Animas Watershed Partnership
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Mr. Chris Sturm
Stream Restoration Coordinator
Watershed and Flood Protection Section
Colorado Water Conservation Board
Department of Natural Resources
1313 Sherman St., Room 721
Denver, CO 80203

SEPTEMBER 16, 2014

Dear Mr. Sturm,

Below and attached please find our final report and deliverables produced under the Animas Watershed Partnership and San Juan RC&D's "Animas River and Lightner Creek Restoration Planning Project."

We are proud to report that CWCB's Watershed Restoration funds have produced data and plans resulting in on the ground watershed improvements on the Florida River, in advancements in our understanding of the scope of the challenge of addressing sediment concerns in Lightner Creek, and in positioning the Animas Watershed Partnership to take increasingly meaningful action toward a healthy Animas Watershed. The Animas Watershed Partnership is deeply appreciative of CWCB's support of these efforts.

TASK 1 – Animas River Action Plan

Description of Task

Complete 3-Year Action Plan for Animas River Restoration. This plan will parlay the findings of the *Animas Watershed-Based Plan* into a set of priority projects that are ready for funding and action. The plan will be drafted by the Animas Watershed Partnership (AWP) Coordinator, through coordination with key partners.

Deliverable: The completed "Animas Watershed Partnership Strategic Action Plan 2013-2016" is attached for your review, This plan, informed by substantial partner outreach and steering committee input, is actively guiding AWP's efforts.

TASK 2 – Animas Watershed Partnership Website

Description of Task

Establish an AWP website in order to effectively and efficiently share information on the purpose, plans, actions and accomplishments of the Animas Watershed Partnership. Develop a site effective at engaging and connecting interested individuals to the on-the ground work of the partnership.

Deliverable: The website has been up and running since 2012 and we continue to update and refine the content. Please visit http://animaswatershedpartnership.org/.

TASK 3 – Lightner Creek & Animas River Aquatic Habitat Improvement Project Implementation Planning

Description of Task

Develop an Implementation Plan that will enable the AWP to successfully implement, measure the effects of, and conduct outreach around a Best Management Practices (BMP) to decrease sedimentation to lower Lightner Creek and to the Animas River. CWCB Watershed Restoration planning funds will enable AWP to "hit the ground running" with a Project Implementation Plan draft for *"Lightner Creek and Animas River Aquatic Habitat Improvement Project"*. Completion of this Project Implementation Plan will enable the commencement of funding (already approved) of the project by the Colorado Non-point Source program. The plan will be drafted by the AWP Coordinator, through coordination with key partners.

Deliverable: The completed "Lightner Creek and Animas Water Quality and Habitat Improvement Project Implementation Plan" is attached. The Plan is currently guiding the use of funds to implement fencing and irrigation improvements and monitor aquatic and riparian habitat in partnership with two landowners on the Florida River, as well as outreach and education efforts by the Animas Watershed Partnership.

TASK 4 –Improving Lightner Creek Sediment and flow rating curve

Description of Task

Produce an improved rating curve for Lightner Creek in order to improve accuracy and sensitivity of loading calculations during the monsoon season, as recommended in the *Lightner Creek Sediment Monitoring Initiative Report – Phase 2*.

Deliverable: This data collection effort is now complete and the attached "Lightner Creek Sediment Monitoring and Rating Curve – Phase III" reports the findings and products of this challenging effort.

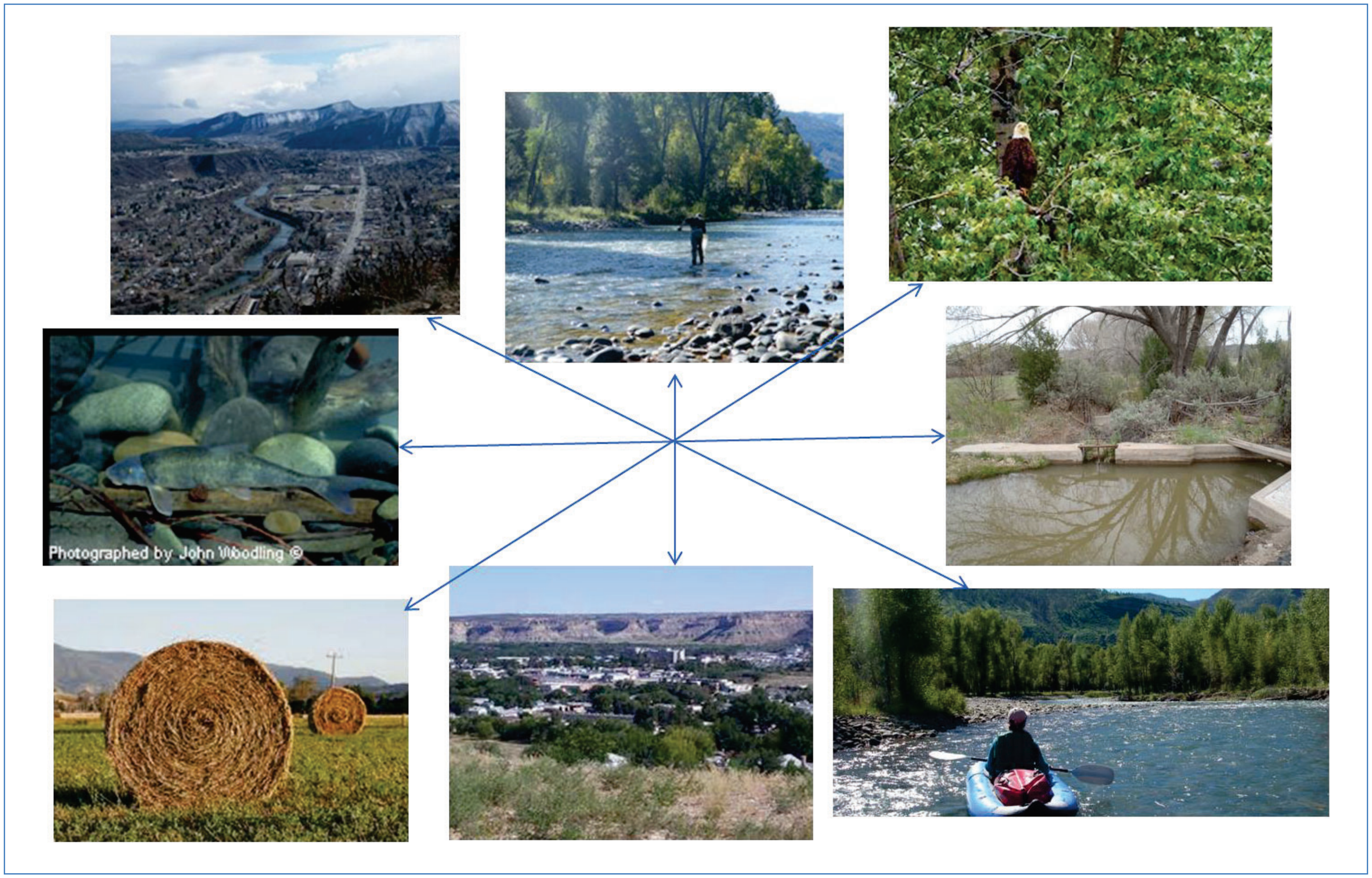
Thank you again for your support of these efforts. Please don't hesitate to contact me with any questions regarding this final report or the attached deliverables.

Most sincerely,

Ann Oliver

Coordinator
Animas Watershed Partnership

Animas Watershed Partnership
Strategic Action Plan 2013 thru 2016



Approved by the AWP Steering Committee on January 30, 2014

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The Animas Watershed Partnership

Mission Statement

To protect and improve the quality of water resources
To benefit the Animas River, now and in the future.

Operating Principles

The Animas Watershed Partnership's (AWP's) efforts are guided by four operating principles. The Partnership:

- Works toward voluntary, non-regulatory solutions to improve water quality and river health.
- Promotes collaboration across all boundaries.
- Uses data and science to make informed decisions.
- Shares information and efforts openly with people and groups.

Organizational Components and Goals

1. Community Engagement

A. Increase awareness, interest, planning and action on the part of local communities for priority issues affecting the health of the Animas River.

2. Water Quality Projects

A. Work with partners to protect and improve water quality within the Animas River watershed.
B. Collect, compile, analyze, interpret and make accessible reliable data that can support and inform efforts to manage water quality in the Animas River.

3. Capacity Building and Fundraising

A. Define the AWP's organizational goals and corresponding objectives for Water Quality Improvement, Community Engagement and Fundraising.
B. Develop staff and volunteer capacity and momentum to plan for and implement water quality improvement projects for priority areas within the Animas River Watershed and continue to engage the community in the mission and work of the Partnership.

Beginnings and Milestones

The AWP is a stakeholder driven, collaborative, watershed-based group made up of partners representing diverse interests across the watershed in New Mexico, the Southern Ute Tribal Lands and Colorado. Current membership is over 100 individuals and entities. The AWP works together across state and Tribal boundaries to protect and improve the quality of water resources in the Animas River. Our partners include private landowners, environmental groups, municipalities, counties and states, as well as the Southern Ute Indian Tribe and the Ute Mountain Ute Indian Tribe.

The AWP grew out of the Animas River Nutrient Workgroup (ARNW). The ARNW was formed in December 2002, out of concern for high nutrient levels in the Animas River. The ARNW included personnel from the Southern Ute Indian Tribe, New Mexico SWQB, State of Colorado WQCD, CPW, and other watershed partners. ARNW designed and tested a nutrient assessment protocol in order to ensure that information collected by different agencies would be comparable. The Workgroup also produced a Quality Assurance Project Plan (QAPP) (BUGS Consulting 2003) to guide data collection and analysis.

During the fall low flows of 2003, 2004, and 2005, ARNW quantified periphyton biomass measured as chlorophyll-a and ash-free dry mass at 12 sites in the Animas River from upstream of the City of Durango to the San Juan River confluence in Farmington, NM, as well as at four sites in two reference streams: the Piedra and the San Juan Rivers. The reference stream sampling sites were located at similar latitudes and elevations to those on the Animas. During this same period, ARNW also completed synoptic sampling of macroinvertebrates and total nitrogen and total phosphorus (BUGS Consulting 2008).

To date the AWP has brought stakeholders together across the various jurisdictional boundaries to assess water quality, identify and discuss concerns, and to plan and implement projects. From 2007 through 2010 AWP stakeholders met monthly to draft an Animas

River Watershed-Based Plan (WBP). The plan's development was based on the U.S. Environmental Protection Agency's Handbook for Developing Watershed Plans to Restore and Protect Our Waters. The EPA's Handbook details nine minimum elements to be included in a watershed plan. The final first version of the Animas River Watershed-Based Plan was completed in December 2011 (BUGS Consulting 2011) with funding from the New Mexico Environment Department SWQB, CO Nonpoint Source program, Colorado Water Conservation Board and Southwest Basins Roundtable, Southwestern Water Conservation District, Trout Unlimited Five Rivers Chapter and others.

The Animas River Watershed Based Plan (2011) assessed water quality in the mainstem from Baker's Bridge in Colorado, through the Southern Ute Tribal lands, to the confluence of the Animas River with the San Juan River at Farmington, New Mexico. This assessment was based on two synoptic sampling efforts conducted at inflows to the mainstem in New Mexico in 2006 and in Colorado/Southern Ute Lands in 2010. The 2010 sampling was guided by a Sampling and Analysis Project Plan (BUGS Consulting 2009). This comprehensive sampling effort allowed the partners to assess and prioritize the relative contributions from inflows to the mainstem of nutrients (total phosphorus and total nitrogen), as well as to consider the channel and floodplain condition of reaches in Colorado. The plan recommends Best Management Practices (BMPs) for addressing the nutrient and sediment related river health issues identified, and provides implementation milestones, cost estimates and timelines. In conjunction with the development of the plan, BUGS consulting also compiled the Animas GIS Database, a geographical and water quality database focused on water quality and land use issues that can affect water quality.

In order to improve water quality and ecological resiliency, AWP has developed partnerships and secured funding to implement several assessment and management projects in areas prioritized by the Animas River Watershed-Based Plan. One such project was completed in 2010 in New Mexico. The AWP worked with a private landowner, Conoco-Phillips, and the San Juan Watershed Group to restore a single thread channel and vegetation to a reach of Kiffin Creek, New Mexico with the goal of significantly reducing the amount of sediment contributed to the Animas River.

Another partnership project has been focused on reducing sediment and nutrients contributed by Lightner Creek, near Durango, Colorado to the Animas River. Since 2011, AWP has partnered with Basin Hydrology Inc., Mountain Studies Institute, the City of Durango, San Juan Citizens Alliance, San Juan National Forest, the Southwestern Water Conservation District, and the Colorado Water Conservation Board Watershed Restoration Program to identify top source areas for sediment in Lightner Creek (Basin

Hydrology Inc. 2011), and to establish a baseline of the amount of suspended sediment conveyed to the Animas River (Peltz et al 2011; Kimple et al 2013).

The AWP held two technical workshops in 2012. The purpose of these workshops was to identify focal source areas for nutrient loading in Colorado, the Southern Ute Tribal Lands and New Mexico, using the results of the synoptic samples presented in the Animas River Watershed-Based Plan. The partners identified five focal inflows to the Animas River in each state (CO and NM). With pro-bono assistance, the areas tributary to these inflows were mapped. The AWP partnered with the San Juan Watershed Group in 2012 to help sponsor the Four Corners River Health Workshop in Farmington, NM. This well-attended workshop brought together people and entities with diverse water quality interests to discuss what has worked, and what hasn't in improving water quality.

Also in 2012, the AWP secured its first Colorado Non-Point Source 319 Implementation Grant to and partner with a local rancher and the Durango-La Plata County Airport to implement the Animas and Florida Rivers Habitat and Water Quality Improvement Project. Matching funds were contributed by the Southwestern Water Conservation District and Trout Unlimited Five Rivers Chapter. The Project will develop a robust riparian buffer along one mile of the Florida River and will convert about 25 acres of adjacent flood irrigated pasture to gated pipe irrigation in order to decrease runoff of nutrients from these pastures to the Florida River. The project implementation will be completed in 2015, with post-implementation monitoring continuing through 2017.

In October 2013, AWP is beginning the Animas Watershed Partnership Expansion Project to develop new partnerships and new project concepts throughout the basin with financial support from the Bureau of Reclamations Water SMART Cooperative Watershed Management Program. The AWP plans to continue outreach to landowners on the Florida River and of Kiffin Creek, as well as in other priority tributaries to identify willing partners and potential projects of mutual interest and benefit to improve water quality. In order to continue this work to improve water quality and ecological function and resiliency, AWP will develop a funding plan to pursue financial support from both traditional and non-traditional sources.

Organization and Management

Steering Committee

The efforts of the AWP are guided by a 9-seat Steering Committee comprised of two local governmental and two citizen seats each from CO and NM, and 1 Tribal seat. The Steering Committee meets monthly, rotating between Farmington, NM, Ignacio, CO and Durango, CO.

Current (January 2014) members on the Steering Committee represent the City of Farmington, NM, City of Durango, CO, Southwestern Water Conservation District, CO, San Juan Watershed Group, Trout Unlimited 5 Rivers Chapter, Southern Ute Indian Tribe, and include two unaffiliated citizens. The NM governmental seat is currently open.

The role of the AWP Steering Committee is to guide the partnership's efforts to safeguard and improve water quality in the Animas River and its tributaries. The Steering Committee is responsible for planning and hosting full partnership meetings, proposing and shepherding the strategic direction of the AWP, approval of grant applications and community engagement and water quality improvement projects.

The Steering Committee is exclusively responsible for the expenditure of AWP funds used to accomplish the mission of the AWP. Decisions made on specific projects are made and decided on a consensus basis by a quorum of the Steering Committee during their monthly meetings. The Steering Committee is also exclusively responsible for any hiring decisions made for the benefit of the AWP regarding staff and/or contractors retained by the AWP. The AWP does not retain any employees but contracts with individual(s) to provide coordination and services for projects. Following review and discussion of qualifications, such decisions will be made on a consensus basis by a quorum of the Steering Committee at a time and place decided on by the Steering Committee.

Coordinator

The role of the Animas Watershed Partnership Coordinator is to coordinate and organize Steering Committee meetings; work with the Steering Committee to develop and maintain partner relations; assist with identification and development of projects that will improve water quality in the Animas River and its tributaries; identify and become familiar with new and existing funding sources; if authorized by the Steering Committee, apply for project funding, and administer the grants for funded projects; work with Steering

Committee to plan, communicate, and coordinate periodic Animas Watershed Partnership Meetings; keep organized records of partnership activities, accomplishments and data; and develop and implement outreach programs as needed.

With respect to hiring contractors, the Coordinator may identify potential contractors for consideration by the Steering Committee, but will not make any hiring or contracting decisions. However, after project contractors have been retained, the AWP Coordinator will manage the successful completion of projects and fulfillment of their contracts in a timely manner.

Partners

The AWP is a grassroots partnership of individuals and entities from Colorado, New Mexico, the Southern Ute Tribe, the Ute Mountain Ute Tribe with an interest in the quality of water resources in the Animas River and its tributaries. The AWP is not an IRS identified 501c3 organization, but partners with an existing 501c3, the San Juan Resource Conservation and Development Council (SJRC&D), as fiscal sponsor. The purpose of AWP is to collaborate across state and Tribal boundaries to protect and improve the quality of water resources in the Animas Watershed.

The grassroots partners include private landowners, interested individuals, community organizations and governmental agencies. A partial listing of partners who provide their knowledge and resources to the partnership include the Animas River Stakeholders Group; Basin Hydrology, Inc.; BHP/Billiton; BUGS Consulting LLC; the Bureau of Reclamation; Colorado RiverWatch; the City of Aztec, NM; City of Durango, CO; City of Farmington, NM; the Colorado Department of Public Health and Environment's Water Quality Control Division (WQCD); Colorado Non Point Source Program; Colorado Parks and Wildlife (CPW); Colorado Water Conservation Board; Durango/La Plata County Airport; Ecosphere; La Plata Conservation District in CO; Mountain Studies Institute; the Natural Resources Conservation Service (NRCS); the New Mexico Environment Department's Surface Water Quality Bureau (SWQB); Public Service New Mexico; San Juan Citizens Alliance; San Juan National Forest in CO; San Juan Soil and Water Conservation District in NM; the San Juan Water Commission; the San Juan Watershed Group; Southern Ute Indian Tribe; Southwest Conservation Corps; Southwestern Water Conservation District; the Tres Rios BLM Management Area in CO; Trout Unlimited Five Rivers Chapter; and the Ute Mountain Ute Tribe.

Fiscal Sponsor

The San Juan Resource Conservation and Development Council (SJRC&D) serves as the AWP's Fiscal Sponsor, under an MOU adopted by both groups on June 10, 2013. As the AWP Fiscal Sponsor, the role of the SJRC&D is to serve as an umbrella 501c3 organization, provide accounting, bookkeeping, and oversight of funds and obligations, with an annual review and audit by a CPA specializing in nonprofits. As fiscal agent, the SJRC&D receives donations to AWP and provides receipts to donors, makes payments for invoiced work based on approval and receipt of funds from the grantors' reimbursement, and pays expenses on behalf of AWP with AWP funds upon approval of AWP chair or coordinator, and provides monthly financial statements detailing deposits and expenditures. The SJRC&D maintains AWPs funds in FDIC insured accounts at local financial institutions, and bonds fiscal managers against loss of funds. In addition, the SJRC&D provides Directors and Officers insurance for board members of the Council, developed and maintains AWP's website, and takes meeting notes during monthly Steering Committee meetings. In exchange for providing these services, SJRC&D assess a 5% administration fee when AWP funds are received.

Definition of the Need

Watershed Concerns

The AWP engages partners across the entire area of the Animas River Watershed (Figure 1). The watershed is 1357 square miles in area and has an 8 digit hydrologic unit code (HUC 14080104). Water quality is an issue within the Animas Watershed, and is the primary focus of the AWP. Poor water quality can have consequences for our health, recreation and economy. By working to maintain and improve the quality of our water resources, we hope to protect and enhance the health of our communities and our natural environment, as well the enjoyment of the river by people throughout the watershed.

A compounding factor for the water quality issues facing the Animas River is the complexity of addressing water quality concerns across boundaries and jurisdictions. As it flows from its headwaters to its confluence with the San Juan River in New Mexico, the river passes through three counties, three distinct state and Tribal jurisdictions, three different EPA jurisdictions, three municipalities, as well as BLM, Forest Service and significant reaches of private land.

Some water quality and system health issues identified in the Animas River Watershed include:

- Segments of the Animas River and its headwater tributaries are on the Colorado 303(d) list for heavy metals.
- A segment of the Animas River is on the Colorado 303(d) list for Manganese.
- There are 29 TMDLS established for pollutants including cadmium, aluminum, copper, iron, lead, zinc, and pH in seven segments of the headwaters of the Animas River in Colorado. Segments of the Animas River are on the New Mexico 303(d) list for temperature, Nutrient/Eutrophication Biological Indicators, Total phosphorus, E. coli, turbidity, and sedimentation.
- A TMDL for Nutrient/Eutrophication Biological Indicators has been established for the lowest reach of the Animas River in New Mexico.
- Draft TMDLs for Temperature, E. coli and Total Phosphorus have been developed for one or both segments of the Animas River in New Mexico.
- The State of Colorado will begin adopting new interim table values for nitrogen, phosphorus, and chlorophyll-a as numeric criteria after 2017.
- The State of Colorado has adopted a new regulation that establishes numerical effluent limitations for nitrogen and phosphorus discharged from wastewater treatment plants above a certain size. The City of Durango's plant meets the minimum size.
- There are 35 community water systems that provide groundwater and/or surface water from the Animas Watershed to their customers.
- There are about 22 permitted dischargers (16 sewerage) discharging waste to the Animas River.
- San Juan County, New Mexico is projected to grow by 35% by 2040 (NMBBER 2012).
- La Plata County, Colorado is projected to grow by over 80% by 2040 (CODOLA 2013).
- Drought has been limiting the amount of water stored in Colorado reservoirs within the watershed, and the releases from those reservoirs
- Segments of the Animas headwaters are largely devoid of fish and other aquatic life due to heavy metals.
- Historic gravel and sand mining has impacted a reach of the Animas River between Baker's Bridge and Durango, affecting the quality of the aquatic and riparian habitat, and the stability of the channel.
- Shale and clay soils in the watershed are highly and naturally erosive, contributing abundant fine sediment to the river, particularly during the monsoon season. Development of these lands exacerbates this situation.

- Oil and Gas development in the southern portion of the Animas watershed has resulted in roads, well pads and pipeline corridors with the potential to increase sediment loading to the river and its tributaries.
- The Animas River is habitat for four native fish species of conservation concern. They are the roundtail chub, flannel mouth sucker and bluehead sucker in the lower reaches and the Colorado River cutthroat trout in some headwater tributaries.
- The Southwest Willow Flycatcher, listed as Endangered under the Endangered Species Act, has been documented to occur within the lower portion of the Animas Watershed. The birds nest in dense riparian shrub vegetation.
- The New Mexico Meadow Jumping Mouse is a Candidate Species under the Endangered Species Act and has potential to occur in riparian areas along the Animas River.

Historically, gold and silver mining were significant economic activities in the upper portions of the Animas River watershed, upstream of Silverton. In the upper Animas River, acidic runoff and groundwater containing high levels of metals comes from both natural and anthropogenic sources. Ore deposits (both underground and exposed) contain sulfides of iron, copper, cadmium, aluminum, lead, manganese, and zinc. At Bakers Bridge, approximately 27 miles downstream of Silverton and 11 miles upstream of Durango, levels of cadmium, iron, and zinc exceed EPA standards for chronic exposure to sensitive aquatic organisms. However, as the Animas River nears Durango, metal concentrations become diluted and hardness increases lessening the impact of metal concentrations on aquatic life. The only exceedance in the segment from Bakers Bridge to Junction Creek is for Water Supply use for manganese (a secondary standard which is essentially an aesthetic issue).

The two lowest segments of the Animas River, Junction Creek to Southern Ute Indian Tribe (SUIT) Boundary, and SUIT Boundary to the Colorado/New Mexico border in Colorado are not included on Colorado's 303(d) list, nor do they have any Total Maximum Daily Loads (TMDLs). However, the latter segment has not been assessed by Colorado, and the Southern Ute Indian Tribe is in the process of developing its water quality standards.

In New Mexico, the segment of the Animas River from the Colorado/New Mexico border to Estes Arroyo is listed on the 303(d) list for E. coli, total phosphorus and temperature. The next segment downstream, from Estes Arroyo to the San Juan River is listed for nutrients, E. coli and temperature. These segments are not in attainment of the following designated uses: cold-water aquatic life and primary contact in the upstream reach, and marginal cold-water aquatic life, warm-water aquatic life, and primary contact in the downstream reach. The State of New Mexico has established Total Maximum Daily Loads (TMDL) for fecal coliform, total nitrogen and total phosphorus in the downstream reach. Draft TMDLs for E. coli and temperature in the downstream segment, and for E. coli and total phosphorus in the upstream segment, are currently undergoing review. A Use Attainability Analysis is planned to evaluate uses related to water temperature.

Wastewater and stormwater discharge permit holders may be affected by TMDLs. A TMDL is the maximum amount of a pollutant that a water body can receive and still meet water quality standards. TMDLs allocate that load among the various sources of that pollutant. Pollutant sources are either point sources or nonpoint sources. Point sources include all sources subject to regulation under the National Pollutant Discharge Elimination System (NPDES) program, e.g. wastewater treatment facilities, some stormwater discharges and concentrated animal feeding operations (CAFOs). Nonpoint sources include all remaining sources of the pollutant as well as anthropogenic and natural background sources. (http://www.epa.gov/owow/tmdl)

High levels of E. coli bacteria in surface water can indicate a risk to human health. E. coli is a type of fecal coliform bacteria that comes from human and animal waste. The Environmental Protection Agency uses E. coli measurements to determine whether fresh water is safe for recreation. Disease-causing bacteria, viruses and protozoans may be present in water that has elevated levels of E. coli. The goal of setting E. coli criteria for surface waters is to provide the public protection from gastrointestinal illness associated with exposure to fecal contamination during water-contact recreation.

High levels of nitrogen and/or phosphorus in surface water can degrade habitat quality for aquatic life, and high levels of nitrates in drinking water can present a risk to human health. Nitrogen and phosphorus are nutrients necessary for growth of all living organisms. In excess amounts, these nutrients in surface water cause an increase in algae growth. Algae can deplete the water of dissolved oxygen and eventually may kill fish and other aquatic life. Sources of nutrients may include human and animal wastes, industrial pollutants and nonpoint-source runoff from heavily fertilized agricultural fields or residential lawns. Under certain conditions high levels of nitrates (10 mg/L or more) in drinking water can be toxic to humans. High levels of nitrates in drinking water have been linked to serious illness and even death in infants (CO RiverWatch 2012).

Organizational Niche

The AWP is one of several citizen groups addressing water quality and river health within the Animas River Watershed. A partial listing of these groups includes the Animas River Stakeholders, Animas River Task Force, Southwest Wetland Focus Area, and the San

Juan Watershed Group. AWP counts each of these groups among its partners, and highly values, respects and seeks to compliment their excellent efforts.

The specific strength and niche of the AWP is captured in its first operating principle and its mission: the AWP works collaboratively across boundaries to benefit the Animas River watershed. River and water management in one part of the watershed effects people and the river in other parts of the watershed. The AWP brings together people from New Mexico, Colorado and the Southern Ute Tribe to gather and consider scientific information collaboratively, to develop a common understanding of this information, and to discuss and collaborate on implementing ways of protecting and improving water quality throughout the Animas River watershed.

2013-2016 Strategic Plan: Components, Goals, Actions, and Tasks

1. Community Engagement Strategy

Background

In their 2013 Steering Committee retreat, the group established a Planning Sub-Committee to develop Strategic, Capacity and Outreach plans. This document is the first iteration of a strategic and capacity planning document for AWP. The anticipated Outreach plan will identify outreach goals and identify and prioritize outreach activities that will be time and cost effective at reaching the diverse key audiences necessary for safeguarding water quality in the Animas River. The AWP holds regular monthly Steering Committee meetings and quarterly Partnership Meetings that are open to all. Partnership Meetings are aimed at informing the general partnership and public of efforts and progress on Animas River water quality. They are advertised to the public in local media outlets (radio and newspaper), with agendas organized around guest speakers and designed to be engaging and informative.

The AWP partnered with the San Juan Watershed Group in 2012 to help host the Four Corners River Health Workshop in Farmington, NM. This well-attended workshop brought together people and entities with diverse water quality interests to discuss what has worked, and what hasn't in improving water quality. The Workshop was well received and successful. It demonstrated a need for this type of conference on a regular basis. The AWP intends to continue to partner and host symposia on a regular basis to focus expertise and attention on water quality in the Animas River.

In 2013 AWP partnered with the Southwest Conservation Corps and the San Juan Watershed Group to develop and implement a "Get to Know the Animas" Float Trip for SCC's summer high school age work programs. SCC hosts two such work programs per summer, drawing high school students mostly from four corners communities. This outreach was successful at developing an understanding of, and interest in, watershed and river health issues. The work program leaders and participants, as well as the rafting guides, enjoyed and learned from the day's activities. AWP and SCC plan to continue this program into the future.

In order to expand its outreach and relationships with private property owners and agricultural producers, AWP plans to partner with the local Conservation Districts (La Plata Conservation District in CO and San Juan Soil and Water Conservation District in NM) to conduct outreach workshops with landowners in these priority tributary areas, focused on sharing AWP data and mapping, learning about landowners problems and needs, and sharing approaches to managing non-point source pollution.

Goals, Actions, Tasks

Component 1: Community Engagement		Funds Available			
Goals **, Actions,** Tasks	**Funding Source**	**FY13**	**FY14**	**FY15**	**FY16**
Goal 2.A Increase awareness, interest, planning and action on the part of local communities for issues affecting the health of the Animas River.					
Action 2.A.1 Complete Education and Outreach actions under the Animas and Florida River Habitat and Water Quality Improvement Project (CO NPS Implementation Grant).					
Task 2.A.1.1 Produce these deliverables:1 press release; 1 article; 1 new website; 6 website updates/yr; 2 Animas Day Camp days/yr; 6 AWP Steering Committee mtgs/yr; 4 AWP mtgs/yr; AWP partners informed and motivated; Additional cash or in-kind support; Additional	CO NPS , OSM/Vista	X	X	X	
Action 2.A.2 Meet with key partners to discuss information, problems and needs related to Animas River water quality, and to develop project concepts.					
Task 2.A.2.1 Meet with municipalities to develop project concepts.	BOR CWMP	X	X		
Task 2.A.2.2 Meet with ditch companies to introduce AWP and discuss concerns/needs.	BOR CWMP	X	X		
Task 2.A.2.3 Meet with permitted dischargers to share data and discuss concerns and needs	BOR CWMP	X	X		
Action 2.A.3 Partner with 2 local conservation districts to conduct 2 outreach workshops with landowners to identify issues and needs relating to nutrient management.					
Task 2.A.3.1 Secure funding.	BOR CWMP	X	X		
Task 2.A.3.2 Work with partners and OSM/Vista Volunteer to plan workshops.	BOR CWMP	X	X		
Task 2.A.3.3 Hold workshops.	BOR CWMP	X	X		
Action 2.A.4 Engage partners to jointly sponsor semi-annual local meeting/seminar focussing on aspects of river health.					
Task 2.A.4.1 Evaluate feasibility/interestwith OSM/Vista Volunteer, SJWG, ARSG and others.	BOR CWMP,	X	X		
Action 2.A.5 Involve volunteers in AWP projects and efforts to monitor and improve the health of the Animas River Watershed.	BOR CWMP				
Task 2.A.5.1 Engage volunteers to cut and plant willow stakes at locations on the Animas and Florida River Habitat and Water Quality Improvement Project site.	BOR CWMP, CO NPS, OSM/Vista		X		
Task 2.A.5.2 Engage volunteers to conduct water quality monitoring at funded locations.	TBD		X		
Action 2.A.5 Develop Community Engagement Plan.	BOR CWMP,				
Task 2.A.5.1 Form outreach committee to work with OSM/Vista Volunteer to develop plan.	BOR CWMP	X	X		
Task 2.A.5.2 OSM/Vista Volunteer drafts plan for review and approval by Steering Committee.	BOR CWMP	X	X		

2. Water Quality Strategy

Background

In December 2011, the AWP completed the first Animas River Watershed-Based Plan (the 2011 Plan). This plan assessed water quality in the mainstem, from below Baker's Bridge in Colorado, through the Southern Ute Tribal lands, to the confluence of the Animas River with the San Juan River at Farmington, New Mexico. Upstream of Baker's Bridge the primary water quality issues are related to historic hardrock mining and background geology and are being addressed by one of our partners, the Animas River Stakeholder's Group. Downstream of Baker's Bridge the primary water quality issues are related to existing landuses (and/or background geology).

This comprehensive sampling effort and assessment allowed the AWP and partners to assess and prioritize the relative contributions from inflows to the Animas River of nutrients (total phosphorus and total nitrogen), as well as to consider the channel condition of reaches in Colorado. The plan recommends Best Management Practices (BMPs) for addressing the river health issues it identifies. Among the list of priority BMPs identified by the 2011 Plan were enhanced stormwater management and working with agricultural producers to implement sprinkler irrigation and develop buffer strips to control runoff.

Based on the 2011 Plan, and as a next step toward refining the needs of the watershed, AWP has identified 10 focal tributaries to the Animas River, five in Colorado and five in New Mexico for focused assessment, partner engagement, and action. These include Junction Creek, Durango Skate Park, Lightner Creek, Trumble Draw, and the Florida River in Colorado, and Cox Canyon, Tucker Canyon, Estes Arroyo, Flora Vista Arroyo, and City of Farmington in New Mexico. Five of the ten focal areas include significant urbanized areas. The remaining five inflows are associated with drainages with significant agricultural land use, as well as oil and gas production.

With these focal nutrient source areas identified, next steps include understanding the relationship between land use and water quality in these areas, and creating beneficial partnerships with landowners, agricultural producers, municipal stormwater managers, permitted dischargers, and oil and gas producers to share data, discuss concerns and develop goals and project concepts for each tributary.

Goals, Actions, Tasks

Component 2: Water Quality Projects		Funds Available			
Goals **, Actions,** Tasks	**Funding Source**	**FY13**	**FY14**	**FY15**	**FY16**
Goal 1.A To protect and improve water quality within the Animas River watershed.					
Action 1.A.1 Complete Florida and Animas River Habitat and Water Quality Improvement Project to reduce nutrient, sediment and bacterial loading along 1 mile of Florida River.		X	X	X	X
Task 1.A.1.1 Install Best Management Practices	CO NPS, TU 5 Rivers	X	X	X	X
Task 1.A.1.2 Monitor and Evaluate Results	CO NPS	X	X	X	X
Task 1.A.1.3 Report Progress and Invoice	CO NPS, SWCD	X	X	X	X
Action 1.A.2 Work with partners to identify, develop and fund new projects to address focal areas within the Animas Watershed.	BOR CWMP	X	X	X	
Task 1.A.2.1 Identify potential project concepts.	BOR CWMP	X	X	X	
Task 1.A.2.2 Develop potential project partners.	BOR CWMP	X	X	X	
Action 1.A.3 Develop new project concept with willing landowners on the Florida River.	BOR CWMP	X	X	X	
Task 1.A.3.1 Explore project concepts with willing landowners on Florida River and Salt Creek.	BOR CWMP	X	X	X	
Goal 1.B To collect, analyze, interpret and make accessible data that can support and inform efforts to manage water quality in the Animas River across jurisdictional boundaries.					
Action 1.B.1 Track and support Microbial Source Tracking Study.					
Task 1.B.1.1 Participate in and support all facets of the MST project.	BHP Billiton/SJSWCD	X	X		
Action 1.B.2 Develop sediment rating curve for Lighter Creek.					
Task 1.B.2.1 Complete data collection.	CWCB Watershed Restoration	X			
Task 1.B.2.2 Write and submit Final Report to CWCB	CWCB Watershed Restoration	X			
Action 1.B.3 Enter AWP data from 2011 Watershed Based Plan into CO Data Sharing Network.					
Task 1.B.3.1 Join CDSN.	CO NPS	X	X	X	X
Task 1.B.3.2 Enter data.	CO NPS	X	X	X	X
Action 1.B.4 Participate in and support Regional GIS Website with San Juan Watershed Group.					
Task 1.B.4.1 Assist in development of RFP and website.	BHP Billiton/SJSWCD	X	X		
Task 1.B.4.2 Contribute AWP data.	BHP Billiton/SJSWCD	X	X		
Action 1.B.5 Identify priority water quality data needs in focal non-point nutrient source areas.					
Task 1.B.5.1 Compile and map existing data.	BOR CWMP	X	X	X	
Task 1.B.5.2 Meet with stakeholders to share data, hear concerns and develop goals for each priority tributary.	BOR CWMP	X	X	X	

Capacity and Fundraising Strategy

Background

In January 2013, the AWP contracted a management consultant/facilitator to guide them through a renewal of their mission statement, clarification of operating principles and a capacity analysis. This two day “retreat” produced a slightly revised mission statement, a refreshed commitment to that mission and the recognition that the group needed to expand its capacity. It also resulted in the formation of the Planning Sub-Committee. This document represents the first draft of a Strategic Plan for the AWP. In addition, the Planning Sub-committee has outlined a draft Budget and Funding Plan. The Budget will outline the operating and project funding needs associated with the strategic plan. The Funding Plan will outline the various sources, including local partners, public and private grants, etc. from which the AWP will raise the budgeted funds. These drafts will be reviewed and updated by the Steering Committee and vetted with the partnership. In 2014, AWP plans to again contract a management consultant/facilitator to guide the development of group by-laws and to refine the Funding Plan.

In 2013 AWP will apply for an OSM/Vista Volunteer who can assist the Coordinator and partners in developing an Outreach Plan, and other tasks under AWP’s Community Engagement, Water Quality, and Capacity and Fundraising Strategies.

Goals, Actions, Tasks

Component 3: Capacity and Fundraising		**Funds Available**			
***Goals*, Actions,** Tasks	**Funding Source**	**FY13**	**FY14**	**FY15**	**FY16**
Goal 3.A. Define AWP's organizational goals, and corresponding objectives and prioritize for WQ improvement, Community Engagement and Fundraising.					
Action 3.A.1 Develop the group's vision and by-laws.					
Task 3.A.1.1 Draft strategic plan and capacity plan.	CWCB Watershed Restoration	X			
Task 3.A.1.2 Facilitate review and feedback of drafts by Steering Committee and Partners, and develop group vision and bylaws.	BOR Watersmart	X	X	X	
Action 3.A.2 Update the strategic plan and capacity plan.	BOR Watersmart	X	X	X	
Action 3.A.3 Complete an Outreach Plan to establish broad-based membership.					
Task 3.A.3.1 Draft Community Engagement Plan.	BOR Watersmart	X	X	X	
Task 3.A.3.2 Facilitate review/feedback by Steering Committee and Partners.	BOR Watersmart	X	X	X	
Action 3.A.4 Develop Quantitative Action Tracking tool.					
Task 3.A.4.1 Structure and populate a spreadsheet to track AWP actions and products quantitatively as a tool to track and inform regarding our efforts and success.	BOR Watersmart	X	X	X	
Goal 3.B. B. Develop staff and volunteer capacity and momentum to plan for and implement water quality improvement projects for priority areas within the Animas River Watershed and continue to engage the community in the mission and work of the Partnership.					
Action 3.B.1 Increase the paid hours of the coordinator.					
Task 3.B.1.1 Propose funding to BOR WATERSMART:CWMP 2013.	BOR Watersmart	X	X	X	
Action 3.B.2 Fund and apply for an OSM/Vista Volunteer, and provide Volunteer with office supplies and equipment support.					
Task 3.B.2.1 Propose funding to BOR WATERSMART:CWMP 2013.	BOR Watersmart	X	X	X	
Task 3.B.2.2 Apply for OHM/Vista Volunteer.	BOR Watersmart	X	X	X	
Action 3.B.3 Develop and maintain AWP Funding Plan.	BOR Watersmart	X	X	X	
Action 3.B.4 Engage partners as volunteer capacity in every project.	BOR Watersmart, CO NPS	X	X	X	X

References

Basin Hydrology, Inc. 2011. Lightner Creek Watershed Evaluation Report. Prepared for the Lightner Creek Watershed Group. January 2011.

B.U.G.S. Consulting. 2003. Draft QAPP: Cooperative Reconnaissance of the Animas River To Assess the Degree of Nutrient Enrichment. Prepared for the Animas River Nutrient Workgroup. July 2003.

B.U.G.S. Consulting. 2008. Pollution Source Identification & Best Management Practice Recommendations: San Juan and Animas Rivers, New Mexico. Prepared for the San Juan Watershed Group. December 2008.

B.U.G.S. Consulting. Sampling and Analysis Project Plan for the Animas River: Surface Water Sampling for Impacts of Nutrients. Prepared for the AWP. March 2009.

Peltz, C., K. Nydick, C. Livensperger. 2011. Lightner Creek Sediment Monitoring Initiative Report - Phase 2. Mountain Studies Institute Report 2010 – 07. January 2011.

Colorado Nonpoint Source Project - FY2011
Project Implementation Plan

Project Title	Animas and Florida River Water Quality and Habitat Improvement Project

1.0 Project Proposal Summary

Sponsor	
Organization Name	San Juan Resource Conservation and Development
E-mail address	sjrcd@hotmail.com
Mailing Address	954 E. 2nd Ave, Suite 104, Durango, CO 81301
City, State and Zip	Durango, CO 81302
Telephone Number	(970) 382-9371
Fax Number	(970) 247-3412
Federal Tax ID	742408579

Project Coordinator or Primary Contact	
Name	Ann Oliver
Title	Coordinator, Animas Watershed Partnership
E-mail Address	annsoliver@gmail.com
Mailing Address	2340 CR 203
City, State and Zip	Durango, CO 81301
Telephone Number	(970) 903-9361
Fax Number	none

Project Funding
CO NPS Funds Requested $159,245 + Match (cash/in-kind) $108,698 = Total Project Cost $267,943
Federal Funds - Federal Cooperator Contribution (Please do not include in the total.) $12,630

Project Start Date	March 2013	Project End Date	February 2016
Geographic Coverage (check one)	Statewide	X Regional (Watershed)	X Site Specific

Project Location	
River Basin	San Juan River Basin
Watershed(s)	Animas River; Florida River
Watershed size	1357 square miles; 221 square miles
303(d) listed Stream	Yes No X Listed Segment
HUC(s) (8 digit USGS Hydrologic Unit Codes)	*14080104; 140801040803*
County(ies)	La Plata County, CO
Position coordinates of project location in decimal form	Latitude 37.15675 Longitude -107.76085

NPS Pollution Source categories to be addressed (Check all that apply)			
X	Agriculture		Silviculture
X	Habitat Modification (drainage/filling wetlands, stream bank destabilization)		Hydrologic Modification (changes to water flow as in reservoir, diversions, etc.)
	Urban runoff/Stormwater		Groundwater Loading
	Mining		Natural Sources
	Construction		Other: Channel and floodplain modification/ encroachment

NPS Pollutants to be addressed (Check all that apply)			
X	Excess Nitrogen		Pesticides
X	Excess Phosphorus		Oil and grease
X	Sedimentation	X	Temperature
X	Pathogens/Bacteria		pH
	Metals	X	Habitat impact
	Low dissolved oxygen		Other:

Estimate Load Reduction, if checked for excess nitrogen, excess phosphorus and/or sedimentation	
# pounds of nitrogen reduced by project Determined through SAPP and project evaluation.	To be estimated in the Sampling and Analysis Project Plan (SAPP)
# pounds of phosphorus reduced by project Determined through SAPP and project evaluation.	To be estimated in the SAPP
# tons of sediment load reduced by project Determined through SAPP and project evaluation.	

Project Description
The Animas and Florida River Water Quality and Habitat Improvement Project ("the project") will be focused on implementing agricultural best management practices (BMPs) recommended in the Animas Watershed Based Plan. The targeted BMPS will address top sources of contamination identified in a major tributary, the Florida River, ranked as a priority inflow for nutrient and sediment loading to the Animas River. The project incorporates riparian fencing and irrigation efficiency improvement BMPs, monitoring and evaluation of project results, and strategic outreach to key audiences.

Project Goal
The primary goal of the project is to improve the water quality and aquatic habitat of the lower Florida River and the Animas River by reducing the amount of nitrogen and phosphorus contributed to the Florida River and ultimately to the Animas River. In addition, the Project aims to sustain and advance the mission and collaboration of the AWP and to educate key audiences about water quality.

2.0 Statement of Need

2.1 Water Quality Priorities

Recent measurements have shown high levels of nitrogen and phosphorus at the inflow of the Florida River to the Animas River. The *Animas River Watershed Based Plan* reports that the Florida River, a perennial tributary, is a significant source of nutrients to the Animas River. In July 2010, of 31 inflows to the Animas River that were sampled between Baker's Bridge and the Colorado/New Mexico state line, the Florida River ranked 2nd among non-permitted inflows located outside of the Durango Municipal Separate Storm Sewer System Permit Area for nitrogen loading and 3rd for phosphorus loading.

Both the Florida River and the Animas River below the Florida are classified as Recreation E, Aquatic Life Cold 1, Water Supply and Agriculture uses by the Colorado Water Quality Control Commission. In Colorado, neither the Florida River, nor the two lowest segments of the Animas River (Junction Creek to Southern Ute Indian Tribe (SUIT) Boundary and SUIT Boundary to the Colorado/New Mexico border) are included on Colorado's 303(d) list, or have completed Total Maximum Daily Loads (TMDLs). However, the latter segment has not been assessed. In NM, the segment from the San Juan River to Estes Arroyo is recognized as impaired for E. coli, nutrient/eutrophication biological indicators, water temperature and turbidity. The nutrient TMDL for this segment states that 93% of total nitrogen and 91% of total phosphorus in the Animas River is from non-point sources. The target load reduction is 130lbs/d total nitrogen and 44lbs/d total phosphorus. In addition, the Animas River from Estes Arroyo to the Southern Ute and Colorado border is on the NM 303(d) list for E. coli, total phosphorus, sedimentation/siltation, water temperature and turbidity. Nutrient levels steadily increase downstream from the stateline to the San Juan River, and the San Juan Watershed Group has identified nutrient enrichment as high priority water quality impairment in their *San Juan Basin Watershed Management Plan.*

The project would implement at a local level the goals and objectives of the *Colorado NPS Management Plan (2005)*. The plan identifies reduction of sediment, nitrogen and phosphorus loading to CO waters as a joint priority with EPA. The project is focused on reducing loading of these pollutants to the Florida River and to the Animas River. The *Colorado 2005 – 2010 Nonpoint Source Action Plan* aims to conduct voluntary nonpoint source projects with active groups of citizens. The AWP is just such a group of citizens. The Action Plan aims for activities to have been identified in a local watershed based plan. The *Animas River Watershed Based Plan* identifies the Florida River as a significant source of sediment and nutrient loading to the Animas River, and suggests BMPs like those in the project. The Action Plan aims to monitor success and support strategic outreach. The project includes monitoring to assess water quality changes associated with BMPs, and proposes outreach linked directly to issues and actions.

2.2 Water Body Description

The Hydrologic Unit Code for the Upper Animas Valley is 1408010405 and for the Lower Florida River is 1408010410. The Animas River is a perennial 3^{rd} or 4^{th} order stream (New Mexico Department of Game and Fish. 2006. Comprehensive Wildlife Conservation Strategy for New Mexico. New Mexico Department of Game and Fish. Santa Fe, New Mexico. 526 pp + appendices). The Florida River is the largest tributary to the Animas River. It is the last perennial tributary to join the Animas River before it's confluence with the San Juan River, about 33 miles downstream.

Stream flow in the Animas River is typical of mountain streams of the southern Rocky Mountains. Stream flow is dominated by snowmelt runoff, which typically occurs between April and July peaking in late May or early June. Snowmelt runoff is augmented by monsoon rains from July through October. Low stream flow conditions exist from late August to March. Base stream flow in the study area is maintained by ground-water flows. Stream flow in the lower Florida River is driven by the management of releases from Lemon Reservoir and by the diversion and return flows of irrigation water downstream of the reservoir. Historical and live stream flow conditions in Colorado can be found at: http://waterwatch.usgs.gov/?m=real&r=co&w=map (BUGS 2011).

The approximately one-mile reach of river to be treated under this implementation project is a C4 stream type (Rosgen 1996). The stream banks are dominated by herbaceous vegetation and largely lack any overstory of woody vegetation. Nevertheless, there is abundant evidence of existing living root stock of native woody vegetation including: coyote and other willows, silver buffalo berry, river hawthorne, skunkbush sumac, etc. The stream channel bed appears to be stable. There are a few short lengths of rapidly eroding cutbanks.

The project site lies on privately owned “fee land” within the Southern Ute Tribal Boundary, where fisheries are managed by the Southern Ute Division of Wildlife. According to the partner landowners at the project site on the Florida River, trout have not been plentiful in this reach of river since the 2002 drought. Due to the lack of woody vegetation overstory within this reach, there is very little shaded water. Also, although embeddedness has not yet been measured in this reach, a walking survey of the channel conducted on August noted that the channel appears highly embedded with fine sediments.

2.3 Map of Watershed Location *(Appendix)*

2.4 General Watershed Information

The Animas and Florida River flow south out of the San Juan Mountains. The Florida River joins the Animas River downstream of Durango, about 4 miles north of the Colorado/New Mexico Stateline. Elevation ranges from 5994 ft at the confluence with the Animas River, over 13,000 feet at the top of each watershed. Average annual precipitation ranges 15 inches to 45 inches in the Florida river drainage, depending on elevation. Soils from south of approximately Highway 160 and Durango are often shale derived. Native upland vegetation in this area is pinyon juniper with some sagebrush and ponderosa pine stands. Native riparian vegetation is dominated by cottonwood (both narrowleaf and Fremont) and willows, with patches of other native species such as, silver buffalo berry, river hawthorne, and skunkbush sumac.

Land Ownership in La Plata County, Colorado is 43% private, 16% tribal and 41% state and federal. Agricultural land makes up about 25% of the total land in La Plata County (BUGS 2011). Similar to the larger Animas Watershed, the Florida Watershed supports a variety of landuses including residential development, commercial development, gravel mining, oil and gas development, and irrigated agriculture. The main crop is grass and/or alfalfa hay irrigated by the range of systems from traditional flood irrigation to modern center pivots. Livestock include cow-calf and sheep operations, commercial and recreational horse properties, as well as lesser numbers of other livestock.

The Florida River watershed upstream of the project site comprises the Source Water Protection Area for seven public water suppliers, including Colorado Trails Ranch, Forrest Groves, Colvig Silver Camps, Edgemont Ranch Metro District, El Rancho Florida Metro District and the Durango La Plata Airport. This area is in a mix of public, private and tribal lands, with most of the headwaters under US Forest Service management and the lower elevation lands almost entirely private or tribal.

2.5 Type of Water Quality Problem including Sources

Water quality problems on the Animas River associated with the Florida River inflow include chemical pollution (nutrients) and degradation of the physical habitat by turbidity and sedimentation. In July 2010 sampling of 31 inflows to the Animas River between Baker's Bridge and the CO/NM state line, the Florida River ranked 4th among non-permitted inflows ranked 2nd among non-permitted inflows located outside of the Durango Municipal Separate Storm Sewer System Permit Area for nitrogen loading and 3rd for phosphorus loading.(BUGS 2011). During the summer months, the Florida River is frequently observed to run more turbid then the Animas at their confluence.

It does not appear that a study has been completed to identify the predominant sources of nutrient and sediment loading in the Florida River. However, the Animas River Watershed Based Plan identified flood irrigation as a likely significant contributor of these contaminants to both the Animas mainstem and the Florida River. The plan also noted that nutrient enrichment can be exacerbated by the loss of riparian habitat (BUGS 2011).

The project site for implementation of BMP's is an approximately 1 mile stretch of river along the Florida River. The river banks in this reach is flanked by irrigated pastures that support year round use by livestock (horses and cows) with free access to the river banks and channel. The predominant vegetation on the river banks is herbaceous. The river is almost completely unshaded by vegetation. The pastures are irrigated using traditional flood irrigation practices. Flood irrigation occurs between March and October on these lands and produces significant overland flow to the floodplain and river channel. This frequent surface flow results in sheet and rill erosion that delivers sediment, nutrients and manure to the floodplain and river.

3.0 Project Description

3.1 Environmental and Programmatic Goals

Environmental Goal: Improve water quality and aquatic habitat in the Florida River by reducing nutrient loading and improving aquatic habitat in approximately 1 mile of this high priority tributary of the Animas River.

Programmatic Goal 1: Implement Best Management Practices that will improve water quality and aquatic habitat in the Florida River.

Programmatic Goal 2: Measure and evaluate project effectiveness.

Programmatic Goal 3: Increase information and awareness of water quality issues and tools in the Animas River watershed.

Programmatic Goal 4: Implement and administer a project that is effective at addressing nonpoint source pollution and at outreach to key audiences.

3.2 Objectives, Tasks, and, Products

Programmatic Goal 1

<u>Objective 1:</u> Reduce nutrient loading from irrigated pasture and upland runoff along 1 mile of the Florida River by increasing irrigation efficiency and protecting riparian areas.

Task 1 Replace traditional flood irrigation with more efficient center pivot sprinkler irrigation, and install riparian fencing BMPs on Durango La Plata Airport and Fassbender properties on the lower Florida River.

Products: 0.8 miles of river channel protected with fencing; approximately 15 acres of native riparian buffer ; approximately 26.5 acres converted from flood to sprinkler irrigation; Pollutant loading reductions estimated through SAPP implementation

Programmatic Goal 2

<u>Objective 2:</u> Plan and conduct monitoring to assess the effectiveness of BMPs and overall project implementation.

Task 2 Work with the Measureable Results Project (MRP) to develop the Sampling and Analysis Project Plan to identify project evaluation and monitoring methods and ensure data quality. Monitor and Evaluate project progress and outcomes. Enter chemistry and macroinvertebrate data into CO Data Sharing Network (DSN). Complete reports to evaluate project progress and effectiveness.

Products: SAPP; report of monitoring methods and results, AWP data entered into STORET via DSN; semi-annual reports and final report

Programmatic Goal 3

<u>Objective 3</u> Conduct education and outreach to inform key audiences about water quality in the Animas Watershed, current efforts and tools for improvement. Improve capacity and momentum to continue water quality improvement projects for priority areas within the Animas River Watershed.

Task 3 Conduct outreach and education processes, involving the local press, a new AWP website, presentations at AWP Meetings as well as to the City of Durango, La Plata County and other key partners.

Products: 1 press release; 1 newspaper article; 6 website updates/year, 6 steering committee meetings, 4 AWP meetings/year; 2 days of youth day camp per year; presentations; volunteer workdays; additional community interest, awareness and support.

Programmatic Goal 4

Objective 5 Successfully complete the project within approved budget by February 2016.

Task 4 Administer and manage the project through monthly reimbursement requests, progress reports, and AWP Steering Committee input. Seek additional cash and in-kind resources (e.g. CWCB, NRCS, etc.). Ensure coordination among partners; timely reporting, expense and match documentation and retention.

Products: 18 reimbursement statements/progress reports; acceptance of all deliverables by WQCD and EPA.

3.3 Milestone Table (*Complete in the 2011 Budget Table)*

3.4 Environmental Permits
No permits will be required for implementing riparian fencing and installation of sprinkler systems.

3.5 Lead Project Sponsor Qualifications
The Animas Watershed Partnership will lead this project, with support from the San Juan Resource Conservation and Development (SJ RC&D) as their fiscal sponsor. The SJ RC&D formed in 1972 as a 501c3 non-profit partnered and supported by the USDA-NRCS. The SJ RC&D serves as fiscal sponsor for many groups and organizations, managing numerous project grants. Over the last 15 years, the SJRC&D has managed many nonpoint source projects from Colorado (CO) and New Mexico (NM).

The AWP Steering Committee is made up of eight key watershed partners from CO and NM, and one from the Southern Ute Indian Tribe. Four members from each state are drawn from local government, municipalities, environmental and private partners. As AWP coordinator, Ann Oliver will manage all aspects of this project. Ms. Oliver has an MS in Wildlife Biology and over 18 years of experience working in watershed management on the west slope of Colorado, designing and implementing riparian research and management projects, working collaboratively with private property owners, public agency experts, contractors, teachers, students and communities.

3.6 BMP Operation and Maintenance

The operation and maintenance (O&M) of the BMPs funded under this project will be the responsibility of the partnering landowners. In order to ensure proper operation and maintenance of the BMPs funded under this project, AWP will conduct annual on-site evaluations with the landowner and lessee. If any O&M problems are identified, AWP, the landowners and lessee will discuss and agree on the remedial steps to be taken by the landowner/lessee, as well as a timeframe for completion of these steps. These agreed upon steps will be described in a letter, to be followed by another on-site evaluation. Remedial steps will be paid for by the landowner.

4.0 Coordination Plan

4.1 Lead Project Sponsor and Cooperating Organizations (*In the Appendix)*

4.2 Local Support

The AWP formed in 2002 out of concern for high nutrient levels in the Animas River in CO and NM. The AWP is working together across state and tribal boundaries to protect and improve the quality of water resources in the Animas Watershed. Partners include private landowners, environmental groups, municipalities, counties and states, as well as the SUIT and Ute Mountain Ute Indian Tribe. BUGS Consulting completed the *Animas Watershed Based Plan (2011).* The efforts of the Animas Watershed Partnership are guided by a highly engaged Steering Committee which is composed of nine members filling the following seats: 1 municipal, 1 governmental, 1 environmental and 1 citizen each from CO and NM, and 1 tribal seat. The Steering Committee meets monthly.

To date the Animas Watershed Partnership has benefitted from over $30,000 in local cash support by the CWCB, San Juan Public Lands (SJPL), Southwest Water Conservation District, Trout Unlimited 5 Rivers Chapter and BHP Billiton/New Mexico Coal.

4.3 Coordination with Other Projects and Organizations

The project is well coordinated with other pertinent and complimentary programs. In March 2011, the AWP coordinator attended an NRCS meeting to provide input to help NRCS targeted conservation funding. The participants agreed that the Florida River should be proposed as a Targeted Conservation Project, in part based on the presentation of findings from the Animas Watershed-Based Plan. As a follow-up to this meeting, the La Plata Conservation District and the NRCS hosted an evening informational meeting to field interest and provide information to landowners within the Florida River drainage. The evening was well attended by about 30 local residents. In addition to the hosts, organizations that presented information and funding opportunities included the Southern Ute Indian Tribe Water Quality Program and the Animas Watershed Partnership.

The City of Durango is a key partner of the Animas Watershed Partnership. The City obtains the majority of its drinking water from the Animas River. In spring 2011 the City joined with six other public water suppliers to form the Florida River Source Water Protection Partnership and to jointly develop a source water protection plan. These porters included: Colorado Trails Ranch, Forrest Groves HOA, Colvig Silver Camps, Edgemont Ranch Metro District, El Rancho Florida Metro District and the Durango La Plata County Airport. The group has identified the potential sources of contamination in the Florida River drainage upstream of the lowest intake, the Durango La Plata County Airport's infiltration gallery on the Florida River. The group prioritized their contamination concerns and identified best management practices for addressing these concerns. Agricultural runoff was one of the top potential sources of contamination of concern to the group.

In developing this project with the Durango La Plata Airport and their neighbor and lessee Keith Fassbender, AWP has sought and received input and cooperation from both NRCS and the Southern Ute Indian Tribe 319 Program. This coordination will continue for the life of this project.

4.4 Similar Watershed Activities *(Not required for the proposal; do not complete or delete)*

This project will compliment and not duplicate existing efforts. No single entity is promoting action or education at this scale and with a focus on the Animas River Watershed as a whole. Many entities are involved in working on specific geographic areas within the watershed, or specific sources of contamination or habitats for specific wildlife species. Efforts to improve aquatic habitat quality and/or water quality in the watershed are currently being conducted by the Southern Ute Indian

Tribe, the Animas River Stakeholders, Trout Unlimited, the San Juan Public Lands, the NRCS, the Colorado Department of Reclamation, Mining and Safety, and Colorado Parks and Wildlife.

The proposed project compliments these efforts because it is focused on reducing nutrient contributions to the river, issues that most of these efforts are not trying to address. And for projects, such as the Southern Ute Indian Tribe's 319 Program, that are aimed at reducing nutrient and sediment pollution in the river, this project is complementary, not duplicative. Major nutrient and sediment contributions to the Animas River are dispersed and cumulative across the watershed. They are contributed by land uses occurring across a high number of relatively small and often privately owned parcels. Reducing nutrient and sediment loading to the Florida and Animas Rivers will depend on robust action at many different sites, employing a range of BMP's across the landscape. Since this is one of the first projects implemented under the guidance of the watershed-based plan, the intent is to encourage and to leverage additional restoration and protection projects in the watershed with this project as a reference site.

5.0 Evaluation and Monitoring Plan

5.1 Evaluation and Monitoring Methods
The Animas Watershed Partnership will coordinate with the Mountain Studies Institute and the WQCD's Measurable Results Project to create a SAPP to monitor and evaluate the outcomes of the efforts outlined in the PIP. Table 5.1provides a breakdown of how each task associated with this project may be monitored. Finalization of some of the strategies will occur with the initial SAPP. The SAPP will include a strategy for collecting pre-project data to establish baseline condition prior to BMP installation, and will specify measures of success.

Table 5.1

Environmental Goal: Improve water quality and aquatic habitat in the lower Florida River and the Animas River.			
	Target Results	Evaluation	Measures of Success
Objective 1 Reduce nutrient loading by implementing BMPs.			
Task 1	Reduce nutrient loading from irrigated pasture and upland runoff along 1 mile of the Florida River by developing a riparian buffer of native vegetation along this reach and by replacing traditional flood irrigation with sprinkler irrigation.	Nutrient modeling, instream Total N (TKN, NO2, NO3) & Total P load, instream DO, macroinvertebrate and pH monitoring, instream algal coverage monitoring, riparian assessment. Photo points.	N&P reductions (predicted by STEPL if possible), trending toward decreasing load. DO, macroinvertebrates and pH trend toward or maintain standards. Algal coverage trends toward decreasing coverage. One point increase in score of rapid assessment of riparian growth.
Objective 2 Plan and conduct monitoring to assess the effectiveness of BMPs and overall project activities.			
Task 2	Approved SAPP. Committee of technical professionals engaged. Useable, high-quality data.	Coordinate with MRP and MSI to develop SAPP. Data Quality Objectives. Data entry into DSN.	Approval of SAPP. All data achieves Data Quality Objectives. All AWP collected chemical

	Accurate evaluation of project effectiveness	# timely semi-annual reports. WQCD accepted Final Report. $ of additional resources # new stakeholders.	and macroinvertebrate data stored in DSN. All data collected in accord with SAPP (responsible parties, completeness etc.) 5 Semi-Annual Reports, 1 NPS Final Report.
Objective 3 Conduct education and outreach.			
Task 3	1 press release; 1 newspaper article 12 website updates 12 AWP Mtgs 18 AWP Steering Committee meetings 6 Days of young adult “day camp” Additional resources. Additional stakeholder/landowner outreach	# positive newspaper articles on Project/ Partnership. # at AWP mtgs # of visits to website # of new inquiries to AWP	3 positive newspaper mentions by others 18 attendees AWP mtgs, avg. >10 new partners $30K additional resources (beyond currently committed match) Interest in further implementation of BMPs in the area.
Objective 4 Successfully complete the project.			
Task 4	Project tasks completed, Grant contract fulfilled. WQCD, AWP, others informed on progress.	# tasks completed # timely reimbursement statements /progress reports	All tasks 18 reimbursement statements/progress reports,

5.2 Development of Sampling and Analysis Project Plan (SAPP)

A Sampling and Analysis Project Plan (SAPP) will be written and approved prior to monitoring and implementation activities. A draft plan is in development following detailed discussions and an additional site visit over the last few months. This has facilitated more detailed cost estimates for the project budget.

5.3 Monitoring Strategy

The project monitoring strategy employs a weight of evidence approach that monitors chemical, biological and physical parameters (see table 5.1). Where applicable, Colorado water quality standards will be the target endpoints. Trending towards these standards is also considered success given the difficulty in assessing progress over time and the background conditions. For parameters that do not have a standard, decrease in loading or overall decrease in concentration is considered success. Pre-project monitoring, commencing in May 2013 will continue until October 2014. During this time period, the riparian fence will be constructed, yet livestock will be allowed to access to the river to simulate a non- fenced condition. This allows the project 2 field seasons of pre-project assessment. In 2015, the irrigation improvement will be constructed, and no monitoring will take place until spring of 2016. This phase of monitoring will continue for two field seasons and serve as post-construction monitoring. The specific monitoring strategy for this project will be finalized and identified through completion of the SAPP. MRP will assume responsibility for post-construction monitoring outside of the contract period as specified in the SAPP. Overall success of the project will be measured in evaluation of trending of the data sets toward state standards or improving condition.

5.4 Data Storage, Management and Reporting

All water chemistry data and macroinvertebrate will be uploaded to the DSN for storage and automatic upload to STORET. All other data will be stored and managed in Excel spreadsheets or appropriate software in accordance with AWP procedures for data storage and provided to CDPHE MRP. MRP will store these data for comparison to post-project data.

5.5 Data Models

Models to be used in the monitoring and evaluation of this project will be identified in the SAPP. STEPL or another similar model may be used to model nutrient load reductions from BMP implementation.

6.0 Budget

6.1 Budget Tables

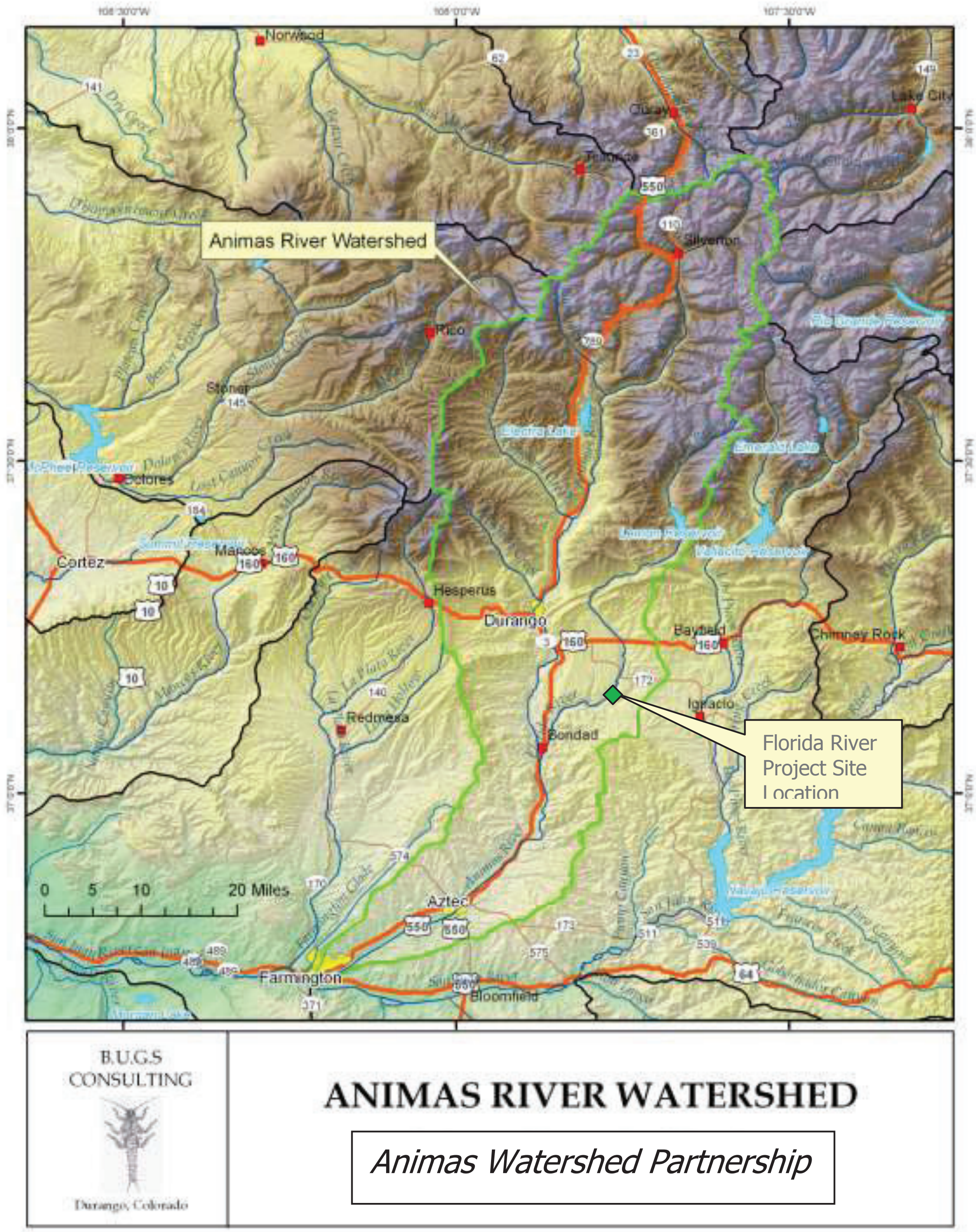
7.0 Public Involvement

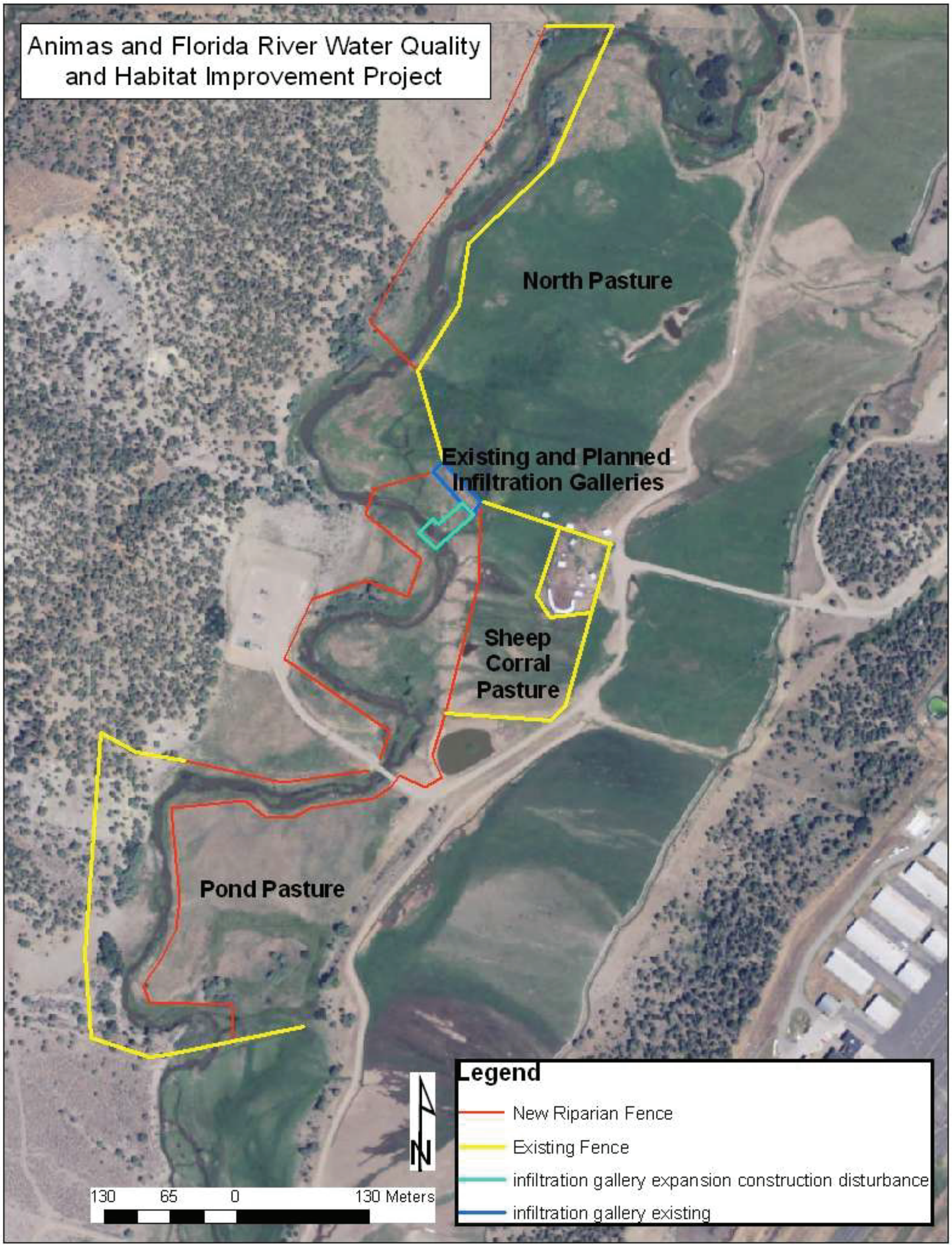
7.1 Process for Public Involvement

To ensure public involvement in the project, the AWP Coordinator will write press releases and inform newspaper articles. The AWP are creating and will regularly update a webpage to be hosted by the SJRC&D, where all meeting notes, presentations, press and data will be accessible to the public. The AWP coordinator will take the lead in planning and advertising quarterly AWP meetings, with invited speakers on topics directly related to nutrient, sediment and microbe monitoring and management within the watershed. All AWP meetings are open to the public and are advertised in via regional newspaper and radio outlets, as well as partner listserves. The AWP will work with community partners including the Southwest Conservation Corps to promote awareness and appreciation of Animas River water quality through day camps with young adults.

Appendix Contents

- 2011 Budget Table
- Project Maps: Watersheds Overview, Site Aerial
- Lead Project Sponsor and Cooperating Organizations


Animas River Watershed
Florida River Project Site Location
Norwood
Ouray
Lake City
Silverton
Rico
Stoner
Dolores
Cortez
Mancos
Hesperus
Durango
Bayfield
Chimney Rock
Ignacio
Redmesa
Bondad
Aztec
Farmington
Bloomfield
0 5 10 20 Miles
B.U.G.S CONSULTING
Durango, Colorado
ANIMAS RIVER WATERSHED
Animas Watershed Partnership


Animas and Florida River Water Quality and Habitat Improvement Project
North Pasture
Existing and Planned Infiltration Galleries
Sheep Corral Pasture
Pond Pasture
Legend
New Riparian Fence
Existing Fence
infiltration gallery expansion construction disturbance
infiltration gallery existing
N
130 65 0 130 Meters

Lead Project Sponsor and Cooperating Organizations

Lead Sponsor			
Agency Name	San Juan Resource Conservation and Development		
Agency Address	954 E. 2nd Ave, Suite 104, Durango, CO 81301		
Role/contribution	AWP Fiscal Agent		
Contact Person	Pam Deem	Telephone	970-382-9371
E-mail address	sjrcd@hotmail.com		

Cooperators			
Agency Name	Durango La Plata County Airport		
Agency Address	1000 Airport Road, Box 1, Durango, CO 81303		
Role/contribution	Landowner, In-kind services		
Contact Person	Don Brockus	Telephone	970-382-6079
E-mail address	brockusdr@ci.durango.co.us		

Cooperators			
Agency Name	City of Durango		
Agency Address	949 East Second Avenue, Durango, CO 81301		
Role/contribution	AWP Steering Committee Member		
Contact Person	Kevin Hall, Assistant Dir. of Community Development	Telephone	970-375-7315
E-mail address	HallKS@ci.durango.co.us		

Cooperators			
Agency Name	City of Farmington		
Agency Address	800 Municipal, Farmington, NM		
Role/contribution	AWP Steering Committee Chair; AWP Participant		
Contact Person	Paul Montoia	Telephone	505-599-1393
E-mail address	pmontoia@fmtn.org		

Cooperators			
Agency Name	n/a		
Agency Address	n/a		
Role/contribution	Landowner Support; Cooperating Lessee; Contractor with in-kind contribution		
Contact Person	Keith Fassbender	Telephone	970-259-7097
E-mail address			

Cooperators			
Agency Name	Mountain Studies Institute		
Agency Address	1315 Snowden St. #305, P.O. Box 426, Silverton, CO 81433		
Role/contribution	In-kind match toward project monitoring		
Contact Person	Aaron Kimple, Project Manager	Telephone	(970) 382-6908
E-mail address	msi.fens@gmail.com		

Cooperators			
Agency Name	Natural Resources Conservation Service		
Agency Address	Ignacio Tribal Office		
Role/contribution	AWP partner, potential funding, landowner partnerships, outreach and education		
Contact Person	Ed McCaw	Telephone	(970) 563-0178
E-mail address	edwin.mccaw@co.usda.gov		

Cooperators			
Agency Name	San Juan Citizens Alliance		
Agency Address	PO Box 2461, Durango, CO 81302		
Role/contribution	In-kind match toward education and outreach program.		
Contact Person	Wendy McDermott	Telephone	(970) 259-3583
E-mail address	meghan@sanjuancitizens.org		

Cooperators			
Agency Name	Trout Unlimited Five Rivers Chapter		
Agency Address	706 County Road 220, Durango, Co 81303		
Role/contribution	Cash match, AWP Steering Committee Member		
Contact Person	Chuck Wanner	Telephone	(970) 259-0075
E-mail address	cwanner@frontier.net		

Cooperators			
Agency Name	San Juan Water Commission		
Agency Address	7450 E. Main Street		
Role/contribution	Animas Watershed Partnership Steering Committee Member; AWP Participant		
Contact Person	Aaron Chavez	Telephone	505-564-8969
E-mail address	achavez@sjwc.org		

Cooperators			
Agency Name	Southwestern Water Conservation District		
Agency Address	841 E. 2nd Ave Durango, CO 81301		
Role/contribution	AWP Steering Committee Member, AWP Stakeholder		
Contact Person	Carrie Lile	Telephone	970-259-5322
E-mail address	carrie@durangowater.com		

Cooperators			
Agency Name	San Juan Watershed Group		
Agency Address	18 Road 4865, Bloomfield, NM 87413		
Role/contribution	AWP Steering Committee Member; Technical support, in-kind Match		
Contact Person	David Tomko	Telephone	505-632-8008
E-mail address	Jtomko73@msn.com		

Cooperators			
Agency Name	n/a		
Agency Address	n/a		
Role/contribution	Private landowner; Animas Watershed Partnership Steering Committee Member		
Contact Person	Diana Luck	Telephone	
E-mail address	good4luck@msn.com		

Cooperators			
Agency Name	n/a		
Agency Address	n/a		
Role/contribution	Private Citizen; Animas Watershed Partnership Steering Committee Member		
Contact Person	Buck Skillen	Telephone	(970)759-2726
E-mail address	fpope@bresnan.net		

Cooperators			
Agency Name	Southern Ute Indian Tribe Water Quality		
Agency Address	PO Box 737, Ignacio CO 81433		
Role/contribution	Animas Watershed Partnership Steering Committee Member		
Contact Person	Sal Valdez	Telephone	(970)563-0135
E-mail address	svaldez@southern-ute.nsn.us		

Cooperators			
Agency Name	Colorado Division of Wildlife and Colorado River Watch		
Agency Address	151 E 16th Ave, Durango, CO 81301		
Role/contribution	In-kind match in the form of River Watch Water Quality Sampling and Analysis		
Contact Person	Barbara Horn	Telephone	970.382.6667
E-mail address	barb.horn@state.co.us		

Lightner Creek Sediment Monitoring & Rating Curve - Phase III

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December 2013

Mountain Studies Institute
SAN JUAN MOUNTAINS, COLORADO

Acknowledgements

Protecting the natural environment, especially water quality and stream habitat, requires a collective effort. There are many partners who provided the financial support for the Lightner Creek Sediment Monitoring Project. Animas River Partnership (AWP) and Mountain Studies Institute (MSI) would like to thank Trout Unlimited, Colorado Water Conservation Board, San Juan Public Lands Center, Basin Hydrology, City of Durango, La Plata County, Colorado Department of Transportation, Colorado Department of Public Health and Environment, and Southwestern Water Conservation District. In addition to the broad organizational support, a range of individuals also provided time, oversight, as well as technical direction and support to the monitoring effort, these people include Mark Oliver, Ann Oliver, Kevin Hall, and Buck Skillen.

Funding for this report was provided by a Colorado Water Conservation Board Watershed Restoration Program grant to the Animas Watershed Partnership. Special thanks also go out to the current and former Mountain Studies Institute interns and employees, and Mark Oliver of Basin Hydrology without whom this project would not have been possible. These folks include Rica Fulton, Tom Grant, and Adrienne Antonsen. We appreciate the work that Basin Hydrology and Mark Oliver conducted on the Phase 1 assessment, and Chris Peltz who oversaw the Phase II assessment effort. Both these reports greatly helped focus our effort and our understanding of the Lightner Creek system. Additionally, we are especially grateful to Colorado Department of Health and Environment for the loan of the automated sampler equipment, Southern Ute Indian Tribe and San Juan National Forest for the loan of discharge meters, and Fort Lewis College for use of their chemistry laboratory. All of these in-kind contributions were central to the sampling effort.

Table of Contents

Executive Summary

The Animas Watershed Partnership (AWP) received funding from the Colorado Water Conservation Board (CWCB) Watershed Restoration Grant Program to sample sediment loads in Lightner Creek during spring and monsoon storm surges and to develop a sediment rating curve. Developing a sediment curve will allow the AWP to prepare for and assess changes to the Lightner Creek drainage. Sediment rating curves are often used to estimate suspended sediment loads where the sampling program is insufficient to define the continuous record of sediment concentration (D.E. Walling 1977) and to identify threshold flows above which sediment is actively mobilized in the water column.

Regional observers have recognized Lightner Creek as a persistent source of water quality degradation in the Animas River because it appears to contribute a large amount of sediment to the river. Sediment loading is a concern because it can influence water temperature, dissolved oxygen, macro invertebrate populations, nutrient availability, and spawning habitat. A group of stakeholders initiated a series of studies to understand the sources and patterns of sediment loading from Lightner Creek into the Animas River. This report is the third phase of an effort to understand the dynamics of seasonal sediment loading as total suspended solids (TSS) by Lightner Creek in the early snowmelt runoff period and during monsoon storms in order to develop a sediment curve.

Two previous studies examined sediment sources; characterized channel conditions to identify potential contributing sub-basins; and quantified the timing and amount of sediment loading into the Animas River (Basin Hydrology 2010, Peltz et al. 2011). Phase II determined that Perins Canyon and the lower reach of Lightner Creek contribute the highest proportion of sediment to the system. Phase II developed a conceptual model of the sediment dynamics for Perins Canyon and Lightner Creek. The conceptual model suggests monsoons and large precipitation events mobilize sediments downslope of Perins Canyon to the confluence with Lightner Creek, where it is stored and transported over time through a series of smaller events to the Animas River (Peltz et al. 2011, pg. 22).

Phase III combined automated sampling to collect suspended sediment and cross-channel measurements to calculate discharge. The sampling site was chosen on Lightner Creek above the confluence with the Animas and below the contributing sub-basins to capture total suspended solids in the system. An automated sampling device (ISCO 1672) was installed and programmed to collect a water sample daily from March through August of 2013. Water samples were filtered in the laboratory and the sediment was weighed (wet and dry). After late July, storm surges proved problematic for the equipment, and for this reason the sampling effort was ultimately discontinued for the remainder of the monsoon season.

The wide range of suspended sediment load across a broad spectrum of low to high flows did not provide a clear relationship that could be translated into a sediment curve. Sampling in 2013 supported Peltz et al. conceptual model (2011). The cycle of sediment loading into Lightner Creek may be described as a heavy sediment load being contributed to Lightner Creek during late summer storms. While some of the load is carried to the Animas River during storm events, a considerable amount of sediment appears to be stored in the low gradient section of Lightner Creek (within 500 meters of the confluence with the Animas River). Stored sediment is then carried into the Animas River during spring runoff and during early summer flow events until the stored sediment is cleared out, by early summer.

Recommendations for further sediment study on Lightner include the need for a permanent, flood-proof monitoring location, the monitoring of sediment movement on the bed of the stream, and GIS assessment of where potential fixes could be implemented within the watershed.

Introduction

Lightner Creek is of concern to the region because of its proximity to designated Gold Medal Trout Waters of the Animas River. The AWP has worked with Mountain Studies Institute (MSI), Basin Hydrology, City of Durango, San Juan National Forest, Bureau of Land Management Tres Rios Field Office, La Plata County, and the Five Rivers Chapters of Trout Unlimited to further understand sediment loading from Lightner Creek. Initial studies examined sediment deposition and identified top sources of sediment in six sub-basins. In response to these studies, the City of Durango developed a catchment basin at the base of Perins Canyon to help mitigate loading from the canyon.

The goal of the Lightner Creek Project is to "reduce the sediment load contributed from Lightner Creek to the Animas River, and improve aquatic habitat and fishing conditions while reducing infilling of water infrastructure." (Basin Hydrology 2010, Peltz et al. 2011). The Lightner Creek Group (San Juan Citizens Alliance, Five Rivers Chapter of Trout Unlimited, City of Durango, and MSI) developed an initiative to better understand the source of sediment in Lightner Creek in 2009. Phase I of the effort located top source areas for contributing sediment and characterized sources of sediment contributions from seven tributary basins (Basin Hydrology 2010). Phase II established that of the six tributaries the lower segment of Lightner Creek below Perins Canyon was more influenced by individual storm events, with intense summer storm events mobilizing the majority of the sediment for the system (Peltz et al. 2011). The objective of this effort, Phase III, was to monitor sediment and stream flows and to develop a sediment rating curve for Lightner Creek above the confluence with the Animas River. Concurrent with these study efforts, the City of Durango installed a sediment basin at the bottom of Perins Canyon in an effort to settle sediment out of the water column before entering Lightner Creek.

Lightner Creek Watershed Context and Assessments

The Phase I assessment of the Lightner Creek watershed, conducted by Basin Hydrology in 2009 (Basin Hydrology, 2010), detailed the geographic extent and soil conditions of the drainages contributing to Lightner Creek. This report describes the Lightner Creek watershed, which encompasses 63.7 square miles, with the highest elevations located on the east slope of the La Plata Mountains at an elevation of approximately 11,500 feet. The watershed discharges to the Animas River in Durango, Colorado just south of Colorado State Highway 160, at an elevation of approximately 6,500 feet.

Soils within the Lightner Creek watershed are comprised of a mix of residuum, alluvium, and alluvial fans derived from inter-bedded sandstone and shale. Badland and Zyme clay loam soils, which contain high percentages of shale, lie within the lower Lightner Creek watershed. The high percentages of fines and the erodibility of the Badland and Zyme soils are notable, as these soils contribute significantly to the sediment found in Lightner Creek (Basin Hydrology 2010). Components of the Archuleta – Sanchez Complex soil also contain soils of similar character as the Zyme clay loam hence this map unit has high potential for high percentages of fines and high erodibility.

Studies conducted by Basin Hydrology and MSI identified likely sediment source locations (Basin Hydrology 2010) and timing of loading (Peltz et al. 2011). In 2010 MSI collected data from six locations along Lightner Creek and at one point on the Animas River just upstream from the confluence with Lightner Creek. Each sampling trip gathered information on dissolved oxygen (DO) (mg/L), temperature (°C), specific conductivity (µS/cm-1), and turbidity (Secchi depth1, cm). The findings of the study suggested (1) that a relationship existed between the snowmelt runoff period (March-May) and the levels of suspended sediment; and (2) that that there is a strong relationship between specific storm events and associated sediment transport from Perins Canyon (Peltz et al. 2011).

Objectives

The Animas Watershed Partnership (AWP) received funding from the Colorado Water Conservation Board (CWCB) Watershed Restoration Grant Program to sample sediment loads in Lightner Creek and develop a sediment rating curve. Developing a sediment curve will allow the AWP to prepare for and assess changes to the Lightner Creek drainage. Specifically, the objective was to understand the dynamics of sediment transport in the early snowmelt runoff period (March- May) and the dynamics of sediment transport during monsoon storms (late July- early September).

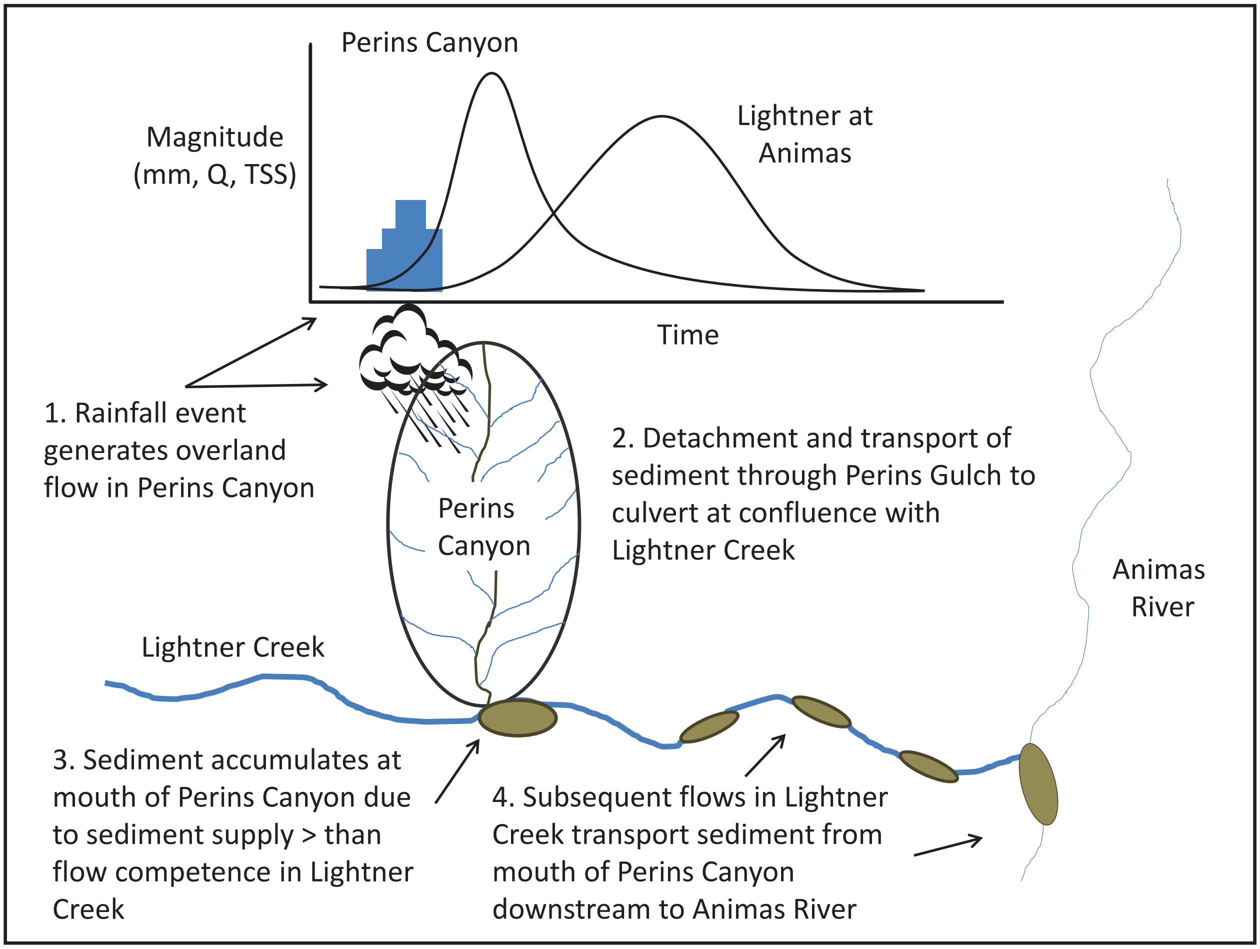
Total Suspended Solids (TSS) is a measure of the wash load within a fluvial system. TSS usually is comprised of material smaller than 2-millimeters (mm) in diameter (Clescerl et al., 1999; EPA, 1971). TSS is an important measure of water quality and landscape condition, as it integrates the amount of erosion and sediment transport within a watershed. The Colorado Department of Public Health and Environment Water Quality Control Commission (WQCC) recognize that excessive salinity and suspended solids can be detrimental to different beneficial water use classifications. In 1993, WQCC established salinity standards for the Colorado River Basin ("Water Quality Standards for Salinity including Numeric Criteria and Plan of Implementation of Salinity Control," Commission Regulation No. 39), but has not yet established standards for suspended solids.

The effect of TSS on aquatic environments and biota are more widely understood (Caux et al., 1997; Wilber and Clarke, 2001) and are similar to turbidity in that excess suspended sediment can have deleterious effects on biota by altering light regimes, thus directly impacting primary productivity, species distribution, behavior, feeding, reproduction, and survival of aquatic biota (Berry et al., 2003).

Sediment rating curves are often used to estimate suspended sediment loads where the sampling program is insufficient to define the continuous record of sediment concentration (D.E. Walling 1977). A rating curve is a graph of discharge versus stage for a given point on a stream, usually at gauging stations, where stream discharge is measured across the stream channel with a flow meter (Herschy, et al 1999). The curve is designed to assess the minimum flows at which sediment becomes actively incorporated into the water column (threshold flow) and at what flows the water column is saturated with sediment. To build the curve multiple measurements of stream discharge are made over a range of stream levels. The process involves 1) measuring the stream characteristics and flow regimes, 2) calculating the amount of sediment that is being carried at given flows, and 3) correlating flows to suspended sediment (sediment in the water column).

In Phase II, Peltz et al. (2011) developed the conceptual model that there is likely a cycle of sediment loading into Lightner Creek. Further the study proposed that the cycle includes a heavy sediment load contributed to Lightner Creek during late summer storms and that deposits sediment on the bed of Lightner Creek and the Animas River at the confluence that can be activated during low flow or spring runoff events until the load is cleared out in early summer (Figure 1). These previous studies determined that Perins Canyon is the largest sediment contributor to Lightner Creek.

The Phase III sampling plan was designed to measure sediment transport, monitor flows, and develop a sediment curve for TSS. This study did not attempt to quantify the potential sediment bedload, i.e. what is creeping downhill along the stream floor that is not suspended in the water column. While it is recognized that bedload also contributes sediment into Animas River, it was beyond the means of this grant to address this component at this time. The sampling equipment was designed for daily collection of samples from the water column and does not offer the ability to sample the movement of the heavier

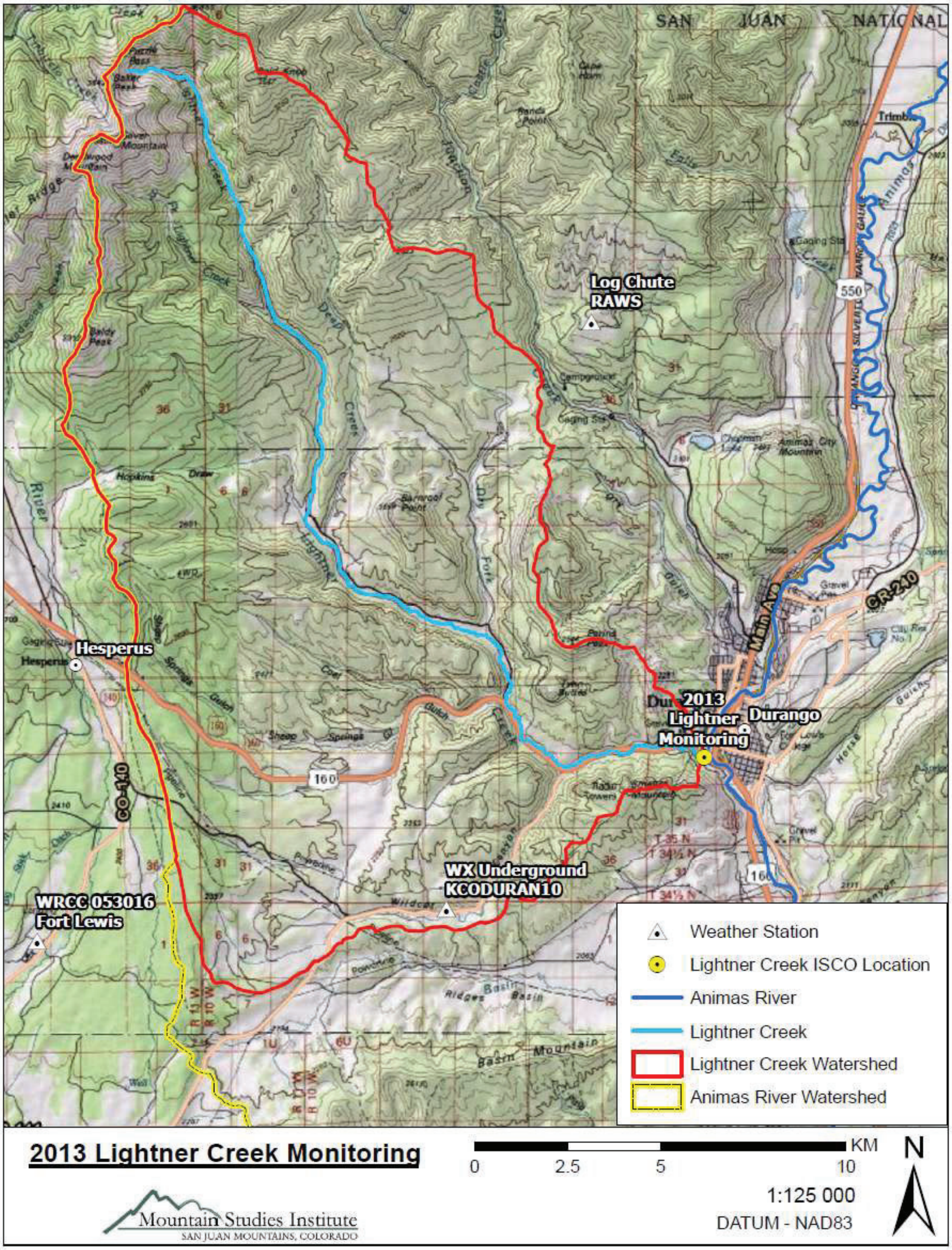


sediment (>2mm) entrained in the creek.

Figure 1: Conceptual Diagram of Sediment Loading. From Peltz et al. (2011). Sediment dynamics model for Perins Canyon and Lightner Creek during summer low flow periods and during/following monsoon precipitation events large enough to detach and mobilize sediment in Perins Canyon downslope to its confluence with Lightner Creek.

Sampling Site

The ideal sampling site was characterized as a location that allowed for the measurement of TSS being contributed to the Animas River from Lightner Creek. Results from previous sampling efforts indicated that the sediment contributions come from sub-drainages to Lightner Creek that have confluences above the Durango Dog Park (Basin Hydrology 2010, Peltz et al. 2011). The sample site for the equipment was chosen on Lightner Creek to be below all major tributaries, including Perins Canyon (Map 1, approximately 100 meters above the confluence with the Animas River). The site was located approximately 20 meters upstream of the bridge that accesses the dog park (very close to the 2011 sampling site). The location was selected because of its uniform channel to moderate flows and stream bottom, bank contours, public access, and proximity to the Animas River. A site further up-stream had been selected for a sampling attempt in 2012 but high flows swept the equipment away from the stream channel. The site location selected in 2013 was intended to offer a more stable location for equipment. Perins Canyon was explored as a complimentary monitoring site; however, field reconnaissance determined that 1) there was not adequate public access to the drainage near the confluence with Lightner Creek and 2) the drainage lacks continuous flow, which would not have worked with the available sampling equipment. The selected Lightner Creek location allowed for the measurement of all sediment contributions to the creek, and thus to the river (Map 2).



Map 1: Lightner Creek Watershed. The Lightner Creek sampling location, and location of weather monitoring stations: Log Chute RAWS from http://www.wunderground.com, Wildcat Canyon Station, and WRCC 053016 Fort Lewis from Western Regional Climate Center.

Map 2: Lightner Creek Sampling Site. Map showing the location of the Lightner Creek sampling location in relation to the confluence of the Animas River and the Dog Park Access Bridge.

Methods

Sediment rating curves are developed by collecting water samples, filtering the sediment, and measuring the dry weight of the sediment in relation to the sample size. These findings are then correlated with a hydrograph developed by measuring stream flow at various stages (very low to very high). The rating curve should demonstrate a "threshold" flow, the flow at which the stream begins to pick up sediment and incorporate it into the water column. The curve then increases until the water column meets maximum capacity, at which point the curve flattens out. The curve is developed by plotting suspended sediment against flow and calculating the curve of fit (D.E. Walling 1977).

MSI installed an ISCO sampler into Lightner Creek approximately 20 meters upstream of the bridge to the Dog Park in Durango, CO. The sampling installation consisted of a stilling well, made from a perforated 5-gallon bucket, secured to a t-post in the center of the stream channel. The large stilling well was designed to minimize turbulent flows around the staff gauge and provide a uniform water column from which to draw the suspended sediment sample. A staff gauge and a sample collection tube for water collection with suspended sediment were also attached to the t-post to secure the equipment mid-channel. The sample collection tube extended to the ISCO, which was secured to vegetation on the northern stream bank. The staff gauge was used to record stream depth when manual discharge measurements were taken. The ISCO collected a 1-liter sample each day, drawing water through the collection tube and depositing it into one of 24 bottles located within the storage area of the ISCO. The ISCO would then automatically pivot the collection tube over the next collection bottle in the rotation. Sample bottles were removed from the ISCO approximately every 2 weeks and the water was filtered in a laboratory. The sediment filtered from the samples was weighed, dried, and weighed again. The weight of sediment was used to calculate TSS (Clescerl et al., 1999; EPA, 1971).

Precipitation and Temperature

Precipitation data was gathered from three established regional weather stations accessible on http://www.wunderground.com/: Log Chute RAWS, Fort Lewis, and Wildcat Station. Data from Log Chute RAWS MTS761 weather station in Junction Creek was used to provide information on daily and monthly weather events in the proximity of Lightner Creek. This station was selected because it is located on the west side of the Animas Drainage in the shadow of the La Plata Mountains (Map 1). Precipitation data was also gathered from the Wildcat Station (weather underground station KCODuran10), located in the Lightner Creek watershed. Historical comparative data was collected from the FORT LEWIS, COLORADO (053016) station from the Western Regional Climate Center - Desert Research Institute Reno, NV page (http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?co3016). This station is located at the old Fort Lewis College Campus in Hesperus Colorado and represents the region west of the Animas River.

The Log Chutes Station and the Fort Lewis stations were selected, in part, because they were used as reference stations for the MSI report of 2011 (Peltz et al. 2011). Selecting these stations offered consistency in comparative analysis of weather conditions for Lightner Creek. The Wildcat Station was added because it is located within the southwestern portion of the Lightner Creek Watershed.

Channel Characterization and Flow Measurement

In order to characterize the channel shape and measure flows at the site, MSI established a cross section in Lightner Creek adjacent to the sediment sampling location (Map 2). The cross section was divided into

1-foot segments. Depth (feet) and velocity (feet per second) were recorded in each segment and summed to calculate a mean discharge (cubic feet per second, or cfs).

Sediment Measurement

Once samples were collected from the ISCO, they were filtered in a laboratory using a hand-powered vacuum pump. Filters were weighed before filtration and after. Filters were then dried and were re-weighed to get dry weight. In some cases multiple filters were required because of the volume of sediment. In these cases the weight of sediment found in each filter were combined. Laboratory analysis of TSS was conducted at Fort Lewis College, using a dry mass method (Clescerl et al., 1999; EPA, 1971) and is summarized as follows:

1. Prior to filtration, a 47mm Whatman© glass fiber filter is weighed.
2. One-liter water samples are remixed by vigorous shaking vigorously for 30 seconds.
3. Mixed samples are filtered through filters, using a suction flask, filter holder and funnel.
4. Filters and residue are placed on an aluminum weighing dish and dried.
5. The equation for determining TSS is:

$$\text{Total Suspended Solid (TSS), mg } l^{-1} = (A-B) \times 1{,}000/C$$

Where:
A = weight of filter and dish + residue in mg
B = weight of filter and dish in mg
C = volume of sample filtered in mL

Results

MSI collected data daily from March through July 2013. The data represents TSS during spring runoff and the early part of the monsoons (Figure 2). Following July, high flows repeatedly interrupted the sampling equipment and prevented data collection during the monsoon season (August and September). Late monsoon data were lost in part because of the complication of keeping equipment in Lightner Creek during high flows (see discussion). The sediment data was used in an attempt to develop a sediment curve associated with the spring runoff. The data offers a range of sediment values for flows that can occur within Lightner, though no clear relationship between flows and suspended sediment was identified.

Precipitation and Temperature

Precipitation and temperature data was gathered for historical averages and compared with 2013 data. When compared with historical data from Western Regional Climate Center Fort Lewis Station (1915 - 2013), data from Log Chute RAWS MTS761 shows that precipitation totals for the months of March, April, May, and June were below average in 2013. July and August were above average in 2013 (Figure 3). Daily precipitation totals from the Log Chute RAWS MTS761 show that there were isolated precipitation events in the spring of 2013. Precipitation events typical of monsoon season began in July and continued through August (Figure 3).

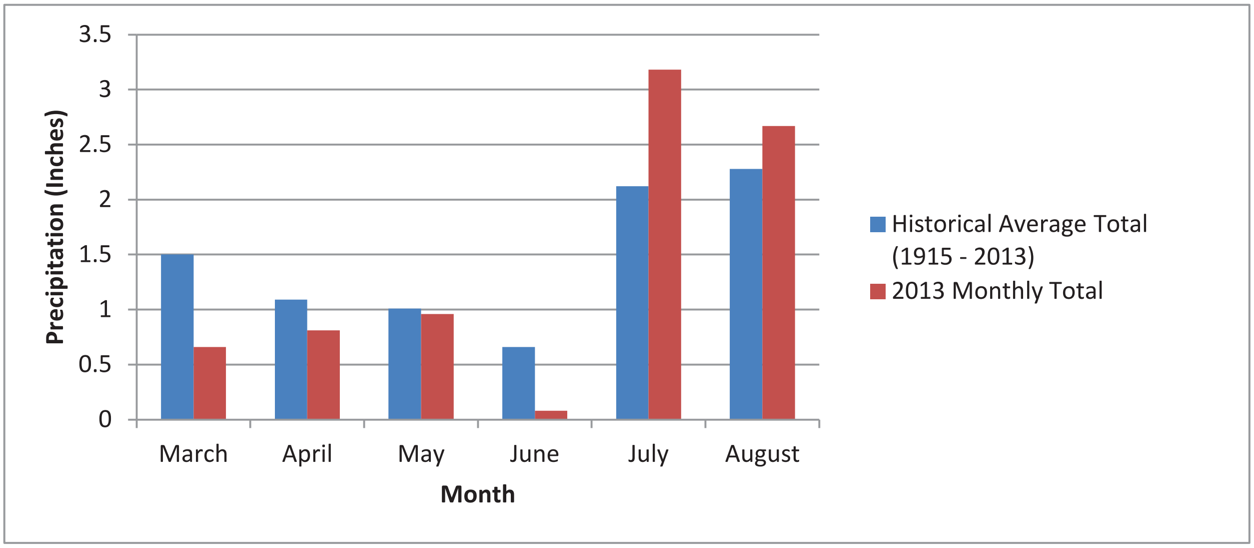


Figure 2: Precipitation: Average Historical Monthly Totals vs. 2013 Compares the average monthly precipitation totals from 1915 to 2013 to the monthly precipitation totals for 2013.

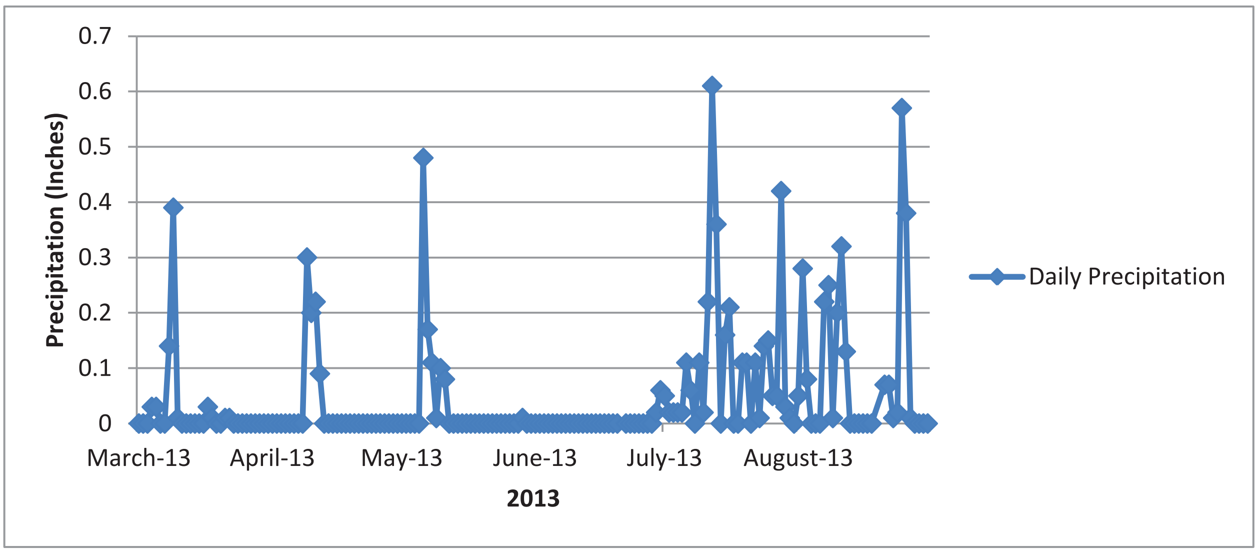


Figure 3: Daily Precipitation Totals: March 1 to August 31 of 2013 (inches).

Channel Characterization and Flow Measurement

The manual stream flow measurements were collected nine times between March 9 and June 20, 2013. The last three measurements collected in June were excluded because the data was suspect after the flow gauge could not be calibrated. The March to June measurements captured a range of discharges between 3 and 12 cfs. Manual stream flow measurements were correlated to stream stage height measurements taken from a staff gage established in the creek at the collection point. The measurements were used to establish a relationship between the stream flow and stream gage. The relationship is expressed through the equation $y = 2.6309x^{0.712}$ with an $R^2 = 0.98736$.

Table 1. Channel Measurements, Width, and Flow

DATE	TIME	WIDTH (Ft)	CFS	Stream gage (In)
3-20-2013	16:25	8	3.0745	6
4-03-2013	9:30	9	5.3407	8.5
4-11-2013	12:00	11.5	8.4183	11.5
4-29-2013	13:30	11.5	11.96125	16
5-03-2013	14:00	11.1	8.9131	13
5-10-2013	11:30	10	8.41175	11.25

Flow measurements were compared to stream gage heights. A strong relationship ($R^2 = 0.98736$) was shown between the two variables. This relationship allows for flows to be calculated from gage heights by using the equation generated by the relationship ($y = 2.6309x^{0.712}$, Figure 5).

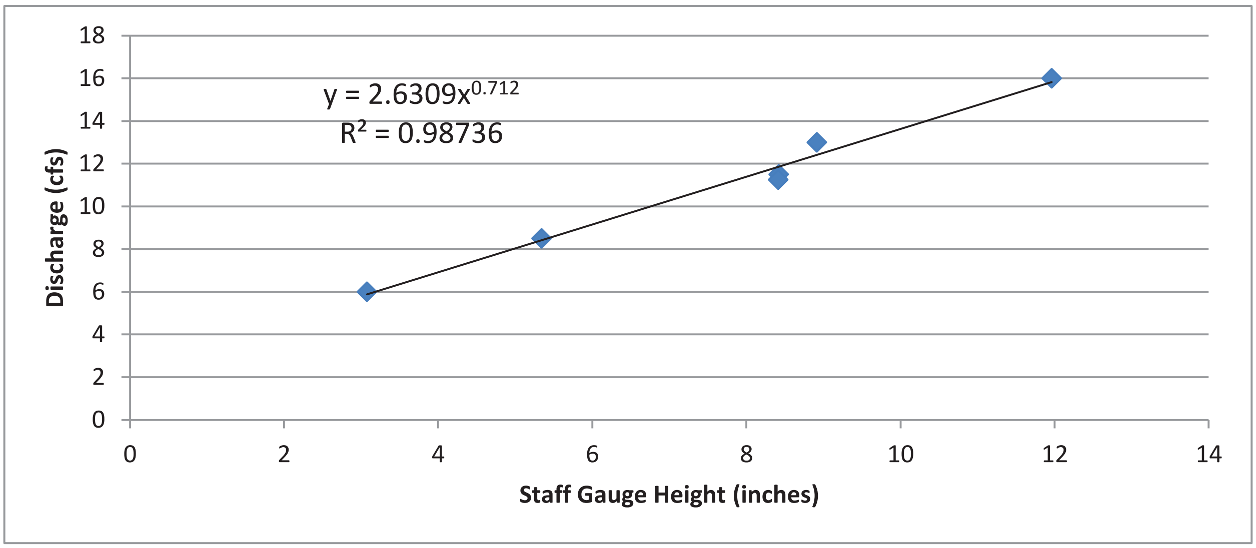


Figure 4: Measured Discharge vs. Staff Gauge Measurements. Stream gage heights plotted against stream discharge in cubic feet per second (cfs).

Sediment Measurement

The ISCO sampler collected a 1-liter sample from Lightner Creek once daily, at 1600 hours from March 21 to August 15, 2013. A total of 118 samples were collected, dried and weighed. There were two periods when data was lost due to issues with the sampling equipment (May 26-30; June 13-14) and one due to high flows dislodging the equipment and carrying it down stream (July 21-August 10). The station was re-established on August 13, however the ISCO was removed from Lightner Creek following August 15 because high flows continued to threaten the equipment.

When TSS is plotted against the daily total precipitation for spring runoff (March to June) no relationship was revealed (R^2 value of less than 0.5). The inability to correlate precipitation events recorded at the monitoring stations in the Lightner Creek watershed with TSS suggests that the pulses of sediment loading are related to snow melt and/ or very localized storms occurring in tributaries that do not have established precipitation monitoring stations. TSS was not determined to be associated with precipitation.

Table 2. Total Suspended Sediment Sample Statistics

Total Number of Samples	118	**Monitoring Period:**	March 21-August 15, 2013
Average (g)	0.620	**Dates of Samples Analyzed:**	3/21-5/26; 5/30-6/12; 6/15-7/21; 8/13-8/15
Minimum (g)	0.006	**Maximum (g)**	15.856
1st Quartile (g)	0.09	**2nd Quartile**	0.142
3rd Quartile (g)	0.50	**4th Quartile**	15.865

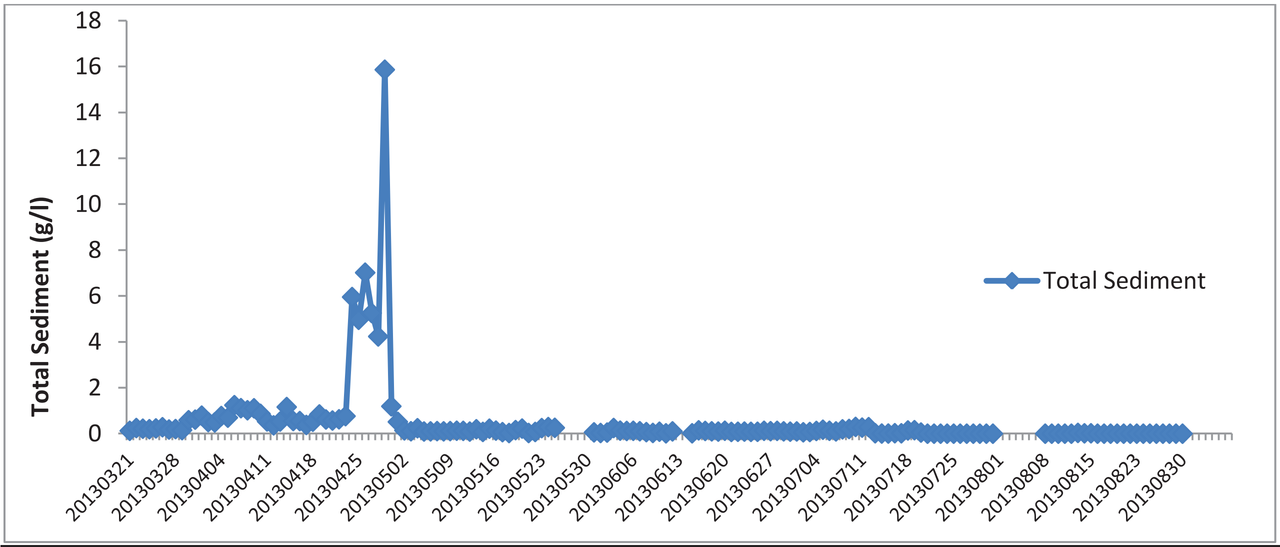


Figure 5: Total Sediment March 2013- August 29. Sediment data plotted over time. The graph shows the extent of data collected, data holes, and sediment load over time.

Sediment Transport

Channel measurements and flow measurements were used to calculate stream flow (cfs) on six days from March 20 to June 20. These data were used to correlate flows to recorded stream gage heights (from the yard stick on the t-post) taken during those sampling periods. A strong correlation (R^2 = 0.98736) was identified between the stream gage heights and stream flow calculations (Figure 4). The resulting equation ($y = 2.6309x^{0.712}$) was used to calculate stream flow from gage height measurements expanding the number of data points incorporated in the calculation of the hydrograph.

From the correlation and additional stream gage measurements, a hydrograph was constructed for the period of time between March and June of 2013 (Figure 7). The hydrograph was plotted against total daily precipitation records for the same period of time. The small sample size for flow does not allow for correlations to be drawn but no relationship was found between cfs from March to June and precipitation events. This suggests flows are most closely associated with snow melt and runoff and/or that the available precipitation gauges are not representing precipitation events occurring in the Lightner Creek watershed.

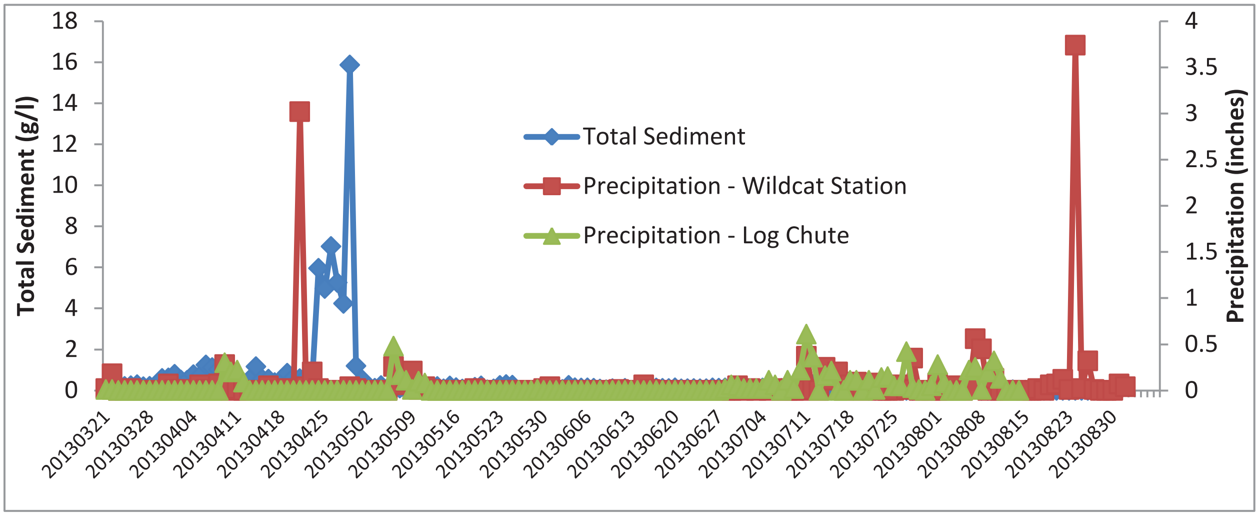


Figure 6: Total Suspended Solids vs. Total Daily Precipitation.

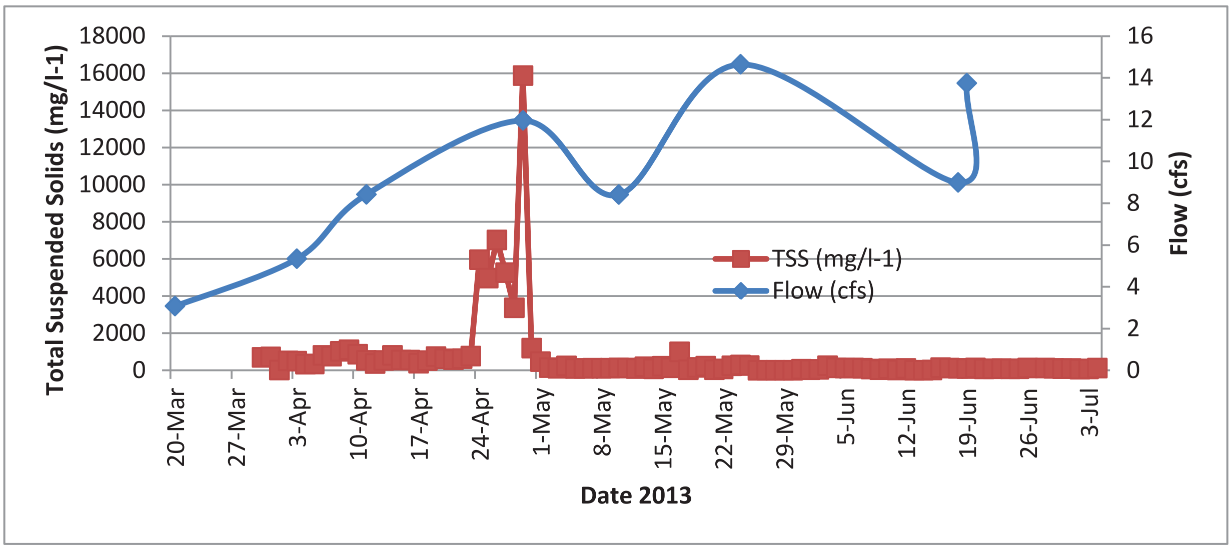


Figure 7: Total Suspended Solids vs. Hydrograph for Lightner Creek, March to June of 2013. Plotting flow (cfs) vs. time. The hydrograph was developed from measurements taken from a manual gage installed at the Lightner Creek sample site. Suspended sediment (mg l^{-1}) during spring flow conditions.

When the hydrograph for the March to June period is plotted with the TSS measurements the results show an initial flush of sediment associated with early snowmelt in the hydrograph (Figure 7). Sediment load is reduced following this flush despite increasing flows (following May 1). Sediment loads for the spring were highest in April of 2013 with a couple of smaller loading events in May. Sediment data is limited to sampling that occurred during spring runoff and pre-monsoon events. The extreme nature of runoff that occurred during the monsoon period made it difficult to maintain equipment required to measure sediment loading.

When plotted, the data shows a wide range of sediment loads (between 1,000 and 12,000 kg/l) for flows in Lightner Creek (Figure 8). Other creeks in the southwest have been shown to have a great degree of variability in sediment load (Ryan et al. 2005). The data gathered was largely collected during periods of high sediment loading. A sediment curve could not be established for Lightner Creek that had a significant statistical relationship. The curve does not suggest a straight forward mathematical relationship between TSS and flow (cfs). It demonstrates that a wide range of sediment loading is possible at a broad spectrum of high and low flows.

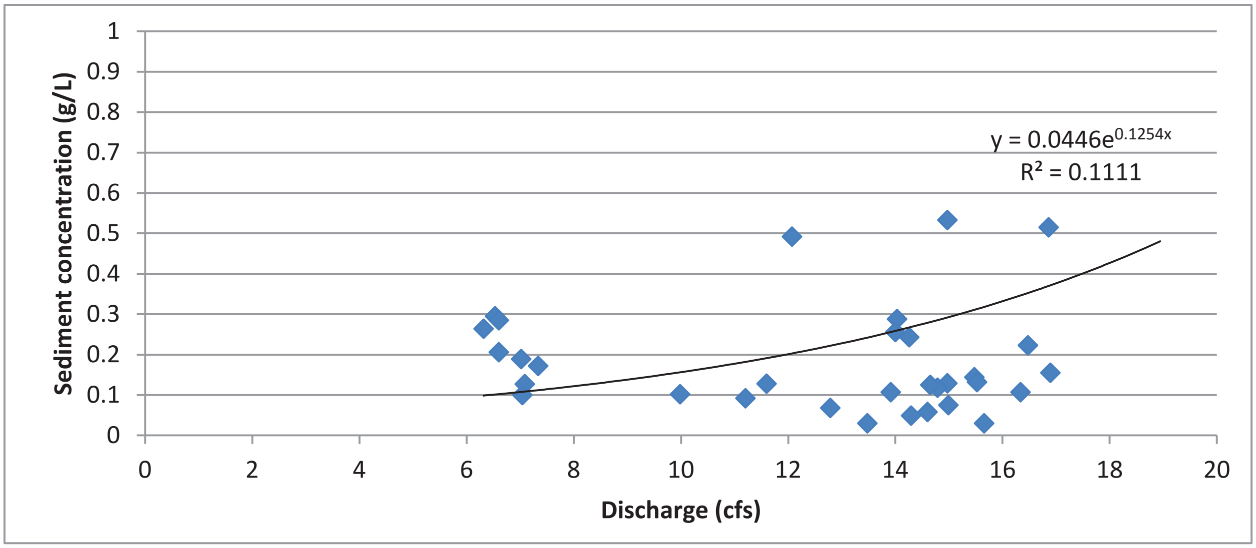


Figure 8: Discharge vs. Sediment concentration - Exponential relationship for discharge plotted against Sediment (R^2=0.1111).

Conclusions & Discussion

Sampling

The automated sampling device (ISCO) was installed within Lightner Creek on March 9 and stayed within the creek until August 24. Other data collection designed to facilitate the study of sediment in Lightner, with an ultimate goal of establishing a sediment rating curve, occurred within that sampling period. Stream channel measurements and flow were taken nine times from March through June of 2013, however three of those measurements were suspect and removed from the study. Stream gage measurement notations occurred up until June 21 of 2013. Because stream gage measurements weren't collected past June, a hydrograph could not be developed for the July to August time frame and the rating curve did not include the monsoonal months.

Precipitation and Temperature

The findings of the study suggest that the spring of 2013 had below average (1915 to 2013) precipitation, while precipitation for the fall was above average. Precipitation measures used in this study included one station within the Lightner Creek watershed and two that were outside of the watershed, in the next drainage to the north, Junction Creek and to the west, old Fort Lewis. Historical averages were provided by the Fort Lewis Station (Map 2). The stations used were selected because of previous reference to these stations (Peltz et al. 2011) and their relative proximity to Lightner Creek.

The data from this study supports the findings of Phase II that suggested that the first flush of the spring runoff carries a large amount of sediment. Eventually sediment is cleared out and TSS was reduced, generally by early summer. Data did not demonstrate a direct correlation between precipitation events during the spring and sediment in Lightner Creek. Ideally, environmental measurements would be taken from within Lightner Creek watershed, specifically in sub drainages identified as major contributors to sediment in Lightner. Storm events can be spotty, effecting small portions of the watershed. Specifically focused precipitation sampling would help to correlate sediment loading with precipitation events in a geographic context.

Channel Characterization and Flow Measurement

On nine occasions between March 9 and June 21, 2013 MSI measured stream cross sections at the established site location, approximately 20 m up-stream of the Dog Park Bridge. Each time stream width, depth and flow was measured, and a reading was taken from an established gage in the stream channel. Of these nine occasions, data from three of the sampling times were removed because the data was suspect. The equipment used to measure flow was found to be giving erratic measurements and could not be calibrated. Statistical significance and correlations increase with the number of stream characterization measurements taken, with a preferred minimum of 10 (Walling 1977). Sampling was spread out so that it included measurements from periods of high and low flows. Depth, width, and flow measurements were used to calculate stream flow in cfs. The lowest flow recorded was 3 cfs and the highest was 12 cfs. A slightly broader spectrum of flows would have given a more thorough picture of the hydrograph in Lightner Creek.

The discharge measurements were correlated with the stream gage measurements so that a quick reading could be taken off the gage that would correlate with cfs. The data gathered was used to develop a hydrograph that could only extend through the period that data associated with flow was collected, that is through June 21. The hydrograph could not be extended any further because no stream gage measurements were taken past that date.

The hydrograph demonstrates the flows in Lightner for the spring runoff. The hydrograph suggests that runoff is composed primarily of snow melt or isolated storm events rather than precipitation events throughout the Lightner Creek drainage.

Sediment Measurement

The ISCO collected a 1 liter sample from Lightner Creek once daily, at 1600 hours. These samples were filtered, the sediment content weighed, and used to calculate Total Suspended Solids (mg/l^{-1}). Despite the programming, there may be some variation in the amount of water that the ISCO collected. The ISCO may not have collected 1 liter every time or water may have been lost in transport (the lids were not secure), and some water may have been lost transitioning between the bottles and the filtering process. This variation was not accounted for in the calculations. Future sediment monitoring should include a measure of the water that was run through the filter.

Sediment Transport

The goal of this study was to develop a sediment rating curve for Lightner Creek. The sediment rating curve for Lightner Creek was restricted to the spring runoff period. This was a result of the difficulties presented by sampling during monsoonal events. Lightner Creek is prone to flash floods. Initial monitoring efforts during 2012 ended when the ISCO sampler was swept from its location by a flash flood. The timing of the event prevented equipment being re-installed until 2013. The delay imposed restrictions on time and money for the research to continue.

During 2013 sampling, MSI did not find a relationship between flows and sediment load and, as a result, were not able to develop a sediment rating curve for Lightner Creek. Data collected during the spring run-off time period (March to June 2013) offered a wide range of sediment load within the stream at a spectrum of flows. The variation in suspended sediment appears to be dependent on the timing of the flow and the amount of sediment that had been deposited on the bed of Lightner during previous high flows. The variations in sediment load observed in Lightner appear to be consistent with findings presented by Ryan et al. (2005) during an assessment of creeks and rivers in Colorado and Wyoming, including the San Juan and Florida Rivers.

High flows made it difficult to adequately secure equipment in Lightner Creek. As a result, a sediment curve was not developed for the monsoon period. In 2012, a high flow event removed the ISCO from Lightner on August 7. High flows on August 10, 2013 again removed the ISCO despite a new location and better securing methods. The ISCO was removed from the stream channel immediately before storm events at the end of August in 2013 that brought flows higher than those that removed the ISCO the first time.

The findings of this study do support the idea that there is a cycle associated with suspended sediment in Lightner Creek. That cycle includes a heavy sediment load contributed to Lightner Creek during late summer storms that may be stored in the bed of Lightner Creek and carried to the Animas River during low flow events (Peltz et al. 2011). This sediment is stored in the lower portions of the creek and in the form of a fluvial fan at the confluence with the Animas River. This study also suggests that spring runoff will carry sediment load at lower flows from Lightner Creek until the stored load is cleared out, usually by early summer. Previous studies determined that Perins Canyon is the largest sediment contributor to Lightner (Basin Hydrology 2010 and Peltz 2011).

In late 2011, the City of Durango installed a catchment basin at the base of Perins Gulch. In August of 2012 a flash flood overwhelmed the catchment basin and large amounts of sediment were deposited in Lightner. This is the same event that washed the ISCO installed in Lightner Creek out of the channel. The results of the sediment event included the development of a large fluvial fan into the Animas. It may be that sediment collected during spring runoff of 2013 was associated with the flash flood that occurred in the fall of 2012.

Accurate sediment curves can be difficult to develop. They have been shown to underestimate sediment load (R.I. Ferguson 1987). Errors of ± 50 percent or more may be associated with many rating curve estimates of sediment load (D.E. Walling 1977). Many variables (rainfall, moisture content of soil, land use pattern, slope factor, soil characteristics etc.) affect sediment load (Özgür Kişi 2007). This is further complicated by the fact that seasonal variations in sediment flux have been shown to be associated with specific conditions at individual sites (Ryan et al. 2005). All this suggests that where and when rain falls within the Lightner Creek watershed, for what duration and at what velocity, as well as the overall condition of soils and vegetation, for a given period of time, will influence a sediment curve.

The correlations between discharge and sediment could be strengthened with increased resources. More modern automated sampling units would allow for sampling to occur with increased flows. It would also provide the opportunity to directly correlate sample collection with flow at sample time. Additionally, the installation of a true "permanent", concreted into the stream channel, stream gaging station would allow for repeatable measurements that can be correlated over a series of years.

Sediment rating curves do miss a component of sediment loading that should be included in future research. Samples collected and analyzed were built around water carried in suspension in the water column. The opening for the collection hose from the ISCO was located as close to the bed of Lightner

Creek as possible (approximately 12.7 mm) while preventing it from sucking up any of the bedload sediment. Heavier sediments will move directly along the bottom of the creek and may not have been included in the development of the sediment rating curve.

Recommendations

The findings of this study suggest that sediment is deposited in Lightner Creek during late summer events and is carried into the Animas River with spring runoff. Addressing the late summer contributions would help to reduce what is carried to the Animas River main stem during the summer low-flow and late summer periods. Both Basin Hydrology (2010) and Peltz et al. (2011) identified Perins Gulch as a primary contributor to sediment in Lightner. Peltz et al. made the following recommendations:

1. Determine the mechanism of sediment transport and expected background level of erosion in tons/year in Perins Canyon.
2. Install sediment reduction technologies, including: biological controls, engineered structures, soil stabilizers, and other erosion control techniques in Perins Gulch.
3. Evaluate the effectiveness of those BMP's for reducing sediment from Perins Gulch to Lightner Creek and the Animas River, including include straw waddles, silt fences, excelsior logs, and vegetation management.
4. Continue to monitor sediment supply and transport in Lightner Creek.

The City of Durango has already installed a catchment basin at the base of Perins. This basin was overwhelmed during a flash flood in August of 2012. Any infrastructure installed should be prepared for large influxes of water and sediment that may occur during dramatic events. Installation of these BMP's and catchments face constraints associated with natural topography and established infrastructure. It is recommended that planning for future development and construction include plans for mitigation measures of appropriate size during initial planning proposals. Other potential sources of sediment can be identified and addressed following the implementation of effective mitigation measure for loads from Perins Gulch.

In order to monitor the effectiveness of mitigation measures, a permanent, concreted or similarly secured, gaging station and monitoring location should be installed within Lightner Creek. Monitoring above the Dog Park Bridge, as the past studies have done, offers an assessment of what is being carried in Lightner with a likelihood of reaching the Animas River. This location could serve as a permanent monitoring station.

The end goal of the project is to reduce sediment influx into the Animas River from Lightner Creek. Three studies have been conducted on where the sediment in Lightner Creek is coming from. The previous studies offer us a reasonable idea of sources. Addressing the problem also requires exploring potential fixes given constraints with property ownership and geography. A GIS assessment that incorporates land ownership and land use within the sub-basins of Lightner could be used to launch development of feasible mitigation measures. Mitigation measures should include creative, new storm water technologies that allow for incorporation of previously unutilized areas (i.e. parking lots) for settling and mitigating silt deposition.

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