Cimarron Watershed-Based Plan

Prepared by
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the Cimarron Watershed Alliance
and the Quivira Coalition

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In particular, information on probable sources, realistic management measures, and financial requirements was provided by Cimarron Watershed Alliance members. Cimarroncita Ranch, C.S. Ranch, Philmont Scout Ranch, and Vermejo Park Ranch, in addition to other local landowners, all contributed practical information. Steve Carson of Rangeland Hands and Rick Smith of Highland Solutions provided field survey reports and recommendations.

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List of Acronyms

BAER	Burn Area Emergency Rehabilitation
BMP	Best Management Practice
cfu	colony forming unit
CFRP	Collaborative Forest Restoration Program
CWA	Cimarron Watershed Alliance
DWS	Domestic Water Supply
E.coli	*Esheria coli*
EMAP	EPA Environmental Monitoring Assessment Program
EPA	U.S. Environmental Protection Agency
HQCAL	High Quality Cold Water Aquatic Life
HUC	Hydrologic Unit Code
j/m2/day	Joules per meter squared per day
LA	Load Allocation
MCAL	Marginal Cold Water Aquatic Life
MOS	Margin of Safety
NMED	New Mexico Environment Department
NPS	Nonpoint Source
ONRW	Outstanding National Resource Water
SC	Secondary Contact
SSTEMP	Stream Segment Temperature Model
STEPL	Spreadsheet Tool for the Estimation of Pollutant Load
TMDL	Total Maximum Daily Load
UNM	University of New Mexico
USFS	U.S. Forest Service
USLE	Universal Soil Loss Equation
WLA	Waste Load Allocation
WBP	Watershed-Based Plan (WBP)
WRAS	Watershed Restoration Action Strategy
WWAL	Warm Water Aquatic Life

1. Introduction

The Cimarron Watershed Alliance (CWA) was formed in 2001 to provide local input on water quality issues in the Cimarron Watershed in northeastern New Mexico. The CWA developed a Watershed Restoration Action Strategy (WRAS) in 2003 to guide watershed restoration efforts (CWA, 2003). The WRAS identified water quality concerns, defined potential watershed restoration projects, and established restoration priorities including water quality monitoring, re-planting riparian areas, reducing forest biomass, and improving wastewater management throughout Colfax County.

After initial development of the WRAS, the U.S. Environmental Protection Agency (EPA) provided additional guidance to direct restoration projects and address nonpoint source pollution (EPA, 2008). The EPA now requires that a Watershed-Based Plan (WBP) be completed prior to receiving new funding for restoration activities. Accordingly, the WBP needs to address the following nine elements of watershed-based planning:

a) ***Source of Load Reductions***. Identify the causes and sources, or groups of similar sources, which must be controlled to achieve load reductions.

b) ***Estimate Load Reductions***. Estimate the expected load reductions by using the management measures described in paragraph (c) below.

c) ***Nonpoint Source Management Measures***. Describe the nonpoint source (NPS) management measures needed to achieve estimated load reductions.

d) ***Cost Estimate***. Provide an estimate of the amounts of technical and financial assistance, associated costs, and/or sources and authorities to be used to implement the Cimarron WBP.

e) ***Information/Education Component.*** Include an information/education component to enhance public understanding of the project and encourage participation.

f) ***Implementation Schedule.*** Devise a schedule for implementing the NPS management measures identified in the WBP.

g) ***Interim Milestones.*** Describe the interim, measurable milestones for determining whether NPS management measures or other control actions are being implemented.

h) ***Load Reduction Criteria.*** Compile a set of criteria to determine whether loading reductions are being achieved over time and to determine if substantial progress is being made towards attaining water quality standards.

i) ***Monitoring Component.*** Include a monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established in item (h) above.

The primary focus of the WBP is to address the root causes of impairment that affect designated uses of water within the watershed. This version of the WBP expands the original WRAS, addresses new guidance directives, and incorporates field data as well as any results from past and current projects that have become available since the original WRAS was prepared. There has been active public involvement throughout the development of this WBP, and the CWA has guided and reviewed all phases of the planning effort.

This WBP will serve as a living document, adding listed impaired stretches of the Cimarron Watershed as updated NMED/SWQB 303(d)-305(b) Integrated Lists become available.

This report is organized as follows:

- Section 2 provides background information on the CWA.
- Section 3 includes an overview of the watershed characteristics.
- Section 4 provides an overview of historic data and previous studies.
- Sections 5-11 address each of the nine elements of watershed-based planning, respectively.
- Section 12 provides the list of references.
- Appendix A provides estimates of load contributions from probable sources of impairment in the Cimarron Watershed.
- Appendix B provides results of Tier 1 Field Surveys.

Due to the complexities of the Cimarron Watershed, including variable water quality and land management issues, this WBP is intended to be a flexible document that can be updated periodically to reflect new data and/or changed conditions in the watershed.

1-1. Introduction to the 2017 Revision

This Cimarron Watershed Based Plan was revised in 2017 to include updates that have occurred since the original 2012 version was completed. Updates to the Watershed Based Plan include:

- Citation and inclusion of the Moreno Valley Wetlands Action Plan in Appendix C of the Cimarron Watershed Based Plan. The Moreno WAP is available online at: https://www.env.nm.gov/swqb/Wetlands/WAP/WAP_Moreno_Valley.pdf.
- Updates and additions to Table 7-2 and Tier 1 Projects listed in Section 7-2.
- Updated Table 10-1, Implementation Schedule and Interim Measurable Milestones.
- Assessment Reports for the Middle Ponil and Ponil Creek added to Appendix B.

2. Cimarron Watershed Alliance

Initial efforts to form a watershed group in the Cimarron Watershed began in 2001. The CWA was created in response to water quality investigations performed by the New Mexico Environment Department (NMED), as required by the United States Environmental Protection Agency (EPA), which identified problems in streams and rivers within the Cimarron Watershed. The group developed by-laws and was incorporated as a 501(c)(3) non-profit in 2004 (Hellman, 2010). CWA holds a monthly stakeholder meeting that is open to the general public.

The CWA is composed of volunteers from both incorporated and unincorporated areas of Colfax County. The CWA has involved stakeholders from all interest groups including public officials, state and federal agency personnel, civic group representatives, ranchers, business people, and community members with the common interest of maintaining and improving water quality and water quantity within the Cimarron Watershed. There are no Native Tribes residing within the watershed, although the Sandia and Taos Pueblos own some non-federal (private) property in the Moreno Valley. Collectively, CWA members represent more than one million acres of private property.

The CWA's mission is "to strive for and maintain a healthy watershed for all residents through collaborative community activities involving all stakeholders with an interest in water."

The objectives of the CWA are:

1. To restore, maintain and/or preserve surface and groundwater quality, aquatic resources, and water supplies.
2. To provide a resource for watershed issues and information.
3. To protect, restore, and maintain natural resources (land, water, forest, and wildlife) in the watershed.

The organizational structure of the CWA is that of a board of directors, which is composed of the CWA officers and a few volunteers from the membership. Additionally, a technical advisory panel, and temporary committees are available to address specific issues as needed.

CWA's initial and recent projects included reducing high temperatures by limiting livestock and wildlife access and re-planting riparian habitats; mitigating wildland fires through forest thinning and re-planting burned areas, sediment transport reduction through bank stabilization, in-stream, and low-water crossing remediation, restoring river channels and wetlands habitat, improving wastewater management, establishing alternative watering sources for wildlife and game, and conservation education.

The CWA collaborates with a variety of partners. The partner organizations currently involved in the Cimarron Watershed Alliance include the following (Hellman, 2010):

- New Mexico Environment Department/Surface Water Quality Department (NMED/SWQD)
- U.S. Forest Service (USFS)
- Quivira Coalition
- New Mexico State Parks
- New Mexico State Forestry
- New Mexico Game and Fish
- New Mexico Office of the State Engineer
- Vermejo Park Ranch
- Philmont Scout Ranch
- C.S. Ranch
- Cimarroncita Ranch
- Angel Fire Resort and Ski Area
- Towns of Raton, Cimarron and Angel Fire
- Many local residents

Examples of CWA collaboration projects include:

- CWA partners with the Quivira Coalition to restore riparian forests, stabilize streambanks, and control erosion on Ponil Creek. Other collaborators include Philmont Scout Ranch, Vermejo Park Ranch, Cimarroncito, Chase, and C.S. Ranches, the Village of Cimarron, NM State Forestry Department, and the NM Department of Game and Fish. The project goal is to decrease the creek temperature so that Ponil Creek can be removed from the NMED list of impaired waterways (Hellman, 2010).
- CWA collaborated with the New Mexico State Parks and Eagle Nest Elementary School to help 7th graders construct an osprey nesting platform.
- CWA collaborated with Colfax County to conduct a workshop on building and maintaining roads that prevent erosion.
- CWA collaborated with Western Wood Products to construct a transfer station in the town of Eagle Nest to reduce the distance required by landowners to haul wood materials that are accrued from forest-thinning projects.

3. Cimarron Watershed Description

The Cimarron River originates in the Sangre de Cristo Mountains of north-central New Mexico and flows generally eastward to the Canadian River (Figure 3-1). The watershed is approximately 1,032 square miles in size and lies on the eastern slopes of the Sangre de Cristo Mountains within Colfax County. The Cimarron River is part of the Canadian River Basin, which ultimately drains to the Mississippi River. Elevations in the watershed range from approximately 12,000 feet (in the headwaters located in the Valle Vidal Unit of the Carson National Forest) to slightly less than 6,000 feet (at the Cimarron/Canadian River confluence near Springer, New Mexico). The hydrologic unit code (HUC) for the Cimarron Watershed is 11080002.

Land ownership in the Cimarron Watershed is primarily private (Figure 3-1), with ranching as the predominant land use. Both the Carson National Forest and the NM Game and Fish Department own and manage the portions of land located within the western forested areas of the watershed. A small area of state-owned lands, located in the southern part of the watershed, is managed by the State Land Office. Cimarron Canyon State Park is owned by the New Mexico Game and Fish Department and managed by the New Mexico State Parks Division, and Eagle Nest Lake State Park is located in the Moreno Valley. These state parks, along with private recreational attractions such as the Angel Fire Ski Area and the Angel Fire Golf Course, have contributed to recent growth and development in the Moreno Valley, particularly in the Angel Fire area.

The upper reaches of the watershed are dominated by forest land, except for the Moreno Valley along Cieneguilla Creek and the grassland located in the lower reaches (Figure 3-2). Vegetation distribution in the Cimarron River watershed generally varies with elevation. The western portion of the watershed is characterized by high mountain landscapes with subalpine and montane vegetation, including coniferous forests of Engelmann spruce, ponderosa pine, and Douglas fir as well as deciduous aspen stands (University of New Mexico, 2010 and U.S. Forest Service, 2009). The eastern portion of the watershed falls within the Great Plains Province and is dominated by grass and shrubs. Plains vegetation includes sagebrush, annual and perennial grasses and small trees such as piñon, juniper, and scrub oak. The watershed also includes numerous riparian corridors. Vegetation in these riparian areas varies with elevation and land use but is generally characterized by alder, willow, cottonwood, and various herbaceous species (UNM, 2010 and U.S. Forest Service, 2009).

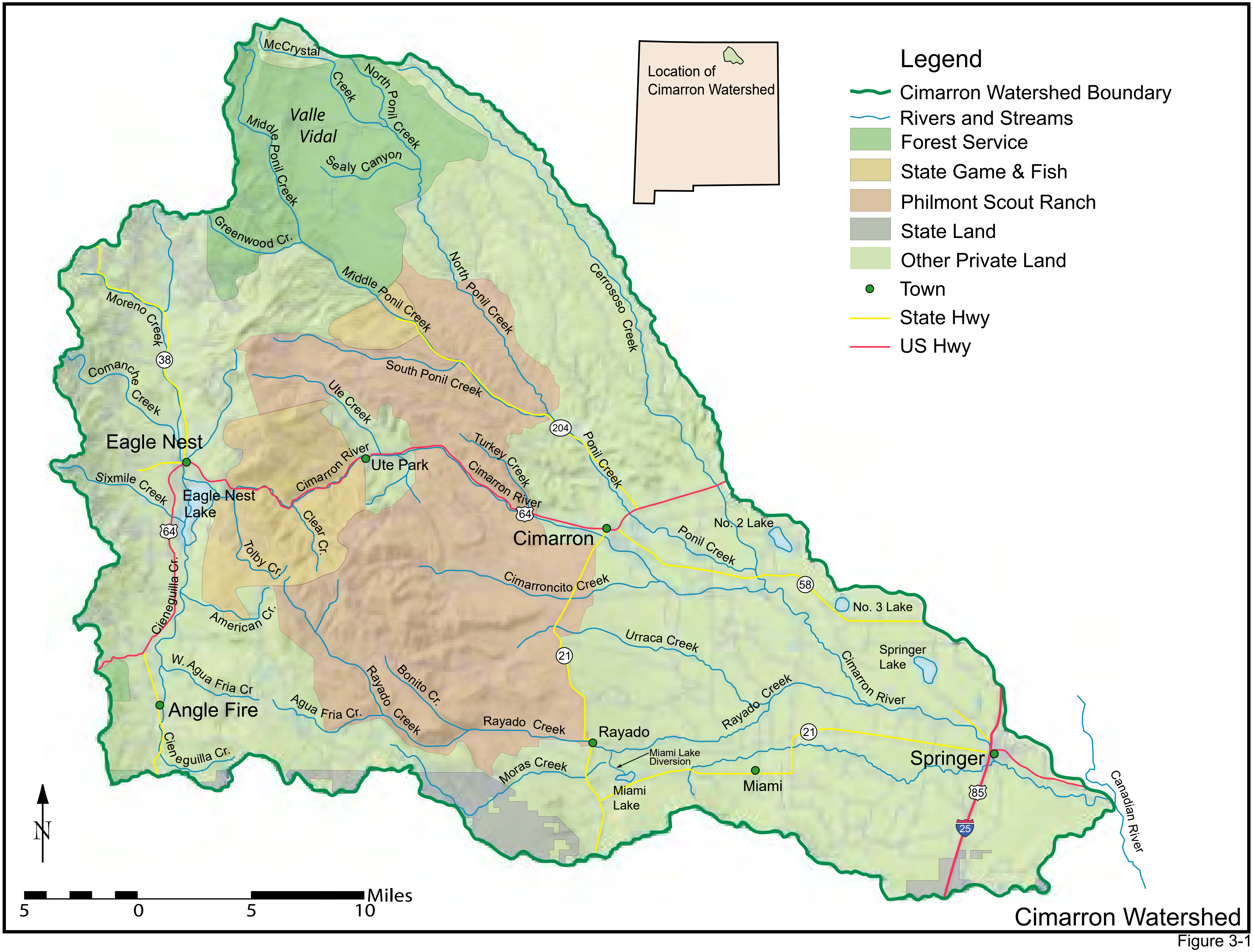
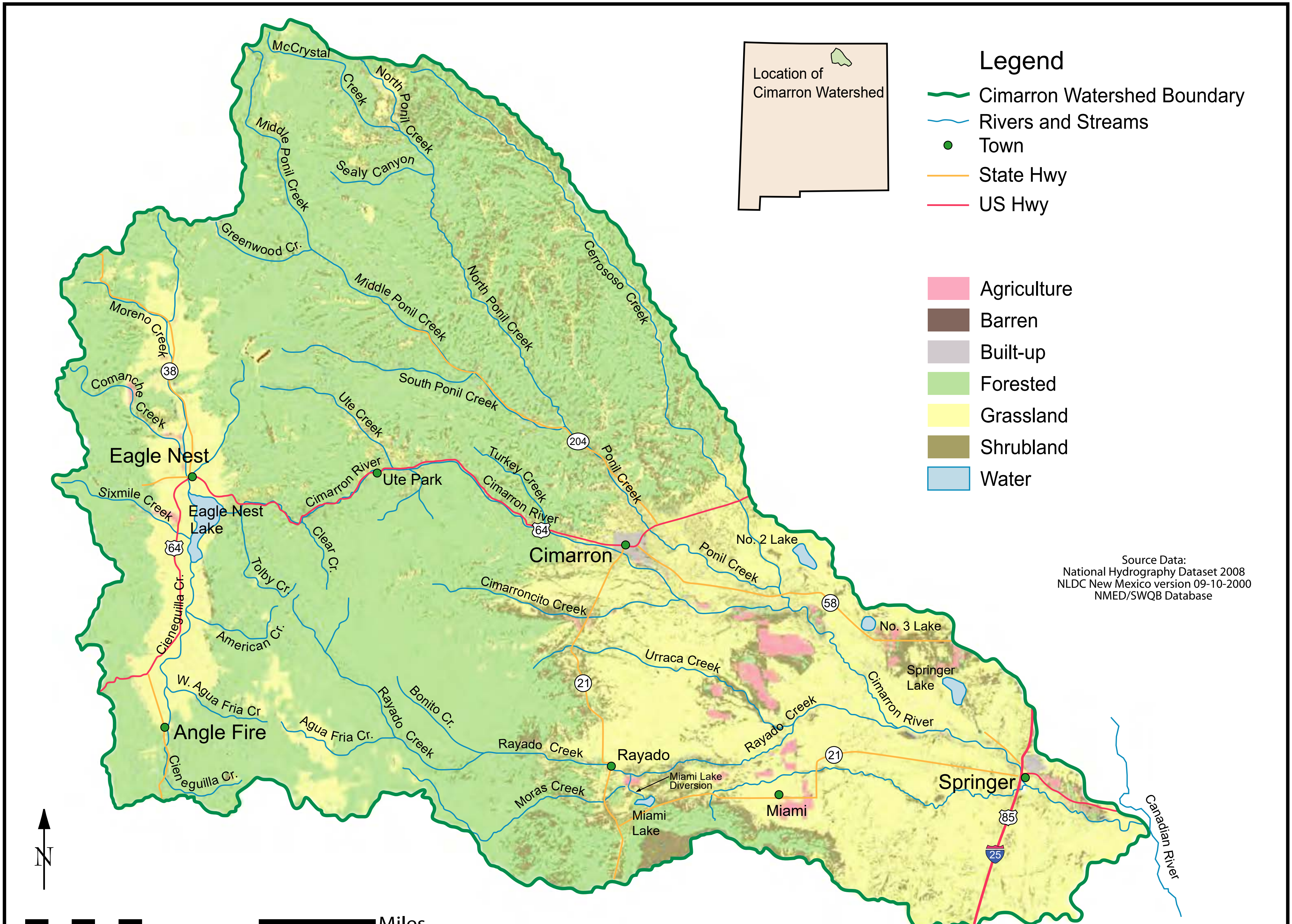

Legend
Cimarron Watershed Boundary
Rivers and Streams
Forest Service
State Game & Fish
Philmont Scout Ranch
State Land
Other Private Land
Town
State Hwy
US Hwy
Location of Cimarron Watershed
Valle Vidal
McCrystal
Creek
North Ponil Creek
Middle Ponil Creek
Sealy Canyon
Greenwood Cr.
Middle Ponil Creek
North Ponil Creek
Cerrososo Creek
Moreno Creek
Comanche Creek
South Ponil Creek
Ute Creek
Eagle Nest
Sixmile Creek
Eagle Nest Lake
Cimarron River
Ute Park
Turkey Creek
Cimarron River
Ponil Creek
Clear Cr.
Tolby Cr.
Cimarron
No. 2 Lake
Ponil Creek
Cimarroncito Creek
Cieneguilla Cr.
American Cr.
No. 3 Lake
Urraca Creek
W. Agua Fria Cr
Angle Fire
Agua Fria Cr.
Rayado Creek
Bonito Cr.
Rayado Creek
Rayado
Rayado Creek
Cimarron River
Springer Lake
Cieneguilla Cr.
Moras Creek
Miami Lake Diversion
Miami Lake
Miami
Springer
Canadian River
38
204
64
58
21
85
25
N
5
0
5
10
Miles
Cimarron Watershed

Figure 3-1

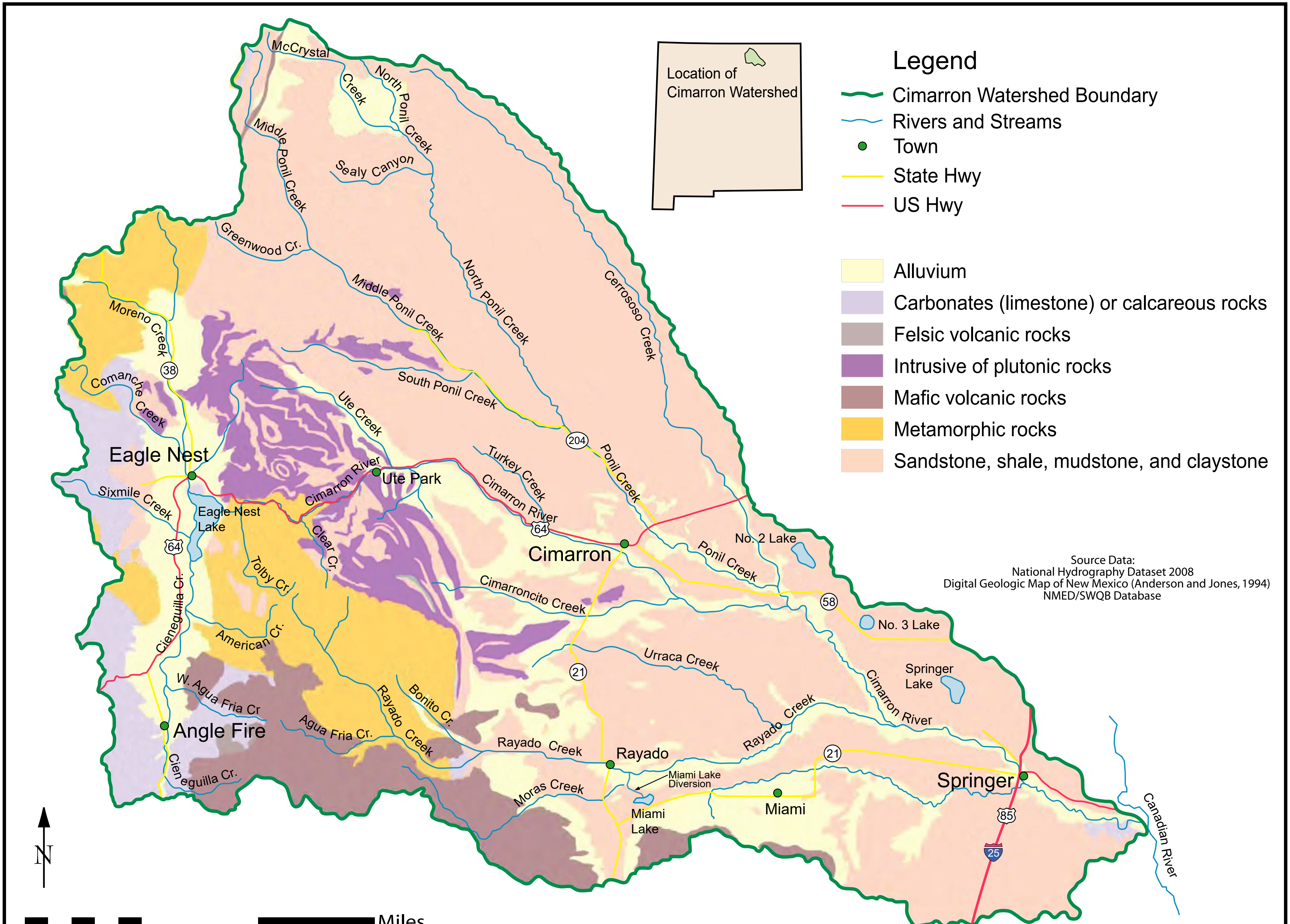


Land Use in the Cimarron Watershed

Figure 3-2

Local wildlife includes deer, elk, bear, pronghorn antelope, turkey, chipmunk, squirrel, beaver, coyote, red fox, porcupine, raccoon, bobcat, mountain lion, a few bighorn sheep, golden eagles, long-billed curlew, and other birds (NMED, 2010a). A valuable recreation population of trout species including Brown, Rainbow and Cutthroat, is also present in the Cimarron Watershed streams. Several species within this watershed are listed as either threatened or endangered by both state and federal agencies. Endangered species include the Southern redbelly dace (*Phoxinus erythrogaster*), Southwestern willow flycatcher (*Empidonax traillii extimus*), Least tern (*Sterna antillarum*), Black-footed ferret (*Mustela nigripes*), and the rare flower, Holy Ghost ipomopsis (*Ipomopsis sancti-spiritus*). Threatened species include the Arkansas River shiner (*Notropis girardi*), Suckermouth minnow (*Phenacobius mirabilis*), Arkansas River speckled chub (*Macrhybopsis tetranema*), Bald eagle (*Haliaeetus leucocephalus*), Mexican spotted owl (*Strix occidentalis lucida*), and Piping plover (*Charadrius melodus*) (NMED 2010a).

Geology in the Cimarron watershed is diverse. Along the Cimarron River, Ponil Creek and lower Rayado Creek, the predominant geologic formations are sandstone, shale, mudstone, and claystone (Figure 3-3). Additionally, a large area in the southeastern part of the Cimarron watershed consists of Pierre Shale and the Niobrara Formation (UNM, 2010). Finally, the western part of the watershed consists of limestone, alluvial and colluvium deposits, and metamorphic rocks (Figure 3-3 and UNM, 2010). A variety of soils are present in the Cimarron watershed; soil types vary according to slope, parent geology, and elevation (UNM, 2010).



Surface Geology in the Cimarron Watershed

Figure 3-3

For purposes of this Watershed-Based Plan, the drainages within the watershed have been grouped into four sub-watershed areas. Within each sub-area, the reaches with Total Maximum Daily Loads (TMDLs), which were identified as active in 2010, are listed below.

Moreno Valley

- Cieneguilla Creek (Eagle Nest Lake to headwaters)
- Sixmile Creek (Eagle Nest Lake to headwaters)
- Moreno Creek (Eagle Nest Lake to headwaters)

Ponil

- South Ponil Creek (Ponil Creek to Middle Ponil)
- Middle Ponil Creek (South Ponil to Greenwood Creek)
- North Ponil Creek (South Ponil Creek to Seally Canyon)
- Ponil Creek (Cimarron River to US 64)
- Ponil Creek (US 64 to confluence of North & South Ponil)

Mainstem of the Cimarron River and Ute Creek

- Cimarron River (Canadian River to Cimarron Village)
- Cimarron River (Cimarron Village to Turkey Creek),
- Cimarron River (Turkey Creek to Eagle Nest Lake)
- Ute Creek (Cimarron River to headwaters)

Rayado Creek

- Rayado Creek (Cimarron River to Miami Lake Diversion)
- Rayado Creek (Miami Lake Diversion to headwaters)

All of the reaches listed above are illustrated in Figure 3-1. In addition to these stream reaches, Eagle Nest and Springer Lakes are discussed in Section 4.

4. Previous Studies and Historic Water Quality Data

Planning for appropriate restoration measures can benefit by considering available data in addition to assessing the results of previous investigations. Key sources of water quality information in the Cimarron Watershed are provided in the assessments conducted by the New Mexico Environment Department (NMED) as part of their ongoing efforts to evaluate water quality conditions and the responses needed in New Mexico. NMED uses a targeted, rotational watershed-based approach to conducting ambient water-quality monitoring (NMED, 2010b). Using the targeted rotational approach to watershed assessment, the Cimarron Watershed is scheduled to be assessed again in 2016 (NMED, 2010b).

Between March and November 2006, the Surface Water Quality Bureau of the New Mexico Environment Department (NMED) conducted a water quality survey of the Canadian River and selected tributaries, including the Cimarron River (NMED, 2010a). Follow-up data were collected in 2007, 2008, and 2009 (NMED 2010a). Water quality monitoring stations were located within the Cimarron Watershed to evaluate the impact of tributary streams and ambient water quality conditions. The water quality survey included 16 sampling sites; most sites were sampled eight times, while some secondary sites were sampled from one to four times. As a result of the monitoring effort and the subsequent assessment of results, several surface water impairments were identified and added to New Mexico's Integrated Clean Water Act §303(d)/305(b) List (NMED, 2010b).

When the scope of work for this Cimarron WBP originated, it was based on the previous Clean Water Act §303(d)/305(b) List (NMED, 2008). There are some differences between these two lists:

- Some listings were revised as a result of changes in assessment protocol. For example, newer protocol identifies *E.coli* rather than the more general fecal coliform bacteria (*E.coli* is a subset of fecal *coliform*).
- Based on updates in sampling methodology, aluminum was determined to no longer be a problem in the watershed.
- Arsenic had not previously been listed but was included in the 2010 TMDL.

In order to provide the most current WBP possible, this plan addresses the more recent group of TMDLs (NMED, 2010a). Since the original scope did not include arsenic, additional arsenic data collection is warranted to fully characterize that issue. However, since further characterizations of arsenic distribution were not included in the scope assigned to this project, only a cursory evaluation has been included in the WBP. Where applicable, data gaps have been identified.

In addition to the CWA §303(d)/305(b) and TMDL information, NMED provides programmatic guidance for Nonpoint Source Management. An updated plan for the Nonpoint Source Management Program was developed and approved in 2009 (NMED, 2009). This plan describes six objectives with an overall goal of meeting and maintaining water quality standards and the usage of surface water and groundwater resources in New Mexico. The Nonpoint Source Management Program is a cooperative effort among watershed stakeholders and NMED, established to educate others, implement best management practices (BMPs), and reduce the ability of nonpoint pollutants to enter surface and ground waters. These objectives are related to planning, restoring water quality, protecting water quality, education, protecting groundwater quality, and interagency cooperation (NMED 2010b.).

In addition to NMED sampling, in June of 2010 the University of New Mexico Water Resources Graduate Program conducted a survey of water quality in the Cimarron Watershed and the Maxwell National Wildlife Refuge as part of this planning effort (UNM, 2010). This study included measuring flows and water quality characteristics at 34 surface water sites in the two study areas. The EPA Environmental Monitoring Assessment Program (EMAP) protocol was used to assess six reaches of the Cimarron River and one reach of Rayado Creek. The assessment evaluated hydrology, geomorphology, riparian vegetation, human impacts, benthic macroinvertebrates, and water quality. In addition, flow measurements and water quality samples were taken at 24 other locations within the basin.

The UNM assessment found generally high quality conditions of the river and riparian environment throughout the Cimarron River. This conclusion was supported by the type and diversity of benthic macroinvertebrates, by channel geomorphic criteria, and by water quality measurements (UNM, 2010). Electrical conductivity, an indirect measure of salinity, was found to increase as the river flows onto the eastern plains; the source was not identified. The water in the river is hard and is dominated by calcium, magnesium and sulfate ions. The UNM assessment was performed near the peak of spring runoff, and the study recognized that it is likely that low-flow conditions later in the summer will present environmental stresses to the system. Low but measurable concentrations of nitrates were found throughout the watershed, with the highest concentrations occurring in Cieneguilla Creek samples collected near a residential area and golf course located downstream from the town of Angel Fire. The UNM study included recommendations for further studies to quantify stream flows and diversions in the watershed to gain a better understanding of water use and to characterize the seasonal concentrations of chemical constituents in the Cimarron River and its tributaries.

An initial Cimarron Watershed Restoration Action Strategy (WRAS) was prepared in 2003 shortly after the Cimarron Watershed Alliance was formed. The WRAS identified key restoration focus areas, including: establishing healthy riparian areas, reducing forest biomass, and improving wastewater systems. The WRAS also identified plans for monitoring and public outreach.

The Colfax Regional Water Plan (DBS&A, 2003) provided an overview of surface and groundwater conditions and water quality in Colfax County. Detailed analysis of stream flow was included in the plan to assess the probability of whether supplies would be able to fulfill adjudicated water rights. The plan also provided an overview of water quality in Colfax County, including the Cimarron Watershed, and identified watershed protection as a key regional water planning priority.

In addition to the studies that pertain to the Cimarron Watershed as a whole, a number of existing studies also pertain to specific parts of the watershed as discussed below.

4-1. Moreno Valley Area

The Moreno Valley includes Eagle Nest Lake and three tributaries: Cieneguilla, Sixmile and Moreno Creeks. These tributaries are all headwater drainages that flow into Eagle Nest Lake from the south, west, and north respectively (Figure 3-1).

The geology, soils, and stream systems of the Moreno Valley were characterized in order to understand why sedimentation is a chronic problem during precipitation run-off (Huerta, 2012). The NRCS Web Soil Survey (websoilsurvey.nrcs.usda.gov/n) was used to define soil properties, elevations, landscape characteristics, and precipitation near Cieneguilla, Six Mile and the Moreno Creeks. The study indicated that the Moreno Valley is a glacial valley with a mean annual precipitation of 15 to 20 inches. The following descriptions pertain to the soil structure of flood plain areas; however, this information does not reflect the soil structure for the entire course of the three perennial creeks (Huerta, 2012):

- The Cieneguilla Creek courses through an elevation of 8,000 to 10,500 feet. The Cieneguilla Creek bed is mainly composed of 65% gently sloping (1-5%) Frolic association with 30% Cumulic Haplaquolls and similar soils. The creek area is moderately well-drained. The capacity of the most limiting layer to transmit water (Ksat) is moderately high up to high (0.60 to 2.00 in/hr). This drainage system is subject to occasional flooding with an average adsorption ratio maximum of 1.0 and an available water capacity at the high end of about 9.6 inches. The Cumulic Haplaquolls soils profile is 0 to 15 inches of very fine sandy loam; 15 to 35 inches of loam; with 35 to 42 inches of fine sandy loam, and 42 to 60 inches of silt (NRCS/WSS 2010). Any run-off in Cieneguilla Creek is loaded with fine soil particulates.

- The Moreno Creek bed is mainly composed of Morval and similar soils at 55%; Moreno and similar soils at 35%; sloping at 1 to 5%. The capacity of the most limiting layer to transmit water (Ksat) is moderately high to high (0.60 to 2.00 in/hr). The depth to the water table is more than 80 inches. Flooding is possible but rare, and the available water capacity is high, at about 10.9 inches. The Morval/Moreno soils profile is 0 to 21 inches of Clay loam; 21 to 57 inches of Clay loam; with 57 to 60 inches of gravelly sandy clay loam; and 60 to 70 inches of stony clay loam (NRCS/WSS 2010).

- Six Mile Creek bed is similar to that of Moreno Creek at 35% Moreno and similar soils and 55% Morval soils, sloping at 1 to 5%. The capacity of the most limiting layer to transmit water (Ksat) is moderately high to high (0.60 to 2.00 in/hr). Flooding is rare and the available water capacity is high at about 10.9 inches. The Morval Moreno soil profile is: 0 to 21 inches of Clay loam; 21 to 57 inches clay loam; with 57 to 60 inches of gravelly sandy clay loam; and 60 to 70 inches of stony clay loam (RCS/WSS 2010).

The 2003 WRAS identified fecal coliform bacteria in the Moreno Valley in Cieneguilla and Moreno Creeks as a key concern. Bacteria continue to be a problem, and the 2010 TMDL included *Escherichia coli* (*E.coli*) for Cieneguilla and Moreno Creeks.

Coliforms (colon bacillus) are bacteria that live in the intestines of warm-blooded animals (humans, pets, farm animals, and wildlife). *Fecal coliform* bacteria are a species of coliform that is associated with human or animal wastes, and *Escherichia coli (E. coli)* is part of this group of fecal coliforms. Most coliforms are not dangerous to humans; however, some may cause adverse health effects such as vomiting or diarrhea (NMED, 2010a). Additionally, coliforms may indicate the presence of other disease-causing bacteria, such as those that cause typhoid, dysentery, hepatitis A, and cholera. To address this issue, the CWA undertook an additional study to better understand both the sources and the distribution of these bacteria. A draft source tracking study indicated that wildlife, specifically waterfowl, has been the dominant contributor to the bacterial presence. This tracking study was released in 2010 (NMSU, 2010).

The bacterial source tracking study reported that *E. coli* is a natural inhabitant of warm-blooded animals, and that because of the unique biochemical environment in the gastro-intestinal tract of each animal, the *E. coli* have become adapted and differ genetically from the *E. coli* in a different animal host. Genetic analyses were used to track the source of *E. coli* back to its animal host. Since there are limitations to this method of analysis, any source tracking studies, such as this one, must only be considered as reasonable estimates to identify various sources of stream *E. coli,* rather than considered to be exact attributions.

Samples were collected from Cieneguilla and Moreno Creeks near the points where they drain into Eagle Nest Lake. Volunteers were trained to collect screening samples to identify the presence of larger quantities of *E.coli*. Samples from select locations were then transmitted to a laboratory for source tracking analyses. Samples were collected over a two-year period using standard methodology.

Results of the bacterial source tracking study indicated seasonal variability, with *E.coli* concentrations highest in the summer, intermediate in the fall, and lowest in the spring. Levels of stream water turbidity followed the same seasonal trends as *E. coli* occurrence in Cieneguilla Creek, but not in Moreno Creek. These results show significant turbidity variations between the two sites, as well as significant differences of *E. coli* levels. These results indicate that differing runoff and and/or land use patterns impact these two creeks.

Overall, of the three most important wildlife sources (24% avian, 12% raccoon and 9.8% elk/deer) each one had greater contributions than the three largest anthropogenic sources (8.7% horse, 7.6% cattle and 6.5% sewage). Since meaningful statistics typically cannot be applied to source track data, these differences only indicate source trends. Nevertheless, results indicate that wildlife, particularly avian sources, are the most important contributors of *E. coli* in the streams that are located immediately upstream of the point where they flow into Eagle Nest Lake. These results are consistent with a source tracking study on the middle Rio Grande, New Mexico, in which avian sources were also identified as the most important contributors of *E. coli* (NMSU, 2010).

In addition to completing the source tracking study, the CWA has participated in a project to restore bank stability along Cieneguilla Creek. Post vanes were installed to deflect water from cut banks. Exclosures have also been established to allow for revegetation in a section of the creek that is upstream from Eagle Nest Lake. A recently completed report (CWA, 2012) documents the observed field improvements resulting from the project.

Another issue facing the Moreno Valley is poorly constructed roads. In particular, the Taos Pines subdivision, located west of the Village of Angel Fire in steep terrain, has numerous unpaved roads that are sources of sediment during storm events. In 2009, Rangeland Hands conducted a field survey of the Taos Pine Roads to assess conditions and develop cost estimates for road improvements that would mitigate erosion and sedimentation. The assessment indicated that road conditions were extremely poor, due to the clay-base soil type, poor original design, a road width that is wider than necessary, poor maintenance and management practices, plugged culverts, and system overloading from driveway runoff and steep grades (Rangeland Hands, 2009). Additionally, this road system is hydraulically connected in numerous locations via wheel tracks, ruts, and improperly maintained road ditches, culverts, and driveways as well as old roads. In these locations, water is trapped on the road surface for hundreds of consecutive feet. Rangeland Hands recommended an effective, reliable road drainage system with long-term maintenance, and prepared a design that calls for the installation of ninety-nine (99) road surface cross drains, the cleaning of thirty-two (32) culverts, the replacement of one (1) culvert, the removal of one (1) culvert, and the cleaning of hundreds of feet of uphill side road ditches (Rangeland Hands, 2009). Implementation of these practices could prove to be crucial for future water quality in the Moreno Valley.

Other projects of interest in the Moreno Valley include fuel reduction by private landowners and local governments. The purpose of these projects is to reduce the risk of catastrophic wildfires, which could cause additional impairment, particularly turbidity, sedimentation, and temperature. These projects are protective of long-term water quality in the area.

Eagle Nest Lake is a key resource in Moreno Valley and one of the oldest reservoirs in New Mexico. According to a 2005 survey completed by NMED (NMED, 2005) Eagle Nest Lake is impounded by a concrete dam which was completed in June of 1918. Charles and Frank Springer built this lake to store irrigation water derived from three perennial streams

(Cieneguilla, Six Mile and Moreno Creeks) that feed the lake. The storage capacity of Eagle Nest Lake is about 81,360 acre-feet at maximum pool. The lake elevation is about 2,500 meters (8,200 ft.) above mean sea level, making Eagle Nest Reservoir the highest large lake in New Mexico.

Both Angel Fire and Eagle Nest treat their domestic wastewater, and Angel Fire discharges their domestic wastewater near Cieneguilla Creek, which empties into Eagle Nest Lake about ten miles north of the wastewater facility.

Eagle Nest Lake was purchased by the State of New Mexico, Department of Game and Fish in 2002. The lake is now managed by New Mexico State Parks Division, who took control of the lake's recreational facilities in 2004. The New Mexico Water Quality Standards list has designated the following uses for Eagle Nest Lake:

- high-quality coldwater aquatic life
- domestic water supply
- irrigation
- livestock watering
- wildlife habitat, municipal and industrial water supply
- secondary contact

The principal fish species, as recognized and supported by the New Mexico Department of Game and Fish, are Kokanee and Coho Salmon, Rainbow Trout, and Cutthroat Trout. Perch have been reported to be of catchable size by State Park employees.

Lake chemistry sampling conducted by NMED consisted of total, dissolved, and calculated nutrients, anions and cations, total and dissolved heavy metals, synthetic organics, radionuclides, bacteria, and cyanide. This sampling covered all standards of criteria that are pertinent to the protection of all designated uses (NMED, 2005). The nitrogen and phosphorus ratio showed that nitrogen was the limiting nutrient during five of the six visits, and co-limiting for the remaining visit.

Eagle Nest Lake experienced thermal stratification during the summer sampling visit, and again in the spring at one deep station (NMED, 2005). Dissolved oxygen fell below the criteria for high-quality coldwater aquatic life at both stations in the summer. The sampling visits during the fall resulted in non-support of this use. Furthermore, a fish consumption advisory was set for Eagle Nest Lake, which also resulted in an impairment of aquatic life use. One exceedence of six measurements for pH was below the 6.6 lower criteria, but did not constitute a use impairment. The lower pH was probably due to the heavy spring snow melt. Snow is typically acidic; reports show that the lake elevation increased by 13 feet during the spring.

Four of six heavy-metals results for arsenic exceeded the 2.3 parts per billion criteria that were adopted for the protection of the domestic water supply use (NMED, 2005). The source of the arsenic is unknown, and may be naturally occurring. In 1998, a similar study conducted by NMED showed levels similar to those from 2005. However, the water quality standard applicable at the time of the 1998 study was 0.05 mg/L or 50 ppb. All other uses were fully supported during the NMED study of Eagle Nest Lake.

Eagle Nest Lake is listed as not supporting either for the domestic water supply or for the high-quality cold water aquatic life categories. However, Eagle Nest Lake is fully supporting for other categories of use (NMED, 2010b). Further assessments for arsenic and dissolved oxygen are scheduled for 2017.

The assessment comments for Eagle Nest Lake point out that there are small legacy hardrock mining operations in the upper watershed that may be contributing to the elevated arsenic levels (NMED, 2012). In addition, the level of mercury in fish has prompted a consumption advisory to be issued to anglers taking fish from the lake.

4-2. Ponil Creek

Ponil Creek is formed by three main tributaries: the North Ponil, the Middle Ponil, and the South Ponil Creeks (Figure 3-1). The CWA has been managing a Clean Water Act section 319 grant primarily to address temperature exceedences in the Ponil watershed; however, restoration treatments will also reduce sediment and lessen turbidity and nutrients within the creek. The CWA has been implementing the three-year project through a collaborative process with Philmont Scout Ranch, Vermejo Park Ranch, the Chase and C.S. Ranches, the Village of Cimarron, the New Mexico State Forestry, and the New Mexico Department of Game and Fish. This project has focused on lowering the stream temperature through the restoration of riparian forests, the stabilization of stream banks, and the implementation of erosion control treatments.

The project consists of the following four components:

- Restore 11 miles of riparian forest by planting native cottonwood trees to provide shade.
- Reduce erosion and sediment through upgrades and improvements of three low-water crossings.
- Repair two cutbanks that are threatening to undermine the road along the Ponil (NM 204) and one large headcut in the main channel that contributes to the stream's increased velocity.
- Assess the Middle Ponil Creek from the confluence with the South Ponil to the confluence at Greenwood Creek, to improve the identification of source problems as well as potential mitigation options.

The treatments identified above will lower the temperature by increasing the amount of effective shade and by reducing both the heat-trapping sediment and the width-to-depth ratio. Further discussion of recent assessment results from this project is provided in Section 7.

4-3. Valle Vidal (Ponil Drainage)

The Valle Vidal is located at the headwaters of Ponil Creek (Figure 3-1). A recent study evaluated the effectiveness of various watershed treatments in the Valle Vidal (Allred 2009). This study considered the possibility that the suppression of wildfires has created opportunities for catastrophic wildfires, which can increase stream temperature, stream flow, erosion, and sediment in nearby streams and lakes. The study also reviewed Burn Area Emergency Rehabilitation (BAER) treatments to minimize the effects that follow a wildfire, considering conditions that resulted from the 2002 92,000 acre Ponil Complex Fire.

One treatment reviewed was induced meandering, which utilizes rock structures to promote the stabilization of incised degrading channels by simulating river riffles, elevating channel bottoms, establishing channel slopes to encourage channel meandering, and forming an active floodplain (Allred, 2009).

The Allred project evaluated the effectiveness of rock baffles, one-rock dams, and aerial seeding in stabilizing an incised discontinuous gully channel post-wildfire. The methods used to evaluate the effects of treatment included photo documentation, vegetation percent cover, cross-sectional measurements, streambed geology, and a riparian habitat assessment.

The Allred (2009) study concluded:

- Results from photo documentation of the channel illustrated that meandering is occurring; however, the cross-sectional data indicated that the channel has stabilized. The findings were supported by vegetation percent cover data and streambed geology.
- Photo documentation and data of vegetation percent ground cover indicated that aerial seeding on the upland slopes was successful.
- The riparian habitat assessment confirms that gullies are not suitable riparian habitat.
- Continued monitoring, research, and understanding of induced meandering and other rehabilitation treatments are needed to provide the best possible post-wildfire treatments.
- The Allred study also included a summary of existing research on the effectiveness of various techniques for post-fire stabilization.

In January 2006, the New Mexico Water Quality Control Commission designated the surface water within the Valle Vidal Unit of the Carson National Forest as Outstanding National Resource Waters (ONRWs) in accordance with the Clean Water Act. This designation disallows any new or increased discharges to ONRWs or to their tributaries that would result in lower water quality. Any project proposals in Valle Vidal Unit will acknowledge the ONRW designation and comply with this policy.

The CWA and the USFS are interested in pursuing Collaborative Forest Restoration Program or other funding to reduce fuel loads and restore habitat in the Valle Vidal Unit.

4-4. Cimarron River and Ute Creek

Surface water for three municipal water systems (the Village of Cimarron, the City of Raton, and the Town of Springer) is supplied by releases from Eagle Nest Dam (on the main stem of the Cimarron River) and by three perennial tributaries (Clear Creek, Tolby Creek, and Cimarroncita Creek), along with seasonal flows from Ute Creek. The Village of Cimarron and the City of Raton both have diversions upstream from the Village of Cimarron. Springer obtains its water supply from a diversion through the Springer Ditch system that supplies Springer Lake, which is located west of Springer. Each of these municipalities collects water quality data as needed for the operation of their treatment plants and drinking water systems.

Both Cimarron and Raton obtain their primary water supply from other sources, and only use Cimarron diversions as supplemental supplies. Due to the 2011 Track Fire that severely damaged the primary municipal watershed for the City of Raton, the Cimarron River was temporarily used to supply all of the drinking water supply for the City of Raton. Studies have not yet been completed to identify other potential suppliers of drinking water for the City of Raton in the event of future wildfires in Cimarron Canyon.

Ute Creek contributes surface water to the Cimarron River from its headwaters on the East side of the Baldy Mountain complex. Flows along Ute Creek are diverted through a system of ditches that irrigate pastures used during the summer by a sizeable local elk herd as well as cattle. Some waters from this area are channeled into pass-through lakes and one reservoir (Huerta, 2012).

Sandia and Los Alamos National Laboratory (LANL) conducted a study of the main stem of the Cimarron River (LANL and Sandia, 2011). Data were collected by both Los Alamos National Laboratory (LANL) and Sandia National Laboratory; the final analysis was performed by LANL. The purpose of the study was to evaluate the impact of the irregular flow regime from Eagle Nest Dam on potential visitors and fishing clients that spend valuable tourism dollars within the upper watershed. The study assessed the minimum flow of the Cimarron River outflow through Eagle Nest dam to provide an appropriate depth estimate for trout habitat, which could/would be useful to guide future conservation decisions and protect a stable tourism economy.

The LANL/Sandia study relied on United States Geological Survey (USGS) stream flow gauges to provide insight into the natural flow regime of the upper Cimarron watershed. This study reported that the minimum combined average flow into Eagle Nest Reservoir from the gage tributaries (Cieneguilla, Sixmile, and Moreno Creek) is 1.9 cubic feet per second (cfs); this occurs during the month of December. This value represents a minimum pre-reservoir flow below Eagle Nest reservoirs, and does not account for the flow from ungaged tributaries and springs.

Seventeen channel profiles were measured in six areas. Manning's equation was used to estimate the required flows to maintain the agency's recommendations for particular depths. To maintain the U.S. Fish and Wildlife Service's recommended depth of 0.5 ft requires 2.9 cfs from

Eagle Nest dam. Alternatively, to maintain the New Mexico Department of Game and Fish's recommendation of 1.0 ft requires 14.9 cfs from Eagle Nest dam. The outflow of Eagle Nest reservoir provides adequate flow for trout during 9 months of the year. In order to provide a minimum depth of 0.5 ft at the Tolby campground, the study estimated that 90 days of flow would be required, for a total of 518 acre feet (LANL and Sandia, 2011).

Cimarroncita Ranch is headquartered along the Cimarron River near the perennial Cimarroncita Creek, whose headwaters lie on the Northern aspect of Cimarroncito Peak. Cimarroncita Ranch is the location of the Cimarron Conservation Camp. This camp is dedicated to conservation education; it regularly monitors temperature, flow levels, and turbidity of the Cimarron River (Huerta, 2012). The Cimarron Conservation Camp has been involved with both Sandia and Los Alamos National Labs through the NM Small Business Association to determine the impact of low flows on the local tourist economy, as discussed above.

Cimarroncita Ranch is in the process of establishing a conservation easement that encompasses the riparian area of the Cimarron River, which passes through the ranch (Huerta, 2012). Cimarroncita Ranch has a management plan that focuses on the protection and conservation of its natural assets, to provide a living laboratory for students of all ages to study and work. In addition to providing a location and opportunity for national laboratory-sponsored studies, Cimarroncita Ranch will be setting aside a riparian conservation easement to establish and monitor a wetlands improvement project which will aide biotic life and water transport. Due to potential impacts of jurisdictional wetlands near Angel Fire, (the result of an electrical sub-station expansion), a plan for wetland mitigation on the Cimarroncito Ranch was prepared (Paramatrix, 2011).

4-5. Rayado Creek

The Philmont Scout Ranch, headquartered along Rayado Creek, owns much of the land located in the headwaters of the drainage. Philmont maintains a conservation department that is actively involved in watershed restoration along Rayado and Ponil Creeks. For example, the Philmont Conservation Department recently prepared an assessment of Bonito Creek, which is a tributary to Rayado Creek, and prepared initial conceptual designs for treatments to mitigate erosion features such as incised channels, head cuts, side arroyos, and collapsed banks on Bonito Creek (Philmont Scout Ranch, 2010). This project defined conservation and education goals to address restoration.

In addition, the Miami Domestic Water Users Association monitors water quality as required by the Safe Drinking Water Act and the NMED Drinking Water Bureau. They recently completed comprehensive source water sampling for *E.coli.* This study indicated that the annual mean coliform concentration of 12.7 *E.coli*/100ml was less than the trigger level of 100 *E.coli*/100ml, indicating that the Association could conduct less extensive monitoring in the future (Vigil, 2010).

5. Causes and Sources of Water Quality Impairment

The first of nine elements of watershed-based planning requires identification of the causes and sources, or groups of similar sources that need to be controlled to achieve load reductions. The cause of a water quality problem refers to a chemical or physical condition that leads to impairment, for example, measurements of arsenic or another chemical or a physical parameter such as temperature that exceeds water quality standards. The source of the problem is the nature of land use or another activity that creates the water quality concern, such as an old mine leaching arsenic, or loss of vegetation that contributes to increased water temperatures.

5-1. Causes of Water Quality Impairment

NMED conducted field water quality measurements (Section 4) to identify the causes of water quality degradation in the Cimarron Watershed. A summary of the causes of water quality degradation by stream reach, as identified in the 2010 TMDL (NMED, 2010a), are shown in Table 5-1 and in Figure 5-1. Temperature, nutrient/eutrophication, and *E. coli* are the most common causes of impairment in the Cimarron Watershed. These impairments also comprise the top three major causes of river and stream water quality impairments in New Mexico (NMED, 2010b).

Table 5-1. Causes of Stream Water Quality Impairment

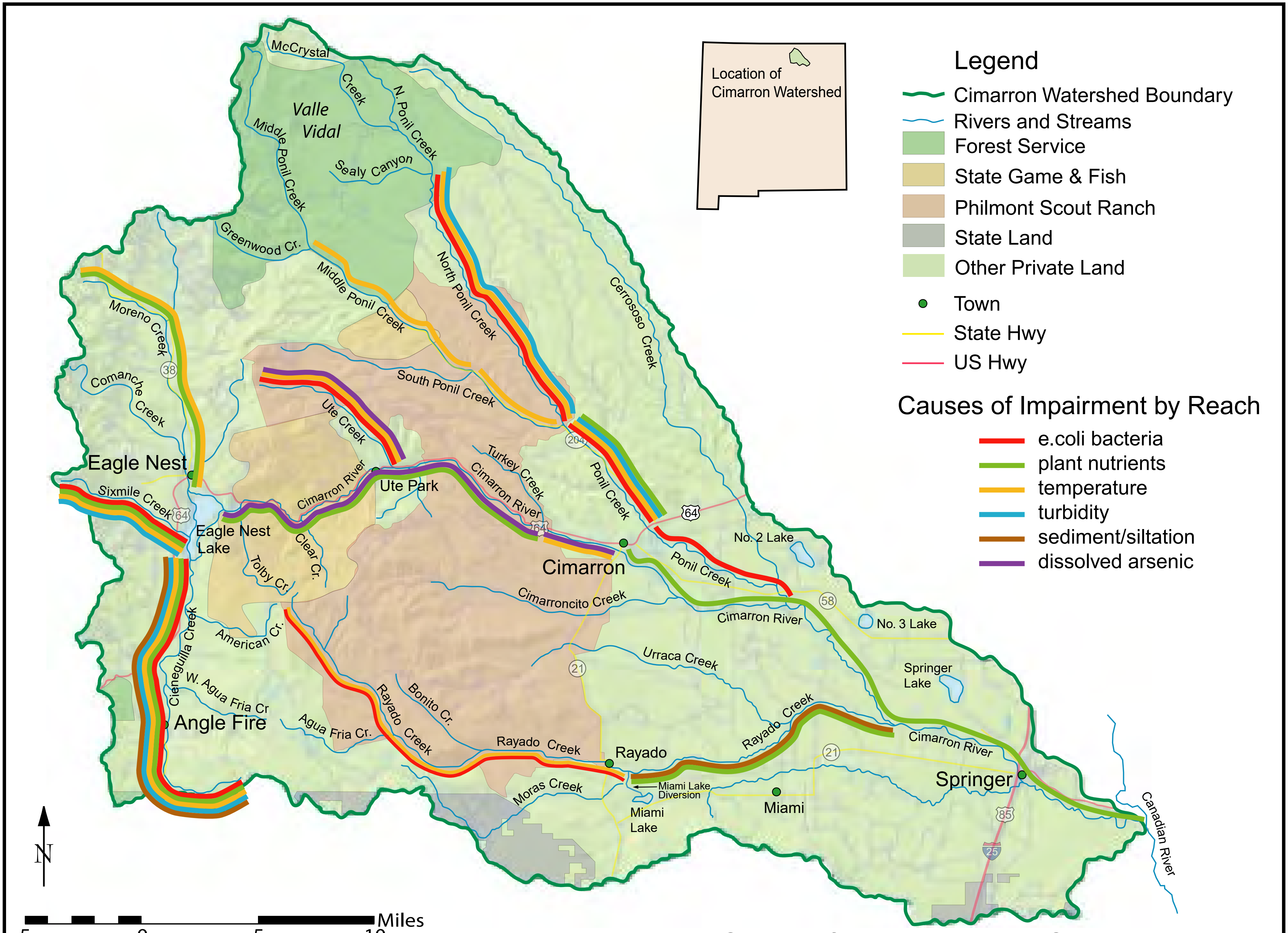
Location	2010 TMDL	Continued Impairment [a]	Not supporting[b]
Moreno Valley			
Cieneguilla Creek (Eagle Nest Lake to headwaters)	*E.coli*, plant nutrients, temperature	turbidity, sediment/siltation	HQCAL, SC
Moreno Creek (Eagle Nest Lake to headwaters)	plant nutrients, temperature		HQCAL
Sixmile Creek (Eagle Nest Lake to headwaters)	*E.coli*, plant nutrients, temperature	turbidity	HQCAL, SC
Ponil Creek and Tributaries			
North Ponil Creek (South Ponil Creek to Seally Canyon)	*E.coli*	turbidity, temperature	HQCAL, SC
North Ponil Creek (Seally Canyon to Headwaters) [c]	temperature		HQCAL
Middle Ponil Creek (South Ponil to Greenwood Creek)	none	temperature	HQCAL
South Ponil Creek (Ponil Creek to Middle Ponil)	temperature		HQCAL
Ponil Creek (US 64 to confluence of North and South Ponil)	*E.coli*, plant nutrients	turbidity, temperature	HQCAL, SC
Ponil Creek (Cimarron River to US 64)	*E.coli*		SC, WWAL
Cimarron River and Ute Creek [d]			
Cimarron River (Turkey Creek to Eagle Nest Lake)	dissolved arsenic, plant nutrients		DWS, HQCAL
Cimarron River (Cimarron Village to Turkey Creek)	dissolved arsenic, temperature		DWS, HQCAL
Cimarron River (Canadian River to Cimarron Village)	plant nutrients		WWAL
Ute Creek (Cimarron River to headwaters)	dissolved arsenic, *E.coli*, temperature		DWS, HQCAL, SC
Rayado Creek			
Rayado Creek (Miami Lake Diversion to headwaters)	*E.coli*, temperature		HQCAL, SC
Rayado Creek (Cimarron River to Miami Lake Diversion)	plant nutrients	sediment/siltation	MCAL, WWAL

a) Impaired based on earlier assessment, listed as continued impairment in 2010 Total Maximum Daily Load (TMDL) document

b) As identified in NMED 2010b. DWS=Domestic Water Supply; HQCAL= High Quality Cold Water Aquatic Life, MCAL = Marginal Cold Water Aquatic Life; WWAL = Warm water aquatic life; SC = Secondary Contact

c) Seally Canyon to Headwaters reach not included in 2010 TMDL so not included in remainder of this WBP

d) Ute Creek from headwaters to main stem of the Cimarron



Causes of Impairment in the Cimarron Watershed

Figure 5-1

5-2. Sources of Water Quality Impairment

In addition to identifying the causes of impairment, the EPA guidance (2008) requires identification of the probable sources of impairment. Sources are defined as activities that may contribute either pollutants or stressors to a water body. A list of probable sources of impairment was included in the TMDL (2010a). The probable source list provided in the TMDL is intended to include any and every activity that could be contributing to the identified impairment. However, this list is not intended to single out any particular land owner or any specific land management activity; therefore, it has been labeled as “probable” (NMED, 2010b).

The CWA reviewed the probable source lists presented in the TMDL, and stakeholders familiar with each stream reach listed the relative percentages of probable sources. The percentages estimated by each stakeholder were averaged, and the averages for each source category were further considered in workshops conducted with local land owners as well as other stakeholders who are familiar with the sub-watersheds and the reaches of concern. Additionally, field reconnaissance of select areas was conducted to observe probable source conditions. For example, if the probable source considered was low-water crossings, then field observations could verify this finding as a likely source. Although the resulting distributions of probable sources are not based on measurable data and are not completely accurate, they are considered to represent a reasonable understanding of the most significant sources in comparison to those of lesser importance.

A summary of the probable sources for each stream reach is presented in Table 5-2. The load from identified probable sources for each reach was estimated by the group of stakeholders and local land owners as described above and is included in Appendix A.

Table 5-2. Probable Sources of Impairments in the Cimarron Watershed

Location	Contaminants of Concern	Primary Probable Sources [a]	Secondary Probable Sources[b]
Moreno Valley			
Cieneguilla Creek (Eagle Nest Lake to headwaters)	*E.coli*, plant nutrients, sediment/siltation, temperature, turbidity	loss of riparian habitat (wildfire), rangeland grazing, roads, streambank modification/ destabilization, wildlife	airport, dam/impoundment, construction, municipal point source discharges, other recreational pollutant sources, septic tanks
Moreno Creek (Eagle Nest Lake to headwaters)	plant nutrients, temperature	mining, rangeland grazing, roads, septic systems, wildlife	corrals, gravel pits, roads, waste from pets
Sixmile Creek (Eagle Nest Lake to headwaters)	*E.coli*, plant nutrients, temperature, turbidity	gravel pits, habitat modification, livestock feeding, rangeland grazing, septic systems	natural sources, roads
Ponil Creek and Tributaries			
North Ponil Creek (South Ponil Creek to Seally Canyon)	*E.coli*, temperature, turbidity	loss of riparian habitat (wildfire), low-water crossings, rangeland grazing, roads	habitat modification, hydromodification, fire suppression, sediment, mining, silvaculture
Middle Ponil Creek (South Ponil to Greenwood Creek)	temperature	loss of riparian habitat (wildfire), rangeland grazing	wildlife
South Ponil Creek (Ponil Creek to Middle Ponil)	temperature	recreational uses, rangeland grazing, wildlife	low-water crossings, roads
Ponil Creek (US 64 to confluence of North and South Ponil)	*E.coli*, plant nutrients, temperature, turbidity	loss of riparian habitat (wildfire), rangeland grazing, roads, streambank modification/ destabilization, wildlife	livestock confinement areas (corral relocation), recreational uses, roads, septic systems, waste from pets
Ponil Creek (Cimarron River to US 64)	*E.coli*	avian sources, rangeland grazing, septic systems, unknown sources, wildlife	recreational uses, roads, waste from pets

a) Primary Probable Sources are those considered by the group as contributing 10% or more of the total load

b) Secondary Probable Sources are those considered by the group as contributing less than 10% of the total load

TABLE 5-2 (continued)

Location	Contaminants of Concern	Primary Probable Sources [a]	Secondary Probable Sources[b]
Cimarron River and Ute Creek			
Cimarron River (Turkey Creek to Eagle Nest Lake)	dissolved arsenic, plant nutrients	dams or impoundment, historical mining, septic systems (cesspools), wildlife	geology, livestock, other recreational sources, roads, unknown sources
Cimarron River (Cimarron Village to Turkey Creek),	dissolved arsenic, temperature	loss of riparian habitat, rangeland grazing, roads, wildlife	baseflow depletion, corrals, diversions, mining, low-water crossings, pets, unknown sources
Cimarron River (Canadian River to Cimarron Village)	plant nutrients	flow alterations from water diversions, rangeland grazing, septic systems (cesspools), wildlife	Low-water crossings, roads, impervious surface run-off
Ute Creek (Cimarron River to headwaters)	dissolved arsenic, *E.coli*, temperature	historic mining, loss of riparian habitat, low-water crossings, rangeland grazing, roads, wildlife	pets, septic systems
Rayado Creek			
Rayado Creek (Miami Lake Diversion to headwaters)	*E.coli*, temperature	baseflow depletions from groundwater withdrawals, roads, low-water crossings, rangeland grazing, wildlife	avian/waterfowl, flow alterations, highways, septic tanks
Rayado Creek (Cimarron River to Miami Lake Diversion)	plant nutrients, sediment/siltation	dam or impoundment, loss of riparian habitat, rangeland grazing, roads, low-water crossings, wildlife	flow alterations, habitat modifications, highways

a) Primary Probable Sources are those considered by the group as contributing 10% or more of the total load

b) Secondary Probable Sources are those considered by the group as contributing less than 10% of the total load

5-3. Data Gaps

The constituents that contribute to water quality problems in the watershed (Table 5-1) all vary depending on streamflow and other conditions. Critical streamflow conditions that cause water quality standards to be exceeded can occur when:

- Low-flow conditions either limit the dilution of chemical constituents or cause temperatures to rise due to slower velocities and greater surface areas, or
- Conversely, some water quality standard exceedences are more likely to occur during storm events, particularly during high-intensity monsoon events that can accelerate erosion and contribution of sediment, chemical constituents, nutrients, and/or bacteria.

The majority of the reaches included in the TMDL exceeded standards primarily at low flows. The TMDL then used the 4Q3 (the minimum average four-consecutive day flow that occurs with a frequency of once in three years) as a critical flow level for achieving standards (NMED, 2010a). This method provides a reasonably conservative estimate for calculating needed load reductions. However, since the available water quality data were limited, and do not fully reflect the large degree of temporal and spatial variability that occurs for each constituent within the characterized stream reaches, more accurate assessments could be completed with a greater range of data. Additional data would help to more fully characterize the temporal variability of the streams that are included in this report as well as both Eagle Nest and Springer Lakes. In particular, water can be released from three different gates at Eagle Nest Dam. Characterizing the stratification could help to optimize the timing and location of releases.

The estimates of relative contributions from probable sources were made by local landowners and others familiar with the watershed, based on visual observations of the watershed. For example, where low-water crossings were identified as a significant probable source, both the number and condition of those roads were considered. However, complete data to characterize water quality conditions, both upstream and downstream of the low-water crossings, or to identify other probable sources under a variety of streamflow conditions, were not available.

As watershed restoration activities are implemented, continued water quality monitoring is needed with a focus on TMDL constituents for the reaches of concern, to refine water quality goals and improvements during implementation. Data needs include the continued operation of existing U.S. Geological Survey (USGS) stream gages (Cieneguilla Creek near Eagle Nest, Sixmile Creek near Eagle Nest, Moreno Creek at Eagle Nest, Eagle Nest Lake Near Eagle Nest, Cimarron River below Eagle Nest, Cimarron River near Cimarron, Rayado Creek near Cimarron, Ponil Creek near Cimarron, and Cimarron River at Springer). In some cases the gages may need to be repaired or reinstalled to allow for continued operation.

Additional streamflow measurements and water quality sampling are also warranted to characterize a fuller range of constituent levels at varying streamflows. Recommended monitoring to address this data gap is discussed in Section 12.

Additionally, NMED has not fully characterized all of the streams within the Cimarron Watershed, including American Creek, West Agua Fria Creek, Clear Creek, Tolby Creek, Bonito Creek, Greenwood Canyon, McCrystal Creek, Seally Canyon, and North Ponil Creek from Seally Canyon to the headwaters. Also, streams that are not currently listed as impaired could be listed in the future, due to possible wildland fires or other changing conditions. As a result of these data gaps and changing conditions, the CWA views this WBP as a living document that may need to periodically include new information and/or addendums for individual reaches, as listed in the subsequent 303(d)/305(b) Integrated Lists.

Specific plans for addressing these data gaps in the Cimarron Watershed are:

- Meet with a representative of the USGS to discuss plans for repair and continued operation of key stream gages and to discuss opportunities for CWA and USGS to work collaboratively to seek funding and support for operation of streamflow gages and water quality monitoring.
- Meet with the OSE to discuss opportunities to collaborate on research and monitoring at Eagle Nest Lake that will help with optimizing release operations.
- Complete monitoring activities as identified in Section 11.
- Review and synthesize ongoing monitoring data collected by NMED, USGS, and other agencies and information collected through specific projects such as the Riparian Ecosystem Restoration Initiative (RERI) grant to provide an integrated and up-to-date water quality database.

Additionally, the CWA will continue to share new data and information through monthly meetings and annual reporting.

6. Load Reductions

The objective of the watershed-based planning process is to improve water quality so that TMDL standards are achieved. Once the causes and sources of pollutants have been identified, the next step in the planning process is to quantify load reductions that are required to meet water quality objectives. Guidance for watershed-based planning indicates that, in cases where a TMDL for affected waters has been developed and approved, or is being developed for approval, the watershed plan should be crafted to achieve the load reductions required by the TMDL (EPA, 2008). A summary of the load reductions, as reported in the TMDL (NMED, 2010a), is provided on Table 6-1, which illustrates the significant load reductions that are required to meet standards. The TMDLs, along with associated load reductions required to meet the TMDLs (NMED, 2010a) are included in Tables 6-2 through Table 6-5. Load reductions expected for select management measures are discussed in Section 7.

Table 6-1. Estimated Load Reductions

Location	Contaminants of Concern	Required Load Reduction (percent) [(a)]
Moreno Valley		
Cieneguilla Creek (Eagle Nest Lake to headwaters)	E.coli	88
	plant nutrients [(b)]	40, 28
	sediment/siltation	NE*
	Temperature	37
	Turbidity	NE*
Moreno Creek (Eagle Nest Lake to headwaters)	plant nutrients	55,45
	Temperature	43
Sixmile Creek (Eagle Nest Lake to headwaters)	E.coli	59
	plant nutrients	51,29
	Temperature	35
	Turbidity	NE*
Ponil Creek and Tributaries		
North Ponil Creek (South Ponil Creek to Seally Canyon)	E.coli	47
	Temperature	NE*
	Turbidity	NE*

a) Per 2010 TMDL (NMED, 2010a)

b) Phosphorus and nitrogen, respectively

* NE –For constituents listed as continued impairment from previous assessments, (see Table 5-1), the TMDL (NMED, 2010a) did not estimate a required load reduction. In most cases, the management measures which were implemented to address other constituents will also address this constituent.

TABLE 6-1 (continued)

Location	Contaminants of Concern	Required Load Reduction (percent) [(a)]
South Ponil Creek (Ponil Creek to Middle Ponil)	Temperature	14
Ponil Creek (US 64 to confluence of North and South Ponil)	E.coli	53
	plant nutrients	59,50
	Temperature	NE*
	turbidity	NE*
Ponil Creek (Cimarron River to US 64)	E.coli	75
Cimarron River and Ute Creek		
Cimarron River (Turkey Creek to Eagle Nest Lake)	dissolved arsenic	64
	plant nutrients	77,65
Cimarron River (Cimarron Village to Turkey Creek)	dissolved arsenic	44
	Temperature	33
Cimarron River (Canadian River to Cimarron Village)	plant nutrients	31,42
Ute Creek (Cimarron River to headwaters)	dissolved arsenic	50
	E.coli	49
	Temperature	24
Rayado Creek		
Rayado Creek (Miami Lake Diversion to headwaters)	E.coli	36
	Temperature	37
Rayado Creek (Cimarron River to Miami Lake Diversion)	plant nutrients, sediment/siltation	53,32

a) Per 2010 TMDL (NMED, 2010a)

b) Phosphorus and nitrogen, respectively

* NE –For constituents listed as continued impairment from previous assessments (see Table 5-1) the TMDL (NMED, 2010a) did not estimate a required load reduction. In most cases, management measures implemented to address other constituents will also address this constituent.

Table 6-2. Calculation of Load Reduction for Dissolved Arsenic

Location	Target Load (lbs/day) [(a)]	Measured Load (lbs/day)	Reduction (lbs/day)	Percent Reduction [(b)]
Cimarron River (Cimarron Village to Turkey Creek)	0.236	0.424	0.188	44%
Cimarron River (Turkey Creek to Eagle Nest Lake)	0.150	0.413	0.263	64%
Ute Creek (Cimarron River to headwaters)	0.004	0.008	0.004	50%

Notes: The Margin of Safety (MOS) is not included in the load reduction calculations because it is a set-aside value, which accounts for any uncertainty or variability in TMDL calculations. Therefore, the MOS should not be subtracted from the measured load.

(a) Target Load = TMDL - MOS

(b) Percent reduction is the percentage amount of the existing measured load that must be reduced to achieve the TMDL, and is calculated as follows: (Measured Load – Target Load) / Measured Load x 100

Table 6-3. Calculation of Load Reduction for *E. Coli*

Location	Target Load (cfu/day) [(a)]	Measured Load (cfu/day)	Reduction (cfu/day)	Percent Reduction [(b)]
Cieneguilla Creek (Eagle Nest Lake to headwaters)	3.01×10^{9}	2.42×10^{10}	2.12×10^{10}	88%
North Ponil Creek (South Ponil Creek to Seally Canyon)	6.45×10^{8}	1.21×10^{9}	5.61×10^{8}	47%
Ponil Creek (US 64 to confl of North and South Ponil)	9.03×10^{8}	1.91×10^{9}	1.01×10^{9}	53%
Ponil Creek (Cimarron River to US 64)	1.97×10^{9}	7.75×10^{9}	5.78×10^{9}	75%
Rayado Creek (Miami Lake Diversion to headwaters)	5.24×10^{9}	8.23×10^{9}	2.99×10^{9}	36%
Sixmile Creek (Eagle Nest Lake to headwaters)	4.73×10^{8}	1.15×10^{9}	6.82×10^{8}	59%
Ute Creek (Cimarron River to headwaters)	2.02×10^{9}	3.94×10^{9}	1.92×10^{9}	49%

Note: The Margin of Safety (MOS) is not included in the load reduction calculations because it is a set-aside value, which accounts for any uncertainty or variability in TMDL calculations. Therefore, the MOS should not be subtracted from the measured load.

(a) Target Load = TMDL - MOS

(b) Percent reduction is the percentage amount of the existing measured load that must be reduced to achieve the Target Load, and is calculated as follows: (Measured Load – Target Load) / Measured Load x 10

Note: cfu = colony forming unit

Table 6-4. Calculation of Load Reduction for Nutrients (Total Phosphorus and Total Nitrogen)

Location	Nutrient	Target Load (lbs/day) [(a)]	Measured Load (lbs/day)	Reduction (lbs/day)	Percent Reduction[(b)]
Cieneguilla Creek (Eagle Nest Lake to headwaters)	P	0.315	0.525	0.210	40%
Cieneguilla Creek (Eagle Nest Lake to headwaters)	N	2.97	4.14	1.18	28%
Cimarron River (Canadian River to Cimarron Village)	P	0.126	0.183	0.057	31%
Cimarron River (Canadian River to Cimarron Village)	N	1.89	3.26	1.37	42%
Cimarron River (Turkey Creek to Eagle Nest Lake)	P	0.324	1.42	1.10	77%
Cimarron River (Turkey Creek to Eagle Nest Lake)	N	3.96	11.4	7.41	65%
Moreno Creek (Eagle Nest Lake to Headwaters)	P	0.018	0.040	0.022	55%
Moreno Creek (Eagle Nest Lake to Headwaters)	N	0.225	0.410	0.185	45%
Ponil Creek (US 64 to confl of North and South Ponil)	P	0.036	0.088	0.052	59%
Ponil Creek (US 64 to confluence of North and South Ponil)	N	0.396	0.788	0.392	50%
Rayado Creek (Cimarron R. to Miami Lake Diversion)	P	0.063	0.135	0.072	53%

Note: The Margin of Safety (MOS) is not included in the load reduction calculations because it is a set-aside value, which accounts for any uncertainty or variability in TMDL calculations. Therefore, the MOS should not be subtracted from the measured load.

(a) Target Load = TMDL – MOS

(b) Percent reduction is the percentage amount of the existing measured load that must be reduced to achieve the target load, and is calculated as follows: (Measured Load – Target Load) / Measured Load x 100.

TABLE 6-4 (continued)

Location	Nutrient	Target Load (lbs/day) [(a)]	Measured Load (lbs/day)	Reduction (lbs/day)	Percent Reduction[(b)]
Rayado Creek (Cimarron R. to Miami Lake Diversion)	N	0.918	1.35	0.433	32%
Sixmile Creek (Eagle Nest Lake to headwaters)	P	0.018	0.037	0.019	51%
Sixmile Creek (Eagle Nest Lake to headwaters)	N	0.207	0.294	0.087	29%

Note: The MOS is not included in the load reduction calculations because it is a set-aside value, which accounts for any uncertainty or variability in TMDL calculations. Therefore, the MOS should not be subtracted from the measured load.

(a) Target Load = TMDL – MOS (refer to Table 5-10)

(b) Percent reduction is the percentage amount of the existing measured load that must be reduced to achieve the target load, and is calculated as follows: (Measured Load – Target Load) / Measured Load x 100.

Table 6-5. Calculation of Load Reduction for Temperature

Location	Target Load (j/m2/sec) [a]	Measured Load (j/m2/sec)	Reduction (j/m2/sec)	Percent Reduction [b]
Cieneguilla Creek (Eagle Nest to headwaters)	131.79	207.83	76.04	37%
Cimarron River (Cimarron Village to Turkey Creek)	104.70	157.05	52.35	33%
Moreno Creek (Eagle Nest Lake to headwaters)	97.35	170.48	73.13	43%
Rayado Creek (Miami Lake Diversion to headwaters)	143.96	226.85	82.89	37%
Sixmile Creek (Eagle Nest Lake to headwaters)	171.46	265.36	93.90	35%
South Ponil Creek (Ponil Creek to Middle Ponil)	143.09	165.98	22.89	14%
Ute Creek (Cimarron River to headwaters)	177.99	232.67	54.68	24%

Notes: The MOS is not included in the load reduction calculations because it is a set-aside value, which accounts for any uncertainty, or variability, in TMDL calculations. Therefore, the MOS should not be subtracted from the measured load.

(a) Target Load = LA + WLA

(b) Percent reduction is the percentage amount of the existing measured load that must be reduced to achieve the target load, and is calculated as follows: (Measured Load – Target Load) / Measured Load x 100.

Note: j/m2/sec = joules per meter squared per second

7. NPS Management Measures

Management measures that will help to achieve needed load reductions were evaluated by cause of impairment as well as by geographic area. When considering nonpoint source management measures or best management practices to achieve load reductions, there are two primary types of actions:

- ***Overall management measures that address the root cause or source of contamination***. These may include changing land use practices, such as grazing management, relocating roads, installing a wastewater treatment plant to replace aging septic tanks, or any other activity that directly addresses the source of contamination.

- ***Mitigation measures that focus on reducing the impacts of degradation***. For example, high levels of erosion from upland land use management practices may cause stream bank instability. Mitigation measures to restore bank stability can be beneficial, but will only have limited long term impact without addressing the root cause of the degradation. Mitigation measures can be important in helping to restore streams and reducing loads to meet water quality standards. However, they must be coupled with appropriate management measures to have long-term success.

As discussed in section 5, the causes of impairment in the Cimarron watershed, as identified in the TMDL process, include *E.coli*, plant nutrients, turbidity, sediment/siltation, temperature, and dissolved arsenic. Although numerous probable sources were also identified in Section 6, plant nutrients, turbidity, sediment/siltation, and to some degree, *E.coli* are largely related to the processes of erosion and resulting contributions of sediment into the stream system. Therefore, a key focus of management measures is to control erosion.

Due to the large size of the Cimarron Watershed, the CWA is approaching this WBP project in two Tiers:

- Tier 1 projects have been evaluated in greater detail; therefore, more specific information has been developed related to management measures, anticipated load reductions and costs. These projects have a high implementation priority, and are ready to move forward. As Tier 1 projects are completed and the CWA proceeds with implementation of the WBP, additional Tier 1 sub-watersheds will be identified for more detailed assessment and to establish on-the-ground project funding.

- Tier 2 management measures have been identified for the entire watershed. These measures are linked both to the causes and the sources of impairment (Section 5) and to the estimated load reductions that are needed to improve water quality (Section 6). However, the scope of this WBP did not allow for detailed field assessment of the entire watershed. Consequently the Tier 2 portion of the watershed is not evaluated in as much detail as the Tier 1 portion.

An overview of management measures for the entire watershed is included in Section 7.1. More detailed discussion of Tier 1 projects is included in Section 7.2.

7-1. Cimarron Watershed Management Measures

While a significant number and variety of management measures will be needed to address impairment throughout the watershed, there are some key categories of management practices that will be essential to achieve load reductions and improve water quality. These categories include:

- ***Livestock Grazing Management Practices:*** Active livestock grazing management practices can limit access to prevent over-grazing. Prescribed grazing is the controlled harvest of vegetation by using grazing or browsing animals, managed with the intent to maintain or improve water quality and quantity. For example, on grazed forest, native pasture, or rangeland, grazing is limited so that the grazing animals will consume no more than 50% of the annual growth of preferred types of vegetation (EPA, 2008). In many situations, the utilization rate should be in the range of 25% to 30%, in order to optimize livestock grazing, wildlife utilization, range biodiversity, and health. These more limited utilization rates can assist all the animals, grasses and forbs through future droughts. Also, de-stocking can be expected to be less severe; the range will recover much more quickly and will be in better condition. Individual ranches, and the managers who are responsible for wildlife management, can develop site-specific grazing management plans that are appropriate for the number of livestock as well as for current vegetation. Some grazing management practices which can be beneficial for water quality include:
    - ***Herding and Rotation.*** By rotating livestock through herding, vegetation can be preserved by allowing only a certain amount of the vegetation to be consumed before livestock is rotated to a new pasture. Herd rotation prevents erosion by leaving sufficient surface litter and root structure in place. ***Rest Rotational*** grazing plans can also be used to protect vegetation and prevent erosion.
    - ***Paddocks or corrals*** can be used to manage herds. There are some locations in the Cimarron watershed where it would be beneficial to relocate corrals a greater distance from water sources to minimize the flux of nutrients, bacteria, and sediment in to the streams.
    - ***Grazing*** should be keyed to range monitoring, where no more than 25- 50% of the forage is used in any one rotation
    - ***A drought management plan*** must be written and adhered to, with triggers that are based on precipitation and range condition.

- ***Riparian Grazing Management***, one type of livestock grazing, can be utilized to reinvigorate vegetation and keep it from becoming decadent. Key species for riparian monitoring are sedges and woody vegetation. Once riparian vegetation has been established, riparian zones can be grazed during 3 out of 4 years, alternating between spring, mid-season, and late-season (this method should be used for upland paddocks when possible). Alternatively, dormant season grazing on the riparian paddocks can normally be done during two out of every three years. In some cases, during initial restoration, livestock may need to be kept completely out of the riparian areas for several years to avoid the destruction of re-growth.
- In some cases, fencing may be more appropriate than rotational herding to control livestock access to key areas.

- ***Managing access to streams and riparian areas.*** Managing access by pets, livestock and wildlife can help to reduce the influx of sediment, nutrients, and turbidity into streams and can protect the vegetation that contributes to lower stream temperatures. Some of the best management practices in this category include:
  - Elk or other wildlife exclosures, which consist of fencing around sensitive areas to exclude access. This feature can be particularly important when trying to establish new vegetation.
  - Alternative water sources, sometimes in combination with animal trails, exclosures, or improved grazing practices, can be used to keep livestock or wildlife away from direct stream access.

- ***Restoring riparian vegetation**.* Healthy riparian areas stabilize soil and can help reduce erosion and sedimentation, as well as the influx of nutrients or other contaminants, by providing a buffer zone between roads or other sources and streams. Restoration of riparian vegetation by planting and limiting livestock and wildlife access and in some cases vehicle access can also aid in reducing water temperatures by increasing shade cover, and can help to restore cold-water fisheries.

- ***Restoring channel stability and natural geomorphologic conditions.*** Stabilizing channels will connect streams to floodplains and reduce erosion and sedimentation. Re-establishing appropriate geomorphologic conditions can help to stabilize stream banks and potentially reduce turbidity, sedimentation, nutrients, and bacteria that enter the stream through erosion processes. Additionally, geomorphologic restoration can assist in establishing riparian vegetation to reduce stream temperatures.

- ***Improving road conditions***. Implementing BMPs for roads can help to reduce the influx of sediment, nutrients, bacteria and other contaminants that may run off of road surfaces into streams, as well as help to reduce road maintenance costs. Typical BMPs include:
    - ***Stabilizing low-water crossings.*** Numerous unpaved roads in the Cimarron watershed cross directly through streams. During high flows, these roads may be impassable. At other times, driving through the water leads to ruts and, in some cases, severe erosion. The road crossings can be stabilized by installing boulders and gravel to provide a more secure driving surface.

- *Relocating Roads.* In some cases, relocating roads, rather than stabilizing stream crossings, may be feasible. Relocating roads out of the riparian area to either eliminate or reduce the number of stream crossings allows for better opportunities to improve drainage as well as adding natural buffer zones to mitigate potential contamination between the road and the riparian area.
- ***Improving drainage.*** Poor road drainage that can accelerate erosion and runoff can be mitigated through both proper placement of culverts and bridges, and low maintenance water harvesting techniques, to minimize erosion from unpaved road surfaces. Additionally, implementing standards and oversight to ensure that any new roads are properly designed and installed can protect against further water quality degradation.

- ***Water Bars.*** Water Bars are commonly constructed on roads or skid trails when they are no longer used. The purpose of Water Bars is to slow the speed of water flow as well as to divert water away from the road or trail.

* ***Implementing best management practices for construction projects.*** Similar to roads, other construction projects can potentially contribute sediment, nutrients, bacteria, and other contaminants to streams through erosion processes. For example, construction of recreation and commercial facilities (ball parks, ski areas, parking lots, etc.) in the watershed are sources of potential concerns. Best management practices related to construction include:
    - ***Pre-construction planning*** to consider how runoff will be addressed can minimize any future impacts of the project under consideration. Stormwater BMPs described below may be identified during the planning and permitting process.
    - ***Temporary sediment fences or wattles*** may be used to ensure that runoff from construction sites does not reach waterways.

- ***Hydraulic mulching (hydromulch)*** is a process by which wood fiber mulch, processed grass, hay, or straw mulch is applied with a tacking agent; this process is performed using a slurry. This mulching method provides for temporary stabilization of bare slopes or other bare areas, as well as uniform, economical slope protection. Hydromulch may be combined with hydroseeding as a revegetation method (EPA, 2006). However, where hydromulching is used, care must be taken to ensure that invasive species are not introduced.

- ***Preventing catastrophic wildfires and conducting post-fire restoration.*** Catastrophic or crown fires have the potential to cause severe erosion and sedimentation, as well as the influx of other contaminants into waterways. Fuel reduction projects can help some fires to have fewer impacts by reducing ladder fuels, allowing for a more natural fire regime (as opposed to a catastrophic crown fire), and helping to minimize post-fire erosion and sedimentation, flooding, and temperature increases due to loss of hillslope and/or streamside vegetation. Also, the installation of swales, sediment ponds, log contouring, mulching, and reseeding after fires can potentially help to mitigate fire impacts.

- ***Management of streamflow releases and diversions.*** As discussed in Section 5, water quality is partially dependent on streamflow. In many cases, streamflow impairment occurs during low-flow conditions. Management of releases from Eagle Nest Dam, and diversions throughout the watershed to optimize water quality conditions, could be beneficial. However, this WBP does not affect water rights, and any changes in diversions would be voluntary, as is the case with all management practices suggested in this WBP. Therefore, this management practice needs further exploration to determine if there is a willingness to pursue voluntary involvement of water rights holders. If there is sufficient interest and funding to cover the considerable expense, water rights could be purchased for watershed restoration purposes. These could be similar to other current projects that have been implemented to protect endangered species through the strategic water reserve on the Rio Grande (OSE, 2008).

  Land managers and water right users along the Cimarron River can help manage flows by:

  - Planning water consumption for irrigation during early morning and late evening hours to reduce evaporation,
  - Grass banking and managing riparian zones to retain soil moisture and minimize soil erosion, and

    Providing buffer zones with shade plants along the river to reduce water temperatures.

- If releases from Eagle Nest Dam are not managed properly, and/or if there are failures in the mechanical operation of the release gates, these releases could become a source of impairment. Releases of eutrophied water and water containing high levels of sediment could contribute to the exceedence of water quality standards for dissolved oxygen, turbidity, and heavy metals such as arsenic, mercury or other constituents. A concerted effort by the managers of Eagle Nest Dam is needed, not only to monitor water quality being released, but also to use the release gates in such a manner as to mix eutrophied waters with oxygenated waters. This management effort would mitigate any point source contamination.
- ***Agriculture Best Management Practices.*** Though the land area involved in agriculture (other than livestock) is relatively small in the overall watershed, there can still be benefits from implementing agricultural BMPs. These benefits are most likely to affect water quality on Rayado Creek and the mainstem of the Cimarron River. Agricultural BMPs include:
    - ***Conservation crop rotation*** is the practice of growing different crops on the same piece of land in a planned sequence. This sequence might involve growing high-residue-producing crops, such as corn or wheat, in rotation with low-residue-producing crops, such as vegetables or soybeans. The rotation might also involve growing forage crops in rotation with various field crops. Crop rotation can help reduce soil erosion and break insect, disease, and weed cycles (EPA, 2006).
    - ***Contour farming*** includes tillage, planting, and other farming operations performed with the rows on or along the contour of the field slope. It helps to reduce sheet and rill erosion and the resulting transport of sediment and other waterborne contaminants (EPA, 2006).
    - ***Critical area planting*** is the planting of grasses, legumes, or other vegetation to stabilize slopes in small, severely eroding areas. This permanent vegetation stabilizes areas such as gullies, over-grazed hillsides, and terraced backslopes. Although the primary goal is erosion control, the vegetation can also provide nesting cover for birds and small animals (EPA, 2006).
- ***Managing Storm Water.*** Though urban and developed areas represent only a small part of the watershed, managing storm water runoff in these areas can help prevent the influx of sediments, nutrients, bacteria, and other contaminants into streams. Additionally, the BMPs in this category can be used to address impacts from construction projects, mines, or other local sources.

- ***Diversion*** is the redirection of a storm drain line or outfall channel so that it can temporarily discharge into a sediment-trapping device. Its purpose is to prevent sediment-laden water from entering a watercourse, public property, or private property through a storm drain system. A diversion may also provide temporary underground conveyance of sediment-laden water to a sediment-trapping device (EPA, 2006).

- ***A dry detention basin*** is a storm water retention basin that remains dry except for short periods of time following large rainstorms or snowmelt events. Its main benefit is the moderating influence it provides on peak flows, which help to control streambank erosion (EPA, 2006).

- ***A filter strip*** is a strip or area of vegetation for removing sediment, organic matter, and other pollutants from runoff and wastewater before they reach water bodies or water sources, including wells (EPA, 2006).

- ***Grass swales*** are elongated depressions in the surface of the land that have been vegetated with erosion-resistant and flood-tolerant grasses. Swales are formed to direct storm water flows into primary drainage channels to allow some storm water to infiltrate into the ground. These depressions are, at a minimum, seasonally wet. Usually, they are also heavily vegetated and they normally lack flowing water. Sometimes check dams are strategically placed in swales to moderate the flow (EPA, 2006).

- ***Implementing Mine BMPs.*** Additional monitoring and assessment of potential impacts from old mine sites is needed. Potential BMPs at these sites include:

  - Diverting drainage away from exposed soils by applying storm water BMPs described above.

  - Working with New Mexico Abandoned Mine Lands Program to implement site specific remediation projects, such as covering tailings or closing shafts.

- ***Addressing Failing Septic Systems.*** Providing education resources to homeowners regarding the proper maintenance and potential replacement of older septic systems, such as those present in Ute Park, can help to reduce loads of nutrients and bacteria to stream systems.

The management measures to be implemented for each geographic area/impaired stream reach that will contribute to needed load reductions are listed on Table 7-1, and priorities impairments to address by sub-watersheds are shown on Table 7-2. The locations of these sub-watersheds are shown on Figure 7-1. Implementation of the management measures will lead to improved water quality and greater resilience in the watershed.

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Table 7-1. Management Measures

Location	Causes of Impairment	Primary Probable Sources	Secondary Probable Sources	NPS Management Measures Needed to Achieve Load Reductions	
				Projects Completed	Additional Projects
Moreno Valley					
Cieneguilla Creek (Eagle Nest Lake to headwaters)	*E.coli*, plant nutrients, sediment/siltation, temperature, turbidity	loss of riparian habitat, rangeland grazing, roads, streambank modification/ destabilization, wildlife	airport, dam/impoundment, construction, municipal point source discharges, other recreational pollutant sources, septic tanks	- bacterial source tracking - geomorphology/bank stabilization - wildlife exclosures - C.S. Ranch Corral Relocation	- Angel Fire effluent re-use - channel stability BMPs - construction BMPs - conservation easements - fuel reduction/fire BMPs - grazing BMPs - open space purchase - riparian vegetation - remediation of older septic systems - sediment traps or filter strips below gravel pits - wildlife management - protection of riparian areas

Location	Causes of Impairment	Primary Probable Sources	Secondary Probable Sources	NPS Management Measures Needed to Achieve Load Reductions	
				Projects Completed	**Additional Projects**
Moreno Creek (Eagle Nest Lake to headwaters)	plant nutrients, temperature	mining, rangeland grazing, roads, septic systems, wildlife	corrals, gravel pit, roads, waste from pets	bacterial source tracking	- abandoned mine assessment - fuel reduction/fire BMPs - remediation of older septic systems - sediment traps or filter strips below gravel pits - septic tank BMPs - wildlife management - livestock corral relocation - road improvements
Sixmile Creek (Eagle Nest Lake to headwaters)	*E.coli*, plant nutrients, temperature, turbidity	gravel pit, habitat modification, livestock feeding, rangeland grazing, septic systems	natural sources, roads		- fuel reduction/fire BMPs - remediation of older septic systems - sediment traps below gravel pits - Taos Pines road improvements - wildlife management

Location	Causes of Impairment	Primary Probable Sources	Secondary Probable Sources	NPS Management Measures Needed to Achieve Load Reductions	
				Projects Completed	Additional Projects
Ponil Creek and Tributaries					
North Ponil Creek (South Ponil Creek to Seally Canyon)	*E.coli*, temperature, turbidity	loss of riparian habitat, low-water crossings, rangeland grazing, roads	habitat modification, hydromodification, fire suppression sediment, mining, silvaculture	initial review of channel conditions	- channel stability BMPs - fuel reduction/fire BMPs - low-water crossings - riparian vegetation - road improvements - livestock corral relocation
Middle Ponil Creek (South Ponil to Greenwood Creek)	Temperature	loss of riparian habitat, rangeland grazing	wildlife	- low-water crossings - channel stability - post fire rehabilitation	- channel stability BMPs - fuel reduction/fire BMPs - low-water crossings - riparian vegetation - road improvements - livestock corral relocation
South Ponil Creek (Ponil Creek to Middle Ponil)	Temperature	recreational uses, rangeland grazing, wildlife	low-water crossings, roads	initial review of channel conditions	- channel stability BMPs - fuel reduction/fire BMPs - low-water crossings - riparian vegetation - road improvements - livestock corral relocation

Location	Causes of Impairment	Primary Probable Sources	Secondary Probable Sources	NPS Management Measures Needed to Achieve Load Reductions	
				Projects Completed	**Additional Projects**
Ponil Creek (US 64 to confluence of North and South Ponil)	*E.coli*, plant nutrients, temperature, turbidity	loss of riparian habitat, rangeland grazing, roads, streambank modification/destabilization, wildlife	livestock confinement areas, recreational uses, roads, septic systems, wastes from pets	initial review of channel conditions	- channel stability BMPs - fuel reduction/fire BMPs - riparian vegetation - road improvements - livestock corral relocation
Ponil Creek (Cimarron to US 64)	*E.Coli*				
Cimarron River and Ute Creek					
Cimarron River (Turkey Creek to Eagle Nest Lake)	dissolved arsenic, plant nutrients	dam or impoundment, historical mining, septic systems, wildlife	geology, livestock, other recreational sources, roads, unknown sources		- channel stability BMPs - evaluate alternative releases from Eagle Nest* - fuel reduction/fire BMPs - road BMPs, including turnouts and filter strips to address runoff - groundwater monitoring and remediation of septic tanks
Cimarron River (Cimarron Village to Turkey Creek),	dissolved arsenic, temperature	loss of riparian habitat, rangeland grazing, roads, wildlife	baseflow depletion, corrals, diversions, mining, low-water crossings, pets, unknown sources		- channel stability BMPs - evaluate alternative releases from Eagle Nest Dam* - fuel reduction/fire BMPs - riparian vegetation

Location	Causes of Impairment	Primary Probable Sources	Secondary Probable Sources	NPS Management Measures Needed to Achieve Load Reductions	
				Projects Completed	Additional Projects
Cimarron River (Canadian River to Cimarron Village)	plant nutrients	flow alterations from water diversions, rangeland grazing, septic systems, wildlife	Low-water crossings, roads, impervious surface run-off		- channel stability BMPs - evaluate alternative releases from Eagle Nest* (no flow periods) - evaluate ditches and storm water runoff in Cimarron - fuel reduction/fire BMPs - Springer Ditch leakage reduction
Ute Creek (Cimarron River to headwaters)	dissolved arsenic, *E.coli*, temperature	historic mining, loss of riparian habitat, low-water crossings, rangeland grazing, roads, wildlife	pets, septic systems		- channel stability BMPs - assess abandoned mines - fuel reduction/fire BMPs - riparian vegetation on lower part of Ute Creek
Rayado Creek					
Rayado Creek (Miami Lake Diversion to headwaters)	*E.coli*, temperature	baseflow depletions from groundwater withdrawals, roads/low-water crossings, rangeland grazing, wildlife	avian/waterfowl, flow alterations, highways, septic tanks		- agriculture BMPs - channel stability BMPs - fuel reduction/fire BMPs - livestock grazing BMPs - manage diversions/water bank - riparian vegetation - wildlife management
Rayado Creek (Cimarron River to Miami Lake Diversion)	plant nutrients, sediment/siltation	dam or impoundment, loss of riparian habitat, rangeland grazing, roads/ low-water crossings, wildlife	flow alterations, habitat modifications, highways	Philmont Conservation Department Project Philmont education projects	- agriculture BMPs - channel stability BMPs - evaluate irrigation diversions and effects on water temperature - fuel reduction/fire BMPs - livestock grazing BMPs - manage diversions/water bank - riparian vegetation - wildlife management

Location	Causes of Impairment	Primary Probable Sources	Secondary Probable Sources	NPS Management Measures Needed to Achieve Load Reductions	
				Projects Completed	Additional Projects
Entire Watershed					
entire watershed	see above	see above	see above		- hire an outreach and implementation coordinator - follow construction BMPs - provide educational resources, particularly to new rural residents - work with County to evaluate road, septic, and other land-use regulations - evaluate use of commercial fertilizers - promote protection and conservation of riparian areas via conservation easements, creation of open space agencies and/or purchase of riparian buffer zones - evaluate use and presence of pesticides in the watershed - conduct ecosystem services evaluation

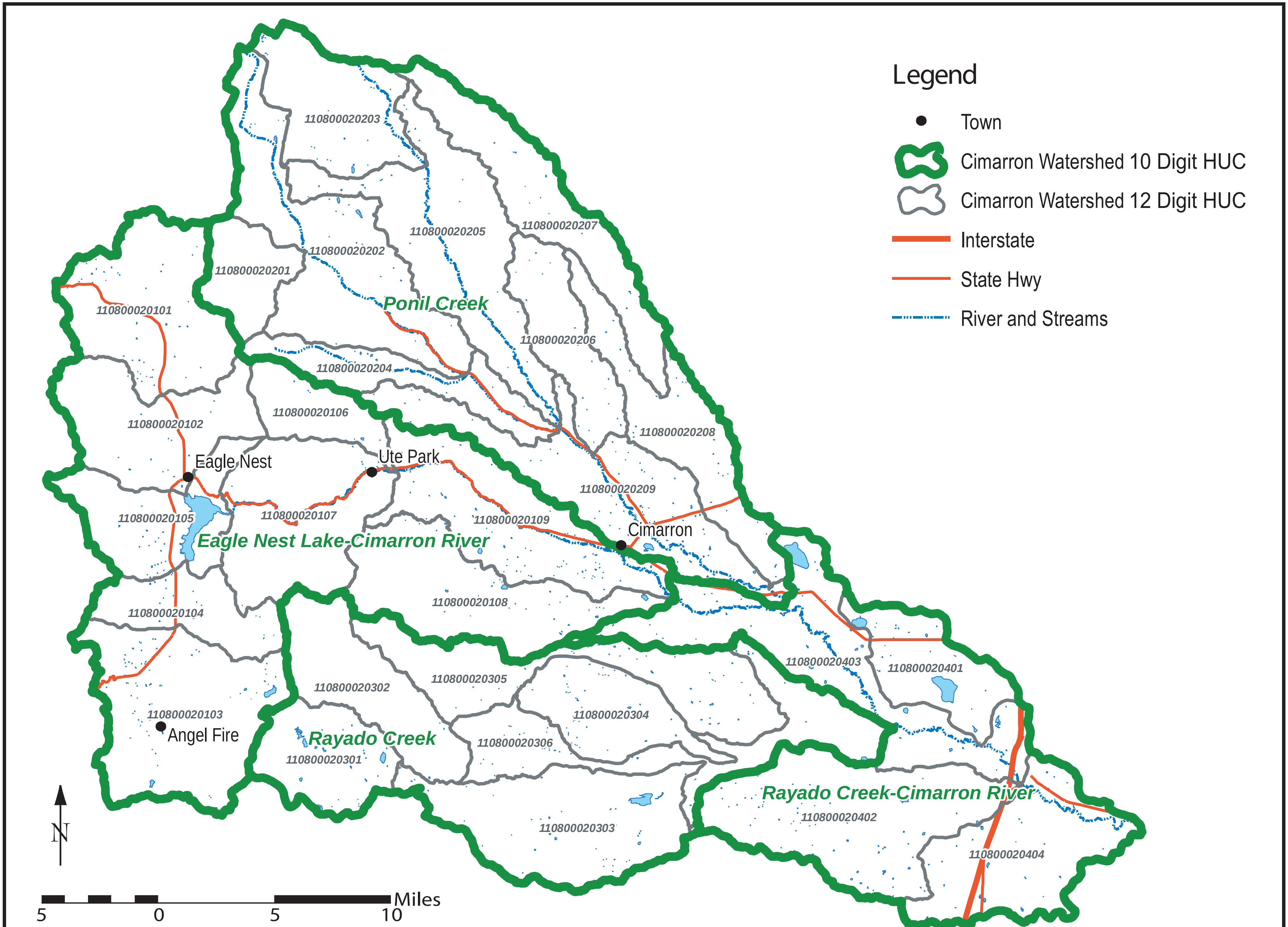
Table 7-2. Priority Best Management Practices by Sub-Watershed

Watershed ID	Watershed Name	Water Quality Impairments	Priority Best Management Practices
110800020103	Headwaters Cieneguilla Creek	*E. coli,* plant nutrients, temperature, turbidity, sediment/siltation (all in Cieneguilla Creek)	Livestock Grazing Management , Riparian BMPs
110800020104	Outlet Cieneguilla Creek	*E. coli,* plant nutrients, temperature, turbidity, sediment/siltation (all in Cieneguilla Creek)	Livestock Grazing Management , Riparian BMPs
110800020109	Cimarroncito Creek-Cimarron River	Plant nutrients, in Cimarron River (Canadian River to Cimarron Village); temperature and dissolved arsenic in Cimarron River (Cimarron Village to Turkey Creek); dissolved arsenic and plant nutrients in Cimarron River (Turkey Creek to Eagle Nest Lake)	Channel stability BMPs, alternative releases from Eagle Nest, fuel reduction/fire BMPs, riparian vegetation, Springer Ditch leakage reduction
110800020108	Cimarroncito Creek	Plant nutrients, in Cimarron River (Canadian River to Cimarron Village)	Channel stability BMPs, alternative releases from Eagle Nest, fuel reduction/fire BMPs, riparian vegetation, Springer Ditch leakage reduction
110800020403	Rayado Creek-Cimarron River	Plant nutrients, in Cimarron River (Canadian River to Cimarron Village)"	Channel stability BMPs, alternative releases from Eagle Nest, fuel reduction/fire BMPs, Springer Ditch leakage reduction
110800020401	Springer Lake	Plant nutrients, in Cimarron River (Canadian River to Cimarron Village)	Channel stability BMPs, alternative releases from Eagle Nest, fuel reduction/fire BMPs, Springer Ditch leakage reduction
110800020402	Salado Creek	Plant nutrients, in Cimarron River (Canadian River to Cimarron Village)	Channel stability BMPs, alternative releases from Eagle Nest, fuel reduction/fire BMPs, Springer Ditch leakage reduction
110800020404	Cimarron River	Plant nutrients, in Cimarron River (Canadian River to Cimarron Village)	Channel stability BMPs, alternative releases from Eagle Nest, fuel reduction/fire BMPs, Springer Ditch leakage reduction

Watershed ID	Watershed Name	Water Quality Impairments	Priority Best Management Practices
110800020107	Ute Creek-Cimarron River	Dissolved arsenic and plant nutrients in Cimarron River (Turkey Creek to Eagle Nest Lake)	Channel stability BMPs, alternative releases from Eagle Nest, fuel reduction/fire BMPs, Springer Ditch leakage reduction
110800020202	Middle Ponil Creek	Temperature in Middle Ponil Creek (South Ponil to Greenwood Creek) Temperature in South Ponil Creek (Ponil Creek to Middle Ponil Creek)	Channel stability BMPs, fuel reduction/fire BMPs, riparian vegetation, livestock corral relocation, rural road improvement BMPs, grazing BMPs, low water crossing upgrades, wildlife management plan, fire rehabilitation projects, alluvial fan restoration
110800020201	Greenwood Canyon	Temperature in Middle Ponil Creek (South Ponil to Greenwood Creek)	Channel stability BMPs, fuel reduction/fire BMPs, riparian vegetation, wildlife management
110800020101	Headwaters Moreno Creek	Plant nutrients and temperature in Moreno Creek.	Fuel reduction/fire BMPs, livestock corral relocation
110800020102	Outlet Moreno Creek	Plant nutrients and temperature in Moreno Creek.	Fuel reduction/fire BMPs, livestock corral relocation
110800020205	Outlet North Ponil Creek	*E. coli,*temperature, and turbidity in North Ponil Creek (South Ponil Creek to Seally Canyon); *E. coli*, plant nutrients, temperature, and turbidity in Ponil Creek (US 64 to confl of North & South Ponil)	Channel stability BMPs, fuel reduction/fire BMPs, riparian vegetation, livestock corral relocation, rural road improvement BMPs, grazing BMPs, low water crossing upgrades, wildlife management plan, fire rehabilitation projects, alluvial fan restoration, earthen dam rehabilitation
110800020209	Ponil Creek	Plant nutrients in Cimarron River (Canadian River to Cimarron Village); *E. coli*, plant nutrients, temperature, and turbidity in Ponil Creek (US 64 to confl of North & South Ponil)	Channel stability BMPs, fuel reduction/fire BMPs, riparian vegetation, livestock corral relocation, rural road improvement BMPs, grazing BMPs, low water crossing upgrades, wildlife management plan, fire rehabilitation projects, irrigation diversion and ditch upgrades, alluvial fan restoration, earthen dam rehabilitation

Watershed ID	Watershed Name	Water Quality Impairments	Priority Best Management Practices
110800020208	Outlet Cerrososo Creek	Plant nutrients in Cimarron River (Canadian River to Cimarron Village)	Channel stability BMPs, alternative releases from Eagle Nest, fuel reduction/fire BMPs, riparian vegetation
110800020204	South Ponil Creek	*E. coli,* plant nutrients, temperature, and turbidity in Ponil Creek (US 64 to confl of North & South Ponil)	Channel stability BMPs, fuel reduction/fire BMPs, riparian vegetation, livestock corral relocation, rural road improvement BMPs, grazing BMPs, low water crossing upgrades, wildlife management plan, fire rehabilitation projects, alluvial fan restoration
110800020206	Chase Canyon	*E. coli,* nutrients, temperature, and turbidity in Ponil Creek (US 64 to confl of North & South Ponil)	Channel stability BMPs, fuel reduction/fire BMPs, riparian vegetation, livestock corral relocation, rural road improvement BMPs, grazing BMPs, low water crossing upgrades, wildlife management plan, fire rehabilitation projects, alluvial fan restoration, earthen dam rehabilitation
110800020306	Outlet Rayado Creek	Plant nutrients and sediment in Rayado Creek (Cimarron River to Miami Lake Diversion); *E. coli* and temperature in Rayado Creek (Miami Lake Diversion to headwaters); plant nutrients, in Cimarron River (Canadian River to Cimarron Village)	Agriculture BMPs, channel stability BMPs, fuel reduction/fire BMPs, riparian vegetation, livestock grazing BMPs
110800020305	Urraca Creek	Plant nutrients and sediment in Rayado Creek (Cimarron River to Miami Lake Diversion)	Agriculture BMPs, channel stability BMPs, evaluate irrigation diversions and effects on water temperature, fuel reduction/fire BMPs, livestock grazing BMPs, manage diversions/water bank, riparian vegetation
110800020304	Chicoso Creek	Plant nutrients and sediment in Rayado Creek (Cimarron River to Miami Lake Diversion)	Agriculture BMPs, channel stability BMPs, evaluate irrigation diversions and effects on water temperature, fuel reduction/fire BMPs, livestock grazing BMPs, manage diversions/water bank, riparian vegetation

Watershed ID	Watershed Name	Water Quality Impairments	Priority Best Management Practices
110800020303	Moras Creek	Nutrients and sediment in Rayado Creek (Cimarron River to Miami Lake Diversion)	Agriculture BMPs, channel stability BMPs, evaluate irrigation diversions and effects on water temperature, fuel reduction/fire BMPs, livestock grazing BMPs, manage diversions/water bank, riparian vegetation
110800020302	Headwaters Rayado Creek	*E. coli* and temperature in Rayado Creek (Miami Lake Diversion to headwaters)	Agriculture BMPs, channel stability BMPs, evaluate irrigation diversions and effects on water temperature, fuel reduction/fire BMPs, livestock grazing BMPs, manage diversions/water bank, riparian vegetation
110800020301	Agua Fria Creek	E. coli and temperature in Rayado Creek (Miami Lake Diversion to headwaters)	Agriculture BMPs, channel stability BMPs, evaluate irrigation diversions and effects on water temperature, fuel reduction/fire BMPs, livestock grazing BMPs, manage diversions/water bank, riparian vegetation
110800020105	Eagle Nest Lake	*E. coli*, nutrients, temperature, and turbidity in Sixmile Creek (Eagle Nest Lake to headwaters)	Livestock Grazing and Fuel reduction/fire BMPs
110800020106	Ute Creek	Arsenic, E. coli, and temperature in Ute Creek. Also, arsenic and nutrients in "Cimarron River (Turkey Creek to Eagle Nest Lake)".	Table 7.1 identifies management measures recommended for each impaired stream reach. "Channel stability BMPs" and "riparian vegetation on lower part of Ute Creek" are listed among management measures for Ute Creek. More detail is provided starting on p 32.



Cimarron Sub-Watersheds and Hydrologic Unit Codes

Figure 7-1

7-2. Tier 1 Projects

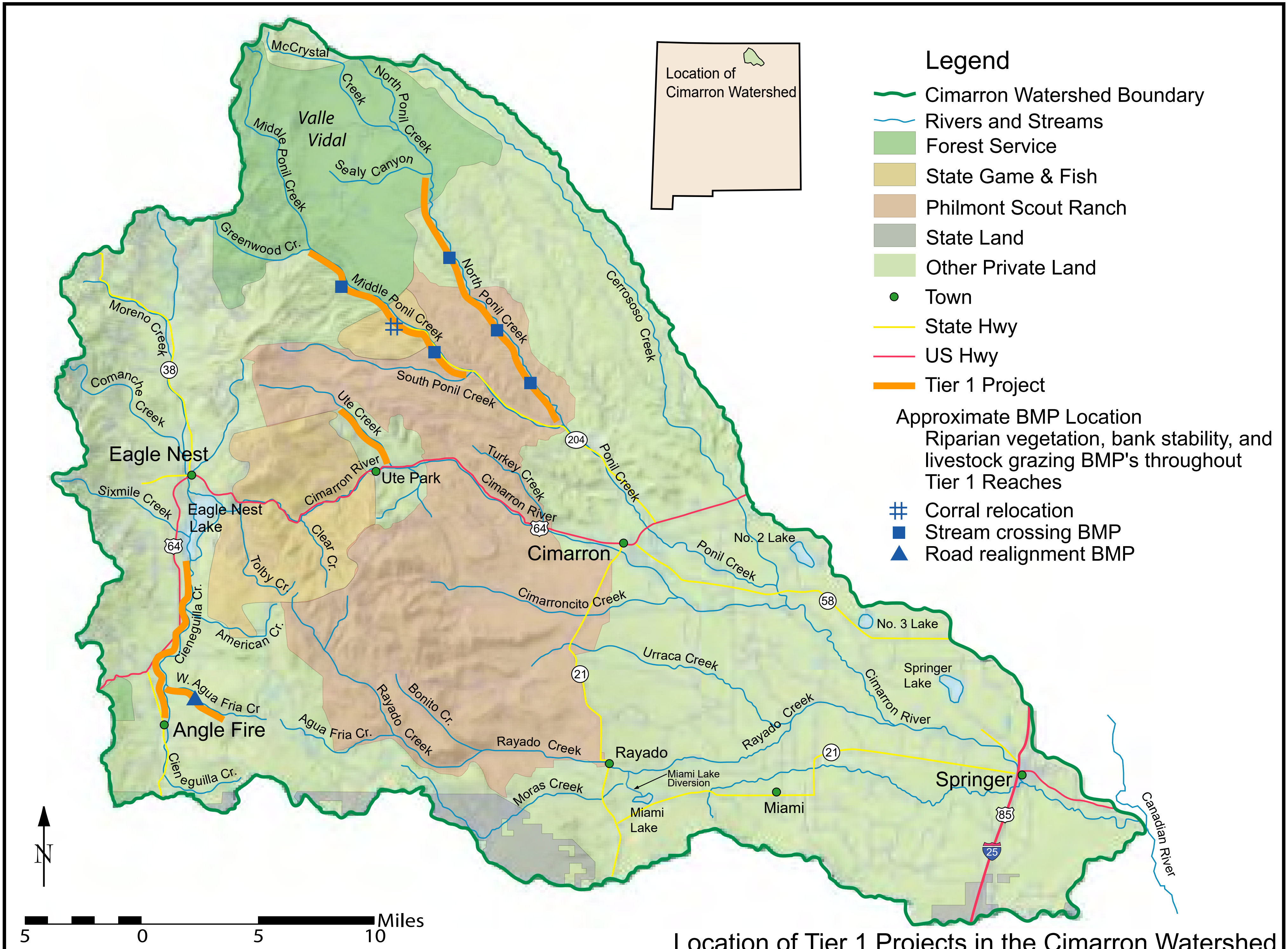
Due to the large size of the Cimarron Watershed, the CWA identified priority areas for additional assessment and implementation of high priority (Tier 1) projects. These priority areas are included in Table 7.1, and additional detail on the areas is included in this sub-section. The locations of the Tier 1 projects are shown on Figure 7-2.

The Tier 1 projects will help to reduce pollutant loads, have active interest and support from land owners, and are ready to proceed toward implementation when funding is secured. Field assessments to provide information for the project design and the costs of Tier 1 projects were completed in 2012, 2016, and 2017, and additional analyses were conducted to estimate load reductions resulting from management measures included in these projects.

The Tier 1 project areas are:

- Moreno Valley Wetlands Action Plan
- Cieneguilla Creek
- West Agua Fria Creek (tributary to Cieneguilla Creek)
- North Ponil Creek
- Middle and South Ponil Creek, Barker WMA to North Ponil Confluence
- Middle Ponil, Greenwood Creek Confluence to Barker WMA
- Ponil Creek, North Ponil Confluence to US HWY 64
- Ute Creek

The discussion outlined below includes the reasons that these specific reaches were chosen as priority project areas, summarizes the results of the field surveys, and discusses estimated load reductions from management measures. More detailed Tier 1 Field Survey Reports are also included in Appendix B.



Location of Tier 1 Projects in the Cimarron Watershed

Figure 7-2

Moreno Valley Wetlands. Numerous wetland resources and potential projects to protect and restore them were identified within the Moreno Valley, in the Moreno Valley Wetlands Action Plan (WAP). The purpose of the WAP is to identify potential impairments to wetlands, identify measures for protecting and restoring them, and to supplement the Watershed Based Plan (WBP) for the Cimarron Watershed. The protection and restoration of wetlands in the Moreno Valley will protect and improve water quality in Cieneguilla, Sixmile, and Moreno Creeks, several of their tributaries, and downstream waters including Eagle Nest Reservoir and the Cimarron River.

Key potential impairments to wetlands in the Moreno Valley include roads, grazing, diversion ditches, and earthen stock tanks. Other potential impairment may result from historic mining and timber activities, poorly planned development, domestic wastewater, and disruption of beaver habitat.

Tier One protection and restoration measures include:

- Restoring poorly designed roads through realignment, porous fill for road crossings, proper drainage, and other methods.
- Grazing exclosures to protect important areas from grazing and browsing impacts by elk and livestock. Livestock best management practices, such as rotation and alternate water sources, can be used by ranches in the area to minimize impacts to wetlands.
- Historic diversion ditches and stock tanks that are no longer needed may be de-commissioned in order to restore slope wetlands.
- Development planning is recommended to avoid future impairment of wetlands.
- Restoration measures for degraded streams may include in-channel measures, such as post vanes, baffles, one rock dams, media lunas, willow planting or other measures that will improve bank stability, slow and redistribute flows, and reconnect channels with floodplains to prevent erosion and sedimentation in wetland areas.
- Fuel reduction by private landowners and local governments can help reduce the risk of catastrophic wildfires.

The Moreno Valley WAP contains numerous project ideas that are now considered Tier 1 projects in the Cimarron Watershed Based Plan. The Moreno Valley WAP is included in full in Appendix C and can be found online at www.env.nm.gov/surface-water-quality/wap.

Cieneguilla Creek. As shown on Table 5-1, Cieneguilla Creek is impaired for temperature, *E.coli*, plant nutrients, sediment/siltation, and turbidity. Due to the multiple causes and sources of impairment on this reach, it has been identified as a high priority area for restoration. The CWA has been involved in restoration and monitoring on Cieneguilla Creek near the Angel Fire airport as discussed in Section 4; there is interest and potential benefit in expanding these activities. Bacterial source tracking (NMSU, 2010) indicated that avian species were the largest contributor to the *E.coli* impairment, but there are also contributions from wildlife and livestock.

A field survey completed in June of 2012 (Appendix B) indicated that most of the creek is devoid of shade and that numerous exposed banks are contributing considerable sediment loads to the creek. This erosion also contributes nutrients and bacteria to the stream system. Additionally, the field survey indicated that grazing is contributing to bank instability. Based on the field survey, the following restoration practices are recommended:

- Plant riparian species along the creek. Tree planting will need to be coupled with wildlife and livestock exclosures to successfully establish shading. Maintain existing wildlife exclosures as well as adding new wildlife exclosures in other areas.
- Restore unstable and eroding banks.
- Remove and restore an old road alignment that is affecting channel function.
- Meet with gravel pit operators to discuss best management practices.
- Work with land owners to provide education and resources regarding grazing management and to assist with off channel stock watering options.
- Meet with managers of Angel Fire Golf Course to discuss management practices and determine if there are any opportunities for collaboration.
- Work with Colfax County and the New Mexico Department of Transportation to conduct a valley wide road assessment to identify which roads may be repaired for improved drainage and to implement BMPs during road construction projects.

Aqua Fria Creek. West Agua Fria Creek is a perennial headwater stream that flows west from the Garcia Park area, off the north side of Agua Fria Peak and east of Angel Fire. The creek then enters Cieneguilla Creek on the east side of the Angel Fire Airport, contributing sediment and nutrients to the impaired reach of Cieneguilla Creek. A field survey conducted by Rangeland Hands indicated significant erosion and sediment contributions from a 1,600 foot section of West Agua Creek. To stop the direct sediment contribution into West Agua Fria Creek, it is recommended that this section of road be closed and drained, and an existing road that is on the north side of the creek be reopened. The old road would be abandoned and drained. The proposed work would include a significant number of cross-drains, so that no one drain has enough discharge to flow into the creek. Drainage would be directed into the limited buffer areas on the south side of the creek. Two culverts would be removed, and the stream channel would be reshaped to its original cross-sectional shape. The road also cuts through a small, spring-fed sloped wetlands. Local soil materials would be used to fill in the truncated end of the sloped wetlands. All berms and ditches would be removed and contoured into the old road prism. The road surface would be ripped and reseeded with native grasses. The new road alignment would be on an abandoned road on the north side of the creek. This new alignment is not as steep as the old road, and provides better buffer areas to sequester road drainage sediment.

North Ponil Creek. The North Ponil Creek is impaired for *E.coli*, temperature, and turbidity. A field survey conducted by the CWA indicated that the watershed has been significantly negatively impacted by historical and current land management practices. Based on data collected by the assessment team, the 3.6 miles of the North Ponil has a sediment contribution load of 5,394 tons per year from unstable stream banks (Appendix B). The field team recommended the following restoration projects:

- Establish an effective grazing management plan.
- Improve the road system and low water crossings within the area.
- Restoration of the North Ponil stream channel and banks to reduce instream erosion and downcutting. Restoration of the stream channel and banks could include grade control, bank stabilization, and reconfiguration of the channel pattern and morphology. Implementation of restoration work would likely utilize a combination of heavy equipment and hand work.
- Restoration of alluvial fans and rehabilitation of earthen dams would also reduce erosion and sedimentation within the watershed.

The team used the BANCS Model to determine that 94 percent of the stream bank erosion in the reach surveyed was due to banks categorized as a high to very high bank erosion hazard. Therefore, addressing these high instability banks, in conjunction with the upland management measures, can help to achievement the load reductions discussed in Section 6.

Middle and South Ponil, Barker WMA to North Ponil Confluence. The Middle Ponil Creek is currently listed for temperature impairment and has previously been listed for sediment/siltation and turbidity. The Ponil below the confluence of the Middle is currently impaired by plant nutrients, *E.coli* and temperature. Consequently, reducing erosion, as well as the influx of nutrients and bacteria from this reach, remains a concern for the larger stream system. The Middle Ponil was surveyed by Steve Carson of Rangeland Hands and Rick Smith of Highland Solutions. Based on data collected by the assessment team and quantified by Rick Smith, the 5.5 mile assessment reach of the Middle Ponil has a sediment contribution load of 7,068 tons per year from unstable stream banks. Restoration priorities that were identified include grazing management, relocating the equine corral, improving road drainage, bank stabilization, willow planting, and/or other hand-work to be completed by Scout crews. Details of the restoration recommendations are provided in Appendix B.

The team used the BANCS Model-Bank Assessment for Non-Point Source Consequences of Sediment (WARSSS 5-55). Field data was collected using the Bank Erosion Hazard Index (BEHI) and the Near Bank Stress Estimating System (NBS) #5 calculation method, ratio of near bank maximum depth to bankfull mean depth. Using this method, it was determined that 87 percent of the erosion in the reach surveyed was due to banks categorized as high to very high bank erosion hazard. Addressing these high instability banks, in conjunction with upland management measures, can help to achievement the load reductions discussed in Section 6.

Middle Ponil, Greenwood Creek Confluence to Barker WMA. In 2017, an assessment of the Middle Ponil Creek was completed from the Greenwood Creek confluence to the upstream Barker WMA boundary. The team used the BANCS method to assess this reach. The BANCS analysis identifies banks that contribute higher sediment loads along a reach and therefore highlights areas for restoration work that would have greater impact towards improving the stream system. The total estimated sediment contribution into the Middle Ponil from eroding banks is 515 cubic yards per year for the 5.6 mile reach of stream from the Greenwood confluence down to the Vermejo / USFS and Barker WMA boundary. The data from this reach was compared to the 2012 BANCS data from the assessment completed just downstream on the Middle Ponil. The comparison shows that the potential sediment loss in the upper reach, studied in 2017, is very minor in comparison to the lower reaches of the Middle Ponil Creek. The data shows that work on the lower reaches of the Middle Ponil Creek would have greater impact in reducing the overall sediment load in the creek.

Ponil Creek, North Ponil Confluence to US HWY 64. In 2017, an assessment of the Ponil Creek and the surrounding watershed was completed from the North Ponil confluence down to US Highway 64. The complete Assessment Report has been added to Appendix B. Issues that were found along the Ponil Creek and within the watershed include: unstable streambanks and an entrenched channel system that is continuing to downcut; major flooding over the past 15 years that has been exacerbated by the 2002 Ponil Complex Fire and extreme rainfall events; widespread erosion within the watershed as a result of historic impacts, ongoing impacts, and the 2002 Ponil Complex Fire; poor grazing management and wildlife management practices; roads that are poorly located, designed, and drained; and erosive geology. High and medium priority restoration recommendations for this area include: improving the Chase Ranch road system; developing grazing and wildlife management plans; constructing riparian fencing to exclude livestock and elk from riparian and wetland areas; upgrading irrigation diversions and ditches; alluvial fan restoration; earthen dam rehabilitation; stream restoration; and developing a more detailed long term restoration plan.

Ute Creek was also identified by CWA as a high priority area, due to its listing for dissolved arsenic, *E.coli* and temperature. However, a field survey has not yet been completed, due to resource limitations.

8. Estimates of Technical and Financial Assistance Needed

The section describes the amounts of technical and financial assistance that will be relied upon to implement the Cimarron WBP. The CWA is an active volunteer group which has been able to contribute to the successful implementation of some important best management practices in the watershed. However, additional assistance will be required to continue the programs and activities that will be needed to move toward compliance with all TMDLs, as well as to prevent future water quality degradation. The resources described below include overall administrative requirements needed to keep the group coordinated and active, to complete funding applications, and to conduct education and watershed-scale monitoring, as detailed in Section 8.1.

Project-specific resources needed to implement BMPs to address impairment in various watershed sub-areas are described in Section 8.2.

8-1. Administrative and Outreach Assistance Requirements

Since much of the watershed is privately owned, ongoing education and outreach will be required to involve numerous landowners in plan implementation. The CWA was formed as a volunteer group and currently anticipates the continued involvement of members and landowners with considerable in-kind contributions toward restoration efforts. The CWA has also consistently encouraged capacity-building among members who have acquired monitoring skills worthy of remuneration. Due to the large size of the watershed, with a total of 14 reaches which have various impairment issues, the effective implementation of this WBP will best proceed with a full-time coordinator. This coordinator would be responsible for preparing, obtaining, and managing grants to implement best management practices, providing education and resource materials, communicating with landowners and other project stakeholders, directing monitoring and adaptive management, and coordinating in-kind and volunteer resources.

Additional costs for office rental and expenses are required to support an ongoing, active watershed group. The cost for the coordinator position is estimated at $45,000 per year plus $20,000 per year for insurance, travel and other expenses. The costs for the office expenses are estimated at $1,000 per month for rent, utilities, and miscellaneous expenses, resulting in a total of approximately $77,000 per year.

In addition to the coordinator position, further monitoring is needed to better understand water quality conditions in a larger range of streamflows (Section 11). CWA can best proceed with monitoring by contracting with skilled members who have expertise in the field, and by partnering with educational institutions where possible, facilitating graduate research to address ongoing water quality questions. The estimated budget for these monitoring tasks is approximately $25,000 to $45,000 per year for at least a five-year period, including costs for instrumentation, sampling, and analysis. Monitoring costs will be lower if local volunteer help can assist and/or if monitoring is coupled with the education component.

8-2. Project-Specific Technical and Financial Assistance Requirements

The BMPs discussed in section 7 are numerous, and will require implementation over a large area to address all the causes and sources of impairment that were identified in Section 5. The costs for watershed-wide BMP implementation are summarized on Table 8-1. These costs were estimated primarily by considering unit costs of recently completed projects in the Cimarron Watershed. Additionally, specific costs have been developed for the Tier 1 projects discussed in Section 7; and the project-specific costs are included in Appendix B, the Tier 1 Field Survey Reports. These project costs range from less than $1,000 (with largely volunteer labor) to more than $40,000 for more extensive rehabilitation projects (Appendix B).

Table 8-1. Summary Financial Assistance Requirements

Project Type	Cost/Unit	Number of Units	Subtotal
Cut bank stabilization with boulder vanes	$5,000 to $6,000 per bank	40-60	$200,000 to $360,000
Head cut restoration with boulder vanes	$7,000 to $9,000 per head cut	20-30	$140,000 to $270,000
Low-water crossings with Rosgen cross vanes	$20,000 to $25,000 per crossing	20-30	$400,000 to $750,000
Riparian vegetation improvements	$4,000 to $6,000 per mile	50-100	$200,000 to $600,000
Taos Pines road improvements	$165,000 for subdivision [(a)]	1	$165,000
Road upgrades [(b)]	$4,500 to $6,000 per mile	50-100 miles	$225,000 to $600,000
Septic tank upgrades	$1,500 to 2,000 per tank [(c)]	50-100 tanks	$75,000 to $200,000
Wildlife exclosures	$2,600 to $3,000 per acre	20-50 acres	$50,000 to $150,000
Water banking [(d)]	$25,000 to $75,000 plus $5,000 to $10,000 per acre-foot	10-50 acre-feet	$75,000 to $575,000
Coordinator/ education and administration	$75,000 to $100,000 per year	5-15 years	$375,000 to $1,500,000
Monitoring	$25,000 to $45,000 per year	5-15 years	$125,000 to $675,000
Total			$1,900,000 to $5,900,000

a) Based on estimate by Rangeland Hands, 2010

b) Using Bill Zeedykes low maintenance/water harvesting techniques for dirt roads

c) Full replacement with new tanks would be more expensive, however, typically the costs would be paid by homeowners

d) Study, evaluate, and purchase water rights

The level of funding available through NMED nonpoint source management programs is unlikely to be sufficient for completing most or all of the activities listed above. It is more likely that select priority projects, as listed in the Tier 1 assessment, will be partially funded over time. To obtain a better success rate for implementation, other potential funding sources should be considered. Some of the potential sources include:

- *The Collaborative Forest Restoration Program (CFRP)* is managed by the U.S Forest Service. The purpose of this program is to promote collaborative efforts that sustain additional forestry projects. The CWA has been working with the Carson National forest to pursue a CFRP grant for a landscape-scale restoration project. The CFRP funding is most likely to fund fuel reduction projects and/or habitat restoration projects that can help to protect the watershed from post-fire erosion and sedimentation.

- *The New Mexico State Forestry Division* supports a cost-share program to improve the health of New Mexico Community Forests. The program focuses on developing sustainable urban fuels reduction projects to reduce fire risks that can help to protect the watershed from post-fire erosion and sedimentation. Grant proposals are staggered throughout the year. Projects that involve storm water management/water quality improvement are supported by the program, and non-profit agencies such as the CWA are eligible for funding. Projects that couple fuel reduction with economic use of the harvested forest products would also be possible projects in the Cimarron watershed. The New Mexico State Forestry Division can also provide technical expertise regarding implementation of fuel reduction BMPs in the Cimarron Watershed.

- *The New Mexico Water Trust Board* funds a variety of projects which are related to the water supply for New Mexico communities. The Water Trust Board funding process includes a separate category for watershed restoration projects. Projects that protect the water quality of drinking water supplies, as listed in Section 7, would be eligible for this funding, particularly those related to the water supply from the Eagle Nest Reservoir or Springer Lake, which both provide drinking water supplies. Funding applications can be completed and submitted only by an eligible public entity, so the CWA could not apply directly for this funding.

- The US Department of Agriculture Natural Resource Conservation Service (NRCS) *Environmental Quality Incentives Program (EQIP)* provides funding for conservation projects to private landowners (with a cost share). As part of a new national directive starting in 2012, NRCS is setting aside 5% of the EQIP budget for work on priority watersheds to address waters on the Integrated 305(b)/303 (d) Report (NMED, 2010b). The primary focus is nutrients and sediment, however, funding can address other listed constituents. The EQIP program could be used to help private landowners fund improved stream-crossing and other farming and ranching BMPs identified in Section 7.

- Potential partners for completing research and monitoring tasks are the *New Mexico Universities,* in particular the University of New Mexico Water Resources Program, New Mexico State University, and New Mexico Forest and Watershed Restoration Institute at Highlands University in Las Vegas, New Mexico. While these institutes are not likely to provide direct funding, they could provide in-kind services such as the monitoring that was conducted in support of this WBP.

- *New Mexico Soil and Water Conservation Districts (SWCDs)* can help to provide technical assistance, particularly to private landowners needing help with implementing agricultural best management practices. The Cimarron Watershed is located within the jurisdiction of the Colfax SWCD.

- *USEPA Clean Water State Revolving Funds (CWSRF)* provide low interest loans to fund water quality protection for wastewater treatment, nonpoint source pollution control, and watershed management. Local governments, farmers and nonprofit groups such as the CWA are eligible recipients. The ability to repay the loan will be central to applicability in the Cimarron Watershed. The most likely projects to be funded through this program would be projects that could be addressed through local government participation, such as septic issues in Ute Park or stormwater management in Angel Fire.

- The *AmeriCorps Volunteers in Service to America (VISTA)* program places volunteers in positions that will provide them with training and experience to improve their prospects for future employment. The CWA could provide training, oversight, and a work place for a VISTA volunteer to help with project coordination and implementation of key projects.

- The *U.S. Fish and Wildlife Service (USFWS)* may provide technical assistance for water quality improvements that will support fish and wildlife. Additionally, funding for small projects may be available through the *Partners for Fish and Wildlife* Small Grant Program.

For the successful implementation of this WBP, a variety of funding and volunteer resources will be required.

9. Education and Outreach Component

The nine elements of watershed-based planning (EPA, 2008) require an information/education component to enhance public understanding of the project and encourage participation. The CWA has emphasized active public education since its inception in 2003. Since the watershed is primarily located on private land, both communication and voluntary cooperation are critical to successful implementation of the plan.

As discussed in Section 3, the stakeholders currently participating in the CWA include public officials, state and federal agency personnel, representatives of civic groups, ranchers, business people, and other community members. Partner organizations currently or recently involved in the Cimarron Watershed Alliance include:

- New Mexico Environment Department/Surface Water Quality Department (NMED)
- U.S. Forest Service (USFS)
- Quivira Coalition
- New Mexico State Parks
- New Mexico State Forestry
- New Mexico Game and Fish
- Vermejo Park Ranch
- Philmont Scout Ranch
- C.S. Ranch
- Cimarroncita Ranch Resort
- Angel Fire Resort and Ski Area
- Towns of Raton, Cimarron and Angel Fire
- Local Area High Schools and Middle Schools (Cimarron High School, Eagle Nest Middle School and Angel Fire High School)
- Sandia National Laboratory
- Los Alamos National Laboratory
- University of New Mexico
- New Mexico State University
- New Mexico Small Business Association
- Trout Unlimited
- New Mexico Wildlife Federation

The CWA intends to continue to work with these participants and conduct outreach to involve more private landowners, ranchers, and other stakeholders in the watershed. As discussed in Section 8, the CWA would like to hire a coordinator that would be responsible for overseeing educational activities, in addition to other duties. The CWA had a coordinator when it was initially formed. The coordinator was extremely helpful in providing educational resources, as well as involving local ranchers and other stakeholders. The coordinator will work with the CWA Board and other members to conduct education and outreach activities.

Education and outreach activities that will be implemented in conjunction with management measures identified in this plan include:

- Maintaining a CWA website where education information on the watershed can be posted, and also contribute any CWA materials that are appropriate for posting on the New Mexico Watershed Association website.
- Attending local events and providing information on CWA.
- Collecting email addresses from watershed stakeholders who are interested in receiving periodic updates about CWA activities.
- Contacting homeowners in areas with septic tank issues to provide information on septic tank maintenance and upgrades.
- Partnering with Quivira Coalition or other conservation organizations to provide training to ranchers on livestock practices that can help protect water quality while maintaining the economic interests of ranches.
- Working with the National Resource Conservation Service, the Colfax County Soil and Water Conservation District, the New Mexico Water Trust Board, and the Office of the State Engineer to provide information about water and soil conservation issues and agricultural best management practices.
- Contacting neighborhood associations such as Taos Pines to evaluate partnerships for addressing road maintenance and upgrades.
- Presenting information on the importance of achieving water quality standards and CWA activities at local meetings such as Chamber of Commerce meetings, agricultural associations, civic groups, or other local groups.
- Conducting tours of completed projects. For example, viewing the benefits of improved low-water crossings on the Ponil could potentially interest other landowners to improve ranch roads and low-water crossings. Project tours can emphasize maintenance issues so that the benefits of BMPs are not lost over time.

- Partnering with the Cimarroncita Ranch and Philmont Scout Ranch to provide education and hands-on experiences for water quality protection, stream bank stabilization, and wetlands restoration to students of all ages. Participation of Philmont Scout Ranch will allow the CWA a unique opportunity to provide education on water quality protection and stream restoration to youth located throughout the Country.
- Continuing to coordinate educational efforts with other collaborators, such as State Parks and Carson National Forest.
- Coordinating education efforts and service-learning projects with other collaborators, including local schools (elementary through High School), State Parks, and other interested partners.
- Educating land owners about practices that affect water quality such as appropriate household cleaning agents, pet management, or other household issues.
- Training CWA members and local citizens in water-monitoring techniques and data collection methods to meet standards set forth by the NMED Surface Water Quality Bureau.

Education efforts will continue to be a high priority throughout the implementation of the Cimarron Watershed-Based Plan. For long-term success, the continued involvement of land owners and other stakeholders in maintaining BMPs is needed. Coordination of BMP maintenance will be accomplished in a collaborative fashion between the CWA coordinator and the project partners. The CWA monthly meetings currently dedicate a portion of the agenda to standard project reporting, and a portion of the agenda is dedicated to guest speakers or revolving topics. As BMPs are implemented, the standard agenda will be revised to include a place for reporting on ongoing project maintenance, needs for volunteer or group assistance, and reporting of any new monitoring data or relevant project information. Even if the project reporting is short, by focusing on the topic at the monthly meetings, the group will be assured that completed projects and BMPs are not forgotten. Additionally, maintenance issues and status can also be included in the CWA annual report.

10. Implementation Schedule, Interim Measurable Milestones, and Achievement Criteria

The schedule for implementing the NPS management measures identified in the WBP is dependent on funding for project implementation. Due to the large number of impaired reaches, impaired sub-watersheds, and numerous small projects to be implemented, the CWA estimates a time frame of 10 to 15 years to fully implement the management measures identified in this plan. Most projects will require a 3-5 year cycle for final design, implementation, and post-restoration monitoring. If full funding had been initially available, it would be possible to shorten this time frame. However, a longer time frame is more realistic, given the scarcity of funding resources for watershed restoration. If base-level funding for group coordination, outreach, project design, and submittal of funding applications is available, the CWA is more likely to quickly move forward toward meeting water quality objectives. The project implementation schedule is shown on Table 10-1.

Table 10-1. Implementation Schedule and Interim Measurable Milestones

Location	Causes of Impairment	NPS Management Measures Needed to Achieve Load Reductions Projects	Schedule	Interim Measurable Milestone and Date		Milestone Achievement Criteria
Entire watershed	See below for impairment by geographic area	Hire an Executive Director	2019	Apply for Grant Funding	2018	Executive Director Hired
		Implement Public Education Plan	2028	5 Educational Events	2018	Event or Written Material Distributed
				2 Events per year	2018-2028	Event or Written Material Distributed
Cieneguilla Creek (Eagle Nest Lake to headwaters)	*E.coli*, plant nutrients, sediment/siltation, temperature, turbidity	Cieneguilla Tier 1 Project	2023	Apply for Grant Funding	2020	Grant Application Submitted
				Project Initiated	2021	Project Funded and Initiated
				Project Completed	2023	Final Project Report
		Agua Fria Tier 1 Project	2020	Apply for Grant Funding	2018	Grant Application Submitted
				Project Completed	2019	Visual Survey of Road Relocation, Final Project Report

Location	Causes of Impairment	NPS Management Measures Needed to Achieve Load Reductions Projects	Schedule	Interim Measurable Milestone and Date		Milestone Achievement Criteria
Cieneguilla Creek (Eagle Nest Lake to headwaters)	*E.coli*, plant nutrients, sediment/siltation, temperature, turbidity	Implement Additional BMPS (Angel Fire effluent re-use, channel stability, construction, conservation easements, fuel reduction/fire, grazing, open space purchase, riparian vegetation, remediation of older septic systems, sediment traps or filter strips below gravel pits, wildlife management	2028	5 stream miles completed	2023	Number of BMPs completed
				Complete additional BMPs and BMP maintenance	2026	20% load reduction sediment (contributor of nutrients to downstream impairment
				Entire reach completed	2028	Number of BMPs completed
Moreno Creek (Eagle Nest Lake to headwaters)	Plant nutrients, temperature	Increase shading, bank stability BMPs, fuel reduction BMPs	2028	2 stream miles completed	2022	Measured shade increase, Number of BMPs completed
				4 additional stream miles completed	2028	Measured shade increase, Number of BMPs completed

Location	Causes of Impairment	NPS Management Measures Needed to Achieve Load Reductions Projects	Schedule	Interim Measurable Milestone and Date		Milestone Achievement Criteria
Sixmile Creek (Eagle Nest Lake to headwaters)	*E.coli*, plant nutrients, temperature, turbidity	Fuel reduction/fire BMPs, remediation of older septic systems, sediment traps below gravel pits, Taos Pines road improvements, wildlife management	2028	2 stream miles completed	2020	Measured shade increase, Number of BMPs completed
				3 additional stream miles completed	2028	Measured shade increase, Number of BMPs completed
North Ponil Creek (South Ponil Creek to Seally Canyon)	*E.coli*, temperature, turbidity	North Ponil Tier 1 Project	2022	Apply for Grant Funding	2019	Grant Application Submitted
				Project Initiated	2020	Project Funded and Initiated
				Project Completed	2022	Final Project Report
		Additional channel stability BMPs, fuel reduction/fire BMPs, low-water crossings, riparian vegetation and road improvement BMPs	2020	Complete additional BMPs and BMP maintenance	2026	20% load reduction sediment (contributor of nutrients to downstream impairment
				Complete additional BMPs and BMP maintenance	2028	Measured shade increase, Number of BMPs completed

Location	Causes of Impairment	NPS Management Measures Needed to Achieve Load Reductions Projects	Schedule	Interim Measurable Milestone and Date		Milestone Achievement Criteria
Middle Ponil Creek (South Ponil to Greenwood Creek)	Temperature	Middle Ponil Tier 1 Project	2017	Apply for Grant Funding	2013	Grant Application Submitted
				Project Initiated	2014	Project Funded and Initiated
				Project Completed	2017	Final Project Report
		Additional BMPs (see Table 7-2)	2020	Complete additional BMPs and BMP maintenance	2020	Measured shade increase, Number of BMPs completed
South Ponil Creek (Ponil Creek to Middle Ponil)	Temperature	Additional BMPs (see Table 7-2)	2028	4 stream miles completed	2020	Measured shade increase, Number of BMPs completed
				4 additional stream miles completed	2028	Measured shade increase, Number of BMPs completed
Ponil Creek (US 64 to confluence of North and South Ponil)	*E.coli*, plant nutrients, temperature, turbidity	Additional BMPs (see Table 7-2)	2028	Reach completed	2028	Measured shade increase, Number of BMPs completed
Ponil Creek (Cimarron River to US 64)	*E.coli*	Additional BMPs (see Table 7-2)	2028	Reach completed	2028	Measured shade increase, Number of BMPs completed

Location	Causes of Impairment	NPS Management Measures Needed to Achieve Load Reductions Projects	Schedule	Interim Measurable Milestone and Date		Milestone Achievement Criteria
Cimarron River (Turkey Creek to Eagle Nest Lake)	Dissolved arsenic, plant nutrients	Channel stability BMPs, evaluate alternative releases from Eagle Nest*, fuel reduction/fire BMPs, road BMPs, including turnouts and filter strips to address runoff groundwater monitoring and remediation of septic tanks	2025	2 stream miles completed	2020	Number of BMPs completed
				3 additional stream miles completed	2025	Number of BMPs completed
Cimarron River (Cimarron Village to Turkey Creek),	Dissolved arsenic, temperature	Channel stability BMPs, evaluate alternative releases from Eagle Nest Dam*, fuel reduction/fire BMPs, riparian vegetation	2028	2 stream miles completed	2024	Number of BMPs completed
				3 additional stream miles completed	2028	Number of BMPs completed

Location	Causes of Impairment	NPS Management Measures Needed to Achieve Load Reductions Projects	Schedule	Interim Measurable Milestone and Date		Milestone Achievement Criteria
Cimarron River (Canadian River to Cimarron Village)	Plant nutrients	Channel stability BMPs, evaluate alternative releases from Eagle Nest* (no flow periods) evaluate ditches and storm water runoff in Cimarron, fuel reduction/fire BMPs, Springer Ditch leakage reduction	2028	4 stream miles completed	2022	Number of BMPs completed
				3 additional stream miles completed	2028	Number of BMPs completed
Ute Creek (Cimarron River to headwaters)	Dissolved arsenic, *E.coli*, temperature	Tier 1 BMPs: channel stability BMPs; assess abandoned mines, fuel reduction/fire BMPs, riparian vegetation on lower part of Ute Creek	2023	Apply for Grant Funding	2020	Grant Application Submitted
				Project Initiated	2021	Project Funded and Initiated
				Project Completed	2023	Final Project Report
Rayado Creek (Miami Lake Diversion to headwaters)	*E.coli*, temperature	Agriculture and grazing BMPs, channel stability BMPs, evaluate irrigation diversions and effects on water temperature, fuel reduction/fire BMPs	2028	2 stream miles completed	2024	Number of BMPs completed
				2 additional stream miles completed	2028	Number of BMPs completed
Rayado Creek (Cimarron River to Miami Lake Diversion)	Plant nutrients, sediment/siltation	Agriculture and grazing BMPs, channel stability BMPs, evaluate irrigation diversions and effects on water temperature, fuel reduction/fire BMPs	2024	2 stream miles completed	2020	Number of BMPs completed
				2 additional stream miles completed	2024	Number of BMPs completed

The implementation schedule shown on Table 10-1 identifies key projects and milestones for a 15-year cycle for BMP implementation. Additionally, the CWA has identified a more detailed set of priorities and interim measurable milestones for completion in the next three years:

- Hire a Cimarron Watershed Alliance Executive Director
- Conduct education/outreach activities including contacting land owners, maintaining a website, conduct tours of completed projects, and continue education projects with local schools.
- Continue channel stabilization and riparian vegetation projects on Cieneguilla Creek as discussed in Section 7.2.
- Seek additional funding to continue channel stability and riparian vegetation improvements on the Ponil and tributaries as discussed in Section 7.2.
- Review the status of abandoned mines in the Moreno Valley.
- Conduct a feasibility study and riparian survey to design and implement riparian buffers using conservation easements or land purchases.
- Meet with State Parks and the Interstate Stream Commission to explore opportunities for considering water quality in water management operations and to outline a plan for improved characterization of water quality in Eagle Nest Lake.
- Conduct a detailed inventory and characterization of septic systems and cesspools in Ute Park, and seek funding to assist homeowners with remediation.
- Conduct an assessment of channel stability on the mainstem of the Cimarron River.
- Meet with landowners on the Rayado to explore opportunities for improved low-water crossings.
- Work with potential project partners such as Universities and local citizen's to develop a more detailed monitoring plan and quality assurance plan.
- Seek funding and continue water quality monitoring efforts to better characterize water quality and to evaluate interim management measures.

The remainder of the management measures identified in Section 7 will be implemented within the 4 to 15-year timeframe, depending on the availability of funding resources, as indicated on Table 10-1. Further definition of second-tier priorities will be established as the project progresses.

Successful implementation of the WBP also requires identification of criteria that can be used to determine whether loading reductions are being achieved over time, and to determine whether substantial progress is being made towards attaining water quality standards. The achievement criteria most applicable to the Cimarron Watershed are those which are in compliance with published TMDLs, including the reduction of loads to levels below water quality standards. Interim monitoring as described in Section 11 will be used to assess compliance with water quality standards. Where standards have changed since completion of the TMDL, the most recent standard will be considered. For example, the arsenic standard has been changed since preparation of the TMDL, and changes to the temperature standards are being considered.

Based on current conditions, the achievement criteria that will be used for each cause of impairment are as follows:

- *Dissolved Arsenic:* laboratory measurements of arsenic concentrations from filtered samples.
- *E.Coli:* laboratory measurements of bacteria concentrations, stream bank stability surveys.
- *Plant Nutrients:* field or laboratory measurements of nitrate and phosphorus, steam bank stability surveys, visual surveys for algae or other aquatic plants.
- *Sediment/siltation and turbidity:* field measurement of turbidity concentrations, laboratory measurements of sediment concentrations, and stream bank stability surveys.
- *Temperature:* field measurements of stream temperatures and field surveys for percent shade.

The quantitative water quality data can be directly compared to the water quality standards and the TMDLs. Additionally, the quantitative data can be supplemented by surveys of stream bank stability, aquatic vegetation, and shading, to provide indications of the conditions that are reflective of the root causes of impairment.

Finally, as discussed in Section 7, for long-term success in achieving water quality standards, upland land management practices that support the stability of the watershed need to be implemented. Therefore implementation of farming, grazing, road construction and other BMPs as identified in Section 7 are also important achievement criteria.

- Progress toward meeting the achievement criteria described above will be dependent on the availability of the funding provided for project implementation.

In addition to the interim milestones listed above, field restoration projects will include interim assessments and resultant adaptive management to optimize field techniques, as directed by the WBP guidance (EPA, 2008). The CWA will also complete an annual report that reviews accomplishments and any adaptive management needed to direct future actives toward compliance with applicable water quality standards.

11. Monitoring Component

Two primary types of monitoring are required for successful implementation of the WBP:

1. Long-term monitoring to better understand the variability of constituents of concern, the degree of impairment, and the condition of overall watershed health under a greater range of streamflow conditions, and

2. Project-specific monitoring to evaluate the effectiveness of specific management measures and to guide adaptive management and help optimize future restoration efforts toward the achievement of water quality standards.

11-1. Watershed Monitoring and Assessment

As discussed in Section 5, there is a high level of variability in water quality and streamflow in the Cimarron watershed. Additional data will help to better characterize both the sources of impairment and the variability of impairment with a greater range of streamflow, and a higher number of sampling points. Watershed monitoring would focus primarily on the existing causes of impairment (arsenic, *E.coli*, nutrients, sediment, temperature, turbidity) with more samples collected to assess the temporal and spatial variability of these components. Some specific additional monitoring that is needed includes:

- ***Sample for Additional Metals.*** To better determine the source and extent of arsenic on the Cimarron River and Ute Creek, sampling for other metals in addition to arsenic could assist in determining if the source is related to historic mining or to natural causes.
- ***Optimize Water Release through Stratification***. Releases from Eagle Nest Lake contribute water to impaired reaches on the mainstem of the Cimarron River. It is possible that releases of water could be optimized by considering water quality stratification in the reservoir and by varying releases according to depth; however, further assessment is needed to address this question. Monitoring that will characterize the temporal and depth variations of water quality over a period of time, along with an evaluation differences in water quality resulting from the usage of different release gates, would help to guide the development of a better operations plan.
- ***Track Bacterial Sources***. Additional bacterial source tracking, such as the study conducted on Cieneguilla and Moreno Creeks, would be useful for all reaches that have E. coli impairment.
- ***Additional Temperature Monitoring.*** Additional water temperature monitoring would help to correlate water temperatures with changes in shade density, or for other restoration efforts. This monitoring can also be used to guide adaptive management.

The Cimarron Watershed Coordinator, once hired, will be the responsible person for monitoring activities. In many cases, watershed monitoring can benefit by cooperating with State and Federal agencies, New Mexico universities, and trained citizens within the Cimarron Watershed. Projects such as the one completed by UNM in 2010 were made possible in cooperation with Wildlife Conservancies, the Cimarron Conservation Camp, and other private land owners within the watershed. The watershed monitoring will include:

- Sampling for each of the listed constituents (arsenic, sediment, turbidity, nitrate, phosphorus (plant nutrients) *E.coli* and temperature).

- Collection of water quality samples at locations upstream and downstream of the impaired reaches shown on Figure 5-1. The CWA estimates collection of samples from approximately 20 locations to characterize the continuing impairment of the reaches illustrated on Figure 5-1.

- Collection of sufficient samples to characterize the temporal variability in streamflow. In particular temperature measurements should be made during low-flow conditions, and other samples should also be collected during low flows periods. Additionally, turbidity and sediment concentrations should be monitored during monsoon when there is higher likelihood for bank erosion and sedimentation. A collection period of 4 samples per year for a three year period, for the 20 locations, results in 240 samples total.

- A detailed sampling plan and quality assurance project plan (QAPP) will be prepared during the first year that a coordinator is hired.

11-2. Project-Specific Monitoring

As each project is implemented, site-specific monitoring protocol will be defined. Monitoring will focus on:

- Using current quality assurance procedures to ensure that reliable data is collected.
- Identifying pre-project baseline conditions for the constituents of interest, focusing on the causes of impairment and considering related indicators of water quality conditions.
- Conducting post-project monitoring under a variety of streamflow conditions to evaluate project success.

As funding applications are prepared, specific monitoring plans for restoration projects will be developed, along with complete project designs.

11-3. Reporting of Monitoring Results

Reporting of project specific monitoring results will be included in project plans at that time that funding is sought for implementation of specific projects. Additionally, the CWA annual report will include a section that summarizes what monitoring has occurred for each project. The annual reporting process will be used to evaluate what the combined monitoring data are indicating about watershed conditions and compliance with water quality standards, and if the data indicates that adaptive management is warranted, that will also be discussed in the annual report.

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Appendix A. Estimated Load Contributions from Probable Sources of Impairment in the Cimarron Watershed

Moreno Valley

Cieneguilla Creek (Eagle Nest Lake to headwaters)
Causes of Impairment: E.coli, plant nutrients, sediment/siltation, temperature, turbidity

Probable Source	Estimated Contribution to Load (Percent)
Loss of riparian habitat	11
Municipal point source discharges	6
Other recreational pollution sources	6
Rangeland grazing	13
Streambank Modification/destablization	10
Wildlife	24
Dam/impoundment	6
Construction	9
Airport	3
Roads	10
Septic tanks/systems	2

Moreno Creek (Eagle Nest Lake to headwaters)
Causes of Impairment: plant nutrients, temperature

Probable Source	Estimated Contribution to Load (Percent)
On-site treatment systems (septic systems and similar decentralized systems)	20
Rangeland grazing	16
Waste from pets	6
Roads	13
Mining	17
Wildlife	18
Gravel pit	8

Sixmile Creek (Eagle Nest Lake to headwaters)
Causes of Impairment: E.coli, plant nutrients, temperature, turbidity

Probable Source	Estimated Contribution to Load (Percent)
Habitat modification - other than hydromodification	14
Livestock (grazing or feeding operations)	18
Natural sources	7
On-site treatment systems (septic systems and similar decentralized systems)	10
Rangeland grazing	18
Wildlife (other than waterfowl)	13
Gravel pit	10
Roads	10

Ponil Creek and Tributaries

North Ponil Creek (South Ponil Creek to Seally Canyon)
Causes of Impairment: E.coli, temperature, turbidity

Probable Source	Estimated Contribution to Load (Percent)
Forest roads (road construction and use)	18
Habitat modification - other than hydromodification	6
Loss of riparian habitat	20
Low-water crossings	21
Rangeland grazing	20
Silviculture harvesting	2
Natural/drought	3
Fire suppression sediment	4
Mining	2
Hydromodification	4

Middle Ponil Creek (South Ponil to Greenwood Creek)
Causes of Impairment: temperature

Probable Source	Estimated Contribution to Load (Percent)
Rangeland grazing	26
Roads	15
Fires	12
Wildlife	15
Loss of riparian habitat	15
Low-water crossings	10
Other recreational uses	7

South Ponil Creek (Ponil Creek to Middle Ponil)
Causes of Impairment: temperature

Probable Source	Estimated Contribution to Load (Percent)
Rangeland grazing	29
Roads	15
Fires	9
Wildlife	15
Loss of riparian habitat	20
Low-water crossings	5
Other recreational uses	7

Ponil Creek (US 64 to confluence of North and South Ponil)
Causes of Impairment: E.coli, plant nutrients, temperature, turbidity

Probable Source	Estimated Contribution to Load (Percent)
Livestock (grazing or feeding operations)	5
Loss of riparian habitat	24
On-site treatment systems (septic systems and similar decentralized systems)	4
Rangeland grazing	18
Waste from pets	4
Streambank modification/destabilization	15
Road use	12
Recreation use	4
Low-water crossings	4
Wildlife	10

Ponil Creek (Cimarron River to US 64)
Causes of Impairment: E.coli

Probable Source	Estimated Contribution to Load (Percent)
Avian sources (waterfowl and/or other)	20
On-site treatment systems (septic systems and similar decentralized systems)	11
Source unknown	19
Waste from pets	8
Recreational uses	4
Road	7
Rangeland grazing	16
Wildlife	15

Cimarron River and Ute Creek

Cimarron River (Turkey Creek to Eagle Nest Lake)
Causes of Impairment: dissolved arsenic, plant nutrients

Probable Source	Estimated Contribution to Load (Percent)
Dam or impoundment	24
On-site treatment systems (septic systems and similar decentralized systems)	20
Other recreational pollution sources	8
Source unknown	5
Wildlife (other than waterfowl)	15
Historical/ mining	15
Geology	3
Roads	8
Livestock	2

Cimarron River (Cimarron Village to Turkey Creek)
Causes of Impairment: dissolved arsenic, temperature

Probable Source	Estimated Contribution to Load (Percent)
Baseflow depletion from groundwater withdrawals	8
Loss of riparian habitat	20
Rangeland grazing	10
Source unknown	8
Mining	8
Roads	13
Raton water diversion	4
Low-water crossings	4
Railway sediments	3
Seasonal pollution; diesel from sludge, pets	6
Corrals, etc.	4
Wildlife	12

Cimarron River (Canadian River to Cimarron Village)
Causes of Impairment: plant nutrients

Probable Source	**Estimated Contribution to Load (Percent)**
Flow alterations from water diversions	25
Impervious surface/ parking lot runoff	5
On-site treatment systems (septic systems and similar decentralized systems)	20
Rangeland grazing	30
Roads	4
Low-water crossings	1
Wildlife	15

Ute Creek (Cimarron River to headwaters)
Causes of Impairment: dissolved arsenic, E.coli, temperature

Probable Source	**Estimated Contribution to Load (Percent)**
Loss of riparian habitat	12
On-site treatment systems (septic systems and similar decentralized systems)	2
Rangeland grazing	12
Historic mining	25
Wildlife	20
Roads	15
Pets	2
Low-water crossings	12

Rayado Creek

Rayado Creek (Miami Lake Diversion to headwaters)
Causes of Impairment: E.coli, temperature

Probable Source **Estimated Contribution to Load (Percent)**

Baseflow depletions from groundwater withdrawals	15
On-site treatment systems (septic systems and similar decentralized systems)	6
Rangeland grazing	25
Wildlife (other than waterfowl)	25
Flow alterations	6
Avian/waterfowl	8
Roads/low-water crossings	15

Rayado Creek (Cimarron River to Miami Lake Diversion)
Causes of Impairment: plant nutrients, sediment/siltation

Probable Source **Estimated Contribution to Load (Percent)**

Dam or impoundment	20
Habitat modification - other than hydromodification	4
Highway/road/bridge runoff (non-construction related)	2
Loss of riparian habitat	10
Rangeland grazing	20
Wildlife	20
Flow alterations	9
Roads/ low-water crossings	15

Appendix B. Tier 1 Field Survey Reports

Ponil Creek Assessment Report

Ponil Creek from the North Ponil confluence to US Hwy 64
Colfax County, New Mexico
HUC: 110800020209

Completed as part of the Ponil Creek Restoration Project, Phase II
Request for Proposals RFP 30-667-13-19783
On-the-Ground Surface Water Quality Improvement Projects
Funded by: New Mexico Environment Department
Surface Water Quality Bureau (SWQB)
Watershed Protection Section

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November, 2017

Assessment Overview

Team: Steve Carson, Rangeland Hands; Rick Smith & Gus Holm, Cimarron Watershed Alliance
Field Work Dates: August 10 - 13, 2016
Reach: Ponil Creek from the North Ponil confluence to US Hwy 64, Colfax County, NM
HUC: 110800020209

Location Description:

The assessment of the Ponil Creek started at the confluence with the North Ponil and Ponil Creek on Philmont Scout Ranch and proceeded downstream from this point (approximately 6 miles in valley length and approximately 8 miles of stream length), across the Heck Tract of Vermejo Park Ranch and the Chase Ranch, ending at the bridge on US Hwy 64 bridge in Cimarron.

Goals:

- Identify, assess, and map issues along the stream and in the nearby watershed that are impacting water quality, ecosystem health, and watershed stability.
- Prioritize restoration needs based on a cost versus benefit rationale. Identify as higher priority issues that are impacting stream temperature.
- Determine the sources of sediment both along the creek and within the watershed and develop recommendations to reduce this sedimentation within the system.
- Complete a report on assessment findings and incorporate the report into a revised Cimarron Watershed-Based Plan.

Method:

The team made general observations along the Ponil Creek stream channel and in the nearby watershed area to assess its general condition, current use, historical use, and opportunities for restoration. The team walked the entire reach of the Ponil Creek from the North Ponil confluence to US HWY 64 and surveyed parts of the surrounding watershed from a UTV.

Conclusions:

Issues that were found along the Ponil Creek and within the watershed include:

- Unstable streambanks and an entrenched channel system that is continuing to downcut
- Major flooding over the past 15 years that has been exacerbated by the 2002 Ponil Complex Fire and extreme rainfall events
- Widespread erosion within the watershed as a result of historic impacts, ongoing impacts, and the 2002 Ponil Complex Fire
- Poor grazing management and wildlife management practices
- Roads that are poorly located, designed, and drained
- Erosive Geology

General Watershed Information

<u>Geologic Formation:</u>

The Raton sandstone is a high relief, flashy, eroding geologic system system and has a natural high geological sediment contribution.

<u>Valley Type:</u>

From the North Ponil Confluence to the Upper Irrigation Diversion for the Chase Ranch, the Rosgen Valley Type is III: Alluvial fan dominated with steep rocky slopes.
Below the Upper Irrigation Diversion for the Chase Ranch, the Valley type is a VII: Steep, highly dissected fluvial slopes.

<u>Channel Types:</u>

- Original / Historic Condition:
    - This system was originally a beaver and/or wetland dominated system. The channels were most likely Rosgen C, E, and sheet flow wetlands that would be classified close to a Rosgen DA channel system. The team observed old channel bed cross sections that are very indicative of sediment deposits found in a wetlands or a lacustrine environment.
- Current Condition:
    - Variable, dominated by Rosgen F and G Types, with very short reaches of C channel type.

Ponil Creek Watershed Conditions

It is very important to understand the historical use of a watershed. The effects of use in any given watershed are generally associated with the current problems.

<u>Ponil Watershed Historical Use:</u>

The Ponil Watershed has a long history of human influence. There is much evidence of Native American cultures using this area. European influence dates back to the early 1800's with the influence of the fur trappers and the impact that this activity had on the stream system due to a heavy reduction in the beaver population. Prior to trapping, beaver was a dominating influence in this watershed.

The post Civil War period brought an influx of pioneers to the western United States. Homesteading, farming, ranching, logging, and mining began in this time period. Large numbers of all type of livestock were introduced into this area and by 1880 the numbers far surpassed the rangeland carrying capacity. Major soil erosion started in this time period due to accelerated runoff caused by the lack of ground cover. The accelerated runoff caused the loss of topsoil, cut deep gullies in the upland areas, overloaded main channels with sediment, and caused down cutting in the main and side channels. When these effects of overgrazing combined with the loss of beavers and the impacts of roads, trails, railroads and farming, the stability of the overall watershed and stream channel system lost its natural equilibrium and went into an unstable downward trend that is still affecting the watershed.

In approximately 1885, a logging railroad was constructed up the middle of the Ponil Valley. Logging railroads of this type were temporary systems that were used to extract the timber resource and then dismantled and moved. The construction of these rail systems typically disregarded any effects they might have on the natural resources that they were built upon which is the case on the Ponil watershed. The rail bed was built up the center of the valley with no regard to the presence of the existing stream channel and the channel's pattern. Materials needed to build the elevated rail bed were dug out of the valley bottom on each side of the bed alignment. The stream channel was straightened and moved to one side of the valley as much as possible to minimize the need for stream crossing trestles and the cost associated with them. The existing meander pattern was eliminated, stream channel slope was increased, and major stream channel down cutting began to occur. As the mainstem dropped, the tributary channels head cut and incised down to the level of the main channel.

The rail system and timber operation brought with it an influx of people, farming and livestock to support the timber operation. The heavy loss of timber cover and the associated impact of logging roads further destabilized the Ponil watershed. By 1910, the entire Ponil watershed was in a state of total instability. Channel systems incised and down cut, upland topsoil eroded to the point that the O and A Horizons were eliminated in many locations, and mineral soils were exposed.

In the area of the Chase Ranch, the valley bottom opens up, allowing room for agricultural development. The bottom of the valley appears to historically have been several linear miles of sheet flow wetlands prior to the arrival of European influence. Because it was too wet to farm, the farmers moved the stream over to one side of the valley to create room for farming the valley bottom and to drain the wetlands. This relocation of the channel had the same effects on the system as the railroad. The existing meander pattern was eliminated, stream channel slope was increased, and major stream channel down cutting began to occur. As the mainstem dropped, all the tributary channels head cut and incised down to the level of the main channel.

The anthropogenic effect on the Ponil has converted a once beaver dominated perennial stream and wetland system to an entrenched eroding stream system with very little associated wetlands. Watershed managers are now dealing with these legacy impacts and associated problems in addition to the current impacts and poor management practices.

Ponil Complex Fire of 2002:

In 2002, the Ponil Complex Fire burned over 92,000 acres, much of which was located in the Ponil Watershed. The loss of ground cover caused by the fire coupled with steep sandstone topography has caused a significant increase in erosion and sediment contribution to the stream system. This erosion is now decreasing due to the re-vegetation occurring on the burn area. The fire and associated vegetation loss also created higher than normal watershed discharges. The increased discharge caused further down cutting and bank erosion on an already impacted stream channel and watershed.

Flood of 2015:

The flood of 2015 caused additional channel down cutting and stream bank erosion, which further overloaded the system with sediment, exacerbating and accelerating all of the existing problems. Much of this sediment was deposited on the point bars, causing the stream to become more overwound.

Grazing:

The current grazing practices in this area have a significant effect on the stability of watershed function. The loss of ground cover and a decrease in species type has increased the surface runoff and soil erosion, which contributes to gully erosion and the amount of sediment that is being discharged into the stream system.

Current livestock grazing on the Chase Ranch is year-round. For the most part, current livestock grazing practices are all or nothing, i.e. pastures are either severely overgrazed or barely utilized at all. Although there are a large number of fenced pastures, the cattle are only rotated through a few pastures on the lower part of the valley. The pastures that are utilized suffer from high intensity, high frequency grazing, resulting in high to severely over grazed rangeland. Livestock grazing in these areas has significantly impacted the riparian vegetation along the creek and has created a number of severely impacted areas where the cattle access the creek for water. The frequently present elk herds in this area have also significantly affected the upland areas and the riparian vegetation. The willows and cottonwoods in these overgrazed areas are generally not able to get well established under the current grazing practices. The upland areas in these pastures suffer from bare ground and a lack of species diversity.

The condition of the riparian vegetation in the pastures that are not utilized for livestock grazing is variable. In the very lowest reach of this system, just upstream from US Hwy 64, the riparian vegetation is very robust along the stream channel. This small area only sees a very limited amount of livestock grazing, and the elk herds seem to spend less time grazing here than other parts of the stream because of the close proximity of the highway. In other reaches of the stream that are located in pastures not utilized for livestock grazing, the condition of the riparian vegetation varies quite a bit. Reaches that are very close to the Ponil Road have some riparian vegetation while the reaches that are farther from the road have much less vegetation. This is almost certainly an effect of elk grazing.

Furthermore, the upland rangeland conditions in the pastures that are not utilized for livestock grazing are also variable. Some areas are in very good condition while other areas have become decadent due to underutilization. However, many pastures that were once used as irrigated hay fields are in poor condition. It appears that many of these old hay fields were traditionally plowed and planted with alfalfa, irrigated, and hayed. But at some point, this haying cycle ended as a result of drought and/or finances. These hay fields were never replanted now containing mostly undesirable forbs, bare ground, and very few native grasses.

Alluvial Fans:

The Ponil Valley contains a number of alluvial fans. Almost all of the alluvial fans have been compromised by the down cutting and relocation of the main channel below them and by the increasing runoff resulting from overgrazing and the Ponil Complex Fire. The less degraded fans now have very steep slopes and headcuts at the bottoms where they transition to the main stream channel. The more degraded alluvial fans contain an incised channel running through the middle that has downcut to the level of the main channel. So instead of spreading out and catching sediment and surface runoff, the flows have been concentrated into one channel that empties into the main stream channel.

Roads:

Poorly designed and drained roads have a large negative impact in this area of the Ponil watershed. A review of the Chase Canyon, Templeton Canyon, and the Slate Hill area showed a concentrated network of steep and poorly drained roads within these areas. There are even some active road systems and a number of old gullied roads that date back to the era of the Santa Fe Trail. From the North Ponil down to the first Chase Ranch irrigation division, there are a number of locations along NM HWY 204 that drain road runoff directly into the Lower Ponil. As with all road systems that have not been properly drained, roads in general contribute a significant amount of sediment into the stream and are a major contributing factor to overall watershed instability.

The Chase Ranch has a considerable number of low standard ranch roads relative to the size of the ranch. Most of these roads seem to have been established without much thought to proper design or proper drainage. Most of the roads within the valley bottoms of the Ponil and Chase Canyons have problematic but fixable drainage issues. In general, these roads have flatter grades and need more frequent, effective drainage. Some of these roads are redundant and could be abandoned and restored, and a few could be rerouted. Most could be left in service in their current locations, but more frequent,and effective drainage is needed. Better drainage would reduce the erosion and sediment contribution coming off of these roads, allow the roads to dry out faster, improve the productivity of the surrounding rangeland through water harvesting, and reduce long term maintenance costs for the roads and the vehicles that travel them.

The Chase Ranch also has a staggering number of very steep roads that climb from the valley bottoms to the ridge tops. It appears that these roads were established either for hunting access and/or simply to provide general access to the ridgetops of the ranch. They do not appear to be necessary for livestock grazing since there is not much rangeland on top of these narrow ridges. Almost all of these roads vary in condition from terrible to impassable. Most of these very steep roads should be abandoned and restored. This includes the roads that are redundant or serve no purpose, the roads that are too steep or should be rerouted, and the roads that are in such bad condition that fixing them would cost more than restoration.

Ponil Creek Stream Channel Conditions

The Ponil Creek, like any heavily impacted stream channel, has attempted to stabilize itself through the natural channel succession process since these major impacts first began in the early 1800's, but there are very few reaches of Rosgen C channel type that have reached a stable equilibrium. Rosgen F and G channel types dominate the system.

Ponil Creek, North Ponil Confluence to Upper Chase Ranch Diversion:

The reach of the Ponil Creek from the North Ponil confluence downstream to the upper irrigation diversion for the Chase Ranch is in relatively stable condition. This reach was heavily impacted by the construction of the railroad bed and the Ponil Road (State Hwy 204), especially since the sides of the canyon are very steep and the valley bottom is very narrow through this stretch. The creek, railroad bed, and road share the limited space at the bottom of the valley. The creek responded to these impacts by downcutting.

The creek is still incised throughout much of this reach. However, the downcutting in this reach seems to have stopped and the creek has reached stable elevation and condition. The most likely explanation for this stable form is geological in that the creek downcut to a layer of large cobble and rock and, in doing so, sorted out enough large material in the stream channel to balance the erosive force of the creek. Additionally, the uppermost irrigation diversion for the Chase Ranch, while dysfunctional, has served as grade control for this reach. Furthermore, the valley bottom and the watershed adjacent to this reach have not been grazed by livestock since the mid-1990's, and the elk do not impact the stream along this reach because the vehicle traffic on the nearby road. The riparian and upland vegetation through this reach is in great condition, and the large majority of the stream banks are reasonably stable. As a result, this reach has not suffered from the flooding impacts like much of the other reaches in the Ponil system. As such, there is very little need to implement restoration work in this reach.

Ponil Creek, Upper Chase Ranch Diversion to US Hwy 64:

The majority of the Ponil Creek from the upper irrigation diversion for the Chase Ranch down to US Hwy 64 is in a degraded condition. The **c**reek is incised through most of this stretch, and is located about 6 feet below the valley bottom at the upper end and about 12-15 feet below the valley bottom at the lower end. Generally speaking, the Ponil Creek in this reach seems to be in a downward trend and is continuing to erode through incising, headcutting, and excessive bank erosion in an attempt to reach stability. As a result of this erosion, the creek is overloaded with sediment. Since the creek cannot transport all of this sediment, it builds up on the point bars which leads to more bank erosion and over-wound meanders. Over time, the creek cuts off these over-wound meanders; this leads to headcuts and more channel incision. The team observed a number of locations where the stream had moved laterally and had created a flat, over-wound meander pattern only to then cut through the meander pattern, straighten itself out, head cut, and incise further. The stream channel in this area also contains numerous transverse bars, mid channel bars, cut off chutes and very steep pool slopes that all add to the continuing instability of the system. Overall, this section of the creek is unstable and trending downward.

Recommendations and Restoration Opportunities

<u>High Priority Goals and Projects:</u>

- Improve Chase Ranch Road System
  - Most of the roads within the valley bottoms of the Ponil and Chase Canyons and in the Slate Hill area have problematic but fixable drainage issues. Some of these roads are redundant and could be abandoned and restored, and a few could be rerouted. Most could be left in service in their current locations, but more frequent, effective drainage is needed.
  - The Chase Ranch has an excessive number of very steep roads that climb from the valley bottoms to the ridge tops, and almost all of these roads are in extremely poor condition with some being impassable. Most of these very steep roads should be abandoned and restored. This includes the roads that are redundant or serve no purpose, the roads that are too steep or should be rerouted, and the roads that are in such bad condition that fixing them would cost more than restoration.
  - The Chase Ranch also has numerous low water crossings on the Ponil Creek. These low water crossings are in poor condition and should be upgraded to current design standards by stabilizing and armoring the stream channel and banks with locally sourced rock and cobble.

Example of erosional gully resulting from poor road drainage

- Grazing Management Plan
  - Change the existing grazing practices and develop a formal grazing management plan. Funding may be needed to develop a formal grazing management plan for the Chase Ranch.
  - Additionally, the ranch has a significant number of individual pastures that could be utilized in a grazing management plan, but most of the existing fences are in need of major repair, replacement, or removal. Funding should be sought for repair of the existing fence system.
  - The return on this investment will be reduction in soil loss and sediment contribution to the stream system, increase in riparian vegetation, reduction of precipitation runoff, increase in infiltration, and increase in rangeland production that would reduce the cost of supplemental hay and feed.

- Wildlife Management Plan
  - Develop and implement a plan to manage the size and health of the elk herd relative to the carrying capacity of the Chase Ranch and livestock numbers. The current elk population would need to be estimated, and a management plan would need to account for the migrating elk herds as well as herd sizes and management plans on adjacent ranches. It is likely that the elk population would need to be decreased to balance the herd size with the ranch's carrying capacity.
  - Develop a plan to manage the other wildlife resources on the ranch, particularly deer.
  - Improved wildlife management and a healthier elk herd will benefit the riparian vegetation and upland rangeland, and it may also improve the quality of hunting and increase hunting revenue.

- Riparian Fence Construction
  - Build riparian game fencing in strategic locations to exclude elk and livestock from riparian and wetland areas to allow the vegetation to recover.

- Irrigation Diversion and Ditch Upgrades
  - There are two dilapidated irrigation diversions on the Chase Ranch that are currently piles of very large boulders and concrete blocks. These diversions are inefficient, require annual maintenance, and cause problems within the channel system. These two diversions should be e completely rebuilt with modern structures that fit the channel morphology.
  - There is a third irrigation diversion just above US Hwy 64 that needs major repairs to the headgates and inlets.
  - Many of the irrigation ditches on the Chase Ranch are in need of maintenance. Many of these ditches are full of sediment, frequently leak, and contain conifer trees that reduce their efficiency. A great deal of maintenance work was completed on these ditches during 2017, but more work is needed. Upgrades to the irrigation diversions would reduce the sedimentation in the ditches.

Second Irrigation Diversion on the Chase Ranch

Medium Priority Goals and Projects:

- Develop a Long Term Restoration Plan
  - Since this assessment was an overview of the Ponil Creek and surrounding watershed, more time and funding would be needed to create a detailed, comprehensive restoration plan. The initial plan should include prioritization of unstable conditions in each reach and a restoration plan to remediate these conditions.

- Alluvial Fan Restoration
  - The natural flow patterns and functions of the alluvial fans within the valley should be reestablished so that the fan system can collect as much sediment as possible before the water enters the stream channel.
  - For the alluvial fans that are intact but are headcutting where they transition to the main channel, headcut structures such as Zuni Bowls could be an effective treatment.
  - Plugging the downcut channels and installing Media Lunas has shown to be an effective treatment for alluvial fans that have an incised channel running through them.

- Stream Channel Restoration
  - The assessment team observed a number of locations in which the stream channel was actively down cutting. These areas could to be treated with grade control structures to stabilize the elevation of the channel. Other treatments could include boulder and tree rootwad bank protection to reduce stream bank erosion and induced meandering to improve channel length, create grade control, and establish a functional meander pattern.
  - There is one location that is about a half mile long where the channel could be placed back into the original valley bottom and a new channel system constructed. The relocated channel would eliminate having to treat the existing degraded channel system that parallels this location.

Entrenched section of Ponil Creek that was intentionally straightened and is continuing to downcut

- Earthen Dam Rehabilitation
  - There are some existing earthen dams on the Chase Ranch that have spillways that are head cutting. These head cuts contribute a continuous amount of sediment into the system. One solution is to armor the spillways with rock to eliminate this contribution of sediment into the system and to prevent the dams from failing. Another solution is to remove the earthen dams completed and restore the entire site.

Lower Priority Goals and Projects:

- Ephemeral Gully Restoration
  - There are numerous upland ephemeral gully systems that could be improved with One Rock Dams and/or other grade control structures with the goal of stabilizing the channel bottoms, promoting the regrowth of vegetation, and perhaps aggrading the channel bottom. These treatments could be very beneficial because they would help stabilize the degraded upland gullies and reduce the sediment contribution from these gullies into the main perennial stream systems. However, these treatments would also be rather expensive relative to realized benefit.

- NM HWY 204 (Ponil Road) Maintenance
  - The Ponil Road is maintained by the State of New Mexico Department of Transportation. This road lies very close to the Ponil Creek for many miles, and in many locations the road drains sediment directly into the creek. However, the sediment contributions from the road into the creek are limited. Portions of the road have been surfaced with gravel, which is an ongoing NMDOT project, and this helps reduce erosion and sediment contributions from the road into the creek. The road drainage could certainly be improved upon in places, and there are locations where the road drainage is causing major erosion below the road. However, when compared with other roads that lie in close proximity to other creeks, the Ponil Road through this reach is in good condition.

Middle Ponil Creek Assessment Report

Middle Ponil Creek from the Greenwood Creek confluence to the Barker WMA Boundary

Colfax County, New Mexico

HUC: 110800020202

Completed as part of the Ponil Creek Restoration Project, Phase II
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On-the-Ground Surface Water Quality Improvement Projects
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Introduction

The CWA utilized the BANCS analysis in 2017, to predict annual streambank erosion for the Middle Ponil Creek from the Greenwood Creek confluence to the Vermejo Greenwood Tract – Elliot Barker State Wildlife Management Area (Barker WMA) boundary. The BANCS analysis (Bank Assessment for Non-Point Source Consequences of Sediment "BANCS") is an EPA approved methodology outlined in the "Watershed Assessment of River Stability and Sediment Supply (WARSSS) (Rosgen, 2002). A previous assessment was completed in 2012 by the Cimarron Watershed Alliance of the Middle Ponil Creek from Philmont Scout Ranch (PSR) Ponil Camp up to the Greenwood – Barker WMA boundary and in 2016, an reconnaissance assessment was completed on the lower reaches of Ponil Creek from the North Ponil – Ponil Creek confluence south to US Highway 64, just east of Cimarron, NM.

The 2017 BANCS model incorporated a bank erosion hazard index (BEHI) and near bank stress (NBS) to calculate annual loss of sediment from a particular bank. BANCS analysis can be very useful in identifying particular banks that contribute higher sediment loads into a reach and therefore, may highlight areas for potential focused restoration work that would have greater impact towards improving stream system as a whole. The combined assessments are a valuable resource for prioritizing future restoration of the system.

Field Data Collection

Field data collection for the BANCS model included gathering measurements for determining BEHI and NBS ratings. BEHI measurements include study bank height, root depth, root density, bank protection, stratification, bank material and bank angle. These measurements determine a ranking that predicts the susceptibility of a streambank to erode. The NBS is determined by a measurement of the near bank maximum depth, taken one-third the channel distance from the study bank. NBS ratings indicate the amount of shear stress exerted on the bank by stream flow. The length of the study bank is also measured for the model and a bank location was recorded on a GPS unit so that the banks could be entered into a GIS.

Some banks on this reach were recorded using Rosgen's rapid assessment method. This method was generally used for banks that shared common characteristics for streambanks in the reach. Measurements taken for the rapid assessment were: study bank height, BEHI rating, NBS rating, and study bank length.

Data

RiverMorph stream modeling software was used to run the BANCS model for the reach. As 198 banks were analyzed during the project, the data had to be divided into sub-reaches. (RiverMorph Reach-Scale Bank Summary Reports have a maximum bank number per reach of 57.) Five sub-reaches were defined using GIS chosen primarily by prominent side drainages. All bank data was input into RiverMorph and sediment loss values were calculated using the 1989 Colorado erosion data. Reach-Scale Bank Summary Reports were generated for each of the five sub-reaches. The reports were combined in an Excel workbook and a histogram of the annual sediment loss value for each bank was created.

Mapping

ArcGIS was used to map the banks quantitatively by sediment loss values in a 'bubble map'. The GPS waypoints recorded during the field data collection were joined to the Excel table created from the combined Reach-Scale Bank Summary Report. The GPS points, taken at the center of each recorded bank, were mapped by amount of calculate annual sediment loss. The resulting map highlights the highest sediment contributing banks.

Conclusions

The total estimated sediment contribution into the Middle Ponil from eroding banks is 515 cubic yards per year for the 5.6 mile reach of stream from the Greenwood confluence down to the Vermejo / USFS and Barker WMA boundary. The mapping of the BANCS model results show that the lower most end of the Greenwood – Barker reach of the Middle Ponil is more impacted than the remainder of the reach. From the histogram, only five of the banks have the potential to erode fifteen or more cubic yards of sediment annually. These five banks combined contribute 123 cubic yards or 24% percent of the total 515 cubic yards for the entire study area. Four of the five highest sediment contributors are located in sub-reach 5, from the Rich Creek confluence south to the Greenwood-Barker Boundary. Of the highest 10 sediment contributing banks, eight are in reach 5, one in sub-reach 4 and one in sub-reach 2. Sub-reach 5 has a total estimated annual sediment loss of 202 cubic yards or 40 percent of the total.

In order to look at the Greenwood – Barker reach in comparison to lower reaches of the Middle Ponil surveyed in 2012, the 2012 BANCS analysis points were added to the GIS project. It becomes very obvious that the potential sediment loss in the Greenwood-Barker reach, studied in 2017, is very minor in comparison to the lower reaches of the Middle Ponil Creek from the northern end of the Elliot Barker Wildlife Management Area to the South Ponil confluence. For a quantitative comparison, 0.74 streambanks per mile in the Greenwood – Barker reach contribute 20+ cubic yards of sediment annually. 19.28 streambanks per mile in the Barker – PSR Ponil Camp reach contribute 20+ cubic yards of sediment annually. It must be taken into account, that the 2012 analysis was completed during a deep drought, and recovery of some banks may have occurred since 2012 in the Greenwood – Barker reach, however, the data suggests that work on the lower reaches of the Middle Ponil Creek would have greater impact in reducing the overall sediment load of the creek.

Table 1. 2017 BANCS RiverMorph Data

Middle Ponil Creek, Greenwood Confluence to Vermejo Park Ranch – Barker State Wildlife Area Boundary

Reach 1

Wpt	Reach	SBHeight	BankAngle	BankLength	Field Date	NBMD	BEHI	NBS	Tons	Yards
133C	1	2.0	0	120	9/10/2017	3.0	High	Very High	9.50	7.31
122	1	2.5	70	40	9/10/2017	0.0	High	Very High	7.57	5.83
144	1	5.0	70	50	9/10/2017	0.0	High	High	6.92	5.32
129	1	5.5	70	85	9/10/2017	1.5	High	Low	6.21	4.78
134	1	6.5	75	50	9/10/2017	1.8	High	Moderate	5.64	4.34
117	1	6.0	75	25	9/10/2017	2.0	High	Moderate	3.08	2.37
138	1	3.0	0	80	9/10/2017	0.0	Moderate	Moderate	2.92	2.25
135	1	6.0	90	40	9/10/2017	0.0	Very High	Low	2.89	2.22
137	1	2.0	0	45	9/10/2017	3.0	Moderate	Very High	2.82	2.17
133	1	2.5	0	60	9/10/2017	0.0	High	Moderate	2.74	2.11
143	1	3.0	0	40	9/10/2017	0.0	Moderate	High	2.73	2.10
125	1	4.5	90	30	9/10/2017	1.5	Very High	Low	2.63	2.03
140	1	8.0	0	40	9/10/2017	0.0	Moderate	Low	2.36	1.81
113	1	3.0	90	60	9/10/2017	1.8	Moderate	Moderate	2.33	1.79
132	1	1.5	0	25	9/10/2017	0.0	Moderate	Extreme	2.09	1.61
148	1	3.0	0	50	9/10/2017	0.0	Moderate	Moderate	1.83	1.41
120	1	2.0	0	40	9/10/2017	0.0	Very High	Moderate	1.46	1.13
121	1	2.0	90	20	9/10/2017	3.0	High	Very High	1.44	1.11
126	1	2.5	90	21	9/10/2017	0.0	Moderate	High	1.24	0.95
139	1	4.0	0	25	9/10/2017	0.0	Moderate	Moderate	1.22	0.94
118	1	4.0	0	25	9/10/2017	0.0	Very High	Low	1.20	0.93
131	1	3.0	80	25	9/10/2017	0.0	High	Moderate	1.15	0.88
136	1	1.5	90	40	9/10/2017	0.0	High	Moderate	1.10	0.84
146	1	4.0	0	20	9/10/2017	0.0	High	Low	0.96	0.74

127	1	2.0	100	21	9/10/2017	0.0	Moderate	High	0.96	0.74
124	1	1.5	0	15	9/10/2017	0.0	High	Very High	0.94	0.73
119	1	2.5	80	36	9/10/2017	1.3	High	Low	0.76	0.58
147	1	4.0	0	50	9/10/2017	0.0	Low	Moderate	0.70	0.54
145	1	3.0	0	40	9/10/2017	0.0	Low	Moderate	0.42	0.32
141	1	1.5	0	30	9/10/2017	0.0	Moderate	Low	0.33	0.26
123	1	2.0	0	20	9/10/2017	0.0	Moderate	Low	0.29	0.23
130	1	2.0	0	10	9/10/2017	0.0	Moderate	Moderate	0.24	0.19
142	1	4.0	0	30	9/10/2017	0.0	Low	Low	0.21	0.16
116	1	1.5	0	25	9/10/2017	0.0	Moderate	Very Low	0.17	0.13
114	1	1.5	90	30	9/10/2017	1.1	Moderate	Very Low	0.00	0.00
115	1	1.5	0	25	9/10/2017	0.0	Very Low	Moderate	0.00	0.00
128	1	0.0	0	50	9/10/2017	0.0		Extreme	0.00	0.00
134A	1	4.0	0	40	9/10/2017	1.0	Moderate	Very Low	0.00	0.00

Reach 2

Wpt	Reach	SBHeight	BankAngle	BankLength	Field Date	NBMD	BEHI	NBS	Tons	Yards
159	2	6.0	0	70	9/10/2017	0.0	Very High	High	11.63	8.94
190	2	4.0	0	50	10/7/2017	0.0	Moderate	Very High	6.71	5.16
167	2	4.5	90	50	10/7/2017	1.5	Extreme	Low	5.97	4.59
166	2	4.0	0	25	10/7/2017	2.3	High	High	5.27	4.05
182	2	5.0	80	25	10/7/2017	0.0	Very High	Very High	5.25	4.04
177	2	3.0	80	60	10/7/2017	0.0	High	High	4.89	3.76
151	2	4.0	0	60	9/10/2017	0.0	Moderate	High	4.85	3.73
156	2	3.0	0	70	9/10/2017	0.0	Moderate	High	4.25	3.27
149	2	6.0	50	30	9/10/2017	2.0	High	Moderate	3.58	2.75
165	2	6.0	80	30	10/7/2017	1.4	Extreme	Low	3.55	2.73
174	2	3.0	70	40	10/7/2017	2.5	High	High	3.40	2.62
168	2	6.0	0	40	10/7/2017	1.8	Moderate	Moderate	3.26	2.51
176	2	8.0	70	50	10/7/2017	1.4	Moderate	Low	3.19	2.46
170	2	6.0	90	40	10/7/2017	1.6	High	Low	3.02	2.32
171	2	2.5	0	25	10/7/2017	0.0	High	Very High	2.62	2.02
184	2	5.0	65	35	10/7/2017	0.0	Moderate	Moderate	2.51	1.93
185	2	5.0	60	30	10/7/2017	1.7	High	Low	2.39	1.84
183	2	3.0	0	40	10/7/2017	0.0	High	Moderate	2.20	1.69
189	2	4.0	0	35	10/7/2017	0.0	Low	Very High	2.18	1.67
181	2	5.0	0	20	10/7/2017	0.0	Moderate	High	2.02	1.56
191	2	3.5	45	30	10/7/2017	2.0	High	Moderate	1.95	1.50
164	2	2.5	60	40	10/10/2017	2.1	Moderate	High	1.87	1.44
157	2	2.0	70	75	9/10/2017	1.8	Moderate	Moderate	1.70	1.31
179	2	2.0	0	25	10/7/2017	0.0	Moderate	Very High	1.68	1.29
169	2	4.0	0	50	10/7/2017	0.0	Low	High	1.45	1.12
150	2	3.0	0	35	9/10/2017	0.0	Moderate	Moderate	1.28	0.98
187	2	2.0	90	25	10/7/2017	2.5	Moderate	High	1.13	0.87

175	2	4.0	0	30	10/7/2017	0.0	Moderate	Low	0.88	0.68
188	2	7.0	0	30	10/7/2017	0.0	Low	Moderate	0.73	0.56
153	2	1.5	0	200	9/10/2017	0.0	Low	Low	0.52	0.40
158	2	2.0	80	60	9/10/2017	1.3	Moderate	Low	0.48	0.37
186	2	2.0	90	40	10/7/2017	2.2	Low	High	0.46	0.35
160	2	3.0	0	20	9/10/2017	0.0	Moderate	Low	0.44	0.34
178	2	3.0	0	40	10/7/2017	0.0	Low	Moderate	0.42	0.32
173	2	3.0	0	50	10/7/2017	0.0	Low	Low	0.26	0.20
180	2	3.0	0	40	10/7/2017	0.0	Low	Low	0.21	0.16
154	2	8.0	0	50	9/10/2017	0.0	Low	Very High	0.00	0.00
155	2	3.5	90	95	9/10/2017	1.0	Moderate	Very Low	0.00	0.00
540	2	4.0	50	75	9/15/2017	1.0	Moderate	Very Low	0.00	0.00
172	2	6.0	90	50	10/7/2017	1.0	Moderate	Very Low	0.00	0.00
192	2	4.0	0	20	10/7/2017	1.1	Moderate	Very Low	0.00	0.00

Reach 3

Wpt	Reach	SBHeight	BankAngle	BankLength	Field Date	NBMD	BEHI	NBS	Tons	Yards
508	3	6.0	35	80	9/15/2017	1.9	High	Moderate	8.49	6.53
503	3	3.0	30	100	9/15/2017	2.4	High	High	7.70	5.93
514	3	4.0	90	50	9/15/2017	2.1	Very High	High	6.83	5.25
529	3	3.5	70	45	9/15/2017	3.0	High	Very High	6.24	4.80
161	3	3.0	0	20	9/10/2017	0.0	Moderate	Extreme	3.57	2.75
518	3	4.0	70	40	9/15/2017	2.1	High	High	3.56	2.74
501	3	5.0	70	40	9/15/2017	1.8	High	Moderate	3.47	2.67
524	3	6.0	90	50	9/15/2017	1.5	High	Low	3.46	2.66
504	3	6.0	0	20	9/15/2017	0.0	Very High	High	3.32	2.56
515	3	3.0	0	25	9/15/2017	0.0	High	Very High	3.15	2.42
500	3	4.0	50	60	9/15/2017	1.5	High	Low	3.13	2.41
516	3	6.0	70	50	9/15/2017	1.3	Very High	Low	3.12	2.40
534	3	4.5	35	120	9/15/2017	1.4	Moderate	Low	2.89	2.23
533	3	6.0	0	30	9/15/2017	0.0	High	Low	2.17	1.67
517	3	2.5	80	20	9/15/2017	3.0	High	Very High	1.98	1.52
520	3	3.0	0	15	9/15/2017	0.0	Very High	Very High	1.89	1.45
512	3	1.5	90	60	9/15/2017	2.0	High	Moderate	1.76	1.36
521	3	2.0	80	30	9/15/2017	2.5	High	High	1.75	1.34
525	3	1.5	90	75	9/15/2017	1.8	Moderate	Moderate	1.58	1.21
506	3	3.5	40	40	9/15/2017	1.4	High	Low	1.55	1.19
535	3	3.0	70	70	9/15/2017	1.2	High	Low	1.52	1.17
513	3	3.0	0	50	9/15/2017	0.0	Moderate	Low	1.11	0.85
509	3	4.0	0	20	9/15/2017	0.0	High	Low	0.96	0.74
527	3	4.0	0	20	9/15/2017	0.0	High	Low	0.96	0.74
78	3	2.0	40	30	9/9/2017	1.7	High	Low	0.81	0.62
531	3	4.0	0	25	9/15/2017	0.0	Low	High	0.73	0.56
523	3	5.5	40	30	9/15/2017	1.2	Moderate	Low	0.69	0.53

510	3	3.0	0	30	9/15/2017	0.0	Moderate	Low	0.66	0.51
528	3	2.0	0	25	9/15/2017	0.0	Moderate	Moderate	0.61	0.47
507	3	2.0	0	40	9/15/2017	0.0	Moderate	Low	0.59	0.45
530	3	4.0	0	20	9/15/2017	0.0	Moderate	Low	0.59	0.45
526	3	4.0	0	40	9/15/2017	0.0	Low	Moderate	0.56	0.43
519	3	1.5	0	20	9/15/2017	0.0	High	Low	0.36	0.28
537	3	3.0	0	70	9/15/2017	0.0	Low	Low	0.36	0.28
532	3	6.0	0	30	9/15/2017	0.0	Low	Low	0.31	0.24
536	3	2.0	0	30	9/15/2017	0.0	Low	Moderate	0.21	0.16
162	3	3.0	0	30	9/10/2017	0.0	Low	Low	0.15	0.12
79	3	1.0	0	21	9/9/2017	0.0	Low	Moderate	0.07	0.06
80	3	2.0	65	30	9/9/2017	1.0	Moderate	Very Low	0.00	0.00
81	3	3.5	40	80	9/9/2017	1.0	High	Very Low	0.00	0.00
502	3	5.0	80	60	9/15/2017	1.1	Very High	Very Low	0.00	0.00
505	3	3.0	30	60	9/15/2017	1.0	High	Very Low	0.00	0.00
511	3	2.5	90	30	9/15/2017	1.1	High	Very Low	0.00	0.00
522	3	5.0	45	70	9/27/2017	1.1	High	Very Low	0.00	0.00
539	3	4.0	45	40	9/15/2017	0.5	Low	Very Low	0.00	0.00

Reach 4

Wpt	Reach	SBHeight	BankAngle	BankLength	Field Date	NBMD	BEHI	NBS	Tons	Yards
96	4	2.5	80	42	9/9/2017	0.0	Very High	Very High	18.22	14.02
82	4	4.0	70	60	9/9/2017	2.5	Very High	High	6.99	5.38
106	4	5.0	80	100	9/9/2017	1.7	Moderate	Low	6.02	4.63
1006	4	1.5	90	120	9/15/2017	2.0	High	Moderate	3.70	2.85
103	4	4.0	30	46	9/9/2017	2.0	High	Moderate	3.23	2.48
104	4	4.0	0	40	9/9/2017	0.0	High	Moderate	2.93	2.25
1016	4	3.5	80	45	9/15/2017	1.8	Moderate	Moderate	2.06	1.59
94	4	2.5	0	36	9/9/2017	0.0	High	Moderate	1.65	1.27
83	4	2.5	60	45	9/9/2017	1.5	High	Low	1.31	1.01
92	4	1.5	100	70	9/9/2017	1.7	Moderate	Low	1.19	0.92
95	4	2.0	0	30	9/9/2017	0.0	Very High	Moderate	1.10	0.84
85	4	3.0	80	40	9/9/2017	1.2	High	Low	1.07	0.82
99	4	2.0	70	30	9/9/2017	1.4	High	Low	0.64	0.50
1011	4	2.5	100	39	9/15/2017	1.2	Moderate	Low	0.64	0.49
88	4	2.5	30	30	9/9/2017	0.0	Moderate	Low	0.57	0.43
86	4	2.0	0	36	9/9/2017	0.0	Moderate	Low	0.53	0.41
1018	4	1.5	0	25	9/15/2017	2.0	Moderate	Moderate	0.53	0.41
98	4	1.0	0	50	9/9/2017	0.0	Moderate	Low	0.37	0.28
84	4	3.0	0	30	9/9/2017	0.0	Low	Low	0.15	0.12
1017	4	1.0	0	41	9/15/2017	1.7	Low	Low	0.12	0.09
93	4	1.5	0	36	9/9/2017	0.0	Low	Low	0.09	0.07
1004	4	2.0	0	25	9/15/2017	0.0	Low	Low	0.09	0.07
87	4	2.0	0	24	9/9/2017	0.0	Low	Low	0.08	0.06
1003	4	1.5	0	9	9/15/2017	0.0	Low	Low	0.02	0.02
90	4	1.5	90	36	9/9/2017	1.0	Low	Very Low	0.00	0.00
97	4	8.0	45	75	9/9/2017	1.0	High	Very Low	0.00	0.00
100	4	4.0	70	85	9/9/2017	3.5	Moderate	Extreme	0.00	0.00

102	4	5.0	80	140	9/9/2017	1.1	High	Very Low	0.00	0.00
105	4	3.5	70	45	9/9/2017	1.0	Moderate	Very Low	0.00	0.00
107	4	2.5	90	90	9/9/2017	1.0	Moderate	Very Low	0.00	0.00
1000	4	3.0	45	70	9/15/2017	0.4	High	Very Low	0.00	0.00
1001	4	6.0	70	75	9/15/2017	0.7	High	Very Low	0.00	0.00
1002	4	6.0	70	75	9/15/2017	0.9	High	Very Low	0.00	0.00
1005	4	2.5	0	24	9/15/2017	0.4	Low	Very Low	0.00	0.00
1007	4	2.0	90	39	9/15/2017	0.6	Low	Very Low	0.00	0.00
1008	4	1.0	0	20	9/15/2017	0.5	Moderate	Very Low	0.00	0.00
1009	4	4.0	60	48	9/15/2017	1.0	Moderate	Very Low	0.00	0.00
1012	4	2.0	0	90	9/15/2017	0.5	Low	Very Low	0.00	0.00
1013	4	2.5	0	18	9/15/2017	0.9	Moderate	Very Low	0.00	0.00
1014	4	3.0	95	80	9/15/2017	0.8	High	Very Low	0.00	0.00
1015	4	10.0	80	45	9/15/2017	1.0	High	Very Low	0.00	0.00
1019	4	3.8	65	120	9/15/2017	0.8	Moderate	Very Low	0.00	0.00

Reach 5

Wpt	Reach	SBHeight	BankAngle	BankLength	Field Date	NBMD	BEHI	NBS	Tons	Yards
1041	5	5.0	0	90	9/20/2017	2.0	Extreme	Moderate	31.97	24.59
1049	5	5.0	0	200	9/20/2017	0.0	High	High	27.69	21.30
1024	5	5.0	0	175	9/15/2017	2.4	High	High	23.73	18.26
1026	5	7.0	0	150	9/26/2017	0.0	Extreme	Low	21.23	16.33
1034B	5	3.0	0	160	9/20/2017	1.5	Extreme	Low	12.73	9.79
1022	5	6.0	30	160	9/15/2017	1.5	High	Low	11.01	8.47
1038	5	5.0	80	180	9/20/2017	0.0	Very High	Low	10.83	8.33
1027	5	4.0	0	90	9/15/2017	0.0	High	High	9.97	7.67
1037	5	4.5	0	160	9/20/2017	1.9	Moderate	Moderate	9.12	7.01
1036	5	15.0	0	25	9/20/2017	0.0	Extreme	Low	7.58	5.83
1029	5	3.5	0	60	9/15/2017	1.7	High	Low	6.81	5.24
1032	5	3.0	0	225	9/15/2017	1.2	High	Low	6.03	4.64
1023	5	3.0	98	120	9/15/2017	1.4	Very High	Low	4.27	3.29
1042	5	2.5	0	66	9/20/2017	2.6	Moderate	High	3.89	2.99
1031	5	4.0	0	75	9/15/2017	1.9	Moderate	Moderate	3.80	2.92
1021	5	3.0	90	75	9/15/2017	1.7	High	Low	3.59	2.76
1028	5	4.0	0	45	9/15/2017	1.8	High	Moderate	3.12	2.40
1044	5	1.5	0	90	9/20/2017	1.8	Moderate	Moderate	1.55	1.19
1040	5	2.0	0	120	9/20/2017	1.2	Moderate	Low	1.23	0.95
1030	5	2.5	0	45	9/15/2017	0.0	Low	High	0.82	0.63
1045	5	2.5	0	45	9/20/2017	1.2	Moderate	Low	0.58	0.45
1033	5	2.5	0	24	9/20/2017	0.0	Low	Low	0.10	0.08
1025	5	1.5	0	2.1	9/15/2017	2.1	High	High	0.07	0.05
1039	5	3.0	75	150	9/20/2017	1.5	High	Low	0.04	0.03
1043	5	2.5	0	1.3	9/20/2017	1.3	Moderate	Low	0.02	0.02
1020	5	4.0	90	75	9/15/2017	0.9	High	Very Low	0.00	0.00
1034A	5	4.0	90	180	9/20/2017	0.7	Very High	Very Low	0.00	0.00

1035	5	2.0	0	30	9/20/2017	1.0	Low	Very Low	0.00	0.00
1046	5	2.5	0	60	9/20/2017	1.0	High	Very Low	0.00	0.00
1047	5	4.0	75	120	9/20/2017	0.7	High	Very Low	0.00	0.00
1048	5	5.0	0	150	9/20/2017	0.5	Moderate	Very Low	0.00	0.00

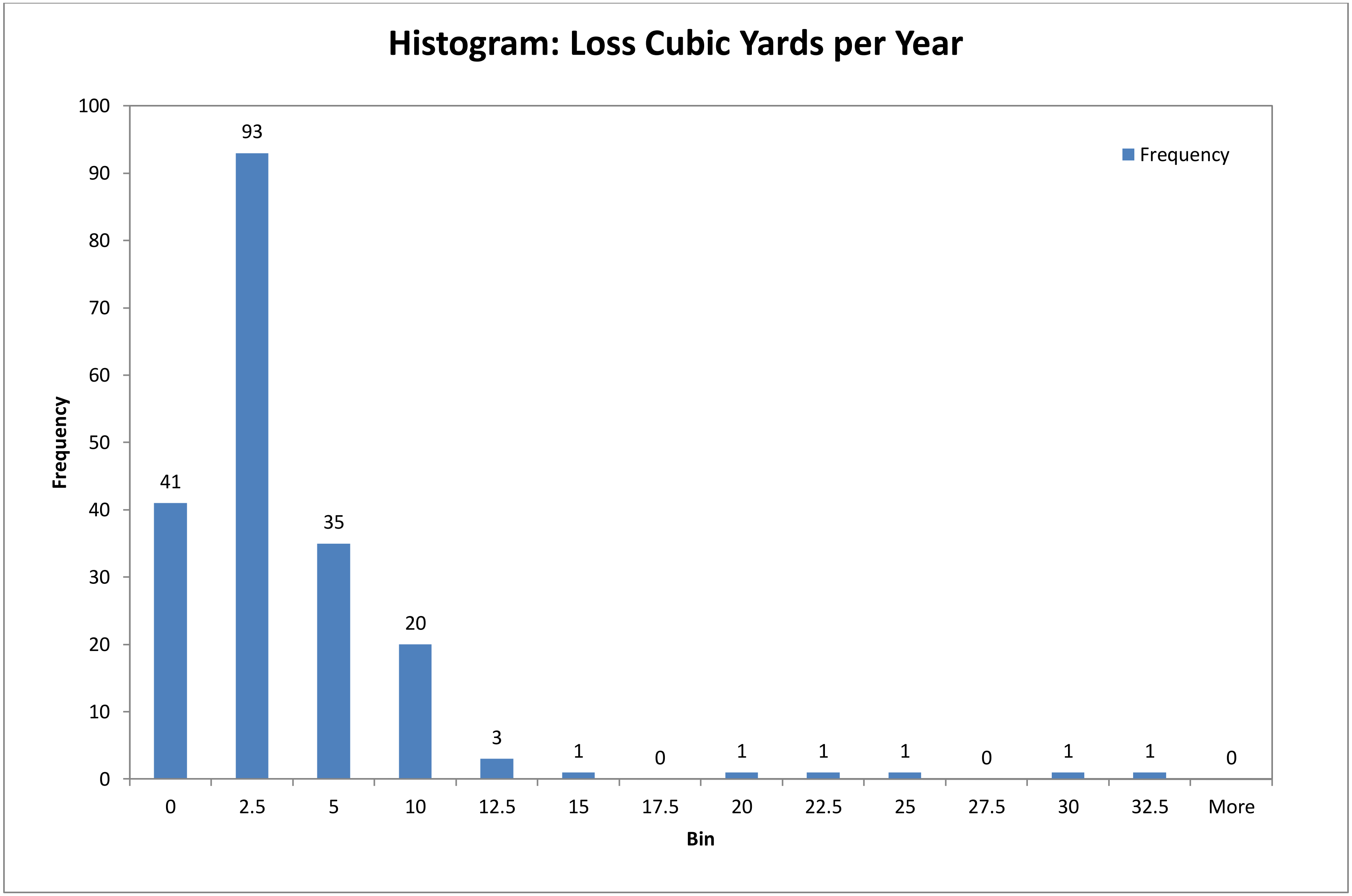
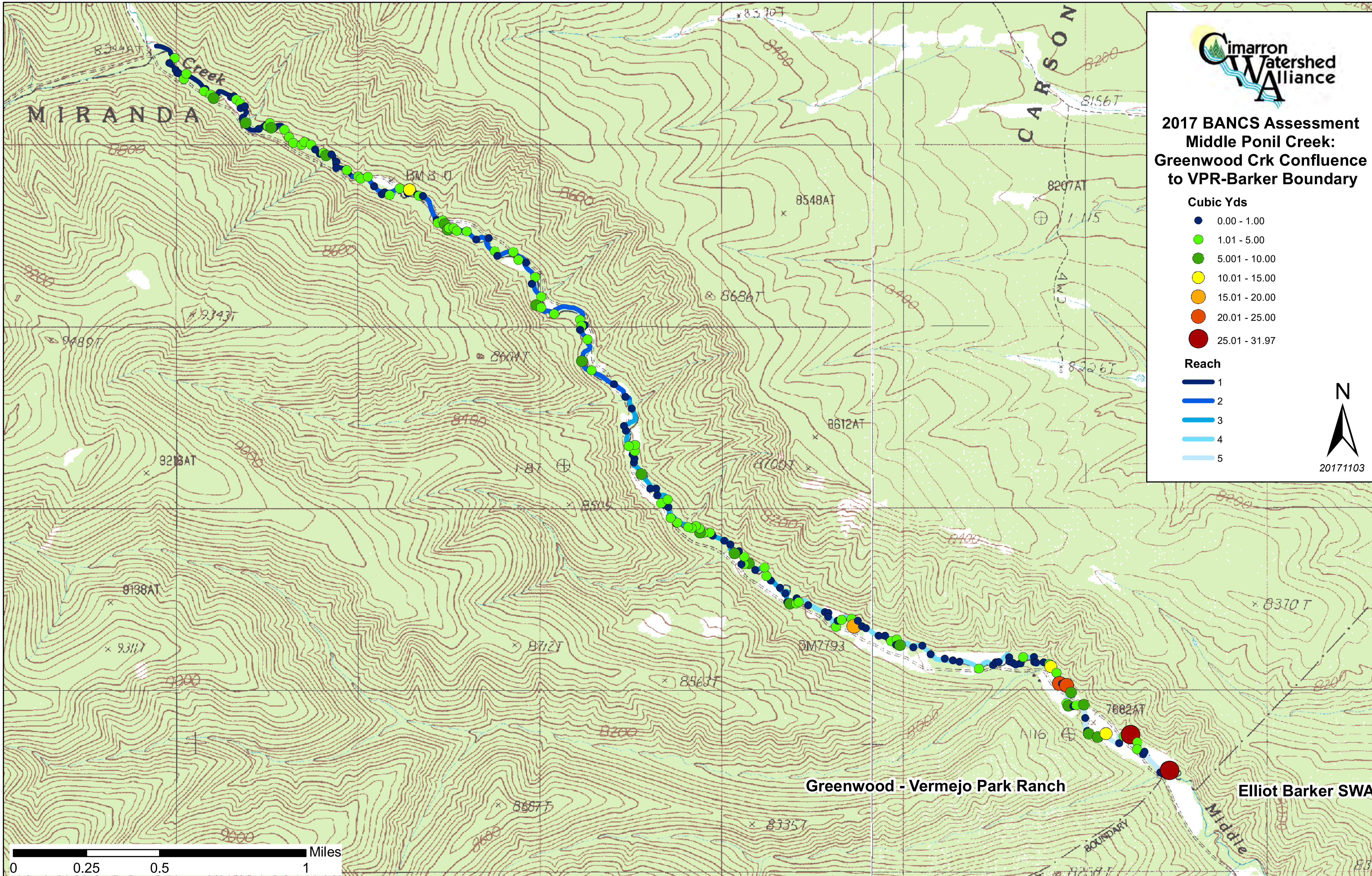
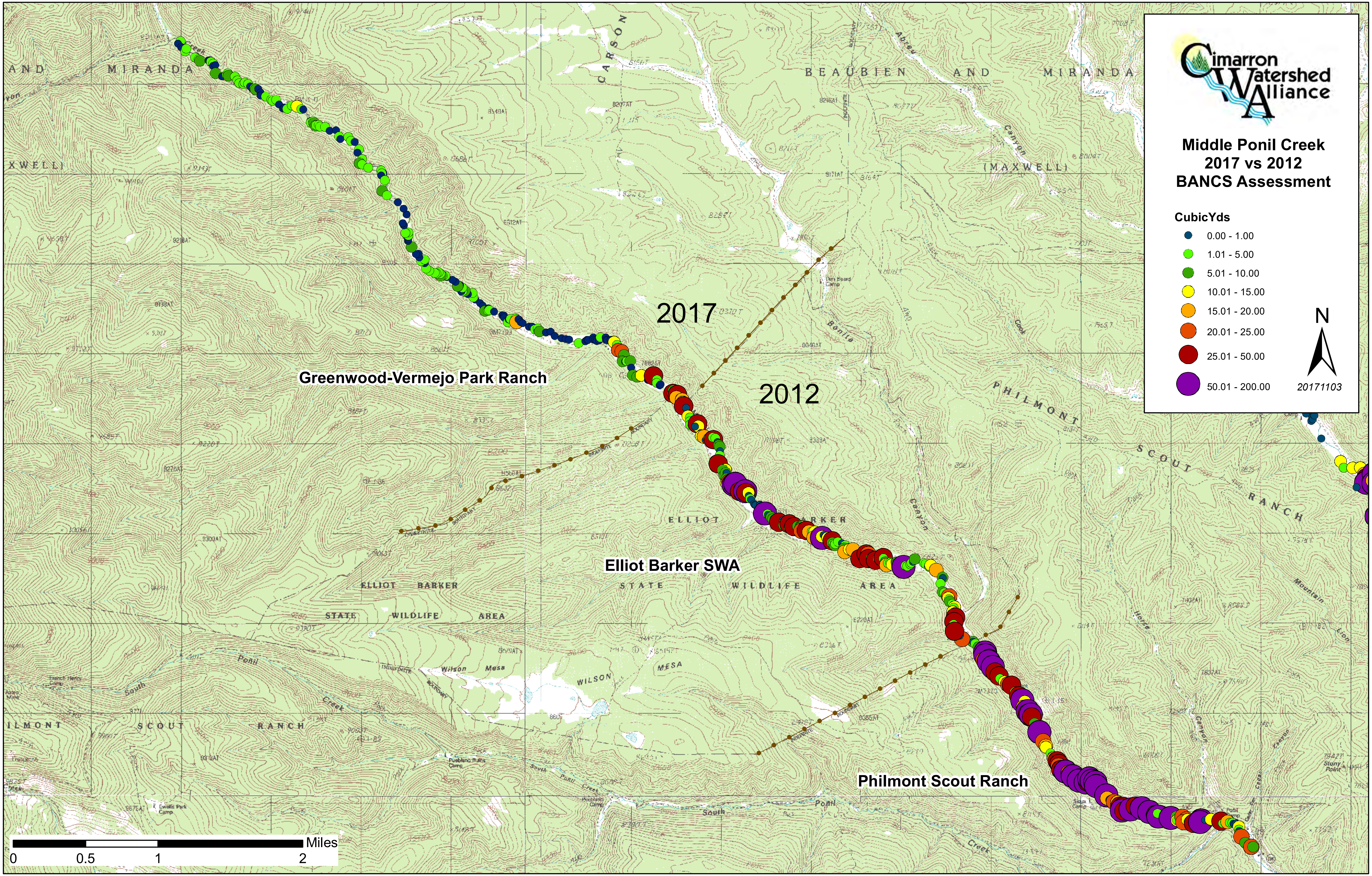

Histogram: Loss Cubic Yards per Year
Frequency
100
90
80
70
60
50
40
30
20
10
0
93
41
35
20
3
1
0
1
1
1
0
1
1
0
0
2.5
5
10
12.5
15
17.5
20
22.5
25
27.5
30
32.5
More
Bin
Frequency

Table 1 pg. 11


Cimarron Watershed Alliance
2017 BANCS Assessment
Middle Ponil Creek:
Greenwood Crk Confluence
to VPR-Barker Boundary
Cubic Yds
0.00 - 1.00
1.01 - 5.00
5.001 - 10.00
10.01 - 15.00
15.01 - 20.00
20.01 - 25.00
25.01 - 31.97
Reach
1
2
3
4
5
N
20171103
Greenwood - Vermejo Park Ranch
Elliot Barker SWA
MIRANDA
Creek
CARSON
Middle
BOUNDARY
Miles
0
0.25
0.5
1



Cimarron Watershed Alliance
Middle Ponil Creek
2017 vs 2012
BANCS Assessment
CubicYds
0.00 - 1.00
1.01 - 5.00
5.01 - 10.00
10.01 - 15.00
15.01 - 20.00
20.01 - 25.00
25.01 - 50.00
50.01 - 200.00
N
20171103
2017
2012
Greenwood-Vermejo Park Ranch
Elliot Barker SWA
Philmont Scout Ranch
Miles
0
0.5
1
2

Stream Survey of Cieneguilla Creek

May 29-31, 2012

Survey Area: **Cieneguilla Creek from headwaters southeast of Angel Fire to Eagle Nest Lake**

Primary Assessment Team and report by: Cieneguilla Creek was surveyed by Joanne Hilton and Ben Christensen with assistance from CWA volunteers Jim Morgan and Alan Huerta. The survey was conducted from May 29-31, 2012.

Assessment Goals: Evaluate the watershed condition and options for mitigating temperature, sediment, nutrients, *E.Coli*, and turbidity impairment.

General Watershed Information:

Geologic Formation: Alluvium, High Glacial Valley

Channel Type: Primarily E6 below Monte Verde Lake in upper part of watershed.

Flow Regime: Snow Melt Dominated, Perennial

Assessment Method:

The team used the BANCS Model-Bank Assessment for Non-Point Source Consequences of Sediment (WARSSS 5-55). Field data was collected using Bank Erosion Hazard Index (BEHI) and the Near Bank Stress Estimating System (NBS) #5 calculation method, ratio of near bank maximum depth to bankfull mean depth. The team also used their general observation skills along the stream channel as well as viewing the watershed area as a whole and its general condition, current use and historical use.

Watershed History:

Farming and ranching have been present in the Moreno Valley since the 1800's. Historic mining occurred south of Eagle Nest Lake also in the 1800s, but not directly in the Cieneguilla Creek watershed. Currently there two gravel pits located near Cieneguilla Creek between Angel Fire and Eagle Nest Lake.

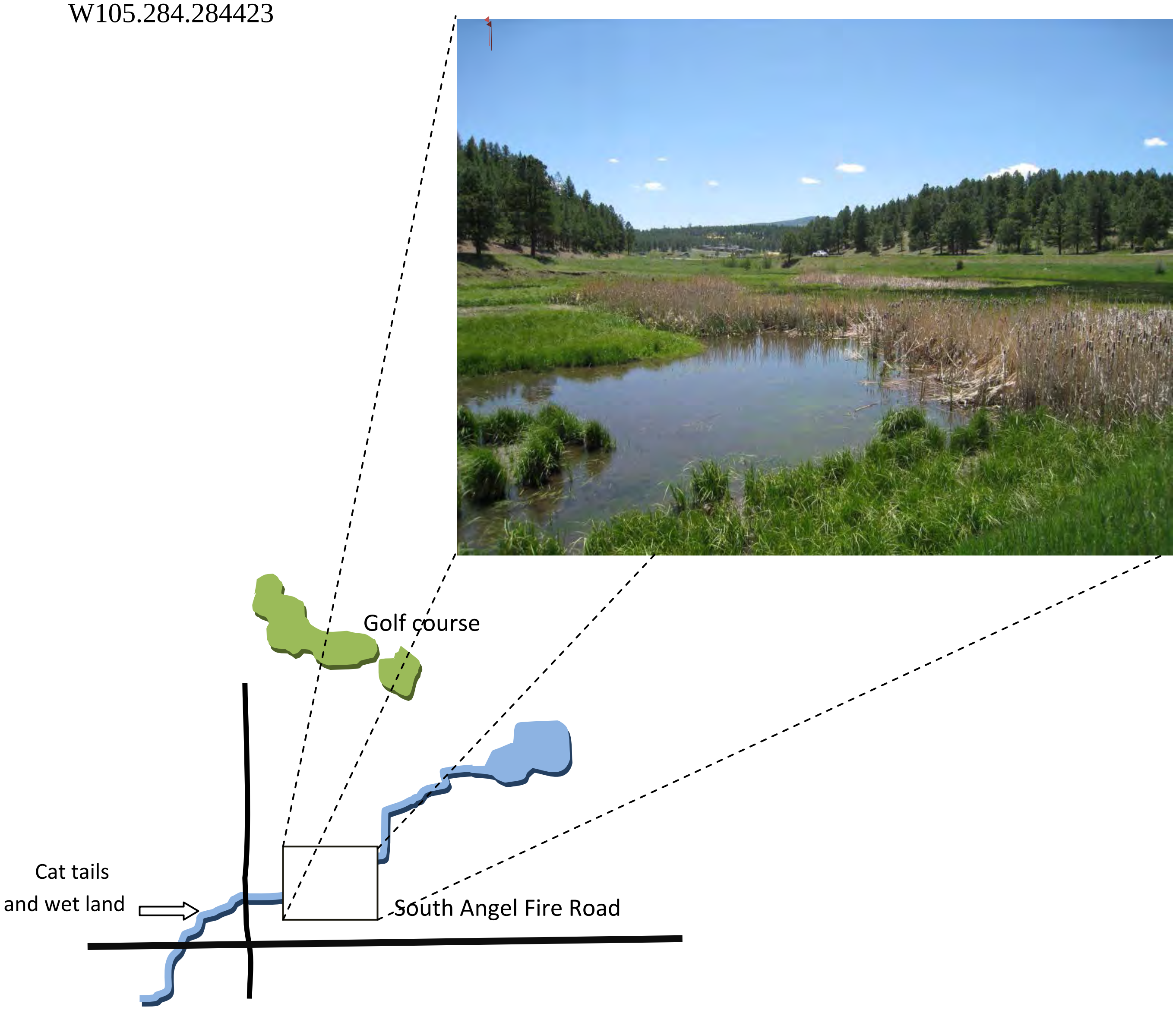
Cieneguilla Creek flows through the Town of Angel Fire. Construction began on the resort community of Angel Fire in 1966. Angel Fire has developed as recreation/resort area with Angel Fire Ski area, Angel Fire Golf Course, and Eagle Nest Lake State Park as key attractions.

Watershed Survey

The following notes document conditions in the watershed, beginning at the headwaters and continuing to Eagle Nest Lake. Forms with BEHI ratings were completed separately and are summarized below.

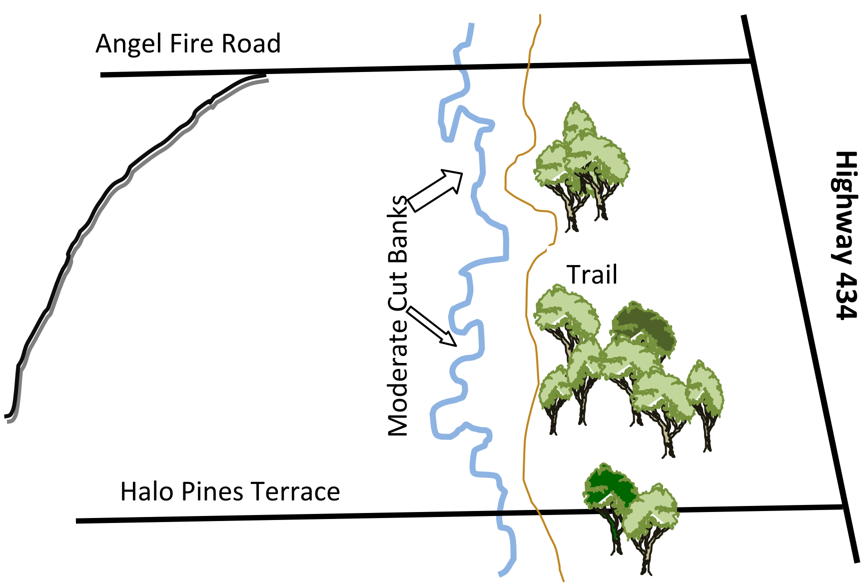
There were ponds and development on the upper Cieneguilla's left fork just downstream of where it leaves the road. Monte Verde lake impounds the water coming from the other tributary.

Relatively healthy wetlands are located below Angel Fire Road downstream of the golf course.
Waypoint 62 N36.38428
W105.284.284423



There are three culverts that discharge downstream of the road

These culverts appear to contribute to stream velocity and should be evaluated for improved placement.



There are 1-2ft cut banks along meanders immediately below the road.

These photos are looking at the stream from Halo Pines terrace looking east

Waypoint 63 is located downstream of El Camino Grande, taking the first left heading toward ranch properties, N36.41708 W105.28721.

At waypoint 64, N36.42305 W10528458 there is an old road crossing that needs to be removed. The stream is cleaner and less silty with a more stable bottom. This photo shows old meander.

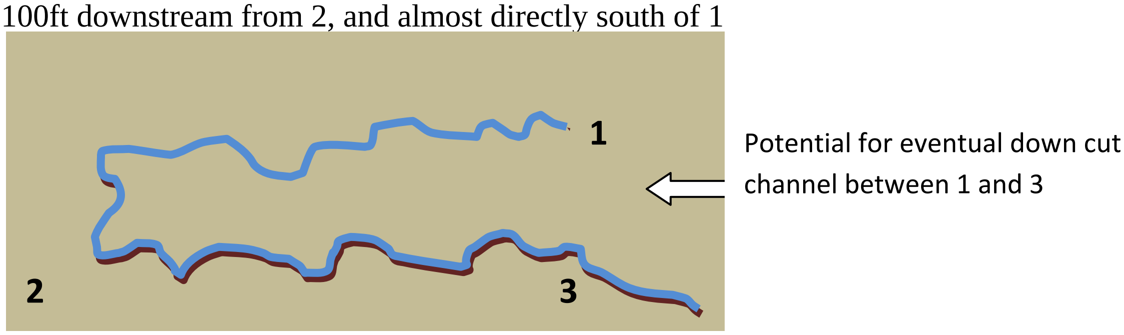
5-30 Waypoint 65, N36.44013 W105.27456, is located downstream of the airport going toward eagle nest on the main road; then on the 1st road to the right just past security building. There is a 3ft culvert at the road crossing.

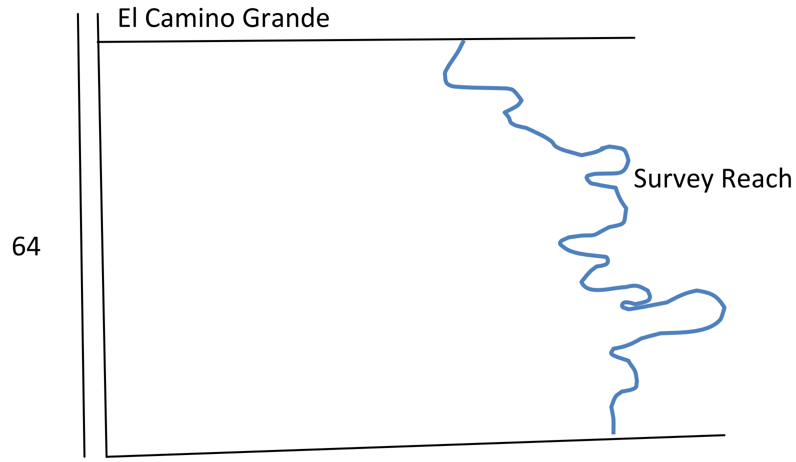
There are extreme-moderate banks downstream and moderate banks upstream and an electric fence on both sides of the road.

5-30 Off of the first road south of the Airport, El Camino Grande, and the survey started at the crossing of the Cieneguilla. It then proceeded downstream to the airport.

Primary areas of stress

1. 100ft downstream of the road there were culverts. It scored a 24 on BEHI and a moderate on the NBS. Some moderate BEHI banks between points 1 and 2
2. 200ft downstream. Some moderates between 2 and 3
3. 100ft downstream from 2, and almost directly south of 1





4. There is a large pond with a very silty stream bottom located 50ft downstream of Halo Pines Terrace road crossing/culvert. There is a lot of trash in the stream, and another moderate bank 340ft downstream of the road. All along the stream there is tall grass sometimes growing in the stream slowing down the current. 130ft farther downstream there is a fence going across the stream. 34ft downstream of the fence there is a moderate bank and grass in the stream. 3 inch and smaller fish were observed 30ft farther downstream there is another moderate bank with a grass bench below.

5. 380ft downstream of the last point there is a bank slump. Waypoint 58. 60ft downstream of waypoint 58 there is a short undercut bank with grassy bench below. Cieneguilla Creek continues to be very silty and slow with some grass in the stream. Another 340ft beyond Waypoint 58 there is a high exposed bank about 70ft long. Another 140ft downstream there is a board bridge across the stream. Another 90ft there is an exposed cut bank with high BEHI indicators.

6. Waypoint 59 is 320ft farther downstream. Vegetation is protecting the bank when the flow is moderate, however, at high flows it is completely exposed. The BEHI index is 35, giving it a high rating. 150ft beyond Waypoint 59 there is a 10ft long undercut bank that is between high and very high on the BEHI. 60ft farther there is an almost identical bank. Another 130ft downstream there is an outside meander, and very high on the BEHI. The flow is better and less obstructed by trash and vegetation in the stream there. 170ft farther downstream there is a log in the stream with scum built up behind it.

7. Another 230ft downstream there is a small silt fence below an industrial site, located about 500ft away from the stream. There was a small gray rat observed. There are moderate BEHI banks throughout this reach. 230 feet beyond the fence there is a moderate bank with a bench below. 90 feet past that there is a silt fence coming in to the stream.

90ft farther downstream there is a blue drum and garbage in the stream.

An additional 150ft downstream there is a fence across the stream. There is a significant amount of trash all throughout the stream. This reach is more stable and grassy. 260ft downstream of the fence there is a side drainage coming in. There is a well about 100ft east of the stream. 120 farther there is a lot of grass and a small wetland area. There is an old pipe in the stream as well as moderate exposed banks.

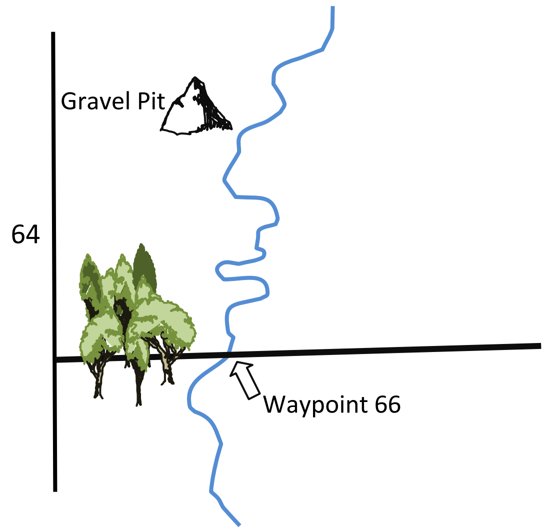
8. Located at N36.40395 and W105.28350 there is 80ft of exposed bank with a BEHI of high to very high. There is a drainage coming in close to the road.

600ft farther down there is a high BEHI bank.

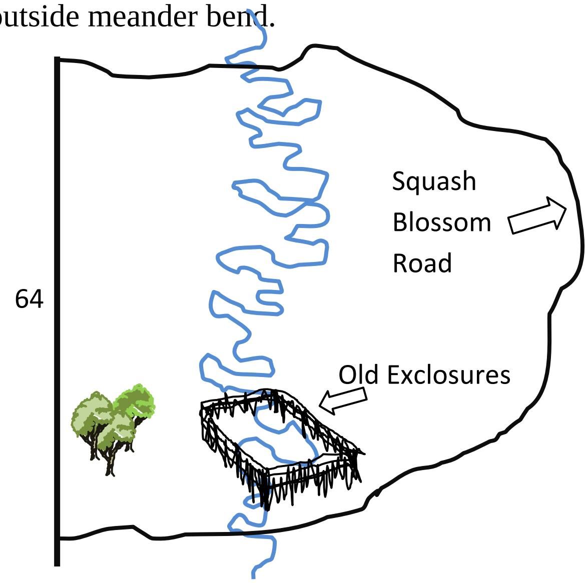
50ft farther downstream many 1inch fish and one 10inch black fish observed. The stream is deeper and slower here. 260ft farther a soccer field is located directly to the west and Moreno Valley High School is to the east. There are banks here that are high- very high BEHI. In the reach there are more moderate banks. 130ft farther the stream is flowing better and the bottom has cobble instead of silt. Downstream an additional 330ft there is a 10ft long and 4ft high bank with a high BEHI.

9. 390ft farther downstream is Waypoint 60, N 36.40815 W105.28467. There is an 80ft long by 3.5ft high exposed bank with less than 10% vegetation, and a high BEHI. 200ft downstream of Waypoint 60 there is a 30ft long 2.5ft high exposed bank (high BEHI). Downstream another 100ft there are more exposed banks with lots of undercut and slumping between there and the road (El Camino Grande). 400ft farther there is a small drainage coming in, at less than 0.2 cubic feet per second (estimated). 150ft downstream of the incoming drainage there is an exposed bank and there are bigger fish in this reach, also the banks are more stable. Another 300ft downstream there is spring discharge into the creek. The spring is located about 250ft upstream of the road. There are moderate banks from here to the road.

5-30 The next road south is where Waypoint 66 is located, N36.45467 W105.27107. There are many cattle trails and moderate banks in this reach.



5-30 Waypoint 67. N36.47556 W105.26476, is located on the crossing at Squash Blossom Road. There are three culverts crossing Squash Blossom Road. There is a 50ft long 4.5ft high bank outside meander bend.



5-31 Waypoint 68, N36.47555 W105.26464, is located off of the first road south of Eagle Nest Lake. Along the Cieneguilla there are a series of exclosures. Upstream there is a fence that has a no trespassing sign. It is south 300ft downstream of the gauging station. The stream is very silty with extreme meanders. Most of the banks are very high to moderate BEHI in both the upstream and downstream direction.

5-31 At Waypoint 69, N36.48659 W105.28814, there is a 100ft long 6ft high bank just North East of the parking lot at the end of the road. That bank has a BEHI of 41: very high erosion potential. 150ft downstream on the Cieneguilla there is a bank with high BEHI, about 100ft long, directly east of the restroom and it borders the exclusion fence.

Looking downstream into the exclosure, there are moderate cut banks with some smaller fencing inside as well as small recently planted vegetation.

It is possible to walk into the exclosure from the north end. Downstream toward Eagle Nest Lake there are moderate to high banks.

Summary Recommendations

Based on the watershed conditions observed above, the following treatments are recommended for Cieneguilla Creek:

- Plant shade species (willow, red alder and cottonwood) in Angel Fire and north of Angel Fire, between the airport and Eagle Nest Dam. Tree planting will need to be coupled with wildlife and livestock exposures to successfully establish shading.
- Maintain existing wildlife exclosures as well as adding new wildlife exclosures in other areas.
- Restore exposed banks, focusing on those that rated as high to very high on the BEHI ranking system. A cut and paste system is recommended to reconfigure the channel morphology at each problem location. The material and vegetation on the enlarged point bars or overlong meanders are removed and placed at the toe of the opposite eroding bank. Additional discussion of this method is included in the North Ponil Assessment report in Appendix C. Simpler methods such as post vanes are appropriate along much of the creek.
- Remove and restore an old road alignment that is affecting channel function.
- Meet with gravel pit operators to discuss best management practices.
- Work with land owners to provide education and resources regarding grazing management and to assist with off channel stock watering options.
- Meet with managers of Angel Fire Golf course to discuss management practices and determine if there are any opportunities for collaboration.
- Work with Colfax County to conduct a valley wide road assessment to identify which roads may be repaired for improved drainage and culvert placement
- Work with Colfax County and the New Mexico Department of Transportation to implement BMP's during road construction projects.
- Work with local schools and community volunteers to clean up trash and debris in the creek.

Costs

The cost for the education and coordination components of this project would be covered by the Watershed Coordinator and only additional expenses are reflected here. Approximate project costs for the recommendation above are:

Exclosures 3 acres at $3,000 per acre =$9,000

Cut bank stabilization: 10 banks at $6,000 per bank = $60,000.

Establishing riparian vegetation 5 miles at $ 5,000 per mile =$25,000

Address old road =$20,000

Monitoring and reporting $20,000

Misc. expenses (mileage, etc.) $5,000

Total project cost: Approximately $140,000

Report Submitted by: Steve Carson,

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Santa Fe, New Mexico 87506
Email: rangehands@gmail.com
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8/6/2012

Proposed West Agua Fria Creek Powerline Road Reroute Assessment Report:

Project Goal: Reduce the direct sediment contribution of 1,600 feet of unimproved dirt road into West Agua Fria Creek.

West Agua Fria Creek is a perennial stream that flows west from the Garcia Park area and off the north side of Agua Fria Peak, east of Angel Fire New Mexico. West Agua Fria Creek is a head water drainage that flows west form elevations of 9,000 to 10,975 feet above sea level and enters Cieneguilla Creek on the east side of the Angel Fire Airport. The drainage area is approximately 25 square miles. The stream system is a snow melt dominated flow regime with contributions from summer monsoon rain events. Average annual precipitation is approximately 25 inches. The dominate geology in this area is volcanic lava flows that have created an abundance of basalt outcroppings and boulder fields along with a dominate high clay content soil type.

The land owner in the proposed project area is the CS Ranch / American Creek Properties.

The existing road system crosses West Agua Fria Creek from the north side of the creek over to the south side along the 245 KV powerline right of way and runs east crossing over the creek again and then turns north. Both creek crossings currently have culverts in them. This section of road is approximately 1,600 feet in length.

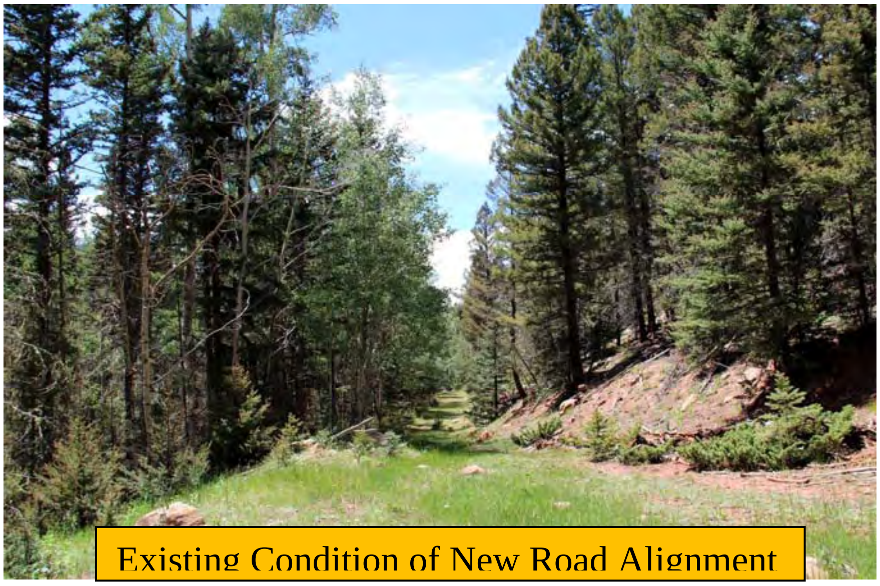
The west section of this road, +/- 750 feet is at a slope of +/- 12% currently drains directly into the creek. The east end of the road, +/- 750 feet also drains directly into the creek at the location of the upper culvert. The soils in this area are fine red clay. This road could be cross drained, however; it is very close to the creek and there are limited buffer areas to filter the runoff water before it enters the stream system.

The proposal to stop the direct sediment contribution into West Agua Fria Creek is to close and drain this section of road and reopen an existing road that is on the north side of the creek.

The old road would be abandoned and drained. The proposed work would include a significant number of cross drains so that no one drain has enough discharge to flow into the creek. Drainage would be directed into the limited buffer areas on the south side of the creek. The two culverts would be removed and the stream channel reshaped to its original cross sectional shape. The road also cuts through a small spring fed sloped wetlands. Local soil materials would be used to fill in the truncated end of the sloped wetlands. All berms and ditches would be removed and contoured into the old road prism. The road surface would be ripped and reseeded with native grasses.

The new road alignment, approximately 1,450 feet long, would be on an abandoned road on the north side of the creek. This new alignment is not as steep as the old road and provides better buffer areas to sequester road drainage sediment. The road would require +/- ten Rolling Dip Road Surface Cross drains as well as +/- 5 drains on an abandoned road that enters the new alignment from the north. The new alignment crosses over a spring fed sloped wetlands. To cross these wetlands a permeable fill crossing would be installed at this location. The preamble fill area is approximately 100 feet long x 15 feet wide x 2 feet deep.

Proposed Re-utilization of New Road Alignment


Existing Condition of New Road Alignment

The project estimated cost is $32,600.00

Project Design References:

A Good Road Lies Easy on the Land….Water Harvesting from Low Standard Rural Roads: Bill Zeedyk 2006

Managing Roads for Wet Meadow Ecosystem Recovery: USDA Forest Service, FHWA-FLP-96 016: Bill Zeedyk 1995

7/1/2012 Revised 7/9/2012 SC

North Ponil Creek / North Ponil Watershed Assessment Report:

Assessment Dates: Spring 2012

Primary Assessment Team and Report by: Steve Carson, Rangelands, Inc. and Rick Smith, Highland Solutions, LLC.

Assessment Goals: Determine the source of sediment contribution to the mainstem stream channel, North Ponil Creek within the North Ponil watershed area and develop remedies to reduce this sediment contribution within the system.

Assessment Conclusions as to the sources of sediment, in order of contribution:
1. Unstable streambanks.
2. Poor grazing management practices.
3. Roads
4. 2002 fire.
5. Geology, a constant that is affected by all of the above.

General Watershed Information:
Geologic Formation; Raton is a sandstone high relief, rocky, flashy, rapidly eroding geologic system. This system has a natural high geological sediment contribution.
Valley Type III, alluvial fan dominated with steep rocky slopes.
Channel Type: C, F and G / Variable
Flow Regime: Snow Melt Dominated, Intermittent Perennial.

North Ponil Watershed Assessment Area:
The assessment to determine the contribution of sediment into the North Ponil Creek from bank erosion and other factors, was started at the fence line of XA Ranch and the Philmont Scout Ranch and proceeded downstream from this point for approximately 3.6 miles.

Assessment Method:
The team used the BANCS Model-Bank Assessment for Non-Point Source Consequences of Sediment (WARSSS 5-55). Field data was collected using the Bank Erosion Hazard Index (BEHI) and the Near Bank Stress Estimating System (NBS) #5 calculation method, ratio of near bank maximum depth to bankfull mean depth. The team also used their general observation skills along the stream channel as well as viewing the watershed area as a whole and its general condition, current use and historical use.

Watershed History:
It is very important to understand the historical use of a watershed. The effects of historical use in any given watershed generally are associated with the present problems and conditions we see today. If we do not understand the cause of the problems we now see, we cannot understand the remedies to reverse the present trends.

North Ponil Watershed Historical Use:

The North Ponil has a long history of human influence. There is evidence of Native American cultures using this area year round. However, historical indicators generally point to summer seasonal use of this area by native cultures. European influence dates back to the early 1800's and the influence of the fur trappers and the impact that this activity had on the stream system due to a heavy reduction in the beaver population, which at one time was a dominating influence in this watershed.

Post Civil War 1866 and beyond, brought an influx of pioneers to the western United States. This area was not exempt from this influx and demographic change, especially with its proximity to the Santa Fe Trail. Homesteads, farming and ranching as well as timber and mineral extraction began in this time period. Large numbers of all types of livestock were introduced into the area and by 1890 the numbers surpassed the limits of the forage carrying capacity and the ability of soils to stay in place due to the reduction in grass cover. Major soil erosion started in this time period due to accelerated surface discharge caused by the lack of ground cover. The accelerated surface discharge not only caused the loss of topsoil, but cut deep gullies in the landform and overloaded the mainstem channels with sediment as well as causing down cutting in the mainstreams and tributary channels. Couple these effects with the loss of beavers and the stability of the overall watershed and stream channel system losses its natural equilibrium and goes into an unstable downward erosional trend.

In approximately 1885 a logging railroad was constructed up the middle of the North Ponil Valley. Logging railroads of this type were a temporary system to be used to extract the timber resource and then be dismantled and moved to the next timber area to be harvested. The construction of these rail systems summarily disregarded any effects that it might have on the natural resources that it was built upon. This is truly the case on the North Ponil. The rail bed was built in the center of the valley with no regard for the presences of the existing stream channel and associated wetlands. Materials needed to build the elevated rail bed were dug out of the valley bottom on each side of the bed alignment. The stream channel was straightened and moved to one side of the valley as much as possible to minimize the need for stream crossing trestles and the cost associate with them. The original meander pattern was eliminated, stream channel slope was increased and major stream channel down cutting occurred at this point. As the mainstem dropped, all the tributary channels head cut and incised proportionately to the down cutting of the mainstem. Channel down cutting and incision drained the water table in these locations. The loss of alluvial water table storage has had a significant effect on this system. The most obvious effects are the loss of wetlands, mature cottonwoods and base flows in the stream channel.

The rail system and timber operation brought with it an influx of people, farming and livestock to support the timber operation. The heavy loss of timber cover and the associated impact of skid and logging roads further destabilized the headwaters of the North Ponil watershed. By 1900 the entire North Ponil watershed was in a state of total instability. The channel system incised and down cut, upland top soils eroded to the point that the A horizon was eliminated and mineral soils exposed.

The stream channel has attempted to stabilize itself through the natural channel succession process over the last 100 +/- years. There are some reaches of C channel type that have reached a stable equilibrium. However, the majority of the North Ponil is still in a very frustrated state, continuing to incise, headcut, carving out its banks in an attempt to create more width. It is overloaded with sediment that builds over wide and over high point bars that further create more bank erosion as well as overlong meanders caused by too much sediment which again creates more bank erosion. This insidious process repeats itself through the entire channel system.

The anthropogenic effects on the North Ponil have converted a once beaver dominated perennial stream system with associated wetlands to a down cut, incised and eroded intermittent stream system with very little associated, if any, wetlands.

We are now dealing with these legacy effects and associated problems as well as current effects and management practices.

Recent and Current Effects on the North Ponil Watershed:

Weather: The flows in this stream system are dominated by snow melt run off. It appears that the last bankfull runoff event was in the spring of 2010. Since that time there has been decline in moisture in this area due to the current drought.

Fire: The watershed has seen continually used since 1900 for ranching, farming, grazing and the associated use of the Philmont Scout operation. As recently as 2002 the Ponil Complex Fire burned a significant amount of this watershed. The loss of ground cover caused by the fire coupled with steep rock sandstone topography has caused a significant increase in sediment contribution to the stream system. This sediment contribution is now decreasing due to the re-vegetation occurring on the burn area. The fire and associate ground cover loss also created accelerated and higher than normal watershed discharges. The increased discharge caused further down cutting and bank erosion on an already fragile, legacy affected stream channel and watershed system.

The team observed that pre fire, many areas on North Ponil Creek were well vegetated with riparian woody vegetation along the stream channel, i.e., willows and cottonwoods. During the post fire flood a large amount of organic debris was caught in the willows along the stream. This debris elevated the stream bank and in many places blocked access to the flood plain creating a willow/debris hardened G channel type. This change in the width to depth ratio has caused the channel bottom to further down cut and incise as well as creating an increase in Near Bank Stress (NBS) in many cases.

Grazing: Current grazing in this area for a herd of horses starts in October and extends into the spring cool weather growing season until June. The team observed what would be described as 100% hoof shear from valley hill slope to hill slope as well as along the stream channel. The hoof shear along the stream channel is so heavy that it has obliterated the bankfull indicators as well as destabilized the bankfull benches where they occur (C, B and in some F channel types). The grass forage utilization was 100% on the terraced areas as well as along the stream channel. There is a considerable amount of bare ground; some areas have some native grass cover and other areas are dominated by annual weeds. The herd of horses has also grazed significantly on the willows and cottonwoods. The cottonwoods are more affected by this grazing due to the grazing impact on the smaller saplings. If continued, this could cause a reduction in cottonwood regeneration. The team observed numerous and closely spaced horse dung piles throughout the North Ponil canyon. This observation denotes that the horses are in this area for an extended time period and along with the 100% hoof shear it can be concluded they repeatedly heavily graze over this area a number of times between October and June. This area has the appearance of a confined horse corral rather than a grazed pastured.

The current grazing practices in this area have a significant effect on the stability of watershed function. The loss of ground cover and a decrease in species type has increased the surface area discharge and velocity causing top soil erosion, increasing gully erosion and increasing the amount of sediment that is being discharged into the stream system.

Roads: The current access road in the North Ponil valley generally follows the alignment of the old rail bed. The road is poorly drained, if at all. Long segments are hydraulically connected causing road surface erosion and generally causing gully/head cut erosion at the point where the water finally exits the roadway. There are some road drainage locations as well as stream crossing locations that the road runoff and sediment is discharged directly into the stream channel. The team members also took two evening road observation trips. One such trip was up Cottonwood Canyon and looping around and coming out on Metcalf Canyon. The other observation route was Cook Canyon road and looping south back over the mesa/burn area and coming back into the North Ponil at +/- Old Camp. These roads have been recently, i.e., Fall 2011, bladed with a bull dozer. The road up Cottonwood Canyon is in the creek channel and has created a channel destabilization which adds to the overall sediment contribution to the watershed system. The remainder of both road systems, although recently bladed, are not well drained, if at all. The blading operation has created a continuous berm on the downhill side of the road that keeps the water trapped on the roadway causing road surface erosion, high sediment discharge and the continued need for costly, repeat road maintance.

Scouting: The main effect of the Scouting operation is the concentrated Scouting activities at locations along the stream channel. These areas have been impacted to the point that the ground is bare and the streambanks destabilized due to trailing. These areas have a direct contribution of sediment into the stream channel.

Conclusion of the Historical and Current Effects on the North Ponil:

The North Ponil watershed has been significantly negatively impacted by historical and current land management practices. Based on the BEHI, NBS and BER data collected by the assessment team and quantified by Rick Smith, the 3.6 miles of the North Ponil has a sediment contribution load of 5,394 tons per year from unstable stream banks. (Note: The unstable streambank sediment contribution could be extrapolated to include the remainder of the North Ponil Creek down to the confluence with the Middle Ponil +/- 3.5 miles) This calculation does not add in the other sediment contributions created by the effects of fire, roads, grazing and other human activities. Given the results of the stream bank erosion data, coupled with the historic and present land management practices, the overall system would be rated at unstable with a downward trend.

Stabilization and Restoration Opportunities:

References:

Watershed Assessment Practices can be reviewed in:

Evaluating the Bank Erodibility Hazard Index In New Mexico, Wilbert Odem, Ph.D., P.E., 1999

Regional Relationships for Bankfull Stage in Natural Channels of the Arid Southwest, Tom Moody, PE, 2003

Watershed Assessment of River Stability and Sediment Supply (WARSSS), Second Addition, Dave Rosgen 2009

A Good Road Lies Easy on the Land…. Water Harvesting From Low-Standard Rural Roads Second Addition, Bill Zeedyk 2010

7/1/2012 Revised 7/9/2012 SC

Middle Ponil / Barker WMA to Ponil Scout Camp Watershed Assessment Report:

Assessment Dates: Spring 2012

Primary Assessment Team and report by: Steve Carson, Rangelands, Inc. and Rick Smith, Highland Solutions, LLC.

Assessment Goals: Determine the source of sediment in the Middle Ponil watershed area and develop remedies to reduce the sediment contribution within the system.

Assessment Conclusions as to the sources of sediment, in order of contribution:
1. Unstable streambanks.
2. 2002 fire.
3. Roads
4. Geology, a constant that is affected by all of the above.

General Watershed Information:
Geologic Formation; Raton, a sandstone high relief, rocky, flashy, rapidly eroding geologic system. This system has a naturally high geological sediment contribution.
Valley Type III, alluvial fan dominated with steep rocky slopes.
Channel Type: Variable, B, Bc, C, F, G
Flow Regime: Snow Melt Dominated, Perennial

Middle Ponil / Barker Watershed Area:
The assessment to determine the contribution of sediment into the Middle Ponil from bank erosion was started at the fence line on the west end of the Barker WMA and proceeded downstream from this point for approximately 5.5 miles to the horse /burro corral at the Ponil Scout camp just below the confluence of the South Ponil.

Assessment Method:
The team used the BANCS Model-Bank Assessment for Non-Point Source Consequences of Sediment (WARSSS 5-55). Field data was collected using Bank Erosion Hazard Index (BEHI) and the Near Bank Stress Estimating System (NBS) #5 calculation method, ratio of near bank maximum depth to bankfull mean depth. The team also used their general observation skills along the stream channel as well as viewing the watershed area as a whole and its general condition, current use and historical use.

Watershed History:
It is very important to understand the historical use of a watershed. The effects of historical use in any given watershed generally are associated with the present problems and conditions we see today. If we do not understand the cause of the problems we now see, we cannot understand the remedies to reverse the present trends.

Middle Ponil WS Historical Use:
The Middle Ponil has a long history of human influence. There is evidence of Native American cultures using this area year round. However, historical indicators generally point to summer seasonal use of this area by native cultures. European influence dates back to the early 1800's and the influence of the fur trappers and the impact that this activity had on the stream system due to a heavy reduction in the beaver population, which at one time was a dominating influence in this watershed.

Post Civil War 1866 and beyond, brought an influx of pioneers to the western United States. This area was not exempt from this influx and demographic change especially with its proximity to the Santa Fe Trail. Homesteads, farming and ranching as well as timber and mineral extraction began in this time period. Large numbers of all types of livestock were introduced into the area and by 1890 the numbers surpassed the limits of the forage carrying capacity and the ability of soils to stay in place due to the reduction in grass cover. Major soil erosion started in this time period due to accelerated surface discharge caused by the lack of ground cover. The accelerated surface discharge not only caused the loss of topsoil, but cut deep gullies in the landform and overloaded the mainstem channels with sediment as well as causing down cutting in the mainstreams and tributary channels. Couple these effects with the loss of beavers and the stability of the overall watershed and stream channel system losses its natural equilibrium and goes into an unstable downward erosional trend.

In approximately 1885 a logging railroad was constructed up the Middle Ponil Valley as far as the Ponil Scout Camp. At this point, the rail line turned south and went up the South Ponil drainage. Logging railroads of this type were a temporary system to be used to extract the timber resource and then be dismantled and moved to the next timber area to be harvested. The construction of these rail systems summarily disregarded any effect that it might have on the natural resources that it was built upon. This is truly the case on the Middle Ponil downstream from the Ponil Scout Camp. The rail bed was built in the center of the valley with no regard to the presence of the existing stream channel. Materials needed to build the elevated rail bed were dug out of the valley bottom on each side of the bed alignment. The stream channel was straightened and moved to one side of the valley as much as possible to minimize the need for stream crossing trestles and the cost associated with them. The existing meander pattern was eliminated, stream channel slope was increased and major stream channel down cutting occurred at this point. As the mainstem dropped, all the tributary channels head cut and incised proportionately to the down cutting of the mainstem. The effects of this channel down cutting and incising can be seen in the assessment area upstream from the Ponil Scout Camp.

The rail system and timber operation brought with it an influx of people, farming and livestock to support the timber operation. The heavy loss of timber cover and the associated impact of skid and logging roads further destabilized the headwaters of the Middle Ponil watershed.

Farming operations dominated the Middle Ponil at the Barker and Rich Ranches. To create more easily managed farm fields the farmers rerouted the stream channel to one side of the valley. The existing meander pattern was eliminated, stream channel slope was increased and major stream channel down cutting occurred at this time. As the mainstem dropped, all the tributary channels head cut and incised proportionately to the down cutting of the mainstem.

By 1900 the watershed stability of the Middle Ponil drainage was significantly compromised. Channel systems incised and down cut and uplands top soils were eroded.

The stream channel has attempted to stabilize itself through the natural channel succession process over the last 100 +/- years. There are some reaches of C and B, Bc channel types that have reached a stable equilibrium. However, there are many locations on the Middle Ponil which are still in a very frustrated, continuing to incise, headcut, carving out its banks in an attempt to create more width. It is overloaded with sediment that builds over wide and over high point bars that further created more bank erosion as well as overlong meanders caused by too much sediment which again creates more bank erosion and this process insidiously repeats itself through the entire channel system. Even in this frustrated state the channel, especially on the Barker Reach, is well vegetated with willows, alders and cottonwoods and has stable reaches of C, Bc and B channels with numerous beaver ponds interspersed along the stream and associated wetlands.

The anthropogenic effect on the Middle Ponil has converted a once beaver dominated meandering C or E stream system with associated wetlands to a down cut and incised B stream system with loss of association wetlands.

We are now dealing with these legacy influences and associated problems as well as current affects and management practices.

Recent and Current Affects on the Middle Ponil Watershed:

Weather: The flows in this stream system are dominated by snow melt run off. It appears that the last bankfull runoff event was in the spring of 2010. Since that time there has been decline in moisture in this area due to the current drought. This reach of the Middle Ponil dried up in May of 2011. The effects of drought can be especially seen in the decline of the beaver and fish populations. There are still a few active beaver dams in this area, but most dams show no sign of activity for this year.

Fire: The watershed has seen continually used since 1900 for ranching, farming, grazing and the associated use of Philmont Scout operations. As recently as 2002 the Ponil Complex Fire burned a significant amount of this watershed. The loss of ground cover caused by the fire, coupled with the steep rocky sandstone topography, has caused a significant increase in sediment contribution to the stream system. This sediment contribution is now decreasing due to the re-vegetation occurring on the burn area. The fire and associated ground cover loss created an accelerated, higher than normal, watershed discharge. The increased discharge caused further down cutting and bank erosion on an already fragile, legacy affected stream channel and watershed system.

Grazing: The Barker Reach is not grazed by livestock. The effect of long term livestock exclosure from this area can be seen in the robust riparian vegetation and well vegetated uplands with little bare ground and a diverse species of native grasses. Down stream of the Barker Reach on the Philmont Scout Ranch there has been some livestock grazing. This area is in fair condition, but does not have the amount of stream side vegetation as does the Barker Reach.

Roads: The current access road in the Middle Ponil valley follows the stream on one side or the other. The road is poorly drained, if at all. Long segments are hydraulically connected causing road surface erosion and generally causing gully erosion at the point where the water finally exits the roadway. There are some road drainage locations that the road runoff and sediment is discharged directly into the stream channel with no buffer area. The blading operation has created a continuous berm on the down slope side of the road that keeps the water trapped on the roadway causing road surface erosion, high sediment discharge and the continued need for costly, repeated road maintance.

Scouting: The main effect of the Scouting operation observed by the team was certain areas at the streams edge where there is heavy concentration of Scout usage, predominantly in the area of the Ponil Camp. These areas have been impacted to the point that the ground is bare and the streambanks destabilized due to trailing. These areas have a direct contribution of sediment into the stream channel.

Ponil Scout Camp Horse and Burro Corral: The equine corral at the Ponil Scout Camp encompasses +/- five acres. The corral straddles the Middle Ponil at this location. As in any livestock confinement area, there is no or very little vegetation. The corral area is bare ground and the riparian vegetation along the stream channel has been eliminated due to the heavy concentration of livestock. The stream banks are bare and void of vegetation. This area is +/- five acres of bare ground within the stream channel corridor and is a significant contributor of sediment and livestock waste directly into the Middle Ponil stream system.

Conclusion of the Historical and Current Effects on the Middle Ponil:
The Middle Ponil watershed has been significantly negatively impacted by historical and current land management practices. Based on the BEHI, NBS and BER data collected by the assessment team and quantified by Rick Smith, the 5.5 mile assessment reach of the Middle Ponil has a sediment contribution load of 7,068 tons per year from unstable stream banks. This calculation does not add in the other sediment contributions created by the effects of fire, roads, grazing, livestock corrals, and other human activities. Given the results of the stream bank erosion data, coupled with the historic and present land management practices, the overall system would be rated on the average in moderately stable condition with a moderate upward trend line in some areas and a downward trend in other areas.

Stabilization and Restoration Opportunities:

Restoration Goal:

Reverse the current downward ecosystem trend to an upward trend. Once the trend is reversed, natural recovery processes can and will take hold and propel the trend further upward toward watershed system stability. It is our collective responsibility to set in place the mechanisms and management practices that will trigger this trend reversal.

Restoration Practitioner's Guiding Principal: Do the easiest first!!!
At first glance, this may sound too simplistic. However, when we look at watershed function and trend analysis, generally there are a couple of actions that can be taken that are easy and cost effective and will create immediate results that will help start the reversal of downward trends.

So using the "do the easiest first" rule, we will lay out the priorities for restoration on the Middle Ponil.

Restoration Priority #1, Equine Corral:
The proximity of this facility to the stream channel and its obvious effects on sediment contribution and riparian vegetation make it an easy fix. The restoration plan would include a new corral fence to keep livestock out of the riparian/stream channel area as well as constructing an earthen berm along stream left to contain the corral run off. This area has a sand and gravel substraight with a high infiltration factor, so ponding of water in the corral should not be an issue. The stream channel riparian area would be replanted with willows, alders, cottonwoods and native grasses by a Scout Crew. There are also opportunities to stabilize this reach of stream channel by installing One Rock Dams and possibly an opportunity to do some Induced Meandering work.

Cost: Earthen Berm, $1,500.00. Fencing: $3,000.00. Re-vegetation, $00.00: Scout Crew. Return on Investment: Clean water, reduction of sediment and livestock waste, a restored reach of riparian vegetation, a learning opportunity for Scouts and a good land management practices demonstrated by the land owner as well as a good restoration demonstration site in the midst of the Ponil Scout Camp.

Restoration Priority #2, Road Drainage:
Install a road drainage system first along the Middle Ponil stream corridor. Install a properly designed and properly constructed Rolling Dip Road Surface Cross Drain System. Cost: Design and Implementation, $20,000.00 (from Ponil Camp to the western boundary of the Barker WMA). Return on this investment is a reduction of erosion and sediment contribution to the stream system and increased forage due to road water harvesting. Stitch the micro watershed back together for proper surface hydrological function which has been interrupted by the road. Place the road drainage in the appropriate locations to achieve this goal. Proper drainage will create significant reduction of road surface erosion which in turn reduces the need for costly repeated road maintance and reduces vehicle maintance cost due to better road conditions. This is the same for the uplands/mountain road system at a cost of +/- $4,100.00 per mile for design and implementation. The greatest return on investment is the reduction in the need for annual road maintenance. By properly draining a low standard dirt road the need and cost of maintenance can be reduced by 90%, which is a significant cost savings.

Some road drainage work as been installed in this area; however, it is somewhat anemic and will need to be better designed and re-worked. The stream channel crossings have been stabilized except for one crossing in the Ponil Scout Camp on the South Ponil Road. This crossing will need a boulder sill on the downstream end and a cobble fill crossing installed.

Cost of South Ponil Road crossing: $5,000.00

Restoration Priority #3, Middle Ponil Stream Channel Stabilization:

The assessment team along with others in this field have developed a restoration system know as “Cut and Paste”. The system has been tested at numerous locations in a variety of channel types and situations. As previously stated in this report, this system suffers from sediment overload which is created by a compilation of the previously stated history and situations. The sediment overload creates over wide and high, steeply sloped point bars, overlong meander bends with tight radiuses, which increase the NBS and causes erosion of the opposite bank. This system sets up an insidious chain reaction by the acceleration of the stream bank erosion. As more sediment enters the system it is then deposited on the next point bar and the process is repeated over and over again along the entire stream system. The other consequence of this type of bank erosion process is the creation of downstream meander scrolling caused by the overlong meander bends and sharp radiuses. This meander down scrolling can lead to a meander cutoff which straighten the channel, steepen the slope and create a head cut that migrates upstream. There are numerous locations on the Middle Ponil that have a high potential for a meander cutoff to occur. The assessment team noted these locations and gave them the highest priority for the restoration work.

To stop this downward trend, the source of sediment must be controlled, i.e., grazing and roads first, then stream bank erosion. If the work does not proceed in this order, then the in-stream work is at risk because of the additional sediment coming off poorly managed rangelands and roads still in the system.

The Cut and Paste system reconfigures the channel morphology at each problem location. The material and vegetation on the enlarged point bars or overlong meanders are removed and placed at the toe of the opposite eroding bank. While doing the cut and paste of these materials, a vegetated bankfull bench is created at the toe of the eroding bank. The pool depth is reduced and the radius of curvature is reduced as the material is removed from the point bar or overlong meander. These geomorphologic modifications change the ratios of the near-bank max depth to the bankfull mean depth, the ratio of radius of curvature to bankfull width as well as changing the width to depth ratio thus reducing the NBS and the stream’s power to erode the opposite bank.

The Cut and Paste system uses a small excavator, +/- 20,000 pound, 100hp, and a skilled fluvial geomorphicly trained operator to conduct this work. This is a very cost effective system. Most locations can be worked in 30 to 45 minutes and there is no need for inhauled material such as rocks or logs and the associated cost of the installation of vane structures. If trees that can be harvested are readily available on site, a "Toe Wood" system can be added to the cut a paste system. Toe Wood is especially useful to fill in deep pools and can create very beneficial fish habitat. The application of Toe Wood in the Barker Reach is very feasible and cost effective due to the number of dead fire trees and other live trees that could be used for this application.

The value of the investment in bank erosion control is first seen in the reduction of sediment for improved water quality. Other benefits are; arresting the potential of meander cutoffs, improved fisheries habit, especially when the work includes a Toe Wood system as well as the increase in wetland due to ox pond being created when an overlong meander is reconfigured. The skill and art of this work is to maximize the ecological benefits in the process of achieving the main goal, i.e., bank stabilization and sediment contribution control.

Cost: +/- $175.00 per location Cut and Paste only.
+/-$550.00 per location for Cut and Paste with a Toe Wood system.
Average cost for budgeting proposes: +/- $375.00 per location each.

There is need for Cross Vane type grade control structures throughout the Middle Ponil assessment area. The assessment team recommends the use of logs for theses structures due to the abundant availability of timber and fire trees next to the stream channel. There are also opportunities to use logs to create bank full benches. Rocks and boulders would be used for these types of structures and /or in conjunction with logs if they are really available on site. The proposed use of local on site materials greatly reduces the cost of these structures compared to using inhauled materials. <u>The value of locally harvested materials hopefully could be used for a project match.</u>

Cost Log and Rock Bankfull benches; $250.00 each

Cost for grade control structures; $4,500.00 each

On the Middle Ponil just upstream from the confluence with Bonita Creek there is a 600 foot +/- reach of degraded stream channel that while require a Rosgen priority #1 channel relocation and grade control structures.

The cost for this channel relocation project would be +/- $40,000.00

<u>Other Stream Channel Restoration Practices:</u>
The assessment team notes numerous locations along the Middle Ponil that hand work could be conducted by Scout Crews. This hand work would include planting willows to stabilize banks, construction of rock or log bankfull benches, installing One Rock Dams, removing mid-channel and transverse bars. Other hand work would be the treatments on terrace headcuts and installation of Media Lunas to re-spread water over the existing alluvial fans.

Cost: $00.00, a good source of in-kind work.

Other Restoration Opportunities: Alluvial Fans:

The general valley type is a valley Type III, alluvial fans and debris cones with a high relief. Many of the alluvial fans have been truncated by the down cutting of the main channel as well as the main channel being pushed to one side of the valley to make room for farm fields. The fans now have very steep and high slopes at the edge of the stream channel with numerous headcuts. On top of many of the fans the distributory flow patterns have been concentrated into one channel and or bisected by a road. The distributory flow patterns should be reestablished on these fans so that the fan system can sequester as much sediment as possible before the water enters the stream channel. This can be done by re-routing the road to the head of the fan, draining and abandoning the old road and installing hand built rock or log Media Lunas constructed using Scout labor. There are also locations that could quickly be reconfigured using a dozer to re-route the flow path in conjunction with the road re-route.

Cost: Scouts Labor $00.00. Dozer cost low if done when dozer is in the area doing road work. +/- 800.00 per fan.

References:

Watershed Assessment Practices can be reviewed in:

Evaluating the Bank Erodibility Hazard Index In New Mexico, Wilbert Odem, Ph.D., P.E., 1999

Regional Relationships for Bankfull Stage in Natural Channels of the Arid Southwest, Tom Moody, PE, 2003

Watershed Assessment of River Stability and Sediment Supply (WARSSS), Second Addition, Dave Rosgen 2009

A Good Road Lies Easy on the Land…. Water Harvesting From Low-Standard Rural Roads Second Addition, Bill Zeedyk 2010

Appendix C. Moreno Valley Wetlands Action Plan

Moreno Valley Wetland Action Plan

Prepared by

Joanne Hilton, P.G.

in cooperation with

the Cimarron Watershed Alliance

and the

New Mexico Environment Department (NMED)

ACKNOWLEDGEMENTS

The Cimarron Watershed Alliance and the residents of Moreno Valley contributed valuable time and resources to prepare this document. In particular, Randa Celley, Rick Smith, Gus Holm, and Julia Davis Stafford assisted with planning meetings and with coordinating efforts for stakeholder outreach. Sara Holm of Vermejo Park Ranch provided Geographic Information System support and prepared figures for this report and Vermejo Park Ranch provided support for meetings. Karen Menetrey of the New Mexico Environment Department (NMED) Surface Water Quality Bureau (SWQB) provided numerous resources, including project coordination and photography, and Emile Sawyer of NMED helped with Geographic Information System (GIS) files. Mollie Walton of the Quivira Coalition provided presentations for the meetings along with information gained by practical experience from previous restoration efforts. Local landowners contributed practical information about the current status of wetlands as well as potential projects. Finally, New Mexico State Parks Division, New Mexico Forestry Division, and Trout Unlimited contributed valuable resources toward the development of this plan. In addition, representatives from various local governments attended meetings and provided valuable input. Together, these alliances, residents, employees, landowners, groups and individuals have provided essential information, and relevant material to compile this Wetland Action Plan for the Moreno Valley.

Funding for this project was provided by the US Environmental Protection Agency Region 6 through a Clean Water Action Section 104(b)(3) Wetlands Program Development Grant to NMED.

EXECUTIVE SUMMARY

The Moreno Valley is located in the Sangre de Cristo Mountains at the headwaters of the Cimarron River Watershed in western Colfax County, New Mexico. Numerous wetland resources have been identified along riparian corridors, slopes, and at other locations within the Moreno Valley.

The purpose of this Wetlands Action Plan (WAP) is to define strategies for protecting and restoring wetlands in the Moreno Valley and to supplement the Watershed Based Plan (WBP) for the Cimarron Watershed, which addressed water quality impairments in the Moreno Valley, including *Escherichia (E.coli)* bacteria, plant nutrients, temperature, sediment and turbidity. The protection and restoration of wetlands in the Moreno Valley will continue to support improved water quality conditions throughout the valley.

The Moreno Valley is a high altitude valley with a semi-arid climate. This valley includes three perennial drainages, all flowing into Eagle Nest Lake, a major supply reservoir for northeastern New Mexico. Shallow groundwater also generally flows toward Eagle Nest Lake. The Moreno Valley contains mountain grasslands in lower elevations, and forests of both conifer and aspen at higher elevations. The principal fish species, as recognized and supported by the New Mexico Department of Game and Fish, are Kokanee Salmon, Rainbow Trout, Northern Pike, and Yellow Perch. Landownership includes a mix of public (Eagle Nest State Park and a small amount of National Forest) and private. Much of the private development is related to recreational resources in the valley.

The mapping of wetlands in the Moreno Valley was recently completed as part of a larger mapping effort in northeast New Mexico by Saint Mary's University of Minnesota and the New Mexico Environment Department Surface Water Quality Bureau (NMED SWQB). Wetlands for the project area were mapped and classified using on-screen digitizing methods established in the GIS. Aerial imagery, combined with soils, topographic, hydrologic, and land cover data sets, was used as a base map. This mapping is consistent with the National Wetland Inventory (NWI), which classifies wetlands by system, and was correlated to the Hydrogeomorphic (HGM) system that is used by the SWQB. The HGM classification system is based on geomorphic settings and includes five classes of wetlands in the Moreno Valley: riverine, lacustrine fringe, depressional, slope and palustrine fringe. The majority of mapped wetlands in the Moreno Valley consist of slope wetlands.

A key objective of the WAP is to identify potential impairments to wetlands and to identify protection and restoration measures. Key potential impairments to wetlands in the Moreno Valley include:

- ***Roads.*** Numerous unpaved roads throughout the Moreno Valley traverse the slope wetlands, causing fragmentation and dewatering of the wetlands due to the interruption of subsurface flow.

- ***Grazing***. Large Elk herds and other wildlife may impact wetlands by disturbing soil and overgrazing in riparian areas. Wetlands may also be affected by livestock grazing.

- ***Diversion ditches***. Ditches that move water away from the head of slope wetlands to water other areas can cause drying of the wetlands downgradient.

- ***Earthen stock tanks***. Tanks excavated into slope wetlands capture and impound the water. Although some of the water infiltrates the earthen dam, the water downstream is reduced, resulting in drying of the wetland.

Other potential impairment may result from historic mining and timber activities, poorly planned development, domestic wastewater, and disruption of beaver habitat. Poorly designed roads or drainage, poorly managed grazing, poorly placed diversion ditches and/or earthen stock tanks, wildfires, other upland land disturbances, or any combination of these impairments can lead to headcuts, channelized flow (disconnection from the floodplain), and sediment loading. Potential protection and restoration measures include:

- Poorly designed roads may be restored through realignment, porous fill for road crossing, proper drainage, and other methods.

- Grazing exclosures may be used to prevent access to important areas for protection. Livestock best management practices, such as rotation and alternate water sources, can be used by ranches in the area to minimize impacts to wetlands.

- In some cases there may be historic diversion ditches and stock tanks that are no longer needed and can be de-commissioned in order to restore slope wetlands.

- Development planning can help to avoid future impairment of wetlands.

- Restoration measures for degraded streams may include in-channel measures, such as post vanes, baffles, one rock dams, media lunas, willow planting or other measures that will improve bank stability, slow and redistribute flows, and reconnect channels with floodplains to prevent erosion and sedimentation in wetland areas.

- Fuel reduction by private landowners and local governments can help reduce the risk of catastrophic wildfires, which could cause additional water quality impairment, particularly turbidity, sedimentation, and temperature. Fuel reduction projects are protective of long-term water quality and wetland resources in the Moreno Valley.

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List of Acronyms

Acronym	Full Name
AIH	Aquatic Invertebrate Habitat
AMO	Atlantic Multidecadal Oscillation
BISON-M	Biota Information System of New Mexico
BSS	Bank and Shoreline Stabilization
CCW	Comanche Creek Watershed
CCWG	Comanche Creek Working Group
CE	Categorical Exclusion
CS	Carbon Sequestration
CWA	Cimarron Watershed Alliance
DWS	Domestic Water Supply
E.coli	*Escherichia coli*
ECOS	Environmental Conservation Online System
EQIP	Environmental Quality Incentive Program
FGDC	Federal Geospatial Data Committee
FH	Fish Habitat
GIS	Geographic Information System
GR	Groundwater Recharge
HGM	Hydrogeomorphic
HQCAL	High Quality Cold Water Aquatic Life
in/hr	Inches per hour
IPaC	Information for Planning and Conservation
IPCC	Intergovernmental Panel on Climate Change
Ksat	Saturated Hydraulic Conductivity
LLWW	Landscape position, Landform, Water flow path and Water body
MCAL	Marginal Cold Water Aquatic Life
NM	New Mexico
NMDGF	New Mexico Department of Game and Fish
NMDOT	New Mexico Department of Transportation
NMED	New Mexico Environment Department
NMHPD	New Mexico Historic Preservation Division
NMISC	New Mexico Interstate Stream Commission
NMOSE	New Mexico Office of the State Engineer

NMRPTC	New Mexico Rare Plant Technical Council
NMSU	New Mexico State University
NRCS	Natural Resources Conservation Service
NT	Nutrient Transformation
ONRW	Outstanding National Resource Waters
OWH	Other Wildlife Habitat
PDO	Pacific Decadal Index
SC	Secondary Contact
SM	Streamflow Maintenance
SR	Sediment and Other Particulate Retention
SWD	Surface Water Detention
SWQB	Surface Water Quality Bureau
TMDL	Total Maximum Daily Load
U.S.	United States
UNM	University of New Mexico
USACE	United States Army Corps of Engineers
USFS	U.S. Forest Service
USGCRP	U.S. Global Change Research Program
WAP	Wetland Action Plan
WBIRD	Water Bird Habitat
WBP	Watershed-Based Plan
WLA	Waste Load Allocation
WSS	Web Soil Survey
WUI	Wildland Urban Interface
WWAL	Warm Water Aquatic Life

1. Introduction

The Moreno Valley is located in the headwaters of the Cimarron River Watershed in western Colfax County, New Mexico (Figure 1-1) and bounded by the Sangre de Cristo Mountains to the north, west, and south. Eagle Nest Lake, a major water supply storage reservoir for eastern New Mexico, is on the east side of Moreno Valley. There are numerous wetland resources along riparian corridors, slopes, and at other locations within the Moreno Valley.

The purpose of this Wetlands Action Plan (WAP) is to define strategies for protecting and restoring wetlands in the Moreno Valley. This WAP is intended to supplement the Watershed Based Plan (WBP) for the Cimarron Watershed, which was completed in December of 2012. The Cimarron WBP defined strategies to address documented water quality impairments in the Cimarron Watershed and water quality impairment within the Moreno Valley, including sediment, turbidity, temperature, and *Escherichia coli* (*E.coli)* bacteria. The protection and restoration of wetlands in the Moreno Valley will continue to support improved water quality conditions throughout the valley.

The Cimarron Watershed Alliance (CWA), in conjunction with Joanne Hilton of Global Hydrologic Solutions, LLC contracted with the New Mexico Environment Department (NMED) to complete this WAP for the Moreno Valley (WBP, 2012). The CWA, a 501(c) (3) non-profit group, is focused on watershed health and addresses water quality issues in the Cimarron watershed. The CWA holds a monthly stakeholder meeting which is open to the general public.

This Moreno Valley WAP includes:

a) a general description of the watershed including climate, soils, geology and groundwater, surface water, water quality, vegetation, wildlife, and land use (Section 2);

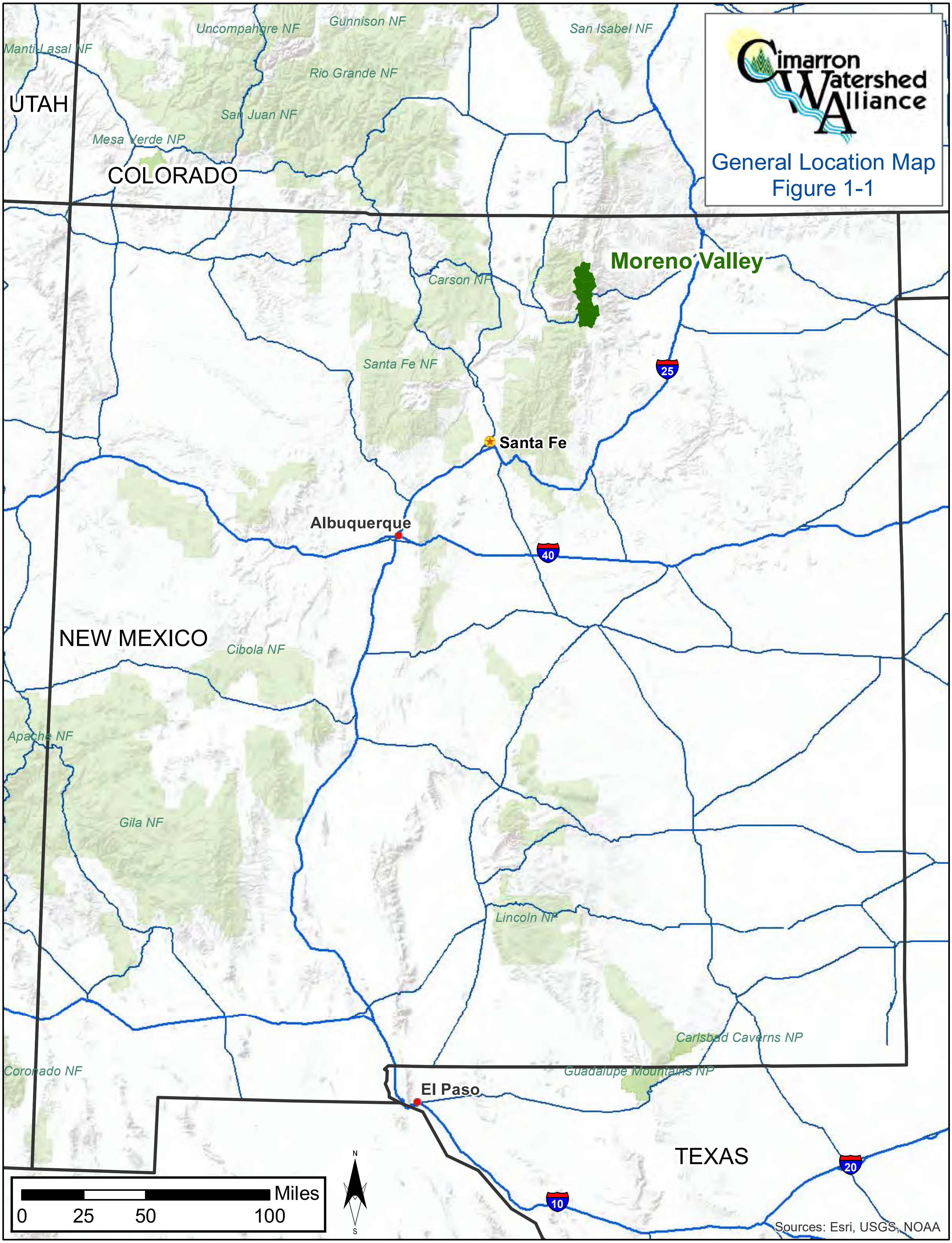
b) a resource analysis including an inventory of wetlands based on previously completed mapping (Section 3);

c) identification of threats and impairment to wetlands (Section 4); and

d) a recommended action plan that identifies measures to protect and restore wetlands (Section 4).

This plan has been developed in an open-public process in accordance with a public involvement strategy, as discussed in Section 5.

This WAP was developed based on currently available information. The development and refinement of the Moreno Valley WAP will continue to be an ongoing process.


Cimarron Watershed Alliance
General Location Map
Figure 1-1
Moreno Valley
UTAH
COLORADO
NEW MEXICO
TEXAS
Uncompahgre NF
Gunnison NF
San Isabel NF
Manti-Lasal NF
Rio Grande NF
San Juan NF
Mesa Verde NP
Carson NF
Santa Fe NF
Santa Fe
Albuquerque
Cibola NF
Apache NF
Gila NF
Lincoln NF
Carlsbad Caverns NP
Guadalupe Mountains NP
Coronado NF
El Paso
25
40
10
20
0 25 50 100 Miles
N
S
Sources: Esri, USGS, NOAA

2. Moreno Valley Watershed

The Moreno Valley elevation ranges from about 8,000 to over 10,000 feet above mean sea level at Eagle Nest Lake. The Moreno Valley includes 3 perennial drainages and riparian corridors:

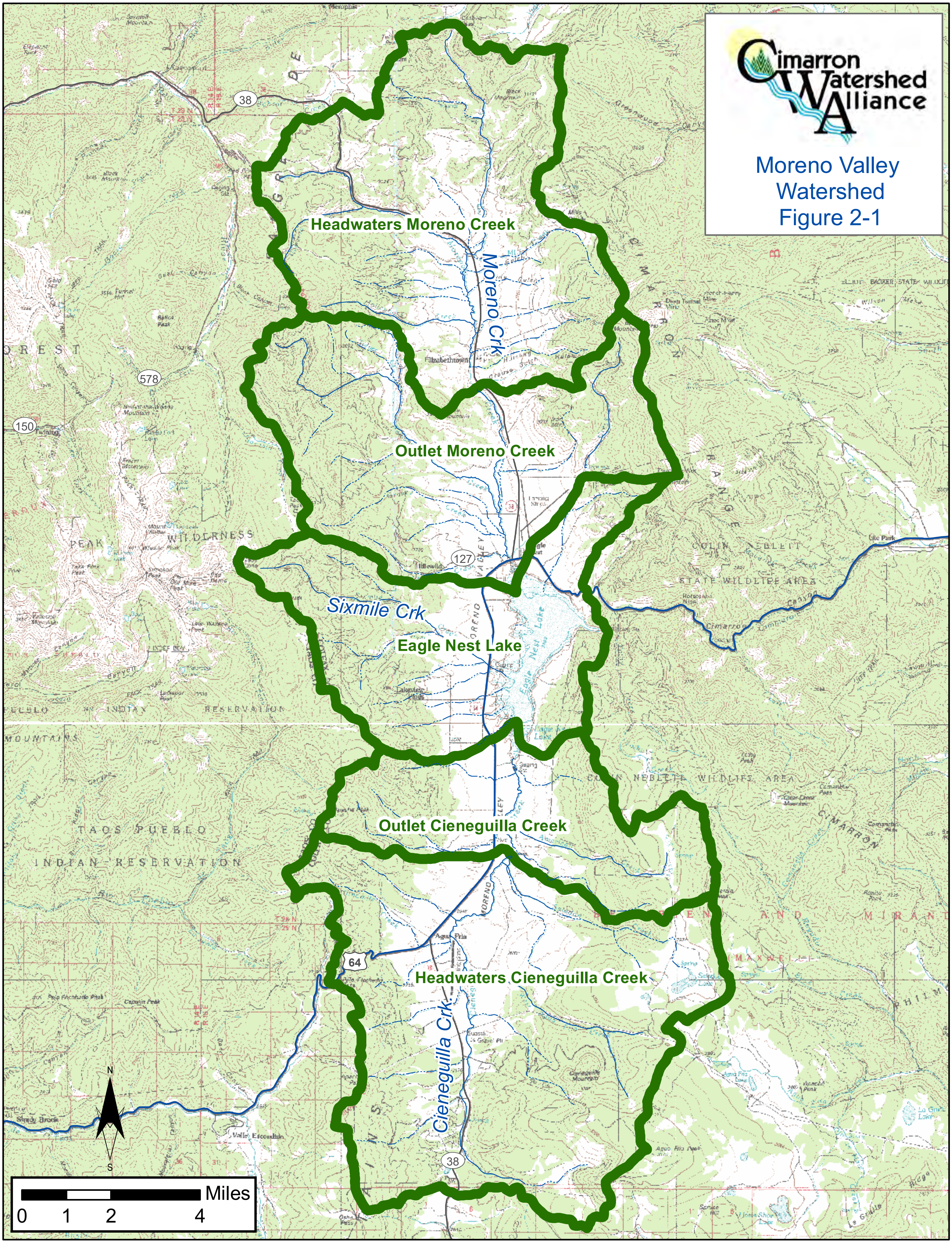
- Moreno Creek
- Sixmile Creek
- Cieneguilla Creek

These tributaries are all headwater drainages that flow into Eagle Nest Lake from the south, west, and north, respectively. The Moreno Valley watershed is divided into five sub-watersheds, from north to south: Moreno Creek Headwaters, Moreno Creek Outlet, Eagle Nest Lake, Cieneguilla Creek Outlet, and Cieneguilla Creek Headwaters (Figure 2-1). Eagle Nest Lake, one of the oldest reservoirs in New Mexico, is a key resource in the Moreno Valley.

2-1. Climate

The Moreno Valley climate is semi-arid. At the Eagle Nest Climate Station, the long-term average annual precipitation is about 15 inches per year, with annual precipitation varying from below 10 inches to more than 20 inches. Long-term average annual temperatures are about 40 degrees; and daily minimum and maximum temperatures average between 22 and 58 degrees, respectively, on an annual basis. This climate is characterized by extreme temperatures. The combination of the high elevation, along with the short growing season, creates agricultural challenges in the Moreno Valley.

The New Mexico climate is historically variable with cycles of drought along with short-term storm events; conditions that are influenced by natural cycles such as el Niño/la Niña, the Pacific Decadal Index (PDO) and the Atlantic Multidecadal Oscillation (AMO). Additionally, recent assessments indicate that the warming of climate systems is unequivocal, and that all current climate models project significant warming trends over continental areas in the 21st century (IPCC, 2013). In the United States, regional assessments conducted by the U.S. Global Change Research Program (USGCRP) have found that temperatures in the southwestern United States have increased and are predicted to continue to increase (USGCRP, 2009). Predictions of annual precipitation are subject to greater uncertainty.


Cimarron Watershed Alliance
Moreno Valley
Watershed
Figure 2-1
Headwaters Moreno Creek
Moreno Crk
Outlet Moreno Creek
Sixmile Crk
Eagle Nest Lake
Outlet Cieneguilla Creek
Headwaters Cieneguilla Creek
Cieneguilla Crk.
Miles
0 1 2 4

The effects of climate change that are likely to occur in the Moreno Valley and throughout New Mexico include (NMOSE/NMISC, 2006, USGCRP, 2009):

- Temperature is expected to continue to rise, resulting in increased evaporation and evapotranspiration.
- Precipitation is expected to be more concentrated and intense, so that increases in the frequency and severity of flooding are also projected.
- Streamflow is projected to decrease overall due to lower snowpack and higher evapotranspiration, and peak runoff will occur earlier and be diminished.
- During drought periods, forests are increasingly susceptible to insects, forest fires, and desiccation. Higher temperatures increase insect survivability as well as risk of fires.

Additional stresses on wetlands due to increasing temperatures, evaporation, and intense precipitation events magnify the importance of protecting and restoring wetland resources.

2-2. Soils

The Moreno Valley soils were first characterized during the initial watershed-based planning effort for the Cimarron Watershed (Huerta, 2012). The Natural Resources Conservation Service (NRCS) Web Soil Survey (WSS) (websoilsurvey.nrcs.usda.gov/) was used to define soil properties, elevations, landscape characteristics, and precipitation near the three perennial creeks. The following descriptions pertain to the soil structure of flood plain areas; however, this information does not reflect the soil structure for the entire course of these three perennial creeks (Huerta, 2012), (NRCS/WSS 2010):

- Cieneguilla Creek courses through an elevation of 8,000 to 10,500 feet. The Cieneguilla Creek bed is mainly composed of 65% gently sloping (1-5%) Frolic association, with 30% Cumulic Haplaquolls and similar soils. The creek area is moderately well-drained. The capacity of the most limiting layer to transmit water (Ksat) is moderately high to high (0.60 to 2.00 in/hr). This drainage system is subject to occasional flooding. The Cumulic Haplaquolls soils profile consists of 0 to 15 inches of very fine sandy loam, and 15 to 35 inches of loam; with 35 to 42 inches of fine sandy loam, and 42 to 60 inches of silt (NRCS/WSS 2010). Typically, the run-off in Cieneguilla Creek is loaded with fine soil particulates.

- The Moreno Creek bed is mainly composed of Morval and similar soils at 55%; with Moreno and similar soils at 35%; sloping at 1 to 5%. The capacity of the most limiting layer to transmit water (Ksat) is moderately high to high (0.60 to 2.00 in/hr). The depth to the water table is more than 80 inches. The Morval/Moreno soils profile is 0 to 57 inches of clay loam; with 57 to 60 inches of gravelly sandy clay loam; and 60 to 70 inches of stony clay loam (NRCS/WSS 2010).

- The Six Mile Creek bed is similar to that of Moreno Creek at 35%; with Moreno and similar soils; and 55% Morval soils, sloping at 1 to 5%. The capacity of the most limiting layer to transmit water (Ksat) is moderately high to high (0.60 to 2.00 in/hr). The Morval Moreno soil profile is 0 to 57 inches of clay loam; with 57 to 60 inches of gravelly sandy clay loam; and 60 to 70 inches of stony clay loam (NRCS/WSS 2010).

2-3. Geology and Groundwater

The Moreno Valley is a glacial valley. The surficial geology of the Moreno Valley consists primarily of alluvium in the lower elevations of the valley, and carbonates, sandstone, and metamorphic rocks at the higher elevations, with some mafic volcanic rocks outcropping east of Angel Fire (Hilton et. al, 2012, UNM 2010).

There are 4 types of water-bearing zones in the Moreno Valley (DBS&A, 2000):

- Unconsolidated Tertiary valley fill, composed of interbedded red and brown clays, sands and gravels;

- Tertiary dikes and sills, composed of fractured quartz porphyry;

- Mesozoic and Paleazoic sandstone and siltstone, including the Madera Group, Sangre de Cristo Formation, Triassic sequence, Entrada Sandstone, Morrison Formation, and the Dakota Sandstone;

- Precambrian crystalline rocks, mainly composed of faulted and fractured granite gneiss; however, these rocks only provide significant water resources where fracturing and faulting is sufficient to transmit flow.

The primary source of groundwater for the Moreno Valley is the Mesozoic and Paleozoic sandstone and siltstone water-bearing zone (Saye, 1990). The valley fill alluvium also supplies numerous domestic wells. Both the Village of Angel Fire and the Village of Eagle Nest receive their water supply from groundwater. The Sangre de Cristo Formation, a complex, interbedded mix of conglomerates, sandstones, siltstones, clay shales, and nodular limestones, provides the primary source of water for the Village of Angel Fire.

Groundwater levels in Moreno Valley wells are relatively shallow and the groundwater generally flows toward Eagle Nest Lake. From a legal and water rights standpoint, the groundwater in the Moreno Valley is considered to be stream-connected. According to the *Agreement for settlement of pending litigation and other disputes concerning State Engineer Permit 71*, groundwater users in the Moreno Valley must curtail pumping and account for conveyance losses in the same manner as surface water users during years when there is not a full water supply.

2-4. Surface Hydrology

The three drainages in the Moreno Valley include Cieneguilla Creek, Moreno Creek and Sixmile Creek. Sixmile creek has long-term gaging records, which indicate annual streamflow ranging from about 700 to 3400 acre-feet per year, with a median streamflow of about 1300 acre-feet per year (ISC, 2016). Moreno Creek is gaged, however, due to frequent periods of missing data, long-term annual statistics are not available. Cieneguilla Creek is not gaged.

The perennial surface drainages also show seasonal variability, with peak streamflow occurring between April and June during the snowmelt runoff season. In some years, between July and September, there may be a secondary peak due to monsoon runoff.

Eagle Nest Lake is impounded by a concrete dam which was completed in June of 1918. The purpose of the dam was to store irrigation water derived from the three perennial streams that feed the lake (WBP, 2012). The storage capacity of Eagle Nest Lake is about 98,000 acre-feet; and the elevation of Eagle Nest Lake is about 2,500 meters (8,200 ft.) above mean sea level, making Eagle Nest Reservoir the highest of the larger lakes in New Mexico.

2-5. Water Quality

The Cimarron Watershed Based Plan indicated that water quality impairment in the Moreno Valley includes *E.coli* bacteria, plant nutrients, temperature, sediment and turbidity as shown in Table 2-1.

Table 2-1. Causes of Stream Water Quality Impairment in the Moreno Valley

Location	2010 TMDL	Continued Impairment [(a)]	Not supporting[(b)]
Cieneguilla Creek (Eagle Nest Lake to headwaters)	E.coli, plant nutrients, temperature	turbidity, sediment/siltation	HQCAL, SC
Moreno Creek (Eagle Nest Lake to headwaters)	plant nutrients, temperature		HQCAL
Sixmile Creek (Eagle Nest Lake to headwaters)	E.coli, plant nutrients, temperature	turbidity	HQCAL, SC

a) Impairment is based on earlier assessment, listed as continued impairment in 2010 Total Maximum Daily Load (TMDL) document

b) As identified in NMED 2010b. DWS=Domestic Water Supply; HQCAL= High Quality Cold Water Aquatic Life, MCAL = Marginal Cold Water Aquatic Life; WWAL = Warm water aquatic life; SC = Secondary Contact

The WBP reported information from a source tracking study conducted by the CWA to understand the source and distribution of the *E. coli* bacteria. This study indicated that wildlife, specifically waterfowl, has been the dominant contributor to the presence of this bacteria (NMSU, 2010). Using standard methodology, samples were collected from Cieneguilla and Moreno Creeks over a two-year period near the points where they drain into Eagle Nest Lake. Results of the bacterial source tracking study indicated seasonal variability, with *E.coli* concentrations highest in the summer, intermediate in the fall, and lowest in the spring. Levels of stream-water turbidity followed the same seasonal trends as *E. coli* occurrence in Cieneguilla Creek, but not in Moreno Creek. These results indicate that differing runoff and/or land use patterns impact these two creeks.

As shown in Table 2-1, sedimentation/turbidity and temperature are also causes of water quality impairment in the Moreno Valley. The protection and restoration of wetlands can help to improve water quality caused by these impairments. Wetlands retain water in the subsurface, releasing cooler water to streams. Wetlands vegetation such as sedges, rushes and willows can also reduce stream temperature by shading a stream. Sediment and turbidity impairments can be mitigated when sediment is trapped and filtered in wetlands instead of being washed into a stream.

The CWA has participated in a project to restore bank stability along Cieneguilla Creek to improve water quality. Post vanes were installed to deflect water from cut banks. Wildlife exclosures have also been established to allow for revegetation in a section of the creek that is upstream from Eagle Nest Lake (WBP, 2012). These types of projects, intended to protect water quality, can also benefit the wetlands. Section 4 includes additional discussions of potential projects.

Eagle Nest Lake was purchased by the State of New Mexico, Department of Game and Fish, in 2002 and is now managed by the New Mexico State Parks Division. Studies of water quality in Eagle Nest Lake were conducted by NMED (2005), as reported in the Cimarron WBP (December 2012). These studies indicated some issues with dissolved oxygen and arsenic, and recommended follow-up sampling.

Eagle Nest Lake is listed as not supporting categories of use either for the domestic water supply or for the high-quality cold water aquatic life categories. However, Eagle Nest Lake is fully supportive of other categories of use including irrigation, livestock watering, wildlife habitat, municipal and industrial water supply, and secondary contact (NMED, 2010b). Further assessments for arsenic and dissolved oxygen are scheduled for the year of 2017.

2-6. Vegetation and Wildlife

The Moreno Valley contains mountain grasslands in the lower elevations, and forests of both conifer and aspen at the higher elevations. None of the floral species in the Moreno Valley are officially threatened or endangered. Five rare plants have been documented in Colfax County (NMRPTC, 2016). The high elevations support rare ecosystems, such as alpine tundra as well as rare species, such as bristlecone pine.

Among various species that utilize resources in the Moreno Valley, the State of New Mexico and the U.S. Fish and Wildlife Service have designated the following 20 species as threatened or endangered: 12 species of birds, 4 species of mammals, 2 species of fish, and 2 species of mollusks (IPaC, 2016) (Table 2-2). Within Colfax County, six species of animals have been listed as federally threatened or endangered, while the State of New Mexico has identified an additional three species as endangered, and 11 species as threatened (BISON-M, 2016). The species listed are for all of Colfax County, and the Moreno Valley has not been specifically differentiated. In addition to these species of concern, at least 27 species of migratory birds visit the Moreno Valley seasonally (IPaC, 2016), and approximately 758 species of animals have been recorded in Colfax County. Among the most diverse groups are birds (266 species), moths and butterflies (166), and mammals (83), followed by grasshoppers (73), mollusks (33), and fish (31) (BISON-M, 2016).

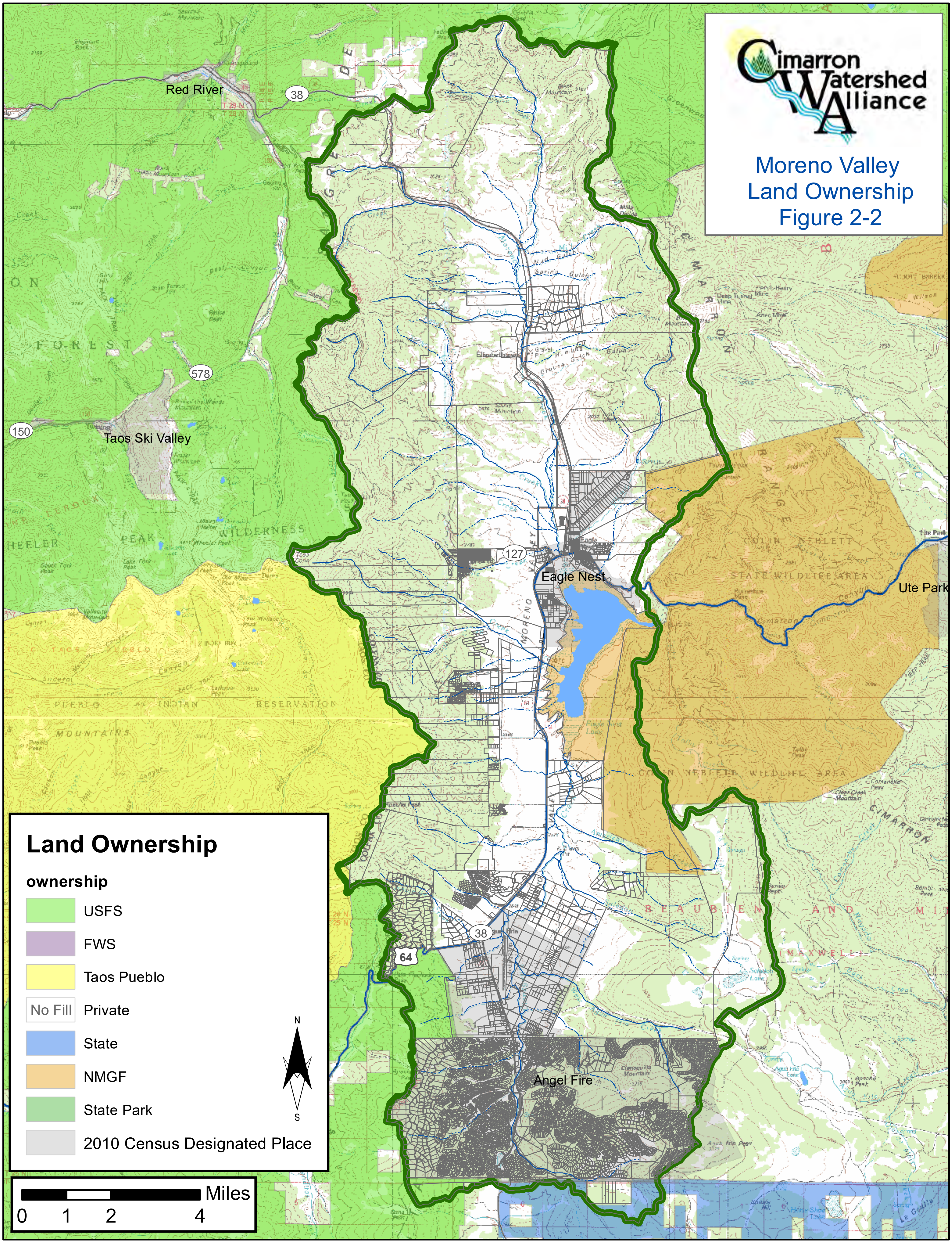
The principal fish species, as recognized and supported by the New Mexico Department of Game and Fish, are Kokanee Salmon, Rainbow Trout, Northern Pike, and Yellow Perch (NMDGF, 2016).

Table 2-2. Threatened and Endangered Species in Colfax County, NM

Threatened and Endangered Species in Colfax County, NM			
	Common Name	**Scientific Name**	**Status**
Mammals	Canada Lynx	Lynx canadensis	**Federal: Threatened**
	Black-footed Ferret	Mustela nigripes	**Federal: Endangered**
	American Marten	Martes americana	State NM: Threatened
	Meadow Jumping Mouse	Zapus hudsonius luteus	**Federal: Endangered** State NM: Endangered
Birds	White-tailed Ptarmigan	Lagopus leucura	State NM: Endangered
	Brown Pelican	Pelecanus occidentalis	State NM: Endangered
	Common Black Hawk	Buteogallus anthracinus	State NM: Threatened
	Bald Eagle	Haliaeetus leucocephalus	State NM: Threatened
	Peregrine Falcon	Falco peregrinus	State NM: Threatened
	Arctic Peregrine Falcon	Falco peregrinus tundrius	State NM: Threatened
	Piping Plover	Charadrius melodus	**Federal: Threatened** State NM: Threatened
	Neotropic Cormorant	Phalacrocorax brasilianus	State NM: Threatened
	Boreal Owl	Aegolius funereus	State NM: Threatened
	Mexican Spotted Owl	Strix occidentalis lucida	**Federal: Threatened**
	Southwestern Willow Flycatcher	Empidonax traillii extimus	**Federal: Endangered** State NM: Endangered
	Baird's Sparrow	Ammodramus bairdii	State NM: Threatened
Fish	Southern Redbelly Dace	Phoxinus erythrogaster	State NM: Endangered
	Suckermouth Minnow	Phenacobius mirabilis	State NM: Threatened
Mollusks	Star Gyro	Gyraulus crista	State NM: Threatened
	Lake Fingernailclam	Musculium lacustre	State NM: Threatened
Federal Threatened and Endangered Species found in the Moreno Valley, NM*			
Sources:			
BISON-M: Biota Information System of New Mexico, NM Department of Game and Fish (bison-m.org)			
ECOS: Environmental Conservation Online System, U.S. FWS (ecos.fws.gov)			
*IPaC: Information for Planning and Conservation, U.S. FWS (ecos.fws.gov/ipac)			

2-7. Land Use and Ownership

Historic land use in the Moreno Valley has included mining, ranching, and some farming. Land ownership in the Moreno Valley is a combination of public and private (Figure 2-2, Land Ownership in the Moreno Valley). Both the Taos Pueblo and Sandia Pueblo own and manage land in the Moreno Valley. A small amount of land belonging to Carson National Forest is located west of Angel Fire. New Mexico State Parks manage the Eagle Nest State Lake State Park. Originally, the land in the area of Angel Fire was part of the Maxwell Land Grant which was formed in 1844. This land grant was divided and changed hands several times; then, in 1966, several thousand acres were obtained by the Monte Verde Corporation, which began developing the ski resort and golf course. These recreational facilities, along with visitors to the State Park, have contributed to an influx of visitors and residents into the Moreno Valley. Numerous roads in the valley, associated with development, have also affected drainage patterns.



Cimarron Watershed Alliance
Moreno Valley
Land Ownership
Figure 2-2
Red River
38
578
150
Taos Ski Valley
127
Eagle Nest
Ute Park
38
64
Angel Fire
Land Ownership
ownership
USFS
FWS
Taos Pueblo
No Fill
Private
State
NMGF
State Park
2010 Census Designated Place
N
S
Miles
0
1
2
4

3. Wetland Inventory

To develop plans that protect and restore Moreno Valley wetlands, an inventory of existing wetland resources is essential. This WAP is being developed based on the most recent mapping and classification of these wetlands, as described in Section 3.1.

Under the Clean Water Act, wetlands are defined, for regulatory purposes, as "areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions" (EPA, 2016).

Wetlands exhibit one or more of the following characteristics (1) at least periodically, the land predominantly supports hydrophytes (plants dependent on saturated soils or a water medium); (2) the substrate predominantly consists of undrained hydric soil; and (3) at some period during the growing season of each year, the substrate is non-soil and either saturated with water or covered by shallow water.

--American Creek with woody riparian vegetation

This WAP also considered riparian areas as well as buffer zones. Riparian ecosystems are characterized by the presence of both phreatophytic and mesophytic vegetation and by habitats that are associated with bodies of water. These ecosystems are also dependent on the existence of surface and subsurface drainage, either perennial, intermittent, or ephemeral. Although water requirements in the wetlands areas are strict, they are not as drastic in riparian ecosystems as in other areas.

To protect wetlands and riparian areas from the impacts of stormwater, pollutants, or other impacts from adjacent land, it is essential to establish buffer zones as areas where natural vegetation is maintained. There are only a few areas with abundant woody riparian vegetation in the Moreno Valley.

--Woody riparian vegetation along Moreno Creek

3-1. Wetland Mapping and Classification

The mapping of wetlands in the Moreno Valley was recently completed as part of a larger mapping effort in Northeast New Mexico. Though many wetlands programs rely on the National Wetland Inventory, previous wetland mapping in northeastern New Mexico was sparse and dated. Hence the NMED, in 2011, identified the need to conduct additional current Geographic Information System (GIS) based mapping, and contracted with Saint Mary's University of Minnesota to complete the effort. A report titled "Mapping and Classification for Wetlands Protection, Northeastern New Mexico Highlands and Plains" was completed in 2015 (Robertson et al., 2015).

Wetlands for the project area were mapped and classified using on-screen digitizing methods established in the GIS. Aerial imagery, combined with soils, topographic, hydrologic, and land cover data sets, was used as a base map (Robertson et al., 2015). The mapping performed by Saint Mary's University is consistent with the Wetlands and Deepwater Habitats Classification used for the National Wetland Inventory (NWI), which classifies wetlands by system.

Three systems are present in the New Mexico mapping area:

- The Riverine System includes deepwater habitats and mostly non-vegetated wetlands that are contained in natural or artificial channels. Either periodically or continuously, these channels contain flowing water that forms a connecting link between two bodies of standing water. Examples of the riverine systems include rivers, streams, creeks, arroyos, washes, or ditches.

- The Lacustrine System includes both wetlands and deepwater habitats. This system is defined by all the following characteristics: deep water that is situated in a topographic depression or in a dammed river channel; wetland areas lacking trees, shrubs, or persistent emergents; wetland areas consisting of emergent mosses or lichens with greater than 30 percent aerial coverage; wetland areas that exceed 20 acres; or wetland areas that total less than 8 hectares and, at low water, are deeper than 6.6 meters. Examples of these wetlands include lakes, reservoirs, or intermittent lakes, such as playa lakes.

- The Palustrine System includes all nontidal wetlands that are dominated by trees, shrubs, emergents, mosses or lichens, and by all wetlands that occur in tidal areas where salinity due to ocean-derived salt is below 0.5 ppt. An estimated 95 percent of all wetlands in the U.S. are freshwater, palustrine wetlands. As a result, these wetlands will predominate in most wetland mapping efforts. No Subsystems exist in the (P) Palustrine System. Examples of Palustrine wetlands found in the New Mexico project area include marshes, swamps, shoreline fringe, bogs, fens, or ponds.

After the Systems are classified, NWI describes wetland characteristics in a hierarchal order including:

- Subsystem (with the exception of the Palustrine System)
- Class
- Subclass (only required for Forested, Scrub-Shrub, and Emergent Classes)
- Water Regime
- Special Modifiers (only required where applicable).

Detailed mapping for each of these NWI classifications is available (Robertson et al., 2015).

In addition to the NWI system, other systems of wetlands classifications are commonly used to distinguish various types and characteristics between wetland resources. The SWQB Wetlands Program uses Brinson's Hydrogeomorphic (HGM) wetland classification (Brinson, 1993) for the Wetlands Action Plan process. Saint Mary's University correlated their more detailed classification system with the HGM system. The HGM classification system, based on geomorphic settings, water sources, and hydrodynamics, results in 6 wetlands classifications based on these 3 essential functions (NMED, 2016). Five of these systems are present in the Moreno Valley:

Riverine wetlands occur in floodplains and riparian corridors in association with stream channels. Dominant water sources consist of either overbank flow from the channel or from subsurface hydraulic connections between the stream channel and the wetlands. Additional water sources may consist of interflow and return flow from adjacent uplands; the occasional overland flow from adjacent uplands; from tributary inflow; and from precipitation.

--Riverine wetlands limited to narrow bands where creek is not incised

Lacustrine fringe wetlands are adjacent to lakes where the water elevation of the lake maintains the water table in the wetland. Both precipitation and groundwater discharge provide additional sources of water. Surface water flow is bidirectional and is usually controlled by water level fluctuations in the adjoining lake. Lacustrine wetlands lose water by water flow that returns to the lake after flooding, by the saturation of surface water flow, and by evapotranspiration.

--Lacustrine fringe wetland shown at right where Cieneguilla Creek enters Eagle Nest Lake

Depressional wetlands occur in topographic depressions with a closed elevation contour that allows surface water to accumulate. Precipitation, groundwater discharge, and interflow from adjacent uplands are the dominant sources of water for these wetlands. Since water normally flows from the surrounding uplands toward the center of the depression, the depressional wetlands may consist of any combination of inlets and outlets, or may lack them completely.

--Depressional wetland (pond)

Depressional wetlands may also lose water through intermittent or perennial drainage from an outlet or through evapotranspiration. If they are not receiving groundwater discharge, these wetlands may slowly contribute to the accumulation of groundwater and will often vary with the seasons. Prairie potholes are a common example of depressional wetlands. Playas are also considered to be depressional wetlands.

Slope wetlands are normally found where there is a discharge of groundwater to the surface of the land. Elevation gradients may range from steep hillsides to gentle slopes. Principal water sources are usually from the return flow of groundwater, interflow from surrounding uplands, and precipitation. If groundwater discharge is a dominant water source, slope wetlands can occur in nearly flat landscapes.

--Slope wetlands upstream of pond

--Slope wetlands with headcut

Slope wetlands lose water primarily by saturation of the subsurface, through surface flows, and by evaporation. Springs are an example of slope wetlands in New Mexico. Slope wetlands are the most prevalent wetlands in the Moreno Valley.

--Slope wetlands west of Eagle Nest Lake

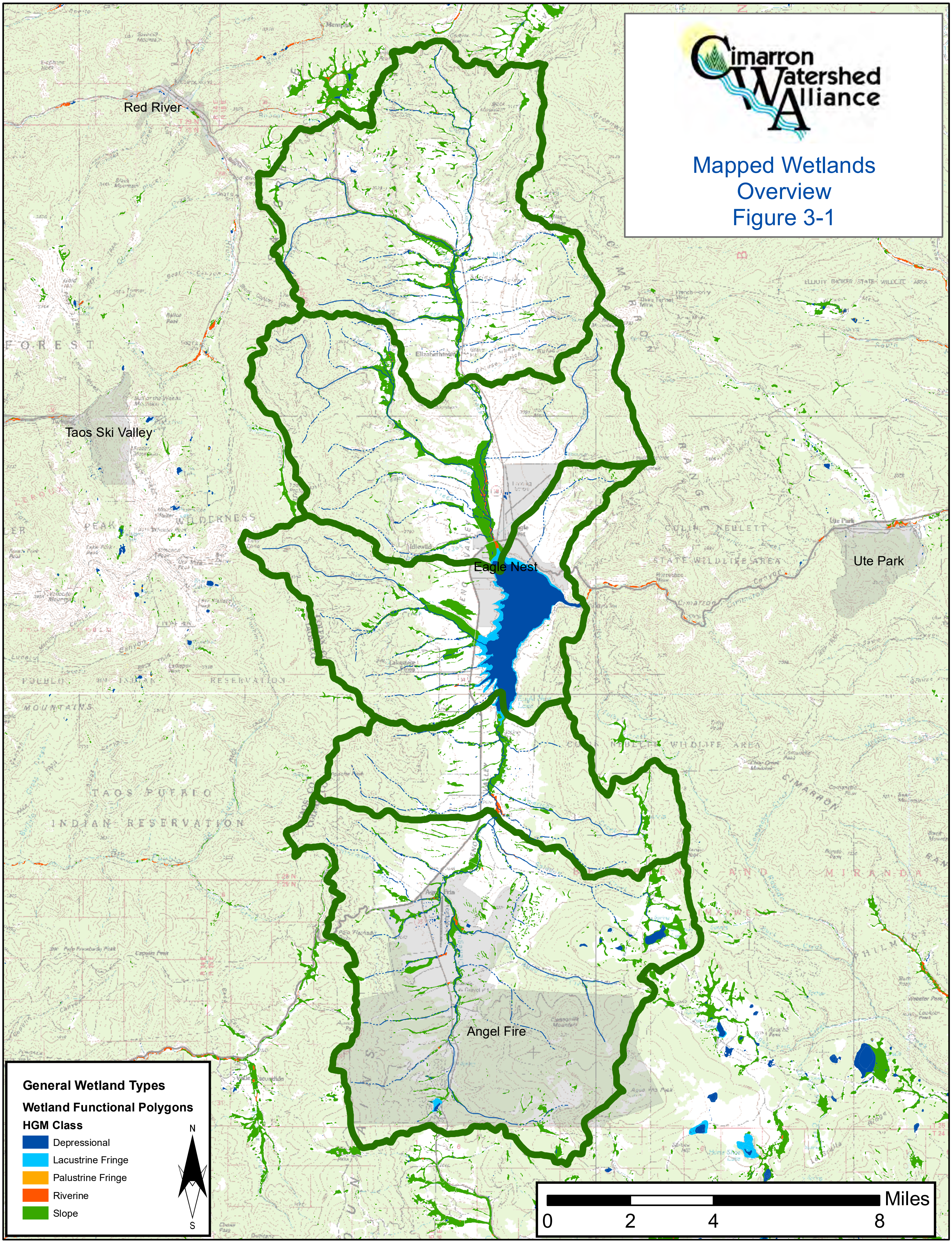
--Slope wetlands along a tributary to Moreno Creek

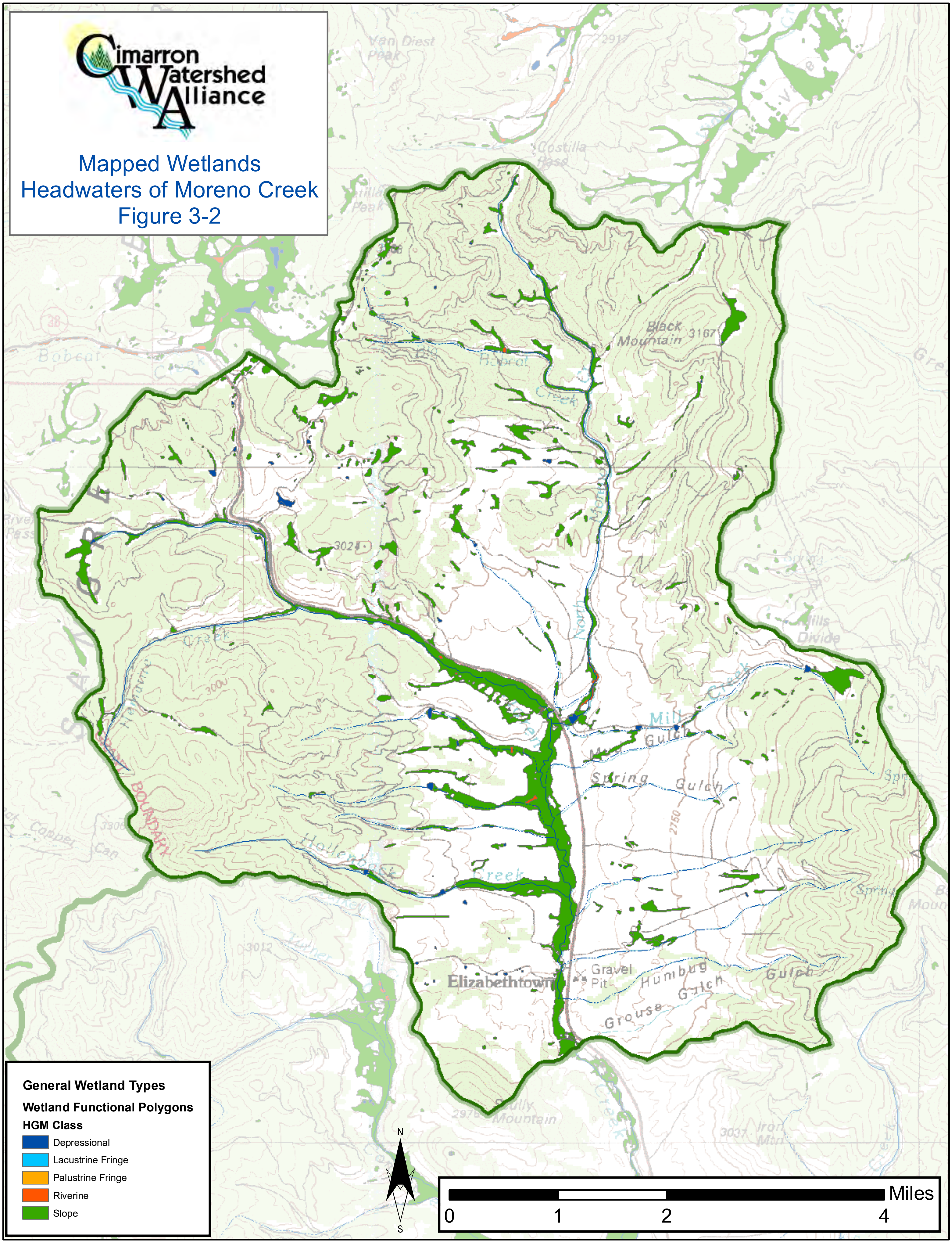
Palustrine fringe wetlands are adjacent to ponds where the water elevation of the pond maintains the water table in the wetland.

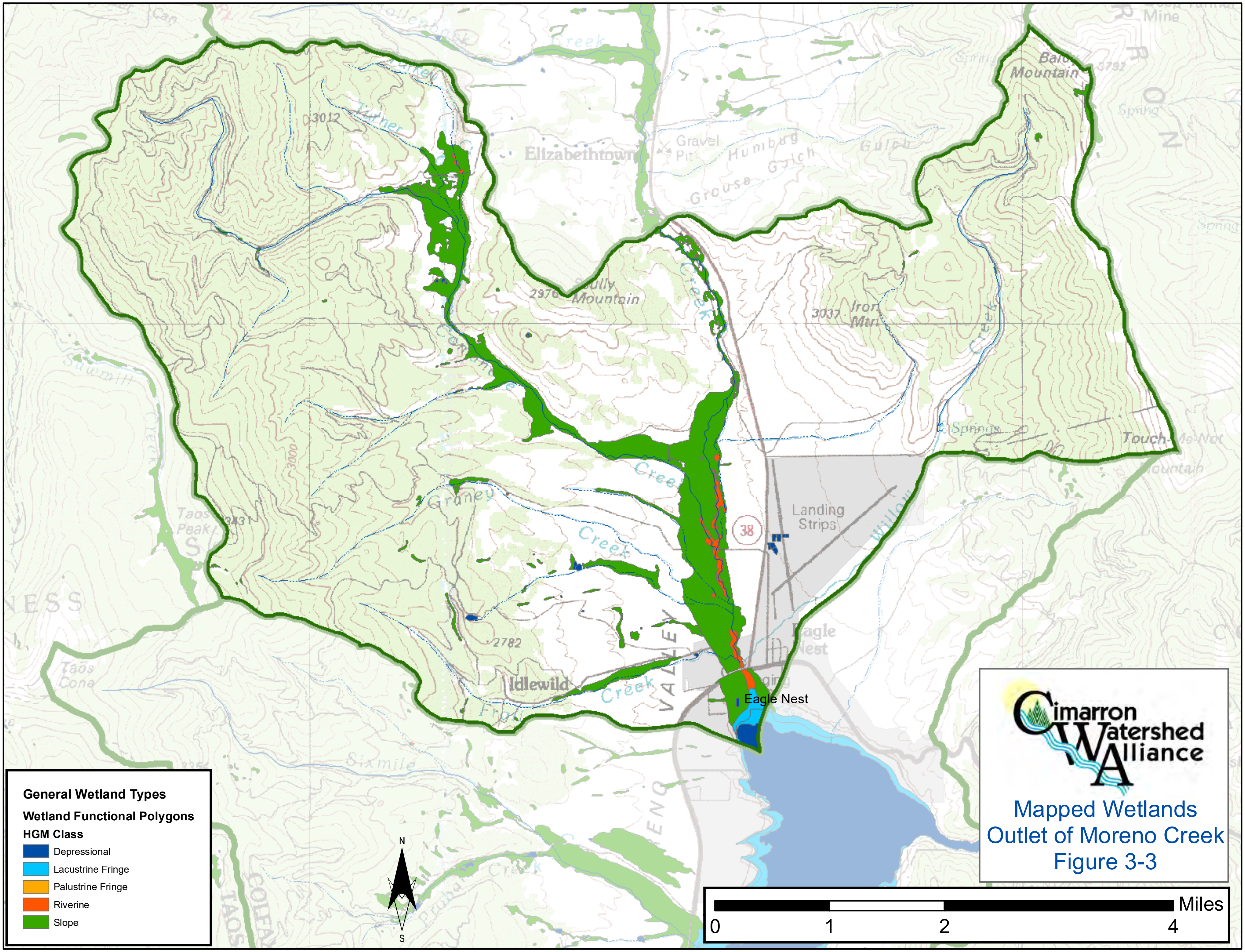
An overview of the mapped wetlands using the HGM classification system is shown in Figure 3-1. More detailed maps of the 5 subwatersheds in the Northern (Moreno Headwaters and Moreno Outlet Subwatersheds), Central (Eagle Nest Lake Subwatershed), and Southern areas (Cieneguilla Outlet and Cieneguilla Headwaters Subwatersheds) of Moreno Valley are shown in Figures 3-2 through 3-6.

--Palustrine fringe on perimeter of pond

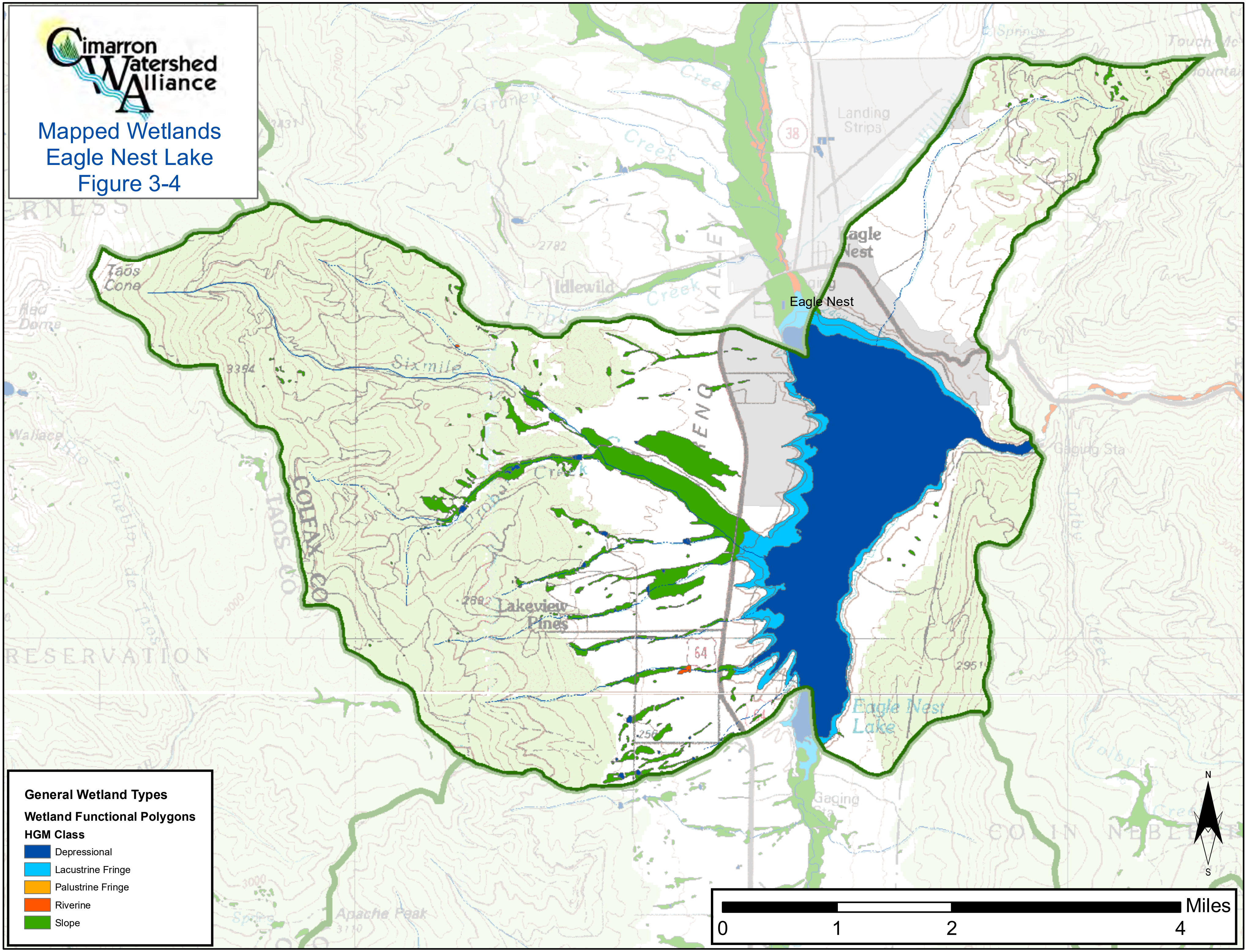
A total of 8,288 acres of wetlands were mapped in the Moreno Valley. Figure 3-7 shows the number of acreage and relative percentages of HGM classes of wetlands. The majority of the wetlands in the Moreno Valley are slope wetlands (5,541 acres- 67%) that occur on hillsides or on the valley floor. Depressional wetlands (2,139 acres- 26%) include Eagle Nest Lake and Black Lake and numerous small ponds located throughout the watershed. Lacustrine fringe wetlands (479 acres- 6%) are on the perimeters of Eagle Nest Lake and Black Lake. Riverine wetlands (71 acres- 1%) occur sparsely along Cieneguilla and Moreno Creeks and other small tributaries. Palustrine wetlands (1 acre- <1%) occur around the small ponds.

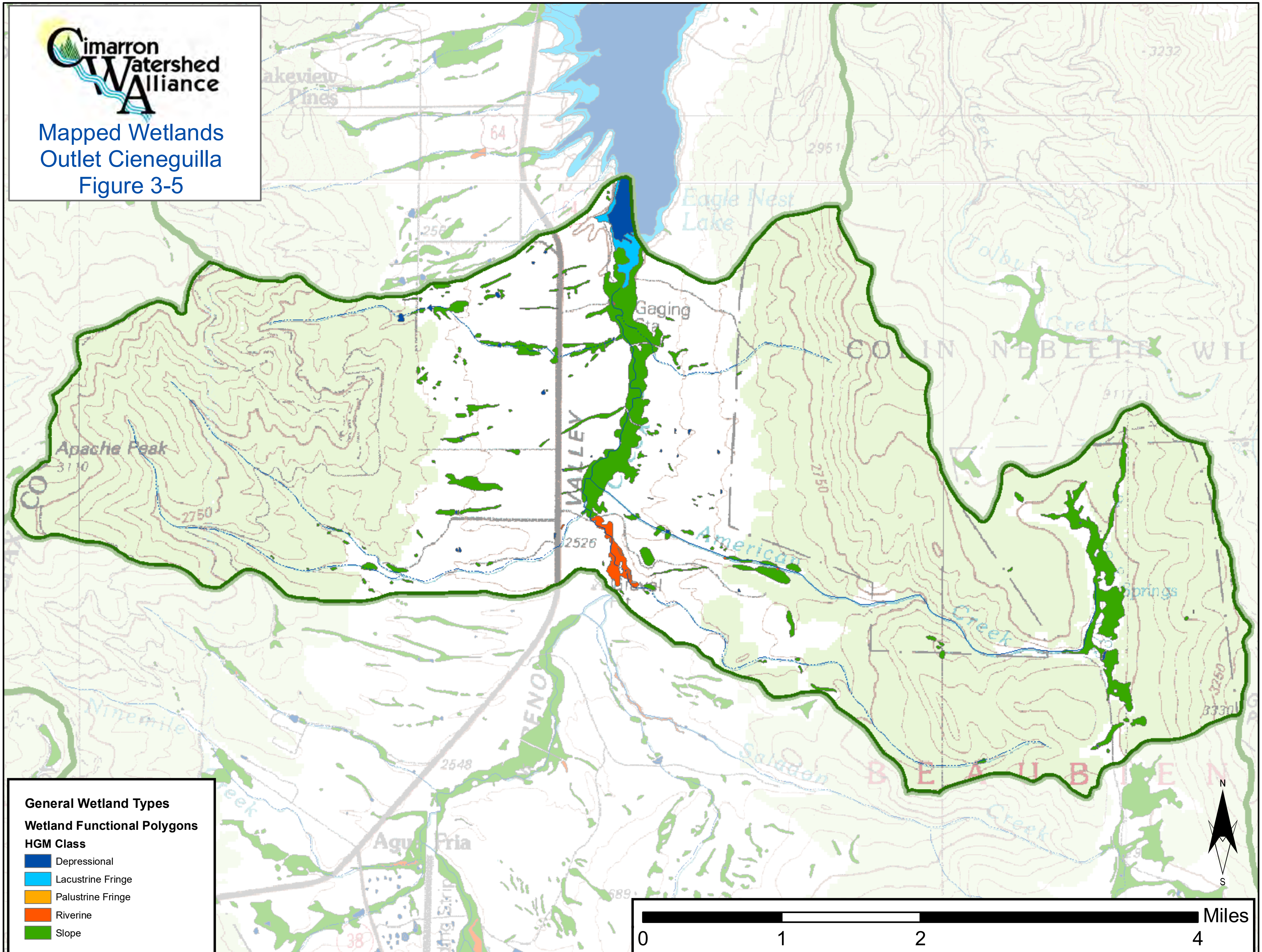

Cimarron Watershed Alliance
Mapped Wetlands
Overview
Figure 3-1
Red River
Taos Ski Valley
Eagle Nest
Ute Park
Angel Fire
FOREST
TAOS PUEBLO
INDIAN RESERVATION
General Wetland Types
Wetland Functional Polygons
HGM Class
Depressional
Lacustrine Fringe
Palustrine Fringe
Riverine
Slope
N
S
0
2
4
8
Miles

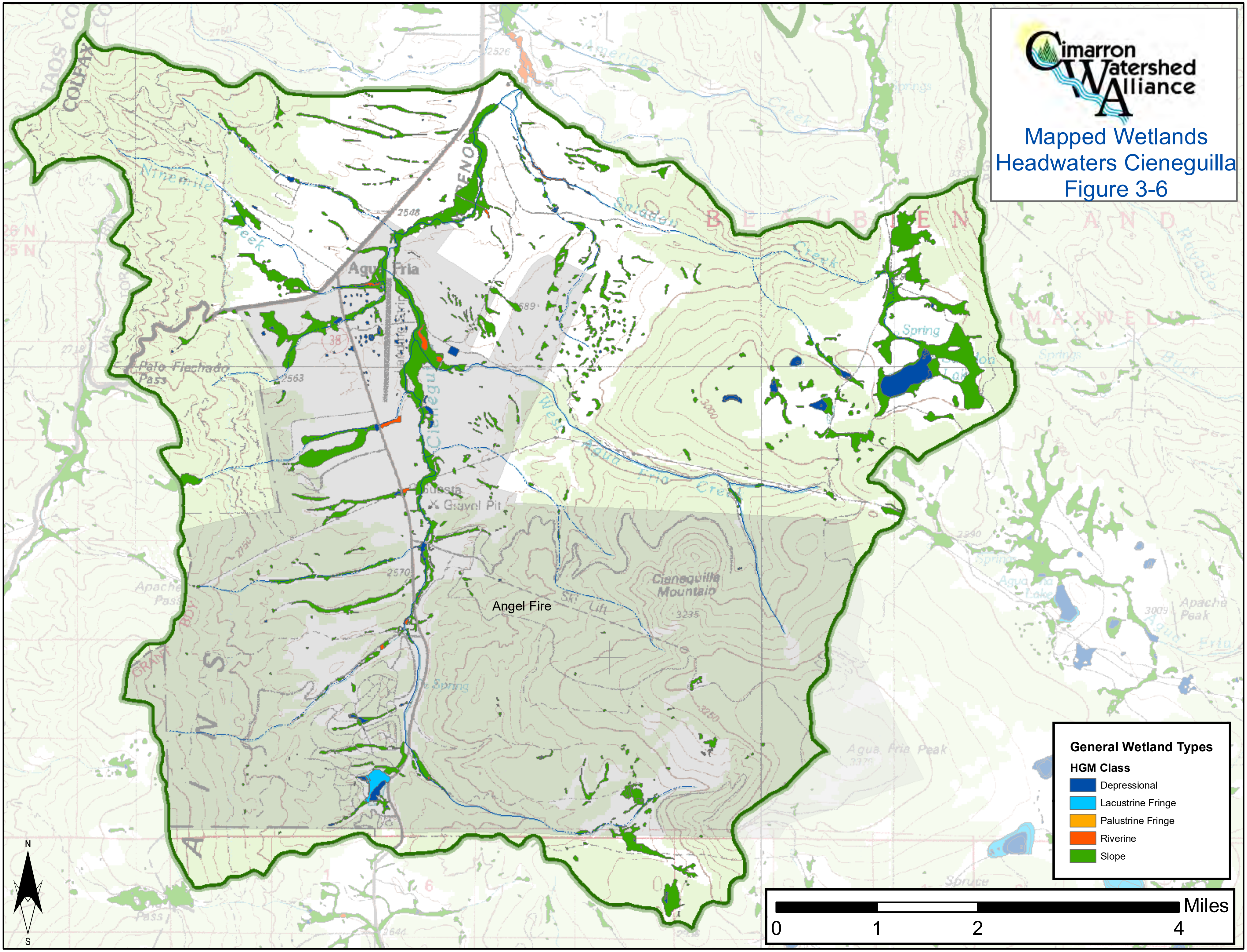

Cimarron Watershed Alliance
Mapped Wetlands
Headwaters of Moreno Creek
Figure 3-2
Van Diest Peak
Costilla Pass
Black Mountain 3167
Bobcat Creek
Creek
North Moreno Cr
3024
3000
Mill Creek
Mill Gulch
Spring Gulch
2750
Mills Divide
Hollenbeck Creek
Copper Can
3306
BOUNDARY
Elizabethtown
Gravel Pit
Humbug Gulch
Grouse Gulch
3012
Scully Mountain
2976
3037
Iron Mtn
General Wetland Types
Wetland Functional Polygons
HGM Class
Depressional
Lacustrine Fringe
Palustrine Fringe
Riverine
Slope
N
S
Miles
0
1
2
4



Mapped Wetlands
Outlet of Moreno Creek
Figure 3-3


Cimarron Watershed Alliance
Mapped Wetlands
Eagle Nest Lake
Figure 3-4
Eagle Nest
Taos Cone
Red Dome
Sixmile
Idlewild
Lakeview Pines
Landing Strips
Eagle Nest Lake
Gaging Sta
COLFAX CO
TAOS CO
RESERVATION
Apache Peak
General Wetland Types
Wetland Functional Polygons
HGM Class
Depressional
Lacustrine Fringe
Palustrine Fringe
Riverine
Slope
N
S
0
1
2
4
Miles


Cimarron Watershed Alliance
Mapped Wetlands
Outlet Cieneguilla
Figure 3-5
General Wetland Types
Wetland Functional Polygons
HGM Class
Depressional
Lacustrine Fringe
Palustrine Fringe
Riverine
Slope
Miles
0
1
2
4
N
S
Eagle Nest Lake
Gaging Sta
Apache Peak
3110
2750
2526
2548
American Creek
Springs
Lakeview Pines
64
38
Agua Fria
VALLEY
2951
3232
3250
3330


Cimarron Watershed Alliance
Mapped Wetlands
Headwaters Cieneguilla
Figure 3-6
General Wetland Types
HGM Class
Depressional
Lacustrine Fringe
Palustrine Fringe
Riverine
Slope
Miles
0
1
2
4
N
S
Angel Fire
Agua Fria
Cieneguilla Mountain
Palo Flechado Pass
Gravel Pit
Spring
Agua Fria Peak
Apache Peak
COLFAX
TAOS

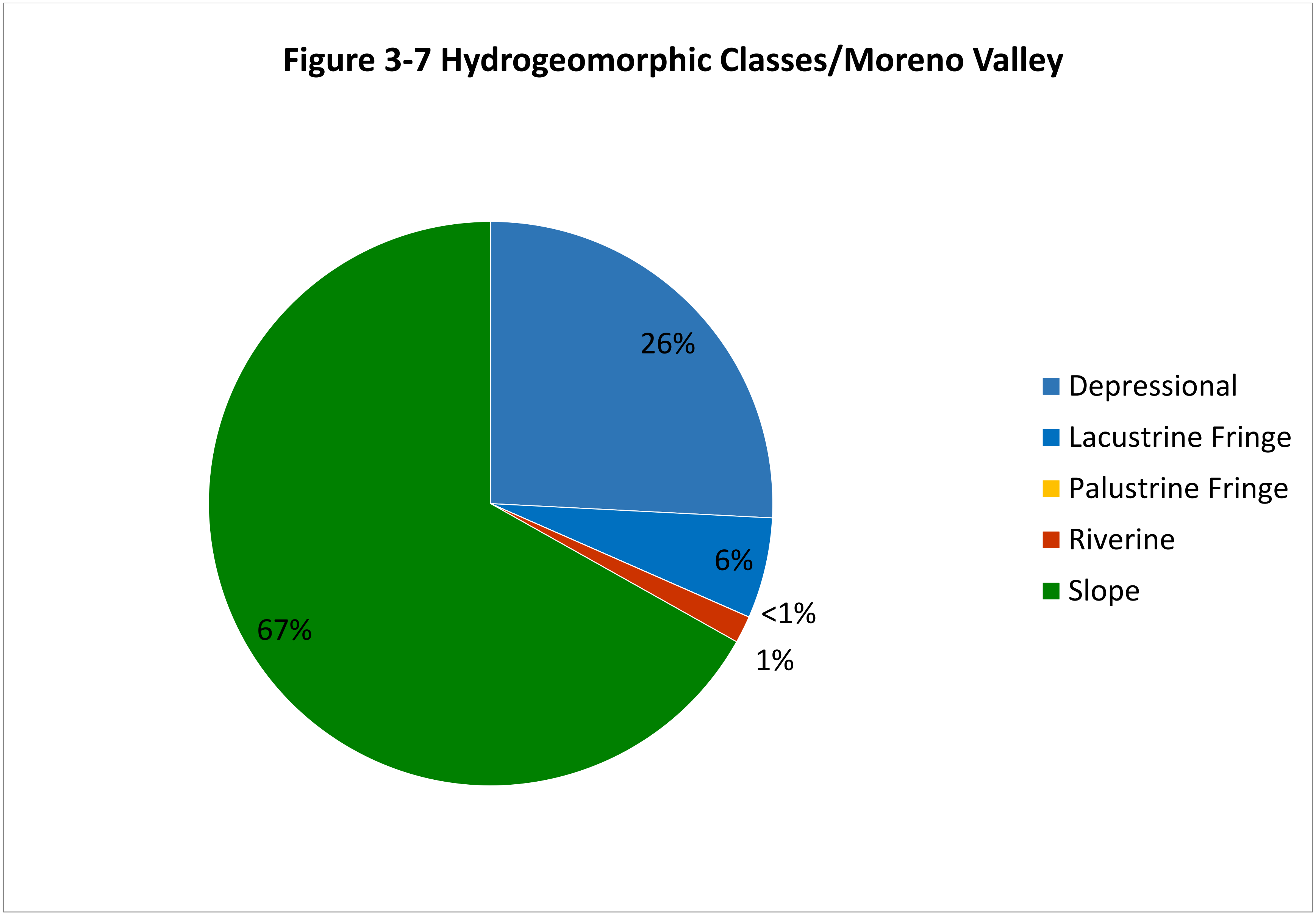


Figure 3-7 Hydrogeomorphic Classes/Moreno Valley
26%
6%
<1%
1%
67%
Depressional
Lacustrine Fringe
Palustrine Fringe
Riverine
Slope

3-2. Wetland Functional Assessment

A wetland functional assessment was completed as part of the St. Mary's mapping program. Wetland functions that were assessed within the project study areas include the following items (Robertson et al., 2015):

- Aquatic Invertebrate Habitat (AIH) – provides habitat for aquatic invertebrates
- Bank and Shoreline Stabilization (BSS) – wetland plants help bind soil to limit or prevent erosion
- Carbon Sequestration (CS) – serves as carbon sinks that trap atmospheric carbon
- Fish Habitat (FH) – habitat for a variety of fish, including a special category containing factors that maintain cold water temperatures for certain species, including trout
- Groundwater Recharge (GR) – sustaining sub-surface water storage and supporting baseflows
- Nutrient Transformation (NT) – breaking down nutrients from natural sources, fertilizers, or other pollutants, essentially treating the runoff
- Other Wildlife Habitat (OWH) – habitat for other wildlife (resident and migratory)
- Sediment and Other Particulate Retention (SR) – acting as filters to physically trap sediment particles before they are carried further downstream
- Streamflow Maintenance (SM) – providing a source of water to prevent streams from drying up during periods of drought conditions or low discharge
- Surface Water Detention (SWD) – storage of runoff from rain events or spring melt waters which reduce the force of peak flood levels downstream
- Unique, Uncommon, or Highly Diverse Wetland Plant Communities
- Waterfowl and Water Bird Habitat (WBIRD) – habitat for waterfowl and other water birds.

Results from the wetland functional assessment indicated that Groundwater Recharge, Waterfowl and Water Bird Habitat, and Other Wildlife Habitat were the most commonly occurring wetland functions in the project area, and these functions were performed by most wetlands. The least common function performed was the Unique, Uncommon, or Highly Diverse Wetland Plant Communities Function.

3-3. Information Gaps

The primary data gap related to the Moreno Valley wetlands is the current lack of detailed field assessments. Previous wetlands mapping included sufficient field checking to verify that the digital mapping correctly reflected current wetland types and locations, but did not include a detailed field assessment of wetland conditions. Information that might be useful to better assess and understand wetland conditions includes:

- An aerial review of each wetland, using available aerial photography to zoom in closely enough to view roads, culverts, or other areas and identify problematic issues.
- An overhead flight with sufficient equipment to view and photograph key wetlands.
- Surface ground surveys to observe and evaluate wetlands conditions, including plant surveys, hydrological surveys, and the assessment of wetland threats.

Additionally, it would be helpful to extend more efforts toward outreach to stakeholders, alliances, and various landowners to stimulate and encourage interest in participating with the protection and restoration of wetlands in the Moreno Valley. These efforts would provide all interested parties with valuable information regarding additional wetlands projects and plans. As discussed in Section 5, some local landowners participated in wetland planning; however, additional outreach and further discussion will be needed to conduct more wetland restoration projects.

4. Wetland Impairment and Actions to Protect and Restore Wetlands

A first step in planning for appropriate wetland protection and restoration measures is to identify land use and other practices that may affect wetland conditions. General conditions that can lead to degraded wetland conditions, along with potential treatment options, were summarized in the 2014 NMED slope wetlands characterization and restoration publication shown in Table 4-1.

Table 4-1. Harmful Conditions and Treatment Options*

Harmful Condition or Situation	Degraded Condition	Treatment Options
Roads, foot paths, ATV trails, wagon trails and livestock trails currently in use	• Captured water • Channelized flow • Headcutting • Gully formation • Bisected shallow aquifers • Lowers water table both upslope and downslope • Compacted soils • Increased sediment transport	• Porous fill for road crossings • Hardened road crossings or waterways • Proper drainage • Barricades • Relocation/realignment of roads • Drift fence
Abandoned roads	• Drying of wetland area (depending upon placement)	• Reconnection of wetland to water source
Road ditches: lead-in, lead- out, barrow	• Channelized flow accelerating bed and bank erosion	• Reduction of spacing intervals • Drainage
Culverts/pipes	• Headcutting • Drying of wetland below due to blocked culvert	• Appropriately sized and placed elevated culverts (minimum of 18 inches diameter) • Porous fills and low water crossings
Berms	• Drying of wetland area (depending upon placement)	• Reconnection of wetland to water source

Harmful Condition or Situation	Degraded Condition	Treatment Options
Stock tanks	• Loss of flow down meadow • Channelization	• Lowered berm • Redesigned/relocated spillway • Remove tank, develop upland water sources • Relocate tank out of wetland
Poorly managed livestock grazing and supplement block placement	• Hoof-sheer • Compaction • Loss of vegetation and root structure • Reduced water infiltration • Drying of fens • Bed and bank erosion • Reduced soil water storage/lower water table	• Managed timing, intensity and duration of grazing • Supplement blocks moved to uplands, away from wetland soils • Development of upland water sources
Poor upland range health	• Sediment loading • Channelized flow	• Managed timing, intensity and duration of grazing • Uplands rested for one entire growing season on a rotational basis (or longer in the event of drought conditions)

* (NMED, 2014)

Common activities in the Moreno Valley with the potential to impact wetlands, and actions to minimize those impacts, are discussed below.

Roads. Roads are not harmful to wetlands in all cases; however, poorly constructed or unpaved roads may affect drainage and sedimentation. There are numerous unpaved roads throughout the Moreno Valley that traverse the slope wetlands and cause fragmentation and dewatering of the wetlands due to the interruption of subsurface flow. In 2009, Rangeland Hands conducted a field survey of the Taos Pines subdivision west of Angel Fire to assess conditions and develop cost estimates for road improvements that would mitigate erosion and sedimentation. This assessment indicated that road conditions were extremely poor due to the clay-base soil type, poor original design, a road width that is wider than necessary, poor maintenance and management practices, plugged culverts, and system overloading from driveway runoff and steep grades (Rangeland Hands, 2009).

--Moreno Valley road

In addition, this road system is hydraulically connected in numerous locations via wheel tracks, ruts, and improperly maintained road ditches, culverts, and driveways as well as old roads. In these locations, water is trapped on the road surface for hundreds of consecutive feet. Similar road drainage issues may be affecting wetlands elsewhere in the Moreno Valley.

--Slope wetlands dried below road

--Poorly placed culverts can accelerate erosion

There are a number of simple techniques that can be used to minimize the impacts of roads. Poorly designed roads may be restored through realignment, porous fill for road crossing, proper drainage, and other methods (NMED et al., 2014; Zeedyk, 2006).

--*Presence of shrubby cinquefoil is an indicator of slope wetlands drying below road and culvert*

--*Slope wetlands dewatered from extensive headcuts*

Grazing. Large Elk herds and other wildlife may impact wetlands by disturbing soil and overgrazing in riparian areas. Wetlands may also be affected by livestock grazing. Overgrazing reduces wetlands vegetation and initiates or exacerbates erosion.

--*Elk and cattle in slope wetland along Cieneguilla Creek*

Grazing exclosures may be used to prevent access to important areas for protection. Elk exclosures have been installed on the south side of Eagle Nest Lake. Livestock best management practices, such as rotation and alternate water sources, can be used by ranches in the area to minimize impacts to wetlands. Education and financial assistance may help local ranches to implement grazing best management practices.

-- *Elk exclosure near Eagle Nest Lake*

--*Bank erosion along Cieneguilla Creek*

Potential Wildfire and Sedimentation. Wildfire has the potential to impact the Moreno Valley. Fuel reduction by private landowners and local governments can help reduce the risk of catastrophic wildfires, which could cause additional water quality impairment, particularly turbidity, sedimentation, and temperature. Fuel reduction projects are protective of long-term water quality and wetland resources in the Moreno Valley.

Diversion Ditches and Earthen Stock Tanks. Diversion ditches that move water away from the head of slope wetlands to water other areas can cause drying of the wetlands downgradient. Earthen stock tanks excavated into slope wetlands capture and impound the water. Although some of the water infiltrates the earthen dam, the water downstream is reduced, resulting in drying of the wetland. In some cases, there may be historic diversion ditches and stock tanks that are no longer needed and can be de-commissioned in order to restore slope wetlands.

--*Stock pond built on slope wetlands*

Poorly designed roads or drainage, poorly managed grazing, diversion ditches, and/or stock tanks, wildfires or other upland land disturbances, or any combination of these impairments can lead to headcuts, channelized flow (disconnection from the floodplain), and sediment loading. Restoration measures may include in-channel measures, such as post vanes, baffles, one rock dams, media lunas, willow planting or other measures to improve bank stability, slow and redistribute flows, and reconnect channels with floodplains to prevent erosion and sedimentation in wetland areas (Zeedyk and Clothier, 2009).

--*Riverine wetlands on incised Cieneguilla Creek*

Additionally, upland land management such as grazing rotation and managed intensity, relocating stock tanks and alternative water sources, redirecting drainage from abandoned roads or ditches, and addressing road crossing can help to reduce erosion and sedimentation reaching the stream channel and can support wetland restoration (NMED et al., 2014).

--Post vanes to mitigate bank cutting along Cieneguilla Creek

Other issues in the Moreno Valley include:

Domestic Wastewater. Both the Village of Angel Fire and the Village of Eagle Nest treat their domestic wastewater. Angel Fire discharges their domestic wastewater near Cieneguilla Creek, which flows into Eagle Nest Lake about ten miles north of the wastewater facility. There are two inactive sewage lagoons southwest of the Village of Eagle Nest that are in need of remediation. There are also many homes scattered throughout the Moreno Valley that rely on septic tanks. Continued monitoring to ensure compliance with water quality standards will help to protect wetlands in the Moreno Valley.

--Angel Fire Airport constructed in Cieneguilla Creek riverine wetland

Development. As new homes and commercial enterprises are developed in the Moreno Valley, recognizing locations of wetlands and protection measures for those wetlands is important. For example, the Angel Fire airport was constructed in a wetland. Ensuring proper location of developments, as well as proper septic tank installation and maintenance, will protect shallow groundwater quality.

Mining. There are small legacy hardrock mining operations in the upper watershed that may be contributing to elevated arsenic levels in Eagle Nest Lake (NMED, 2012). The Town of Elizabeth, which no longer exists, once had as many as 7,000 residents involved in gold mining near Baldy Mountain on the north side of the Moreno Valley.

Beaver Habitat. Beavers were present historically in the Moreno Valley and beaver trapping was an historic economic activity. Efforts to re-establish beaver populations and habitat can help to slow stream flow and support wetland resources.

Monitoring and Tracking. A long-term objective of this WAP is to acquire funding for wetland monitoring and tracking. Potential partnerships with New Mexico University professors and graduate students may be beneficial to provide and support ongoing wetland research in the Moreno Valley.

Specific issues that have the potential to cause impairment, as well as actions to protect and restore Moreno Valley wetlands are shown in Table 4-2. Potential funding sources for wetlands restoration actions are shown in Table 4-3.

Table 4-1 Moreno Valley Wetland Threats/Impairment and Actions

Threats/Impairment	Recommended Actions
Moreno Valley (Overall Area)	
Historic Impacts: • Abandoned irrigation ditches • Poorly constructed stock ponds or fishing ponds • Poorly designed/drained roads and/or roads crossing wetlands • Beaver trapping • Overgrazing • Mining • Timber Harvest Current Impacts: • Low density housing development • Poorly designed/drained roads and/or roads crossing wetlands • Septic Systems • Utility Corridors • Overgrown forests • Potential for catastrophic wildfire • Lack of grazing management in some areas • Elk grazing • Irrigation • Loss of beaver habitat • Some systems in degrading state due to historic impacts (drying wetlands and meadows)	Road Improvements: Work with Colfax County and NM Department of Transportation (NMDOT) on road planning possibilities to relocate roads to reduce impacts, proper culvert placement and design and/or porous fills for roads where they cross wetlands. Grazing management – Potential projects might include: establishing off channel water sources, installing riparian fences to facilitate grazing management, and/or hosting short courses about grazing management for livestock producers in the Moreno Valley. Beaver re-introduction – Assistance for landowners who are interested in beaver re-introduction and supportive of efforts to revisit the NMGFD "Beaver Rule" which would enable land owners more flexibility for beaver re-introduction, thereby reducing landowner commitment from five miles to one or two miles. Forest thinning – There are potential projects for thinning throughout the Moreno Valley. Potential projects should focus on forest health to open the canopy, thereby reducing the threat from catastrophic wildland fires and improving the base flow of a healthier forest ecosystem which in turn would support wetlands. Identification of Wetlands at Risk – Seek funding for an evaluation of existing wetlands using GIS and remote sensing. This project would entail using the wetlands data collected by NMED/St. Mary's University as a starting point; reviewing the identified wetlands and any potential threats; and then ranking areas of concern. Outreach to landowners where there are extensive wetlands along Comanche Creek, Moreno Creek, and Frolic Creek just north of the Village of Eagle Nest to explore restoration options. A long-term objective of this WAP is to acquire funding for wetland monitoring and tracking. Potential partnerships with New Mexico University professors and graduate students may be beneficial to provide and support ongoing wetland research in the Moreno Valley.

Northern Sub-area	
Historic Impacts: • Mining • The Big Ditch – a large diversion ditch constructed for hydraulic mining, circa 1900. • Timber Harvest • Water quality impacts from gold mining around Elizabeth Town and Baldy Mountain, e.g. Deep Tunnel Current Impacts: • See area wide list of current impacts	Dirt stock tanks – There is an opportunity for improving existing on-channel dirt stock tanks to reduce their impacts on riverine and slope wetlands, specifically: upgrades to spill ways that would reduce concentrated flow and potential erosion; lower berm / dam heights; utilize spreader ditches for tank outflows to distribute flow across existing wetlands; and assure that inflows to dirt stock tanks are not causing head-cuts. Field assessment - Conduct more detailed field biologic assessment water quality sampling to better determine if historic mining activity is affecting wetlands. Detailed assessment of impairment -Review aerial photographs followed by field checks to determine if historic diversions are leading to channelized flow and headcutting at specific locations.
Central Sub-area	
Historic Impacts: • Timber Harvest Current Impacts: • Watershed and ecosystem health are primary issues for Taos Pueblo Land in the central subarea • The Village of Eagle Nest has two inactive sewage lagoons on State Park property just south of the Hwy 64 and Hwy 38 intersection. • To the east and south of Lakeview Pines subdivision, numerous wetlands are located along streams that run west to east down towards the southern end of Eagle Nest Lake. Nearly all these wetlands are intersected by private, county, state, and federal roads.	Taos Pueblo representatives expressed interest in wetland restoration on their lands, particularly in the Probar Creek and Six Mile and watersheds where there are numerous wetlands. The Village of Eagle Nest would support an effort to seek funding for reclamation of inactive sewage lagoons near the Village, including design of restoration efforts to maximize benefits to wetlands. The Village of Eagle Nest is also open to improving the wetlands that are shown near their current sewage lagoons north of the village near the landing strip, if funding and support would be available. Explore restoration options of wetlands to the east and south of Lakeview Pines subdivision through field assessment and outreach to landowners.

Southern Sub-area	

<u>Girl Scout Camp</u>
1. Meadow is drying out. Why?
    a. Blue flowers typically bloom in this meadow, but they are no longer blooming.
2. Stock pond is largely full of silt
    a. Six years ago was approximately 6ft deep. Now it is approximately 2ft deep. The levee is still present.
<u>Other areas</u>
 	
Issues include stock pond management, fen management, grazing management, and development in the Angel Fire area.
	Apply for a Wildland Urban Interface (WUI grant) for forest thinning uphill from the meadow on the Girl Scout property.
	
	Apply for a grant to use "Water For Wildlife" techniques to restore stock tanks to dual purpose wetland and stock water functions.
	
	Would like to cross-fence the Girl Scout Camp meadow for grazing rotation (possible Farm Bill funding source); this would serve as privacy for participants as well as allow grazing in multiple meadows to maintain the health of each area.
	
	Since the causes for some issues at the Girl Scout Camp are unknown, a local field wetland assessment would be helpful to determine root causes uphill of the affected areas. The land uphill of the camp belongs to the Forest Service; therefore, a number of activities occur in that area. Whatever measures are taken, the camp would like to include the participants as much as possible, because they value the educational component and would like to see that knowledge utilized as much as possible.
	
	Other potential restoration actions in the southern sub-area include:
	
	• Restoring slope wetlands that increase base flow to American Creek and Six Mile Creek and thus to Cieneguilla Creek would contribute to the spawning of trout in the deltas of Eagle Nest Lake.
	• Implementing porous roadfill at slope wetland crossings along the Lake View Pines Rd.
	• American Creek headwaters (CS Ranch): road improvements, culverts too low, possibilities for beaver reintroduction, close out some stock ponds.
	• Flying Horse Ranch may be interested in beaver reintroduction also.
	• Angel Fire Ski Area and Halo Homeowners Association are stakeholders along W. Aqua Fria Creek.
	• Work along Cieneguilla Creek: address steep banks, plant woody vegetation in some areas, instream structures to aggrade creek to increase base flow.
	• Village of Angel Fire (and resort) stormwater management because Cieneguilla Creek gets very muddy every time it rains.
	• Generally, treating the slope wetlands would have more impact to reduce temperature in Cieneguilla Creek than shading the mainstem with woody vegetation.

Table 4-3. Potential Funding Sources for Wetland Restoration

Source	Agency	Grant
Federal	Environmental Protection Agency	Clean Water Act Section 319 Watershed Restoration Grants
		5 Star Restoration Challenge Grant Program
		Environmental Education Grants
	Natural Resource Conservation Service	Environmental Quality Incentive Program (private lands cost-matching)
		Wildlife Habitat Incentive Program
		Wetland Reserve Program
	U.S. Fish and Wildlife Service	North American Wetland Conservation Act
		Fish Passage
	U.S. Forest Service	Collaborative Forest Restoration Program
		Collaborative Forest Landscape Restoration Program
State	State of New Mexico	River Stewardship Program
	NM Game and Fish Department	Potential matching monies for other grants
	New Mexico Community Foundation	NM River Conservation & Restoration Fund
	New Mexico State Forestry	New Mexico Forestry Division Watershed Restoration Project
	New Mexico Water Trust Board Grants	Grants can be used for watershed restoration
County	Colfax Soil and Water Conservation District	
	Patagonia 1% for the Planet Grant and World Trout Initiative	
	Western Native Trout Initiative	
	Orvis Conservation Grant Program	
	National Fish and Wildlife Foundation	
	Trout Unlimited	
	Wildlife Conservation Society	
	Mitigation Funds	
	Private Donors	
	Volunteer Labor	

5. Local, Public Involvement Strategy

This wetlands action plan relies on the voluntary actions of willing landowners to protect and restore the wetlands. The NMED SWQB Wetlands Protection Program does not rely on any mandatory regulatory measures for wetland protection. Consequently, the participation of landowners and land managers is a critical component to complete and implement an effective WAP.

The Cimarron Watershed Alliance has been actively involved in watershed restoration projects along Cieneguilla Creek in the Moreno Valley (WBP, 2012). Moreno Valley residents have also been members of the CWA Board. Through these prior efforts, this group was familiar with many landowners and land managers in the Moreno Valley, and invited them and others to participate in the effort.

Four meetings were held in the Moreno Valley during the course of this planning effort. Cimarron Watershed Alliance members, as well as those who expressed interest in the planning effort, were notified of the meetings via the CWA email list. Additionally, the CWA members called local landowners to invite them to meetings; flyers with meeting announcements were also posted in public locations for the third and fourth meetings. These meeting dates and content included:

- August 26, 2015. A general overview of the WAP guidelines and objectives was provided. The remainder of the meeting focused on identifying individuals, agencies, and organizations that would have an interest in wetland planning and inviting them to participate in the effort.

- September 23, 2015. Since a larger group was in attendance, an overview of the WAP guidelines and objectives was again presented. Karen Menetrey of the NMED Surface Water Quality Bureau presented an overview of wetlands mapping and classifications in the Moreno Valley.

- March 2, 2016. Mollie Walton of the Quivira Coalition provided a presentation on wetland restoration in the Comanche Creek watershed. Participants broke into subgroups to discuss issues and potential projects related to lands that they either own and/or manage.

- May 3, 2016. Local landowners and managers continued to discuss plans for wetlands protection and restoration.

Continued outreach efforts to involve the Moreno Valley residents will be a key component for the successful implementation of the WAP.

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