and function of the river ecosystem. Second, to collect quality aquatic ecosystem data over space and time to be used for the Clean Water Act and other water quality decision-making processes.

Colorado RiverWatch activity in the Animas River Watershed varies. At one time most of the monitoring was done by almost every school along the Animas River, including schools in Aztec, NM. Now monitoring is primarily completed by adult volunteers and partnerships. Twelve stations are monitored monthly from Silverton to the state- line for field and metal parameters. Nutrients are collected monthly from Baker's Bridge to state-line in cooperation with Bureau of Reclamation. Nutrients are collected in the upper stations two times per year during high and low flow periods. Field indicators include pH, temperature, alkalinity, hardness and dissolved oxygen. Lab indicators include total and dissolved fractions for twelve metals, total suspended solids, total phosphorus, nitrate/nitrite, ammonia, chloride and sulfate.

This sampling serves to monitor remediation activities by the Animas River Stakeholders Group and characterize nutrient concentrations for the Animas Watershed Partnership. The Bureau of Reclamation assists in this effort by helping monitoring Silverton area stations every other month and about five other stations lower in the basin for the Animas Watershed Partnership. These data sets are combined for the respective groups and monitoring questions. Data can be obtained on the River Watch Website (www.wildlife.state.co.us/riverwatch/), the Colorado Data Sharing Network site (http://www.codsnstoret.org).

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[2] http://water.state.co.us/pubs/datasearch.asp#tabData

[3] Now operated by the Colorado Watershed Assembly, http://www.coloradowater.org/

## Bureau of Reclamation

Along with Colorado RiverWatch, the Bureau of Reclamation collects monthly water samples at 17 stations and analyzes the samples for a suite of nutrients. The BOR is responsible for the Animas La Plata Project which has been diverting water from the Animas River since 2009.

## US Geological Survey Nutrient Data

The USGS has conducted long-term quarterly sampling of nutrient concentrations at two sites on the lower AnimasRiver and one site on the San Juan River near the confluence with the Animas Riverwith over 30 years of record at each site. These stations provide means for calculating a distribution of seasonal data for trend and central tendency analysis. The USGS also runs a real-time flow gauging program with 6 gages on the Animas River and 2 on tributaries on the Animas River near Silverton, Colorado (Table 10). The USGS has the most comprehensive monitoring network in the Animas River Watershed in terms of length of time taking water quality measurements and the number of sites visited. Monitoring is ongoing as funding and program priorities dictate. The most recent water quality measurements were collected at Silverton, CO and Farmington, NM in December 2008, with no other stations having water samples collected since 2004.

## San Juan Watershed Woody-Invasives Initiative

The mission of the SJWWII is to plan for and implement comprehensive and culturally-sensitive restoration of riparian communities, to eradicate woody invasive species in the San Juan Basin, and to provide coordination, resources and technical assistance.

## Southwest Wetlands Focus Area Wetland Group

Wetland Focus Areas in Colorado are designated by the Colorado Division of Wildlife. Currently, Colorado has 10 official Focus Areas, with the Southwest Focus Area being the newest. Official designation was granted to the Southwest Focus Area in August of 2001. The concept of Focus Areas is part of the Colorado Wetland Wildlife Conservation Program, and it is the Focus Areas that help to implement the goals of the Colorado Wetlands Program at a local level.

## Friends of the Animas River

Friends of the Animas River (FOAR) is a registered 501(c)(3) located in Durango, Colorado. FOAR was started in 1993 by a group of citizens in an effort to protect the AnimasRiver and other riverine systems located in the Southwest. FOAR is committed to ensuring that the AnimasRiver and its watershed remains a healthy ecological system. FOAR has become an integral part in the ongoing protection of this valuable, natural resource.

## Colorado Division of Wildlife

The mission of the Colorado Division of Wildlife (CDOW) is to perpetuate the wildlife resources of the state and provide people the opportunity to enjoy them. The CDOW just finished a strategic plan for 2010 – 2020 and can be found at:http://wildlife.state.co.us/About.

## Southern Ute Wildlife Division

The Department of Natural Resources is empowered by the Southern Ute Indian Tribal Council with the mission to develop, administer and manage the natural resources of the Southern Ute Indian Reservation for the benefit of the Tribe and Tribal Members. The Department is entrusted with promoting the beneficial use, protection, conservation, preservation, and developmental enhancement of the Tribe's natural resource by using sound administrative, ecological, cultural, socioeconomic and educational methods for the benefit of present and future generations."
The Wildlife Resource Management Division und Natural Resources is primarily responsible for managing, protecting and enhancing the diverse and abundant wildlife and fisheries resources of the Southern Ute Indian Reservation. Division staff carry out a wide variety of functions, including developing and managing Tribal hunting and fishing programs, field research on fish and wildlife populations, enhancing fish and wildlife habitats, developing Tribal wildlife conservation policies, working cooperatively with Federal and State wildlife management agencies, providing wildlife educational programs, managing the Tribe's bison herd and assistance with clearances and environmental assessments related to development or land-disturbing activities.

## New Mexico Game and Fish

The mission of the NMG&F is: to provide and maintain an adequate supply of wildlife and fish within the state of New Mexico by utilizing a flexible management system that provides for their protection, propagation, regulation, conservation, and for their use as public recreation and food supply.

## Southwestern Water Conservancy District

The Southwestern Water Conservation District (SWCD or District) was created by the State of Colorado legislature through House Bill #795 which was approved by the General Assembly on April 16, 1941. The District serves the southwest Colorado counties of Archuleta, Dolores, La Plata, Montezuma, San Juan, and San Miguel, as well as portions of Hinsdale, Mineral, and Montrose. The District is funded through a mill levy on real property.The purpose of the District is many fold and includes surveying existing water resources and basin rivers, taking actions necessary to "secure and insure an adequate supply of water - present and future", constructing water reservoirs, entering into contracts with other water agencies, organizing special assessment districts (known as conservancy districts), providing for instream flows for fisheries and other legal responsibilities needed by the District to fulfill its purposes.

## Animas-La Plata Water Conservancy District

The Animas-La Plata Water Conservancy District (ALP) is a special district formed on March 18, 1981 as set forth in C.R.S. 37-45-102. The territory included within the boundaries of the District are divided into three subdivisions with Directors appointed from each.The general purpose of the District includes, but is not limited to: "acquire and appropriate waters of the Animas and La Plata rivers and their tributaries and other sources of water supply by means of "works" as defined in the "Water Conservancy Act" and to divert, store, transport, conserve and stabilize all of said supplies of water for domestic, irrigation, power, manufacturing and other beneficial uses within and for the territory to be included in the District."

### San Juan Water Commission

The San Juan Water Commission, through a Joint Powers Agreement was created on March 5, 1986, to protect the use of future and existing water rights and water resources of its member entities. The San Juan Water Commission's member entities include the City of Aztec, City of Bloomfield, City of Farmington, San Juan County, and San Juan County Rural Water Users Association, all of which receive their municipal and industrial water from surface water supplies. Over 60% of New Mexico surface waters are San Juan River flows. The Colorado River Compact (1922) divided the water between the upper and lower Colorado River Basin states. Later, the upper Colorado Basin states divided the upper basin share, New Mexico received 11.25% of the annual upper basin water.

### San Juan Recovery and Implementation Program

The SJRIP is designed to help recover the Colorado Pikeminnow and the Razorback Sucker while allowing water development to continue in the San Juan River Basin. Their web site contains information regarding the activities of the SJRIP and other related activities (http://www.fws.gov/southwest/sjrip/).

### Farmington Stormwater Program

The City of Farmington has collected samples at 13 urban outfall sites on 12 dates between February 2007 and May 2008, as part of their Stormwater Program[4]. Parameters measured include nutrients, bacteria, metals, and physical parameters such as specific conductivity, temperature, and pH. This is an ongoing monitoring program.

### Durango Stormwater Program

The City of DurangoCity of Durango requires the implementation of stormwater treatment facilities that are in accordance with the Urban Drainage and Flood Control District's (UDFCD) Urban Storm Drainage Criteria.

## Section II. Inventory of the Watershed

The purpose of this section was to describe natural features such as geography, geology, soils, land cover, climate, hydrology and land cover as well as anthropogenic features such as politics demographics, recreation, economics, certified drinking water sources, agriculture land practices, diversions, point discharges water treatment plants, threatened and endangered species and land-use patterns that may currently or in the future affect water quality in the Animas River.

[4]http://www.fmtn.org/city_government/public_works/stormwater_management.html.

# Natural Features

## Geography

The headwaters of the AnimasRiver originate in southwestern Colorado in the San Juan Mountains. The watershed is 1,357 square miles. The Animas River flows through the Towns of Silverton, CO, Durango, CO, Aztec, NM, Flora Vista, NM and to the Confluence with the San Juan River that lies within the town of Farmington, NM. Within the State of Colorado theAnimas River also flows through the reservation of the Southern Ute Indian Tribe (SUIT). Counties in the Watershed include San JuanCounty in Colorado, La PlataCounty in Colorado and San JuanCounty in New Mexico. The reservation of the Southern Ute Indian Tribe and the State of Colorado are under the jurisdiction of the Environmental Protection Agency's Region 8 and New Mexico is under the jurisdiction of EPA Region 6.

The New Mexico portion of the AnimasRiver watershed is approximately 277 $mi^2$ and includesseveral ephemeral tributaries. The Colorado portion is approximately 1,080 $mi^2$ and of that there is approximately 170 $mi^2$ within the boundaries of the Reservation of the SUIT.

In NM, land ownership within the Animas River Watershed is 34% private, 60% BLM, and 6% State land.  Land use includes 56% forest, 8% agriculture, 29% rangeland, 5% built-up land, 1% water, and less than 1% wetlands and barren land.

The total land area of La PlataCounty is 1,083,085 acres (1,692 sq. miles). Of these, 43% are private lands, 16% are tribal lands (Southern Ute and Ute Mountain Ute), and 41% are state and federal lands. Agricultural land comprises 25% of the total land in La PlataCounty. The boundaries of the Southern Ute Reservation encompass about 681,000 acres. The Tribe has approximately 309,000 surface acres of trust land, and another 4,000 acres of allotted land. The remaining 368,000 acres within the reservation boundary are privately owned or belong to government agencies. Land use on the Reservation within the boundaries of the SUIT is primarily undeveloped with roads and well pads serving coal-bed methane extraction.

San Juan County in Colorado is 250,880 acres. Of these 28,000 acres is private, 172,000 acres is National Forest, 49,000 acres is BLM, and the State of Coloradoowns1,880 acres.

## Geology

Different types of rocks differ in their erosional capacity and chemical constituents, each with various impacts on water quality. For example: rocks in the headwaters of the Animas River have high levels of metals and sedimentary rocks found from just below Silverton, Colorado downstream on the Animas may have high levels of phosphorus.

The geology of the western San Juan Mountains in the region of the AnimasRiver headwaters has rock types representing every geologic era from the Proterozoic to Cenozoic. Precambrian rocks are exposed south of Silverton along the AnimasRiver and are part of an uplifted and eroded surface. Many of the rocks contain calcite which is important for their acid-neutralizing potential.

Below Silverton, the Animas River flows through a deeply incised canyon until just above the confluence with Hermosa Creek where the river empties into the broad, Animas River Valley and becomes a meandering river through riverine deposits.

At Durango, the Animas River flows through glacial moraines and changes to a steeper gradient and flows across the geological formation known as the Fruitland outcrop and into the San Juan Basin (Figure 2 and Figure 3).

The Fruitland outcrop is a complex anticline with a number of layers of sedimentary strata that include: Kirtland Shale, Fruitland Formation, Lewis Shale, Mesa Verde Group, Mancos Shale, Dakota Sandstone, Morrison Formation, Entrada Sandstone, and Chinle Formation.

The San Juan Basin is a large depressed region in northwestern New Mexico and SW Colorado. Cretaceous and Tertiary sedimentary rocks bow down in the San Juan basin into a large, shallow sag approximately 100 miles across. The geology of the Animas River Watershed in the San Juan Basin is predominantly comprised of the Tertiary Nacimiento Formation with limited areas of the San Jose Formation near the northeast section of the New Mexico portion of the Animas River Watershed.The sedimentary rocks that fill the San JuanBasin contain both source rocks and natural reservoirs for oil and gas and the San Juan basin gas field contains many well sites and roads. The gas is found several thousand feet below the surface.

## *Land Cover and Ecoregions*

Ecoregions (Figure 4) denote areas of general similarity in ecosystems and in the type, quality, and quantity of environmental resources.They are designed to serve as a spatial framework for the research, assessment, management, and monitoring of ecosystems and ecosystem components. These general-purpose regions are critical for structuring and implementing ecosystem management strategies and monitoring strategies across federal agencies, state agencies, and non-government organizations that are responsible for different types of resources within the same geographical areas. Ecoregion data also reveals land cover-types and therefore reflects the amount of erosion that may take place in a landscape and thus the effect on water quality.

Ecoregions of Colorado can be viewed at http://www.epa.gov/wed/pages/ecoregions/co_eco.htm and ecoregions of New Mexico at: http://www.epa.gov/wed/pages/ecoregions/nm_eco.htm.

## *Climate*

The climate in the watershed is characterized by a steep gradient where average annual precipitation ranges from 44 inches in the highest elevations (over 13,000ft) to 13 inches in the lower elevations at5,500ft (Figure 5). The primary sources of precipitation in the watershed are winter snowfall and late summer monsoonal thunderstorms. Where approximately 40% of the watershed is above 8,000 feetand higher, the snowpack typically accumulates throughout late fall to early spring. The winter snowpack is an essential element of water storage where the volume of water stored in the snowpack is greater than the demand and the storage capacity of area reservoirs. Lemon Reservoir on the Florida River, a major tributary of the Animas River, was built in order to store runoff from snowmelt and precipitation after the snowmelt season.

### *Hydrology*

Streamflow in the Animas River is typical of mountain streams of the southern Rocky Mountains. Streamflowis dominated by snowmelt runoff, which typically occurs between April and July peaking in late May or early June and decreasing in July. Snowmelt runoff is augmented by monsoon rains from July through September. Low streamflow conditions exist from late August to March. Base streamflow in the study area is maintained by ground-water flows.Historical and live stream flow conditions in Colorado can be found at: http://waterwatch.usgs.gov/?m=real&r=co&w=map and in New Mexico at: http://waterwatch.usgs.gov/?m=real&r=nm&w=real%2Cmap.

## Anthropogenic Features

### *Water Rights*

Water rights in Colorado are governed by the Colorado Doctrineand water in Coloradocan legally be diverted for a purpose and used beneficially to obtain a water right. Beneficial use is the use of a reasonable amount of water necessary to accomplish the purpose of the appropriation, without waste. Some common types of beneficial use are: irrigation, municipal, wildlife, recreation, mining, and household use.

InNew Mexico, water law is based on the doctrine of prior appropriation or "first in time - first in right." All waters in New Mexico are declared to be public and subject to appropriation for beneficial use. There are five basic components of a water right in New Mexico: point of diversion (or constructed work), place of use, purpose of use, owner, and quantity. Although these factors are statutorily required, past court decisions, legal opinions, and the discretion of the state engineer allow flexibility in the interpretation of these basic requirements.

Water rights data and use information in New Mexicocan be found at: http://www.ose.state.nm.us/waters_db_index.html. Colorado water rights and use data and information can be found at: http://cdss.state.co.us/DNN/Home/tabid/36/Default.aspx.

The Decision Support System in Coloradoprovides a wide range of water related research tools that are available online free of charge. These tools enable users to retrieve water data contained within HydroBase; including streamflows, lake levels, water rights, diversion records, calls, etc..Map Viewer is a map based tool available online and free of charge. This tool enables users to view data layers on a map. Layers include climate stations, stream gages, diversion structures, well permitsand land use studies. Productsis a list of all of the products produced by the Decision Support System. Includes links to consumptive use, data management interfaces (DMI) utilities, GIS data, ground water model, surface water model, water budget, and other products.

### *Demographics*

The population estimate for San Juan County, Colorado in 2005 was 577. San Juan County, NM population estimate in 2004 was 124,166 (59% urban, 41% rural), an increase of 9.11% from the 2000 census. The population estimate for La PlataCounty in 2005 was 47,452 (35% urban, 65% rural).The latest population estimate for the Southern Ute Tribal membership (2006) was 1,365

persons. About 75% of the Tribal members live on the reservation.In Durango,CO the estimated population in July 2007 was 16,007 and the population change since 2000 was plus 14.3%
In 2000 the population of Flora Vista, NM was 1,383 and in Aztec, NM the population in July 2007 was 6,810, a 6.8% increase since 2000. The estimated population of Farmington, NM in 2003, was 41,420.

## *Economics*

Economic statistics are available from the Bureau of Economic Affairs and from the United States Agricultural Service. Information regarding compensation by industry, employment structure and breakdowns of farm incomes are available for each of the Counties in the Animas Watershed. Of particular interest to water quality is data on the agricultural sector (Table 1, Table 2, Table 3, and Table 4). Agriculture has a disproportionate, negative impact on the river when compared to beneficial employment and economic statistics in the watershed. Data is not available for recreational use of the river which includes fishing, rafting and kayaking. Region 9 economic data in Colorado can be found at: http://www.scan.org/regional_data.html. Economic data for San Juan County can be found through the San Juan Economic Development Services at: http://www.sanjuaneds.com/.

## *Agriculture*

The growing season for high elevation areas are often shortened by frost in the late spring and early fall. The 20% of the watershed that falls above 9,000 feet can reach sub-freezing temperatures throughout the year. The growing season in the lowest elevations of the watershed is where most agriculture is concentrated and is approximately 100 days.

The Wilderness Society published an economic profile of La Plata County in 1997(Wilderness Society 1997). This document illustrated how the county has changed economically over a 25-year period. As has happened in many areas of the country, between the years of 1970 and 1997 agriculture has been in steady decline since its peak in 1975. Agricultural-related income in La Plata County had fallen from 5% of total personal income in 1972 to 0.4% in 1997, and agricultural-related employment had declined from a 10% high in 1970 to 4% of total employment in 1997. This decline is credited as a response to a decrease in agricultural commodity prices and the significance of agricultural income as other sectors of the economy, such as service, retail, construction and trade expanded (Table 1). Over 95% of the water diverted from the Animas River is used for the Agricultural sector. The rest is used for municipal and industrial purposes.

Within the agricultural employment sector there has been an increase in employment in the agricultural services category. This encompasses off-farm, agriculturally related jobs such as machine repair, bookkeeping, administration, science, research and transportation (Table 2).

Within the Animas River Watershed in San Juan County, NM, agriculture is similar to that found in La PlataCounty. The statistics in New Mexico, however, reflect the progress of the Navajo Agricultural Products Industry (NAPI) which is not within the boundaries of the Animas River Watershed and are not typical of the agriculture that is found along the Animas River in New Mexico.

The majority of agriculture land in the Animas River Watershed is found within the Florida River Watershed, a major tributary of the Animas River and a major contributor of agricultural related pollutants. The majority of irrigation in the watershed is accomplished by flood irrigation, a very inefficient but inexpensive method of irrigating farmland that results in a number of pollutants, such as warm water, sediment, nutrients and salts entering Animas River (Table 5 and Figure 6). A method of reducing the amount of polluted runoff to rivers is through a sprinkler irrigation system and according to the local USDA Natural Resource Conservation Service (NRCS) office, irrigators on the Florida Mesa and Oxford tracts are converting about 500 acres from flood to sprinkler irrigation each year, utilizing a financial assistance program offered through the NRCS (EQIP).

## *Diversions*

Structures that divert surface and ground water occur within the AnimasRiver channel throughout the watershed and dramatically reduce stream flows of the AnimasRiver. Water from the Animas River is diverted for a variety of uses, though the majority is for irrigation purposes primarily to grow hay, maintain pastures for livestock and irrigate lawns and golf courses. Commercial uses (i.e. making snow) also divert water from the stream during winter months.

The larger diversions along the Animas River are associated with agricultural purposes and not all of the water is utilized by the crops, especially on hobby farms where there is very little oversight or consideration to the amount of water applied to a field. Thus, there is leftover water that flows back to the Animas River from agricultural fields.Agricultural return flows are warmer, with less oxygen and carry a number of pollutants, especially sediment and nutrients. Diversions also result in reduced water in the river channel, especially during late summer and early fall low flows when demand for watering crops is at the highest, resulting in warmer water temperatures and less oxygen.

The offices of the Colorado and New Mexico State Engineers have databases that make the agency's water rights records readily accessible[5]. The databases provide individual water right claims in New Mexico and Colorado and their point of diversions in the watershed. Using these databases, one can obtain information concerning water use, including data about domestic, irrigation, commercial and other types of water rights, the location of specific water rights, and the owners of those water rights. In particular, users can find out how

**Animas- La Plata (A-LP) Project**

The A-LP project was authorized in 1968 through the Colorado River Basin Storage Project Act. Water shares are divided between the: A-LP Water Conservancy District, La Plata Water Conservation District (NM), Navajo Nation, San Juan Water Commission (NM), State of Colorado, Southern Ute Indian Tribe and the Ute Mountain Ute Tribe. The two Ute tribes own 80% of the water, Navajo Nation own less than 1%, Colorado owns 10% and Durango owns 3%. The project is 99% complete and cost 574 million dollars. There are 108 environmental compliances that have to be met. During May the Animas River must at have a flow of at least 280 cubic feet per second (cfs) and during the summer months the cfs must be at least 225cfs and for winter, 125 cfs and in the fall, 160cfs. If these standards are met than the A-LP project can pump water.

[5] Water rights data and use information in New Mexico can be found at: http://www.ose.state.nm.us/waters_db_index.html. Colorado water rights and use data and information can be found at: http://cdss.state.co.us/DNN/Home/tabid/36/Default.aspx.

much water is in use under permits in a water basin, track changes in water use patterns, bring together regional data on water use, and compile and analyze data to build water use models. A search of the databases reveals over 700 records of water rights claims and other structures that affect water within the Animas RiverWatershed. Organizing these claims and looking at the amount of water being diverted from the river shouldbe accomplished in order to complete existing and potential loading analysis of pollutants to the river. Building in-stream diversions that do not degrade the functioning capacity of the river or impede fish passage is important.

A major diversion, the Animas-la Plata Project, has begun diverting up to 280cfs from the Animas River in 2009. The sewage outfall from the Durango Sewage Treatment Plant has been located below this diversion that may result in between a 2 to 3 times increase in the concentration of sewage effluent in the river downstream of the ALP diversion. Also, return flows from the project will be put into the river at Basin Creek. It is unclear how the operation of the ALP will affect water quality in the river or what the quality of the return flows from the ALP will be and their effect on the river.

## Drinking Water Sources

Use of AnimasRiver or groundwater sources in the watershed for domestic uses affects both the quantity of the water in the river as well as management of the river. There are 18 entities (Table 6) within the watershed that have permits for providing drinking water to customers. The total withdrawal of fresh water for domestic uses in San Juan County, New Mexico is 17.29 million gallons per day (2% from groundwater sources and 98% is from surface water sources). Total withdrawal of fresh water for domestic uses in La Plata County is 7.01 million gallons per day (18% is from groundwater and 82% is from surface water sources, data from: http://www.city-data.com/county/).

Information on sources of drinking water in La Plata County can be found at (Web Link) and information on sources of drinking water San Juan County can be found at: (Web Link).

## Discharge Permits

There are 29 discharge permits in the Animas River Watershed (Table 7, and Figure 7). The towns of Silverton, CO, Durango, CO and Aztec, NM have larger, municipal treatment plants that discharge into the Animas River. A number of other permits exist for small, waste-water treatment plants that serve resorts or mobile home parks. Other discharge permits are for hardrock mining in the Silverton area or for gravel mining north of Durango in the Animas River Valley (See Envirofacts at: http://www.epa.gov/enviro/index.html)

## Waste Water Treatment

Waste products from waste-water treatment plants contribute organic matter into aquatic systems and highly available forms of nitrogen and phosphorus. These additions result in increases in algal growth. The algal growth reduces dissolved oxygen levels and impacts habitat quality through the process of eutrophication.

## Threatened, Endangered and Sensitive Species

Management of threatened and endangered species is significant to the AnimasRiver because the San Juan River downstream of the Animas Riveris the site of a the San Juan Recovery Implementation Program (SJRIP). The SJRIP has thepurpose to protect and recover endangered fishes in the San JuanRiver basin while water development proceeds in compliance with all applicable Federal and State laws. Endangered species include the Pikeminnow (formerly known as the Colorado Squawfish), or *Ptychocheilus lucius*, and the Razorback Sucker, or *Xyrauchen texan*us. It is anticipated that actions taken under this Program will provide benefits to other native fishes in the basin and prevent them from becoming endangered in the future. The SJRIP Hydrology Committee provides oversight regarding hydrologic data and models used in the SJRIP. The SJBHM is used to simulate and assess the impacts of various levels of water development or depletion scenarios on stream flows and determine if the flow criteria could be met with a given level of development. The model is a guidance tool only.

**From: Mike Meschke, San Juan Basin Health Department**

One point important to any Colorado or USA waterway discussion is the lack of treatment for complex & persistent compounds of a manmade nature. Many chemicals are known as endocrine disruptors. Also, Colorado treatment standards, as well as national, allow discharge permits which are above the drinking water standards for the parameters that they do list, a cause for concern (e.g., nitrates). In one generation globally, our fish have acquired unsafe levels of mercury (from atmospheric sources), and many waterways suffer dramatically before discharging to an ocean, creating large dead zones, where there used to be prolific sealife.

The list of continuing damage from an environmental cocktail of low-dose poisons is getting pretty long.

**Relevent Links:**

http://www.americanrivers.org/our-work/clean-water/sewage-and-stormwater/pharmaceuticals-and-personal.html

http://www.epa.gov/ppcp/

Other fish species of concern in the Animas River include: roundtail chub (Gila robusta), flannelmouth sucker (Catostomus latipinnis), and bluehead sucker (Catostomus discobolus). Colorado River cutthroat trout are a species of concern and a significant restoration effort is occurring in the upper part of the watershed.

The Southern Ute Indian Tribe the Colorado Division of Wildlife (CDOW) and the New Mexico Game and Fish maintain lists of sensitive fish and monitor fish populations in the AnimasRiver and tributaries. The NM Game and Fish mention the Animas River as a possible stream within which to recover Roundtail Chubs.The CDOW maintains cutthroat populations in Dry Creek and Hermosa Creek and regularly stock trout for recreational fishing. They also maintain a Gold Medal Fishery in the Animas River below Durango. The SUIT also stocks significant amounts of recreational fish (trout) annually, and maintains a trophy regulation stretch on SUIT lands.

# Section III. Water Quality Monitoring Data

## *Monitoring Entities*

Water quality monitoring has been completed in the Animas River Watershed since 1900, with over 165,000 measurements of various physical, chemical, and biological water quality parameters at over 250 locations (Table 8). Many of the 13 agencies and stakeholder groups listed in Table 8 are actively collecting water quality data in the Animas River Watershed. The date ranges and number of results in Table 8 refer to the contents of the database created and updated for the purposes of the Animas Watershed Partnership.

This extensive data record is useful for identifying water quality tendencies and trends at visited locations. There is currently a need to coordinate the numerous monitoring efforts that occur in the AnimasRiver. The Colorado Water Quality Monitoring Council hosts the Data Sharing Network[6], which provides a means for sharing data for monitoring locations in Colorado. The following are descriptions of past and current monitoring activities at each agency or stakeholder group listed in Table 8.

## *Sampling and Analysis Project Plan (SAPP) Development*

A Sampling and Analysis Project Plan (SAPP) was developed for the Animas Watershed Partnership(B.U.G.S. Consulting 2009). Cooperating agencies include the Colorado Department of Public Health and Environment, New Mexico Environment Department, Colorado Division of Wildlife, and the cities of Durango and Farmington. The SAPP served as guidance and protocol to sampling and analysis efforts conducted along the Animas River watershed among the various stakeholders and monitoring agencies. The SAPP is focused on the effects of nutrient enrichment, as this has been identified as the initial focus for the Animas Watershed Partnership.

## *Water Quality Database*

The water quality database compiled and updated for this project consists of data sourced from the following databases, with websites footnoted for databases that are available over the internet:

- BUGS Consulting (Proprietary Company Database, various projects)
- EPA Storet[7]
- EPA Legacy Storet[8]
- Southern Ute Indian Tribe (Proprietary Tribal Database, limited access Storet)
- USGS National Water Information System[9]

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[6] http://cwqmc.coloradowatershed.org/
[7] http://www.epa.gov/storet/dw_home.html
[8] http://www.epa.gov/storpubl/legacy/gateway.htm
[9] http://waterdata.usgs.gov/nwis

## Data Elements

Over 1,300 water quality parameters have been measured in the Animas River Watershed for the period of record in the Water Quality Database. These parameters include physical measures (such as river flow, electrical conductivity, and temperature), chemical measures (such as organic compounds, nutrient concentrations, metal concentrations), and biological measures (such as macroinvertebrate community, algal biomass, and bacteria). The bulk of data are physical and chemical, where recent efforts by the Southern Ute Indian Tribe, the Animas River Nutrient Workgroup, and the San Juan Watershed Group have begun to add substantial biological data in the Animas River Watershed.

## Future Data Sharing and Repository

A relatively recent database called the Data Sharing Network[10] has been created at the Colorado Water Quality Monitoring Council[11]. This database may be an important component in facilitating data sharing within the Animas River Watershed. At this point, it is very time consuming to convert the wide variety of databases within the Animas River Watershed to a common format for analysis. This task has been completed with funding for the AWP, however, it is recommended to seek new tools to facilitate database compatibility for future efforts. The Data Sharing Network, may play a role in optimizing data analysis efficiency and the AWP needs to decide what to do with future data and compiled legacy and data collected by the Bureau of Reclamation over the last several years..

# *Geographic Information System*

A Geographic Information System (GIS) was initially developed by the San Juan Watershed Group, where numerous updates and additions were made with the AWP funding. The core elements of the GIS Database include layers that address:

- Land Cover Data
- Land Disturbance Layer
- Geology, Topography
- National Pollution Discharge Elimination System (NPDES) Permit Locations
- Drainage Network: natural and man-made
- Digital Orthophotos
- AnimasRiverInflow GPS Database
- Animas River Bank Database

The Land Cover and Geology data were sourced from the Southwest Regional GAP Program[12]. The Land Cover data was amended with gas well point locations derived from the New Mexico Oil Conservation Division and the Colorado Oil and Gas Conservation Commission. The Land Cover data was also amended with the Missionary Ridge fire area. The NPDES Permit Locations were acquired from the USEPA[13]. Digital orthophotos were collected for the project

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[10] http://www.codnsstoret.org, http://codsnarcdev.goldsystems.com
[11] http://cwqmc.coloradowatershed.org/
[12] U.S. Geological Survey Gap Analysis Program, multiagency cooperative project. http://fws-nmcfwru.nmsu.edu/swregap/
[13] USEPA Geospatial Data Access http://www.epa.gov/enviro/geo_data.html

area. Imagery consists of New Mexico Office of State Engineer color infrared captured in September 2003, and black and white orthophotos from the USGS 1998.

Virtually all the inflows to the Animas River from the New Mexico state line to the confluence with the San Juan River, ranging from pipes of various size to natural tributary drainages, were mapped with sub-meter GPS and attributed with photographs. The locations where a water quality measurement was taken are also attributed with the water quality results. In addition to inflows, actively eroding banks and armored banks were also mapped with GPS. Bank armoring includes vehicles, various grades and size of rip-rap, and engineered bank stabilization projects.

A number of these core GIS layers were updated, added, or created with AWP funds. These updates include:

- Water Quality Tendencies GIS layers for the Animas River Watershed
- Land Use/Land Cover data update with Missionary Ridge Fire area
- Point Source Pollution update
- Natural Drainage Network update
- Irrigation Network from the Natural Resources Conservation Service GPS project
- Colorado Division of Water Resources GIS data

## Water Quality Tendencies

GIS layers were created for the Animas Watershed Partnership, which includes descriptive statistics for each parameter at each station within the Animas River Watershed. These GIS layers were calculated from the Water Quality Database described above. This allows summary results or results for a specific monitoring run to be symbolized on a map. The database created for this project can also be used for plotting water quality tendencies, summary information, or values from a specific monitoring event.

## Land Use/Land Cover

The Land Cover data were sourced from the Southwest Regional GAP Program[14]. The Land Cover data was amended with gas well point locations derived from the New Mexico Oil Conservation Division and the Colorado Oil and Gas Conservation Commission. The Land Cover data was also amended with the Missionary Ridge fire area with AWP funds.

## Point Source Pollution

The NPDES Permit Locations were updated from the USEPA[15]. Permit compliance information and additional information on NPDES permits can be found on the EPA Enforcement & Compliance History Online (ECHO) website[16].

[14] U.S. Geological Survey Gap Analysis Program, multiagency cooperative project. http://fws-nmcfwru.nmsu.edu/swregap/
[15] USEPA Geospatial Data Access http://www.epa.gov/enviro/geo_data.html
[16] http://www.epa-echo.gov/cgi-bin/get1cReport.cgi?tool=echo&IDNumber=110024382498

## Natural Drainage Network

The USGS National Hydrography Dataset (NHD) was updated for the San JuanBasin, providing high resolution locations for rivers, ephemeral streams, major irrigation ditches, springs, and wells[17]. The NHD is periodically updated by the USGS, as new mapping detail becomes available. The NHD can also be linked to recently developed databases and tools such as WATERS (Watershed Assessment, Tracking & Environmental ResultS), which unites water quality information from several EPA databases in the spatial framework of the NHD[18].

## Irrigation Network

The USDA San Juan Natural Resources Conservation Service has been mapping irrigation ditches within the Animas River Watershed, and the San Juan Basin with sub-meter GPS. All currently available GPS datasets for individual ditch systems was compiled into a single, quality controlled GIS layer in the Animas GIS Database.

[17] http://nhd.usgs.gov/
[18] http://www.epa.gov/waters/

# Section IV. Water Quality Issues

## *Water Quality Impairments*

A survey of the AnimasRiver by personnel of the NMED Surface Water Quality Bureau during the summer of 2002 found that the streambed contained anaerobic, fine-grained sediment. During the same period, biologists and river users within Colorado and the Southern Ute Indian Reservation noticed large quantities of algae. These observations suggested that the assimilative capacity of the Animas River for nutrients was exceeded. The 2002 monitoring also revealed high bacterial levels along the lower Animas Riverand excessive nutrient loading in the Animas River (Anderson, Animas River Nutrient Assessment 2008).

Synoptic sampling by the SWQB and the ARNW in 2003 and 2004 confirmed these findings which resulted in the 303(d) listing of the AnimasRiver for not supporting Cold Water Aquatic Life and Warm Water Aquatic LifeBeneficial Use Designations on the Animas Riversegment from Estes Arroyo at Aztec to the confluence of the San Juan River. It was estimated that approximately 90% of the measured loads werefrom nonpoint sources (New Mexico Environment Department 2006). The stated likely stressors associated with the nutrient enrichment listing were:

- Municipal Point Source Discharges
- Municipal (Urbanized High Density Area)
- On-site Treatment Systems (Septic Systems)
- Channel Modifications
- Loss of Riparian Habitat
- Flow Alterations from Water Diversions
- Petroleum/Natural Gas Production Activities
- Irrigated Crop Production
- Rangeland (Unmanaged Pasture) Grazing
- Drought Related Low Flows

In 2005, aTotal Mass Daily Load (TMDL) was completed in order to address nutrient enrichment on the AnimasRiver between Estes Arroyo and the confluence with the San Juan River. The TMDL called for load reductions in both nitrogen and phosphorus.

## *Water Quality Issues Scoping*

The following sections of this report detail the general water quality stressors in the Animas River Watershed, as identified by the stakeholder processes in the watershed.Figure 8 shows an overview of some of the issues with water quality.

## *Overall Critical areas*

1. Between Baker's Bridge and Trimble Lane there is approximately 3 miles of abandoned in-stream gravel pits that needs repaired in order to restore the functioning capacity of the river. This reach is particularly important for reducing the impacts of historical mining

from the upper Animas River to the lower Animas River and sources of nutrients from Silverton, Cascade Village, Durango Mountain Resort, and Fairfield Resort.

2. The river reach between Trimble Lane and 32nd street has approximately 20 miles of eroding stream bank resulting in an almost 100% disconnect between the riparian ecosystem and the river that requires repair to reduce loading of nutrients and to restore the functioning capacity of the river in this reach. Trimble Lane to 32nd street will require at least 25 miles of reconnection of the river to the riparian ecosystem and 5 miles of repairing stream banks as well as reducing nutrient loading from subdivisions, the Dalton Ranch Golf Course the effluent of the Hermosa Sanitation District.
3. The river reaches between 32nd street and Basin Creek are impacted primarily by urban runoff from the City of Durango. The river reach through Durango will require reducing sediment and pollutants from storm water urban runoff, protecting the riparian community as much as possible and reducing nitrogen and phosphorus loading from the Durango and South Durango Waste Water Treatment Plants.
4. Near the middle of Durango Reach is a perennial tributary, Lightner Creek, which has been the focus of recent efforts to reduce sediment deposition. Lightner Creek has been identified as a major loader of nutrients to the Animas River.
5. The functioning capacity of the river reach within the SUIT Reservation, between Basin Creek and the State Line, is in good shape. There are, a myriad number of inflows with significant amounts of nutrient loading from the flood irrigation practices on Florida Mesa and the floodplains of the Animas River and within the Florida River watershed, a perennial tributary to the Animas River and,
6. The Florida River, a perennial tributary to the Animas River contains significant amounts of flood irrigated agricultural land containing trans-basin irrigation water from the Pine River resulting in high loading of sediment and nutrients to the Animas River.
7. The reach between Aztec, NM and the confluence with the San Juan River will require from 20 to 25 sites having BMPs implemented along with significantly reducing the effects of urban runoff from the City of Farmington and eliminating leaking septic tanks that have effluent reaching the Animas River. Small tributaries of the Animas River, such as Kiffen Canyon, NM where a BMP project is being completed, will require repairing road and pipeline crossings that negatively impact the geomorphology of these tributaries leading to loading of nutrients especially during storm events.

There are more sites within the perennial and ephemeral tributaries of the reaches in Colorado and New Mexico where road and pipeline crossings have altered channel morphology and increased erosion into the Animas River that require identification and repair (*i.e.* as identified on the Kiffen Canyon BMP and in the Source Identification Report).

## NonpointSources

The AnimasRiver is impacted by a multitude of both point and nonpoint sources of pollution. The river corridor contains industry, agriculture, municipalities, a growing human population, and private land use practices. Water is diverted for irrigation, industrial, and municipaluses and is returned after draining from agricultural fields and treatment plants. Non-point sources from snowmelt and stormwater roadways, rooftops, parking lots.  As a result, water quality in the river varies from reach to reach and some stretches support diverse, biological communities while others less so.

## Sedimentation

Several environmental concerns are associated with sediment loads in the river. Sediment that settles out of the river can fill the river bed, destroying important fish habitat, reducing survivability of fish and impeding decomposition and reduce the functioning capacity of the river and its ability to assimilate pollutants. Nutrients, especially phosphorus, are attached to sediments (Riley 2009).

Between 2000 and 2002, two sections of the AnimasRiver between its confluence with the San Juan River and the New Mexico-Colorado Border were listed as impaired under the section 303 (d) of the Clean Water Act for stream bottom deposits. The two stretches were from the mouth at the San Juan River to Estes Arroyo and from Estes Arroyo to the New Mexico-Colorado Border.

Sediment deliveryto the Animas River and tributaries is primarily a result of natural hydrologic processes (Simon 2003) because the local geology of the Animas River Watershed includes several loose material sources including Mancos shale, sandstone, and clay formations. However,these natural sources can be aggravated by the manipulation of river corridors, the loss of ground cover and riparian habitat through road and utility networks, pipelines, wellpads, construction sites, in-channel impacts and agricultural practices. Also, in an effort to protect property, land holders have taken efforts to secure river banks that result in a hardening of banks and an increase in velocities, ultimately contributing to overall channel instability. These efforts result in increased erosion rates down stream as well as upstream by the destabilization of stream banks.

Lightner Creek has been identified by citizens and stakeholders to be a significant source of sediment to the Animas River and several sources of sediment within Lightner Creek have been identified though a recent survey of the watershed(Basin Hydrology 2009).

## In-stream gravel Mining

The primary impact of in-stream gravel mining is the impact to the functioning capacity of the river and increases in sediment loads to the river. Gravel mining in the Animas may have occurred as early as the late 1800's in the Animas Valley to help facilitate the construction of the Durango & Silverton Narrow Gage Railroad, and again during the original construction of Highway 550 and the realignment in the 1970s.. Most of the mining was located in the reach between BakersBridge and TrimbleLane, though some operations occurred as far as1.0 mile south of Trimble Lane. In the early 2000's there were four in-stream gravel mine operations located on the AnimasRiver. Currently, onein-stream gravel mining operation in the Animas River, the Bar D Pit, is in operation.One of the largest, the Thompson Pit, was located just north of James Ranch, and was in operation from the late 1970s to 1996.

In-stream gravel mining operations were historically conducted by creating a low point in theriver channel where the gravel accumulates. The construction of the depression alters the river velocity by increasing gradients at the upriver end of the depression. The increase in velocity results in head-cutting of the river bottom on the up river end of the pit. The head-cutting can continue up river and result in a straightening of the river. In addition, the decline in river bottom elevation results in channeling the once meandering river.The gravel is excavated from the depression and sorted. During excavation a berm is constructed that redirects the river away from the active work site. Once excavation is complete the river is redirected into the depression and the process begins again. Overtime, the process results in the lowering of the river bottom's elevation.

When compared with data collected by the Army Corps in 1976, river bottom elevations associated with the Bar D Pit in 2005 were 9 to 16 feet lower, though the actual decline is disputed by a few feet because of issues associated with the 1976 data (Mary Gillam Pers. Comm. 2010).

Additional off-site impacts from in-stream mining include the incising of banks due to the absorption of the increased velocity of the river that result from the increased gradient. The water can carve into banks at turn locations. Often the erosion occurs on property downstream of the mining operation. Land holders, threatened with the loss of property install rip rap and bank stabilization structures to prevent property loss. These activities, because they are not designed on a system level, shift the velocity further down river, forcing the associated issues down river as well.

In addition, the high cut banks that result from forcing the river into a contained channel act to segregate what were integrated flood plain ecosystems. Most healthy rivers include areas of gradual transition from water, to riparian, to land. These transition areas assist to decrease velocity, particularly during periods of high flow. The drop in elevation of the river bottom may prevent the river from over-topping banks the way that it has historically, both in terms of the level at which it used to top the bank and location.

Aerial photos reveal a gradual straightening of the river in regions that have been mined, which could add to increased velocity downstream resulting in the river being artificially entrenched. The loss in riparian areas and vegetation reduces habitat for wildlife, decreases shading of the river, increasing water temperatures and reducing the functioning capacity and the rivers' ability to assimilate nutrients.

## Oil and Gas

The construction of dirt roads, pipeline corridors, and well pads are all associated with oil and gas development and with sediment loading to rivers. In addition to sediment, drilling practices have the potential to release chemicals into groundwater and surface water resources in the proximity of the drilling operations via hydraulic fracturing and oilfield pits.

## Construction Projects

Construction projects have similar impacts to the construction of roads and well pads by oil and gas development– mainly through the mobilization and transport of sediment to surface waters through the exposure of disturbed surfaces to precipitation events, at least until the construction areas are restored. Municipalities and counties regulate construction activities greater than 1 acre in Colorado. Construction activities also alter flow regimes across landscapes, resulting in new erosion channels and head-cutting and result in an increase in permanent, impervious surface areas resulting in greater erosion downstream.

## Nutrient Enrichment

Increases in nutrients (primarily phosphorus and nitrogen) increases the growth of algae and impairing a range of beneficial uses. Municipal, agricultural, and recreational uses are harmed by decomposing organic matter that clogs water delivery systems, taxes water treatment systems, causes foul odors, and results in aesthetic impairments.

Changes in algal productivity and organic matter supply affect stream metabolism patterns, reflected by the amount of dissolved oxygen in the water column (Mulholland, Houser and Maloney 2005). During the day, algae produce oxygen through photosynthesis which is utilized for respiration by aquatic fauna (such as fish and insects) and microbes. At night, while photosynthesis is inactive, microbial respiration associated with decomposition of algae results in a shortage of oxygen which kills aquatic fauna.

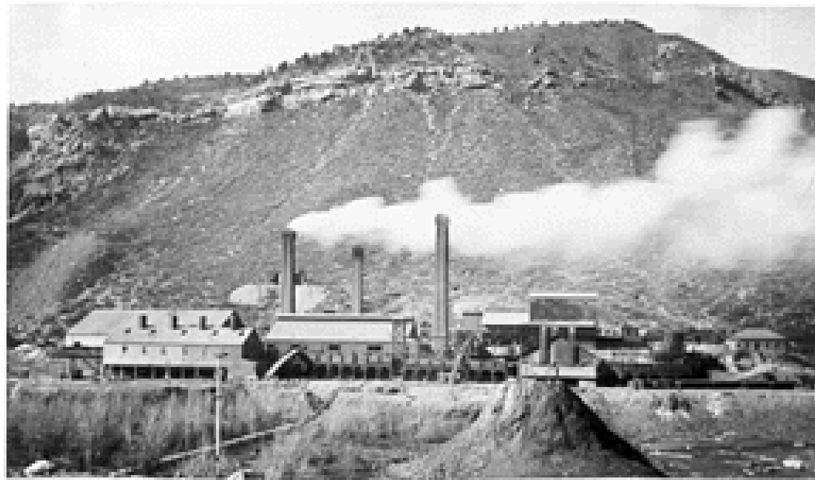
The source of nutrients is primarily from wastewater treatment plants and stormwater runoff and the effects on the river are exacerbated by the destruction of riparian communities and associated wetlands and bank stabilization and hardening practices(Cooper, Gilliam and Jacobs 1986).

## Mine Waste

Historically, the upper reaches of the Animas River were heavily mined for silver and gold. In the upper Animas River, acidic runoff containing high levels of heavy metals comes from both natural and anthropogenic sources. Ore deposits (both underground and exposed) contain sulfides of iron, copper, antimony, arsenic, and zinc. Exposing Iron pyrite located in these deposits to the atmosphere directly or indirectly results in a series of reactions with water and oxygen to produce ferric hydroxide. Ferric hydroxide precipitates out of water ways rapidly as a result of its insolubility, coating rocks in the stream bed with light yellow to orange precipitate. These precipitates are clearly visible in the upper reaches of the Animas River down to Trimble Lane.

The Animas River Stakeholders Group (ARSG) has done an extensive amount of work toward mitigating contributions associated with mining and mine waste, though the expansive nature of mining in the area and spectrum of mine size makes addressing all contributors difficult.

As the AnimasRiver flows towards Durango, metal concentrationsare diluted considerably, though at BakersBridge levels of copper, lead, and zinc exceed EPA standards for chronic exposure to aquatic organisms, with cadmium and iron close to the threshold.



Durango's San Juan Smelter in the 1880's

An additional area of concern is the historic smelter location in Durango, CO. Ore was brought to Durango from Silverton and other mine locations because of the availability of water and coal. Up until 1961 a smelter operated at what is now the cross-roads of Hwy 550N and Hwy 160. Originally, the smelter was used to process silver, lead, gold and copper. After World War II the smelter was modified into a uranium mill. The site is currently a Uranium Mill Tailings Remedial Action (UMTRA) site. At one time the smelter was discharging over 2 tons of material into the river per day. There is concern that material from this operation remains in the stream sediments and if disturbed may affect water quality. Currently, groundwater near the river is classified as polluted and it is projected that the groundwater will be remediated by natural flushing within 70 years. The smelter was active until 1963. Tailings were concentrated at the base of SmelterMountain, in an area currently used as a dog park. In the 1980s the Smelter Mountain area was designated as a superfund site. Reclamation efforts included the removal of 2.5 million cubic yards of radioactive tailings to safe deposit areas and lining and capping the area.

## Stormwater Management

Stormwater runoff from urban areas contribute contaminants to river ecosystems that include chemicals, especially oil and gas that has been spilled onto streets and parking lots (Table 9). Stormwater also carries sediment, residual pesticides, herbicides, fertilizers, petroleum products, and other toxins from urban areas to water ways. Heavy metals have also been associated with stormwater and include cadmium, chromium, iron, copper, manganese, nickel, lead, and zinc.

Major, urban stormwater sources in the Animas River Watershed include the Town of Silverton, Cascade Resort, Durango Mountain Resort, Fairfield Resort, the Cities of Durango, Aztec, and Farmington. Stormwater also transfers pathogens, including bacteria, viruses, protozoa, and parasites from fecal contamination from wildlife, livestock, and pets.

Management of stormwater as a source of pollutants began with the passing of the 1972 Clean Water Act. The Clean Water Act targeted new technology as a means of addressing water quality contamination concerns, requiring National Pollutant Discharge Elimination System ("NPDES") permits to reflect advanced levels of pollutant control technology. A second, back up measure, requires permit holders to adopt more stringent control measures to further reduce the impacts of its discharges in the event that the new technology-based limits are not sufficient to achieve water quality standards. The Clean Water Act was amended in 1987 under the Water Quality Act to include provisions in Section 402(p) that specifically address stormwater discharges. Dischargers of stormwater, including large and medium municipal separate storm sewer systems ("MS4s"), were required to obtain permits by October 1992 under the new section 402(p). When Congress determined that stormwater discharges from municipal storm sewers were "point source" discharges they imposed the same technology based management and stringent control criteria that was used to regulate industry. In the new section Congress endowed permit writers to apply "such other provisions … appropriate for the control of [stormwater] pollutants. CWA §402(p)(3)(B)(iii).

On December 8, 1999 the Environmental Protection Agency (EPA) released Phase II of its Storm Water Permit Program to include construction sites of less than five acres and MS4s operated by smaller municipalities with populations of less than 100,000 people, but with at least a population of 50,000 at an overall density of 1,000 per square mile (40 C.F.R. § 122.34 et seq.). In addition, the Phase II Rule allows state permit agencies to extend the permitting requirements to even smaller MS4s designated by rule when it discharges to impaired waters or may be a cause of impairments to water quality (40 C.F.R. § 122.32(a)(2)). Municipalities that fall under Phase II regulations were required to obtain NPDES permit coverage as well as a stormwater management plan. The 1999 regulations mandate that Phase II SWMP's include the development and implementation of "six minimum measures" that prevent or reduce stormwater pollution to the maximum extent possible, including:

1. Public education and outreach,
2. Public participation and involvement,

**From: Kinsey Holten, City of Durango Stormwater Quality Program Coordinator**

The State of Colorado was required, at least by the Colorado Water Quality Control Act, to evaluate municipalities with populations from 10,000-50,000 people, that are outside of an urbanized area and have a population density of at least 1000 people per square mile for MS4 discharge permit coverage. The City of Durango meets this criteria as well as the discharge to sensitive waters and high growth potential as outlined in the CDPHE-WQCD stormwater program summary. Therefore, the City of Durango applied for and was issued a CDPHE-WQCD MS4 stormwater discharge permit in March 2003. The City's program has been fully implemented and continues to work to control the discharge of pollutants into our MS4 and ultimately the Animas River. A pdf PowerPoint presentation outlining the MS4 permit and the City's stormwater quality program is available for reference.

Most stormwater quality treatment facilities are designed to treat the smaller 2-year storm events, which make up about 95% of the rainfall events. Research and studies conducted have determined that the "purity" of stormwater increases with larger storms where the first-flush of stormwaters accounts for the greatest portion of the annual pollutant loads from stormwater runoff (see http://www.udfcd.org/downloads/pdf/critmanual/Volume%203%20PDFs/02%20Stormwater%20Quality%20Management%202005-10.pdf). By implementing the treatment facilities, which the City of Durango requires in accordance with the Urban Drainage and Flood Control District's (UDFCD) Urban Storm Drainage Criteria Manuals (USDCM) (see http://www.udfcd.org/downloads/down_critmanual.htm) these pollutants can be controlled.

As for control of stormwater quantity impacts due to increased impervious areas, both the City of Durango and La Plata County require stormwater detention so that increased runoff from new development does not cause adverse impacts to downstream properties or waterways. This is a basic philosophy of Colorado water law, which basically prohibits negative impacts to upstream or downstream property due to alteration of a land's historic hydrology.

3. Illicit discharge detection and elimination,
4. Construction site runoff control,
5. Post-construction runoff control, and
6. Pollution prevention / good housekeeping.

The only individual municipality that falls under the Federal Phase II Storm Water Regulations is Farmington, NM. The City of Aztec and San Juan County manage storm water jointly and, in doing so, are required to operate under Phase II regulations because the joint filing includes a population of 99,000 (Storm Water Plan for San Juan County and the City of Aztec). The other major municipalities along the AnimasRiver have populations smaller than 50,000 people and therefore, are not regulated under Phase II. New Mexico does not have the authority to issue National Pollution Discharge Elimination System (NPDES) permits, so all NPDES permits in the state are issued by EPA region 6. In Colorado the Colorado Department of Public Health and Environment (CDPH&E) is responsible for administering the states stormwater management plan. State stormwater requirements are mirrored after the federal NPDES program, requiring that stormwater be treated to the maximum extent practicable (MEP). All designated MS4s in Colorado are required to obtain permit coverage, including developing a SWMP under either the Phase I, or under Phase II of the NPDES stormwater regulations. Municipal SWMPs are required to be reviewed every five (5) years.

As human populations expand and grow, more natural vegetation is converted into hardened, impervious surfaces such as buildings roads, and parking areas. Impervious surfaces reduces the ability of water to infiltrate the ground and recharge groundwater resources which are important sources of drinking water and serve as an important supply of water to stream systems during dry periods.

**From Ryan Gladden, P.E., Associate Project Engineer, City Of Farmington**

The main impacts of construction activities can be separated into two distinct areas, 1) construction and 2) post construction.

1) During Construction an increase in both, conventional and non-conventional pollutants to US waters may be increased. Therefore, in order to regulate those pollutants, the EPA requires permitting. Any construction activity that will disturb more than one acre of land must apply for coverage under an NPDES permit.Colorado State is the permitting authority for the state of Colorado, whereas in New Mexico, the EPA acts as the permitting authority. In both cases however, the minimal controls on the construction industry remain the same. In applying for coverage, the contractor/builder must create a Storm Water Pollution Prevention Plan (SWPPP) that details the measures that will be taken, specific to that site, to prevent/minimize the amount of pollutants that may be discharged to US waters. Pollutants, under this rule, cover such things as sediment, debris, metals, chemicals, etc.. Typically, pollutants are minimized through the use of Best Management Practices (BMPs) and discharges are not subject to required monitoring or numeric limitation. Under new EPA rules, turbidity is defined as a non-conventional pollutant that in the future will be monitored for construction sites disturbing more than 10 acres at any one time. Turbidity, a measure of light refraction off of solids in the water, is a direct and indirect measurement of pollutants in stormwater discharged from construction sites. Without such controls, or when such controls are not maintained properly or monitored for efficacy, pollutants from sites are increased and delivered to our nations waters.

2) After construction is complete, an increase in impervious surface results in greater amounts of runoff that, if not controlled through the use of detention/retention or other comparable means, increases runoff to US waters. The result of such affects can be quite large for areas downstream. The increase of flow from barren undeveloped land into impervious residential, commercial, or industrial areas can cause flows to greatly increase. Such impacts result in wider areas of flooding as well as greater erosion and sedimentation. An increase in flows and sedimentation can drastically alter a river's flow regime downstream, creating a change in the river's slope, alignment, water surface elevation, width, etc.

There are a number of BMPs that can be implemented during development to reduce the amount of impervious surfaces constructed and the amount of stormwater water reaching streams and rivers.

Further information on stormwater management can be found at the following links: Durango's Stormwater Management Programs (http://www.durangogov.org/stormwater/index.cfm), New Mexico's Stormwater Management Program (http://www.nmenv.state.nm.us/swqb/StormWater/index.html) and, Colorado's Stormwater Management (http://www.cdphe.state.co.us/wq/permitsunit/index.html).

## Loss of Riparian Habitat, Channel Manipulations and Functioning Capacity

Loss of riparian vegetation results in decreased bank stabilization, an increase in water temperatures, greater sheet flow from overland sources, and a decrease inthe capacity for assimilation of chemicals and nutrients from aquatic ecosystems(Klapproth 2000, Riley 2009 and J. J. Cooper 1987)

Research has shown that there is a strong relationship between the concentration of pollutants in the river and the strength of the hydrological connection between the river and the riparian community(Riley 2009). When there is a strong, subsurface, hydrological connection between the river and the riparian community, pollutants are filtered out through a series of biological, chemical and mechanical means.Riparian areas also play essential roles as transition zones between land surface and water bodies, helping prevent scouring and erosion, filtering pollutants out of stormwater, and increasing the filtering capacity of ground water/surface waters exchange. Riparian areas have been lost to erosion, direct removal of vegetation and other anthropogenic causes such as channelization,artificial hardening of banks and over or improper grazing.

In the Animas RiverValley north of Durango, the connection between the riparian community and the AnimasRiver has been significantly reduced due to improper grazing practices, sand and gravel mining and over armoring of the banks. The result of this disconnect is decadent stands of cottonwoods, very little recruitment of cottonwoods, incising of the river, lowering of the water table and increased contributions of sediment to the river. Continued incising of the river will lead to essentially complete loss of the riparian community and its filtering capacity (Catherine Ortega, Pers. Comm.).

The riparian community on the Southern Ute Indian Reservation is in relatively good shape due to less grazing and in-stream habitat improvements that dissipate the energy of the river and result in less incising and a stronger connection between the river and the riparian community.

Downstream of the Reservation, in New Mexico, there are several places where the river has again incised significantly, reducing or eliminating the filtering capacity of the riparian system.

## Fire

Fires are a part of the natural system, especially in the arid southwest and have the ability to alter the chemical and physical characteristics of rivers and streams Most studies of the impacts of fires on aquatic ecosystems found an immediate dramatic increase in nitrogen and phosphorus (Hopkins 2001, Minshall et al. 2001b, Hauer and Spencer 1998, Spencer and Hauer 1991, Minshall et al. 1989, Tiedemann et al. 1978). Spencer and Hauer (1991) further explained increases in phosphorus to be due to deposition of ash in the streams while nitrogen increases can be attributed to diffusion of smoke gases into the water's surface. Nitrogen and phosphorus loading also increases with increased surface water runoff after a fire (Minshall 1997, Rieman and Clayton 1997). Sediment production along with attached nutrients from burn areas can be extremely high until the burn areas recover with new vegetation. The Missionary Ridge Fire of 2002 continues to produce sediment flows from several drainages to the Animas River during high intensity precipitation events (Anderson, 2007).

# Section V. Key Elements

## *Source identification and load reductions expected*

The pollutants specifically addressed in this section are total nitrogen and total phosphorus (nutrients) that result in large concentrations of periphyton biomass (algae), large diurnal fluctuations in dissolved oxygen and pH. Data for this section comes from a study completed in 2006 on the Animas River from the Colorado State Line to the confluence with the San Juan River (B.U.G.S. Consulting 2008) and data collected July 2010 on the Animas River from Baker's Bridge in Colorado through the Southern Ute Indian Reservation to the Colorado State Line with New Mexico. Data were collected in accordance with an EPA approved Quality Assurance Project Plan.

Two factors must be considered when discussing nutrient pollution: 1) loading of nitrogen and phosphorus to the river and 2) assimilation of nitrogen and phosphorus through proper functioning capacity of the river[19].

Sources of nutrient pollution and impacts to the assimilative capacity of the river on the main-stem were mapped, described and ranked according to measured amounts of nitrogen and phosphorus from over 98 inflows to the Animas River (Table 11Table 12and Table 13) and 60 mainstem sites. Sources of nutrient pollution have not been identified, quantifiedor ranked within sub-watersheds. To calculate nitrogen and phosphorus loading for each inflow, discharge was measured for each inflow and estimated from USGS Gages on the Animas.

To determine the carrying capacity (4QE3 see New Mexico Environment Department 2006 for methods)of the Animas River for nitrogen and phosphorus, the discharge in the Animas was estimated using the USGS gages at Tall Timbers Resort, CO, in Durango, CO, at Twin Crossings (the State Line), the USGS gage near Aztec, NM and the USGS gage near Farmington, NM. From each gage estimated flow taken from the river due to irrigation diversions was subtracted and measured inflows were added. The NMED standard of 0.42 ug/l of nitrogen and 0.07 ug/l of phosphorus were used to calculate carrying capacity.

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[19]See Ann L. Riley, 2009. Putting A Price On Riparian Corridors As Water Treatment Facilities for an excellent discussion on the value of riparian corridors as assimilators of nutrients.

The average load of total nitrogen in the Animas River Colorado/S. Ute reach in July/August 2010 was 1,328 lbs/d and the average carrying capacity was 1,650 lbs/d. The average load of total phosphorus in the Animas River Colorado/S. Ute reach in July 2010 was 435lbs/d and the average capacity was 277 lbs/d. The total loading of nitrogen measured from inflows was 1,644 lbs/d and the total loading of phosphorus from inflows was 427 lbs/d (Table 11). At the State Line in July 2010 the total load of nitrogen was measured as 3,933 lbs/d and load of total phosphorus was 1,338 lbs/d. In 2006 at the state line there was approximately 4,000 lbs/d of nitrogen in July and October and 26 lbs/d of phosphorus in July 2006 and 75 lbs/d in October 2006.

In the July 2006 sampling event in the NM reach of the Animas, the measured average load of total nitrogen in the Animas River was 2,412 lbs/d and the calculated average carrying capacity of the Animas River (4QE3) was 912 lbs/d(Table 12 and Figure 11). For phosphorus, the measured average load in the Animas was 185 lbs/d and the calculated average carrying capacity was 151 lbs/d (Table 12 and Figure 12). In the October 2006 sampling event, the measured average load of nitrogen in the Animas River was 6,100 lbs/d and the calculated average carrying capacity was 2,740 lbs/d and for phosphorus the measured average load was 473 lbs/d and the calculated average carrying capacity was 456 lbs/d (Table 13, Figure 13Figure 14).

Of the 27 Animas River sites sampled July 2006 in the New Mexico portion of the river, 21 sites exceeded the NMED standard (0.42mg/l) for nitrogen and 15 exceeded the NMED standard of 0.07ug/l for phosphorus (Table 12). Of the 27 Animas River sites sampled in October, 17 sites exceeded the NMED standard for total nitrogen and 9 sites exceeded the standard for total phosphorus (Table 13).

The largest contributors of nitrogen and phosphorus found in the Colorado/Southern Ute Reservation in 2010 included effluent from the 4 sewage treatment plants found in this reach: KOA Campground, Hermosa Sanitation District, City of Durango and South Durango Treatment Plant. Other large contributors included an inflow entering the Animas River near the Durango Skate Park, an inflow at Bondad, an inflow near a campground just north of Durango, Falls Creek flowing into the Animas River in the Animas Valley north of Durango, Junction Creek and effluent from the Colorado Division of Wildlife Fish Hatchery in Durango. Specific sites to be remediated in the CO S. Ute reach of the Animas are listed in Table 18. The specific sites to be remediated in the NM reach of the Animas are listed in (Table 16 and Table 17).

Storm water runoff has also been shown to contribute significant amounts of nitrogen and phosphorus to the Animas River. Samples collected 9/18/05 and 9/19/05 by NMED showed an increase in flows of the Animas from 598 cfs to 886 cfs in a 24 hour period as a result of over 1/2/ inch of rain in the watershed. Concentration of total nitrogen at Flora Vista increased from 0.14 mg/l to 9.2 mg/l and concentration of total phosphorus at Flora Vista increased from 0.049 to 4.28 mg/l. Loading of total nitrogen increased from 451 lbs/d to 48,266 lbs/d and loading of total phosphorus increased from 158 lbs/d to 20,453 lbs/d. The area of the watershed that the runoff came from was an area of significant amounts of natural gas extraction with associated well pads and roads.

## *Best Management Practices*

The general best management practices that need to be implemented to obtain load reductions expected for the Animas River fall into the general categories of:

1) Repairing the hydrological functions of the river so that energy is focused where it does not damage and erode stream-banks and reduce the functioning capacity of the river,
2) Increasing the connection between the river and the riparian ecosystem and thus the functioning capacity of the river,
3) Improving the riparian condition and increasing the size of the riparian area,
4) Improve flood irrigation practices through educating landowners about the consequences of overwatering agricultural fields and letting flood irrigation return flows reach the river,
5) Mitigating sources of pollution from agricultural land through sprinkler irrigation systems rather than utilizing flood irrigation practices,
6) Increasing the size of and improving existing buffer strips along the river
7) Increasing the size of and improving buffers strips along irrigation ditches that have overflows that return directly to the river,
8) Review the potential for increasing and protecting instream flows,
9) Utilizing conservation easements and habitat programs to remove land from agricultural production and create incentives for landowners to protect land near irrigation ditches and the river,
10) Improving and increasing the number of urban storm-water entrapments and filtering systems,
11) Reducing sediment and attached nutrient loading from poorly designed and maintained roads and well-pads in the natural gas fields with adequate storm-water controls,
12) Reducing the amount of nutrients from sewage treatment plants through installation of tertiary treatment systems,
13) Continued movement towards centralized wastewater treatment for areas with failing septic systems (*i.e.* Flora Vista area and Animas Valley north of Durango, CO).

Specific best management practices and estimated costs for the Colorado prioritized sources of nutrients are listed in Table 14. Specific best management practices for prioritized sources of nutrients in the NM Reach of the river are listed in Table 15.

## *Further best management practices*

More than 50% of the nitrogen and phosphorus loading within a stream reach can be assimilated if the connectivity to riparian wetlands and vegetation is increased and overbank flooding is allowed and/or enhanced with a 30 meter buffer strip (Sherer 2009, Riley 2009). Within the Animas GIS Database, areas with impacts to the assimilative capacity of the river in the NM Reach have been identified (*i.e.*Figure 9 and Figure 10) and should be evaluated as potential sites to reduce loading of nitrogen and phosphorus to the Animas River. In the Colorado Reach see (Basin Hydrology 2011)

The use of gabions, concrete, steel and other structural materials in the river channel should be discouraged. Development of any kind should be discouraged within the floodplain and modern engineering techniques that include natural looking designs and promote vegetation recruitment and account for the interactions between channel morphology and hydraulics should be utilized to protect existing, streamside infrastructure. Best management practices to increase assimilative capacityalso include: conservation easements, levee removal, and strategic purchases of poorly located residential property (spread over 20 or more years).An advantage to improving riparian function also results in increases in wildlife habitat, recreational opportunities and aesthetics.

## ***Load reductions expected***

To reduce the loads of phosphorus to the measured carrying capacity in the Colorado/Southern Ute Reservation reach of the Animas from the average measured load of 460 lbs/d TP in the Animas to the average carrying capacity of  276 lbs/d TP addressing nutrient loading at a couple of the sewage treatment plants would suffice (Table 18). Loads of nitrogen measured July/August 2010 currently exceeds the carrying capacity of the Animas in the Colorado/S. Ute reach of the Animas although efforts to reduce loads here will help and will be *critical* to reduce overall loading measured downstream in New Mexico.

The total loading of nitrogen to the Animas River in the NM reach from inflows that were sampled in July 2006 was 1,822 lbs/d (Table 13). To reduce loading of nitrogen in the Animas River New Mexico reach from the measured average loading of 2,412 lbs/d to the calculated average carrying capacity of 912 lbs/d the top 15 inflow sites identified would need to be 100% remediated (Table 16). The measured total loading of phosphorus in July 2006 from inflows was 281 lbs/d. To reduce the load of phosphorus from the measured average loading found in the Animas River in July 06 of 185 lbs/d to the calculated average carrying capacity of 151 lbs/d only the top loading inflow site identified would have to be 60% remediated (Table 16).

The total loading of nitrogen to the Animas River from inflows in the NM portion of the Animas that were sampled in October 2006 was 3,960 lbs/d. To reduce the loading of nitrogen from the average loading measured in the Animas River of 6,100 lbs/d to the calculated average carrying capacity of 2,740 lbs/d, the top 7 loading inflows would have to be remediated (Table 17). The total measured loading of phosphorus to the Animas River from inflows that were sampled in October 2006 was 792 lbs/d. To reduce the load of phosphorus from the average loading observed in the Animas River of 473 lbs to the calculated carrying capacity of 456 lbs/d according to October 06 data, only the top loading inflow would need to be partially remediated. Most of the top loading sites found in July were also top loaders in October 2006.

As an example of specific BMPs to be implemented and taking a look at the top loading site for phosphorus in the NM reach of the river (inflow # 89, Figure 17 and Figure 16) we see that it is a side channel that diverts a significant amount of water for an irrigation ditch. In October 2006 there was an increase in the concentration of total phosphorus from the upstream Animas Site (Site No. 85) from 0.03 mg/l to 0.25 mg/l. The high volume of water (354 cfs) and relative high concentration of nitrogen resulted in the high amount of loading to the Animas River. The side channel has no buffer zone between it and the urban development near the channel and consequent urban runoff.  Reducing the amount of water in the side channel, creating buffer strips and diverting the urban runoff into storm water structures and into manmade wetlands are the recommended BMPs for this site at an on-the-ground cost of approximately $20,000. The city and several landowners would be potential partners in this project (Table 19).

As another example, when we look at site no. 45, July 2006 total nitrogen increased from 4.5 mg/l (as measured at Animas Site No. 42) to 7.5 mg/l and total phosphorus increased from 0.1 to 2.7 mg/l with a discharge to the river of 6.1 cfs. The result was a significant source of nitrogen loading to the Animas River. The discharge was an irrigation ditch overflow where the upstream portion of the ditch had very little buffer zone between the road and the agricultural land (Figure 18). The recommended BMP is to move the overflow upstream to an area where a wetland can be created to filter nutrients and to increase the buffer strips between the ditch and agriculture fields at an estimated on-the ground cost of $15,000. There is 1 landowner to negotiate with for this particular site.

**Denitrification** is a microbially facilitated process of dissimilatory nitrate reduction that may ultimately produce molecular nitrogen (N2) through a series of intermediate gaseous nitrogen oxide products. This respiratory process reduces oxidized forms of nitrogen in response to the oxidation of an electron donor such as organic matter. The preferred nitrogen electron acceptors in order of most to least thermodynamically favorable include nitrate (NO3−), nitrite (NO2−), nitric oxide (NO), and nitrous oxide (N2O). In terms of the general nitrogen cycle, denitrification completes the cycle by returning N2 to the atmosphere(Wikipedia 2011).

Improving the assimilative capacityof nitrogen and phosphorus through increasing the functioning capacity of the river is another area within which pollution loading in the Animas River can be reduced; *i.e.*denitrificationconsidered one of the major sinks for nitrogen in an aquatic environment. For example, ATTRA (accessed 9/27/10)suggests a conservative estimate that natural riparian forests can denitrify and release 25 to 35 pounds of nitrogen per acre per year.

Given a load reduction goal of 130 lb/day (as per the nitrogen TMDL for the Animas River per the NMED (New Mexico Environment Department 2006)), 47,450 lbs/year of nitrogen needs to be assimilated. At 25 pounds per acre per year 1,898 acres of new or restored wetland or riparian buffer area needs to be created or restored in the watershed (includes tributaries) to meet the nitrogen load reduction goal.

If the Durango NRCS office continues to replace 500 acres of flood irrigated land on the Florida Mesa to sprinkler irrigation each year there will be continued improvement in reducing inflows and nutrient loading to the Animas within the Southern Ute Reservation Boundaries.

Improving stormwater programs in the urban areas as well as in the natural gas fields will help considerably in reducing the loading of nitrogen and phosphorus to the Animas.

## *Technical and financial assistance needed and associated costs*

In the Colorado/S. Ute portion of the watershed (as well as for the whole watershed), the greatest benefit for the cost is installing tertiary treatment systems at the Durango and Hermosa sewage treatment plants at estimated costs of $200,000 to $500,000 for on the ground work (Table 14 and Figure 24). Other costs for BMPs in the Colorado/S. Ute portion of the watershed are shown in Table 14. A cost/benefit model was created for the NM reach of the Animas (Table

19 and Figure 15) utilizing the Animas River GIS Database and 4 on-site surveys completed with the inflow studies and 2 irrigation ditch surveys to estimate the degree that loading of nitrogen and phosphorus can be reduced with selected BMPs in relation to costs. Information input for the BMP aspect of the model also came from the International Stormwater BMP Database (http://www.bmpdatabase.org/index.htm, accessed 9/27/10). Costs for each BMP project were partially estimated from what the Stakeholder Group learned from implementation of the Kiffen Creek BMP project. Estimated costs to develop each BMP project include funds to cover Coordinator tasks such as: obtaining stakeholder input, contacting the landowner, educating the landowner, describing the project to the landowner, obtaining permission and access from the landowner, and the process of obtaining cost estimates for construction of the BMP (estimated at $2.000 per BMP). Also included in the model are costs required for design of the BMP and the cost of constructing the BMP (estimated as an average of $5,500 per BMP). In the model, the optimal BMP was estimated, percent load reductions expected from BMP implementation and total load reduction calculated for each BMP. Further costs not included in the model will be incurred for establishing baseline conditions and completing post-remediation monitoring (estimated at $7,500 per year).

Further site visits and surveys will further define the type and extent of the BMPs to employ to remediate the inflows and significantly reduce loading of TN and TP and further define the costs of the BMPs.

Based on the July 2006 NM sampling event, the model illustrates that only about 60% (844lbs/d of the 1,501 lbs/d required) of the required July nitrogen loading reduction can be met by remediating 33 sites at a cost of over $1,535,000. The model does predict that phosphorus could be reduced to the carrying capacity for a cost of less than $150,000. The numbers are about the same for the October 2006 loading values. The model also shows clear reductions in cost/benefit at around $65,000 and again at just over $1,135,000 (Table 19, and Figure 15 ). The NMED TMDL recommends that only 130 lbs/d of nitrogen needs to be eliminated from the system (New Mexico Environment Department 2006)

Implementing a BMP at each site identified in NM is technically feasible given that criteria such as landowner permission and access to the site are obtained. Selection of BMP sites within subwatersheds in NM should begin with the small inflows that have been identified as high nutrient loaders in this plan. Once the sites have been identified, landowners have been contacted, and permission has been obtained, an on-the ground survey of the sub-watershed by a qualified hydrologist should be completed. The hydrologist should identify areas where significant impacts have occurred to the geomorphology of the stream and to the riparian ecosystem as well as noting other potential tributaries and if water is flowing in the channel they should obtain water chemistry samples from each tributary and from the mainstem above each tributary for measurements of total phosphorus and total nitrogen.

The processes for identifying high sources of nutrients in the larger subwatersheds that have been found to be major contributors (Lightner Creek and the FloridaRiver) are being worked out under the jurisdiction of the Lightner Creek Workgroupon Lightner Creek and by staff of the SUIT's Water Quality Program on the FloridaRiver. The focus of reducing the impacts of storm water runoff falls under the technical jurisdiction of programs implemented by the Cities of Durango, CO and Farmington, NM. Dealing with non-point pollution in the upper watershed is under the technical auspices of the Animas River Stakeholder Group. Technical assistance for tertiary treatment of sewage effluent and urban runoff will come from experts within the City's sewage treatment stormwater programs. Technical assistance to deal with impacts to the functioning capacity of the river and subwatersheds may come from within NRCS. Further technical assistance will be required to identify loading sites within subwatersheds and to design BMPs for each bank erosion site and other types of impacts to the functioning capacity of the river.

Other technical assistance may be required for developing an educational program (see sections below, estimated to be $11,500). Technical assistance for completing monitoring, updating the Animas GIS and Water Quality Databases and for data analysis may come from water quality staff within the NMED SWQB, SUIT WQP and CDPH&E WQCD with additional annual costs to the AWP of $3,500. Beyond the above mentioned technical expertise, the AWP Coordinator and staff should be able to handle the additional tasks identified below. Regular updates to the AWP by each of the groups in the watershed is critical to help facilitate prioritization of projects throughout the whole watershed to meet objectives set by the AWP.

Recommendations and costs for organizational development of the AWP and for the AWP Coordinator are listed in Table 20.

To cover these costs sources of funding maycome from: foundations, grants, and local governments for coordination, administration, and education; the EPA's storm-water runoff program for dealing with urban runoff; and NRCS, EQIP and EPA 319 program funds as well as small State funds such as Colorado Water Conservation Board, Wetlands Focus Areas, Habitat Partner Programs and U.S. Fish and Wildlife's, Partners' for Wildlife Program for repairing riparian.

Additional costs not listed in Table 19for restoring stream function in the Baker's Bridge to Trimble Lane Reach (restoring 2 abandoned in-stream gravel mines) were estimated at between $1,000,000 and $2,000,000 each. Cost for repairing cut banks and reconnecting the river to the riparian ecosystem between Trimble Lane and 32nd street will be in the several million dollar range. Costs for improving the quality of storm water runoff in the oil and gas fields, the cities of Durango, CO, Aztec, NM and Farmington, NM will be in the half million range for each. The economic and pollution reduction benefits of protecting riparian wetlands and the functioning capacity of the river are discussed in Riley 2009.

## *Educational Informational Components*

An informational/educational component is necessary to enhance public understanding of the BMPs and to encourage early and continued participation in selecting, designing, and implementing best management practices (See Stakeholders Section of this document).

There are several existing avenues for education and outreach in the region that cover basic river ecological concepts. The important component that is missing from these educational programs is in regards to the functioning capacity of the river and the importance of riparian ecosystems and wetlands to water quality in the river. The groups currently teaching basic concepts about river ecology should be the targets of an educational program by AWP that teaches them about this important concept and, along with educating specific landowners in regards to individual BMPs, should be the responsibilityof the Coordinator and the Stakeholders. Other components of river health including monitoring and measuring health as well as general river ecology are being covered by other entities including Durango Nature Studies and Colorado RiverWatch.

A number of educational programs and outreach efforts exist in the Animas River Watershed and include programs through the Water Information Program, San Juan Citizen's Alliance, Durango Nature Studies, Mountain Studies Institute, Colorado RiverWatch, Colorado Watershed Assembly, Animas River Keeper, Colorado Trout Unlimited and two, annual, children's water fairs held in Farmington, NM and Durango, CO that provide venues for reaching out to grade school children and their parents regarding water related issues. The San Juan Water Commission hosts the annual children's water fair held in Farmington, NM and the Southwest Water Conservation District hosts the annual children's fair in Durango, CO.

Through programs developed by the AmeriCorps and the Western Hardrock Watershed Team a VISTA volunteer at the AWP spent time visiting school classes and clubs to educate children on watershed issues.The AmeriCorps VISTA volunteer developed a 20 minute presentation on watershed mapping for use at the regional water festivals. This program introduced children to the scope of a watershed while teaching them that everything affecting water quality in a watershed will affect them as inhabitants of the watershed. The VISTA also developed a more in depth lecture focusing on water quality issues for upper level students including high school and college students.

There are several steps in developing an information/education (I/E) program that include:Defining I/E Goals and Objectives beginning with determining the driving forces that include for the Animas Watershed:

- Maintaining the recreational and economic benefits of the animas;
- Maintaining a cold-water fishery;
- Meeting state and tribal standards, and;
- Improving the functioning capacity of the stream;
- Maintaining green space along the river corridor.

The AWP 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/**.

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 AWP'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 AWP's objectives will be to focus on reporting progress of the I/E campaign.

In later stages of the campaign, the AWP should identify the target audiences that need to be reached to meet the objectives. After gathering information on the target audience, the AWP will be ready to craft a message to engage and enlist the target audienceto 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 using less water to irrigate, participating in the NRCS EQUIP program to install sprinkler irrigation systems, planting cottonwoods and willows along the stream corridor, and 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 recreational and economic 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. 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 (*i.e.* Animas River Days). 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, rafters, kayakers 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 monitors environmental.

## *Schedule and Milestones*

There are a number of milestones that need to be completed before best management practices can be implemented and they include those listed in the following table::

| Task | Timeline |
|---|---|
| • Obtaining funding for a Watershed Coordinator | 2011 |
| • Training the Watershed Coordinator, especially in the use, maintenance and upkeep of the Animas GIS and Water Quality Databases, | 2011 |
| • Laying out Coordinator responsibilities that include: | 2011 |
| o Updating the Animas GIS and Water Quality Databases, | 2112 |
| o Informing stakeholders about the various projects and obtaining feedback and consensus from stakeholders on specific projects, | 2012 |
| o Contacting and educating landowners about the BMP projects | 2012-2020 |
| o Obtaining permission and access to the BMP site | 2012-2020 |
| o Finding the necessary technical expertise to design each BMP | 2012-2020 |
| o Keeping the Stakeholders abreast of the various design options | 2012-2020 |
| o Obtaining cost estimates for each BMP that are based on the design options | 2012-2020 |
| o Finding qualified construction companies to construct the BMP | 2012-2020 |
| o Monitoring the construction | 2012-2020 |
| o Monitoring the stability and effectiveness of the BMP at protecting streambanks and the riparian ecosystem | 2012-2020 |
| o Following up with the landowner and determining their satisfaction with the project, how it was implemented and what could be improved | 2012-2020 |
| o Following up with the Stakeholders on aspects that could be improved, | 2013 |
| o Creating a checklist for implementing BMPs | 2012 |
| o Creating literature to educate landowners and the public about BMPs and the AWP | 2012 |
| • The whole AWP Stakeholder Group should be responsible for monitoring specific reaches of the watershed to determine the effectiveness of BMPs in improving water quality conditions and to identify whether or not course corrections are needed. The schedule is wholly dependent on costs and availability of funds. Each stakeholder and entity that is doing work in the watershed should be required to update the AWP semi-annually, supplying the AWP with data and reports on efforts and future plans. | 2012-2020 |

Given the implementation of the above tasks and the large number of partners involved in the AWP, meeting the load reduction goals can conceivable be completed within 10given the implementation of 3 BMPs each year in the NM section of the Animas, especially for phosphorus and given and estimate of 30 BMPs to implement. Several BMPS can be implemented by several partners each year.

## *Measurement Criteria*

The amount of loading required through increasing the functioning capacity of the river to achieve measureable results should be measuredusing the25 mile stretch of the Animas River that crosses the SUIT Reservation and the river reaches on the Piedra and San Juan Rivers near the southern end of the SUIT Reservation as references. At the downstream end of each of these reaches there is a diverse assemblage of pollution intolerant macroinvertebrates, relatively low periphyton biomass and lower average concentration of nutrients (Table 21, Figure 19, Figure 20) . These reaches each have riparian conditions that are in relatively good shape and thus higher functioning capacity. At the downstream end of the SUIT Animas River reach the amount of filamentous algae is less and the diversity of macroinvertebrates and the presence of sensitive species of macroinvertebrates is greater than what is found at the upstream end of this reach (Table 21, Figure 19 and Figure 20).

The New Mexico Environment Department has TMDL targets for nutrients that include levels of total nitrogen (0.42 mg/l), total phosphorus (0.07 mg/l), periphyton biomass measured as chlorophyll-a (10ug/cm$^2$) and ash-free dry mass (5 mg/cm$^2$), maximum and minimum values of dissolved oxygen (<6mg/l and < 120% saturation) and pH(< 6.6 or > 8.8). These values, along with a comparison of macroinvertebrate communities in the Animas River to reference sites (Table 23 and Figure 19) should be the values used for determining whether the Animas River is meeting the objectives set by the AWP and the NMED TMDL. The State of Colorado is currently in the process of developing standards for nutrients. The TMDL target load reduction is 44lbs/d for total phosphorus and the TMDL target load reduction is 130 lbs/d for total nitrogen. The margin of safety is 10% and total nitrogen and total phosphorus are considered to be conservative(New Mexico Environment Department 2006).

In 2010 for the Colorado S. Ute Reach, total nitrogen load in the Animas exceeded the carrying capacity. For phosphorus, it exceeded the carrying capacity by 156lbs/d.

In July 2006 the average loading reduction required to meet the 4Q3 was 1,500 lbs/d for total nitrogen and 34 lbs/d for total phosphorus. In October 2006 the average target load reduction was 3,360 lbs/d for total nitrogen and 17 lbs/d for total phosphorus.

It is recommend that these load reduction values and the nutrient criteria listed above be utilized as initial measurement criteria to evaluate the effectiveness of implemented BMPs but that the response variables of periphyton biomass (10ug/cm2)and and HBI of less than 2 for benthic macroinvertebrate communitiesbe used as *the* targets since the stakeholders are primarily concerned with stream health, not concentrations of nitrogen and phosphorus.

To move forward with this assessment the Animas Water Quality Database would have to be kept updated and analyzed on an annual basis.

## Monitoringstrategy

Because of the relatively small contribution of each source of total nitrogen and total phosphorus compared to the pollutant loads found in the Animas River, it will be difficult to individually measure the effectiveness of each BMP on water quality parameters. However, the

**Stream Bioassessment**

Stream ecologists have long recognized that benthic macroinvertebrates (BMIs) are excellent indicators of the health of a watershed. The Water Pollution Control Act Amendments of 1972 (the Clean Water Act) called for protection of the biological integrity of water bodies and thus stimulated development of macroinvertebrate monitoring protocols and indices to assess watershed health.

Macroinvertebrates are excellent biological indicators of watershed health because they

1. are easy to collect and identify,
2. have cosmopolitan distributions and are present in a variety of habitats,
3. have a diversity of species that are responsive to a gradient of conditions ranging from degraded to healthy,
4. are abundant enough so that reasonable sampling efforts do not deplete populations,
5. have well known natural histories and tolerances to environmental conditions, being sensitive to temperature, dissolved oxygen, sedimentation, scouring, nutrient enrichment and chemical and organic pollution,
6. have limited mobility so that they do not move in and out of habitats seasonally,
7. are long-lived enough to be impacted by chronic degradation and thus:
    a. compound and integrate the effects of water quality, habitat degradation and exposure,
    b. function as continual monitors of environmental quality, increasing the likelihood of detecting the effects of episodic events (e.g., spills, dumping, treatment plant malfunctions, nutrient enrichment),
8. are conducive to laboratory studies designed to test mechanisms of the effects of pollution,
9. provide the public with a more familiar expression of ecological health.

Because of these advantages, the transition is well under way from solely using chemical indices for water quality to the development and use of macroinvertebrate indices.

A commonly used macroinvertebrate index for nutrient pollution is the Hilsenhof Biotic Index. Macroinvertebrats have been collected on the Animas River and reference streams (Piedra and San Juan) since the mid 1990s and as illustrated in Figure 20 the HBI is an excellent indicator of the impact of nutrients on the Animus River. This data set allows for the establishment of baseline conditions to measure the effectiveness of implemented BMPs.

Another commonly used metric and recommended by the EPA as a measure of nutrient pollution in streams and rivers is periphyton biomass measured as chlorophyll-a. This metric has been collected on the Animas since 2003 and the NMED has set a standard of 10 $ug/cm^2$ (Table 21&Figure 19).

effectiveness of a number of implemented BMPs within a particular reach of the Animas River can be measured at the downstream end of the reach. This is a model used by the Animas River Stakeholders Group (ARSG) who has and continues to remediate a number of mine sites in the upper basin of the Animas River. The ARSG have established targets for benthic macroinvertebrates, concentration of zinc and other metals at the downstream end of the reach where the sources of contamination are found and they monitor thes sites on an annual basis as well as individual reaches where they can identify the effectiveness of a number of remediation activities in particular areas.

Reaches on the lower Animas Rivermay best delineated as: Baker's Bridge to Trimble Lane, Trimble Land to 32$^{nd}$ Street, 32$^{nd}$ Street to the High Bridge, the High Bridge to Basin Creek, Basin Creek to the State Line, the State Line to Aztec, NM, Aztec, NM to Flora Vista, Flora Vista to the confluence with the San Juan River. Sample sites have been established at the downstream end of each of these reaches and data has been collected at each of these sites (Table 22).

To measure the effectiveness of BMPs in a particular reach of the Animas Riverwill require establishing baseline conditions. There is an adequate amount of data at the Basin Creek sample site within the SUITs database and at the State Line sample site within the NMED and the SUITs databases to establish baseline conditions for the reaches above these sample sites. These data sets include data on periphyton, macroinvertebrates and water chemistry parameters. There is some data at other sample sites but not enough data to establish baseline conditions. To establish baseline conditions at these sample sites, data should continue to be collected at each of the sample sites on an annual basis over the next 5 years. Data collection efforts should follow procedures outlined in the Animas River Sampling and Analysis Project Plan(B.U.G.S. Consulting 2009).

To measure the effectiveness of BMPs,post remediation data should be collected after a substantial number of BMPs have been completed within a particular reach (i.e. every 3 years after 5 BMPs implemented). The post remediation data should be collected annually for a minimum 3 year period to account for natural variability in the data, to have a comparable dataset to the baseline data, and to complete statistical analysis on the data (Table 23).Measurement metrics should include those mentioned in the section on Measurement Criteria.

# Figures

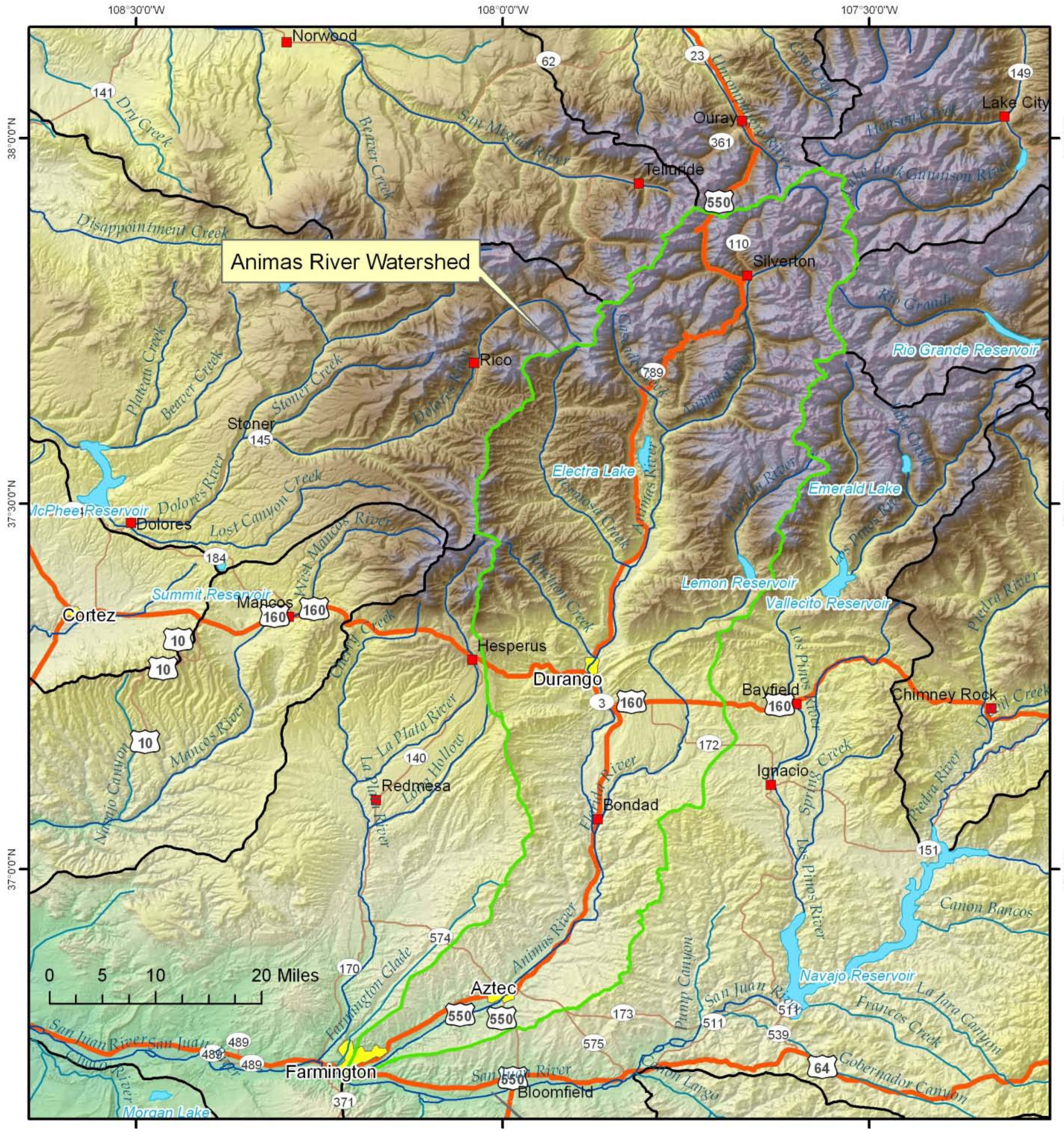



**Figure 1. Animas River Watershed.**

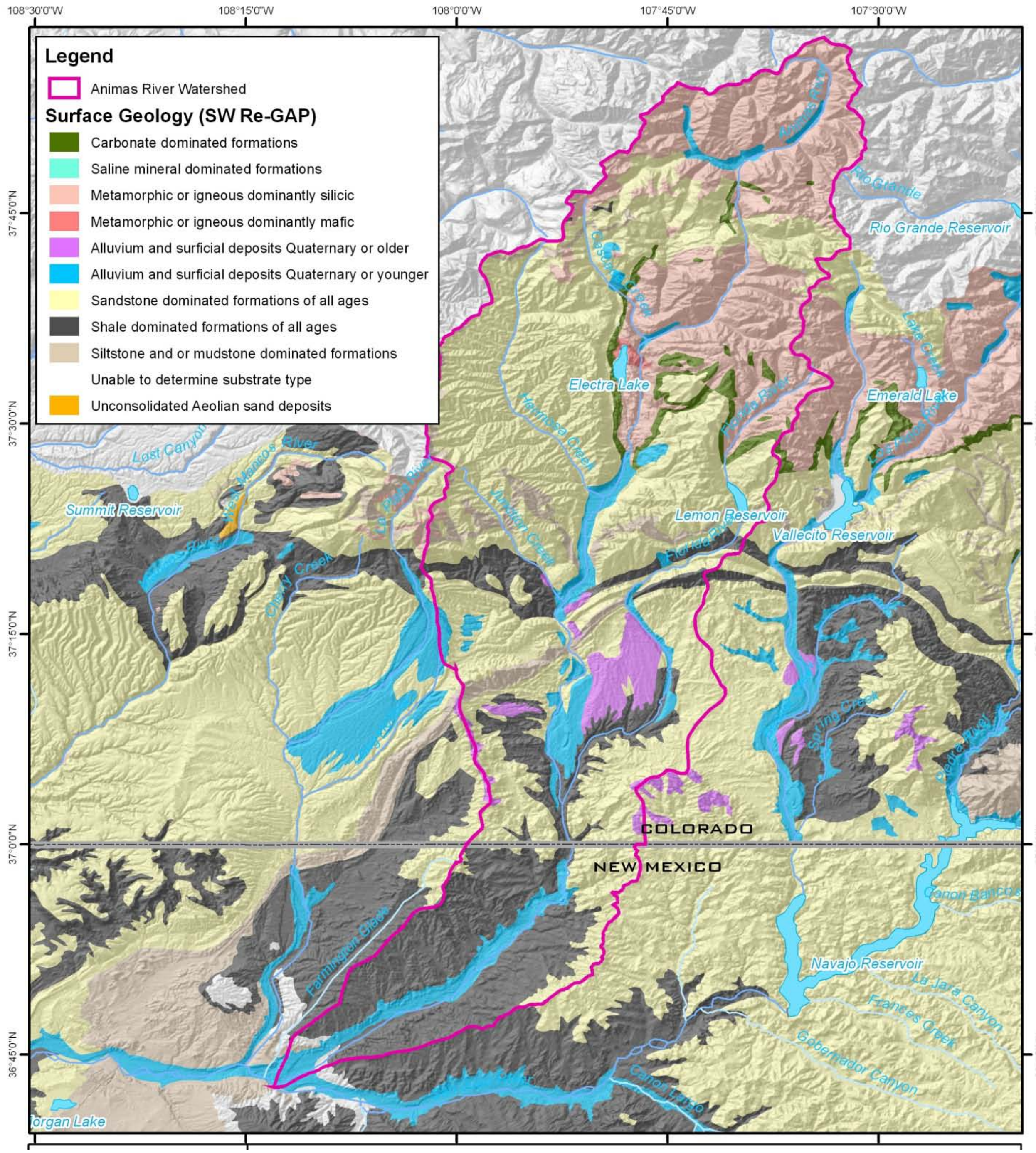
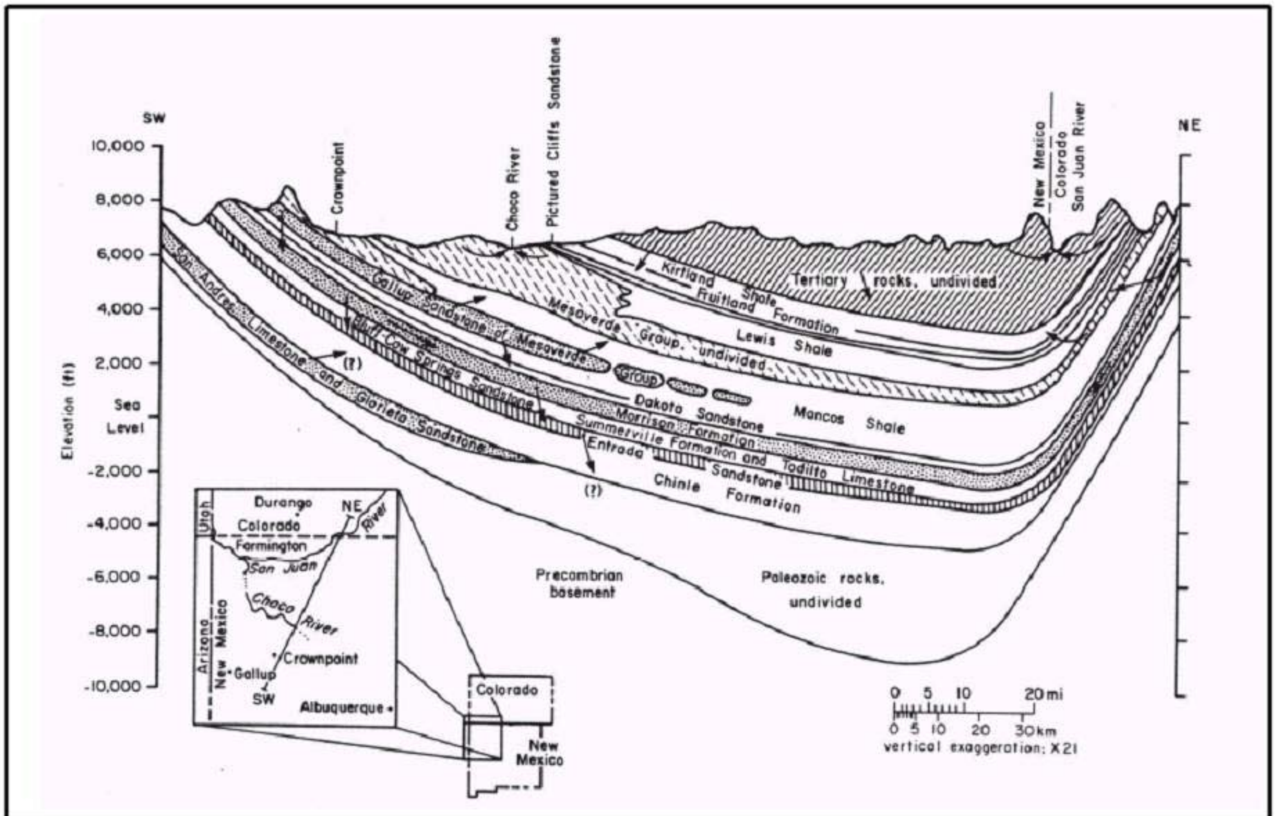



**Figure 2. Surface geology in the Animas River Watershed.**




Generalized Hydrogeologic Cross-Section of the San Juan Basin (Stone et al., 1983)

7/14/01 kk 1027-SJ-2.cdr | Figure A1-2

**Figure 3. Cross sectional geology . The Animas flows across the anticline (Fruitland Outcrop) shown at the right of the figure.**

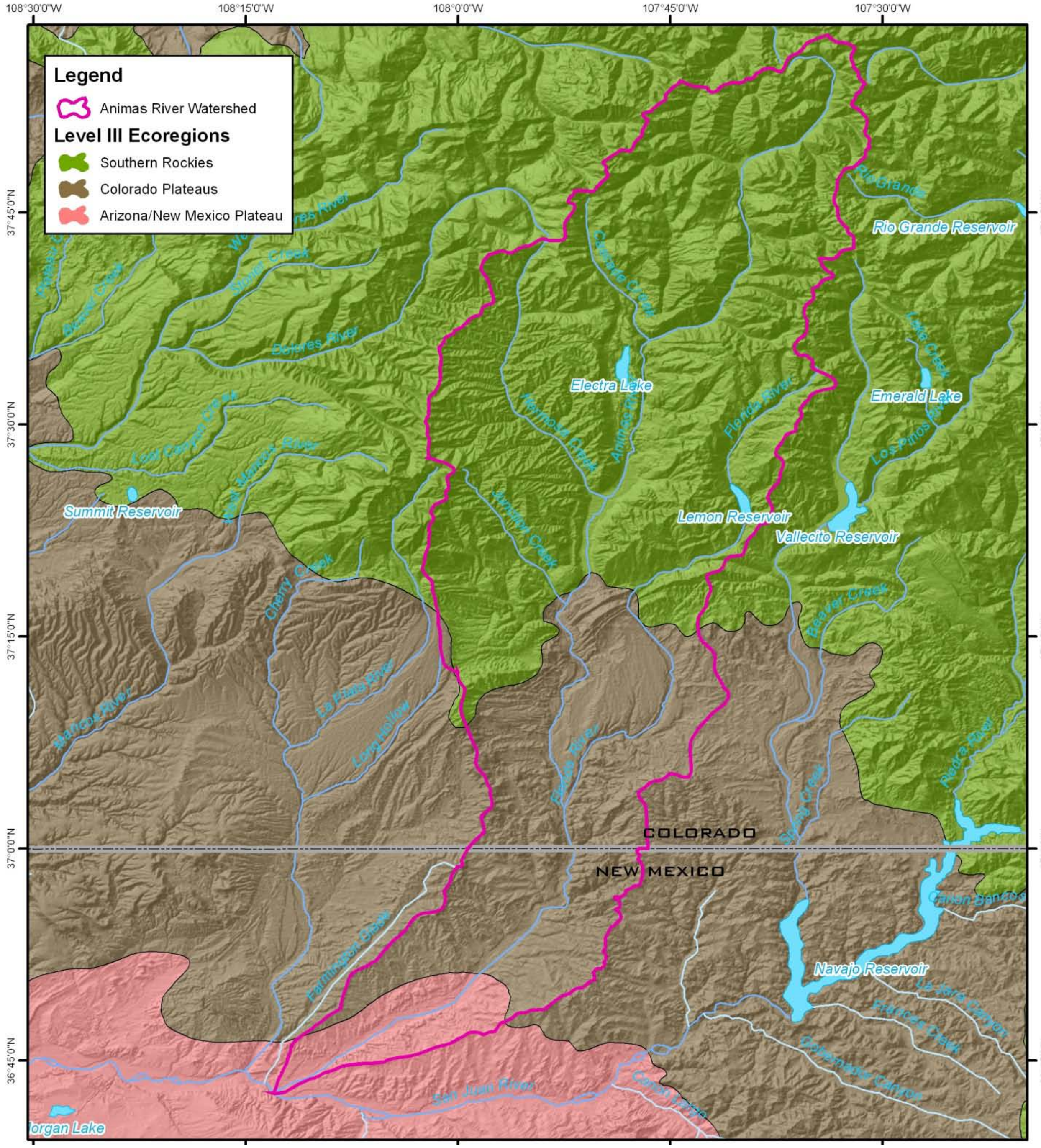



**Figure 4. Ecoregions of Animas River Watershed, Level III.**

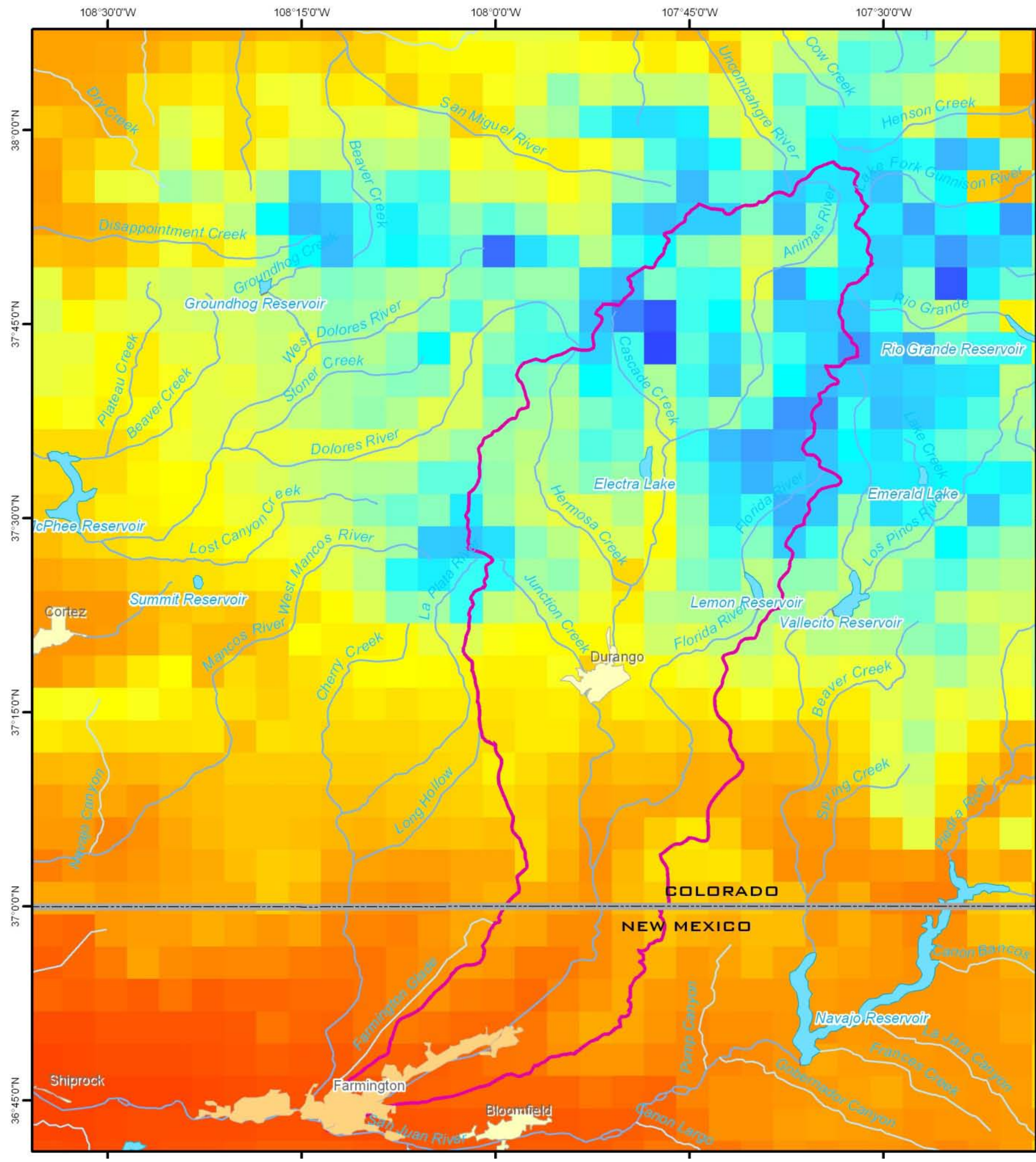



**Figure 5. 100 year average of annual precipitation in the Animas River Watershed.**

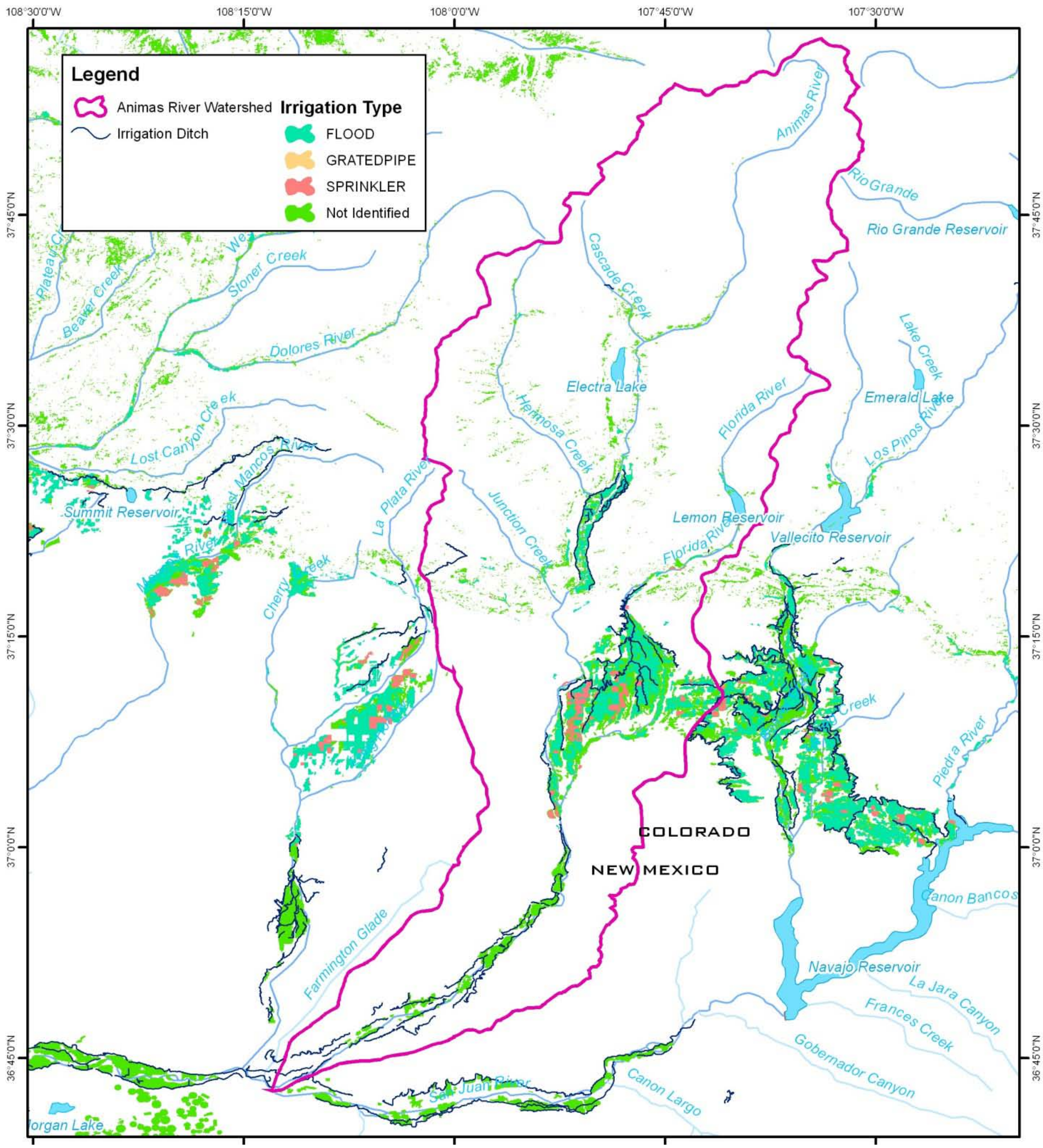



**Figure 6. Map showing irrigated agricultre in the Animas River Watershed.**

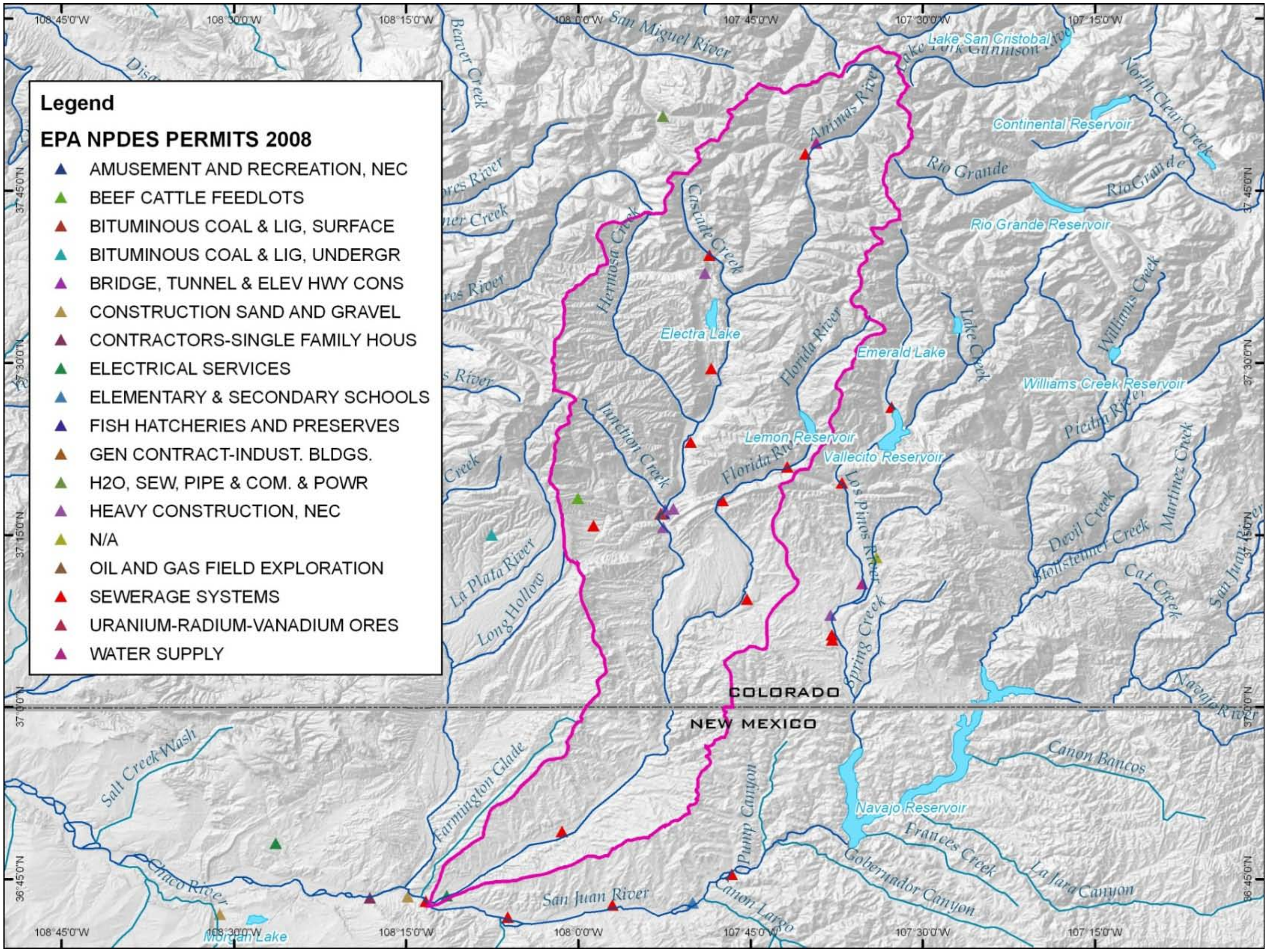



**Figure 7. National Pollutant Discharge Elimination Permits in the Animas River Watershed.**

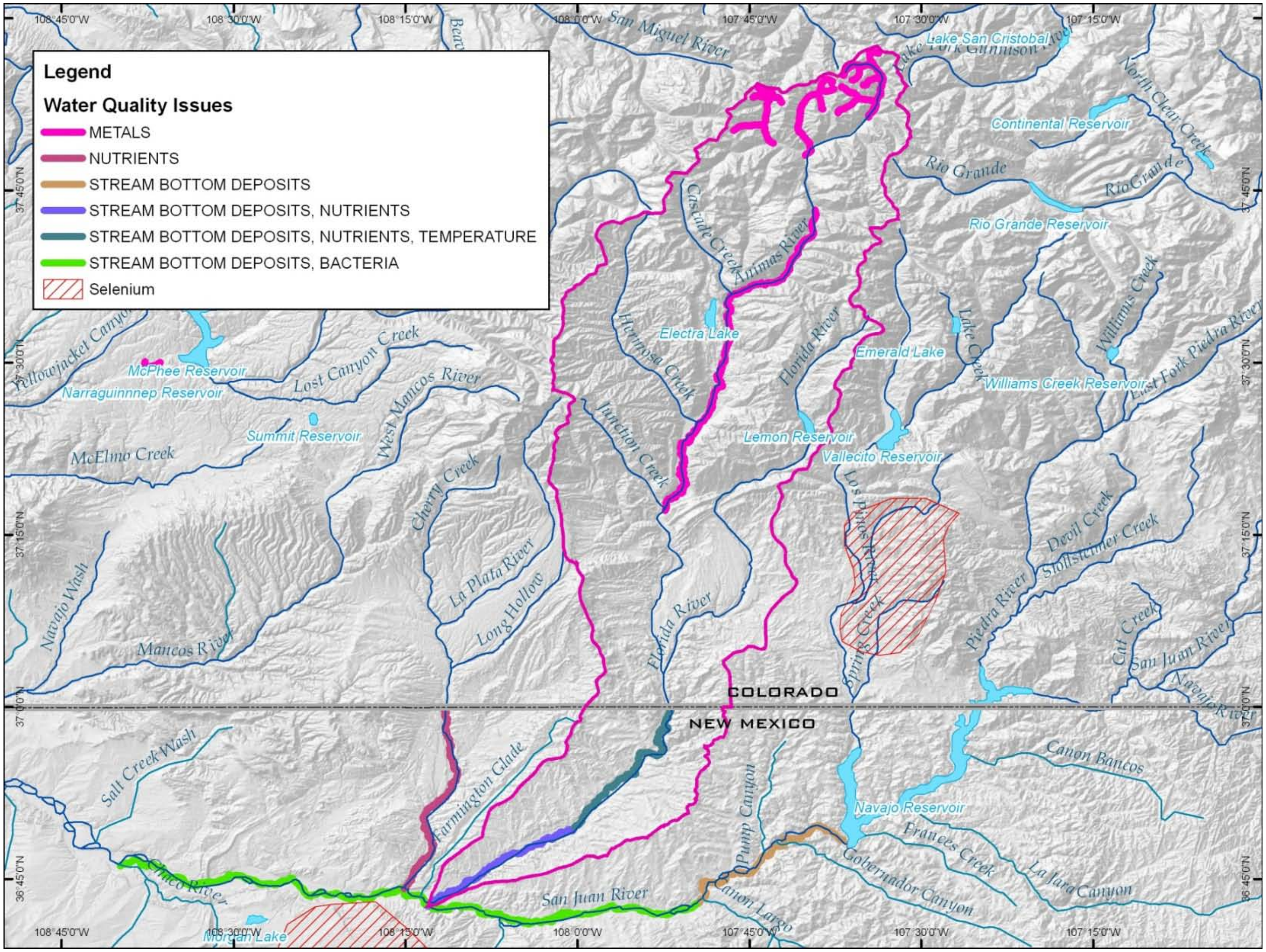



**Figure 8. Water quality issues in the Animas River.**

**Figure 9: Picture of poorly engineered bank stabilization in the Animas River, NM.**

**Figure 10: Picture of actively cutting river bank due to upstream bank hardening in the Animas River, NM.**

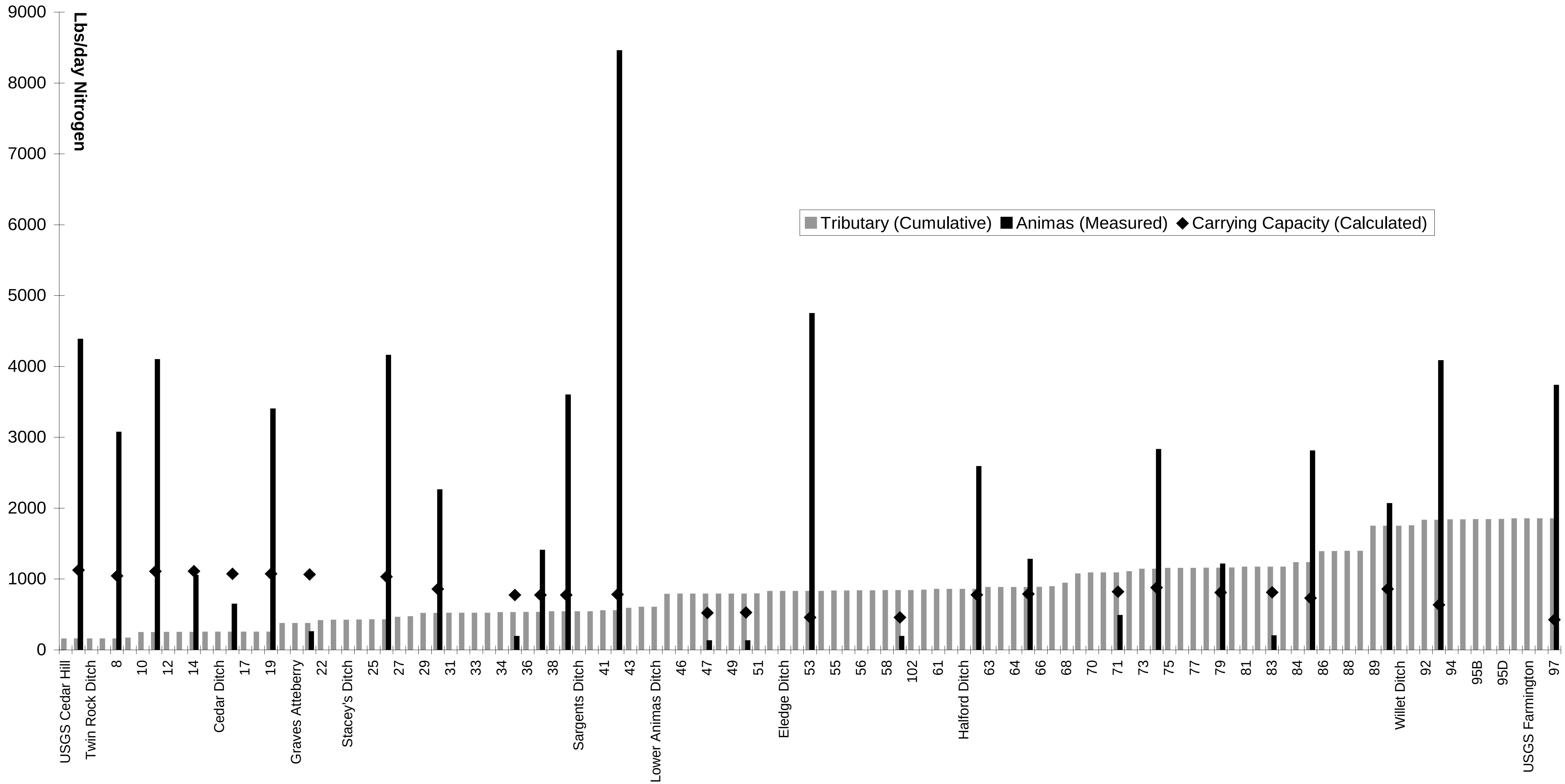



**Figure 11. July 2006 total nitrogen loading. Grey bars are cumulative loading from inflows, black bars are measured loading into the Animas River and black diamonds are calculated carrying capacity of the Animas River (all units are lbs/d, see Figure 1 for Animas River flow estimates, see Table 12&Table 13 for data.**

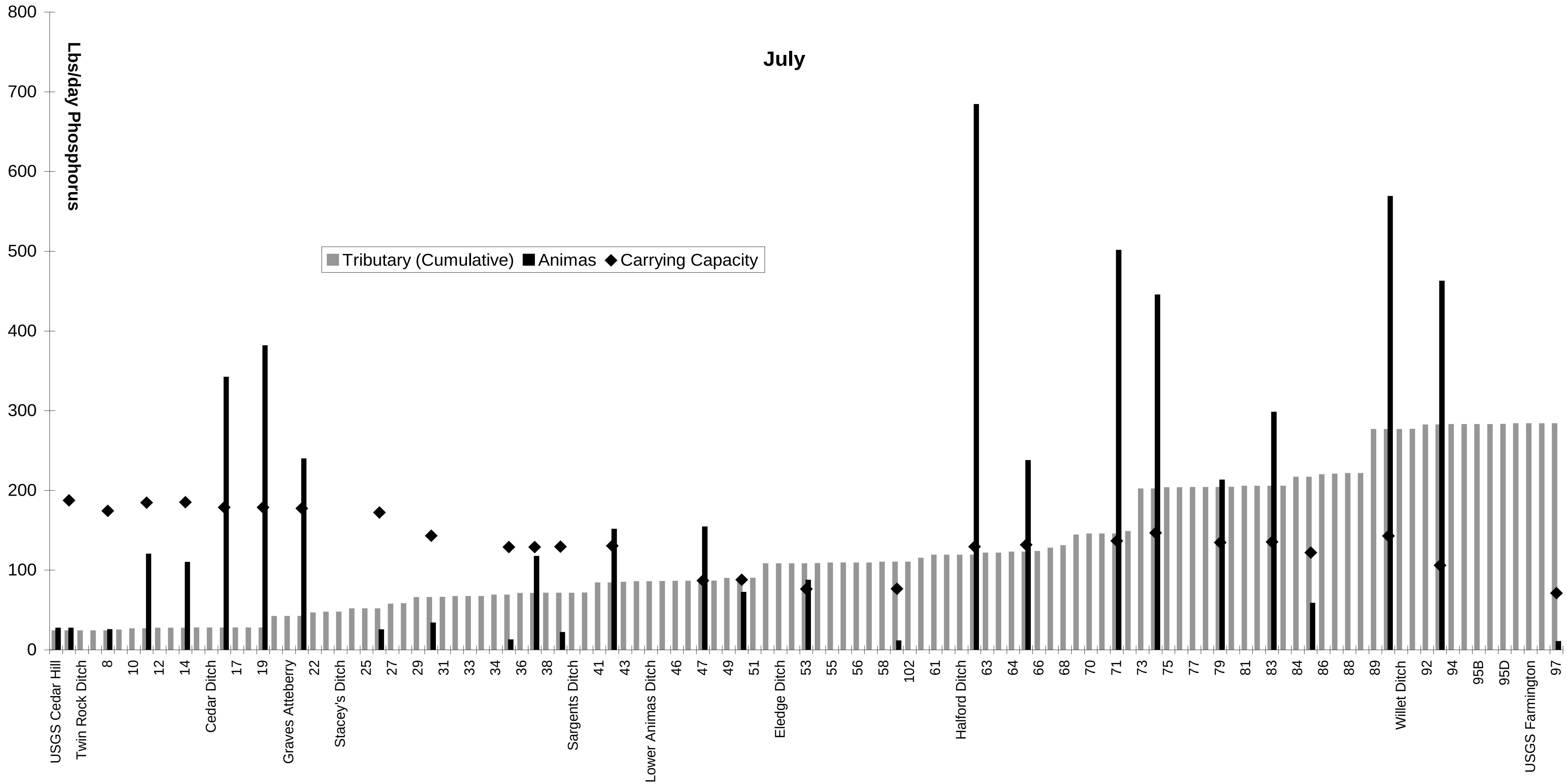



**Figure 12. July 2006 total phosphorus loading. Grey bars are cumulative loading from inflows, black bars are measured loading into the Animas River and black diamonds are calculated carrying capacity of the Animas River (all units are lbs/d, see Figure 1 for Animas River flow estimates, seeTable 12&Table 13 for data.**

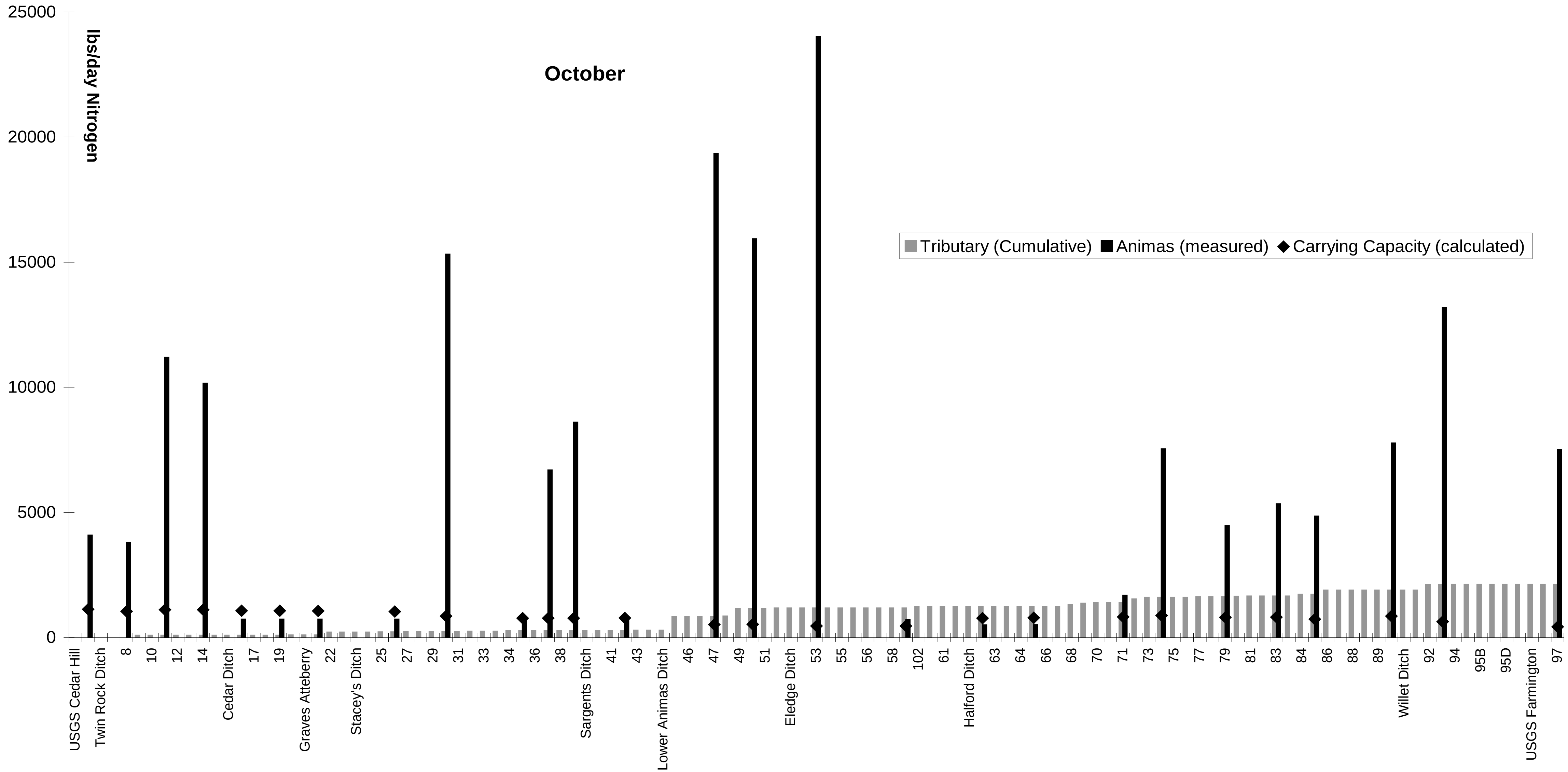



**Figure 13. October 2006 total nitrogen loading. Grey bars are cumulative loading from inflows, black bars are measured loading into the Animas River and black diamonds are calculated carrying capacity of the Animas River (all units are lbs/d, see Figure 2 for Animas River flow estimates, see Table 12&Table 13 for data.**

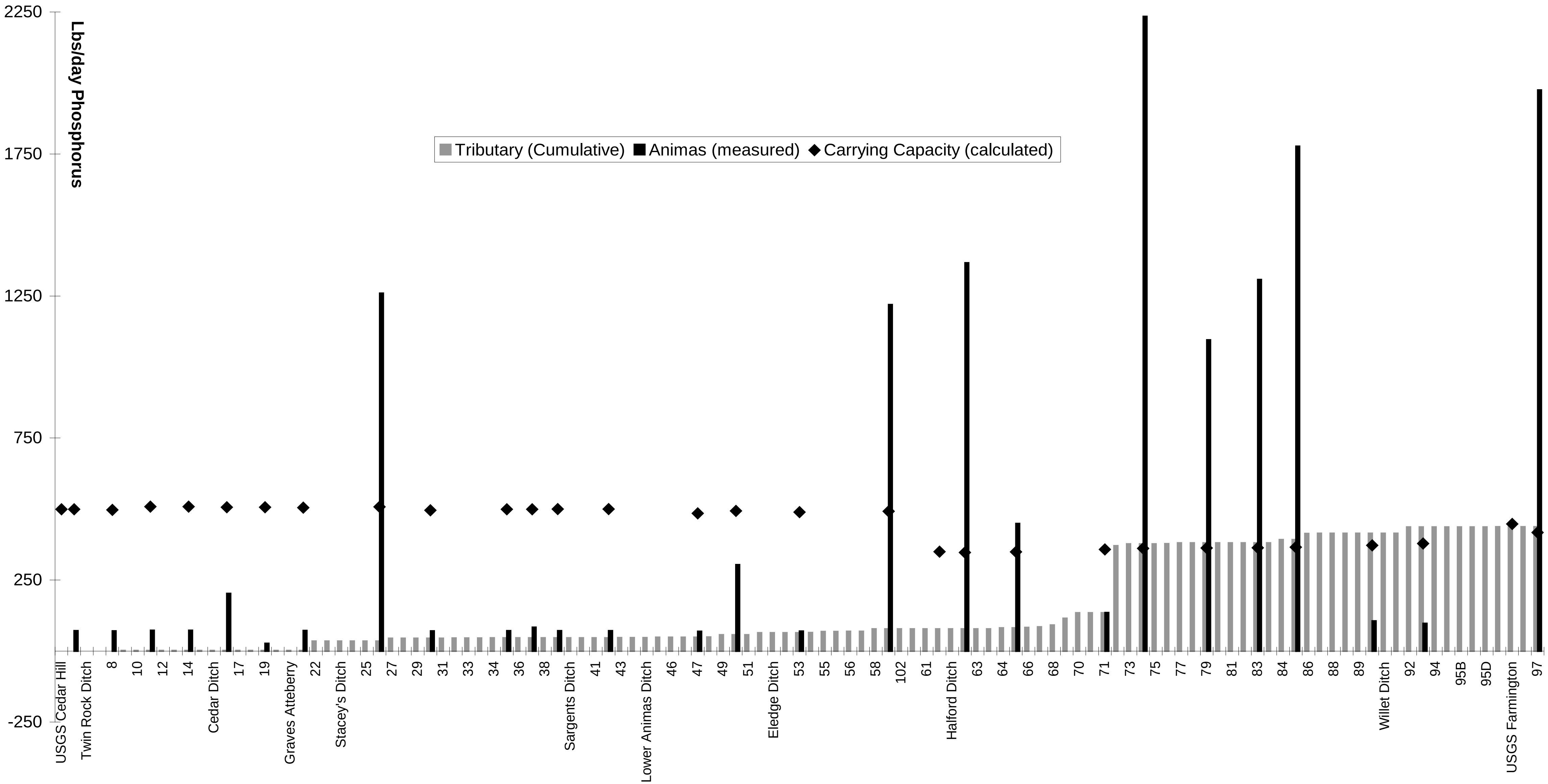



**Figure 14. October 2006 total phosphorus loading. Grey bars are cumulative loading from inflows, black bars are measured loading into the Animas River and black diamonds are calculated carrying capacity of the Animas River (all units are lbs/d, see Figure 2 for Animas River flow estimates, see Table 12&Table 13for data.**

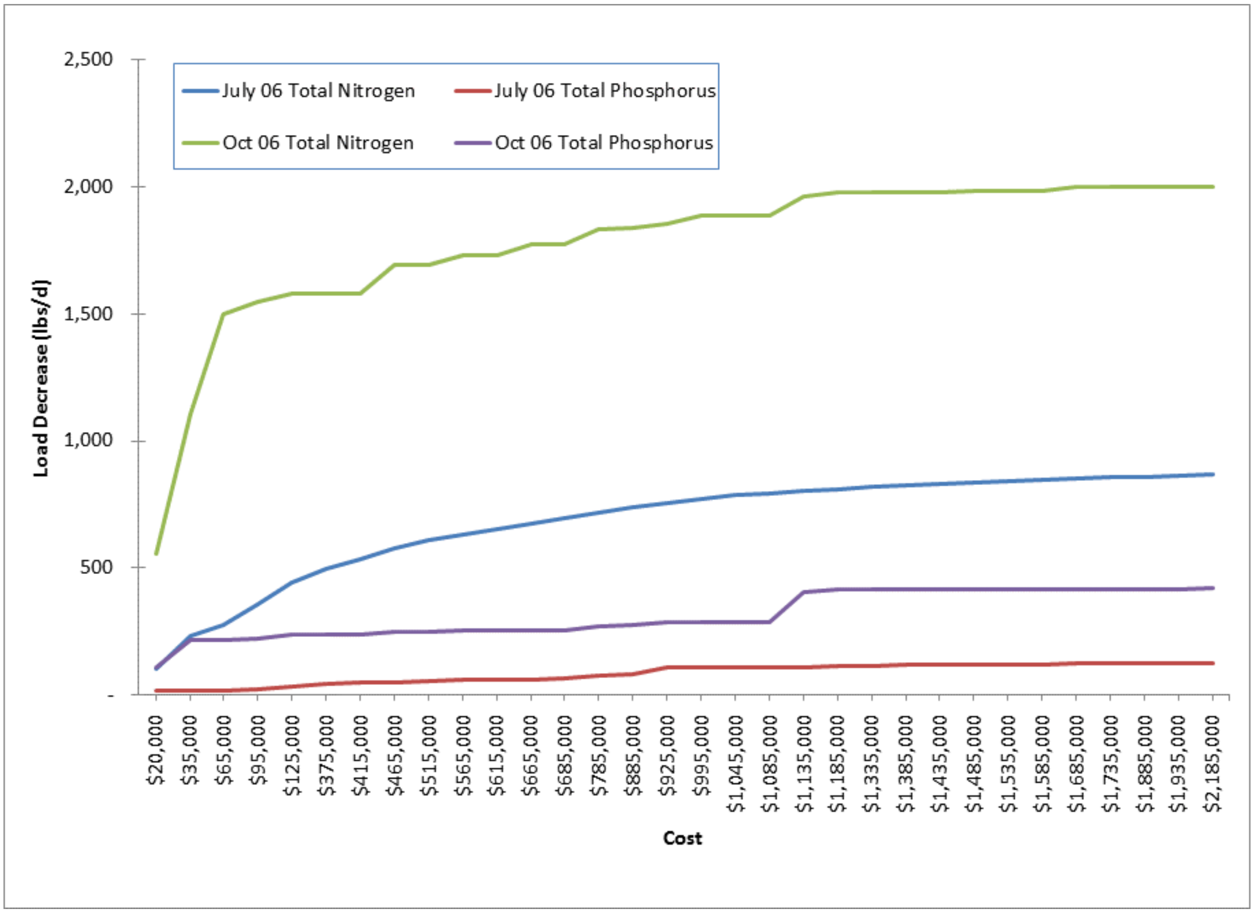



**Figure 15. Cost benefit analysis for data collected July 2006 and October 2006.**

**Figure 16. Aerial of inflow # 89, a top loading site of nitrogen and phosphorus.**

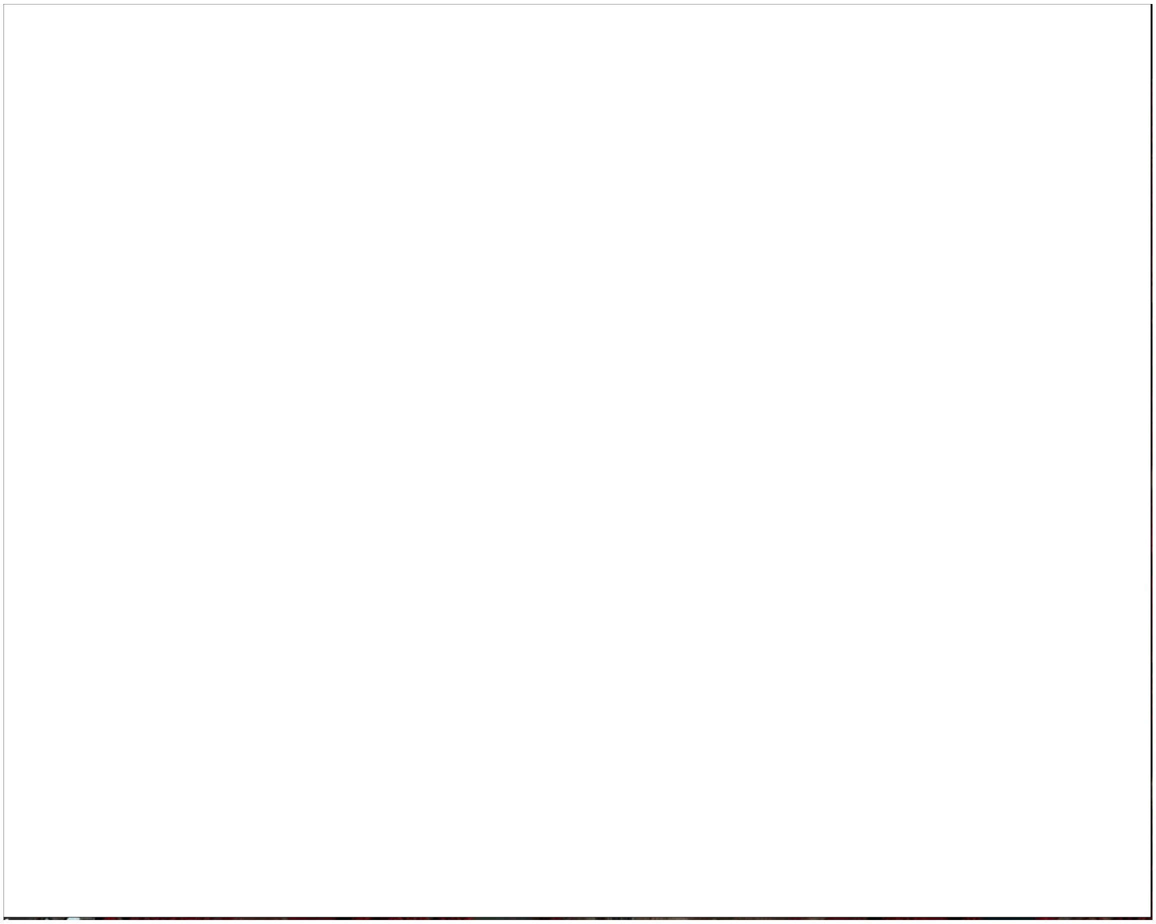


**Figure 17. Closer look at inflow 89 and proximity to urban development.**

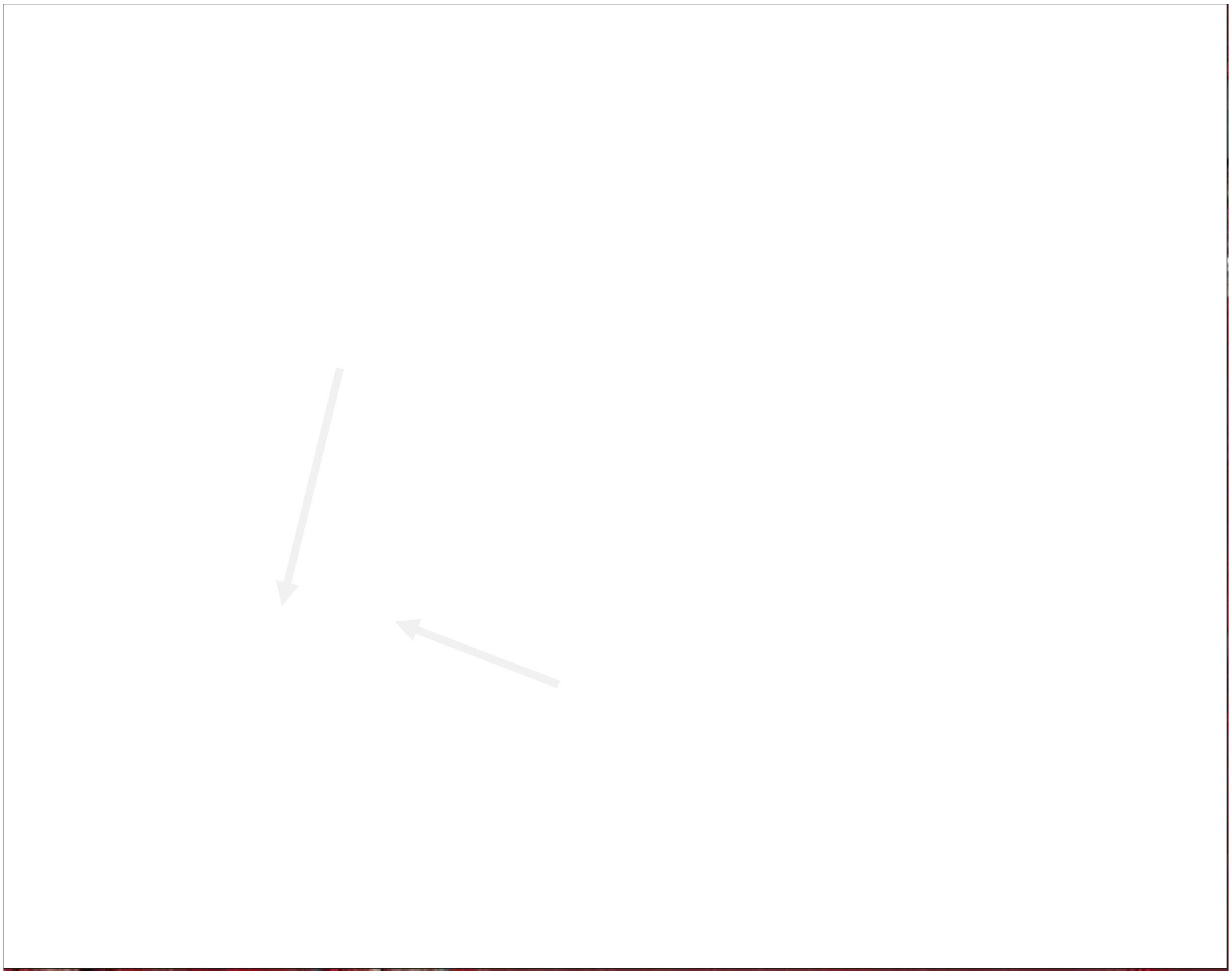


**Figure 18. Inflow 45 and identified impact to functioning capacity of the river.**

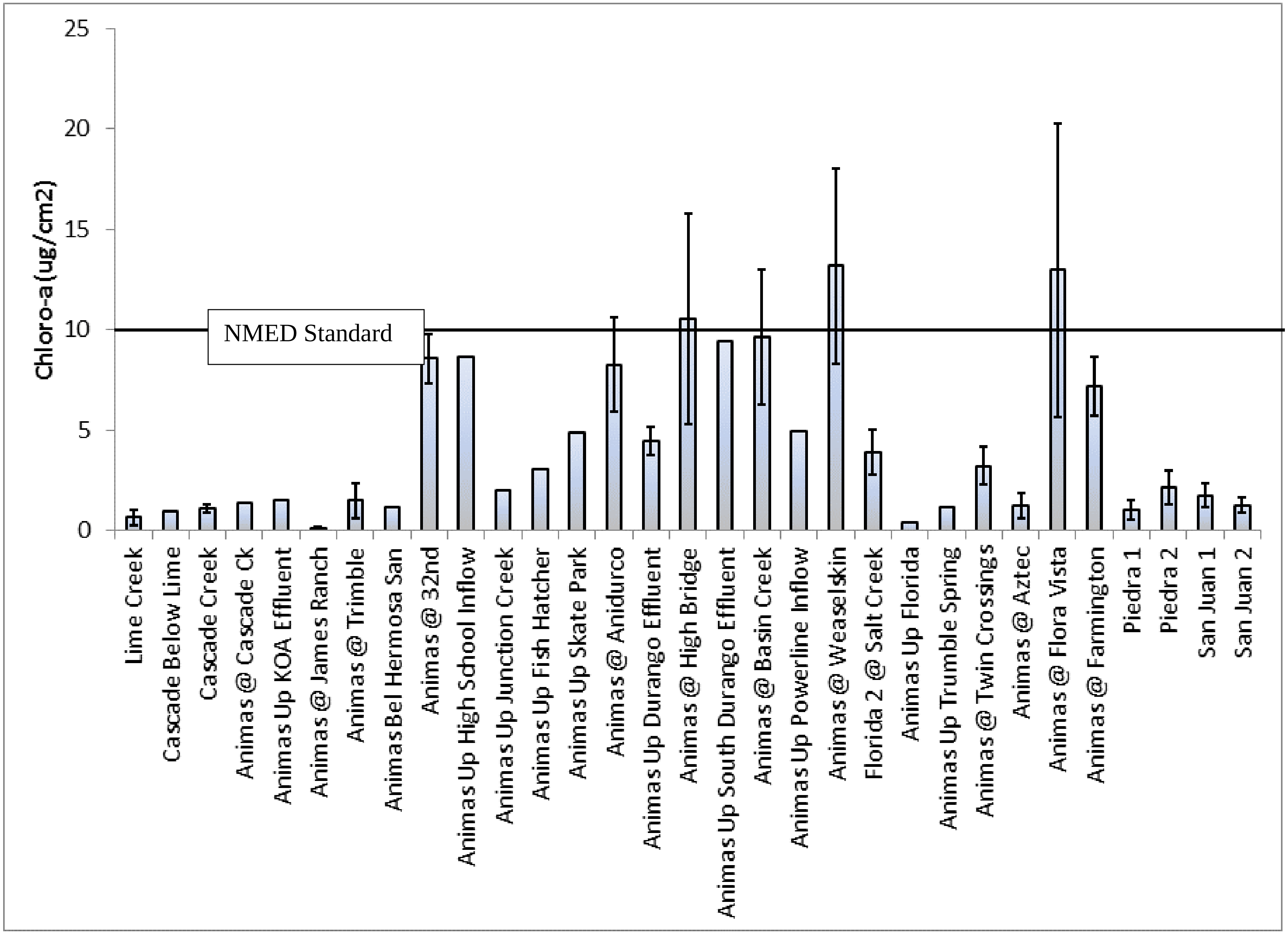



**Figure 19. Average periphyton biomass (± standard error) measured as chlorophyll-a. The NMED standard is 10ug/cm2.**

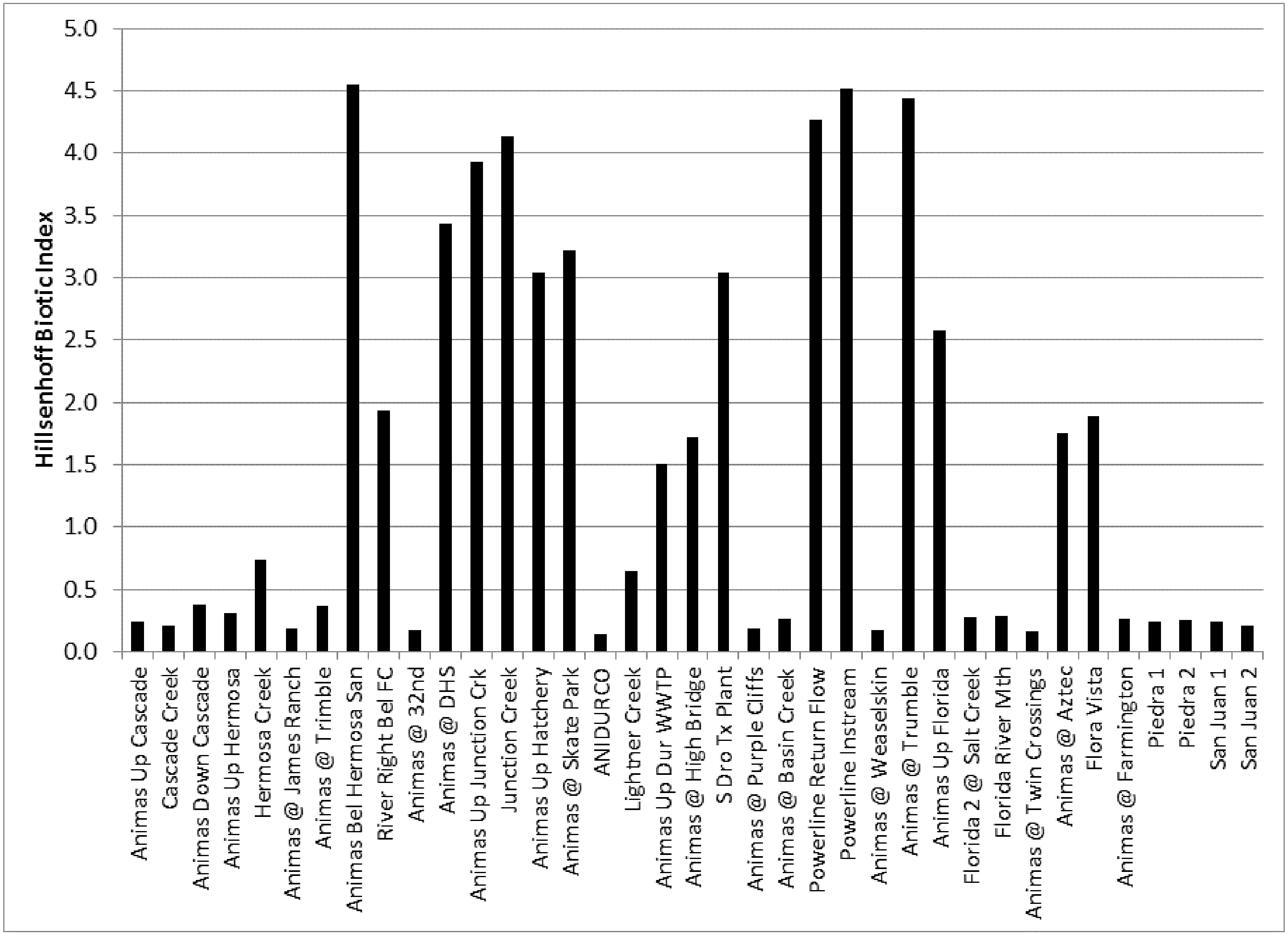



**Figure 20. Hilsenhoff Biotic Index for benthic macroinvertebrates. The HBI value represents the tolerance of benthic macroinvertebrates to pollution. High values indicate high tolerance to pollution; therefore, low values are the desirable condition. It is recommended that the Stakeholders establish a goal of less than 2 throughout the river.**

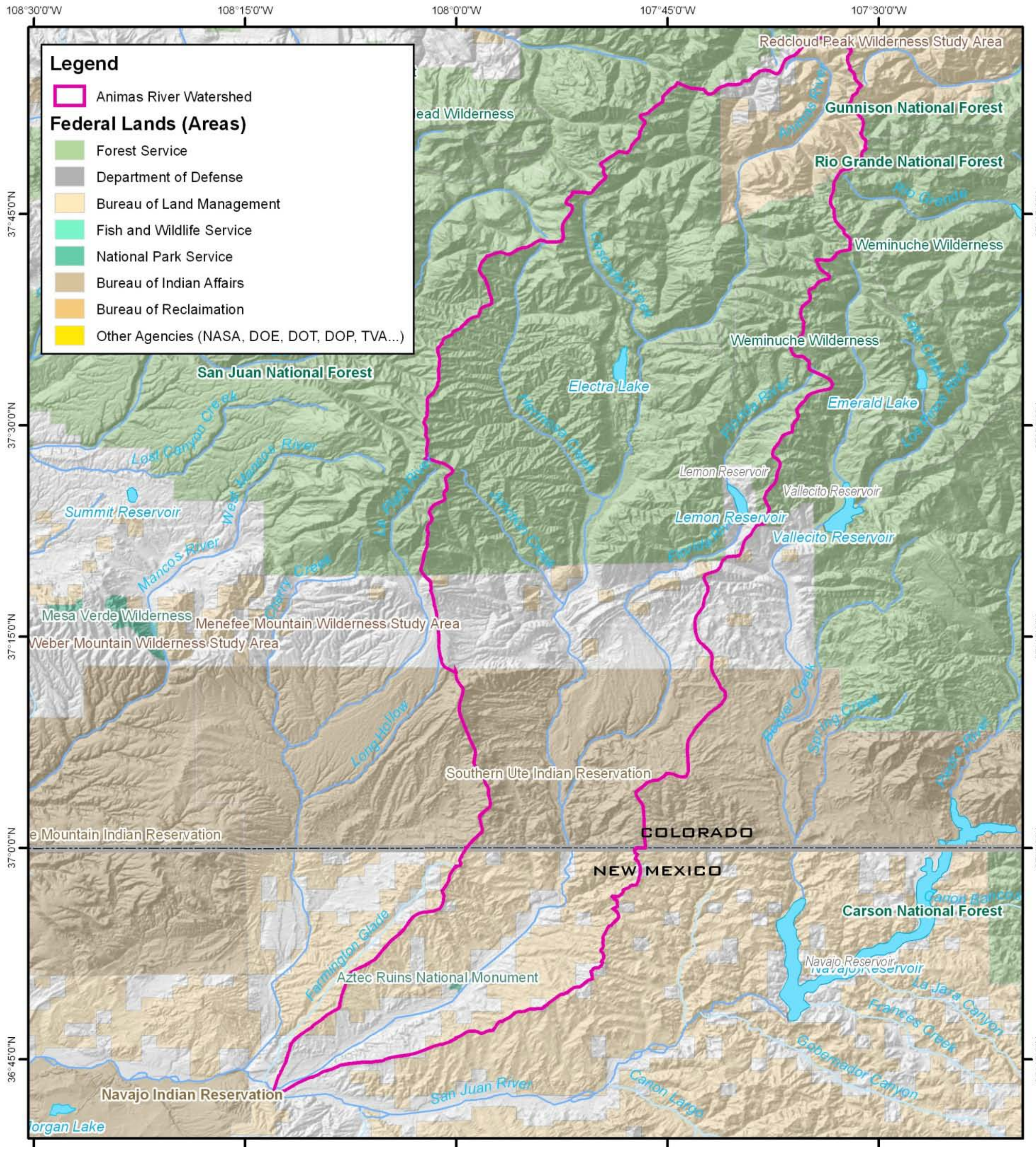



**Figure 21. Federal lands in the Animas River Watershed.**

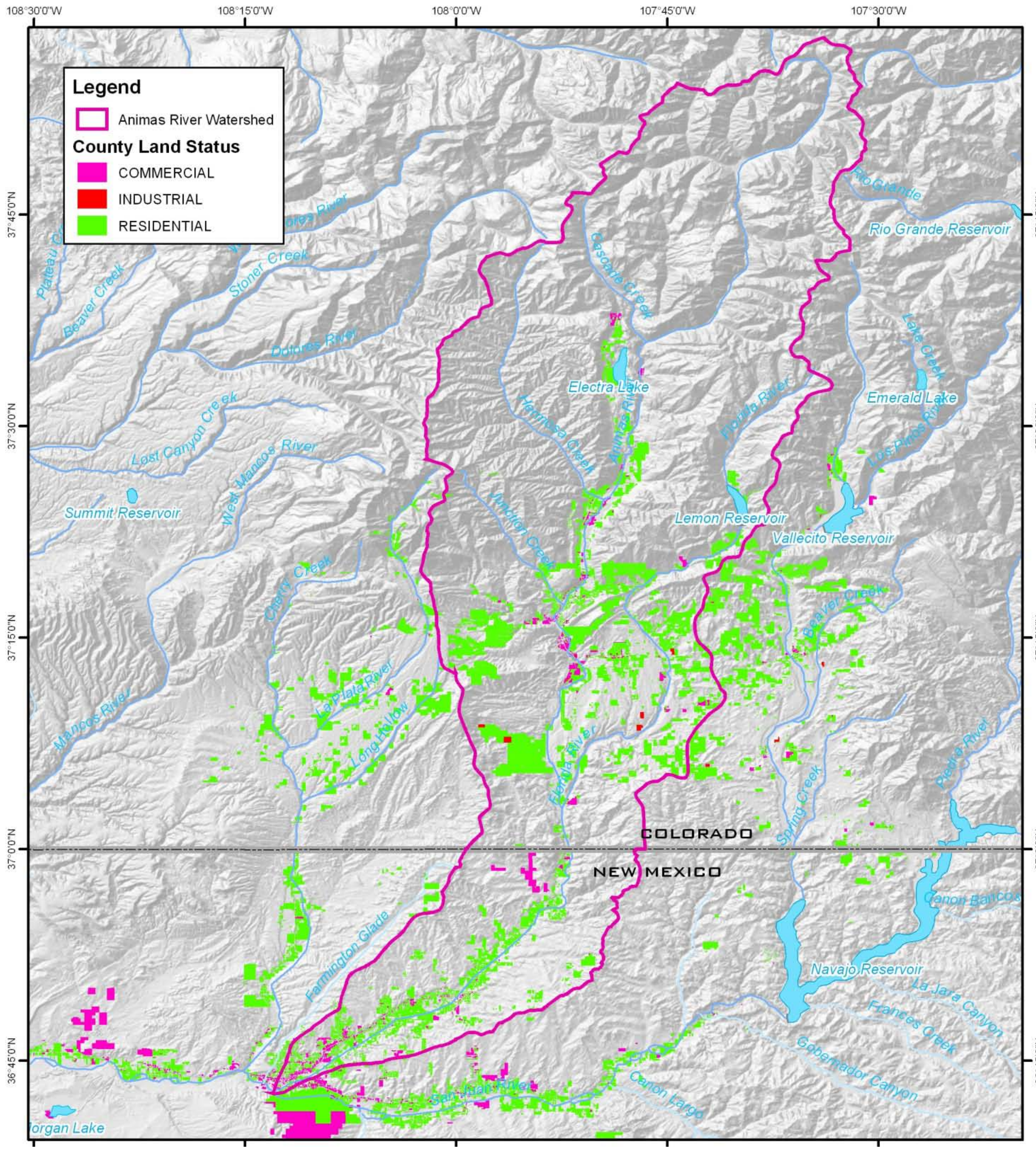



**Figure 22. County land status in the Animas River Watershed.**

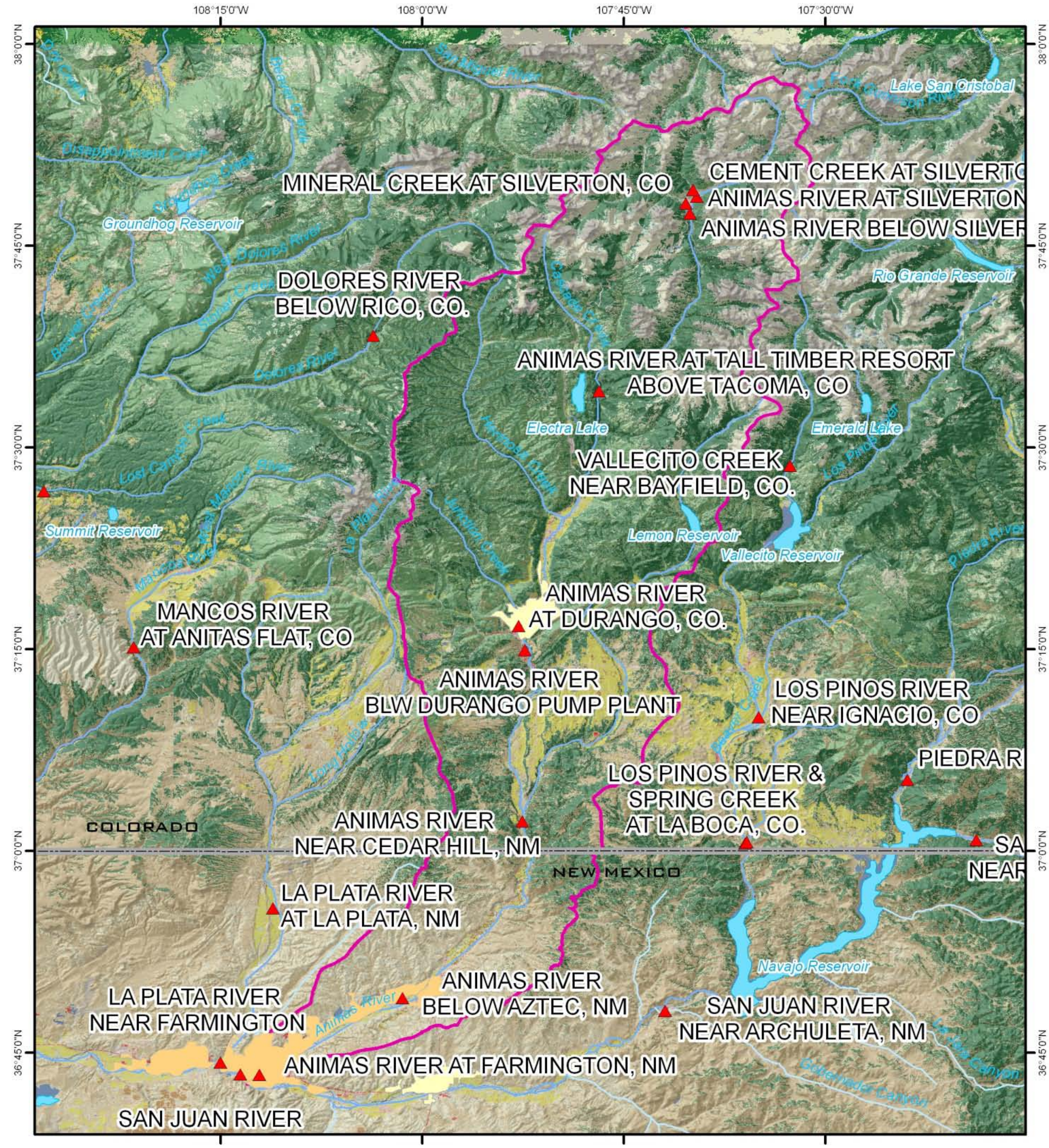



**Figure 23. USGS gauges in the Animas River Watershed.**

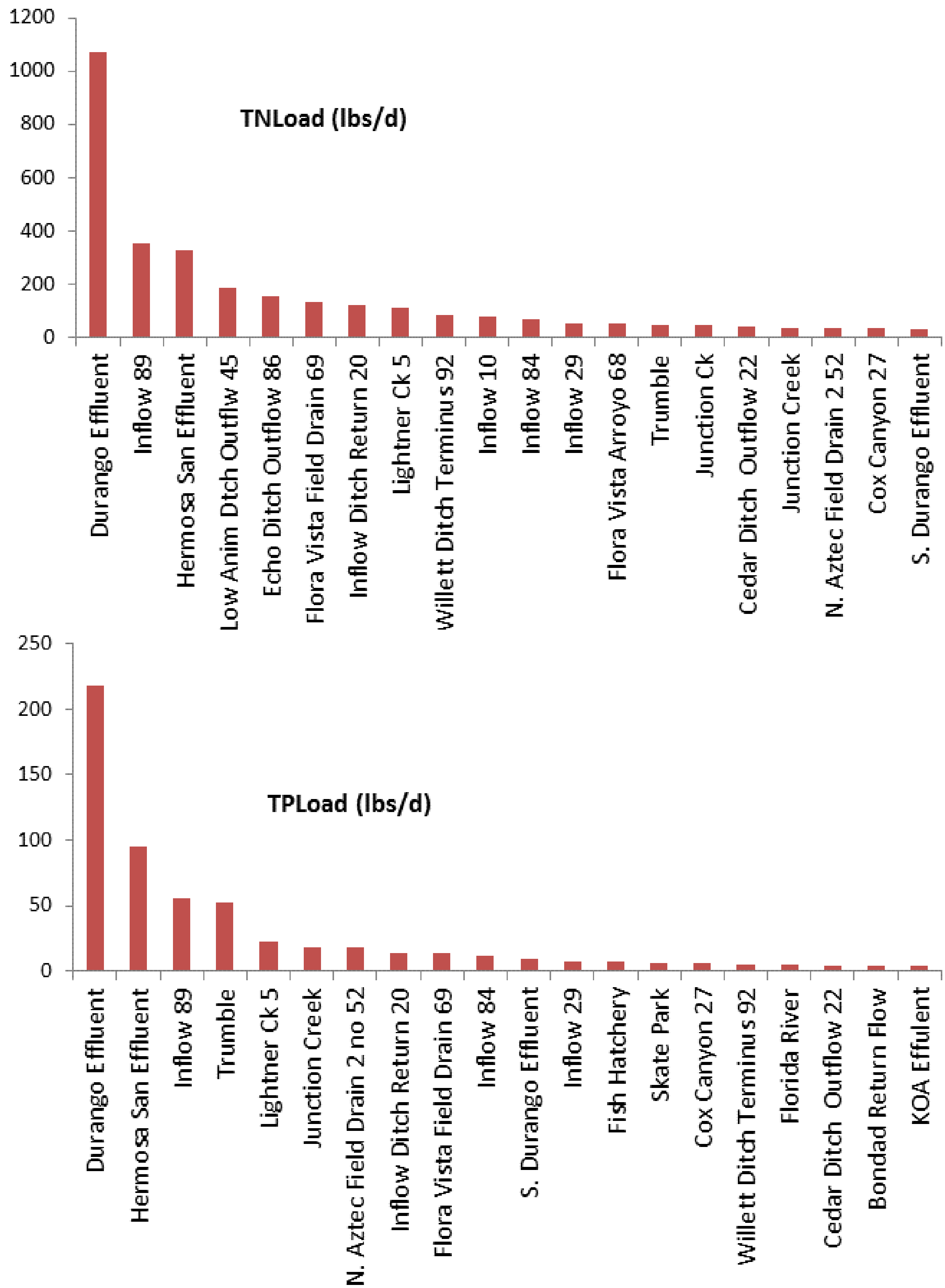



**Figure 24. Overall loading data for the Animas watershed Baker's Bridge to the San Juan River.**

# Tables

**Table 1. Major categories of compensation by Industry in each County within the Animas River Watershed, 2006.**

| Compensation By Industry | SJCoCO | LaPlataCo | SJCoNM |
|---|---|---|---|
| Farm compensation | $- | $2,455 | $19,811 |
| Nonfarm compensation | $7,721.00 | $1,091,174 | $2,377,549 |
| Private compensation | $4,892.00 | $816,433 | $1,855,723 |
| Forestry, fishing, related activities, and other 3/ | $- | $974 | $4,015 |
| Forestry and logging | $- | (D) | $- |
| Fishing, hunting, and trapping | $- | $- | $- |
| Agriculture and forestry support activities | $- | (D) | $4,015 |
| Mining | (D) | $50,563 | $470,927 |
| Oil and gas extraction | $- | $34,475 | (D) |
| Mining (except oil and gas) | $- | (D) | (D) |
| Support activities for mining | (D) | (D) | $205,143 |
| Construction | $352.00 | $135,342 | $204,584 |
| Construction of buildings | (D) | $25,600 | $35,028 |
| Heavy and civil engineering construction | (D) | $36,789 | $67,765 |
| Specialty trade contractors | $339.00 | $72,953 | $101,791 |
| Manufacturing | (D) | $23,176 | $74,381 |
| Wholesale trade | $- | $34,665 | $103,725 |
| Retail trade | (D) | $95,098 | $184,111 |
| Information | (D) | $27,476 | $15,451 |
| Finance and insurance | (D) | $45,633 | $39,851 |
| Real estate and rental and leasing | (D) | $20,223 | $26,567 |
| Professional and technical services | (D) | $67,631 | $53,266 |
| Management of companies and enterprises | $- | $2,845 | $16,164 |
| Administrative and waste services | (D) | $29,421 | $42,256 |
| Educational services | (D) | $9,587 | $21,865 |
| Health care and social assistance | (D) | $120,453 | $211,260 |
| Arts, entertainment, and recreation | (D) | $18,141 | $10,773 |
| Accommodation and food services | (D) | $58,540 | $63,912 |
| Other services, except public administration | (D) | $30,718 | $76,237 |
| Government and government enterprises | $2,829.00 | $274,741 | $521,826 |

**Table 2. Employment profile for each county within the Animas River Watershed, 2006.**

| **Employment Profile (no. employees)** | **SJCoCO** | **La Plata** | **SJCoNM** |
|---|---|---|---|
| Total employment | 580 | 37,867 | 64,891 |
| Wage and salary employment | 294 | 26,535 | 53,945 |
| Proprietors employment | 286 | 11,332 | 10,946 |
| Farm proprietors employment | - | 856 | 766 |
| Nonfarm proprietors employment | 286 | 10,476 | 10,180 |
| Farm employment | - | 901 | 1,076 |
| Nonfarm employment | 580 | 36,966 | 63,815 |
| Private employment | 508 | 31,427 | 52,063 |
| Forestry, fishing, related activities, and other 3/ | (L) | 171 | 261 |
| Mining | (D) | 707 | 6,253 |
| Utilities | - | 123 | 1,291 |
| Construction | 55 | 4,743 | 5,708 |
| Manufacturing | (D) | 842 | 1,835 |
| Wholesale trade | (L) | 746 | 2,450 |
| Retail trade | (D) | 4,214 | 7,841 |
| Transportation and warehousing | (D) | 797 | 1,806 |
| Information | (D) | 629 | 444 |
| Finance and insurance | (D) | 1,322 | 1,349 |
| Real estate and rental and leasing | (D) | 2,407 | 1,860 |
| Professional and technical services | (D) | 2,557 | 1,899 |
| Management of companies and enterprises | - | 76 | 292 |
| Administrative and waste services | (D) | 1,529 | 2,053 |
| Educational services | (D) | 500 | 1,005 |
| Health care and social assistance | (D) | 3,233 | 5,960 |
| Arts, entertainment, and recreation | (D) | 1,328 | 1,006 |
| Accommodation and food services | (D) | 3,629 | 4,902 |
| Other services, except public administration | (D) | 1,874 | 3,848 |
| Government and government enterprises | 72 | 5,539 | 11,752 |
| Federal, civilian | (L) | 440 | 1,547 |
| Military | (L) | 115 | 334 |
| State and local | 68 | 4,984 | 9,871 |
| State government | (L) | 1,321 | 443 |
| Local government | 60 | 3,663 | 9,428 |

**Table 3. Farm income distribution for San Juan County, NM and La Plata County CO, 2006. There was no  farm income in San Juan County, CO.**

| **Farm Income Distribution** | **La Plata Co.** | **SJ Co. NM** |
|---|---|---|
| Cash receipts from marketings (*1000) | $19,009.00 | $100,829.00 |
| Cash receipts: livestock and products | $12,972.00 | $45,748.00 |
| Cash receipts: crops | $6,037.00 | $55,081.00 |
| Other income | $5,273.00 | $2,949.00 |
| Government payments | $706.00 | $1,046.00 |
| Imputed and miscellaneous income received | $4,567.00 | $1,903.00 |
| Total production expenses | $33,780.00 | $83,609.00 |
| Feed purchased | $1,857.00 | $15,077.00 |
| Livestock purchased | $2,311.00 | $13,719.00 |
| Seed purchased | $504.00 | $4,353.00 |
| Fertilizer and lime (incl. ag. chemicals 1978-fwd.) | $1,157.00 | $8,126.00 |
| Petroleum products purchased | $2,012.00 | $3,353.00 |
| Hired farm labor expenses | $3,214.00 | $22,399.00 |
| All other production expenses | $22,725.00 | $16,582.00 |
| Value of inventory change | $628.00 | (L) |
| Value of inventory change: livestock | $401.00 | $259.00 |
| Value of inventory change: crops | $218.00 | $(299.00) |
| Value of inventory change: materials and supplies | (L) | (L) |
| Total cash receipts and other income | $24,282.00 | $103,778.00 |
| less: Total production expenses | $33,780.00 | $83,609.00 |
| Realized net income | $(9,498.00) | $20,169.00 |
| plus: Value of inventory change | $628.00 | (L) |
| Total net income including corporate farms | $(8,870.00) | $20,148.00 |
| less: Net income of corporate farms | (L) | $384.00 |
| plus: Statistical adjustment | $- | $- |
| Total net farm proprietors' income | $(8,849.00) | $19,764.00 |
| plus: Farm wages and perquisites | $2,181.00 | $17,901.00 |
| plus: Farm supplements to wages and salaries | $274.00 | $1,910.00 |
| Total farm labor and proprietors' income | $(6,394.00) | $39,575.00 |

**Table 4. Breakdown of agricultural sectors in San Juan County, NM and La Plata County, CO, 2005.**

| **Item** | **La Plata CO** | **SJ Co** |
|---|---|---|
| Average size of farms | 610 acres | 2174 acres |
| Average value of agricultural products sold per farm | $17,294 | $45,829 |
| Average value of crops sold per acre for harvested cropland | $111.97 | $495.28 |
| The value of nursery, greenhouse, floriculture, and sod as a percentage of the total market value of agricultural products sold | 6.31% | |
| The value of livestock, poultry, and their products as a percentage of the total market value of agricultural products sold | 75.58% | 27.13% |
| Average total farm production expenses per farm | $18,957 | $48,890 |
| Harvested cropland as a percentage of land in farms | 6.19% | 3.10% |
| Irrigated harvested cropland as a percentage of land in farms | 86.83% | 98.82% |
| Average market value of all machinery and equipment per farm | $53,361 | $92,036 |
| The percentage of farms operated by a family or individual | 89.06% | 94.43% |
| Average age of principal farm operators | 55 years | 55 years |
| Average number of cattle and calves per 100 acres of all land in farms | 3.55 | 1.31 |
| Milk cows as a percentage of all cattle and calves | 0.28% | 0.10% |
| Vegetables | 5 harvested acres | |
| Land in orchards | 122 acres | 238 acres |

**Table 5. Use of agricultural water in La Plata County. Data from Tax Assessors Office.**

| **Category** | | | |
|---|---|---|---|
| **Irrigated** | **No. Acres** | **Percent** | **Uses** |
| Sprinkler Irrigation | 8,147 | 13% | Primarily alfalfa for hay, contracting with horse farms in Phoenix and Texas, high N hay b/c so much sunshine. Used in horse racing industry. |
| Flood Irrigation | 38,761 | 62% | Grazing Land (cattle, sheep, horses, llamas, elk (2 in county) |
| Orchard Land | 48 | 0% | B/c they are no longer actively being harvested historic orchards cannot be qualified as ag land. Most are in Hermosa area, one in Bayfield area - being developed. |
| Meadow Hay (sub-irrigated land) | 15,091 | 24% | Usually grazed, but not as high quality. In riparian areas where there is access to ground water. |
| Total | 62,047 | | |
| **Non-irrigated** | | | |
| Dry Farm | 30,643 | | Primarily wheat, oats, & canola. |
| Grazing | 180,240 | | |
| Total | 210,883 | | |

**Table 6. Drinking water stations with addresses in Durango and Farmington areas, populations served and source of waters.**

| Entity | Population Served | Source of water |
|---|---|---|
| Durango City Of | 30000 | Surface_water |
| Animas Wc | 3200 | Groundwater |
| Lake Durango Wc | 3000 | Surface_water |
| Durango West Metro Dist No 2 | 930 | Purch_surface_water |
| Durango West Md No 1 | 750 | |
| Edgemont Ranch Md | 450 | Surface_water |
| Florida River Estates Hoa Inc | 291 | |
| Durango Regency | 200 | Groundwater |
| Aztec Domestic Water System | 6378 | Surface_water |
| North Star Water Users Association | 2737 | Surface_water |
| Dutchmans Hill Water Company | 360 | Groundwater |
| East Aztec Water Users | 147 | Purch_surface_water |
| Hydro Pure Technology Inc. | 25 | Purch_surface_water |
| Morningstar Water Supply System | 5184 | Surface_water |
| Lee Acres Water Users Association | 4718 | Purch_surface_water |
| La Vida Mission Community Water Supply | 53 | Groundwater |
| Westwood Culligan | 25 | Purch_surface_water |
| Lee/Hammond Water Treatment Plant | 0 | Surface_water |

**Table 7. Discharge permits in the Animas River Basin, those highlighted in yellow it is unkown whether or not they are in the watershed.**

| Permit # | Permittee Company Name | Facility Name | Title | County |
|---|---|---|---|---|
| CO-0020311 | Silverton, Town Of | Town Of Silverton | Mayor | San Juan |
| CO-0024082 | Durango, City Of | Water Treatment Plant | Director | La Plata |
| CO-0026468 | Amorelli, Joe & Cheryl | Dba, Lightner Creek Campground | | La Plata |
| CO-0027529 | Gold King Mines Corporation | American Tunnel | President | San Juan |
| CO-0029904 | Lightner Creek Mhp | Mobile Home Park | Owner | La Plata |
| CO-0035939 | Tamarron Management Assoc., Llc | Glacier Club At Tamarron | Dir. Develop & Const | La Plata |
| CO-0039691 | Mill Creek Management Co., Llc | Cascade Village | Owner | San Juan |
| CO-0040266 | Edgemont Ranch Metro District | Metropolitan District | President | La Plata |
| CO-0040860 | Needles Homeowners Association | Needles Hoa | Manager | La Plata |
| CO-0041548 | U.S. Dept. Of Energy/S.M. Stoller Corp. | Umtra Bodo Canyon Wwtf | Project Manager | La Plata |
| COG-071561 | Weeminuche Construction Authority | Ridges Basin Dam | General Manager | La Plata |
| COG-130005 | Colo Div Of Wildlife | Durango | Director | La Plata |
| COG-500241 | Sandco, Inc | Dalton Pit | President | La Plata |
| COG-500328 | Oldcastle Sw Group, Inc. | Thomas Pit | President | La Plata |
| COG-500368 | Nielsons Skanska, Inc. | Red Mesa Gravel Pit | V.P. | La Plata |
| COG-581010 | Purgatory Metro District | Wastewater Treatment Plant | | La Plata |
| COG-582024 | Durango West Metro District #2 | Sewage Treatment Plant | President | La Plata |
| COG-582028 | Loma Linda Sanitation District | Sanitation District | President | La Plata |
| COG-584010 | Hermosa Sanitation District | Sanitation District | Chairman | La Plata |
| COG-584011 | Upper Valley Sanitation, Inc. | Upper Valley Sanitation, Inc. | President | La Plata |
| COG-584020 | Bailey, Fritz L. & Rebecca D. | Dba, Durango N.-Ponderosa Koa | Owner | La Plata |
| COG-584030 | Forrest Groves Estates | Sewage Treatment Facility | President, H.O.A. | La Plata |
| COG-584057 | South Durango Sanitation District | Sanitation District | Manager | La Plata |
| COG-600510 | Bear, Ruedi | Trimble Hot Springs | Owner | La Plata |
| COG-630035 | Old Homestead Mhp | Old Homestead Mhp | Owner | La Plata |
| COG-630058 | Read, Dawn | Dba, Sundown Acres Park | Owner | La Plata |

| **Permit #** | **Permittee Company Name** | **Facility Name** | **Title** | **County** |
|---|---|---|---|---|
| COG-640008 | Silverton, Town Of | Water Treatment Plant | Mayor | San Juan |
| COG-850001 | National King Coal, Llc | King Coal Mine | President | La Plata |
| COG-850042 | Oakridge Energy, Inc. | Carbon Junction Mine | President | La Plata |

**Table 8. Monitoring entities in the Animas River Watershed.**

| Agency/Stakeholder Group | AKA. | First Year | Most Recent Entry | Number of Results |
|---|---|---|---|---|
| Animas River Nutrient Workgroup | ARNW | 2002 | 2005 | 2,644 |
| Animas River Stakeholders Group | ARSG | 1994 | Ongoing | Not compiled in AWP database |
| Colorado Department of Public Health & Environment | CDPHE | 1901 | 2007 | 25,835 |
| Colorado Division of Water Resources | CDWR | | | |
| Colorado Division of Wildlife | CDOW | 2001 | 2005 | 1,340 |
| Farmington Stormwater Management Program | Farmington | 2007 | Ongoing | Not compiled in AWP database |
| New Mexico Environment Department | NMED | 1973 | 2004 | 5,587 |
| Rivers of Colorado Water Watch Network | RiverWatch | 1991 | 2005 | 30,233 |
| San Juan Watershed Group | SJWG | 2006 | 2007 | 1,297 |
| Southern Ute Indian Tribe | SUIT | 1992 | 2007 | 31,303 |
| United States Bureau of Reclamation | BOR | 2005 | 2007 | 678 (recent data not compilte) |
| United States EPA | USEPA | 1971 | 2003 | 301 |
| United States Forest Service | USFS | 1978 | 1980 | 470 |
| United States Geological Survey | USGS | 1900 | 2008 | 65,532 |

**Table 9: Sources of urban stormwater pollutants (Minton 2005).**

| Source | Major Pollutants |
|---|---|
| Atmospheric deposition | Ammonia, fine particles, metals, nitrate, pesticides, petroleum products, phosphorus, toxic organics |
| Public infrastructure | Bacteria, metals, nitrogen, organics, petroleum products, phosphorus |
| Pavement and pavement maintenance | Materials from abraded or degraded pavement, petroleum derivates from asphalt, temperature modification |
| Pavement deicing | Chlorides, coarse sediments, cyanide, organics from acetate deicers, sulfates |
| Transportation vehicles | Brake drum and tire wear; fuels; fine particles; metals, especially cadmium, chromium, copper, lead, and zinc; petroleum products such as oil, grease, and PAH |
| Residential activities | Bacteria, herbicides, landscaping debris, nitrogen, paint, pesticides, petroleum products, phosphorus, vehicle maintenance fluids, wood preservation, zinc |
| Building exteriors | Chipped and eroded paints, corrosion of surfaces accelerated by acid rain, galvanized metals, other metals |
| Site development | Cement, concrete, high pH, organics, paint, particulate matter, petroleum products, phosphorus |
| Residential and roadside landscape maintenance | Dissolved organics from soil amendments, herbicides, humic organics, nitrogen, pesticides, phosphorus; personal and commercial debris discarded to roadways and parking lots such as cans, food, paper, plastics; leaves and yard debris |
| Urban wildlife and pets | Bacteria, nitrogen, phosphorus |
| Commercial activities | Bacteria, $BOD_5$, discarded food, metals, nitrogen, petroleum products, phosphorus, used cooking oil and grease, packaging materials |

**Table 10. USGS Gauges in the Animas River Watershed.**

| USGS Station Name | Number of Parameters | Begin Date | Most Recent | Number of Results |
|---|---|---|---|---|
| Animas River At Farmington, Nm | 360 | 9/6/1900 | 12/9/2008 | 27087 |
| Animas River Near Cedar Hill, Nm | 188 | 11/5/1942 | 8/12/1998 | 4850 |
| Animas River Below Silverton, Co | 99 | 10/17/1991 | 12/2/2008 | 4520 |
| Animas River At Durango, Co | 119 | 9/18/1958 | 5/17/2004 | 1540 |
| Animas River At Silverton, Co. | 58 | 5/13/1959 | 5/10/2004 | 700 |
| Animas River Below Durango, Co. | 92 | 7/28/1972 | 4/11/2003 | 327 |
| Animas River At Weaselskin Bridge Nr Laposta Co. | 109 | 5/10/1989 | 3/7/2003 | 299 |
| Animas River At Bakers Bridge Near Hermosa, Co | 77 | 1/24/2003 | 4/10/2003 | 140 |
| Animas River At 32nd St Near Durango, Colorado | 76 | 1/23/2003 | 3/6/2003 | 113 |
| Animas River Near Carbon Junction, Co | 39 | 8/1/2002 | 9/3/2002 | 69 |

**Table 11. Colorado/Southern Ute Reservation loading data, Baker's Bridge to NM State Line.**

| | | | Animas River Sample Sites | | | | | | | Inflows | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Site Name** | **Latitude** | **Longitude** | **Discharge** | **TN Conc. (ug/l)** | **TN Load** | **TN Carrying Capacity** | **TP Conc. (ug/l)** | **TP Load** | **TP Carrying Capacity** | **Discharge** | **TN Conc. (ug/l)** | **TN Load** | **TP Conc. (ug/l)** | **TP Load** |
| KOA Effluent | 37.44917 | 107.80125 | 823 | 0.4 | 1775.58 | 1863.08 | 0.08 | 355.12 | 310.51 | 0.09 | 38.48 | 18.16 | 9 | 4.25 |
| Hot Spring | 37.44758 | 107.80237 | 600 | 0.28 | 906.13 | 1358.26 | 0.07 | 226.53 | 226.38 | 0.02 | 0.46 | 0.05 | | 0.00 |
| Trimble | 37.38541 | 107.83654 | 700 | 0.04 | 151.02 | 1584.63 | 0.09 | 339.80 | 264.11 | 1.9 | 0.14 | 1.43 | 0.12 | 1.23 |
| Hermosa San Effluent | 37.38519 | 107.84279 | 700 | 0.18 | 679.60 | 1584.63 | 0.02 | 75.51 | 264.11 | 0.71 | 84.66 | 324.20 | 4.9 | 18.76 |
| Sherer Creek Inflow | 37.37906 | 107.84881 | | | | | | | | 1.13 | 0.05 | 0.30 | 0.02 | 0.12 |
| Falls Creek Inflow | 37.3633 | 107.8471 | | | | | | | | 29.39 | 0 | 0.00 | 0.04 | 6.34 |
| Animas River Right Down Falls Creek | 37.34977 | 107.8448 | 732 | 0.16 | 631.70 | 1657.07 | 0.025 | 98.70 | 276.18 | | | 0.00 | | 0.00 |
| Inflow House Right | 37.33076 | 107.84297 | | | | | | | | 1.2 | 0.04 | 0.26 | 0.01 | 0.06 |
| S. Campground Inflow | 37.3183 | 107.84993 | | | | | | | | 886 | 0 | 0.00 | 0.02 | 95.57 |
| City Diversion Inflow | 37.2962 | 107.87024 | | | | | | | | 1.08 | 0.07 | 0.41 | 0.03 | 0.17 |
| Riverview Storm Drain | 37.28865 | 107.870029 | | | | | | | | 1.90 | | 0.00 | | 0.00 |
| High School | 37.28715 | 107.87187 | 545 | 1.5 | 4409.28 | 1233.75 | 0.24 | 705.48 | 205.63 | 0.2 | 0.78 | 0.84 | 0.13 | 0.14 |

| | | | Animas River Sample Sites | | | | | | | Inflows | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Site Name** | **Latitude** | **Longitude** | **Discharge** | **TN Conc. (ug/l)** | **TN Load** | **TN Carrying Capacity** | **TP Conc. (ug/l)** | **TP Load** | **TP Carrying Capacity** | **Discharge** | **TN Conc. (ug/l)** | **TN Load** | **TP Conc. (ug/l)** | **TP Load** |
| Junction Creek | 37.2856 | 107.87218 | 545 | 0.08 | 235.16 | 1233.75 | 0.03 | 88.19 | 205.63 | 7.51 | 0.87 | 35.22 | 0.19 | 7.69 |
| Fish Hatchery | 37.28096 | 107.87344 | 545 | 0.07 | 205.77 | 1233.75 | 0.03 | 88.19 | 205.63 | 5.93 | 0.82 | 26.22 | 0.06 | 1.92 |
| Main Street Pipe Inflow | 37.28106 | 107.87872 | | | | | | | | 0.4 | 0.74 | 1.60 | 0.04 | 0.09 |
| Mains Street Spring Inflow | 37.28102 | 107.87872 | | | | | | | | 0.3 | 0.56 | 0.91 | | 0.00 |
| Skate Park | 37.27768 | 107.88274 | 545 | 0.08 | 235.16 | 1233.75 | 0.03 | 88.19 | 205.63 | 2.1 | 2.31 | 26.16 | 0.02 | 0.23 |
| Lightner Creek | 37.26819 | 107.88609 | 545 | 0.08 | 235.16 | 1233.75 | 0.03 | 88.19 | 205.63 | 2.57 | 0.38 | 5.27 | 0.09 | 1.25 |
| Durango Effluent | 37.25908 | 107.8773 | 545 | 0.32 | 940.65 | 1233.75 | 0.09 | 264.56 | 205.63 | 13.44 | 14.74 | 1068.51 | 3 | 217.47 |
| High Bridge | 37.23419 | 107.86833 | 545 | 0.24 | 705.48 | 1233.75 | 0.12 | 352.74 | 205.63 | | | | | |
| Grandview Inflow | 37.21769 | 107.85383 | | | | | | | | 0.99 | 0.15 | 0.80 | 0.04 | 0.21 |
| Inflow Up S. Durango Effluent | 107.84727 | 107.84733 | | | | | | | | 0.8 | 0.13 | 0.56 | 0.04 | 0.17 |
| S. Durango Effluent | 37.20361 | | 800.00 | 0.08 | 345.19 | 1811.01 | 0.03 | 129.45 | 301.83 | 2.10 | 2.48 | 28.03 | 4.6 | 51.99 |
| Animas @ Basin Creek | 37.18503 | 107.87916 | 985.00 | 0.33 | 1753.19 | 2229.81 | 0.09 | 478.14 | 371.63 | | | | | |
| Animas @ Weasel Skin | 37.15221 | 107.888286 | 992 | 0.235 | 1257.36 | 2245.65 | 0.135 | 722.31 | 374.28 | | | | | |
| Powerline Return Flow | 37.13327 | 107.88906 | 992 | 0.61 | 3263.78 | 2245.65 | 0.14 | 749.07 | 374.28 | 0.56 | 1.32 | 3.99 | 0.08 | 0.24 |

| | | | Animas River Sample Sites | | | | | | Inflows | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Site Name** | **Latitude** | **Longitude** | **Discharge** | **TN Conc. (ug/l)** | **TN Load** | **TN Carrying Capacity** | **TP Conc. (ug/l)** | **TP Load** | **TP Carrying Capacity** | **Discharge** | **TN Conc. (ug/l)** | **TN Load** | **TP Conc. (ug/l)** | **TP Load** |
| Trumble | 37.10082 | 107.88776 | 992 | 0.42 | 2247.20 | 2245.65 | 0.31 | 1658.64 | 374.28 | 7.99 | 1.05 | 45.26 | 0.1 | 4.31 |
| Trumble Spring Inflow | 37.10082 | 107.88776 | | | | | | | | 0.5 | 2.38 | 6.42 | | 0.00 |
| Spring River Right Inflow | 37.05584 | 107.88065 | | | | | | | | 1.10 | 0.63 | 3.74 | 0.01 | 0.06 |
| Florida River | 37.05003 | 107.87278 | 992 | 0.735 | 3932.59 | 2245.65 | 0.25 | 1337.62 | 374.28 | 4.5 | 1.07 | 25.97 | 0.215 | 5.22 |
| Bondad Return Inflow | 37.04494 | 107.87598 | | | | | | | | 13.11 | 0.28 | 19.80 | 0.13 | 9.19 |
| | | **Average** | | | **1328.33** | **1650.41** | | **435.91** | **275.07** | | | **Sum=1644.11** | | **Sum=426.70** |

**Table 12. Concentration of total nitrogen and total phosphorus in Animas River in the New Mexico portion of the watershed sampled July and October 2006 along with loading and carrying capacity calculations (see NMED Source Identification and TMDL Reports for methods and Animas GIS database for site descriptions. Sites are organized upstream to downstream).**

| | | July | | | | | | | | October | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Tot Nitrogen | | | Tot Phosphorus | | | | | Tot Nitrogen | | | Tot Phosphorus | | |
| Data Base No | Site Name | Sample Date | Flow (cfs) | Conc. (mg/l) | Load (lbs/d) | Car Cap (lbs/d) | Conc. (mg/l) | Load (lbs/d) | Car Cap (lbs/d) | Sample Date | Flow (cfs) | Conc. (mg/l) | Load (lbs/d) | Car Cap (lbs/d) | Conc. (mg/l) | Load (lbs/d) | Car Cap (lbs/d) |
| 1 | James Ranch | 7/14/06 | 687.60 | 0.36 | 1321.8 | 1556.6 | 0.02 | 75.29 | 259.43 | | | | | | | | |
| 3 | Animas @ Jxn | 7/14/06 | 693.00 | 1.84 | 6870.8 | 1568.8 | 0.10 | 368.54 | 261.46 | | | | | | | | |
| 4 | ANIDURCO | 7/14/06 | 693.00 | 1.01 | 3781.5 | 1568.8 | 0.01 | 0.00 | 261.46 | | | | | | | | |
| 6 | HighBridge | 7/14/06 | 699.55 | 2.02 | 7621.7 | 1583.6 | 0.14 | 538.05 | 263.94 | | | | | | | | |
| 7 | USGS Cedar Hill | 7/15/06 | 497.00 | | 0.0 | 1125.1 | | 0.00 | 187.51 | 10/25/06 | 1323.00 | | | 2995.0 | | | 499.16 |
| 8 | 7 | 7/15/06 | 497.00 | 1.63 | 4379.3 | 1125.1 | 0.01 | 0.00 | 187.51 | 10/25/06 | 1323.00 | 0.57 | 4084.5 | 2995.0 | 0.00 | 0.00 | 499.16 |
| 11 | 8 | 7/15/06 | 462.00 | 1.23 | 3068.7 | 1045.9 | 0.01 | 0.00 | 174.31 | 10/25/06 | 1318.10 | 0.53 | 3792.8 | 2983.9 | 0.00 | 0.00 | 497.31 |
| 14 | 11a | 7/15/06 | 489.85 | 1.55 | 4092.0 | 1108.9 | 0.05 | 119.68 | 184.82 | 10/25/06 | 1347.98 | 1.54 | 11184.9 | 3051.5 | 0.00 | 0.00 | 508.58 |
| 17 | 14 | 7/15/06 | 490.75 | 0.40 | 1048.7 | 1110.9 | 0.04 | 109.32 | 185.16 | 10/25/06 | 1347.99 | 1.40 | 10146.0 | 3051.5 | 0.00 | 0.00 | 508.59 |
| 20 | 16 | 7/15/06 | 474.07 | 0.25 | 642.6 | 1073.2 | 0.13 | 341.61 | 178.86 | 10/25/06 | 1342.33 | 0.00 | 0.0 | 3038.7 | 0.03 | 202.55 | 506.45 |
| 23 | 19 | 7/15/06 | 474.18 | 1.33 | 3395.1 | 1073.4 | 0.15 | 381.07 | 178.90 | 10/25/06 | 1342.33 | 0.00 | 0.0 | 3038.7 | 0.00 | 27.06 | 506.45 |
| 26 | 21 | 7/15/06 | 470.29 | 0.00 | 0.0 | 1064.6 | 0.09 | 239.20 | 177.44 | 10/25/06 | 1338.76 | 0.00 | 0.0 | 3030.6 | 0.00 | 0.00 | 505.11 |
| 32 | 26 | 7/15/06 | 456.96 | 1.68 | 4151.9 | 1034.4 | 0.01 | 0.00 | 172.41 | 10/25/06 | 1346.46 | 0.00 | 0.0 | 3048.1 | 0.17 | 1259.41 | 508.01 |
| 36 | 30 | 7/16/06 | 379.32 | 1.10 | 2255.0 | 858.7 | 0.02 | 33.35 | 143.12 | 10/27/06 | 1313.19 | 2.16 | 15313.1 | 2972.8 | 0.00 | 0.00 | 495.46 |
| 42 | 35 | 7/16/06 | 341.85 | 0.00 | 0.0 | 773.9 | 0.01 | 12.17 | 128.98 | 10/27/06 | 1323.50 | 0.00 | 0.0 | 2996.1 | 0.00 | 0.00 | 499.35 |
| 44 | 37 | 7/16/06 | 342.05 | 0.76 | 1401.5 | 774.3 | 0.06 | 116.78 | 129.05 | 10/27/06 | 1323.50 | 0.94 | 6684.5 | 2996.1 | 0.01 | 83.52 | 499.35 |
| 46 | 39 | 7/16/06 | 342.95 | 1.94 | 3594.0 | 776.4 | 0.01 | 21.46 | 129.39 | 10/27/06 | 1324.21 | 1.20 | 8597.1 | 2997.7 | 0.00 | 0.00 | 499.61 |
| 50 | 42 | 7/16/06 | 346.02 | 4.53 | 8451.8 | 783.3 | 0.08 | 150.80 | 130.55 | 10/27/06 | 1324.23 | 0.00 | 0.0 | 2997.7 | 0.00 | 0.00 | 499.62 |
| 57 | 47 | 7/16/06 | 230.48 | | 0.0 | 521.7 | 0.12 | 153.77 | 86.96 | 10/27/06 | 1284.79 | 2.79 | 19342.0 | 2908.5 | 0.00 | 0.00 | 484.74 |
| 60 | 50 | 7/16/06 | 233.15 | 0.00 | 0.0 | 527.8 | 0.06 | 71.81 | 87.97 | 10/27/06 | 1306.90 | 2.26 | 15927.1 | 2958.5 | 0.04 | 304.00 | 493.09 |
| 65 | 53 | 7/17/06 | 202.58 | 4.34 | 4742.9 | 458.6 | 0.08 | 86.98 | 76.43 | 10/28/06 | 1296.13 | 3.43 | 24010.4 | 2934.1 | 0.00 | 0.00 | 489.02 |
| 72 | 59 | 7/17/06 | 203.15 | 0.17 | 184.3 | 459.9 | 0.01 | 0.00 | 76.65 | 10/28/06 | 1303.95 | 0.00 | 0.0 | 2951.8 | 0.17 | 1219.36 | 491.97 |

| Data Base No | Site Name | July Sample Date | July Flow (cfs) | July Tot Nitrogen Conc. (mg/l) | July Tot Nitrogen Load (lbs/d) | July Tot Nitrogen Car Cap (lbs/d) | July Tot Phosphorus Conc. (mg/l) | July Tot Phosphorus Load (lbs/d) | July Tot Phosphorus Car Cap (lbs/d) | October Sample Date | October Flow (cfs) | October Tot Nitrogen Conc. (mg/l) | October Tot Nitrogen Load (lbs/d) | October Tot Nitrogen Car Cap (lbs/d) | October Tot Phosphorus Conc. (mg/l) | October Tot Phosphorus Load (lbs/d) | October Tot Phosphorus Car Cap (lbs/d) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 76 | USGS Aztec | 7/17/06 | 382.93 | | 0.0 | 866.9 | | 0.00 | 144.48 | 10/28/06 | 928.00 | | 0.0 | 2100.8 | | 0.00 | 350.13 |
| 78 | 62 | 7/17/06 | 343.50 | 1.39 | 2583.4 | 777.6 | 0.37 | 683.65 | 129.60 | 10/28/06 | 920.69 | 0.00 | 0.0 | 2084.2 | 0.28 | 1367.02 | 347.37 |
| 82 | 65 | 7/17/06 | 349.30 | 0.68 | 1273.6 | 790.7 | 0.13 | 237.01 | 131.79 | 10/28/06 | 925.43 | 0.00 | 0.0 | 2094.9 | 0.09 | 449.18 | 349.16 |
| 89 | 71 | 7/17/06 | 362.26 | 0.25 | 481.6 | 820.1 | 0.26 | 500.78 | 136.68 | 10/28/06 | 947.98 | 0.33 | 1676.8 | 2146.0 | 0.03 | 135.04 | 357.67 |
| 92 | 74 | 7/17/06 | 389.01 | 1.35 | 2823.5 | 880.6 | 0.21 | 444.81 | 146.77 | 10/28/06 | 958.58 | 1.46 | 7529.9 | 2170.0 | 0.43 | 2234.45 | 361.67 |
| 97 | 79 | 7/18/06 | 357.15 | 0.63 | 1208.0 | 808.5 | 0.11 | 212.67 | 134.75 | 10/28/06 | 961.13 | 0.86 | 4461.8 | 2175.8 | 0.21 | 1095.32 | 362.63 |
| 101 | 83 | 7/18/06 | 358.80 | 0.00 | 0.0 | 812.2 | 0.15 | 297.64 | 135.37 | 10/28/06 | 963.15 | 1.03 | 5336.2 | 2180.3 | 0.25 | 1308.03 | 363.39 |
| 104 | 85 | 7/18/06 | 323.49 | 1.61 | 2804.4 | 732.3 | 0.03 | 57.93 | 122.05 | 10/28/06 | 968.50 | 0.93 | 4843.9 | 2192.4 | 0.34 | 1777.46 | 365.41 |
| 110 | 90 | 7/18/06 | 379.01 | 1.01 | 2060.0 | 858.0 | 0.28 | 568.29 | 143.00 | 10/28/06 | 1486.14 | 1.46 | 11706.1 | 3364.3 | 0.02 | 159.49 | 560.71 |
| 114 | 93 | 7/18/06 | 281.08 | 2.69 | 4077.4 | 636.3 | 0.30 | 462.09 | 106.05 | 10/28/06 | 1122.55 | 2.44 | 14744.5 | 2541.2 | 0.02 | 109.16 | 423.53 |
| 121 | USGS Farmington | 7/18/06 | 270.52 | | 0.0 | 612.4 | | 0.00 | 102.07 | 10/28/06 | 1186.74 | | 0.0 | 2686.5 | | 0.00 | 447.75 |
| 123 | 97 | 7/18/06 | 188.52 | 3.67 | 3728.6 | 426.8 | 0.01 | 0.00 | 71.13 | 10/28/06 | 1106.74 | 1.26 | 7511.2 | 2505.4 | 0.33 | 1975.11 | 417.57 |
| | **No. Samples** | | | 30 | | | 31 | | | | | 27 | | | 27 | | |
| | **No Exceeders NMED Stdrd** | | | 21 | | | 16 | | | | | 17 | | | 9 | | |
| | **Mean** | | | 1.31 | 2413 | 912 | 0.10 | 185 | 152 | | | 0.98 | 6100 | 2740 | 0.09 | 473 | 457 |

**Table 13. Concentration of total nitrogen and total phosphorus of inflows in the New Mexico portion of the watershed sampled July and October 2006 along with loading calculations (see NMED Source Loading and TMDL Reports for methods and Animas GIS database for site descriptions. Sites are organized upstream to downstream).**

| | | July | | | | | | October | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Tot Nitrogen | | Tot Phosphorus | | | | Tot Nitrogen | | Tot Phosphorus | |
| Data Base No | Inflow ID | Sample Date | Flow (cfs) | Conc. (mg/l) | Load (lbs/d) | Conc. (mg/l) | Load (lbs/d) | Sample Date | Flow (cfs) | Conc. (mg/l) | Load (lbs/d) | Conc. (mg/l) | Load (lbs/d) |
| 2 | Junction Crk | 7/14/06 | 5.40 | 1.52 | 44.3 | 0.01 | 0.00 | | | | | | |
| 5 | Lightner Ck | 7/14/06 | 6.55 | 3.04 | 107.6 | 0.65 | 23.14 | | | | | | |
| 12 | 9 | 7/15/06 | 20.47 | | 0.0 | 0.01 | 0.00 | 10/25/06 | 29.88 | 0.53 | 85.7 | 0.00 | 0.00 |
| 13 | 10 | 7/15/06 | 7.38 | 1.97 | 78.3 | 0.04 | 1.60 | 10/25/06 | 0.00 | 0.00 | 0.0 | 0.34 | 0.00 |
| 15 | 12 | 7/15/06 | 0.61 | 0.40 | 1.3 | 0.21 | 0.69 | 10/25/06 | 0.01 | 1.27 | 0.0 | 0.12 | 0.00 |
| 16 | 13 | 7/15/06 | 0.29 | 0.39 | 0.6 | 0.05 | 0.08 | 10/25/06 | 0.00 | | 0.0 | | 0.00 |
| 18 | 15 | 7/15/06 | 0.61 | 1.09 | 3.6 | 0.04 | 0.13 | 10/25/06 | 0.00 | | 0.0 | | 0.00 |
| 21 | 17 | 7/15/06 | 0.08 | 0.87 | 0.4 | 0.08 | 0.03 | 10/25/06 | 0.00 | 0.86 | 0.0 | 0.04 | 0.00 |
| 22 | 18 | 7/15/06 | 0.03 | 2.11 | 0.4 | 0.28 | 0.05 | 10/25/06 | 0.00 | | 0.0 | | 0.00 |
| 24 | 20 | 7/15/06 | 14.09 | 1.61 | 122.2 | 0.19 | 14.32 | 10/25/06 | 1.84 | 0.00 | 0.0 | 0.03 | 0.28 |
| 27 | 22 | 7/15/06 | 4.46 | 1.68 | 40.5 | 0.19 | 4.46 | 10/25/06 | 6.62 | 3.42 | 122.2 | 0.92 | 32.99 |
| 28 | 23 | 7/15/06 | 0.66 | 1.46 | 5.2 | 0.29 | 1.05 | 10/25/06 | 0.00 | | 0.0 | | 0.00 |
| 30 | 24 | 7/15/06 | 1.94 | 0.35 | 3.7 | 0.39 | 4.05 | 10/25/06 | 0.00 | | 0.0 | | 0.00 |
| 31 | 25 | 7/15/06 | 0.10 | 1.44 | 0.8 | 0.28 | 0.15 | 10/27/06 | 1.08 | 0.31 | 1.8 | 0.00 | 0.00 |
| 33 | 27 | 7/15/06 | 2.61 | 2.46 | 34.6 | 0.42 | 5.85 | 10/27/06 | 0.73 | 5.37 | 21.2 | 2.59 | 10.20 |
| 34 | 28 | 7/15/06 | 0.28 | 6.55 | 10.0 | 0.30 | 0.45 | 10/27/06 | 0.00 | | 0.0 | | 0.00 |
| 35 | 29 | 7/15/06 | 10.47 | 0.84 | 47.5 | 0.14 | 7.72 | 10/27/06 | 0.00 | | 0.0 | | 0.00 |
| 37 | 31 | 7/16/06 | 0.21 | 0.35 | 0.4 | 0.23 | 0.27 | 10/27/06 | 0.00 | | 0.0 | | 0.00 |
| 38 | 32 | 7/16/06 | 0.68 | 0.00 | 0.0 | 0.30 | 1.12 | 10/27/06 | 0.45 | 2.29 | 5.6 | 0.14 | 0.33 |
| 39 | 33 | 7/16/06 | 0.10 | 0.30 | 0.2 | 0.01 | 0.00 | 10/27/06 | 0.02 | 0.00 | 0.0 | 0.00 | 0.00 |
| 41 | 34 | 7/16/06 | 1.57 | 1.12 | 9.5 | 0.23 | 1.92 | 10/27/06 | 9.84 | 0.68 | 36.0 | 0.00 | 0.00 |
| 43 | 36 | 7/16/06 | 0.20 | 3.85 | 4.2 | 1.77 | 1.91 | 10/27/06 | 0.00 | | 0.0 | | 0.00 |
| 45 | 38 | 7/16/06 | 0.90 | 1.25 | 6.1 | 0.09 | 0.43 | 10/27/06 | 0.70 | 0.12 | 0.5 | 0.05 | 0.17 |
| 48 | 40 | 7/16/06 | 0.37 | 0.45 | 0.9 | 0.11 | 0.22 | 10/27/06 | 0.01 | 1.11 | 0.0 | 0.00 | 0.00 |
| 49 | 41 | 7/16/06 | 2.71 | 1.09 | 16.0 | 0.86 | 12.49 | 10/27/06 | 0.02 | 5.74 | 0.5 | 4.95 | 0.47 |
| 51 | 43 | 7/16/06 | 0.67 | 9.52 | 34.4 | 0.22 | 0.81 | 10/27/06 | 0.16 | 3.59 | 3.2 | 0.13 | 0.11 |
| 52 | 44 | 7/16/06 | 0.68 | 3.97 | 14.6 | 0.22 | 0.79 | 10/27/06 | 0.00 | 5.34 | 0.1 | 0.22 | 0.01 |

| | | July | | | | | | October | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Tot Nitrogen | | Tot Phosphorus | | | | Tot Nitrogen | | Tot Phosphorus | |
| **Data Base No** | **Inflow ID** | **Sample Date** | **Flow (cfs)** | **Conc. (mg/l)** | **Load (lbs/d)** | **Conc. (mg/l)** | **Load (lbs/d)** | **Sample Date** | **Flow (cfs)** | **Conc. (mg/l)** | **Load (lbs/d)** | **Conc. (mg/l)** | **Load (lbs/d)** |
| 54 | 45 | 7/16/06 | 4.55 | 7.43 | 182.1 | 0.01 | 0.00 | 10/27/06 | 38.00 | 2.72 | 556.5 | 0.00 | 0.00 |
| 55 | 46 | 7/16/06 | 2.92 | 0.16 | 2.5 | 0.01 | 0.00 | 10/27/06 | 0.00 | | 0.0 | | 0.00 |
| 58 | 48 | 7/16/06 | 0.89 | 0.00 | 0.0 | 0.07 | 0.34 | 10/27/06 | 2.19 | 1.46 | 17.3 | 0.00 | 0.00 |
| 59 | 49 | 7/16/06 | 1.79 | 0.00 | 0.0 | 0.37 | 3.52 | 10/27/06 | 19.93 | 2.83 | 304.4 | 0.07 | 7.86 |
| 61 | 51 | 7/16/06 | 0.10 | 3.38 | 1.8 | 0.01 | 0.00 | 10/27/06 | 0.00 | | 0.0 | | 0.00 |
| 62 | 52 | 7/16/06 | 4.84 | 1.35 | 35.2 | 0.70 | 18.20 | 10/27/06 | 1.57 | 1.18 | 10.0 | 0.91 | 7.69 |
| 64 | 101 | 7/17/06 | | | 0.0 | | 0.00 | 10/27/06 | 23.66 | | 0.0 | | 0.00 |
| 66 | 54 | 7/17/06 | 0.44 | 0.00 | 0.0 | 0.13 | 0.31 | 10/28/06 | 1.32 | 0.00 | 0.0 | 0.02 | 0.17 |
| 67 | 55 | 7/17/06 | 12.17 | | 0.0 | | 0.00 | 10/28/06 | 2.68 | 0.22 | 3.2 | 0.28 | 4.00 |
| 69 | 56 | 7/17/06 | 2.01 | 0.00 | 0.0 | 0.01 | 0.00 | 10/28/06 | 0.53 | 0.00 | 0.0 | 0.18 | 0.52 |
| 70 | 57 | 7/17/06 | 0.09 | 1.21 | 0.6 | 0.07 | 0.03 | 10/28/06 | 0.05 | 0.00 | 0.0 | 0.02 | 0.01 |
| 71 | 58 | 7/17/06 | 2.78 | 0.00 | 0.0 | 0.07 | 1.02 | 10/28/06 | 3.91 | 0.00 | 0.0 | 0.40 | 8.54 |
| 73 | 102 | 7/17/06 | | | 0.0 | | 0.00 | 10/28/06 | 6.96 | 1.14 | 43.0 | 0.00 | 0.00 |
| 74 | 60 | 7/17/06 | 0.10 | 11.06 | 6.0 | 9.04 | 4.87 | 10/28/06 | 4.00 | | 0.0 | | 0.00 |
| 75 | 61 | 7/17/06 | 2.22 | 1.10 | 13.2 | 0.32 | 3.89 | 10/28/06 | 0.00 | | 0.0 | | 0.00 |
| 79 | 63 | 7/17/06 | 4.03 | 1.20 | 26.1 | 0.12 | 2.60 | 10/28/06 | 2.58 | | 0.0 | | 0.00 |
| 80 | 103 | 7/17/06 | | | 0.0 | | 0.00 | 10/28/06 | 0.01 | 1.12 | 0.1 | 0.19 | 0.01 |
| 81 | 64 | 7/17/06 | 1.77 | 0.00 | 0.0 | 0.11 | 1.08 | 10/28/06 | 2.14 | 0.00 | 0.0 | 0.27 | 3.07 |
| 83 | 66 | 7/17/06 | 0.55 | 0.91 | 2.7 | 0.28 | 0.82 | 10/28/06 | 1.50 | 0.00 | 0.0 | 0.26 | 2.07 |
| 84 | 67 | 7/17/06 | 1.30 | 1.28 | 9.0 | 0.62 | 4.31 | 10/28/06 | 1.01 | 0.00 | 0.0 | 0.31 | 1.69 |
| 85 | 68 | 7/17/06 | 2.87 | 3.06 | 47.4 | 0.20 | 3.03 | 10/28/06 | 6.52 | 2.26 | 79.3 | 0.18 | 6.32 |
| 86 | 69 | 7/17/06 | 10.93 | 2.21 | 130.1 | 0.23 | 13.45 | 10/28/06 | 9.59 | 1.14 | 58.8 | 0.47 | 24.11 |
| 87 | 70 | 7/17/06 | 1.57 | 1.92 | 16.3 | 0.16 | 1.32 | 10/28/06 | 3.92 | 1.12 | 23.7 | 0.89 | 18.90 |
| 90 | 72 | 7/17/06 | 2.82 | 1.18 | 17.9 | 0.19 | 2.87 | 10/28/06 | 3.34 | 8.49 | 152.9 | 13.13 | 236.49 |
| 91 | 73 | 7/17/06 | 23.94 | 0.27 | 34.4 | 0.41 | 53.51 | 10/28/06 | 7.26 | 1.66 | 65.0 | 0.17 | 6.71 |
| 93 | 75 | 7/17/06 | 1.20 | 1.68 | 10.9 | 0.24 | 1.55 | 10/28/06 | 0.00 | | 0.0 | | 0.00 |
| 94 | 76 | 7/17/06 | 0.10 | 1.44 | 0.8 | 0.02 | 0.01 | 10/28/06 | 0.04 | 2.40 | 0.5 | 0.21 | 0.04 |
| 95 | 77 | 7/17/06 | 0.76 | 0.13 | 0.5 | 0.04 | 0.15 | 10/28/06 | 1.88 | 2.22 | 22.5 | 0.33 | 3.38 |
| 96 | 78 | 7/17/06 | 0.08 | 2.50 | 1.1 | 0.20 | 0.09 | 10/28/06 | 0.63 | 0.80 | 2.7 | 0.00 | 0.00 |
| 98 | 80 | 7/18/06 | 0.15 | 2.77 | 2.3 | 0.18 | 0.15 | 10/28/06 | 0.87 | 2.78 | 13.1 | 0.02 | 0.09 |
| 99 | 81 | 7/18/06 | 1.49 | 1.41 | 11.3 | 0.16 | 1.31 | 10/28/06 | 1.16 | 1.27 | 7.9 | 0.00 | 0.00 |

| Data Base No | Inflow ID | July | | | | | | October | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Tot Nitrogen | | Tot Phosphorus | | | | Tot Nitrogen | | Tot Phosphorus | |
| | | Sample Date | Flow (cfs) | Conc. (mg/l) | Load (lbs/d) | Conc. (mg/l) | Load (lbs/d) | Sample Date | Flow (cfs) | Conc. (mg/l) | Load (lbs/d) | Conc. (mg/l) | Load (lbs/d) |
| 100 | 82 | 7/18/06 | 0.00 | 2.05 | 0.0 | 0.31 | 0.00 | 10/28/06 | 0.00 | | 0.0 | | 0.00 |
| 103 | 84 | 7/18/06 | 17.70 | 0.69 | 66.2 | 0.12 | 11.39 | 10/28/06 | 10.93 | 1.30 | 76.4 | 0.19 | 11.38 |
| 105 | 86 | 7/18/06 | 19.69 | 1.43 | 151.9 | 0.03 | 3.14 | 10/28/06 | 17.44 | 1.72 | 161.8 | 0.22 | 21.11 |
| 106 | 87 | 7/18/06 | 0.36 | 2.10 | 4.1 | 0.34 | 0.66 | 10/28/06 | 0.32 | 1.39 | 2.4 | 0.32 | 0.56 |
| 107 | 88 | 7/18/06 | 0.38 | 1.36 | 2.8 | 0.38 | 0.78 | 10/28/06 | 0.45 | 0.35 | 0.9 | 0.00 | 0.00 |
| 109 | 89 | 7/18/06 | 40.71 | 1.61 | 352.6 | 0.25 | 55.27 | 10/28/06 | 500.45 | 0.68 | 1846.4 | 0.13 | 359.18 |
| 112 | 91 | 7/18/06 | 0.16 | 7.05 | 6.1 | 0.28 | 0.24 | 10/28/06 | 0.10 | 2.92 | 1.6 | 0.05 | 0.03 |
| 113 | 92 | 7/18/06 | 5.26 | 2.81 | 79.6 | 0.19 | 5.36 | 10/28/06 | 18.21 | 2.27 | 222.6 | 0.23 | 22.63 |
| 115 | 94 | 7/18/06 | 0.72 | 1.32 | 5.1 | 0.14 | 0.53 | 10/28/06 | 0.18 | 2.67 | 2.6 | 0.10 | 0.10 |
| 116 | 95a | 7/18/06 | | | 0.0 | | 0.00 | 10/28/06 | 0.00 | | 0.0 | | 0.00 |
| 117 | 95B | 7/18/06 | 0.10 | 5.47 | 2.9 | 0.30 | 0.16 | 10/28/06 | 0.00 | 3.65 | 0.1 | 0.22 | 0.00 |
| 118 | 95C | 7/18/06 | 0.10 | 3.25 | 1.8 | 0.08 | 0.04 | 10/28/06 | 0.02 | 2.89 | 0.3 | 0.00 | 0.00 |
| 119 | 95D | 7/18/06 | 0.10 | 4.47 | 2.4 | 0.44 | 0.24 | 10/28/06 | 0.03 | 2.58 | 0.4 | 0.21 | 0.03 |
| 120 | 96 | 7/18/06 | 0.99 | 1.33 | 7.1 | 0.12 | 0.66 | 10/28/06 | 0.20 | 3.24 | 3.6 | 0.20 | 0.22 |
| | **No. Samples** | | | 66 | | 67 | | | | 52 | | 52 | |
| | **No. Exceeders NMED Standards** | | | 51 | | 52.00 | | | | 38 | | 33.00 | |
| | **Mean** | | | 2.00 | | 0.37 | | | | 1.75 | | 0.57 | |
| | **Sum** | | | | 1822 | | 281 | | | | 3957 | | 792 |

**Table 14. Suggested best management practices and estimated cost for Colorado/S. Ute priority sites.**

| Site Name | BMP or next step | Estimated Cost |
|---|---|---|
| Durango Effluent | Tertiary treatment system | $500,000 |
| Hermosa San Effluent | Tertiary treatment system | $200,000 |
| Trumble Inflow | Sprinkler Irrigation and landowner education about flood irrigation | $350,000 |
| Junction Creek | Recon upstream to identify sources of nutrients | $4.500 |
| S. Durango Effluent | Tertiary treatment system | $200,00 |
| Fish Hatchery | Improving existing tertiary treatment | $50,000 |
| Skate Park | Recon upstream to identify sources of nutrients | $3,500 |
| Florida River | Sprinkler Irrigation and landowner education about flood irrigation | $1,000,000 |
| Bondad Return Flow | Sprinkler Irrigation and landowner education about flood irrigation | $350,000 |
| KOA Effulent | Tertiary treatment | $200,000 |
| Trumble Spring Inflow | Sprinkler Irrigation and landowner education about flood irrigation | $350,000 |
| Lightner Creek | Sediment reduction (Lightner Creek Task Force) | $350,000 |
| Powerline Return Flow | Sprinkler Irrigation and landowner education about flood irrigation | $350,000 |
| Srping River Right | Sprinkler Irrigation and landowner education about flood irrigation | $150,000 |
| S. Campground Inflow | Recon upstream to identify sources of nutrients | $3,500 |

**Table 15. Specific best management practices for prioritized sources of nutrient pollution in the NM portion of the Animas.**

| BMP | Data Base No. | Water Body | Name |
|---|---|---|---|
| Increase buffer strip between urban interface and side channel, increase urban stormwater catchment and filtering capacities. | 109 | Inflow | 89 |
| Move ditch overflow upstream to area where wetland can be created to filter nutrients and sediments. Increase and improve buffer strips between irrigation ditch and runoff from agricultural fields. | 54 | Inflow | 45 |
| Create wetlands to filter overflows through.Recon upstream to identify sources of nutrients and sediment. | 105 | Echo Ditch Inflow | 86 |
| Create wetlands to filter return flows through | 86 | Inflow | 69 |
| Create wetland to filter out nutrients from irrigation return flows | 24 | Inflow | 20 |
| Increase and improve riparian zone, install and improve sediment traps, increase amount of and improve urban runoff entrapment and filtering system. | 5 | Inflow | Lightner Ck |
| Create wetlands to filter flows, improve and increase buffer zone between ditch and urban areas, improve stormwater catchments and filtering system. | 113 | Willett DitchInflow | 92 |
| Increase riparian buffer strips, improve agricultural practices to reduce amount of runoff (i.e. install sprinkler irrigation system), create wetlands to filter return flows through. | 13 | Inflow | 10 |
| Increase riparian buffer strips, improve agricultural practices to reduce amount of runoff (i.e. install sprinkler irrigation system), create wetlands to filter return flows through. | 103 | Inflow | 84 |
| Increase riparian buffer strips, improve agricultural practices to reduce amount of runoff (i.e. install sprinkler irrigation system), create wetlands to filter return flows through. | 35 | Inflow | 29 |
| Increase riparian buffer strips, improve agricultural practices to reduce amount of runoff (i.e. install sprinkler irrigation system), create wetlands to filter return flows through. | 85 | Inflow | 68 |
| Recon upstream to identify sources of nutrients. | 2 | Junction Creek | Junction Crk |
| Move irrigation overflow upstream where there is room to create a wetland to discharge overflow into. Increase the size of and improve the quality of the buffer strip between the ditch and the agricultural fields to filter runoff. Improve agricultural practices to reduce amount of runoff (i.e. install sprinkler irrigation system). Place some of the agricultural land near the ditch and river into a conservation easement or into the wildlife habitat program. | 27 | Inflow | 22 |
| Reduce agricultural return flows, increase buffer strips between agricultural fields and drain, increase and improve buffers strips between agricultural fields and river. Improve agricultural practices to reduce amount of runoff (i.e. install sprinkler irrigation system). Place some of the agricultural land near the ditch and river into a conservation easement or into the wildlife habitat program. | 62 | Inflow | 52 |
| Increase riparian area in tributary, reduce agricultural return flows and complete further upstream reconnaissance to identify heavy amounts of sediment loading and attached sources of phosphorus. | 33 | Cos Canyon Inflow | 27 |
| Improve floodplain condition to assimilate nutrients and filter flows through. | 91 | Inflow | 73 |
| Recon upstream to identify sources. Reduce agricultural runoff. Increase wetland size to filter flows. | 51 | N. Aztec Field Drain, | 43 |

| BMP | Data Base No. | Water Body | Name |
|---|---|---|---|
| | | Inflow | |
| Increase riparian buffer zone, improve agricultural practices, and create wetland to filter flows through. | 79 | Inflow | 63 |
| Move overflow downstream where there is room to create a wetland to discharge overflow into. Increase and improve buffer strip between ditch and vacant land. | 90 | Inflow | 72 |
| Create wetland to filter flows through. | 87 | Inflow | 70 |
| Recon upstream to identify sources of sediment in tributary. | 49 | Kiffen Canyon Inflow | 41 |
| Reduce agricultural inflow, increase wetland size to filter runoff, improve riparian condition of tributary, and remove riprap downstream of inflow to improve functioning capacity of the river, recon upstream to identify sources of sediment. | 52 | Inflow | 44 |
| Increase riparian buffer, improve agricultural practices to reduce runoff and sediment and nutrient loading, and create wetland to filter return flows through. | 75 | Inflow | 61 |
| Increase riparian buffer, improve agricultural practices to reduce runoff and sediment and nutrient loading, and create wetland to filter return flows through. | 99 | Inflow | 81 |
| Increase riparian buffer, improve agricultural practices to reduce runoff and sediment and nutrient loading, and create wetland to filter return flows through. | 93 | Inflow | 75 |
| Increase riparian buffer, improve agricultural practices to reduce runoff and sediment and nutrient loading, and create wetland to filter return flows through. | 34 | Inflow | 28 |
| Increase riparian buffer, improve agricultural practices to reduce runoff and sediment and nutrient loading, and create wetland to filter return flows through. | 41 | Inflow | 34 |
| Increase buffer strips, improve abandoned agricultural land near inflow, recon upstream to identify sources of fine sediment. | 84 | Inflow | 67 |
| Increase riparian buffer, improve agricultural practices (i.e. better irrigation practices to reduce runoff), install sprinkler irrigation system, create wetland. | 120 | Inflow | 96 |
| Increase buffers strips, improve storm-water runnoff entrapment and filtering. | 112 | Inflow | 91 |
| Increase riparian buffer, improve ag practices, create wetland. | 45 | Inflow | 38 |
| Add tertiary treatment to filter out nutrients. | 74 | Aztec WWTP Effluent | 60 |

**Table 16. Top 15 nitrogen and phosphorus loading sites to Animas River for the July 2006 sampling event. If the total nitrogen for each site was 100% eliminated from reaching the AnimasRiver, the loading of the AnimasRiver would be reduced from the measured average of 2,414 lbs/d to below the calculated average carrying capacity of 912 lbs/d, a reduction of 1,501 lbs/d. To meet the carrying capacity for total phosphorus as measured in the July sampling, a reduction of 32 lbs/d would be required and could be met by any number of sites being remediated (see Animas GIS database for a description of each site. Sites with asterisk overlap with top loading sites identified in October).**

| | | | July | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Tot Nitrogen | | | Tot Phosphorus | |
| Data Base No | Inflow Name | Site ID | Sample Date | Flow (cfs) | Conc. (mg/l) | Load (lbs/d) | Cum Load (lbs/d) | Conc. (mg/l) | Load (lbs/d) |
| 109* | Inflow | 89 | 7/18/06 | 40.71 | 1.61 | 352.6 | 352.6 | 0.25 | 55.27 |
| 54* | Lower Animas Ditch Outflow | 45 | 7/16/06 | 4.55 | 7.43 | 182.1 | 534.7 | 0.01 | 0.00 |
| 105* | Echo Ditch Outflow | 86 | 7/18/06 | 19.69 | 1.43 | 151.9 | 686.6 | 0.03 | 3.14 |
| 86 | Flora Vista Field Drain | 69 | 7/17/06 | 10.93 | 2.21 | 130.1 | 816.7 | 0.23 | 13.45 |
| 24* | Inflow Ditch Return | 20 | 7/15/06 | 14.09 | 1.61 | 122.2 | 938.8 | 0.19 | 14.32 |
| 5 | Lightner Ck | 5 | 7/14/06 | 6.55 | 3.04 | 107.6 | 1046.4 | 0.65 | 23.14 |
| 113* | Willett Ditch Terminus | 92 | 7/18/06 | 5.26 | 2.81 | 79.6 | 1126.0 | 0.19 | 5.36 |
| 13 | Inflow | 10 | 7/15/06 | 7.38 | 1.97 | 78.3 | 1204.3 | 0.04 | 1.60 |
| 103 | Inflow | 84 | 7/18/06 | 17.70 | 0.69 | 66.2 | 1270.5 | 0.12 | 11.39 |
| 35 | Inflow | 29 | 7/15/06 | 10.47 | 0.84 | 47.5 | 1318.0 | 0.14 | 7.72 |
| 85 | Flora Vista Arroyo | 68 | 7/17/06 | 2.87 | 3.06 | 47.4 | 1365.3 | 0.20 | 3.03 |
| 2 | Junction Ck | | 7/14/06 | 5.40 | 1.52 | 44.3 | 1409.7 | 0.01 | 0.00 |
| 27* | Cedar Ditch Outflow | 22 | 7/15/06 | 4.46 | 1.68 | 40.5 | 1450.1 | 0.19 | 4.46 |
| 62 | N. Aztec Field Drain 2 | 52 | 7/16/06 | 4.84 | 1.35 | 35.2 | 1485.3 | 0.70 | 18.20 |
| 33 | Cox Canyon | 27 | 7/15/06 | 2.61 | 2.46 | 34.6 | **Sum Tot = 1520** | 0.42 | 5.85 |

**Table 17. Top 7 nitrogen and phosphorus loading sites to the Animas River for October 2006 sampling. If the total nitrogen for each site was 100% eliminated from reaching the AnimasRiver the total nitrogen loading in the Animas River would be reduced from the measured average of 6,100 lbs/d to the calculated average carrying capacity of 2,740 lbs/d, a reduction of 3,360 lbs/d. To meet the carrying capacity for total phosphorus as measured in the October sampling, a reduction of 16 lbs/d would be required and could be met by any number of sites being remediated (see Animas GIS database for a description of each site. Sites with asterisk overlap with top loading sites identified in July).**

| | | | **October 2006** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | **Total Nitrogen** | | | **Total Phosphorus** | |
| **Data Base No** | **Inflow Name** | **Site ID** | **Sample Date** | **Flow (cfs)** | **Conc. (mg/l)** | **Load (lbs/d)** | **Cum Load (lbs/d)** | **Conc. (mg/l)** | **Load (lbs/d)** |
| 109* | Inflow | 89 | 10/28/06 | 500.45 | 0.68 | 1846.4 | 1846.4 | 0.13 | 359.18 |
| 54* | Lower Animas Ditch Overflow | 45 | 10/27/06 | 38.00 | 2.72 | 556.5 | 2403.0 | 0.00 | 0.00 |
| 59 | Inflow | 49 | 10/27/06 | 19.93 | 2.83 | 304.4 | 2707.3 | 0.07 | 7.86 |
| 113* | Willet Ditch Terminus | 92 | 10/28/06 | 18.21 | 2.27 | 222.6 | 2929.9 | 0.23 | 22.63 |
| 105* | Echo Ditch Outflow | 86 | 10/28/06 | 17.44 | 1.72 | 161.8 | 3091.7 | 0.22 | 21.11 |
| 90 | Terrell Ditch Outflow | 72 | 10/28/06 | 3.34 | 8.49 | 152.9 | 3244.5 | 13.13 | 236.49 |
| 27* | Inflow | 22 | 10/25/06 | 6.62 | 3.42 | 122.2 | **Sum Tot = 3366.7** | 0.92 | 32.99 |

**Table 18. Top Colorado/Southern Ute loading sites for nitrogen and phosphorus.**

| Site Name | TN Load | | Site Name | TP Load |
|---|---|---|---|---|
| Durango Effluent | 1068.51 | | Durango Effluent | 217.47 |
| Hermosa San Effluent | 324.20 | | S. Campground Inflow | 95.57 |
| Trumble | 45.26 | | S. Durango Effluent | 51.99 |
| Junction Creek | 35.22 | | Hermosa San Effluent | 18.76 |
| S. Durango Effluent | 28.03 | | Bondad Return Flow | 9.19 |
| Fish Hatchery | 26.22 | | Junction Creek | 7.69 |
| Skate Park | 26.16 | | Falls Creek Inflow | 6.34 |
| Florida River | 25.97 | | Florida River | 5.22 |
| Bondad Return Flow | 19.80 | | Trumble | 4.31 |
| KOA Effulent | 18.16 | | KOA Effulent | 4.25 |
| Trumble Spring Inflow | 6.42 | | Fish Hatchery | 1.92 |
| Lightner Creek | 5.27 | | Lightner Creek | 1.25 |
| Powerline Return Flow | 3.99 | | Trimble | 1.23 |
| Srping River Right | 3.74 | | Powerline Return Flow | 0.24 |
| Main Street Pipe | 1.60 | | Skate Park | 0.23 |
| Trimble | 1.43 | | Grandview Inflow | 0.21 |
| Mains Street Spring | 0.91 | | City Diversion Inflow | 0.17 |
| High School | 0.84 | | Inflow Up S. Durango Effluent | 0.17 |
| Grandview Inflow | 0.80 | | High School | 0.14 |
| Inflow Up S. Durango Effluent | 0.56 | | Shere Creek Inflow | 0.12 |
| City Diversion Inflow | 0.41 | | Main Street Pipe | 0.09 |
| Shere Creek Inflow | 0.30 | | Inflow House Right | 0.06 |
| Inflow House Right | 0.26 | | Srping River Right | 0.06 |
| Hot Spring | 0.05 | | Trumble Spring Inflow | 0.00 |
| Animas River Right Down Falls Creek | 0.00 | | Mains Street Spring | 0.00 |
| Falls Creek Inflow | 0.00 | | Hot Spring | 0.00 |
| S. Campground Inflow | 0.00 | | Animas River Right Down Falls Creek | 0.00 |
| Riverview Storm Drain | 0.00 | | Riverview Storm Drain | 0.00 |
| **Average** | **1644.11** | | **Average** | **426.70** |

**Table 19. BMP Cost/benefit model for the New Mexico reach of the Animas**

| BMP | Data Base No. | Water Body | Name | Est. Cost | Cum Cost | Est. Percent decrease in loading | July Est. TN Load Decrease | July Est. TP Load Decrease | October Est. TN Load Decrease | October Est. TP Load Decrease |
|---|---|---|---|---|---|---|---|---|---|---|
| Increase buffer strip between urban interface and channel, increase stormwater catchment and filtering. | 109 | Inflow | 89 | $ 20,000 | $ 20,000 | 30% | 105.77 | 16.58 | 553.92 | 107.75 |
| Move overflow upstream to area where wetland can be created to filter nutrients. Increase buffer strips between ditch and ag fields. | 54 | Inflow | 45 | $ 15,000 | $ 35,000 | 70% | 127.48 | 0.00 | 389.58 | 0.00 |
| Create wetlands to filter flows through, recon upstream to identify sources of sediment. | 105 | Echo Dtch Inflow | 86 | $ 30,000 | $ 65,000 | 30% | 45.58 | 0.94 | 48.53 | 6.33 |
| Create wetlands to filter flows through | 86 | Inflow | 69 | $ 30,000 | $ 95,000 | 60% | 78.03 | 8.07 | 35.27 | 14.47 |
| Created wetland to filter nutrients from irrigation | 24 | Inflow | 20 | $ 30,000 | $ 125,000 | 70% | 85.51 | 10.03 | 0.00 | 0.19 |
| Increase riparian zone, install and improve sediment traps, improve urban runnoff entrapment and filtering. | 5 | Inflow | Lightner Ck | $250,000 | $ 375,000 | 50% | 53.78 | 11.57 | 0.00 | 0.00 |
| Create wetlands to filter flows, increase buffer between ditch and urban areas, improve storwater catchments and filtering. | 113 | Willett DtchInflow | 92 | $ 40,000 | $ 415,000 | 50% | 39.81 | 2.68 | 111.30 | 11.31 |
| Increase riparian buffer, improve ag practices, create wetland | 13 | Inflow | 10 | $ 50,000 | $ 465,000 | 50% | 39.15 | 0.80 | 0.00 | 0.00 |

| BMP | Data Base No. | Water Body | Name | Est. Cost | Cum Cost | Est. Percent decrease in loading | July | | October | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Est. TN Load Decrease | Est. TP Load Decrease | Est. TN Load Decrease | Est. TP Load Decrease |
| Increase riparian buffer, improve ag practices, create wetland | 103 | Inflow | 84 | $ 50,000 | $ 515,000 | 50% | 33.08 | 5.69 | 38.18 | 5.69 |
| Increase riparian buffer, improve ag practices, create wetland | 35 | Inflow | 29 | $ 50,000 | $ 565,000 | 50% | 23.76 | 3.86 | 0.00 | 0.00 |
| Increase riparian buffer, improve ag practices, create wetland | 85 | Inflow | 68 | $ 50,000 | $ 615,000 | 50% | 23.68 | 1.52 | 39.66 | 3.16 |
| Recon upstream to identify sources. | 2 | Inflow | Junction Crk | $ 50,000 | $ 665,000 | 40% | 17.73 | 0.00 | 0.00 | 0.00 |
| Move overflow upstream where there is room to create a wetland to discharge overflow into. Increase buffer strip between ditch and ag fields. | 27 | Inflow | 22 | $ 20,000 | $ 685,000 | 50% | 20.23 | 2.23 | 61.09 | 16.50 |
| Reduce ag return flows, increase buffer strips between ag fields and drain, increase buffers strips between ag fields and river. | 62 | Inflow | 52 | $100,000 | $ 785,000 | 70% | 24.65 | 12.74 | 7.00 | 5.38 |
| Increase riparian area in tributary, reduce ag return flows and will require further upstream recoinassance to identify heavy amounts of sediment loading and attached sources of phosphorus. | 33 | Cos Canyon Inflow | 27 | $100,000 | $ 885,000 | 60% | 20.78 | 3.51 | 12.71 | 6.12 |

| BMP | Data Base No. | Water Body | Name | Est. Cost | Cum Cost | Est. Percent decrease in loading | July | | October | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Est. TN Load Decrease | Est. TP Load Decrease | Est. TN Load Decrease | Est. TP Load Decrease |
| Improve floodplain condition | 91 | Inflow | 73 | $ 40,000 | $ 925,000 | 50% | 17.21 | 26.76 | 32.50 | 3.35 |
| Recon upstream to identify sources. Reduce ag runnof into inflow. Increase wetland size to filter flows | 51 | N. Aztec Field Drain, Inflow | 43 | $ 70,000 | $ 995,000 | 50% | 17.19 | 0.41 | 1.58 | 0.06 |
| Increase riparian buffer, improve ag practices, create wetland | 79 | Inflow | 63 | $ 50,000 | $1,045,000 | 50% | 13.06 | 1.30 | 0.00 | 0.00 |
| Move overflow downstream where there is room to create a wetland to discharge overflow into. Increase buffer strip between ditch and vacant land. | 90 | Inflow | 72 | $ 40,000 | $1,085,000 | 50% | 8.95 | 1.43 | 76.44 | 118.25 |
| Create wetland to filter flows through | 87 | Inflow | 70 | $ 50,000 | $1,135,000 | 60% | 9.75 | 0.79 | 14.20 | 11.34 |
| Identify sources of sediment in tributary | 49 | Kiffen Canyon Inflow | 41 | $ 50,000 | $1,185,000 | 40% | 6.38 | 4.99 | 0.22 | 0.19 |
| reduce ag inflow, increase wetland size to filter runnoff, improve riparian condition of tributary, remove riprap downstream of inflow, recon upstream to identify sources of sediment. | 52 | Inflow | 44 | $150,000 | $1,335,000 | 50% | 7.32 | 0.40 | 0.06 | 0.00 |
| Increase riparian buffer, improve ag practices, create wetland | 75 | Inflow | 61 | $ 50,000 | $1,385,000 | 50% | 6.62 | 1.95 | 0.00 | 0.00 |

| BMP | Data Base No. | Water Body | Name | Est. Cost | Cum Cost | Est. Percent decrease in loading | July | | October | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Est. TN Load Decrease | Est. TP Load Decrease | Est. TN Load Decrease | Est. TP Load Decrease |
| Increase riparian buffer, improve ag practices, create wetland | 99 | Inflow | 81 | $ 50,000 | $1,435,000 | 50% | 5.67 | 0.66 | 3.97 | 0.00 |
| Increase riparian buffer, improve ag practices, create wetland | 93 | Inflow | 75 | $ 50,000 | $1,485,000 | 50% | 5.45 | 0.78 | 0.00 | 0.00 |
| Increase riparian buffer, improve ag practices, create wetland | 34 | Inflow | 28 | $ 50,000 | $1,535,000 | 70% | 7.00 | 0.32 | 0.00 | 0.00 |
| **TOTAL** | | | | **$1,535,000.00** | | | **843.62** | **120.01** | **1426.21** | **310.09** |

**Table 20. Costs for organization development, coordinator costs for BMP development and implementation, for data analysis and monitoring, and developing an information and education program**

| Milestone | Time frame | Cost Estimates |
|---|---|---|
| Construct webpage | Year 1 | $4,500 |
| Build Board of Directors | Year 1 | $2,500 |
| Apply for non-profit status w/BOD in place | Year 2 | $6,500 |
| Build member base | Year 3 | $3,500 |
| Build partnership MOU base for educational. monitoring and financial support | Year 3-4 | $5,500 |
| Build foundation fund source from local entities (counties, water districts, cities and towns) | Year 4 (base funding should be ~$45,000 to keep a minimum of a part-time coordinator) | $4,500 |
| Solicit donations | Year 3 | $2,500 |
| Create newsletters | Year 4 | $2,500 |
| Hold an annual Event | Year 4 | $5,000 |
| **TOTAL ORGANIZATIONAL DEVELOPMENT COSTS =** | | **$37,000.00** |
| | | |
| | | |
| Coordinator Tasks | For 30 BMPs | $60,000 |
| Updating GIS and Water Quality Database | Annual cost | $3,500 |
| Monitoring | Annual cost | $7,500/year |
| Developing Education/Information Program | One time cost | $11,500 |

**Table 21. Average of Chlorophyll-a (ug/cm2)**

| Average of Chlorophyll-a (ug/cm2) | Year | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample Name** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** | **Average** | **St Dev** | SE |
| Lime Creek | | | 0.08 | 1.21 | | | | | | 0.65 | 0.57 | 0.40 |
| Cascade Below Lime | | | 0.97 | | | | | | | 0.97 | | |
| Cascade Creek | | | 0.78 | 1.36 | | | | | | 1.07 | 0.29 | 0.21 |
| Animas @ Cascade Ck | | | | 1.38 | | | | | | 1.38 | | |
| Animas Up KOA Effluent | | | | | | | | | 1.49 | 1.49 | | |
| Animas @ James Ranch | 0.50 | 0.09 | 0.03 | 0.02 | -0.17 | | | | 0.19 | 0.11 | 0.21 | 0.08 |
| Animas @ Trimble | | 4.51 | 0.19 | 0.21 | | | | | 1.05 | 1.49 | 1.78 | 0.89 |
| Animas Bel Hermosa San | | | | | | | | | 1.13 | 1.13 | 0.00 | 0.00 |
| Animas @ 32nd | 6.84 | 7.84 | 7.50 | 7.62 | 15.08 | | | | 6.52 | 8.57 | 2.99 | 1.22 |
| Animas Up High School Inflow | | | | | | | | | 8.62 | 8.62 | | |
| Animas Up Junction Creek | | | | | | | | | 2.03 | 2.03 | | |
| Animas Up Fish Hatcher | | | | | | | | | 3.02 | 3.02 | | |
| Animas Up Skate Park | | | | | | | | | 4.89 | 4.89 | | |
| Animas @ Anidurco | | 15.83 | 5.22 | 3.72 | | | | | 8.19 | 8.24 | 4.67 | 2.33 |
| Animas Up Durango Effluent | | 6.86 | 3.64 | 4.02 | | | | | 3.31 | 4.46 | 1.41 | 0.71 |
| Animas @ High Bridge | | 28.38 | 3.40 | 7.34 | | | | | 3.02 | 10.54 | 10.47 | 5.23 |
| Animas Up South Durango Effluent | | | | | | | | | 9.41 | 9.41 | 0.00 | 0.00 |
| Animas @ Basin Creek | 33.31 | 2.79 | 1.69 | 7.54 | 14.30 | 0.04 | 0.29 | 14.66 | 12.08 | 9.63 | 10.05 | 3.35 |
| Animas Up Powerline Inflow | | | | | | | | | 4.92 | 4.92 | | |
| Animas @ Weaselskin | | 4.58 | 29.66 | 9.78 | | | | | 8.64 | 13.17 | 9.73 | 4.86 |
| Florida 2 @ Salt Creek | 7.04 | | 3.83 | 6.04 | 7.73 | 0.07 | 0.10 | 2.39 | | 3.88 | 2.94 | 1.11 |
| Animas Up Florida | | | | | | | | | 0.41 | 0.41 | | |
| Animas Up Trumble Spring | | | | | | | | | 1.15 | 1.15 | | |
| Animas @ Twin Crossings | 7.50 | 1.42 | 4.95 | 5.95 | 4.18 | 0.01 | 0.07 | 1.66 | | 3.22 | 2.64 | 0.93 |
| Animas @ Aztec | | 2.10 | 0.37 | | | | | | | 1.24 | 0.87 | 0.61 |
| Animas @ Flora Vista | | 2.98 | 30.77 | 5.10 | | | | | | 12.95 | 12.70 | 7.33 |
| Animas @ Farmington | | 7.24 | 10.25 | 4.03 | | | | | | 7.17 | 2.57 | 1.48 |
| Piedra 1 | | 4.21 | 0.66 | 0.68 | 0.40 | 0.06 | 0.05 | 1.14 | | 1.03 | 1.35 | 0.51 |
| Piedra 2 | 7.92 | 2.09 | 1.39 | 2.82 | 0.75 | 0.03 | 0.04 | 2.14 | | 2.15 | 2.38 | 0.84 |
| San Juan 1 | | 3.33 | 0.38 | 2.15 | 1.67 | 0.04 | 0.11 | 4.53 | | 1.75 | 1.60 | 0.60 |
| San Juan 2 | 2.96 | 0.77 | 0.29 | 1.57 | 1.60 | 0.02 | 0.03 | 2.72 | | 1.25 | 1.09 | 0.38 |

**Table 22. Monitoring stations.**

| |
|---|
| KOA Campground |
| Trimble Lane |
| $32^{nd}$ Street |
| High Bridge |
| Basin Creek |
| Weaselskin Bridge |
| Twin Crossings |
| Aztec, NM |
| Flora Vista |
| Farmington, NM |

**Table 23. Measurement criteria for determing the effectiveness of implemented BMPs.**

| **Measurement Cirtiera** | **Criteria Amount** | **Monitoring Cycle** |
|---|---|---|
| Hillsenhof Biotic Index | <2.0 | Every other year |
| Periphyton Biomass | <10ug/cm$^2$ chlorophyll-1 | Every other year |
| Periphyton Biomass | < 5ug/m$^2$ ass-free dry mass | Every other year |
| pH daily max/min | Min >6.6 and max < 8.8 | Annually |
| Dissolved Oxygen daily max/min | Min >6mg/l and max < 120% saturation | Annually |
| Total Nitrogen | < carrying capacity | Annually |
| Total Phosphorus | < carrying capacity | Annually |

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# Appendix 1. Assimilative capacity (Gale 2010)

Assimilative capacity refers to the ability of the environment or a portion of the environment (such as a stream, lake, air mass, or soil layer) to carry waste material without adverse effects on the environment or on users of its resources. Pollution occurs only when the assimilative capacity is exceeded. Some environmentalists argue that the concept of assimilative capacity involves a substantial element of value judgment, i.e., pollution discharge may alter the flora and fauna of a body of water, but if it does not effect organisms we value (e.g., fish) it is acceptable and within the assimilative capacity of the body of water.

A classical example of assimilative capacity is the ability of a stream to accept modest amounts of biodegradable waste. Bacteria in a stream utilize oxygen to degrade the organic matter (or biochemical oxygen demand) present in such a waste, causing the level of dissolved oxygen in the stream to fall; but the decrease in dissolved oxygen causes additional oxygen to enter the stream from the atmosphere, a process referred to as reaeration. A stream can assimilate a certain amount of waste and still maintain a dissolved oxygen level high enough to support a healthy population of fish and other aquatic organisms. However, if the assimilative capacity is exceeded, the concentration of dissolved oxygen will fall below the level required to protect the organisms in the stream.

Two other concepts are closely related: 1) critical load; and 2) self purification. The term critical load is synonymous with assimilative capacity and is commonly used to refer to the concentration or mass of a substance which, if exceeded, will result in adverse effects, i.e., pollution. Self purification refers to the natural process by which the environment cleanses itself of waste materials discharged into it. Examples include biodegradation of wastes by natural bacterial populations in water or soil, oxidation of organic chemicals by photochemical reactions in the atmosphere, and natural dieoff of disease causing organisms.

The Federal Water Pollution Control Amendments of 1972 established the elimination of discharges of pollution into navigable waters as a national goal. More recently, pollution prevention has been heavily promoted as an appropriate goal for all segments of society. Proper interpretation of these goals requires a basic understanding of the concept of assimilative capacity. The intent of Congress was to prohibit the discharge of substances in amounts that would cause pollution, not to require a concentration of zero. Similarly, Congress voted to ban the discharge of toxic substances in concentrations high enough to cause harm to organisms.

Well meaning individuals and organizations sometimes exert pressure on regulatory agencies and other public and private entities to protect the environment by ignoring the concept of assimilative capacity and reducing waste discharges to zero or as close to zero as possible. Failure to utilize the natural assimilative capacity of the environment not only increases the cost of pollution control (the cost to the discharger and the cost to society as a whole); more importantly, it results in the inefficient use of limited resources and, by expending materials and energy for something that nature provides free of charge, results in an overall increase in pollution.


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