RIO PUEBLO DE TAOS WATERSHED BASED PLAN

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List of Abbreviations

AU- Assessment Unit

BLM- Bureau of Land Management

BMP- Best Management Practice

CWA- Clean Water Act

EPA- U.S. Environmental Protection Agency

GIS – Geographic Information Systems

HFRA- Healthy Forest Restoration Act

HUC- Hydrologic Unit Code

NMED- New Mexico Environment Department

NMWQA- New Mexico Water Quality Act

NPDES- National Pollutant Discharge Elimination System

NPS- Non-point Source Pollution

OHV- Off-highway Vehicle

QAPP- Quality Assurance Project Plan

RFPs- Request for Proposals

SSTEMP- Stream Segment Temperature Model

SWQB- Surface Water Quality Bureau

TAS- Treatment as States

TMDL- Total Maximum Daily Load

USFS- United States Forest Service

WPS- Watershed Protections Section

WQCC- Water Quality Control Commission

WQS- Water Quality Standards

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PART ONE - OVERVIEW

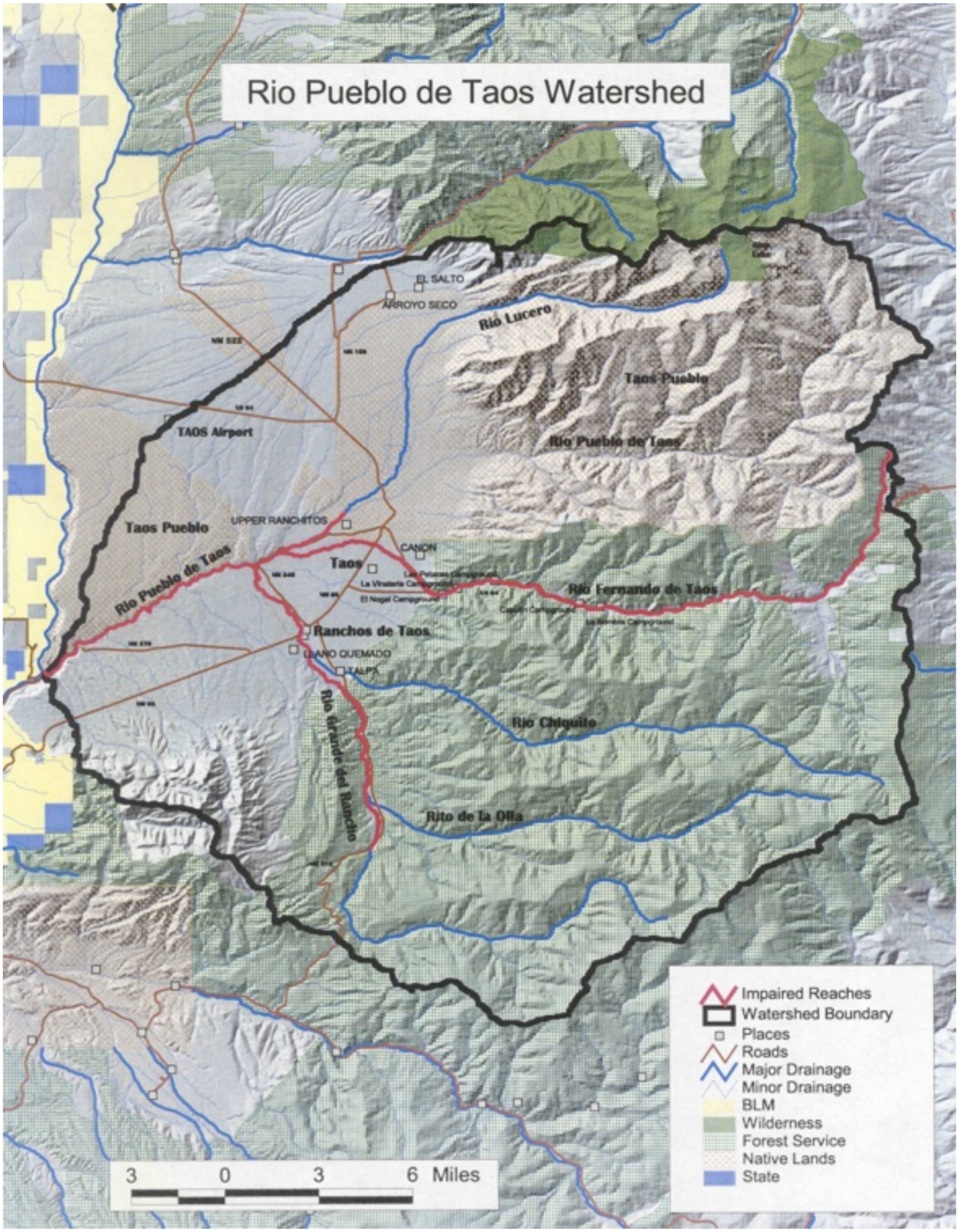
1.1. INTRODUCTION

The purpose of this watershed plan is to provide a roadmap to comprehensive watershed restoration in the Rio Pueblo de Taos watershed. This plan identifies causes and sources of pollution as well as detailed management measures to address that pollution. An implementation schedule is outlined, as are milestones and monitoring mechanisms to help track the restoration process.

Successful implementation of this watershed plan will require a collaborative and many pronged approach and effort. As mentioned below, the planning processes for different pollutants as well as for different subsections of the watershed will be completed through separate but connected processes. This planning document has attempted to incorporate a framework and space for all of these processes.

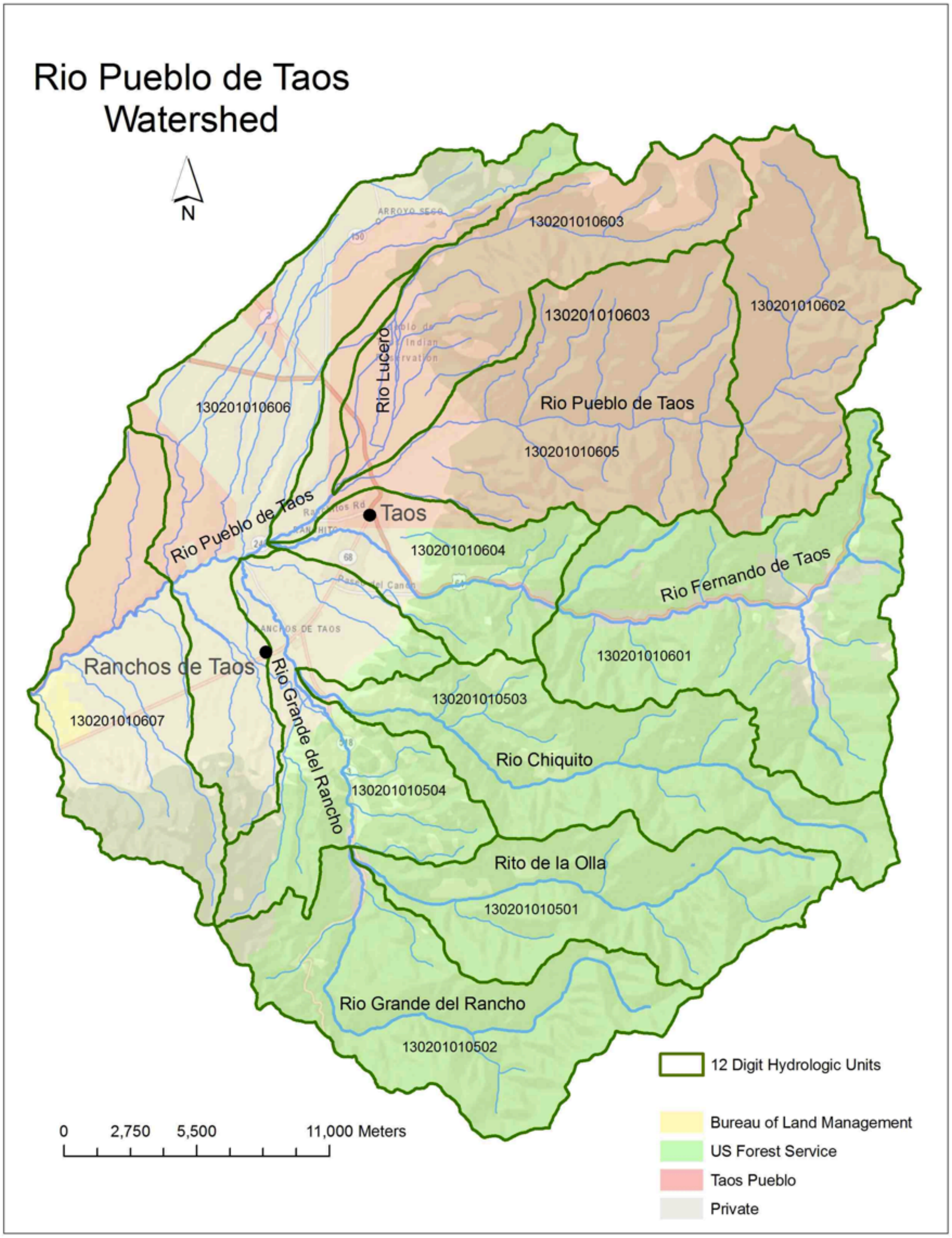
Part one of this document provides some general watershed wide information. Part two of this document is separated into different sections according to subsections of the watershed and different pollutants.

Map 1-1: Map of Rio Pueblo de Taos Watershed



Source: New Mexico Environment Department (Skinner, 2005)

Map 1-2: Map of Rio Pueblo de Taos Watershed – 12 Digit Hydrologic Units



1.2 OVERVIEW OF THE PLANNING PROCESS

1.2.1 SUB-WATERSHED AND POLLUTANT SPECIFIC ORGANIZATION OF DOCUMENT

Comprehensive watershed planning for the Rio Pueblo de Taos has multiple components. The planning process is dictated by timing of impairment status as well and different planning efforts and different planning bodies for different parts of the watershed. Impairment status refers when the New Mexico Environment Department determines when water quality standards are not being met. For example, the non-tribal portion of the mainstem of the river was listed as impaired for Temperature and Sediment in 2002 and for E.coli and Nutrient/Eutrophication in 2012. In addition, the river has two distinct jurisdictional statuses – 1. Parts of the watershed that are owned and controlled by Taos Pueblo and 2. non-tribal portions of the watershed. Of the non-tribal portions of the watershed, there are several tributary streams, several of which are also not meeting water quality standards. Tributaries of the Rio Pueblo de Taos include – Rio Fernando de Taos, Rio Lucero, Rio Grande de Rancho, Rio Chiquito, and Rito de La Olla. This plan has been organized in a manner to facilitate future planning in these tributary systems as well as planning for new impairments as they arise on the mainstem. Taos Pueblo planning efforts for tribal portions of the watershed are mentioned and information about who to contact to request information about that planning process is included. Part Two of this plan incorporates these subwatershed planning efforts and placeholders.

1.2.2 NINE ELEMENTS OF THE WATERSHED PLAN

The Environmental Protection Agency (EPA) has provided a guideline for watershed planning that includes nine minimum elements that must be included in a watershed plan that is funded through federal 319 grant funds. Additional components can be added and planning processes funded through alternative mechanisms could choose to not incorporate one or several of the nine elements. Though it should be noted that on-the-ground funding for restoration funding through the 319-grant program is contingent on an approved watershed based plan that incorporates all of the nine elements. The nine elements include:

1. Identifying Sources and Causes of Pollution
2. Determine Load Reductions
3. Develop Management Measures
4. Develop Implementation Schedule

5. Develop Milestones to Track Implementation
6. Develop Monitoring Component
7. Develop Information and Education Component
8. Identify Resources Necessary to Implement Plan

1.2.3 CLEAN WATER ACT REGULATORY STRUCTURE / 303D LISTING STATUS

The Clean Water Act (CWA) of 1972, which was amended in 1977 and 1987, lays the foundation for the management of water quality in the United States. It is a culmination of over a century of federal water policy aimed directly at preventing water pollution and improving water quality on a national scale. Its primary goal is to achieve a level of water quality that is "fishable and swimmable". While it is an act of Congress, with the U.S. Environmental Protection Agency (EPA) providing administration and oversight of the CWA, it also empowers states to take responsibility for administrative and permitting duties. The CWA was developed initially with the inherent objective "to restore and maintain the chemical, physical, and biological integrity of the nation's waters." In order to do so, it calls upon the states to establish water quality standards (WQS), and monitor compliance and discharges.

Water Quality Standards - Each state begins with establishing water quality standards for the state's waters. The first part of developing water quality standards is adopting designated uses of a watercourse. Designated uses must include all current and existing uses. Examples of designated uses include aquatic life, drinking water, irrigation, and recreation. Specific biological, chemical and descriptive thresholds, or criteria, are then established along with an anti-degradation measure to prevent the watercourses from deteriorating below the standards necessary to support the established designated use. Sections 303(d)/305(b) of the CWA call for bi-annual watercourse assessments conducted by the states. Watercourses not meeting standards for designated uses are categorized as "impaired" and are included on the state's 303 list.

Implementation of the CWA falls under both federal and state environmental agencies. The EPA is the federal agency charged with issuing and enforcing the CWA. To accomplish this mandate, the EPA works in conjunction with state environmental agencies to facilitate implementation of strategies. In New Mexico, it is the Water Quality Control Commission (WQCC), under authority from the New Mexico Water Quality Control Act (NMWQCA), which establishes water quality standards for both surface water and groundwater. The state standards are then subject to approval by the EPA. The WQCC has no technical staff to monitor and enforce state water quality standards and its other duties under the CWA; therefore, it has delegated its responsibilities to the New Mexico Environment Department (NMED).

NMED is the state agency that coordinates with federal, state and local organizations to address water pollution. NMED's responsibilities under the CWA include implementation of water quality standards, monitoring and reporting on the State of New Mexico's waters, creating a list of impaired waters, regulating point-sources of pollution in conjunction with the EPA, creating limits to concentrations and volumes of pollutant inputs and providing financial and technical assistance to private landowners, businesses and municipalities to reduce NPS pollution. The bureau within the NMED that implements these programs is the Surface Water Quality Bureau (SWQB).

Impairment and Total Maximum Daily Load (TMDL) - The New Mexico Environment Department's (NMED) Surface Water Quality Bureau (SWQB) routinely tests water quality in all of the state's waters. If water quality standards are exceeded, then the water body is considered impaired and gets placed on the state's 303(d) list of impaired waters. NMED then drafts Total Maximum Daily Loads (TMDLs) for each water body on this list. A TMDL is a watershed-based allowance for the pollution permitted in a watercourse. It is defined by the U.S. Environmental Protection Agency (EPA) as "a written plan and analysis established to ensure that a water body will attain and maintain water quality standards including consideration of existing pollutant loads and reasonably foreseeable increases in pollutant loads." A TMDL can be established for an entire watercourse or a specific segment. With an emphasis on watershed-based planning for non-point source (NPS) programs, a TMDL cleanup plan that includes implementation of NPS reduction practices is a necessary component of a NPS program proposal. The total maximum daily load documents the amount of a pollutant a water body can assimilate without violating a state's water quality standards. It also allocates that load capacity to known point sources and non-point sources.

Once a TMDL has been drafted for a water body, the New Mexico Environment Department makes that water body eligible to receive 319 monies to address the non-point source pollution problems in the watershed.

Section 319 of the Clean Water Act - Section 319 is the section of the Clean Water Act (CWA) that authorizes programs at the local level, on a watershed scale, to mitigate the effects of non-point source pollution (NPS). Section 319 has three main criteria. First, states must prepare an impairment report, or 303(d)/305(b) report, that documents the state's water quality problems. In this report, impaired waters must be identified along with the categories of pollutants that are contributing to the impairment. Along with this report, state and local programs must be identified that will be utilized in the control of the NPS pollution.

Second, states must develop a management program to address NPS pollution problems identified in their report. This program must identify best management practices (BMPs), local resources to be utilized and a timeline indicating a schedule of implementation for controlling the NPS pollution.

Third, section 319 allocates funding for states through the U.S. Environmental Protection Agency (EPA) to fund programs for NPS pollution prevention and control. The NPS pollution control grants, or section 319 Grants, were created to address NPS pollution through the implementation of state management programs. Congress appropriates these funds annually. The monies go to the EPA, which distributes the funds to states based on a formula including such factors as state population and critical habitat.

NPS program monies from section 319 allow for 10% of the funds to be used for administering a state NPS program. The remaining 90% are distributed in a pass-through grant program that allows other agencies, local governments and non-profit organizations to apply in a competitive process for the monies to survey NPS problems, create outreach campaigns to prevent further NPS and implement practices that will reduce NPS. Much like the federal-state matching funds requirement, 319 grantees must also provide a 40% non-federal funding match. This matching fund can come from a variety of sources including private individuals, organizations, local or state governments and in-kind donations of volunteer time, equipment or space.

Grants are administered under two programs. One for watershed planning and one for on-the-ground watershed restoration projects. To be eligible for 319 on-the-ground funding, an EPA approved watershed based plan, usually completed and funded through the planning 319-grant process, must be in place.

1.3 GENERAL WATERSHED INFORMATION

1.3.1 LAND USE

The Rio Pueblo de Taos Watershed is located in Taos County in north-central New Mexico within the Upper Rio Grande, or Hydrologic Unit Code (HUC) 13020101. The Rio Pueblo de

Taos Watershed covers an area of land draining approximately 400 square miles, entering the Rio Grande at its confluence near Taos Junction upstream from Pilar. Its tributaries include the Rio Chiquito, Rita de la olla, Rio Fernando de Taos, Rio Grande del Rancho and Rio Lucero. The watershed has a rich set of diverse cultural and natural resources, which provide for a unique area in which the land and water are interconnected. Managing the river and the adjacent land is a complex endeavor encompassing a diverse range of stakeholders.

The Rio Pueblo de Taos begins and ends flowing through Taos Pueblo lands, comprising 56% of the watershed. In between, it flows through the Town of Taos and Taos County, including private landholdings, making up 14% of the land, and public lands managed by the Bureau of Land Management (BLM) and headwater tributaries to the east managed by the Carson National Forest of the United States Forest Service (USFS), which comprise of 30% of land in the watershed. Land use in the Rio Pueblo de Taos watershed is 78% forest, 9% agriculture, 7% rangeland, 5% built-up lands and 1% barren tundra (NMED, 2004).

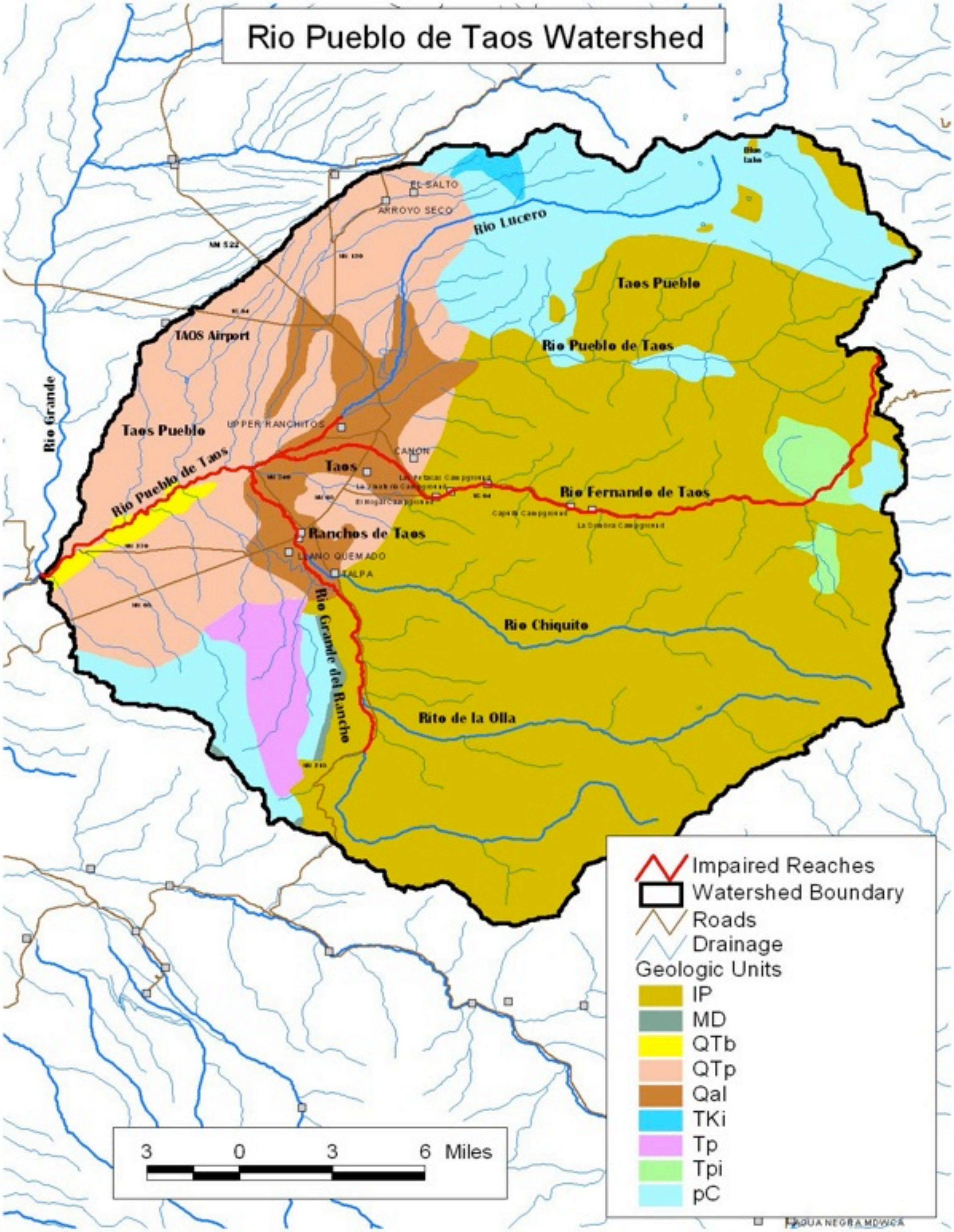
1.3.2 GEOLOGY

The northern boundary of the watershed's geology consists of Precambrian igneous, metamorphic and sedimentary rocks. As the Rio Pueblo de Taos flows southwesterly, it leaves sedimentary rock formations from the Pennsylvanian period of the Paleozoic era in the Sangre de Cristo formation, and enters alluvial gravels deposited in the Quaternary period from the Cenozoic era. These Quaternary deposits are important areas for groundwater recharge. "Quaternary deposits in the Taos area generally are unconsolidated, make up the shallow aquifers, and provide areas for ground water recharge" (Bauer et al. 1999).

The valleys containing fluvial sediments along the Rio Grande del Rancho, Rio Chiquito, Rio Pueblo de Taos and Rio Fernando de Taos are areas of primary importance due to their critical role in providing shallow aquifer recharge. These areas have also been subject to land use practices that have affected both surface and ground water quality and quantity.

The eastern flank of the watershed boundary, the Sangre de Cristo Mountains, parallels the sinuous fault patterns of the Rio Grande rift. As the river flows west and enters the Rio Pueblo de Taos gorge, it flows through igneous and metamorphic mantle-derived basalt rocks that were exposed from volcanic activity during the Cenozoic era, before joining the Rio Grande.

Map 1-2: Geology of Rio Pueblo de Taos Watershed



Source: New Mexico Environment Department (Skinner, 2005)

Table 1-1: Legend for Geologic Units

IP	Undivided Pennsylvanian sedimentary rocks- consists chiefly of poorly exposed, olive, brown, red, and dark gray shale and siltstone plus fine- to coarse-grained sandstone with lesser amounts of conglomerate and limestone
MD	Mississippian– quartz sandstone, local quartzite conglomerate, siltstone, and shale
QTb	Basaltic and andesitic volcanic interbedded with Pleistocene and Pliocene sedimentary units
QTp	Older piedmont alluvial deposits and shallow basin fill
Qal	Stream channel and valley-floor alluvium, and active floodplains (Holocene)- poorly to well-sorted, poorly sorted sand, pebbles, and boulders
TKi	Paleogene and Upper Cretaceous intrusive rocks
Tp	Picuris Formation, undivided (Oligocene)- light gray to pinkish gray, immature, pumice-rich conglomeratic sandstone
Tpi	Picuris Formation, upper member (Oligocene)- light gray to pinkish gray, immature, pumice-rich, sandstone. Consists mainly of sandstones with gravel-sized clasts of pumice and silicic volcanic rocks and minor Precambrian quartzite and intermediate composition volcanic rocks
pC	Precambrian igneous, metamorphic and sedimentary rocks

Source: Bauer and Kelson, 2003; Skinner, 2005

1.3.3 TOPOGRAPHY

The Rio Pueblo de Taos begins in a high alpine environment nearly 13,000 feet above sea level, near Blue Lake. It flows south and westerly through a steep, forested mountain canyon, mountain valleys, piedmont and outwash plains and a gorge cut through basalt layers. It reaches the mighty Rio Grande approximately 30 miles from its headwaters and 7,000 feet below where it begins.

The Rio Pueblo de Taos Watershed belongs to the Southern Rocky Mountain Physiographic Province. This can be characterized by three broad geomorphic categories: 1) the Sangre de Cristo Mountains; 2) westward sloping alluvial piedmont plains and alluvial fans; and 3) basalt areas. The Sangre de Cristos to the east, drain primarily to the west and southwest.

1.3.4 SOILS

The soils in the Rio Pueblo de Taos Watershed range from deep soils in alluvial fans, dunes, terraces and valleys, at an elevation up to 8,000’ that support native vegetation that includes short-mid grasses, shrubs and scattered trees, to deep soils on high mountains, formed in alluvium, colluvium, and residuum, that support native vegetation including mid grasses, shrubs, ponderosa pine, Douglas fir, white fir, Engelmann spruce and sub-alpine fir at the higher elevations in the watershed up to 13,000'. In between, there are shallow soils on basalt mesas, formed from basalt, in eolian sediment and mixed alluvium, which support grasses, shrubs, piñon and juniper at mid-elevations of 6,500' – 10,000', to moderately deep to deep soils on dissected piedmonts, mountainsides, alluvial fans and terraces formed from mixed alluvium, colluvium, and residuum that support native vegetation including mid grasses, shrubs, juniper, piñon and ponderosa pine, Douglas fir and white fir at elevations of 6,800' – 9,800' (Hacker et. al. 1976).

1.3.5 CLIMATE

The climate of the Rio Pueblo de Taos Watershed, the Taos area, and northern New Mexico varies greatly with regard to both precipitation and temperature. "The effects of mountains, elevation, and different north-south weather patterns create a mosaic of arid to sub-humid climates" (Johnson, 2001). Located in the interior of the North American continent along the southernmost tip of the Southern Rockies, Taos has a typical continental climate with significant daily and seasonal temperature gradients. Winters are typically cold and summers are moderate in temperature. Most of the precipitation that reaches the area comes from mid-latitude westerlies from the Pacific, however seasonal variations occur with air masses from the Gulf of Mexico to the southeast also bringing significant precipitation to the area (Whiteman, 2000). Annual precipitation for the town of Taos is averaged over 90 years at 12.29 inches annually (Western Regional Climate Center, 2004). This varies drastically however, between the high alpine environs of the watershed and the lower sagebrush mesas. The Sangre de Cristo range to the north and east of the watershed may receive over 35 inches of precipitation annually, most of it in the form of snow (U.S. Department of Agriculture, 1990). Seasonal variations come in two distinct patterns: winter storms occurring from November to March, and summer monsoons occurring from July to September. Northern Pacific storms tracking over California to the west provide low-moderate intensity storms that result in low elevation rain and high elevation snow showers during the winter storm cycle. These winter storms supply up to 30% of the annual precipitation and supply groundwater recharge from spring snowmelt, which runs off, infiltrating shallow aquifers and replenishing flow to the area's surface water in the spring. Monsoonal storms in the summer months are a result from moisture-laden air masses coming northward from both the Gulf of California and the Gulf of Mexico. As southeasterly flow from the Gulf of Mexico brings moisture inland, surface heating over land and orographic lifting over the mountain fronts causes brief, frequent and intense storms. This seasonal pattern varies over time. Periods of drought have plagued the Southwest for as long as climatic data has been kept. Tree ring research suggests drought is normal for this part of the continent.

1.3.6 HYDROLOGY

The watershed's surface water consists of three major perennial tributaries and many smaller ephemeral ones. The Rio Lucero to the north, originates slightly north of Blue Lake on Taos Pueblo lands, and joins the Rio Pueblo de Taos at the southern most boundaries of Taos Pueblo. The Rio Fernando de Taos begins to the east, in the Sangre de Cristo Mountains on the Carson National Forest land holdings, and flows westerly through several unincorporated communities in Taos Canyon, Cañon and the town of Taos. The Rio Chiquito and Rita de la Olla both join the Rio Grande del Rancho after flowing west from the Carson National Forest and joining the Rio Grande del Rancho in the community of Talpa. The Rio Grande del Rancho continues through Ranchos de Taos and joins the Rio Pueblo de Taos in the village of Los Cordovas. These surface waters are interconnected to the ground water of the Taos area. Quaternary deposits of fluvial sands and gravel allow groundwater recharge to shallow aquifers. In addition, "mountain-stream channel and arroyo-channel recharge are known to be important mechanisms of mountain-front recharge to the ground water systems" (Bauer et al. 1999). Ground water also supplies base-flow to the Rio Pueblo de Taos through accretion at several points along the main stem, although there is mounting concern about municipal and domestic wells drawing down the aquifer and resulting in less water being discharged to the river. Reduced flow has a significant impact on water quality as reduced flow situations often cause a concentration of contaminants. The Rio Pueblo de Taos, as part of the Upper Rio Grande, provides water resources to the rest of the state and to Texas and Mexico.

1.3.7 TAOS PUEBLO

For longer than human memory and before recorded history, Taos Pueblo has made its home in the Rio Pueblo de Taos watershed. Blue Lake and the Rio Pueblo de Taos are sacred to the Pueblo of Taos. Tribes, under section 518 of the CWA, may assume regulatory authority of certain programs. This right was established as an amendment in 1987 to the CWA allowing the U.S. Environmental Protection Agency (EPA) to treat Indian tribes as states, or similar to states (TAS). Tribes, under section 518, may seek "primacy" from the EPA to administer and implement programs, including the implementation of more stringent water quality standards, within their borders (Royster, 1999). However, TAS is a recognition based on a case-by-case basis. TAS allows for applications of tribes to administer a CWA program, such as the National Pollution Discharge Elimination System (NPDES) permitting system, or apply for a variety of funding opportunities available to states (Cutler, 1999). Taos Pueblo received TAS status in December, 2005. Taos Pueblo's Water Quality Standards were approved by EPA in June of 2006. Taos Pueblo is in charge of all planning and action related to their portions of the watershed.

1.3.8 ACEQUIAS

As the Rio Pueblo de Taos flows beyond the boundaries of Taos Pueblo, it becomes an arterial waterway for Spanish acequia systems, or irrigation ditches. When the first Spanish settlers arrived in the Taos Valley, they built small communities along the Rio Pueblo de Taos and engineered a complex irrigation system, modeled both after irrigation ditches at Taos Pueblo and those of the Old World that incorporated agricultural, economic, political, religious and social systems into the development and implementation of the acequia, considered to be the backbone of traditional Spanish culture in New Mexico to this day (Rivera, 1998).

Surface water diverted from the Rio Pueblo de Taos and its' tributaries in the watershed provide water to the acequias which transport it to fields for crops. More than 400 years after the first acequia system in Taos was developed, over 22 ditch associations still thrive along the Rio Pueblo de Taos, providing irrigation water to traditional farmers and ranchers throughout Taos and the outlying rural villages of Ranchos de Taos and Los Cordovas (Potter, 2001).

PART TWO – SUB-WATERSHEDS

2.1 TAOS PUEBLO PORTIONS OF RIO PUEBLO DE TAOS

Taos Pueblo as a sovereign nation has sole access to all documents related to their portions of the watershed. For more information about Taos Pueblo's ongoing work to protect and restore the Rio Pueblo, contact either the Taos Pueblo's Governor's office or the Taos Pueblo War Chief's office at 575-758-8626.

2.2 THE RIO PUEBLO DE TAOS - MAINSTEM (NON-TRIBAL PORTIONS) FROM TAOS PUEBLO BOUNDARY DOWNSTREAM TO RIO GRANDE (TEMPERATURE AND SEDIMENT)

* Note this portion of the planning document is addressing the both the temperature impairment and sediment impairment. During the planning process, the sediment impairment for the middle section of the Rio Pueblo de Taos was removed, yet many stakeholders believe that the river will be listed once again for sediment impairment due to no observed improvement in sediment loading and better assessment data. Further planning is needed for the additional impairments of E.coli and Nutrient/Eutrophication Biological indicators that were added in the 2012-2014 303d listing cycle. In addition, this portion of the plan does not address any impairments that may have been added since 2012.

2.2.1 DESCRIPTION

This portion of the watershed-based plan addresses the non-pueblo stretch of the mainstem of the Rio Pueblo de Taos. The New Mexico Environment Department (NMED) divides this stretch into three separate assessment units or AUs: 1. The Rio Pueblo de Taos from the Taos Pueblo Boundary downstream to the confluence with the Rio Grande del Rancho (AU NM-2120.A_511) which is not meeting the High Quality Coldwater Aquatic Life or the Primary Contact designated uses; 2. The Rio Pueblo de Taos from the Rio Grande del Rancho downstream to the Arroyo del Alamo (AU - NM-2119_30), which is not meeting the Coldwater Aquatic life designated use; and 3. The Rio Pueblo de Taos from the Arroyo del Alamo downstream to the confluence with the Rio Grande (AU- NM-2119_20), which is not meeting the Coldwater Aquatic Life Use. For purposes of this plan we have labeled the sections as follows:

Upper Section – Rio Pueblo de Taos from Taos Pueblo Boundary down to Rio Grande del Rancho

Middle Section – Rio Pueblo de Taos from Rio Grande del Rancho downstream to the Arroyo del Alamo

Lower Section – Rio Pueblo de Taos from the Arroyo del Alamo downstream to the confluence with the Rio Grande.

To locate the boundaries of what we are calling the Upper, Middle, and Lower Sections of the river please see Map 2-1. The Upper Section consists of all sites that start with AU1, the Middle Section consists of all sites that start with AU2, and the Lower Section consists of all sites that start with AU3. In addition, map 2-3 delineates the sections the Upper, Middle and Lower Sections in shades of green and blue. The Upper Section is in light green, the Middle Section is in darker green and Lower Section is depicted in blue.

The mainstem of the Rio Pueblo de Taos that is included in this part of plan starts at the Taos Pueblo Boundary near the crossing with Paseo del Pueblo Norte just north of the center of the Taos. It flows through a heavily treed part of Taos and gets progressively more rural as you move downstream. There are three main perennial tributaries to the Rio Pueblo de Taos in the non-pueblo stretch of the river– The Rio Lucero, The Rio Fernando de Taos and the Rio Grande del Rancho. In addition, there are several large arroyo systems that also drain into this stretch of the river. About halfway down the middle section the river starts to enter into a canyon type topography. The lower section is in a deep canyon with very hard access.

2.2.2 CAUSES OF IMPAIRMENT

NMED defines probable causes as the parameters and/or constituents that are causing non-attainment of the noted designated uses (water quality standards). See Section 1.2.3 for an overview of water quality standards including designated uses and criteria. Simply put, causes of impairment are the pollutants that are present at levels that cause non-attainment of water quality standards.

Upper Section Causes of Impairment

The upper section is listed as not meeting either the High quality Coldwater Aquatic Life designated use or the Primary Contact designated use. The listed probable causes of impairment are Temperature and E.coli (page 160 of the 2012-2014 303d list)

Middle Section Causes of Impairment

The middle section is listed as not meeting the Coldwater Aquatic Life designated use. The listed probable causes of impairment are Temperature and Nutrient/Eutrophication Biological Indicators (Page 159 of the 2012-2014 303d list). Note in previous listing cycles this segment was also listed as impaired for sediment.

Lower Section – Causes of Impairment

The lower section is listed as not meeting the Coldwater Aquatic Life designated use. The listed probably causes of impairment are Temperature and Nutrient/Eutrophication Biological Indicators (Page 161 of the 2012-2014 303d list).

This plan focuses on the Temperature Impairment in all three sections of the Rio Pueblo de Taos. The other impairments were added after the initiation of this current planning process. This plan also provides some information on the previous sediment impairment, which has been recently been delisted as a cause of impairment (see Section 2.2.6 for more on sediment impacts and management measures). Another planning document will need to be prepared to address the E.coli and Nutrient/Eutrophication impairments.

NMED's considers the high quality cold water aquatic life standard (which is what applies to all three segments of the Rio Pueblo de Taos) to be exceeded when instantaneous (hourly) temperature exceeds 23.0°C (or the segment-specific maximum temperature) or temperatures exceed 20.0°C (or the segment specific 4T3 temperature) for four or more consecutive hours in a 24-hour cycle for more than three consecutive days (4T3). (SWQB 2011)

So the water is too hot, why should we care?

The warmer the water, the less dissolved oxygen it contains. Fish need dissolved oxygen to breathe. Trout in particular need more dissolved oxygen than other fish. When water gets above 20°C (68°F) trout have trouble surviving. Basically, we should care about too warm rivers because when rivers get too warm, fish die.

2.2.3 SOURCES

NMED defines probable sources as those activities that may be leading to non-attainment of the noted uses (water quality standards). See Section 1.2.3 for an overview of water quality standards including designated uses and criteria. This section includes both the probable sources that are listed in New Mexico 305b/303d Reports and those that were identified by stakeholders during watershed meetings both during the current process 2010-2012 and during the previous Watershed Based Plan development process 2004-2005. The TMDL does not establish maximum acceptable loads for individual sources or source activities of nonpoint source pollution, and nor does it establish quantitative load reduction goals for them.

2.2.3.1 Segment Specific Sources

Upper Segment - Probable Sources of Impairment

The 303d list describes the probable sources of impairment of the upper section of the river as Habitat Modification (other than hydro modification), Loss of Riparian Habitat, Rangeland Grazing, and Source Unknown. Stakeholders have identified car washing in the river, filling in of arroyos for development, septic tanks, illegal dump sites, stormwater runoff from construction sites, decrease in base flow of the river

Middle Segment- Probable Sources of Impairment

The 2012 – 2014 303d list describes the probable source of impairment of the middle section of the river as Source Unknown. The 2010-2012 303d List describes the probable source of impairment of the middle section of the river as Crop Production (Crop Land or Dry Land), Highway/Road/Bridge Runoff (non-construction), Highways, Roads, Bridges, Infrastructure (Non-Construction), and Rangeland Grazing. Stakeholders during watershed meetings have identified tires in the river, channelization by landowners, decrease in base flow, and old dump sites as addition potential sources of impairment.

Lower Segment – Probable Sources of Impairment

The 303d list describes the probable sources of impairment for the lower section of the river as Flow Modification from Water Diversions, Habitat Modification (other than hydro modification), Other Recreational Pollution Sources, Rangeland Grazing, and Source Unknown. Stakeholders during watershed meetings have identified development along the canyon rim, roads from subdivision projects, decrease in base flow, old dump and new dump sites, and runoff from the old road down the canyon as other potential sources of impairment.

2.2.3.2 Watershed Wide Potential Sources of Pollutants

NPDES Permits

Town of Taos Wastewater Treatment Plant (found in the middle segment)

NPDES Permit No. NM0024066 – administered by the Environmental Protection Agency with input from the New Mexico Environment Department. From 2000 until 2011, EPA has noted a series of ongoing violations by Town of Taos for incomplete reporting in their Discharge Monitoring Reports (DMRs) and exceedences of effluent limits. A new permit was issued on September 1, 2012. This new permit expires on August 31, 2017.

The plant is not required to measure temperature as part of the permit requirements, but there are concerns that the effluent may be a source of temperature in the Rio Pueblo de Taos. The wastewater treatment facility discharges into an arroyo that then flows for about a quarter of mile before emptying into the Rio Pueblo. Sampling in the arroyo by Water Sentinels and Amigos Bravos show that the temperature in the arroyo in always higher than other sites in the Rio Pueblo de Taos watershed see Table 2-5. This had not been flagged as a major issue since sampling typically occurs between 8:30am and 10:30am when all the temperature readings have been well below standards until a sample in July of 2012 showed a temperature reading in the wastewater arroyo of 21.2°C, which is above the standard that applies to the Rio Pueblo de Taos (20°C.)

More sampling of temperature both as the water leaves the wastewater treatment plant as well as in the arroyo needs to be conducted. This sampling needs to be more comprehensive then the single temperature reading in the morning hours that is currently conducted by the volunteer monitoring efforts of Amigos Bravos and Water Sentinels of Taos.

Construction and Industrial General Permit (all segments)

Erosion and runoff from construction and industrial sites could be a major source of pollution for sediment. There are also connections between excess sediment and increased temperature. The more sediment in a river the shallower and wider it can become causing more surface area to be exposed to solar radiation. Construction and Industrial activities are covered under a general NPDES permit. Facilities apply for coverage under these general permits in a notice of intent (NOI) process. There are currently 85 active construction NOIs in Taos County (though this data is only current through the end of 2011 because at the time of the drafting of this document the 2012 EPA NOI database was still under construction). In addition, this number may be quite a bit greater than the actual number of active permitted sites since many of these active NOIs date back up to 7 years ago and presumably some or most of these older projects have completed and the contractor has simply neglected to close out the permit. There are 8 active industrial stormwater NOIs in Taos County. Activities of these 8 facilities range from wastewater facilities, mining, to auto salvage yards. It is important to note that this data is for the whole of Taos County and the Rio Pueblo de Taos watershed is just a small component of the county. Yet it is also important note that the Rio Pueblo de Taos watershed does include the most densely populated area in the county, so presumably many of the construction permits at least would most likely fall in the Rio Pueblo de Taos watershed.

Amigos Bravos has historically been concerned about the number of construction sites that have not obtained permit coverage. This has been an especially big concern since the middle stretch of the Rio Pueblo de Taos was previously listed as impaired for sediment. While the sediment impairment as been officially delisted as of the 2012-2014 303d listing cycle, Amigos Bravos and other stakeholders in the watershed continue to think that sediment impairment is still a substantial problem in the watershed. Assessment and modeling of arroyos and their sediment contributions has been included later in this planning document. Lack of permit coverage, which is a Clean Water Act violation, has been rampant across the county. Several years ago Amigos Bravos sent out a letter to all listed contractors in Taos County informing of CWA stormwater permit requirements. In addition, Amigos Bravos has reached out to both Taos County and the Town of Taos to educate their staff about stormwater permit requirements.

A list of the active NOIS can be found on the following EPA website:
http://cfpub.epa.gov/npdes/stormwater/noi/noisearch.cfm

Canopy
Lack of canopy was identified both in the TMDL and by watershed stakeholders as the major source of temperature impairment. Canopy cover in the upper segment was identified by stakeholders as relatively good and this is confirmed by Google earth and county wide high definition aerial photos. Improvement in canopy in the middle and lower sections was identified both in the TMDL and by stakeholders as a necessary. The TMDL also identifies a need for substantial increase in canopy in the upper section, which was not confirmed by our observations, stakeholder input, and the data that was gathered. The source for lack of canopy is grazing. Predictably the areas with the most ongoing grazing (lower portion of Upper Section and upper portion of Middle Section) are the areas that have the highest levels of ongoing grazing.

Grazing
Grazing (both historic and current) is the primary source of lack of canopy along the river. Historic grazing occurred all along the river. In recent decades grazing has been drastically reduced in the lower portion of the Middle Section and all of the Lower Section. The Upper portion of the Upper Section has also seen a drastic reduction in grazing as more

development has occurred along that segment of the river. Grazing continues along the lower portion of the Upper Section (sites AU1S5 and AU1S6) and the upper portion of the Middle Section (sites AU2S1 and AU2S3). See Map 2-1 for site locations.

Flow

There are numerous acequia diversions in both the Rio Pueblo de Taos and it's tributaries (Rio Lucero, Rio Fernando, Rio Grande del Rancho). These diversions result in a substantial reduction in flow in the river, which can result in increased water temperature. Specifically, decreased flow has the potential to increase daily temperature peaks because solar radiation is applied over less depth in a shallower stream, causing a larger temperature increase.

Roads

Roads can be a major factor in contributing sediment to river systems, especially if they have not been installed with proper drainage features. More information about the sediment impacts on the Rio Pueblo de Taos can be found in Section 2.2.6.

Changes to Channel Structure

Channel restoration has the potential to improve both Temperature and Sediment Loading in the river. Over time, the Rio Pueblo de Taos has been modified and the channel moved to the northern edge of the valley to create more land for irrigated agriculture. The channel has also become wider and shallower over time due to land management practices.

2.2.3.3 Data Gathering and Analysis on Sources

Canopy

The TMDL (SWQB, 2004)) identifies the percent shade for the three segments of the Rio Pueblo de Taos as follows:

Table 2-1 - TMDL Canopy Figures

RIVER SEGMENT	**% CANOPY**
Upper Segment (AU NM-2120.A_511)	7%
Middle Segment (AU - NM-2119_30)	5%
Lower Segment (AU- NM-2119_20)	16%

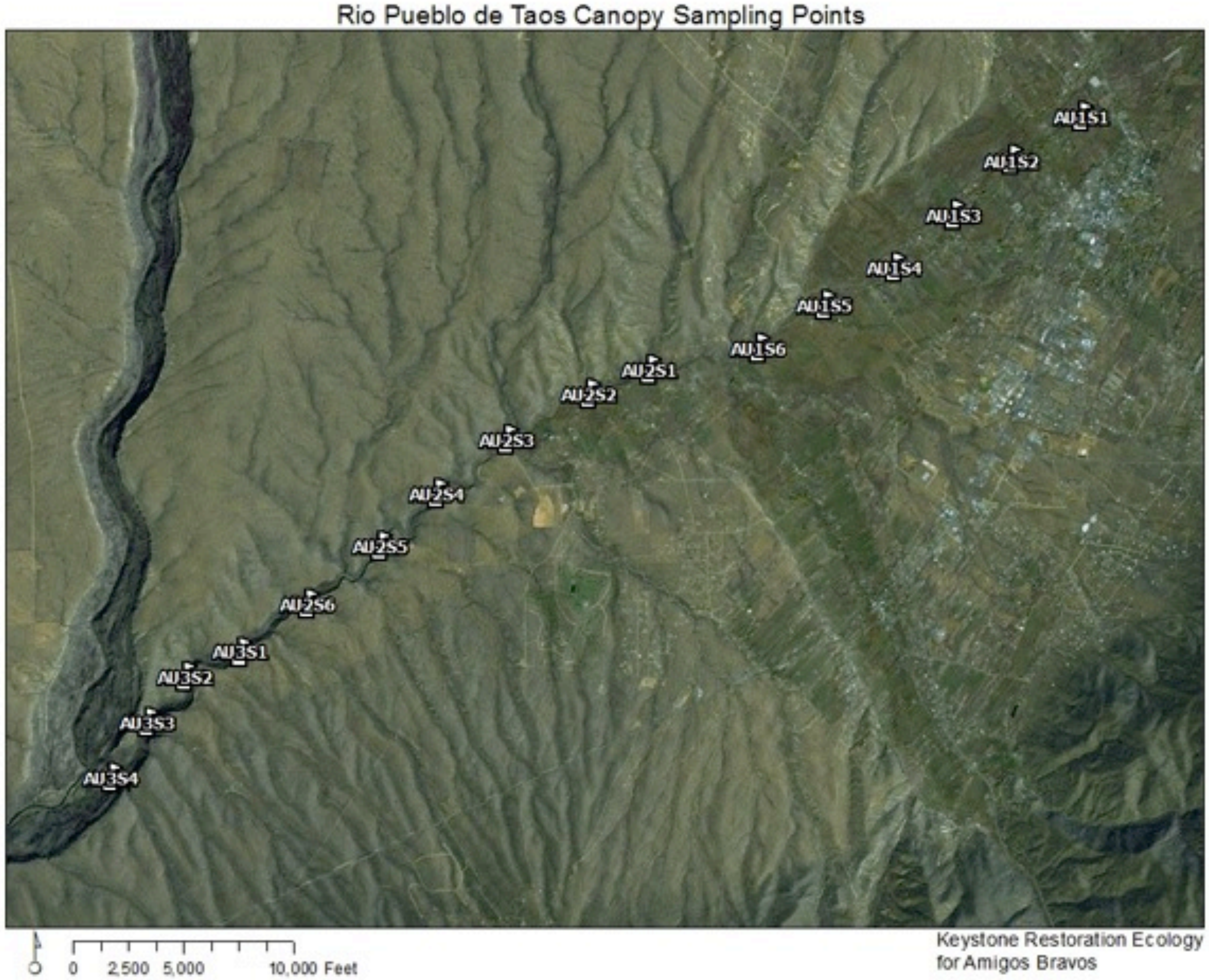
Watershed stakeholders, including Amigos Bravos, did not feel that these numbers were reflective of the actual shading of the river. Early in the planning process watershed stakeholders identified measuring the canopy through use of a densiometer as a priority.

Amigos Bravos contacted NMED to find out what method was used to determine shading in the development of the TMDL. NMED sent us information about what equipment they use (a concave spherical densiometer) and the associated field protocols and data sheets (Appendix A). Amigos Bravos ordered the same model of densiometer and Amigos Bravos staff and stakeholder volunteers joined NMED staff on the Rio Pueblo for training in use of the densiometer.

Densiometer Training with NMED

At first an attempt to take field readings from a few select sites as references and then use high definition aerial photography of the river to create a method for determining canopy from the photos by comparing to these reference sites. Unfortunately we were not able to make a strong enough correlation between field readings and the aerial photography to give us a reliable percent canopy to input into the SSTEMP model. Instead, Amigos Bravos staff and many watershed stakeholders spent several months gathering densiometer readings in the three segments of the Rio Pueblo de Taos. Sites were chosen by evenly dividing up the upper and middle segments into 6 portions each and the lower segment into 4 portions. The reason the lower segment of the river was only divided into 4 segments was because of concerns about access and safety in the steep canyon of the lower part of the river. It was also determined that because of the steep nature of this part of the canyon management measures were going to be difficult if not impossible to implement. The segments were divided as described via GIS see Map 2-1 for map of sites. As work on this watershed based plan progressed it became obvious that NMED had delineated the AUs differently then Amigos Bravos' interpretation of the AU description. See section 2.2.5 for more details and for a map (Map 2-3) showing the differences in delineation of AUs.

Map 2-1 – Map of Canopy Measurement Sites



GPS coordinates for each portion were written down and staff and volunteers then headed out with a GPS device in hand to get as close to possible (pending landowner approval) to these sites. All the sites were accessed. Once reaching each site, 6 densiometer readings were taken at 5 cross-section transects (A-E) with transect C being the site GPS coordinate. This added up to 30 densiometer readings per site, times 16 sites equals 480 densiometer readings total. The results we found were drastically different (higher percentage shade) from those included in the TMDL. See Appendix B for full results of densiometer readings.

Amigos Bravos Measurements:

Table 2-2. Canopy cover as measured in the field.

Percent Canopy Cover Summary			
Site	Avg. % Canopy	AU Average	
AU1S1	90		
AU1S2	74		
AU1S3	77		
AU1S4	67		
AU1S5	52		
AU1S6	52	AU1	68.43333
AU2S1	21		
AU2S2	45		
AU2S3	15		
AU2S4	24		
AU2S5	14		
AU2S6	29	AU2	24.43333
AU3S1	31		
AU3S2	33		
AU3S3	29		
AU3S4	24	AU3	29

Table 2-3. Average Canopy Cover as Measured in the field

RIVER SEGMENT	**% CANOPY**
Upper Segment/AU1 (Amigos Bravos AU delineation)	68%
Middle Segment/AU2 (Amigos Bravos AU delineation)	24%
Lower Segment/AU3 (Amigos Bravos AU delineation)	29%

In the Upper Segment, where the most amount of canopy was recorded also had the most variability between sites - 90% shade found at most shaded site and 52% shade at least shaded site. All of the shade in the upper segment was from vegetation.

AU1S1

AU1S5

AU1S2

The middle segment also had a large amount of variability between sites - 45% shade found at most shaded site and 14% shade at least shaded site. In the Middle Segment most of the shading was from vegetation with the exception of a slight amount of shading from the canyon walls and large boulders in the lower sites in the segment.

AU2S3

AUS23

AU2S4

AU2S5

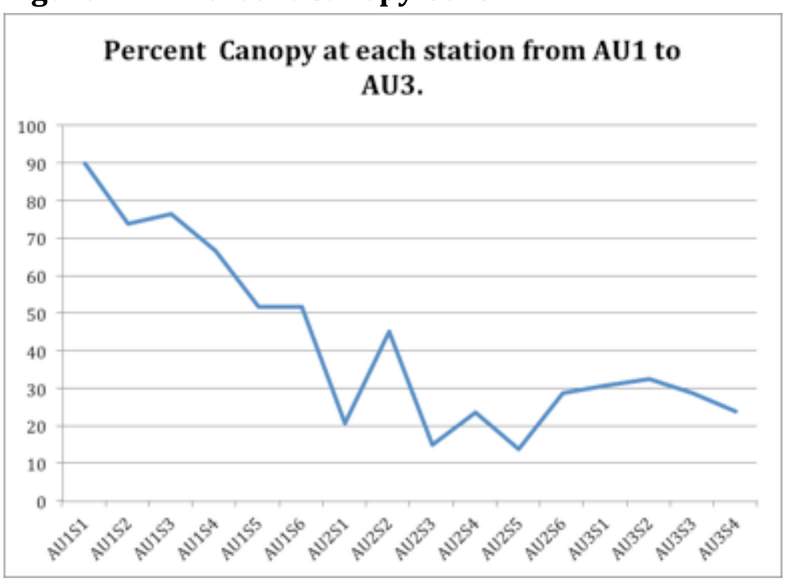
The Lower Segment had the least amount of variability between sites - 29% shade found at most shaded site and 24% shade at least shaded site. A significant amount of shading in the sites in the Lower Segment came from the canyon walls and large boulders found in and beside the river.

AU3 - Photos

Overall, the trend was a decrease in canopy as we moved downstream (see Figure 2-1) though the lower segment had a bit more than the middle segment. The difference between the canopy percentages used in the TMDL and those that Amigos Bravos and watershed stakeholders measured in the field were drastic. Complete densiometer readings for all sites can be found in Appendix B.

Figure 2-1 – Percent Canopy Cover



Temperature Data – 2009-2011

Amigos Bravos also worked with entities that have ongoing monitoring programs and Quality Assurance Project Plans (QAPPs) in the watershed. We worked with Taos Pueblo to deploy a TidbiTV2 HOBO Data Logger at the upper boundary of the Upper Segment. In addition Amigos Bravos worked with BLM to gather temperature readings right above the confluence with the Rio Grande (lower boundary of the Lower Segment). This data can be found in Appendix C. In addition, new NMED data from 2009 was incorporated into the model. This data can be found in Appendix D. The TMDL, which was drafted in 2004, was based on data that NMED gathered in 2000, so the data used in the current run of the SSTEMP model, both the canopy and temperature readings, was considerably more up to date.

Map 2-2 Temperature data collection sites for the Rio Pueblo de Taos, Rio Fernando, and the Rio Grande del Rancho

Temperature data collected by NMED, BLM and Amigos Bravos with our partners show that the middle segment (AU2) is clearly the hottest stretch of the river. The temperature data collected by NMED in 2009 (Appendix D) shows that this middle segment has the highest highs and the most days, (both total and consecutive days) with more than 4 hours above 20° of any of the three AUs. Canopy data shows that AU2 also has the least amount canopy. The temperature data, canopy data, and issues of access led to our prioritizing restoration in AU2.

Table 2-4 Maximum Temperature Readings per AU - 2009

AU	MAX TEMP 2009 C°	DATE
AU1 – Upper Segment	25.623	8/22/09
AU2 – Middle Segment	26.867	8/22/09
AU3 – Lower Segment	24.436	7/11/09

Figure 2-2 - AU1 NMED 2009 Temperature Data

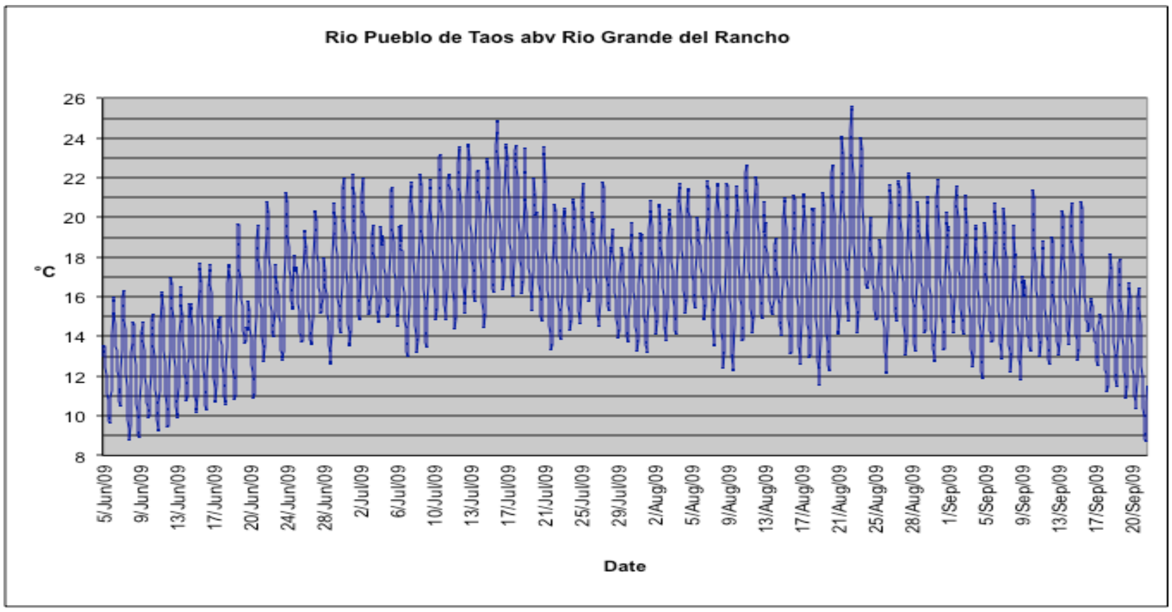


Figure 2-3 AU2 NMED 2009 Temperature Data

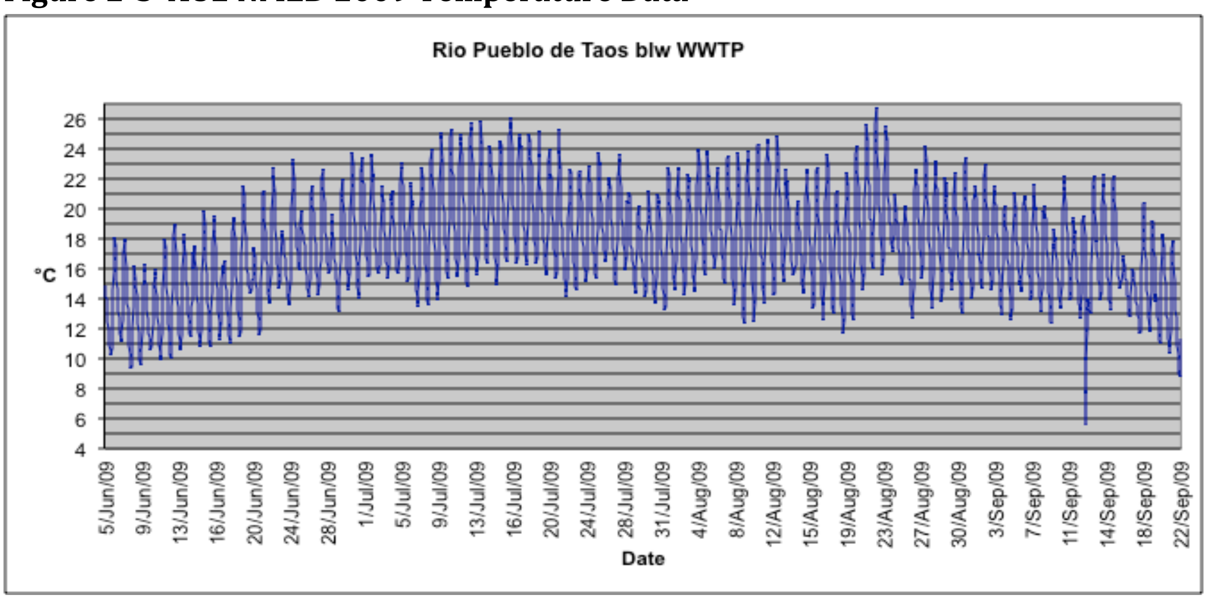
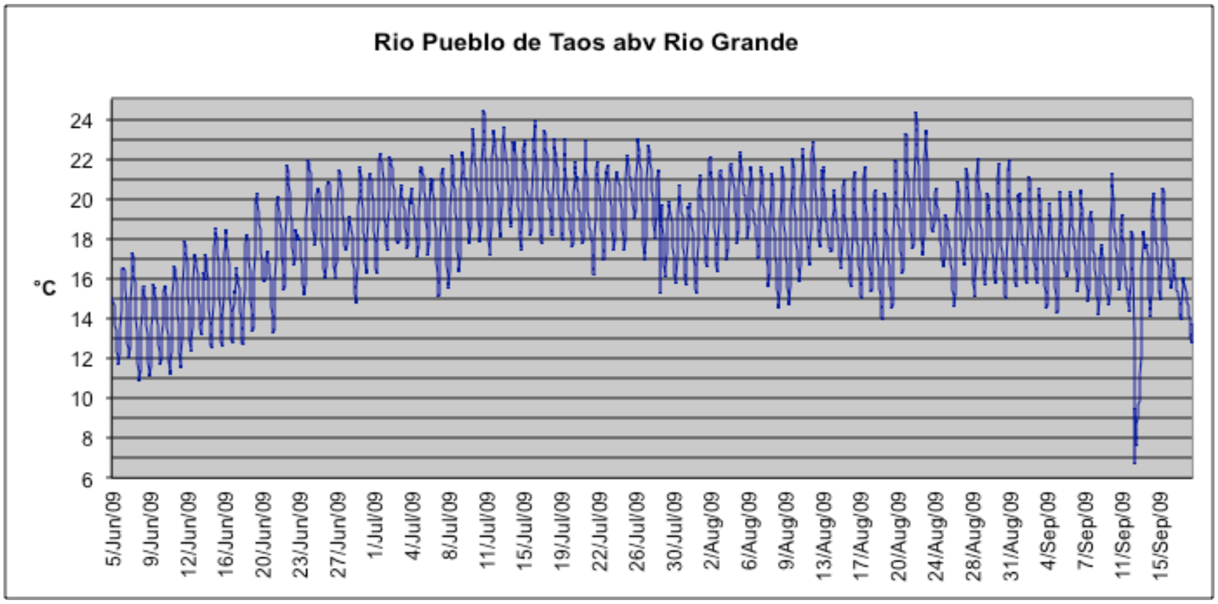


Figure 2-4 AU3 NMED 2009 Temperature Data



Water temperatures for 2009 were reviewed and studied to determine what was the hottest time of the year and, during this hottest period, what was typically the hottest time of day. In doing this analysis, any day with an individual temperature reading above 20°C was included as a data point. For the Upper Segment (AU1) there were 69 days with a temp reading above 20°C. The Middle Segment (AU2) had 82 days with a temp reading above 20°C. The Lower Segment (AU3) had 79 days with a temp reading of 20°C or higher. Figures 2-5 and 2-6 show the hottest times of the day for AU1 and AU2. For AU1, 25 of the 69 days with temps above 20°C had the highest temperatures recorded during the hour of 4:00pm. For AU2, 52 of the 82 days with temps above 20°C had the highest temperatures recorded during the hours of 4:00pm and 5:00pm.

Figure 2-5 Hottest Time of Day AU1

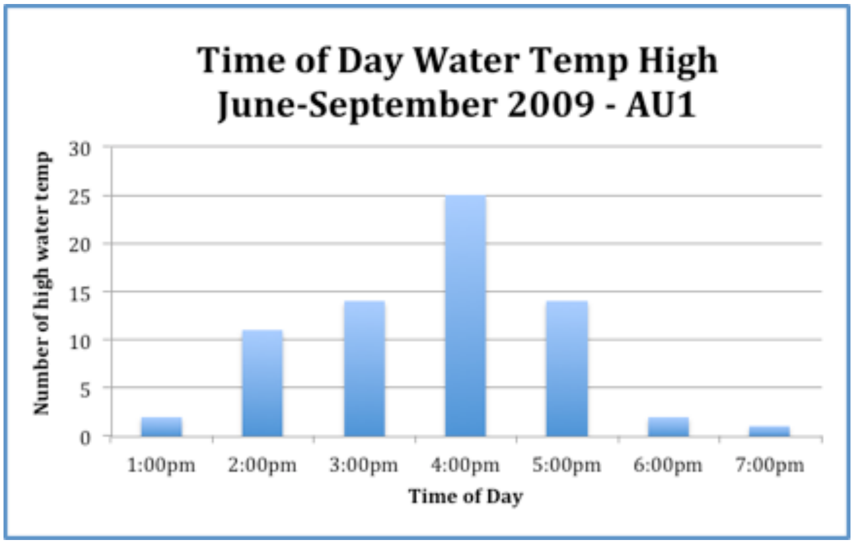
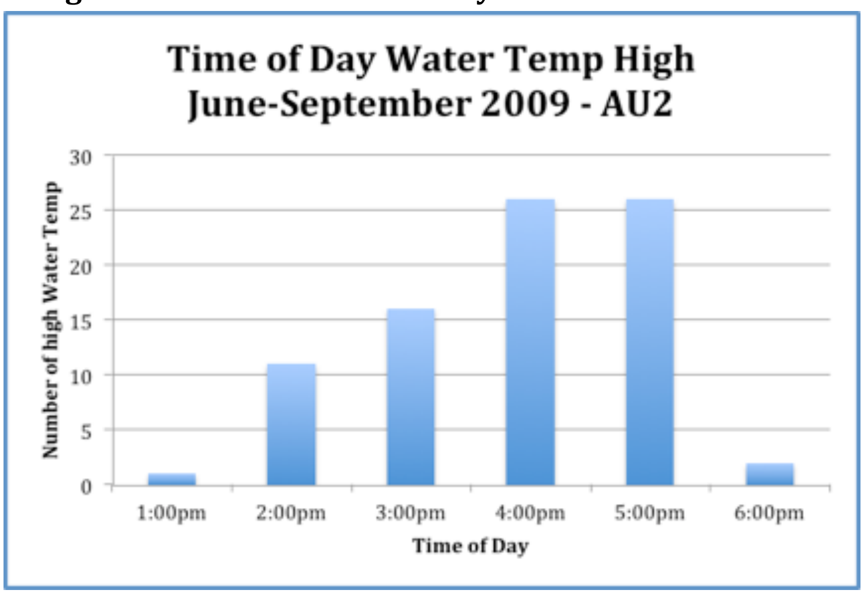


Figure 2-6 Hottest Time of Day AU2



The highest temperatures in all segments typically occurred between the hours of 2:00pm and 5:00pm, with the hottest 2 hours being the hours between 3:00pm and 5:00pm. The Upper Segment (AU1) typically did not have long stretches of high temperatures and rarely had days with temperatures above 23° C. In contrast both the Middle and Lower Segments (AU2 and AU3) both had temperatures above 23° C on several days and typically had long stretches of 4 or more hours above 20° C on consecutive days. This information will be helpful in directing education about river friendlier irrigation hours as outlined under the management measures section.

TMDL Data (2000- 2003)

This is the data that was gathered and used by NMED to develop the 2004 TMDL.

Upper Segment (AU1) – Three thermographs were deployed in this segment and all showed exceedances of the high quality coldwater aquatic life criterion. The upper thermograph in 2000 showed that the recorded temperatures exceeded the HQCWAL criterion 410 of 1,426 times (29%) with a maximum temperature of 27.2°C. The middle thermograph in 2002 showed that HQCWAL criterion was exceeded 648 of 1,426 times (45%) with a maximum temperature of 30.1°C . The lower thermograph in 2003 showed that the HQCWAL criterion was exceeded 693 of 1,426 times (49%) with a maximum temperature of 30.8°C. (SWQB, 2004)

Middle Segment (AU2) – A thermograph was deployed in the middle of this segment (below the WWTP) in 2000. The HWCWAL criterion was exceeded 745 out of 1,426 times (52%) with a maximum temperature of 28.3°C. (SWQB, 2004)

Lower Segment (AU3) – One thermograph was deployed in 2000 right near the Rio Grande confluence and again in 2003 at the same location. In 2000 the HQCWAL criterion was exceeded 682 of 1,426 times (48%) with a maximum temperature of 25.4°C. (SWQB, 2004)

Additional Data

In addition to the temperature HOBO devices that measure temperature continuously over a period of time, that were used by the various entities mentioned above, Amigos Bravos and Water Sentinels of Taos have collected individual temperature readings as part of the ongoing Taos rivers collaborative sampling project conducted under an approved QAPP. Sampling reports and a copy of the QAPP can be seen at http://amigosbravos.org/cleanwater-2.php.

These temperature readings are always read during the morning hours to facilitate getting samples to the lab for analysis before close of business day and are therefore taken well before temperature exceedances are typically found in the river. Accordingly there have been few water quality standard exceedances for temperature. Interestingly enough the only three high temperature samples we found in all four of the rivers we sample (Rio

Pueblo, Rio Hondo, Rio Fernando, Red River), were found in the Rio Pueblo. Specifically, a site in the Lower Segment, just upstream of the confluence with the Rio Grande had a temperature reading of 20°C on July 24, 2007. While this isn't an exceedance of water quality standards (the standard is 20°C), it is right at the standard. Even more of note two samples taken in July of 2012 were high. One sample taken on July 25, 2012 in the Middle Segment at a site located about a quarter of a mile downstream from where the wastewater arroyo feeds into the river, had a temperature reading of 20.1°C. Another sample taken on that same day from the wastewater arroyo about 200 yards downstream from the wastewater treatment plant discharge showed a temperature reading of 21.2° C, which is above standard for the Rio Pueblo de Taos (though not for that specific arroyo, which has a warmwater aquatic life standard of 32.2°C). So while the specific standard that is applicable to the arroyo was not exceeded, this relatively high reading at 9:55am in the morning on July 25, 2012 in this arroyo tells us that that the arroyo may be contributing warm water to the Rio Pueblo de Taos at levels above the applicable standards for the mainstem.

In addition, it is interesting to note that during all sampling events, including the two listed above, while the temperature readings were well below standards, the wastewater arroyo, at least for the two years of readings we have for that site, is always hotter than all other sites in the watershed (See Table 2-5). This could warrant further investigation to see if the wastewater stream from this arroyo is contributing to the temperature impairment in the Rio Pueblo de Taos.

Table 2-5 shows higher temperatures in wastewater arroyo compared to other sites in the Rio Pueblo de Taos Watershed (PS2 is the wastewater arroyo site and is highlighted below). All sites listed in the table are found in the Rio Pueblo de Taos Watershed. A complete report on these sampling results, including full descriptions of all sites can be found at http://amigosbravos.org/cleanwater-2.php.

Table 2-5 High Comparable Temps in Wastewater Arroyo

SITE	Date	Sample time	Temp°C
P1	9/14/11	10:40 AM	12
P2	9/14/11	10:32 AM	13
P2A	9/14/11	10:12 AM	13
PS2	9/14/11	9:35 AM	16
PS3	9/14/11	10:15 AM	12
P1	7/13/11	11:00 AM	16
P1A	7/13/11	9:05 AM	15
P2A	7/13/11	9:45 AM	14
PS2	7/13/11	10:05 AM	17

P1A	5/25/11	9:15 AM	9
P2	5/25/11	9:55 AM	9
PS1	5/25/11	10:45 AM	10
PS2	5/25/11	10:10 AM	13
P1	7/25/12	11:30 AM	18
P2	7/25/12	9:25 AM	16.7
PS2	7/25/12	9:55 AM	21.2
PS3	5/25/11	10:15 AM	20.1
P1A	6/14/12	8:52 AM	14
P2A	6/14/12	10:10 AM	16
PS2	6/14/12	9:45 AM	17.8
PS3	6/14/12	9:25 AM	15.6

2.2.4 MANAGEMENT MEASURES (TEMPERATURE)

Management measures were identified by stakeholders, restoration consultants and by doing a through literature search for best BMPs/Management Measures to address temperature impairments. The following list of BMPs to address temperature impairment were the ones that were identified as possible for the Rio Pueblo de Taos.

2.2.4.1 Increase Canopy

Increasing canopy is the primary management measure identified for decreasing water temperatures in the Rio Pueblo de Taos. Studies have shown that riparian shading greatly influences water temperature (Sugimoto, 1997). In addition, increased canopy for temperature impaired streams can greatly improve summertime stream temperatures in most situations. In many instances it may be possible to reduce temperatures so they no longer exceed state water quality standards. (Beschta, 1997). Canopy measurements shown in Table 2-3 show that middle segment (AU2) has the greatest opportunity for increased canopy and thus many of the management measures will be focused in this segment of the river. Five detailed management measures for increasing canopy are outlined below.

***Plantings* –** The primary management measure for increasing canopy will be to plant both trees (cottonwoods, ash, alders,) and smaller canopy species such as willows and other herbaceous shrubs along the riverbanks. In some cases promoting the planting of fruit trees in the riparian area may be appropriate to convince landowners of the benefits of increased riparian plantings.

Riparian Fencing – Fencing off of riparian areas will be essential for both protecting existing riparian vegetation and any new plantings that occur. Livestock impacts on riparian vegetation can extensive and are in fact probably the biggest contributing factor to the current lack of riparian vegetation. It is well documented that grazing has a large impact on elevation of stream temperature due to the associated vegetation removal and widening and shallowing of the streambed (Webb et al. 2008; Belsky et al., 1999). Livestock grazing has been documented to impact approximately 80% of riparian areas in he western US (Belsky et al., 1999). Riparian fencing could be installed to still allow limited access by livestock to the river for water access. Fencing of the approximately 16,000 feet of 4 of the high priority sites (AU1S5, AU1S6, AU2S1, and AU2S2,) was prioritized in the budget and project implementation. Fencing for the other high priority canopy site was not prioritized since there is no grazing at the bottom of the canyon. Three of these 4 sites were also identified as prioritization for channel restoration and the need for fencing to protect the channel. Since these high priority channel restoration sites are all included in the canopy high priority sites fencing costs are only calculated once.

Enhance Upland Water Access – To encourage use of upland pastures and discourage grazing and congregating of livestock by the river upland water tanks and other water sources should be installed in upland pastures.

Tax Credit Research and Alternatives – During our outreach to stakeholders and interviews with land owners it was discovered that many land owners lease their land for livestock grazing or even just allow neighbors to graze on their land to be able to claim an agricultural tax credit. Even just a few animals on a non-riparian fenced pasture can have a substantial impact. More than a few landowners said that the *only* reason they graze or allow grazing on their land is because of this tax credit. Research into the details of this tax credit as well as into alternative options for landowners is needed.

Riparian Buffer Ordinance – To protect the many areas of healthy riparian areas found throughout the watershed, and especially in the upper segment (AU1) where there is the highest density of people as well as the most potential for increased growth, riparian buffer protections are needed in both the town and county. A riparian buffer ordinance will also be important for protecting areas once riparian restoration has occurred. Research into riparian buffer ordinances indicates that, to be effective a riparian buffer ordinance must protect a buffer area of at least 85 feet (EPA, 2012). While this EPA study was focused primarily on nitrogen pollution, this should still have relevance in terms of land use planning on the Rio Pueblo de Taos, especially in light of the fact of the new E.coli (upper segment) and Nutrient/Eutrophication Biological Indicators (middle and lower segments) impairments in the watershed.

2.2.4.2 Increase/Stabilize Flow

Many studies have documented the relationship between flow and river water temperatures. In fact, besides heat load, flow is the only other main factor in influencing temperature (Poole, 1999). In addition, it has been found that occurrence of high temperatures can be eliminated by increased in-stream flow (Sinokrot, 2000). There are a number of diversions on the Rio Pueblo de Taos that reduce the flow of the river during the irrigation season, which also happen to be during the hottest months of the year when temperature exceedances are also observed. Efforts to increase flows in the Rio Pueblo de Taos could have positive impacts on reducing the high temperatures in the river. This planning document, and in fact the Clean Water Act overall, does not have the authority to set in stream flows or have any impact on private water rights. Thus the bulk of management measures identified are education based in an effort to raise awareness about the impact of low flows on the river and provide two concrete actions private landowners can use to improve water quality through increased flow. These two education based management measures to increase and stabilize flow are detailed below.

Education – River Unfriendly Irrigating Hours - As Figure 2-5 and Figure 2-6 show, the hottest time of the day, in the two segments examined, is from 3-6pm, with the 4:00pm hour typically being the very hottest. While there are exceedances from June – September, the hottest time of the year for water temperatures is the second week of July through the third week of August (at least as is seen from the data we have from 2009 and 2010). If irrigators were to commit to reducing irrigation during these hours during the hot summer window, more water would be left in the stream to stabilize and reduce the temperature. An education campaign to irrigators could help draw attention to the river and hopefully encourage some reduction of irrigating during these hours. This education campaign could also be combined with information about the reduced efficiency of irrigating during these hours due to evapotranspiration.

Education – Beaver Ecosystem Functions – It has been shown that beaver dams can stabilize flows. Beavers have been found to be a source of ground water recharge and ground water table elevation (Grannes, 2008). This can lead to more stabilized flow during low flow periods and more cold water springs charging rivers and lakes. A more stabilized flow during low flow times of year, which coincide with the hot period, could help lower temperatures. Unfortunately, beavers have been systematically removed from most watersheds in New Mexico and the Rio Pueblo de Taos is no exception. This is especially true in the upper segment of the river, which is also more densely populated. In addition beavers have been shown to have a positive impact on reducing sediment in river systems (Collen, 2001). Educating landowners about the benefits of beavers on flow as well as on mitigating sediment could help stabilize flows and therefore temperatures in the Rio Pueblo de Taos. (Excess sediment is another concern in the watershed and is addressed in a discussion in Section 2.2.6)

Quantification of Diversions and Identification of Potential Flow Sources
A more detailed analysis of the amount of water that is diverted and during what periods would be helpful. In addition identifying potential sources of flow could also be helpful. For example the wastewater treatment plant diverts a good portion of its flow during the hot summer months to the Golf Course. Much of this water is stored in ponds up at the golf course and presumably much water is lost to evaporation. Avenues for increasing the flow from wastewater treatment plant during the hot months and specifically during the hot periods of the day could be investigated. Perhaps more water could be diverted to the Golf Course during winter months and stored for summer usage?

2.2.4.3 Other

Several other management measures to help reduce stream temperatures have been identified.

***Reduce Width to Depth Ratio (Stream Channel Restoration)* -** The wider and shallower a stream the more surface area is exposed to solar gain. Reducing the width and increasing the depth of a stream system can help to reduce water temperatures (Poole, 1999). In many cases riparian plantings can help reduce stream width but in some cases the installation of vanes and baffles may be needed. Stream channel restoration is discussed in more detail in Section 2.2.7.

***Reduction of Sediment* -** Increased sediment loads can contribute to stream widening and shallowing (Poole, 1999). In addition there is some evidence that sediment, especially if the soils are darker in color than the gravel deposits in a stream can cause warming by soaking up solar radiation. Therefore efforts to decrease sediment could also help to decrease temperatures by restoring the geomorphology of the stream channel. Sediment loading and impacts are discussed further in Section 2.2.6.

***Removal of Tires* -** During discussions with stakeholders and during the canopy measurement fieldwork it was discovered that there are many tires embedded in the stream channel. These tires embedded in the streambed could be small source of temperature loading (along with petrochemicals and other contaminant loading) as the black color of the tires in the predominately shallow stream system could be attracting solar radiation. Work to remove an illegal deposit of thousands of tires on private property has begun, so hopefully the main source of tires in the river will soon be addressed. Unfortunately this work will not address the tires that have already made their way into the streambed. Removal of these tires, which are predominately found in the rocky canyon sections (Middle and Lower Segments) of the river with be laborious and time consuming.

Tire in River - AU2S6

Site Specific Detailed Plans - Throughout the planning process several landowners were identified and Amigos Bravos staff, a river restoration consultant, and stakeholder volunteers visited with three separate river front landowners and toured their property to assess restoration potential. Restoration outlines were developed for a couple of these properties (see Appendix E). These projects have canopy, sediment control and stream channel restoration components.

2.2.5 CURRENT LOAD AND ESTIMATED LOAD REDUCTIONS (TEMPERATURE)

2.2.5.1 SSTEMP Modeling – Current load

The 2011 canopy data, the 2009 temperature data, as well as several other new data sources were used to do a new run of the SSTEMP model for the Rio Pueblo de Taos. A full report of this modeling effort can be found in Appendix F.

Several discrepancies between the TMDL SSTEMP modeling and the current effort were found during this effort and are outlined in the SSTEMP Report (Appendix F). Increased stakeholder oversight and involvement during any future NMED SSTEMP modeling will need to conducted to ensure these issues are not repeated. In addition, segments were misidentified in the TMDL and presumably in assessment protocols and documents.

AU Identification- One of the most notable difference between TMDL data measured conditions was that 1.6 miles of river that should be included in the upper portion of AU1, were not included by NMED and thus were not included in the TMDL. For some reason the TMDL had tribal boundaries starting considerably downstream from the actual boundary. This 1.6 section of the river is almost entirely (besides several limited inholdings of Pueblo land) non-tribal and should be assessed during cyclical water quality assessments done by NMED. Map 2-3 shows the differences between Amigos Bravos' and NMED's AU delineations. In addition, the TMDL, and presumably assessment protocols, incorrectly identifies Arroyo del Alamo, thus making AU2 considerably shorter in length then if it truly ran from Rio Grande del Rancho downstream to the Arroyo del Alamo. Instead, the NMED AU2 runs 1.2 miles downstream from the Rio Grande del Rancho and terminates in an unnamed arroyo, which we have named Otter Arroyo in subsequent sections of this plan (see Map 2-4 for a map of arroyos). From a geographic standpoint, the NMED delineation of AU2 from Rio Grande del Rancho to the Otter Arroyo makes sense as it right at this point that the canyon starts to deepen, though the AU should be clarified to end in the unnamed arroyo so as not to confuse the public. Because of these discrepancies Amigos Bravos was operating under a completely different understanding of the AU boundaries for the majority of the planning process. Therefore the site names for canopy measurements and restoration priorities are in some cases labeled as AU2, when the NMED delineation (if you are going on the mile length of the AU, and not the written description of the AU) would actually identify those sites as falling in AU3.

Canopy Measurements- Another notable difference was the difference between the TMDL current canopy conditions and the ones Amigos Bravos measured in the field in 2011. These differences are detailed in section 2.2.3.3 above.

Map 2-3 Difference Between NMED and Amigos Bravos AU Delineations

SSTEMP Run – In running the SSTEMP model we stuck to the NMED AU delineations and used the new canopy measurements. In addition more current weather data was used. All data sources are detailed in the SSTEMP Report (Table 1, Appendix F). The current loading conditions measured in the updated SSTEMP run, using the updated data, modeled different current loading conditions than those found in the TMDL. For planning purposes this Watershed Based Plan will use the Updated SSTEMP numbers for current condition figures. Complete information on model run for Updated SSTEMP conditions can be found in Table 3 of Appendix F.

Table 2-6 Current Temperature Loading Conditions 2004 and 2012

	AU1 (Upper Segment)	%Shade	AU2 (Middle Segment)	%Shade	AU3 (Lower Segment)	%Shade
2004 TMDL Current Conditions	264.22 joules/m2/s	7	305.14 joules/m2/s	5	269.81 joules/m2/s	16
Updated SSTEMP Current Conditions	199.63 joules/m2/s	35	229.41 joules/m2/s	26.9	221.33 joules/m2/s	

2.2.5.2 Load Reductions Related to Management Measures (Temperature)

Using SSTEMP we generally found that increasing canopy cover to a maximum of 75% resulted in attainment or near attainment of the Cold Water Aquatic Life Use Temperature Criterion. Management measures to increase shade to 75% will involve both planting and fencing projects at all sites. Canopy restoration sites are mapped and prioritized in Map 2-6. Given that in AU1 there were three sites with more than 75% canopy and three sites with under 75% canopy cover we felt that this level of shading could realistically be met in the Rio Pueblo de Taos. We did not run any SSTEMP model runs using more than 75% canopy cover. When increasing shade does not fully result in attainment of the Cold Water Aquatic Life Use in AU1 and AU2 it comes extremely close, increasing shade in the watershed to 75% canopy cover does show attainment of water quality standards for AU3. Non -canopy increasing management measures related to flow and width to depth ratio will be used to further reduce loading in AU1 and AU2, which will also improve water quality in the downstream AU3 segment. Management measures to even slightly increase flow and narrow the channel in the upper two segments is anticipated to lower water temperatures below standards.

Table 2-7 Modeled Temp with 75% Shade

	AU1	AU2	AU3
Shade	75%	75%	75%
Max Modeled Temp	71.07°F (21.70 °C)	70.98°F (21.65°C)	68.03°F (20.02°C)
Joules/m2/s	75.96	75.96	90.12
Water Quality Goal	20 °C	20 °C	20 °C

As Canopy cover was increased from current conditions up to 75% average Shade water temperatures dropped as expected. For each Percent Increase in Shade the Thermal Energy is decreased by 3.04 joules/m²/s.

Table 2-8 Percent Shade (Canopy Cover) for each Site and Assessment Unit and Associated Decrease in Thermal Energy per Site and Assessment Unit.

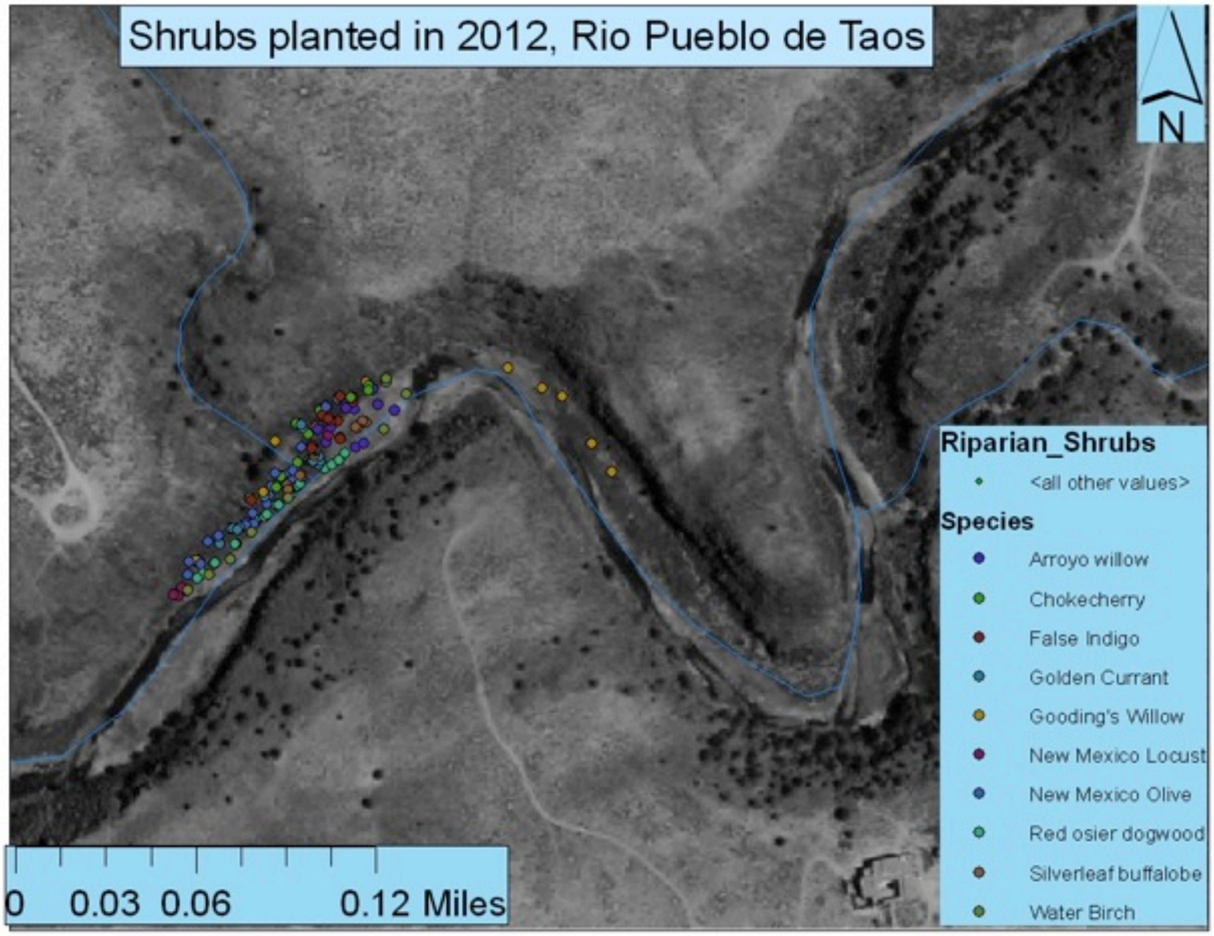
AU Restoration Sites	Canopy	Average Canopy/ AU	Increase in Canopy to 75%	Decrease in joules/m²/s	Max Modeled Temperature with increase of Canopy to 75%
AU1S1	90%	68.43	0%	0	
AU1S2	74%		1%	3.04	
AU1S3	76.60%		0%	0	
AU1S4	66.60%		8.40%	25.536	
AU1S5	51.80%		23.20%	70.528	
AU1S6	51.60%		23.40%	71.136	Bottom of AU1 21.70 °C
AU2S1	20.60%	26.87	54.40%	165.376	
AU2S2	45.20%		29.80%	90.592	
AU2S3	14.80%		60.20%	183.008	Bottom of AU2 21.65 °C
AU2S4	23.60%	26	51.40%	156.256	
AU2S5	13.80%		61.20%	186.048	
AU2S6	28.60%		46.40%	141.056	
AU3S1	30.80%		44.20%	134.368	
AU3S2	32.60%		42.40%	128.896	
AU3S3	28.80%		46.20%	140.448	
AU3S4	23.80%		51.20%	155.648	Bottom of AU3 20.02°C

Taos Pueblo Plantings

Taos Pueblo, between 2010 and 2012 have planted several miles of river in AU2. These plantings occurred both on the Tribal (north) and non-tribal (south) sides of the river. Specifically, heavy amount of willow plantings have occurred from AU2S6 upstream to AU2S3. Work in this watershed based plan, which covers only the non-tribal portions of the river, will focus on areas where these plantings have not occurred as well as supplementing and monitoring plantings done by Taos Pueblo on the non-tribal portions of the river. See Maps 2-4 and 2-5 for quantity and locations of Taos Pueblo plantings. As you can see from the maps below, Taos Pueblo has conducted extensive plantings in the along the stretch of

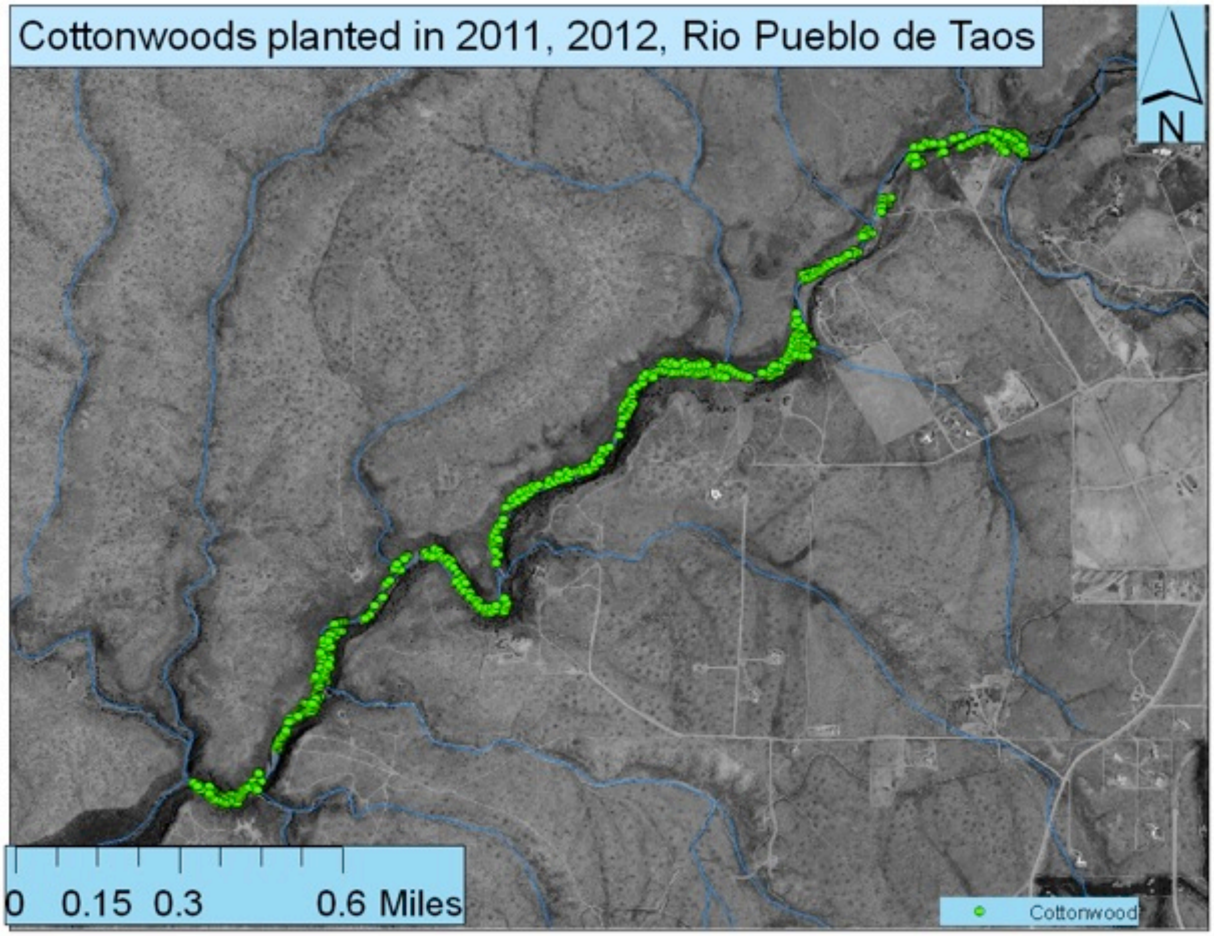
AU2S3-AU2S6. For this reason these sites have been ranked moderate priority instead of high priority for future plantings.

Map 2-4 Taos Pueblo Plantings -Shrubs– Rio Pueblo de Taos (For site location reference this map depicts AU2S5)



Map provided curtsy of Taos Pueblo Environment Office

Map 2-5 – Taos Pueblo Plantings – Cottonwoods – Rio Pueblo de Taos (For site location reference, this map shows AU2S4-AU2S6)



Map provided curtsy of Taos Pueblo Environment Office

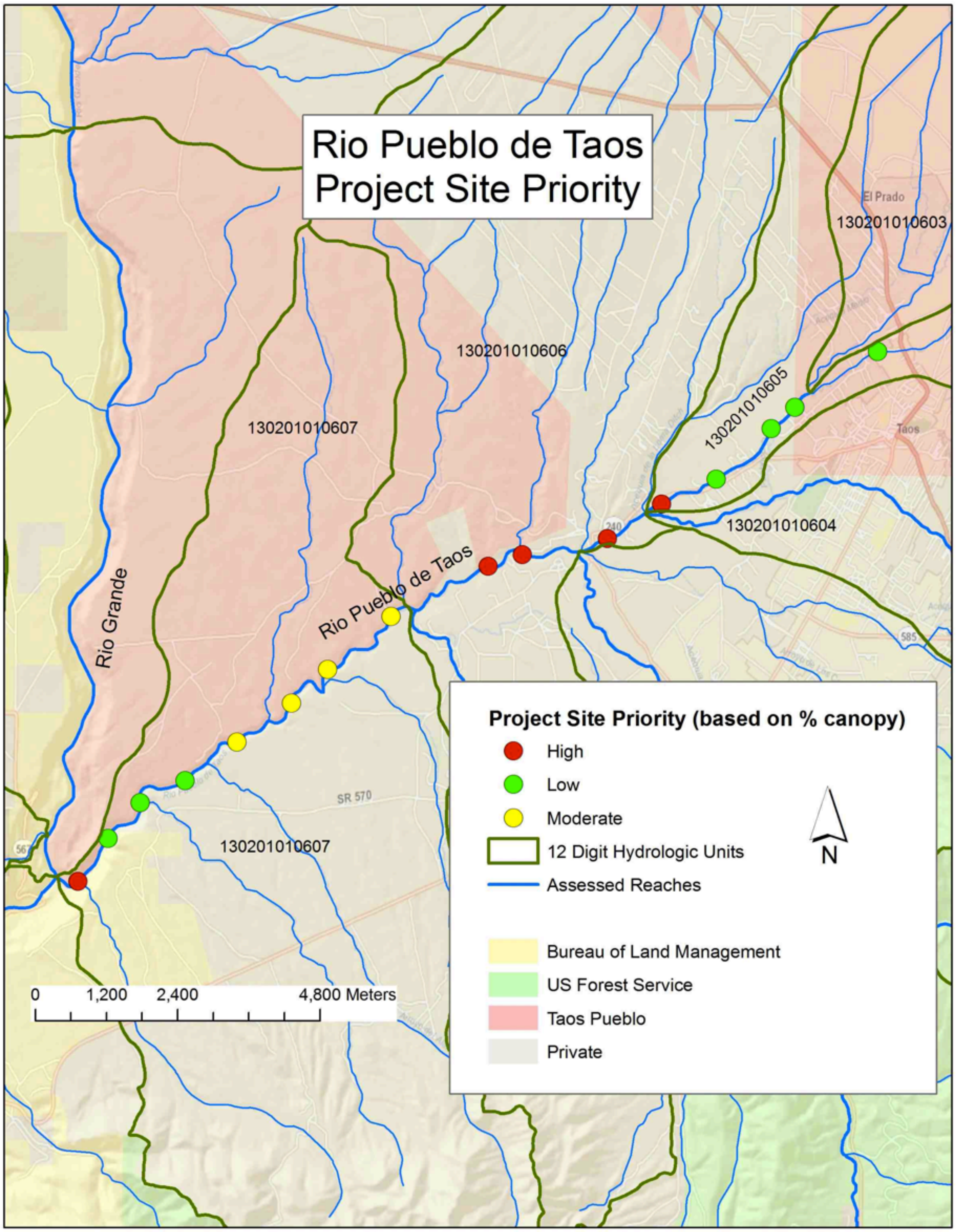
Canopy Project Prioritization

Each site was then prioritized based on both amount of anticipated load reduction, prior planting efforts by Taos Pueblo, partner potential, and site access (Table 2-9). Sites in AU3, with the exception of the bottom site, were rated as low priority despite opportunities for substantial load reduction associated with increased canopy because of serious access issues related to the steep nature of the canyon. In addition, the floor of this section of the canyon itself is narrow and rocky and not conducive to large-scale plantings. There is an opportunity to partner with BLM on plantings on the bottom part of AU3 (AU3S4)- the last stretch of river before confluence with the Rio Grande. Access to AU3S4 can be obtained from the bottom, from the Orilla Verde Recreation area. Due to opportunity to partner on this site, in addition to the easier access from the bottom this site (AU3S4) has been ranked as high priority. Sites that are located in areas where Taos Pueblo had conducted willow plantings (AU2S3-AU2S6) are ranked as moderate priority. Monitoring and potential follow-up plantings will be prioritized in these areas. Canopy projects in lower AU1 (upper segment) and upper AU2 (upper segment) rank the highest in priority. Low priority sites in AU1 and AU2 will focus on fencing to protect existing canopy with some limited planting to slightly increase canopy. Low priority sites in AU3 will not require fencing as there is no longer any grazing in the lower section of the river.

Table 2-9 Prioritization of Canopy Projects

Priority (priority rank)	Management Measures	Completion Target Date	Project Sites	Canopy	Increase in Canopy to 75%	Decrease in joules/m²/s
Low (16)	Fencing/Ordinances	-	AU1S1	90%	0%	0
Low (11)	Planting/ Fencing/Ordinances	-	AU1S2	74%	1%	3.04
Low (15)	Fencing/Ordinances	-	AU1S3	76.60%	0%	0
Low (10)	Planting/ Fencing/Ordinances	-	AU1S4	66.60%	8.40%	25.536
High (3)	Planting/ Fencing/Ordinances	2021	AU1S5	51.80%	23.20%	70.528
High (4)	Planting/ Fencing/Ordinances	2017	AU1S6	51.60%	23.40%	71.136
High (1)	Planting/ Fencing/Ordinances	2017	AU2S1	20.60%	54.40%	165.376
High (2)	Planting/ Fencing/Ordinances	2015	AU2S2	45.20%	29.80%	90.592
Moderate (6)	Planting/ Fencing/Ordinances	2021	AU2S3	14.80%	60.20%	183.008
Moderate (8)	Planting/ Fencing/Ordinances	2021	AU2S4	23.60%	51.40%	156.256
Moderate (7)	Planting/ Fencing/Ordinances	2021	AU2S5	13.80%	61.20%	186.048
Moderate (9)	Planting/ Fencing/Ordinances	2021	AU2S6	28.60%	46.40%	141.056
Low (12)	Planting/Ordinances	-	AU3S1	30.80%	44.20%	134.368
Low (13)	Planting/Ordinances	-	AU3S2	32.60%	42.40%	128.896
Low (14)	Planting/Ordinances	-	AU3S3	28.80%	46.20%	140.448
High (5)	Planting/Ordinances	2015	AU3S4	23.80%	51.20%	155.648

Map 2-6 Canopy Restoration Project Locations and Prioritization



2.2.6 SEDIMENT IMPACTS, MANAGEMENT MEASURES, AND LOAD REDUCTIONS

While as of 2012 the Rio Pueblo de Taos is no longer officially impaired for sediment (SWQB, 2012) there is still wide concern about the amount of sediment in the watershed. Many stakeholders maintain that the stream will be listed again based on data collection from 2011-2013. Watershed tours and field visits identified a number of areas where heavy sediment loading was visually apparent in the river. This section of plan identifies sediment sources, management measures and estimated load reductions associated with those load reductions.

The previous sediment impairment was for the middle segment (AU2) and so we focused our efforts on potential sources and sediment loading in this segment.

2.2.6.1 Sediment Assessment

Sediment modeling and GIS were used to assess four arroyos that are believed to be contributing the most amount of sediment to the middle segment of the river. These arroyos were picked for assessment based on GIS analysis and stakeholder input. All of the arroyos were flowing from the South into the Rio Pueblo. The arroyos chosen for assessment and modeling were Arroyo del Alamo, Arroyo Medio, Otter Arroyo, and Treatment Plant Arroyo. The Arroyo del Alamo, Arroyo Medio, and Otter Arroyo subwatersheds are within the “Arroyo del Alameda-Rio Pueblo de Taos” watershed (HUC 130201010607). The Treatment Plant Arroyo subwatershed is within the “Arroyo Seco-Rio Pueblo de Taos” watershed (HUC 130201010606).

The arroyos flowing from the North into the Rio Pueblo flow off of “Tract A”, which belongs to Taos Pueblo. There were no obvious sediment issues from these arroyos. It was determined that a combination of low grazing pressure, enormous cattle tanks (sediment detention) and good land conditions has led to little erosion.

2.2.6.1.1 - Sediment Modeling

Amigos Bravos worked with Keystone Restoration Ecology to use the PSIAC sediment evaluation method (PSIAC 1968) to determine which arroyos had the greatest contribution of sediment to the Rio Pueblo. A ground assessment in August of 2012 was conducted on four arroyos on the south side of the river that contribute sediment to the Rio Pueblo. A recent flood event had deposited large sediment plumes at the outlet of each arroyo into the Rio Pueblo. From this ground assessment, the PSIAC model was evaluated for each arroyo, giving estimates of the total sediment contribution per year.

Table 2-10. Sediment Yield of 4 Arroyos

Arroyo	Visual rating	PSIAC rating	acre-feet/squaremile/yr	Sediment yield
Arroyo del Alamo	Healthy	51	0.51	3.3 acre feet per year
Arroyo Medio	Unhealthy	62	0.76	1.3 acre feet per year
Otter Arroyo	Unhealthy	62	0.76	1.1 acre feet per year
Treatment Plant Arroyo	Unhealthy	62	0.76	7.6 acre feet per year

2.2.6.1.2 - GIS and Ground Assessments of Erosion

In combination with the August 2012 ground assessment, an assessment using Google Earth and ArcGIS 10.1 was performed to identify erosion issues in each watershed. The GIS and ground assessments allowed for the identification of headcuts and historic roads, both of which contribute to erosion and sediment issues. The results of the this assessment are shown for each arroyo, and are consistent with the PSIAC model. Of note during the ground assessment large sediment plumes were visable at the mouth of each Arroyo.

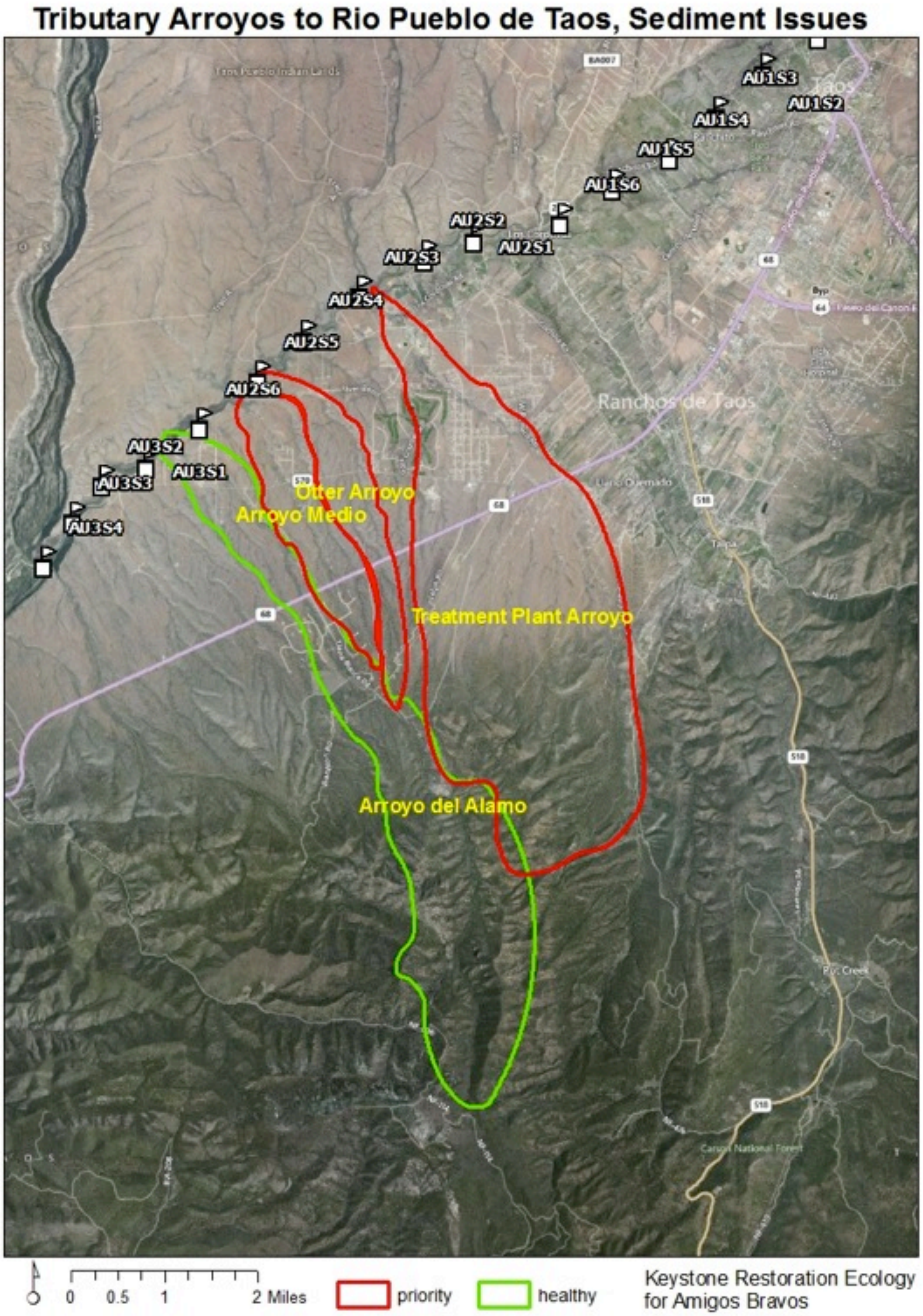
The erosion issues were split into five classes:

- Headcuts
- Low-water arroyo crossings
- Splash pad needed, erosive road crossings
- Well-installed culverts, good road crossings (positive)
- Detention ponds (positive)

2.2.6.1.3 Arroyo Assessments

Four Arroyos were assessed using both the PSIAC sediment model and GIS erosion assessment methods detailed above. These four arroyos included Arroyo del Alamo, Arroyo Medio, Otter Arroyo, and Treatment Plant Arroyo.

Map 2-4. Assessed Arroyos in AU2



Arroyo del Alamo

This arroyo flows from Picuris Peak downstream to the Rio Pueblo de Taos and is the only arroyo that is named on the topographic maps. The name Arroyo del Alamo comes from the presence of cottonwoods in the channel, perhaps due to intermittent flows, rather than being an ephemeral channel. A visual assessment of the channel showed that it had a Rosgen "B" channel as well as a small floodplain. This arroyo is the furthest from development, and had the least number of erosion issues based on the GIS assessment. Since this channel is well developed, there are fewer eroding banks than the other three arroyos, each of which appears to have gulling and bank erosion issues.

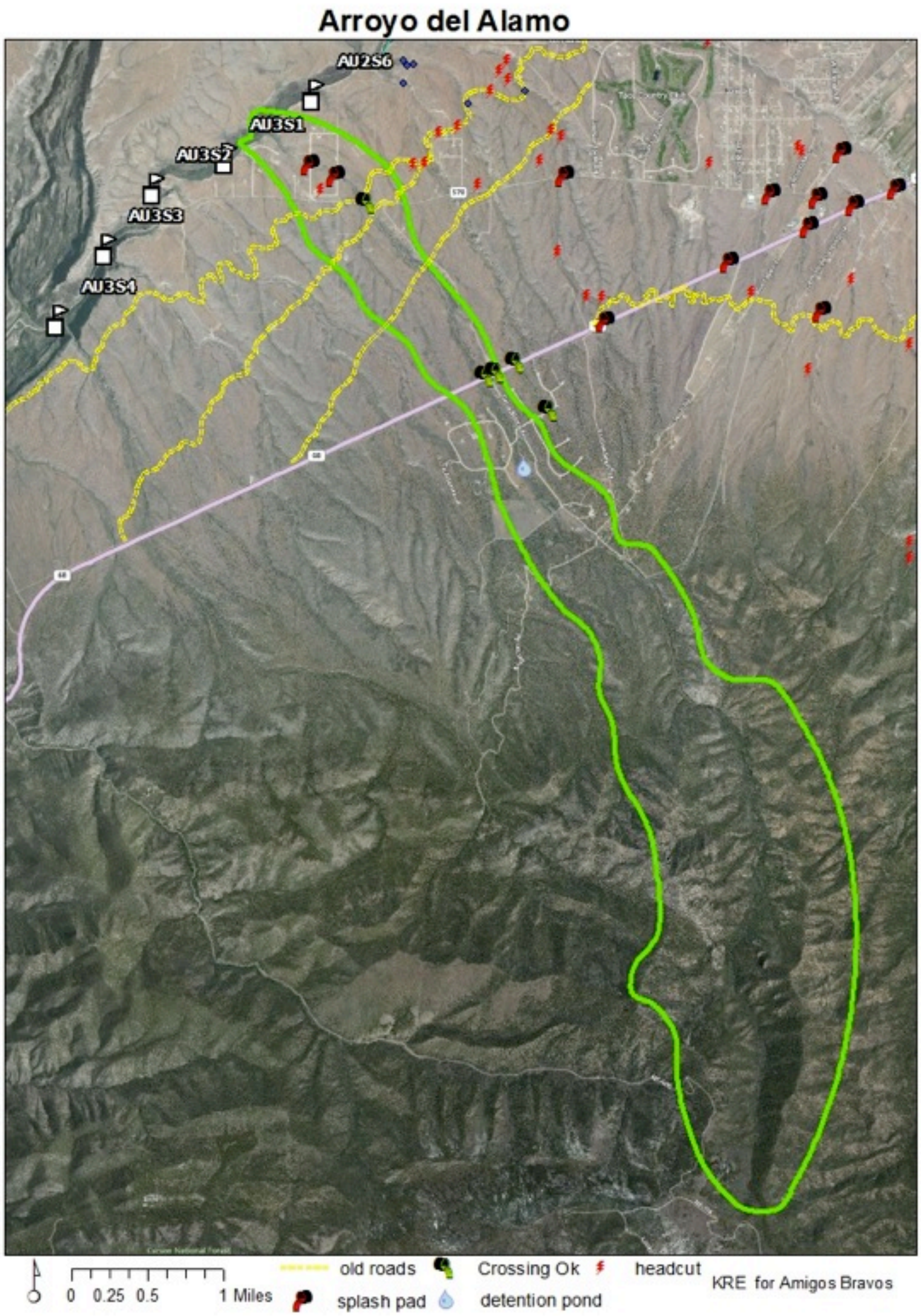
Table 2-11. Erosion Assessment Totals – Arroyo del Alamo

Square Miles	Headcuts	Erosive road crossings	Good road crossings	Detention ponds	Low-water arroyo crossings
6.5	1	2	3	1	0

Arroyo del Alamo has a few poorly installed culvert crossings low-down in the watershed (on Alamo Circle). Each of these could be treated with a "splash pad", some rock or gabion structure to reduce scour and dissipate energy at the outlet of the culvert. There is also a "detention pond" or cattle tank fairly high in the watershed, which acts as a sediment trap for the upper half of the watershed. One headcut, also close to the Alamo Circle Area, could be treated with a "Rock Rundown" structure to prevent further migration upstream that would lengthen that small gully. This particular headcut is close to a home, so there may be important reasons other than sediment in the river to fix it.

Arroyo del Alamo at HWY 570 crossing, upstream channel is not gullied and has a floodplain

Map 2-8. Arroyo del Alamo



Arroyo Medio
This arroyo is the next watershed flowing into the Rio Pueblo de Taos upstream from Arroyo del Alamo. This arroyo has slightly more housing development, but the presence of several old, abandoned roads has triggered head cutting and gulling of both the main branches and several tributary channels. This channel is well developed upstream from HWY 68, and appears to be healthy and to have good watershed condition.

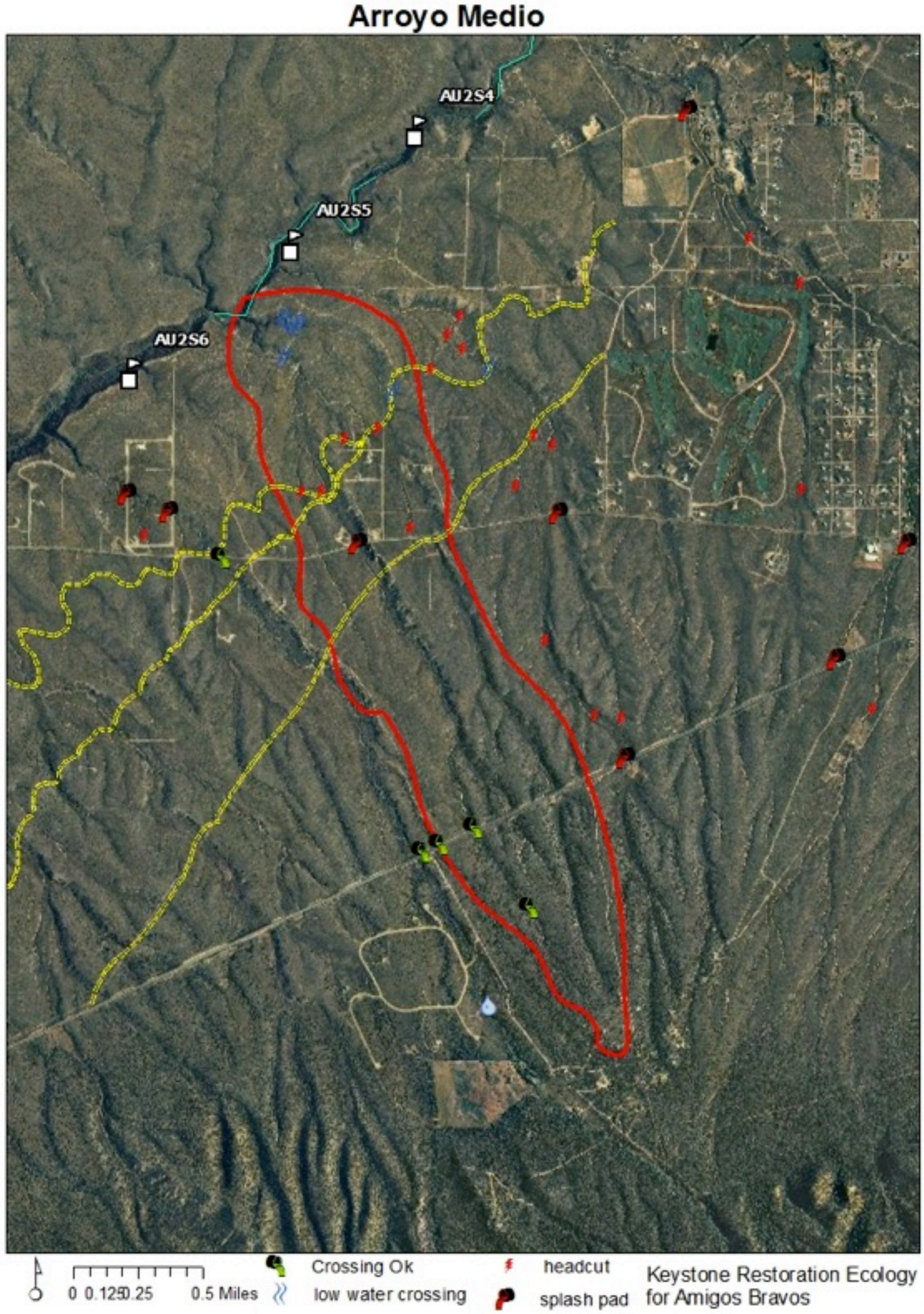
Table 2-12. Erosion Assessment Totals – Arroyo Medio

Square Miles	Headcuts	Erosive road crossings	Good road crossings	Detention ponds	Low-water arroyo crossings
1.7	5	1	3	0	5

The table above shows that there are a larger number of erosion issues on the Arroyo del Medio, and the map shows that most of these are lower down in the watershed. In particular, the presence of the "old roads" on the map is directly linked to the 5 headcuts found in the GIS assessment. Proper drainage of these old roads and the treatment of the headcuts with Rock Rundowns would address some of the major sources of sediment. The "low water arroyo crossing" column is related to a large number of un-paved high clearance roads and when they cross the arroyo, they can cause gulling upstream and mobilization of sediment. Improving these crossings with grade control structures will "hold the grade" and prevent gullying. The one "erosive road crossing" is on the HWY 570 crossing, and the downstream end of this culvert needs a splash pad to stop erosion and dissipate flood energy.

Sediment plume from Arroyo Medio into Rio Pueblo

Map 2-9. Arroyo Medio



Otter Arroyo

This small watershed is upstream from Arroyo Medio. Another large sediment plume was found at the mouth of this arroyo during the ground assessment of erosion in August 2012.

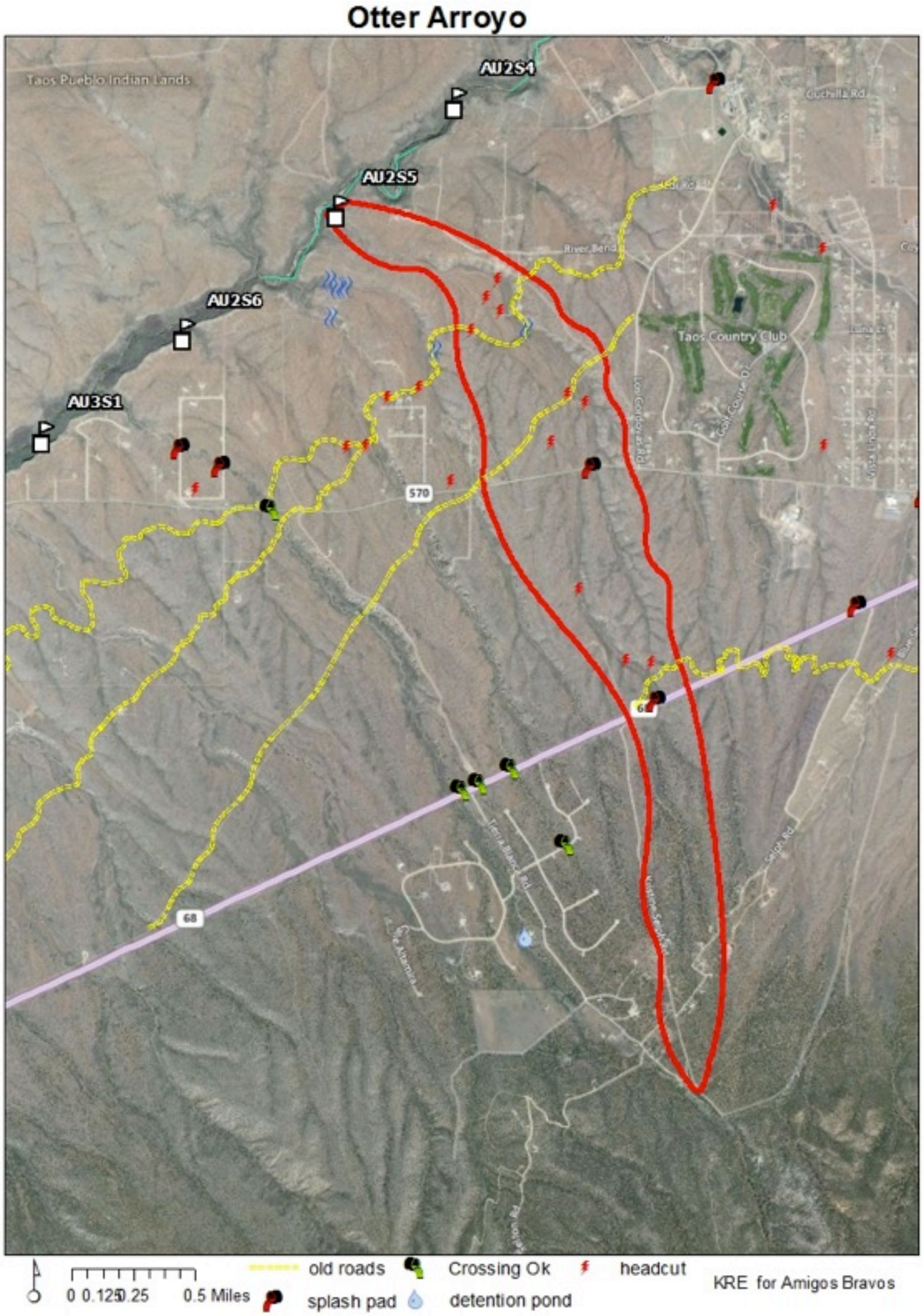
Table 2-13. Erosion Assessment Totals – Otter Arroyo

Square Miles	Headcuts	Erosive road crossings	Good road crossings	Detention ponds	Low-water arroyo crossings
1.4	10	2	0	0	1

There are a large number of headcuts associated with the same old, abandoned roads that have caused head cutting in the Arroyo Medio Watershed. These should be treated with Rock Rundown structures to prevent further erosion upstream. Both HWY 570 and HWY 68 need splash pad structures at the culverted road crossings to dissipate energy and prevent erosion.

Sediment Plume in Rio Pueblo from Otter Arroyo

Map 2-10. Otter Arroyo



Treatment Plant Arroyo

This large watershed is 10 square miles and flows into the Rio Pueblo just downstream of the sewage treatment plant. The lowest mile of this arroyo has perennial flow from the outflow of the treatment plant. A detailed restoration design for this arroyo was submitted to the NMED as a 319 grant proposal, and can be found in the appendix. This arroyo appears to be the most eroded of the three un-healthy watersheds, most likely due to development factors and its close proximity to the Town of Taos. The channel of this arroyo is still a Rosgen “G” gullied channel, with many thousands of feet of eroding banks (from ground assessment).

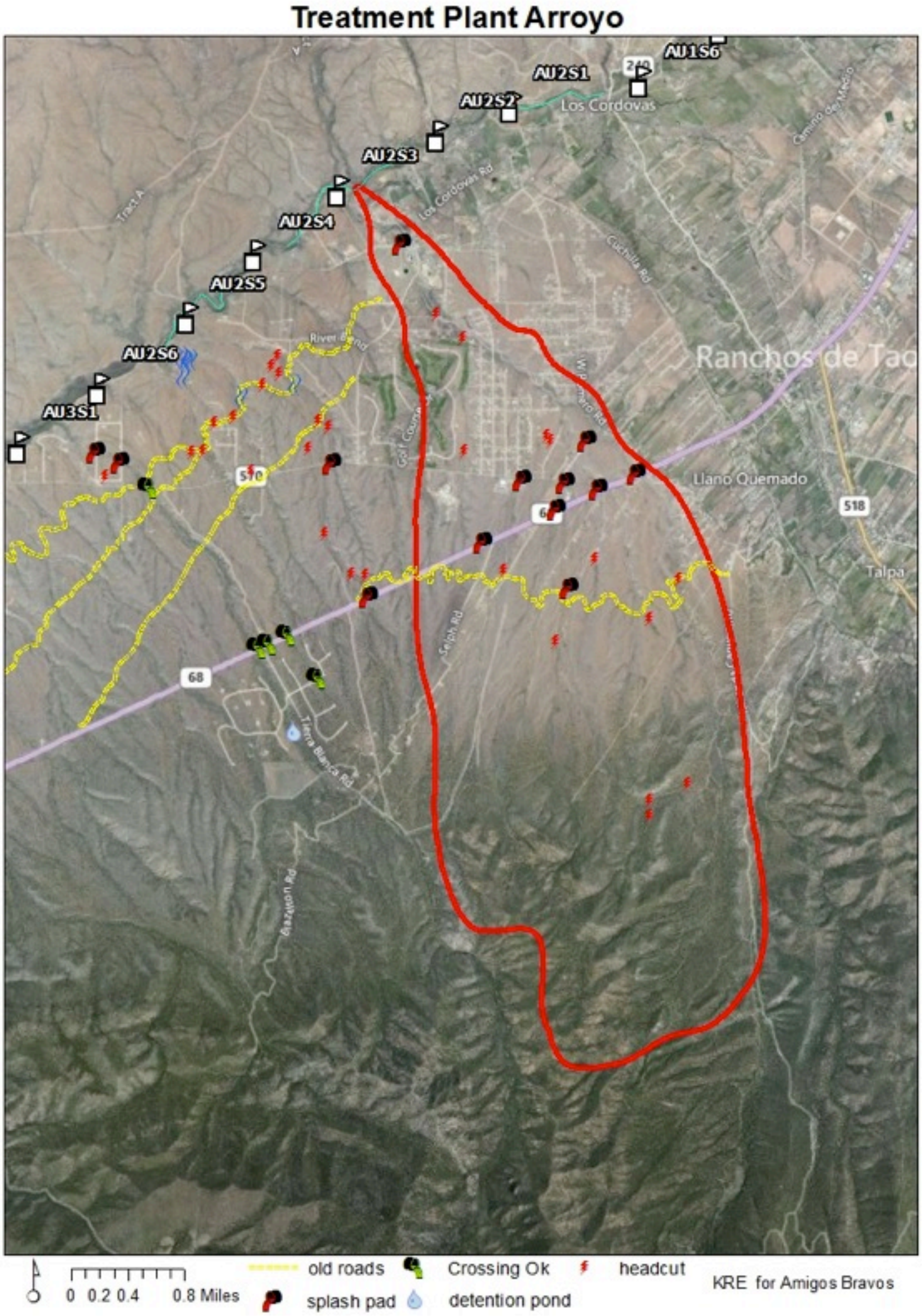
Table 2-14. Erosion Assessment Totals – Treatment Plant Arroyo

Square Miles	Headcuts	Erosive road crossings	Good road crossings	Detention ponds	Low-water arroyo crossings
10	13	9	0	0	0

This arroyo suffers from a large amount of erosion, and is depositing this sediment into the Rio Pueblo. The large number of headcuts could be treated with Rock Rundown structures, and the nine erosive road crossings could be treated with the construction of splash pads on the downstream end of the culvert. Several unique treatments for this arroyo are listed in the 319-grant proposal. The gullied portions of this channel could be treated with the Induced Meandering design system to cause the Arroyo to meander and develop a floodplain.

Treatment Plant Arroyo, Subdivision near Golf Course, note eroding banks

Map 2-11. Treatment Plant Arroyo



2.2.6.2 Management Measures (Sediment)

GIS Spatial Analysis - The only issues that can be seen in basic GIS are ones visible in plan view, such as headcuts, old roads, erosion below culverts, and so on. Eroding banks, a major source of sediment in watersheds, are hardly visible in a plan view aerial photo (they are vertical). A complete GIS assessment would use the "Spatial Analyst" plug in to model the watersheds and locate each gullied portion of a channel. The base layer for this is a 10M Digital Elevation Model.

Ground Assessment - A ground assessment is needed and would consist of walking the areas identified by the GIS analysis. This ground process would locate which banks are most eroded as well identifying the smaller headcuts that could not be seen on the aerial photo. Unique locations for treatment would be seen during the ground assessment, such as areas where culverts could be moved to create small detention basins above roads, culvert inlet structures could prevent gullying, and other issues.

GIS Analysis of Roads and Development Patterns - The largest factor to change from the healthiest arroyo (Arroyo del Alamo) to the worst (Treatment Plant Arroyo) is the number and size of the roads. This portion of Taos is "ex-urban" and appears to be developing piecemeal as developers put in one or two houses at a time. The pattern of roads on the landscape is seemingly un-related to the contours, slopes, or locations of nearby arroyos. These roads are also poorly drained, and a common situation is for each roadside ditch to become its own gully feeding to the larger gully and arroyo system.
The GIS watershed assessment could be used to easily identify roads that run across rather than along contour, road drains that lead to gullies, and other road issues.

Road and Subdivision Ordinances - Development patterns that are successful and not causing sediment loading to the watershed could be identified by the GIS analysis above and then be modeled. Changes in development ordinances could then be suggested to the Town of Taos and Taos County with a goal of a road and development pattern that would not harm the watershed. Most of this development in the 4 arroyos studied appears "stuck in limbo" after the recession, and it may be timely to come up with these suggestions now.

Splash pads - A common source of sediment and erosion is the concentration of water due to the installation of culverted road crossings. While most of these culverts are appropriately sized, during large flood events they become "water jets" that erode the downstream channel of the arroyo.


Rock Splash pad under culvert disperses force

Rock Rundowns - One headcut treatment that has shown to be effective over time is a Rock Rundown. This treatment involves widening and "laying back" the headcut to a 3:1 slope. Seeds are raked into the soil, and tamped into place. Rocks are laid by hand on top of this ramp to armor the surface against erosion; the rocks also act as mulch and keep the soil surface wet. Over time the growth of grass anchors the rocks and soil in place with their roots.

Road Drainage and Rolling Dips - A rolling dip road drain is used on a low-standard dirt road to drain portions of the road. This treatment is used in conjunction with a road that is "outsloped" and drains water downhill off the surface of the road. Many of the dirt roads and all of the old, historic roads could be drained by this technique.

Other road drainage techniques are standard, but seem to be few and far between in this area. Roadside ditches, wattles, swales, and other techniques can be used to harvest water and sediment before it reaches the arroyo and begins a gully.

Induced Meandering - This technique uses the power of floodwaters to induce the arroyo to meander and create a floodplain. A gullied channel will naturally evolve to a new channel type - induced meandering speeds this process. A variety of structures can be installed to bend the arroyo first one way, and then another, in time, the capacity of the arroyo to carry floods is increased, and bank erosion is lessened.

Pinon trees used to meander an arroyo and create floodplain.

Armoring Low Water Crossings - A number of the dirt roads in the watersheds studied are causing erosion where they cross the arroyos. The road can concentrate water into the arroyo and cause erosion if not-properly drained uphill of the crossing. The traffic across the arroyo also causes scour on the bed of the channel, lowering the channel and sending a headcut upstream in the arroyo. Properly armoring these low water crossings can keep them passable, and prevent this erosion from occurring.

Gully formed by road, rock structure protecting road from headcut

Detention Ponds - Dirt ponds are commonly used to provide water for cattle, and in the Western U.S. are called "Tanks". These provide excellent sediment capture, but they do fill up over time and need maintenance. If these tanks were built by bulldozer on the edge of the escarpment (overlooking the Rio Pueblo), the basalt bedrock could be used for the overflow of the tank and prevent erosion. These are large, expensive treatments that would need to be installed correctly and maintained over time to remove sediment and keep the capacity of the tank at maximum.

Considering the amount of sediment that would need to be captured yearly, 1.3 acre-feet per year in the Arroyo Medio alone, the size of the tanks would be about 1,000,000 gallons for Arroyo Medio and Otter Arroyo. There is no appropriate location in Treatment Plant Arroyo, and it is not a safe or effective treatment in that watershed.

2.2.6.3 Load Reductions (Sediment)

An assessment of the future sediment yield after erosion treatment made several assumptions. The four categories "ground cover', "land use", "upland erosion" and "channel erosion" were considered to be higher in the three un-healthy watersheds. Land use was higher due to the high concentration of roads, if the old roads were drained, and splash pads installed at the culverted road crossings, we assume that the value of this category could be reduced from 5 to 2 (0 being the baseline of Arroyo del Alamo).
In terms of ground cover and upland erosion, no treatments are suggested to address these issues. The area is mostly un-grazed at present, in the past, heavy grazing pressure probably converted this area from a grassland to a Big Sagebrush shrubland. While there are treatments to eliminate sage and bring back grasses, they use an herbicide called "Spike" and often end in a monoculture of Crested Wheatgrass, a non-native bunchgrass. This treatment may actually lead to more bare soil and surface erosion. Because of this, both of these categories were left unchanged in the future "treated" condition.

The channel erosion and sediment transport category was valued at 20 in the eroding watersheds and 15 in the Arroyo del Alamo. The headcut treatment would address some of the active head cutting and would be relatively easy to apply by crew or machine. The eroding banks are long and there are many miles of them to treat by Induced Meandering, so we assumed that they would not be treated in the near future. If the headcuts were all treated, we assume that the value for this category could be reduced to 18 from 20.

Table 2-15. Reduced Load Associated with Management Measures (Sediment)

Arroyo	PSIAC current	PSIAC future	# of proposed management measures	Sediment Yield current	Sediment yield future
Arroyo del Alamo	51	51	3	3.3 acre feet per year	3.3 acre feet per year
Arroyo Medio	62	57	11	1.3 acre feet per year	1.1 acre feet per year
Otter Arroyo	62	57	13	1.1 acre feet per year	0.9 acre feet per year
Treatment Plant Arroyo	62	57	22	7.6 acre feet per year	6.5 acre feet per year
				OVERALL CHANGE FOR 3 TREATED ARROYOS	**1.5 acre feet per year**

2.2.7 CHANNEL RESTORATION - (TEMPERATURE AND SEDIMENT)

Channel restoration has the potential to improve both Temperature and Sediment Loading in the river. Over time the Rio Pueblo de Taos has been modified and the channel moved to the northern edge of the valley to create more land for irrigated agriculture. Formerly the channel flowed in the middle of the valley and was probably bordered by wetlands. Depending on the slope and substrate, the original Rosgen Channel type was probably an "E" or "C" channel. An "E" channel would have been deep and narrow, with overhanging banks of wetland vegetation. Where the substrate was courser and the channel less sinuous, a Rosgen "C" channel would have active gravel point bars with Coyote willows.

Either channel type would have been deeper and narrower, with good habitat for fish and other aquatic species. Beaver ponds were most likely common and provided off-channel storage of water and additional aquatic habitat.

At present, the channel is pushed to the northern edge of the valley and has lost much of its sinuosity and floodplain. In addition, the river is accessible to livestock for much of this length. Livestock trample the banks and eliminate the native riparian willows and cottonwoods. The overstory vegetation at present is mostly Russian Olives (*Elaeagnus angustifolia*). These non-native species are thorny, nitrogen fixing trees that grow extremely fast. While they provide a shady overstory, they crowd out native vegetation and can reduce the diversity of arthropods and birds by creating a monoculture of one tree species. The primary rationale for moving the channel was to dry out the boggy wetlands so that the land could be used for vegetable agriculture and pasture. An additional reason for moving the channel was to simplify the irrigation and cultivation of the land by creating larger fields.

The present channel form is a Rosgen "B" channel, with a high Width/Depth ratio that inhibits the movement of sediment through the system. The excess sediment in this area is most likely due to uplands erosion from watersheds in poor condition as well as bank erosion from grazing cattle and horses. This sediment forms mid-channel bars in the river, which pushes the river against its banks and causes bank erosion on the outside bends. The sediment from the bank erosion is deposited downstream on the next mid-channel bar, which causes more bank erosion, and this problem continues downstream. This shallow, wide channel is poor habitat for fish and other aquatic species.

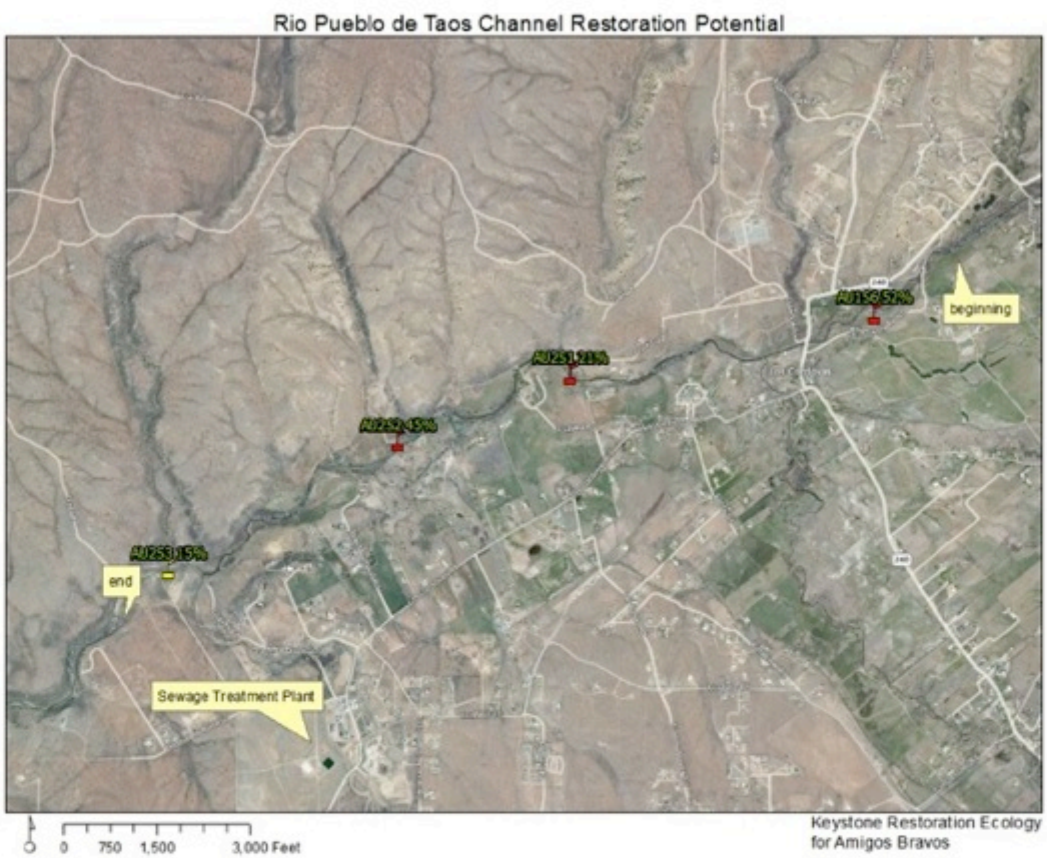
The channel form that would be most desirable in the present location would be a Rosgen "C" channel with a meandering form, active floodplains with willows thickets, and a riparian overstory of cottonwoods. A Rosgen "E" channel is much more sinuous, requiring much more of the floodplain and is less likely to be acceptable to landowners. A Rosgen "C" channel would have pools form at the outside of the bends; sediment in the channel would move downstream and be captured on floodplains covered by coyote willows on the inside of the new meanders. The channel form would be narrower and deeper and provide better habitat for aquatic species.

The exact location and type of channel restoration would depend on the location of willing landowners and the unique properties and constraints of each site. A combination of fencing, adding pools to the channel with cross-vane structures, inducing meandering with baffles, and other rock structures could improve the channel in its present location. Where possible, the channel could be moved back into its former location, adding length to the Rio Pueblo and re-establishing access to the floodplain. These relocated reaches could even be re-created as Rosgen "E" channels, giving another channel and habitat type for living creatures in the river.

Restoring 12,000 feet of the Rio Pueblo de Taos would have to be done in phases, and would start by creating relationships with willing landowners. Demonstration projects on their property would be used to sell the restoration to other landowners nearby. If enough of the area can be fenced, replanted and restored, a healthy trout population will be the reward for the community that live along the Rio Pueblo de Taos.

The 12,000 feet of proposed restoration area was selected by field visits and examination of aerial photography. The 12,000 feet includes 3 high priority canopy sites and 1 moderate priority canopy see Map 2-9.

Map 2-12. Channel Restoration Priority Area



2.2.7.1 Channel Restoration – Management Measures

Fencing- One of the largest constraints to healthy channel, healthy canopy, and a healthy ecology at present is the heavy livestock grazing on a large portion of the middle section and lower portion of upper section. There is plenty of excellent pastureland in the uplands, so the livestock access is mostly for watering purposes. Cattle grazing eliminates cottonwoods and severely curtails the growth of coyote willows, while areas grazed by horses do not lose their woody riparian species. Both cattle and horses trample and graze the bank vegetation, widening the channel and adding sediment to the Rio Pueblo.

If livestock access can be limited to localized areas with armored stream crossing used only for watering the livestock, the banks and riparian vegetation will have a chance to recover and perform their ecological function. A 200 or 300-foot wide floodplain would allow for a very healthy riparian corridor with excellent fishing and stream health. Limiting livestock access would be achieved through additional fencing and fence repair, as cattle roam most of the area. This fencing would be expensive and would have to be done by willing landowners as a match, possibly with NRCS or other funding sources to help defray the costs.

Large areas of coyote willows already exist and would respond quickly to grazing exclusion. They would help narrow the river channel , and help stabilize floodplains that slow floodwaters and remove fine sediments from the channel. Areas without willows would be re-planted by a crew and large numbers of cottonwoods would be re-introduced and pole planted. The willows and cottonwoods would help shade the channel, reducing max temperatures and helping fish populations.

Cross Vanes / J hooks – Cross Vanes and J-hooks are arch-like rock structures used to prevent bank erosion and create a pool downstream of the structure. They are usually constructed from large boulders, and installed just above a bend pool at a meander bend. The vane portion of the cross vane deflects the flow away from the bank towards the scour pool. These structures are usually installed in locations where the channel needs grade control, as they are more stable than a conventional check dam structure. The need for approximately 2 cross vane / j hook structures was identified in the channel restoration priority reach.


Hand-built cross vane in Cuba, NM

Baffles – Baffles are intended to induce a meander in the river and are shaped like a 90-degree right triangle. They are constructed either with rocks or hammered "picket posts" cut from native junipers. The river is deflected by the baffle, which causes erosion on the outside bank opposite to the baffle. Sediment from upstream is deposited behind the baffle in the eddy current, this sediment becomes a floodplain. This deposition behind the baffle creates a natural sorting of the sediment sizes, with larger particles on the bottom, water flowing through this large particle layer creates sub-irrigation of the point bar floodplain. Coyote willows are usually planted in the baffle and they colonize the floodplain and stabilize the deposited sediment. The need for approximately 20 baffles has been identified in the channel restoration priority stretch.

Channel Relocation- Channel relocation would be used in situations where the old channel was easily accessible and at a similar elevation to the present channel. The old channel would be excavated carefully to preserve the buried cobble layers and sediments that were the original bed of the river. These re-located portions of the channel would be able to sub-irrigate large areas of farmland that have been cut off from the groundwater table. Two sites have been identified as potential channel relocation sites (see Map 2-9).

2.2.8 STAKEHOLDER OUTREACH , EDUCATION AND ORDINANCES

Amigos Bravos is in a good position to reach out to stakeholders in the Rio Pueblo de Taos Watershed. As a 25-year old statewide river advocacy organization, based in Taos, Amigos Bravos has a long history of and a wide base of support for advocating for clean water in

Taos County.

While Amigos Bravos is in a strong position to conduct outreach it should be noted that almost 100 percent of the project area covered by this plan is on private property. This has presented a challenge with access and identification of potential restoration projects. Planning processes on public lands have better access and easier ability to identify restoration projects both because it is easier to deal with one or two landowners (US Forest Service, BLM or State agencies) instead of hundreds of landowners, most of which only own small tracks of land and because public land agencies are bound by their missions to work to protect water quality and, at least on the face of things, are already on board and at familiar with the language of and concepts of Clean Water Act and related watershed planning and restoration efforts.

In 2005 Amigos Bravos worked with stakeholders to draft a Watershed Restoration Strategy for the Rio Pueblo de Taos. Through the 2005 process and the current 2012 Watershed Based Plan process a strong core of active stakeholders that participate in watershed meetings and volunteer activities has formed.

Email Lists **-** In addition to Amigos Bravos' broader membership and action alert email list which we periodically receives Rio Pueblo de Taos related news and action items, a 100+ Rio Pueblo de Taos Watershed Stakeholder list has been developed by collecting names and emails from those that have attended watershed meetings over the years. This list will be essential during plan implementation

Watershed Meetings **-** During the current Watershed Based Planning Process, eight watershed meetings were held. In addition, individual stakeholder meetings were conducted with the following stakeholders: Taos Pueblo, Taos Fly Shop, Town of Taos, Taos Soil and Water Conservation District, Bureau of Land Management Taos Office, Carson National Forest, Water Sentinels of Taos, Taos River Guiding Companies (Far Flung Adventures and Los Rio River Runners), and the Taos Bar Association. At these meetings the Project Manager gave an overview of the project and asked for input and ideas from each stakeholder. These stakeholders all communicated an interest in participating in the watershed plan and have been kept up to date with the process via group watershed meetings and email updates. At least quarterly watershed meetings will be essential for implementing the plan. In addition outreach and communication with individual stakeholders on an ongoing basis will also be essential.

US Postal Mail **-** Stakeholder volunteers joined with Amigos Bravos in doing the lengthy research to obtain the names and mailing addresses of all landowners along the Rio Pueblo de Taos. Hard copies of county maps of the land ownership along the river were obtained are now are housed in the Amigos Bravos library. This research resulted in a Rio Pueblo de Taos landowner US postal service mailing list. Numerous mailings were sent to this list throughout the planning process. These mailings consisted of flyers about the meetings and information about the watershed planning process in general. Landowners that were interested in learning more about the project but who couldn't make it to the meeting were encouraged to contact the Amigos Bravos staff to find out more information. Numerous individual meetings were conducted with private landowners as a result of these mailings. Because many landowners either do not have email or we have not been yet able to obtain their email addresses, communication via US postal mail will continue to be an essential tool for conducting outreach to stakeholders.

Door-to-Door Contact - In addition to the watershed meetings and individual stakeholder meetings Amigos Bravos staff and stakeholder volunteers spent many days and evenings going door-to-door to talk to landowners along and near the river in an effort to inform stakeholders about the project and identify landowners that may be interested in participating in watershed restoration projects. Door-to-door communication may serve as an important tool especially when trying to target certain sections of the river for on-the-ground restoration projects.

Volunteer Watershed Monitoring - Many watershed stakeholders are involved with and or interested in the ongoing watershed monitoring that Water Sentinels of Taos and Amigos Bravos have been conducting for many years. This sampling has resulted in many stakeholders getting more involved in watershed issues. This activity should continue to be used to communication with stakeholders and recruit volunteers for on-the-ground restoration projects. In addition, these ongoing Sentinel /Amigos Bravo monitoring efforts should be leveraged to coordinate with plan specific monitoring. Utilizing volunteers in the monitoring process will help further education about water quality and water quality standards in general and links between management measures and improved water quality.

Trainings and Technical Assistance – During the planning process stakeholders expressed concern about the Taos Wastewater Treatment Plant, which discharges into the Rio Pueblo. Amigos Bravos staff helped stakeholders understand and participate in the NPDES permit renewal and public comment process. Ultimately helping stakeholders to participate in the regulatory and permitting process, not only improved the regulatory landscape but also gained a lot of interest and support in watershed issues in general.

Implementation of the plan should capitalize on this interest to generate public support for plan implmention. Implementation of the plan will involve trainings, updates and technical assistance to watershed stakeholders about water quality issues and regulatory processes impacting the watershed. Specific trainings about water quality and water quality standards should be offered to help further stakeholder understanding about the importance of implementing management measures.

Radio - As part of this planning process numerous radio shows were recorded and aired. During these radio shows Amigos Bravos staff and volunteers outlined the watershed planning process and encouraged people to attend watershed meetings. Amigos Bravos has a long standing relationship with all three of the local radio stations (KRZA, KTAO, KVOT) and use and outreach through interviews and PSAs at these stations will be crucial in moving forward with restoration and implementing the watershed plan.

Watershed Tours and Watershed Cleanups - Two watershed tours and cleanups were conducted as part of the planning process. The annual watershed tour/cleanup is a good avenue for reaching out to stakeholders. This ongoing event will be critical as plan implementation moves forward.

In addition to the watershed tour a tour of the wastewater treatment plant was conducted during the planning process. As mentioned previously, concern about the wastewater treatment plant has generated a substantial amount of interest from the public and has resulted in increased awareness about water quality in the Rio Pueblo de Taos. Continued updates about the discharge and future tours of the treatment plant combined with watershed restoration and planning efforts will help to increase overall participation in watershed planning and restoration.

Education Campaigns – Several issue specific education campaigns will be essential for implementing the plan. Education campaigns about river friendly irrigation hours, beaver ecosystem functions, river friendly tax deduction options, river buffers, road and subdivision BMPs, and importance of long-term watershed stewardship will be essential in educating stakeholders about actions that can be taken both at an individual level as well as at a community level for reducing temperature and sediment impacts to the Rio Pueblo de Taos. These education campaigns will be essential in educating stakeholders about the relationship between implementation of management measures and attainment of water quality standards:

- For the *River Friendly Irrigation Hour Campaign*, the link between more water (flow) in the river and lower temperatures will be made.

- For the *Beaver Ecosystems Function Campaign* links between beaver dams and groundwater storage and release of water throughout the year and related increase of sustained flows and decrease of temperatures through the dry months will be made. In addition, these education campaigns will be essential in increasing awareness and participation about the overall plan.
- The importance of adopting buffers to protect riparian areas and canopy health will be communicated to stakeholders in *River Buffer Education Campaign*. The relationship between a healthy canopy and lower water temperatures will be conveyed.
- Stakeholders will be educated about the relationship between road BMPs and decreasing sediment loading in the river in the *Road/Subdivision BMP Campaign*. The need for better road building and maintenance to attain water quality standards in the river will be communicated during this education campaign. A model road ordinance will be used as a tool for education as well as an advocacy goal.
- The need for a longterm vision to maintain gains made projects and efforts implemented under this watershed plan will be communicated to stakeholders in the *Watershed Stewardship Education Campaign*. This campaign will be focus on the importance of longterm commitment towards maintaining water quality long into the future and long after the projects outlined in this plan are implemented. This stewardship will have to include maintenance of actions and BMPs that were implemented to restore water quality as well as identification of new actions and BMPs that could be implemented to protect gains in water quality.

Ordinances: Two model ordinances will be drafted and advocated for over the period of plan implementation. These include:

- A Riparian Buffer Ordinance – This model ordinance will include protections for riparian areas along the Rio Pueblo de Taos and will prohibit or limit development or activities within a buffer width of the river. A Riparian Buffer Ordinance would protect existing canopy as well as protect planting efforts detailed in this plan.
- A Road/Subdivision Ordinance – Lack of a comprehensive standard for road and subdivision development has led to substantial sediment loading in the Rio Pueblo de Taos. A model ordinance will be developed to set guidelines for road building and subdivision development. Inclusion of road maintenance guidelines will be an essential component of a Road/Subdivision Ordinance.

These model ordinances will be used to approach local planning entities (Taos County and Town of Taos) to advocate for adoption of model ordinances or work with local entities to adopt something similar. They will also be an essential tool in the education campaigns outlined above.

2.2.9 IMPLEMENTATION SCHEDULE

Table 2-16. Implementation Schedule

Management Measures	2013	2014	2015	2016	2017	2018	2019	2020	2021
Apply for funding									
Watershed Education (watershed meetings, watershed cleanups, watershed tours, watershed updates, trainings, dissemination of education materials)									
Reach out to project partners and develop specific project work plans									
Obtain necessary permits and landowner permission									
Draft Quality Assurance Project Plan (QAPP)									
Coordinate monitoring efforts with other entities and partners in watershed.									
Implement Monitoring (HOBO devices and densiometer readings)									
Education campaign about river friendly irrigating hours									
Implement 1 high priority * planting/canopy projects per year (4 projects)									
Develop model river buffer ordinance									
Advocate adoption of buffer ordinance by									

local decision makers									
Research non-grazing tax deduction options for landowners									
Implement 1 moderate priority* planting/canopy project per year (4 projects total)									
Implement 1 High Priority* planting/canopy project									
Implement 1-2 fencing/upland water access projects per year (16,000 feet total fencing - but work will be divided up into much smaller sections/projects)									
GPS identification of tires in the channel									
Tire removal from middle and lower segments of river									
Implement channel restoration (baffles, vanes and J-hooks) implementation in priority reach (20 treatments total)									
Channel relocation project 1`									
Channel relocation project 2`									
Education campaign about beaver ecosystem functions									
"Spatial Analyst" GIS analysis of gullied portions of Otter, Treatment Plant, and Medio Arroyos									
Ground truthing of GIS analysis									

Stakeholder education/outreach campaign about roads – drainage sediment impacts									
Road and subdivision model ordinance development									
GIS analysis roads and development patterns									
Advocate adoption of road and subdivision ordinances									
On–the-ground road/arroyo treatments^ Treatment Plant Arroyo° (22 treatments)									
On–the-ground road/arroyo treatments^ Otter Arroyo° (13 treatments)									
On-the-ground road/arroyo treatments^ Medio Arroyo° (11 treatments)									
Stewardship Education Campaign									
Evaluation Reports									

*** See Table 2-9 for list of priority planting/canopy projects/ and site specific implementation target dates**
` See Map 2-9 for channel relocation sites
^ Road Treatments include splash pads, rock rundowns, rolling dips, crossing armoring, and detention ponds. See Section 2.2.6 for more details about these management measures.
° Specific locations and types of management measures for each arroyo are identified in Section 2.2.6

2.2.10 RESOURCE NEEDS

Table 2-17 – Financial Resources Needed to Implement Plan

DESCRIPTION	# OF YEARS	COST PER YEAR	TOTAL COST
Project Management			
Project Director	8	30,000	240,000
Project Administrator	8	8,000	64,000
Staff Benefits (including education and monitoring staff)	8	15,000	120,000
Travel	8	750	6,000
Supplies	8	500	4,000
Subtotal		**54,250**	**424,000**
Planning, Education, Outreach			
Regulatory Research, Development, and Advocacy (Buffer Ordinances, Tax Credits, LID/GI, Road and Subdivision River Friendly Planning and Zoning)	3	15,000	45,000
Education and Outreach (watershed meetings, meeting with stakeholders, development of education materials, trainings)	8	20,000	160,000
Education Materials	8	2,000	16,000
Subtotal		**22,000 - 37,000**	**221,000**
Monitoring			
Purchase monitoring equipment	1	10,000	10,000
Develop QAPP	1	5,000	5,000
Coordinate Monitoring Efforts	8	10,000	80,000
Subtotal		**10,000 - 16,000**	**86,000**

DESCRIPTION	COSTS
Canopy Treatments (Temperature)	
Understory and overstory planting in 5 high priority sites: Willow	168,500

planting 3,750 feet of 15,000 feet high priority reaches and planting of 500 cottonwoods	
Overstory planting in 4 moderate priority sites: planting of 200 cottonwoods along 12,000 feet of moderate priority reaches.	30,000
Russian olive removal along 12,000 feet of high priority reach	80,000
Fencing approximately 16,000 feet at approximately 1.50 a foot cost	24,000
Subtotal	**302,750**

DESCRIPTION	# OF STRUCTURES	COST PER STRUCTURE	TOTAL COSTS
Sediment / Erosion Project Implementation in Arroyo Tributaries			
Headcut control structure	29	5,000	145,000
Low water crossings with crossvane	6	5,000	30,000
Splash pad	14	3,000	42,000
Subtotal			**217,000**
Channel Treatments (Temperature and Sediment)			
J Hooks or cross vanes	20	10,000	200,000
Baffles	20	3,000	60,000
Channel relocation	2	30,000	60,000
Subtotal			**360,000**

TOTAL COSTS OF PLAN IMPLEMENTATION	**1,610,750**

* Costs of design and permitting are incorporated into these cost estimates.

<u>Sources of Funding</u>

Healthy Rivers New Mexico
319 Program
Clean Water Act Revolving Loan Fund
Public Land Agencies – USFS and BLM (General operating budgets, specific grant programs such as the USFS CFRP Grant,)
US Fish and Wildlife Service (Partners for Fish and Wildlife, Landowner Incentive Program)
NM Game and Fish Department (Share with Wildlife Program)
Private Landowners
Foundations and Non-Profits

New Mexico Water Trust Board
NRCS (programs and funding opportunities such as EQIP and NWQI would be good sources for plan implementation: http://www.nm.nrcs.usda.gov/programs/)
OSM/VISTA (Administrative and outreach assistance)
Town of Taos
Taos County

With temperature being a major impairment in the Rio Pueblo de Taos, grant opportunities from funding sources that focus on mitigating the impacts of climate change would be a good source to apply for funding to implement restoration efforts in the river. Some examples of funding sources that have focused on climate change in the past include the Wildlife Conservation Society, US Fish and Wildlife Foundation.

The Bureau of Land Management (BLM) has indicated interest in collaboration and possibility of funding to implement the high priority planting project at site AU3S4.

The Town of Taos has indicated willingness to provide substantial match in the form of heavy equipment usage for a planting project and wastewater channel restoration project in upper reach of site AU2S3 (see appendix E)

One local landowner has indicated interest in having work done on their land as well as a willingness to host education programs on their river front property. Multiple landowners have been approached about restoration potential and collaboration both for channel restoration and plantings in sites AU1S6, AU2S1, and AU2S2. These are the highest priority areas for implementing management measures for both channel and canopy projects. There has been some openness shown in working collaboratively among these landowners though also some suspicion and reluctance. For more information about specific landowners that have been contacted please contact Amigos Bravos at bravos@amigosbravos.org. In addition, working with Taos Soil and Water Conservation District as well as Taos County or Town of Taos would be a good avenue for approaching these landowners and developing a broad collaboration to leverage funding and technical expertise.

Sources of Technical Knowledge:

New Mexico Environment Department – Surface Water Quality Bureau (505) 827-0187
NRCS - (800) 410-2067
Taos Soil and Water Conservation District- (575) 751-0584

Keystone Restoration Ecology Consulting (505) 490-0594
Native Waters Consulting (505) 577-0233
River Source Consulting (505) 660-7928
Other Regional Restoration Consultants: Craig Sponholtz, Steve Carson, Bill Zeedyk
Taos Office BLM (575) 758-8851
Carson National Forest (575) 758-6200
Taos Pueblo
Amigos Bravos (575) 758-3874
Water Sentinels of Taos (575) 776-2833

Technical Assistance and Data Needs:

- Site specific planning for channel restoration management measures (Keystone Restoration Ecology, Native Waters Consulting, River Source Consulting, Craig Sponholtz, and Steve Carson could be good resources for this technical need).
- Plans for appropriate fencing and alternative water sources associated with each canopy project will have to be developed (NRCS, TSWCD, Keystone Restoration Ecology, Native Waters Consulting, River Source Consulting, Craig Sponholtz, and Steve Carson could be good resources for this technical need).
- Additional data about the temperature of the wastewater treatment plan arroyo should be collected and analyzed to determine impact on temperature loading in the Rio Pueblo de Taos. (Taos Pueblo, Water Sentinels, Amigos Bravos and NMED could be good resources for this technical need)
- GIS expertise will be need to identify additional sediment reduction projects in the 4 identified arroyo (Keystone Restoration Ecology and Native Waters Consulting could be good resources for this technical need)
- SSTEMP modeling of temperature data that will be collected in 2014, 2017 and 2020 will need to be conducted (NMED and Native Waters Consulting could be good resources for this technical need).
- Additional data about how water is being diverted from the river and during what specific times would be helpful in implementing the River Friendly Irrigation Education Campaign as well as to identify other possible mechanisms for increasing flow in the river.
- Quantifying the amount of water the wastewater treatment plant diverts to the Golf Course and identifying possibilities for decreasing this amount could increase the flow in the river during the hottest periods of the year.
- As mentioned in Section 1.1 (page 1), Section 2.2 (page 13), there is a need for future planning efforts to address the nutrient and bacteria impairments that were added to the Rio Pueblo de Taos during the 2012 303d list development process. Section 2.3 of the plan has been set aside for this future planning process. As

mentioned in Section 1.1, this is a living document that is intended to be revised and added to through separate but connected planning processes as impairments are addressed and new impairments are detected (Taos Pueblo, NMED could be good resources for this technical need).

2.2.11 MONITORING, MILESTONES, AND EVALUATION OF PLAN'S EFFECTIVENESS

Monitoring:

Several monitoring techniques will be used to monitor the progress of addressing temperature impairment and sediment impacts in the Rio Pueblo de Taos.

A Quality Assurance Project Plan (QAPP) will be developed early in plan implementation to outline monitoring priorities and practices. Within the first 2 years of the plan, coordination with other entities (BLM, Taos Pueblo, Water Sentinels) in the watershed and development of collaborative data gathering efforts will be explored.

Temperature Monitoring:
HOBO continuous temperature monitoring devices will be deployed in approximately 6 sites (2 per AU- one near the lower and one near the upper portions of each AU) locations detailed by the QAPP in years 2014, 2017 and 2020. This will provide a baseline which will be included in the 2016 report, an intermediate progress report which will be included in the 2018 and a final assessment report which will be prepared in 2021. The SSTEMP model will be run each year there is new data. The results of these model runs will be included in the 2016, 2018 and 2021 reports.

Densiometer readings will be conducted prior to planting activities at each planting site. In addition, densiometer readings at all 16 sites in Table 2-3 will be collected three times during the planning process, once in 2015, once in 2017 and once in 2020. Densiometer readings will also be conducted at all planting sites in 2020.

Sediment Monitoring:
The PSIAC sediment modeling tool will be used in 2017 and in 2020 to determine progress towards reducing sediment in each of the arroyos. In addition an accounting of the number of management measures implemented by 2017 and 2020 in each arroyo system multiplied by estimated acre feet reduction per management measure (see table 2-18 below) will give a estimate of number of acre feet per year reduction achieved.

Table 2-18 Load Reduction Per Arroyo Management Measure

Arroyo	# of proposed management measures	Sediment Yield current	Sediment yield future	Acre feet reduction per management measure
Arroyo del Alamo	3	3.3 acre feet per year	3.3 acre feet per year	
Arroyo Medio	11	1.3 acre feet per year	1.1 acre feet per year	.018
Otter Arroyo	13	1.1 acre feet per year	0.9 acre feet per year	.015
Treatment Plant Arroyo	22	7.6 acre feet per year	6.5 acre feet per year	.05
		OVERALL CHANGE FOR 3 TREATED ARROYOS	**1.5 acre feet per year**	

Milestones and Evaluation Effectiveness of Plan

Milestones will be used to help determine progress of plan implementation and the effectiveness of management measures. Three evaluation reports, written over the period of plan implementation, will provide the main mechanism for tracking milestones and assessing the effectiveness of plan implementation. These evaluation reports will be written in 2016, 2018 and 2021. These reports will provide both a quantitative and qualitative assessment on the progress of plan implementation. The quantitative assessment will be based on the temperature data, densiometer data, photo points, and progress towards completing on-the-ground restoration project and education campaign project milestones (project specific timelines/milestones are detailed in Table 2-16). The qualitative assessment will primarily based on evaluation and feedback from watershed stakeholders during watershed meetings. Each evaluation report will also include recommendations as to whether or not the plan's implementation schedule needs to be changed and whether management measures should be added or dropped.

Table 2-19. Project Milestones

	# of Completed Canopy Projects	# of Channel Restoration Projects	# of Fencing Projects	Sediment road management measures completed	Other
2016 Report	2 high priority projects		2 fencing projects completed		2 ordinances drafted (buffer and road)
2018 Report	4 high priority projects	6 channel restoration projects completed	4 fencing projects completed	10 completed in WW Arroyo	2 ordinances adopted (buffer and road)
2021 Report	5 high priority project completed 4 moderate priority projects completed	22 channel restoration projects completed	9 fencing projects completed	22 completed in WW Arroyo 11 completed in Arroyo Medio 13 completed in Otter Arroyo	Tires removed from AU3

Additional Canopy and Sediment Milestones:

By 2016:

- Canopy at site AU2S2 will be increased by 29.8%
- Canopy at site AU3S4 will be increased by 51.2%

By 2018:

- Canopy at site AU2S2 will be increased by 29.8%
- Canopy at site AU3S4 will be increased by 51.2%
- Canopy at site AU1S6 will be increased by 23.4%
- Canopy at site AU2S1 will be increased by 54.4%

- Sediment will be decreased by .5 acre feet per year

By 2021:

- Canopy at site AU2S2 will be increased by 29.8%
- Canopy at site AU3S4 will be increased by 51.2%
- Canopy at site AU1S6 will be increased by 23.4%
- Canopy at site AU2S1 will be increased by 54.4%
- Canopy at site AU1S5 will be increased by 23.3%
- Canopy at site AU2S3 will be increased by 60.2%
- Canopy at site AU2S4 will be increased by 51.4%
- Canopy at site AU2S5 will be increased by 61.2%
- Canopy at site AU2S6 will be increased by 46.4%
- Sediment will be decreased by 1.5 acre feet per year

Canopy Increases will be measured by densiometer readings during years 2015, 2017 and 2020 and reported in the progress reports scheduled to be completed in 2016, 2018, and 2021.

PLACEHOLDERS FOR FUTURE PLANNING EFFORTS

2.3 RIO PUEBLO DE TAOS – E.COLI AND NUTRIENT/EUTROPHICATION BIOLOGICAL INDICATORS (NON-TRIBAL PORTIONS) - this is a placeholder for future planning efforts.

2.4 RIO LUCERO (NON TRIBAL PORTIONS) – this is a placeholder for future planning efforts

2.5 RIO FERNANDO (NON TRIBAL PORTIONS) – this is a placeholder for future planning efforts

2.6 RIO GRANDE DEL RANCHO (NON TRIBAL PORTIONS) – this is a placeholder for future planning efforts

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